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# Tomasz Koziara

**Nationality: Polish**

## Employment

*2016-present* Developer of open-source parmes.org software; Contractor at Rullion, UK.

*2012-2015* Lecturer in Computational/Theoretical Solid Mechanics, Durham University, UK.

*2009-2011* Postdoctoral Research Fellow, University of Glasgow, UK.
EDF Energy funded fellowship on development of a High Performance Computing software, SOLFEC-1.0, for application to safety assessment of graphite nuclear plant cores.

*2001-2004* Software developer, Robobat, Cracow, Poland.
Developer of Finite Element Method software products for Civil Engineering.

## Education

*2004-2008* PhD in Computational Mechanics.
Department of Civil Engineering, University of Glasgow.
Thesis: "Aspects of Computational Contact Dynamics".
The thesis received the ECCOMAS award as one of two best PhD theses of 2008 in Europe on computational methods in applied sciences and engineering.

*1997-2002* Masters degree in Computational Mechanics.
Department of Civil Engineering, Cracow University of Technology, Poland.
Thesis: "XFEM modeling of cohesive fracture in concrete".
Defended with distinction. Based on originally implemented computational software.

## Current work

I work developing and supporting open-source parmes.org software in relation to its industrial application in the civil nuclear context in the UK. This work is funded by EDF Energy via a UK agency, Rullion. It is flexible in terms of time and location and has a part-time character.

## Programming experience

I have a general interest in software development and I am open to learning new approaches and roles as practically required. Due to my background in Computational Mechanics, I worked on a variety of mesh-based algorithms, mostly in the context of the Finite Element Method (both 2D and 3D, linear and nonlinear). I worked implementing holistic solution frameworks in this context, including (non)linear dense/sparse algebra schemes, time stepping, and computational geometry. For dynamic contact simulations in SOLFEC-1.0, the geometrical aspect of such algorithms corresponded to contact detection, i.e. an efficient spatial search aimed at identifying pairs of interacting geometrical features. I implemented a variety of spatial search approaches (e.g. spatial hashing, segment-tree, kd-tree, octree, etc.) and classical computational geometry (e.g. Quickhull, GJK, etc.) and other classical algorithms and data structures (e.g. red-black trees, skip lists, memory pools, etc.). Many of these are available within the open-source SOLFEC-1.0 code (predominately written in C). I have used FORTRAN, C and C++ to implement numerical software, as well as Python, Scilab, MATLAB and some Julia, to prototype ideas across the past 20 years. I have experience of visualizing geometrical data using OpenGL (e.g. SOLFEC-1.0's viewer); using embedded Python as input interpreter; using FDH5 in conjunction with XML to output data in formats compliant with third party viewers (e.g. ParaView). I have a breadth of experience of applying MPI to achieve distributed memory parallelism (e.g. non-blocking implementations of non-linear Gauss-Seidel and Newton solvers in SOLFEC-1.0, as well as complex load balancing therein; one-sided MPI-3.0 Remote Direct Memory Access based communication in SOLFEC-2.0). I use an explicit Single Instruction Multiple Data (SIMD) programming approach (Single Program Multiple Data, SPMD), ISPC, to achieve high efficiency on modern compute cores (e.g. see PARMEC code and a prefix sort example distributed with ISPC), combined with various approaches for task-based parallelism (e.g. ISPC native, cpp-taskflow). The parmes.org portal documents some of the codes I worked on. See also: https://github.com/parmes and https://github.com/tkoziara. (Some experience with development of websites using Wordpress, or GitHub pages and Sphinx, Python, HTML, and JavaScrip can also be noted).

### Research and development

I have been developing High Performance Computing (HPC) codes in the areas of multi-body and discrete element analysis. This includes development of various aspects of discretization and implicit time-stepping methods for multi-body frictional contact/impact problems, e.g. [1], [2] and [3]. I developed SOLFEC-1.0, a general implicit multi-body contact/impact simulation software [4], which provides context for current employment. Recent work on SOLFEC-2.0, a technological successor in this context, involves upgrades of modeling technology (e.g. contact resolution approach) and programming approaches (modern C++, MPI-3.0, SPMD/SIMD, tasks) in alignment with the evolution of the state of the art in the respective areas. See also: https://researchgate.net/profile/Tomasz_Koziara.

### Academic experience

While at Durham I taught: Year 2 Static Systems: matrix methods for statics of 2d trusses and frames (a lecture course for 150+ students); Year 3 Civil Design: basics of concrete and steel design according to Eurocodes (a lecture course for 20-30 students of civil engineering); Year 4 Contact and Friction: basics of classical contact mechanics and aspects of numerical contact analysis (a lecture course for 75-100 students; developed from scratch); Supervised 4 to 7 final year students annually; Supervised one PhD student; Co-supervised one PhD student; Developed a year 2 experimental laboratory to accompany the Static Systems course; Supported other teaching activities: Year 1 CAD (basics of SolidWorks), Year 3 Civil CAD (basics of AutoCAD), Year 4 ABAQUS course (basics of nonlinear finite element analysis); Wrote and submitted two research proposals in collaboration with academics and industrial partners; Acted as a reviewer in International Journal for Numerical Methods in Engineering, Computer Methods in Applied Mechanics in Engineering; Presented at about 15 international conferences.

### Invitations

I was invited to give a lecture on the HPC implementation of SOLFEC during a summer school on Nonsmooth Contact Mechanics (Aussois, France, Sep 2012, organized by Prof. Brogliato, INRIA, Grenloble); A visiting researcher at INRIA in Grenoble, France, summer 2011.

### Awards

Zienkiewicz Prize for the best PhD thesis in 2008 in Computational Mechanics, awarded by the Association of Computational Mechanics in Engineering (ACME) in the UK; ECCOMAS award for one of two best PhD theses of 2008 in Europe on computational methods in applied sciences and engineering.

### Note

Download this CV at https://parmes.org/_downloads/Tomasz-Koziara-CV.pdf in order to use active hyperlinks.

### Selected publications

*[1]* T. Koziara, N. Bićanić. Semismooth Newton method for frictional contact between pseudo-rigid bodies. *Computer Methods in Applied Mechanics and Engineering* **2008**, *197*, 2763–2777.

*[2]* T. Koziara, N. Bićanić. Simple and efficient integration of rigid rotations suitable for constraint solvers. *Journal for Numerical Methods in Engineering* **2009**, *81*, 1073 – 1092.

*[3]* T. Koziara, S. Brasier, L. Kaczmarczyk. Co-rotated and reduced order finite element time integrators for multibody contact dynamics. *PARMES technical report TR1* **2017**.

*[4]* T. Koziara, N. Bićanić. A distributed memory parallel multibody Contact Dynamics code. *International Journal for Numerical Methods in Engineering* **2011**, *87*, 437–456.