Mario de Lucio

Regenstrief Center for Healthcare Engineering, 203 S Martin Jischke Dr, West Lafayette, IN 47906

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🌐 Personal website ‖ in LinkedIn profile

PROFILE

Experienced engineer with a proven track record in designing and analyzing complex systems and components using fundamental techniques, Finite Element Analysis (FEA), fluid mechanics, and heat transfer. Skilled in providing actionable recommendations and quality assurance by verifying design and analysis work performed by team members. Expertise in using analytical tools such as Abaqus and ANSYS for a broad range of applications in medical, pharmaceutical, and consumer industries. Proficient in developing tools to automate tasks, enhancing efficiency and accuracy through scripting languages such as Python and MATLAB.

RESEARCH INTERESTS

Soft tissue biomechanics, fluid-structure interaction, drug delivery, poroelasticity, large deformations, isogeometric analysis.

EDUCATION

Purdue University   West Lafayette, IN, USA
Ph.D. Mechanical Engineering   2020 - 2024
Concentration: Computational Science and Engineering and Solid Mechanics

Ph.D. thesis: *"Numerical simulation and poromechanical modeling of subcutaneous injection of monoclonal antibodies."* [Link]

University of A Coruña   A Coruña, Spain
M.Sc. Civil Engineering (Graduated with Honors, ranked 1st)   2017 - 2019
Concentration: Structural and Construction Engineering

Master's thesis: *"A multi-layered in-silico model for rupture risk assessment of abdominal aortic aneurysms with non-atherosclerotic intimal thickening."* [Link]

Professional master's project: *"Cable-stayed bridge over the San Martin Strait to connect the towns of Laredo and Santoña (Cantabria, Northern Spain)."* [Link]

University of A Coruña   A Coruña, Spain
B.Sc. Civil Engineering (Graduated with Honors, ranked 1st)   2013 - 2017
Concentration: Structural and Geotechnical Engineering

Bachelor's thesis: *"Environmental Restoration and Channeling of Juan Diaz River in Panama City."* [Link]

EXPERIENCE

Purdue University   West Lafayette, IN
Research Scientist [Regenstrief Center for Healthcare Engineering]   May 2024 - present

- Engaged in a strategic collaboration between Eli Lilly and Purdue University, concentrating on the analysis and optimization of injectable medicine delivery systems.
- Conducted advanced numerical simulations to enhance understanding of the auto-injection process mechanics, aiming to improve drug bioavailability, minimize injection site pain, and boost patient compliance and overall health.
- Explored innovative approaches and technologies for improving drug delivery systems, focusing on device design, injection parameters, and drug formulation.
- Supported and advanced the strategic collaboration between Eli Lilly and Purdue University, promoting the translation of research findings into practical applications within the pharmaceutical industry.

- ○ Demonstrated expertise in advanced computational methods, quantitative analysis, Bayesian and causal inference modeling, and AI methods in health and life sciences.
- ○ Contributed to research grant writing, project management, and publication in reputable healthcare, medical, and biomedical journals.

Purdue University — West Lafayette, IN
Research Assistant [Gomez Lab] — January 2020 - May 2024

- ○ Involved in a project within a strategic collaboration between Eli Lilly and Purdue University, focusing on the analysis of the delivery of injectable medicines.
- ○ Performed numerical simulations to analyze the delivery of injectable medicines with the overall goals of better understanding the fundamental mechanics of the auto-injection process and its effect on skin, improved drug bioavailability, and reducing injection site pain in order to better patient compliance and enhance overall health.
- ○ Developed high-fidelity computational models using the Finite Element Method and Isogeometric Analysis to understand and predict tissue deformation and fluid pressure build-up as well as their impact on drug transport and absorption.
- ○ Investigated innovative approaches and technologies to improve drug delivery systems, considering factors such as device design, injection parameters, and drug formulation.
- ○ Utilized data from computational models to drive informed decision-making in medical device development, enabling effective optimization and innovation in design and functionality.
- ○ Supported the strategic collaboration between Eli Lilly and Purdue University, fostering innovation and facilitating the translation of research findings into practical applications in the pharmaceutical industry.

Purdue University — West Lafayette, IN
Visiting Researcher [Gomez Lab] — July 2019 - Dec 2019

- ○ Developed computational methods utilizing isogeometric analysis, poroelasticity, and data-driven tissue geometries to model the complex dynamics of high-volume, high-speed subcutaneous injection of monoclonal antibodies.
- ○ Developed highly sophisticated numerical algorithms capable of running in parallel, utilizing 200+ processors in Purdue's Rosen Center for Advanced Computing.
- ○ Leveraged the computational power and parallel processing capabilities to efficiently simulate and analyze the complex fluid-structure interactions during the subcutaneous injection process.
- ○ Conducted extensive simulations using the developed computational methods to investigate the effects of injection parameters, tissue properties, and geometrical variations on the injection dynamics and the resulting distribution of monoclonal antibodies.

Norwegian University of Science and Technology — Trondheim, Norway
Graduate Research Assistant [Centre for Advanced Structural Analysis] — July 2018 - Sep 2018

- ○ Acted as a main collaborator in the project *"Industrial Implementation of 3D printed AlSi10Mg components under quasi-static loading"*.
- ○ Conducted experimental tests on structures under both quasi-static and dynamic conditions, specifically focusing on extreme deformations and crushing.
- ○ Utilized Digital Image Correlation (DIC) tools to postprocess experimental results, enabling precise measurements and analysis of structural behavior.
- ○ Applied crashworthiness optimization techniques to enhance the performance and efficiency of the structures.
- ○ Developed finite element models to simulate the behavior of aluminum alloy thin-walled structures.
- ○ Developed comprehensive material card for AlSi10Mg 3D printed aluminum, encompassing mechanical, thermal, and viscoelastic properties for accurate simulation in engineering analyses.
- ○ Collaborated closely with industry partners to ensure the successful implementation of 3D printed components under quasi-static loading.

University of A Coruña — A Coruña, Spain
Graduate Research Assistant [Structural Mechanics Group] — Oct 2017 - July 2018

- ○ Awarded a prestigious fellowship by the Spanish Ministry of Education and Science to serve as a principal investigator, collaborating with the Department of Cardiovascular Surgery at the Complejo Universitario Hospitalario de A Coruna (CHUAC), to conduct research on the risk of rupture of abdominal aortic aneurysms (AAA) with atherosclerotic intimal thickening.

- Developed an in-house code, called *AneuPy*, to generate idealized geometrical models of AAAs using clinical data. This code facilitated the creation of accurate and representative computational models for further analysis.
- Performed cardiovascular fluid-structure interaction simulations of AAAs using different constitutive models for aortic tissue that allowed to better determine the risk of rupture.
- Analyzed the stress distribution, deformation patterns, and hemodynamic factors within the AAA models to gain insights into the potential mechanisms of rupture.
- Collaborated closely with the Department of Cardiovascular Surgery at CHUAC, exchanging knowledge and expertise to bridge the gap between research and clinical applications.

- **University of A Coruña** A Coruña, Spain
  Undergraduate Research Assistant [Structural Mechanics Group] Sep 2016 - July 2017
  - Granted with a research scholarship from the University of A Coruña to conduct research under the project *"Mechanical Characterization of Structural Adhesives for Crashworthiness Applications"*.
  - Analyzed the mechanical behavior of various structural adhesives through rigorous experimental tests (single lap, double lap, thermal tests).
  - Developed computational models with cohesive elements and nonlinear contact mechanics to accurately reproduce the structural behavior of the adhesives.
  - Incorporated experimental data into the computational model, enabling precise predictions of adhesive performance under different loading and thermal conditions.
  - Successfully replicated the adhesive's structural behavior in the computational model, validating the quality of the mechanical characterization.
  - Provided engineers and researchers with a reliable tool for assessing adhesive performance and optimizing their use in various industries.

- **Environmental Hydraulics Institute of Cantabria** Santander, Spain
  Project Manager Assistant [Hydraulic Engineering Group] June 2016 - Sep 2016
  - Worked as a hydraulic modeler on large-scale flood management projects in Panama and Venezuela in collaboration with the World Bank and the Inter-American Development Bank.
  - Conducted two and three-dimensional numerical simulations of free surface flow in rivers and estuaries to assess and quantify the level of flood hazard in densely populated urban areas.
  - Utilized advanced numerical models to assess the level of flood hazard and create accurate flood risk maps, providing valuable information for urban planning and disaster management strategies.
  - Generated accurate flood risk maps by analyzing the hydraulic behavior of water bodies, considering factors such as water flow, topography, and urban infrastructure.
  - Designed and proposed innovative solutions including flood barriers, coastal defenses, waterfront parks, flood-resilient buildings and landscapes, reducing flood hazards by up to 60%.
  - Conducted feasibility studies and cost-benefit analyses to evaluate the economic and environmental implications of proposed flood mitigation solutions, assisting decision-makers in selecting the most suitable approaches.

JOURNAL PUBLICATIONS [GOOGLE SCHOLAR]

- **Modeling Drug Transport and Absorption in Subcutaneous Injection of Monoclonal Antibodies: Impact of Tissue Deformation, Devices, and Physiology.** M de Lucio, Y Leng, H Wang, PP Vlachos, H Gomez. (Submitted for publication), Int. Journal of Pharmaceutics, 2024.
- **A MPET2-mPBPK model for subcutaneous injection of biotherapeutics with different molecule sizes: from local scale biomechanism and drug absorption to whole-body scale pharmacokinetics.** H Wang, T Hu, M de Lucio, Y Leng, H Gomez. (Submitted for publication), Journal of Controlled Release, 2023.
- **Poro-hyperelastic Characterization and Modeling of Subcutaneous Tissue Under Confined Compression.** J Barsimantov, J Payne, M de Lucio, M Hakim, H Gomez, L Solorio, A Buganza Tepole, Annals of Biomedical Engineering, 2023.
- **Stabilized isogeometric formulation of the multi-network poroelasticity and transport model (MPET2) for subcutaneous injection of monoclonal antibodies.** H Wang, T Hu, Y Leng, M de Lucio, H Gomez. Computer Methods in Applied Mechanics and Engineering, 2023.

- **Computational modeling of the effect of skin pinch and stretch on subcutaneous injection of monoclonal antibodies using autoinjector devices.** M de Lucio, H Wang, Y Leng, AM Ardekani, PP Vlachos, G Shi, H Gomez. Biomechanics and Modeling in Mechanobiology, 2023.
- **MPET2: A multi-network poroelastic and transport theory for predicting absorption of monoclonal antibodies delivered by subcutaneous injection.** H Wang, T Hu, Y Leng, M de Lucio, H Gomez. Drug Delivery, 2023.
- **Modeling large-volume subcutaneous injection of monoclonal antibodies with anisotropic porohyperelastic models and data-driven tissue layer geometries.** M de Lucio, Y Leng, A Hans, M Brindise, I Bilionis, AM Ardekani, PP Vlachos, H Gomez. Journal of the Mechanical Behavior of Biomedical Materials, 2023.
- **Mixed-dimensional multi-scale poroelastic modeling of adipose tissue for subcutaneous injection.** Y Leng, M de Lucio, H Wang, H Gomez. Biomechanics and Modeling in Mechanobiology, 2022.
- **Using poro-elasticity to model the large deformation of tissue during subcutaneous injection.** Y Leng, M de Lucio, H Gomez. Computer Methods in Applied Mechanics and Engineering, 2021.
- **Isogeometric analysis of subcutaneous injection of monoclonal antibodies.** M de Lucio, M Bures, AM Ardekani, PP Vlachos, H Gomez. Computer Methods in Applied Mechanics and Engineering, 2020.
- **On the importance of tunica intima in the aging aorta: a three-layered in silico model for computing wall stresses in abdominal aortic aneurysms.** M de Lucio, Marcos Fernandez García, Jacobo Diaz García, Luis E. Romera Rodríguez, Francisco Álvarez Marcos. Computer Methods in Biomechanics and Biomedical Engineering, 2020.
- **Construction project of the new cable-stayed bridge over the San Martin Strait to connect the cities of Laredo and Santona, Spain.** M de Lucio, A Anton. Journal of Public Works, Spanish Institution of Professional Civil Engineers, 2019.
- **Testing and simulation of additively manufactured AlSi10Mg components under quasi-static loading.** M Costas, D Morin, M de Lucio, M Langseth. European Journal of Mechanics-A/Solids, 2019.

CONFERENCE PRESENTATIONS │ Speaker is underlined

- **Cardiovascular fluid-structure interaction modeling of abdominal aortic aneurysms with non-atherosclerotic intimal thickening,** M de Lucio, Marcos Fernandez García, Jacobo Diaz García, Luis E. Romera Rodríguez, Francisco Álvarez Marcos, 8th Summer School on Biomechanics, from Protein to Tissue to Organ: Modeling and Computation, Graz University of Technology, Graz, Austria (2018).
- **A three-layered model for computing wall stresses in abdominal aortic aneurysms with non-atherosclerotic intimal thickening,** M de Lucio, Marcos Fernandez García, Jacobo Diaz García, Luis E. Romera Rodríguez, Francisco Álvarez Marcos, International Conference on Numerical Methods in Engineering, Universidade do Minho, Guimaraes, Portugal (2019).
- **Engineering and Medicine: Numerical simulation as a bridge connecting both,** M de Lucio, 2nd International Conference on Engineering Applications, Universidad Cooperativa de Colombia, Cali, Colombia (2022).
- **Porohyperelastic modeling of high-dose subcutaneous injection of monoclonal antibodies using data-driven tissue geometries,** M de Lucio, Y Leng, A Hans, I Bilionis, AM Ardekani, PP Vlachos, H Gomez, Engineering Mechanics Institute Conference, Georgia Institute of Technology, Atlanta, Georgia, USA (2023).
- **High-fidelity numerical modeling of large-volume subcutaneous injection of monoclonal antibodies using data-driven tissue geometries,** M de Lucio, Y Leng, A Hans, I Bilionis, AM Ardekani, PP Vlachos, H Gomez, Society of Professional Hispanic Engineers National Conference, Salt Lake City, UT, USA (2023).

HONORS AND AWARDS

- **Ben M. Hillberry Graduate Scholarship in Mechanical Engineering, Purdue University.**
  The Ben M. Hillberry Graduate Scholarship is a highly competitive award for students pursuing research in the area of biomechanics or materials. It is sponsored by the friends of Prof. Ben Hillberry in honor of his years of dedication to the School of Mechanical Engineering and the College of Engineering at Purdue University.
- **2023 Trailblazers in Engineering Fellow, Purdue University College of Engineering.**
  Trailblazers in Engineering (TBE) is a multi-day workshop focused on preparing future outstanding engineering scholars for future engineering faculty careers who are also committed to increasing the success of underrepresented communities of engineers. Trailblazers in Engineering Fellows are selected not only for their outstanding scholarly achievements but also for their potential impact in expanding representation and diversity in engineering.

- **Winner of the 2023 Poromechanics Student Competition, Engineering Mechanics Institute, American Society of Civil Engineers.**
  Recipients of the EMI Poromechanics Committee Student Paper Competition Award, are honored for outstanding contributions to the field of Poromechanics. This accolade underscores their commitment to advancing research and encouraging student engagement in Poromechanics.
- **Purdue Graduate Student Government Doctoral Travel Grant, Purdue University.**
  The Travel Grant provides funding for graduate students to present Purdue research at academic conferences. This grant enhances the academic development of our awarded students and augments the overall quality of research at Purdue University.
- **College of Engineering Conference Travel Grant, Purdue University.**
  This program provides support to engineering Ph.D. candidates and postdoc researchers traveling to professional conferences to present papers on their research.
- **National Award to the best Master's Thesis in Civil Engineering, Spanish Institution of Civil Engineers.**
  Recognized by the prestigious Spanish Institution of Civil Engineers for achieving the highest distinction attainable by a civil engineering student in Spain. Awarded the highest honor highlighting exceptional achievement in the field. This distinguished recognition underscores the remarkable quality and significance of the Master's thesis within the realm of civil engineering.
- **Graduate Research Fellowship, Spanish Ministry of Education**
  Commended for securing an esteemed national-level Graduate Research Fellowship awarded exclusively to top master's students for their exemplary commitment and excellence in conducting departmental research.
- **Award to the Best Master's Thesis in Structural Engineering, Grupo Puentes.**
  Honored by Grupo Puentes for authoring the most outstanding Master's thesis in the field of Structural Engineering, showcasing exceptional expertise and innovation.
- **Award to the Best Master's Thesis in Construction Engineering, COPASA.**
  Acknowledged by COPASA for producing the top Master's thesis in Construction Engineering, reflecting exceptional research, insight, and contributions to the field.
- **Award to the Highest Cumulative GPA (B.Sc. & M.Sc), School Civil Engineering, University of A Coruña.**
  Commended for achieving the highest cumulative grade point average across both Bachelor's and Master's programs at the School of Civil Engineering, University of A Coruña, highlighting consistent academic excellence.
- **Outstanding Civil Engineering Student Award (B.Sc. & M.Sc.), The Galician Civil Engineering Foundation.**
  Recognized by The Galician Civil Engineering Foundation as an exceptional Civil Engineering student both during the Bachelor's and Master's programs, demonstrating a strong commitment to the field.
- **Award to the Best Bachelor's Thesis in Hydraulic Engineering, Gas Natural Fenosa.**
  Awarded by Gas Natural Fenosa for producing the most distinguished Bachelor's thesis in Hydraulic Engineering and Environmental Engineering, showcasing insightful research and knowledge in the domain.
- **Best Undergraduate Poster Award at the 2016 Graduate & Undergraduate Research Symposium, University of A Coruña**
  Acknowledged for crafting the finest undergraduate poster presentation at the 2016 Graduate & Undergraduate Research Symposium, University of A Coruña, reflecting exceptional communication and research skills.

Mentorship

- **Alberto de Castro.** Ph.D. student in Civil Engineering at University of A Coruna, Spain. Co-advising his PhD thesis (April 2024 − Currently)
- **Husam H. Elgaali.** Master's student in Civil Engineering at Purdue University (July 2019 − Currently)
- **Mason Rodriguez Rand.** Master's student in Mechanical Engineering at UC Berkeley. Mentored through USACM Student Chapter - Computational Mechanics Student Mentorship Program (April 2024 − Currently)
- **Trent Frandson.** Undergraduate student in Mechanical Engineering at UC Berkeley. Mentored through USACM Student Chapter - Computational Mechanics Student Mentorship Program (April 2024 − Currently)

Professional memberships

- Society of Hispanic Professional Engineers, SHPE (December 2022 − Currently)
- American Association of Pharmaceutical Scientists, AAPS (June 2021 − Currently)
- Licensed Professional Engineer (PE), Spanish Institution of Professional Civil Engineers (July 2019 − Currently)
- Spanish Society of Computational Mechanics and Computational Engineering, SEMNI (June 2019 − Currently)

Volunteering service

- Mentor, USACM Student Chapter - Computational Mechanics Student Mentorship Program.
- Society of Professional Hispanic Engineers (SHPE), recruiter representative for Purdue University College of Engineering undergraduate and graduate programs at the National Conference in Salt Lake City, UT.
- Panelist for the panel: *Thriving at Purdue as an International Graduate Student* at the Purdue Engineering Virtual Graduate Showcase.
- Journal reviewer for Journal of the Mechanical Behavior of Biomedical Materials and Computer Methods in Applied Mechanics and Engineering.
- Mentor for incoming graduate students in Mechanical Engineering, OMEGA Graduate Student Association, Purdue University.
- Student representative and member of the Advisory Committee at the School of Civil Engineering, University of A Coruna, Spain.
- Volunteer, The VI International Conference of the Spanish Association for Structural Engineering (ACHE), A Coruña, Spain.

Skills Summary

- **Programming Languages:** C, C++, Python, Fortran.
- **Software:** Abaqus, COMSOL, ANSYS, LS-DYNA, FEnics, SolidWorks, Matlab, FEnics, STARCCM+, PETSc, PetIGA, Paraview, AutoDesk.

References

- **Dr. Hector Gomez,** Full Professor, School of Mechanical Engineering and Weldon School of Biomedical Engineering, Purdue University, West Lafayette, IN, USA.
- **Dr. Pavlos P. Vlachos,** Full Professor, School of Mechanical Engineering, Purdue University, St. Vincent Health Professor of Healthcare Engineering, Director Regenstrief Center for Healthcare Engineering.
- **Dr. Adrian Buganza Tepole,** Associate Professor, School of Mechanical Engineering and Weldon School of Biomedical Engineering, Purdue University, West Lafayette, IN, USA.