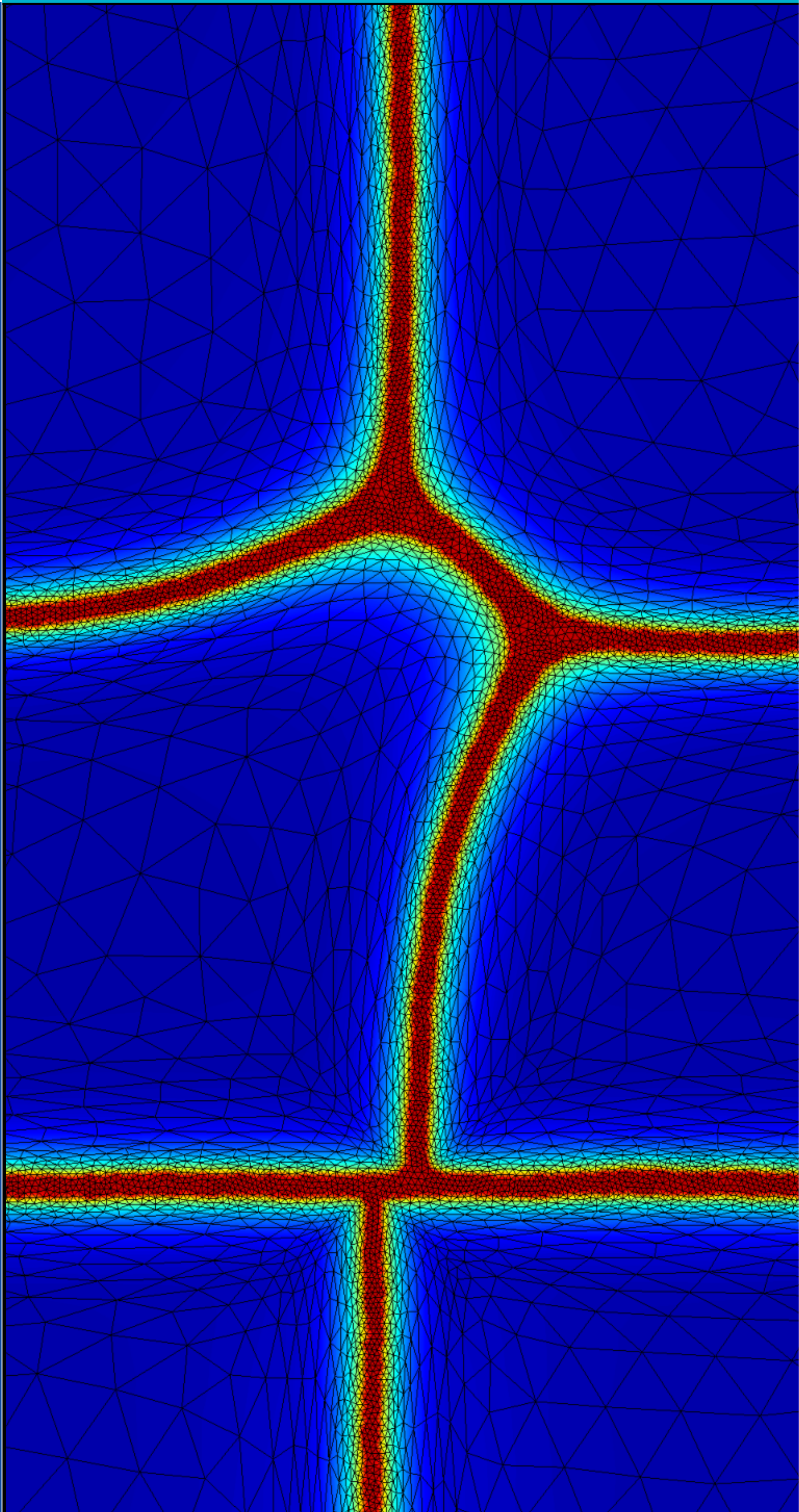
IACM expressions



Bulletin for The International Association for Computational Mechanics

Nº 54
January 2025

Executive Council

IACM General Council

IACM Honorary Members

IACM Honorary Members

Members of the Executive Council, Honorary Members & Presidents of Affiliated Associations are also members of the General Council

IACM Membership : https://iacm.info/about-iacm/membership/

Active IACM members receive the following benefits:
Discounts for WCCM congress registration fee, Discounts for CFC congress registration fee, Registration discount for IACM SIC (Special Interest Conferences), Expressions (digital copy)

IACM Affiliated Associations and Presidents

IACM Expressions

Published by: (IACM)
The International Association for Computational Mechanics
Editorial Address:
IACM Secretariat, Edificio C1, Campus Norte UPC, Gran Capitán s/n, 08034, Barcelona, Spain.
Email: secretariat@iacm.info
Web: www.iacm.info
Editor: Diane Duffett
Email: diane.duffett@telefonica.net

IACM members are invited to send their contributions to the editors.
Views expressed in the contributed articles are not necessarily those of the IACM.

contents

constitution

The objective of the Association shall be to stimulate and promote education, research and practice in Computational Mechanics, to foster the interchange of ideas among the various fields contributing to this science, and to provide forums and meetings for the dissemination of knowledge.

The Association seeks to implement and ensure the highest level of ethical standards and responsible conduct of research rules among its membership.

How do Cracks in Brittle Materials Evolve, and how do we Compute them?

by
***Benjamin E. Grossman-Ponemon*[1]**
***Eleonora Maggiorelli*[2]**
***Matteo Negri*[2]**
***& Adrian J. Lew*[3]**
[1]Dept of Physics
John Carroll Uni
USA
[2]Dept of Mathematics
University of Pavia
Italy
[3]Dept of Mechanical Engineering
Stanford University
USA
lewa@stanford.edu

Fracture is one of the most severe modes by which a solid material or structure can fail. Its importance in engineering context is well-known, in particular from the standpoint of safety, e.g., the collapse of the Morandi Bridge [14]. However, it also plays an important role in various aspects of our lives, ranging from the mundane (e.g., to peel a banana, one must introduce and grow a tear in the skin), to the field of preservation of cultural heritage (*Figure 4* shows the rich morphology of cracks which can appear as oil paints dry, known in the art world as craquelure) and to the mechanics of our earth.

In this article, we highlight some of the key challenges that are faced when simulating irreversible, brittle fracture growth under quasi-static loading. We center our discussion around the ultimate goal of predicting how a pre-existing crack (or cracks) within a material evolves in time. We are not concerned with the question of whether a crack nucleates in a sound material; rather we focus on what happens after crack initiation.

A core challenge in this endeavor is the evolution model itself. There are two general approaches to represent the crack geometry, and each of them has its own mechanism for evolution. A crack may be described as a **sharp**, zero-thickness surface embedded within the elastic domain which allows for displacement discontinuity. The evolution theory for such cracks is that of Griffith [9] coupled with a directional selection criterion. Alternatively, a crack can be represented as a diffuse, continuous damage field or **phase-field**, which causes a loss of stiffness. Instead of Griffith's theory, the evolution of phase-field cracks is posed in terms of the equilibrium configurations of a total energy combining elastic and phase-field parts.

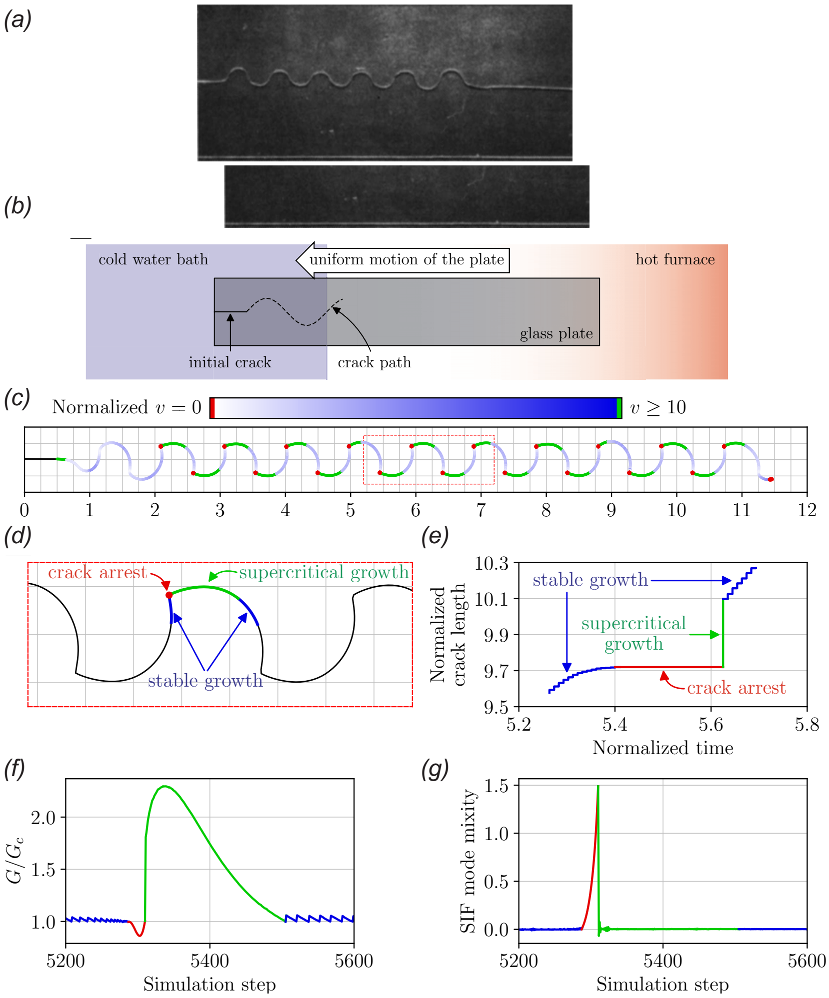
Achieving convergent simulations using either approach requires carefully designed numerical methods *and* understanding of the models and the evolutions which they produce. But once the two numerical evolutions are computed and converged, will their results predict the same crack front trajectory? After a discussion of how convergent crack evolutions are obtained with both approaches, mainly highlighting our own work, we present some incipient ideas on this question towards them.

Evolution of Sharp Cracks

The classical theory for quasi-static brittle crack evolution along a predetermined path originates with Griffith [9]. Griffith postulated that a crack grows when the elastic energy relieved via crack extension balances the energy needed to create two new surfaces in the material, i.e., the two faces of the crack. Respectively, these energies per unit crack area are called the "energy release rate" and the "critical energy release rate," and are denoted by G and G_c. The parameter G_c is one characterization of the toughness of a material. Irwin later showed that G can be expressed in terms of "stress intensity factors" (or SIFs), a set of three parameters which characterize the modality of the stress singularity around the crack tip: tensile, in-plane shear, and anti-plane shear. When the crack path is not known *a priori*, then an additional condition is needed to determine the direction of growth. Several empirical criteria exist in the literature which give comparable predictions, e.g. the Principle of Local Symmetry, which expresses the direction of growth in terms of the SIFs, and the Principle of Maximum Energy Release.

Griffith's theory is challenged when the elastic and surface energy rates become imbalanced (specifically, $G > G_c$). A simple example where this can happen is when a crack in a heterogeneous material grows into a region with reduced G_c. Another case where this occurs is when G increases with crack extension. Such situations are called "catastrophic," "supercritical," or "unstable" crack propagation, in contrast with "stable" crack growth discussed previously. Experimentally, these situations coincide with a rapid increase in crack length over very short times, which strains the quasi-static assumption. However, when the ratio of G/G_c is close to 1, we expect dynamic effects to minimally impact crack trajectories. Meanwhile, as shown in *Figure 1*, supercritical growth may be only a small part of the overall crack extension, such as in the case of cracks growing in

Figure 1:
Simulation of quasi-static crack growth in a rapidly quenched glass plate.
(a) Experimentally observed crack path by Yuse and Sano [Yuse and Sano, Nature 362, 329–331 (1993)]
(b) Problem schematic. A rectangular glass plate with an initially straight crack is moved from a hot furnace into a cold water bath. The crack grows due to the thermal stresses.
(c) Crack path and estimated crack velocity, for a particular combination of quenching speed and plate toughness. The problem parameters of this simulation differ from those in (a).
Areas where crack arrest occur are indicated with red dots, while areas of rapid crack growth are shown in green.
(d) Closeup of a single oscillation. Areas with stable crack growth, crack arrest, and supercritical growth are indicated in blue, red, and green, respectively.
(e) Length-versus-time graph for the indicated regions of the crack path. Because of separate time and crack extension steps in a given simulation, a staircase-like curve emerges.
(f) Ratio of G/G_c versus simulation step number. When the crack is growing stably, the ratio remains close to 1. When the crack arrests, $G/G_c < 1$, while G exceeds G_c during supercritical crack growth.
(g) Stress intensity factor mode mixity versus simulation step number, which correlates with the potential direction of growth. During stable growth, the mode mixity is zero, and so the crack grows straight ahead. When the crack stops, the mode mixity changes and the crack grows at a kink. Subfigures (c)-(g) are adapted from [5]



quenched glass plates [5]. Resolving dynamics in these situations would be computationally expensive for minimal benefit, and so a quasi-static evolution model that allowed G to exceed G_c is desirable.

How does one model quasi-static crack growth in the presence of the supercritical regime? One possibility is to allow the crack length to be discontinuous in time whenever a supercritical event occurs, as in the model by Negri and Ortner [19]. However, by doing so the evolution can no longer be parameterized by time or crack length alone, due to supercritical events and periods where the crack does not grow, respectively, cf. *Figure 1e*. Instead, an independent parameter is required. Thus, time and crack length are both functions of the parameter. In Ref. [5], we re-stated the model of Negri and Ortner as a set of complementary inequalities. These, and the fact that the model defines an evolution when $G > G_c$, provide a natural way to build a discretization of the evolution through a collocation scheme. We depict this scheme in *Figure 2*.

Figure 2:
Crack evolution model and discretization.
(a) A double cantilever beam specimen (DCB) subjected to end displacements δ(t) which grow linearly in time
(b) Space of possible time and crack length combinations, divided into regions where $G < G_c$ (green region), and $G > G_c$ (black dashed line)
(c) Continuous evolution and discrete evolution for the DCB problem with an initial crack of finite length.
The crack does not grow until the loading reaches a certain value, after which the crack grows in a stable fashion with $G = G_c$. Because it is almost surely the case that $G \neq G_c$ the discrete evolution proceeds via time steps (horizontal red segments) and crack growth steps (green vertical segments)

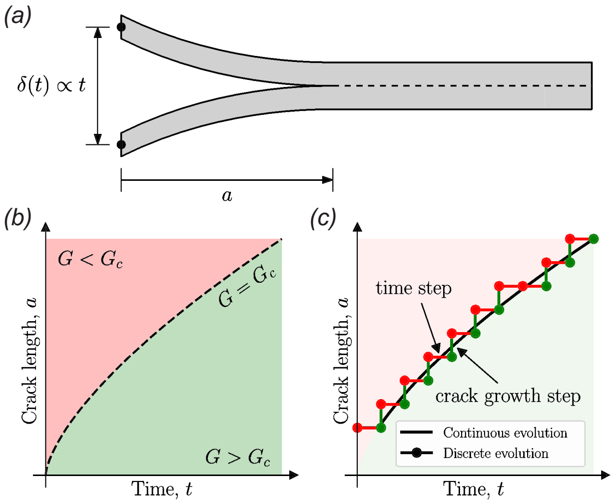
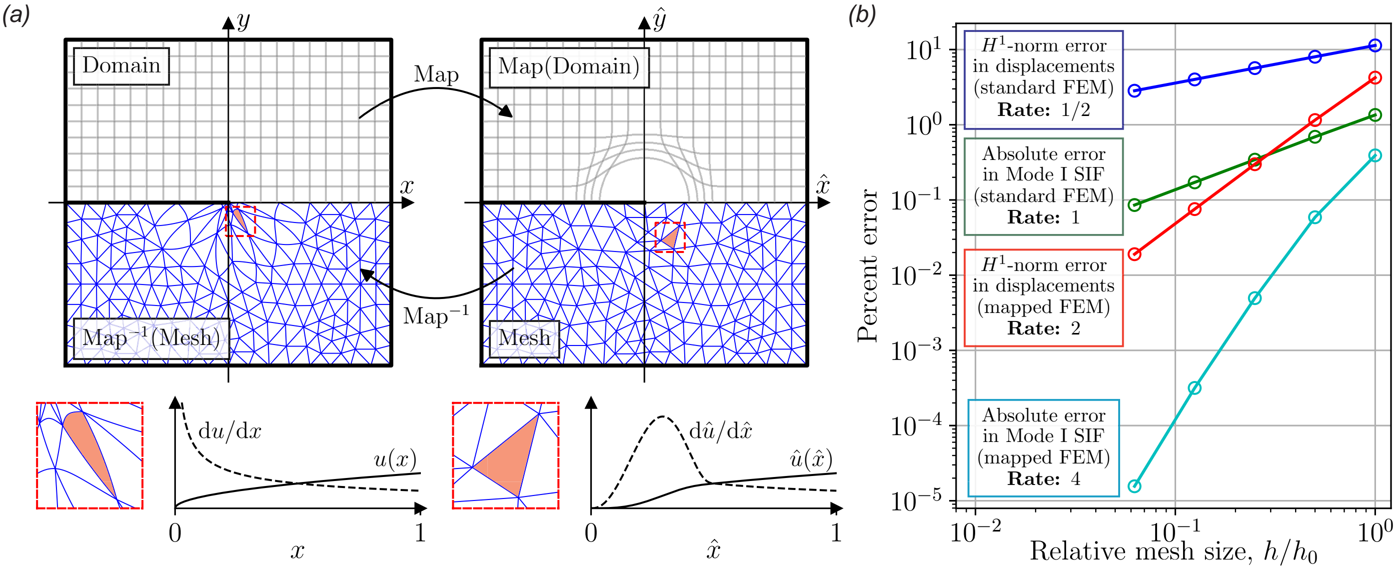


Figure 3:
The Mapped Finite Element Method (MFEM).
(a) A square domain contains an edge crack along the −x-axis, with the crack tip at the origin. The problem is mapped to a new domain, which stretches around the crack tip. The mapped domain (a, right) is meshed with standard finite elements, such as quadratic triangles. In the original domain (a, left), the mesh is composed of non-uniform triangles with curved edges. A triangle and its image under the inverse map are shown in the insets below the two domains. The elasticity problem in the original domain possesses displacement gradients which are singular at the crack tip. When the problem is mapped, the mapped displacement fields are sufficiently smooth so that their derivatives do not contain the aforementioned singularities. The variations in displacements and their derivatives along the +xaxis are shown as insets for the original and mapped problems.
(b) Errors in the displacement field and the Mode I stress intensity factor for solutions to the elasticity problem computed using standard FEM and MFEM, each with quadratic triangular Finite Elements. With standard FEM, the convergence rates are order 1/2 and 1 for the displacements and the SIF, respectively. For MFEM, these rates are 2 and 4, which are optimal for the chosen elements



A challenge in implementing this evolution model is **accurately** computing G and the stress intensity factors at each step in the simulation. Within this long-studied problem in the field of computational fracture mechanics, we developed an approach based on the interaction integral, which represents the SIFs as continuous linear functionals of the exact displacement field around the crack tip [6, 11]. We developed new functionals—tailored to accommodate curvilinear cracks in 2D and non-planar cracks in 3D, as well as body forces and crack face tractions—that coincide with the interaction integral at the exact displacement field. We proved that the new functionals are continuous and linear with respect to the numerical displacement field. Thus, as the numerical displacement field converges to the exact field, we guarantee that numerical SIFs converge to the exact values. Additionally, we can show that the convergence rate of the numerical SIFs is faster than that of the numerical displacement field, cf. *Figure 3*.

The rate of convergence of the numerical SIFs can be made even faster through high-order computation of the numerical displacement field. However, the stress field around a crack is singular, blowing up like $r^{-1/2}$, where r is the distance to the edge of the crack. Such singularities adversely affect the convergence rates of standard numerical methods like FEM, even if high-order elements are used, and the suboptimal convergence rates extend to the numerical SIFs. Solutions to this problem in the literature include graded meshes around the crack edge and enrichment of the approximation space with the known singularities (G/XFEM [3, 7, 22]). We developed a different approach: the Mapped Finite Element method (MFEM). In MFEM, we map the elasticity problem to a new domain so that the mapped problem possesses no radial singularity around the crack edge. Solving the mapped problem with standard FEM yields approximations of the displacement field which converge at the optimal rates of convergence for elements of any order. Thus, in concert with interaction integrals, we can achieve high-order approximation of the SIFs at each step in our simulations, see *Figure 3*.

The final challenge is how to discretize the problem **geometry** as the crack grows. Specifically, we require discrete function spaces which accommodate the displacement discontinuity. While this goal can be achieved with basis function enrichment or other special techniques (such as G/XFEM [3, 7, 22]), it is convenient when the mesh conforms to the crack geometry so that the elasticity problem may be solved with standard FEM or MFEM. Additionally, the element edges (or faces in 3D) which conform to the crack provide a natural discretization of the crack surface, which is especially useful for problems where there is extra physics occurring along the crack, such as the flow of pressurized magma within cracks growing away from a volcano [10]. Remeshing the domain at each simulation step is expensive, but the cost can be reduced by restricting the remeshing to a neighborhood of the crack geometry. This is the core idea of our technique of Universal Meshes (UM) [20]. In UM, we start with a mesh of the uncracked geometry (the "universal mesh"); to make the mesh conform, nodes in the vicinity of the crack are moved, but their connectivity is unaltered. As the crack evolves, new nodes in the universal mesh may need to be moved, but the number is far fewer than the overall number of nodes in the universal mesh. We refer the interested reader to Ref. [12] and the references cited therein for more details of the method and its application to fracture problems.

Evolution of Phase-Field Cracks

In the phase-field approach, fractures are described in terms of a damage parameter $d = 0$, assessing the integrity of the material, together with an internal length parameter ϵ, controlling the width of the transition layer between $d = 0$ and $d = 1$, corresponding respectively to sound material and fracture (see *Figure 4*). There are *a priori* no restrictions on the morphology of the phase-field crack, which makes this approach particularly suitable to simulate complex crack **geometries**; branching and merging are naturally allowed, see *Figure 4*, and complex crack geometries are feasible.

As opposed to the sharp-crack approach, which is based on energy release rate G and SIFs, phase-field evolutions are based on equilibrium configurations of the total energy, i.e. the sum of elastic and fracture energy. In general, since the total energy is non-convex, there are many equilibria and different schemes may lead to different evolutions.

Such models have origins in the Variational Theory of Fracture (VTF) [8] in which cracks form and grow to globally minimize the total energy. This approach is consistent with Griffith's criterion whenever evolutions are continuous in time, however, it may predict catastrophic evolutions for $G < G_c$ (see *Figure 5* and [15, 16]). Numerical simulations are based on a different approach: the evolution of damage and displacement is defined by means of an energy descent algorithm (e.g. staggered or monolithic) converging to an equilibrium configuration, which is not always a global minimum. In principle, the simulations depend on the adopted scheme. Noteworthy, in the stable state regime, the evolution is consistent with Griffith's criterion independently of the algorithm [15, 16]. However, at the onset of catastrophic propagation (see *Figure 5* top row) the numerical solution may depend on the scheme; for instance, alternate minimization (or staggered) [4]

(a) *(b)*

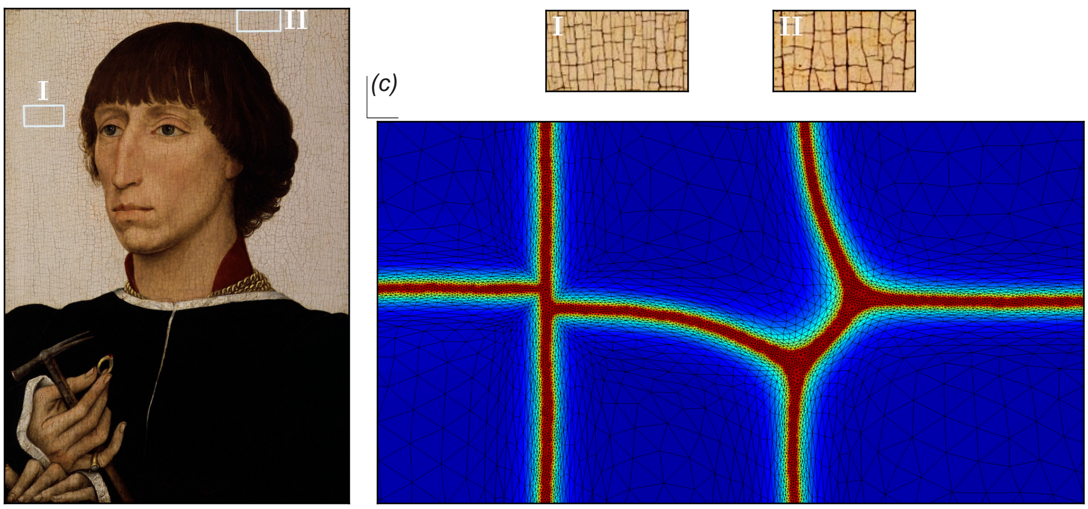


Figure 4:
(a) Portrait of Francesco d'Este by Rogier van der Weyden, showing the complex network of cracks which formed in the oil paint.
(b) Closeup of the craquelure pattern at locations I and II in the painting.
(c) Phase-field simulation of fracture, depicting similar crack patterns. The colors represent the value of the damage field. The mesh has been heavily refined in the vicinity of the damage field

may not detect the steepest descent direction, causing a delay in the trigger time. Employing second order derivatives of the energy may solve this issue [13].

> *"Research into these questions hence remains a rich and ongoing effort in the applied mathematics community."*

Phase-field approaches face two questions of **accuracy**. First, from the perspective of phase-field cracks as a "regularizations" of sharp cracks, the internal length should be very small, compared to the size of the specimen. However, there are no quantitative estimates on "how small" it should be or "how close" a phase-field crack simulation is to the corresponding sharp crack simulation. Second, because the damage field must be narrow, adequate mesh refinement is required to resolve it along the entirety of the crack (see *Figure 4*), whereas sharp-crack simulations only require mesh refinement in the vicinity of the tip/front. These considerations can make phase-field simulations computationally expensive.

Comparison and Convergence of Phase-Field Crack and Sharp Crack Evolutions

Above we have discussed separately some of the challenges faced in sharp crack and phase-field simulations of fracture.

To conclude, we wish to raise the following question: how do the evolutions predicted by these models compare?

The theory of Γ-convergence [1] provides a connection between these two approaches in terms of convergence of total energy and global minimizers in the zero-thickness limit, i.e. as the internal length vanishes. However, evolutions depend not only on the values of the energy but also on its derivatives, and not so much on minimizers as on equilibrium configurations. As of today, the convergence of derivatives and equilibria (see e.g. [2]) is a challenging mathematical problem, pointing in some sense toward an "order one" Γ-convergence theory.

As anticipated, it turns out that phase-field crack evolutions, computed by energy descent algorithms, can be recast in terms of Griffith's criterion together with the Maximal Energy Release Rate directionality criterion [15, 16]. Convergence of the energy release rate (from phase-field crack to sharp crack) would be the final step to show the consistency of the two models. Up to now, only partial theoretical results are available in this direction. Convergence

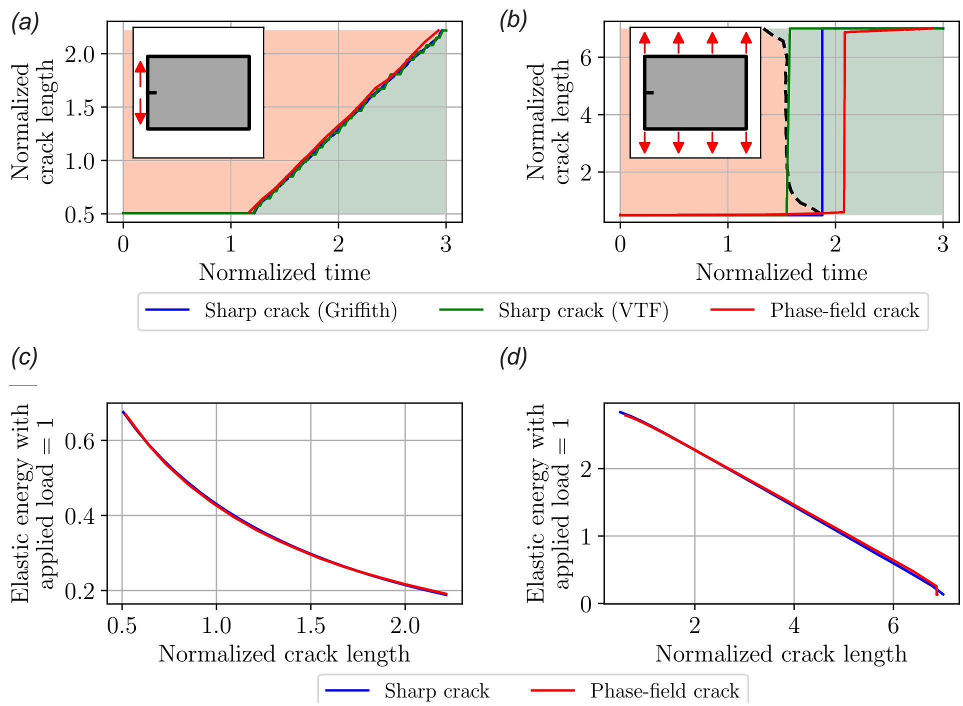


Figure 5:
Comparison between sharp crack and phase-field crack evolutions.
(a) Crack length versus time for a rectangular specimen subjected to end-loading (see inset). For this loading, the crack evolution is stable, and the data agree for simulations with a phase-field crack, a sharp crack (with Griffith), and a sharp crack (with VTF). (b) Crack length versus time for a rectangular specimen subjected to tensile loading (see inset). The specimen fractures completely once a critical load is reached. When VTF is used to model crack growth, the specimen fractures earlier than when Griffith is used. Meanwhile, the specimen fractures later for the phase-field crack. In (a) and (b), the red and green regions correspond to potential crack lengths and loading times where $G < G_c$ and $G > G_c$, respectively, see Figure 2. (c and d) Elastic energy versus crack length for the end-loaded and tensile-loaded specimens, respectively. The elastic energy has been rescaled at each crack length so that the magnitude of the applied loading is constant. For both loading configurations, the elastic energy values are nearly identical regardless of whether a phase-field or a sharp crack representation is used.

is proven in [21, 18] though under very strict assumptions: the evolution of the damage variable d must occur along an assigned regular path. This requirement is necessary as a notion of energy release rate in BV-like spaces (the spaces used in VTF) is still unclear. Research into these questions hence remains a rich and ongoing effort in the applied mathematics community.

In the absence of satisfactory theoretical results, we show the remarkable outcomes of numerical simulations for a double cantilever beam (DCB) specimen: a rectangular domain with an edge crack is subjected to end-displacements on either side of the crack. Looking at *Figure 5* bottom row, the phase-field energy release (computed by finite differences) well approximates the sharp-crack energy release, which guarantees the convergence of the evolutions as well: indeed, both are determined by Griffith's criterion and thus from the energy release [15, 16].

It is important to note that the DCB specimen features continuous (stable) evolutions along a straight crack, and so caution must be exercised before generalizing this result to other crack geometries and to other evolutions (potentially featuring supercritical growth). Nevertheless, it is encouraging that the two approaches share deep connections even beyond the well-established results of Γ-convergence. ●

References:

[1] *L. Ambrosio & V. M. Tortorelli*. **Approximation of functional depending on jumps by elliptic functional via Γ-convergence**. Communications on Pure and Applied Mathematics, 43(8):999–1036, 1990.

[2] *J.-F. Babadjian, V. Millot & R. Rodiac*. **On the convergence of critical points of the ambrosio-tortorelli functional**. 2022.

[3] *T. Belytschko and T. Black*. **Elastic crack growth in finite elements with minimal remeshing**. International Journal for Numerical Methods in Engineering, 45(5):601– 620, 1999.

[4] *B. Bourdin, G. Francfort & J.-J. Marigo*. **Numerical experiments in revisited brittle fracture**. Journal of the Mechanics and Physics of Solids, 48(4):797 – 826, 2000.

[5] *M. M. Chiaramonte, B. E. Grossman-Ponemon, L. M. Keer & A. J. Lew*. **Numerical analyses of crack path instabilities in quenched plates**. Extreme Mechanics Letters, 40:100878, 2020.

[6] *M. M. Chiaramonte, Y. Shen, L. M. Keer & A. J. Lew*. **Computing stress intensity factors for curvilinear cracks.** International Journal for Numerical Methods in Engineering, 104(4):260–296, 2015.

[7] *C. Duarte, I. Babǔska & J. Oden*. **Generalized finite element methods for threedimensional structural mechanics problems**. Computers & Structures, 77(2):215 – 232, 2000.

[8] *G. A. Francfort & J.-J. Marigo*. **Revisiting brittle fracture as an energy minimization problem**. Journal of the Mechanics and Physics of Solids, 46(8):1319–1342, 1998.

[9] *A. A. Griffith*. **VI. The phenomena of rupture and flow in solids**. Philosophical Transactions of the Royal Society of London. Series A, Containing Papers of a Mathematical or Physical Character, 221(582-593):163–198, 1921.

[10] *B. E. Grossman-Ponemon, E. R. Heimisson, A. J. Lew & P. Segall*. **Logarithmic growth of dikes from a depressurizing magma chamber**. Geophysical Research Letters, 47(4):e2019GL086230, 2020. e2019GL086230 10.1029/2019GL086230.

[11] *B. E. Grossman-Ponemon, L. M. Keer & A. J. Lew*. **A method to compute mixedmode stress intensity factors for nonplanar cracks in three dimensions**. International Journal for Numerical Methods in Engineering, 121(19):4292–4328, 2020.

[12] *B. E. Grossman-Ponemon & A. J. Lew.* **An algorithm for the simulation of curvilinear plane-strain and axisymmetric hydraulic fractures with lag using the universal meshe**s. International Journal for Numerical and Analytical Methods in Geomechanics, 43(6):1251–1278, 2019.

[13] *A. A. Léon Baldelli & C. Maurini*. **Numerical bifurcation and stability analysis of variational gradient-damage models for phase-field fracture**. J. Mech. Phys. Solids, 152:Paper No. 104424, 22, 2021.

[14] *M. Lowen*. **Genoa readies new bridge two years after tragic collapse.** BBC News, Aug 2020. https://www.bbc.com/news/world-europe-53628580.

[15] *E. Maggiorelli*. **Griffith criterion for steady and unsteady-state crack propagation**. In Mathematical Modeling in Cultural Heritage, Springer INdAM Series. Springer.

[16] *E. Maggiorelli & M. Negri*. **Energy release and griffith criterion for phase-field fracture** (to appear).

[17] *M. Negri*. **Modelling paintings on canvas and simulation of local crack patterns**. In Mathematical Modeling in Cultural Heritage, Springer INdAM Series. Springer.

[18] *M. Negri*. **From phase-field to sharp cracks: convergence of quasi-static evolutions in a special setting**. Appl. Math. Lett., 26:219–224, 2013.

[19] *M. Negri & C. Ortner*. **Quasi-static crack propagation by Griffith's criterion.** Mathematical Models and Methods in Applied Sciences, 18(11):1895–1925, 2008.

[20] *R. Rangarajan & A. J. Lew*. **Universal meshes: A method for triangulating planar curved domains immersed in nonconforming meshes**. International Journal for Numerical Methods in Engineering, 98(4):236–264, 2014.

[21] *P. Sicsic & J.-J. Marigo*. **From gradient damage laws to Griffith's theory of crack propagation**. J. Elasticity, 113(1):55–74, 2013.

[22] *T. Strouboulis, I. Babǔska & K. Copps*. **The design and analysis of the generalized finite element method**. Computer Methods in Applied Mechanics and Engineering, 181(1-3):43–69, 2000.

Analysis & Optimization of Beam-Type Structures with a Globally Enriched XFEM\GFEM Approach

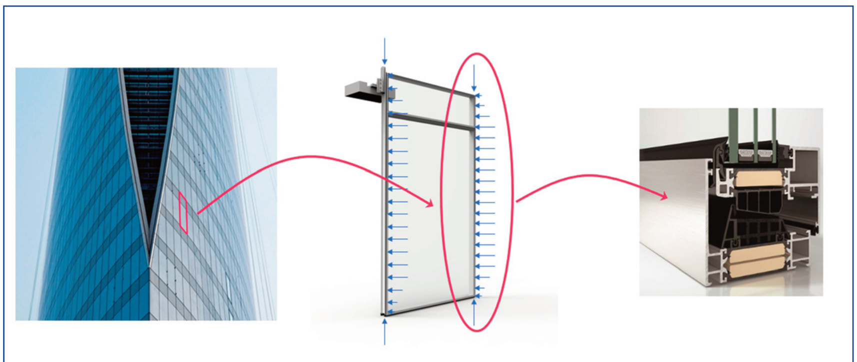
by
Ameer Marzok[1]
& Haim Waisman[2]
[1]Dept.of Aerospace Engineering, Technion-Israel Institute of Technology
marzok@technion.ac.il
[2]Dept. of Civil Eng. & Eng. Mechanics, Columbia University, New York
hw2286@columbia.edu

Beams have extensive applications in aerospace, civil, and mechanical engineering. Analyzing these elements is a long-standing area of research in computational mechanics, originating from the early work of Euler-Bernoulli (EB). An extension of this theory is the Timoshenko-Ehrenfest (TE) beam theory, which incorporates shear deformations into the kinematic assump tions. Both theories assume that the beam's cross-section remains plain in the longitudinal direction after deformation due to bending. As the beam's aspect ratio increases, this assumption becomes less accurate, necessitating higher-order theories, such as the one proposed by Reddy [1].

In the case of more general loading conditions beyond bending, such as axial loading, torsion and warping, the number of deformation modes for these elements increases. This includes distortional and warping deformations [2]. Additionally, it has been shown that beams with large flanges subjected to flexural bending produce a non-uniform normal stress distribution in the large flange [3]. This non-uniform stress distribution results from their uneven deformations, a phenomenon known as shear-lag.
The methods available for the efficient analysis of these elements are still under development, with ongoing efforts to incorporate these deformation modes into the applicable formulations. While 1D beam models, such as those based on Generalized Beam Theory (GBT) [4], can capture various deformation modes with relatively small computational effort, their accuracy and generality are limited.
A more general approach for modelling beams is based on 3D finite element (FE) models. This approach can potentially capture all the deformation modes involved in the beam's behavior. However, the large refinement required in these models makes them computationally expensive. Therefore, several notable numerical schemes have been developed to reduce the computational effort required for 3D FE models.
Specifically, the Finite Strip\Prism Method (FSM\FPM) [5] leverage the beams' longitudinal solution to solve a semi-analytical simplified problem at the section level. This is achieved by decoupling the deformation fields of the cross-section and the longitudinal direction and employing analytical or approximate functions in the longitudinal direction. Although these methods offer improved computational efficiency, they do have significant limitations. For example, they are unable to model general boundary conditions nor can they easily model tapered beams.

In addition to the challenges associated with beam analysis, the development of automated optimization-based design procedures for these elements is also limited. In structural optimization, the number of analyses required can range from hundreds to thousands, depending on the optimization algorithm used [6]. Therefore, an efficient optimization framework can only be developed when the cost of structural analysis is kept reasonable.

Figure 1:
Industry example of extruded thin-walled beam: aluminum window frame used in high rise buildings



The current work is motivated by a practical civil engineering project, addressing the aforementioned shortcomings. Specifically, due to the rising cost of aluminum in industry and the environmental effects of its production, companies have started to optimize their products. For example, in the window-framing construction industry, the frames of windows, doors, and facades are being optimized. These components have typically complex cross-sections, as shown in *Figure 1*, and are usually manufactured by an extrusion process. Additionally, the design of some parts of these elements is determined by functional and manufacturing requirements. The optimization-based

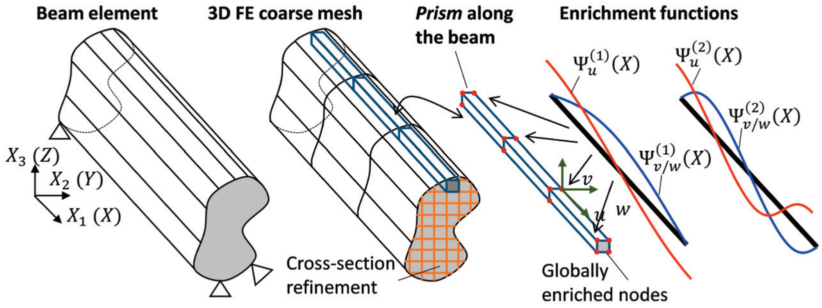


Figure 2:
Schematic representation of the globally enriched XFEM\GFEM model: (from left) a schematic beam element, 3D discretization using FE coarse mesh, prism along the beam, enrichment functions that enhance the approximation space

structural design of these components requires efficient tools for the forward analysis in order to capture complex deformation modes, buckling and fracture.

To address this, the authors have proposed an efficient approach for beam analysis [7, 8] which was utilized to develop an effective optimization procedure for extruded beams [9, 10]. This approach employs a 3D FE mesh as the primary discretization scheme for the domain, supplemented with an improved approximation field in the longitudinal direction. This method significantly reduces the number of degrees of freedom required to get accurate solutions. Our approach utilizes the eXtended\Generalized Finite Element Method (XFEM\GFEM) method [11, 12, 13], which enhances the FE approximation fields with analytical solutions by utilizing the concept of partition of unity [14].

Further, we showed that this approach significantly relieves the computational burden while maintaining high accuracy and sufficient generality, e.g. nonstandard boundary conditions. The forward method was then used to develop an efficient optimization approach for the design of extruded beams [9, 10]. It has been also shown that the method is applicable to problems beyond linear elasticity, such as the modeling of cracked beams [15].

XFEM\GFEM approach for the analysis of beams

Beams are characterized by a longitudinal dimension that is larger than the dimensions of their cross-section. The behavior of the problem along the beam is typically smooth and often resembles the solutions of the traditional beam bending problem. However, in cases of nonstandard boundary conditions, complex loadings or fracture phenomena, more complicated behavior is expected. With this in mind, the proposed approach enhances the approximation field by incorporating analytical knowledge into a finite element approximation. This is achieved by using the XFEM\GFEM method, where analytical enrichments are obtained from the solution of classical Euler-Bernoulli (EB) beams.

In addition, several analytical functions can be used to span a wider range of potential solutions, further enhancing the approximation space. For example, one can simultaneously use multiple solution modes of EB beams, or employ simply supported conditions together with clamped-clamped boundary conditions. These features lead to an increased number of unknowns in the problem; however, this capability allows for additional refinement possibilities and more generality.

In the proposed method, the functions used to enrich the approximation field are derived from the solution of the beam's free-vibration problem. This problem provides an infinite number of functions that describe the in-plane deformations of the cross-section for a given set of boundary conditions, allowing for a more accurate and refined approximation. To enrich the section's out-of-plane degrees of freedom (normal-axial displacements), the derivatives of the in-plane functions are adopted, inspired by the EB theory. The concept is illustrated schematically in *Figure 2*. The elements are divided into prisms along the longitudinal direction, forming part of a standard 3D FE mesh. While the EB theory's assumptions may not fully capture the special deformation modes of thin-walled beams, enriching the FE nodes independently in each cross-section may still capture deformation modes that are not well captured by traditional FE. This property opens the door for multiple enrichments coming from different physics, thereby leading to a generic 3D prism element. The method's capability to deliver accurate displacements with a reduced number of degrees of freedom was initially investigated in [7]. Subsequently, the method was extended to compute linearized buckling modes analysis [8], and mode shapes.

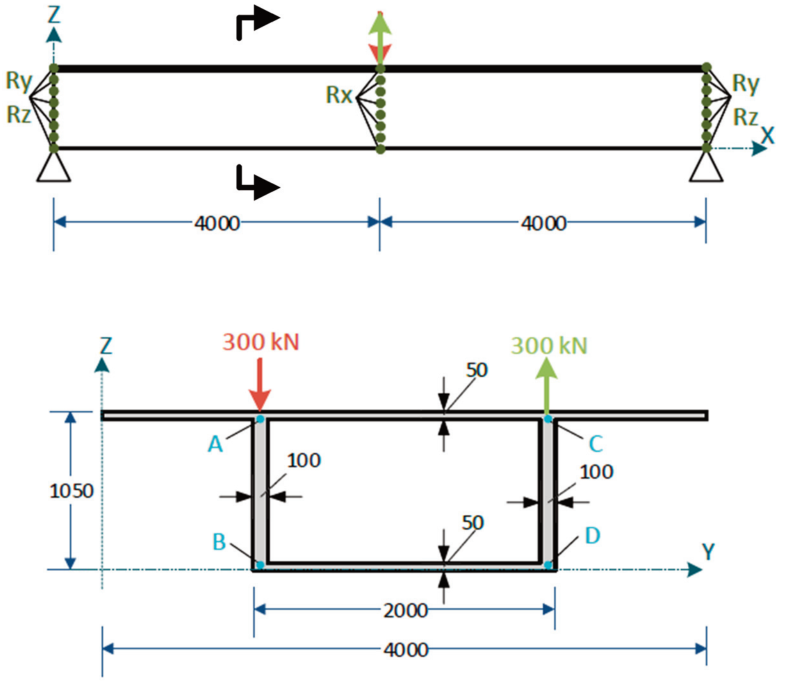


Figure 3:
Geometry and boundary conditions of the modelled beam

Linear elastic beams

A beam subjected to torsion was modeled using our method, and the results were compared with those from a standard FE model. The beam's geometry is shown in *Figure 3*, and the material properties are detailed in [7]. A comparison of the results obtained using the proposed approach with 2 and 12 elements in the longitudinal direction, versus the standard FE model with 200 elements in the longitudinal direction, is presented in *Figure 4*. The results demonstrate that the proposed method accurately computes displacements and stresses, even in the presence of complex deformation modes, while significantly reducing the number of elements required in the longitudinal direction. This reduction leads to a notable decrease in the total number of degrees of freedom.

Buckling loads

The formulation was extended to compute linearized buckling modes [Marzok and Waisman 2023]. In this case, an eigenvalue problem, derived by considering the Green-Lagrange strain tensor, was formulated, under the assumption that the material stiffness at the onset of buckling is equal to the initial stiffness of the structure [16]. Superior convergence rate for the first few modes was demonstrated [8].

The method's capability to capture various buckling modes was investigated by analyzing a cantilever beam with a channel section of different lengths, subjected to a concentrated load at its free end, applied at the top junction of the cross section. The problem parameters are given in [8]. A 3D plot of the buckling modes is shown in *Figure 5*, along with the deformed cross-sections at the mid-spans. These results were obtained from a benchmark finite element (FE) model (total of 33,633 degrees of freedom) and an XFEM\GFEM model with only two elements in the longitudinal direction (total of 3996 degrees of freedom).

It is noteworthy that local buckling modes are observed in beams with $L_{beam} = 0.1\ [m]$ and $L_{beam} = 0.3\ [m]$. In these cases, there is no observable rotation of the cross-section, but significant distortion is evident. Specifically, the beam with $L_{beam} = 0.1\ [m]$ shows bending of the top flange and web due to buckling, with these parts exhibiting noticeable curvature. For the beam with $L_{beam} = 0.3\ [m]$, the top and bottom flanges remain straight.

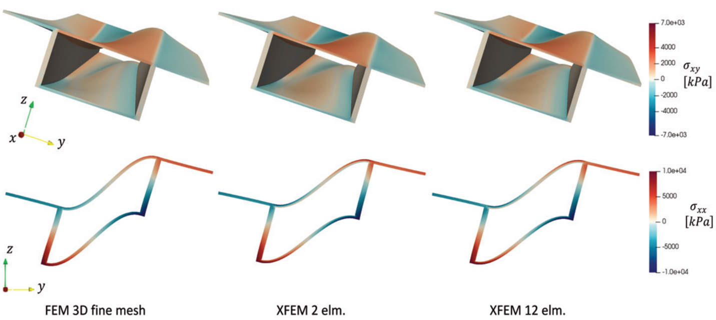


Figure 4:
Deformed shapes of s beam with box cross section subjected to torsion obtained. Comparison between the globally enriched XFEM\GFEM method and standard 3D FE model with fine mesh

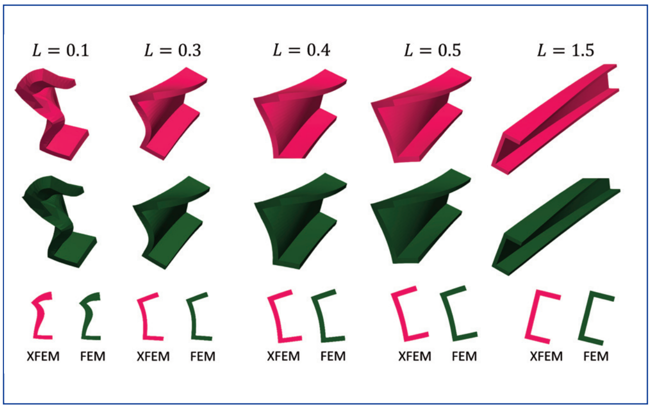


Figure 5:
Buckling modes of beams with different lengths obtained using a globally enriched XFEM\GFEM model and standard FE model with fine mesh

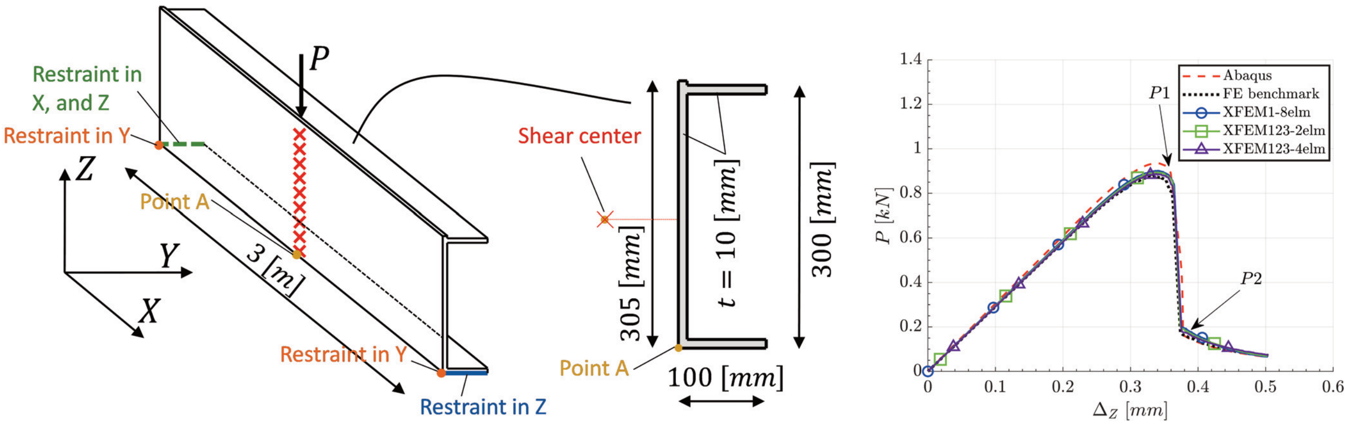


Figure 6:
Beam with a channel cross-section subjected to concentrated load at mid-span, eccentric to the shear center

In contrast, for beams with $L_{beam} = 0.3\ [m]$, cross-sectional rotation is observed, and global buckling modes are evident. For the long beam with $L_{beam} = 1.5\ [m]$ (see *Figure 5*), the cross-sectional shape is preserved, showing only rigid body rotation. This case study demonstrates the approach's ability to capture complex deformation modes and its effectiveness in providing accurate solutions for different cases.

Analysis of cracked beams

The globally enriched beam formulation was extended to analyze cracked elements, raising a key question about the efficiency of the global enrichment functions. To address this, the method's ability to capture deformations for a predefined length was evaluated for various crack lengths and orientations [15].

It was observed that increasing the crack length results in larger errors because the global enrichment functions do not account for the localized behavior near the crack, leading to discontinuities in the beam's longitudinal direction. However, employing high-order functions was shown to improve the convergence rate of the method when dealing with cracked beams [15].

The method was also examined for crack propagation by extending the formulation to include cohesive zone elements, assuming a predetermined crack path. A 3D beam with a channel-type cross-section, supported with pinned supports for vertical deformations and fixed for rotation at both ends, was modeled. A concentrated point load was applied eccentrically to the shear center, as shown in *Figure 6*, resulting in a concentrated torsional moment at the center of the beam. A predefined crack path was modeled at the beam's center using cohesive zone elements and considering a mixed mode traction separation law. The material properties are detailed in [15].

The problem was modeled using two different methods: the globally enriched XFEM\GFEM approach with varying enrichment orders and a standard 3D FE model. The results were compared to a benchmark solution obtained from an FE model with 100 elements in the longitudinal direction and 193 elements in the cross-section, resulting in 89,652 degrees of freedom (DOFs).

To evaluate the effectiveness of the global enrichment, the refinement of the XFEM\GFEM and FE models was investigated by varying the number of elements in the longitudinal direction and the enrichment sine wave orders, while keeping the cross-sectional discretization constant. The problem was solved incrementally in a displacement control manner with an increment size of $1\times10^{-3}\ [mm]$. An automatic reduction in the increment size was applied in the case of divergence.

Figure 6 shows the applied force against the vertical component of the mid-span displacement at the section's corner, marked as point A in *Figure 6*. It was observed that the proposed XFEM\GFEM model provided accurate predictions across all refinement schemes. In contrast, the standard FE models produced poor predictions even with up to 16 elements in the longitudinal direction, which resulted in a similar number of DOFs as the XFEM\GFEM model with 8 elements [15]. The XFEM\GFEM model, however, provided significantly more accurate results.

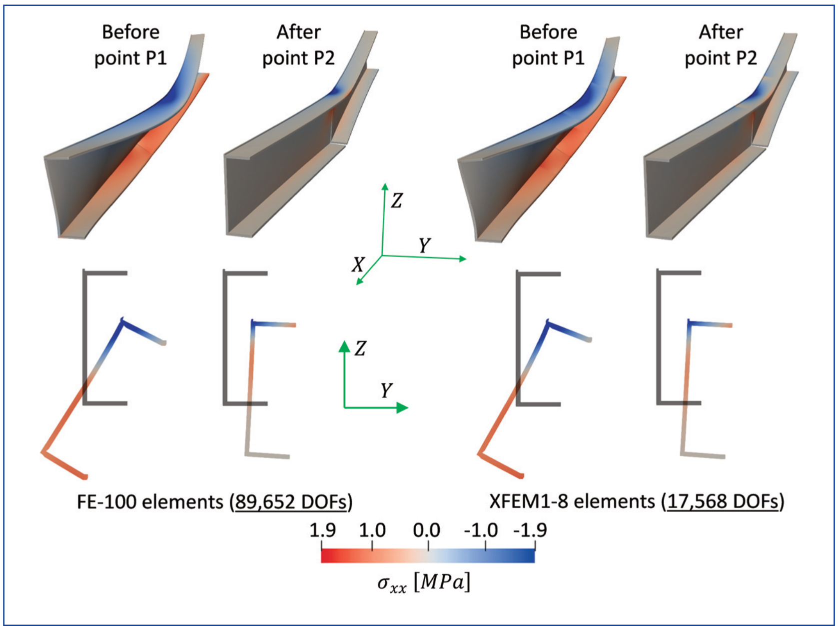


Figure 7:
Deformed shapes before and after extensive crack propagation

the right plots of *Figure 7* (e.g., in the FE model with 100 elements), which illustrate that the bottom parts of the section have zero resistance. Additional animations of the deformed shape during the loading process are provided as supplementary material in reference [15].

Figure 7 shows the deformed shapes before and after passing points P1 and P2 on the force-displacement curves (Figure 6). Notably, when the crack starts propagating in an unstable manner, the discontinuity at the bottom flange causes a change in the cross-section's shape. The crack initiates at the left corner of the cross-section, at point A, due to the increased normal stress in that point resulted due to combined bending and warping.

Once the bottom flange fully separates, the effective section becomes an L-shaped, with the shear center located at the top corner, eliminating the eccentricity w.r.t the external load. This shape is evident from the sectional stress distribution shown in

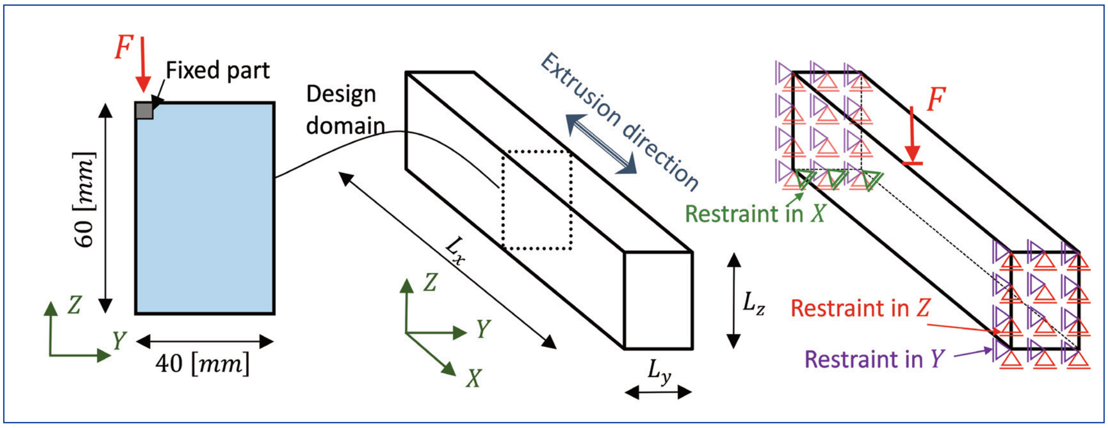
Optimization of extruded beams

The proposed method was used as a forward problem to optimize the cross-section of extruded beams, [9]. The optimization problem aims to minimize the amount of material used in the beam while satisfying predefined performance constraints. This formulation utilizes the well-known SIMP (Solid Isotropic Material with Penalization) method [17], in which the elements used to discretize the beam's cross-section are defined as the design variables, as shown in *Figure 8*. Due to the extrusion process the elements in the cross-section are mapped along the length of the beam, resulting in prism-like 3D solid elements.

The beam is subjected to an eccentric concentrated load within the design domain. The performance constraints considered include the maximum allowable vertical displacement along the beam, the minimum buckling load, and the maximum allowable stress. The problem was solved for different beam lengths and buckling load values utilizing a gradient-based optimization algorithm with analytical sensitivity analysis com puted using the adjoint variable method. The results of the optimized cross-sections are presented in *Figure 9*.

The results indicate that increasing the beam's length necessitates adding material to the top and bottom flanges to meet the displacement constraints. This adjustment increases the moment of inertia I_{yy}, thereby enhancing bending rigidity. Increasing the minimum allowable buckling load requires adding material from the load application side to the opposite side of the design

Figure 8:
Design domain and problem's boundary conditions of extruded beam



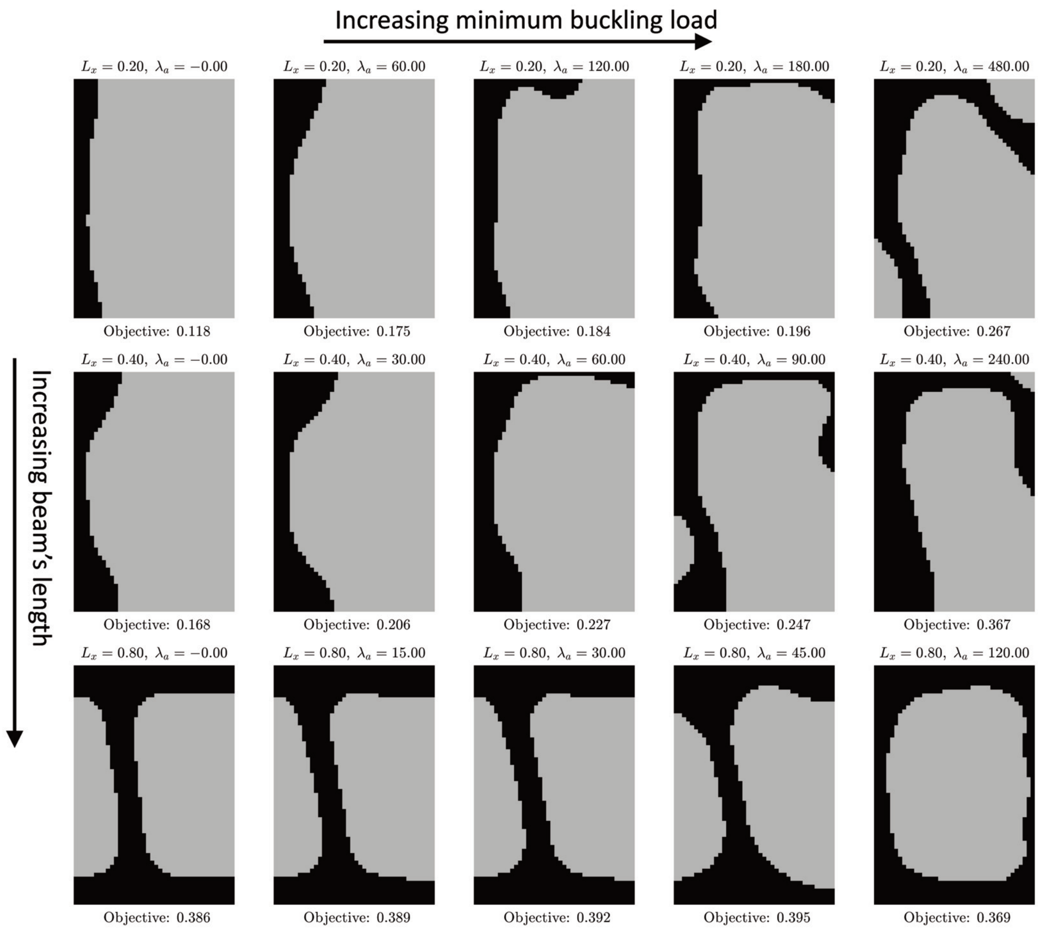
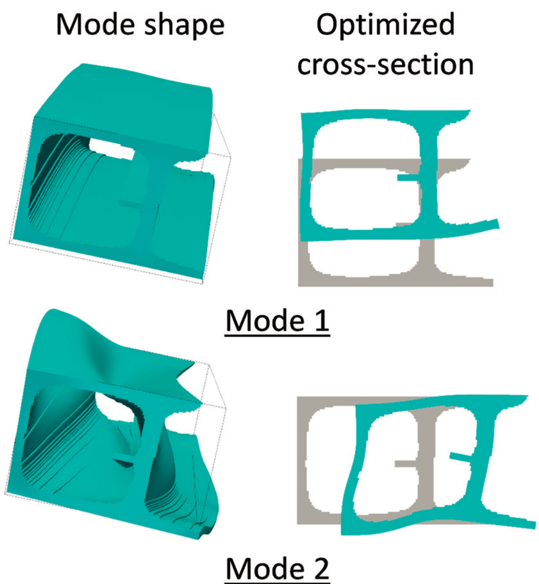


Figure 9:
Effect of beam length and minimum allowable buckling loads on the optimized design of extruded beam subject to eccentric load

domain, which increases the moment of inertia I_{zz} about the weak axis of the beam. This modification improves the beam's lateral-torsional buckling capacity. When both factors are taken to the extreme, the result is a closed cross-section with high torsional rigidity, which further enhances the beam's lateral-torsional buckling capacity.

The problem was also extended to optimize the natural frequencies of extruded beams. *Figure 10* shows the free-vibration mode shapes of an optimized extruded beam, with some parts having a fixed design based on functionality requirements. The optimization procedure results in a cross-section that integrates the fixed part within the optimized shape to enhance performance. For more details on this extension, the interested reader is referred to [10].

Figure 10:
First two free vibration modes of an optimized extruded beam



Concluding Remarks

The analysis and design of beams with arbitrary cross-sections is challenging due to the presence of complex deformation modes, buckling and fracture. Traditional beam theories often fail to provide accurate results in such cases, and standard FE methods are prohibitively expensive. Moreover, designing these elements for improved performance through optimization requires a large number of analyses, which demands computationally efficient numerical schemes for solving the forward problem.

We propose a new approach for modeling these elements using a 3D solid FE model enhanced with global enrichment functions. This model significantly reduces the computational burden compared to traditional FE models in various problems, including linear elasticity, linearized buckling, and fracture, making it particularly attractive for optimization schemes.

"The XFEM/GFEM approach significantly reduces the computational burden compared to traditional FE models."

This numerical scheme has provided valuable insights into the optimal solutions for extruded beams and highlighted various trade-offs when tuning parameters. It has been shown that the optimal design of the cross-section is significantly affected by size effects. Therefore, a geometrical design of the cross-section properties under the assumption that the behavior is governed by classic beam theories may lead to sub-optimal designs or a violation of performance constraints.

Both the numerical approach and the optimization framework hold significant potential for extension to other cases, representing a promising direction for future research. ●

Acknowledgement:
The financial support of the Schüco-USA LLLP company under Grant 22-0900 is gratefully acknowledged. The authors wish also to thank Dr. Tejav DeGanyar from Schüco-USA LLLP company for his valuable suggestions.

References:

[1] *Reddy, J. N.* (1984). **A simple higher-order theory for laminated composite plates**. J. Appl. Mech. 1984, 51(4): 745-752.
[2] *Mentrasti L*. **Distortion (and torsion) of rectangular thin-walled beams**. Thin-Walled Structures 1990;10(3):175–93.
[3] *Reissner E*. **Analysis of shear lag in box beams by the principle of minimum potential energy**. Quart. Appl. Math. 1946;4(3):268–78.
[4] *Schardt, R.* (1989). **Verallgemeinerte Technische Biegetheorie**. Springer-Verlag.
[5] *Cheung, Y. K.* (2013). ***Finite strip method in structural analysis.*** Elsevier.
[6] Haftka, R. T., & Gürdal, Z. (2012). **Elements of structural optimization (Vol. 11)**. Springer Science & Business Media.
[7] *Marzok, A., DeGanyar, T., & Waisman, H*. (2023). **Efficient XFEM approach for the analysis of thin-walled beams**. Engineering Structures, 285, 116068.
[8] *Marzok, A., & Waisman, H*. (2023). **XFEM based method for buckling analysis of thin-walled beams**. Thin-Walled Structures, 189, 110942.
[9] *Marzok, A., & Waisman, H*. (2024a). **XFEM\GFEM based approach for topology optimization of extruded beams with enhanced buckling resistance**. Computer Methods in Applied Mechanics and Engineering, 418, 116541.
[10] *Marzok, A., & Waisman, H*. (2024b). **Topology optimization of extruded beams modeled with the XFEM for maximizing their natural frequencies**. Mechanics Research Communications, 135, 104234.
[11] *Moës, N., Dolbow, J., & Belytschko, T.* (1999). **A finite element method for crack growth without remeshing**. International journal for numerical methods in engineering, 46(1), 131-150.
[12] *Duarte, C. A., Babuška, I., & Oden, J. T.* (2000). **Generalized finite element methods for three-dimensional structural mechanics problems**. Computers & Structures, 77(2), 215-232.
[13] *Strouboulis, T., Copps, K., & Babuška, I.* (2001). **The generalized finite element method**. Computer methods in applied mechanics and engineering, 190(32-33), 4081-4193.
[14] *Babuška, I., & Melenk, J. M.* (1997). **The partition of unity method.** International journal for numerical methods in engineering, 40(4), 727-758.
[15] *Marzok, A., & Waisman, H.* (2024c). **Globally enriched XFEM/GFEM approach for cracked beams**. Thin-Walled Structures, 203, 112224.
[16] *De Borst, R., Crisfield, M. A., Remmers, J. J., & Verhoosel, C. V.* (2012). **Nonlinear finite element analysis of solids and structures.** John Wiley & Sons.
[17] *Bendsøe, M. P.* (1989). **Optimal shape design as a material distribution problem.** Structural optimization, 1, 193-202.

New Executive Committee and New Executive Director

At the 16th World Congress on Computational Mechanics and 4th Pan American Congress on Computational Mechanics, the new executive committee members started their tenure. Rekha Rao (Sandia National Laboratories) is the new President, Jessica Zhang (Carnegie Mellon University) is the new Vice President, and Lucy Zhang (Rensselaer Polytechnic Institute) is the new Secretary/Treasurer. The new members-at-large are Nikolaos Bouklas (Cornell University), Ming-Chen Hsu (Iowa State University), Emma Lejeune (Boston University), Pania Newell (The University of Utah) and Pablo Seleson (Oak Ridge National Laboratory). We would like to thank Past President, John Dolbow, for all of his contributions and leadership for the past decade.

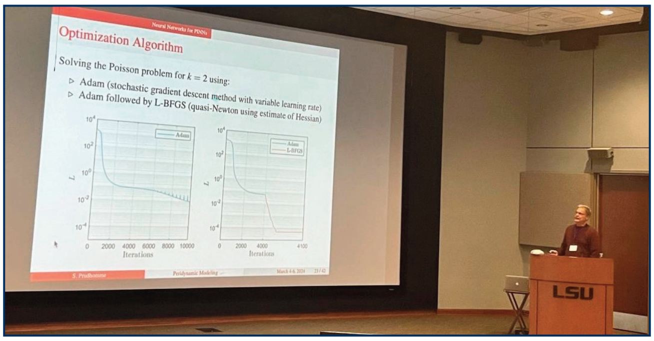
After 17 years of service to USACM, our Executive Director, Ruth Hengst, has rotated off and is now working part-time supporting the USACM Foundation as she transitions to retirement. Our new Executive Director is Bethany Roicki who has been with USACM for five years. We congratulate Ruth on her many years of service to USACM and her exhaustive efforts to make our meetings and our association successful. We will miss Ruth and her steady hand running the association but are confident that Bethany is more than ready to be another steady hand.

Workshop on Experimental and Computational Fracture Mechanics

The second "Workshop on Experimental and Computational Fracture Mechanics" (WFM2024) was held on March 4–6, 2024 at the LSU Center for Computation & Technology at Louisiana State University (LSU) in Baton Rouge, Louisiana. The workshop brought together experts in experimental and computational fracture mechanics, scientific machine learning, and uncertainty quantification. The workshop facilitated a collaborative environment for these diverse scientific communities and helped advance the state of the art in experimental design and computational modeling for fracture mechanics.

Recently, new approaches for fracture modeling, such as phase-field fracture modeling, Peridynamics, the eigen-erosion approach, and the reproducing kernel particle method, have shown promising results for simulating complex fracture phenomena. However, the validation of these models cannot be carried out without the design of suitable validation experiments, which is essential to gain confidence in their predictability and reliability. Moreover, while scientific machine learning and uncertainty quantification have been successfully applied in many fields, their application in fracture mechanics is still limited. Hence, some specific objectives of the workshop were to find new opportunities for using methods from scientific machine learning and uncertainty quantification in the context of fracture mechanics and identify challenges and pathways for robust validation of fracture models through integration of experimental and modeling efforts.

__Figure 1:__ Prof. Serge Prudhomme (Polytechnique Montréal) delivering his talk



The workshop was attended by fifty participants. It featured three keynote lectures, twenty-one oral presentations, nine poster presentations, and an industrial talk. The keynote lectures on scientific machine learning and experimental fracture mechanics were presented by Steve WaiChing Sun (Columbia University) and Andrew Bunger (University of Pittsburgh), respectively. The industrial talk was delivered by Agnes Blom-Schieber from Boeing.

The meeting was organized by Patrick Diehl (Louisiana State University now at Los Alamos National Laboratory), Serge Prudhomme (Polytechnique Montréal), Pablo Seleson (Oak Ridge National Laboratory), and Gowri Srinivasan (Los Alamos National Laboratory). The workshop was sponsored by the Technical Thrust Area (TTA) on Large Scale Structural Systems and Optimal Design and the TTA on Uncertainty Quantification and Probabilistic Modeling of the U.S. Association for Computational Mechanics (USACM), the LSU Center for Computation & Technology (CCT) at Louisiana State University (LSU), and Los Alamos National Laboratory. The organizers gratefully acknowledge their support. Further information about the event may be found at https://wfm2024.usacm.org/home.

Conference Celebrating a Quarter Century of Peridynamics

Peridynamics (PD) was introduced by Stewart Silling 25 years ago in the now-celebrated paper published in JMPS. We have witnessed an explosion in the number of contributions sent to journals on Peridynamic topics, encompassing mathematical foundations, numerical algorithms, material models, and industrial applications. Several Peridynamic books have also appeared at major publishers. The wealth of information makes it more and more difficult to get the full picture of the state-of-the-art and the possible fruitful future directions in Peridynamics. To rectify this situation, a workshop to review the first 25 years of Peridynamics, exchange ideas between theory, computations, and practical applications, and project paths into the future of PD research was held in Tucson, Arizona, USA, April 23-25, 2024, at the El Conquistador Hotel and Resort.

Figure 2: *The general session room at El Conquistador Hotel and Resort*

“Quarter Century of Peridynamics” was organized by F. Bobaru (University of Nebraska), S. Silling (Sandia National Laboratories), and E. Madenci (University of Arizona) with sponsorship provided by University of Arizona, National Science Foundation, and “Modelling”, an open access Journal by MDPI. The conference featured nine plenary talks and 57 contributed technical talks. The structure of the conference allowed for numerous networking opportunities and informal discussions.

Quarter Century of Peridynamics was a USACM Thematic Conference under the Technical Thrust Area Novel Methods in Computational Engineering and Sciences. The conference organizers are planning a Special Issue in the "Journal of Peridynamics and Nonlocal Modeling" (a Springer journal, https://link.springer.com/journal/42102).

Second
USACM Thematic Conference
on Uncertainty Quantification for Machine Learning
Integrated Physics Modeling
(UQ-MLIP 2024)

The USACM Technical Thrust Areas (TTAs) on Data-Driven Modeling and Uncertainty Quantification and Probabilistic Modeling organized the second in-person thematic conference on UQ for Machine Learning Integrated Physics Modeling (UQ-MLIP) on August 12-14, 2024, in Crystal City, Arlington, Virginia.

Computational models of real-world systems are increasingly integrating data-driven models from the field of machine learning with models that are derived from physics. It is thus of greatest importance to carefully characterize and quantify the uncertainties associated with each model class. Furthermore, the propagation of uncertainties to the outcomes of the integrated models demands novel approaches or extension of existing methodologies. Invited speakers discussed novel ideas related to these and other topics including, digital twins, model reduction, large scale integrated computations, and active decision making under UQ frameworks.

The meeting also featured two panels. One that was focused on the role of Industry in this area for which the panel consisted of researchers from different industries working at the intersection of machine learning and UQ. The second panel was focused on aspects related to research funding in this area, where the panelists included program managers whose portfolios include topics covered in the workshop. Both panels were very well attended and featured lively discussions.

Figure 3:
Participants enjoying the poster session

The meeting was partially supported by the National Science Foundation (NSF) and Sandia National Laboratories. Funds were used to support the travel expenses of students and early career scientists.

We thank the speakers and participants for their time and effort, the NSF and Sandia National Laboratories for their financial support, and gratefully acknowledge the involvement of program managers Siddiq Qidwai (NSF) and Yannis Kevrekidis (DARPA).

Further information about the event may be found at **https://uq-mlip2.usacm.org/**. ●

USACM Upcoming Events

- **18th U.S. National Congress on Computational Mechanics**
  July 20-24, 2025
  Chicago Illinois (**usnccm18.usacm.org**)

Information on other upcoming conferences may be found at **usacm.org/conferences**. ●

MECOM 2024
XL Argentine Congress on Computational Mechanics

Rosario, Santa Fe, Argentina
5 to 8 November 2024

TheThe XL Argentine Congress on Computational Mechanics (MECOM 2024) took place from November 5th through November 8th, 2024, in the city of Rosario, Santa Fe, Argentina. This new edition of the annual AMCA Congresses was organized by researchers from the Faculty of Exact Sciences, Engineering and Surveying (FCEIA) and the Institute of Physics of Rosario (IFIR), dependent on Rosario National University (UNR), together with the Argentine Association for Computational Mechanics (AMCA).

Figure 1:
Opening Ceremony, from left to right:
Dr. César I. Pairetti (scientific committee), Dr. César M. Venier (chair of the congress), Prof. Pablo Kler (president of AMCA), and M.Sc. Yolanda Galassi (vice dean of FCEIA).

The Organizing Committee included Dr. César M. Venier (Chairman), Dr. Luciano Ponzellini Marinelli (Co-Chairmen), and Dr. Mariela Olguín. The Scientific Committee was chaired by Dr. César I. Pairetti with Prof. Oscar Moller as Co-Chairmen.

The Congress hosted nine Invited Lecturers, Prof. Carlos Tomé (Los Alamos National Lab, USA), Prof. Rainald Löhner (George Mason University, USA), Prof. Daniel Fuster (Sorbonne Université, France), Prof. Stéphane Zaleski (Sorbonne Université, France), Prof. Ivo Roghair (Eindhoven University of Technology, Netherlands), Prof. Paul Steinmann (FAU Erlangen-Nürnberg, Germany), Prof. Rodney Fox (Iowa State University, USA), and Dr. Alberto Passalacqua (Iowa State University, USA).

Full-length papers were submitted to a peer review process prior to publication. Accepted papers have been published in the proceedings series "Mecánica Computacional", which are openly available at the following website: http://www.amcaonline.org.ar/mcamca. The Conference consisted of 21 Technical Sessions with more than 220 papers presented.

A special session was devoted to undergraduate students, with awards for best posters, that were granted to:

- **Milagros Rosser**, from the Research Group on Numerical Methods in Engineering, National Technological University, at Santa Fe, Argentina.

Figure 2:
All conference participants at the FCEIA-UNR main entrance

Figure 3:
Milagros Rosser (left) & Valentina Rosano (right) receiving the Poster contest prices from Prof. Zaleski & Prof. Fox

- **Valentina Rosano** from the Faculty of Exact Sciences, Engineering and Surveying, National University of Rosario, Rosario, Argentina.
- **Natanael R. Moya and Paolo Maldonado**, from National Technological University (UTN) at Parana, Argentina.

The Congress also included other activities like the XII Meeting of OpenFOAM users, a special session to honor Prof. Javier Signorelli, who was also remembered by his friends, family and the AMCA community lead by the words of Prof. Raul Bolmaro, and the annual ordinary meeting of the Association.

Figure 4:
Participants of the Congress during the welcome cocktail

AMCA Awards 2024

AMCA executive board is pleased to announce AMCA Awards 2024 winners:

- The *AMCA Young Researcher Award* 2024 was granted to **Juan Carlos Álvarez Hostos** from CIT at Universidad Nacional de Rafaela and CONICET, Argentina
- The *AMCA Award 2024 for Scientific, Professional and Teaching Trajectory* was granted to **Víctor Fachinotti** from CIMEC at Universidad Nacional del Litoral and CONICET, Argentina (currently at SINTEF, Norway).
- The *AMCA Award 2024 for International Scientific Trajectory* was granted to **Marcela Cruchaga** from Universidad de Santiago de Chile, Chile.

The AMCA Awards 2024 Ceremony took place during the XL MECOM Congress dinner. ●

Figure 5:
Closing photo of Prof. Javier Signorelli homage session

Figure 6:
Prof. Marcela Cruchaga with her 2024 AMCA Award and the banner of the Conference

Call for Papers

The Argentine Association for Computational Mechanics (AMCA) announces the XLI Argentine Congress on Computational Mechanics (MECOM 2025) to be held in Buenos Aires, Argentina, organized by the Faculties of Engineering (FIUBA), and Exact and Natural Sciences (FCEN) of the Buenos Aires University (UBA). The Conference will be chaired by Profs. Paula Folino, Marcela Goldschmidt and Antonio Caggiano in the Organizing Committee and Profs. Pablo Mininni and Guillermo Etse in the Scientific Committee.

More information will be published in **https://amcaonline.org.ar/mecom2025/** ●

Report from
The Association of Computational Mechanics Taiwan (ACMT)

The Association of Computational Mechanics in Taiwan (ACMT) is marking two years since officially registering with the Ministry of Interior in Taiwan. Under the leadership of **President Chuin-Shan (David) Chen** and board members of the association, the young organization has demonstrated remarkable growth and influence within the academic community. Here's a look back at a few activities.

High School Science Camp in July: Inspiring the Next Generation in Mechanics

In early July, several ACMT board members *(Figures 1 & 2)* organized a science camp for high school students. The event was designed to teach students through hands-on activities, allowing them to experience the excitement of mechanics firsthand. This program not only sparked a deeper interest in science among students but also planted the seeds for future talent in the field of mechanics.

Figure 1

Figure 2

WCCM2024 in Vancouver:
A Highlight for Taiwanese Scholars on the International Stage

Figures 3

Figure 4

Figures 5

Figure 6

Also in July, ACMT organized a delegation to attend the **16th World Congress on Computational Mechanics and the 4th Pan American Congress on Computational Mechanics** in Vancouver, Canada.

Nearly 50 participants from Taiwan joined *(Figures 3-6)*, showing the society's commitment to engaging in international academic events.

Additionally, ACMT sponsored three students to attend, encouraging young scholars to broaden their perspectives and foster cross-border academic exchanges.

October ACMT Annual Meeting: Record-Breaking Participation

In October, ACMT hosted its second annual conference, drawing nearly 200 registrants — a new record for the event. The organizing committee invited three keynote speakers, including **Prof. Wing-Kam Liu** from Northwestern University in the USA, who brought unique perspectives and expertise to the conference.

The event received 141 submissions for the minisymposium and 31 submissions for the poster competition, showcasing ACMT's excellence in academic research.

Figure 7:
Group photo at the opening ceremony of 2024 ACMT annual meeting

Figure 8:
Prof. Wing-Kam Liu and Prof. Chuin-Shan (David) Chen

Figure 9:
Prof. Ming-Jyh Chern and Prof. Chuin-Shan (David) Chen

Figure 10:
Prof. Zhao Qin and Prof. Chia-Ching Chou

As the year ends, ACMT continues to expand its influence in the academic community, with growing support from its members. We look forward to the coming year, aiming to provide our members with even more valuable academic resources and opportunities.

UK acm
UK Association for Computational Mechanics

UKACM President-Elect

Following an election process, *Dr Jelena Ninic* has been unanimously elected for the position of UKACM President. Dr Ninic is Associate Professor in Digital Engineering in the School of Engineering at the University of Birmingham, and she led the organisation of the 2022 UKACM conference. Dr Ninic will start his period in office in January 2025.

The executive committee also created the position of UKACM Vice President.
Dr Ninic has taken this role with immediate effect until the end of 2024.
Prof Andrew McBride is the Vice President-elect, and he will start his period in office in January 2025.

2025 UKACM Conference

UK acm
UK Association for Computational Mechanics
2025

The next UKACM conference will be hosted by the Queen Mary University of London and Oxford University, from 23rd-25th April 2025, chaired by *Dr Wei Tan* and *Prof Emilio Martínez-Pañeda*.

The following plenary speakers have agreed to speak at the conference:

- *Prof Neil Sandham*, University of Southampton
- *Prof Catherine O'Sullivan*, Imperial College London
- *Prof Mark Parsons*, University of Edinburgh
- *Dr Paulo R. Refachinho de Campos*, UKACM 2023 Roger Owen PhD thesis prize winner (Swansea University and Universitat Politècnica de Catalunya).

The conference will be complemented by a half day School on the afternoon of Wednesday 23rd April 2025, focused on advanced computational methods in engineering. The speakers are:

- *Professor Angela Busse*, University of Glasgow
- *Dr Burigede Liu*, Cambridge University
- *Dr Tim Hageman*, Oxford University

Further details can be found in
https://sites.google.com/view/ukacm2025conference/home ●

UKACM Involvement in Conferences

- In 2024 UKACM proudly sponsored the **UK Fluids Conference 2024** that took place in Swansea from 9th-11th September 2024.

- UKACM is supporting the organisation of the **3rd IACM Digital Twins in Engineering Conference (DTE 2025)** and **1st ECCOMAS Artificial Intelligence and Computational Methods in Applied Science (AICOMAS 2025)** that will take place from 17th-21st February 2025 in Paris, France. ●

2024 UKACM Conference

The 2024 UKACM conference was hosted by the Department of Engineering of Durham University, from 10th-12th April2024, chaired by *Professor Will Coombs* as announced in the last issue of IACM Expressions.

The conference was attended by 100 delegates and three prizes were awarded:

- *Callum Lock*, Swansea University: Laura Annie Wilson Prize to the best presentation by a postgraduate student.
- *Sadaf Maramizonouz*, Newcastle University: Nina Cameron Graham Prize to the best presentation by a post-doctoral researcher.
- *Nathan Ellmer*, Swansea University: Mike Crisfield Prize to the best presentation.

2024 UKACM-SEMNI Autumn School

UKACM and SEMNI co-organised an Autumn School on data-centric engineering in computational mechanics from 16th-19th September 2024. The School was an on-line event, free of charge, and combined lectures with hands-on sessions and individual work activities.
Almost 200 participants registered, from 26 different countries, and the speakers were:

- *Prof Burigede Liu*, Cambridge University
- *Prof Ivan Markovsky*, ICREA/CIMNE
- *Prof Fehmi Cirak,* Cambridge University
- *Prof Elías Cueto*, *Prof Icíar Alfaro, Prof David González,* Universidad de Zaragoza

UKacm
UK Association for Computational Mechanics

SEMNI

Further details can be found in
https://sites.google.com/view/ukacm2025conference/home

UKACM President's Farewell Address

In January 2019 I took the role of UKACM President, after serving three years as Board and Executive Committee Member. As my term comes to an end, I want to express my deepest gratitude to all the community for your support, trust, and collaboration. Especial thanks to *Prof Charles Augarde* and *Prof Omar Laghrouche* for their dedication and support. It has been an honour to serve and work alongside a dedicated team that shares a passion for our field. I believe that, together, we have achieved significant milestones and laid a strong foundation for the future.

I am confident that under the capable leadership of *Dr Jelena Ninic*, UKACM will continue to thrive and evolve. I look forward to seeing the remarkable progress our community will continue to make.

Prof Rubén Sevilla, *UKACM President*

JACM 日本計算力学連合
Japan Association for Computational Mechanics

Report from

the Japan Association for Computational Mechanics

The Japan Association for Computational Mechanics (JACM) is a union of researchers and engineers working in the field of computational mechanics mainly in Japan. The 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 355. JACM members actively participate in the IACM activities.

The JACM elected a new executive council in March 2024. Seiya Hagihara is appointed to serve as the president of JACM for next three years. The former vice president, Professor Kenji Takizawa, continues his service as the vice president. Professor Yoshitaka Wada is appointed to serve as the vice president. The former secretary general, Professor Yuichi Tadano, continues his serve as the secretary general. The new executive council members for 2024–2027 are as listed below:

President:
Professor Seiya Hagihara, Saga University - *hagihara@cc.saga-u.ac.jp*
https://research.dl.saga-u.ac.jp/profile/en.d42663754dcf613b59c123490551be02.html

Vice Presidents:
Professor Kenji Takizawa, Waseda University - *Kenji.Takizawa@waseda.jp*
https://www.jp.tafsm.org/
Professor Yoshitaka Wada, Kindai University - *wada@mech.kindai.ac.jp*
https://www.kindai.ac.jp/english/research/researchers/introduce/wada-yoshitaka-bfa.html

Secretary General:
Professor Yuichi Tadano, Saga University - *ytadano@cc.saga-u.ac.jp*
https://sentan.me.saga-u.ac.jp/profile_tadano_eng.html

On March 9th, 2024, the fifth JACM awardee seminar was held in an in-person/online hybrid format. The purpose of this seminar series is to have researchers who received the JACM awards recently give lectures on their latest research activities. Two lectures were given in the seminar. The first one entitled "Relaminarization Control of Turbulent Flow and Its Development" was presented by **Professor Hiroya Mamor**i (University of Electro-Communications), who is the JACM Young Investigator Award winner of year 2022. The second one was "Finite Element Analysis Makes a Good Engineer Great, and a Bad Engineer Dangerous" given by **Dr. Hiroshi Watanabe** (Techspire) received the JACM Fellows Award of year 2023.


(a)

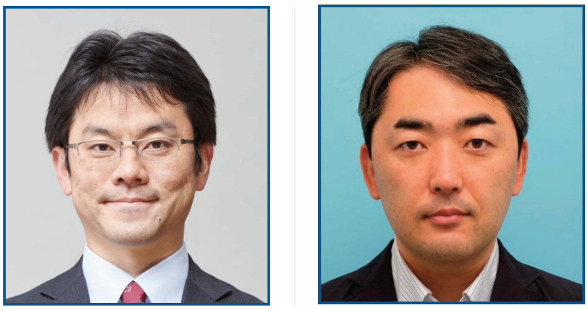

(b)

Figure 1:
Recipients of the 2024 JACM Computational Mechanics Award, (a) Professor Ryuji Shioya (Toyo University) and (b) Professor Mamoru Tanahashi Institute of Science Tokyo (former Tokyo Institute of Technology)

On September 7th, 2024, the 2024 JACM annual meeting and award ceremony were held in Green Computing Systems Research and Development Center of Waseda University in Tokyo. The meeting was also broadcasted by Zoom to remote participants.

In this year, JACM inducted two new honorary members. Before the award ceremony, new honorary members were introduced. They have distinguished records of researches and services to computational mechanics related professional societies. The new honorary members are **Professor Hideyuki Azegami** (Professor Emeritus, Nagoya University) and **Professor Shinobu Yoshimura** (Professor Emeritus, The University of Tokyo). Each of the new honorary members gave a short speech, after their introductions.

Following the introduction of the new honorary members, the award ceremony took place. There are three categories of JACM Awards. They are the ***JACM Computational Mechanics Award*** which is the highest award, ***JACM Fellows Award*** and the J***ACM Young Investigator Award***.

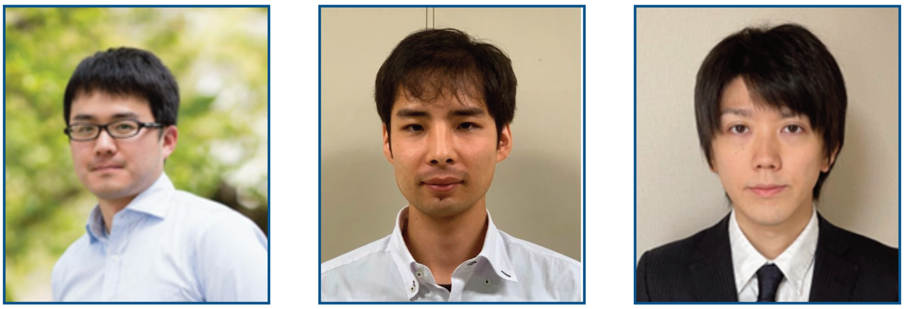


(a) *(b)*

Figure 2:
Recipients of the 2024 JACM Fellows Award,
(a) Professor Takahiro Tsukahara
(Tokyo University of Science) and
(b) Professor Hideki Fujii (The University of Tokyo)

Professor Ryuji Shioya (Toyo University) and **Professor Mamoru Tanahashi** (Institute of Science Tokyo (former Tokyo Institute of Technology)) were awarded ***2024 the JACM Computational Mechanics Award*** (*Figure 1*).

The recipients of the ***JACM Fellows Award*** were **Professor Takahiro Tsukahara** (Tokyo University of Science) and **Professor Hideki Fujii** (The University of Tokyo) (*Figure 2*).



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

Figure 3:
Recipients of JACM Young Investigators Award,
(a) Professor Garuda Fujii (Shinshu University),
(b) Professor Shunichi Ishida (Kobe University) and
(c) Professor Takuya Matsunaga (The University of Tokyo)

The winners of ***JACM Young Investigator Award*** were **Professor Garuda Fujii** (Shinshu University), **Professor Shunichi Ishida** (Kobe University) and **Professor Takuya Matsunaga** (The University of Tokyo) (*Figure 3*).

The second part of the annual meeting was the fourth JACM awardee seminar. The purpose of this seminar series is to have researchers who received the JACM awards recently give lectures on their latest research activities. Two lectures were given in the seminar. The first one entitled “Space–Time Computational Analysis of Tire Aerodynamics with Complex Tread Pattern, Road Contact, Tire Deformation, and Fluid Friction” was presented by Professor Takashi Kuraishi (Toyohashi University of Technology), who is the JACM Young Investigator Award winner of year 2020. The second one was “Analysis, Design and Optimization of Finite Dimensional Structures” given by Professor Makoto Ohsaki (Kyoto University), received the JACM Computational Mechanics Award of year 2019. At the end of the 2024 JACM meeting, we took a group photo (Figure 4). ●

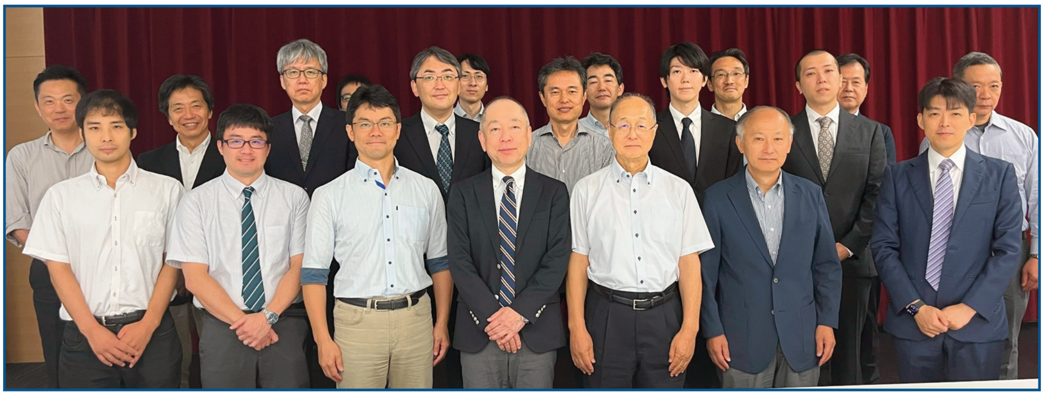


Figure 4:
Group Photo of the
2024 JACM annual meeting

Greeting from the President of JSCES
Toshio Nagashima
The 15th president of JSCES

The Japan Society for Computational Engineering and Science (JSCES), an academic organization that aspires to develop and apply computational engineering, is now in its 29th year since its establishment in 1995 and is now reaching its maturity stage. Since our incorporation in 2010, we have undergone repeated revisions and improvements to our articles of incorporation and various regulations, and our operating structure is becoming more stable. In 2025, we will finally reach the milestone of the 30th anniversary of the establishment of the society. The operations of this association have been maintained despite the various hardships caused by the coronavirus pandemic and the economic environment that has become increasingly severe since then, and the number of regular and corporate members continues to increase slightly. In addition, the number of participants and presentations at JSCES's main event, the Computational Engineering Conference, has recovered to roughly the same level as before the coronavirus pandemic, and we are receiving various forms of support from companies. It is thought that the activities are recognized and expected by society.

Figure 1: *Prof. Toshio Nagashima, the 15th president of JSCES*

We have established an activity policy to revitalize academic activities and make our society a solid management system that can contribute to the further development of computational engineering. We would like to uphold the following mission:

“We aim to be an academic society that can disseminate reliable and correct information about computational engineering in response to society's expectations, and we strive to develop human resources who will be responsible for the next generation of computational engineering.” ●

The JSCES Grand Prize 2023

Prof. Javier Bonet (*Figure 2*) of CIMNE, Spain, received the JSCES Grand Prize 2023 for his outstanding contributions in the field of computational engineering and sciences. The awarding ceremony and his plenary lecture were held during the 29th Conference on Computational Engineering and Science, June 10 to 12, 2024, at *Kobe Convention Center (Kobe, Japan). The tittle of his plenary lecture was “First order conservation law formulations in solid dynamics: applications to dynamic crack propagation, contact mechanics and stable SPH discretization.”* The plenary lecture was particularly impressive and inspiring for young researchers, and the lecture hall was filled with the joy of the many participants. ●

Figure 2: *Prof. Javier Bonet*

Figure 3: *Opening of Banquet in a Japanese traditional way*

*for all inclusions under **JSCES** please contact*
Junji Kato
kato.junji.i5@f.mail.nagoya-u.ac.jp

IWACOM-IV

The 4th International Workshops on Advances in Computational Mechanics (IWACOM-IV), chaired by Prof. Junji Kato and vice-chaired by Prof. Yuichi Tadano, was held at Kobe during September 18-20, 2024. The conference contained 9 workshops, each with the latest and hottest topics in the field of computational mechanics. Over 50 speakers from abroad including 2 plenary lecturers, Prof. Manfred Bischoff (University of Stuttgart) and Prof. Ferdinando Auricchio (University of Pavia), and about 90 speakers from Japan delivered their talks. The number of participants were approximately 200.

The biggest objective of this conference was to provide chances to young researchers for intensive discussions about their own selected topics and identify future directions for the development of related modeling strategies and computational techniques. During two days of fruitful discussions in the workshops, a reception party with “Night Bay Cruising” (*Figures 6 & 7*) and a banquet were held as social events. The participants experienced an exciting dinner at the Industrial Club of West Japan, which is registered as the National Important Cultural Property, seeing the beautiful gardens. ●

Figure 4:
Prof. Manfred Bischoff

Figure 5:
Prof. Ferdinando Auricchio

Figure 6 & 7:
Night Bay Cruising & Reception

COMPSAFE2025

The Japan Society of Computational Engineering and Science (JSCES) and the Japan Association for Computational Mechanics (JACM) will co-host COMPSAFE2025 from July 1 to 4, 2025, in Kobe, Japan. As an APACM Thematic Conference and an IACM Special Interest Conference, this event will bring together researchers from around the world focused on disaster prevention, structural failures, and safety.

Key topics include computational mechanics and engineering applications related to disaster prevention, engineering failures, and environmental issues. We eagerly anticipate your valuable contributions and look forward to warmly welcoming you to Kobe in July 2025.

Important Dates

Online submission of abstracts opens:	November 15, 2024
Deadline for abstracts submission:	January 15, 2025
Notification of acceptance:	March 1, 2025
Deadline for early registration:	April 1, 2025
Conference:	July 1-4, 2025 ●

ECCOMAS 2024

The Portuguese Association of Theoretical, Applied and Computational Mechanics, APMTAC, has organised the 9th European Congress on Computational Methods in Applied Sciences and Engineering, ECCOMAS 2024, which was held at the Congress Centre of Lisbon from 2-7 June 2024.

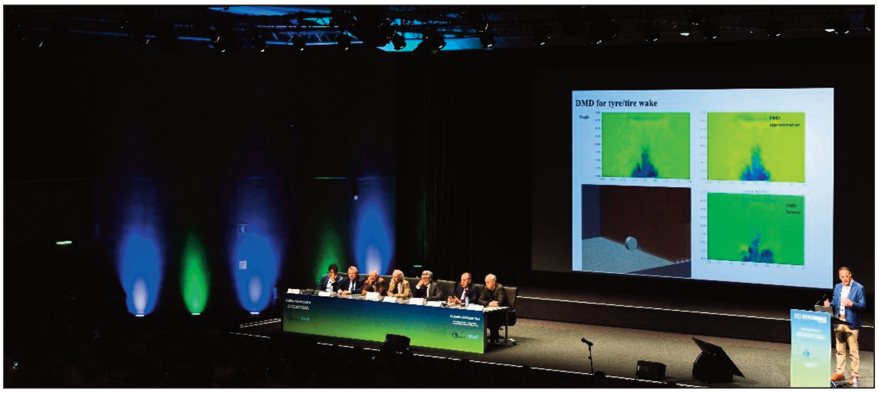


Figure 1:
Opening Session and Plenary Lecture.

Figure 2:
A view of the Delegates at the Opening Session

Figure 3:
Opening Plenary Lecture on Deep Learning Architectures for Science and Engineering by J. Nathan Kutz

The Congress provided an encounter for scientists and engineers from within Europe and all around the World. The Technical Programme of ECCOMAS 2024 offered nearly 2600 presentations, including 8 Plenary Lectures, 20 Semi-Plenary Lectures, and 75 Keynote Lectures, included in 188 Minisymposia and 15 Special Technical Sessions and with participants from 58 countries.

It was an excellent opportunity to disseminate the latest scientific and technical developments and to exchange new ideas on common and emerging topics.

A broad spectrum of themes was addressed, ranging from the more traditional subjects in Solid and Fluid Mechanics, Computer Science and Applied Mathematics to new ideas and methods. These are now spreading through all those areas to abridge existent impediments and limitations of current models for complex problems involving "multiphysics" phenomena at different scales, in time and space, and also a panoply of new paradigms related to Data-Driven Science and Engineering.

The quality of the submitted abstracts, the high number of participants and the significant percentage of young researchers give us hope for the positive influence this community will continue to have in the future development of Computational Methods in Applied Sciences and Engineering and its positive impact in our societies.

The Congress of Numerical Methods in Engineering

The Congress of Numerical Methods in Engineering is biennial and is jointly organised by the Portuguese Association of Theoretical, Applied and Computational Mechanics (APMTAC) and the Spanish Society of Computational Mechanics and Computational Engineering (SEMNI). The 2024 edition took place at the University of Aveiro (UA), Portugal, from 4 to 6 September and was a meeting point for researchers and technicians from both countries of the Iberian Peninsula, as well as from the Latin American community.

Figure 4:
The closing session

The Congress had seven invited lectures and was organised in three parallel sessions over three days, addressing most of the important issues in current research on the application of numerical methods in engineering. The conference had 145 participants from seven different countries. ●

Figure 5:
Preparing for the boat trip through the river to the congress banquet

Follow GACM

GACM Best PhD Award 2023

Already in 2012, GACM has established an award for young academics, namely the GACM Best PhD Award. It is our great pleasure to announce that the outstanding doctoral thesis of Dr.-Ing. Maximilian Ries is honored with this award for the year 2023. The award will be officially conferred at the next GACM Colloquium in Braunschweig. We are also delighted that Maximillian Ries was also subsequently honored with the ECCOMAS Best PhD Award 2023.

His thesis "Characterization and Modeling of Polymer Nanocomposites Across the Scales - A Comprehensive Approach Covering the Mechanical Behavior of Matrix, Filler, and Interphase“ was conducted at Friedrich-Alexander-Universität Erlangen-Nürnberg and has been performed under the academic supervision of Prof. Paul Steinmann. In his interdisciplinary doctoral thesis, Maximilian Ries combined aspects of computational chemistry, mechanical engineering as well as material sciences to unravel the highly complex structure-property relation of polymer nanocomposites. To this end, he employed molecular dynamics to characterize the behavior of the polymer matrix and the inorganic filler and calibrate suitable constitutive mechanical models. As a novelty, he employed atomistic-to-continuum multiscale simulations to identify the elastoplastic property gradients within the matrix-filler interphase, responsible for the outstanding properties of polymer nanocomposites. In summary, he introduced a methodology to transfer structural insights on the molecular scale into mechanical material properties relevant at the engineering scale. Therefore, his work contributes significantly to the numerical modeling of nano-structured materials and thus complements experimental studies. Furthermore, his doctoral project establishes an essential link between the chemistry and engineering communities, facilitating a holistic understanding of polymer nanocomposites.

Figure 1: *Dr.-Ing. Maximilian Ries*

At the time of the nomination, Maximilian Ries published his scientific results in an outstanding number of 15 Scopus-listed publications (12 journal articles, 3 conference proceedings), already achieving an h-index of 3 (excluding self-citations). His publications include highly respected journals in the field of mechanics, such as Composites Part A: Applied Science and Manufacturing or International Journal of Mechanical Sciences, as well as journals from chemistry (Journal of Chemical Theory and Computation) and material science (Express Polymer Letters), highlighting the interdisciplinary character of his doctoral project. Furthermore, he presented his findings at 9 international conferences and organized the mini-symposium “Computational Treatment of Polymer Fracture Across the Scales” at the ECCOMAS YIC 2023. Moreover, his commitment to the interdisciplinary research training group 2423, “Fracture Across Scales - FRASCAL,” deserves recognition, in which he not only successfully graduated but also contributed by inviting external speakers and holding his own seminar.

GACM Colloquium 2025 in Braunschweig

We are pleased to announce that the 11th GACM Colloquium on Computational Mechanics for Young Scientists from Academia and Industry will be held at Technical University of Braunschweig from September 21st to 24th, 2025.

The GACM Colloquium is a biennial conference that brings together young researchers in the field of computational mechanics. It offers students and postdocs a platform to present their work, gain new insights into numerical modeling in engineering and science, and build a professional network. Recent GACM Colloquia in Kassel, Duisburg-Essen, and Vienna, attracted between 180 and 300 attendees, with very strong international participation.

Colloquium Chairpersons:
Mischa Blaszczyk, Christian Flack, Jorge Urrea, Cordula Reisch, Saddam Hijazi, and Knut Andreas Meyer.
For more information, visit: **https://colloquia.gacm.de/**

Preparations for WCCM-ECCOMAS 2026 in Munich

Following the conclusion of WCCM 2024 in Vancouver, preparations are underway for the 17th World Congress on Computational Mechanics and 10th ECCOMAS Congress in Munich. In particular, International Steering Committee, Scientific Advisory Committee, and Local Organizing Committee have been formed, and the web site and the call for minisymposia organization will be launched soon.

Renewal of the GIMC Executive Committee

The Italian Group of Computational Mechanics **(GIMC)** has renewed its Executive Committee. **Francesco Marmo** and **Michele Marino** have been elected as new members, while **Giovanni Garcea**, a member of the previous committee, has been appointed as the Committee Coordinator. ●

GIMC SIMAI YOUNG 2024
Naples, July 10-12, 2024

GIMC (Gruppo Italiano di Meccanica Computazionale) and SIMAI (Società Italiana di Matematica Applicata e Industriale) jointly organized a workshop dedicated to young scientists (aged ≤ 35). The 2024 edition of the GIMC-SIMAI Young Conference was held at the University of Naples Federico II from July 10 to 12, 2024.

The event featured a rich and engaging program, including plenary lectures by distinguished experts in Computational Mechanics and Applied Mathematics, a special session highlighting emerging talents selected by GIMC and SIMAI representatives, and multiple thematic sessions led by participants. On this occasion, GIMC awarded prizes for the best PhD theses to Alessandro della Pia and Alessandro Marengo, while SIMAI honored Simone Dovetta and Francesco Regazzoni with the SIMAI Young Researcher 2024 Awards.

The conference brought together 220 young researchers, showcasing 175 presentations across five parallel tracks and organized into 21 minisymposia.

Further details about the program and the book of abstracts can be found on the conference website: **https://sites.google.com/view/gsyw24/home-page.** ●

GIMC SEMNI workshop
Barcelona, January 30-31, 2025

The **First Joint Workshop** between **GIMC** and the **Spanish Society of Computational Mechanics and Computational Engineering (SEMNI)** will be held in Barcelona on January 30–31, 2025. This event represents an exceptional opportunity for the Spanish and Italian scientific communities to come together, exchange ideas, and engage in insightful discussions on the present and future of **Computational Engineering**. The workshop will take place at the prestigious **Barcelona School of Nautical Studies**, part of the Universitat Politècnica de Catalunya (UPC), located near the iconic and scenic Barcelona Harbour.

Further details can be found on the conference website: **https://gimc.semni.org/**

1st HICOMP Conference
1st Hellenic-Italian Conference on Computational Mechanics, Biomechanics and Mechanics of Materials
Rhodes, June 19-21, 2025

Traditionally, **GIMC** organizes its meetings in collaboration with **GMA** (Group of Mechanics of Materials) and **GBMA** (Group of Biomechanics), two prominent groups within the **Italian Association of Theoretical and Applied Mechanics (AIMETA)**.

Next year, for the first time, the joint meeting will be held in collaboration with the **Greek Association of Computational Mechanics (GRACM)**. The historic and picturesque setting of Rhodes, with its rich history and breathtaking landscapes, will offer an ideal backdrop for fostering innovative ideas and forging new professional connections.

The conference aims to serve as a unique forum for discussing interdisciplinary topics at the intersection of **Computational Mechanics, Biomechanics, and the Mechanics of Materials**. By bringing together two dynamic communities, it will provide a springboard for building meaningful interdisciplinary and cross-border partnerships in an inspiring environment.

Further details are available at the following link: **https://hicomp2025.org/**

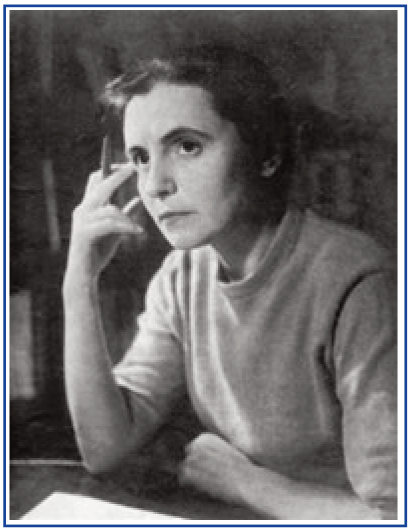
IACM Introduces the Simo-Ladyzhenskaya Award and Renames the Computational Mechanics Award in Honor of Tinsley Oden

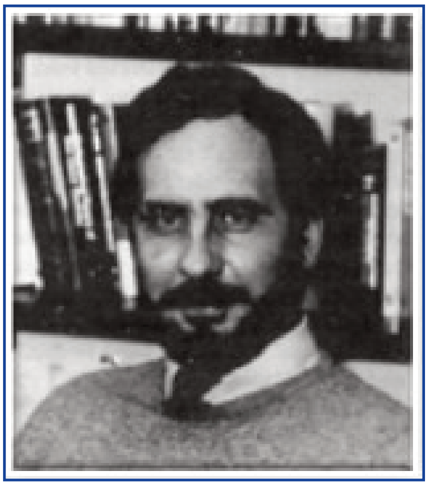
At the recent World Congress on Computational Mechanics (WCCM 2024) in Vancouver, Prof. Antonio Huerta, Past President of the IACM, introduced two significant updates to the IACM Awards: a new mid-career award and the renaming of the IACM Computational Mechanics Award.

The Simo-Ladyzhenskaya Award: Recognizing Mid-Career Excellence

To honor outstanding mid-career researchers, the IACM has established the Simo-Ladyzhenskaya Award, recognizing computational mechanicians with 12 to 20 years of experience post-PhD. This award aims to celebrate individuals who demonstrate exceptional promise and sustained excellence in computational mechanics research.

Following input from the community, the award is named in honor of Olga Ladyzhenskaya and Juan Carlos Simo - two distinguished figures in the field whose contributions have significantly shaped computational mechanics. The inaugural Simo-Ladyzhenskaya Award will be presented at WCCM-ECCOMAS 2026 in Munich.





Figures 1 & 2: *Olga Ladyzhenskaya and Juan Carlos Simo*

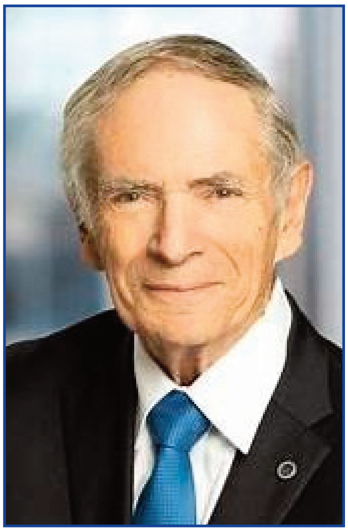


Figure 3: *Tinsley Oden*

IACM Computational Mechanics Award Named in Honor of Tinsley Oden

Beginning in 2026, the IACM Computational Mechanics Award will be renamed the IACM Oden – Computational Mechanics Award in tribute to J. Tinsley Oden.

A founding member of the IACM in 1981 and its second president after O.C. Zienkiewicz, Oden played a pivotal role in shaping the computational mechanics community. He served on the IACM Executive Council until 2022 and chaired the first-ever WCCM in Austin in 1986. His groundbreaking contributions to computational science and mechanics remain an inspiration for future generations.

With these changes, the IACM continues to recognize and honor excellence in computational mechanics, fostering a legacy that inspires both current and future researchers. ●

The International Association for Computational Mechanics (IACM) 2024 Awards

The International Association for Computational Mechanics (IACM) announced the recipients of its 2024 awards, recognizing outstanding contributions to the field of computational mechanics.

These awards honour individuals across various career stages for their significant achievements.

These distinguished awardees were formally recognized at the 16th World Congress on Computational Mechanics (WCCM XVI) and PANACM 2024, held in Vancouver, Canada, from July 21 to 26, 2024.

IACM Gauss-Newton Award (Congress Medal)

The prestigious IACM Congress Medal, also known as the Gauss-Newton Medal, is awarded to *Professor Peter Wriggers*, Leibniz University of Hannover.

This medal is the highest honor conferred by the IACM, recognizing individuals who have made significant contributions to the field of computational mechanics.

Figure 1:
Professor Peter Wriggers

IACM O.C. Zienkiewicz Award

Professor Wolfgang A. Wall, Technical University of Munich, is the recipient of the 2024 O.C. Zienkiewicz Award.

This award honors individuals who have made outstanding and innovative contributions to the field of computational engineering sciences.

Figure 2:
Professor Wolfgang A. Wall

IACM Computational Mechanics Award

The 2024 IACM Computational Mechanics Award is presented to *Professor Marc Geers*, Eindhoven University of Technology.

This award recognizes significant contributions to traditional areas such as computational structural and solid mechanics, as well as computational fluid dynamics. It was received by Ron Peerlings, on behalf of Prof. Marc Geers.

Figure 3:
Ron Peerlings, on behalf of Prof. Marc Geers

IACM John Argyris Award for Young Scientists

Dr. Emilio Martínez-Pañeda, Oxford University, is honored with the 2024 John Argyris Award for Young Scientists.

This award acknowledges outstanding accomplishments by researchers aged 40 or younger, particularly those who have published exceptional papers in the field of computational mechanics.

Figure 4:
Dr. Emilio Martínez-Pañeda

These distinguished awardees will be formally recognized at the 16th World Congress on Computational Mechanics (WCCM XVI) and PANACM 2024, scheduled to take place in Vancouver, Canada, from July 21 to 26, 2024.

The IACM's bi-annual awards program continues to celebrate and honour the exceptional contributions of its members and to the achievement of computational mechanics worldwide

IACM Fellows

The IACM Fellows Award recognizes individuals with a distinguished record of research and publication in computational mechanics, as well as demonstrated support of the IACM through membership and participation.

The 2024 Fellows are:
Marcela Andrea Cruchaga - University of Santiago de Chile
Eduardo Alberto de Souza Neto - Swansea University
Mats G. Larson - Umea University
Laura de Lorenzis - ETH Zürich
Gilles Lubineau - KAUST
Beatrice Riviere - Rice University
Yongjie Jessica Zhang - Carnegie Mellon University

(a)

(b)

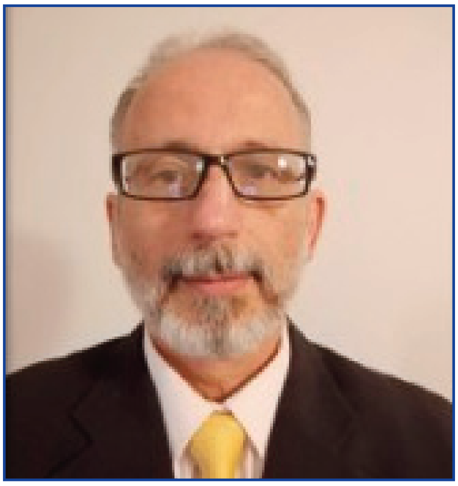


Figure a:
Marcela Andrea Cruchaga - University of Santiago de Chile

Figure b:
Eduardo Alberto de Souza Neto - Swansea University

(c)

(d)

Figure c:
Mats G. Larson - Umea University

Figure d:
Laura de Lorenzis - ETH Zürich

(e)

(f)

Figure e:
Gilles Lubineau - KAUST

Figure f:
Beatrice Riviere - Rice University

(g)

Figure g:
Yongjie Jessica Zhang - Carnegie Mellon University

conference diary planner

30 - 31 Jan 2025	**GIMC SEMNI Workshop**
	Venue: Barcelona, Spain *Contact:* https://gimc.semni.org/
17 - 21 Feb 2025	**DTE & AICOMAS 2025 - 3rd IACM Digital Twins in Engineering Conference) & 1st ECCOMAS Artificial Intelligence and Computational Methods in Applied Science**
	Venue: Paris, France *Contact:* https://dte_aicomas_2025.iacm.info/
17 - 20 March 2025	**CFC 2025 - 23rd IACM Computational Fluids Conference**
	Venue: Santiago de Chile *Contact:* https://cfc2025.iacm.info/
3 - 4 April 2025	**NSCM 2025 - 34th Nordic Seminar on Computational Mechanics**
	Venue: Göteborg, Sweden *Contact:* https://nscm2025.cimne.com/
26 - 29 May 2025	**COUPLED 2025 - XI International Conference on Coupled Problems in Science and Engineering**
	Venue: Sardinia, Italy *Contact:* https://coupled2025.cimne.com/
4 - 6 June 2025	**M2P - Math 2 Product**
	Venue: Valencia, Spain *Contact:* https://www.m2p2025.com/M2P2025/
9 - 11 June 2025	**ADMOS 2025 - XII International Conference on Adaptive Modeling and Simulation**
	Venue: Barcelona, Spain *Contact:* https://admos2025.cimne.com/
19 - 21 June 2025	**HICOMP - 1st Hellenic-Italian Conf. on Computational Mechanics, Biomechanics & Mechanics of Materials**
	Venue: Rhodes Island, Greece *Contact:* https://hicomp2025.org/
23 - 25 June 2025	**MARINE 2025 - XI International Conference on Computational Methods in Marine Engineering**
	Venue: Edinburgh, Scotland *Contact:* https://marine2025.cimne.com/
1 - 4 July 2025	**COMPSAFE2025 - 4th Computational Engineering & Science for Safety & Environmental Problems**
	Venue: Kobe, Japan *Contact:* https://www.compsafe2025.org/
1 - 4 July 2025	**CM3P - 5th Computational Methods for Multi-scale, Multi-uncertainty and Multi-physics Problems**
	Venue: Porto, Portugal *Contact:* https://cm3p.org/
20 - 24 July 2025	**18th U.S. National Congress on Computational Mechanics**
	Venue: Chicago Illinois *Contact:* usnccm18.usacm.org
2 - 5 Sept 2025	**COMPLAS 2025 - XVIII Int Conference on Computational Plasticity**
	Venue: Barcelona, Spain *Contact:* https://complas2025.cimne.com/
9 - 11 Sept 2025	**Sim-AM 2025 - The Fifth International Conference on Simulation for Additive Manufacturing**
	Venue: Pavia, Italy *Contact:* https://sim-am2025.cimne.com/
14 - 17 Sept 2025	**IGA 2025 -13th International Conference on Isogeometric Analysis**
	Venue: Eindhoven, The Netherlands *Contact:* https://iga2025.cimne.com/
8 - 10 Oct. 2025	**STRUCTURAL MEMBRANES 2025 - XII Int. Conference on Textile Composites & Inflatable Structures**
	Venue: Munich, Germany *Contact:* https://structuralmembranes2025.cimne.com/
22 - 26 Sept 2025	**HFSS 2025 - 2nd International Conference on Highly Flexible Slender Structures**
	Venue: Kaiserslautern, Germany *Contact:* https://hfss.uniri.hr/
20 - 22 Oct 2025	**PARTICLES 2025 - IX International Conference on Particle-based Methods**
	Venue: Barcelona, Spain *Contact:* https://particles2025.cimne.com/
7 - 10 Dec 2025	**9th APCOM 2025 - Asia Pacific conference on Computational Mechanics**
	Venue: Brisbane, Australia *Contact:* https://web.aeromech.usyd.edu.au/ACCM2013/AACM/
19 - 24 July 2026	**WCCM - ECCOMAS 2026 17th World Congresses on Computational Mechanics**
	Venue: Munich, Germany *Contact:* https://wccm-eccomas2026.org