Jason K. Furtney – ITASCA Minneapolis

Chief Technical Officer & Principal Engineer

Expertise	Numerical modeling of mechanical behavior, fluid flow, and heat transfer in Earth materials
Education	Ph.D. (Applied Fluid Mechanics), 2006 BP Institute, University of Cambridge, England B.S. (Geology with Honors), 2002 Edinburgh University, Scotland
Professional Affiliations	Member: Society for Industrial and Applied Mathematics
Awards	2021 Tekne Award: Innovation in Artificial Intelligence and Machine Learning Advances Safety and Efficiency in Wind Energy Construction
Keynote Lectures	Slope Stability 2022, Tucson, Arizona, USA

Professional Experience

	ITASCA Minneapolis
2023 – Present	Chief Technical Officer / Principal Engineer
2018 – 2023	Chief Technical Officer / Senior Engineer
2013 – 2018	Senior Engineer / Software Developer
2006 – 2013	Project Engineer / Software Developer
1998 – 2006	University of Cambridge, England Teaching Assistant (2002 – 2006) Web Design and Maintenance (1998 – 2006)
2001	BP Aberdeen, Scotland Student Internship

Project Experience

Numerical Modeling of Rock Blasting: Starting in 2006, developed the *Blo-Up* software for the Hybrid Stress Blast Model (HSBM) project. *Blo-Up* uses a unique combination of continuous and discontinuous numerical methods to model the complete rock blasting process. The software and experience gained has been used to study: 1) fragmentation optimization; 2) mine-scale, blast-induced vibrations; 3) ore movement; 4) high wall damage; and 5) rapid tunneling and other topics. Took over management of this project in 2011.

Enhanced Geothermal Reservoirs: Developed 2D and 3D fully coupled thermo-hydro-mechanical numerical models to study the feasibility and production of enhanced geothermal systems (EGS) for the US Department of Energy (DoE). The Python programming environment in ITASCA software allowed us to combine existing ITASCA solver technology with faster implicit solution methods. The analysis gives valuable insights into reservoir stimulation techniques, well placement, and expected resource lifetime. Participated in the DoE geothermal code comparison study.

Solution Mining and In-situ Mining: Developed mathematical and numerical models to predict cavern shape, mechanical deformation and production in solution mines. The modeling combines aspects of computational geometry, geochemistry, fluid-flow, and heat transfer. Devised a novel use of implicit surface representation and the level-set method to track complex cavern shape change, including topology change. The model has been applied to several deposits, including commercial salts and in-situ metal leaching.

Dynamic Down-hole Permeability Enhancement: Used *PFC2D* and *PFC3D* to model the growth of radial fractures around a wellbore due to a rapid pressurization. The objective of the analysis was to predict the extent and number of radial fractures created by a variety of pressure pulse generation technologies. The analysis combines a model of compressible fluid mechanics with a model for dynamic fracture growth.

Modeling Ground Support in Highly Fractured Rock: Contributed to the development of the *3DEC*-based Bonded Block Model (BBM) and associated hybrid-bolt ground support model. The model is used to give insight into ground support design in the extraction level of large cave mines. Developed a fast ground support material property calibration tool based on an implicit formulation of the hybrid bolt.

Geomechanics Consulting: Used ITASCA software to give design recommendations and insights into the mechanical behavior of rock in the engineered environment to a variety of customers in the mining, civil, and energy industries. Field work has included core logging, site investigations, and mapping in the United States, United Kingdom, Botswana, Cyprus, and Spain.

Machine Learning: Developed a workflow to predict intact rock strength using random forests trained with a combination of point load test (PLT) data and comprehensive borehole logs. This workflow is used to predict rock mass strength variation at large cave mines where full coverage with PLT tests would be cost prohibitive. Developed a methodology to train machine learning based surrogate models using synthetic data generated by numerical models. ITASCA was awarded the 2021 Tekne award for the application of these surrogate models to construction crane bearing capacity analysis.

Software Development Experience

Commercial Software: Contributed development, maintenance, and documentation to all ITASCA commercial geomechanics software. Provided software training. Broad experience with the internals of ITASCA software, including solvers, visualization, graphical interface, security, and scripting.

Research Software: Development and maintenance of ITASCA lattice software: *Blo-Up*, *Slope Model*, and *XSite*. The lattice products are fast, application-specific discrete element models. These codes each use a different custom discrete element formulation and have application-specific user interfaces.

Parallel Programming: Experience with both the shared memory and distributed memory paradigms of parallel computing. Devised shared memory parallelism schemes for *Blo-Up*. Contributed to the Message Passing Interface (MPI) version of *XSite*.

Web Applications: Experience developing engineering web applications that allow customers to easily upload engineering analysis inputs, trigger cloud-based computation, and visualize the results. Experience with Python/Flask, deployment on Amazon Web Services, and running ITASCA software in the cloud.

Cloud Computing: Development and promotion of cloud computing within ITASCA. Development of a web portal for managing cloud virtual machines and storage. Development of an internet-based network licensing scheme

for ITASCA commercial software. Cloud computing allows ITASCA to use an unlimited number of high-end computers without upfront capital cost, to scale up and down usage as needed, and to transparently pass the expense of computation to customers.

Python Integration for ITASCA Software: Embedded the Python programming language and a collection of Python-based scientific programming tools into ITASCA software. This development has made ITASCA software more capable and more easily integrated with third-party software. Many scripting tasks that are time consuming with *FISH* can be done much faster with NumPy array expressions.

Fluid-Particle Interaction: Developed a variety of numerical techniques to study fluid-particle interaction problems in discrete element models. Published a review paper and collaborated with academic researchers on this topic. Maintained the *PFC3D* CFD module and the community supported *PFC3D* OpenFOAM coupling capability.