

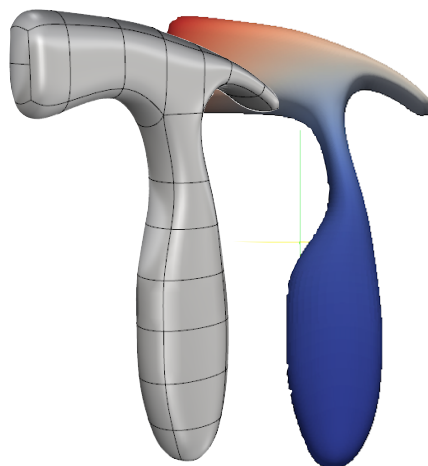
Real time cutting for surgical simulation — Hadrien Courtecuisse (ERC RealTcut), collaboration Inria
[[open access version of the paper](#); [paper @ the journal's site](#), [video](#)]

time to go back to the continent after 7 exciting years in the UK — **follow** us on <http://scholar.google.lu/citations?user=QKZBZ48AAAAJ&hl=en> —

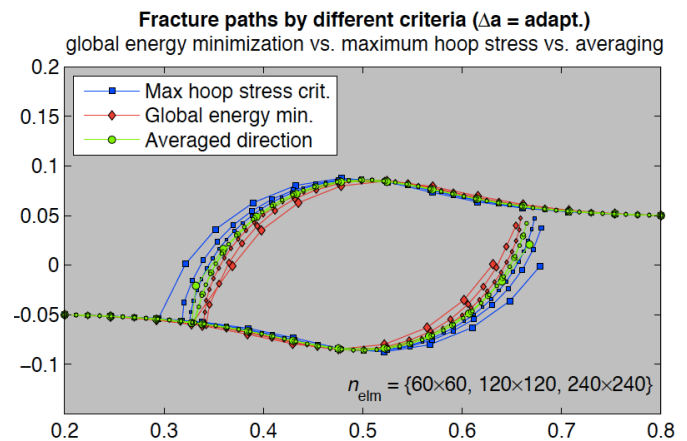
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Shape optimisation without meshing and remeshing - optimised hammer shape: IGABEM T-splines — Haojie Lian [[paper1](#), [paper2](#)]



Energy based growth criterion for multiple cracks — Danas Sutula funded by Soitec SA [[report](#)]

Glasgow-Cardiff-Luxembourg

As of November 1st 2013, I took up a professorial appointment at the University of Luxembourg. This University was created in 2003 and can therefore be considered still an infant on academic time scales. The dynamic Luxembourgish environment, at the center of Europe, its international flavor and multi-linguist culture is most invigorating.

2013 and 2014 were exciting years for Cardiff, which was ranked 1st in Civil Engineering and 5th in General Engineering at the latest [UK Research Excellence Framework, measuring the quality of UK research institutions](#).

Within our Computational Mechanics Lab, we made progress

on a number of fronts, thanks to the assiduous work of the team, in particular Pierre Kerfriden and the students and post-doctoral fellows we have been supervising together. Pierre remains in Cardiff and is taking on the leadership of the group, managing the projects and the day-to-day activities. I am delighted to remain affiliated to Cardiff and to go back to Wales regularly.

The core of this year's research was within the [ERC Starting Grant RealTcut](#), and materialized through a now strong collaboration with the INRIA project team of Stéphane Cotin, through the work of Hadrien Courtecuisse and an FNR funded

Sabbatical for Prof. Karol Miller, University of Western Australia. This work was published in *Medical Image Analysis* [[open access version of the paper](#), [paper @ the journal's site](#), [video](#)] and shows that it is possible to simulate cutting at 40 frames per second in heterogeneous non-linear organs. This was one of the major goals of RealTcut.

Still within RealTcut, Hoang Khac Chi has developed a goal-oriented sampling strategy using reduced basis approximation for linear elastodynamics problems; 2d morphing mesh problems are also under investigation [[paper1](#), [paper2](#), [paper3](#), [paper4](#), [paper5](#)].

Jack Hale joined recently funded by a Fonds National de la Recherche and Marie Curie project is investigating the reduction of the mesh burden for finite strain incompressible elasticity [paper]. He has started working with Patrick Farrell at Oxford on inverse problems based on adjoint approaches.

Within the INSIST ITN project, led by Prof. Timon Rabczuk has been most successful. In addition to the 2013 paper on 3D IGA BEM, which enable [linear elastic stress analysis without any mesh generation](#) [paper1, paper2], our contributions have been in the area of stable extended finite elements, XFEMs with smooth nodal stresses [paper1], commercial implementations of isogeometric analysis, error bounds in stochastic homogenisation [paper], gradient smoothing in hyper elasticity [paper] and damage tolerance assessment directly from CAD [paper]. We also started a fruitful collaboration with Gang Xu, which resulted in a geometry independent field approximation for IGA.

Olivier Goury defended his PhD thesis on model reduction for fracture [thesis]. Congratulations for an excellent piece of work which led to one of the first attempts of POD-based model order reduction for bridging analytical and computational homogenisation in a damage model [paper1, paper2, paper3, paper4, paper5].

Ahmad Akbari defended his PhD thesis as well in the Autumn of 2014 [paper] and devised a hybrid multiscale model and discretization-adaptive scheme for multi-scale fracture of polycrystalline materials.

Research on polygonal finite elements led by Dr. Sundararajan Natarajan progressed with developing T-complete elements for elasticity [paper1], establishing connections between the smoothed finite element method (SFEM)

and the recently proposed virtual element method [paper2]. The method was further extended to arbitrary polygons and polyhedra and combined with scaled boundary finite element to study problems with singularities. The SFEM was further extended to plates by combining it with unified formulation [paper3, paper4].

Based on the earlier work on 3D IGA BEM based on T-splines, Haojie Lian developed a fast shape optimisation algorithm which is seamlessly integrated with CAD (hammer above) and also **successfully defended his [Ph.D. Thesis]**.

Xuan Peng developed a method for damage tolerance assessment without any mesh generation in 2D and 3D [poster, paper1, internal report].

Lisa Cahill who had been working in collaboration with us since the Glasgow-times **defended successfully her PhD thesis** at the University of Limerick. She investigated crack growth in unidirectional lamina [paper].

Coarse-graining in molecular dynamics is being investigated in collaboration with Timon Rabczuk, Pascal Aubertin, and Wing Kam Liu [paper1, [OpenSource Software Permix](#)].

Mao Sheng and Xujun Zhao defended their PhD thesis at their home institution in China and Northwestern University.

Lars Beex developed, among other contributions, including joint work with eX-stream Luxembourg and the Materials Science Chair at Saarbrücken on metallic foams, a QC approach for planar beam lattices in contrast to (non-linear) spring lattices for which QC approaches are normally used [paper1].

Octavio Andrés González-Estrada continued his work on **goal-oriented error estimation for**

extended finite element approximations of linear elastic problems [paper1, paper2, paper3, paper4, paper5, paper6, paper7, paper8].

Year 2014 has been very fruitful for international collaborations, including the work in boundary element methods and Cosserat elasticity, we have been doing with Elena Atroshchenko from University of Chile, who's been visiting University of Luxembourg this December and Gang Xu from Hangzhou Dianzi University, China, who visited Cardiff University this year as well. Isogeometric boundary element methods, particularly in application to crack-growth modelling: [paper1], and the corresponding conference presentations: [paper2, paper3, paper4].

The Geometry Independent Field approximation (GIFT) approach, in the framework of both boundary and finite element methods, [paper5], enables the use of “independent” approximation spaces for the geometry and the field variables in Isogeometric Analysis [paper6, paper7, paper8]. These ideas are being employed within the framework of Cosserat fracture for which solutions were derived by Elena Atroshchenko [paper9].

We are looking forward to continuing working with our international friends and colleagues and wish you all the best for year 2015.

Happy 2015 to everybody! Let life bring you only joy.

Stéphane P.A. Bordas
and the team

Spaß

Early 2015, we are welcoming Ms. Elisa Schenone, Mr. Alexandre Bilger, and Mr. Satyendra Tomar, who are joining us as post-doctoral research fellows in model reduction and error estimation in biomechanics.

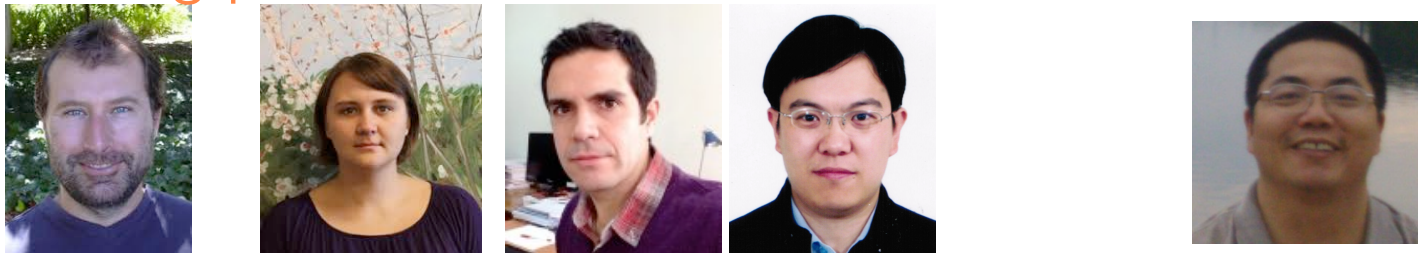
We are also thrilled to welcome three visiting professors:

- Winthrop Professor Karol Miller from University of Western Australia and Distinguished Honorary Professor at Cardiff University, under the INTERMOBILITY Scheme from the Luxembourgish National Research Fund (FNR) for his sabbatical visit;
- [Jan Zeman](#), from the Czech Technical University in Prague and his wife for a three months visit;
- [Alejandro Ortiz](#) from the University of Chile, for a few weeks;
- [Elena Atroshchenko](#) from University of Chile for a three months visit.

Luxembourg team



Visiting professors



Alumni



Partners

