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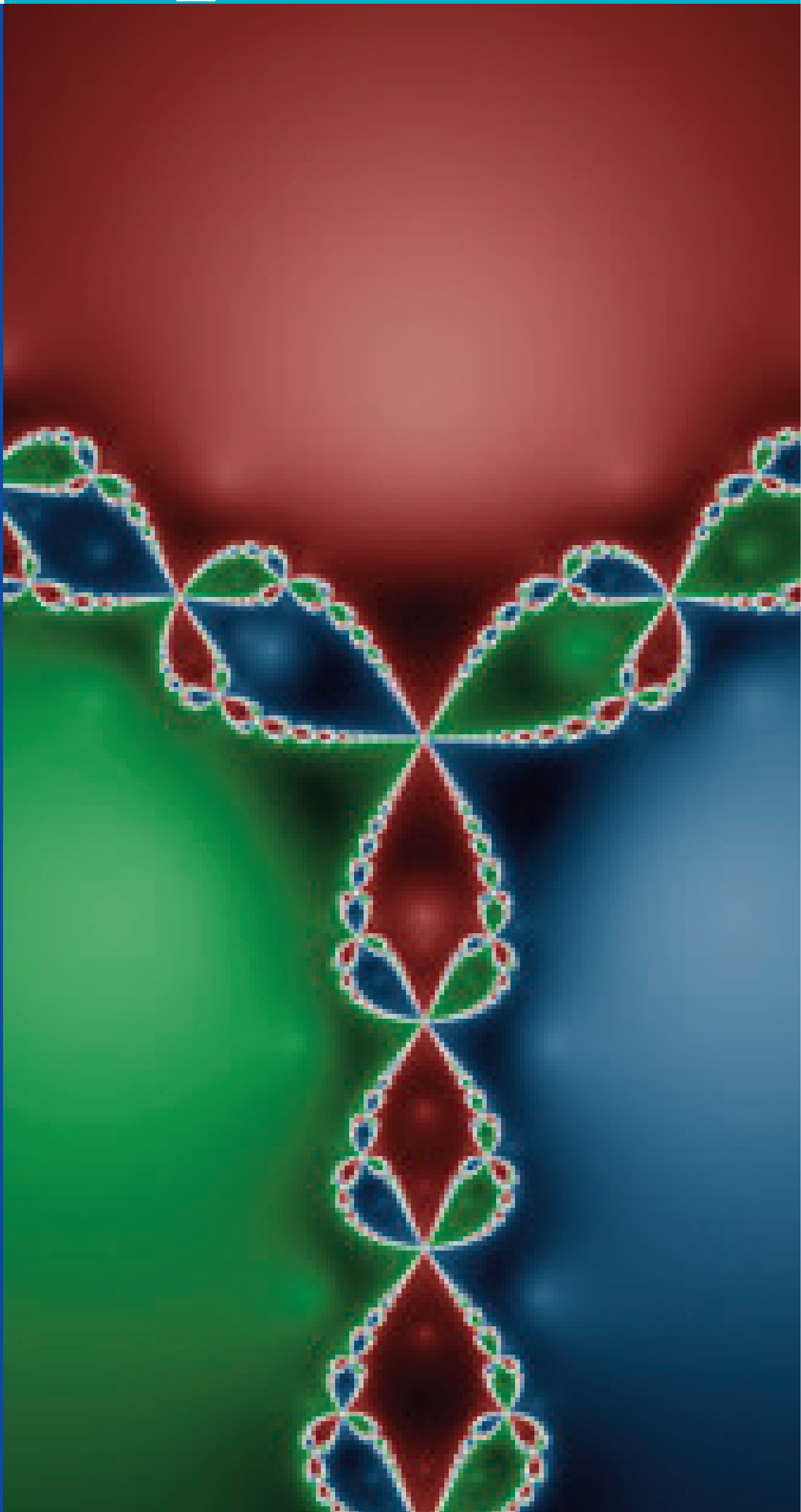

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contents

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Analysis and Optimization of Piezoelectric Energy Harvesters for Self-powered Wireless Sensors: Road-compatible PEH and Magneto-PEH

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Piezoelectric energy harvester

Energy harvesting is the process of harvesting energy from ambient waste energy such as solar, wind, and mechanical energy. The energy harvesting has been performed based on various physical phenomena such as electrochemistry, thermoelectricity, triboelectricity, electromagnetic and so on. Among the various types of the energy harvester, piezoelectric energy harvester (PEH), which is based on the piezoelectricity, has significantly attracted attention as a major energy harvesting element because it has the advantage of high energy density as shown in *Figure 1*.

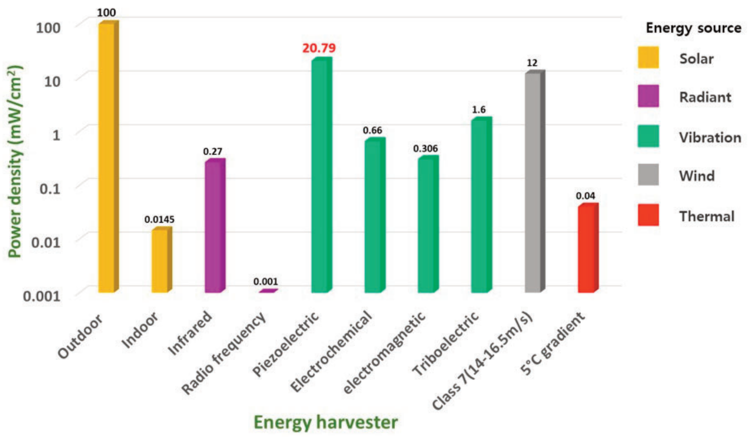


Figure 1:
Power density of various energy harvesting system

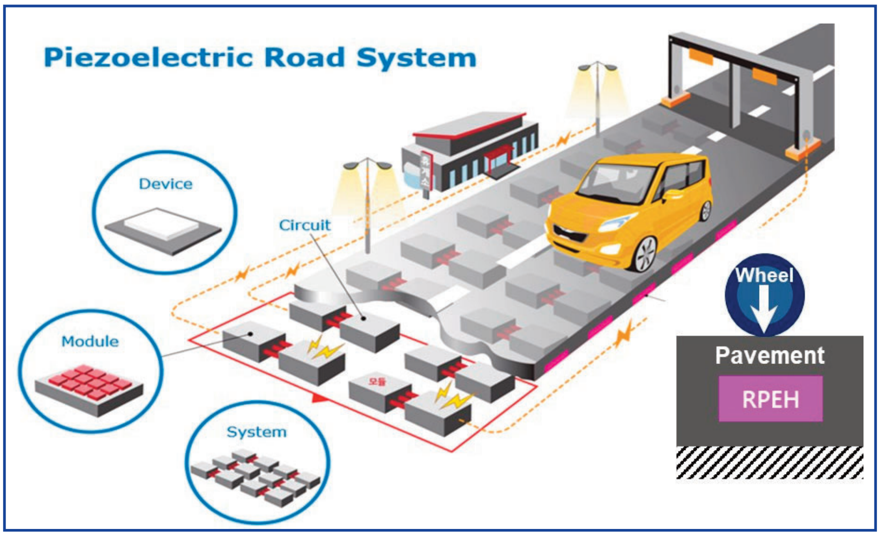


Figure 2:
Conceptual design of RPEH system

Recently, various studies have been conducted to utilize the advantages of the PEH, and studies on PEH for roadway and smart factory have been actively conducted. Our research team in Hanynag University has outperformed various researches on PEH including development of new piezoelectric materials, harvester circuit and packages, and energy harvester modules for various industrial applications. At this article analysis and optimization of piezoelectric energy harvesters for self-powered wireless devices from roadway system and electric wires are addressed.

Application of PEH to roadway system (RPEH)

As shown in *Figure 2*, road-compatible piezoelectric energy harvester (RPEH) can generate electric power by using the mechanical load transmitted to the road pavement when the vehicles move on the road. The roadway can provide stable energy by using continuous vehicle traffic and have large kinetic energy due to speed and weight of vehicles. In order to perform the energy harvest using the characteristics of the roadway system, various studies have been conducted from a laboratory scale [1,2] to a highway scale [3,4] in recent years.

As a representative example, there is a pilot installation of RPEH for a highway rest area conducted by Hanyang University in Korea [5]. The RPEH is the impact type PEH that generates the electric power by means of hitting the harvester from wheels of travelling vehicle load, which makes the deflection of the simply supported beam type piezoelectric energy harvester. First, in order to determine the efficient power generation structure of the harvester, the stress distribution of the harvester for each power generation type using finite element analysis was confirmed as shown in *Figure 3*. Also, as shown in *Figure. 4*,

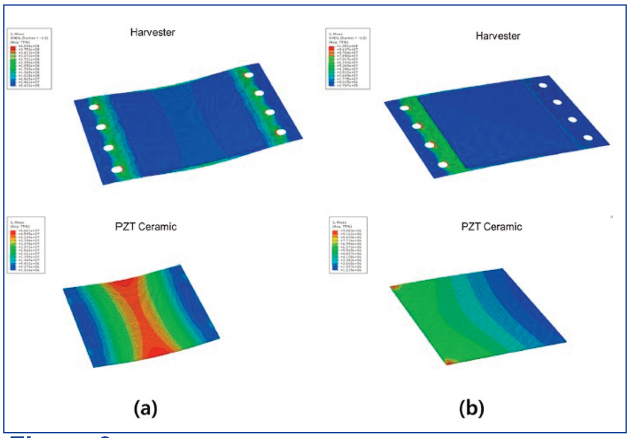


Figure 3:
Stress distributions of the piezoelectric device for the (a) both-end-fixed type and (b) one-end-fixed type [5]

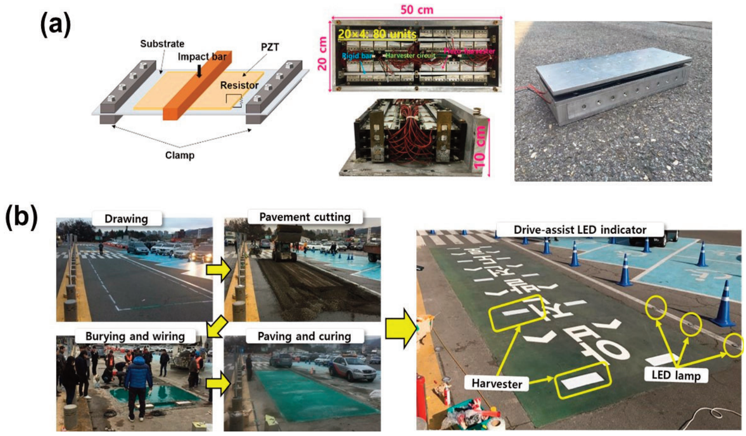


Figure 4:
(a) Schematic of RPEH module and
(b) PREH installation process at the highway rest area [5]

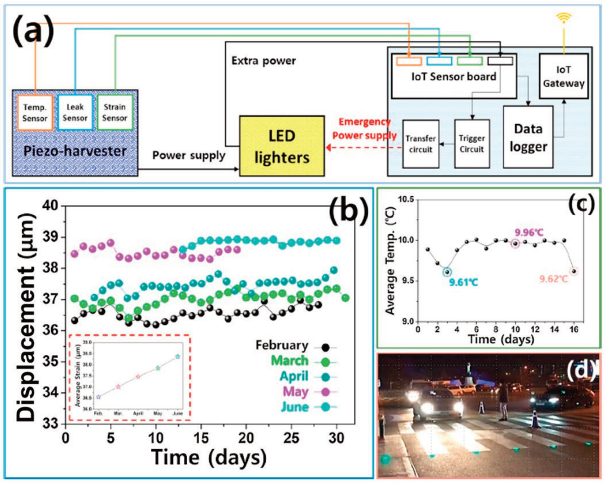


Figure 5:
(a) Schematic diagram of the RPEH system with wireless sensor network and LED indicators,
(b) graph of the average displacement (μm) with the module for 5 months,
(c) average temperature (°C) data from the module for 16 day, and
(d) a photograph of the LED indicators installed on the roadway [5]

10 harvester modules were installed on the traffic road for independent energy source, and the driving assistance LED and wireless sensor system were installed to demonstrate the state of energy harvesting. The installed wireless sensor system measured the internal temperature, deformation, and leakage of the harvester module as shown in *Figure 5 (a)*. *Figures 5 (b) and (c)* show some data collected from the wireless sensor system. In addition, the information of power generation according to vehicle speed was also collected, and a maximum power density of 23.81W/m^2 was archived (*Figure 6*).

Application of PEH to smart factory (MPEH)

Another representative application of the PEH is a wireless sensor system for smart factory. Since the smart factory is operated under low light, and generates low vibration and noiseless conditions, there is not enough ambient energy sources for energy harvesting.

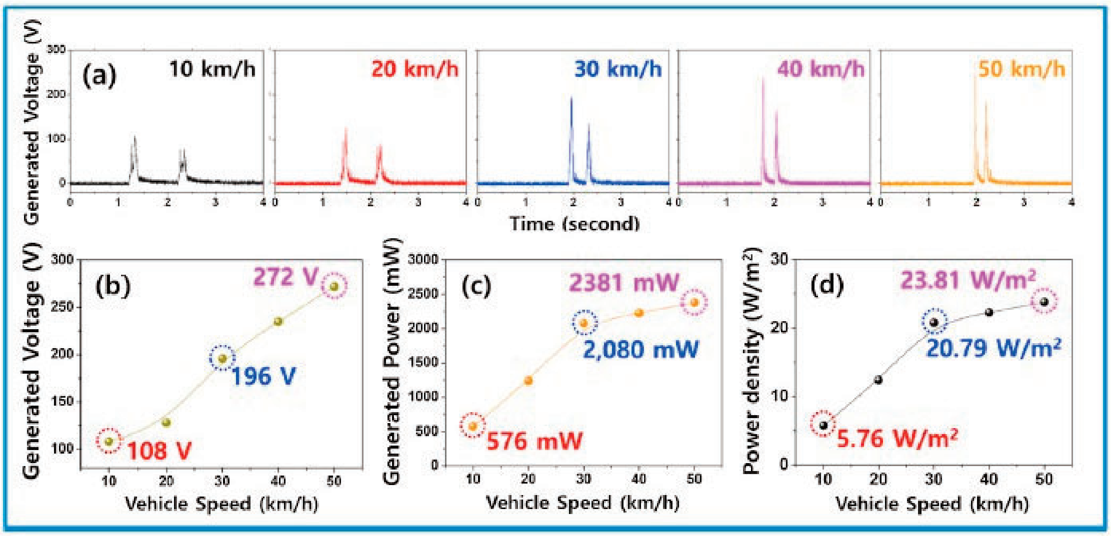


Figure 6:
Generated voltages, powers, and power density from RPEH:
(a) generated voltage with time,
(b) generated voltage with vehicle speed,
(c) generated power, and
(d) power density at various vehicular speeds up to 50km/h [5]

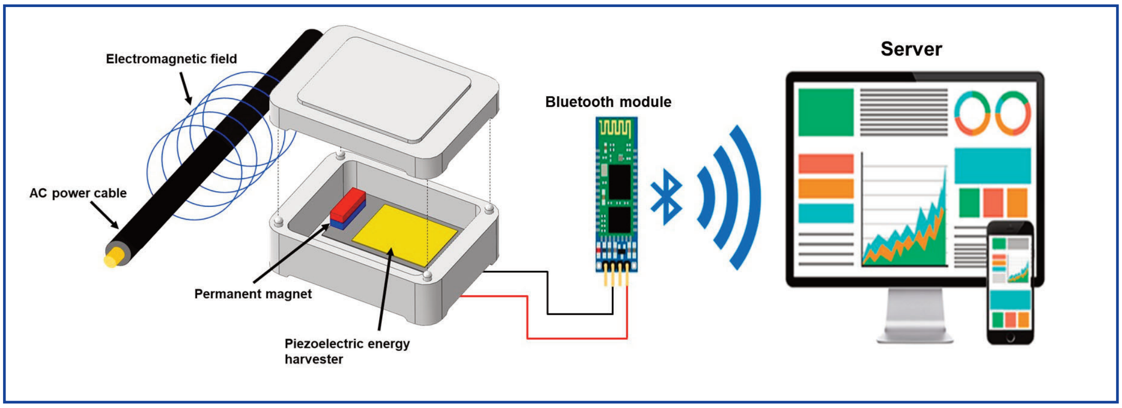
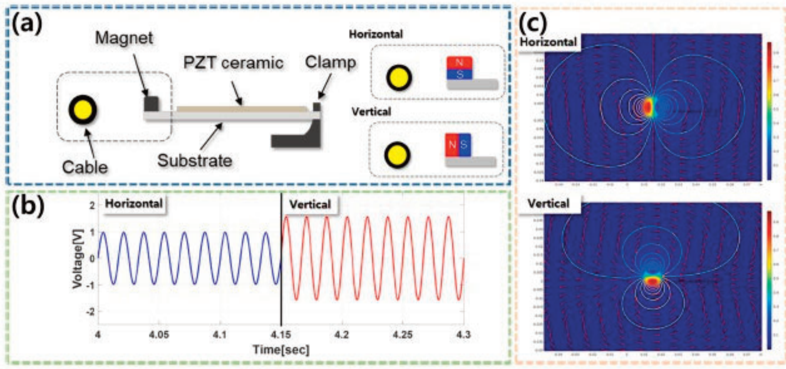


Figure 7:
Conceptual design of MPEH for wireless sensor system



In this situation, magneto-piezoelectric energy harvester (MPEH) using the magnetic field of the power line cable emerged as a new alternative. As shown in *Figure 7*, an MPEH is proposed to drive a PEH by using the magnetic field of a power line cable which AC current generates the Lorentz force between the magnets. Even in an environment where no vibration source exists, stable power generation is possible because fully reversed Lorentz forces are generated using the magnetic field of the AC power cable.

Figure 8:
(a) Two cases of the tip magnet direction,
(b) output voltage of the MPEH, and
(c) magnetic flux density and vector potential [6]

A representative example of MPEH is to illustrate the wireless transmission of temperature data using independent power source harvested from power cables of home appliances or power plants [6]. In this study, the influence of the magnet direction on the power generation efficiency of MPEH was analyzed through CAE simulation model and verified the simulation results through physical experiments. As shown in *Figure 8*, the magnetic flux density and vector potential according to the magnet direction were calculated, and the Lorentz force acting on the magnet and the amount of power generation were compared. As a result of the simulation, it was confirmed that the generation power of MPEH is higher in the case of the vertical type of the magnetic direction, and it was verified through an experiment using a Helmholtz coil as shown in *Figure 9*.

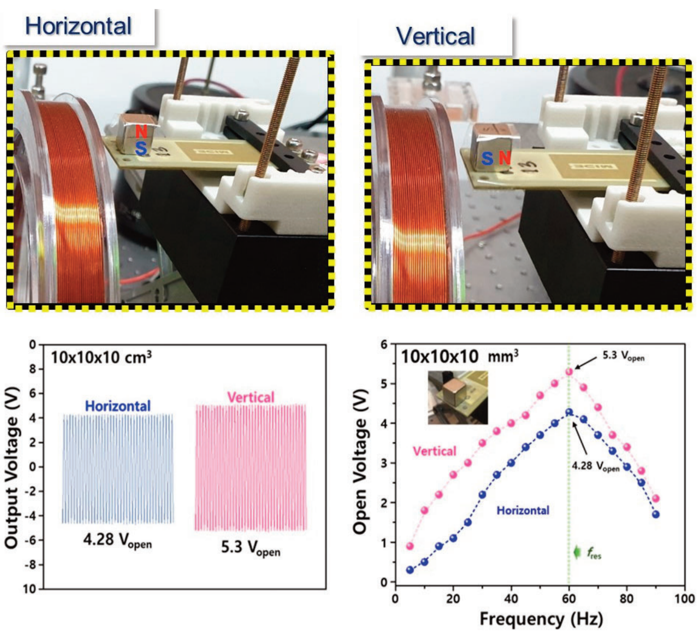


Figure 9:
Verification of simulation result through experiment using Helmholtz coil [6]

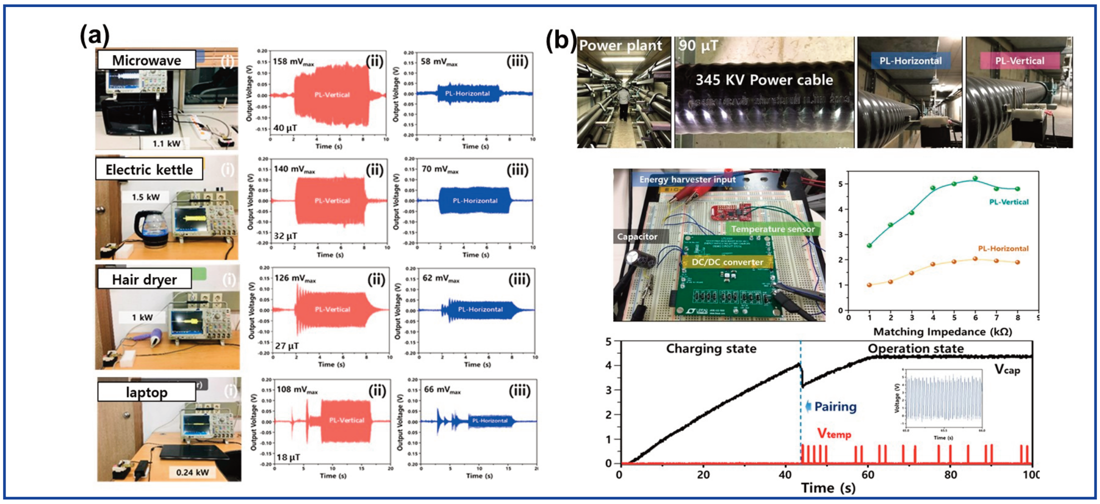


Figure 10:
Applications of MPEH:
(a) home appliance test and
(b) power plant [6]

Also, based on the simulation and experimental results, a wireless temperature sensor system using power source harvested from power cable of home appliances or power plants was constructed as shown in *Figure 10*.

CAE-based design optimization of PEH

PEH has a higher power density than other types of energy harvesters, but it still has insufficient to drive various sensor systems. To solve this problem, various studies of design optimization of the PEH using CAE simulation model have recently been conducted. As shown in *Figure 11*, the design optimization for the vibration type RPEH was performed using the commercial finite element software ABAQUS [7]. The RPEH is a cantilever beam type, and the fixed end is vibrated by vehicle kinetic energy. The design optimization of vibration type RPEH was formulated as follows:

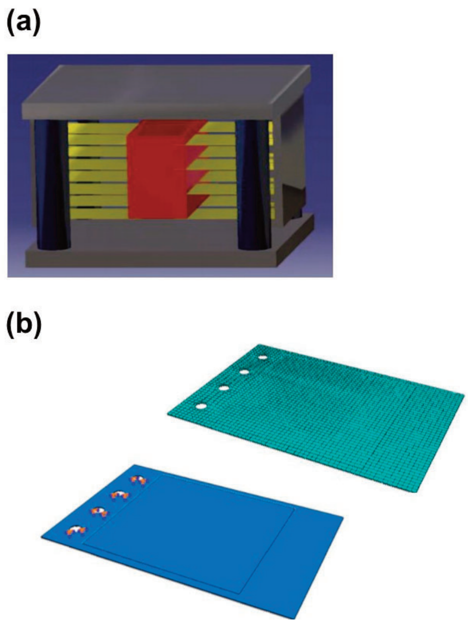


Figure 11:
a) Conceptual design of the RPEH module and
(b) simulation model of the vibration type RPEH [7]

$$\max_{\mathbf{x}} V_{RMS}$$

$$\text{subject to } \; Mass^{PEH} \leq Mass_0^{PEH}$$

$$(f_N - 31)(f_N - 49) \geq 0$$

The V_{RMS} is the root-mean-squared (RMS) value of the output voltage. $Mass^{PEH}$ and f_N are the total mass and natural frequency of the PEH, respectively. Objective functions and constraints were constructed to obtain improved power generation performance of the RPEH without increasing the weight. At the early study, the natural frequency was avoided in a certain frequency range in order to prevent damage due to resonance of the harvester as shown in the above equation. And, the kriging surrogate model and design and analysis of computer experiments (DACE) technique were employed in the optimization process to reduce the excessive computational cost of the time-dependent analysis of RPEH. The result of design optimization of RPEH is given in *Figure 12*. The width and thickness of PZT ceramic and width of substrate are decreased and the length of the substrate is increased. As a result of the design optimization, the RMS value of the output voltage is dramatically increased

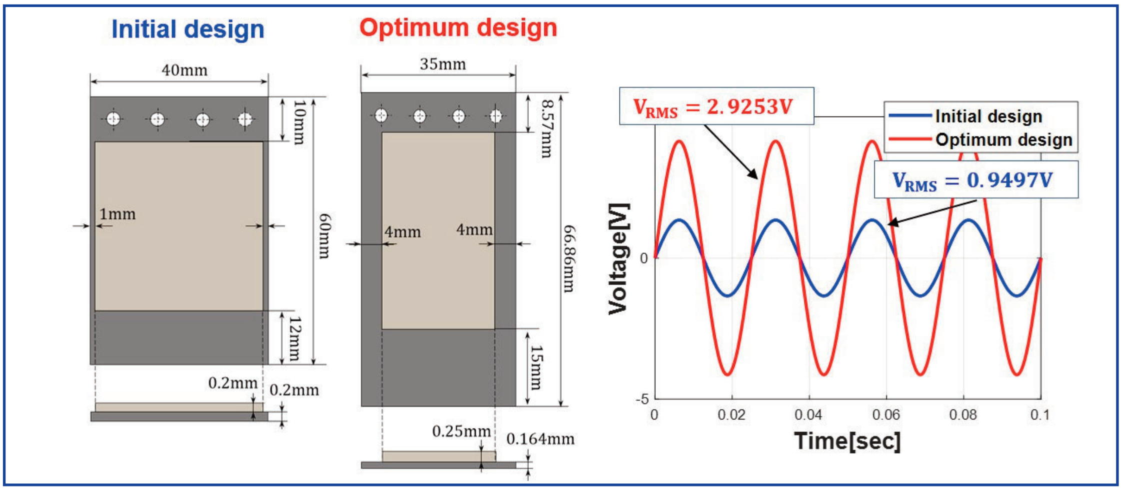


Figure 12: *Design optimization results of RPEH [7]*

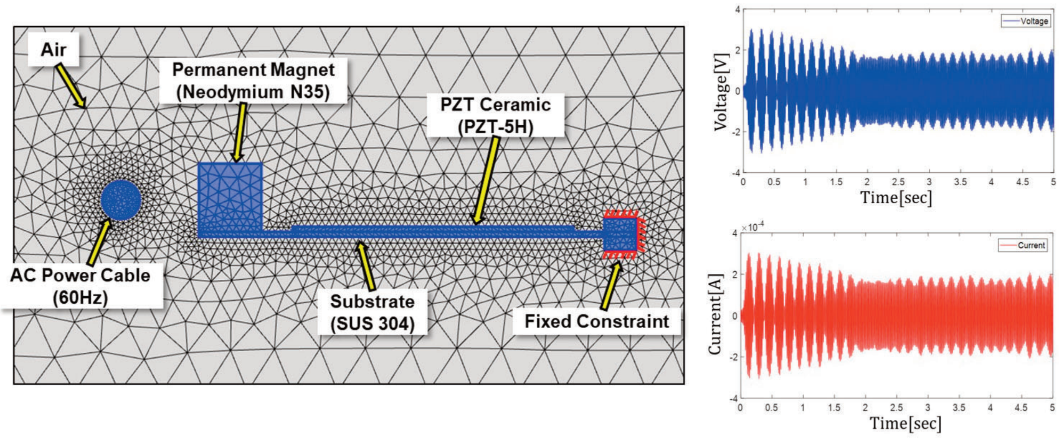


Figure 13: *Multiphysics simulation model of MPEH [8]*

"... as various multi-physics analysis techniques ... are actively employed, the performance of the PEH can be accurately predicted, the amount of power generation is quite improved, and the cost of the physical experiments is effectively reduced."

by 208% from 0.9497V to 2.9253V. Recently, more practical problem formulation and design optimization of MPEH was performed using CAE simulation model [8]. Since the MPEH has a multiphysics phenomenon of electric-magnetic-piezoelectric, analysis of the multiphysics is required to predict the power generation performance of the MPEH. In this study, as shown in *Figure 13*, the multiphysics analysis model of the MPEH was constructed by using commercial software COMSOL Multiphysics. The design optimization of MPEH was formulated as follows:

$$\max_{\mathbf{x}} P_{RMS}$$

$$\text{subject to } \; Mass^{PEH} \leq 1.5 Mass_0^{PEH}$$

$$Mass^{PM} \leq 1.5 Mass_0^{PM}$$

$$\sigma_{max}^{PZT} \leq S_{Ut}^{PZT}$$

$$\sigma_{max}^{SUS} \leq S_y^{SUS}$$

where P_{RMS} is RMS value of the output power, σ_{max}^{PZT} and σ_{max}^{SUS} are the maximum stresses of the PZT ceramic and substrate, S_{Ut}^{PZT} and S_y^{SUS} are the ultimate strength of PZT ceramic and the yield strength of the substrate, respectively. $Mass^{PEH}$ and $Mass^{PM}$ are masses of the PEH and permanent magnet. In this study, kriging surrogate model was used to reduce the high computational cost of multiphysics model in the optimization process. The optimization result of the MPEH is given in *Figure 14*. Both the length and thickness of the PZT ceramic and substrate are increased. As a result of the design optimization of the MPEH, the RMS value of the output power is significantly increased by 730.28% from 0.469mW to 3.894mW.

Concluding Remarks

Although PEH has the advantage of high-power density and ease of use compared to other harvesters, it is necessary to increase the amount of power generation for an independent power source to operate various sensor systems. However, many PEH studies have been conducted based on physical experiments, so there is a limit to deriving the best performance of the energy harvester. CAE technology with optimum design should be introduced to solve this problem. Therefore, as various multi-physics analysis techniques and model calibration methods that consider uncertainty are actively employed, the performance of the PEH can be accurately predicted, the amount of power generation is quite improved, and the cost of the physical experiments is effectively reduced. In addition, if the performance of the harvester is optimized through uncertainty-based optimization design techniques, the reliability and robustness of the system can be improved as well. Moreover, the analysis of PEH incorporated with multiscale modeling and simulation can enhance greatly the performances of PEH and may promise as an independent power source of IoT and smart systems. ●

Acknowledgements

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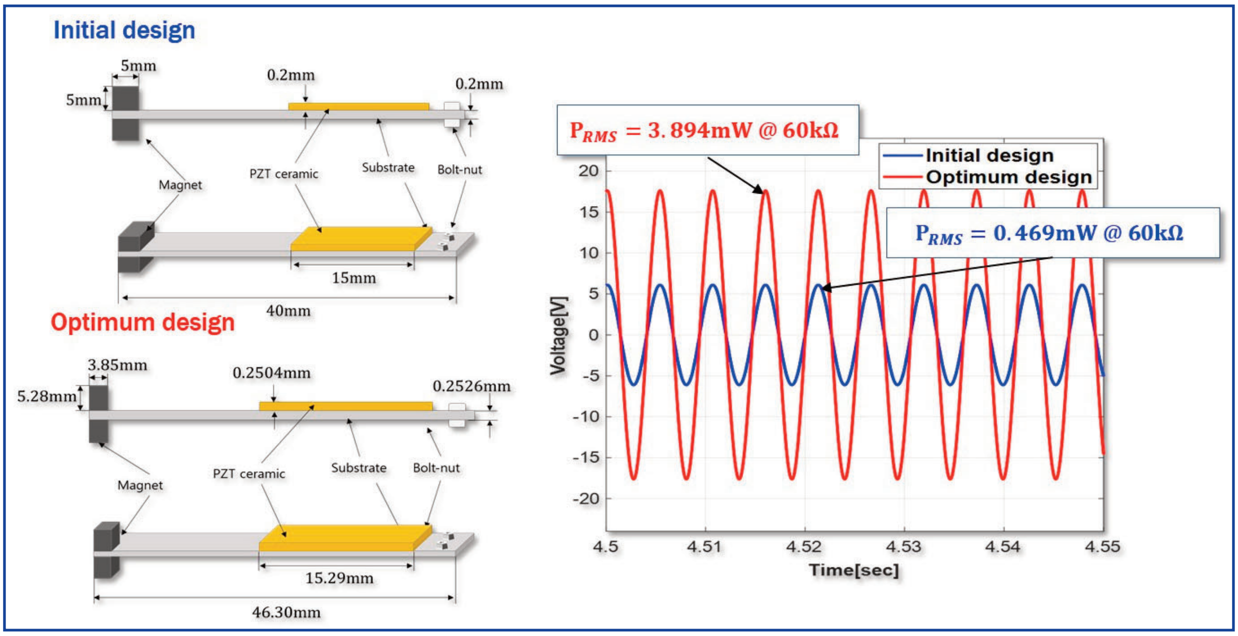

Figure 14:
Design optimization results of MPEH [8]

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Autonomous Finite Elements (AFE) –
Are they precursors of a paradigm shift?

by
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As *"Laziness is built deep into our nature"*[1] we are on a constant search for methods to allow minimal efforts to perform verified finite element (FE) analyses. For more than five decades FE analysis required a qualified analyst to determine the domain of interest, apply material properties and boundary conditions, generate a mesh, solve the resulting system of equations, verify the output and post process the analysis results to reach a meaningful conclusion. The required expertise and labor efforts have precluded the use of FE methods in daily medical practice. Imagine that with a push of a button, an orthopedic surgeon could obtain a fracture risk assessment of a patient's femur determined by FE analysis – see *Figure 1*.

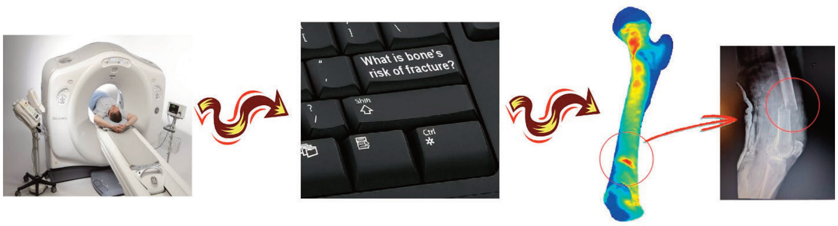

Figure 1:
An AFE concept: with a push of a button, a patient's CT scan is down-loaded from hospital's database (PACS system), the femurs identified, automatically meshed, loaded and solved, and the verified results interpreted and presented in a report that predicts the risk of fracture and illustrates the expected location

Recent scientific advancements such as machine learning and high order FE methods [1], facilitate a fully automated methodology for assessing numerical accuracy. This process, that we refer to as *"Autonomous Finite Elements"* (AFE) might be considered a paradigm shift in the use of FEA. Similar to the well-known autonomous vehicle which can navigate without the assistance of a driver, the Autonomous FE concept is a FE analysis performed without the assistance of an analyst. AFE is possible because we are customizing the individual technologies to a fairly specific problem and a specific goal. Following [2] we describe *Simfini*, an AFE for a specific medical application: determination of the risk of fracture for patients with tumors of the femur. *Simfini* is the first CE accredited[2] application being used in clinical practice to help physicians determine whether or not a patient should undergo prophylactic surgery to avoid an imminent fracture.

A set of components are required for an AFE realization for the analysis of bones (see *Figure 2*):

(a) Image analysis of computed tomography (CT) scans by deep-learning algorithms that segment the femur automatically.
(b) Pointwise estimation of the inhomogeneous mechanical properties of the bone by analysis of image density in the CT scan [3].
(c) Application of personalized physiologic boundary conditions (loads and constraints) that simulate daily activities or falls on the side.
(d) Automatic generation of a FE mesh (with curved faces) to represent the bone of interest.
(e) An efficient high-order FE algorithm that provides verification and control of numerical errors.
(f) A post-processing algorithm that analyzes the FE solution and automatically produces a report with the most relevant data for the medical doctor.

Automating bone segmentation, mesh generation and application of boundary conditions eliminate human intervention which is labor intensive and prone to creation of "subjective" models.

Such an AFE must be rigorously verified before it can be safely used and thereafter validated. Validation in our case requires that predictions made by the AFE are supported by in-vitro experiments [4] and clinical outcomes on real patients [5-7]. We herein describe the different components assembled to generate the AFE and demonstrate its use in daily clinical practice.

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1 Quotation from *Thinking, Fast and Slow* (2011) by Nobel Laureate in Economics, Prof. Daniel Kahneman

2 Indicates conformity with health and safety standards for products within the European Economic Area.

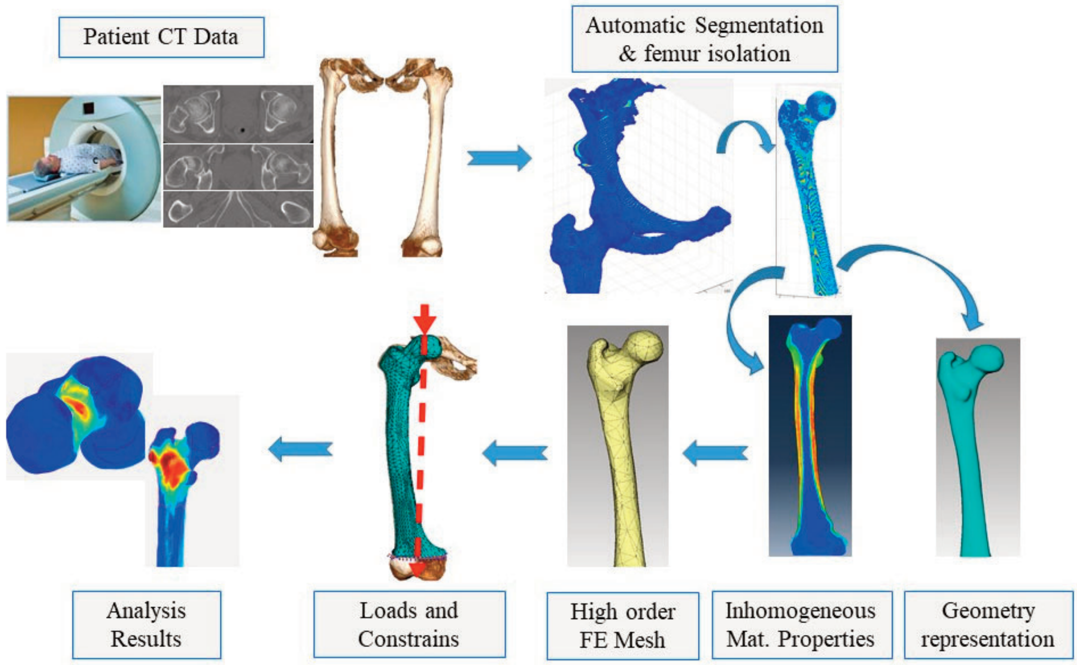


Figure 2:
Schematic diagram of the components of the AFE Simfini (Figure from [2])

Automatic segmentation of patient's femurs from CT scans

Segmenting a femur from CT scans is the process by which the bone volume of interest (voxels in the CT scan that are associated with the bone) is isolated from the rest of the image. Because a bone's surface is not always clearly visible in the CT scan and since the layer of cartilage that separates the femur from the pelvis is sometimes not visible, segmentation is problematic. We apply two convolution neural networks, trained on 70 manually segmented femurs from 39 different patients. The CT scans were obtained from various scanners and from different hospitals. In each CT of the training set, the voxels belonging to femur, pelvis and other tissues were manually tagged. The segmentation process is illustrated in *Figure 3*.

The accuracy of the automatic segmentation was verified by comparing results obtained from manual segmentation for 41 bones (which did not participate in the training process), from male and female, young and old patients. The Sørensen-Dice Coefficient and Average Surface Distance were 0.98 ±0.003 and 0.36±0.05 mm, considered as excellent accuracy. Once segmentation is completed, a series of anatomical points are determined and used for the application of boundary conditions and post-processing operations.

Assignment of inhomogeneous material properties to the femur and boundary conditions

Empirical relationships between longitudinal Young's modulus and Hounsfield Units (gray values in the CT scan) for cortical and

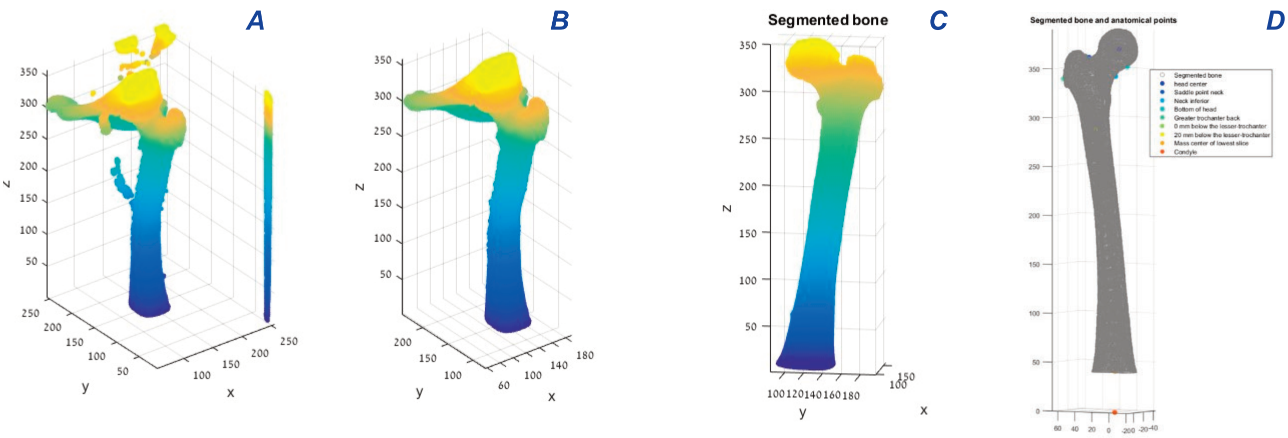


Figure 3:
Segmentation pipeline. A. Separated bone after initial threshold segmentation - femur, pelvis attached and scattered point clouds remain in the image. The colors in the figure represent CT slice height.
B. The bone after removing small unconnected components - femurs and pelvis remain connected.
C. The final voxels that represent the segmented femur.
D. Determination of the anatomical points used to apply the load and for post-processing

trabecular tissues at each point within the bone are given by formulae [3,4]. Thus, inhomogeneous material properties are assigned at each integration point with the femur based on the Hounsfield Unit at the closest voxel in the CT scan.

Personalized loading boundary conditions, the hip contact force, of a magnitude of approximately 2.5 times body weight are applied along a vector that connects the center of femur's head and the inter-condylar notch. The distal part of the femur is fully clamped. Falling on the side boundary conditions can also be applied using different anatomical points.

Automatic mesh generation and p-FE solution

Simfini utilizes an automatic meshing library from Simmetrix[3] that converts voxel data into a discrete geometric surface and then generates tetrahedral volume mesh. Blending function methods are used for the mapping to the standard element so the high-order elements have an accurate representation of element's surfaces independently of the approximation space. The automatic mesh generator also generates a graded mesh in regions of high curvatures such as the femur neck, for example. Typically, a whole femur is meshed by 4000 to 6000 tetrahedral elements (see a typical mesh for a femur in *Figure 4*).

p-Finite elements have several attractive properties ideally suited for AFE such as the ability to automatically estimate the numerical error by keeping the mesh unchanged and systematically increasing the polynomial degree p of the shape functions. Also p-elements may be significantly distorted yet show robustness in terms of deterioration of the numerical accuracy [1]. The automatic verification of the numerical error is performed by increasing the polynomial order of trial and test functions over a fixed mesh, resulting in hierarchical FE spaces and a monotonic convergence of the error in energy norm[4]. This allows the use of three consecutive FE solutions, call them FE_1, FE_2, FE_3, with increasing number of degrees of freedom $N_1 < N_2 < N_3$, and potential energies $\Pi_{FE1} > \Pi_{FE2} > \Pi_{FE3}$. . The exact potential energy Π_{EX} is estimated by solving the non-linear equation [1]

$$\frac{\Pi_{EX}-\Pi_{FE_3}}{\Pi_{EX}-\Pi_{FE_2}} \approx \left(\frac{\Pi_{EX}-\Pi_{FE_2}}{\Pi_{EX}-\Pi_{FE_1}}\right)^{\frac{\log N_2-\log N_3}{\log N_1-\log N_2}}$$

and by obtaining Π_{EX}, the relative error in energy norm (%) for each FE solution is computed by [1]

$$\frac{\left\|\boldsymbol{u}_{FE_i}-\boldsymbol{u}_{EX}\right\|_{\mathcal{E}}}{\left\|\boldsymbol{u}_{FE_i}\right\|_{\mathcal{E}}} = 100 \times \sqrt{\frac{\Pi_{FE_i}-\Pi_{EX}}{\frac{1}{2}\mathcal{B}\left(\boldsymbol{u}_{FE_i},\boldsymbol{u}_{FE_i}\right)}}$$

These error estimates are used to automatically determine whether the quality of the solution is sufficient to draw conclusions from the latest FE solution, or a more refined FE solution is required.

A parallel implementation uses multiple threads to distribute the computation of element stiffness and load to different CPU cores.

Since femur's response under physiological stance position loading is well described by the linear theory of elasticity and excellent results have been obtained using isotropic inhomogeneous relations for stance position loadings, see [3,4] and references therein, a linear finite element analysis is performed.

Automatic post processing of data for a clinical application: risk assessment of a pathological fracture

An important requirement for an AFE is a clear definition of the required output. *Simfini* was designed to provide an assessment of femurs' stiffness and

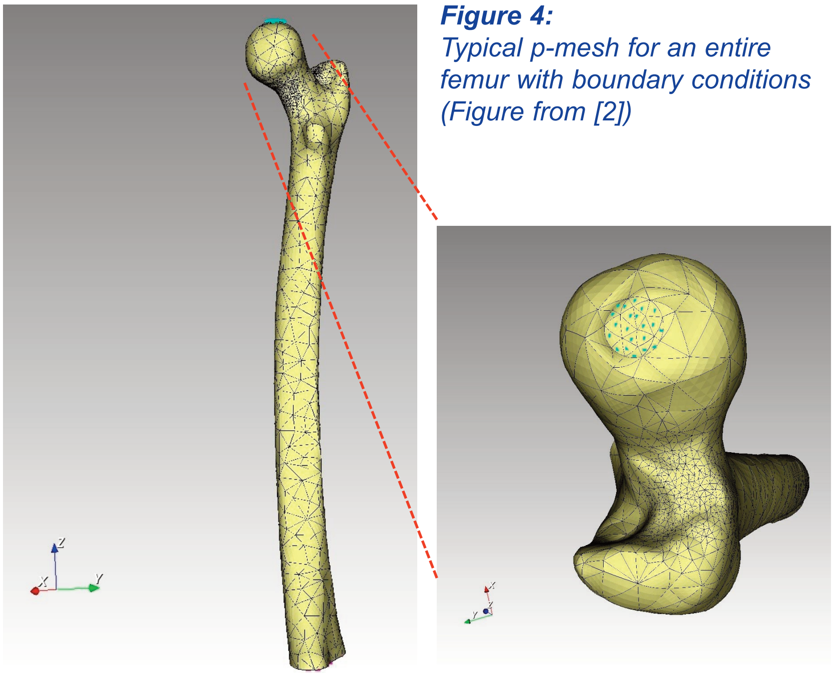


Figure 4:
Typical p-mesh for an entire femur with boundary conditions (Figure from [2])

[3] Simmetrix Inc., Clifton Park, NY 12065, USA

[4] The energy norm of the vector function w is defined as $\|\boldsymbol{w}\|_{\mathcal{E}} = \sqrt{\frac{1}{2}\mathcal{B}(\boldsymbol{w},\boldsymbol{w})}$ where $\mathcal{B}(\cdot,\cdot)$ is the bilinear form of the linear elasticity operator.

strength. Since bone tissue failure depends on averaged principal strains [8,9], these are computed on a bone's surface over an area around a local extremum at five regions in the femur — neck, trochanters, proximal shaft, middle shaft, and distal shaft. The "typical median principal strains" for the five regions in a "healthy femur" were computed for many healthy femurs and used as reference values. The ratio between the absolute maximum principal strain in an analyzed femur and the median strain in the same anatomical region of the disease-free femur is calculated and identified as the "strain fold ratio" (SFR). Clinical trials determined the threshold SFR = 1.48 as the threshold for a pathological femoral fracture [5]. An example of *Simfini's* output report for the physician is presented in *Figure 5*.

Application of AFE in clinical practice: Predicting risk of a pathological fracture in femurs with metastatic tumors

Metastasis of the femur may weaken the bone to the point at which a pathologic fracture may occur during normal daily activity, a major contributor to the deterioration of the quality of life of patients with cancer. Pathologic fractures initiate the period of dependent care, so preventive (prophylactic) surgery for patients with an impending femur fracture improves short-term survival, morbidity, functional outcome, and reduces length of a hospital stay. Orthopedic oncologists have an acute need for an accurate estimation of the risk of fracture to avoid both under-treatment and over-treatment in such patients.

Simfini was validated to be used by orthopedic oncologists to accurately determine which patients are at high risk of fracture. A clinical retrospective study was performed at the Sourasky Medical Center in Tel-Aviv on a group of 15 patients who fractured their femurs and had a pre-fracture CT scan within the past five months, and a control group of 26 patients who had CT-based analyses, did not undergo surgical intervention, and remained mobile and free of fracture over the next five months [6]. All 41 CT scans were automatically analyzed by *Simfini* and the SFR was computed for all regions in the femurs. In cases where the SFR was higher than the 1.48 threshold, the predicted fracture location was reported. *Figure 6A* presents a descriptive analysis of the SFR of the 41 patients in the clinical study. As a comparison, *Figure 6B* presents the commonly used Mirels score, for which 8 is the threshold for a prophylactic surgery.

As may be clearly observed, all patients that fractured were identified by *Simfini* ahead (prior to fracture), whereas those who were fracture free for five months following the CT scan were mostly identified. Compared to the Mirels score, the AFE is superior and a valuable tool for the clinical community both in terms of specificity and especially in terms of sensitivity. The location of the pathological fracture was correctly predicted for all 15 patients with a subsequent fracture.

The AFE *Simfini* has been installed at the Sourasky Medical Center where it is used on a daily basis, and in parallel a prospective clinical trial is ongoing. A typical recent example of the use of *Simfini* is illustrated by *Figure 7*. A patient diagnosed with hepatocellular carcinoma (liver cancer) underwent a CT scan in which the metastatic tumor was hardly visible in the cortical right femur. A *Simfini* analysis was performed by the orthopedic surgeon that estimated a SFR of 2.05, in the distal

2 Location of risk of fracture

Area of interest	Right Femur	Left Femur
Neck	Low	**High**
Greater / Lesser Trochanter	Low	**High**
Proximal Shaft	Low	Low
Middle Shaft	Low	Low
Distal Shaft	Low	Low

The risk of fracture in the right femur is low.
The risk of fracture in the left femur is **high**.

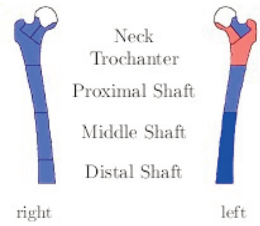


Figure 5:
An example of the Simfini report for a patient that has an strain-fold-ratio>1.48 in the right femur at the neck and intertrochanteric region

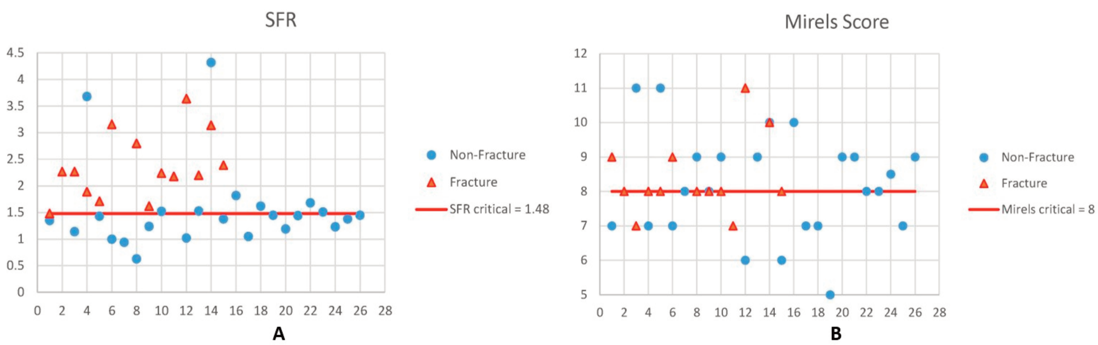
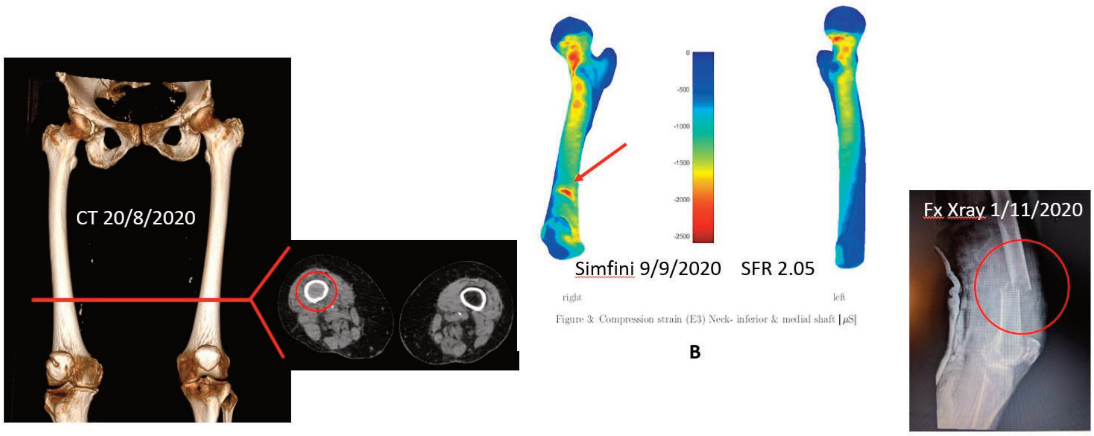


Figure 6:
SFRs (in A) and Mirels score (in B) for patients who eventually sustained a pathological fracture compared with those who did not within six months following the CT scan (Figures from [6])



A C

Figure 7:
A) CT scan of femurs and slice in the region of interest;
B) AFE analysis with the predicted location of the fracture;
C) radiograph after fracture

femur region, indicating a high risk of fracture. Ten weeks after the CT scan, while the patient was under radiation therapy, a pathological fracture occurred at the predicted location during normal daily activity.

Summary

An AFE analysis might be considered a paradigm shift in the use of FEA. The AFE described herein (although limited to linear elastic problems) has successfully combined automatic input acquisition (see also [10]), automatic FE modelling, an automatic rigorous verification algorithm and is supported by a thorough validation process. *Simfini* has been developed to automatically determine risk of fracture for patients with tumors of the femurs, has been validated and is in use in clinical practice. For each patient *Simfini* retrieves automatically the CT scan of interest from hospital's PACS system, performs the analysis for both femurs and places a report back into the PACS for the phisician within an hour. The knowledge and tools are available to deploy the power of FE analyses into the hands of non-FE-specialists by developing AFEs for various applications.

Acknowledgements

The presented article is based on close collaboration with Mr. Kent Myers of PerSimiO Ltd, Beer-Sheva, Israel,
Dr. Nir Trabelsi of Shamoon College of Engineering, Beer-Sheva, Israel and
Dr. Amir Sternheim, head of the Orthopedic Oncology National Unit at Sourasky Medical Center in Tel-Aviv, Israel. ●

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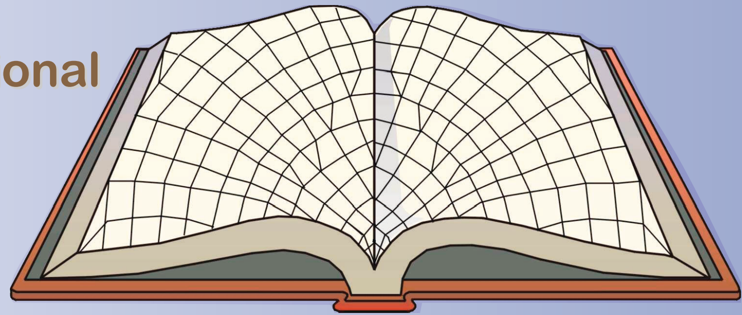
A First Course in Computational Fluid Dynamics



Hassan Aref and
Sivaramakrishnan (Bala) Balachandar
Cambridge University Press, UK, 2018

BOOK REVIEW

***ISBN:** : 978-1316630969, 404 pages, soft cover, £45.99 (List Price). .*
***Contents:** Preface; 1: CFD in perspective; 2: Mappings; 3: Ordinary differential equations – initial value problem; 4: Spatial discretization; 5: Boundary and Eigenvalue ODEs; 6: Methods based on functional expansions; 7: Partial differential equations; 8: Multi-dimensional partial differential equations; References; Index.*

This is a very interesting and unique book on CFD. It is dramatically different in its approach than all other CFD books that I have encountered. Its main unique feature is that it considers fluid mechanics and basic numerical methods more than just necessary "background" for CFD, that has to be quickly acquired in a couple of chapters (if at all) before "getting to business", i.e., before considering the solution of 2D or 3D fluid flow equations. Quite the contrary: the basic preparation for CFD here is deep and occupies most of the book. In fact, what is usually regarded as the focus of CFD is covered only in the last two chapters, and especially in the last chapter, which, for the first time in the book, discusses multi-dimensional PDEs and the solution of the incompressible Navier-Stokes equations. I find this non-traditional approach wise and useful for a reader who wishes to deeply understand the basics of CFD, not just to master its technical aspects.

The book is selective in the CFD areas it chooses to cover, and quite a few important areas are left out. Navier-stokes equations (for viscous flow) are discussed, Euler equations (for inviscid flow) are not. Incompressible flow is discussed, compressible flow is not. Finite difference methods and spectral methods are discussed at length, finite volume methods only briefly, and finite element methods are not mentioned at all. Stepping in pseudo-time to reach steady state is not discussed. But one can hardly complain; there is so much material that can be compressed into 400 pages. I much prefer deep analysis which is limited in scope, like this book offers, over a shallow catch-it-all treatment. The missing areas can be found in other books.

The two authors are well-known experts in fluid mechanics and CFD. Aref, a world leader in fluid mechanics, was a professor at Virginia Tech, and passed away in 2011, before the book was completed. Balachandar, a professor and chairman at the University of Florida, finished writing the book.

It is clear that the authors devoted a lot of effort and thought to every little detail while writing the book. The chapter and section structure is logical, and it is easy to find one's way when looking for a certain subject. The explanations are usually crystal clear. There are many excellent examples, problems and computer exercises scattered in every chapter, all standing out in shaded boxes. Important concepts are written in bold face. There are quite a few illustrations (although in some cases additional illustrations could have helped, e.g., in the discussion on spurious oscillations in Chapter 7). The entire appearance of the book is pleasant to the eye and inviting to read.

by
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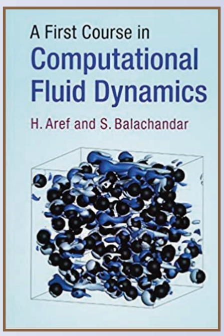


Hassan Aref

Sivaramakrishnan (Bala) Balachandar

Chapter 1 is an introduction, presenting numerical concepts like convergence and round off error, fluid mechanics concepts like turbulence and the Kolmogorov microscale, and CFD concepts like RANS, LES and DNS. To motivate the investigation of apparently simple model problems (instead of jumping directly into the ocean of CFD), the authors make the interesting remark that "some of the most profound discoveries in CFD have come from the study of models using special purpose numerical methods." As an example, they discuss the Lorenz equations, which look quite simple but exhibit remarkably complicated solution behavior, and constitute a simplified mathematical model for atmospheric convection. The chaotic nature of weather prediction begins there!

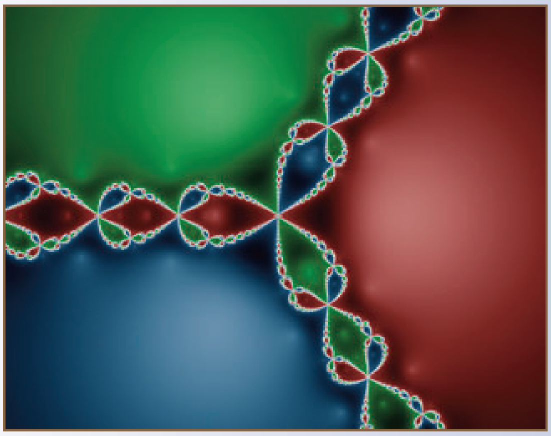


Figure 1:
The "Julia set", which represents the solution of a certain (algebraic) cubic equation in the complex plane.
The picture is taken from Wikipedia (use permitted), and appears as Figure 2.4 in the book

Chapter 2 discusses "models" that can be described purely at the algebraic level. The authors discuss the solution of nonlinear algebraic equations using simple (fixed-point) iteration and Newton's method. They analyze the stability of the fixed point and of the numerical method. Later they explain the concept of subharmonic bifurcations and the use of Newton's method in the complex plane. An example to the latter is the "Julia set"; see *Figure 1*. The chapter ends with a discussion on the connection between algebraic mappings and fluid flows, and especially that related to Poincaré sections.

Chapter 3 is about initial value problems governed by ODEs. The entire chapter discusses the numerical solution of this type of problems using Finite Difference (FD) methods, including implicit and explicit Euler, Runge-Kutta, Adams-Bashforth and many other methods. The stability and accuracy of the methods are carefully analyzed. All this is extremely well written.
The last half of the chapter is devoted to presenting nice examples for the solution of physical problems modeled by initial value problems. It is incredible that the authors could find such a rich sequence of fluid mechanics problems that can be modeled by a system of ODEs (directly, not by discretizing a PDE):
a drop on a flat plate, a collapsing bubble (an important example of cavitation), the potential flow that a rigid body moving in the fluid generates, and motion of a vortex in the flow.
See *Figure 2* in relation with the latter application.

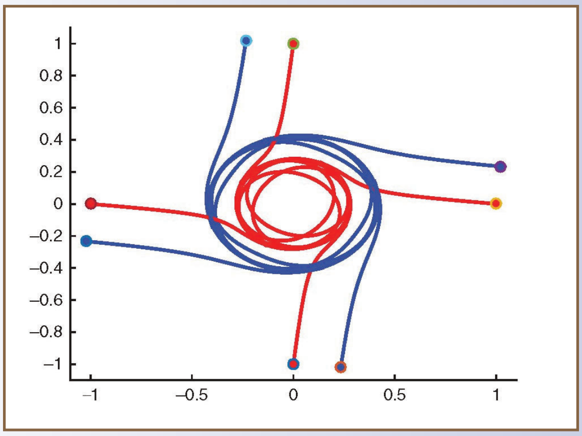


Figure 2:
Motion of four symmetrically placed vortex pairs, obtained from the solution of a set of ODEs describing the evolution of vorticity in fluid flow.
This is Figure 3.10 in the book.

Chapter 4 discusses spatial discretization in 1D. FD approximations for differential operators, using central and one-sided stencils, are presented and analyzed. Von Neumann error analysis is introduced, and amplitude and phase (dispersion) errors are discussed. The chapter also includes sections on compact difference schemes, non-uniform discretization such as that using Chebyshev-Gauss-Lobatto points, interpolation methods and various numerical integration schemes.

Chapter 5 discusses two-point boundary value problems and two-point eigenvalue problems. Two types of methods are covered: shooting methods and so-called relaxation methods. In the latter, discretization leads to a system of algebraic equations which are solved iteratively. (An ethnological observation: even though such methods dominate computational solid mechanics using finite element methods, the term "relaxation" is almost never used in that context.) Applications that are considered here include the Blasius equation, boundary layer on a wedge, Poiseuille flow, Couette flow and von Karman flow. Eigenvalue problems considered include the Graetz problem, thermal (Rayleigh-Benard) instability, shear flow instability (associated with the Orr-Sommerfeld equation), and more.

Chapter 6 concerns spectral methods (still in 1D). The first half of the chapter is a very nice exposition of the basic theory of spectral methods. The second half discusses specific methods, i.e., the Galerkin, tau, collocation and pseudo-spectral methods. The explanation on pseudo-spectral methods is the best I have ever seen. Aliasing and FFT are also discussed. Incidentally, the authors write that in the Galerkin method, one requires that each of the trial functions individually satisfy all the boundary conditions. This is not generally true, as trial functions are required to satisfy only essential boundary conditions (Dirichlet conditions for 2nd order equations), not all boundary conditions (the others being treated as natural boundary conditions).

Chapter 7 is an excellent discussion of numerical methods for space-time PDEs (still in 1D). The four main PDEs treated here are the 1D advection equation, the 1D diffusion (heat) equation, the advection-diffusion equation (that a conference speaker once called "the defection-confusion equation" due to its complexities – thanks to Tom Hughes for reminding me) and Burgers' equation. The modified Helmholtz equation also appears, although it is called throughout "the Helmholtz equation". There is a major difference between the two, since the modified Helmholtz operator is positive definite, whereas the Helmholtz operator is indefinite, hence much more difficult for numerical treatment. Concepts like upwind schemes, the CFL number and stability analysis, Godunov's theorem about monotonicity, the Riemann problem, and much more, are nicely and systematically explained.

Chapter 8 is the climax of the book – the moment the reader has prepared for. Finally multi-D PDEs are discussed. The first half of the chapter concerns FD methods in space-time in Cartesian boxes. The second half discusses CFD in complex geometries, including body-fitted grids, sharp interface schemes and immersed boundary schemes. See *Figures 3 and 4*.

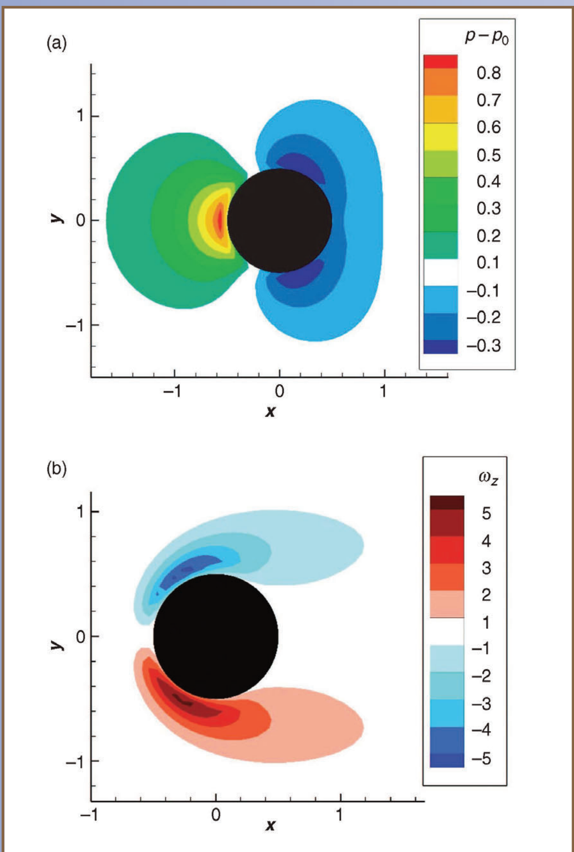


Figure 3:
Pressure and vorticity ((a) and (b), respectively) distribution for uniform flow over a sphere at Re=16.7.
This is Fig. 8.6 in the book

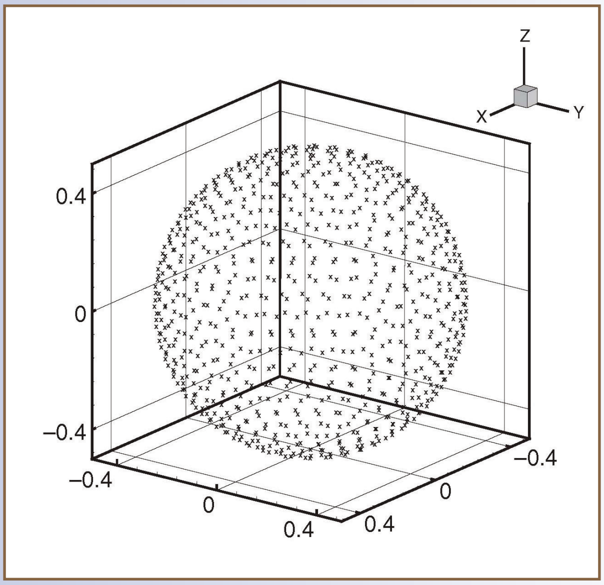


Figure 4:
Use of the Immersed Boundary Method (IBM) for the case of a spherical particle in a flow within a rectangular channel.
The figure shows the distribution of the Lagrangian markers used for the particle.
This is Figure 8.10(b) in the book

In summary, this is a very interesting and well written book that is highly recommended. It is not very broad in its scope, but it is thorough and deep, and does a superb job in exposing the reader to those areas of CFD focused on here. ●

New Executive Committee members

UKACM welcomes two new members to the Executive Committee.

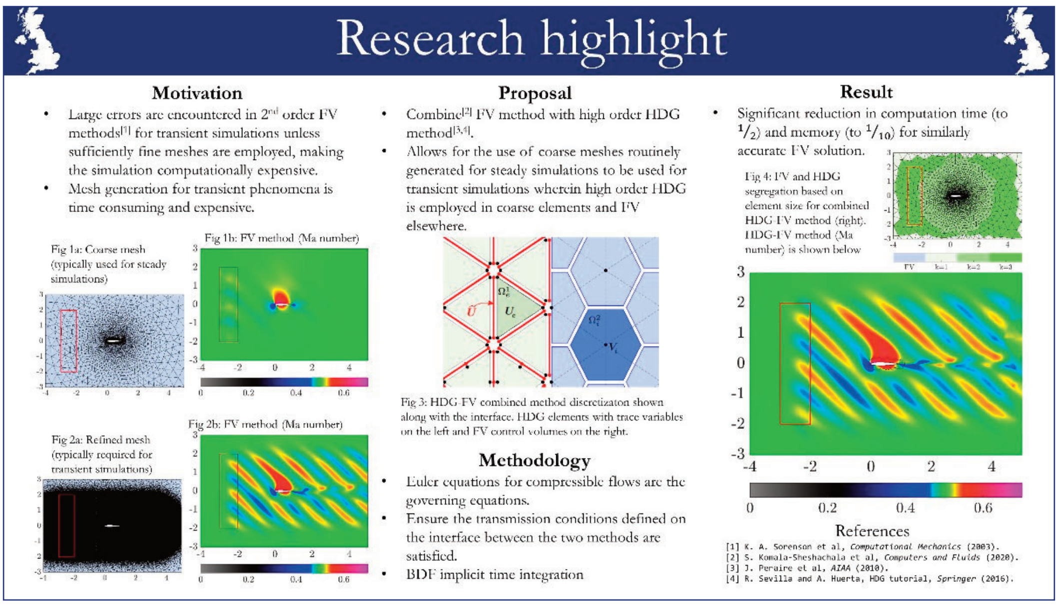
- Dr Chun Hean Lee (Glasgow University) is the new UKACM secretary, replacing Prof Tony Jefferson (Cardiff University).
- Dr Emilio Martinez-Paneda (Imperial College) is the new UKACM YIC representative, replacing Dr Will Coombs (Durham University).

UKACM 2021 Conference

The organising committee and the UKACM Executive are working towards the preparation of the 2021 conference, contemplating a hybrid or fully online approach in case travel restrictions continue to apply. The conference will be organised by Dr Marco Discacciati, Lecturer at the Department of Mathematical Sciences and member of the UKACM Executive Committee.

UKACM Research Highlight Competition

The effect of the COVID-19 crisis in the organisation of scientific events has been profound. The UKACM 2020 conference, planned to take place on April 1-3, 2020 in Loughborough University, was cancelled. As the main remit of UKACM is to provide a platform for UK PhD students and post-doctoral researchers to showcase their research, UKACM organised the first Research Highlight Competition. Participants were asked to submit one slide and a video explaining their research. A committee of UKACM members selected the following winners:



Sanjay Komala-Sheshachala, *Swansea University.* Mike Crisfield Prize for the best research highlight (£250)

Events sponsored and supported by UKACM

2020 Zienkiewicz Lecture

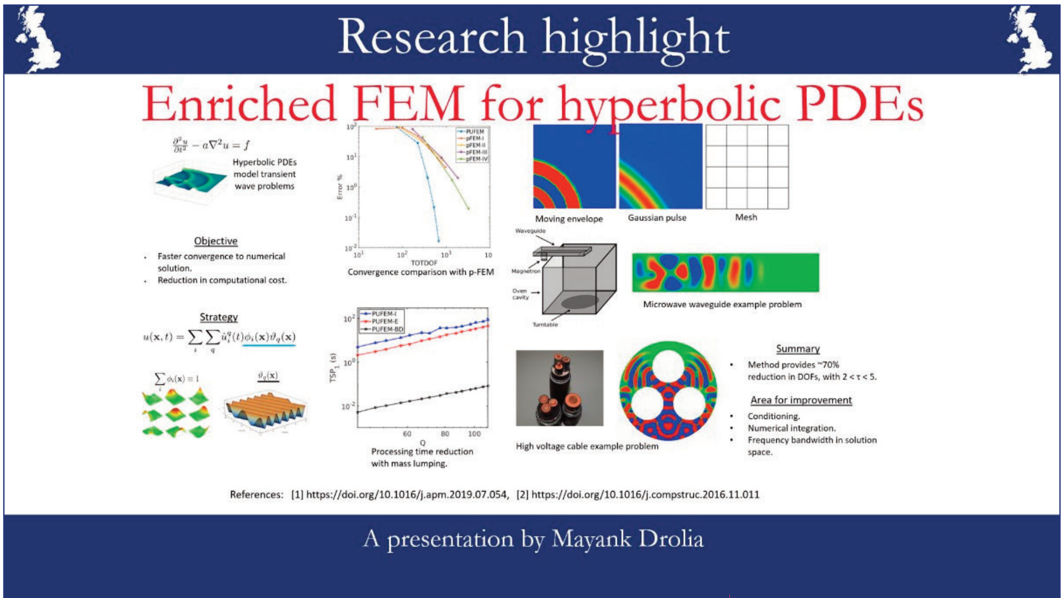
On Wednesday 18th November 2020, Swansea University's College of Engineering hosted its fourth Zienkiewicz Lecture, supported by UKACM. The guest speaker was Professor Andy Hopper (Cambridge University) who will deliver a lecture entitled *"Computing for the Future of the Planet".*

A framework for the role of computing in dealing with sustainability of the planet was presented. The framework has a number of goals: an optimal digital infrastructure, sensing and optimising the use of resources in the physical world, guaranteeing the performance of indispensable systems, and digital alternatives to physical activities.

International Conference of the Engineering Mechanics Institute

The ASCE engineering mechanics institute international conference planned for April 5-8, 2020 was also cancelled due to the COVID-19 crisis. The conference will be organised in Durham in 2022 and will be sponsored by UKACM. ●

Mayank Drolia, *Heriot-Watt University*. Best highlight by a post-graduate Research Student (£100)



In addition, Tim Hageman (Sheffield University) and Kensley Balla (Swansea University) received a highly commended award for their submissions. ●

During the past year the Israel Association for Computational Methods in Mechanics (IACMM) held one symposium. **The 47th Israel Symposium on Computational Mechanics (ISCM-47)** was held in Nov 2019 at Ben-Gurion University of the Negev, organized by Drs. Yuri Feldman and Pavel Trapper.

The interesting opening lecture was given by the international invited speaker Prof. Alessandro Reali from the Pavia University in Italy, titled "Isogeometric Analysis: Advanced modeling and applications with a special focus on shells and laminates". *Figure 1* shows Prof. Reali lecturing.

The symposium included 12 other lectures, presented by practitioners and researchers from industry and academia. These lectures spanned a broad spectrum of computational mechanics topics such as structural topology optimization, sheet metal forming, inverse problems, immersed boundary methods, liquid sloshing, biomechanics and more. Mr. Rafi Sela, a PhD student of Dr. Yuri Feldman from the Department of Mechanical Engineering at Ben-Gurion University was the winner of the ISCM-47 competition for the best presentation – the title of his talk was *"An extension of the immersed boundary method based on the distributed Lagrange multiplier approach: Theory and applications"*.
Mr. Sela was also the winner of the combined ISCM46-ISCM47 best presentation award, and he will be awarded a $1000 prize for attending an international conference on CM. *Figure 2* shows Mr. Sela during his talk, and *Figure 3* is a group photo of the Invited speaker, the IACMM executive council and the organizers of ISCM-47.

The 48th IACMM Symposium was planned for March 2020 at the Technion, organized by Profs. Mahmood Jabareen and Oded Amir and the international invited lecturer was planned to be Prof. Sanjay Govindjee of the University of California, Berkley.

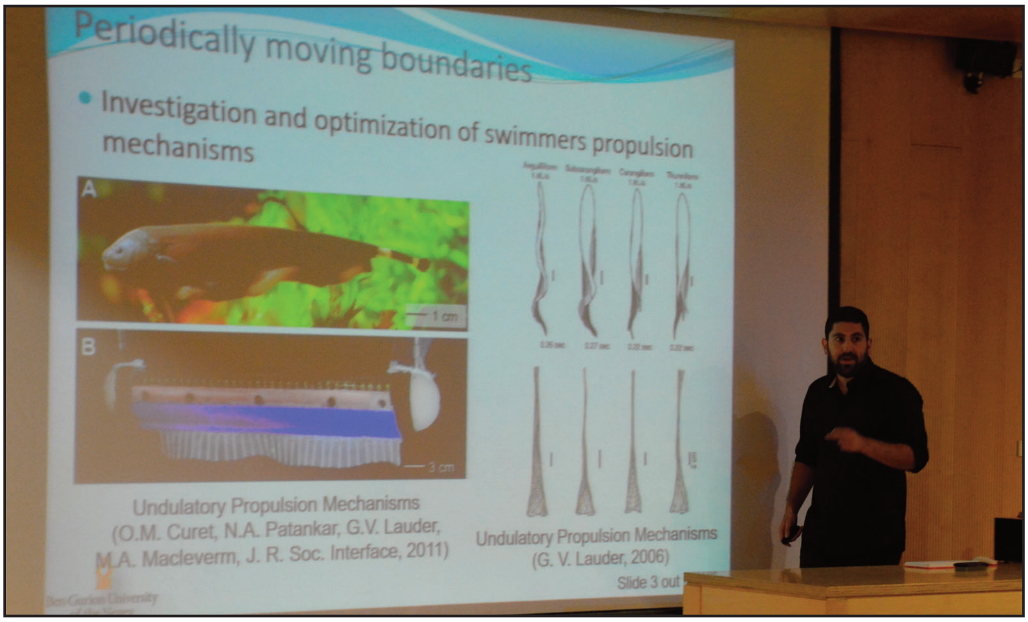
At the last moment, due to the restrictions imposed by the Covid-19 pandemic, ISCM-48 had to be postponed, and if the situation allows will be held in 2021. Instead, the IACMM executive council decided to hold a virtual workshop with four invited lectures delivered on Oct 29th, 2020.

This virtual workshop was attended by many and was very interesting. Prof. Michel Bercovier delivered a talk titled *"Deep Learning and Computational Methods in Mechanics"*,

Figure 1:
Prof. Alessandro Reali the invited international lecturer of ISCM-47, Nov 2019, Ben-Gurion University

for all inclusions under ***IACMM***
please contact
Zohar Yosibash
yosibash@tauex.tau.ac.il

Figure 2:
Mr. Sela, the winner of the ISCM-47 competition for the best presentation, during his talk



Prof. Steven Frankel spoke on *"Quantum Computing Algorithms for Simulating Turbulent Flows*", Dr. Gil Marom spoke on *"Computational Fluid Dynamics Models for Leaflet Thrombosis Risk Assessment Post-Transcatheter Aortic Valve-in-Valve Implantation with Leaflet Laceration"* and Prof. Mahmood Jabareen spoke on *"Recent Advances in Finite Elements Formulation for Solids and Structures"*. ●

Figure 3:
Group photo of IACMM executive council, international speaker and organizers of ISCM-47.
Left to Right: M. Engelman, Y. Feldman, J. Tal , Z. Yosibash, P. Trapper, A. Herszage, A. Reali, I. Harari, E. Priel, D. Givoli and P. Bar-Yoseph

USNCCM16 Update Regarding Abstract Submission and Meeting Format

The 16th U.S. National Congress on Computational Mechanics is scheduled to take place July 25-29, 2021 in Chicago, Illinois. Abstract submission is now open until January 15, 2021. While we welcome abstracts in all areas of computational mechanics, we have designated five areas of emphasis for this congress. They are Computational Fluid and Solid Mechanics; Novel Methods; Computational Medicine; Materials, Manufacturing, and Optimization; and Data-Driven Modeling, Uncertainty Quantification and Machine Learning. Currently the plan is to hold the congress as a hybrid event. We hope that most will be able to attend in person, but if not, a virtual component will be provided. Further information and updates may be found at **http://16.usnccm.org**.

Figure 1: Skyline of Chicago, location for USNCCM16

Virtual IGA 2020

Due the postponement of IGA 2020, USACM held its first virtual conference, VIGA 2020, August 11-12, 2020, with over 250 registered. The conference consisted of eight invited talks over two days, an industrial panel, and several breakout sessions to discuss approximately 30 contributed pre-recorded video talks from participants. A repository is being maintained of the invited speaker talks as well as the contributed talks for those who attended. These are available to those who did not attend by completing the online post-conference registration at **iga2020.usacm.org/registration**.

USACM Female Research Group

The USACM Female Research Group (FRG) has been formed to promote gender balance among the US computational mechanics community and to provide a supportive network for female researchers. USACM-FRG is an affiliate of IACM-FRC. The first networking event took place on August 12, immediately following the conclusion of VIGA 2020. The online event included speakers Professor Elaine Cohen (University of Utah) and Stefanie Elgeti (Vienna University of Technology). For more information about the FRG and its activities, visit **frgusacm.org**. ●

USACM Summer Seminar Series

During June-July, 2020 USACM hosted a series of virtual seminars presented by junior faculty members of USACM. Each talk was approximately 40 minutes in length, with ample time for questions and answers. Below is a list of the seminars presented. All seminars are recorded and links to the videos may be found at **https://usacm.org/seminar-series**.

June 11 **Dr. Adrian Buganza Tepole**, Purdue University,
Predictive Models of Skin Through the Integration of Machine Learning and Computational Mechanics

June 17 **Dr. Steve WaiChing Sun**, Columbia University,
Some Applications of Graph Theory in Data-Driven Multiscale Mechanics

June 25 **Dr. John Evans**, University of Colorado at Boulder,
Data-Driven Turbulence Modeling and Simulation: From RANS to LES

July 1 **Dr. Pania Newell**, University of Utah,
Examining Fracture Behavior in Heterogeneous Poro-elastic Media rom Nano to Macro-scale

July 16 **Dr. Kai James**, University of Illinois at Urbana-Champaign,
Topology Optimization of Self-Actuating Shape-Memory Polymer Mechanisms

July 23 **Dr. Manuel Rausch**, University of Texas at Austin,
Image- and Experiment-based Modeling of the Forgotten Right Side: Right Ventricle, Tricuspid Valve, and Venous Blood Clot

New Technical Thrust Areas (TTA) Formed

USACM announces the formation of two new Technical Thrust Areas in 2020.

TTA – Data-Driven Modeling
Chair: Ellen Kuhl, *Stanford University*
Vice-Chair: Assad Oberai, *University of Southern California*
Members-at-Large: Alireza Doostan, *University of Colorado, Boulder*
Paris Perdikaris, *University of Pennsylvania*

TTA – Modeling and Simulation of Infectious Diseases
Chair: Tarek Zohdi, *University of California, Berkeley*
Vice-Chair: Ellen Kuhl, *Stanford University*
Members-at-Large: Thomas J.R. Hughes and J.T. Oden,
University of Texas at Austin

For information on these and other TTAs, go to **https://www.usacm.org/ttas**. ●

USACM Upcoming Events

further details at usacm.org

- **16th National Congress on Computational Mechanics,** July 25-29, 2021; *Chicago, Illinois;* **http://16.usnccm.org**
- **New Trends and Open Challenges in Computational Mechanics: from Nano to Macroscale,** (virtual event), March 25-26, 2021
- **Meshfree and Novel Finite Elements with Applications,** September 25-27, 2022; *Berkeley, California*; ***http://16.usnccm.org***
- **Isogeometric Analysis 2020,** November 6-9, 2022***;*** *Banff, Canada*; ***http://iga2020.usacm.org.*** ●

Priority Programme Related to GACM by the German Research Foundation (DFG)

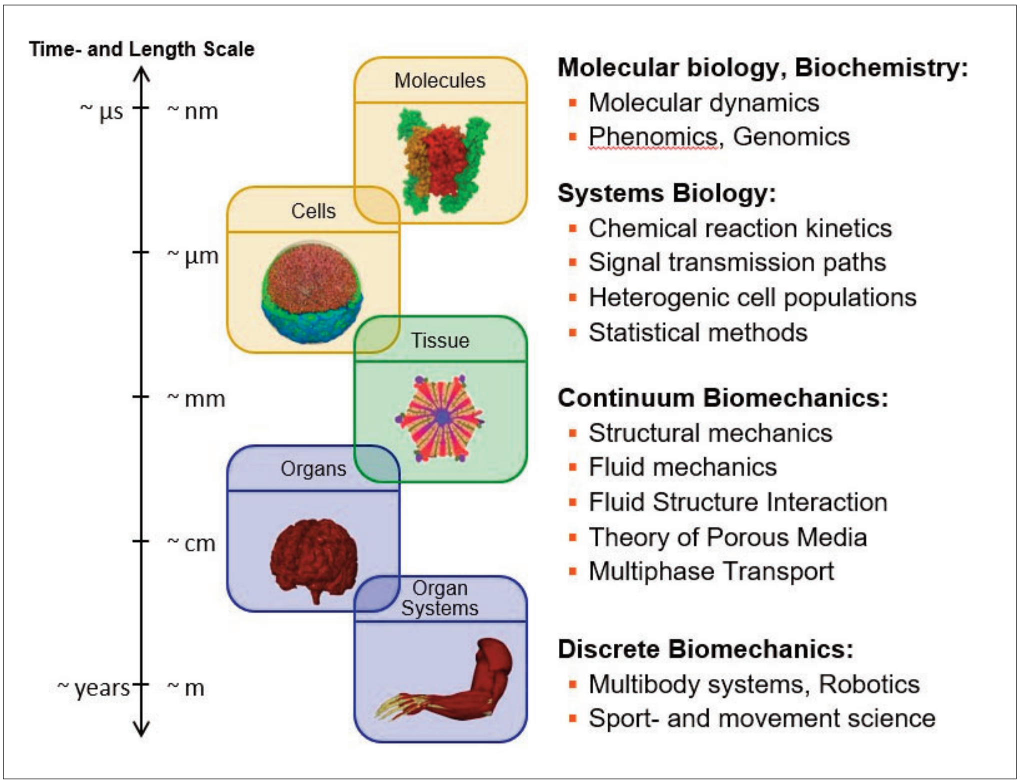
"A particular feature of the Priority Programme is the nationwide collaboration between its participating researchers. The DFG Senate may establish Priority Programmes when the coordinated support given to the area in question promises to produce particular scientific gain. As a rule, Priority Programmes receive funding for a period of six years." [http://www.dfg.de/en]

Priority Programme DFG SPP 2311:
Robust Coupling of Continuum-biomechanical In Silico Models to Establish Active Biological System Models for Later Use in Clinical Applications - Co-design of Modelling, Numerics and Usability

In healthcare, computational (in silico) models can contribute to obtain more specific diagnosis and individualized treatment of diseases. However, this potential is still barely exploited, because biological units such as muscles or organs have so far been viewed mainly in isolated functions, scales or areas. A new DFG Priority Programme now aims to couple the so far isolated models in order to better understand and predict the complex interactions between structures and scales as well as their functions and sub-functions.

In this context, the new founded DFG Priority Programme (SPP 2311) creates an interdisciplinary network that focuses on the research of new methodological approaches to coupling several computational models and considers their physiological functions in a three-dimensional view based on continuum mechanical descriptions. Their aim is to further develop the existing methodological foundations as key qualifications and, thus, enable the generation of robust biomechanical models.

Figure 1:
Research fields of SPP 2311



Although the project does not reach the phase of clinical studies, it aims to create a platform for the qualification of biomechanical simulation models for later use in clinical practice.

Speaker:
Prof. Oliver Röhrle, PhD, Universität Stuttgart
Co-speaker:
Prof. Dr.-Ing. Tim Ricken, Universität Stuttgart
Further Program Committee:
Prof. Dr. med. habil. Dipl.-Ing. Rainer Bader, Universitätsmedizin Rostock
Dr.-Ing. Silvia Budday, Friedrich-Alexander Universität Erlangen-Nürnberg
Prof. Dr. Axel Klawonn, Universität zu Köln

Homepage: **https://www.spp2311.uni-stuttgart.de/**

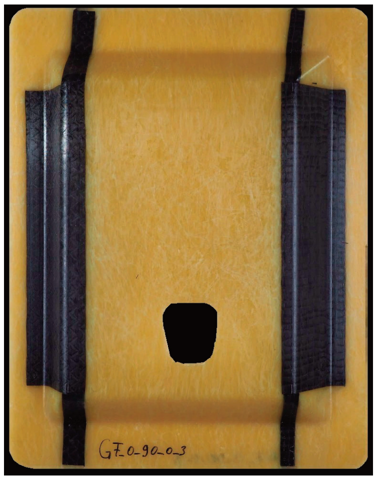
GACM Related Research Training Group by the German Research Foundation (DFG)

"Research Training Groups are established by universities to promote early career researchers. They are funded by the DFG for a period of up to nine years. Their key emphasis is on the qualification of doctoral researchers within the framework of a focused research programme and a structured training strategy."
[http://www.dfg.de/en]

International Research Training Group (IRTG) DFG GRK 2078: Integrated engineering of continuous-discontinuous long fiber reinforced polymer structures (CoDiCoFRP)

The DFG-GRK 2078 research project located at Karlsruhe Institute of Technology (KIT) has been funded by the German Research Foundation (DFG) since 2015. This international consortium consists of several academic partners and research institutes in Germany and Canada accompanied by two local industrial advisory boards. The IRTG is thematically clustered in the four research areas Technology, Characterization, Simulation and Design. The core research idea is to establish integrated engineering strategies for materials science of polymer-based materials, multi-scale and multi-physics simulations, process technology, and product development. In this context, interdisciplinary research approaches for material design, structure and process optimization along with aspects of material characterization as well as quality control in manufacturing of continuous-discontinuous fiber-reinforced polymer (CoDiCoFRP) structures are developed. The joint work of all projects aims at establishing a real and multi-scale virtual process chain representing the entire process from material development and pressing process to the final component, by corresponding simulations. Furthermore, based upon the virtual process chain, the real process chain shall be improved. By taking advantage of the complementary competencies and research expertise in the IRTG, an efficiently structured scientific education of doctoral candidates in the strategically important, but not fully developed, field of CoDiCoFRP structures is guaranteed. This ensures a continuous transfer of scientific findings to industrial applications and contributes to a strong link to national industries. In 2019, the outcome of the first generation has been published as a book, titled as *Continuous – Discontinuous Fiber-Reinforced Polymers: An Integrated Engineering Approach*, *Hanser Verlag*. After the positive evaluation in 2019, currently 14 doctoral researchers and 1 PostDoc of the second generation of the project are jointly supervised by principal investigators from Germany and Canada. Additionally, several associated doctoral researchers and PostDocs at the different institutes are active in this new field and indicate the strong and lasting effect of this IRTG on research as well as on teaching especially in the KIT-faculty of mechanical engineering.

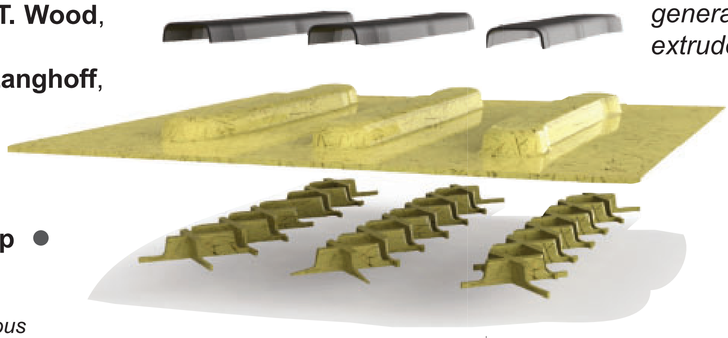
Figure 2:
Manufactured demonstrator part of 1st IRTG generation [1]



Speaker: **Prof. Dr.-Ing. Thomas Böhlke**, Institute of Engineering Mechanics, KIT
Co-speaker: **Prof. Dr.-Ing. Frank Henning**, Institute of Vehicle System Technology, KIT, and Fraunhofer Institute of Chemical Technology, Pfinztal
Speaker of Canadian partners: **Prof. Jeffrey T. Wood**, University of Western Ontario
Academic Director: **Dr.-Ing. Tom-Alexander Langhoff**, Institute of Engineering Mechanics, KIT

Homepage: **https://www.grk2078.kit.edu**
List of publications:
http://www.grk2078.kit.edu/publications.php

Figure 3:
3D CAD model of the demonstrator part of 2nd IRTG generation with extruded ribs and beads [2]



[1] Böhlke, T., Henning, F., Hrymak, A. N., Kärger, L., Weidenmann, K., Wood, J. T.: Continuous-Discontinuous Fiber-Reinforced Polymers. An Integrated Engineering Approach. Hanser Fachbuchverlag (2019)
[2] Picture provided by Thilo Richter (IRTG project D3)

Renewal of SEMNI Executive Board

After the elections held last October 16th, 2020, a new executive board has been formed. A new member has been elected, Prof. Xesús Nogueira (Universidade da Coruña). Other members have been re-elected, such as Profs. Irene Arias, Joan Baiges and Antonio Huerta (Polytechnic University of Catalonia), Ignacio Romero (Polytechnic University of Madrid) and Ignasi Colominas (Universidade da Coruña). Only one half of the members of the board were subject to renewal, so the rest of the members will continue until the end of their term in 2022. They are Profs. Rena Yu, Juan José Ródenas, Francisco Montáns and Riccardo Rossi. Prof. Elías Cueto has been re-elected as president for the term 2021-2024. As past-presidents, Profs. Eugenio Oñate, Manuel Casteleiro and Xavier Oliver will also continue serving in the board.

The president, Prof. Elías Cueto, gratefully acknowledged the valuable work and generous dedication of the member that now leaves the board: Prof. Fermín Navarrina (Universidade da Coruña), who served in the board during the last 27 years! ●

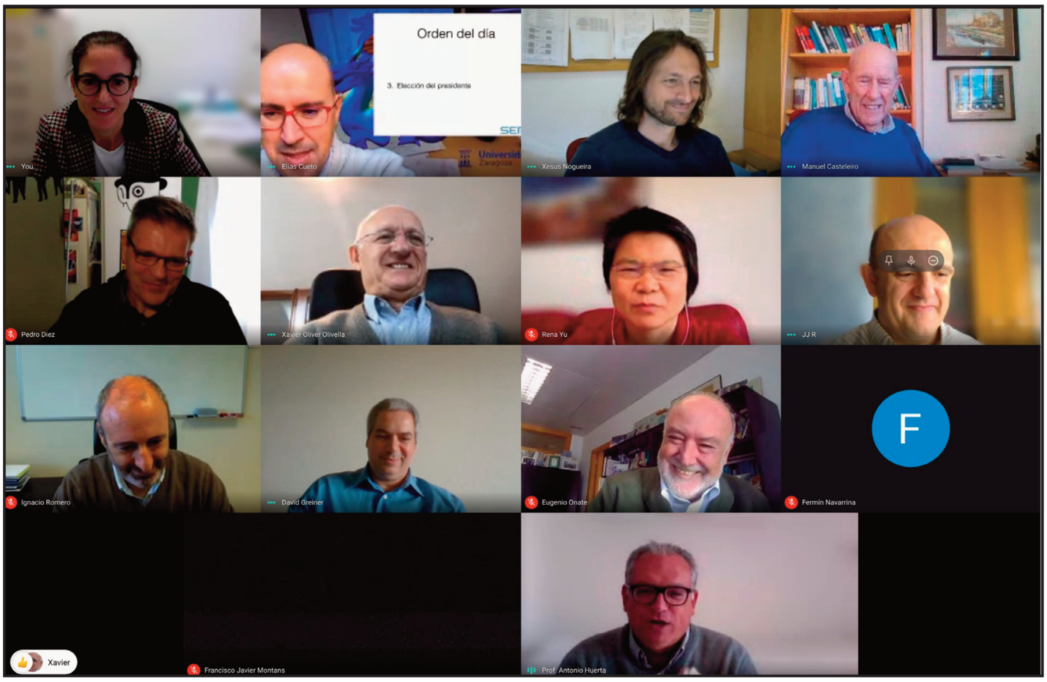


Figure 1: *(1st row) Irene Arias, Elias Cueto, Xesús Nogueira, Manuel Casteleiro (2nd) Pedro Díez, Xavier Oliver, Rena Yu, Juan J. Ródenas, (3rd) Ignacio Romero, David Greiner, Eugenio Oñate, (absent) Fermín Navarrina (4th) (absent) Francisco Montans, Antonio Huerta (receiving congratulations for his just-announced prize)*

SEMNI O. C. Zienkiewicz award 2020

The highest distinction provided biennially by SEMNI to personalities in the field of numerical methods in engineering is the O. C. Zienkiewicz prize. In this occasion, the award goes to **Prof. Antonio Huerta**, from the Polytechnic University of Barcelona.

Prof. Huerta is a member of the Spanish Royal Academy of Engineering, president of IACM and a renowned specialist in the field of numerical methods. Prof. Huerta, whose work within the Spanish Society for Numerical Methods is thus acknowledged by our community, will receive a diploma and a plaque during the gala dinner of the next Conference on Numerical Methods, CMN, to be held in Las Palmas de Gran Canaria in 2022. ●

SEMNI and APMTAC postpone their biennial joint conference

Given the actual circumstances of the pandemic due to the COVID-19 disease, SEMNI, along with its sister Portuguese association, APMTAC, have agreed to defer the conference, that would have taken place next July 2021, and postpone it to September 12-14th 2022, thus avoiding coincidence with existing and well-stablished ECCOMAS and IACM conferences.

More info from https://congress.cimne.com/cmn2022/frontal/default.asp ●

SEMNI Juan C. Simó award 2020

SEMNI has awarded its annual **Juan C. Simó** prize during its last executive meeting. The awardee will receive his prize during the gala dinner ceremony of the joint Spanish-Portuguese Conference on Numerical Methods, CMN, to be held in Las Palmas de Gran Canaria next 2022.

SEMNI's prize to young researchers commemorates the legacy of the late Prof. Juan C. Simó in the field of numerical methods. The committee was formed in this occasion by Profs. P. Díez (president), Ferdinando Auricchio, Fredrik Larsson, Thierry J. Massart, and Francisco Chinesta.

In this occasion, the awardee is prof. Emilio Martínez Pañeda, (Imperial College London), for his contributions to nonlinear solid mechanics with emphasis on applications to fracture mechanics in different fields of engineering sciences. The Committee has valued the breadth of his research activities and the variety and extent of his national and international research collaborations. ●

Report from the Japan Association for Computational Mechanic

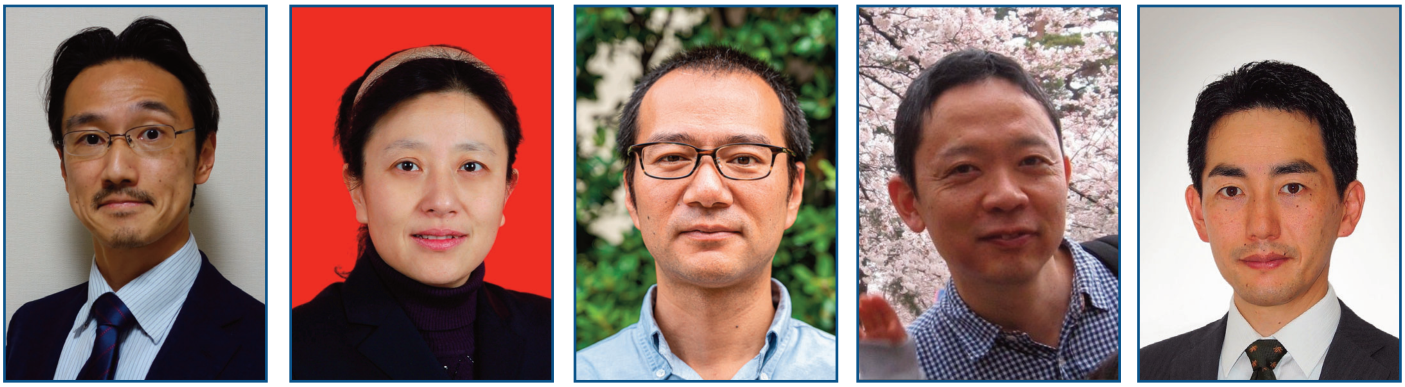
The JACM is a union of researchers and engineers working in the field of computational mechanics mainly in Japan. JACM is a loosely coupled umbrella organization covering 29 computational mechanics related societies in Japan through communication with e-mail and web page (https://ja-cm.org/index-e.html). The number of individual members is about 330. JACM members actively participate in the IACM activities.

The ONLINE 2020 JACM Annual Meeting was held in the evening of July 2020. It was originally scheduled to be held in conjunction with the WCCM2020, but due to the cancellation of WCCM2020, it was held ONLINE on the scheduled date. JACM executive members used a virtual background with the Eiffel Tower (*Figure 4*), the symbol of Paris, which was the planned venue for WCCM2020.

The meeting started at 17:00 on 22th July and 45 members participated the meeting. Hiroshi Okada, President, JACM reported the past activities of JACM. The report included the present number of members, executive members, affiliated societies, mini-symposium proposals for IACM related conferences by the JACM members, WCCM 2022, some future plans, etc. Then, the award ceremony followed. In the award ceremony, each awardee was introduced.

(a) ***(b)*** ***(c)***

Figure 1:
Computational Mechanics Award:
(a) Prof. Hideyuki Azegami (Nagoya Univ.), (b) Prof. Daigoro Isobe (Univ. of Tsukuba) and (c) Dr. Hirofumi Tomita (RIKEN)

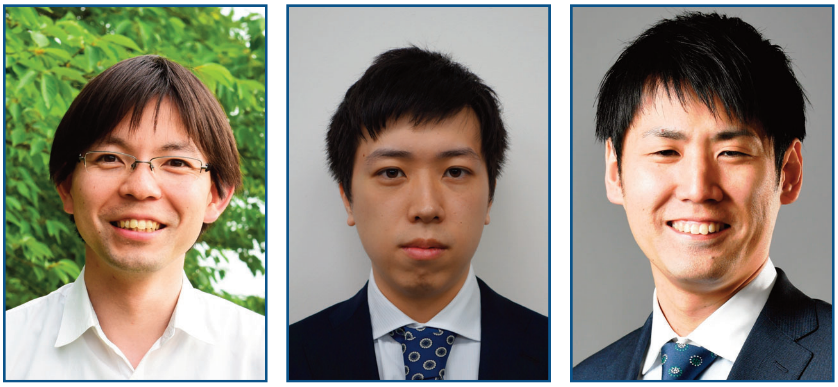


(a) ***(b)*** ***(c)*** ***(d)*** ***(e)***

Figure 2:
Fellows Award:
(a) Prof. Yuichi Tadano (Saga Univ.), (b) Prof. Fei Xu Northwestern Polytech. Univ.), (c) Prof. Ryosuke Matsumoto (Kyoto Univ. of Adv. Sci.), (d) Prof. Tomoshi Miyamura (Nihon Univ.) and (e) Prof. Yoshitaka Wada (Kindai Univ.)

In 2020, The JACM Computational Mechanics Awards which are the highest awards were presented to Profs. Hideyuki Azegami (Nagoya Univ.), Daigoro Isobe (Univ. of Tsukuba) and Hirofumi Tomita (RIKEN) (*Figure 1*). The JACM Fellows Awards were presented to Profs. Yuichi Tadano (Saga Univ.), Fei Xu (Northwestern Polytech. Univ.), Ryosuke Matsumoto (Kyoto Univ. of Adv. Sci.), Tomoshi Miyamura (Nihon Univ.) and Yoshitaka Wada (Kindai Univ.) (*Figure 2*). The JACM Young Investigator Award were presented to Profs. Yoshitaka Kameo (Kyoto Univ.), Takashi Kuraishi (Rice Univ.) and Kazuki Shibanuma (UTokyo) (*Figure 3*).

After the ceremony, the award winners gave short speeches. The JACM meeting ended with a photo session using zoom (*Figure 5*). ●



(a) ***(b)*** ***(c)***

Figure 3:
JACM Award for Young Investigators in Computational Mechanics (a) Prof. Yoshitaka Kameo (Kyoto Univ.), (b) Dr. Takashi Kuraishi (Rice Univ.) and (c) Prof. Kazuki Shibanuma (UTokyo)

Figure 4:
Virtual background with the Eiffel Tower

Figure 5:
A photo of the 2020 JACM annual meeting participaints

The Japan Society for Computational Engineering and Science

Toward an Attractive Academic Society that can Respond to Various Changes

by:
Dr. Naoya Sasaki
The 13th president of JSCES

The The Japan Society for Computational Engineering and Science (JSCES) was established in 1995, after the success of the 3rd World Congress of Computational Mechanics (1994, Chiba, Japan) (WCCM III). This year, we are celebrating its 25th anniversary.

At present, the number of members of the JSCES is gradually increasing, while the decrease in number of members is a big issue for most of academic societies. The JSCES has carried out many other activities to promote the computational engineering and science. For example, Short Courses, Summer Camp and Seminars are regularly provided. The Research Committee of JSCES operates Study Groups for HQC (High Quality Computing), PSE (Problem Solving Environment), Hypercomplex Disaster Simulation, Uncertainty Modeling and Simulation, Education of Computational Mechanics, and Automobile Structural Model-Based Development, to exchange information among the members and cooperation between academia and industries.

COMPSAFE2020

(December 8-11, 2020)
Kobe, Japan

The 3rd International Conference on Computational Engineering and Science for Safety and Environmental Problems (COMPSAFE2020), which is an APACM Thematic Conference and an IACM Special Interest Conference, was held fully online.

There were 326 registered participants and 254 presentations in minisymposia. 4 plenary lectures by Prof. J. Westerink (Univ. of Notre Dame), Prof. M. Papadrakakis (National Technical Univ. of Athens), Prof. S. Koshizuka (The Univ. of Tokyo), Prof. M. Tsubokura (RIKEN R-CCS/Kobe Univ.) and 10 semi-plenary lectures were given. To operate the online presentations with Zoom, members of the Local Organizing/Arrangement Committees gathered at an operation room set up in the RIKEN Center for Computational Science (R-CCS).

Figure 1:
Opening ceremony by Chair, Prof. Isobe (Univ. of Tsukuba)

Figure 2:
Performance in pre-conference event

Furthermore, the JSCES has hosted the 3rd International Conference on Computational Engineering and Science for Safety and Environmental Problems (COMPSAFE2020) with JACM (Japan Association for Computational Mechanics) during 8-11 December, 2020, which was held fully online.

Computational engineering and mechanics are applied in various fields as useful technologies and methods, and also as a way of thinking, in the cyber space of the CPS (Cyber-Physical System) field in cooperation with mathematical information science and data analysis in major movements such as SDGs, AI, and IoT, and technological changes and evolution. Also, as seen in the recent unpredictable phenomena such as COVID-19, a computational engineering approach that takes advantage of the characteristics of analysis and synthesis may act greatly in the relationship between humans, society, nature, information and mechanical systems.

One of the roles that the JSCES should play is to drive research, technological development, and dissemination awareness that meet such social demands. Therefore, we would like to discuss a way to evolve computational engineering for the coming era and a way to lay foundation for innovative changes, with the parties concerned. ●

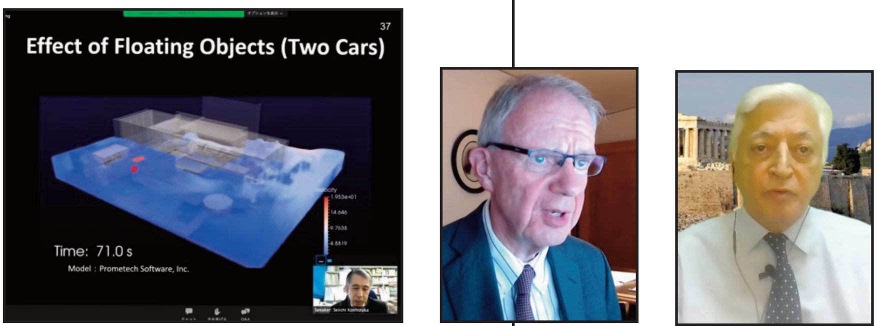


Figure 3:
Plenary talks by Prof. Koshizuka, Prof. Westerink and Prof. Papadrakakis

The conference has become the largest in number of registered participants in the COMPSAFE series and was successfully closed with the plenary talk by Prof. Tsubokura, in which the droplet/aerosol infection simulation against COVID-19 was presented to evaluate the infection risk together with “Safety”. ●

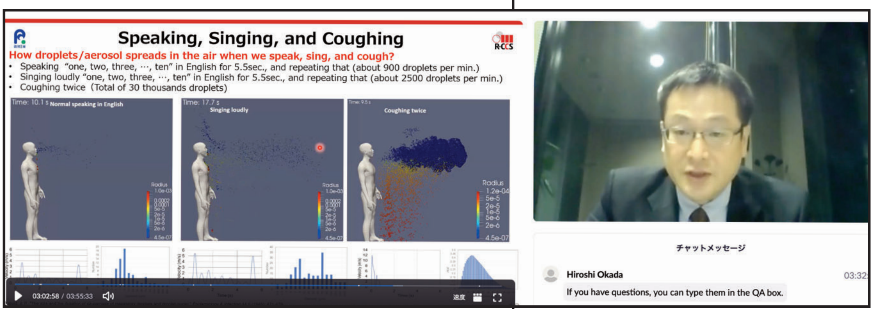


Figure 4:
Plenary talk by Prof. Tsubokura

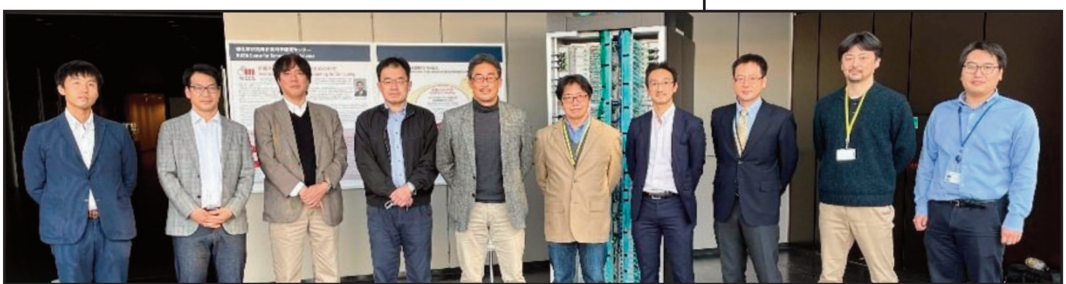


Figure 5:
Members of local organizing/arrangement committees at RIKEN R-CCS

Gruppo Italiano di
Meccanica Computazionale

In Memory of
Prof. Raffaele Casciaro

It is with profound sadness that we share the news that Prof. Raffaele Casciaro passed away on 27 July 2020. He is buried in his beloved Rossano, a small city in southeast Italy, where he was born in 1943.

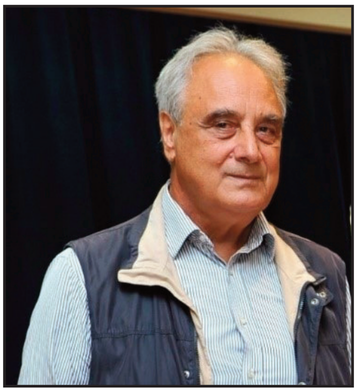


Figure 1:
A recent picture of Raffaele

After a short research period in Rome ``La Sapienza'', where he earned his master degree in civil engineering (1967), he moved to the University of Calabria (UNICAL) where he spent his entire academic career life.

His scientific interests, since the early 1970s, were focused on computational mechanics. Raffaele foresaw the great potential of computational mechanics which, he believed, have played a key role in structural analysis and in the related research activities. Based on his belief, he became one of the pioneers and founders of the Italian Group of Computational Mechanics.

Raffaele was an outstanding Italian researcher of his time. His scientific activities have always been aimed at developing structural models and numerical methods for simulating the mechanical behavior of structures. In doing that he firmly believed that research must be driven by practical problems. His scientific contributions have covered variety of topics: limit and shakedown analysis, structural dynamics, nonlinear analysis of slender structures prone to buckle, modeling of geotechnical problems, solution algorithms for nonlinear problems, nonlinear structural models and their finite element formulations, multigrid methods, modeling of masonry and reinforced concrete structures.

His initial work, which already shows some of the ideas that would have inspired Raffaele's more mature scientific contributions, began in the early 1970s. This period can be considered as the "Stone Age" of the computer revolution in structural mechanics. Among his first works, it is worth note to remember those on limit analysis of plates reformulated as a min-max problem using mixed finite elements in which both stresses and displacements are interpolated. The use of direct methods for the solution of limit analysis (and shakedown) problems and the advantages of using mixed finite elements in plasticity are topics that Raffaele deeply investigated in the following years with notable scientific contributions.

In the late 1970s, at a conference, Raffaele met Eduard Riks with whom he established a relationship of mutual respect and friendship. Inspired by Riks' work, Raffaele started studying plasticity and other nonlinear problems using incremental arc-length methods. The arc-length formulation for the analysis of slender structures was significantly strengthened by a proposal of Raffaele and his coworkers of the late 1990s, which was highly appreciated by Riks himself. In that work, the use of a mixed description in stress and displacement is proposed, where stresses are taken as primary variables in both the predictor and corrector states of the iterative scheme. Moreover, the Riks path-following analysis was generalized, years afterwards, by other important research contributions of Raffaele. Among the others, it was adopted as a strategy for solving the optimization problem deriving from the static shakedown theorem and for handling the unstable static response of softening materials in masonry walls.

A list of publication is available on ***Researchgate***

A commemorative note for Raffaele ***Meccanica***

In the late 1970s he started working on a mile-stone of his research activity, namely the finite element implementation of Koiter's theory of elastic stability. Raffaele had followed some of Koiter's lectures which had had a deep impact on him. He immediately foresaw the potentialities of a finite element formulation of this theory for designing slender structures prone to buckle. It resulted into an innovative tool able to efficiently estimate the initial post-critical behavior of elastic slender structures taking into account the imperfection sensitivity also in case of almost coincident buckling loads. In the subsequent years Raffaele and his research group developed the method into a consolidated analysis and design tool.

Finally, throughout his career life, Raffaele gave a large contribution to developing methods and algorithms for seismic analysis and design of reinforced concrete and masonry structures. These works, many of them unfortunately never published, inspired many of his students and collaborators to found software houses in Calabria, which directly uses Raffaele's efficient algorithms.

Raffaele loved working with other people, especially with young researchers. He used to spend many hours in programming, working side by side with master or PhD students. He truly believed that this was the correct way to quickly transfer knowledge he had acquired over the years to younger researchers, allowing them to deal with complex problems. The exchange of views and ideas, often carried out through long technical discussions in front of a blackboard, was for him the most effective way to advance the research process, which benefited from his brilliant intuition. Young researchers loved him because of his profound generosity, his never giving up and the support he gave to everyone in facing the difficulties.

Figure 2:
Raffaele and J.N. Reddy

Intelligence and intuition were the best Raffaele's qualities. His capacity to deeply explore new topics in a few minutes, after short technical discussions or presentations, was impressive and amazing at the same time. He had the ability to eliminate, from a complex problem, all the redundant details, thereby focusing on its main logical scheme.

Raffaele left a memorable mark on the Italian community of Computational Mechanics. University was his home for almost his entire life, the place where he followed his passion for doing high level research and creating a group of researchers who shared this purpose.

Figure 3:
Raffaele at a GIMC conference

Figure 4:
Raffaele and L.A. Godoy at a GIMC conference

Deadline for abstracts submissions is 31st January 2021

Piazza De Nava, 26 89100 Reggio di Calabria (RC)

On November 16-19, 2020, the Brazilian Association for Computational Methods in Engineering (ABMEC) promoted the 42nd edition of CILAMCE, the Ibero-Latin-American Congress on Computational Methods in Engineering. Due to the COVID-19 pandemic, the congress was held for the first time in virtual mode, being organized by the Federal University of the Latin American Integration, from Foz do Iguaçu, under the chair of Prof. Aref Kzam. Despite the enormous challenge in organizing a conference in this exceptional year, CILAMCE-2020 was a tremendous success in all respects. We had over 640 participants from all parts of Brazil and Latin America, plus a few other colleagues from farther abroad. This truly expresses the very spirit of CILAMCE. The congress took place within a virtual platform that was especially designed for CILAMCE-2020, into which the participants could log in and feel inside a virtual foyer, being able to browse from there through the main virtual auditorium and several mini-symposium virtual rooms. We also organized a virtual cocktail on the evening of November 18, to enable a more relaxed environment for the participants to keep in touch with old friends – many of whom we only have the chance to meet once in a year, during CILAMCE.

Figure 1: *CILAMCE-2020, virtual foyer*

On November 17, we held ABMEC´s 2020 General Assembly meeting, also for the first time in virtual mode. On the occasion, the official website of CILAMCE-PANACM-2021 (https://cilamce-panacm2021.com.br) was launched. Also, we formally approved the bid from our colleagues Prof. Renato N. Jorge and Prof. Rui Calçada to organize the CILAMCE-2023 in Porto, Portugal. We are very excited for these two upcoming editions of CILAMCE and take this opportunity to invite all IACM members and enthusiasts of computational mechanics alike to participate in both events. We hope to see many of you there!

During the General Assembly meeting, we have sanctioned the election of our new Board of Directors, including our new President, Prof. Felício B. Barros, as well as half of our Executive Council members. They will be in duty from January 1, 2021, up to December 31, 2022 (Directors) and December 31, 2024 (Executive Council members).

The newly elected are:
Board of Directors (from January 1, 2021 to December 31, 2022):
Felício B. Barros*, President*
Roque L. S. Pitangueira*, Vice-President*
Lapo Gori*, Treasurer*
Darlan Karlo Elisiário de Carvalho*, First Secretary*
Marcos Arndt*, Second Secretary*
Executive Council members (from January 1, 2021 to December 31, 2024):
Eduardo M. B. Campello, Gray F. Moita, José Luís D. Alves, Paulo M. Pimenta, Paulo R. M. Lyra, André T. Beck *(substitute) and* ***Christianne L. Nogueira*** *(substitute)*

We take this opportunity to thank all ABMEC members for the strong support during the course of the last four years, in which we have been proudly in charge of ABMEC. We restored ABMEC´s fiscal and financial situations, and this would not have been possible without such support. Also, we organized four very successful editions of CILAMCE, including one in France for the first time (Paris/Compiègne, in 2018) and one in virtual mode this year, also for the first time. We have seen the number of our associates raise from 120 to nearly 300 (effective members), and to roughly 700 if we consider our student members. We are very proud of the vibrant computational mechanics community in Brazil. On behalf of ABMEC, we would like to stress our gratitude and honor in serving the Association during the past four years, and send the best of our wishes to the newly elected Directors and Executive Council members.

We hope 2021 will be a better year to us all!

Warmest regards from the tropics,

Prof. Eduardo M. B. Campello
ABME President
until 31 December 2020
Prof. Felício B. Barros
ABMEC Vice-President
until 31 December 2020
Liang-Yee Cheng
ABMEC Treasurer
until 31 December 2020
André T. Beck
ABMEC First Secretary
until 31 December 2020
Henrique C. Gomes
ABMEC Second Secretary
until 31 December 2020

WCCM-ECCOMAS Congress

For the first time in the history of joint **WCCM-ECCOMAS congresses**, the next WCCM-ECCOMAS Congress will take place in a digital version, from **January 11 to 15, 2021**.

The organization is handled by the French associations:

- CSMA: Computational Structural Mechanics Association
- AFM: French Mechanical Association
- SMAI: French Association of Applied and Industrial Mathematics
- GAMNI: Group for Numerical Methods in Engineering with the support of the German associations:
- GACM: German association for Computational Mechanics
- GAMM: International Association of Applied Mathematics and Mechanics

The platform of the congress will allow to follow pre-recorded talks corresponding to more than 2,500 papers. All the contributed presentations will be accessible for all the participants one week before and two weeks after the conference. All the participants will be able to virtually wander through the sessions (as well as the plenaries and semi-plenaries as soon as they are recorded) at their own convenience and at the time that suits them best. Special events will also be organized during the conference: Woman Chapter, PhD ECCOMAS Olympiads, ECCOMAS Young Investigators Activities…

In order to maintain the main features that have contributed to the scientific success and conviviality of the previous WCCM-ECCOMAS congresses, facilities will be provided to offer many opportunities for rich and inspiring moments of exchanges and discussions: live-discussions, round tables, networking, …

The organizers have done their utmost to make this very special congress a success!

Chairmen of the conference:

Local organizing committee:

Rémi Abgrall: UZH Zurich
Olivier Allix: ENS Paris-Saclay
Delphine Brancherie: Université de technologie de Compiègne
Francisco (Paco) Chinesta: ENSAM
Olivier Fandeur: CEA
Luc Laurent: CNAM
David Néron: ENS Paris-Saclay
Cécile Oliver-Leblond: ENS Paris-Saclay
Guillaume Puel: CentraleSupélec

A digital event

Finally, here we are!

The tragedy of the covid-19 pandemic has made impossible to organize the joint 14th World Congress in Computational Mechanics and ECCOMAS Congress in Paris in July 2020. The enthusiastic response of all the community with more than 300 mini-symposia (MS) and more than 3000 papers accepted, along with an exceptional implication of the young community, has motivated the organizers to do whatever was possible in order not to lose the work and involvement of so many scientists.

2500+	3000+	280	30+
Scientific contributions	Participants	Minisymposia	Countries

In Memoriam
Fernando Basombrío
April 13, 1939 – Aug 9, 2020

It is not easy to say goodbye to Fernando Basombrío, to get used to the idea that he is no longer with us. Fernando has been a fundamental piece in the Bariloche Atomic Center (CAB) and the Balseiro Institute (IB), at Bariloche, Argentinian Patagonia.

Fernando graduated as a Surveyor in 1962 and as a Civil Engineer in 1963 at the Faculty of Engineering of the National University of Buenos Aires (UBA). From 1963 to 1967, he was a lecturer at UBA as well as at the National University of Technology (UTN) at Buenos Aires. Then, until 1969, he was at the Poincaré Institute (University of Paris). After that, he returned to Argentina and worked at the Faculty of Exact Sciences of UBA until 1975, when he moved to CAB. There, he met colleagues like Gustavo Sánchez Sarmiento, Sergio Pissanetzky and Bibiana Cruz, who shared his interest in numerical simulations, giving raise to the small group that was the seed of today's Department of Computational Mechanics (MECOM) at CAB.

From 1980 to 1982 he visited the Institute for Materials and Physics of Solids (IMF III) at the Karlsruhe Institute of Nuclear Technology, Germany.

Back in Argentina in 1983, he became a researcher of the National Council for Scientific and Technical Research (CONICET-Argentina). He continued his lectures on “Continuum Mechanics” at IB, where his mathematically elegant and rigorous notes, continuously improved, are unforgettable. In 1989, he became a full professor at IB and, in 2001, an honorary professor at the National University of Cuyo, Argentina.

He obtained his PhD in 1993 at the Universidad Nacional de Córdoba under the tutorship of Prof. Luis Godoy. In August 1994, he was elected as member for AMCA in the General Council of IACM. In 2008, he received the AMCA award for teaching, professional and scientific career in Argentina.

Fernando was one of the pioneers of Computational Mechanics in Argentina, founding and honorary member of the Argentine Association for Computational Mechanics (AMCA). He organized the first meetings of finite element method users in 1982 and 1983 in Bariloche, seed of the Argentinian Conferences on Computational Mechanics (ENIEF/MECOM), today at their 37th annual edition.

Fernando has left a strong mark on CAB, and not only from a professional point of view but also from the human perspective. A lot of people at CAB are indebted to him and will always keep him in their hearts, trying to follow his example and to honour his memory.

CAB, IB and AMCA join his family and colleagues in saying goodbye to a good friend. ●

Adapted from a note sent
by Fernando Quintana
to AMCA's bulletin

Figure 1:
Fernando Basombrío receiving AMCA Award 2008

AMCA Awards 2020

AMCA executive board is pleased to announce AMCA Awards 2020 winners:

- The AMCA Young Resercher Award 2020 was granted to **Juan Marcelo Giménez** from *CIMEC at Universidad Nacional del Litoral and CONICET*, Argentina.
- The AMCA Award 2020 for Scientific, Professional and Teaching Trajectory was granted to **Bibiana Luccioni** from *Facultad de Ciencias Exactas y Tecnología at Universidad Nacional de Tucumán and CONICET*, Argentina.
- The AMCA Award 2020 for International Scientific Trajectory was granted to **Sergio Oller** from *Universidad Nacional de Salta and CONICET*, Argentina, and *CIMNE*, Spain.

Due to the re-schedule of the XXXVII Argentine Congress on Computational Mechanics, the AMCA Awards 2020 Ceremony will be held next year during the Congress dinner.

Figure 2:
Juan Marcelo Giménez, winner of the AMCA Young Resercher Award 2020

Figure 3:
Bibiana Luccioni, winner of the AMCA Award 2020 for Scientific, Professional and Teaching Trajectory

Figure 3:
Sergio Oller, winner of the AMCA Award 2020 for International Scientific Trajectory

MECOM 2021
XXXVII Argentine Congress on Computational Mechanics
Resistencia, Chaco, Argentina.

Dear AMCA Members,

We like to inform you that the thirty-seventh edition of the Argentine Congress of Computational Mechanics, which should have taken place in November 2020, will be celebrated from 2nd to 4th November 2021. At this moment, we can not ensure the modality of the Congress (partial or completely virtual) given the changing status regarding SARS-CoV-2, but every new information will be posted at the Congress' website: https://amcaonline.org.ar/mecom2021.

We hope we can count once again on your support and with your distinguished presence. We will remain available to answer any questions that you may have in the future.

Best regards,

Dr. Ing. Javier Mroginski
Organizing Committee President

Dr. Ing. Guillermo Castro
Scientific Committee President

CALL FOR PAPERS
The Argentine Association for Computational Mechanics (AMCA) announces the XXXVII Argentine Congress for Computational Mechanics (MECOM 2021), which will be held at Resistencia, Argentina, organized by the Faculty of Engineering of the National University of the Northeast (UNNE) and AMCA.
http://amcaonline.org.ar/mecom2021

conference diary planner

13 - 16 Oct 2020	**MuSMe2020 - 7th International Symposium on Multibody Systems and Mechatronics** *Venue:* Córdoba, Argentina *Contact:* https://amcaonline.org.ar/
6 - 10 Nov 2020	**IGA2020 - Isogeometric Analysis 2020** *Venue:* Banff, Canada *Contact:* ruth@usacm.org
16 - 19 Nov 2020	**XLI CILAMCE - XLI Ibero-Latin-American Congress on Computational Methods in Engineering** *Venue:* ON-LINE *Contact:* www.cilamce.com.br
30 Nov - 2 Dec 2020	**AfriComp - African Conference on Computational Mechanics** *Venue:* Cape Town, South Africa *Contact:* https://africomp2020.org/
8 - 11 Dec 2020	**COMSAFE 2020 - Computational Engineering & Science for Safety & Environmental Problems** *Venue:* ON-LINE *Contact:* https://www.compsafe2020.org/
11 - 15 Jan 2021	**WCCM-ECCOMAS - 14th World Congress in Computational Mechanics & ECCOMAS Congress** *Venue:* ON-LINE *Contact:* https://www.wccm-eccomas2020.org
1 - 5 March 2021	**CSE21 - SIAM Conference on Computational Science and Engineering** *Venue:* Fort Worth, Texas US *Contact:* Siam.org/Conferences/CM/conference/cse21
2 - 4 June 2021	**Marine 2021 - International Conference on Computational Methods in Marine Engineering** *Venue:* Edinburgh, Scotland *Contact:* https://congress.cimne.com/marine2021/
13 - 16 June 2021	**COUPLED 2021 – 1X International Conference on Coupled Problems in Science & Engineering** *Venue:* Sardinia, Italy *Contact:* https://congress.cimne.com/Coupled2021/
21 - 23 June 2021	**COMPDYN 2021 - 8th International Conference on Computational Methods in Structural Dynamics & Earthquake Engineering** **UNCECOMP 2021 – 4th International Conference on Uncertainty Quantification in Computational Sciences & Engineering** *Venue:* Athens, Greece *Contact:* https://2021.compdyn.org/
21 - 23 June 2021	**ADMOS 2021 – X International Conference on Adaptive Modeling and Simulation** *Venue:* Gothenburg, Sweden *Contact:* https://congress.cimne.com/ADMOS2021/
27 - 30 June 2021	**CSME 2021 - Canadian Society for Mechanical Engineering International Congress** *Venue:* Charlottetown, PEI *Contact:* https://www.csmecongress.org/
25 - 29 July 2021	**USNCCM16 - 16th U.S. National Congress on Computational Mechanics** *Venue:* Chicago, Illinois *Contact:* http://16.usnccm.org/
22 - 27 Aug 2021	**25th ICTAM - International Conference of Theroetical and Applied Mechanics** *Venue:* Milan, Italy *Contact:* http://www.icta,2020.org/
7 - 10 Sept 2021	**COMPLAS 2021 XVI International Conference on Computational Plasticity** *Venue:* Barcelona, Spain *Contact:* https://congress.cimne.com/complas2021/
13 - 15 Sept 2021	**Structural Membranes 2021 – X International Conference on Textime Composites and Inflatable Structures** *Venue:* Munich, Germany *Contact:* https://congress.cimne.com/Membranes2021/
22 - 27 Aug 2021	**IUTAM Symposium on Computational fracture mechanics in multi-field problems** *Venue:* Milan, Italy *Contact:* https://iutam.org/
4 - 6 Oct 2021	**PARTICLES 2021 – VI International Conference on Particle-based Methods** *Venue:* Hamburg, Germany *Contact:* https://congress.cimne.com/Particles2021/
17 - 21 Oct 2021	**21st International Symposium on Finite Element Methods in Flow Problems** *Venue:* Hangzhou, China *Contact:* https://iacm.info/scientific-events/fef/
6 - 9 Nov 2022	**USACM Thematic Conference - Isogeometric Analysis 2020** *Venue:* Banff, Canada *Contact:* http://iga2020.usacm.org/