6th Health Care Engineering Systems Symposium

and Interactive Medical Simulation Exposition

Wednesday, October 9, 2019
University of Illinois Memorial Stadium
Colonnades Club
Champaign, IL

healthengsymp.illinois.edu

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AN OSF HEALTHCARE
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN
AND UNIVERSITY OF ILLINOIS COLLEGE OF
MEDICINE PEORIA COLLABORATION

AGENDA

8:00 – 9:00 AM	**Breakfast and Registration**
9:00 – 10:00 AM	**Inauguration Ceremony of Jump ARCHES Expansion** **Remarks by OSF and UIUC Leadership**
10:00– 10:10 AM	**Break**
10:10 – 11:10 AM	**Presentations of Projects Funded by Jump ARCHES** **Moderator**: Elizabeth Hsiao-Wecksler **Scott Barrows, OSF** *Heart Failure and Behavior Change: Patient/Provider Interactive Clinical Education App for Mobile Devices* **Arif Masud, UIUC** *Virtual Heart Patch for Determining Complex Shapes for Surgical Patching* **Trina Croland, OSF** *The i-AREA-p; an Intelligent Mobility-based Augmented Reality Simulation Application for Pediatric Resuscitation Training* **Vahid Tohidi, OSF** *Mixed-Reality based Visualization and Simulation of Nerve Conduction Study* **Hyun Joon Kong, UIUC** *Surgical Planning via Preoperative Surgical Repair of Next-Generation 3D, Patient-Specific, Cardiac Mimic* **Minh Do, UIUC** *Lung Cancer Radiomics and Radiogenomics* **William Cope, UIUC** *MedLang: A Semantic Awareness Tool in Support of Medical Case Documentation Using Simulations* **Abigail Wooldridge, UIUC** *Using Simulation to Evaluate and Improve Team Cognition in Handoffs*
11:10-11:20	**Break**

11:20 AM – 12:00 PM	**Technology Insight – Social and Behavioral Talks** **Moderato**r: Matthew Bramlet **Sarah De Ramirez, OSF** *Complex Solution Innovation Lab* **Yerko Berrocal, UICOMP** *Virtual Physiology Engine-based Simulation Modules to Understand Valvular Heart Disease* **Joseph Irudayaraj, UIUC** *Point of Care Biosensors for Monitoring Infectious Pathogens, Protein and Genetic Biomarkers* **Brian Cunningham, UIUC** *Digital Resolution Proteomic and Genomic Liquid Biopsy using Plasmonic-Photonic Hybrid Resonators* **Rachel Switzky, UIUC** *The New Siebel Center for Design* **Harshal Mahajan, UIUC** *Living in Interactive Future Environments (LIFE) Home Research Center* **Brent Roberts, UIUC** *The Center for Social and Behavioral Science and Jump ARCHES*
12:00 – 12:30 PM	**Pitch of Research Ideas** **Moderator**: Kesh Kesavadas
12:30 – 1:30 PM	**Lunch**
1:30 – 3:00 PM	**Jump ARCHES Funding Workshop & Networking Session**
1:00 – 4:30 PM	**Interactive Medical Simulation Expo, Posters & Refreshments**

Jump ARCHES Partnership Expands Beyond Medical Simulation & Education to Include Social and Behavioral Determinants of Health Endowment Now Exceeds $100 Million

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A longstanding partnership between OSF HealthCare and the University of Illinois at Urbana-Champaign's (U of I) Grainger College of Engineering for joint research to revolutionize clinical simulation, health care systems and medical education will expand dramatically through additional endowments. This will fuel a new generation of joint research projects to include mobile sensors, Internet of Things applications, data analytics and understanding social and behavioral determinants of health. Known as Jump ARCHES (Applied Research for Community Health through Engineering and Simulation), the partnership was established in 2013 with $62.5 million in support. With new commitments of $50 million, it will now be backed by a total of $112.5 million in endowment support.

The multifaceted expansion includes a $25 million gift from the DiSomma Family Foundation to the endowment pool held within the OSF HealthCare Foundation, an additional $12.5 million commitment from the OSF HealthCare Foundation, and the equivalent of $12.5 million in endowment support from University of Illinois Urbana-Champaign.

Jump ARCHES expansion

Jump ARCHES expansion will increase the types of investigators who may apply for funding beyond The Grainger College of Engineering. That expansion includes:

- Social and behavioral determinants of health
- Health care and wellness sensors
- Mobile health devices
- Artificial intelligence and machine learning
- Health data analytics and management
- Human factors and ergonomics
- Social robotics and health automation
- Mobility options for health and wellness

healtheng.illinois.edu/collaboration/jump-osf

Symposium Co-Chairs and Jump ARCHES Co-Directors

John Vozenilek
Vice President & Chief Medical Officer for Simulation
Jump Simulation and Education Center, OSF HealthCare
Duane and Mary Cullinan Professor in Simulation Outcomes
Professor of Medicine, University of Illinois College of Medicine at Peoria
Professor of Bioengineering and Co-Director of Jump Simulation Center
College of Engineering, University of Illinois at Urbana-Champaign

Thenkurussi "Kesh" Kesavadas
Director, Health Care Engineering Systems Center
Co-Director, Jump Simulation Center
Professor, Industrial and Enterprise Systems Engineering
Professor, Computer Science and Electrical and Computer Engineering
University of Illinois at Urbana-Champaign
College of Engineering
Professor, Carle Illinois College of Medicine

Presentations of Projects Funded by Jump ARCHES

Heart Failure & Behavior Change: Patient/Provider Interactive Clinical Education App for Mobile Devices.

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Jump Simulation, Peoria
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After the initial diagnosis of heart failure, the 5-year mortality is 50%. The one-year mortality after an admission primarily for heart failure is 30% and worsens with each hospitalization. The financial burden imposed by HF is high around the world. Recent work has demonstrated, however, that even simplified interventions can lead to improved adherence with a therapeutic regimen which reduces disease severity, mortality, and readmission rates.

It is known that clear and effective communication between the provider, the patient, and their caregivers is imperative for improving patient outcomes and decreasing the human and financial burden of HF. The development and use of an interactive mobile app may provide a new robust tool to support this, while also providing the benefits of additional information and education presented at varying depths for patients and caregivers.

Now in the second year of this grant, the research team at Jump Simulation (graphic designers, Unity app programmers, medical illustrators, game developers, and instructional designers), UIUC Bioengineering (programming and engineering), OSF Cardiology (content direction), and the OSF- St. Francis Medical Center Heart Failure Patient Care Transition Program have created an interactive mobile app prototype for testing and evaluation with the goal of clinical integration in early 2020.

Scott Barrows is the new Jump Design Lab Director at Jump Simulation and Education Center at the OSF Saint Francis in Peoria, IL. He was previously vice-president of clinical engagement and strategic development at a biotechnology laboratory in Virginia, and vice-president of creative development at a medical software “think tank” in Nevada. He has also worked with eHuman, a Stanford-based medical-dental software company and served as an advisor to Apple.

Barrows is a clinical assistant professor of emergency medicine at University of Illinois College of Medicine at Peoria and retains the role of clinical assistant professor in biomedical visualization at the University of Illinois at Chicago. He was also an assistant professor at the University of Texas Southwestern Medical Center in Dallas and was the former director of the biomedical visualization graduate program at UIC.

Barrows has been the recipient of numerous awards, including recognition from two U.S. Presidents, the Smithsonian Institution and the University of Illinois. His work has been presented at Nobel presentations and is included in the archives of the National Library of Medicine.

Virtual Heart Patch for Determining Complex Shapes for Surgical Patching

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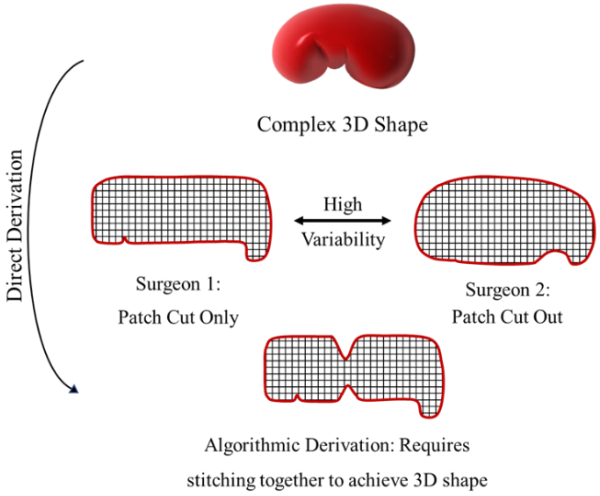

In heart-patch surgeries complex 3D patches have to be created to correct anatomical and functional deficits in the heart. These 3D patches initially start out as 2D sheets of material that the surgeon has to size, shape, and place to remedy the defect and properly route blood flow in the heart. Visualizing how the complex 3D structure results from an oddly shaped 2D piece of material can be challenging, requiring the surgeon to modify the material in real-time during the surgery. At times real-time improvising of the shape of the patch necessitates multiple tries to get the optimal shape and this adds to the risk factor for the patient who is under general anesthesia and therefore every minute counts. This project aims at developing a virtual reality (VR) heart patching process to enable both simulation of complex heart patch surgeries while also enabling a surgeon to determine the size and complex shape of a patch that will be inserted. Once this virtual platform is developed, objective is to use it in conjunction with a 3D printed heart of the patient to simulate the surgical placement of the patch.

Reference

T.J. Truster and A. Masud, A Unified Mixture Formulation for Density and Volumetric Growth of Multi-Constituent Solids in Tissue Engineering. Computer Methods in Applied Mechanics and Engineering, Volume 314, 222-268, 2017.

Arif Masud is Professor of Engineering Mechanics in the Department of Civil and Environmental Engineering at the University of Illinois at Urbana-Champaign. Prof. Masud has made fundamental and pioneering contributions to the development of Stabilized and Variational Multiscale Methods for fluid and solid mechanics. He is past Chair of the Fluid Mechanics Committee of ASME, past Chair of the Computational Mechanics Committee of ASCE. Dr. Masud has served as an Associate Editor (AE) of the ASME Journal of Applied Mechanics, AE of the ASCE Journal of Engineering Mechanics, and currently serves as the AE of the International Journal of Multiscale Computational Engineering. He was the Co-Chair of the Finite Elements in Flow Problems Conference (FEF 2019), held in Chicago in March 2019. Dr. Masud is an Associate Fellow of AIAA, and Fellow of US Association of Computational Mechanics (USACM), International Association of Computational Mechanics (IACM), American Academy of Mechanics (AAM), American Society of Mechanical Engineers (ASME), and the Engineering Mechanics Institute (EMI) of ASCE. He has been awarded the 2019 G.I. Taylor Medal by the Society of Engineering Science.

The i-AREA-p; an Intelligent Mobility-based Augmented Reality Simulation Application for Pediatric Resuscitation Training

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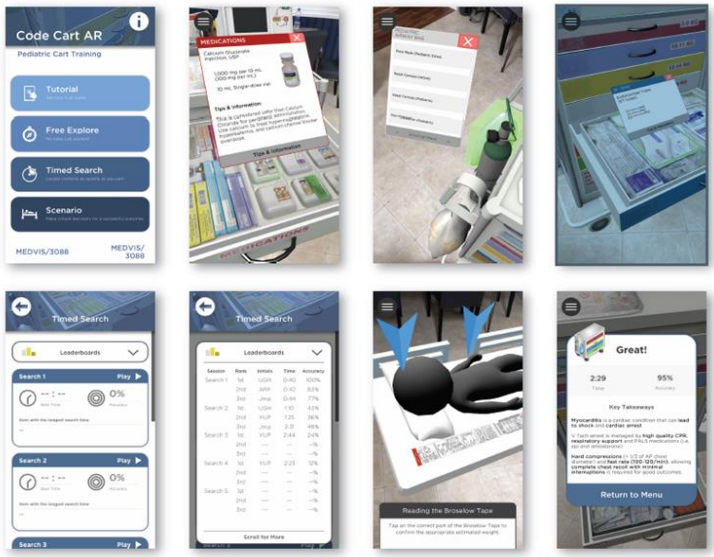
In-situ simulations at OSF Healthcare Children's Hospital of Illinois (CHOI) reveal that familiarity with the pediatric crash cart is essential to efficient and timely resuscitation. Lack of familiarity with the code cart contents has been a recurrent theme noted by students, residents, nursing and pediatric providers. The iAREA-p is a learner-driven educational simulation application that will provide immediate and individualized access to this content without the need of a classroom or instructor. The iAREA-p is a highly interactive three-dimensional virtual representation of a pediatric weight-based resuscitation cart and its related equipment such that a learner or group of learners can explore, encounter, learn, and test their understanding through a variety of methods. The technology combines augmented reality (AR) features to simulate the code cart on a learner's personal mobile device (smart-phone), and will add additional data collection from the mobility device itself and synthesize on-board technologies to enhance and verify that knowledge transfer has occurred. The clinical team is refining and validating content and proof of concept for professional use, and is assessing the educational impact. The engineering team from UIUC is evaluating the usability of the technology and the impact to the system through a human factors approach to inform design improvements and implementation strategy.



Dr. Croland is an Associate Professor of Pediatrics at the University of Illinois College of Medicine Peoria (UICOMP) and is the Section Chief for Hospital Medicine for the Dept of Pediatrics, and the Medical Director for General Pediatrics at OSF Healthcare Children's Hospital of Illinois (CHOI). She in on faculty at Jump, with over 15yrs experience in simulation based education, and previously directed the pediatric simulation program at UICOMP. She currently runs the local and regional in situ simulation program for CHOI, and is actively involved in quality improvement and patient safety. She has won the UICOMP Curriculum Innovation Award 2015, UICOMP Outstanding service award 2016, OSF Mary Draeger Schultz Patient Safety Award 2016, and received the Dean's Award Grant for Innovative Medical Student Education in 2018.

Mixed-Reality based Visualization and Simulation of Nerve Conduction Study

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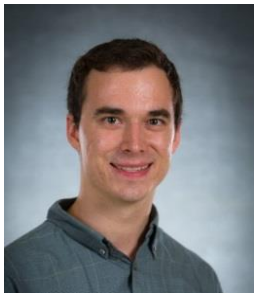
Peripheral nervous system (PNS) by itself and separate from central nervous system is indeed a complex structure, and its length throughout a typical human body is estimated to be longer than 90000 miles. A Nerve Conduction Study/Electromyography (NCS/EMG) study provides electrical recording of functional ongoing pattern of activities of the nerve and muscle. Therefore, the proper performing of NCS/EMG study and accurate interpretation of data have an important role in diagnosis and management of disorders of PNS. We are developing an educational platform using mixed-reality based visualization and simulation of NCS patterns of specific nerves associated with specific PNS disorders. The visualization of nerve conduction traces is projected on a virtual manikin. Further, we use augmented reality in mixed reality form so that the trainees can interact with real objects (manikin) while to be able to observe specific data patterns (virtual) based on the access points of specific nerves in different pathological conditions. We use Microsoft HoloLens as a Windows based wearable computing platform to develop holographic simulations that can be seamlessly integrated with real-world objects. This project uses previous developments by Dr. Chembrammel related to interactable augmented reality (see Figure) for medical diagnosis and real-time data visualization during surgery by using Microsoft HoloLens. The educational platform will be used in conjunction with clinical history to incorporate nerve conduction study data in supervised or unsupervised scenarios, and the trainees could be tested in a comprehensive way by being exposed to different scenarios.

References:

1. J. Chen, S. Pareek, P. Chembrammel, and T. Kesavadas, “Augmented reality as a medical and diagnosis tool,” in IEEE EMBC, 2017
2. P. Chembrammel, S. Gupta, M. Doose, and T. Kesavadas, “Simulation training for mechanical support in extracorporeal membrane oxygenation in adult patients,” in IEEE EMBC, 2017.4

Vahid Tohidi is a Clinical Assistant professor at the Illinois Neurological Institute. He received his MD from Iran University of Medical Sciences in 1998 and PhD in Biology in 2008. He finished his Neurology residency training in 2014 and fellowship in Neuromuscular Medicine in 2015. He joined INI-OSF and UICMP in 2015 as a subspecialist in the field of neuromuscular medicine. His interests are to use his training in biomedical and computational science to address major clinical problems affecting lives of many patients. He is currently working on a simulation of the nerve conduction studies data to be able to develop an educational platform for trainees. This will incorporate current biomedical research directly to address the clinical aspect of patient care especially for neuromuscular medicine. Previous research had included using neural networks in analysis of complex data such as EEG for possible clinical applications, computational modelling and in vivo electrophysiologic study of a groups of pacemaker neurons as his PhD thesis and several clinical studies. He is also board certified in autonomic disorders.



Surgical Planning via Preoperative Surgical Repair of Next-Generation 3D, Patient-Specific, Cardiac Mimic

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William Balance
PhD Candidate

Hyunjoon Kong
Professor

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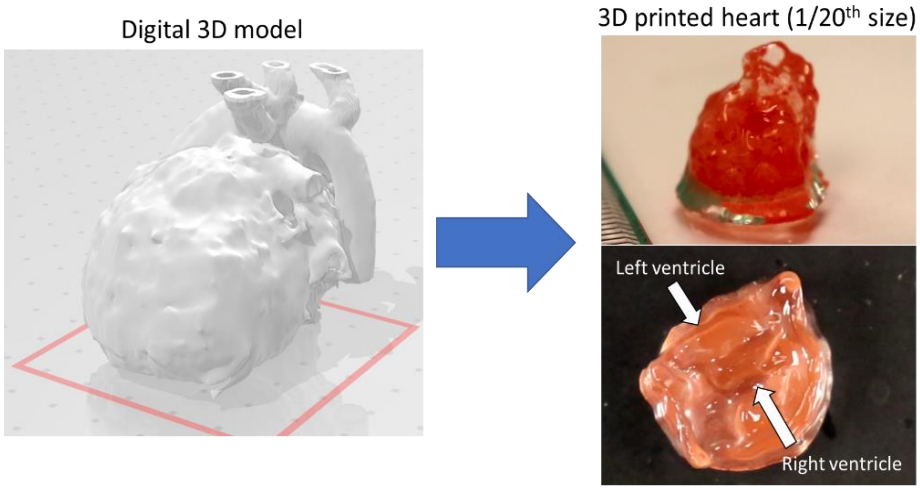
Surgical clinical simulation refers to the ability to recreate physical organs or tissues to simulate the real-world surgery environment. With the rapid advancements in the field of 3D printing, images from magnetic resonance imaging (MRI)/computed tomography (CT) and information from MR elastography (MRE) can now be used to fabricate 3D objects with the same shape, internal structure, and physical properties of a patient's heart. We have developed stereolithographic based 3D printing approaches that allow the printing of polymeric hydrogel materials with the desired shape and controlled mechanical properties (e.g., softness and toughness). These new models can be used to allow surgeons to plan patient specific surgeries and to also train new surgeons, given the short supply of donated tissues and organs. Our approaches can be broadly applied to a range of tissue and organ types and advance the field of clinical simulation to the next level.



Reference: Ganguli, A., Pagan-Diaz, G.J., Grant, L. et al. Biomed Microdevices (2018) 20: 65. https://doi.org/10.1007/s10544-018-0301-9

Hyunjoon Kong is a professor in the Department of Chemical and Biomolecular Engineering, Carle Illinois College of Medicine, and Pathobiology at the University of Illinois at Urbana-Champaign (UIUC). He received his engineering education from the University of Michigan at Ann Arbor (Ph. D.) and performed post-doctoral research at the University of Michigan and Harvard University. He joined the University of Illinois in 2007. During the academic life, he received the Scientist Development Grant from the American Heart Association, the Career Award from NSF, Center for Advanced Study Fellowship, UIUC Engineering Dean's Award for Research Excellence, Centennial Scholar, and Promotion Award. He was recently elected to an American Institute of Medical and Biological Engineering (AIMBE) Fellow.

Lung Cancer Radiomics and Radiogenomics

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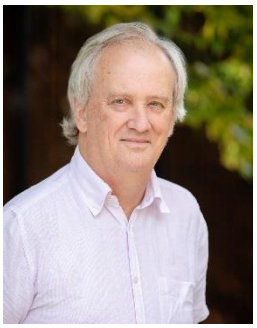
Lung cancer is the leading cause of cancer death in the United States, with 234,000 new diagnoses and 154,000 new cases estimated for 2018. Despite notable improvements in treatment, the 5-year survival rate remains low at 20% largely due to the substantial proportion of patients diagnosed with advanced disease -- holding steady around 60% -- which has very low cure rates. Computed tomography (CT) screening offers hope to shift diagnosis to earlier stage disease with higher cure rates as was confirmed in the National Lung Screening Trial where CT screening reduced lung cancer mortality 20%. Artificial Intelligence (AI) has shown promise in automating nodule detection and tracking. If early stage lung cancer is diagnosed, there is often clinical uncertainty about the balance of risks and benefits in this generally unhealthy patient population. Combining imaging and genomic features into a radiogenomics risk signature would provide valuable information about the aggressiveness of the newly diagnosed cancer. With the onset of paired multimodal datasets which provide genomics and CT images of the same patients, we propose to predict recurrence by fusing information from the multiple modalities. We evaluate several fusion techniques for this task. When tested on a recent non-small lung cancer radiogenomics dataset of 130 patients, the different fusion techniques achieve improved concordance index (C-index) values across folds by over 10 points, and the best average C-index of 77.76, demonstrating the potential of multimodal fusion.

Minh N. Do received the B.Eng. degree in Computer Engineering from the University of Canberra, Australia, in 1997, and the Dr.Sci. degree in Communication Systems from the Swiss Federal Institute of Technology Lausanne (EPFL) in 2001. Since 2002, he has been a Professor in the Department of Electrical and Computer Engineering at the University of Illinois at Urbana-Champaign (UIUC), and held joint appointments with the Coordinated Science Laboratory, Beckman Institute, Department of Bioengineering, and Department of Computer Science. He received a Silver Medal from the 32nd International Mathematical Olympiad in 1991, University Medal from the University of Canberra in 1997, Doctorate Award from the EPFL in 2001, CAREER Award from the National Science Foundation in 2003, Xerox Award for Faculty Research from UIUC in 2007, and Young Author Best Paper Award from IEEE in 2008. He was an Associate Editor of the IEEE Transactions on Image Processing, and a member of several IEEE Technical Committees on Signal Processing. He was elected as an IEEE Fellow in 2014 for his contributions to image representation and computational imaging. He has contributed to several tech-transfer efforts, including as a co-founder and CTO of Personify and Chief Scientist of Misfit.



MedLang: A Semantic Awareness Tool in Support of Medical Case Documentation Using Simulations

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Simulations are now widely used in medical education. However, in order for a student or trainee to demonstrate how they use and interpret a simulation and the conclusions they draw from it, they need to articulate their clinical thinking. This project involves the creation of an innovative new technology tool (MedLang) that supplements an existing tool (Common Ground Scholar or CGScholar) to support clinical reasoning processes. For this project, we define "simulation" as representation of a clinical case using video animation, 3D imaging, virtual reality or biomedical models. Interaction will be recorded in video recording, still image, and diagram, with linking text supplemented by "explain protocols" in tags and concept visualizations. MedLang will use standard medical ontologies to make suggestions during clinical case development (formative feedback) and to support educator as they evaluate clinical case reports (summative assessment).

Dr. Bill Cope is a Professor in the Department of Education Policy, Organization & Leadership, University of Illinois at Urbana-Champaign, USA. He is also a director of Common Ground Research Networks, a not-for-profit publisher and developer of "social knowledge" technologies. His research interests include theories and practices of pedagogy, cultural and linguistic diversity, and new technologies of representation and communication. His recent research has focused on the development of digital writing and assessment technologies, with the support of a number of major grants from the US Department of Education, the Bill and Melinda Gates Foundation and the National Science Foundation. The result has been the ***CGScholar*** multimodal writing and assessment environment. Recent sites of testing and application have included programs in medical and veterinary education, global health courses, and training programs for the World Health Organization. Among his publications are a volume edited with Mary Kalantzis, ***e-Learning Ecologies***, and a book co-authored with Kalantzis and Magee, ***Towards a Semantic Web: Connecting Knowledge in Academic Research***.

Using Simulation to Evaluate and Improve Team Cognition in Handoffs

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Handoffs are important to patient safety, providing opportunities to detect and correct errors but also risking information loss, patient harm and decreased quality of care. Much effort has been dedicated to improving handoffs, but the evaluation of these improvement interventions has been based on insufficient measures. This work conceptualizes handoffs as team cognition, presenting new, innovative opportunities to develop technology-based approaches to evaluate handoffs. To do so, we are simulating handoffs of a pediatric trauma patient from the operating room (OR) to pediatric intensive care unit (PICU). Based on the content and flow of the simulated handoffs, we are developing a novel measure of team cognition in handoffs to provide feedback to medical professionals in training and evaluate handoff interventions in future research. Through debriefs following the simulations, we are identifying sociotechnical system barriers, facilitators and solutions to high-quality handoffs to inform the preliminary development of an inter-professional education and/or team-based technology intervention.

Abigail R. Wooldridge is an Assistant Professor in the Department of Industrial and Enterprise Systems Engineering and PI of the Human Factors in Sociotechnical Systems Laboratory. She also holds courtesy appointments in Kinesiology and Community Health and the School of Information Sciences. Dr. Wooldridge's research focuses on understanding, modeling and improving complex sociotechnical systems, in particular those found in health care. Her current work conceptualizes care transitions as processes and approaches handoffs examples of team cognition, thus informing efforts to improve patient safety, quality of care and worker outcomes associated with care transitions. Dr. Wooldridge completed her PhD in Industrial and Systems Engineering at the University of Wisconsin-Madison. Between 2013 and 2015, she managed Decision Support and Surgical Scheduling at the University of Miami Ann Bates Leach Eye Hospital.

Technology Insight – Social and Behavioral Talks

Complex Solution Innovation Lab

Sarah Stewart de Ramirez
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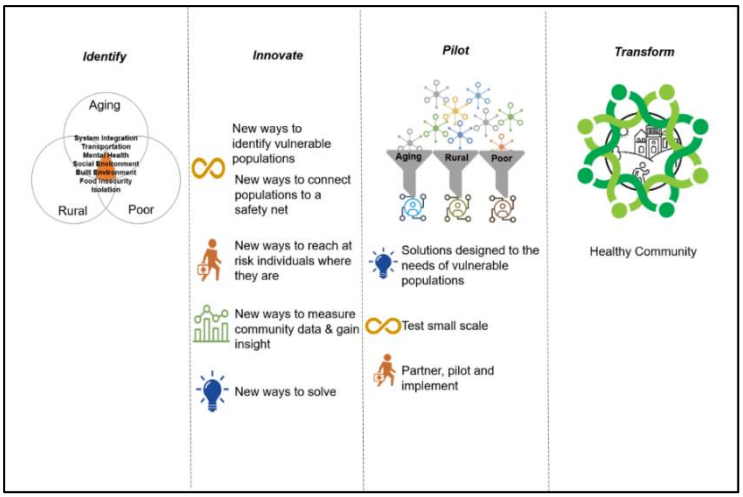
The Complex Solution Innovation (CSI) Lab strategizes how to build the healthcare structure of the future by determining how to care for the patient as a whole person, in the context of their community. As a leader in piloting innovative solutions, team members are addressing health inequities through their work in rural innovation hubs in Central Illinois. The triangulation of qualitative interview, quantitative clinical, and social service data have led to insights which allow for the foundational infrastructure research agenda to achieve health equity in vulnerable populations (the elderly, the rural, and the poor). The CSI Lab partners to build innovative devices and care models to address the needs in vulnerable populations through its knowledge of clinical innovation, multi-disciplinary academic partnership, and austere setting care delivery.



The CSI Lab team is focused on advancing innovation in the following four (4) areas:

1. Prediction of social risk utilizing new data sources to quantify the social determinants of health
2. Development of new ways to reach and care for vulnerable populations, specifically new innovations for Community Health Workers
3. Creation of community care networks that use new data sources to promote equitable health outcomes
4. Application of technology to strengthen the ability to address the social needs of patients and communities

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Sarah Stewart de Ramirez, MD MPH MSc is currently the Chief Medical Officer and Vice President of Clinical Innovation for OSF HealthCare. After completing two years of health systems work on HIV in Namibia for the United States Agency for International Development, she studied at the London School of Economics and the London School of Hygiene and Tropical Medicine, and received two Masters degrees, in Health Economics and in Public Health. She then went on to pursue her medical degree at Harvard Medical School and held numerous leadership and consulting positions with various organizations, including the World Health Organization, the Gender Health Equity Network, the United Nations, the International Office of Migration, and the Bill and Melinda Gates Foundation. She worked as an Emergency Medicine physician at Johns Hopkins Hospital for over 10 years, and in addition to academic instruction, Dr. de Ramirez served as the Director of Global Emergency Services, overseeing operations of 10 emergency departments in Latin American and the Middle East. Upon moving back home to Peoria, she became the Vice President for Clinical Innovation at OSF Healthcare, and created the Complex Solution Innovation division, a multidisciplinary innovation effort focused on healthcare's most complex problems: the social determinants of health, aging in place, and radical access to care. She also directs University of Illinois College of Medicine's strategic efforts for innovation in global and rural health. She and her husband Miguel have 4 kids: Diego, Liliana, Sebastian and Cecilia.

Virtual Physiology Engine-based Simulation Modules to Understand Valvular Heart Disease

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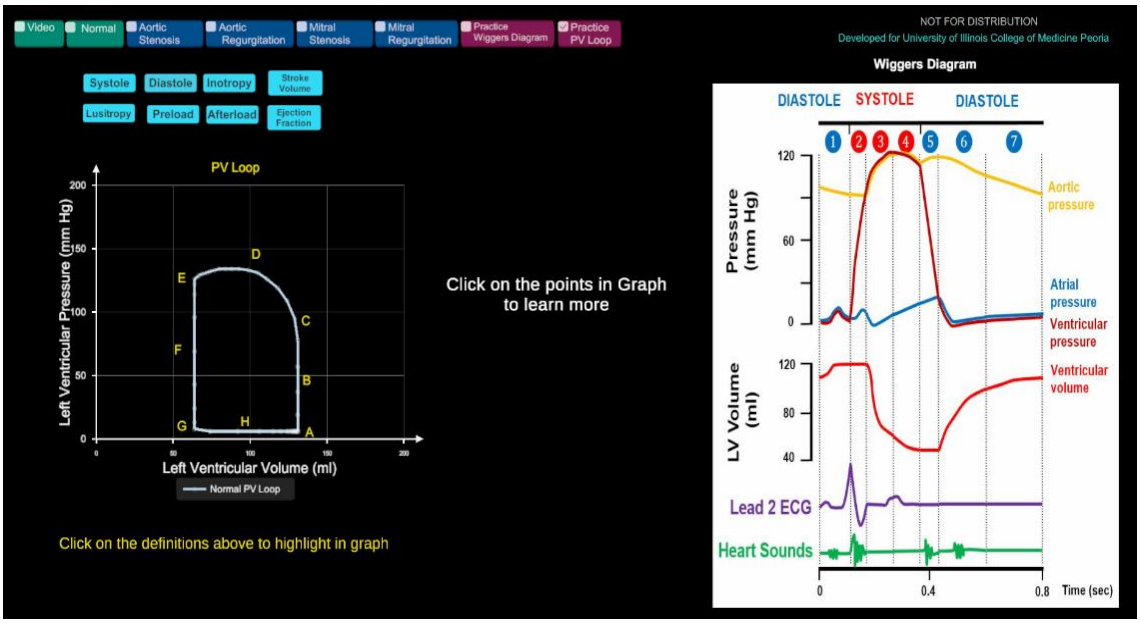
The aim of this interactive educational tool is to utilize the technological advancements in 3D modelling, animations and a virtual physiology engine in order to develop effective tools for understanding cardiovascular physiology through visualization, interactive learning and comparison.
Modelling diseases using virtual physiology software has the potential to transform medical education by allowing medical students to learn in a consequence free environment. Medically accurate physiology models are required to ensure that lessons learned in the virtual space/environment translate to the real world. By providing animations of valvular heart disease linked to the virtual physiology engine and class-specific learning objectives, we can better educate medical students using high fidelity simulations of different medical condition



Dr. Berrocal is an Associate Professor and Academic Program Director of Clinical Health Sciences Education as well as the Course Director of the Circulation and Respiration course at the University of Illinois College of Medicine-Peoria. His expertise includes curriculum development, active learning methodologies, use of technology in education, and integration of basic science and clinical medicine. He has extensive experience in undergraduate medical education, development of medical curriculum, accreditation, and student support. His areas of research include medical education and development of cellular transplantation strategies to repair injuries in the human central and peripheral nervous systems. He is currently pursuing a Master's degree in Health Professions Education at the University of Illinois at Chicago.

Point of Care Biosensors for Monitoring Infectious Pathogens, Protein and Genetic Biomarkers

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We report on a generalized magnetic focus lateral flow biosensor (mLFS) for ultrasensitive detection of protein and biomarkers and infectious pathogens in a practical format onsite. The conceptualized strategy utilizes a simple magnet placed beneath the 3-D printed Lateral Flow device to concentrate the targets at the signal generation zone without any additional instrumentation. Protein mixtures extracted from the tissue of cervical cancer patients were utilized to detect cervical cancer biomarkers at fg/ml sensitivity by simply monitoring the change in color (Colorimetry). Infectious pathogens such as E. coli and Salmonella sp. could be detected at a limit of 25 CFU/ml. The proposed mLFS can be utilized to detect a range of trace protein biomarkers and gene targets for early diagnosis and can be combined with diverse pretreatment and signal amplification steps to query complex samples

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Joseph Irudayaraj has degrees in Agricultural Engineering, Computer Sciences, and Biological Engineering. He moved to UIUC Bioengineering as the Founder Professor of Bioengineering in 2017 after 14 years of service in Purdue. He is also the Associate Director of Shared Resources of the Cancer Center at Illinois and a PI of the T32 training grant on Microbial Systems Engineering (In Review). He is also leading an effort to initiate a multidisciplinary Center for Toxicology and Environmental Health. He is a Fellow of the Biomedical Engineering Society, American Institute for Medical and Biological Engineering, Academic Leadership Program (Committee for Institutional Cooperation) and Entrepreneurship Leadership Academy. He has also served as the Interim Director and Deputy Director of the Bindley Bioscience Center and the Chair of the Agricultural and Biological Engineering (Rated #1 by US News and World Report 2009-present) at Purdue. Prior to Purdue he was a faculty at Penn State and Utah State University.

His group is interested in developing biosensors for rapid monitoring of infectious pathogens and cancer biomarkers for screening in low-resource settings. Recently their team has also developed highly sensitive colorimetric sensors for detecting genetic markers based on sequencing of epigenomic and metagenomic data relevant to the gut-liver axis to explore mechanistic links between microbiome and epigenome in triggering diseases of the liver and pancreas. Their goal is to translate basic discoveries into products that have clinical and/or commercial impact. Examples include, biosensors for onsite monitoring of infectious pathogens and cancer; drug delivery vehicles for controlled release of oxygen and drugs to treat ischemia, intelligent computing-driven biomarker identification platforms. Their key collaborators are clinicians at the Carle Foundation Hospital and faculty at the College of Veterinary Medicine, School of Molecular and Cellular Biology and Grainger College of Engineering. Their group has published over 300 refereed publications (Citations > 16,000 and h_index > 71). He is a member of the Biomedical Engineering Society, American Chemical Society, Institute of Biological Engineering, Biophysical Society, and the American Society of Agricultural and Biological Engineers.

Digital Resolution Proteomic and Genomic Liquid Biopsy using Plasmonic-Photonic Hybrid Resonators

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The strong electromagnetic coupling between plasmonic nanoparticles and photonic crystal surfaces is used as the basis for an ultrasensitive detection platform technology called “Activate Capture + Digital Counting” (AC+DC) that offers single step, isothermal, rapid, 100 aM detection of protein and nucleic acid target molecules. Because AC+DC operates at room temperature and does not utilize wash steps or enzymatic amplification, it is well suited for applications that include point of care diagnostics, frequent monitoring of the effects of therapy, and quantitative analysis of biomarkers in bodily fluids. The talk will describe the underlying electromagnetic and biochemisty principles of the AC+DC approach, and show representative applications in cancer genomic diagnostics and viral load monitoring.

Brian T. Cunningham is the Willett Professor of Engineering in the Department of Electrical and Computer Engineering at the University of Illinois at Urbana-Champaign, where he also serves as the Director of the Micro and Nanotechnology Laboratory. His research interests include biophotonics, bionanophotonics, micro/nanofabrication processes & materials, BioMEMS, lab-on-a-chip, microfluidics, biosensing, and applications in drug discovery, health diagnostics, mobile point-of-use detection systems, life science research, environmental monitoring, animal health, and food safety. Prof. Cunningham’s key technical contributions and achievements stem from his invention and application of nanostructured photonic surfaces that efficiently couple electromagnetic energy into biological analytes, enabling high signal-to-noise sensing of materials that include small molecules, nucleic acids, proteins, virus particles, cells, and tissues. He has made key foundational contributions to the application of mobile devices (such as smartphones) to point-of-use detection systems that provide equivalent capabilities to laboratory-based instruments. He is a Fellow of IEEE, OSA, AAAS, NAI, and AIMBE.

The New Siebel Center for Design

Rachel Switzky
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Our mission at the Siebel Center for Design is to foster multidisciplinary collaborations across campus, using design thinking as an approach to promote human-centered design and mandated quick iterations.

At SCD, we have a hard-working, collaborative team of individuals that help guide our mission. Though we are waiting for our brand-new building to be built, we are piloting many initiatives in order to bring awareness to what SCD does to campus and the community.

Rachel Switzky is the inaugural Director of the Siebel Center for Design. Prior to her current appointment, she has been a global design leader working with Fortune 100 companies over the past 20 years.

Most recently, she served as an Executive Director at IDEO, the company who pioneered the concept of design thinking. For the last decade in this role, she helped teams imagine futures and then put them into action, focusing on digital design, emergent technologies and impact at-scale.

Rachel attended the University of Illinois at Urbana-Champaign, receiving her BFA and MFA in Industrial Design from the College of Fine and Applied Arts.

Living in Interactive Future Environments (LIFE) Home Research Center

Harshal P. Mahajan
Research Assistant Professor
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The College of Applied Health Sciences is poised to develop cutting-edge technologies to support independent living, healthcare needs, social interaction, and community participation in our Living in Interactive Future Environments (LIFE) Home Research Facility. This 5670 sq. ft. facility will include a simulated home research environment as well as provide space for the research and development of next generation technologies (including smart home devices, wearables, and robots) that would allow people of all ages and abilities to live fuller, healthier, and autonomous lives. This multi-function facility will also serve as an inter-disciplinary hub for research teams, industry partners, clinicians and community members for activities related to technologies for health and independence including: in-home sensors, wearables, human-computer interfaces, telemedicine, rehabilitation, home materials, smart appliances, indoor climate technologies, robotics, assistive devices, and communication technologies. This facility will also support educational, clinical and community outreach activities. Construction of the LIFE Home is well underway and it is expected to be operational in early 2020.

Harshal Mahajan, is a Research Assistant Professor in College of Applied Health Sciences at University of Illinois at Urbana-Champaign and serves as the Assistant Director for research for the LIFE Home research center. His primary role in this position is to manage research and development activities with smart technologies to enhance the quality of life of individuals with disabilities and older adults. His role further extends to supervising and mentoring student projects. Before joining UIUC, Harshal was a Research Scientist in the Georgia Institute of Technology, Atlanta, GA. While part of the Rehabilitation Engineering Research Center on Technologies to Support Successful Aging with Disability, his research comprised of understanding specific barriers and facilitators that influence health and function in older adults. He developed intervention strategies to encourage activity performance in older adults during their daily activities, especially, using smart technologies and personal robots. His other interests include development and psychometric evaluation of clinical assessment tools for fear of falling and evaluating universal design aspects of workplaces. His educational background is in biomedical and rehabilitation engineering and he completed his doctoral and post-doctoral training in clinical research at the Wheelchair Center for excellence at the VA Pittsburgh, PA. There his research comprised of iterative development and clinical research with a virtual reality wheelchair driving simulator for older adults and people with physical and neurological disabilities. He also developed a smart kitchen for individuals with cognitive impairments.

The Center for Social and Behavioral Science and Jump Arches

Brent W. Roberts
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The Center for Social and Behavioral Science (CSBS) was created to help address the grand challenges facing society that can be answered using the deep social and behavioral science expertise housed at the University of Illinois at Urbana-Champaign. The Jump Arches program brings together two of our high priority grand challenges—social science and the digital revolution, and the social and behavioral causes of health. I will provide an overview of the resources offered by the CSBS, some of the social and behavioral science projects already supported by the CSBS that fit the Jump Arches goals, and how the CSBS can help Jump Arches succeed.

Brent W. Roberts is a Professor of Psychology and Director of the Center for Social and Behavioral Science at the University of Illinois at Urbana-Champaign. Dr. Roberts received his Ph.D. from Berkeley in 1994 in Personality Psychology and worked at the University of Tulsa until 1999 when he joined the faculty at Illinois. He has received multiple awards for his work including the Carol and Ed Diener Mid-Career Award in Personality Psychology, the Theodore Millon Mid-Career Award in Personality Psychology, the Henry Murray Award, and an Honorary Doctorate of Psychology from the University of Basel. He has served as the Associate Editor for the *Journal of Research in Personality* and *Psychological Science*, and as a member-at-large, Executive Officer, and President for the Association for Research in Personality.

Dr. Roberts's research has focused on determining the replicable patterns of continuity and change in personality traits across adulthood, the life experiences associated with changes in personality traits over time, and the significance of these changes for individual functioning. Dr. Roberts also conducts research on psychometric issues, in particular how to measure the traits of conscientiousness and narcissism, and more recently, how to best assess socio-emotional skills.

jump | ARCHES

AN OSF HEALTHCARE
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN
AND UNIVERSITY OF ILLINOIS COLLEGE OF
MEDICINE PEORIA COLLABORATION

FUNDING

♦

2019 Jump ARCHES Call for Proposals
healtheng.illinois.edu/funding

♦

Previously funded research
healtheng.illinois.edu/collaboration/jump-osf

2019 Jump ARCHES Request for Applications

Description
The Jump Applied Research for Community Health through Engineering and Simulation [Jump ARCHES] Endowment offers this Request for Proposals to members of faculty of the University of Illinois at Urbana-Champaign, members of faculty of the University of Illinois College of Medicine at Peoria, and/or OSF HealthCare clinicians. The goal of this select competitive grant is to improve health care quality and patient safety through the combined efforts of researchers, engineers, and clinicians.

The award is for 1 year of startup/seed money support. Requests for continuing funding will be based upon reported progress.

Fund Activity Category
Science and Technology and Other Research and Development

Category Explanation
Medical Simulation, Computational Modeling, Artificial Intelligence, Machine Learning, Predictive Analytics, Sensors, Mobile Health, Social and Behavioral Health, Population Health, Industrial Design, Human Factors, Ergonomics, Applied Health Sciences, Advance Care

Goals
Through new technologies, methods, or training, this program will use our combined expertise in the broad areas of Sensing Devices, Materials and Mechanics, Health Information Technologies, Simulation, Human Factors/Industrial Ergonomics, Artificial Intelligence, Design and Social and Behavioral Sciences for executing collaborative projects. These projects will be directed to the current or the future state of Community Health. Community Health refers to the health status of a population of people, and the actions and conditions, both private and public, to promote, protect, and preserve their health. Disparities in the distribution of health care access and its non-clinical drivers produce inequitable health outcomes in communities throughout the world.

Successful proposals in this cycle will explore and apply technologies and systems in the following areas:

- Jump ARCHES is exploring solutions to Community Health disparities involving advanced data analytics in the identification and assessment of vulnerable populations.
- Also, we are looking for in home and coordinated community tools, technologies and networks for assessing wellness and the social determinants of health while promoting access to health care, health literacy and community resources. This may also involve the creation of digital tools for community health workers and integrating AI, machine learning and robotics to provide better delivery of health care.
- The training and evaluation of current and future medical professionals including AR, VR, XR and technologies for tele-health.
- Innovative new solutions using AI, machine learning and robotics to provide better monitoring and delivery of health care at home and health care facilities.
- Novel sensors, cloud-based systems, and other technologies for early detection of health risks which could be included into algorithms to determine immediate need to notify a doctor or the user's emergency contacts.

To pair with OSF's radical access initiative we are looking to support solutions to the health care challenges in providing health care to rural communities. We anticipate that a new ARCHES rural health care testbed will be operational in the near future. This testbed could help in catalyzing and testing proposed solutions.

- The misuse of and addiction to opioids is a serious national crisis that is responsible for 130 casualties in the US every day. To address the strains on public health and social and economic welfare, projects involving predictive analyses to identify people at risk and addressing underlying conditions that if treated well could prevent opioid addiction, will be considered
- New solutions to health care issues will require broader assessments of the role of agents, AI and machine learning as it relates to health literacy, social determinants assessments, and other behavioral health concerns. Involving the examination of human factors that influence whether people will adapt to assistive technology options as part of the more direct assessments is significant to any of these possible solutions.

Special Response for Proposals

- Autism Spectrum Disorders (ASDs) refers to a broad range of conditions characterized by challenges with social skills, repetitive behaviors, speech and nonverbal communication that affects an estimated 1 in 59 children in the United States today. Through our efforts with OSF Children's Hospital of Illinois, Developmental Pediatrics, special projects will be considered for support. Specifically, projects involving early diagnosis, treatment, and quantitative assessment of the treatment of ASDs, as well as supporting children and adults with ASDs, allowing them to be more functional at home, school, and the workplace, while exploring technologies to utilize the unique skillset of these individuals with ASDs to advance new knowledge.
- Amyotrophic Lateral Sclerosis (ALS), Lou Gehrig's disease, is a progressive neuromuscular disease that affects roughly 30,000 people in the United States, with 5,000 new cases diagnosed each year. Building on the existing relationship between the Illinois Neurological Institute, OSF Saint Francis Medical Center, University of Illinois at Urbana- Champaign, and the University of Illinois College of Medicine at Peoria, new proposals are solicited that propose novel technologies, systems and assistive devices for communication and immobility associated barriers experienced by people with ALS and projects addressing the difficulties of their families and caregivers.

Evaluation Criteria

Proposals will be specifically evaluated for their respective alignment to program goals [**Relevance**], the potential impact on patient and learner outcomes [**Impact**], and the proposed plan and quality of the team proposed [**Approach**].

Who can submit a proposal? The Primary Investigator may be from any discipline. Additionally, proposals are **REQUIRED** to include one Investigator from the Grainger College of Engineering at the University of Illinois at Urbana-Champaign and one Investigator from either the health care providers of the OSF HealthCare or the University of Illinois College Of Medicine at Peoria Faculty.

The steering panel for Jump ARCHES will prioritize:

- Applied research programs that evaluate the improvement of patient outcomes.
- The creation of equipment and facilities to evaluate and improve health care.
- Contributions to scholarship and support for advanced degrees to prepare new generations of experts in the field.

Continued Funding
For the current ARCHES grantees, we invite you to submit a proposal for funding to continue your project, if excellent progress has been made during the initial phase(s) of the project. Will require a final report before the continued funding request is reviewed. In addition, evidence of proposal/s submitted for extra-mural funding and technology disclosure to UIUC OTM or OSF OIM must be presented. The proposal must show potential for translational research or external funding opportunity.

For more information:
https://www.gotomygrants.com/Public/opportunities/details/f03f6c96-c4e7-42b7-b7ff-4427e646bfc3

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