

EUROMECH

Colloquium 476

**Real-time Simulation and
Virtual Reality Applications of
Multibody Systems**

**FINAL PROGRAM
&
ABSTRACTS**



**March 13 – 16, 2006
University of La Coruña
Ferrol, Spain**

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An EUROMECH Colloquium

“Real-time Simulation and Virtual Reality Applications of Multibody Systems” belongs to the series of Colloquia promoted by the European Mechanics Society (EUROMECH).

Essential features of EUROMECH Colloquia are that they are specialized in content, small in size and informal in character. This type of scientific meeting has been found in practice to give good results and to meet a definite need.

For further information about EUROMECH visit: www.euromech.org

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Supporting Organizations

- European Mechanics Society (EUROMECH).
- University of La Coruña (UDC).
- Council of Ferrol.
- Regional Government of Galicia.
- Spanish Ministry of Science and Education (MEC).

Scope

Nowadays, the market demands more and more products within shorter timeframes, and the industry is forced to face this challenge. The virtual product development is a modern approach to overcome the time and money consuming hardware steps. To carry out such a strategy, simulation of mechanical systems appears as an essential tool, since it provides the means to anticipate the physical behavior of components and systems.

However, due to the intrinsic complexity of input and output data in this discipline, traditional user interfaces consisting of files and plots are being progressively substituted by virtual environments, authentic replica of their real counterparts. Real-time simulation plays a key role in such virtual reality applications, which not only require fast calculation of motion and deformation, but also interactive communication with input and output devices. Concepts like human-in-the-loop, hardware-in-the-loop, haptic interfaces, or augmented reality are just some ingredients of these new simulators which offer an increasing degree of immersion to the user.

Applications include assembling and disassembling of mechanical systems, control systems, ergonomics, aimed to improve the whole product cycle: design, analysis, testing, manufacturing, maintenance and recycling.

Topics

Computational methods for real-time performance and applications, which include:

- Modelling techniques: choice of coordinates, rigid and flexible bodies, model reduction, linearization.
- Equation formulations: global vs local, numerical vs symbolic, recursive.
- Consideration of dynamic phenomena like contact and impact.
- Numerical integrators for efficient and robust simulations.
- Implementation aspects: hardware architecture, compilers and libraries, parallelization.
- Simulators and virtual reality applications with human-in-the-loop, hardware-in-the-loop, haptic interfaces.

Venue

The Colloquium will be held at the Conference Hall of Campus de Esteiro (University of La Coruña), situated in the city center of Ferrol. The City map (page 4) shows the situation of Campus de Esteiro in the city. The Campus map (page 5) shows the situation of the main entrance, the conference hall, and the dining hall, where lunch will be provided to the participants during the days of the Colloquium.

Resources and equipment

An LCD projector and a computer running Microsoft Windows XP with Power Point 2003 and Adobe Acrobat Reader 7.0 installed, are available at the presentation room. Therefore, authors using these formats are recommended to bring their presentations in a CD or USB drive in order to avoid delays caused by laptop connection and start-up during the sessions.

Free wireless Internet access is available inside the Conference Hall.

In order to get access to the wireless network, an EAP-TTLS client software shall be installed in your laptop computer. This software can be downloaded at:

http://www.udc.es/udcwifi/sw/SecureW2_300.zip

Instructions to install and configure the EAP-TTLS client in your computer can be found in the following webpage: <http://www.udc.es/udcwifi/configuracion.htm>

Although not written in English, the webpage provides step-by-step screenshots of the process, which can be easily followed.

Assistance to configure the software, as well as the login and password needed to connect to the Internet, will be provided at the Colloquium front desk.

Social program

Reception at the Town Hall

On Monday 13, at 20.00, the participants will be welcome by the Mayor of the city at the Town Hall. Afterwards, drinks and snacks will be served.

Boat excursion

In the afternoon of Tuesday 14, a boat excursion has been planned so that the participants may enjoy the view of the city and its main landmarks from the estuary, while described by a tourist guide.

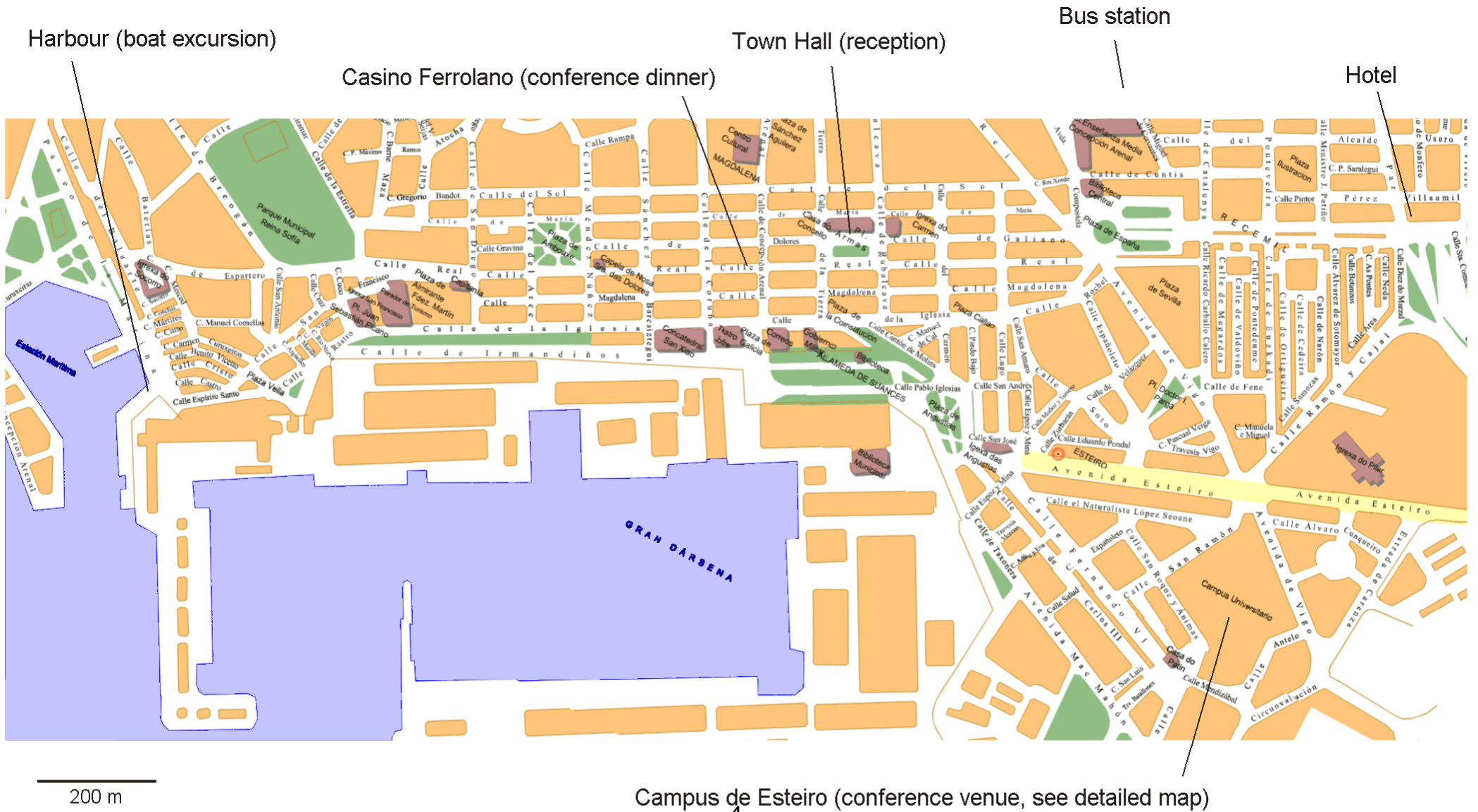
Colloquium dinner

The conference dinner will take place on Wednesday 15, at 20.30, at one of the most exclusive clubs of the city, the Casino Ferrolano, where the participants will enjoy the traditional local cuisine.

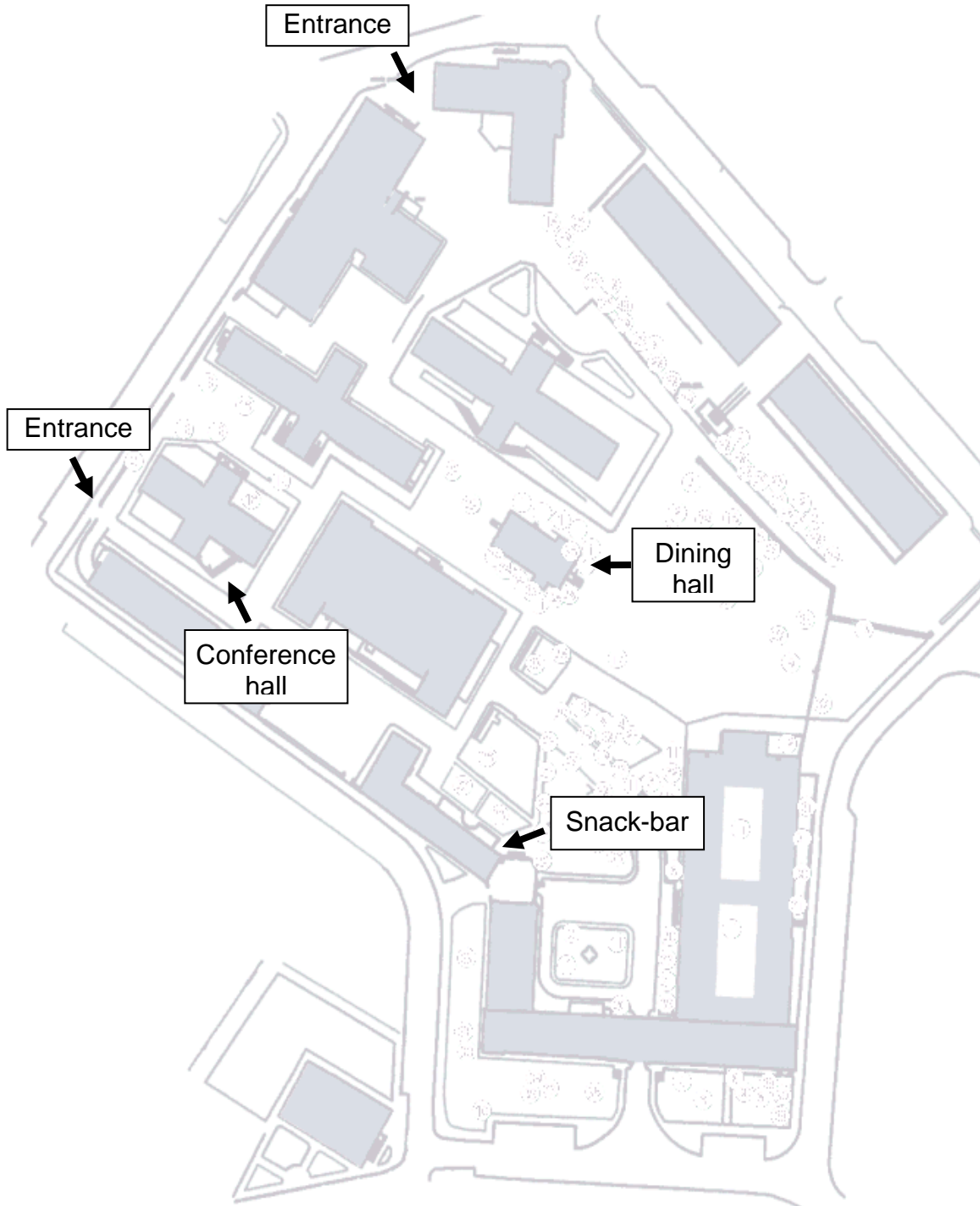
Tour in Santiago de Compostela

On Thursday 16, at 12.30, just after the closure of the Colloquium, those participants interested in visiting the historical city of Santiago de Compostela are invited to a guided tour leaving from the Conference Hall and returning to the Hotel Hesperia in Ferrol. The cathedral of this city, where the Apostle St. James is buried, has been and still is one of the three main Catholic pilgrimage destinations (along with Rome and Jerusalem) for many centuries.

City map



Campus de Esteiro map



Accommodation

In order to favor the interaction among the participants, accommodation at Hotel Hesperia Ferrol is recommended. The hotel is within walking distance (10 minutes) of *Campus de Esteiro*, where the Colloquium will take place (see City Map on page 4).

Hotel Hesperia Ferrol
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Phone: +34-981330226
Fax: +34-981330228
E-mail: hotel@hesperia-ferrol.com
Web: <http://www.hesperia-ferrol.com>

Transportation

Ferrol is placed in Galicia, on the northwestern corner of Spain. We recommend to arrive by air at the airport of either La Coruña (50 km to Ferrol) or Santiago de Compostela (100 km to Ferrol), and then travel to Ferrol by bus, taxi or a combination of both.

To get to Ferrol from the airport of either La Coruña or Santiago de Compostela, it is recommended to follow the next steps:

- 1- Take a taxi from the airport to the bus station of the corresponding city.
- 2- Take the bus to Ferrol.
- 3- Take a taxi from the bus station of Ferrol to Hotel Hesperia Ferrol (if you have got a lot of luggage, since it is only a 10-minutes walk, see City Map on page 4).

Timetables of buses are shown on the next page.

BUS TIMETABLES

La Coruña Airport → Ferrol

La Coruña Airport – La Coruña (bus station), operated by Asicasa

Mon – Fri	9:15	10:15	11:15	13:15	13:45	14:15	15:15	18:15	19:45	21:15
Sat		10:15	11:15	13:15			15:15	18:15		21:15
Sun				13:15				18:15	19:20	21:15

Journey duration: 25 minutes

Price: 0.95 EUR (one way)

La Coruña (bus station) – Ferrol (bus station), operated by Arriva

Mon – Fri	Every hour from 7:30 to 20:30									
Sat	10:30	11:30	12:30	15:30	16:30	19:30	20:30			
Sun		11:30	12:30	15:30	16:30	19:30	20:30	21:30		

Journey duration: 45 minutes

Price: 5.70 EUR (one way) / 10.30 EUR (round trip)

Santiago Airport → Ferrol

Santiago Airport – Santiago (bus station), operated by Freire

Mon – Fri	7:15	8:30	9:30	10:30	11:00	11:45	12:40	13:30	14:50	15:15	16:00	17:00	18:00	18:40	19:00	20:45	21:00	22:00	23:30
Sat	7:15	8:30		10:30			12:40	13:30			16:00		18:00	18:40	19:00	20:45		22:00	
Sun		8:30		10:30			12:40	13:30			16:00		18:00	18:40	19:00	20:45	21:00	22:00	23:30

Journey duration: 20 minutes

Price: 1.70 EUR (one way)

Santiago (bus station) – Ferrol (bus station), operated by Arriva

Monday - Friday	9:15	11:00	12:00	13:30	15:00	16:00	18:00	19:30	21:00	
Saturday	9:15	11:00		13:30		16:00	18:00		21:00	
Sunday	9:15			13:30			18:00	19:30	21:00	22:00

Journey duration: 70 minutes

Price: 8.00 EUR (one way) / 14.40 EUR (round trip)

Santiago (bus station) – Ferrol (bus station), operated by Castromil

Monday – Friday	9:00	11:00	12:00	13:30	16:00	16:30	18:00	19:30	21:00	
Saturday	9:00	11:00		13:30	16:00		18:00		21:00	
Sunday				13:30			18:00	19:30	21:00	22:00

Journey duration: 70 minutes

Price: 8.00 EUR (one way) / 15.20 EUR (round trip)

Scientific Program

The following sessions have been organized within the Colloquium:

- Applications.
- Control I.
- Control II.
- Efficient formulations I.
- Efficient formulations II.
- Efficient formulations III.
- Flexibility.
- Haptics and contact I.
- Haptics and contact II.
- Numerical methods I.
- Numerical methods II.
- Simulators.
- Virtual reality and multibody systems.

Moreover, the following three main lectures will be delivered:

<i>Topic</i>	<i>Lecturer</i>	<i>Institution</i>	<i>Country</i>
HIL simulation	A. Eichberger	INTEC GmbH	Germany
Virtual Reality	C. Cruz-Neira	Iowa State University	USA
Haptics	M. Bergamasco	Scuola Superiore Sant'Anna	Italy

On the next two pages, tables are provided showing the session schedule, as well as the chairmen and speakers distribution.

Pages 11 to 14 provide the detailed program.

The list of participants can be found on page 15.

SESSIONS

	Monday 13	Tuesday 14	Wednesday 15	Thursday 16
9.00 – 9.25	Check-in	Virtual Reality	Haptics	Control II
9.25 – 9.50	Opening	Main Lecture 2	Main Lecture 3	
9.50 – 10.15	Effic. form. I	VR & MBS	Hapt. & cont. I	
10.15 – 10.40				
10.40 – 11.10	Coffee break	Coffee break	Coffee break	Coffee break
11.10 – 11.35	Effic. form. II	Effic. form. III	Applications	Num. meth. II
11.35 – 12.00				Closure
12.00 – 12.25				Tour in Santiago
12.25 – 12.50				
12.50 – 14.00	Lunch	Lunch	Lunch	
14.00 – 14.25	HILS	Simulators	Flexibility	Tour in Santiago
14.25 – 14.50	Main Lecture 1			
14.50 – 15.15	Num. meth. I	Boat excursion	Coffee break	
15.15 – 15.40				
15.40 – 16.10	Coffee break		Hapt. & cont. II	
16.10 – 16.35	Control I		Spare time	
16.35 – 17.00				
17.00 – ...	Spare time	20.30 Colloquium dinner		
	20.00 Town Hall reception			

CHAIRMEN

	Monday 13	Tuesday 14	Wednesday 15	Thursday 16
9.00 – 12.50	Bottasso Cuadrado	Ambrosio Talaba	Eberhard Valasek	Arnold Schiehlen
12.50 – 14.00	Lunch	Lunch	Lunch	
14.00 – ...	Hiller Kovences	Kim	Blajer Rahnejat	

Total number of presentations: 3 main lectures + 37 contributed works = 40.

Time allocated for each main lecture: 40 min. (30 min. talk + 10 min. questions).

Time allocated for each contributed work: 25 min. (20 min. talk + 5 min. questions).

Check-in will be also opened at Hotel Hesperia Ferrol on Sunday evening, from 18.00 to 20.00, and at the front desk during the days of the Colloquium.

SPEAKERS

	Monday 13	Tuesday 14	Wednesday 15	Thursday 16
9.00 – 9.25	Check-in	Cruz-Neira	Bergamasco	Alvarez-Caldas
9.25 – 9.50	Opening	Main Lecture 2	Main Lecture 3	Hiller
9.50 – 10.15	Sousa	Eberhard	Matey	Kovecses
10.15 – 10.40	Valasek	Rouvinen	Talaba	Naya
10.40 – 11.10	Coffee break	Coffee break	Coffee break	Coffee break
11.10 – 11.35	Kim	Pankiewicz	Bascoul	Awrejcewicz
11.35 – 12.00	Lugris	Ros	Daunay	Biral
12.00 – 12.25	Naudet	Saha	Gaspar	Closure
12.25 – 12.50	Schaefer	Zahariev	Rahnejat	Tour in Santiago
12.50 – 14.00	Lunch	Lunch	Lunch	
14.00 – 14.25	Eichberger	Brazalez	Lehner	
14.25 – 14.50	Main Lecture 1	Iriarte	Lichtneckert	
14.50 – 15.15	Ambrosio	Shiiba	Terumichi	
15.15 – 15.40	Arnold	Boat excursion	Zavrel	
15.40 – 16.10	Coffee break		Coffee break	
16.10 – 16.35	Blajer		Le Garrec	
16.35 – 17.00	Bottasso		Park	
17.00 – ...	Spare time		Spare time	
	20.00 Town Hall reception		20.30 Colloquium dinner	

MONDAY 13

9.50 EFFICIENT FORMULATIONS I

Chairmen: *C. Bottasso, J. Cuadrado*

Generic Road Model for Crashworthiness

P. Verissimo, L. Sousa, J. Ambrosio*

Instituto Superior Tecnico, Lisbon, Portugal

Multibody Formalism for Real Time Application Using Natural Coordinates and Modified State Space

M. Valasek, Z. Sika, O. Vaculin*

Czech Technical University in Prague, Czech Republic

11.10 EFFICIENT FORMULATIONS II

Chairmen: *C. Bottasso, J. Cuadrado*

Subsystem Synthesis method with Approximate Function Approach for a Real-time Multibody Vehicle Model

S.-S. Kim, C.-H. Lee, W.-H. Chung, S.-H. Lee*

Chungnam National University, Daejeon, Korea

Efficiency of a Semi-Recursive Penalty Formulation when Applied to Flexible Multibody Systems

U. Lugris, J. Cuadrado, D. Dopico, F. Gonzalez*

University of La Coruña, Ferrol, Spain

On the Use of Canonical Momenta for Real-Time Simulations

J. Naudet, D. Lefeber*

Vrije Universiteit Brussel, Brussels, Belgium

Time-Efficient Algorithm for Computation of Free-Flying Redundant Space Robot Dynamics

B. Schäfer, B. Rebele, R. Krenn*

German Aerospace Center (DLR), Wessling, Germany

14.00 HIL SIMULATION (Main Lecture 1)

Chairmen: *M. Hiller, J. Kovecses*

Hardware-in-the-Loop Simulation of Multi-body Models

*A. Eichberger**

INTEC GmbH, Wessling, Germany

14.50 NUMERICAL METHODS I

Chairmen: *M. Hiller, J. Kovecses*

Optimization of a Satellite with Composite Materials

J. Ambrosio, M.A. Neto, R. Leal*

Instituto Superior Tecnico, Lisbon, Portugal

Time Integration in Real-Time: The DAE Case

M. Arnold, B. Burgermeister*

Martin-Luther University Halle-Wittenberg, Halle (Saale), Germany

16.10 CONTROL I

Chairmen: *M. Hiller, J. Kovecses*

Load Trajectory Modelling and Control Synthesis of Gantry Cranes in Cluttered Work Environment

W. Blajer, K. Kołodziejczyk*

Technical University of Radom, Poland

Neural Adaptive Control of Multibody Systems

C.L. Bottasso, A. Croce, R. Nicastrò, L. Riviello, B. Savini*

Politecnico di Milano, Italy

TUESDAY 14

9.00 **VIRTUAL REALITY** (Main Lecture 2)

Chairmen: *J. Ambrosio, D. Talaba*

Virtual Reality as an Enabling Technology

*C. Cruz-Neira**

Iowa State University, Ames, Iowa, USA

9.50 **VIRTUAL REALITY AND MULTIBODY SYSTEMS**

Chairmen: *J. Ambrosio, D. Talaba*

Virtual Reality Simulation of Multibody Systems

P. Eberhard, Z. Li*

Institute of Engineering and Computational Mechanics, Stuttgart, Germany

Development of a Real-Time Simulation Environment

A.J. Rouvinen, P.M. Korkealaakso, J.K. Peusaari, S.M. Moisio, T.J. Eskola*

Lappeenranta University of Technology, Finland

11.10 **EFFICIENT FORMULATIONS III**

Chairmen: *J. Ambrosio, D. Talaba*

MBS Template For Hardware-in-the Loop Application in Vehicle Dynamics

E. Pankiewicz, W. Rulka*

BMW, Munich, Germany

A Symbolic Algorithm in Real Time Simulation of Multi-Body Systems

J. Ros, J. Gil, X. Iriarte*

Public University of Navarre, Pamplona, Spain

Efficient Jacobian Formulation for Serial Robots

*P. Bhangale, S.K. Saha**

Indian Institute of Technology Delhi, New Delhi, India

Spatial Matrices in Multibody System Kinematics and Dynamics

*E.V. Zahariev**

Bulgarian Academy of Sciences, Sofia, Bulgaria

14.00 **SIMULATORS**

Chairman: *S.S. Kim*

Driving Simulators: Past, Present and Future

A. Brazalez, J. Ares, L. Matey*

CEIT, San Sebastian, Spain

Filtering Noisy Peripherals' Data to Interact with a Realtime Forklift Truck Simulator

X. Iriarte, J. Gil, J. Ros, J.M. Pintor, J.M. Jimenez*

Public University of Navarre, Pamplona, Spain

Evaluation of Drivers' Behavior with Multibody Based Driving Simulator

T. Shiiba, Y. Suda*

Meiji University, Kanagawa, Japan

WEDNESDAY 15

9.00 HAPTIC INTERFACES (Main Lecture 3)

Chairmen: *P. Eberhard, M. Valasek*

Haptic Interfaces in the Product Development Process

M. Bergamasco, A. Frisoli, C.A. Avizzano*
Scuola Superiore Sant'Anna, Pisa, Italy

9.50 HAPTICS AND CONTACT I

Chairmen: *P. Eberhard, M. Valasek*

A New Haptic System for Virtual Maintainability in Aeronautics

L. Matey, J. Savall, D. Borro, J.J. Gil*
CEIT, San Sebastian, Spain

Design and Development of a Wired Haptic System for the Interaction with Virtual Mechanical Systems

*C. Antonya, T. Butnaru, D. Talaba**
University Transilvania of Brasov, Romania

11.10 APPLICATIONS

Chairmen: *P. Eberhard, M. Valasek*

Virtual Sketch in Mechanical Design

C. Bascoul, P. Ray*
French Institute of Advanced Mechanics and Blaise Pascal University, Aubiere, France

6D Haptic Feedback for Molecular Docking

B. Daunay, S. Haliyo, S. Regnier*
Commissariat à l'Energie Atomique, Fontenay aux Roses, France

Parametric Modeling of Aerobic Fitness Devices

*C. Pereira, F. Ventura, C.M. Santos, M.C. Gaspar**
I.P.C.B., Castelo Branco, Portugal

Combined MBS-based Numerical and Experimental Investigation of Impact-Induced Noise and Vibration Concerns in Modern Vehicles

*M.M. Gnanakumarr, P.D. King, S. Theodossiades, P. Kelly, H. Rahnejat**
Loughborough University, UK

14.00 FLEXIBILITY

Chairmen: *W. Blajer, H. Rahnejat*

Model Reduction of Flexible Multibody Systems Using Krylov-Subspaces and Mode Selection

M. Lehner, P. Eberhard*
Institute of Engineering and Computational Mechanics, Stuttgart, Germany

Simulation of Mechanisms with Compliant Members Consisting of Transversal-Isotropic Material Using a Convected Rate Formulation

T. Lichtneckert, D. Franitza, K.-H. Modler*
Technical University of Dresden, Germany

An Efficient Approach Using Multiple Nonlinear Time Scales for Flexible Bodies with Time-Varying Length

Y. Terumichi, K. Stefan, K. Sogabe*
Sophia University, Tokyo, Japan

Comparison of Flexible Body Dynamics Reduction Techniques

J. Zavrel, Z. Sika, M. Valasek*
Czech Technical University in Prague, Czech Republic

16.10 HAPTICS AND CONTACT II

Chairmen: *W. Blajer, H. Rahnejat*

Virtual Grasping of Deformable Objects in Real Time

J. Le Garrec, C. Andriot, P. Bidaud*
Laboratoire de Robotique de Paris, Fontenay-aux-roses, France

Computer Simulation and Physical Experiment for the Contact Pressure Distribution on the Tire

S.-J. Park, W.-S. Yoo, J.-R. Cho*
Pusan National University, Busan, Korea

THURSDAY 16

9.00 **CONTROL II**

Chairmen: *M. Arnold, W. Schiehlen*

Vehicle Lateral Behaviour Using a Fuzzy Based Controller in a Virtual Reality Environment

C. Alvarez-Caldas, B.L. Boada, M.J.L. Boada, J.L. San Roman, V. Diaz*

University Carlos III of Madrid, Spain

Manual Cartesian Control for the Tendon-Based Parallel Robot SEGESTA

T. Bruckmann, M. Hiller, D. Franitza*

University Duisburg-Essen, Duisburg, Germany

Dynamics Modelling and Stability of Multibody Systems in Interactions with Virtual Environments

J. Kovecses, L. Kovacs, G. Stepan*

McGill University, Montreal, Quebec, Canada

Virtual Environment for Control Design and Evaluation with Real Driver Assessment

M.A. Naya, D. Dopico, M. Gonzalez, J. Cuadrado*

University of La Coruña, Ferrol, Spain

11.10 **NUMERICAL METHODS II**

Modeling, Numerical Response and Response Sensitivity of Three Coupled Links with Rigid Limiters of Motion System

J. Awrejcewicz, G. Kudra*

Technical University of Lodz, Poland

Real-Time Constrained Path Planning Algorithm based on an Indirect Method: Application Example and Numerical Issues

E. Bertolazzi, F. Biral, M. Da Lio*

University of Trento, Italy

List of Participants

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