John Thornton

Email: jthornton232@gmail.com | Mobile: +16145723527
LinkedIn: linkedin.com/in/thornton254
Scholar: scholar.google.com/citations?user=B_IPU-i253EC
GitLab: gitlab.com/jthornton232

Summary

I am a materials scientist/research software engineer with over **6 years of experience** in modeling heat and mass transfer during atmospheric entry. I have experience developing finite volume solvers (**C++**, **python**), uncertainty quantification software (**perl**), and a code for coupling CFD with heatshield response simulations (**python**).

Technical Skills

Programming	:	Python, C++, Perl, Shell, Matlab
CFD	:	OpenFOAM, ANSYS Fluent, Star-CCM+
Libraries	:	PyQt, OpenMP, OpenACC, FFTW, Dakota
Dev Tools	:	Visual Studio Code, Git, Github, Gitlab

Experience

NASA Ames Research Center — Mountain View, CA
Materials Scientist/Research Software Engineer – Analytical Mechanics Associates, Inc. — *Oct 2020 – Present*
Research Scientist – Science & Technology Corp. — *Apr 2018 – Sep 2020*

- Developer of PATO, a **C++** software coupled with **OpenFOAM** capable of computing the material response of an ablating heatshield at the macro-scale using finite volume methods.
- Developer of PuMA, an open source software written in **C++** for analyzing porous materials used in spacecraft heatshields, obtaining their material properties, and performing micro-scale oxidation simulations to emulate atmospheric entry. PuMA was named NASA's **Software of the Year** in 2022, an award given to a single code each year developed within NASA.
- Presented at conferences, workshops, and other events to audiences from a wide variety of backgrounds including scientists, software developers, publicists, new interns, and tour groups.
- Managed interns over the summer following their work closely. Gave guidance when needed but gave them space to focus on aspects of the projects that interested them.

NASA Ames Research Center — Mountain View, CA
Research Intern — *Jun 2017 – Apr 2018*

Uncertainty Quantification Lab — Stanford University
Graduate Research Assistant — *Jan 2017 – Jun 2017*

Integrated Material Systems Lab — Ohio State University
Undergraduate Research Assistant — *Jan 2014 – Sep 2016*

Battelle Memorial Institute — Columbus, OH
Mechanical Engineering Intern — *Jun 2015 – Oct 2015*

Education

Stanford University | Stanford, CA — GPA: 3.62
Master of Science in Mechanical Engineering — *Sep 2016 – Apr 2018*

Ohio State University | Columbus, OH — GPA: 3.90
Bachelor of Science in Mechanical Engineering — *Sep 2011 – May 2016*

Awards

NASA Software of the Year — *July 2022*

Graduation with Honors Research Distinction (Ohio State) — *May 2016*

PROJECTS

Atmospheric Entry Analysis for Uranus Orbiter and Probe

- Worked with a small team to create a proposal for exploration of Uranus
- Performed heatshield response simulations and proposed a heatshield design
- Uranus Orbiter and Probe was selected as NASA's **highest priority mission** in the Planetary Decadal Survey

Coupling CFD and Heatshield Response Simulations

- Developed a tool in **python** for coupling heatshield response simulations with **CFD** and radiative heating computations
- The coupling involves using blowing gases computed in the heatshield response simulations in a blowing boundary condition in CFD
- The coupling tool was first tested on a 2D sphere case before being used in 3D with the MSL and Mars2020 heatshields

Uncertainty Quantification for Atmospheric Entry

- Developed a code in **perl** for performing **monte carlo** based **uncertainty quantification** with heatshield response simulations
- The code provided confidence intervals for success based on material temperature limits
- Used this code to perform risk assessments for commercial flight tests for the Boeing Starliner CST-100

Mars Science Lab Heatshield Response Simulations

- Performed material response simulations with the geometry and material properties of the MSL heatshield
- Computed Mars aerothermal environment with **CFD**
- Results compared to measured temperature data from Mars entry

Sensitivity Analysis of Parameters in Mars Entry

- Performed sensitivity analysis using **Dakota** to assess impact of material properties on temperature during entry

Inverse Analysis of Mars Atmosphere

- Performed inverse analysis using **Bayesian calibration** to compute heating rate estimates during entry
- The calibration minimized error between measured temperatures from NASA missions and computed temperatures from PATO
- Bayesian calibration was done in **Dakota**

Development of Thermal Conductivity Solvers for Porous Media

- Developed two conductivity solvers in **C++** for PuMA software
- Conductivity computed on voxel grid based on 3D micro-CT images of porous material
- The first solver uses an implicit **finite volume** method while the second uses an explicit jump method utilizing **discrete fourier transforms** for increased performance
- Solvers were parallelized using **OpenMP**

Porting and Optimization of PuMA for GPU

- Added support for GPUs to thermal conductivity module using **OpenACC**
- Achieved a **25x speedup** compared to a single processor

Development of Carbon Fiber Dynamics Simulator

- Created a module in **C++** simulating the manufacturing process to obtain a realistic woven material
- Each fiber is treated as a set of pinned elastic rods with tensile force applied until steady state is reached
- The initial geometry is obtained from the open source library, TexGen

Development of Plugin for Dragonfly Software

- Created a plugin for Dragonfly, an advanced image visualization and processing software, using their built-in **python** framework.
- Created a wrapper for PuMA's C++ material property solvers allowing them to be imported and called in **python**
- Created a GUI for the plugin using **PyQt**

Analysis of Permeability in Oxidizing Heatshields

- Performed oxidation simulations for carbon composite materials
- Calculated permeability at multiple stages of oxidation using GeoDict stokes flow solver
- Created a model relating permeability to porosity in oxidizing fibrous carbon based on results and similar models found in literature

Publications

Journal Articles

1. P. Rostkowski, J. B. Meurisse, **J. M. Thornton**, R. C. Smith, and M. Panesi, "Effects of problem complexity reduction on parameter sensitivity and classification in charring ablator scenarios," *Aerospace Science and Technology*, vol. 124, p. 107522, 2022
2. J. C. Ferguson, F. Semeraro, **J. M. Thornton**, F. Panerai, A. Borner, and N. N. Mansour, "Update 3.0 to "puma: The porous microstructure analysis software",(pii: S2352711018300281)," *SoftwareX*, vol. 15, p. 100775, 2021
3. R. G. Northcutt, **J. M. Thornton**, and V. B. Sundaresan, "An investigation of morphology dependent charge storage in polypyrrole membranes," in *Smart Materials, Adaptive Structures and Intelligent Systems*, vol. 46155. American Society of Mechanical Engineers, 2014, p. V002T06A001

Conference Proceedings

1. **J. M. Thornton**, D. K. Prabhu, J. B. Meurisse, A. Borner, J. D. Monk, and B. A. Cruden, "Coupling heatshield response and aerothermal environment for mars entry via surface gas blowing," in *AIAA SCITECH 2023 Forum*, 2023, p. 0963
2. F. Semeraro, J. C. Ferguson, **J. M. Thornton**, F. Panerai, A. Borner, N. N. Mansour, J. B. Meurisse, and S. Fraile Izquierdo, "Porous microstructure analysis (puma) software," in *AIAA SCITECH 2023 Forum*, 2023, p. 1536
3. J. B. Meurisse, G. Bellas Chatzigeorgis, D. K. Prabhu, A. Borner, **J. M. Thornton**, B. A. Cruden, N. N. Mansour, J. D. Monk, and B. K. Bessire, "3d ablation modeling of silicone-coated heatshield compared to medli2 in-flight data," in *AIAA SCITECH 2023 Forum*, 2023, p. 2720
4. J. Monk, D. Prabhu, G. Allen Jr, **J. Thornton**, H. Hwang, A. Pensado, and S. Dutta, "Uranus atmospheric entry probe thermal protection design study," in *IPPW 2022*, 2022
5. **J. M. Thornton**, J. B. Meurisse, D. K. Prabhu, A. P. Borner, J. D. Monk, N. N. Mansour, and B. A. Cruden, "Analysis of the msl/medli entry data with coupled cfd and material response," in *18th International Planetary Probe Workshop*, 2021
6. **J. M. Thornton**, J. B. Meurisse, and N. N. Mansour, "Determination of aerothermal environment and ablator material response using inverse methods," in *Ablation Workshop*, no. ARC-E-DAA-TN73346, 2019
7. S. J. Visser, R. J. King, **J. M. Thornton**, J. M. Brock, and N. N. Mansour, "Micro-scale artificial weave generation capabilities for thermal protection system material modeling," in *Ablation Workshop*, no. ARC-E-DAA-TN73345, 2019
8. **J. M. Thornton**, F. Semeraro, S. J. Visser, A. Borner, J. C. Ferguson, F. Panerai, and N. N. Mansour, "Microscale analysis of spacecraft heat shields," in *International Conference for High Performance Computing, Networking, Storage, and Analysis*, no. ARC-E-DAA-TN77266, 2019
9. **J. M. Thornton**, J. C. Ferguson, F. Semeraro, F. Panerai, A. Borner, and N. N. Mansour, "The porous microstructure analysis (puma) software for high-temperature microscale modeling," in *Annual InterPore Meeting*, no. ARC-E-DAA-TN68690, 2019
10. J. C. Ferguson, F. Panerai, F. Semeraro, A. Borner, **J. Thornton**, R. King, P. Diaz-Hyland, K. Swaminathan-Gopalan, and N. N. Mansour, "Recent developments to the porous microstructure analysis (puma) software," in *Ablation Workshop*, no. ARC-E-DAA-TN61349, 2018
11. **J. M. Thornton**, F. Panerai, J. C. Ferguson, A. Borner, and N. N. Mansour, "Modeling the relationship between porosity and permeability during oxidation of ablative materials," in *Ablation Workshop*, no. ARC-E-DAA-TN46701, 2017