

## RESEARCH EXPERIENCE

**Senior Member of the Technical Staff**, Sandia National Laboratories, California, USA **2015-present**

- Developer of the Dakota toolkit, a framework for optimization and uncertainty quantification
- Applying Bayesian inversion for modeling mechanical responses of specimen with material variability due to additive manufacturing
- Coupled data assimilation with shallow-water equation to predict near-shore wave heights for energy harvesting
- Developed uncertainty propagation schemes for networks of interconnected models
- Developed statistical classification techniques for arms-control treaty-accountable items
- Applied time-series modeling and sequential data assimilation for prediction of physical processes
- Performed chemical mechanism reduction for advanced spark ignition engines

**Adjunct Research Professor**, Civil & Env. Engineering, Carleton University, Canada **2018-present**

- Co-advising 3 PhD students + 2 Master students at Carleton university, Canada
- Collaborating with academics at Carleton University, Royal Military College of Canada, and US Naval Academy

**Postdoctoral Research Associate**, Sandia National Laboratories, California, USA **2013-2015**

- Tackled large-scale stochastic inverse problems in reaction kinetics using Bayesian inference
- Propagated parametric uncertainty through Large-Eddy Simulations of turbulent flow
- Applied global sensitivity analysis and uncertainty quantification in nonlinear stochastic systems
- Developed probabilistic algorithms for inference of missing data from indirect summary statistics

**Research Intern**, Canadian Department of National Defence, Canada **2009-2011**

- Developed a probabilistic method for predicting the onset of dynamic instabilities for military aircraft from subcritical measurement data
- Used Bayesian inference and Markov Chain Monte Carlo sampling for parameter estimation
- Conducted a blind validation test of the proposed method using supplemental experimental data

**Research Assistant**, Mechanical & Aero. Engineering, Royal Military College, Canada **2007-2011**

- Modeled nonlinear aerodynamic loads on an airfoil mounted in a wind-tunnel
- Compared and contrasted Bayesian filtering techniques for joint state and parameter estimation
- Designed and implemented a parallel probabilistic estimation algorithm and executed it on high performance computing systems
- Examined applicability of model selection techniques for strongly nonlinear dynamical systems

**Research Assistant**, Civil & Env. Engineering, Carleton University, Canada **2004-2010**

- Assessed the performance of parallel algorithms for numerical simulations of stochastic engineering systems governed by stochastic partial differential equations
- Monte Carlo sampling and polynomial chaos expansion for uncertainty quantification techniques
- Principal Component Analysis and Independent Component Analysis for dimension-reduction

## EDUCATION

- **Doctor of Philosophy**, Civil Engineering, Carleton University, Canada **2013**
- **Master of Applied Science**, Civil Engineering, Carleton University, Canada **2006**
- **Bachelor of Engineering**, Computer and Electrical Engineering, McGill University, Canada **2004**
- **Bachelor of Science**, Microbiology and Immunology, McGill University, Canada **2000**

## TEACHING EXPERIENCE

**Primary Course Instructor, Civil & Env. Engineering, Carleton University, Canada** **2007**

- Undergraduate course “Numerical Methods” for Engineering students (enrolment of 73)
- Topics covered include: the solution of systems of linear equations, including direct and iterative techniques, roots of equations, numerical interpolation, differentiation and integration, finite-difference solutions to ordinary differential equations, and error and convergence analysis
- Laboratory component taught students MATLAB for implementation and application of the methods

**Primary Course Instructor, Civil & Env., Carleton University, Canada** **2011, 2012**

- Undergraduate course “Mechanics of Solids II” in Civil Engineering (enrolments of 104, 114)
- Topics covered include: Shear flow, definition of shear centre, Saint-Venant and warping torsional constants, governing differential equations for torsion, beam-columns, lateral torsional buckling of doubly symmetric beams, axially loaded doubly symmetric, singly symmetric and asymmetric columns, and failure criterion
- Laboratory component focused on evaluating and reporting the characteristics of mechanical systems

## PROFESSIONAL ACTIVITIES

- Reviewer, Measurement.
- Reviewer, AIAA Journal.
- Reviewer, International Journal for Uncertainty Quantification.
- Reviewer, Computer Methods in Applied Mechanics and Engineering.
- Reviewer, Proceedings of the Combustion Institute.
- Reviewer, Numerical Algorithms.
- Reviewer, Digital Signal Processing.
- Reviewer, Combustion and Flame.
- Reviewer, ASME Journal of Verification, Validation and Uncertainty Quantification.
- Reviewer, Entropy.
- Reviewer, SIAM Journal on Scientific Computing.
- Reviewer, International Journal for Numerical Methods in Engineering.
- Reviewer, Journal of Computational Physics.
- Reviewer, Computational Materials Science.
- Reviewer, Artificial Intelligence for Engineering Design, Analysis and Manufacturing.
- Reviewer, Mechanical Systems and Signal Processing.
- Reviewer, Journal of Applied Statistics.
- Reviewer, Proceedings of the Royal Society A.
- Reviewer, Journal of Sound and Vibration.
- Reviewer, Energy Conversion and Management.
- Reviewer, SIAM/ASA Journal on Uncertainty Quantification.
- Reviewer, Probabilistic Engineering Mechanics.
- Reviewer, Applied Mathematical Modelling.
- Reviewer, Journal of Vibration and Control.

## TECHNICAL SKILLS

- Parallel programming: Message Passing Interface and OpenMP
- Programming Languages: Fortran, MATLAB/Octave, C++, Python, Assembly
- Finite Element Method: Gmsh (mesh generation) and Paraview (data visualization)
- Optimization and Uncertainty Quantification: Dakota and UQtk

## RESEARCH CONTRIBUTIONS

Full list can be found on my [Google Scholar](#) profile

### Refereed journal papers:

1. F. Rizzi, M. Khalil, R. Jones, J. Templeton, J. Ostien, and B. Boyce. "Bayesian Modeling of Inconsistent Plastic Response due to Material Variability". *Computer Methods in Applied Mechanics and Engineering*. Under Review.
2. M. Khalil, and H. N. Najm. "Probabilistic inference of reaction rate parameters from summary statistics". *Combustion Theory and Modeling*. 22 (2018), pp. 635-665.
3. A. Desai, M. Khalil, C. Pettit, D. Poirel, and A. Sarkar. "Scalable domain decomposition solvers for stochastic PDEs in high performance computing". *Computer Methods in Applied Mechanics and Engineering*. 335 (2018), pp. 194-222.
4. L. Hakim, G. Lacaze, M. Khalil, K. Sargsyan, H. Najm, and J. Oefelein. "Probabilistic parameter estimation in a 2-step chemical kinetics model for n-dodecane jet autoignition". *Combustion Theory and Modeling*. 22 (2018), pp. 446-466.
5. R. Sandhu, C. Pettit, M. Khalil, D. Poirel, and A. Sarkar. "Bayesian model selection using automatic relevance determination for nonlinear dynamical systems". *Computer Methods in Applied Mechanics and Engineering*. 320 (2017), pp. 237-260.
6. R. M. Galassi, M. Valorani, H. N. Najm, C. Safta, M. Khalil, and P. P. Ciottoli. "Chemical model reduction under uncertainty". *Combustion and Flame*. 179 (2017), pp. 242-252.
7. M. Khalil, K. Chowdhary, C. Safta, K. Sargsyan, and H. N. Najm. "Inference of reaction rate parameters based on summary statistics from experiments". *Proceedings of the Combustion Institute*. 36 (2017), pp. 699-708.
8. L. Hakim, G. Lacaze, M. Khalil, H. Najm, and J. Oefelein. "Modeling auto-ignition transients in reacting Diesel jets". *Journal of Engineering for Gas Turbines and Power*. 138 (2016), pp. 112806-112806-8.
9. M. Khalil, D. Poirel, and A. Sarkar. "Bayesian analysis of The flutter margin method in aeroelasticity". *Journal of Sound and Vibration*. 384 (2016), pp. 56-74.
10. R. Sandhu, D. Poirel, C. Pettit, M. Khalil, and A. Sarkar. "Bayesian inference of nonlinear unsteady aerodynamics from aeroelastic limit cycle oscillations". *Journal of Computational Physics*. 316 (2016), pp. 534-557.
11. M. Khalil, G. Lacaze, J. C. Oefelein and H. N. Najm. "Uncertainty quantification in LES of a turbulent bluff-body stabilized flame". *Proceedings of the Combustion Institute*. 35[2] (2015), pp. 1147-1156.
12. P. Bisailon, R. Sandhu, M. Khalil, C. Pettit, D. Poirel, and A. Sarkar. "Bayesian parameter estimation and model selection for strongly nonlinear dynamical systems". *Journal of Nonlinear Dynamics*. 82 (2015), pp. 1061-1080.
13. M. Khalil, A. Sarkar, S. Adhikari, and D. Poirel. "The estimation of time-invariant parameters of noisy nonlinear oscillatory systems". *Journal of Sound and Vibration*. 344 (2015), pp. 81-100.
14. R. Sandhu, M. Khalil, A. Sarkar, and D. Poirel. "Bayesian model selection for nonlinear aeroelastic systems using wind-tunnel data". *Computer Methods in Applied Mechanics and Engineering*. 282[1] (2014), pp. 161-183.
15. M. Khalil, and A. Sarkar. "Independent component analysis to enhance performances of Karhunen-Loeve expansions for non-Gaussian stochastic processes: application to uncertain systems". *Journal of Sound and Vibration*. 333[21] (2014), pp. 5600-5613.
16. M. Khalil, D. Poirel, and A. Sarkar. "Probabilistic parameter estimation of a fluttering aeroelastic system in the transitional Reynolds number regime". *Journal of Sound and Vibration*. 332[15] (2013), pp. 3670-3691.
17. M. Khalil, A. Sarkar, and S. Adhikari. "Tracking noisy limit cycle oscillations with nonlinear filters". *Journal of Sound and Vibration*. 329[2] (2010), pp. 150-170.

18. M. Khalil, and A. Sarkar, and S. Adhikari. "Nonlinear filters for chaotic oscillatory systems". *Journal of Nonlinear Dynamics*. 55[1-2] (2009), pp. 113-137.
19. M. Khalil, S. Adhikari, and A. Sarkar. "Linear system identification using proper orthogonal decomposition". *Mechanical Systems and Signal Processing*. 21[8] (2007), pp. 3123-3145.

**Selected conference contributions:**

1. A. Desai, M. Khalil, C. Pettit, D. Poirel, and A. Sarkar. "Domain Decomposition of Stochastic PDEs - New Developments", 25th International Domain Decomposition Conference, St. John's, Newfoundland, Canada, July 2018.
2. M. Khalil, F. Rizzi, A. L. Frankel, C. Alleman, J. Templeton, J. Ostien, B. Boyce, and R. E. Jones. "Embedded Model Error and Bayesian Model Selection for Material Variability", SIAM Conference on Uncertainty Quantification, Orange Grove, California, April 2018.
3. M. Khalil. "Data-Driven Bayesian Model Selection: Parameter Space Dimension Reduction using Automatic Relevance Determination Priors". Seminar Series, The Institute for Computational Engineering & Sciences at UT Austin. Austin, Texas, USA. January 2018.
4. H. Najm, T. Casey, and M. Khalil. "Parameter Estimation in Chemical Systems". Uncertainty Quantification, Parameter Identification, and Challenges in Engineering Computations. Budapest, Hungary. July 2017.
5. H. Najm, K. Sargsyan, X. Huan, M. Khalil, L. Hakim, J. Oefelein, G. Lacaze, and Z. P. Vane. "Bayesian Estimation of Model Error in Physical Systems". International Conference on Uncertainty Quantification in Computational Fluid Dynamics. Shanghai, China. July 2017.
6. M. Khalil, J. Lee, and M. Salloum. "Predictive Modeling of Wavelet Coefficients for Physical Processes". US National Congress on Computational Mechanics. Montreal, Canada. July 2017.
7. B. Robinson, L. J. Rocha da Costa, D. Poirel, C. Pettit, M. Khalil, and A. Sarkar. "Large amplitude aeroelastic oscillations of a cantilever with structural and aerodynamic nonlinearities: Theory and wind tunnel test". US National Congress on Computational Mechanics. Montreal, Canada. July 2017.
8. A. Desai, P. Bisailon, M. Khalil, C. Pettit, D. Poirel, and A. Sarkar. "Large amplitude aeroelastic oscillations of a cantilever with structural and aerodynamic nonlinearities: Theory and wind tunnel test". US National Congress on Computational Mechanics. Montreal, Canada. July 2017.
9. P. Bisailon, R. Sandhu, M. Khalil, C. Pettit, D. Poirel, and A. Sarkar. "Colored Process Noise in Nonlinear Aeroelastic Systems". US National Congress on Computational Mechanics. Montreal, Canada. July 2017.
10. R. Sandhu, Chris Pettit, M. Khalil, A. Sarkar, and D. Poirel. "Bayesian Model Selection in Continuous Model Domain Using Automatic Relevance Determination with Applications to Nonlinear Aeroelasticity". US National Congress on Computational Mechanics. Montreal, Canada. July 2017.
11. A. Sarkar, R. Sandhu, L. J. Rocha da Costa, B. Robinson, A. Matachniouk, S. Chajjid, P. Bisailon, A. Desai, M. Khalil, C. Pettit, and D. Poirel. "An integrated approach for fluid-structure interaction: uncertainty quantification, Bayesian inference, scalable algorithms for high performance computing, and wind tunnel testing". US National Congress on Computational Mechanics. Montreal, Canada. July 2017.
12. H. Najm, T. Casey, and M. Khalil. "Statistical Inference given Summary Statistics in Chemical Models". Computational Inverse Problems Workshop. Creswick, Australia. June 2017.
13. Khalil, M. "Data-Driven Bayesian Model Selection: Parameter Space Dimension Reduction using Automatic Relevance Determination Priors", USACM Workshop on Uncertainty Quantification and Data-Driven Modeling, Austin, Texas, March 2017.
14. Khalil, M., Brubaker, E. M., Hilton, N. R., Kupinski, M. A., MacGahan, C. J., and Marleau, P. A. "Null Hypothesis Testing Using Distance Metrics for Verification of Arms-Control Treaties", IEEE Nuclear Science Symposium and Medical Imaging Conference, Strasbourg, France, November 2016.
15. Khalil, M., and Najm, H. N. "Probabilistic inference of reaction rate parameters based on summary statistics", 15th International Conference on Numerical Combustion, Avignon, France, April 2015.

16. Khalil, M., Lacaze, G., Oefelein, J. C., and Najm, H. N. "Uncertainty Quantification in LES of a Turbulent Bluff-body Stabilized Flame", 35th International Symposium on Combustion, San Francisco, California, USA, August 2014.
17. Khalil, M., Subber, W., and Sarkar, A. "Data Assimilation for Large-Scale Computational Models", in Proceedings of the 54th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Boston, Massachusetts, USA, April 2013.
18. Khalil, M., Poirel, D., and Sarkar, A. "Application of Bayesian inference to the flutter margin method", International Forum on Aeroelasticity and Structural Dynamics 2011, Paris, France, June 2011.
19. Khalil, M., Poirel, D., and Sarkar, A. "Probabilistic parameter estimation of nonlinear systems: theory and experiment", Engineering Mechanics Institute Conference, Boston, Massachusetts, USA, June 2011.
20. Khalil, M., and Sarkar, A. "Karhunen-Loeve expansion versus independent component analysis for non-Gaussian stochastic processes: application to uncertain systems". 10th US National Congress on Computational Mechanics (USNCCM10), Columbus, Ohio, USA, July 2009.
21. Khalil, M., Poirel, D., and Sarkar, A. "Data assimilation in stochastic differential equations: applications to aeroelasticity and contaminant tracking", 6th Montreal Scientific Computing Days, Montreal, Canada, May 2009.
22. Khalil, M., and Sarkar, A. "Ensemble Kalman and particle filter for noise-driven oscillatory systems", 48th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics & Materials Conference, Schaumburg, Illinois, USA, April 2008.
23. Khalil, M., Sarkar, A., and Adhikari, S. "Data assimilation in structural dynamics: extended-, ensemble Kalman and particle filters", 1st International Conference on Uncertainty in Structural Dynamics, Sheffield, UK, June 2007.
24. Khalil, M., Adhikari, S., and Sarkar, A. "Identification of damping using proper orthogonal decomposition", 8th International Conference on Computational Structures Technology, Las Palmas de Gran Canaria, Spain, September 2006.