As the Chief Scientist for all of the U.S. Air Force’s human-centered research at the Air Force Research Laboratory, I invite you to submit an application to participate in our 2016 Dr. Daniel Repperger Research Intern program. This program posthumously honors Dr. Repperger, who mentored many young people during his 35 year research career with our organization, by providing research opportunities for students to work in one of our facilities under the mentorship of an Air Force scientist. Each of these scientists has been hand-selected to mentor because of their technical knowledge, experience and willingness to help science and engineering students enhance their learning through participation in an actual Air Force research project.

Please review the information and application instructions on page 4 of this brochure to determine your eligibility and then review the research projects on pages 5-33 to see if any match your research interests. If selected for one of the projects, you will have temporary summer employment through our contract with the Oak Ridge Institute for Science and Education (ORISE) to participate in this 10-week research internship at one of our two research locations; Dayton, Ohio or San Antonio, Texas. Along with gaining first-hand research experience, you’ll learn the inner workings of an operational laboratory and develop contacts and friendships that will last a lifetime. Again, please review the information in this brochure carefully to understand the specifics of the program before you apply. I look forward to reviewing your application and wish you the best of luck in the selection process.

Rajesh R. Naik, PhD, ST
Chief Scientist
711th Human Performance Wing
WHO WE ARE

AFRL leads the discovery, development and integration of affordable warfighting technologies for America's air, space and cyberspace forces. We are a full-spectrum laboratory, responsible for planning and executing the Air Force's science and technology program. AFRL leads a worldwide government, industry and academic partnership in the discovery, development and delivery of a wide range of revolutionary technologies. The laboratory provides leading edge warfighting capabilities keeping our air, space and cyberspace forces the world's best. Operating from over 40 sites worldwide, AFRL focuses on technologies for air vehicles, human performance, materials and manufacturing, sensors, propulsion, space vehicles, directed energy, information and weapons. The lab employs approximately 5,800 government people (1,400 military and 4,400 civilian personnel). It is responsible for the Air Force's science and technology program of $2.1 billion including basic research, applied research, advanced technology development, and an additional $2.3 billion in externally funded research and development.

The 711th Human Performance Wing advances human performance in air, space, and cyberspace through research, education, and consultation, accomplished through the synergies created by the wing’s three distinct but complementary entities: The U. S. Air Force School of Aerospace Medicine (USAFSAM) is an internationally renowned center for aerospace medical learning, consultation, aerospace medical investigations and aircrew health assessments. The school trains approximately 5,000 students each year. It also performs research on technologies for the rapid detection of chemical, biological and radiological events, hyperbaric medical research and light, durable intensive care capabilities. USAFSAM also has the Nation's only Radiological Assessment Teams available for 24/7 deployment. The Human Performance Integration Directorate (711 HPW/HP) focuses on human performance optimization and sustainment through human systems integration (HSI). The directorate is the bridge among the acquisition communities and lead integration agent for the promotion, guidance, consultation, and implementation of human systems integration. It also provides HSI consulting services and technical advisory support to capability requirements developers, program managers, and engineers throughout the Air Force.

The Human Effectiveness Directorate (711 HPW/RH) leads the U.S. Air Force’s human-centered research, discovering biological and cognitive technologies to optimize and protect the Airman’s capabilities to fly, fight, and win in air, space, and cyberspace. The Directorate provides a strong in-house research program and extensive research partnerships with industry and academia. Its research team is composed of the most diverse range of technical disciplines in the Air Force to explore the human from the bio-molecular level to the societal behavior level. The Directorate focuses its research in four Core Technical Competencies: Training, Decision Making, Bioeffects and Human-centered Intelligence, Surveillance and Reconnaissance.

AFRL Laboratories

711th Human Performance Wing

DISTRIBUTION STATEMENT A. Approved for public release, distribution unlimited. 88ABW-2015-5963
The Repperger Research Intern Program honors the life and works of Dr. Daniel W. Repperger (1942-2010) a scientist and mentor to many young engineers and scientists. As a researcher in the Air Force Research Laboratory’s Human Effectiveness Directorate for 35 years, Dr. Repperger’s mathematical and scientific innovations have revolutionized image and network complexity analysis. He received international recognition in haptic controllers, human-machine interface performance enhancement, and mathematical methods development. While Dr. Repperger’s significant research accomplishments helped advance the performance of Air Force airmen and the field of human-centered research, his most significant accomplishment may well be the impact he had as a kind and caring mentor of many young Air Force scientists and science and engineering students. Dr. Repperger received a BS and MS in Electrical Engineering from Rensselaer Polytechnic Institute and a PhD in Electrical Engineering from Purdue University. He was a David Ross Research Fellow at Purdue from 1971-1973 and a National Research Council Post-Doctoral Fellow at Wright-Patterson AFB from 1973-1975. A member of Eta Kappa Nu, Tau Beta Pi and Sigma Xi, Dr. Repperger was a Registered Professional Engineer in Ohio and on the Board of Trustees of the Ohio Academy of Sciences. He was a Fellow of the IEEE, Air Force Research Laboratory, American Institute of Medical and Biological Engineering, the Ohio Academy of Science and the Aerospace Medical Association. Dr. Repperger authored over 400 technical journal articles, reports and conference publications, was selected as Associate Editor of five international journals and obtained 14 U.S. patents and 28 Air Force invention registrations. His honors and awards include the Harry G. Armstrong Scientific Excellence Award, Human Effectiveness Directorate Mentor of the Year, IEEE Third Millennium Medal Winner and the IEEE Dayton Fritz Russ Award. Dr. Repperger is listed in the Who's Who in Science and Engineering and the American Men and Women of Science.
# REPPERGER RESEARCH INTERN PROGRAM

## INFORMATION AND APPLICATION INSTRUCTIONS

<table>
<thead>
<tr>
<th><strong>Program Dates:</strong></th>
<th>June 6 – August 12, 2016 (arrive June 5 – depart August 13)</th>
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<tbody>
<tr>
<td><strong>Program Hours:</strong></td>
<td>40 hours per week Monday-Friday (actual hours set by mentor)</td>
</tr>
<tr>
<td><strong>Stipend:</strong></td>
<td>$12,000 for 10-week period</td>
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<tr>
<td><strong>Lodging:</strong></td>
<td>Student’s expense - Click on items below for lodging options:</td>
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<td></td>
<td>• Wright State University Summer Housing</td>
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<td>• Apartment Finder</td>
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<td>• Local Hotel Search</td>
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<tr>
<td><strong>Research Locations:</strong></td>
<td>Wright-Patterson AFB, Dayton, OH or Ft Sam Houston, San Antonio, TX</td>
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<tr>
<td><strong>Number of Positions:</strong></td>
<td>Approximately 12 students will be selected for participation</td>
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<tr>
<td><strong>Requirement:</strong></td>
<td>• Graduate students and undergraduate juniors and seniors.</td>
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<td></td>
<td>• Must be a U.S. citizen</td>
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<td><strong>Final Report:</strong></td>
<td>PowerPoint presentation or poster at end of internship</td>
</tr>
<tr>
<td><strong>Application Deadline:</strong></td>
<td>February 26, 2016 at 5:00 p.m. EST</td>
</tr>
</tbody>
</table>

**Application:**

1. Application form (below on page 5)
2. Curriculum Vitae
3. Copy of Transcript (unofficial is sufficient)
4. Copy of proof of U.S. citizenship
5. Letter of recommendation from current faculty adviser (if sent directly from your advisor, please have them add your name in the subject line)

**Proof of U.S Citizenship**

(submit 1 of the items shown on list with application)

- Copy of U.S. Passport
- Copy of Certified birth certificate issued by the city, county or state of birth
- Copy of Certification of Birth or Consular Report of Birth (of U.S. citizen) Abroad
- Copy of Naturalization Certificate
- Copy of Certificate of Citizenship

**Application Submission Instructions**

Send: (1) application form, (2) Curriculum Vitae, (3) copy of transcript, (4) copy of proof of U.S. citizenship, and (5) signed letter of recommendation from adviser by email to: 711th HPW Chief Scientist’s Office at 711.hpw.chiefscientist@us.af.mil. NOTE: Be sure to indicate on the application the project for which you are applying. If more than one, please indicate your priority by entering the research project number in the appropriate choice box.

**Notification:**

Students selected for the program will receive a fellowship with the Oak Ridge Institute for Science and Education (ORISE) to perform duties in the 711th Human Performance Wing and will be required to undergo a National Agency Check before being granted access to government computer systems. This is not a U.S. Government position.

**For More Info:**

Mike Reynolds, 937-255-7629, mike.reynolds.ctr@us.af.mil
Repperger Research Intern Program

RESEARCH PROJECT #: 16-01

INVESTIGATION OF BIOLOGICAL RESPONSE TO ELECTROMAGNETIC EXPOSURE

PROJECT SYNOPSIS: Understanding the mechanism(s) underlying the interaction of electromagnetic (laser, thermal, short-pulse electric) energies with biological systems is integral for development of novel technologies provided by interfacing these energies with biology. This project focuses on understanding the subtle impacts of electromagnetic energy on cells, with a particular focus on the plasma membrane. Depending on the interests of the researcher, advanced optical imaging techniques such as coherent Raman scattering, high-speed imaging, STED, or confocal or multi-photon microscopy may be used to observe the effects on neurons and immortalized cells from stimulation by electromagnetic sources. Additionally, wave propagation in neurons may be explored with laser trapping and fluorescence correlation. Candidates with expertise in neuroscience seeking to expand their techniques repertoire by combining optical approaches with single cell events, such as patch clamp for investigation of their observed cell response phenomenon, are particularly desired, as well as those individuals with demonstrated experience with novel optical sensing and imaging applications.

STUDENT LEVEL/DISCIPLINE NEEDED: PhD or Master’s/ Biomedical Engineering, Neural Science, Biochemistry

RESEARCH LOCATION: Optical Radiation Bioeffects, Fort Sam Houston, TX

RESEARCH ADVISER: Hope Beier, PhD

DEGREE: Biomedical Engineering, Texas A&M University, 2009

Hope Beier is a principle investigator for efforts in applying optical techniques to explore the effects of directed energy on biology. She is PI on two three-year Air Force Office of Scientific Research LRIR grants: one to study the biomechanisms underlying infrared stimulation of neural tissue and a second to examine the thermodynamic propagation of solition waves in neuronal axons during action potentials. She also leads efforts exploring the biomechanisms of infrared stimulation and use of stimulated emission depletion (STED) nanoscopy to study membrane dynamics. Dr. Beier joined the Air Force Research Laboratory in 2010 as a National Research Council Postdoctoral Research Associate and is currently working as a Research Biomedical Engineer.
Repperger Research Intern Program

RESEARCH PROJECT: 16-02

MODELING MULTITASKING FOR HUMAN COMPUTER INTERACTION

PROJECT SYNOPSIS: The goal of this research is to develop cognitive models for analyst multitasking that can be used to guide adaptive interface designs. Models of interest include computational cognitive and biomechanical models to simulate behaviors and mathematical models for characterizing response dynamics (e.g., sequential sampling models, workload capacity coefficients, Gaussian Processes). We apply models to response times and choices, eye tracking, motor tracking, EEG and other physiological measures. Models that further integrate latent variable models are of interest, including personality and multitasking preference. The Repperger Intern joining the team will work on model development or apply models to multitasking data sets collected in the lab. S/he may aid in additional data collection. S/he will help develop visualizations of human data and model behaviors in order to aid in visual analytics, deepen model comparisons, and provide effective methods for communicating findings. Experience in human subjects research and in mathematical or statistical cognitive modeling, as well as programming skills in R/Matlab/Python, will be helpful.

STUDENT LEVEL / DISCIPLINE NEEDED:
Master’s/ Statistics, Mathematical Psychology, Mathematics, Cognitive Science
PhD/ Cognitive Science, Statistics, Mathematical Psychology, Mathematics

RESEARCH LOCATION: Battlespace Visualization, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Leslie M. Blaha, PhD

DEGREE: Psychology – Cognitive Science, Indiana University, 2010

Mathematical psychologist Dr. Leslie Blaha joined the U.S. Air Force Research Laboratory in 2010 to pursue in-house basic research in the Battlespace Visualization Branch. Her doctoral research was completed in the Mathematical Psychology Lab of Dr. James Townsend, where she developed a non-linear dynamic systems model of perceptual learning and visual perceptual expertise. Her research interests include statistical modeling of high dimensional and asymmetric data for visualization, and models of human visual decision making efficiency and expertise. Current efforts are focused on integrating mathematical and computational cognitive modeling tools for more effective modeling of workload efficiency in dynamic multitasking visualization environments. Visit http://sai.mindmodeling.org
Repperger Research Intern Program

RESEARCH PROJECT: 16-03

HUMAN-MACHINE INTERFACE DESIGN (HUMID) FOR OPTIMAL AEROMEDICAL EVACUATION PAIN MANAGEMENT STRATEGIES

PROJECT SYNOPSIS: The cumulative effects of flight on warfighter health and performance are of great interest across all Department of Defense agencies and are especially important for Air Force aeromedical personnel. Among the critical research needs is an in-depth understanding of the efficacy and safety of medications during in-flight transport. Many therapeutic interventions pre-flight and during flight include pain management strategies, of which the majority are active within the brain. It is therefore of the utmost importance that drug absorption by the brain at altitude is understood and taken into account during treatment. The overall goal of this program is to fully address a need for determining optimal time-to-fly patients by developing a simple to use interface based on experimental and computational models for predicting the optimal in-flight dosing regimen for medications during transport. The specific aim of work being proposed here is to exploit laboratory evidence demonstrating changes in blood brain barrier permeability at altitude into a user-friendly, mobile interface for use by flight surgeons. These flight surgeons are responsible not only for ensuring adequate treatment of our injured brothers and sisters at arms, but also with ensuring safe and effective pain management during evacuation.

STUDENT LEVEL / DISCIPLINE NEEDED:
Bachelor’s/ Computer Science, Information Sciences, Biomedical Engineering
Master’s/ Computer Science, Biomedical Engineering, Information Sciences
PhD/ Computer Science, Information Sciences, Biomedical Engineering

RESEARCH LOCATION: United States Air Force School of Aerospace Medicine, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Richard Chapleau, PhD

DEGREE: Chemistry, University of California, Santa Barbara, 2009

Dr. Richard Chapleau is a Research Biochemist in the US Air Force School of Aerospace Medicine’s Aeromedical Research Department. He currently leads research efforts in biosurveillance, human genomics, and technology evaluations. Prior to joining USAFSAM in 2013, Dr. Chapleau was a member of the Molecular Bioeffects Branch of the Human Effectiveness Directorate where he led the development efforts of novel therapeutics for nerve agent poisoning, including developing computational models of specific effects. His primary research goal is to develop tools capable of being used in less than 5 years by downrange Airmen, Sailors, Marines and Soldiers.
Repperger Research Intern Program

RESEARCH PROJECT: 16-04

SYSTEMS ENGINEERING OF AEROMEDICAL RESEARCH
AND TRAINING EQUIPMENT

PROJECT SYNOPSIS: The 711th Human Performance Wing will be man-rating and preparing to enter Initial Operating Capacity of a high G Centrifuge and several hypobaric chambers during the summer of 2016. There are numerous systems engineering and/or operations research trade studies and procedure verifications that need to be accomplished, including a consistency and compibility study of operator's manuals and training materials. Most importantly will be a detailed study of the performance of the Advanced Tactical Flight Simulator. The student would perform document and literature analysis as well as performance assessment of the new facility. Included will be a familiarization with the Perception Driven Robotic Control System developed by Dr. Repperger.

STUDENT LEVEL / DISCIPLINE NEEDED:
Bachelor’s/ Biomedical Engineering, Human Factors, Systems Engineering
Master’s/ Operations Research, Biomedical Engineering, Systems Engineering

RESEARCH LOCATION: Warfighter Readiness Research, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Tamara Chelette, PhD

DEGREE: Biomedical Engineering, Wright State University, 1994

Dr Chelette is a Principal Research Biomedical Engineer and Extramural Program Manager for the Warfigher Readiness Research Division. One of her current reseach interests is in the usablity and efficacy of new state-of-the-art Aerospace Medical Research and Training simulators. She is a Fellow of the Aerospace Medical Association and the Aerospace Human Factors Association. Dr Daniel Repperger was her PhD Advisor.
Repperger Research Intern Program

RESEARCH PROJECT: 16-05

PAIN MANAGEMENT IN EN ROUTE CARE (ERC)

PROJECT SYNOPSIS:  A series of studies are taking place to provide rigorous scientific evidence to inform clinical practice during ERC. Our goal is to optimize pain management within en route care by addressing physical, cognitive and systems-related issues. Findings from previous studies within military care, clinical practice guidelines and civilian pain management strategies will drive this research area. We use a variety of approaches that monitor and intervene to optimize pain management practices within ERC. Various research methodologies are utilized to address pain management to include qualitative, quantitative, mixed methods and experimental designs. The interdisciplinary team that manages this program of research draws on each person’s unique capabilities to address the complex issue of optimal pain management. We seek an intern who can contribute to this research program by collecting data, reviewing pertinent literature and work with others to analyze data. Specific ERC experience or knowledge is not required. This opportunity will provide the intern invaluable experience of working with an interdisciplinary team to acquire knowledge of research methodology, data collection, management, analysis and dissemination on topics related to pain management.

STUDENT LEVEL / DISCIPLINE NEEDED:
Other/ Nursing, Health Sciences

RESEARCH LOCATION:  United States Air Force School of Aerospace Medicine, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER:  Susan Dukes, PhD

DEGREE:  Nursing Science, University of Maryland, Baltimore, 2010

Lt Col Susan F. Dukes has been a member of the Aeromedical Research Department within USAFSAM since September 2010. In 2014, she assumed the role of AE/CCAT Team Lead and Core Research Competency Lead. She currently is the Division Chief for the En Route Care Research Division. Her USAF experience has been diverse and extensive beginning as a critical care nurse. After obtaining a Masters in Trauma/Critical Care, she became a Critical Care Clinical Nurse Specialist and served as a White House Nurse for over four years. She deployed in support of OPERATION ENDURING FREEDOM (OEF) as the Deputy Director of the Joint Combat Casualty Research Team (JC2RT) and currently is the Military Consultant to the Surgeon General for Nursing Research.
Repperger Research Intern Program

RESEARCH PROJECT: 16-06

EFFECTS OF TASK INTERRUPTIONS ON WORKLOAD AND SITUATION AWARENESS IN DEFENSIVE CYBER OPERATIONS

PROJECT SYNOPSIS: Defensive cyber operations require analysts to sustain attention in order to detect occasional, often disguised, evidence of cyberattacks in a background of false alarms – a task that also entails substantive levels of cognitive workload (Sawyer et al., 2014). An anecdotal, but common complaint of analysts engaged in defensive cyber operations is the frequency and volume of task interruptions they experience during execution of their primary duties. Previous research examining the effects of interruptions on task performance in other military contexts (e.g., Loft, Sadler, Braithwaite, & Huf, 2015) suggests that interruptions may have a pervasive negative impact on subsequent task performance and situation awareness. However, the impact of interruptions in cyber defense tasks has yet to be examined and quantified. Consequently, the goal of this research project will be to examine the performance impact of task interruptions on operators performing cyber defense monitoring. In addition, this research will assess operator cognitive workload and situation awareness using self-report and physiological metrics to further explicate the effects of interruptions analysts.

STUDENT LEVEL / DISCIPLINE NEEDED:
Master’s/ Human Factors Psychology, Experimental Psychology, Psychology
PhD/ Human Factors Psychology, Experimental Psychology, Psychology

RESEARCH LOCATION: Applied Neuroscience, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Gregory Funke, PhD

DEGREE: Experimental Psychology (Human Factors), University of Cincinnati, 2007

Dr. Funke is an Engineering Research Psychologist in the Air Force Research Laboratory’s Applied Neuroscience Branch. His current research foci are cyber operations and understanding team processes that contribute to team successes and failures.
PROJECT SYNOPSIS: Advances in computational architectures for simulating cognition have provided increasingly broad and detailed accounts of the foundational mechanisms of human information processing that support complex cognition in a variety of domains. In recent years, theories have made greater connection to neurofunctional data, like fMRI, to inform and constrain theoretical accounts. This project builds upon that research in two critical ways. First, the focus of the research is on the vigilance decrement, it is one of a variety of factors, called cognitive moderators, which continually impact the efficiency and effectiveness of goal-directed processing. Computational models of cognitive moderators are rare, despite their relevance and importance in real-world environments. Secondly, the research will seek to link evidence from EEG data to computational models, expanding the constraints applied in developing models of human cognition. The project involves working with an existing model of the vigilance decrement, along with EEG data from a recent experiment to identify theoretical links between the proposed mechanisms and evidence from the EEG results. The goal is to develop new approaches to link EEG data to computational mechanisms to better understand the vigilance decrement, its causes, and the underlying impacts to the cognitive system that produce it.


RESEARCH LOCATION: Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Glenn Gunzelmann, PhD


Dr. Gunzelmann is a Senior Research Psychologist and the Science and Technology Advisor for the Air Force Research Laboratory's Cognitive Model's and Agents Branch (711 HPW/RHAC). The branch conducts research into the science and application of computational and mathematical models of the human mind. The technology objectives are to create validated, adaptive, and credible constructive agents for Live, Virtual, Constructive (LVC) training, and to enable autonomous agents for human-machine teams in contested environments. Dr. Gunzelmann's background is in developing computational models of human cognition, and leads research in modeling the effects of fatigue on cognition.
Repperger Research Intern Program

RESEARCH PROJECT: 16-08

COMPUTATIONAL MODELS OF HUMAN INFORMATION PROCESSING

PROJECT SYNOPSIS: This research focuses on basic cognitive science research to improve our understanding of human information processing, behavior, and performance. The long-term goal is to develop psychologically valid models of human cognition that can be used in a variety of ways to improve the effectiveness and efficiency of training (e.g., as synthetic teammates or instructors to support training, or as training analysis tools). We are pursuing this long-term objective through the use of computational cognitive modeling, focused on changes in cognitive performance resulting from sleep loss and extended time on task. We utilize a variety of research methodologies, including empirical research studies with human participants, cognitive model development using multiple modeling formalisms, validation of model performance through careful comparison to empirical human data, and development of quantitative theoretical mechanisms to account for important psychological phenomena. We seek interns who can contribute to the development of formal, quantitative accounts of human performance in the context of fatigue and/or other areas of research within the Cognitive Models and Agents Branch. Some relevant publications can be found at: http://palm.mindmodeling.org/~glenng/ for research on fatigue; http://palm.mindmodeling.org/palmListings/ for a complete listing of research being pursued by the Cognitive Models and Agents Branch at AFRL.

STUDENT LEVEL / DISCIPLINE NEEDED:
Master’s/ Cognitive Science, Mathematics, Computer Science
PhD/ Cognitive Science, Mathematics, Computer Science

RESEARCH LOCATION: Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Glenn Gunzelmann, PhD


Dr. Gunzelmann is a Senior Research Psychologist and the Science and Technology Advisor for the Air Force Research Laboratory's Cognitive Model's and Agents Branch (711 HPW/RHAC). The branch conducts research into the science and application of computational and mathematical models of the human mind. The technology objectives are to create validated, adaptive, and credible constructive agents for Live, Virtual, Constructive (LVC) training, and to enable autonomous agents for human-machine teams in contested environments. Dr. Gunzelmann's background is in developing computational models of human cognition, and leads research in modeling the effects of fatigue on cognition.
A HIGH THROUGHPUT BIOINFORMATICS METHOD FOR ANALYZING NUCLEOTIDE POLYMERS DEMONSTRATING PHYSIOLOGICAL EFFECTS WITHIN EUKARYOTIC CELLS

PROJECT SYNOPSIS: This project focuses on exploration of cellular function and gene regulation via high-throughput in-silico polymer folding to identify novel secondary and tertiary nucleotide structures demonstrating the potential for powerful interactions with human physiology. Despite recent advances in computational capabilities, in-silico folding of the entire human genome remains an intractable problem. This project analyses viral genomes to reduce the size and scope of the associated problem domain. Because the technology required to complete project goals is novel, most of the requisite tools must be fabricated within the lab. Students interested in combining biology or chemistry with mathematics, engineering, physics, or computer science will have a rich, rewarding research-oriented experience, and will acquire lucrative bioinformatics skills requisite to education as an inter-disciplinary scientist/engineer. Possible project contributions include but are not limited to relational database development, supercomputer script development, R/MatLab add-in development, C++/Java/Objective-C core algorithm development, GUI design, and smart device app development. Successful contributions will also result in multiple peer-reviewed publications.

STUDENT LEVEL / DISCIPLINE NEEDED:
Bachelor’s/ Computer Science, Mathematics, Biology
Master’s/ Computer Science, Mathematics, Biology
PhD/ Computer Science, Mathematics, Biology

RESEARCH LOCATION: Molecular Bioeffects, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Stephen Donald Huff, PhD

DEGREE: Bioinformatics, University of Houston, 2011

Upon arrival at the AFRL (RHDJ) in December of 2011, Dr. Huff has labored to establish a state-of-the-art bioinformatics laboratory to investigate the role RNA structural motifs play within eukaryotic cells. The Biological Informatics Group (BIG) within RHDJ has since acquired substantial applications development capabilities with implementations targeting DoD High Performance Computing (HPC) supercomputers, Windows 8 blade server clusters, as well as iOS (Apple), Android (Google) and Windows 7-10 devices. These implementation include a high-throughput BASH script data management pipeline (HPC), smart device apps (iOS, Android and Windows handheld devices), a large MySQL taxonomic/genomic database system, and a variety of ancillary software tools developed in Python, R, MatLab & C++. 
PROJECT SYNOPSIS: Engineered nanomaterials (NM), within dimensions ranging between 1-100 nm in size, possess novel physical and chemical properties that can be applied to create uniquely engineered devices. NM quantum characteristics can confer unique electrical, optical and magnetic properties at the nanosystem level with attributes not found in the corresponding prepared bulk chemical materials. Nano-scale prepared materials are useful for military applications with engineering aspects important for portable battlefield systems such as remote monitoring devices. This project will seek to understand the fundamental mechanism of interaction of engineered nanomaterials based on their unique physiochemical characteristics including, dimensional size, structure, shape and surface chemistries that can interact with cultured cell components that initiate novel molecular events such as membrane receptor modulation, enhanced endocytosis dynamics and subcellular signal activation. The work supports the understanding of the interaction between biological systems and novel human synthetically engineered nanomaterials to aid in the development of novel material-based biosensors for military applications.

STUDENT LEVEL / DISCIPLINE NEEDED:
Bachelor’s/ Biomedical Engineering, Chemistry
Master’s/ Biomedical Engineering, Chemistry

RESEARCH LOCATION: Molecular Bioeffects, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Saber Hussain, PhD

DEGREE: Biology, Indian Institute of Chemical Technology, 1991

Dr. Hussain is the Senior Toxicology Scientist and Nanotoxicology Group Lead, for the Air Force Research Laboratory’s Molecular Bioeffects Branch. He began his scientific career in 1987 as a toxicology research fellow at the Indian Institute of Chemical Technology (IICT) and received his doctorate degree in 1991. Here, his novel exploration of heavy metal biotransfer between different proteins in complex biological environments led to a series of prestigious research fellowships in Italy, Switzerland, and the U.S.. Dr. Hussain joined the Air Force Research Laboratory at Wright-Patterson AFB in 1999, where his research interests transitioned into evaluating potential toxicity arising from the physicochemical properties of nanoscale structures.
Repperger Research Intern Program

RESEARCH PROJECT: 16-11

3-D SATELLITE ANALYSIS USING MOTION PARALLAX

PROJECT SYNOPSIS: The student will develop a simulation of satellite proximity operations in a virtual 3-D environment. This simulation will be used in a study where subjects will try to determine if one satellite is spying on another (Satellite A's camera is facing Satellite B's sensor). New 3-D display technology will be used to evaluate relationships between two or more space objects. In particular this study will assess how well an observer can determine if an object is intentionally pointing at (e.g., taking pictures of) another object. The study will compare benefits, if any, of the 3-D technology compared to unenhanced 3-D. With guidance from the mentor, the student will develop simulations that are conducive to comparative studies. This may just involve two boxes with various motions to simulate rendezvous and tumbling. The technology of this effort exploits motion parallax, which is a powerful depth cue derived from an observer’s head movement. When people think of 3-D simulation, many will picture an audience wearing cardboard glasses. These glasses only provide one depth cue (stereoscopic vision) but in the real world depth is actually perceived with many cues including motion parallax. New technology that track head/eye position is allowing motion parallax to be simulated but it still is not clear how much analytic value this can provide. This effort will give an indication as to if or when such immersive technology can be useful for space analysts.

STUDENT LEVEL / DISCIPLINE NEEDED:
Master’s/ Computer Science, Experimental Psychology, Human Factors

RESEARCH LOCATION: Battlespace Visualization, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: John D. Ianni, MS

DEGREE: Computer Science, Wright State University, 1993

Over 30 years ago, Mr. Ianni started performing ground-breaking research in 3-D simulation including virtual and augmented reality. The research then was focused on anthropometric (human body) models used for cockpit and maintenance accommodation. Fifteen years later, Mr. Ianni changed his focus to human-in-the-loop needs for space including on-orbit servicing, satellite operations, space situational awareness and space command and control. Mr. Ianni has been the face of RH and the 711th Human Performance Wing to Air Force Space Command (AFSPC), Space and Missile Systems Center (SMC), AFRL space directorates (RV & RD) at Kirtland AFB, and other space organizations.
Repperger Research Intern Program

Research Project: 16-12

Impact of Short Pulse Electromagnetic Fields on Mammalian Cells

Project Synopsis: Our laboratory’s goal is to understand the biological effects of high peak power microwaves. Utilizing directly applied nanosecond pulsed electric fields (nsPEF) as a microwave surrogate; we study changes in cell plasma membrane structure, morphology and physiological, and genetic and proteomic expression. To study such changes, we use electrophysiological and optical microscope systems to record changes in membrane conductance in real time allowing for the determination of thresholds for effect of various nsPEF exposure parameters. In addition, we study the impact of such pulses on neurological cells to investigate the impact of electrical pulses on the conduction of action potentials. Genetic and proteomic techniques are used in conjunction with an exposure system capable of exposing a population of cells to elucidate stressful and lethal exposure endpoints. Lastly, we pursue the development of theoretical models that describe and predict the impact and response of cells exposed to nsPEF. We aim to generate models that compliment empirical results to predict observed cellular effects and lethality. The overarching aim of this research effort is to generate a comprehensive model that can predict the field distribution and biological impact of high peak power microwave exposures to ensure soldier safety in the battlefield.

Student Level / Discipline Needed:
Bachelor’s/ Biomedical Engineering, Electrical Engineering, Biology
Master’s/ Biomedical Engineering, Electrical Engineering, Biology
PhD/ Biomedical Engineering, Electrical Engineering, Biology

Research Location: Radio Frequency Bioeffects, Fort Sam Houston, San Antonio, TX

Research Adviser: Bennett Ibey, PhD

Degree: Biomedical Engineering, Texas A&M University, 2006

Dr. Ibey began working for the Air Force Research Laboratory in 2007 as the Principal Investigator of high peak power microwaves (HPPM) bioeffects. His research includes the construction of HPPM microwave systems, the use of patch clamp to study cellular bio-electric effects, the development of theoretical models, cellular microscopy, and the measurement of genetic or proteomic effects of HPPM exposure. Dr. Ibey has published 1 book chapter, 2 patents, and 34 peer-reviewed publications. He is a board member of Bioelectromagnetics Society, active member of SPIE, and the Direct Energy Professional Society. He was named the AF Junior Civilian Scientist of the Year 2010 and received an honorable mention for the McLucas Basic Science Award in 2010.
**Repperger Research Intern Program**

**RESEARCH PROJECT: 16-13**

**ENHANCING COMMUNICATION IN COMPLEX, AUTOMATION-RICH ENVIRONMENTS**

**PROJECT SYNOPSIS:** Tomorrow's AF will require operators to interact with many sources of automation from assistive agents like intelligent route planners or even fully autonomous systems like UAVs and surveillance satellites. This increased level of automation comes with the ability to communicate from anywhere with anyone in adverse and often rapidly changing environments, thus posing an interesting challenge to communication effectiveness. The aim of the research effort is to develop the scientific foundations of how interlocutors adapt the acoustic and/or linguistic aspects of their speech in disparate environmental/acoustic barriers in order to motive the design of more robust and novel speech output systems. Aspects of projects might include evaluating ways in which how talkers modify/adapt their speech patterns, the time-course/pattern of any adaptation that occur in these environments and whether or not these modifications/adaptations result in measurable benefits in intelligibility or communication effectiveness.

**STUDENT LEVEL / DISCIPLINE NEEDED:**
Bachelor’s/ Hearing Science, Psychology, Electrical Engineering  
Master’s/ Psychology, Electrical Engineering, Cognitive Science  
PhD/ Psychology, Electrical Engineering, Cognitive Science

**RESEARCH LOCATION:** Battlespace Acoustics, Wright-Patterson AFB, Dayton, OH

**RESEARCH ADVISER:** Nandini Iyer, PhD

**DEGREE:** Speech and Hearing Science, Ohio State University, 2001

Dr. Nandini Iyer is a Research Audiologist in the Battlespace Acoustics Branch. Her research interests include basic research in the areas of speech perception and communication in complex listening environments and the role of spatial hearing in improving auditory situation awareness as well improve intelligibility. Dr. Iyer has several journal articles in top-tier journals and conference proceedings in the area of speech perception and auditory masking. She was a member of the AFOSR Star Team and also completed a postdoctoral fellowship at the National Academy of Sciences. Dr. Iyer is currently a member of the Acoustical Society of America and the Association for Research in Otolaryngology.
PROJECT SYNOPSIS: The current research will involve laboratory studies to identify factors that influence the process of trust calibration between humans and machines. The project will include understanding multi-modal communication methods that enable humans to calibrate trust with robotic partners. Example methods may include but are not limited to task oriented dialogue, joint action cues, and spatial movement indicators within a human-robot interaction. The most promising methods will be demonstrated as a suite of fundamental Baxter Research Robot behavior capabilities that can be used in a set of experiments that manipulate aspects of transparency between humans and machines in order to gauge their impact on trust and performance.

STUDENT LEVEL / DISCIPLINE NEEDED: Master’s/ Mechanical Engineering

RESEARCH LOCATION: Human Trust and Interaction, Wright-Patterson AFB, Dayton OH

RESEARCH ADVISOR: Joseph Lyons, PhD

DEGREE: Industrial/Organizational Psychology, Wright State University, 2005

Dr. Lyons is the Technical Advisor of the Human Trust and Interaction Branch within the Human-Centered ISR Division, Human Effectiveness Directorate. Dr. Lyons has technical interests in the area of human-machine trust in domains such human-automation interaction, human-robot interaction, and human-machine teaming. More specifically, Dr. Lyons is interested in understanding what dispositional factors, transparency factors, and contextual factors shape the trust calibration process between humans and machines.
Repperger Research Intern Program

RESEARCH PROJECT: 16-15

ASSESSMENT OF POST-DEPLOYMENT MENTAL HEALTH PROBLEMS IN AIR FORCE MILITARY MEDICAL PERSONNEL

PROJECT SYNOPSIS: The purpose of this project is to conduct a correlational study to determine the association between post-deployment incident mental health conditions in Air Force healthcare providers and the following: a) healthcare utilization, b) pharmacotherapy use, and c) performance-related outcomes. The intern will investigate the relationship between post-deployment mental health conditions and a variety of variables including demographic characteristics, deployment environmental and occupational exposures, and health-related data to determine risk and/or protective factors.

STUDENT LEVEL / DISCIPLINE NEEDED:
Master’s/ Operations Research, Information Sciences, Industrial/Organizational Psychology, Social Psychology
PhD/ Operations Research
Other/ Biostatistics/Statistics

RESEARCH LOCATION: United States Air Force School of Aerospace Medicine Wright-Patterson AFB, Dayton OH

RESEARCH ADVISER: Gen Maupin, MS

DEGREE: Public Health, University of Rochester, 2008

Ms. Gen Maupin, MPH, is a quantitative research epidemiologist with over ten years of research experience in immunology, respiratory diseases, en route care, and occupational and aerospace medicine. Her methodological interests are in descriptive epidemiology, secondary data analysis, and predictive analytics.
PROJECT SYNOPSIS: Protecting the health of military operators involves assessing, treating, and developing countermeasures to illness, injury, or exposure to foreign substances commonly encountered in harsh and varied environments. A complicating factor in this is the wide range of responses that exist for every treatment or exposure due to underlying differences in each person’s genetic profile. Understanding how genetics influences response to chemical exposure is critical for advancing the Air Force’s Total Exposure Health. This effort seeks to develop a high content analysis assay utilizing a diverse panel of genetically characterized cell lines exposed to known toxic chemicals or pharmaceutics to identify the specific genetic polymorphisms that correlate with differential phenotypic responses. We seek interns who can apply their expertise to either A) identify correlations between genetic markers and differential phenotypic cell responses or B) can contribute to the execution of our high content analysis assay.

STUDENT LEVEL / DISCIPLINE NEEDED:
Master’s/ Information Sciences, Computer Science
PhD/ Information Sciences, Computer Science, Biochemistry
Other/ Bioinformatics

RESEARCH LOCATION: United States Air Force School of Aerospace Medicine, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Lt Col Kathy Fullerton, PhD

DEGREE: Chemical Engineering, University of Akron, 1988

Lieutenant Colonel Kathy Fullerton, a bioenvironmental engineer, currently serves as the lead for the US Air Force School of Aerospace Medicine’s Force Health Protection Research team. The branch pursues basic and applied research to develop and/or improve methods to measure occupational exposures to a variety of hazards and to assess the human health and performance risks from these exposures. LtCol Fullerton is currently involved in research promoting the Total Exposure Health Initiative which looks at exposure/risks to a specific individual through development of individual passive dosimeters and high throughput assays.
Repperger Research Intern Program

RESEARCH PROJECT: 16-17

PERSONALIZED SPATIAL AUDIO FOR VIRTUAL/AUGMENTED REALITY

PROJECT SYNOPSIS: Tomorrow's Air Force will rely heavily on the use of virtual and augmented reality for providing non-obstructive information displays, realistic training opportunities, and effective presence in teleoperations. Unfortunately, the bulk of today's technology is focused primarily on providing realistic and compelling visual environments, with less regard for the important role our auditory system plays in maintaining immersion and situation awareness. Our research hopes to help close this gap through the design, development, and validation of spatial sound field capture, synthesis and rendering technologies for use in virtual and augmented reality displays. The current project will involve incorporation of personalized head-related transfer function technology into existing spatial audio rendering software for use with low-cost VR/AR platforms (e.g. Oculus Rift, Google Cardboard, etc.), and the design of interactive “games” to objectively measure and validate various spatial audio rendering technologies.

STUDENT LEVEL / DISCIPLINE NEEDED:
Master's/ Computer Science, Electrical Engineering, Psychology
PhD/ Computer Science, Electrical Engineering, Psychology

RESEARCH LOCATION: Battlespace Acoustics, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Griffin Romigh, PhD

DEGREE: Electrical and Computer Engineering, Carnegie Mellon University, 2012

Dr. Griffin Romigh is a research engineer and the program manager of the Enhanced Tactical Communication Group within the Battlespace Acoustics Branch. Dr. Romigh's research interests include the application of signal processing and machine learning techniques to solve problems in the areas of auditory situation awareness and communication. Dr. Romigh has authored or co-authored several peer-reviewed manuscripts, conference proceedings, and a book chapter within the topics of spatial hearing, head-related transfer functions, and speech communication, and was selected as an AFOSR STAR Team member and awarded the Dept. of Defense SMART Scholarship in 2009.
Repperger Research Intern Program

RESEARCH PROJECT: 16-18

DEVELOPMENT OF A MOBILE SOFTWARE APP FOR TEAM-BASED PHYSIOLOGICAL MONITORING IN FIELD TRAINING ENVIRONMENTS

PROJECT SYNOPSIS: In collaboration with the US Air Force Academy, RHCP researchers are working to develop a mobile software app that will provide real-time physiological information and multiple field soldiers to a dismounted commander in charge of monitoring and modulating the behavior of his/her Airmen. Initial app concept needs, user interface design and data transmission structure have been established. The next step is to program and test the app before it is used in laboratory studies and submitted to entry-level field tests.

STUDENT LEVEL / DISCIPLINE NEEDED:
Bachelor’s/ Computer Science, Information Sciences, Systems Engineering
Master’s/ Computer Science, Information Sciences, Systems Engineering
PhD/ Computer Science, Information Sciences, Systems Engineering

RESEARCH LOCATION: Applied Neuroscience, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Adam Strang, PhD

DEGREE: Cognitive Psychology, Miami University, 2010

Dr. Adam Strang is director of the PaCE (Physical and Cognitive Enhancement) research team. He is a certified and licensed Athletic Trainer with clinical experience in musculoskeletal injury prevention and management. In addition, he has a PhD in cognitive psychology, which includes expertise in cognitive test batteries, psychophysiology, and nonlinear time-series analysis. To date, Dr. Strang has authored more than 60 peer reviewed research articles and presentations.
REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: 16-19

NUTRITION AND EXERCISE ENHANCEMENT
OF PHYSICAL AND COGNITIVE PERFORMANCE

PROJECT SYNOPSIS: The objective of this study is to examine the combined effects of an innovative nutritional supplement and functional exercise intervention on Airmen physical and cognitive performance. Specifically, this research will evaluate, for the first time in humans, whether a nutritional supplement developed specifically to enhance cognitive function and muscle recovery can accelerate the positive relationship that is known to exist between physical fitness and cognitive function.

STUDENT LEVEL / DISCIPLINE NEEDED:
Bachelor’s/ Experimental Psychology, Human Factors Psychology, Psychology
Master’s/ Experimental Psychology, Human Factors Psychology, Social Psychology
PhD/ Experimental Psychology, Human Factors Psychology, Psychology

RESEARCH LOCATION: Applied Neuroscience, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Adam Strang, PhD

DEGREE: Cognitive Psychology, Miami University, 2010

Dr. Adam Strang is director of the PaCE (Physical and Cognitive Enhancement) research team. He is a certified and licensed Athletic Trainer with clinical experience in musculoskeletal injury prevention and management. In addition, he has a PhD in cognitive psychology, which includes expertise in cognitive test batteries, psychophysiology, and nonlinear time-series analysis. To date, Dr. Strang has authored more than 60 peer reviewed research articles and presentations.
A PRACTICAL WAVE FIELD SYNTHESIS SYSTEM FOR STUDYING SOUND LOCALIZATION

PROJECT SYNOPSIS:  Wave field synthesis is a method of creating virtual acoustic environments within a bounded area or volume through overlaying the sound fields emitted from numerous loudspeakers in an array. We are developing a circular loudspeaker array for the purpose of studying sound source localization with a portable system. This system could be useful to the Air Force for field or clinical tests of localization for determining an airman’s fitness for duty, or for measuring the impact of hearing protection on localization ability. Accurate sound source localization requires the presentation of frequencies that are above the limits of typical wave field synthesis systems, due to spatial aliasing. The new system overcomes this with a dense array of speakers. With this project, we will test the limits of our new system through simulation, as well as through measurements on the implemented system.

STUDENT LEVEL / DISCIPLINE NEEDED:
Bachelor’s/ Electrical Engineering, Computer Science, Mechanical Engineering
Master’s/ Electrical Engineering, Computer Science, Mechanical Engineering
PhD/ Electrical Engineering, Computer Science, Mechanical Engineering

RESEARCH LOCATION:  Battlespace Acoustics, Wright-Patterson AFB, Dayton, OH
RESEARCH ADVISER:  Eric Thompson, PhD
DEGREE:  Electrical Engineering, Technical University of Denmark, 2009

Dr. Eric Thompson is a research engineer with the Battlespace Acoustics branch. His research interests include developing models of auditory perception including signal detection, spatial hearing and communication.
A COMPARISON OF METABOLIC MEASUREMENTS USING VARIOUS PHYSIOLOGICAL MONITORING DEVICES

PROJECT SYNOPSIS: Feedback from physiological monitoring devices during missions in the battlefield or in an aircraft can provide military operators with individualized knowledge of cardiac and metabolic status to enable real-time adjustments in physical workload. Individualized augmentation of workload can prevent mishaps and injuries. The primary purpose of this study is to determine the accuracy of various physiological monitoring devices that can be worn in settings in which traditional laboratory equipment is not practical, such as in the battlefield and in an aircraft. The intern will work with a team of investigators to perform human subject testing of commercial devices and devices that are still in development. Management of the devices, data transfer, and data analysis will be required. Accuracy of the devices when compared with gold standard laboratory equipment will be analyzed to evaluate usefulness in field settings.

STUDENT LEVEL / DISCIPLINE NEEDED:
Bachelor’s/ Biomedical Engineering, Human Factors
Master’s/ Biomedical Engineering, Human Factors
PhD/ Biomedical Engineering, Human Factors
Other/ Physiology

RESEARCH LOCATION: United States Air Force School of Aerospace Medicine, Wright-Patterson AFB, Dayton, OH

RESEARCH ADVISER: Molly Wade, MS

DEGREE: Exercise Physiology, Northern Arizona University, 2003

Ms. Molly Wade, MS, is a research physiologist in the Department of Aeromedical Research specializing in exercise and aerospace physiology. Her current research involves wearable and equipment-mounted sensor technologies to monitor physiological workload as well as physical training and pharmaceutical interventions to improve performance and decrease musculoskeletal injuries in military populations.
REPPERGER RESEARCH INTERNSHIP PROGRAM

RESEARCH PROJECT: 16-22

COGNITIVE AND HUMAN FACTORS OF ANOMALY DETECTION

PROJECT SYNOPSIS: Many jobs require a person to detect anomalies in routine data input streams. Tasks range from those of Air Traffic Controllers and rush-hour traffic reporters who view video-feeds under real-time pressures; whereas medical researchers and stock market analysts follow large volumes of text data over days to spot new breakouts and trends. Unfortunately, key signals often go undetected and planes crash or markets plummet. We need answers to three questions: How prevalent are failures to detect both "obvious" and subtle items? Why do detection failures occur? How do we improve and aid human monitors? Perceptual and cognitive research shows that people, even when actively looking for anomalies that they have been forewarned about, often miss glaring oddities in dynamic events when they are engaged in information gathering tasks. In addition to psychological research on "change blindness" and "inattention blindness," personality and thinking styles may affect anomaly detection, but the research is still in its infancy. Research projects should focus on the reasons for detection failures and improvement, but also be aware of false alarms and performance quantification. Students can research various factors which contribute to anomaly detection and inattention blindness such as (1) Display factors (e.g., number, position, motion, pattern, & complexity of elements, (2) Task factors (e.g., number of tasks, communications, distractions), (3) Human factors (e.g. training, workload, personality, culture, teamwork). Student will be involved at all phases of research including hypothesis generation, experimental design, data analysis, and documentation. Original ideas encouraged.

STUDENT LEVEL / DISCIPLINE NEEDED:
Bachelor's/ Computer Science, Mathematics, Human Factors
Master's/ Psychology, Human Factors, Biomedical Engineering
PhD/ Psychology, Human Factors, Biomedical Engineering

RESEARCH LOCATION: Human Analyst Augmentation, Wright-Patterson AFB, Dayton OH

RESEARCH ADVISOR: Rik Warren, PhD

DEGREE: Experimental Psychology, Cornell University, 1975

Dr. Warren is a National Research Council Post-Doctoral Advisor and has mentored numerous NRC post-docs and graduate students. He is a perceptual psychologist and currently is interested in failures of perception to detect critical items in rich natural environments, for example, inattention and change blindness. He is also developing statistical methods for finding anomalies in large and small datasets. The role of cultural factors in perception and mis-perception is also central. He serves on three journal editorial boards and is on the program committees of several social dynamics and complex systems conferences.
Project Synopsis: Research has shown that biophysical processes, such as laser-tissue interaction, deviate from the predictions given by traditional mathematical models for short laser exposure times. In general, it was found that the shorter the exposure time is, the stronger the deviation will be. However, generalizing these models by recasting them as fractional order differential equations have resulted in models that show high agreement with experimental observation regardless of exposure duration. The purpose of this project is to analyze these new equations that employ elements of the fractional calculus and apply them to other biophysical phenomena, beginning with thermal diffusion resulting from laser heating. Methods will include an introduction to the fractional calculus; a powerful branch of mathematics dealing with differentiation and integration of arbitrary order, and the development of new analytical and/or numerical models as needed. Secondary objectives will include the development of models that have the capability to simulate combinations of different biophysical processes.

Student Level / Discipline Needed:
Bachelor’s/ Biomedical Engineering, Physics, Mathematics
Master’s/ Biomedical Engineering, Physics, Mathematics
PhD/ Biomedical Engineering, Physics, Mathematics

Research Location: Optical Radiation Bioeffects, Fort Sam Houston, TX

Research Adviser: Andrew Wharmby, PhD

Degree: Biomedical Engineering, University of San Antonio/UTHSCSA, 2013

Andrew Wharmby is a Research Biomedical Engineer in the Optical Radiation Branch at the Air Force Research Laboratory Human Effectiveness Directorate. He joined the Air Force Research Laboratory in 2006 as where he focused on the development and application of digital image and video processing algorithms, automated instrumentation control, and data analysis for the Vision Science team. He then moved to the Modeling and Simulation team where he developed finite element analysis code for simulating real-time dynamic thermal lensing events in the human eye. Upon completing his Ph.D., he returned to RHDO where he now focuses on the application of fractional calculus to solve problems involving directed energy effects on materials and biological systems.
NUMERICAL SOLVER FOR FRACTIONAL ORDER WAVE EQUATION

PROJECT SYNOPSIS: A rudimentary numerical solver has been developed for a newly-derived wave equation that incorporates fractional order derivatives currently being used to describe the dispersion and absorption of electromagnetic radiation in a dielectric material. At present, the numerical solver is fully capable of approximating one dimensional propagation. The purpose of this project is to extend the capabilities of this numerical solver to higher spatial dimensions and coordinate systems so cylindrical and spherical waves can be modeled. Methods will include an introduction to the fractional calculus; a powerful branch of mathematics dealing with differentiation and integration of arbitrary order, and the development of a numerical solver based upon findings from a literature survey. Secondary objectives will include the introduction of energy deposition due to wave absorption in the solver, an analysis of the accuracy and precision of the developed numerical solver, and the optimization of the developed algorithm for its execution on both serial and parallel processing architectures.

STUDENT LEVEL / DISCIPLINE NEEDED:
Bachelor’s/ Mathematics, Physics or Biomedical Engineering
Master’s/ Mathematics, Physics, Mechanical Engineering
PhD/ Mathematics, Physics, Mechanical Engineering

RESEARCH LOCATION: Optical Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

RESEARCH ADVISER: Andrew Wharmby, PhD

DEGREE: Biomedical Engineering, University of Texas San Antonio/UTHSCSA, 2013

Andrew Wharmby is a Research Biomedical Engineer in the Optical Radiation Branch at the Air Force Research Laboratory Human Effectiveness Directorate. He joined the Air Force Research Laboratory in 2006 as an where he focused on the development and application of digital image and video processing algorithms, automated instrumentation control, and data analysis for the Vision Science team. He then moved to the Modeling and Simulation team where he developed finite element analysis code for simulating real-time dynamic thermal lensing events in the human eye. Upon completing his Ph.D., he returned to RHDO where he now focuses on the application of fractional calculus to solve problems involving directed energy effects on materials and biological systems.
Repperger Research Intern Program

RESEARCH PROJECT: 16-25

BIOCHEMISTRY/MOLECULAR BIOLOGY OF PHOTOBIOMODULATION

PROJECT SYNOPSIS: Photobiomodulation (PBM) is the term now used, in place of Low Level Laser (or Light) Therapy, to refer to a general invigoration of cells following exposure to low doses of red or near infrared (NIR) electromagnetic radiation (“light”). Because the first observation of this effect was therapy-like, the vast majority of research on PBM has been therapy oriented. However, PBM has also been shown to protect mouse retina cells in vivo against both methanol toxicity and injurious levels of white light, and also to improve cognition in mice with brain injury. In our hands PBM protects human retinal pigmented epithelium (hTERT-RPE) cells, in vitro, against the lethal effects of a pulse of 2 µm laser radiation, modulates expression of genes associated with growth control and apoptosis, increases levels of nitric oxide in the cells, and stimulates oxygen consumption by mitochondria. Also, we have recently found that 810 nm is ~1.3 times as effective as 637 nm in producing this effect. The goal of this research is to discover the physical, chemical, molecular, biological, and cellular mechanisms of PBM in order to exploit the observed performance and protection effects to the benefit of the warfighter. The effects of light exposures on reduction/oxidation potentials in cells, gene expression (DNA methylation, DNA transcription, RNA translation, protein levels), nitric oxide biochemistry, cyclic GMP synthase, protein phosphorylation, cell cycle perturbations, cell membrane effects, reactive oxygen species and the competing roles of apoptosis and necrosis are all of interest.

STUDENT LEVEL / DISCIPLINE NEEDED:
Bachelor’s/ Biochemistry, Chemistry, Biology
Master’s/ Biochemistry, Biology, Chemistry
PhD/ Biochemistry, Biology, Chemistry

RESEARCH LOCATION: Optical Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

RESEARCH ADVISER: Jeffrey Wigle, PhD

DEGREE: Radiation Biophysics, University of Rochester, NY 1982

Dr Wigle is a Research Biological Scientist in the Optical Radiation Branch of the Bioeffects Division. After completing the Ph.D. , Dr Wigle did a Postdoctoral Fellowship in Genetic Toxicology, then joined the USAF, where he served primarily in research management positions. After leaving the USAF in 1999 he worked as an in-house contractor for the Laser Eye Protection Advanced Development Program, and then was hired as a civilian scientist. His overarching research interest is molecular mechanisms of bioeffects from light-tissue interactions. His current research effort is aimed at understanding the biochemistry of red-light induced photobiomodulation in order to determine how one might exploit those pathways towards enhancing performance and protection of the warfighter.
**Repperger Research Intern Program**

**RESEARCH PROJECT: 16-26**

**MEASURING ABSORPTION COEFFICIENTS OF LIGHT IN CELLS AND SUBCELLULAR FRACTIONS**

**PROJECT SYNOPSIS:** The "first law" of photobiology is that photons must be absorbed to have an effect. For x-rays the unit of absorption is the "Gray," which is 1 Joule/kg of absorbed energy. For visible light and near-infrared radiation (NIR) in the waveband from 400 nm to 1400 nm, no such measure of absorbed dose exists. As a result, biological effects at these wavelengths are measured with units of exposure, i.e. W/cm^2 or J/cm^2. Unfortunately, because of the way light and NIR interact with cells and tissues, absorption isn't uniform as a function of wavelength. This creates problems with the fidelity in bioeffects models of light-tissue interactions. Although there is a recognized need for measures of visible light and NIR absorption, this has not been possible because mammalian cells are very weak absorbers and very strong scatterers of light and NIR and scattering obscures true absorption. A method of measuring absorption coefficients, Integrating Cavity Ring Down Spectroscopy (ICRDS), is exceptionally well-suited for measuring absorption coefficients in weakly absorbing and strongly scattering media. This project entails measuring the absorption coefficients of mammalian cells and subcellular fractions over wavelengths of 400-1400 nm using ICRDS.

**STUDENT LEVEL / DISCIPLINE NEEDED:**
- Bachelor’s/ Physics, Biomedical Engineering, Chemistry
- Master’s/ Physics, Biomedical Engineering, Chemistry
- PhD/ Physics, Biomedical Engineering, Chemistry

**RESEARCH LOCATION:** Optical Radiation Bioeffects, Fort Sam Houston, San Antonio, TX

**RESEARCH ADVISER:** Jeffrey Wigle, PhD

**DEGREE:** Radiation Biophysics, University of Rochester, NY 1982

Dr Wigle is a Research Biological Scientist in the Optical Radiation Branch of the Bioeffects Division. After completing the Ph.D., Dr Wigle did a Postdoctoral Fellowship in Genetic Toxicology, then joined the USAF, where he served primarily in research management positions. After leaving the USAF in 1999 he worked as an in-house contractor for the Laser Eye Protection Advanced Development Program, and then was hired as a civilian scientist. His overarching research interest is molecular mechanisms of bioeffects from light-tissue interactions. His current research effort is aimed at understanding the biochemistry of red-light induced photobiomodulation in order to determine how one might exploit those pathways towards enhancing performance and protection of the warfighter.
Repperger Research Intern Program

RESEARCH PROJECT: 16-27

HUMAN MACHINE TEAMING FOR INTEL ANALYSIS IN CONTESTED ENVIRONMENTS

PROJECT SYNOPSIS: U.S. Air Force intelligence components are increasingly shifting focus from supporting tactical missions in permissive environments toward enabling more strategic operations in contested environments. There is a growing need to adapt existing technologies and capabilities to this mission set. At the same time, coping with the need to perform information analysis under data overload conditions will require analysts to effectively and efficiently team with advanced analytics and automation to achieve success. This project will research empirically derived predictions for enabling joint human and automation analytical sensemaking under data overload. The objective of this project is to explore specific instances of adapting advanced analytics capabilities to team with intelligence analysts in support of Intelligence, Surveillance, and Reconnaissance (ISR) operations in contested environments, including envisioning, designing, building, and evaluating concepts.

STUDENT LEVEL / DISCIPLINE NEEDED:
Bachelor’s/ Human Factors, Psychology, Information Systems
Master’s/ Human Factors, Psychology, Information Systems
PhD/ Human Factors, Psychology, Information Systems

RESEARCH LOCATION: Human Centered ISR, Wright-Patterson AFB, Dayton OH

RESEARCH ADVISER: Daniel Zelik, PhD

DEGREE: Industrial and Systems Engineering, Ohio State University, 2012

Dr. Zelik is a Senior Cognitive Systems Engineer in the Human-Centered ISR Division with expertise in Intelligence & Information Analysis, Human-Centered Research & Development, and Technology Design & Assessment. He serves as a lead technical contributor for the ISR Analyst Performance program, which focuses on discovery and development of technical solutions for a spectrum of high priority initiatives in ISR domains with ill-defined requirements and significant uncertainty, including envisioning concepts of operations, workspace design specifications, prototype development, and user evaluations. His research interests include how professional intelligence analysts assess analytical rigor, cope with data overload, and overcome challenges to effective analysis.
Repperger Research Intern Program

RESEARCH PROJECT: 16-28

EVENT BASED REPRESENTATION FOR INCREASED ANALYTIC INSIGHT

PROJECT SYNOPSIS: The motivating problem domain for this research effort is Full Motion Video (FMV) Processing, Dissemination, and Exploitation (PED) as practiced by intelligence analysts across the U.S. Air Force. Current FMV PED operations are performed by teams of analysts who share responsibility for viewing and interpreting live FMV data streams, identifying activities of interest, capturing those observations in a persistent digital form, and disseminating their findings to intelligence customers. A critical analytic need in this environment is the generation of accurate and detailed descriptions of observed activities that can be communicated in real time. Key challenges that inhibit analysts from achieving success include noticing when something meaningful has occurred (detection), maintaining focus on the task (vigilance), simultaneously monitoring multiple areas of interest (attention), and organizing observations into coherent narratives (sensemaking). Techniques that integrate and then visualize data in terms of operationally meaningful events/activities have been proposed as a means to respond to these challenges, but additional research is needed to justify the expected performance benefits and, ultimately, to enable these techniques to transition into analyst tools. The objective of this project is to investigate the potential for event/activity-based representation techniques to improve analytic reasoning and inference about an observed/sensed world of interest.

STUDENT LEVEL / DISCIPLINE NEEDED:
Bachelor’s/ Human Factors, Psychology, Information Sciences
Master’s/ Human Factors, Psychology, Information Sciences
PhD/ Human Factors, Psychology, Information Sciences

RESEARCH LOCATION: Human Centered ISR, Wright-Patterson AFB, Dayton OH

RESEARCH ADVISER: Daniel Zelik, PhD

DEGREE: Industrial and Systems Engineering, Ohio State University, 2012

Dr. Zelik is a Senior Cognitive Systems Engineer in the Human-Centered ISR Division with expertise in Intelligence & Information Analysis, Human-Centered Research & Development, and Technology Design & Assessment. He serves as a lead technical contributor for the ISR Analyst Performance program, which focuses on discovery and development of technical solutions for a spectrum of high priority initiatives in ISR domains with ill-defined requirements and significant uncertainty, including envisioning concepts of operations, workspace design specifications, prototype development, and user evaluations. His research interests include how professional intelligence analysts assess analytical rigor, cope with data overload, and overcome challenges to effective analysis.
REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT: 16-29

BREATHE DETECTION OF HYPOXIA AND FATIGUE FOR PILOT
PHYSIOLOGY AND COGNITIVE PERFORMANCE

PROJECT SYNOPSIS: High performance fighter aircraft subsystems are routinely monitored to a very high degree, with hundreds of data streams typically being recorded during sorties, enabling a high degree of “forensic” analysis of any inflight “incident.” Yet the degree of monitoring of the pilot of these aircraft is minimal at best, despite the fact that the pilot is a critical element in any flight. This lack of performance monitoring of the pilot, an integral “system” in terms of aircraft flight, hampers analyses of “hypoxia-like incidents” in next-generation aircraft. In addition, screening for volatile organic compounds (VOCs) in exhaled breath has been an important tool in previous aircraft physiological incident investigations. However, there are significant limitations in the assessment of the data, as there were noteworthy levels of VOCs observed in some incidents, but it is not clear if those compounds were generated from physiological/metabolic functions within an individual or from an environmental exposure that may have occurred during the flight. This effort seeks to address this knowledge gap in understanding breath volatile profiles through both the establishment and characterization of physiological states of concern in the operational environment such as hypoxia, stress, and fatigue and the subsequent development of selective volatile sensors for their detection in real-time.

STUDENT LEVEL / DISCIPLINE NEEDED:
Masters/ Chemistry, Biomedical Engineering
PhD/ Chemistry, Biomedical Engineering, Electrical Engineering

RESEARCH LOCATION: Human Signatures, Wright-Patterson AFB, Dayton OH

RESEARCH ADVISER: Claude Grigsby, PhD

DEGREE: Biomedical Science, Wright State University, 2013

Dr. Grigsby is an analytical chemist and board certified medical technologist with over 20 years of experience in mass spectrometry based proteomics, metabolomics, volatile analysis, and clinical diagnostics utilizing a variety of analytical chemistry and bioinformatics techniques. He is currently serving as a research chemist at the Air Force Research Laboratory in the Human Biosignatures Branch, where, for the past several years, he has applied his mass spectral expertise in support of the air quality investigation of the F22A Raptor conducted by the 711th Human Performance Wing and is co-PI in leading numerous USAF efforts focused on cockpit environmental exposures and breath based biomarker discovery.

NOTE TO APPLICANTS: If selected for participation in this program, you will be offered temporary summer employment through a contract to perform work for AFRL’s Human Effectiveness Directorate. This is not a U.S Government position. If selected, you will be required to undergo a National Agency Check before being granted access to government computer systems.

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