Personal Statement

Career Highlights

- Primary Appointment: Virginia Modeling, Analysis, and Simulator Center
- Adjunct Appointments: Department of Computational Modeling & Simulation Engineering, ODU & Department of Pathology and Anatomy, Eastern Virginia Medical School
- Doctorate Students: 1 graduated, 2 current (advising and co-advising) & Master's Students: 1 graduated, 1 current (advising and co-advising)
- Mentored Students: 18 (all levels)
- 22 Grants (PI on 10), $8.86M in total funding (personal credit: $1.4M)
- Publications and Patents: 33+ publications, 1 patent, 168 citations, h=7, https://scholar.google.com/citations?hl=en&user=-2jzkccAAAAJ
- Founder & Director of the Digital Senses Lab & Co-Founder of the Simulation Experiences and Analytics Lab
- Founder and Lead (2020-2021): the VMASC Agile Development Team: 4 Sr. Project Scientists, 8 Project Scientists
- Organizer: Inclusive events for children on the autism spectrum, such as STEAM on Spectrum, Night on Spectrum and STEAMclusive

Overview

I, Krzysztof Rechowicz, am applying for promotion to the position of Research Associate Professor at Old Dominion University. I have been at the ODU Virginia Modeling, Analysis, and Simulation Center (VMASC) since 2014 after completing my post-doctorate training in the ODU Department of Modeling, Simulation and Visualization Engineering. Due to my versatile training and an extensive background spanning engineering domains, from mechanical to modeling and simulation to visualization, I lead research in mixed and virtual reality (VR), simulation-based training, and accessible human-environment interfaces. My research focuses on identifying mismatches between people's needs and wants and interfaces provided by the virtual, mixed and physical environments and mitigating them by applying inclusive and universal design principles and accessibility guidelines. The domains of the questions have included medical training and education, manufacturing, applied behavioral therapy, live theater, naval aviator and ship-handling training. In recent years, the unifying theme across my work is using technology and insight generated from rich data sources to help individuals access and leverage the environment, such as work, school, and home, effectively and efficiently. An overview of my work can be found on my Website, my VMASC Web Page and Google Scholar.

As a research faculty, I have been evaluated based on research and service. At the Center, the primary focus for research is generating external funding, while service helps generate new, sustain, build, and promote existing endeavors.

Research

Since my appointment, I have been aggressive in funding. As a principal investigator, I have been awarded 10 of the 18 proposals I have submitted (55.5% success rate), totaling $729,588. Due to my extensive expertise in VR/XR, simulation-based training, machine learning and strong relationships with the community, I have been a sought-after co-principal investigator for other researchers at the university. I

teamed up with 12 PIs from VMASC, ODU and other universities to submit 29 proposals, of which 12 were funded (41.4% success rate), totaling $8,130,397 (ODU portion: $3,702,624).

During the first two years of my appointment at VMASC, I was the on-site ODU representative at the Commonwealth Center for Advanced Manufacturing (CCAM) in Disputanta, VA. In that role, I interacted and collaborated with over 25 industry and university members, such as Rolls-Royce, NASA, and Airbus. Besides the researcher's duties, my tasks included identifying challenges that industry members faced in the advanced manufacturing domain and building collaborative research teams for industry-funded projects. During my tenure at CCAM, I served on projects as PI or Co-PI totaling $200,377 ($150,407 as PI). I also created funded opportunities for faculty across the ODU campus, creating long-lasting relationships that became fruitful once I relocated to the VMASC main campus.

At CCAM, I led collaborative research leveraging VR, extended reality (XR), computer vision and image processing to visualize simulation data and improve manufacturing process control and monitoring. The driving challenge I aimed to solve was using rich datasets and live data streams to generate insights about complex manufacturing processes and deliver meaningful information to workers when needed. To illustrate, I developed immersive visualization software integrated with a legacy simulation engine, Lava-3DI, to generate insight into how various parameters in the plasma deposition process affected the plasma plume and, hence, the coating layer. Consecutively, I developed a framework for integrating AR in industrial process control scenarios. The aim was to guide the user through a process and visualize relevant information in real-time. I implemented the framework at CCAM and integrated it with a product lifecycle management (PLM) system and a physical CNC machine that live-streamed data to test the framework. This project created a foundation for further CCAM work in augmented reality.

The focus at CCAM was on creating prototypes that can be developed into applications characterized by a higher technology readiness level. To that end, I led a project to create a smartphone-based application for measuring tool wear. Typically, a cutting tool must be unmounted from the holder and taken under a microscope to evaluate the wear. Such an operation takes time, and if the wear is not appropriately evaluated, a catastrophic tool failure can lead to a damaged part and delays in production. I developed the application with the expertise of one of the largest cutting tools suppliers, Sandvik Coromant. The application leveraged an android-based smartphone's built-in optical system with an off-the-shelf add-on lense to photograph cutting surfaces and manually measure various metrics indicating tool wear. I also utilized OpenCV to implement a semi-automatic mode where the user indicated where the worn area was with one tap on the screen (Figure 1). The algorithm segmented the region based on the surface's color and extracted the edges to calculate tool wear. After the prototype application was developed, it was implemented on iPhone devices and adopted by the sponsor in their operations.

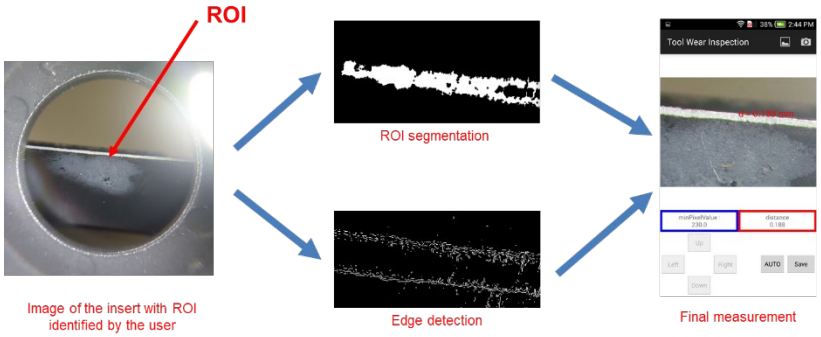

Figure 1. Tool wear measurement mobile application: workflow for semi-automatic measurements (ROI: region of interest).

Due to the IP control requirements for research conducted with direct and generic funds, I could not publish the work in peer-reviewed journals and conferences except for the specific results of the generic projects.

However, this highly applied work was recognized by the members of CCAM by continued support even after my role as an on-site representative had ended.

In parallel to my work in manufacturing, I continued supporting the work I started as a Ph.D. student and postdoctoral researcher. Building on the validation methodology for the Nuss procedure simulator and planner, I developed a method to objectively measure the improvement of chest wall deformity treatment using non-ionizing radiation in contrast to x-ray and CT. In my approach, 3D scanning collected information about chest shape while physiological landmarks were used for registration. This technique can be used for all treatments (from invasive to minimally invasive to non-invasive) of pectus excavatum and pectus carinatum. I built the initial software prototype using the Insight Segmentation and Registration Toolkit and the Visualization Toolkit. A group of graduate students later developed the prototype into a portable system equipped with a Microsoft Kinnect as a 3D scanner. The tool was featured in local news and described in the Medicine Meets Virtual Reality Conference proceedings.

After my relocation to VMASC's main campus in 2016, I decided to apply my experience in VR and AR to support, in an unfunded capacity, the ongoing Modeling Religion Project. As part of the effort, I created and implemented interfaces and interaction models for a VR environment reconstructing Çatalhöyük, one of the oldest settlements known to humans. Besides the visual representation of the buildings and everyday objects, the experience provided olfactory stimuli of what the researchers investigating the excavation site believed would be perceived by the people living in that proto-city. The experience was used by leading archeologists and researchers studying Çatalhöyük, detailed in a documentary with over ten thousand views.

This work, leveraging multisensory stimuli, was foundational to my passion for inclusion and accessibility in STEAM. Allowing people to perceive and interact with the environment, physical or virtual, in a way that matches their abilities and needs is critical to increasing participation. It also led to the founding of the Digital Senses Laboratory (DSlab).

My work in developing multisensory environments with sensors collecting data about the people in the space led to funded work in application to training naval aviators, which generated $210,750. As a university partner of a team comprising small businesses from the US and Germany, under the Small Business Technology Transfer program, we developed automated human performance analysis allowing instructors to provide more immediate and consistent assessments while freeing up time to focus on more advanced evaluation and feedback. I was responsible for creating a training environment representing the cockpit of Cessna 172SP equipped with devices that can inject multisensory stimuli, such as smoke and heat, based on the state of the simulation and training objectives. At the same time, sensors collected physiological data, such as electrodermal activity and heart rate, to detect arousal. I also developed the experimental protocol to collect data from pilots and student pilots. 21 pilots performed multiple data collection sessions until the experiment needed to be stopped due to the COVID-19 pandemic. However, we developed a prototype presented in an I/ITSEC 2021 paper with the collected data. This work and the experimental setup developed in my lab are also utilized in a similar work to improve ship handling operations sponsored by the Small Business Innovation Research program.

This series of projects grounded my research and opened it to new opportunities. I have been a Co-PI on two projects focusing on developing accessible human-machine interfaces in manufacturing to enable people with diverse abilities to perform otherwise challenging tasks. The ultimate motivation behind those projects was to create more inclusive workplaces in the manufacturing industry and increase the independence of people with disabilities. I was responsible for leading students in designing and developing a system comprising a suite of off-the-shelf sensors integrated with low-power microcontrollers capable of performing on-device analytics. That system was integrated with the 3D printer's operating system to

enable two-way communication and ultimately simulate a manufacturing cell. A significant aspect of the project was the participation of the community through two focus groups. The groups gathered industry subject matter experts, educators, therapists, and caregivers of individuals with a disability. Among the information collected was a multi-perspective view on skills needed for an individual on the autism spectrum to succeed in a manufacturing-oriented workplace, prerequisite skills to be acquired in high school, and the mentors' role. A journal publication reporting the results of the studies is under development.

I had an opportunity to apply my experience with developing inclusive and accessible solutions to TRUSTup, a software solution funded by two grants for creating cyber-trust in connected homes. TrustUp implemented elements of a cyber-trust framework developed by collaborators at ODU and the College of William and Marry.

TRUSTup combines automatic scans of the local network to discover IoT devices with automatic identification of the associated vendor. Based on that information, the app searches for Privacy Policies (PPs) and Terms of Service (ToS) associated with the IoT devices and (4) the corresponding community-based rating related to how the user's data is handled (Figure 2). For PPs and ToS that the community has not rated, the app (5) leverages natural language processing (NLP) to identify similar clauses in the database of rated documents and (6) adopts their rating. My team achieved the highest AAA Web Content Accessibility Guidelines compliance. Elements of the solution were critical of a recently awarded grant by the Department of Education, which, in part, focuses on creating inclusive and accessible environments for learning daily living skills by individuals diagnosed with autism and building trust between technology and caregivers.

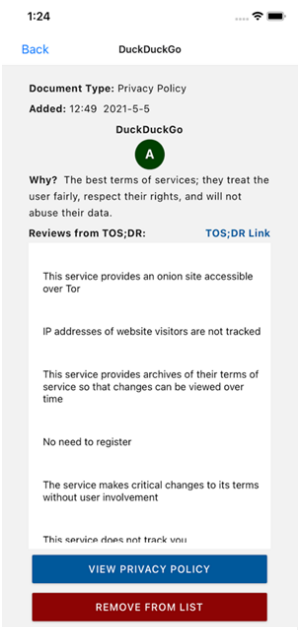

Figure 2. TRUSTup: screen with PP and ToS grade based on community contributed grades.

In line with the investigation of how IoT devices impact individuals with special needs, I led a team conducting an unfunded project in collaboration with ABA therapists from the local autism support center. We developed an Alexa-based skill to measure how well the intelligent speaker identified verbalization by autistic children and distributed the devices to be used in therapeutic sessions practicing echoic skills. The skill was trained to recognize utterances and evaluate them as a therapist would—simultaneously, a therapist scored the child's responses. The study identified no significant difference between how the skill and the therapists scored participants. This indicates considerable potential for providing a continuum of therapeutic opportunities and reinforcement outside of clinical settings. The results were published in the Sensors journal.

I have recently led a collaborative effort with the Eastern Virginia Medical School's Department of Pathology and Anatomy. This ongoing initiative aims to leverage VR, data science, and machine learning to increase medical students' empathy and the humanism of medical education. There are three research thrusts within the project: (1) provide an immersive environment for experiencing an anatomical donor's story by medical students, educators, and community members, (2) create a framework for analyzing reflections and life stories generated by medical students and living donors, and (3) increase diversity of anatomical donors to raise appreciation and empathy of future medical professionals towards patients representing all backgrounds. This initiative has attracted two awards. I am PI on those projects, and my role is to (1) design all technical architectures related to the VR experience and analytical framework, mainly to organize, maintain, provide and control access to the data generated and (2) identify and lead the implementation of the analytical approaches addressing research questions of interests to medical educators.

This project has already generated two publications in medical journals and one accepted journal article in revision (please see the draft here). The impact generated by this effort is vital in attracting additional funding from the National Endowment for the Humanities (NEH) and the American Association for Anatomy.

In early 2020, I started collaborating with the ODU Department of Philosophy and Religious Studies on developing a prototype VR application for conducting moral dilemma-like experiments with participants at large. We implemented a Trolley Problem, a series of thought experiments in ethics and psychology involving stylized ethical dilemmas of whether to sacrifice one person to save a larger number. The prototype attracted Level II funding from the National Endowment for the Humanities, which was interested in adopting VR as a valuable tool in humanities and a distributed data collection instrument. One of the objectives was to create resources, such as 3D assets, computer code and documentation, for researchers without an extensive programming background. The intent was to allow them to develop their experiments using Unity, a popular game development platform. We also made the VR application publicly available for Oculus Quest and Rift headsets to collect data from users worldwide. My role as a Co-PI was to provide insights into the development of accessible and inclusive VR experiences, development of data collection instruments and analysis of results. The resources, documentation and data generated during the project can be found on the Virginia Reality Philosophy Lab's Github and the project's Open Science Framework page. As publications are in progress, the project was featured in Magazine Philosophie (in French), ODU News and Between Realities.

Teaching

Although I have no teaching responsibilities as a research faculty, I am firmly committed to advising and mentoring students. I have been part of three committees for dissertation projects at Old Dominion University. I have also chaired one master's thesis project and been part of another. Aside from dissertation and master's thesis committees, I also mentor many students I work with. Since my appointment, I have mentored and funded 18 students (9 undergraduate and 9 graduate). The students have come from various colleges and departments, such as Nursing, Psychology, Computer Science, Art and English, and two from other universities. After completing their assistantship, four students I mentored became full-time project scientists at VMASC. Influenced by my mentorship, several students decided to pursue the next level of education.

Service

Professional Service

I actively participate in the broader engineering, modeling, and simulation communities. It includes peer-reviewing for various journals and participating in program committees for international conferences. Since 2019, I have worked in various roles, from tutorial track chair to Simulation Education track chair to program committee member for the Society for Modeling & Simulation International's annual Spring and Winter Simulation conferences. In 2021, I was proceedings chair for the ACM SIGSIM Conference on Principles of Advanced Discrete Simulation. Between 2020-2021, I was the treasurer for the IEEE Hampton Roads Section and its Educational Activities Officer for four years, starting in 2017.

VMASC Service

I am the director of the Digital Senses Lab and co-founder of the Simulation Experiences and Analytics Lab. Between 2019 and 2021, I was responsible for the Virginia SmallSat Data Consortium community-building activities. Within the Consortium, I built and led a team of software developers, engineers, data

scientists and UX designers to create solutions, such as the first Virginia Open Data Cube, leveraging data from autonomous platforms to solve societal problems. The Center's executive director appointed me as the VMASC Agile Development Team lead. In that role, I supervised the transition of a group of developers and project scientists providing software solutions across multiple projects to fully remote operations due to the COVID-19 pandemic. I also started at the Center a grassroots initiative called Future Living, bringing together students, project scientists, and researchers interested in applying their training and education to advancing accessibility and inclusion.

University and Community Engagement

Since 2017, I have been the ODU representative to the Commonwealth Center for Advanced Manufacturing's Technical Advisory Council. I participated in creating the ODU Strategic Planning Committee for 2023-2028 by serving on the Challenges and Opportunities Subcommittee. I have also served on search committees for project scientists and postdocs. In 2020, I co-organized an inclusive gaming competition for students to design and build a prototype of a game that is accessible to as many people as possible.

My engagement with the community is inspired by providing accessible and inclusive environments for people of all abilities. I am an organizer of events, such as STEAM on Spectrum and Night on Spectrum, for children on the autism spectrum and their families to expose them to Science, Technology, Engineering, Art, and Math (STEAM) principles through accessible and inclusive activities. I also led the development of inclusive display aids for a touch tour for the visually impaired at the Mariner's Museum in Newport News, VA. Recently, I co-founded the Teach Me How Foundation, which helps individuals learn how to access the environment effectively and efficiently for them. It provides the assistance and the educational tools they need to learn and grow at school, home, and work. The goal is to set individuals with differing abilities to achieve their goals and provide a strong start toward an independent and fulfilled life.

I trust that this document and my CV highlight my accomplishments and contributions to VMASC, Old Dominion University, and the wider academic community. Further overviews of work and additional materials can be found on my Website, my VMASC Web Page and Google Scholar

Thank you for your consideration and time.

Sincerely,

Krzysztof J. Rechowicz, Ph.D.