



**International Centre for
NUMERICAL METHODS
IN ENGINEERING**

ANNUAL REPORT 2023

CIMNE^R

 EXCELENCIA
SEVERO
OCHOA

COMPUTATIONAL ENGINEERING RESEARCH
FOR A SUSTAINABLE WORLD



CENTRE **CERCA**

Annual Report 2023

CIMNE^R

COMPUTATIONAL ENGINEERING RESEARCH
FOR A SUSTAINABLE WORLD

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DIRECTOR'S LETTER

Javier Bonet // General Director of CIMNE

The International Centre for Numerical Methods in Engineering (CIMNE) was created in April 1987. Following my appointment as Director in mid-2022, the Governing Body of CIMNE approved the new 5-year strategy for the Centre in 2023. During the year, the Centre has implemented the agreed changes and actions contained in the strategy with the aim of preparing the Centre to meet the research challenges and objectives that we have set out for ourselves. This has required the help and support of the leadership team and all staff at CIMNE, for which I am tremendously grateful. The main actions and changes adopted in 2023 are listed below within each of the 5 sections of the strategy.

1. Developing a research strategy and structure fit for the next phase of CIMNE

CIMNE has decided to focus its research along 5 key themes and 4 enabling technologies. The key application themes respond to UN Sustainable Development Goals and government priorities at EU, Spanish and Catalan levels. These are:

- Adaptation to Climate Change
- Mobility, Cities and Territory
- Energy and Environment
- Industrial processes
- Health

The key enabling methodologies are:

- Discretization techniques
- Physical and mathematical models
- Data driven technologies
- High performance computational models

Based on these themes and methodologies, CIMNE has re-structured its research groups into 9 Research Clusters and 3 Innovation Units. The Research Clusters are responsible for leading the development of research at the highest levels of international excellence, whereas the Innovation units are focused on applied research and its application to create excellence through impact in society. In future, the work of the Centre will be reported according to this revised research structure.

Five of the Research Clusters are closely aligned with the application themes and are:

- **Geomechanics & hydrogeology:** aligned to themes of territory, mobility, and adaptation to climate change.
- **Machine learning and models in hydro-environmental engineering:** aligned to themes of environment and adaptation to climate change
- **Aeronautical, automotive, marine and energy engineering:** aligned to themes of mobility
- **Solid and fluid simulation in industrial processes:** aligned to the application theme of industrial processes
- **Computational mechanics in medical engineering and living matter:** closely aligned to the theme of health

The other four Research Clusters are aligned with enabling methodologies:

- **Mechanics of advanced materials and metamaterials:** aligned to physical and mathematical models
 - **Credible high fidelity and data driven models:** aligned to data driven technologies
 - **Structural and particle mechanics:** aligned to discretisation techniques
 - **Kratos multiphysics:** aligned to discretisation techniques and high performance computing
- the three Innovation Units are:

- **CENIT:** The Centre for Innovation in Transport; strongly aligned to the themes of mobility, cities, and territory.
- **BeeGrup:** Building, Energy and Environment Group; closely aligned to the themes energy & environment and adaptation to climate change.
- **DIGIT:** Digital services for research and engineering. This unit provides support and development of key industrial software such as GiD and other digital technologies.

Each cluster and unit includes a number of academic leaders who are responsible for defining its lines of research, identifying specific projects and securing financial resources.

The Scientific Advisory Council visit took place in November and in addition to meeting with the senior leadership of the Centre, the Council had in depth discussions with 4 of the new clusters. The aim is that in a period of two years the Council will have an opportunity to meet with each research cluster and comment on its developments and level of international excellence. A summary report from the Scientific Council was presented to the governing bodies of CIMNE.

2. Enhancing relationships with our patrons and international partners

The year 2023 marks the end of the four-year contract between CIMNE and the Catalan Government to provide core funding. During the second half of the year the general director, the vice-president and the managing director of CIMNE have been engaged in numerous conversations with senior political and administrative leaders in the Catalan government to secure an improved settlement for the next four-year period. The discussions have been completed with partial success as the contribution to core funding from the Department for Research and Universities has increased by 300K, whilst the contribution from the De-

partment of Territory has remained unchanged. The overall government support to CIMNE still represents less than 20% of its total funding, but it provides a much valued contribution to ensuring the financial stability of the Centre.

CIMNE has continued to work closely with UPC given that a significant number of our principal investigators and academic leaders are also professors at the university. Discussions have progressed significantly during 2023 in relation to complex issues such as premises in the Castelldefels campus and we are preparing for the renewal of the memorandum of agreement that governs the formal relationships between the two institutions in 2024.

3. Attracting, retaining and developing the best international researchers, innovators and professional support staff

CIMNE incorporated a new ICREA professor, Ivan Markovsky in January 2023. We have also developed and implemented the position of Senior Distinguished Researcher to consolidate and secure the continued affiliation of international figures in our field who have strong links with the Centre and have retired from their primary positions. For instance, the founder and former general director of CIMNE, Prof. Eugenio Oñate has been appointed as a Senior Distinguished Researcher of the Centre and will continue to play a leading role in the Structural and Particle Mechanics cluster.

During 2023 a total of seven academic members of staff were promoted in accordance to the Centre's approved criteria following an evaluation by a promotions panel. These included promotions to Associate Professor from Assistant Professor and to Assistant Research Professor from Research Engineer.



4. Ensuring that our research has maximum impact in society

During 2023, the Impact, Innovation and Technology Transfer unit has developed a detailed impact strategy aligned with the training provided by iCERCA. This strategy is presented in more detail below in the corresponding section. In addition, *CIMNE Tecnología* has re-structured itself significantly in order to provide a greater emphasis on providing higher level support to our Spin offs and researchers. A significant effort during the year has been the preparation for the Road mapping exercise in collaboration with the Institute of Manufacturing of the university of Cambridge and the economical contribution of iCERCA. The workshop component of the exercise will take place in 2024.

RESEARCH FOCUS, OUTCOMES AND ACHIEVEMENTS

During 2023 research at CIMNE has focused on the development of NM of interest to the following scientific fields: structural mechanics, geomechanics, fluid dynamics, material sciences, optimization, biomechanics coupled multi-physics processes and high-performance computing. Applications include problems in civil, mechanical, aeronautics, naval/marine, biomedical and environmental engineering, energy efficiency and fusion technology, among others.

A description of the different activities carried out at CIMNE can be seen at the CIMNE web page

During 2023 CIMNE was under the auspices of the Department of Territory of the Catalan Government. An example of the strong collaboration between the Department of Territory of the Catalan Government and CIMNE in these areas has been the project PIKSEL, which won the Joan Roget prize as best collaborative project in 2023 against 34 other entries.

In 2023 CIMNE researchers published about 153 papers in JCR journals, of which 80% were published in first quartile journals. The papers published by CIMNE researchers in the period 2018-2023 and have received close to 2500 citations in 2023, according to Scopus. CIMNE scientists are chief editors or associated editors of 4 JCR journals and members of the editorial board of more than 10 JCR journals. In 2023, CIMNE researchers have taken part in 79 RTD projects funded by international (33 projects) and national (46 projects) organisations, which have meant funding of 4.2 M€ for CIMNE. In the same period CIMNE had 106 RTD contracts with companies and private organisations amounting some 2.8 M€. CIMNE has implemented a self-sustainable financial model with limited annual public funding. This has been possible by combining public seed funding (from the Catalan Government) with income from RTD projects sponsored by public and private organisations, dissemination activities, revenues from CIMNE spin-off companies and an efficient management structure. In 2023, the self-obtained income obtained by CIMNE amounted to some 84.2% of its total annual budget.

I thank CIMNE staff and its many partners and friends in universities, research centres and industry worldwide for their cooperation that contributes to making of CIMNE a centre of reference in its field.

Javier Bonet
General Director of CIMNE

2023 in news



CIMNE Unveils a New Strategic Plan

CIMNE chartered its future with the approval of a new 5-year strategic plan. Through extensive consultations and expert advice, this roadmap outlines four key areas: 1) Revamping research to tackle societal challenges aligned with UN goals, 2) fortifying partnerships with universities and industries, 3) attracting and retaining top talent, and 4) maximizing societal impact through knowledge transfer and spin-off creation. This strategic shift lays the groundwork for CIMNE's leadership in computational engineering and impactful contributions to a sustainable future.

Further information: cimne.com/vnews/11941



PIKSEL project awarded Joan Roget Knowledge Transfer Prize

CIMNE's PIKSEL project, a pioneering tool for forecasting regional trends, won the Joan Roget Knowledge Transfer Prize, awarded by the Catalan Foundation for Research and Innovation (FCRI). This collaborative effort, co-led by Scientific Director of the Severo Programme of Excellence at CIMNE, Prof. Oñate, equips public authorities with crucial insights into environmental, demographic, and economic shifts. Developed with funding from the Catalan Government, PIKSEL empowers strategic decision-making for sustainable, resilient planning.

Further information: cimne.com/vnews/12051

CIMNE renews its Scientific Advisory Council



CIMNE revamped its Scientific Advisory Council, with three renowned experts: Prof. Karen Willcox, director of the Oden Institute at UT Austin, Prof. Spencer Sherwin, leading Aerospace Engineering at Imperial College London, and Prof. Estefania Peña, a prominent figure at the University of Zaragoza. These additions strengthen research guidance and advanced gender parity, with the council now comprising 30% female representation.

Full Scientific Advisory Council: cimne.com/m3264



CIMNE participates in a UNESCO Chairs meeting in Cordoba to discuss the challenges of higher education

CIMNE joined Spanish UNESCO Chairs discussing the future of Higher Education. Cecilia Soriano, representing the UPC and CIMNE, participated in this 2-day gathering in Córdoba addressing transformation, collaboration, and the role of Chairs in shaping universities.

Further information: cimne.com/vnews/12009



InnoDelta: Partnering with Local Communities to Boost Innovation



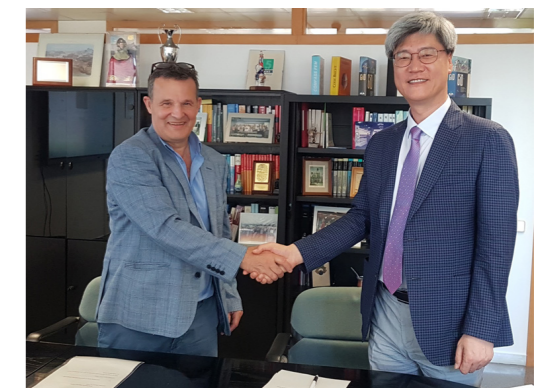
CIMNE joined local communities in the Llobregat delta in the EU-funded InnoDelta project, spearheading innovation through knowledge platforms, specialized labs and business support. City governments, local businesses, UOC, and other CERCA research centers collaborate in this Territorial Specialization and Competitiveness Project (PECT).

InnoDelta webpage: innodelta.cat

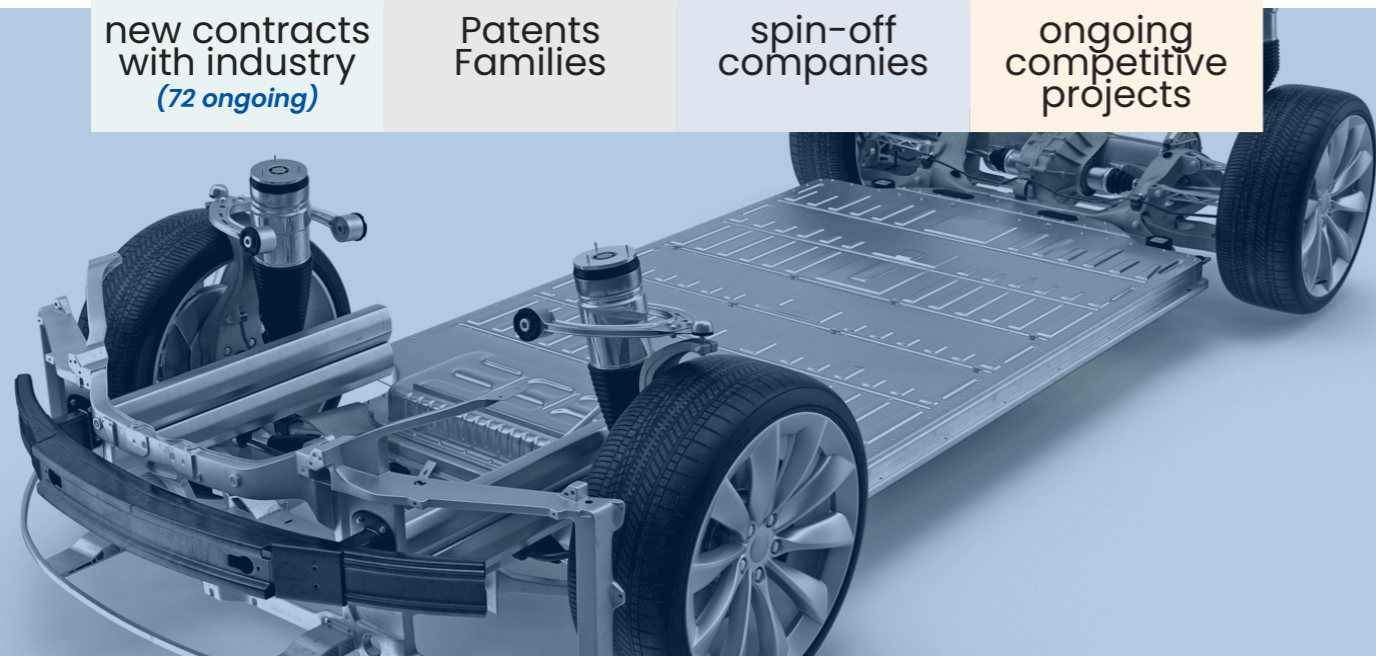
CIMNE signs an agreement with the Korean Railway Research Institute

CIMNE signed a collaborative agreement with the Korean Railway Research Institute (KRRRI) to analyze public transport data for travel pattern insights. Utilizing data from Barcelona and expertise from CENIT, the project leverages ticket validation records and KRRRI's TRIPS tool to develop improved origin-destination matrices. This international partnership fosters knowledge exchange and advances transportation planning worldwide.

Further information: cimne.com/vnews/11947



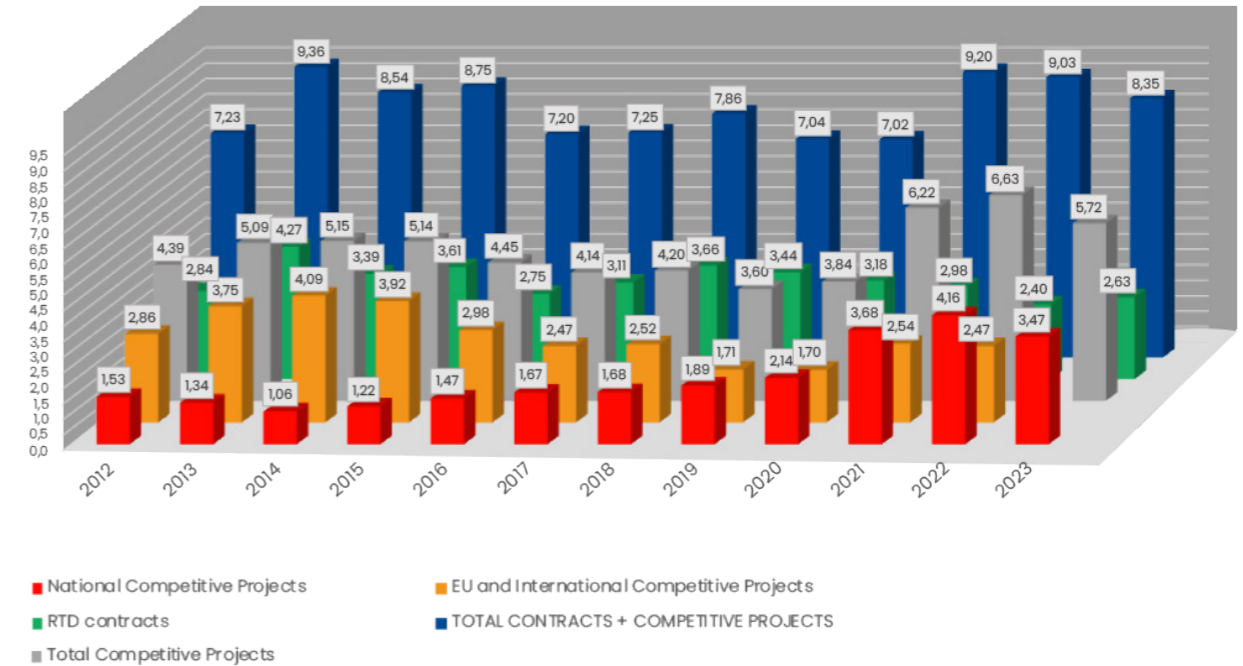
CIMNE in Numbers 2023



Income from contracts and competitive projects (2012-2023)

*Data: March 2024 (audit pending)

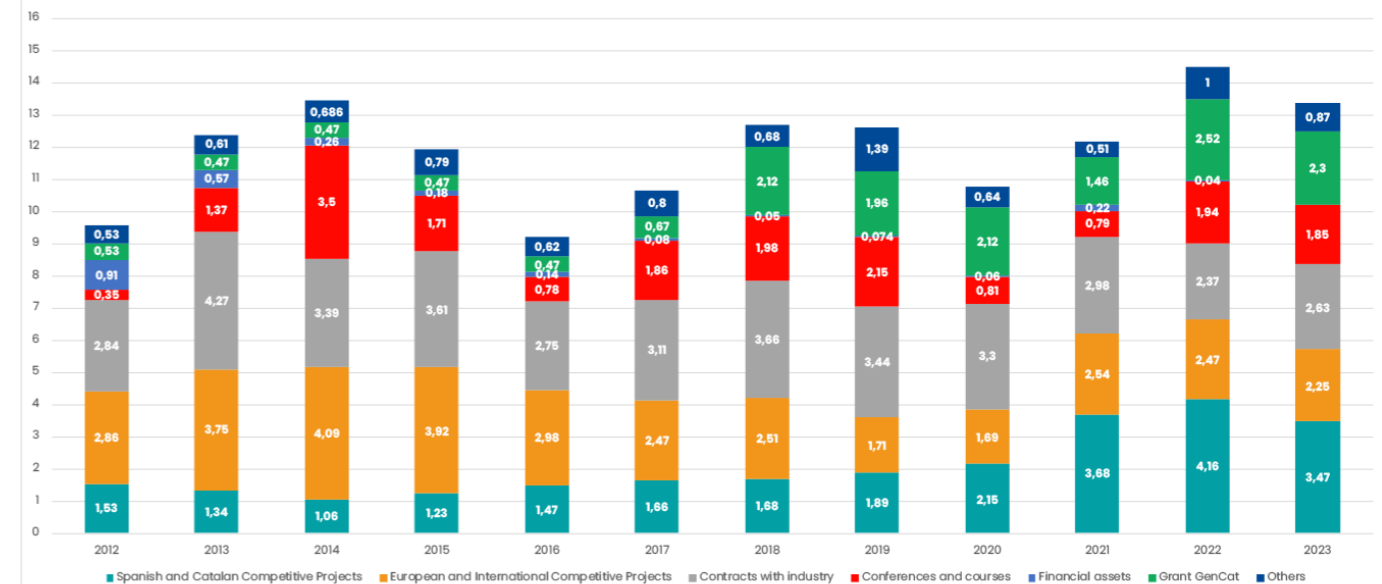
in M€



Split of annual income (2012-2023)

*Data: March 2024 (audit pending)

in M€

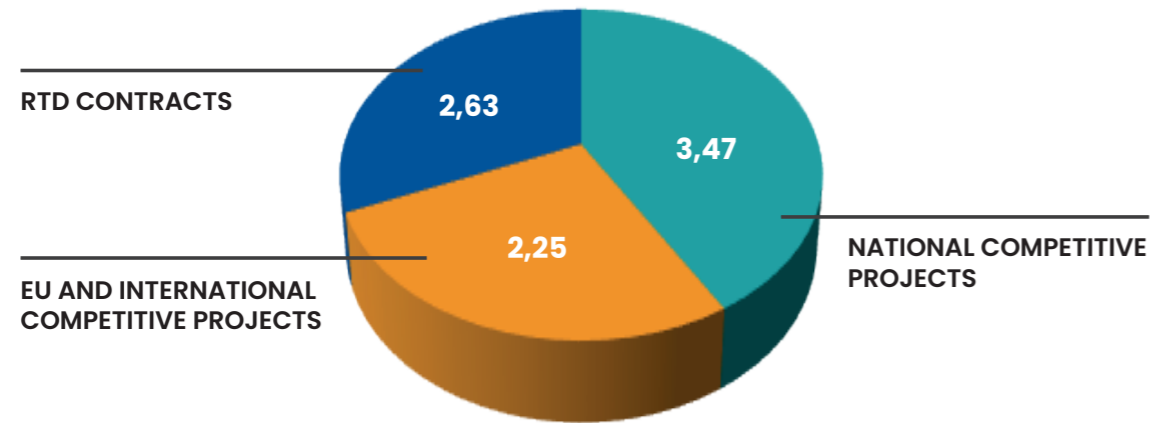




Income from contracts and competitive projects in 2023

*Data: March 2024 (audit pending)

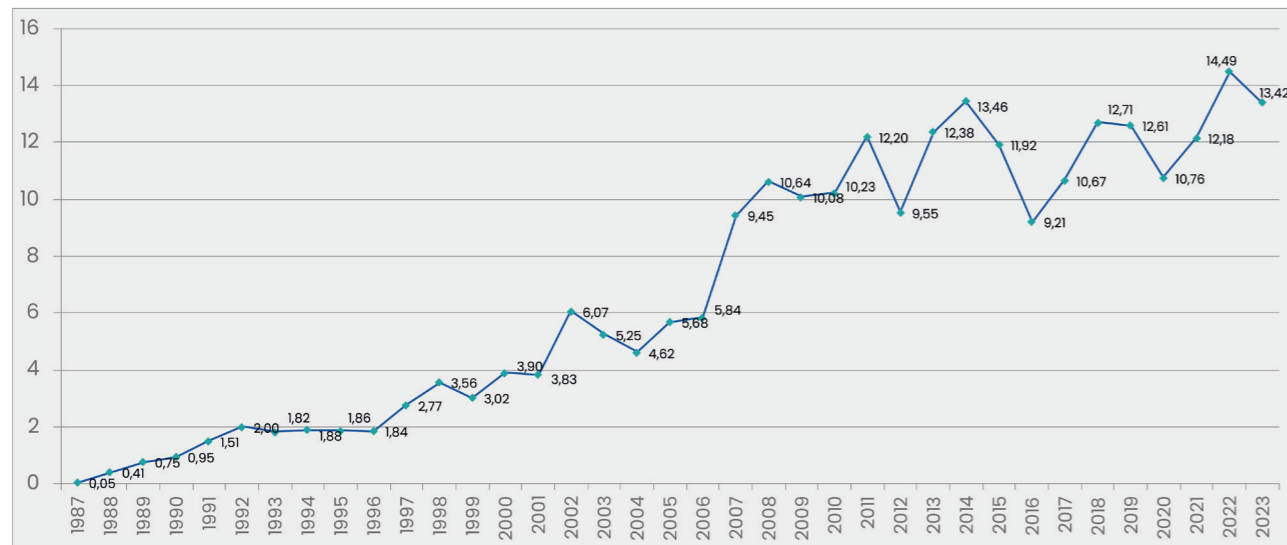
in M€



Evolution Annual Income (1987-2023)

*Data: March 2024 (2023 audit pending)

in M€



Scientific Achievements

- ERC
 - 2011 Advanced Grant
- 29 Awards and Prizes
 - 2008 Grand Prize of the Japan Society JSCEs
 - 2010 Gauss-Newton Medal of IACM
 - 2020 Ritz-Galerkin medal of ECCOMAS
- 6 honorary doctoral degrees (Portugal, Cuba, France, UK, St. Petersburg)
- Member in 3 Academies

ETS d'Enginyeria de Camins,
Canals i Ports de Barcelona

Governing Bodies

Governing Council

President

Hon. Ms. Ester Capella

Minister of Territory and Sustainability (Government of Catalonia)

Representing Catalan Government

Mr. Marc Sanglas

Secretary for Infrastructure and Mobility (Government of Catalonia)

Dr. Joan Gómez Pallarès

Director-General for Research (Government of Catalonia)

Mr. Oriol Alcoba

Director-General for Industry (Government of Catalonia)

Vice-President

Mr. Ferran Falcó

Representing UPC · BarcelonaTech

Dr. Daniel Crespo

Rector (UPC · BarcelonaTech)

Dr. Jordi Llorca

Vice-rector for Scientific Policy (UPC · BarcelonaTech)

Dr. Esther Real

Full Professor (UPC · BarcelonaTech)

Representing UNESCO

Dr. Lluís Ramallo

President of the Spanish Commission of UNESCO

Executive Council - Finance and Compliance

Chair

Mr. Ferran Falcó

Vicepresident (CIMNE)

Members

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General Director (CIMNE)

Ms. Anna Font

Managing Director (CIMNE)

Ms. Teresa Prohías

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Ms. Esther Morales

Deputy General Director of Economic Management, Procurement and Patrimony (Gencat-Department of Research and Universities)

Mr. Ivan Planas

General Manager (UPC · BarcelonaTech)

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Prof. Gabriel Bugeda

Guest member

Institutional Relations Director (CIMNE)

Mr. Javier Marcipar

Guest member

Director (CIMNE Tecnologia)

Ms. M^a Carmen Linares

Guest member

Accounting and Finance Director (CIMNE)



Executive Council - Science and Innovation

Chair

Mr. Ferran Falcó

Vicepresident (CIMNE)

Members

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Director of the Technological Transformation Unit and Disruption (Gencat-ACCIÓ)

Mr. Marc Darder

Head of the Technical Office (Gencat-Department of Territory)

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Managing Director (CIMNE)

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Guest member

Project Development Director (CIMNE)

Prof. Gabriel Bugeda

Guest member

Institutional Relations Director (CIMNE)

Mr. Javier Marcipar

Guest member

Director (CIMNE Tecnologia)

Mr. Jordi Jiménez

Guest member

Head of Technology Transfer (CIMNE)



Scientific Advisory Council

The Scientific Advisory Council (SAC) of CIMNE is formed by prestigious international researchers in the field of numerical methods in engineering.

Its role is to provide advice and guidance to the Executive and Governing Councils of CIMNE on the scientific policy of CIMNE.



Prof. PETER WRIGGERS
(Chair)
Leibniz University Hannover, Germany



Prof. FRANCISCO CHINESTA
ENSAM Paris, France



Prof. LAURA DE LORENZIS
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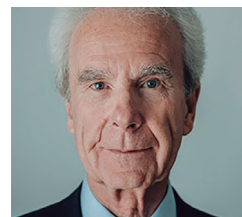
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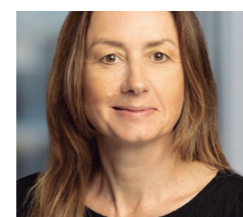
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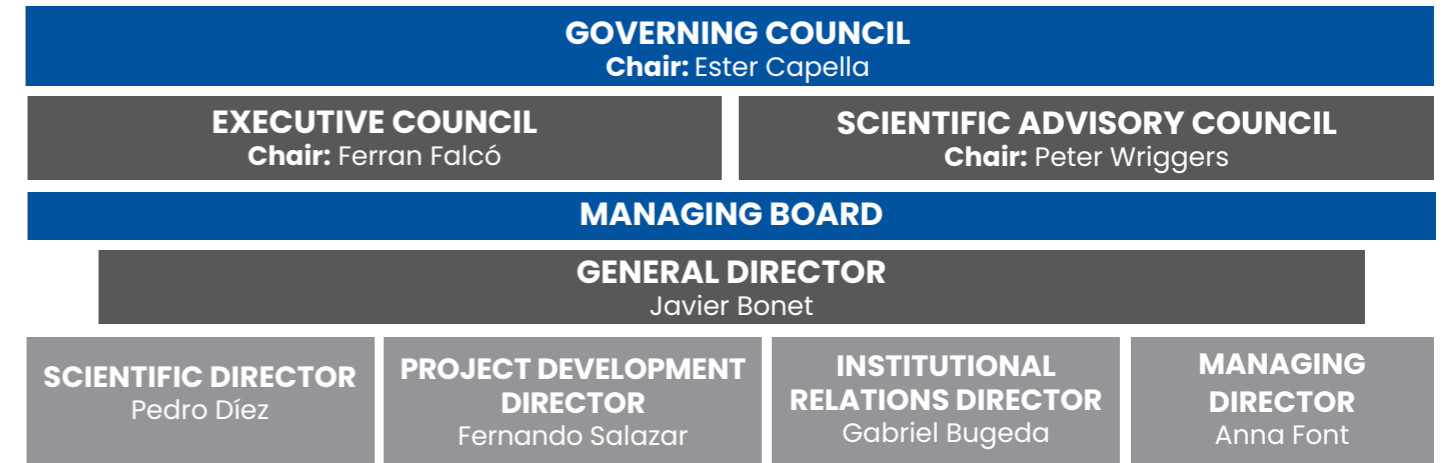
Prof. KAREN WILLCOX
The Oden Institute for Computational Engineering & Sciences, US



Prof. ROLAND WUCHNER
Technical University of Braunschweig, Germany



Organization Chart



Research and Tech Development (RTD Areas & Groups)

CIVIL AND ENVIRONMENTAL ENGINEERING

Building, Energy and Environment
Leader - Jordi Cipriano

Disaster Risk and Resilience
Leader - Liliانا Carreño

Geomechanics
Leader - Sebastià Olivella

Hydrogeology
Leader - Xavier Sánchez Vila

Machine Learning in Civil Engineering
Leader - Fernando Salazar

River Dynamics and Hydrologic Engineering (FLUMEN Institute)
Leader - Ernest Bladé

Structural Mechanics
Leader - Eugenio Oñate

COMPUTATIONAL MATERIALS DESIGN & ANALYSIS
Composites and Advanced Materials for Multifunctional Structures
Leader - Xavier Martínez

Computational Design & Analysis of Engineering Metamaterials
Leader - Xavier Oliver and Juan Carlos Cante

Mechanics of Electroactive Materials
Leader - Irene Arias

Soft and Living Material Interfaces
Leader - Marino Arroyo

ENGINEERING MECHANICS AND PROCESSES
Bio-Medical Engineering
Leader - Eduardo Soudah

Fluid Mechanics
Leader - Ramon Codina

Industrial Manufacturing Processes
Leaders - Michele Chiumenti and Miguel Cervera

INNOVATIVE ALGORITHMS AND HPC TECHNIQUES
Data-driven high-fidelity modeling
Leader - Pedro Díez and Antonio Huerta

Kratos Multiphysics
Leader - Riccardo Rossi

Large Scale Scientific Computing
Leader - Santiago Badia

TRANSPORT AREA
Aeronautics
Leader - Jordi Pons

CENIT Group for Innovation in Multimodal Transport
Leader - Sergi Saurí

Naval and Marine Engineering
Leader - Borja Serván

INNOVATION SUPPORT AND TECHNOLOGY TRANSFER
Information and Communication Technology
Leader - Ángel Priegue

Pre and Post Processing
Leader - Abel Coll

Valorization of Research and Technology Transfer
Leader - Jordi Jiménez

Administration

FINANCES
Leader - M^a Carmen Linares

COMMUNICATION
Leaders - Laura Bermúdez and Josep A. Palacios

CONGRESS BUREAU
Leader - M^a del Mar Santiago

HUMAN RESOURCES
Leader - Irene Martínez

POST-GRADUATE TRAINING
Leader - Lelia Zielonka

IT-DEVELOPMENT
Leader - Javier Tous

PRE-AWARD UNIT
Leader - Fernando Salazar

PROJECT MANAGEMENT
Leader - Sandra Pérez

PUBLICATIONS
Leader - M^a Jesús Samper

QUALITY
Leader - Ignacio Valero

SYSTEMS
Leader - Miguel Alonso

CIMNE Staff

This is the list of all persons who collaborate with CIMNE at December 31st 2023

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Juan Miquel
Xavier Oliver
Sergio Oller
Eugenio Oñate

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Matteo Giacomini
José Manuel González
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Joaquín Irazábal
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Eduardo Soudah
David J. Vicente
Rubén Zorrilla

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Gabriel Barbat
Ramón Barboza
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Miguel Calpe
Gaia di Carluccio
Juan Marcelo Giménez
Laura González
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Ramón O. Salomón
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Francisco Javier Garrido
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Agustina Giuliadori
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Daniel Yago
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RESEARCH STUDENTS

PhD Students

Oluwakemi Akinwehinmi
Nicolo Antonelli
Mohammad Azizpooryan
Hadi Bakhshan
Lucie François Beaufour
Irene Berdugo
Ashutosh Bijalwan
Pau Blanco
Alvaro Boiero
María Jesús Bopp
Alvaro Borrás
Matteo Boschian
Jose Manuel Broto
Mónica Alexandra Buitrago
David Candela
Karen Lorena Casallas
Ton Creus
Zulkeefal Dar
Malik Dawi
Danial Dehghan Suraki
Sofía Di Capua
Maria Montserrat Dolz
Diego Enrique Duran
Arnau Fabra
Sima Farshbaf
Mariano Tomás
Oriol Frigola
Stephan Gahima
Marc Girona
Andrea Gorgi
Sthefania Grajales
Maurici Hervas
Eduard Jove
Sheraz Ahmed Khan
Sergio Ricardo Lopez
Yuranny López
Edgar Alexis Martinez
Ignacio Martinez
Gabriel Mendonça
Hossein Mohammadi
Samar Momin
Aníbal Andrés Moncada

VISITING SCIENTISTS

Christian Narváez
Ethel Bibiana Olmos
Rafel Perello
David Pujol
Runeal Ramma
Richard Andrés Ramos
Mohammad Razavi
Iván Rivet
Raul Rubio
Gaston Sal
Aniol Sala
Antonio J. Salazar
Jatnna Alexandra Sán-chez
Sebastián Sandoval
Chiara Saragani
Samra Sarwar
Babak Sayad
Javad Sekhavati
Chengshun Shang
Laurence Sigler
Irene Simó
Mehdi Slimani
Fernando A. Sossa
Alireza Taherzadeh
Marta Torres
Francesc Turón
Gerard Villalta
Pablo Nicolas Wierna
Davood Yazdani
Buse Yetisti
Wanchang Zhang
Polytimi Zisimopoulou
Marco Antonio Zuñiga

VISITING SCIENTISTS

CIMNE promotes the visits of academics and researchers from around the world. Visiting Scientists at CIMNE in 2023:

Visiting Scientists

Rainald Lohner
Norberto Nigro
Jacques Periaux



Administration staff

GENERAL DIRECTOR

Javier Bonet

SCIENTIFIC DIRECTOR

Pedro Díez

PROJECT DEVELOPMENT DIRECTOR

Fernando Salazar

DIRECTOR FOR INSTITUTIONAL RELATIONS

Gabriel Bugeda

MANAGING DIRECTOR

Anna Font

Administration staff in CIMNE is formed by highly qualified professionals who address the increasing needs of researchers and scientific personnel in the centre.

FINANCES

Leader - M^a Carmen

Linares

(Head of Unit)

Katherine J. Brenes

Elisabet Laya

Cristina Luque

Jon Rodríguez

COMMUNICATION

Laura Bermúdez/Josep

A. Palacios

(Heads of Unit)

Luís Lillo

CONGRESS BUREAU

M^a del Mar Santiago

(Head of Unit)

Gemma Barberillo

Alessio Bazzanella

Mónica Camanforte

Sergi Gumà

Sara Rocamora

Beatriz Rodríguez

DIRECTOR SECRETARY

Berta Claramunt

Laura Rangel

HUMAN RESOURCES

Irene Martínez

(Head of Unit)

Mar Mesa

PROJECT MANAGEMENT

Sandra Pérez

(Head of Unit)

Marina de la Cruz

Francisco de la Rosa

Carla Fadlallah

Mahavir Singh

Gerard Vilar

David Casabuena

Alberto Tena

Anna Cruz

Alex Berra

POSTGRADUATE TRAINING

Lelía Zielonka

(Head of Unit)

Cristina Pérez

PUBLICATIONS

M^aJesús Samper

(Head of Unit)

RECEPTION

Jordi López

SYSTEMS

Miguel Alonso

(Head of Unit)

Aitor Lázaro

Pau Rambla

Oscar Ruiz

Gianfranco Sáenz

TECHNICAL STAFF

Sergio Chacón

Jacqueline E. Davies

Andreu Marí

Javier Tous

TECHNOLOGY TRANSFER

Jordi Jiménez

Javier Marcipar

Sergio Otero

Jazmín Ríos



Where we are



Photos: C1 Building at Campus Nord UPC Barcelona

Headquarters



Premises in Spain



B0 Building at Campus Nord UPC Barcelona



Main premises at UPC

CIMNE's main premises are located at the heart of the North Campus of Universitat Politècnica de Catalunya · BarcelonaTech.

The offices are situated at the C1 Building, adjacent to the Civil Engineering School of UPC and occupy some 1,000 m² of modern office facilities and state of the art equipment with last generation computers linked via a fast intranet and a multicore cluster for parallel computing.

This space, created in 1987, hosts around 90 CIMNE researchers and the main administration offices.

CIMNE-BARCELONA

Campus Nord UPC, C1 Building
C/ Gran Capità, S/N, 08034 Barcelona, Spain
+34 93 401 74 95

B0 Building

In September 2014 CIMNE started the construction of a new building of some 2,000 m² in the North Campus of the Universitat Politècnica de Catalunya · BarcelonaTech.

The B0 building, that also hosts the Flumen Institute, was completed by the end of 2015. Several CIMNE researchers moved to the new facilities in 2016. This new building is equipped with modern experimental facilities for model scale testing of river dynamic and hydraulic problems and it also provides work areas for researchers at the graduate level (master, doctoral and postdocs) and for senior researchers from CIMNE and UPC · BarcelonaTech.

CIMNE-B0

Campus Nord UPC, B0 Building
C/ Gran Capità, S/N, 08034 Barcelona, Spain
+34 93 401 09 50

CIMNE - Terrassa

CIMNE offices in Terrassa (Barcelona, Spain) opened in 2001. The premises cover an area of 150m² and house part of the department of Building Energy and Environment Group (Bee-Group).

Director: J. Cipriano

Address

Campus de Terrassa UPC
Edifici GAIA (TR14)
C/ Rambla Sant Nebridi, 22
08222 Terrassa (Barcelona), Spain
+34 93 789 91 69

CIMNE - Castelldefels

CIMNE's headquarters in the city of Castelldefels (Barcelona, Spain) were inaugurated on October 15th 2008. The facilities are located in the building CIMNE-C3 of the Mediterranean Technology Park of the UPC, and occupy 1,500m² in a new building constructed in collaboration with the UPC. The premises are shared with the Technical School of Castelldefels.

Director: J. Mora

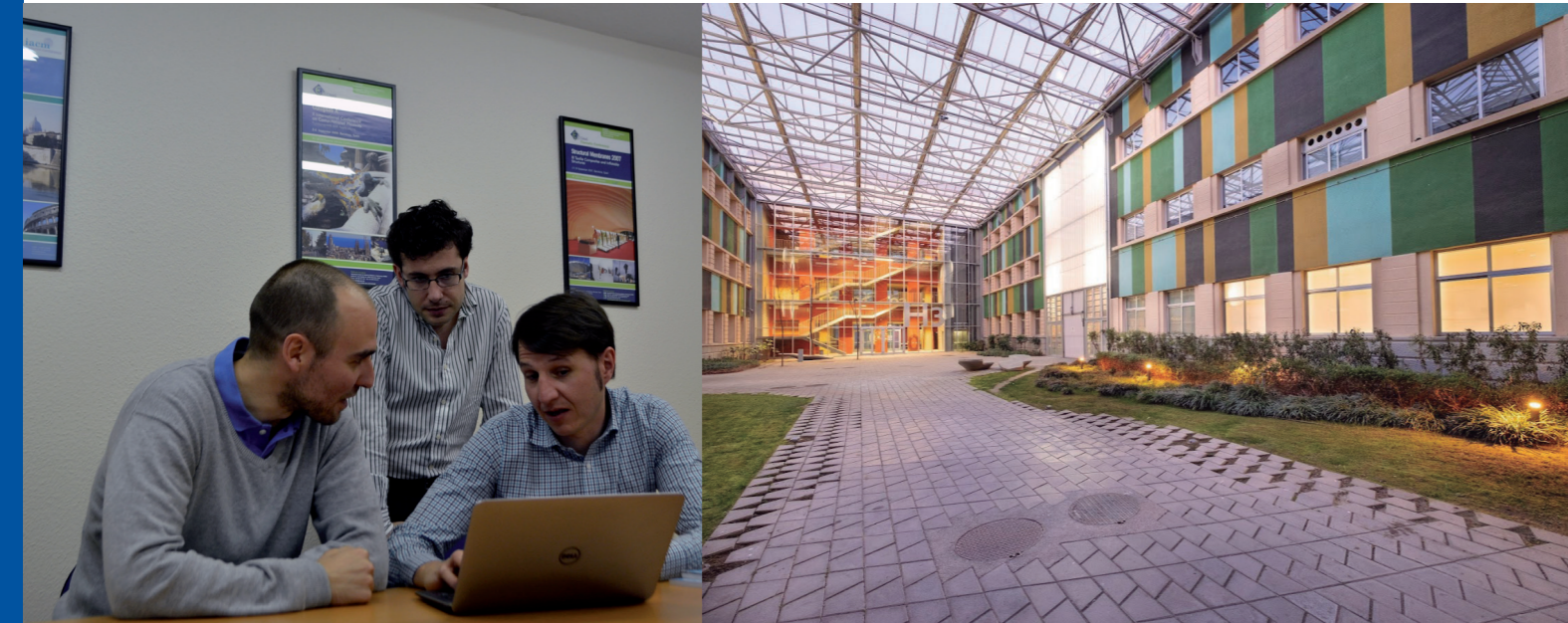
Address

Campus del Baix Llobregat UPC
CIMNE Building C3
C/ Esteve Terradas, 5
08860 Castelldefels, Barcelona, Spain
+34 93 413 41 86



International Branches

Exterior view of the *Centro de Estudios de Matemática Computacional* at the Universidad de las Ciencias Informáticas in Havana, Cuba. The building houses one of the two *Aulas CIMNE* on the island.



CIMNE - Madrid

CIMNE - MADRID started its activities in September 2007 and on May 2008 CIMNE opened its premises located in the centre of the city (150m²). The main goal of CIMNE Madrid is to build a strong research team in Madrid and foster the links between CIMNE, the Central Government of Spain, the Technical University of Madrid (UPM) and partner companies and research centres based in Madrid.

Director: F. Salazar

Address

Calle General Oraá, nº 70 6ª izquierda
28006 Madrid

CIMNE - Lleida

CIMNE's premises in Lleida are located at the Parc Agrobiotech, one of the main scientific and technological platforms of the agri-food sector and ICT in the Catalan and national sphere.

Director: J. Cipriano

Address

Parc Agrobiotech Lleida
Turó de Gardeny, H3 Bulding, 1st floor, wing A,
office 11
25003 Lleida, Spain
+34 694 484 777






Aulas CIMNE

TOTAL: **32** AULAS CIMNE

Aulas CIMNE are physical spaces (Joint Labs) for cooperation in education, research and technological development (RTD) activities created jointly by CIMNE and one or several universities. The 32 Aulas CIMNE promote educational and training activities at graduate and postgraduate level and development of RTD projects in cooperation with companies around the world.






ARGENTINA (5)




	<p>AULA FICH – CIMNE Universidad Nacional del Litoral Director: Gerardo Franck Created in October 2002 Activity: Applications of numerical methods to problems related to water resources, mechanical and computer engineering.</p>
	<p>AULA ITBA – CIMNE Instituto Tecnológico de Buenos Aires Director: Sebastián d’Hers Created in April 2015 Activity: Application development of numerical methods in different fields (mechanical, naval, petroleum, etc.)</p>
	<p>AULA UNER – CIMNE Universidad Nacional de Entre Ríos Director: José Di Paolo Created in March 2013 Activity: Applications of numerical methods to problems related to Bioengineering.</p>
	<p>AULA UNSA – CIMNE Universidad Nacional de Salta Director: Sergio Oller Created in April 2008 Activity: Development of computer models for application in civil engineering.</p>
	<p>AULA FACET – CIMNE Universidad Nacional de Tucumán Director: Eduardo Martel Created in November 2002 Activity: Development of computational models in civil engineering and bioengineering.</p>





BRAZIL (4)

	<p>AULA FEMEC – CIMNE Universidade Federal de Uberlândia Director: Gilmar Guimarães Created in April 2004 Activity: Forming process applications, structural design and biomechanics.</p>
	<p>AULA Infralab – CIMNE Universidade de Brasília Director: Márcio Muniz Created in 2016 Activity: Applications of numerical methods in engineering problems.</p>
	<p>AULA IFSP – CIMNE Instituto Federal de Educação, Ciência e Tecnologia de Sao Paulo Director: Kauê Reis dos Santos Created in July 2009 Activity: Applications of numerical methods in engineering problems in forming processes, solid mechanics and biomechanics.</p>
	<p>AULA IFG – CIMNE Instituto Federal de Educação, Ciência e Tecnologia de Goiás Director: Ecio Duarte Naves Created in October 2018 Activity: Applications of numerical methods in engineering problems.</p>


CHILE (3)


	<p>Aula DIMEC-CIMNE Universidad Técnica Federico Santa María Director: Franco Perazzo Created in March 2004 Activity: Numerical methods in mechanical engineering. Development of numerical methods without mesh. Applications in Engineering.</p>
	<p>AULA FIULS (Chile) Universidad La Serena Director: Carlos Garrido Created in 2019 Activity: Applications of numerical methods to problems in Engineering.</p>
	<p>AULA PUCV (Chile) Pontificia Universidad Católica de Valparaíso Director: Juan Carlos Vielma Created in October 2017 Activity: Numerical Methods for the evaluation of seismic vulnerability of structures, dynamic response of non-linear structures and pre-seismic reinforcement techniques.</p>


CUBA (2)

	<p>AULA UCI – CIMNE Universidad de las Ciencias Informáticas Director: Jorge Gulín Created in October 2015 Activity: Development of computational models and tools with application in high performance computation.</p>
	<p>AULA UCLV – CIMNE Universidad Central de las Villas Director: Carlos Recarey Created in July 2003 Activity: Modelling and analysis of structures and grounds to the application of numerical methods.</p>

COLOMBIA (5)	
	<p>AULA UNC – CIMNE Universidad Nacional de Colombia Director: Jairo Andrés Paredes Created in June 2005 Activity: Numerical methods applied to civil engineering.</p>
	<p>AULA UNIMAR – CIMNE Universidad Mariana de Colombia Director: Diego Valencia Created in May 2018 Activity: Structural analysis.</p>
	<p>AULA UNIANDÉS – CIMNE Universidad de los Andes Director: René Meziat Created in January 2003 Activity: Teaching and research in numerical methods, optimization, variational principles and computational mechanics.</p>
	<p>AULA IUPB-CIMNE Institución Universitaria Pascual Bravo Director: Gustavo Suárez Created in 2023 Activity: Computational analysis of nanocarriers in the tumour microenvironment for cancer treatment, materials design, neural network implementation, aeronautics.</p>
	<p>AULA EAFIT-CIMNE Universidad EAFIT Director: Juan Manuel Rodríguez Created in 2023 Activity: Computational simulation of manufacturing processes, especially machining and granular materials.</p>


EL SALVADOR (1)	
	<p>AULA UCA – CIMNE Universidad Centroamericana “José Simeón Cañas” Director: Mauricio Pohl Created in Feb. 2010 Activity: Civil engineering applications and multi objective optimization and applications.</p>

GUATEMALA (1)	
	<p>AULA UMG – CIMNE Universidad Mariano Gálvez Director: Rolando Torres Created in February 2011 Activity: Development of computer models for application in civil engineering.</p>

PERU (1)	
	<p>AULA PUCP – CIMNE Universidad Católica de Perú Director: Rosendo Franco Created in April 2009 Activity: Modelling and analysis of structures and grounds to the application of numerical methods.</p>



SPAIN (6)	
	<p>AULA EEBE – CIMNE Escola d’Enginyeria de Barcelona Est Director: Daniel Di Capua Created in July 2017 Activity: Development of numerical methods in industrial and civil engineering.</p>
	<p>AULA ESEAAT – CIMNE UPC · BarcelonaTech Terrassa Director: Óscar Fruitós Created in April 2007 Activity: Industrial and aeronautical engineering</p>
	<p>AULA ETSII – CIMNE Universidad Politécnica de Madrid Director: Jorge Rodríguez-Chueca Created in February 2021 Activity: Development and applications of numerical methods in industrial engineering</p>
	<p>AULA ETSINO – CIMNE (Spain) Universidad Politécnica De Cartagena Director: José Gutiérrez Created in May 2018 Activity: Development of numerical naval engineering.</p>
	<p>AULA FNB – CIMNE (Spain) Facultad de Náutica de Barcelona Director: Borja Servan Created in March 2002 Activity: Applications of numerical methods to problems related to marine engineering.</p>
	<p>AULA UPM – CIMNE (Spain) Universidad Politécnica de Madrid (UPM) Director: Rafael Morán Created in May 2010 Activity: Applications of numerical methods in civil engineering.</p>

MÉXICO (4)	
	<p>AULA CIMAT – CIMNE Centro de Investigaciones en Matemáticas Director: Salvador Botello Created in June 2006 Activity: Applied mathematics, numerical methods, engineering and statistical analysis.</p>
	<p>AULA UGTO – CIMNE Universidad de Guanajuato Director: Humberto Esqueda Created in January 2002 Activity: Civil engineering applications and multi objective optimization and applications.</p>
	<p>AULA MORELIA – CIMNE Universidad Michoacana de San Nicolás de Hidalgo Director: Francisco Domínguez Created in October 2015 Activity: Civil, mechanic and electric engineering.</p>
	<p>AULA TEC – CIMNE Instituto Tecnológico de Monterrey Director: Juan Álvarez Created in 2021 Activity: Structural analysis.</p>

CIMNE, Centre for Research Excellence

Research Excellence for a Sustainable World

CIMNE is committed to contributing to a more sustainable and equitable world through computational engineering research.

CIMNE's Strategic Plan defines five research themes and four enabling technologies to address pressing societal challenges.

Research Themes & Technologies

5 Research Areas

These themes are aligned with UN's Sustainable Development Goals (SDGs), EU Missions, Strategic lines of the Spanish Government and the Thematic axes of R&D of the *Departament de Territori* of the Government of Catalonia

1. ADAPTATION TO CLIMATE CHANGE

Assessing hazards, risks; protecting coast, floods, landslides; adapting infrastructure; managing land sustainably.

2. MOBILITY, CITIES, AND TERRITORY

Transport & civil infrastructure; urban mobility; logistics; aerospace & vertical mobility; maritime & automotive transport.

3. ENERGY AND ENVIRONMENT

Renewable energy; materials for energy; fusion, nuclear, waste treatment; energy storage; efficiency; water treatment; contamination control.

4. INDUSTRIAL PROCESSES

Advanced manufacturing; industrial automation; emerging materials such as metamaterials; smart construction.

5. HEALTH

Modelling bio-systems, materials; patient-specific disease detection; medical devices; bionics; mechanobiology.

4 Key Enabling Technologies

1 DISCRETIZATION TECHNIQUES

Novel grid and grid-free approaches; particle methods; unfitted methods, error assessment and adaptivity.

2. PHYSICAL AND MATHEMATICAL MODELS

Comprising multiphysics constitutive models and formulations, variational and mathematical principles, optimization techniques and similar technologies.

3. DATA DRIVEN TECHNOLOGIES

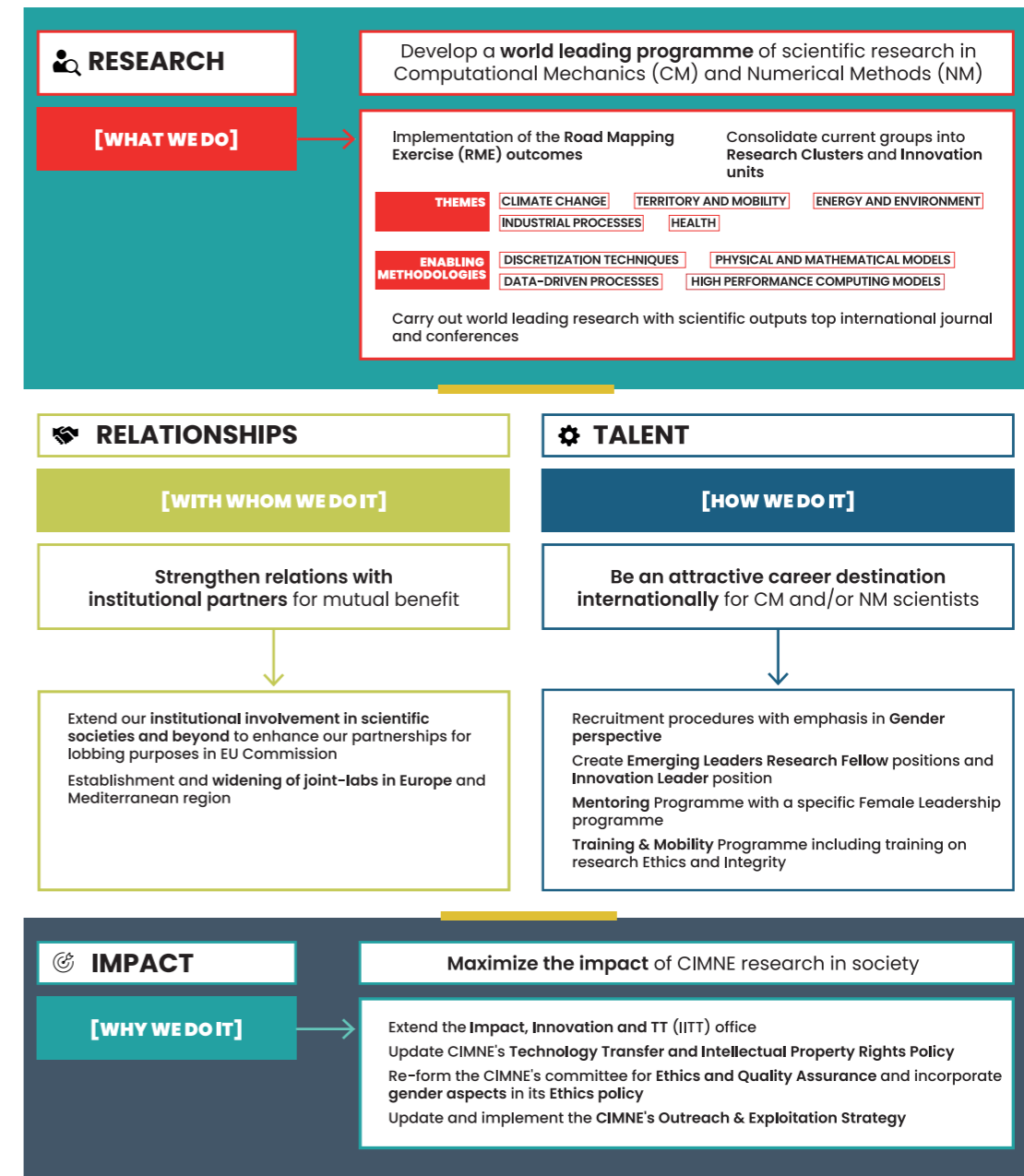
Including machine learning and artificial intelligence, reduced order models, big data, uncertainty quantification and digital twins.

4. HIGH PERFORMANCE COMPUTATIONAL MODELS

Including modelling technologies to exploit emerging computer architectures.



Centre of Excellence Severo Ochoa



RTD Areas and Groups

RTD AREAS AND GROUPS	
<p>CIVIL AND ENVIRONMENT ENGINEERING</p> <p>BUILDING, ENERGY AND ENVIRONMENT PI: Jordi Cipriano</p> <p>DISASTER RISK AND RESILIENCE PI: Liliانا Carreño</p> <p>GEOMECHANICS PI: Sebastià Olivella</p> <p>HYDROGEOLOGY PI: Xavier Sánchez-Vila</p> <p>MACHINE LEARNING IN CIVIL ENGINEERING PI: Fernando Salazar</p> <p>RIVER DYNAMICS AND HYDROLOGIC ENGINEERING (FLUMEN INSTITUTE) PI: Ernest Bladé</p> <p>STRUCTURAL MECHANICS PI: Eugenio Oñate</p>	<p>COMPUTATIONAL MATERIALS DESIGN & ANALYSIS</p> <p>COMPOSITES AND ADVANCED MATERIALS FOR MULTIFUNCTIONAL STRUCTURES PI: Xavier Martínez</p> <p>COMPUTATIONAL DESIGN & ANALYSIS OF ENGINEERING METAMATERIALS PIs: Xavier Oliver & Juan Carlos Cante</p> <p>MECHANICS OF ELECTROACTIVE MATERIALS PI: Irene Arias</p> <p>SOFT AND LIVING MATERIAL INTERFACES PI: Marino Arroyo</p>
<p>ENGINEERING MECHANICS AND PROCESSES</p> <p>BIO-MEDICAL ENGINEERING PI: Eduardo Soudah</p> <p>FLUID MECHANICS PI: Ramon Codina</p> <p>INDUSTRIAL MANUFACTURING PROCESSES PIs: Michele Chiumenti and Miguel Cervera</p>	<p>INNOVATION SUPPORT AND TECHNOLOGY TRANSFER</p> <p>INFORMATION AND COMMUNICATION TECHNOLOGY PI: Àngel Priegue</p> <p>PRE AND POST PROCESSING PI: Abel Coll</p> <p>VALORIZATION OF RESEARCH AND TECHNOLOGY TRANSFER PI: Jordi Jiménez</p>
<p>INNOVATIVE ALGORITHMS AND HPC TECHNIQUES</p> <p>DATA-DRIVEN HIGH-FIDELITY MODELLING PIs: Pedro Díez, Antonio Huerta</p> <p>KRATOS MULTIPHYSICS PI: Riccardo Rossi</p> <p>LARGE SCALE SCIENTIFIC COMPUTING PI: Santiago Badia</p>	<p>TRANSPORT</p> <p>AERONAUTICS PI: Jordi Pons</p> <p>CENIT - INNOVATION IN TRANSPORT PI: Sergi Saurí</p> <p>NAVAL AND MARINE ENGINEERING PI: Borja Serván</p>



Building, Energy and Environment

The Building Energy and Environment Group (CIMNE BEE Group) involves over 15 researchers (Physics, Engineering, ICT and Statistics specialists). It was founded in 2001 and has two main offices, one in the GAIA building of the UPC Campus in Terrassa and the other in the Agrobiotech Park in Lleida.

CIMNE BEE Group scouts the science world looking for knowledge and inspiration. Developing better building energy management by improving precision, providing faster response, setting up adaptive and predictive control and making buildings more responsive to users' requirements and wishes.

Making energy data more useful to professionals and companies by reducing cost and increasing applicability and reliability through Big Data Analytics, personalized energy services and adaptive visual interfaces and mobile applications.

BEE Group collaborates with national and international leading research centres and public and private companies to develop research projects related with energy, buildings and the environment.

Research

Smart Grids and Demand response in buildings

PI: Gerard Mor

Energy empowerment and user behavior

PI: Stoyan Danov

Big data analytics for energy efficiency in buildings

PI: Jordi Carbonell

Bio-digesters

PI: Jaime Martí

Energy communities and Energy positive municipalities

PI: Jordi Cipriano

Staff

Jordi Cipriano (Leader)

Jaume Asensio

Jose Manuel Broto

Jordi Carbonell

Francesc Contreras

Stoyan Danov

Eloi Gabaldon

Marc Girona

Arian Rodrigo Huapaya

Gerard Laguna

Alvaro Luna

Andreu Marí

Jaime Emilio Martí

Edgar Alexis Martínez

Josep Mayos

Gerard Jordi Mor

Pablo A. Moreno

Antonio Pariente

Daniel Pérez

Maria Teresa Sellart

Irene Simó

On-going RTD Projects

BIGG - Building Information aGGregation, harmonization and analytics platform

EC - H2020 - SC3-Secure, clean & efficient energy

Coordinator: REALDOLMEN NV - 01/12/2020 - 30/11/2023

EN-TRACK - Energy Efficiency Performance-Tracking Platform for Benchmarking Savings and Investments in Buildings

EC - H2020 - SC3-Secure, clean & efficient energy

Coordinator: CIMNE - 01/11/2020 - 31/10/2023

ePLANET - European Public Local Authorities' Network for driving the Energy Transition

EC - H2020 - SC3-Secure, clean & efficient energy

Coordinator: CIMNE - 01/09/2021 - 31/08/2024

GAVIUS - From reactive to proactive public administrations

EC - UIA Initiative

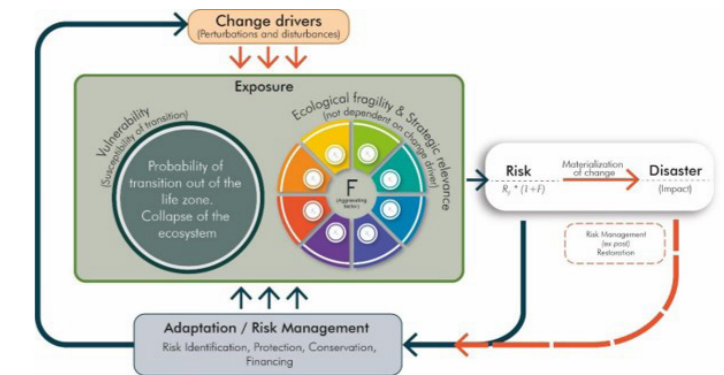
Coordinator: Ajuntament de Gavà

01/09/2019 - 28/02/2023



Disaster Risk and Resilience

The Disaster Risk and Resilience Group (DRR Group) focuses on the development of prospective models to estimate possible economic and human losses caused by events with a natural and anthropogenic origin. This includes the development of multi-hazard catastrophe risk models at different scales and the use of a multidisciplinary and comprehensive framework that considers socio-economic and lack of resilience indicators.



Conceptual framework for a holistic disaster risk assessment in the environment sector.

Current global agendas encourage countries, regions, and cities to manage disaster risk and design climate change adaptation strategies. For that, risk assessments with probabilistic approaches and the development and application of indicators about resilience and disaster risk management provide valuable information to monitor progress in a quantitative manner.

The objective of the DRR Group is to provide approaches, tools, and frameworks to be used in comprehensive risk assessments aiming to have a more resilient society.

The DRR Group collaborates with several multi-lateral organizations and has been actively engaged in research, consulting, and capacity building activities in different world regions.

Research

- Disaster risk assessments at different scales. **PI: Liliana Carreño**
- Development of indicators for disaster risk evaluation, resilience and disaster risk management. **PI: Liliana Carreño**
- Integration of catastrophe models with financial instruments. **PI: Liliana Carreño**

Collaboration agreements

Cálculo para la reevaluación de los espectros de piso de los edificios de control y auxiliar de la C.N. de Vandellòs II, mediante la modelización de los edificios, ANAV.

Staff

M. Liliana Carreño (Leader)
 Alex Barbat
 Sthefania Grajales
 Samar Momin

CR-BCN - Climate-Ready BCN
 ICLEI - ICLEI Action Fund 2.0
 Coordinator: Ecoserveis Associació
 01/05/2023 - 30/06/2025

DEDALUS - Data-driven Residential Energy Carrier-agnostic Demand Response Tools and Multi-value Services

EC - Global Challenges & EIC
 Coordinator: ENG
 01/05/2023 - 30/04/2026

INFRASTRUCTURES - Implementació i posada en servei del sistema centralitzat de gestió de dades dels edificis titularitat d'infraestructures.cat

INFRASTRUCTURES.CAT
 Coordinator: CIMNE
 01/06/2023 - 31/12/2023

SIME-ICAEN - Desenvolupament i posada en marxa del Sistema d'Informació i Monitorització energètica de la Generalitat de Catalunya
 Institut Català d'Energia
 Coordinator: CIMNE
 01/01/2023 - 31/12/2023

Technology transfer

The BEE Group collaborates with national and international companies and institutions since 2001, a long journey with some 50 national and international RTD projects that has carried on a trade to emerge two new business "Start-ups": Inergy (created in 2012) and Beedata Analytics (created in 2017).



Further information at "Spin-off Companies" section at page 80.

For the last few years, the BEE Group started a technology transfer process towards two institutions belonging to the Catalan regional government, the Catalan Institute of Energy (ICAEN), and the public company Infraestructures.cat. These processes will help both institutions set up their digital infrastructure to support energy services and energy-conservative measures over all the administrative buildings of the Generalitat de Catalunya.

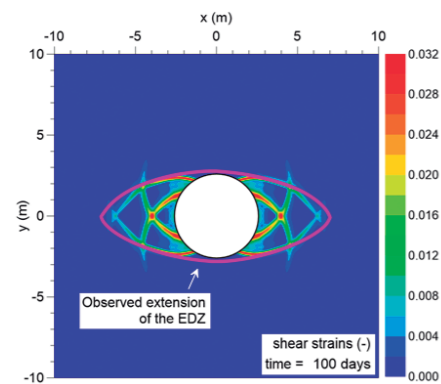
Geomechanics

The research work of the Geomechanics Group focuses on the contribution to fundamental understanding and modelling of soil and rock behavior, the development of advanced computational tools and testing techniques at laboratory scale and the participation in applied engineering projects.

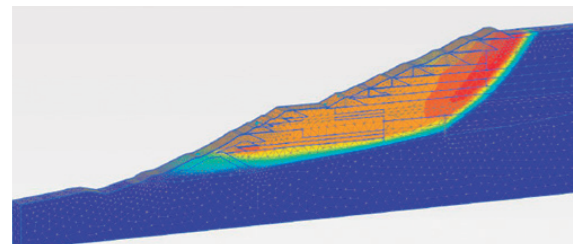
Achieving a proper balance among these aspects has been a permanent objective of the group over the years. The research of the group and the software developed are a reference in the analysis of coupled thermal, hydraulic, mechanical and chemical processes in porous media applied to the analysis and design of underground structures (tunnels, foundations, geo-reservoirs, etc), earth and rockfill dams and fluid-soil-structure interaction problems.

Research

- Coupled multi-physical analyses of porous media. Application to radioactive waste disposal. **PIs: Sebastià Olivella and Antonio Gens**

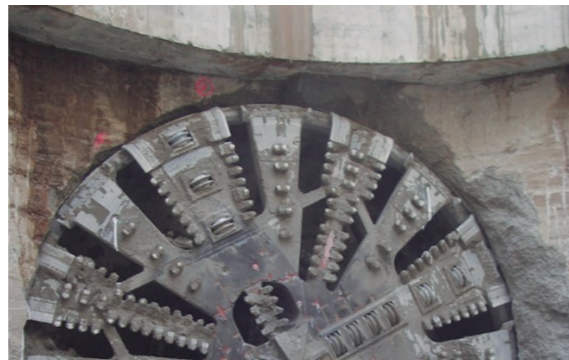


- Analysis and modelling of tailings dams.

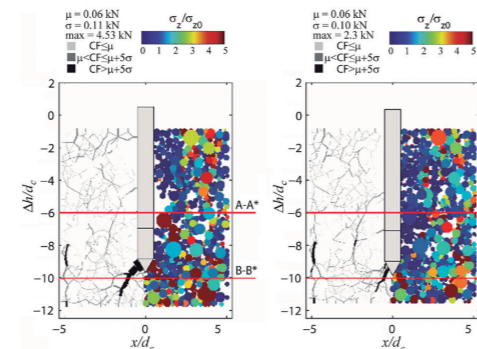


PIs: Marcos Arroyo, Daniel Tarragó and Antonio Gens

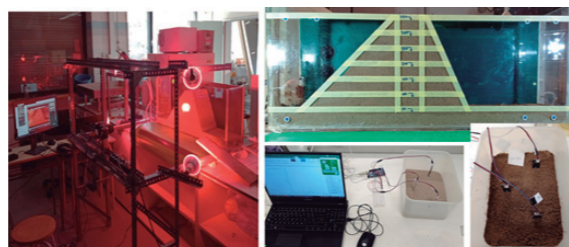
- Numerical analysis of large-scale infrastructure projects. **PI: Antonio Gens**



- DEM and PFEM modelling of penetration problems in Geomechanics. **PIs: Marcos Arroyo and Antonio Gens**

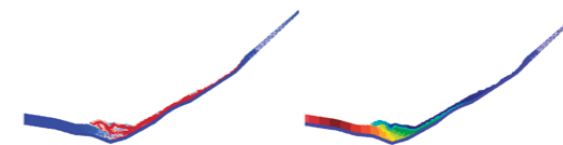


- Advance image analysis techniques for laboratory experiments in soils including large displacements and deformations. Measurements of degree of saturation based on infrared-images. **PI: Núria M. Pinyol**



- Thermal-hydro-mechanical large deformation problems in porous media. Development of a Material Point Method open source code. **PI: Núria M. Pinyol**

- Thermal accelerated seismic-induced-landslides.
- MPM modelling of flow-landslides.
- Design and construction of a geotechnical drum centrifuge for evaluating physical models subjected to large displacements and deformations.

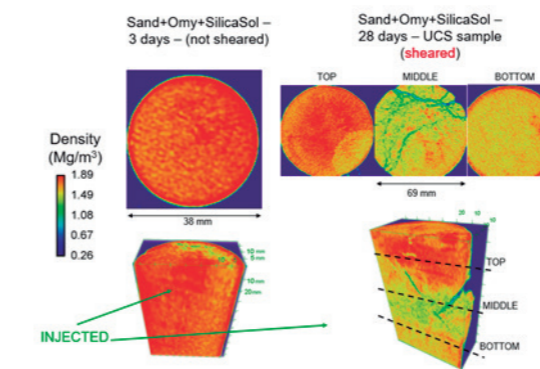


- Unsaturated Soil Mechanics. Experimental and theoretical advances. Application to embankments, dams and radioactive waste disposal. **PI: Eduardo Alonso.**

- Rockfill Mechanics. Particle breakage. Relative humidity effect. DEM modelling. **PI: Eduardo Alonso**

- Multi-scale experiments and analyses of geomaterials. **PIs: Enrique Romero and Laura González Blanco**

- Multi scale analysis of low-carbon soil binders. **PIs: Alessandro Fraccica, Enrique Romero, & Marcos Arroyo**



- Multi-physics experiments and modelling of geomaterials. **PIs: Enrique Romero and Laura González Blanco**

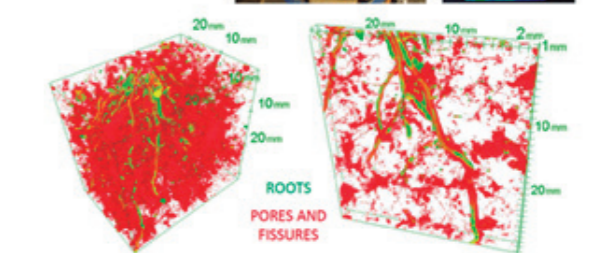
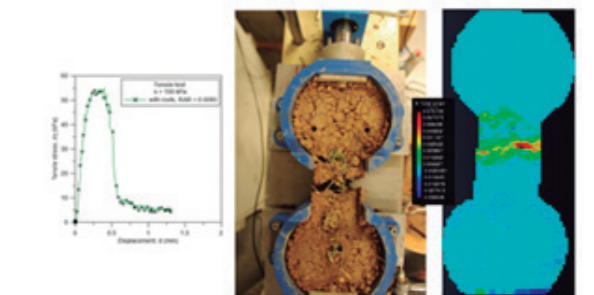
PIs: Enrique Romero and Laura González Blanco

- Cracking in desiccating soils. **PIs: Alberto Ledesma and Pere Prat**

- Crystal Growth in sulphated soils and rocks. Swelling and structure interaction. **PI: Anna Ramon**

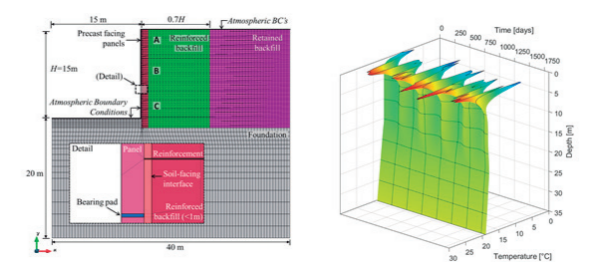
- Effects of Vegetation on the hydro-mechanical behaviour of soils. **PIs: Enrique Romero and Alessandro Fraccica**

PIs: Enrique Romero and Alessandro Fraccica



- Coupled modelling of polymeric reinforced geotechnical structures subjected to environmental conditions. **PIs: Ivan P. Damians, Aníbal Moncada and Sebastià Olivella**

PIs: Ivan P. Damians, Aníbal Moncada and Sebastià Olivella





Ongoing projects

EURAD – European Joint Programme on Radioactive Waste Management – H2020 (2014-2020) – EURATOM
 Coordinator: AALTO – 01/06/2019 – 31/05/2024

ANHYROCK – Mecanismos de expansión y criterios de diseño en rocas anhidríticas
 MICINN – Generación de Conocimiento
 Coordinator: CIMNE – 01/09/2022 – 30/08/2026

MAKE-UP ANURA3D – Towards a user-friendly and efficient open-source code Anura3D
 MICINN – Generación de Conocimiento
 Coordinator: CIMNE – 01/12/2022 – 30/11/2024

PASMA – Principios y aplicaciones de la mecánica del suelo para anclaje de instalaciones marinas de energías renovables – MCIU – Retos Investigación
 Coordinator: CIMNE – 01/09/2021 – 31/08/2024

REROOT – REalistic models of soil-ROOT mechanical interaction
 MICINN – Generación de Conocimiento
 Coordinator: CIMNE – 01/12/2022 – 30/11/2024

Staff

Sebastià Olivella (Leader)

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 Katia Boschi
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 Marcel Hürlimann
 María J. Knobelsdorf
 Judith Landinez
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 Mateu Maglia
 Arisleidy Mesa

Aníbal A. Moncada
 Lluís Monforte
 Núria Pinyol
 Ivan Puig
 Anna Ramon
 Richard Andrés Ramos
 Mohammad Razavi
 Alfonso Rodríguez
 Enrique Romero
 Jatnna A. Sánchez
 Sebastián Sandoval
 Núria Sau
 Babak Sayad
 Fernando A. Sossa
 Daniel Tarragó
 Erdem Toprak
 Jean Vaunat
 Davood Yazdani
 María Teresa Yubero

Hydrogeology



The Hydrogeology Research Group conducts research and knowledge transfer to society in the fields of subsurface hydrology and bio-geochemistry. The Group works on the characterization of permeable media by hydraulic data, hydrochemical and environmental isotope. Applications include groundwater resources, aquifer management, saltwater intrusion, managed aquifer recharge, and transport of pathogenic microorganisms in the subsurface.

The methods span several scales, from the pore to regional aquifers, strongly based on quantitative methods, with the use of numerical modeling of flow and mass transport including bio catalyzed chemical reactions. Emphasis is placed on process understanding, based on experimental efforts at the laboratory and the field, leading to model conceptualization of complex phenomena in the field of Water Resources that need to be addressed by new computing.

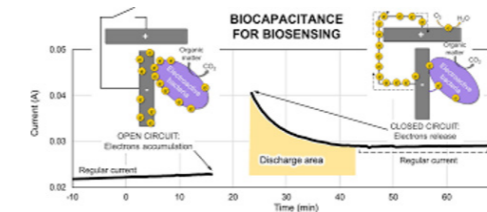


Figure from the paper “Exploring the biocapacitance in M3C-based biosensors for the assessment of microbial activity and organic matter”, by M. Fernandez-Gatell et al., Science of the Total Environment, 2023.

Research

- Simulations of biofilm growth in porous media.
PI: Xavier Sánchez-Vila
- Hydraulic test interpretation in heterogeneous aquifers.
PI: Xavier Sánchez-Vila

Staff

Xavier Sánchez-Vila (Leader)
 Malik Dawi
 Buse Yetisti

Machine Learning in Civil Engineering

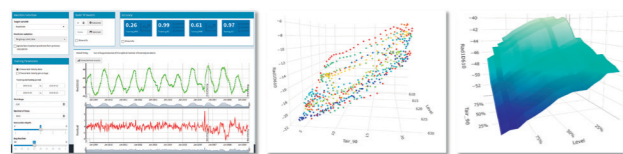
The main objective of the group is to solve complex engineering problems by applying Machine Learning (ML) techniques with data obtained from sensors and numerical models. The main area of activity is the field of hydraulic works: dams, spillways, water supply networks, hydrology and water treatments for contaminant disinfection. Moreover, ML-based techniques are being applied in other fields such as the analysis of railway ballast, air quality forecasting or optimization of manufacturing processes such as metal forming. We also have a demonstrated background in the development and implementation of numerical models applied to hydraulic problems (CFD) as well as to other types of processes: thermo-mechanical behaviour of infrastructures and development of discrete particle methods (DEM).

The group has solid experience in all the stages of ML-modelling application: (i) development of pre-process actions (imbalanced data strategies, data imputation methods, augmented data processes), (ii) implementation and analysis of different algorithms (ensemble-tree based, neural networks-based, among others) (iii) proposal of innovative methodologies (improving extreme range forecasting, automatic calibration, anomaly detection, quantification of uncertainty in complex problems, combination with numerical modelling and graph theory concepts), and (iv) post-process analysis (analysis of results based on a wide range of performance metrics, probabilistic approaches and in-depth knowledge of feature importance interpretation). The group has a clear practical approach, and includes among its capabilities the development of customized software prototypes with graphical-user interfaces.

Research

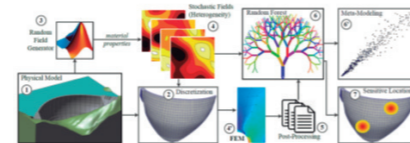
Research activities involving Machine Learning techniques:

- **Machine Learning (ML) for dam safety assessment:** Development of methodologies and software for analysis of dam monitoring data, including generation of ML predictive models and their interpretation, with the final objective of supporting decision making in dam safety.



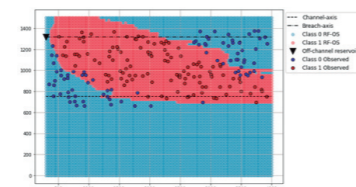
Software for dam safety assessment through ML: screenshots of PREDATOR/SOLDIER application

- **New computational tools for reliability-based dam safety assessment:** Use of ML models to support FEM analysis to predict dam response in ordinary and extreme scenarios.



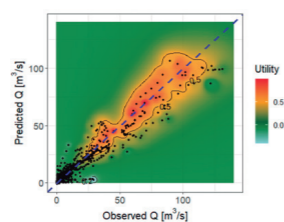
Anomaly detection in dams: example of monitoring network (left) and numerical model to simulate anomalous events (right)

- **Evaluation of potential risk of off-stream reservoirs:** Development of data-driven classification models for fast evaluation of damages due to failure of off-stream reservoirs.



Results of ML model for predicting damages due to failure of off-stream reservoirs

- **Short-term streamflow prediction:** Combining synthetic (based on the physically-based model Iber) and measured data to produce prediction of hourly streamflow with machine learning models.



Results related to short-term streamflow prediction research

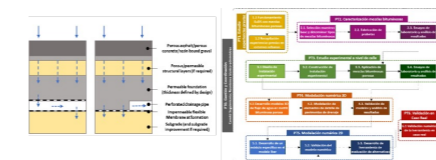


- **Smart optimization of industrial processes:** Support and optimization of rotational metal deformation design processes. Use of FEM-based Digital Twin framework combined with ML classification techniques.

- **Development of calibration utilities:** Calibration of Discrete Element Method (DEM) parameters combining high performance numerical calculation with ML.

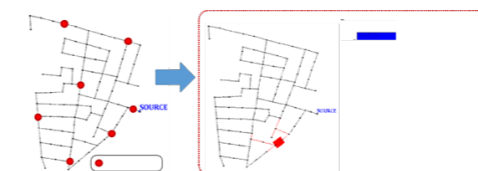
- **Design of advanced water quality treatment techniques:** Application of ML models for water contaminant disinfection forecasting and optimization of advanced oxidation processes.

- **Numerical modelling for simulating urban drainage with permeable pavements:** Development of numerical models for the three-dimensional characterization of infiltration laws in porous bituminous mixtures and modelling of different drainage techniques.



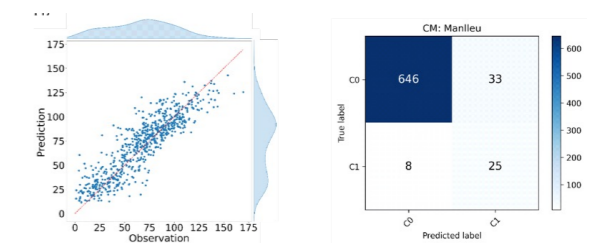
Schematic representation of pavements with different drainage systems (left) and WP structure of BITSRAIN project (right)

- **Leakage management in Water Distribution Networks (WDN):** Development of data-driven classification models based on pressure monitoring data, combining ML techniques and graph theory for leakage location.



- **Water quality forecasting in reservoirs:** Combination of satellite images and ML modelling to predict water quality indicators (turbidity, chlorophyll a, Secchi disk) in reservoirs located in the region of Madrid.

- **Tropospheric ozone concentration forecasting based on ML techniques:** Analysis of meteorological and air quality data; development of new criteria to assess regression and classification models for ozone (O3) forecasting and analysis of occurrence of high episodes.



Results obtained with regression (left) and classification (right) ML-based approaches.

- **Prediction of modified Treatment in Cerebral Ischemia (mTICI):** Development of surrogate models, based on numerical simulation framework and ML-based models to predict the probability of occurrence of mTICI 3.

On-going RTD Projects

DIGIT4WATER – Development of digital tools based on Machine Learning models for the prediction of removal levels of different pollutants in advanced tertiary treatments

MCIU - Generación de Conocimiento
 Coordinator: CIEMAT- 01/12/2022 - 30/11/2024

DOLMEN – Control de la seguridad de presas con umbrales de aviso dinámicos combinando modelos numéricos y aprendizaje automático

MCIU - Generación de Conocimiento
 Coordinator: CIMNE - 01/09/2022 - 31/08/2025

OPTIPRO – Sistema inteligente de optimización de procesos de deformación de metal por rotación mediante simulación avanzada

MCIU – Retos Colaboración
 Coordinator: Industrias Puigjaner, S.A - 01/07/2020 - 30/06/2023

OPTIREP – Millores tecnològiques per optimitzar els processos de conformat metàl·lic per repulsat

Acció - Nuclis d'R+D empresarial

Coordinator: CIMNE - 01/01/2023 - 31/12/2024

PIKSEL 2023 DACC – Portal integrador de coneixement per a la gestió sostenible dels ecosistemes i del territori (Portal Integrative of Knowledge for a Sustainable Ecosystems and Land management) – piPLATES Fase III

GENCAT

Coordinator: CIMNE - 01/06/2023 - 31/12/2023

PIKSEL 2023 DTER – Portal integrador de coneixement per a la gestió sostenible dels ecosistemes i del territori (Portal Integrative of Knowledge for a Sustainable Ecosystems and Land management) – piPLATES Fase III

GENCAT

Coordinator: CIMNE - 01/01/2023 - 31/12/2023

MECA-ICTUS – Mecánica Computacional y Aprendizaje Automático para el apoyo en la toma de decisiones urgente en el tratamiento del Ictus Isquémico.

MICINN

Coordinator: LaCàN - 01/09/2023 - 31/08/2026

Staff

Fernando Salazar (Leader)

Joaquín Irazábal

Sergio Ricardo Lopez

Pavel Pascacio De Los Santos

Nathalia Silva

David J. Vicente



River Dynamics and Hydrologic Engineering (Flumen Institute)



Research

• River hydrodynamics:

- Settlements and land use concerning flood risks
- Solid transport and river geomorphology
- Transport of non reactive substances
- River rehabilitation
- Preservation and rehabilitation of wetlands



The FLUMEN Institute is the outcome of merging the FLUMEN RTD group existing since 2005 at the School of Civil Engineering of UPC - BarcelonaTech and CIMNE, bringing together the numerical and experimental expertise of FLUMEN RTD group in hydraulics with the broad experience of CIMNE on numerical methods, computer simulation and integration of decision support systems.

The objectives of FLUMEN are the promotion of RTD and technology transfer activities in the field of River Dynamics and Hydrologic Engineering.

FLUMEN is an Academic Research Institute affiliated with the Technical University of Catalonia (UPC · BarcelonaTech) and CIMNE. FLUMEN was founded by the Government of Catalonia (Generalitat de Catalunya) through the order ECO/305/2012 on October 3rd (DOGC October 17th) and it is an interdisciplinary research group (SGR 1139).

The FLUMEN Institute is actively engaged in research activities, consulting, training and technology transfer in relation to hydrology and river dynamics. When first established in the 1980's the experience of the Flumen Research Group was incorporated.

These activities have been developed and perpetuated inside the framework provided by the School of Civil Engineering of Barcelona, and the Department of Civil and Environmental Engineering of UPC.



• Urban hydrology:



- Urban drainage: sewer network/surface runoff. Inlets
- Pollutant load in urban hydrology
- Flood risks in urban areas

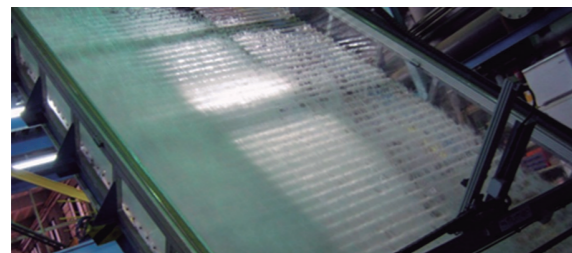


Structural Mechanics



- Thermal and hydrodynamic behaviour
- Sediment and nutrients dynamics
- Reservoir impact on river dynamics
- Corrective measures

• Dam hydraulics:

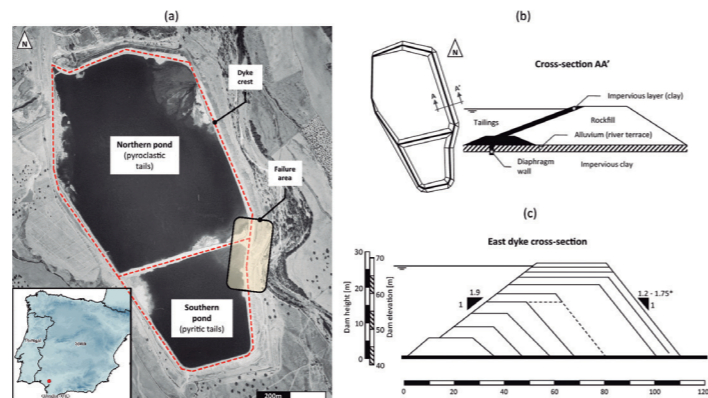


- New designs for spill-flows
- Spills over crest

• Irrigation canals exploitation:



- Automatic control algorithms
- Control structure and lateral storage



Revisiting the Hydraulics of the Aznalcóllar Mine Disaster (M. Sanz et al., 2022)

• Flow-soil-structure interaction:

- New numerical methods based on the integration particles technique with discrete element methods and finite elements
- Stability and safety of structures under hydraulic influences (water)

Staff

Ernest Bladé (Leader)

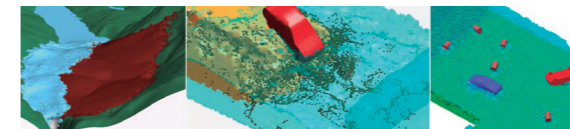
Danial Dehgan Suraki
Gonzalo Olivares
Anaïs Ramos

The objective of the Structural Mechanics Group is the development of innovative numerical methods for analysis of structures of standard materials (metallic materials and concrete), as well as structures incorporating new materials such as composites and hybrid materials.

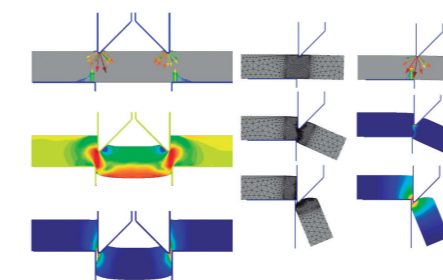
The numerical methods developed by the group include the finite element method (FEM) and a number of particle-based computational techniques, such as the discrete element method (DEM) and the particle finite element method (PFEM), among others.

Research

- **Finite element methods (FEM) for nonlinear analysis of solids and structures with standard and composite materials.** Applications in the building and construction sector and the transport sector. **PIs: F. Rastellini and E. Oñate.**
- **Particle Finite Element Method (PFEM) for multidisciplinary coupled problems in engineering.**

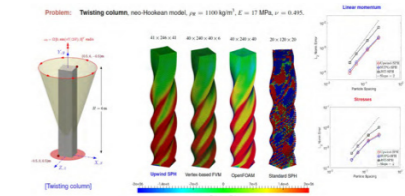


- **Innovative interface elements** for modelling discontinuities in solids. **PI: I. de Pouplana**
- **Particle Finite Element Method (PFEM) for multidisciplinary problems in solid mechanics.** **PIs: J.M. Carbonell and E. Oñate**

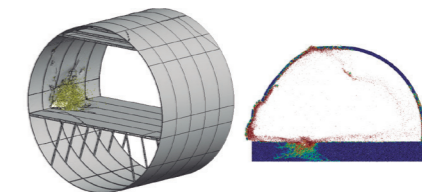


- **Discrete element methods (DEM)** for analysis of non-cohesive and cohesive materials. **PIs: M.A. Celigueta and E. Oñate**

- **First order hyperbolic laws for solids.** Applications in structural mechanic problems. **PI: J Bonet**

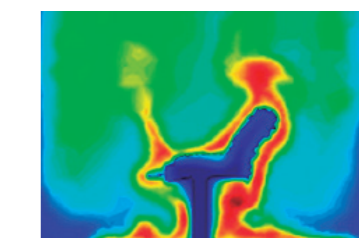


- **Coupling of DEM, FEM and PFEM procedures.** **PIs: M.A. Celigueta, G. Casas and I. Pouplana**
- **Finite elements** for analysis of plates and shells. **PIs: E. Oñate, F. Rastellini and J.M. González**
- **FEM-DEM procedures** for analysis of multi-fracture problems in solids and structures. **PIs: F. Zarate, A. Cornejo, J.M. Cornejo and E. Oñate**



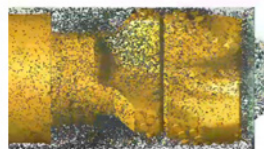
- **Innovative fatigue models accounting** for coupled damage and plasticity effects for analysis of structures under high, medium and low cycling loads with the FEM. **PIs: S. Jimenez, L. Barbu and E. Oñate**

- **Modelling and simulation** of the melting and burning of objects in fire. **PIs: J. Marti and E. Oñate**



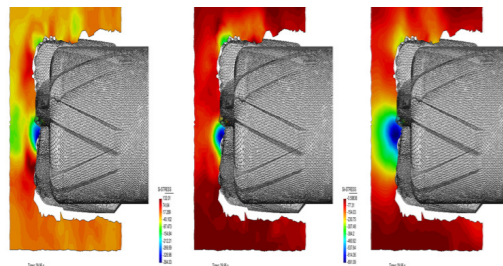
- **Particle-based methods for analysis of particulate flows.** Applications to the modelling and simulation of suspended particles in fluids.

PIs: S. Idelsohn, E. Oñate, J.M. Gimenez and G. Casas



- **Numerical methods for accurate and fast solution** of transient problems in continuum and structural mechanics using particle-based techniques and finite element procedures. Applications to problems in the oil and gas industry, environmental safety problems and industrial forming processes.

PIs: E. Oñate and I. de Pouplana



- **Numerical methods for analysis of the propagation of pollution in air flows.** Application to the study of propagation of NO₂ emissions due to traffic in urban environments. **PIs:** I de Pouplana and E.Oñate



- **Fast explicit time integration schemes with large time steps.** Applications in transient heat conduction problems, Stokes flows and Lagrangian flows. **PI:** E. Oñate

On-going RTD Projects

ADAPTA - Computational models for assessment and treatment aortic dissections: evaluation and design endovascular devices

MICINN - Generación de Conocimiento
Coordinator: CIMNE - 01/09/2022 - 31/08/2025

COMET-KI -Modeling and simulation of laser-controlled process and manufacturing techniques (VII-2.06)

FFG - COMET
Coordinator: PCCL - 01/01/2021 - 31/12/2024

DIDRO - Towards building of Digital Twins for manufacturing processes based on drop-on-demand printing

MICINN - Generación de Conocimiento
Coordinator: CIMNE - 01/12/2022 - 30/11/2024

GRAIN - An innovative multi-scale data-driven paradigm for the modelling of granular flows

MICINN - Generación de Conocimiento
Coordinator: CIMNE - 01/09/2022 -31/08/2025

MATHEGRAM - Multiscale analysis of thermomechanical behaviour of granular materials

EC - H2020 - Coordinator: USUR - UNIS
01/01/2019 - 30/06/2023

OPTIPRO - Sistema inteligente de optimización de procesos de deformación de metal por rotación mediante simulación avanzada

MCIU - Retos Colaboración - 01/07/2020 - 30/06/2023

PARAFUIDS - Un Método Numérico Multi-Escala para Fluidos con Partículas

MCIU - Retos Investigación - 01/06/2020 - 31/05/2023

PECT InnoDelta - Projecte d'Especialització i Competitivitat Territorial InnoDelta: Territori laboratori per a la sostenibilitat ambiental, social i econòmica del teixit industrial

GENCAT - Instruments per a la especialització intel·ligent
Coordinator: Viladecans City Council
30/04/2021 - 31/12/2023

REROOT - REalistic models or soil-ROOT mechanical interaction

MICINN - Generación de Conocimiento
Coordinator: CIMNE - 01/12/2022 - 30/11/2024



Staff

Eugenio Oñate (Leader)

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Mónica A. Buitrago
Albert Cabane
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Josep Maria Carbonell
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Guillermo Casas
Ton Creus
Ignasi De Pouplana
Daniel Di Capua
Sofía Di Capua
Cuauhtemoc Escudero
Alessandro Franci
Juan Marcelo Gimenez
José Manuel González
Joaquín Gonzalez
Mohammad Reza Hassemi
Sergio R. Idelsohn
Salvador Latorre
Julio Marcelo Marti
Gabriel Mendonça
Javier Mora

Rafael Nazareth
Alejandro Núñez
Ethel Bibiana Olmos
Humberto Perez
David Pujol
Brain Junior Ramírez
Fernando Gabriel Rastellini
Aniol Sala
Antonio Jose Salazar
Omar Salomón
Chengshun Shang
Laurence Sigler
Marta Torres
Xavier Tort
Francesc Turón
Pere-Andreu Ubach
Yeudy Felipe Vargas
Roland Wüchner
Ana María Zapata
Francisco Zárate

SECCO2 - Software libre para la digitalización del proceso de secuestro de CO₂

MICINN -Generación de Conocimiento
Coordinator: CIMNE - 01/12/2022 - 30/11/2024

OPTIREP - Milllores tecnològiques per optimitzar els processos de conformat metàl·lic per repulsat.

ACCIÓ - Nuclis d Innovacio Tecnologica
Coordinator: Puigjaner - 01/01/2023 - 31/12/2024

PIKSEL 2023 DACC - Portal integrador de coneixement per a la gestió sostenible dels ecosistemes i del territori (Portal Integrative of Knowledge for a Sustainable Ecosystems and Land management) - piPLATES Fase III

GENCAT
Coordinator: CIMNE - 01/06/2023 - 31/12/2023

PIKSEL 2023 DTER - Portal integrador de coneixement per a la gestió sostenible dels ecosistemes i del territori (Portal Integrative of Knowledge for a Sustainable Ecosystems and Land management) - piPLATES Fase III

GENCAT
Coordinator: CIMNE - 01/01/2023 - 31/12/2023

POTENTIAL - ComPutatiOnal Tools to Enable the design of smarT soft materIAls

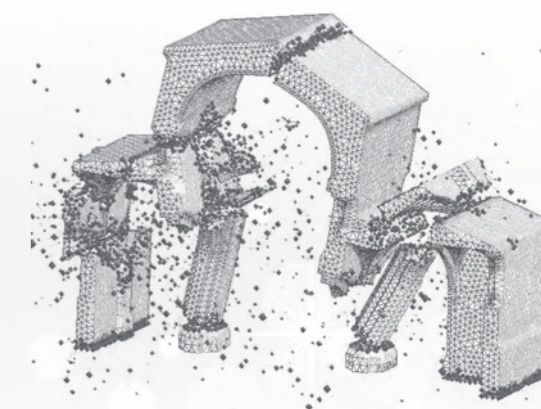
MICINN
Coordinator: CIMNE - 01/09/2023 - 31/08/2026

RESILMOB - Sistema Predictiu per una Mobilitat Resilient

ACCIÓ - Nuclis d'Innovació Tecnològica
Coordinator: PIGRA - 01/01/2023 - 31/12/2024

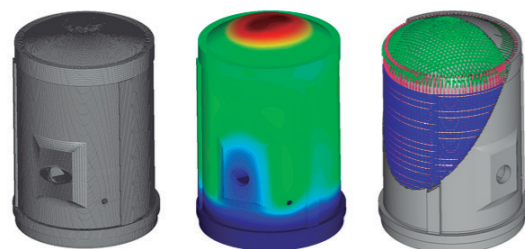
SuPreAM - PREdictive simulation of finishing operations in steel Additive Manufacturing for optimal SURface integrity

EC - RFCS-Research Fund for Coal and Steel
Coordinator: EURECAT - 01/07/2023 - 31/12/2026



Composites and Advanced Materials for Multifunctional Structures

The main objective of the Composites and Advanced Materials for Multifunctional Structures (CAMMS) group at CIMNE is to develop numerical methods and procedures for the prediction and characterization of the performance of such materials, and to use these methods in the analysis of large multifunctional structures.



Geometry and Finite Element mesh of a nuclear containment building. See the steel tendons distributed within the structure

Research

Numerical Strategies for the analysis of Composites Materials

Composites and Advanced Materials are understood as all materials with improved properties, requiring of specific formulations for their correct analysis and characterization. Among those, the group has a large tradition on the development of numerical strategies for the analysis of composite materials made of fibres embedded in a matrix system, ranging from an improved version of the mixing theory, to more advanced multiscale procedures.

Additional research lines:

- Constitutive laws for the analysis of plasticity and damage
- Models for the analysis of fibre-metal laminates
- Reinforced and prestressed concrete
- Topological optimized materials
- Fatigue

Subdomain deformation modes of an omega pultruded beam obtained with the ROM



Integration with FE Codes

The final objective of all advanced materials models developed is the analysis of large structures and multifunctional structures.

Staff

Xavier Martínez (Leader)

Barbara Alcayde	Fermin E. Otero
Lucía G. Barbu	Raul Rubio
Alejandro Cornejo	Pablo Sierra
Maria Montserrat Dolz	Alireza Taherzadeh
Àlex Ferrer	Gerard Villalta
Luis Antônio Gonçalves	
Sergio Jimenez	
Sergi Ocón	

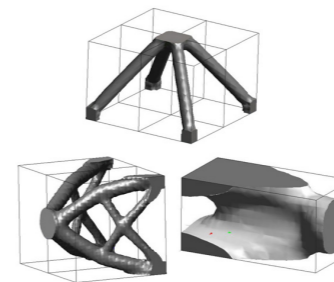
On-going RTD Projects

Fatigue4Light - Fatigue modelling and fast testing methodologies to optimize part design and to boost lightweight materials deployment in chassis parts
H2020 - SC4-Smart, green & integrated transport
Coordinator: CIMNE - 01/02/2021 - 31/01/2024

FIBRE4YARDS - FIBRE composite manufacturing technologies FOR the automation and modular construction in shipYARDS
EC- H2020 - SC4-Smart, green & integrated transport
Coordinator: CIMNE - 01/01/2021 - 31/12/2023

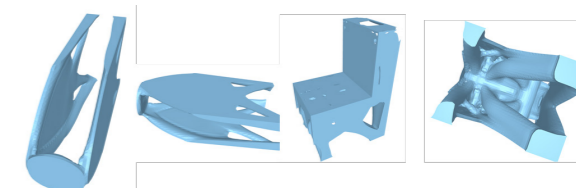
FIBREGY - Development, engineering, production and life-cycle management of improved FIBRE-based material solutions
H2020 - Leadership in enabling & industrial technologies
Coordinator: CIMNE - 01/01/2021 - 31/12/2023

GRAIN - An innovative multi-scale data-driven paradigm for the modelling of granular flows
MICINN - Generación de Conocimiento
Coordinator: CIMNE
01/09/2022 - 31/08/2025

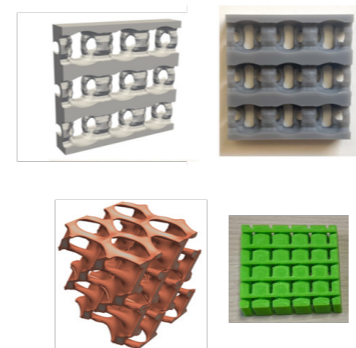


Shape and topology algorithms implemented for generative design of materials and structures

GECKO - Design for IGA-type discretization workflows
EC
Coordinator: CIMNE
31/12/2022 - 31/12/2026



BLAST_IT - New numerical methodology for the simulation of fracture due to pressure pulses. Gas-structure interaction
MICINN
Coordinator: CIMNE
01/09/2023 - 31/08/2026

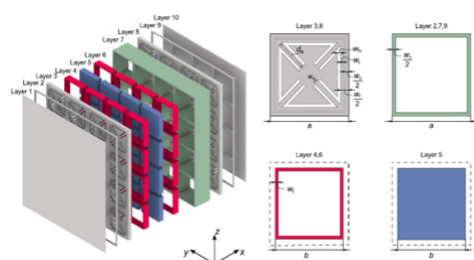


Computational Design & Analysis of Engineering Metamaterials

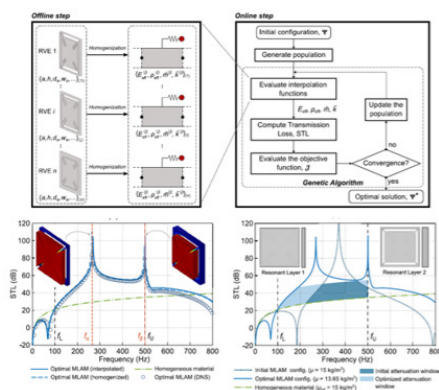
The mission of the Computational Design & Analysis of Engineering Metamaterials group is the development of new computational tools for designing metamaterials with extreme acoustic, mechanical and electro-magnetic properties, focusing engineering applications.

Research

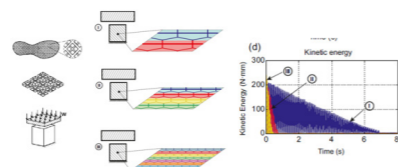
- **Computational Design of Engineering Metamaterials.** Sound transmission loss enhancement through triple-peak coupled resonances acoustic metamaterials. Applications: high-performance acoustic insulation of buildings.



- **Computational topology optimization of materials.** Optimal design of Multiresonant Layered Acoustic Metamaterials (MLAM) via a homogenization approach. Applications: optimal design of materials and metamaterials.



- **Multiscale computational design of energy dissipation metamaterials.** Applications to packaging and sport equipment.



- **Efficient and accurate non-linear computational modelling of laminated composites.** Novel proposal: the 2D+ multiscale approach. Applications: virtual characterization and certification of aerial and terrestrial transport vehicle structures.

Staff

**Xavier Oliver/
Juan Carlos Cante
(Leaders)**

Oriol Lloberas

David Roca

Gastón Sal-Anglada

Pablo Wierna

Daniel Yago

On-going RTD Projects

AC-METATECH-DES - Noise mitigation via acoustic metamaterial technology: computational design and prototyping solutions

MICINN - Generación de Conocimiento

Coordinator: CIMNE - 01/12/2022 - 30/11/2024

METACOUSTECH - Demonstration of acoustic metamaterial-based technology for soundproofing applications

AGAUR - PRODUCTE 2021

Coordinator: CIMNE - 19/10/2022 - 18/04/2024

DMK-COMPOSITE - Técnicas de Multiescala con Cinemática Degenerada (DMK) en la cualificación del aprendizaje automático asistido de materiales compuestos laminados para aplicaciones aeronáuticas

MICINN

Coordinator: CIMNE - 01/09/2023 - 31/08/2026



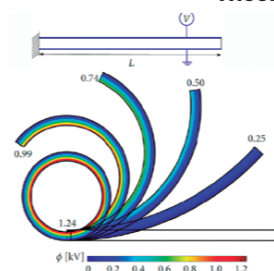
Mechanics of Electroactive Materials

This group will develop theoretical and computational models to quantify flexoelectricity in solids, focusing on continuum models but also exploring multiscale aspects, in tight collaboration with experiments.

The research group explores the effects of strain gradients on the physics of dielectrics, identifying fundamental manifestations and identifying the underlying engineering principles for a new generation of electromechanical metamaterials.

Research

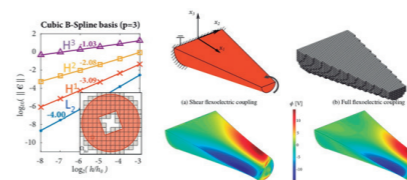
- **Theoretical framework of flexoelectricity.** A comprehensive theoretical framework for flexoelectricity in infinitesimal and finite deformation, establishing the precise connections between the different families of formulations, their physical interpretation and the physical meaning of the corresponding set of high-order boundary conditions.



PIs: D. Codony, H. Mohammadi and I. Arias

- **Efficient numerical solution of high-order general electromechanics problems:** Advanced discretization methods, including immersed B-splines and C0 penalty, for the efficient solution of the 4th-order PDE system arising in flexoelectricity in general geometries, material and electrode configurations.

PIs: D. Codony, S. Fernández and Irene Arias



- **Reduced theories of flexoelectric beams and shells:** Reduced theories for non-linear flexoelectric beams and non-linear shells to gain understanding of the physics and aid the design of new devices.

PIs: P. Gupta, D. Millán and I. Arias

- **Flexoelectricity from first principles:** Electronic structure calculations of flexoelectric systems to establish a precise connection with continuum models both guiding the development of enriched models accounting for nanoscale effects and finite surface effects and characterizing continuum model parameters. **PIs: D. Codony, M. Dingle, I. Arias in collaboration with P. Suryanarayana**

- **Fundamental manifestation of flexoelectricity in torsion mechanics:** Development of new methods to mobilize flexoelectricity under torsion to provide understanding about the fundamental physics and flexoelectricity characterization tools.

PIs: Irene Arias and A. Mocci

- **Fundamental manifestation of flexoelectricity in strain and electric field singularities:** cracks, ferroelectric domain walls, creasing, AFM: Exploration of the physics of flexoelectricity in situations where large strain or electric field gradients develop.

PIs: H. Mohammadi, I. Arias and external collaborators (G. Catalan, N. Domingo, ICN2, P. Paruch, U. Geneva, S. Hong, KAIST).

- **Design and characterization of flexoelectric devices and metamaterials:** New concepts for the design of effectively piezoelectric metamaterials and devices from non-piezoelectric components.

PIs: Irene Arias, A. Mocci, D. Codony, P. Gupta and F. Grecco

- **Theoretical and computational modeling of flexo-photovoltaics:** Development of a theoretical and computational framework for the simulation of flexo-photovoltaics aiming at the design and optimization of a new family of solar-cells.

PIs: Irene Arias, D. Codony and S. Fernández

Staff

Irene Arias (Leader)

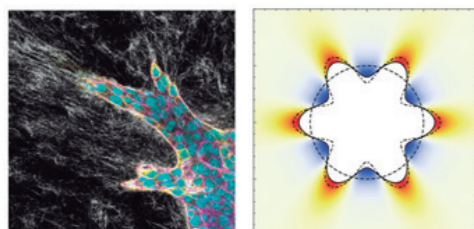
Hossein Mohammadi

Soft and Living Material Interfaces

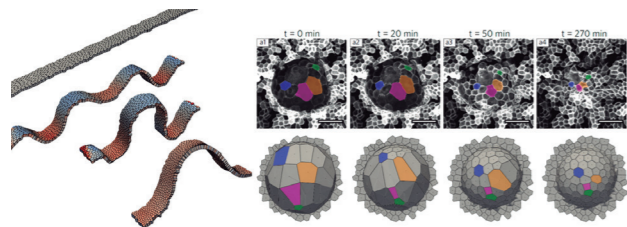
The group develops theoretical and computational models for the mechanobiology biological interfaces, cells and tissues, with the goal of quantitatively understanding these systems, rationally manipulating active living materials and engineering new bionic materials.

Research

- **Mechanisms of collective invasion in breast cancer organoids:** In tight collaboration with Group Khalil (UMC Utrecht), identification of the mechanisms leading to collective invasion in the context of invasive ductal carcinoma, specifically the two-way interplay between cellular activity and collagen matrix chemo-mechanics. **PI: Marino Arroyo**

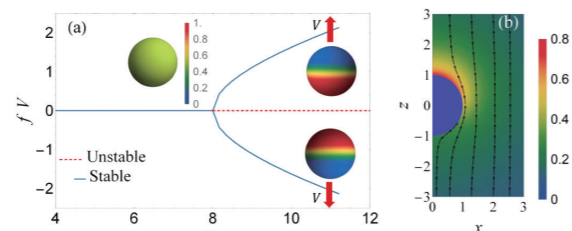


- **Mechanics of Epithelial materials:** Development of theoretical and computational models to understand and rationally manipulate epithelial materials in-vivo and in bio-hybrid devices. **PI: Marino Arroyo**

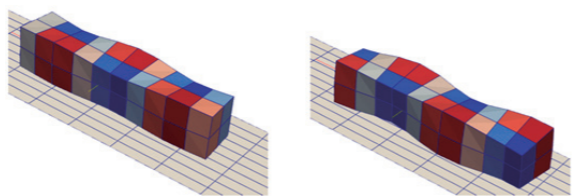


- **Mechanics of the cell envelope:** Development of theoretical and computational models to understand and quantify the mechanics of the cell envelope, and to develop biomimetic multifunctional systems based on the engineering principles of the cell envelope. **PI: Marino Arroyo**

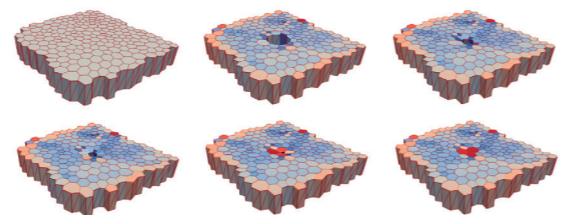
- **Motility of cells and of artificial bio-inspired systems:** Development of theoretical and computational models to understand cell motility and to understand and conceive mechanisms for bio-inspired motile artificial systems. **PI: Marino Arroyo**



- **Analysis of cell and tissue dynamics:** Modelling of regulation of cell contractility and intercalation during morphogenesis. Development of specific finite element and vertex models. **PI: José Muñoz.**



- **Control and optimisation in organism locomotion:** design of optimisation and control numerical algorithms for understanding locomotion patterns of microorganism. **PI: José Muñoz**



Staff

Marino Arroyo (Leader)

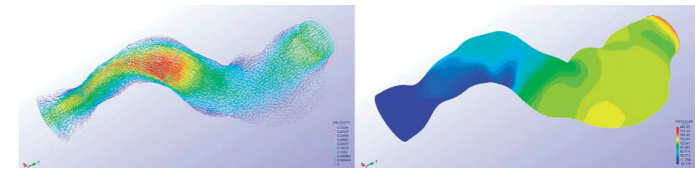
- Ashutosh Bijalwan
- Pau Blanco
- Eduard Jove
- Jose J. Muñoz



Bio-Medical Engineering

The main objective of the group is to solve complex biomedical engineering problems by applying numerical models, machine learning techniques and virtual and augmented reality models.

- **Artificial Intelligence Methods:** Combination of numerical simulations with machine learning techniques for different pathologies.

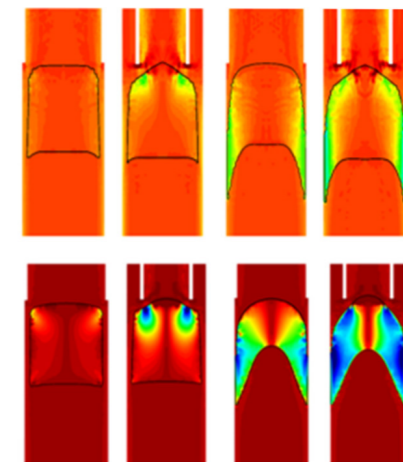


The Biomedical Engineering (BME) group of CIMNE offers software solutions to automatically transform medical imaging to create a 3D digital twins of the patients to help diagnostics, to virtually try treatments, and to automatically design optimal braces and devices.

One of the main areas of activity of the BME group is the field of personalized cardiovascular devices. For medical companies and physicians who need to improve their personalized designs, BME brings innovative tools based on our numerical simulation technology to better design cardiovascular medical devices during the pre-prototype stage. The BME group aims at making patient care more personalized and secured.

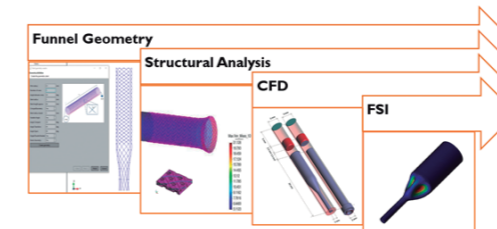
- **Medical Device R&D:** Medical devices for medical companies and physicians to improve their personalized designs. Innovative tools based on our numerical simulation technology to better design medical devices during the pre-prototype stage.

PIs: E. Soudah and J. A. Hernández.

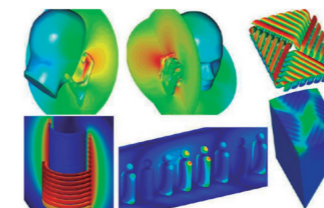


Research

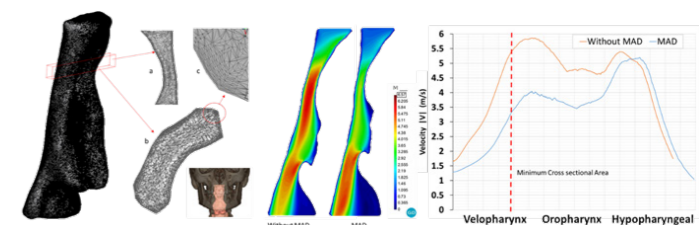
- **Cardiovascular Research:** Methods to simulate blood flow simulation for different cardiovascular pathologies as Abdominal Aneurysm, Aorta coarctation and dissection, etc. Full scale cardiovascular models: 0D-1D-3D. **PI: E.Soudah.**



- **Electromagnetics in Health:** Numerical simulations model to study the effect of the electromagnetic field inside humans.

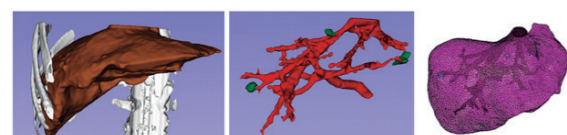


- **Respiratory System:** New solution for Obstructive Sleep Apnea treatment (OSAS). **PI: E. Soudah.**

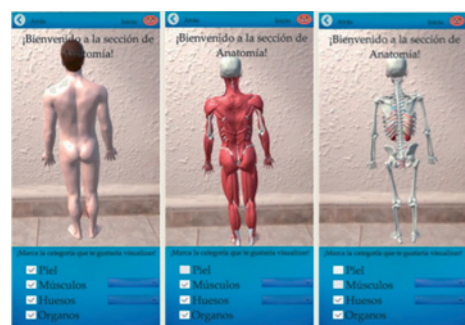




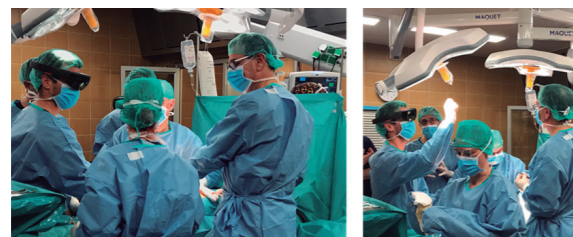
- **Image Processing & Modelling:** Software solutions to automatically transform medical imaging to create a 3D digital models to help diagnostics, to virtually try treatments, and to automatically design optimal devices. **PI: E. Soudah.**



- **BIM & TIC Applications:** Mobile applications and virtual scenarios for teaching and training anatomy, anesthesia and cardiovascular pathologies for medical/resident students and continuous training of the healthcare system. BIM environment for hospitals. **PI: E. Soudah.**



- **Augmented and Virtual Reality:** Interactive surgical communication platform based on augmented reality technology for clinical remote assistance in real time. **PI: E. Soudah.**



On-going RTD Projects

ADAPTA. Computational models for assessment and treatment Aortic dissections: evaluation and design endovascular devices

MICINN - Generación de Conocimiento
 Coordinator: CIMNE - 01/09/2022 - 31/08/2025

NEXTGEM: Next Generation Integrated Sensing and Analytical System for Monitoring and Assessing Radiofrequency Electromagnetic Field Exposure and Health.

EC- HE (2021-2027)
 Coordinator: FORTH - 01/07/2022 - 30/06/2026

SIMUPATCH. Safety and efficacy validation of a medical device to treat aortic dissection using in silico and in vitro tools

MICINN - Transferencia de Conocimiento
 Coordinator: CIMNE - 01/09/2022 - 31/08/2025

MECA-ICTUS - Mecánica Computacional y Aprendizaje Automático para el apoyo en la toma de decisiones urgente en el tratamiento del Ictus Isquémico

MICINN - Generación de Conocimiento
 Coordinator: CIMNE - 01/09/2023 - 31/08/2026

Staff

Eduardo Soudah (Leader)

Agustina Giuliodori
 Michele Nigro
 Rubén Otín



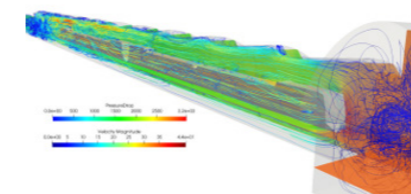
Fluid Mechanics

The Fluid Mechanics Group focuses on the development of mathematical models and numerical methods for the solution of a wide range of problems in engineering and other applied sciences involving external and internal flows.

Applications include, among others, high speed compressible flows, turbulent flows, shallow water flows, flow in porous media, aero-acoustics, wave propagation, viscoelastic fluids, bio-flows and many multidisciplinary coupled problems involving fluids, such as magneto-hydro-dynamics, fluid-structure interaction, and thermal flows.

Research

- **Stabilized finite element methods for problems** involving waves, viscoelastic flows, compressible flows, shallow water flows, magneto-hydro-dynamics, approximation of eigenvalues, finite strain solid dynamics and structural elements. **PI: R. Codina**
- **Embedded techniques in moving domains.**



- **Reduced order models in fluid mechanics (ROM).** Development of POD and adaptivity/Artificial-Neural-Network based reduced order models, with special emphasis on stabilization issues. **PIs: R. Codina and S. Idelsohn**

- **Fluid-structure interaction problems.**
- **Numerical simulation of Friction Stir Welding.** This research line focuses on using h-adaptive and for-

mulation adaptive methodologies, to the problem of Friction Stir Welding.

- **Approximation of lubrication models.**
- **Numerical modeling of ultrasonic waves and waveguides.**
- **Fracture mechanics.**
- **Numerical simulation of Additive manufacturing processes.** H-adaptive methodologies, high performance computing and large scale parallelization. Application to metallic materials, plastics and concrete. **PI: J. Baiges**

On-going projects

ePLANET European Public Local Authorities' Network for driving the Energy Transition
 EC - H2020 - SC3
 CIMNE - 01/09/2021 - 31/08/2024

SSeCoID - Stability and Sensitivity Methods for Flow Control and Industrial Design
 EC - H2020 - MSCA-Marie Skłodowska-Curie actions
 Coordinator: UPM - 01/01/2021 - 31/12/2024

TOP-FSI - Topology Optimization of structures subject to fluid structure interaction
 MCIU - Retos Investigación
 Coordinator: CIMNE - 01/01/2019 - 31/09/2022

Staff

Ramon Codina (Leader)

Joan Baiges	Ignacio Martinez
María Jesús Bopp	Carlos Augusto Moreira
Zulkeefal Dar	Javad Sekhavati
Arnau Fabra	
Hauke Gravenkamp	
Behrooz Karami	
Sheraz Ahmed Khan	

Industrial Manufacturing Processes

Since 1998, the Industrial Manufacturing Processes Group develops computational tools for thermo-mechanical modeling and advanced non-linear analysis tools.

The outcomes are generally implemented in COMET, a Finite Element based framework for the solution of engineering problems in both academic and industrial environments.

Multiple software modules of COMET have been successfully commercialized in Spain and worldwide for different industrial applications:

- Casting analysis: VULCAN
- Mold filling: CLICK2CAST
- Welding: WELDPACK
- Additive Manufacturing: ADD2MAN
- Sheet metal forming: STAMPACK

Research

PIs: M.Cervera and M. Chiumenti

- **Advanced Manufacturing Processes:** Additive Manufacturing, Friction Stir Welding, Electron Beam Welding, Shaped Metal Deposition, Casting processes and Metal Forming.
- **Constitutive Modeling and Computational Failure Mechanics.** New constitutive models appropriate for mechanical and civil engineering materials.

On-going projects

KYKLOS 4.0 – An Advanced Circular and Agile Manufacturing Ecosystem based on rapid reconfigurable manufacturing process and individualized consumer preferences – EC – H2020 – Coordinator: TECNALIA 01/01/2020 – 31/12/2023

RESILMOB – Sistema Predictiu per una Mobilitat Resilient GENCAT – ACCIÓ
Coordinator: PIGRA – 01/01/2023 – 31/12/2024

OPTIPRO – Optimización inteligente de procesos de deformación de metal por rotación mediante simulación avanzada

MCIU – Retos Colaboración

Coordinator: Industrias Puigjaner, SA
01/07/2020 – 30/06/2023

SSeCoID – Stability and Sensitivity Methods for Flow Control and Industrial Design

EC – H2020 – MSCA-Marie Skłodowska-Curie actions

Coordinator: UPM – 01/01/2021 – 31/12/2024

TOPFSI-APP – Software de optimización topológica de estructuras sujetas a interacción fluido-estructura

MICINN – Transferencia de Conocimiento

Coordinator: CIMNE – 01/12/2022 – 30/11/2024

PriMuS – Printing pattern based and MultiScale enhanced performance analysis of advanced Additive Manufacturing components

MCIU – Retos Investigación

Coordinator: CIMNE – 01/09/2021 – 31/08/2024

SuPreAM – PREDictive simulation of finishing operations in steel Additive Manufacturing for optimal surface integrity

EC – RFCS

Coordinator: EURECAT – 01/07/2023 – 31/12/2026

Staff

Miguel Cervera (Leader)

Michele Chiumenti (Leader)

Carlos Agelet

Gabriel Barbat

Manuel Caicedo

Narges Dialami

Sima Farshbaf

Oscar Fruitos

Xufei Lu

Runeal Ramma

Iván Rivet

Mehdi Slimani

Henning Venghaus



Data-Driven High-Fidelity Modeling

In daily industrial practice, Computational Engineering faces two critical issues: efficiency and credibility. Indeed, efficient strategies are needed to carry out computationally-demanding multiple queries of complex multi-physics and multi-disciplinary problems arising in parametric studies. Besides, the output of the model is expected to be credible, namely with guaranteed numerical accuracy and quantified and controlled uncertainty. In a data-driven approach, data is used to update the model and quantify uncertainty.

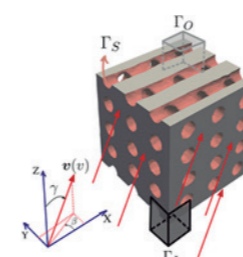
The group responds to these challenges adopting a comprehensive approach in the discipline of computational science and engineering, developing new mathematical models and numerical methods to produce high-fidelity solutions in a variety of complex interdisciplinary problems.

The group is also active in the development of open-source software and in the integration of innovative algorithms in existing open-source libraries.

Research

- **Credible computational modeling & Uncertainty Quantification.** Development of numerical tools to assess and control credibility. This embraces four underlying ideas: control the numerical accuracy (Verification), enhance the quality of the approximation (Adaptivity), monitor the pertinence of the model (Validation) and account for the aleatoric nature of the systems analyzed (Uncertainty Quantification).

- **Data-driven model-updating.** Data assimilation strategies incorporate into models data from sensors, observations, and also from other models. This is complementary to Validation (via parameter identification) and strongly related with Uncertainty Quantification. This line includes developing novel Bayesian-based Markov chain Monte Carlo approaches.



- **Reduced order models.** Intrusive and nonintrusive Reduced Order Models, using different numerical strategies accompanied by error control.

- **Multi-fidelity surrogates for parametric studies.** Detailed simulations of complex phenomena are often unaffordable due to their computational cost. At the same time, simplified models are usually not sufficiently accurate to achieve the precision required by physicists and engineers. In order to make real-time solution of parametric problems affordable, this line constructs and blends a hierarchy of simulations of different fidelities, bridging robust solvers with high-fidelity discretizations and reduced order models.

- **High-fidelity and robust solvers for Computational Science and Engineering (CSE).** Development of simulation tools, insensitive to mesh quality, tailored to specific physical problems of industrial interest. Methodologies include robust, low-order Face-Centered Finite Volume (FCFV) and accurate, high-order Hybridizable Discontinuous Galerkin (HDG) methods.

- **Direct data-driven design.** Uncertainty quantification, Numerically efficient methods and software, Generalization to multi-dimensional systems.

On-going RTD Projects

SMiLE – Machine Learning for data-driven modeling

MCIU- Retos Investigación

Coordinator: UNIZAR – 01/09/2021 – 31/08/2024

Staff

Pedro Díez (Leader)

Antonio Huerta (Leader)

Álvaro Borrás

Mariano Fernandez

Stephan Gahima

Matteo Giacomini

Luan Malikoski

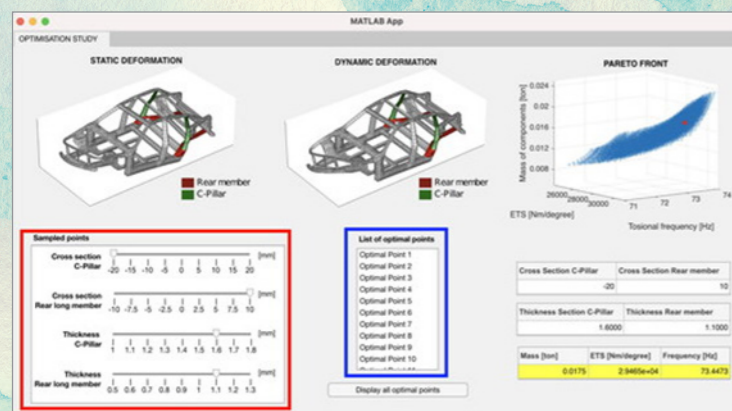
Ivan Markovsky

Rafel Perelló

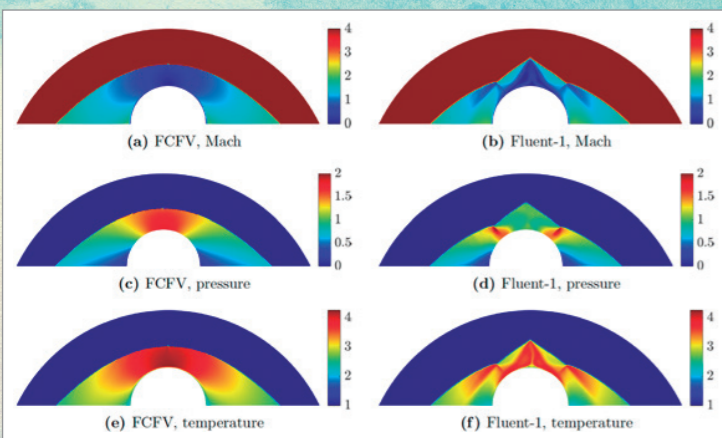
Josep Sarrate

Wanchang Zhang

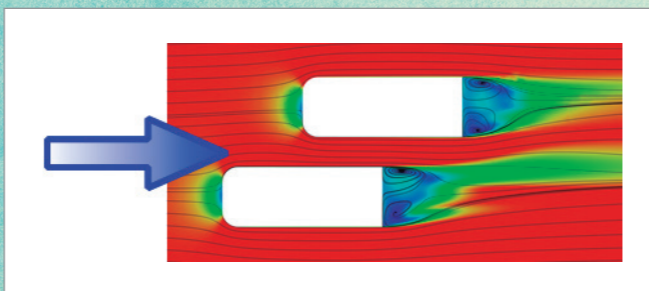
Sergio Zlotnik



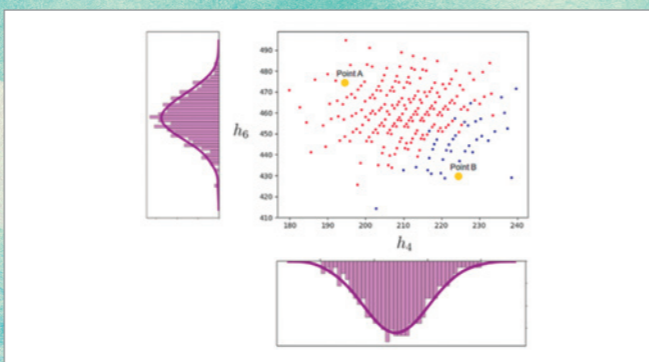
Reduced order models



Robust solvers for computational science and engineering

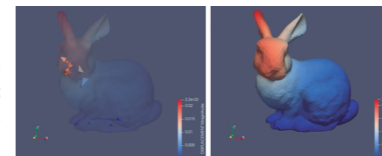


Multi-fidelity surrogates for parametric studies



Credible computational modeling & Uncertainty Quantification

Hyper Reduction (HROM) Results
Left: Active simulated elements, Right: Result projection.



Kratos Multiphysics

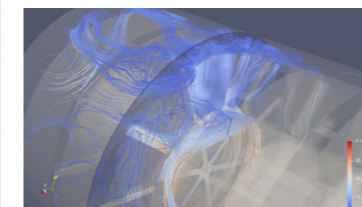
The Kratos Multiphysics group aims at the development of a global purpose research code integrating state-of-the-art capabilities in multiple fields, with the explicit goal of allowing the simulation of complex multiphysics problems.

The group aims at the exploitation of High Performance Computing (HPC) capabilities to be employed for the simulation of realistic engineering problems. This goal will be achieved both by the development of new solution technologies and by exploring the integration of models from different areas, thus making the research intrinsically transversal.

The research will foster open source developments and the collaboration with groups located in different places and working in different areas. It will also contribute to the integration of different technologies within a single, unified, workflow with the goal of enriching the solution capabilities of the Kratos framework.

Research

Development of CFD models and other FEM technologies, including model order Reduction



CFD Simulation of a Motor

Kratos is continuously developing its solver capabilities to better serve projects. This includes the expansion and optimization of existing solvers for levelset-based computational fluid dynamics (CFD) and fluid-structure interaction (FSI) problems featuring two-phase flows.

Development of Simulation Based Digital Twins

The group is actively exploring the combination of Hyperreduced-order models (HROMs) and HPC in order to significantly enhance the development and deployment of digital twins.

HPC Workflows for constructing ROMs

The construction of reduced-order models (ROMs) entails a computationally intensive offline process that has been attacked by means of recourse to high-performance computing. The parallel workflow using Kratos Multiphysics and the COMPS parallelization framework by the Barcelona Supercomputing Center performs the following tasks: a) Model creation; b) High-fidelity simulation; c) Reduction techniques; d) Feedback and refinement.

On-going projects

DIDRO - Digital Twins for manufacturing processes based on drop-on-demand printing

MICINN - Generación de Conocimiento

Coordinator: CIMNE - 01/12/2022 - 30/11/2024

eFlows4HPC - Enabling dynamic and Intelligent workflows in the future EuroHPCecosystem

EC-H2020 - Coordinator: BSC 01/01/2021 - 29/02/2024

NextSim - CODA: Next generation of industrial aerodynamic simulation code

EC-H2020 - Coordinator: BSC - 01/03/2021 - 29/02/2024

DECIMA - DEsign-supporting Computational framework for modeling Coupled Microfluidics in Advanced manufacturing.

MICINN - Generación de Conocimiento -

Coordinator: CIMNE - 01/09/2023 - 31/08/2026

GECKO - Design for IGA-type discretization workflows

EC - MSCA-Marie Skłodowska Curie Actions

Coordinator: CIMNE - 01/01/2023 - 31/12/2026

Staff

Riccardo Rossi
(Leader)

Nicolo Antonelli
Angela Ares De Parga
Mohammad Azizpooryan
Alejandro Cornejo
Francisco Javier Gárate
Andrea Gorgi
Alireza Hashemi
Joaquin Hernandez

Carlos A. Roig
Pavel Ryzhakov
Guglielmo Scovazzi
Nicolás Sibuet
Julio Tozo
Polytimi Zisimopoulou
Rubén Zorrilla
Marco A. Zuñiga

Large-scale Scientific Computing

The large scale scientific computing group develops advanced numerical methods for the simulation of problems governed by PDES, e.g., solid and fluid mechanics and electromagnetics, together with the design and implementation of scalable solvers for the arising linear systems.

Research

- **Uncertainty quantification.** Development and analysis of multilevel Monte Carlo methods for stochastic partial differential equations, discretisation of PDEs on stochastic domains.

PIs: J. Principe

- **Unfitted finite element methods:** Design of robust finite element schemes on embedded meshes, adaptive embedded methods on tree meshes, applications to moving geometries and interfaces.

PIs: S. Badia

- **Advanced geometrical discretisations:** Design of robust and general geometrical discretization tools for embedded/unfitted approximation. One of the main objectives of this research is to develop numerical quadratures that exactly captured complex geometries for this kind of schemes.

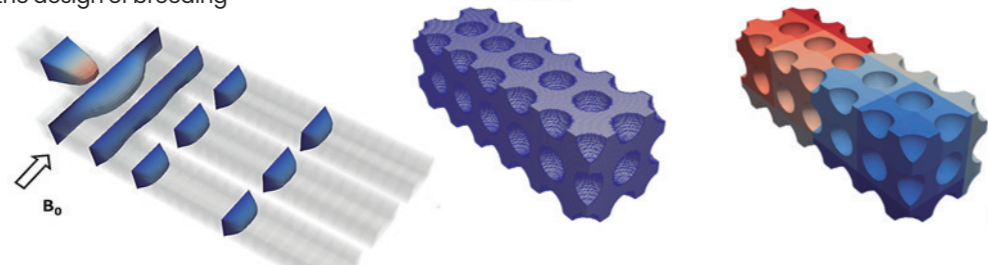
PI: S. Badia

- **Open source scientific software:** Design of advanced mathematical software, e.g., using novel programming languages and programming paradigms, scalable implementations on distributed memory machines.

PIs: S. Badia

- **Numerical methods for fusion technology:** Development of advanced discretization methods for the numerical solution of magnetohydrodynamic problems with application to the design of breeding blankets in fusion reactors.

PIs: S. Badia



On-going RTD Projects

EUROFUSION - Implementation of activities described in the Roadmap to Fusion during Horizon 2020 through a Joint programme of the members of the EUROfusion consortium
 EC - HE (2021-2027)
 Coordinator: MPG - 01/01/2021 - 31/12/2024

AMBBOS - Advanced computational Mathematics for Breeding Blanket Optimal deSign
MICINN - Generación de Conocimiento
 Coordinator: CIMNE - 01/09/2022 - 31/08/2025

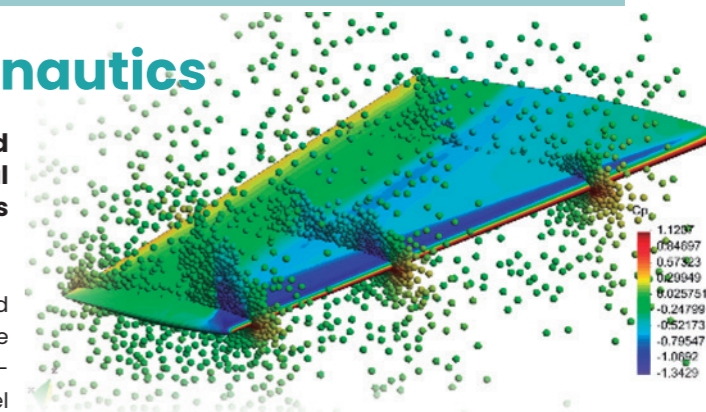
Staff

Santiago Badia (Leader)

Pere Antoni Martorell
 Javier Príncipe
 Saman Rahmani



Aeronautics



The Aeronautics group develops new and challenging projects in the aeronautical field, optimization and data modelling, as well as fuel cells.

The group deals with research in computational fluid dynamics, fluid structure interaction with Particle Finite Element Methods and thin membrane structures, optimization and machine learning, and fuel cells technology and also collaborates with other CIMNE groups in Composites materials analysis or IT technology applied to sensing and data management.

Research

- **FEM and meshless methods for aerodynamics analysis and drag reduction in aeronautics.** This research line is oriented to develop, implement and apply meshless methods in aeronautical and engineering applications. PIs: J. Pons-Prats and E. Ortega

- **Fluid-Structure Interaction and aeroelastic problems.** This research line is intended to develop methods for FSI problems in aeronautical and civil engineering. Emphasis is placed on fast (low-fidelity/surrogate) solution methods suitable for practical applications. PIs: E. Ortega and J. Pons-Prats

- **Optimization algorithms for robust optimal design, shape optimization and material design in aeronautics.** This research line is oriented to develop, implement and apply meshless methods in aeronautical and engineering applications. PIs: G. Bugeda and J. Pons-Prats

- **Future Mobility and future airport.** This research line focuses on future mobility paradigms, like Urban Air Mobility for passenger transport, and the effects on the design of airports. PIs: J. Pons-Prats

On-going RTD Projects

GAVIUS - Gavius: from reactive to proactive public administrations
 EC - 4th Call for Proposals (2019)
 Coordinator: Ajuntament de Gavà
 01/09/2019 - 28/02/2023

NextSim - CODA: Next generation of industrial aerodynamic simulation code
 EC-H2020 - Coordinator: BSC
 01/03/2021 - 29/02/2024

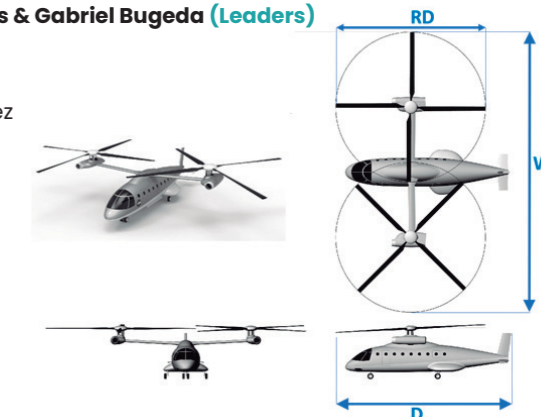
SSeCoID - Stability and Sensitivity Methods for Flow Control and Industrial Design
 EC-H2020 - Coordinator: UPM
 01/01/2021 - 31/12/2024

Impact Monitor - Impact Monitor
 EC - Global Challenges. Climate, Energy & Mobility
 Coordinator:
 DLR - 01/02/2023 - 31/01/2025

Staff

Jordi Pons-Prats & Gabriel Bugeda (Leaders)

Oriol Frigola
 Sergio González
 Christian Narváez
 Enrique Ortega
 Jacques Periaux
 Agustí Porta
 Raúl Sáez



Innovation in Multimodal Transport

The main activity of The Innovation in Multimodal Transport Group (CENIT) is the knowledge generation related to transport, from logistics and mobility, to its transmission to society through research, training and technology transfer.

CENIT has carried out a large number of research projects, development and technology transfer projects in different areas of transport economics and engineering. The main goal has always been trying to focus on the social agents demand in specific areas. Especially in urban environment, enhancing the comfort of its inhabitants, providing more efficient transportation, and respect the environment. Investing in new mobility solutions so as to help streamline and optimize traffic management.

- **Transport economics.** Financing of public transport, cost-benefit analysis and pricing strategies.
- **Urban Freight Distribution.** Assessment of the impact of e-commerce on urban mobility and strategies for optimizing the delivery.
- **Green transport.** Environmental impact of several transportation modes and developing strategies and measures to reduce the impacts. The analysis has been focused mainly on port and urban freight sectors.
- **Digitalization.** Impact of digitalization on transport operations and economics, drivers of the digitalization, disruptive technologies. The main focus has been on port sector, urban transport and road freight transport.

Staff

Sergi Saurí (Leader)

Matteo Boschian
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Francesc Gasparin
Maurici Hervas
Yuranny López
Genis Majoral
África Marrero
Alex Mumbrú

Andrés F. Reyes
Francisco Rodero
Paola Rodriguez
Chiara Saragani
Samra Sarwar
Muhammad A. Shafique
Clara Soler

On-going RTD Projects

LASH FIRE - Legislation Assessment addressing Safety Hazards of Fire and Innovations in Ro-ro ship Environments - EC - H2020 (2014-2020)

Coordinator: RISE
01/05/2019 - 30/04/2023

OCEAN - Operator-Centered Enhancement of Awareness in Navigation
EC-HE (2021-2027) - 5.Climate, Energy&Mobility
Coordinator: HVL - 01/10/2022 - 30/09/2025

PIONEERS - PORTable Innovation Open Network for Efficiency and Emissions Reduction Solutions
EC- H2020
Coordinator: Havenbedrijf Antwerpen
01/10/2021 - 30/09/2026

SUPPORT - Captura y valorización de CO2 para el desarrollo de una ruta sostenible para producir combustibles verdes sintéticos para el transporte marítimo
MICINN - Generación de Conocimiento
Coordinator: IREC - 01/12/2022 - 30/11/2025

GREEN MARINE MED - MediterraneAn GRreen Shipping Network: Linking Ports, Industries, Investment and Innovation for Monitoring
EMFAF (2021-2027)
Coordinator: CTN - 01/10/2023 - 30/09/2025

RAIL4CITIES - Railwaystations for green and socially inclusive cities
EC - HORIZON-ER-JU-2022-02
Coordinator: FACTUAL - 01/07/2023 - 30/06/2025



Naval and Marine Engineering

CIMNE has a large experience in conducting RTD projects in naval and marine engineering.

The main activities in these fields are related to the development and application of computational methods and computer aided design and verification tools on the following topics:

- Hydrodynamic analysis of vessels / optimum shape design methods for ships.
- Ship structures / composite materials / fluid-structure interaction effects.
- Offshore structures / fluid-structure interaction effects.
- Environmental problems in naval and marine engineering.
- Multidisciplinary problems in naval and marine engineering.
- Decision support systems in naval and marine engineering / wireless sensor networks / artificial intelligence technology.
- Artificial Intelligence applied to marine engineering.

Development of an IoT platform and implementation of digital twin models for manufacturing processes in shipbuilding, aiming at:

- Providing an IoT platform based on industry standards and the extension of open source libraries.
- Providing a methodology to create digital twins of the different production processes fed with the monitoring system data.

Development of a hydroelastic seakeeping solver based on structural reduce order models with application to:

- Hydroelastic analysis of floating structures.
- Development of digital twins for structural health monitoring.
- Fatigue assessment of floating structures.

Development of state-of-the-art semi-Lagrangian methods with applications to:

- Hydrodynamics.
- Non-linear Seakeeping.

• **Artificial Intelligence (AI) for marine engineering.**

The objective is to obtain an AI tool based on Artificial Neural Networks (ANNs) capable of predicting instantly the seakeeping behavior of ships.

• **Development of an IoT platform and implementing Digital Twin Models for the W2Power platform.**

• **Coupling of hydroelastic solver with Wind Turbine simulator.** The objective of this line is to obtain a computational framework for the full simulation of floating wind turbines.

On-going RTD Projects

FIBRE4YARDS - FIBRE composite manufacturing technologies FOR the automation and modular construction in shipYARDS
EC - H2020
Coordinator: CIMNE - 01/01/2021 - 31/12/2023

FIBREGY - Development, engineering, production and life-cycle management of improved FIBRE-based material solutions
EC - H2020
Coordinator: CIMNE - 01/01/2021 - 31/12/2023

prodPhD - Social network tools and procedures for developing entrepreneurial skills in PhD programmes - EC - H2020
Coordinator: CIMNE - 01/01/2021 - 28/02/2023

MLAMAR - Development of a Machine Learning strategy for hydroelastic analysis of ships
MICINN- Generación de Conocimiento
Coordinator: CIMNE - 01/09/2022 - 31/08/2025

Staff

Borja Serván (Leader)

Irene Berdugo
Miguel Calpe

Rafael Pacheco
Andrés Pastor

Information and Communication Technology

The Information and Communication Technology Group is an R&D group of CIMNE expert in providing new services, applications and solutions based on the state-of-the-art of groundbreaking ICT technologies ranging from Artificial Intelligence to Internet of Things, Blockchain and GIS.

The main research lines of CIMNE TIC consist of Artificial Intelligence technologies, IoT platforms, Decision Support Systems, GIS technologies, Blockchain and Web and App technologies covering different fields in engineering such as civil, maritime, aerospace, environmental, agricultural, manufacturing, mechanical, telecommunication and biomedical engineering.

Research

Computation and Information Technologies

PIs: Àngel Priegue

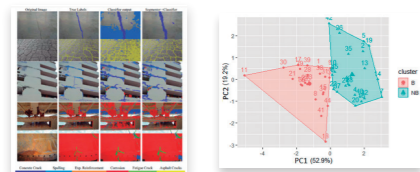
- IOT Technologies
- AI Technologies (ML, DL, TinyML)
- Blockchain
- GIS Technologies & Simulations
- Computer Vision
- DSS/EWS/CPS/ Monitoring Platforms Development
- Biomedical Signal Processing
- Web/App Development
- Proactive Communications Tools
- Water
- Data analytics

Staff

Àngel Priegue (Leader)

Pedro A. Arnau
Laura Almunia
Alberto Burgos
Sergi Macian
Andreu Marí

Javier Soraluze
Alberto Tena
Sergio Valero
Claudio M. Zinggerling



Ongoing projects

LIFE4MEDECA - Support for the preparation of Emission Control Areas in the Mediterranean Sea

EC - LIFE (2014-2020) - **Coordinator:** Autorità di Sistema Portuale del Mar Tirreno Centro Settentrionale - 01/01/2021 - 31/12/2023

GAVIUS - From reactive to proactive public administrations

EC - UIA Initiative - **Coordinator:** Ajuntament de Gavà 01/09/2019 - 28/02/2023

LASH FIRE - Legislation Assessment addressing Safety Hazards of Fire and Innovations in Ro-ro ship Environments

EC - H2020 - SC4 - Smart, green & integrated transport **Coordinator:** RISE - 01/09/2019 - 31/08/2023

PECT InnoDelta - Projecte d'Especialització i Competitivitat Territorial InnoDelta

GENCAT - **Coordinator:** Viladecans City Council - 30/04/2021 - 31/12/2023

COSTETRA - Valorització i transferència de la tecnologia Cool Steam a la cadena de valor de l'Hidrogen verd (COol Steam TEchnology valorization and TRANSfer to green Hydrogen value chain)

AGAUR - **Coordinator:** CIMNE - 16/09/2023 - 17/10/2023

LAIF - Un nuevo concepto basado en técnicas de visión por computador para salvar vidas en situaciones de riesgo de ahogamiento

ACCIÓ - Nuclis d'Innovació Tecnològica **Coordinator:** PRO-ACTIVA - 01/06/2023 - 31/05/2025

PRyS - Modelo Predictivo de Riesgos y Seguros

ACCIÓ - Nuclis d'Innovació Tecnològica **Coordinator:** MELMACIA LAB SL- 01/02/2023 - 31/01/2025

RETHINK TOURISM - Estandarización Digital de los indicadores de sostenibilidad hotelera (2023)

MITYC **Coordinator:** Asociación RE Think Tourism 01/05/2023 - 31/03/2024



Pre and Post-Processing

The Pre and Postprocessing Group works on the development of advanced methods for efficient generation of data for numerical simulations and visualization of computational results. This group holds the development team of the commercial pre and post-processing environment GiD, which is a universal pre and post-processor for numerical simulations.

Research

• Computational Geometry. PI: E. Escolano

- Computer Aided Design (CAD) tools development to cover numerical simulation tools.
- Adaptation of CAD tools to deal with real complex industrial models

• Mesh Generation. PI: A. Coll

- Development and improvement of mesh generation tools for numerical simulations, covering the needs of all CIMNE groups devoted to numerical simulations, as well as the GiD users.
- Advanced mesh generation techniques for 3D images to get simulation mesh automatically from the input 3D images data.
- Implementation of GiDMeshLibrary to allow the use of meshing and remeshing techniques directly from the simulation solvers.

• Postprocessing for numerical simulations.

PI: M. Pasenau

Development of advanced postprocessing techniques for numerical simulations, specially for cases of huge distributed results focused on High Performance Computing (HPC) architectures.

• Advanced visualization. PI: M. Pasenau

Advanced 3d visualization techniques adapted for numerical simulations, considering very big models and sets of results, as well as remote solutions to allow the use of light devices (mobile) for visualizing simulations adapted to cloud architectures.

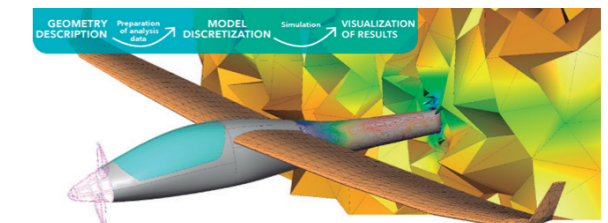
• Software architecture. PI: A. Melendo

- Design of Graphical User Interface (GUI) for simulation software, and customization of solvers to be integrated in GiD pre and postprocessing platform.
- Adaptation of cloud architectures to cover the needs of simulation software, and implementation of a new platform for simulations based on Software as a Service (Saas) business model paradigm.

On-going RTD Projects

NextSim - CODA: Next generation of industrial aerodynamic simulation code

EC-H2020 - **Coordinator:** BSC 01/03/2021 - 29/02/2024

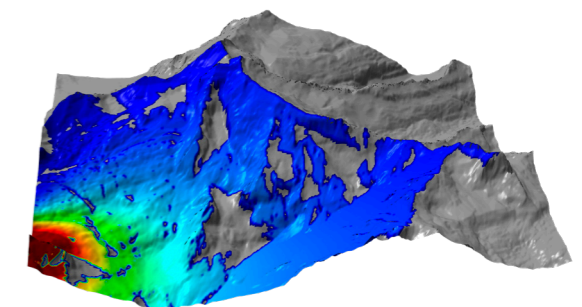


Staff

Abel Coll (Leader)

Enrique Escolano
Javier Gárate
Adrià Melendo
Anna Monros

Miguel Pasenau
Laura Santos



Valorization of Research and Technology Transfer

The Valorization of Research and Technology Transfer (VRTT) Group focuses on the development and implementation of innovative procedures for transforming the outputs of RTD activities of CIMNE into useful prototypes and products of practical interest and their subsequent transfer to industry.

The **VRTT Group** mission is to transfer technology in its broadest sense, by helping to identify and by putting together all the key players in the entire value chain of technology, from creators to distributors in the market. Moreover, the aim of VRTT Group is take new discoveries and innovations from the research and turn them into products or services that can have benefit and Impact on society.

Two main tools are used by CIMNE for the technology transfer: Technology License agreements and creation and shareholding in spin-offs.

The VRTT Group works in cooperation with **CIMNE Tecnologia SAU**, the spin-off company of CIMNE (100% owned by the centre) responsible for taking into market the outcomes of the research activities of CIMNE (www.cimnetecnologia.com).

New technologies under valorization process during year 2023

During 2023, the Valorisation and Transfer Group of the CIMNE (VRTT), together with CIMNE Technology (CT), carried out an inventory process of the technologies/innovations developed by the CIMNE research groups, with the aim of identifying and prioritising the valorisation of those with the greatest potential to reach the market and generate the greatest IMPACT on society:

SimTwins –Kratos Multiphysics

SimTwins is an innovative Digital Twin technology designed to create virtual replicas of physical assets for predictive analysis and decision-making. This technology stands out due to its ability to simulate real-world scenarios in real-time, allowing operators to foresee potential outcomes and make informed decisions.

The novelty of SimTwins lies in its integration of advanced computational models and machine learning algorithms.

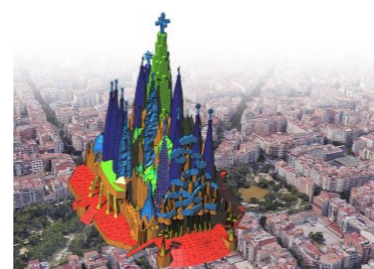
SimTwins won first place in the Innovation Journey 2023, a program dedicated to promoting technology transfer to the market, winning an incubation period at Barcelona Activa and Norrskén House.

GiD Simulation Cloud Platform

The GiD Simulation Cloud Platform as the new paradigm for the upcoming simulation challenges and architectures. This next step in GiD evolution integrates tools from academic and industrial sectors, including open-source software in various computing languages and is accessible via an internet browser and light devices (such as smartphones and tablets), compatible with existing High-Performance Computing (HPC) software and infrastructures.

Digital Twin for Real Time Control of DED for High Energy metal Additive Manufacturing and Repairing Operations (DIGDED)

The technology providing intelligence (AI) to optimize the Direct Energy Deposition (DED) manufacturing process, taking advantage of the current predictive capacity of the numerical models that simulate the process and, in particular, the thermal field and its temporal evolution. This technology can very accurately estimate the laser power delivery along its trajectory, as well as cooling during repositioning pauses, waiting times.



Euglena Shells: Morphable, modular and reusable meta-surfaces for free-form structural engineering inspired by the active envelope of Euglena cells

The patented innovation consists of meta-surfaces composed of parallel slidable strips, which morph by non-uniform patterns of sliding between adjacent strips, and can be made rigid by constraining this sliding. This solution overcomes the main limitations existing mechanisms. The broad potential applicability and radical novelty of the morphing-by-sliding principle make it a potentially disruptive innovation for which a clear value proposition can be articulated and for which government and industry stakeholders have expressed keen interest.



Example of morphable tubular meta-surface made of identical 3D printed sliding strips



Impact Research Strategy at CIMNE

Within the framework of the CIMNE's Strategic Plan 2023-2028, during 2023 the CIMNE's Research Impact Strategy has been created, with the aim of establishing clear criteria for identifying and promoting the impact derived from research at the centre. For this, during 2023, the VRTT Group and CIMNE Technology, together with CIMNE Director, established an impact strategy to ensure that research has tangible applications and benefits for society and industry, beyond academia. In addition, with the goal of to be valued and measured, fostering closer relationships with its stakeholders, such as industry, government and other centres/universities.

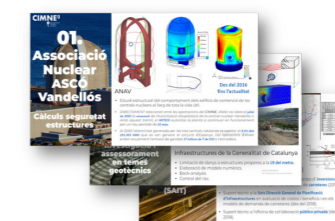


CIMNE Impact Cases

In order to give visibility to the impact achieved by the CIMNE, information has been collected and cases have been written that demonstrate the contribution of the institution's research beyond the academic field, towards the resolution of real problems in society and industry with a high degree of impact. These cases aim to communicate the value of CIMNE's research to funders, collaborators and society in general.

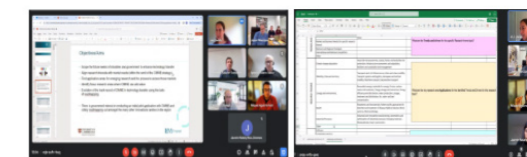
CIMNE Roadmapping Exercise

The CIMNE Roadmapping project, in collaboration with the Institute for Manufacturing (IFM) of the University of Cambridge and with the financial support of the CERCA Centres and the Departament de Transferència i Societat del



Coneixement de la Generalitat de Catalunya, is an initiative that seeks the effective integration of academic research with the needs of the industrial market.

The Roadmapping Exercise stands out for its strategic approach in promoting effective collaboration among key players in the innovation ecosystem. In doing so, CIMNE not only seeks to align its research activities with market needs but also aims to establish itself as a key facilitator in technology transfer and innovation applied to industrial and societal challenges.



IFM Cambridge-CIMNE online working sessions

Publications

CIMNE publishes books, journals, monographs, scientific reports and educational software on the theory and applications of numerical methods in engineering and applied science. The publications of CIMNE can be visited and ordered via Internet on the website books.cimne.com. Most publications can be freely downloaded from the web. We list below the publications of CIMNE in 2023.

NUMBER OF CIMNE PUBLICATIONS (1987-2023)

Edited books	87
Text books	48
Research reports	417
Technical reports	643
Monographs	280
Papers in journals (since 2009)	1.445

Journals



Archives of Computational Methods in Engineering. **Editors:** Kleiber M., Oñate E. Springer, 2023. Journal Impact Factor (2022): 9.7; 5 Year Impact Factor (2022): 9.23; Downloads (2023): 839.293.



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Martínez X., Pons-Prats J., Turon F., Coma M., Barbu L.G., Bugeda G., Multi-objective multi-scale optimization of composite structures, application to an aircraft overhead locker made with bio-composites, Mathematics, vol. 11, 2023.

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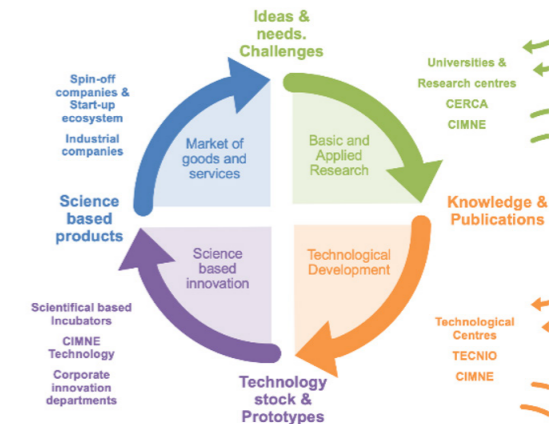
Innovation and technology transfer

Promoting technology transfer from CIMNE.

CIMNE's **Valorization and Tech Transfer** process includes several phases and activities, from the identification of applied research with the potential to be transferred to its effective commercialization, including the protection of intellectual property, licensing of technology, creation of spin-offs and participation in networks and innovation projects.

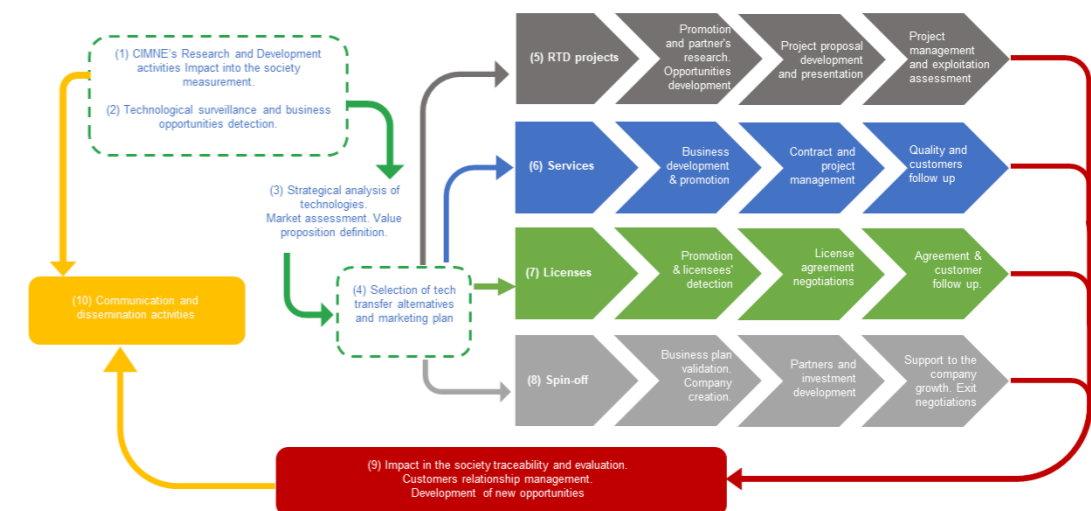
The process begins with **technological surveillance** and the development of research to understand the evolution of the results that are obtained, as well as the adjustment of opportunities that are detected in the industry. The different opportunities are evaluated according to the type of technology transfer alternative that best suits the type of technology and the capabilities and intentions of the research team.

Depending on the case, the development of **R&D projects** with industry, consulting services and tailored developments or the promotion of **technology licenses** to industrial companies are proposed and promoted.



In the case of positively evaluating the creation of a new **spin-off**, the process of market evaluation, business plan and feasibility begins to obtain the industrial partners and investors to take the proposal forward.

As feedback from the process, the **IMPACT** generated by the process in industry and society is assessed and communicated and reported through dissemination actions.



Check the full list of publications on [CIMNE.COM/SCIENTIFIC-PAPERS](https://cimne.com/scientific-papers)



CIMNE Products

PRE AND POST PROCESSING SOFTWARE

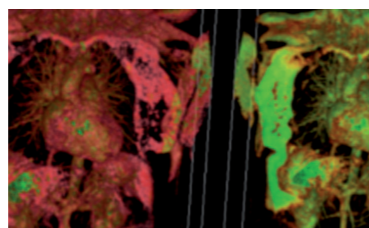
GID



A universal and adaptive pre and postprocessor for computer simulation in engineering and applied science. Developed & marketed by CIMNE since 1998.

✦ www.gidsimulation.com

DIPPO



Versatile platform for digital image processing combined with numerical modelling and simulations.

Developed and marketed by CIMNE since 2011.

ENGINEERING SYSTEMS AND HARDWARE

INFATABLE STRUCTURES



Inflatable pavilions, shelters and bridges for applications in engineering and architecture. Developed by Buildair and CIMNE. Marketed by Buildair since 2002.

✦ buildair.com

OKO



Software and hardware for the intelligent management of audiovisual content and digital signage.

Developed by CIMNE. Marketed by OKTICS ATZ SL.

✦ okobusiness.com

COOL STEAM



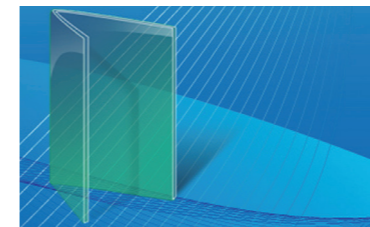
Fresh water production system. Developed by CIMNE and Fresh Water Nature, SL. Marketed by Fresh Water Nature, Ltd. since 2016.

✦ freshwaternature.com



COLLABORATIVE WORK PLATFORMS

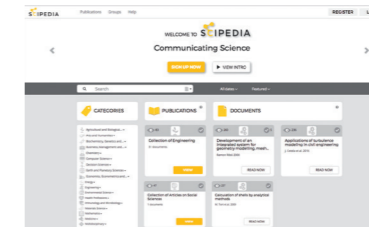
SIGPRO



Integrated software platform for the management of the research and financial activities and reports in RTD projects.

Developed by CIMNE.
✦ cimne.com/sigpro

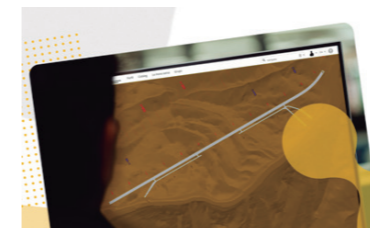
SCIPEDIA



Web platform for free publishing and open access of scientific publications. Developed by Scipedia, S.L. in cooperation with CIMNE. Marketed by Scipedia, S.L. since 2016.

✦ scipedia.com

BIMTEAM

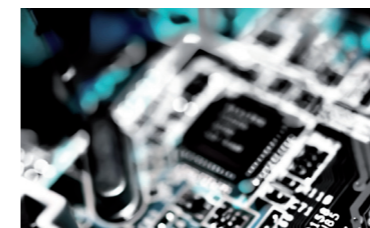


Daily management of all the models and data associated with a BIM project.

Developed by Scipedia.
✦ bim-teamup.com

DECISION SUPPORT SYSTEMS

RMO



Integrated platform for robust multiobjective optimization in engineering.

Developed by CIMNE.
✦ tts.cimne.com/RMOP

GIS+

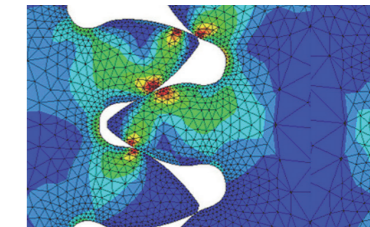


Web-based interactive Geographic Information System.

Developed by CIMNE.

EDUCATIONAL SOFTWARE

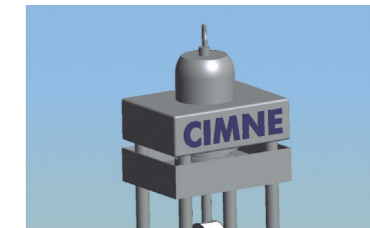
MAT-FEM



Educational program in MATLAB for introduction to the finite element method for analysis of structures and field problems.

Developed by CIMNE.
✦ cimne.com/mat-fem

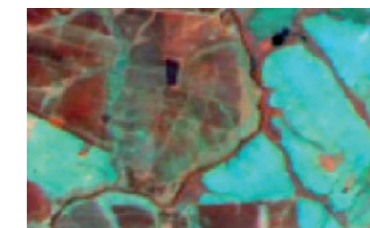
VLAB



An open-source software, a simple virtual press to simulate destructive tests of models and obtain valuable information afterwards.

Developed by CIMNE.
✦ vlab.cimne.com

SIE



Information system for management of energy consumption in public buildings and municipalities. Developed by CIMNE. Marketed since 2005 by Gassó Auditores SL and CIMNE. ✦ inergybcn.com

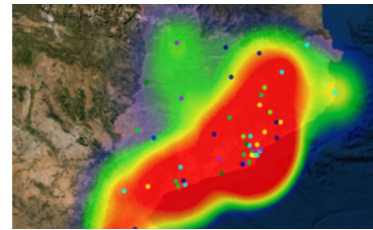
DECISION SUPPORT SYSTEMS

RESILTRAK



System monitors the real-time status of railway infrastructure and anticipates adverse weather phenomena. Developed by CIMNE.

PIKSEL



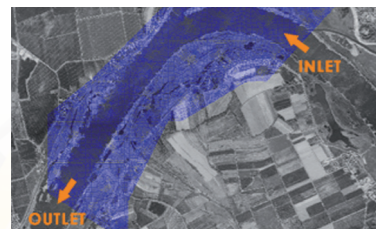
Management and prediction tool based on computational models to study environmental, demographic, economic and social phenomena that affect the Catalan territory.

E-TESTING



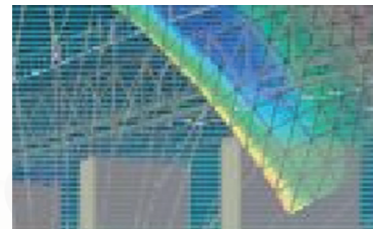
Web-based platform for e-management of experimental tests. Developed by CIMNE and Applus.

RAMFLOOD



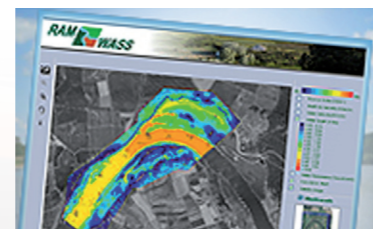
Decision support system for risk assessment and managing of floods. Developed by CIMNE and Flumen. www2.cimne.com/ramflood

WSNP



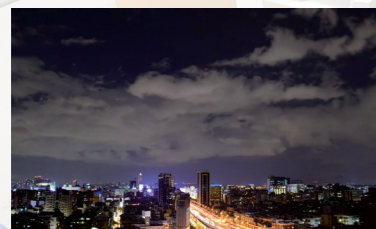
An integrated platform for e-monitoring using wireless sensor network technology. Developed by CIMNE. www2.cimne.com/wsnap

RAMWASS



Decision support tool for the risk assessment and management of environmental and human-induced hazards on the water/sediment/soil system in fluvial ecosystems. Developed by CIMNE. www.cimne.com/ramwass

BEE DATA



Open source BiG Data Analytics platform for deep analysis of massive data coming from smart metering infrastructure of utility companies. Developed by CIMNE and marketed by Inergy. beedataanalytics.com



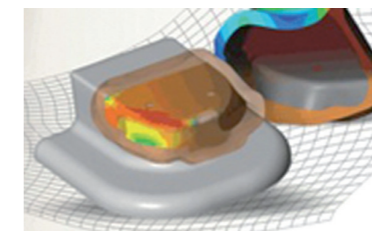
SIMULATION SOFTWARE FOR INDUSTRIAL PROCESSES

WELDPACK



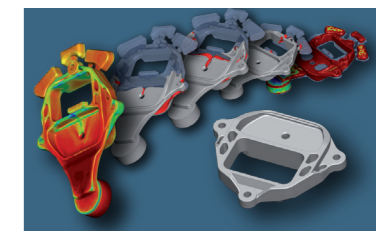
Welding processes software. Developed by CIMNE.

STAMPACK



Software for sheet metal forming processes. Developed by Quantech ATZ, SA and CIMNE. Marketed by Quantech ATZ, SA since 1999. stampack.com

CLICK2CAST



Software for fast simulation of casting processes. Developed by Quantech ATZ in cooperation with CIMNE. Marketed by Altair since 2015.

SCUT



Software able to simulate cutting processes for the metal manufacturing industry. Developed by CIMNE.

ADD2MAN



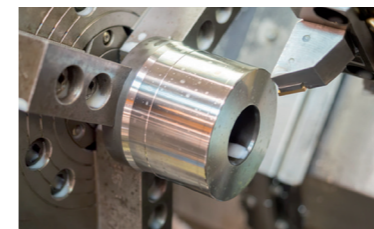
Additive manufacturing processes software. Developed by CIMNE in cooperation with Eurecat.

FORGEPACK



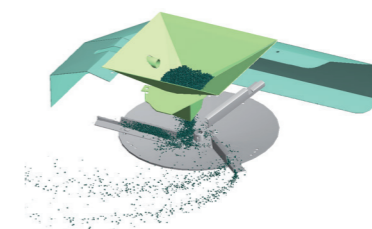
Forging manufacturing processes software. Developed by CIMNE.

MACHPACK



Software able to simulate machining manufacturing processes. Developed by CIMNE.

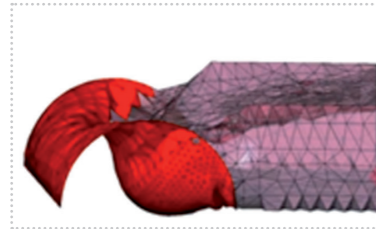
SPREADDEM



Simulation software for the study of the particle flow on centrifugal fertilizer spreaders. Developed and marketed by CIMNE. cimne.com/spreaddem

SIMULATION SOFTWARE FOR MULTIPHYSICS

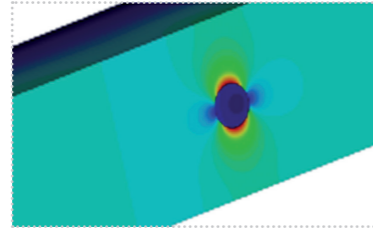
KRATOS



Object-oriented software platform for the development and application of finite element codes for multidisciplinary applications. Developed by CIMNE.

* cimne.com/kratos

ERMES



Computational electromagnetics using advanced finite element methods.

Developed by CIMNE.

* tts.cimne.com/ermes

PFIRE

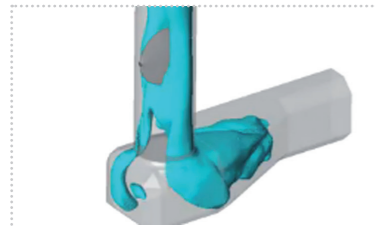


Analysis of propagation of fire and its effect on the burning and melting of objects.

Developed by CIMNE.

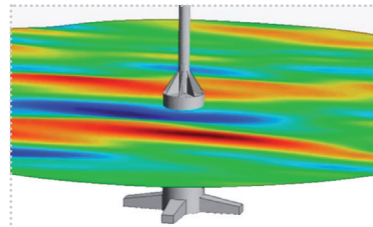
SIMULATION SOFTWARE FOR FLUID DYNAMICS

TDYN



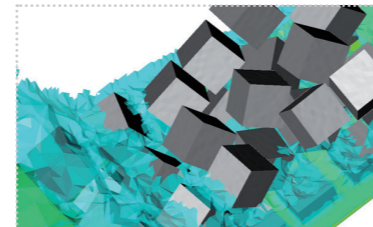
Finite element code for analysis of a wide range of multi-physic problems in engineering and applied science. Developed by Compass Ingeniería y Sistemas, SA. and CIMNE. Marketed by Compass since 2003. * compassis.com

SEAFEM



Hydrodynamics and seakeeping analysis of ships and marine structures. App for wind tower generators in the sea. Developed by Compass Ingeniería y Sistemas, SA. and CIMNE. Marketed by Compass since 2011. * compassis.com

PFLOW



Analysis of fluid dynamics and fluid-structure-soil-thermal interaction problems into the Particle Finite Element Method (PFEM). Developed by CIMNE.

* cimne.com/pfem

PARACHUTES



Computer program for the fast simulation of parachute-payload systems. Developed and marketed by CIMNE since 2016.

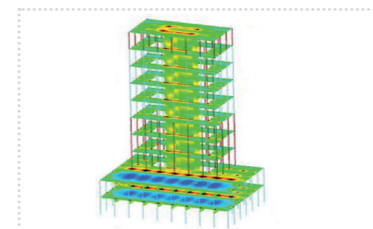
* cimne.com/parachutes

* cimne.com/products



SIMULATION SOFTWARE FOR STRUCTURAL AND GEOTECNICAL ENGINEERING

RAMSERIES



Finite element code for analysis of structures in engineering and architecture. Developed by Compass Ingeniería y Sistemas, SA. and CIMNE.

Marketed by Compass since 2003.

* www.compassis.com

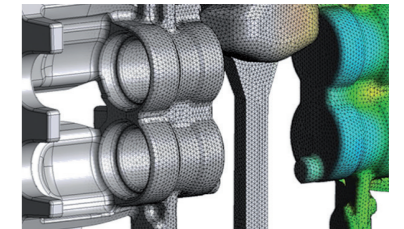
DEMPACK



Analysis of granular systems and multifracturing problems in geomechanics and industrial processes using discrete and finite element methods. Developed by CIMNE.

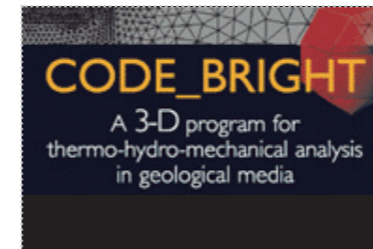
* cimne.com/dem

COMET



Finite element code for none linear analysis of thermomechanical problems in solid and structural mechanics accounting for frictional contact situations. Developed by CIMNE.

* cimne.com/comet



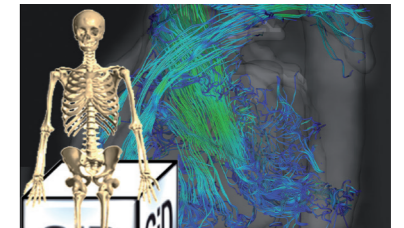
CODE_BRIGHT

Finite Element Method (FEM) program capable of performing coupled thermo-hydro-mechanical (THM) analysis in geological media.

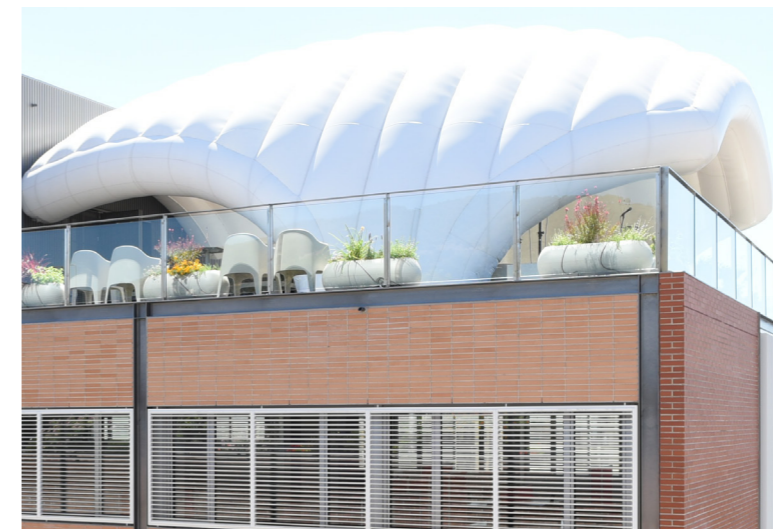
* https://deca.upc.edu/en/projects/code_bright

BIOMECHANICS & HEALTH

BODYGID



Multiscale representation and analysis of the human body. Developed by CIMNE.



VISIT CIMNE PRODUCTS AT
CIMNE.COM/PRODUCTS

* cimne.com/products

Spin-off companies

COMPANIES CREATED BY CIMNE:



SOLUCIONES INTEGRALES DE FORMACIÓN Y GESTIÓN STRUCTURALIA, SA

Created in 2001

* structuralia.com

Training and consulting activities in the civil engineering via Internet. It was sold in 2011 to KAPLAN (The Washington Post Group).



COMPASS INGENIERÍA Y SISTEMAS, SA

Created in 2002

* compassis.com

It develops commercial activities related to numerical methods in engineering, with emphasis on civil, naval and maritime engineering. CIMNE owns 24% of COMPASS.



QUANTECH ATZ

Created in 1996

* quantech.es

Development and marketing of simulation software for production processes.

CIMNE TECNOLOGÍA, SAU

Created in 2011

* cimnetecnologia.com

CIMNE Tecnología SAU is managed by an administration committee formed by the following persons:

- **Chair:** Ferran Falcó
- **Members:** Xavier Baulies, Josep M^a Gassó, Daniel Marco, Eugenio Oñate, David Prat and Lluís Rovira.

The Director General of the company is Javier Marcipar.

COMPANIES CREATED BY CIMNE TECNOLOGIA SAU

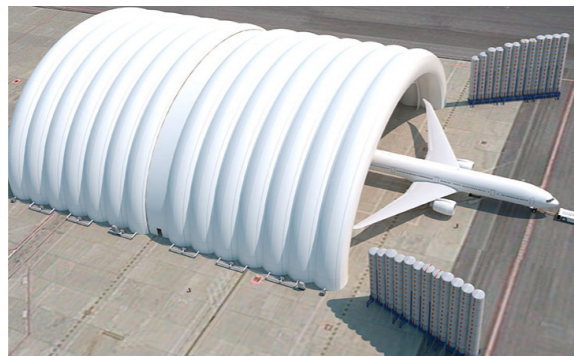


BUILDAIR INGENIERÍA Y ARQUITECTURA, SA

Created in 2001

* buildair.com

Inflatable structures for engineering and architecture applications.



COMPANIES WITH PARTICIPATION OF CIMNE TECNOLOGIA SAU



BEEDATA ANALYTICS, SL

Created in 2017

* beedataanalytics.com

ICT services based on mass analytical data treatment to users and business intelligence for companies and institutions. CIMNE Tecnología owns 36,35% of Beedata



INLOC ROBOTICS, SL

Created in 2014

* inlocrobotics.com

Positioning and navigation solutions for mobile robots in buried environments. CIMNE Tecnología owns 6,19% of INLOC Robotics since October 2015.



FRESH WATER NATURE, SL

Created in 2013

* freshwaturnature.com

Solutions for obtaining fresh water from desalination and distillation of waste water. The company is 92,99% owned by CIMNE Tecnología SA.



METAMATERIALS SOLUTIONS, SL

Created in 2021

Design, develops and commercialize through joint ventures, new meta-materials to provide new and extreme solutions to daily-life engineering problems.



RSM GASSÓ CIMNE ENERGY, SL

Created in 2012

* inergybcn.com

Advanced engineering energy services. CIMNE Tecnología, SA. owns 50% of Inergy.



OKTICS ATZ, SL

Created in 2019

* okobusiness.com

Digital Signance Technologies and products. CIMNE Tecnología, SA owns the 24,5% of OKTICS ATZ SA.



SCIPEDIA, SL

Created in 2015

* scipedia.com

Free publishing and open access for scientific publications. CIMNE Tecnología owns 16,67% of Scipedia, SL.

VISIT

CIMNE COMPANIES AT

CIMNE.COM/COMPANIES

Alliances

CIMNE, leader in research on computational engineering, has established relevant alliances with international institutions and companies since its creation in 1987.



CIMNE host of UNESCO Chair of Numerical Methods in Engineering Since 1989.

Prof. Olgierd Zienkiewicz was UNESCO Chair until his death (2009).



Secretariat of SEMNI Since 1989



Pilot Center of ERCOFTAC in Spain Since 1989



Secretariat of ECCOMAS Since 1992



Secretariat of IACM 1994 - 2016



Partner of FLUMEN Since 2012



Creation of AIAC Since 2015



United Nations Educational, Scientific and Cultural Organisation.



UNESCO Chair in Numerical Methods in Engineering. Technical University of Catalonia.

UNESCO and UPC · BarcelonaTech reached an agreement to create the first UNESCO chair in the world in 1989: the UNESCO Chair of Numerical Methods in Engineering.



Dr. Jacques Périaux

Unesco Chair in Numerical Methods in Engineering

The main mission of the Chair is to promote the development, dissemination and application of numerical methods in engineering at an international level, through education, research and technology transfer, with the aim of contributing to the solution of complex problems in lower-income countries.

Prof. O. C. Zienkiewicz held the UNESCO Chair since its creation in 1989 until his death on January 2nd, 2009. Since 2009 Dr. Jacques Périaux is the Chairholder of the Unesco Chair of Numerical Methods in Engineering. He is a recognized expert in the field of numerical methods applied to aerospace engineering.

Dr. Périaux contributions have resulted in a significant increase in the RTD activities of CIMNE in the aerospace sector, in particular with academic organizations and industry in China, the organization of numerous training courses, exchanges with leading scientists worldwide and several RTD projects at an international level.

It is important to note that computational methods are especially useful in resource-limited countries because they enhance the ability of people to predict outcomes and optimize solutions before committing resources to specific investments.

An important UNESCO Chair activity over the years has been the creation of a series of "Aulas CIMNE" (CIMNE Classrooms), physical spaces of collaboration with other research groups in universities and research centres located mainly in Latin America and Europe. All nodes in the network connected to each other are using, transforming and broadcasting knowledge generated in CIMNE over the last thirty years.

Both the people and the knowledge generated by the network members easily circulate within the network. "Aulas CIMNE" is now a growing network of centres of excellence in research and training in the field of numerical methods. A priority in the network is the promotion of joint projects in research and training using international competitive funds and existing programs that target specific local needs. Links with scientific groups and other organizations established locally are also actively encouraged.

Dr. Cecilia Soriano is the coordinator of the UNESCO Chair of Numerical Methods in Engineering.

In 2022 the UNITWIN/UNESCO Chairs Programme celebrated its 30th birthday.

In 2012, the Government of Catalunya created the FLUMEN Institute for River Dynamics and Hydrologic Engineering as a partnership between CIMNE and UPC · BarcelonaTech.

FLUMEN Institute

FLUMEN Institute is the outcome of merging the prestigious Flumen RTD group existing since 2005 at the School of Civil Engineering of UPC · BarcelonaTech and CIMNE, bringing together the numerical and experimental expertise of Flumen RTD group in hydraulics with the broad experience of CIMNE on numerical methods, computer simulation and integration of decision support systems.

The objectives of FLUMEN are the promotion of RTD and technology transfer activities in the field of river dynamics and hydrologic engineering. The Flumen Institute is directed by Prof. Ernest Bladé.



Flumen is actively engaged in research activities, consulting, training and technology transference in relation to hydrology and river dynamics.

www.flumen.upc.edu

FLUMEN Premises



Flumen Institute is located at the B0 Building in the North Campus of UPC · BarcelonaTech since 2016. The building is equipped with modern experimental facilities for model scale testing of river dynamic and hydraulic problems. It also provides work areas for researchers at the graduate level (masters, doctoral and postdoc) and for senior researchers from CIMNE and UPC · BarcelonaTech.



Since 1989 CIMNE supports the activities of the Spanish Association for Numerical Methods in Computational Engineering (SEMNI).

Sociedad Española de Mecánica e Ingeniería Computacionales

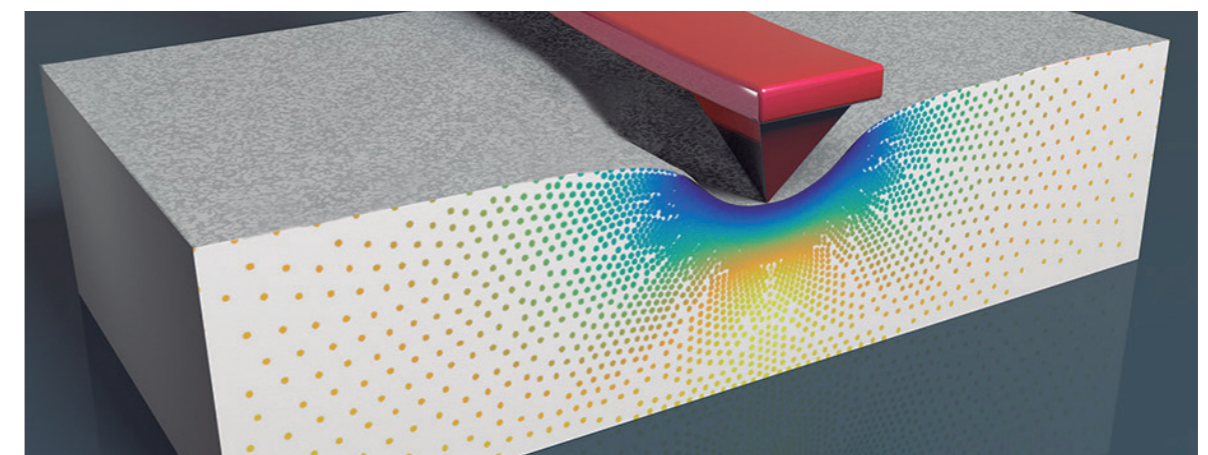
SEMNI aims at organizing and coordinating activities related to numerical methods in engineering in Spain and being the Spanish representative in the International Association for Computational Mechanics (IACM).

SEMNI is linked to similar associations in other countries, such as the European Community on Computational Methods in Applied Sciences (ECCOMAS), the International Association for Computational Mechanics (IACM), the Groupe pour l'Avancement des Méthodes Numériques de l'Ingénieur in France and the United States Association for Computational Mechanics in the United States, among others.

The headquarters and the secretariat of SEMNI are based in CIMNE. Currently, SEMNI has over 400 members worldwide.

Some of the main activities of SEMNI include the organization of technical workshops and the organization of the Spanish Conference on Numerical Methods in Engineering, held every two years.

SEMNI organized the Congress on Numerical Methods in Engineering (CMN 2022) on September 12-14, 2022, in the city of Las Palmas de Gran Canaria (Spain). It was attended by more than 160 experts.



ECCOMAS is a scientific organization founded in 1992. It groups European associations with interests in the development and application of computational methods in applied sciences and technology. The ECCOMAS Secretariat is located at CIMNE.

The International Association for Computational Mechanics (IACM) was founded in 1981 and, since then, it has been strongly connected to CIMNE.

European Community on Computational Methods in Applied Sciences

The mission of ECCOMAS is to promote joint efforts of European universities, research institutes and industries which are active in the broad field of numerical methods and computer simulation in Engineering and Applied Sciences (i.e. Computational Solid and Structural Mechanics, Fluid Dynamics, Acoustics, Electromagnetics, Physics, Chemistry, Applied Mathematics, and Scientific Computing), to address critical societal and technological issues with particular emphasis on multidisciplinary applications and disseminate innovative research.

The three main scientific events that ECCOMAS organizes every four years are the ECCOMAS Congress, the ECCOMAS Conference on Computational Solid and Structural Mechanics (ECCM) and the ECCOMAS Conference on Computational Fluid Dynamics (ECFD). They attract approximately 5,000 participants in total.

The ECCOMAS Congress is addressed to scientists and engineers both in and outside Europe. Its main objective is to provide a forum for presentation and discussion of state-of-the-art in scientific computing applied to engineering, with emphasis on basic methodologies, scientific development and industrial applications. It also includes invited lectures, Special Technological Sessions (STS), contributed papers from Academy and Industry and organized Minisymposia. Proceedings of the ECCOMAS Congresses are widely disseminated in Europe.

These series of ECCOMAS global meetings are complemented with more focused thematic conferences on state-of-the-art topics in computational sciences and engineering.

The 9th ECCOMAS Thematic Conference on the Mechanical Response of Composites draw 170 experts from 12th to 14th of September in Trapani, Italy.



International Association for Computational Mechanics

The goal of IACM is the promotion of advances in computational mechanics in a wide sense. IACM defines computational mechanics as the development and application of numerical methods and digital computers to solve problems in engineering and applied sciences with the objectives of understanding and harnessing the resources of nature.

Computational Solid Mechanics (CSM) and Computational Fluid Dynamics (CFD) are at the core of IACM activity. Subjects such as thermodynamics, electromagnetics, rigid body mechanics, control systems and some aspects of particle physics fall naturally within the scope of the IACM. Indeed providing a common forum for discussion, education and re-

search information transfer between the diverse disciplines represented is the main raison d'être of IACM.

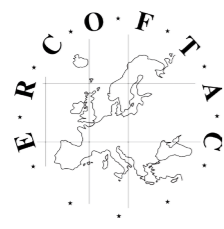
Dissemination

IACM publishes a periodic bulletin and supports Special Interest Conferences, IACM Symposia and courses in various fields of computational mechanics.

The 16th World Congress on Computational Mechanics – PANACM2024 will take place from 21th to 26th July, 2024, in Vancouver (Canada).

Further info: iacm.info/scientific-events/wccm





The ERCOFTAC network was founded in 1987. It is promoted by several European aerospace companies and it groups together more than 60 research centres and companies working primarily in the numerical simulation of fluid mechanics problems in engineering.

The International Association of Aulas CIMNE (AIAC) is a non-governmental non-profit civil organization with the objective of fostering the advances of numerical methods in a common academic space: the Aulas CIMNE (Joint Labs). Aulas CIMNE are the basis for cooperation in scientific, technological and training among its members, aiming to achieve social and economic improvements in society.

European Research Community on Flow, Turbulence and Combustion

Since 1989, CIMNE is a Pilot Centre of ERCOFTAC in Spain.

CIMNE, acting as Pilot Centre, has organized a number of activities, including, among others, the 8th European Turbulence Workshop (Barcelona 2000), the Europe-Russia Workshop (Barcelona 2006), the 3rd Workshop on Research in Turbulence (Seville 2008), the 5th Workshop on Research in Turbulence (Tarragona 2010) and ERCOFTAC Spring Festival (Terrassa 2014).

CIMNE has coordinated the FP7 E-Caero projects 1 and 2 (E-CAERO: European Collaborative Dissemination of Aeronautical research and applications, 2009-2013 and 2014-2017).

Both projects aim to promote joint activities of different scientific associations in the aeronautic field in Europe. ERCOFTAC is a partner in both projects.

Related event

- **2nd Spanish Fluid Mechanics Conference**
2nd - 5th July 2023
Universitat Politècnica de Catalunya (UPC)
Barcelona, Spain



International Association of Aulas CIMNE

Mission

To contribute to the development, strengthening and consolidation in:

- Training, by promoting and organizing courses of interest to its members.
- Scientific and technological research, including the processes of innovation, adaptation and technology transfer in strategic areas.
- The use of numerical methods in engineering as a tool to help developing countries.

The interaction of the members of the Association with the society at large, by disseminating scientific and technological advances that drive progress.

AIAC members benefit from:

- Continuous education, enhancing the set of high-level human resources of Aulas CIMNE and the Network and by the competitive advantage of installed capacity in the regions.
- The development of multi- and inter-disciplinary activities in areas of basic research, applied research and experimental developments.
- Exchange programs for teachers, researchers, students and academic and innovation managers.
- Research and development programs in emerging knowledge areas, related to new professional profiles identified as strategic.

AIAC's vision

To promote a common project and create a network of experts from around the world, which results in the international benchmark in the field of numerical methods in engineering.

AIAC intends to encompass an international environment in which scientists, technical staff and engineers can benefit directly from CIMNE's tools (developed or in development), international collaborations, participation in projects, exchange of information and industry technology transfer, among others.



Dissemination

Knowledge transfer is of vital importance for CIMNE, which invests great efforts in training and education addressed to its research staff as well as to graduates and professionals from schools of engineering and universities in applied sciences.

CIMNE regularly organises Severo Ochoa Seminars, Severo Ochoa Coffee Talks, courses and post-graduate studies related to the theory and application of numerical methods in engineering. It has also developed a web environment for online learning.

The research centre also plays an important role as an organiser of events in the field of computational engineering. On the following pages a summary of the conferences organised by the CIMNE Congress Bureau in 2023 can be found. The agenda of congresses and conferences for 2024 is also included.



POST-GRADUATE STUDIES

COURSES

SEMINARS

COFFEE TALKS

CONFERENCES



Training

Post-graduate Studies

CIMNE supports the organization of the following postgraduate degrees awarded by the UPC · BarcelonaTech.

Master Degrees

Master on Numerical Methods in Engineering

Duration: 2 academic years, 120 ECTS

- Line 1. Local Master Degree
 - Line 2. International Double Degree*
- Programme in Computational Mechanics

* Double Degree UPC BarcelonaTech + universities of Swansea, Nantes, Stuttgart or Padova

cimne.com/education

Doctoral Degrees

PhD Degree in Civil Engineering

Duration: PhD studies, 3 years period

cimne.com/phd-civil

PhD Degree in Structural Analysis

Duration: PhD studies, 3 years period

cimne.com/phd-structural

Courses

CIMNE also organised courses and workshops related to its areas of expertise:

CIMNE Winter School 2022

23–27 January 2023
Barcelona, Spain

XX Jacques-Louis Lions Spanish-French School on Numerical Simulations in Physics & Engineering

Physics & Engineering
3–7 July 2023
Barcelona, Spain

XVII Short Course on Computational Plasticity

3–4 September 2023
Barcelona, Spain

Short Course on Particle-Based Methods in Engineering and Applied Science

7–8 October 2023
Milan, Italy

TETRATHEDRON VII

9–11 October 2023
Barcelona, Spain

cimne.com/training



Severo Ochoa (SO) Seminars at CIMNE in 2023

21
SO seminars


Available
online

100%
hybrid/online
format

Severo Ochoa (SO) Coffee Talks at CIMNE in 2023

12
Coffee talks


Available
online

100%
hybrid/online
format



Conferences organized by CIMNE in 2023

CIMNE gathered some 3,800 experts in the 20 international congresses organized during 2023. A selection is listed below:



22nd Computational Fluids Conference
Cannes, France, 25 – 28 April



Math 2 Product (M2P) Emerging Technologies in Computational Science for Industry, Sustainability and Innovation
Taormina, Sicily, Italy, 30 May – 1 June



X international Conference of Computational Methods for Coupled Problems in Science and Engineering
Chania, Crete, Greece, 5 – 7 June



The Fourth International Conference on Simulation for Additive Manufacturing
Munich, Germany, 26 – 28 July



XVII International Conference on Computational Plasticity. Fundamentals and Applications
Barcelona, Spain, 5 – 7 September



VIII International Conference on Particle-Based Methods
Milan, Italy, 9 – 11 October



Upcoming conferences organized by CIMNE in 2024 & 2025

<p>SIAM UQ24 SIAM Conference on Uncertainty Quantification (UQ24) 27 February–1 March 2024 Trieste, Italy</p>	<p>SIMPOSIO TALUDES 2025 XI Simposio Nacional sobre Taludes y Laderas Inestables 8–10 July 2025 Bilbao, Spain</p>
<p>ECCOMAS 9th European Congress on Computational Methods in Applied Sciences and Engineering 3–7 June 2024 Lisbon, Portugal</p>	<p>COMPLAS 2025 XVIII International Conference on Computational Plasticity. Fundamentals and Applications 2–5 September 2025 Barcelona, Spain</p>
<p>ISC7 7th International Conference on Geotechnical and Geophysical Site Characterization 18–21 June 2024 Barcelona, Spain</p>	<p>SDSS 2025 International Colloquium on Stability and Ductility of Steel Structures 28 – 30 June 2023 Barcelona, Spain</p>
<p>SPANCOLD XIII Jornadas Españolas de Presas 18–21 June 2024 Barcelona, Spain</p>	<p>Sim-Am 2025 International Conference on Simulation for Additive Manufacturing 8–10 September 2025 Barcelona, Spain</p>
<p>COUPLED PROBLEMS 2025 XI International Conference on Coupled Problems in Science and Engineering 26–29 May 2025 Sardinia, Italy</p>	<p>IGA 2025 XIII International Conference on Isogeometric Analysis 14–17 September 2025 Eindhoven, The Netherlands</p>
<p>ADMOS 2025 XII International Conference on Adaptive Modeling and Simulation 9–11 June 2025 Barcelona, Spain</p>	<p>STRUCTURAL MEMBRANES 2025 XII International Conference on Textile Composites and Inflatable Structures 8–10 October 2025 Germany</p>
<p>MARINE 2025 XI International Conference on Computational Methods in Marine Engineering 23–27 June 2025 Edinburgh, Scotland</p>	<p>PARTICLES 2025 IX International Conference on Particle-based Methods 20–22 October 2025 Barcelona, Spain</p>

Awards

Chronology of the prizes awarded to CIMNE

Below we briefly review some of the awards granted to the research centre along its history.

SPECIAL MENTION TO THE CIUTAT DE BARCELONA AWARD 1999

Special Mention to the Ciutat de Barcelona Award 1999 in the category of Technological Research for the work carried out by Drs. P. Roca, M. Cervera and E. Oñate on the modelling and structural analysis of the Barcelona Cathedral.

NARCÍS DE MONTURIOL PLATE AWARD TO THE SCIENTIFIC AND TECHNOLOGICAL MERIT 1999

In 1999 the Generalitat de Catalunya granted to CIMNE the Narcís de Monturiol Plate Award for Scientific and Technological Merit:

- For its contribution to the development of new methods for analysis and design for products and processes in engineering.
- For fostering the cooperation between industry and university research groups.
- For the organization of training activities and the promotion of science and technology at an international level.

2002 IST PRIZE TO THE BEST PRODUCT OF THE INFORMATION SOCIETY TECHNOLOGIES, EUROPEAN COMMISSION (EC)

The EC granted the IST Award to the pre/post processor system GiD (www.gidsimulation.com) developed at CIMNE.

CIUTAT DE BARCELONA 2002 AWARD IN TECHNOLOGICAL RESEARCH

On February 11th, 2003, the Ciutat de Barcelona Award in Technological Research was awarded to the CIMNE research team formed by Eugenio Oñate, Ramon Ribó, Enrique Escolano, Miquel Pasenau and Jorge Suit Pérez.

The prize recognized the development of the pre/postprocessor GiD.

AWARD DURAN I FARRELL FOR RESEARCH AND TECHNOLOGY UNIVERSITAT POLITÈCNICA DE CATALUNYA, 2004

The Award was delivered to CIMNE scientists Dr. Oñate and Dr. García for their work entitled: "Development of a new finite element code for the hydrodynamic study of vessels. Applications to the design of sailing ships for the America Cup race".

CUBAN NATIONAL PRIZE 2016 TO THE SCIENTIFIC RESEARCH RESULT BY THE CUBAN ACADEMY OF SCIENCES

This award is a recognition of the research work entitled "Development of advanced technologies for the generation and packaging of particles focused on the methods of discrete elements".

The research was carried out by the Central University "Las Villas" of Cuba (UCLV) and the CIMNE within the Aula UCLV-CIMNE. It also involved the collaboration of the universities of Leuven (KU Leuven, Belgium), and Brasilia (UnB, Brazil), as well as foreign and local institutions.

JOAN ROGET KNOWLEDGE TRANSFER PRIZE

The CIMNE-led PIKSEL project, which has developed a management and forecasting tool to study environmental, demographic, economic and social phenomena in Catalonia, has been recognised as the best R+D+I collaborative work in the second edition of the Joan Roget Knowledge Transfer Awards for its contributions to innovative regional planning.

SEVERO OCHOA ACCREDITATION

CIMNE is a "Centre for Excellence Severo Ochoa" accredited by the Spanish State Research Agency (attached to the Spanish Ministry of Science, Innovation and Universities) for the period December 2019-June 2024.

FIMA 'TECHNICAL NOVELTY' AWARD 2018

The Centrifugal Spreading Simulation Software, SpreadDEM, developed by CIMNE, was awarded by the 40th International Fair of Agricultural Machinery (FIMA) with the "Technical Novelty" award in the category of "Agricultural Management Solution".



Awards to CIMNE scientists in 2023



Barbat, Gabriel

Special Doctoral Award, Technical University of Catalonia, 2023



Oliver, Xavier

OCZ Zienkiewicz Award, SEMNI, 2023



Oñate, Eugenio

Icaro Award, University of A Coruña, 2023



Reyes, Andrés

Futur Cerdà Award, Professional Association of Civil Engineers of Catalonia, 2023

Abertis Prize, Abertis Chair Spain, 2023

CIMNE in the Media in 2023

CIMNE's scientific activity was present in the media during 2023, highlighting its presence in online, specialised and local media. We list below some examples of press appearances.

SIMPLIFIED PROCESSING OF SOCIAL BENEFITS THROUGH AN INNOVATIVE VIRTUAL ASSISTANT



Eight partners, including local government bodies and technology partners, including CIMNE, presented the Gàvius platform in Gavà, near Barcelona. Gàvius simplifies citizens' access to subsidies and social aids using artificial intelligence. The project shifts urban administration to a proactive, personalized service model, fostering closer citizen engagement and informed decision-making. Citizens actively shaped the tool, emphasizing its innovative approach in local governance.

IA TO ENHANCE MARITIME SHIPPING SAFETY

Researchers from various European centers are collaborating on a project called OCEAN to tackle maritime accidents. Led by UPC and CIMNE, the project employs algorithms and machine learning to detect sea obstacles. This initiative aims to enhance navigation safety, addressing technical, human, and operational factors. The consortium involves 13 entities from seven countries, fostering interdisciplinary solutions for marine safety.



TURNING THE LLOBREGAT DELTA INTO AN INNOVATION HUB



CIMNE participated as a technological partner in the InnoDelta Territorial Specialization and Competitiveness Project (PECT). It is a territorial specialization and competitiveness project financed by the Government of Catalonia and the European Commission through FEDER funds. Its mission is to create a laboratory territory of the industrial network to promote environmental, social and economic sustainability solutions.



EL DELTA DEL LLOBREGAT, TERRITORI D'INNOVACIÓ ECONÒMICA, SOCIAL I SOSTENIBLE

Les ciutats de Viladecans, Sant Boi, Castelldefels, el Prat i Gavà treballen per convertir el territori del Delta en un hub d'innovació gràcies a la iniciativa InnoDelta. El Delta és una realitat econòmica i social diversa. És un territori amb una gran capacitat d'innovació i desenvolupament. A través de la iniciativa InnoDelta, les ciutats del Baix Llobregat treballen conjuntament per convertir el territori del Delta en un hub d'innovació gràcies a la iniciativa InnoDelta.

Dissemination Matters

A science activity to be explained

CIMNE emphasizes a fruitful conversation with society as part of its research strategy. To fulfil this objective, its communications department implements a comprehensive 360-degree communication plan, encompassing social media updates, corporate website postings, and other communication strategies in coordination with local and global stakeholders. Presented below are three notable tools within this framework, intended to reach relevant and varied audiences.



Social Media

CIMNE carries out an intense activity through social media, especially on X (formally Twitter), and LinkedIn. With almost 9,000 combined followers, the centre uses social channels to reach specialized and generic audiences, combining dissemination content with corporate news. These platforms also serve as a mainstay for strategic priorities, such as talent acquisition and transparency.

[@cimne](#)



Audiovisual repository

Most of the Severo Ochoa Seminars & Coffee Talks can be found on our Youtube Channel, but not only. Visit them and discover CIMNE projects, simulations, etc.

[@CIMNEMC](#)



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