

Modeling and Simulation Program (MSP) Program Fiscal Year 2023 Summary of Funding

- **FY 2023 Appropriation:** \$8,000,000
- **FY 2023 Amount for New Awards:** 7,920,000
- **Total Amount Funded FY 2023 MSP Competition:** \$7,920,000
- **Number Absolute Priority 1 New Awards:** 3
- **Total Number of FY 2023 MSP New Awards:** 7

[illegible]

Title: Enhancing Undergraduate Modeling and Simulation Education through Proactive Recruitment, Inclusive Fellowships, and State-of-the-Art Curricula

Institution: Old Dominion University

Priorities: Absolute Priority 1: Enhancing Modeling and Simulation at Institutions of Higher Education, and Invitational Priority: Promoting Equity in Student Access to Educational Resources and Opportunities.

Total Amount Requested: \$1,154,926

This project aims to enhance the Modeling and Simulation (M&S) Engineering undergraduate major offered by the Department of Electrical and Computer Engineering at Old Dominion University (ODU). This will be achieved by the development and implementation of innovative recruitment materials and activities, the introduction of inclusive fellowships encompassing both merit-based and need-based awards, the development of new courses that stay abreast of the cutting-edge advancements in the field of modeling and simulation and enhance the multidisciplinary nature of modeling and simulation, and the creation of learning communities to foster student engagement. The project team will actively engage and play a prominent role in the Modeling and Simulation Task Force to promote awareness of and establishing a comprehensive framework for the study of modeling and simulation.

ODU has been at the forefront of advancing the field and has established itself as a leader in offering high-quality academic programs and conducting cutting-edge research in M&S. To increase program enrollment, an assortment of compelling recruitment materials and activities will be developed to cater to different populations, aiming to effectively engage and attract individuals from various backgrounds and demographics. Fellowships will be leveraged as a significant financial incentive to encourage and boost student enrollment. To promote both student success and access to the program, this project will provide a combination of merit-based and need-based fellowships. To optimize the effectiveness of the fellowships, this project will devise a fellowship distribution and disbursement model that considers a wide range of factors, such as the ratio between merit-based and need-based fellowships, the amount of fellowship offered, and class standing. ODU's rich resources for student advising and success will be fully utilized to ensure the success of fellowship recipients. This project will develop a range of state-of-the-art courses that reflect emerging developments in M&S, including high-performance computing, machine learning and artificial intelligence, virtual reality (VR) and augmented reality (AR), data analytics and big data, medical digital twin technology, and autonomous and connected systems. All faculty involved in this project have extensive expertise and experience in various fields of modeling and simulation; they will participate in the M&S Task Force and play a leading role in defining the study of modeling and simulation. An Advisory Board will be formed to guide development of new courses, participation in the M&S Task Force, and other MSP project activities.

ODU is a minority serving institution and all project activities will purposely target underrepresented groups, drawing from high school students and undergraduate students, and employing members of underrepresented groups (both faculty and graduate assistants) in this project. A comprehensive and rigorous project evaluation plan will be developed and implemented by an independent evaluator. The results of this project will be disseminated via various Internet channels such as GitHub and YouTube, presentations at premier professional venues, and publications in peer-reviewed journals.

Project Title: Modeling and Simulation: From Physics and Data to Digital Twins and Metaverse

University of Maryland, College Park, Department of Mechanical Engineering

Abstract: As the boundaries of engineering expand, the modern engineer must not only master the foundational principles of engineering, but also demonstrate proficiency in harnessing machine learning and AI through data. In an era, where data is the pre-eminent currency and digital environments are becoming the new reality, education must keep pace. The aim of the proposed educational program is to equip students with this broad skill set, providing an advanced understanding of dynamics, physics-based modeling, data-centric systems, and robotics, all set within the context of creating and utilizing digital twins. The program will help blend theoretical knowledge with practical applications, providing a holistic learning experience that caters to modern technological trends. The ultimate goal is for students to create data-centric systems for cloud-based AI-augmented modeling and simulation by using cutting-edge tools such as NVIDIA Omniverse and NeuralAngelo. This progressive learning approach will help bridge the gap between conventional education and the ever-evolving technological world.

a. Target Population: This project aims to involve approximately 30-40 undergraduate students, along with around 30-50 graduate students.

b. Services and Proposed Activities: Our proposed program is structured around five core objectives. Objective 1 will be to perform literature review and conduct research on new methodologies and approaches within the field of system dynamics as well as industrial AI. This work will pave the way for the development of new courses and the revamping of existing ones. Objective 2 will be to foster problem-solving skills by encouraging students to engage and interact with peers outside their cohorts through workshops, seminars, and collaborative events, including opportunities to use advanced tools like NVIDIA Omniverse, and NeuralAngelo. Objective 3 will be to recruit students for modeling and simulation activities by using scholarships and assistantships as incentives. A key focus will be on diversifying the student body and fostering an equitable, inclusive community. Objective 4 will be to conduct outcome assessments by tracking student progress across cohorts. As Objective 5, we will also participate in annual task force meetings and disseminate our findings through major professional conferences and publications in peer-reviewed journals.

c. Anticipated Results: The proposed work is expected to result in the creation of new graduate certificate programs. Upon completing the program, students will have developed a comprehensive understanding of system modeling and simulation, alongside practical skills in using state-of-the-art tools. They will be well-prepared to contribute to industries that leverage these technologies, such as robotics, AI, and data science.

d. Absolute Priority Addressed: We are responding to Absolute Priority 1. The proposed certificate programs will expand our established curriculum in system dynamics, nonlinear oscillations, data-driven engineering, and robotics by integrating them with advanced techniques in system modeling and simulation. The current curriculum offers advanced courses in these areas, preparing students for successful careers in industries spanning mechanical design, robotics, advanced manufacturing, automation, and data science to system design and digital twin creation. It provides an in-depth background in the computational methods commonly used in modeling, simulation, and the design optimization of complex mechanical and robotic systems. Incorporating AI-augmented modeling and simulation, with particular emphasis on creating and utilizing digital twins, will significantly broaden and deepen the program's scope and impact.

PROJECT ABSTRACT

The University of Central Florida Board of Trustees (FL), \$1,154,940 AP 1 - Enhancement Grant

Project Title: *Graduate Certificate in Digital Twins for Next Generation Modeling and Simulation*

This project proposal aims to address the **Absolute Priority 1 - Enhancing Modeling and Simulation at Institutions of Higher Education**, particularly enhancing our existing Modeling and Simulation (M&S) programs with a comprehensive graduate M&S certificate program in Digital Twins (DTs) at the **School of Modeling, Simulation, and Training (SMST) at the University of Central Florida (UCF)**. Over the three-year performance period, our institution will offer targeted services and conduct activities to develop and implement this graduate certificate program, benefitting a diverse range of professionals. **The total amount requested is \$1,154,940.**

DTs are a live digital replica of complex systems (i.e., simulations) with high-fidelity, large-scale level of integration, and real-time streams of data to facilitate understanding, training, and conducting real-time predictive analysis. This next generation technology requires next generation academic programs to support its design, development, implementation, and deployment. The goal of the **project** is to equip the next generation of professionals from diverse backgrounds and industries with the knowledge and skills necessary to harness the potential of the DT technology.

Through the development and delivery of this certificate, we will empower graduates, including minoritized students, with the expertise they need to design, implement, manage, and innovate using DT solutions. The project is designed to accomplish the following **objectives**: (1) Develop a graduate certificate program in Digital Twin (CDT); (2) Develop and implement a multi-mode version of CDT to allow students to complete the program online, in person, or in hybrid mode; (3) Immerse students in industry and research motivated by real-life applications for effective workforce development in M&S; and (4) Serve Hispanic and other underrepresented student populations with intention.

Our **target population** consists of professionals from diverse industries such as manufacturing, education, energy, healthcare, transportation, defense, smart cities and amusement parks, among others. This includes simulation analysts, engineers, data scientists, social scientists, urban planners, project managers, and executives who seek enhanced DT skill and knowledge.

The **primary activities** of our program involve developing and delivering a comprehensive curriculum encompassing core concepts, including digital transformation, real-time simulation modeling, data-driven modeling, and machine learning for DTs. We will provide hands-on training through industry collaborations, case studies, and practical projects which will allow students to apply their knowledge in real-world scenarios. We will also facilitate networking and knowledge exchange through guest lectures, industry panels, and collaborative projects.

Anticipated results include graduates who are equipped with the knowledge and skills to develop and implement DT solutions in their respective industries. We expect increased adoption of DT technology, leading to improved operational efficiency, and optimized decision-making in industries. Furthermore, we anticipate enhanced collaboration between academia and industry, and innovative workforce that fosters innovation and drives the development of DT technologies.

UCF, a federally recognized Hispanic Serving Institution (HSI), meets the **Invitational Priority** by being one of 30 HSIs nationwide that is certified with the Seal of *Excelencia* for serving Latino students. UCF is also one of 21 institutions in the country that are both an HSI and Research 1 (very high research activity) and is a member institution of the Alliance of Hispanic Serving Research Universities. UCF plans to implement a program that focuses on encouraging and recruiting graduate students and professionals from Hispanic and other underrepresented backgrounds, locally, nationally, and internationally.