

# Richard D Myers, Ph.D.

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## Professional Summary

Principal research and software engineer with deep expertise in numerical methods for transient pipeline flow, scientific computing, and simulation software architecture. Led multi-year research, validation, and production deployment of advanced time-integration algorithms (notably Time-Step Doubling) within large-scale commercial pipeline simulators.

Extensive experience bridging theory and practice: PDE modeling; stability and accuracy analysis; adjoint methods; optimization; thermal-hydraulic coupling; legacy code modernization; and developer enablement. Proven ability to translate advanced mathematics into robust, production-quality software and to communicate complex technical concepts to diverse audiences.

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## Core Technical Expertise

Numerical Methods for PDEs and ODEs

Transient Pipeline Hydraulics (Isothermal & Thermal)

Time Integration ( $\theta$ -method, Step Doubling, Local Extrapolation, Method of Characteristics)

Linear Stability & Order-of-Accuracy Analysis

Adjoint Sensitivities & Gradient-Based Optimization

State Estimation, Calibration, and Leak Detection

Scientific Computing (C++, Python, FORTRAN)

Legacy Code Modernization (FORTRAN  $\rightarrow$  C++)

Machine Learning for Scientific Interpolation

Developer Tooling, Debugging, and Technical Training

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## Professional Profile

Combines **deep mathematical rigor** with **production software impact**

Operates effectively across **research, architecture, and implementation**

**Strong communicator** of complex technical concepts to both expert and non-expert audiences

Proven record of **long-horizon technical ownership** and sustained innovation

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## Professional Experience

- Sept 2007 – Mar 2025 **Software Development Scientist**, DNV – Katy, TX
- Led **research, development, validation, and production deployment** of advanced numerical algorithms for real-time and offline pipeline simulation platforms, including **Synergi Gas, Stoner Pipeline Simulator (SPS), Attune, GTO, and TSM**.
  - Conducted **long-horizon applied research in numerical methods for transient pipeline flow**, developing, analyzing, and validating time-integration schemes with **provable stability and accuracy properties**.
  - Served as a technical authority for **transient hydraulic and thermal simulation**, spanning **PDE formulation, spatial discretization, nonlinear solvers, stability analysis, and runtime robustness** under SCADA-driven operational conditions.
  - Bridged **theoretical numerical analysis and large-scale production simulation code**, reverse-engineering and modernizing legacy **FORTRAN** and **C++** codebases while preserving **numerical fidelity, performance, and backward compatibility**.
  - Drove **cross-team technical enablement and knowledge transfer** through **internal seminars, developer training, technical documentation**, and direct collaboration with **research, product, and customer-facing engineering teams**.
  - Proven record of long-horizon technical ownership and sustained innovation
- Sept 2006 – Aug 2007 **Director of Computing Facilities for the Mathematics Department**, University of St Thomas – Houston, TX
- Built and maintained a departmental Beowulf cluster.
  - Installed and configured operating systems and software on departmental computers and students' personal laptops.
  - Designed a Linux-based computer lab.
- Sept 2005 – Aug 2007 **Visiting Assistant Professor of Mathematics**, University of St Thomas – Houston, TX
- Taught undergraduate courses across calculus, linear algebra, probability, differential equations, and numerical analysis.
  - Supervised undergraduate research and developed new curriculum offerings.
  - Served on departmental curriculum revision committee.
  - Served as department library liaison.
  - Developed a computer science minor for the Mathematics Department.
- Aug 2003 – Aug 2005 **Teaching Assistant**, University of Houston–University Park – Houston, TX
- Responsible for Calculus labs.
  - Provided one-on-one student assistance.
  - Graded exams/assignments and recorded grades.
- June 2000 – Aug 2003 **Graduate Research Assistant**, University of Houston–University Park – Houston, TX
- Explored numerical algorithms for simulating advection-diffusion-reaction equations arising in atmospheric chemistry and transport modeling.
  - Built and ran NCAR's MM5 numerical weather prediction model.
  - performed code validation, verification, and performance analysis on high-performance computing platforms.

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## Selected Projects

- 2024 **Pipeline model conversion between SPS, Attune/GTO/TSM and LANL GasModels.jl**  
Simulator and Optimizer Interoperability
- Began initial work on a Python-based tool to convert pipeline models between DNV's Synergi Pipeline Simulator (SPS), Attune/GTO/TSM, and LANL's GasModels.jl.
  - The goal was to use GasModels.jl to jump start State-Finding and Transient Optimization for Attune and GTO.
  - Researched the model formats for SPS, Attune/GTO/TSM, and GasModels.jl to understand their differences and similarities.
  - Implemented initial code to read/write pipeline models for all target platforms.
- 2023 **Investigate merging Attune/GTO/TSM Thermal Shell Calculations into Synergi Gas Slow Transients Engine**  
Research & Development
- Researched the integration of Attune/GTO/TSM thermal shell calculations into Slow Transients Engine.
  - Analyzed existing thermal shell implementations in Attune, GTO, and TSM to understand their methodologies and assumptions.
  - Code spelunked finding where to insert the calculations.
  - Found that manual FORTRAN memory management in Slow Transients Engine made integration challenging.
  - The full thermal calculations in Attune/GTO/TSM were tightly integrated to the hydraulic calculations, so using the thermal calculations required replacing the pipe hydraulics in the slow transients engine.
  - Thoroughly documented everything in mathematically rigorous detail for the next person (future-me).
- 2022 **Column Separation Estimation**  
Advanced Numerical Methods
- Developed/Reversed engineered a novel algorithm for estimating fluid properties from column separation data in gas pipeline simulations.
  - Implemented and validated the algorithm using real-world data.
  - The real-time algorithm would process pressure data obtained during shut-in conditions and would estimate fluid vapor pressure, vapor volume, and time of column separation.
  - The algorithm thresholds divided difference derivatives to estimate local geometry of the shut-in region of the pressure data series.
  - This thresholding algorithm can be generalized with quadratures to estimate the data series geometry further.

2022 **Python Integration & Debugging for SPS**

Developer Enablement & Training

- Developed and delivered training on debugging Python scripts integrated with SPS, covering both API-driven and embedded execution.
- Demonstrated live attachment to SPS runtime processes for breakpoint-based debugging and stack inspection.
- Standardized workflows using Visual Studio Community Edition, improving developer productivity and script reliability.
- Documented challenges related to Python versioning, symbols, and enterprise deployment constraints.

2019 **Time-Step Doubling (TSD) & Local Extrapolation for Pipeline Hydraulics**

Research, Development, Validation, and Production Deployment

- Researched, implemented, and productionized Time-Step Doubling (TSD) and Step Doubling with Local Extrapolation (SDoLE / ASDoLE) as stable, second-order time integration methods for transient pipeline hydraulics.
- Derived and analyzed linear stability regions, amplification factors, and order-of-accuracy properties, comparing explicit, implicit, Crank–Nicolson,  $\theta$ -method, and TSD schemes.
- Demonstrated that TSD provides second-order accuracy with built-in error estimation, eliminating numerical oscillations during rapid boundary condition changes.
- Implemented TSD for isothermal gas flow PDEs using box-scheme discretization and Newton linearization.
- Validated methods using single-pipe, multi-pipe, and gun-barrel compressor models, benchmarking against highly resolved reference solutions.
- Conducted extensive runtime performance studies, showing TSD can be up to 6 $\times$  faster than the  $\theta$ -method in favorable regimes, while identifying cases where fallback is required.
- Integrated TSD into Synergi Pipeline Simulator (SPS), including runtime enable/disable logic and automatic fallback to  $\theta$ -method under challenging hydraulic conditions.
- Authored and delivered reviewed internal seminars, ISS virtual seminars, and PSIG conference presentations, translating numerical analysis into practical operational guidance.

2019 **Transient Isothermal Pipe Flow Modeling**

Foundational Theory, Solver Design, and Reverse Engineering

- Derived isothermal gas pipeline governing equations from conservation of mass and momentum.
- Analyzed hyperbolicity, eigenstructure, and characteristic speeds, establishing validity regimes for transient simulations.
- Implemented finite-difference spatial discretization combined with  $\theta$ -method and Newton iteration for nonlinear systems.
- Reverse-engineered legacy SPS, Attune, GTO, and TSM codebases, reconciling production implementations with theoretical formulations.
- Documented automatic time-step selection and validation logic, including pressure- and velocity-based error metrics.
- Clarified matrix formulations and discretization details used in production solvers.

## 2019 **Thermal Transient Pipe Flow & Heat Transfer**

### Coupled Hydraulic-Thermal Simulation

- Extended transient flow models to include energy conservation and thermal dynamics.
- Implemented upwinding schemes to suppress numerical oscillations in temperature during sharp transients.
- Modeled radial heat conduction through pipe walls and surrounding soil using a Galerkin finite-element approach.
- Integrated thermal solvers with hydraulic box schemes using  $\theta$ -weighted time integration.
- Compared thermal implementations across SPS, Attune, GTO, and TSM, identifying accuracy and feature trade-offs.
- Evaluated effects of film coefficients, soil properties, and SCADA boundary conditions on thermal response.

## 2018 **Machine Learning & Interpolation for Thermophysical Properties**

### Research & Prototyping

- Designed and trained ReLU neural networks to approximate gas compressibility  $Z(T,P)$  and compressor efficiency surfaces.
- Achieved sub-1% median absolute error across high-dimensional operating domains.
- Interpreted ReLU networks as continuous piecewise-linear spline approximators, enabling principled model design.
- Explored model-reduction techniques (PCA, SVD, feature selection) to balance accuracy and inference cost.
- Evaluated deployment strategies using exported ANN weights and C++ linear-algebra inference.
- Compared ANN interpolation against classical polynomial and spline methods for robustness and numerical stability.

## 2018 **Method of Characteristics (MOC)**

### Numerical Methods Review

- Presented Method of Characteristics (MOC) formulation for transient gas pipeline hydraulics.
- Reviewed thermodynamic assumptions related to compressibility, speed of sound, and heat transfer.
- Derived characteristic equations and Riemann invariants for isothermal and non-isothermal flow.
- Compared MOC with finite-difference and box-scheme approaches in terms of stability, accuracy, and applicability.
- Clarified historical trade-offs influencing solver choices in commercial simulators.

## 2017 **Attune vs StateFinder & Pipeline State Estimation**

### Analytics Evaluation and Model Diagnostics

- Compared performance of Attune (adjoint method based state-finding data assimilation optimization) and StateFinder (single-state least-squares estimation) methodologies.
- Designed realistic SCADA-driven test cases to evaluate pressure and velocity reconstruction accuracy.
- Identified observability limits, data requirements, and workflow mismatches between analytics tools.
- Evaluated slackline flow implementations, reverse-engineering legacy algorithms and documenting assumptions.
- Provided recommendations for algorithm modernization and solver upgrades.

## 2017 **Adjoint Sensitivities & Gradient-Based Optimization**

### Advanced Numerical Methods

- Worked with and debugged(!) adjoint sensitivity analysis for large nonlinear systems arising in pipeline simulation.
- Derived continuous and discrete adjoint formulations for box-scheme-based transient solvers.
- Demonstrated computational advantages of adjoint methods when the number of outputs is small relative to parameter count.
- Validated adjoint implementations using inner-product tests and finite-difference comparisons.
- Responsible for care and feeding of adjoint methods into Attune / TSM / GTO optimization workflows, enabling efficient gradient-based calibration.

## 2015 **Legacy Code Modernization – FORTRAN to C++**

### High-Performance Scientific Computing

- Investigated automated conversion of legacy FORTRAN simulation code to modern C++ using FABLE.
- Diagnosed extreme initial performance regressions ( $\sim 10^5\times$  slower) and systematically optimized generated code.
- Eliminated unnecessary runtime memory allocation by replacing emulated common blocks with namespace-scoped static variables.
- Applied profiling-driven optimizations (VTune), improving memory locality and numeric efficiency.
- Reduced performance gap to  $\sim 10\times$  or better, restoring feasibility for production use.
- Identified remaining challenges (row-major vs column-major ordering) and proposed generator-level improvements.

## 2014 **Signal Processing & Imaging Techniques**

### Exploratory Research

- Applied wavelet-based signal denoising techniques to noisy engineering and SCADA data.
- Compared wavelet filtering and Empirical Mode Decomposition (EMD) with traditional smoothing methods for transient preservation.
- Investigated Eulerian Video Magnification (EVM) to amplify subtle temporal variations in video data.
- Analyzed spatial derivative operators (e.g., Sobel filters) and frequency-domain trade-offs for noise suppression.

### Technical Leadership & Knowledge Sharing

- Delivered recurring research reviews and innovation updates, synthesizing numerical, algorithmic, and performance findings.
- Participated in several internal Simulation Software Seminar Series focused on hands-on technical learning.
- Communicated complex mathematical concepts clearly to cross-disciplinary engineering audiences.
- Served as a technical bridge between research, product development, and customer-facing teams.

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## **Publications**

May 2019 *Step Doubling for Pipeline Flow*

This paper defines and studies a simple, efficient method for discretizing pipeline equations in time.

Todd F Dupont, Richard D Myers

[onepetro.org/PSIGAM/proceedings-abstract/PSIG19/PSIG19/PSIG-1923/2121](https://onepetro.org/PSIGAM/proceedings-abstract/PSIG19/PSIG19/PSIG-1923/2121) (Paper presented at the PSIG Annual Meeting, London, UK, May 2019)

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## **Education**

Sept 2003 – Aug 2005 **University of Houston–University Park**, PhD in Mathematics – Houston, TX

- Dissertation: *Numerically Consistent Approximations for Optimal Control Problems Applied to Stiff Chemical Systems*
- Abstract: In the context of optimal control problems of state-finding and time-based controls, adjoint discretizations for Runge-Kutta methods were developed that converge at the same rate as the solution and objective function.
- Advisor: Prof. Jiwen He
- [github.com/rdm375/RichardMyers-Dissertation/](https://github.com/rdm375/RichardMyers-Dissertation/)

Sept 2000 – May 2002 **University of Houston–University Park**, MS in Applied Mathematics – Houston, TX  
Focused on Numerical Analysis and Scientific Computing: Numerical ODEs, PDEs, Linear Algebra, Optimization, and Parallel Programming.

Sept 1995 – May 2000 **University of Houston–University Park**, BS in Mathematics – Houston, TX

- Graduated Magna Cum Laude

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## Technical Skills

**Platforms:** Linux, Windows, WSL

**Languages:** Python, FORTRAN, C++, Bash

**Automatic Differentiation:** Odyssee, Tapenade

**Parallel Programming:** MPI, OpenMP

**Environments:** GCC, Clang, Make/CMake, MS Visual Studio, VS Code, TFS

**Document Processing:** LaTeX, Markdown, HTML

**Research Areas:** Numerical Analysis, Scientific Computing, Signal Processing, Machine Learning

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## Additional Training

**Python Boot Camp:** Jan. 2007. Covered use of the Python programming language in a scientific computing context.

**Sun Application Tuning Seminar:** Mar. 2004. Focused on using Sun's application profiler to locate and optimize code bottlenecks. MPI and OpenMP were used for writing code for various parallel computing architectures.

**CompTIA A+ Certification:** July 2003. Focused on building, repairing, and configuring operating systems for PCs.

**Parallel Programming with MPI Seminar at UH:** Oct. 2000. Taught by Marc Garbey. Covered parallel programming on distributed memory systems using the MPI message passing interface.

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## Courses Taught

**Calculus I, MATH 1431,** University of St. Thomas: Summer 2006

**Calculus II, MATH 1432,** University of St. Thomas: Fall 2005, Spring 2006, Fall 2006

**Calculus III, MATH 2431,** University of St. Thomas: Spring 2007

**Differential Equations, MATH 2343,** University of St. Thomas: Fall 2005, Fall 2006

**Intro to Technical Computing, MATH 2338,** University of St. Thomas: Spring 2007

**Numerical Analysis, MATH 3339,** University of St. Thomas: Fall 2005, Spring 2007

**Linear Algebra, MATH 3334,** University of St. Thomas: Spring 2006

**Probability, MATH 3335,** University of St. Thomas: Fall 2006

**Real Analysis, MATH 4331,** University of St. Thomas: Fall 2006

**Junior Research Seminar, MATH 3181,** University of St. Thomas: Fall 2005, Spring 2006, Fall 2006

**Senior Research Seminar, MATH 4181,** University of St. Thomas: Spring 2006, Fall 2006

**Independent Study, MATH 4392,** University of St. Thomas: Spring 2006, Summer 2006, Fall 2006

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## Courses Developed

**Junior/Senior Research Seminar, MATH 3181/4181,** University of St. Thomas

**Introduction to Technical Computing, MATH 2338,** University of St. Thomas

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## Undergraduate Research Supervision

Michael Deeb - *The Mathematics Behind Basketball*, Fall 2006

Ashley Gibbs - *Mathematics of Stringed Instruments*, Fall 2006

David Gutierrez - *The Use of Mathematics in Predicting Human Strength Performance*, Fall 2006

Kulvir Kaur - *The Techniques of Teaching Mathematics in Grades 8-12*, Fall 2006

Hai Le - *The Mathematics of Digital Photography*, Fall 2006

Michael Nguyen - *P vs. NP*, Fall 2006

Claudia Oramas - *Stabilization of Structures*, Fall 2006

Linh Tran - *Mathematics and Pool*, Fall 2006

Mary Tapado - *The Golden Mean*, Fall 2006

Giselle Ramos-Bryan - *Pascal's Triangle*, Spring 2006

Moses Khan - *The Relevance of Mathematics in Our Daily Lives*, Spring 2006

Ashley Gibbs - *Bezier Curves*, Spring 2006

Michael Nguyen - *Cryptology: The Study of Cryptography and Cryptanalysis*, Spring 2006

Janie Garcia - *Tomography: A mathematical Background for Medicine's Image Machine*, Spring 2006

Randhi Panapitiya - *Mathematical Relationships with Traffic Flow*, Spring 2006

Robin Stone - *Chaos, Fractals, and Perlin Noise in the Generation of Virtual Landscapes*, Spring 2006

Mary Tapado - *Wallpaper Patterns*, Spring 2006

Janie Garcia - *Galileo Galilei: His Life, His Work*, Fall 2005

Moses Khan - *The Life and Philosophy of Pythagoras*, Fall 2005

Dominic Novak - *Algorithmic Composition: How can math be used in the composition of music?*, Fall 2005

Giselle Ramos-Bryan - *Math in Art: Prospective Geometry*, Fall 2005

Robin Stone - *Unlocking Young Minds: Methods of Teaching Mathematics*, Fall 2005

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## The University of St. Thomas Research Symposium (Sponsored Students)

Ashley Gibbs - *Bezier Curves in Application*, Spring 2006

Christopher LaVallee - *The Use of Mathematics in the Design of a Long-Bow*, Spring 2006