NOBLEGASSYSTEMS.COM

Complex Modeling of Pressure Vessel Performance

Two Sentence Elevator Pitch:
Noble Gas Systems designs unique conformable pressure vessels for a variety of uses. The students on the Noble Gas Systems project team will create a multi-physics model of one of their pressure vessels to predict burst failure, validate it with physical testing, as well as documenting insights and general heuristics to support design decisions in all vessels.

Abstract:
Noble Gas Systems designs conformable pressure vessels for a variety of uses. Their continuous manufacturing process provides increased packaging flexibility, lower weight, improved safety, and scalable production versus conventional hoop wound storage cylinders. The students on this team will create an improved modeling system, multi-physics models (1D to 3D) and/or sequential models and validate them with physical testing (30,000 psi) at a specialty third party supplier. Students will have the opportunity to design and observe the testing process.

Impact:
Currently, Nobel Gas uses a combination of tools to evaluate designs within pressure vessels (e.g., Excel based heuristics, 1D physical models, etc.). They seek to improve the accuracy of performance predictions to improve design decisions and reduce physical testing in the design cycle, and also to unify various tools into a more compact set. All of these will increase the quality and the efficiency of the development team's work.

Minimum Viable Product Deliverable (Minimum level of success)

- A 1D multi-physics model for the test vessel demonstrating an improved fit to test data.

And/or

- A set of tools that solve the different physical parameters (strength, thermal, etc.) sequentially, using results from some tests as inputs for other tests.
- An automated workflow which uses a set of tools to compute the final solution by performing all of the tests, using computed results as inputs for subsequent models.

Expected Final Deliverable (Expected level of success)

- 2D/3D multi-physics model for conformable vessel with improved accuracy over status quo system.
- A documented business process to best utilize the models developed by the team including error estimates.

Stretch Goal Opportunities (High level of success - May include one or more of the following)

- 3D multi-physics models that acts as a digital twin for the conformable pressure vessel.
- Additional 1D and 2D models of more complex geometries.
- Documented test/validation methodology for new vessel designs and ongoing engineering analysis.
- Demonstrated use of the tools to optimize test vessel design, potentially leading to new intellectual property.

Student Skills:

MDP Sponsored Projects are both a professional and academic learning experience for students. By participating in this program, students are actively preparing for graduate school and a professional career. As part of the experience, MDP expects professional behavior. To best prepare you for future professional opportunities, your experiences on this MDP team will be very broad. In addition to key technical skills that you will bring to the team, you will engage deeply in the self-directed learning of new and important concepts, demonstrate flexibility, collaboration, and cooperation, and develop strong professional communication skills. This also means that you will need to be able to work outside of your traditional area of study in the true multidisciplinary nature of our projects. You won't always be able to anticipate how your skills and expertise will be used, so the MDP Sponsored Project will challenge you to grow and develop as a professional.

Project Area	**Specific Skills**	**Likely Majors**
Modeling (3-4 Students)	1D and 3D simulation model development.	ChE (ALL) MSE (ALL) MECHENG(MS/MSE) Any with model development skills
Advanced Fluid Dynamics Modelling (1-2 students)	3D CFD model and simulation	ChE (MS/MSE) MECHENG (MS/MSE) AEROSP (MS/MSE) PHYSICS (BS)
Thermal Modeling (1 Student)	Advanced thermal/materials modeling, including conduction heat transfer.	ChE (MS/MSE) MSE (MS/MSE) MECHENG (MS/MSE)
FEA (1 Student)	Composite structures analysis (static stress, cyclic fatigue, and thermal)	MSE (ALL) MECHENG (ALL)

Additional Desired Skills/Knowledge/Experience

Any of the following Skills, Knowledge, Experience, Interest or Outlook, would be valuable to the 2020 team. We don't expect students to be familiar all or even most of the technical items, but strong candidates will have familiarity or experience with *some* of them and a positive attitude to learn what is necessary as the project gets underway. Please highlight your experience with any of the items on this list in your personal statement on the application.

- Excited about translating academic and technical experience to develop real-world solutions to challenging engineering problems
- Interests in Hydrogen fueled vehicle technology
- Previous experience in modelling including CFD, Thermal and FEA – please describe this as part of your personal statement.
- Previous Multi-physics modeling, please indicate 1D, 2D, and/or 3D experience as well as the specific software platform you worked on.
- Dassault Systems Dymola experience a plus.
- CAD proficiency (Solidworks, Inventor, or similar) a plus.
- Strong communication skills
- Diligence and attention to detail
- Well-rounded balance of technical skill and product/market thinking
- Self-starting, interested in operating in a fast-paced start-up environment
- Technical writing competence and interest in order to document the work product and record detailed process steps to enable others to become proficient

Location:
Project work and meetings will take place on the Ann Arbor campus with periodic meetings held at the Noble Gas office in Novi, Michigan. (MDP will provide transportation)

Sponsor Mentor:

Steve Johnston,
Engineering Manager Noble Gas Systems
Steve is a veteran automotive professional with a background in chassis engineering, fuel systems, and vehicle development. Steve has worked with Noble Gas Systems since its inception, and has worked closely with developing engineering solutions and working with OEMs and industrial gas customers to define specific solutions. Steve is also very experienced with and managed various physical and virtual test initiatives.

Executive Mentor:

Chris Kondogiani,
CEO Noble Gas Systems

Chris is a co-founder and Principal of a boutique private equity and advisory firm, Third Shore Group, which is focused on technology commercialization. A Detroit area native, he has experience working in a wide range of organizations from start-ups to multi-nationals. Relying on his background with fuel cells and pressure vessels, Chris is helping Noble Gas Systems solve the storage problem for alternative fuels and industrial gases.

Faculty Mentor

Johannes W. Schwank
James and Judith Street Professor of Chemical Engineering

Professor Johannes Schwank has taught the capstone design course in Chemical Engineering for many years and has specific expertise in fuel storage technologies. He has developed and taught short courses on fuel cell technology for NASA, and the US Army (TARDEC), that focused on the challenge of hydrogen storage. He testified before a US Congressional Subcommittee on the "Hydrogen Economy". He has served as director of the University of Michigan Energy Institute and as director of the University of Michigan Center for Materials Characterization.

Legal Requirements:

Citizenship Requirements.

- This project is open to all students on campus

Intellectual Property Agreements / Non-Disclosure Agreement

- Students will sign standard University of Michigan IP/NDA documents

Summer Project Activities

- Students will be guaranteed an interview for summer 2020 internships. The interviews will take place between February 3, 2020 and March 31, 2020.

Company Information:

Noble Gas Systems was formed in 2017 to address the storage problem related to using heavy and monolithic traditional hoop would cylinders for many alternative fueled vehicle and industrial gas applications. The conformable pressure vessel technology developed by Noble Gas Systems provides a practical and economic way to store and utilize high pressure gases—significantly reducing capital and operating expenses, as well as making a substantial improvement to the end use experience.

www.noblegassystems.com