The University Senate of Michigan Technological University

Proposal 19-09
(Voting Units: Academic)

"Proposal for a Ph.D. Program in Applied Cognitive Science and Human Factors and M.S. in Applied Cognitive Science and Human Factors"

Summary

This is a formal proposal to establish a Doctor of Philosophy and M.S. degree in Applied Cognitive Science & Human Factors in the Department of Cognitive and Learning Sciences at Michigan Technological University. The proposed program will help meet strong demand for Human Factors professionals, will build on Michigan Tech's existing strengths in science and technology, and will enable Michigan Tech to develop a nationally recognized program in an emerging discipline critical to technology. This document provides the rationale for, and details about the program.

Applied Cognitive Science - Human Factors

Applied cognitive science addresses a diverse array of contemporary human phenomena, resulting in practical solutions for many real world problems. Through the application of cognitive psychology's principles, applied cognitive scientists investigate diverse topics such as effective modes for the delivery of instruction, eyewitness memory, artificial intelligence, and human factors considerations in the design of systems.

Human Factors (HF) is the multi-disciplinary science within the purview of cognitive science that focuses on the needs of the human in the design of products, work processes, and technology systems in an effort to optimize human well-being and overall system performance. HF is concerned with the design and evaluation of technological systems from the perspectives of human needs, abilities, and limitations. HF professionals may examine human-machine interactions from cognitive, social, biological, physical, or other perspectives.

From an Applied Cognitive Science perspective, Human Factors is involved in conducting research regarding human cognitive abilities and limitations with respect to the design, operation, or use of products or systems. It is a subfield of applied cognitive science that focuses upon human-machine interactions. Overall goals include optimizing human performance, health, safety, and/or habitability. Thus, the proposed program in Applied Cognitive Science and Human Factors will integrate the knowledge of human experts (psychology and cognitive science) and built systems experts (for example, technology and engineering).

Human Factors is a critical area of research because of (a) human safety concerns, (b) market forces, and (c) environmental sustainability. Human operators are often critical contributors to lapses in overall system safety. Human errors, for example, have been attributed as the cause of up to 98,000 preventable patient deaths a year in US medical practice. Despite our desire for automated, faultless systems, our current technological knowledge is not capable of foolproof technological fixes to problems of human error. Substantial funding has been allocated to research on machine intelligence, pattern-recognition technologies, and expert systems, but there is only one alternative for many complex systems: human operators. Although they have limitations, humans are excellent pattern recognizers and, unlike current automated systems, are immensely flexible. HF is concerned with understanding human abilities and limitations, information critical to the prevention of human-related errors and the preservation of human life and well-being.
Critical to understanding market forces, HF researchers are motivated to assess customer needs and desires in order to increase customer satisfaction by improving the usability of products. User-centered design is a widespread paradigm in information technology and consumer products. The success of a

human factors perspective in improving customer satisfaction in these industries suggests wider application.

Human Factors is not only important for human safety, well-being, and the economy, but it is also a critical component in forming a sustainable society. Many environmental disasters, such as the Exxon Valdez incident, are due to poor HF design, task design, and working conditions. Good HF design not only prevents human casualties, it also prevents environmental catastrophes. In addition, HF leads to better consumer products. Customers will discard poorly-designed products as they seek products they can actually use. Throwing away products because of poor user design is not a sustainable practice. Therefore, HF design is sustainable design.

There is increasing need for personnel trained in Human Factors in industry, government, and academia. According to the US Dept. of Labor Occupational Outlook handbook (2008-09 edition), employment for all psychologists (including all specialty areas) is expected to grow 15 percent from 2006 to 2016, faster than the average for all occupations. Further, they state "Job prospects should be the best for people who have a doctoral degree from a leading university in an applied specialty…Psychologists with extensive training in quantitative research methods and computer science may have a competitive edge…" A survey of three doctoral programs in Human Factors revealed that 90-95% of their graduates have secured positions prior to graduation, and 99% obtained employment after graduation, typically in the exact sub-discipline they desired. Clearly, Human Factors is a growth field with immense potential that offers great career opportunities. Moreover, salaries for human factors specialists are the highest among all subfields within psychology and cognitive science. According to a 2005 salary survey conducted by the Human Factors and Ergonomics Society, the mean annual base salary is approximately $92K for a master's level profession and $105K for persons holding a doctorate. Doctoral-level consultants are reported as earning an average of $175K annually.

Opportunities exist and are expanding in all major employer groups: government, not-for-profit institutions, consulting firms, private industry, and academic institutions. Work settings range from classroom, to laboratory, to the industrial design team. Applied Experimental and Engineering Psychology is increasingly employed in litigation involving product and workplace safety. Salaries are competitive with those of engineers and other professionals who work in similar settings. In industry, there has been explosive growth in the HF job market with the development of increasingly complicated consumer products, network-centric business (electronic commerce), and more stringent product liability laws. With new technology, businesses are increasingly capable of customizing products for individual users. Jobs in this area of industry are often titled *cognitive engineer*, *customer experience specialist*, *ergonomist*, *human factors engineer*, *knowledge engineer*, *usability specialist*, *usability engineer*, *user experience specialist*, and/or *user interface designer*. There has also been a surge of employment in the government sector for personnel trained in HF. For example, employment opportunities exist in the Department of Defense, Department of Homeland Security, Federal Aviation Administration, National Aeronautic and Space Agency, transportation, and intelligence services. The military, for example, has a number of career tracks for Ph.D.-level HF specialists, including the US Navy's aviation experimental psychologist, surface research psychologist, and subsurface research psychologist, the US Army's research psychologist, and the US Air Force's aerospace research physiologist. In terms of government support, the Department of Defense's broad agency announcements consistently identify HF research as one of the most critical areas of research. HF careers are also available in academia, in particular in psychology, which is currently the second largest undergraduate major in the United States, and in interdisciplinary programs housed in colleges of engineering, science, and medicine.

Rationale

This graduate program focuses on the application of cognitive science to understanding human use of and interaction with technology. The Human Factors interdisciplinary field builds upon psychology, engineering, and computer science/information technology. Emphasis is on using the methods and theories of cognitive science to create interventions designed to enhance safety and performance. Implementation of a graduate program in Human Factors is a key component in the development of a technological university. This facet, currently underdeveloped at Michigan Tech, builds upon existing strengths in the Department of Cognitive and Learning Sciences and in other academic units of the university, integrates behavioral science research with expertise in engineering and natural sciences, and is consistent with Michigan Tech's current strategic plan to *"offer programs in new and emerging areas, particularly interdisciplinary areas*." More specifically, the proposed program addresses the following areas of Michigan Tech's strategic plan:

Goal 2: Deliver a distinctive and rigorous discovery-based learning experience grounded in science, engineering, technology, sustainability, and the business of innovation.

2.2 Develop undergraduate and graduate programs in new and emerging areas.

Goal 3: Establish world-class research, scholarship and innovation in science, engineering, and technology that promotes sustainable economic development in Michigan and the nation.

3.1 Increase interdisciplinary initiatives to expand knowledge and address societal needs.

…develop and support superior graduate programs.

This program will contribute significantly to the goals of 500 enrolled Ph.D. students at the university by 2012, and the conferring of 60 Ph.D. degrees annually.

Michigan Tech faculty members possess considerable expertise in cognitive science and applied cognitive psychology and in science and engineering fields which study the interaction of human and technological systems. Current expertise in the Department of Cognitive and Learning Sciences is in the areas of human memory, perception, attention, and cognition. Current research projects include work in human-robot interaction, interface design, multi-modal display design, data visualization, cognitive-perceptual performance assessment, transportation systems, computer automated systems, covert communication strategies, detection of deception (polygraph), human performance modeling, and STEM education. Affiliated faculty in the departments of Computer Science, Civil and Environmental Engineering, Electrical and Computer Engineering, Exercise Science, Health, and Physical Education, Mechanical Engineering-Engineering Mechanics, and Biomedical Engineering have expertise in human computer interaction, simulations, robotics, biomechanics, and work physiology.

By integrating cognitive and HF psychologists and STEM education researchers with science and engineering faculty, this program merges cognitive science research with applications in a wide range of STEM fields. By combining faculty expertise in human subjects research with scientific and engineering expertise, the program will enhance interdisciplinary research at Michigan Tech and strengthen the university's competitiveness on complex projects at the interface of human and technical systems.

This program responds to the national need to better understand how technological systems are limited by human operators. The modern world is increasingly being integrated with advanced, although very complicated, communication equipment. While this speeds up the pace of transactions, it also introduces new risks for designers who may make products unsuitable for the intended users. The business world is shifting to fast, lean, agile, just-in-time production methods. There will increasingly need to be a tight integration between usability-consumer research and manufacturing. Transportation systems are becoming more complex. Without seriously considering human operators and their limitations, modern society is setting itself up for catastrophic loses. Many disasters can be attributed to poor human-machine interaction or systemic design errors. Our graduates will be well prepared to rectify this situation, and the skills the program will provide are in very high demand by industry and government.

1. Program Description

The proposed program will be offered by the Department of Cognitive and Learning Sciences. Affiliated faculty in other academic units will also be directly involved as adjunct faculty in the program. The program provides a strong scientific basis in human subjects research and in the core areas of cognitive science necessary to skillfully undertake research on the interface of human behavior and technological systems. The program is a research-intensive curriculum, which includes a core in psychology and research methods. Students will select an area of specialization in which to focus their elective coursework and their dissertation research.

Course Requirements

The doctoral program in Applied Cognitive Science and Human Factors (ACSHF) will require a minimum of 72 credit hours. This consists of 32 hours from the core courses and required research, 30 hours of electives, and 10 dissertation research hours. Although most Michigan Tech Ph.D. programs require only 60 credits, nationally, most Human Factors and related programs require between 80 and 90 credits. A sampling of such programs yielded an average of 83 credits required. Likewise, many Michigan Tech programs have limited course requirements; however, Applied Cognitive Science and Human Factors is

a field in which students rarely have much undergraduate preparation, so considerable work in basic subject matter is necessary to prepare students to conduct appropriate research. Below is a list of required and potential elective courses; a list of which faculty may teach each course is listed in Appendix A.

Core Courses and Required Research (32 credits)*
PSY 5100 Applied Cognitive Science (3 hrs)
PSY 5850 Human Factors I (3 hrs)
PSY 5860 Human Factors II (3 hrs)
PSY 5210 Advanced Statistical Analysis and Design I (4 hrs)
PSY 5220 Advanced Statistical Analysis and Design II (4 hrs)
PSY 5010 Cognitive Psychology (3 hrs)
PSY 5160 Sensation and Perception (3 hrs)
PSY 5060 Behavioral Neuroscience (3 hrs)
PSY 5900 Graduate Research Project (6 hours)

*Depending upon background of individual students, some of these courses may be waived.

Electives (30 credits)**
PSY 5300 Human Performance (3 hrs)
CS 5760 Human-Computer Interaction and Usability Testing (3 hrs)
PSY 5400 Ergonomics and Biomechanics (3 hrs)
ED 5510 Educational Technology (3 hrs)
PSY 5500 Supervised Teaching Practicum (3 hrs)
PSY 5610 Automation (3 hrs)
PSY 5620 Displays and Alarms (3 hrs)
PSY 5910 Independent Research (3 hrs)
PSY 5880 Current Issues in Human Factors (1-3 hrs)
PSY 5190 Special Topics in Cognitive Science (3 hrs)
PSY 5890 Special Topics in Human Factors (3 hrs)

* At least 9 credits must be from coursework; students will select courses in consultation with the advisor. Additional courses not listed here may be accepted as electives (see Section 7, Other Courses). Up to 21 credits of independent research may be applied towards the 30 required elective hours. A minimum of 9 elective hours must come from coursework, which comprises a student's area of specialization within ACSHF.

Dissertation (10 credit hours)
PSY 6999 Dissertation Research (10 hrs)

72 Credit Hours Total

M.S. degree requirements. Students who wish to terminate their studies after two years may acquire a M. S. degree by completing the core courses and six credits of required research for a 32-credit master's degree in Applied Cognitive Science and Human Factors. It is not our intention to admit students to a terminal master's degree program, however utilizing standard practice in graduate programs at Michigan Tech, students who are unable to complete the Ph.D. may be allowed to earn a M. S. degree upon completion of the core courses and required research.

2. Rationale

See pp. 2-4, above.

3. Related Programs at Michigan Tech and Elsewhere

The proposed Doctorate of Philosophy in Applied Cognitive Science and Human Factors will complement other programs at Michigan Tech and will be interdisciplinary in nature. There are no related programs at the university, although faculty in the Department of Cognitive and Learning Sciences has established a collaborative network for research in Human Factors with researchers in numerous

science, engineering, and related departments. The Department of Cognitive and Learning Sciences offers a B.S. degree in Psychology.

There are no doctoral programs in Human Factors in Michigan. Central Michigan University offers a Ph.D. in applied experimental psychology, which potentially overlaps with Cognitive Science and Human Factors when applied to technological systems. Several Michigan universities offer graduate programs in Industrial Engineering or Industrial Design, somewhat related yet distinct disciplines that typically offer a single course pertaining to Human Factors. Michigan State University offers an interdisciplinary specialization in Cognitive Science, but not a degree.

In the upper Midwest, only the University of Minnesota-Twin Cities has a comparable degree program. They offer a graduate minor in Cognitive Science *or* in Human Factors for Ph.D. or M.A./M.S. programs. Additionally, they offer a Human Factors emphasis as part of their Kinesiology Ph.D. program.

The Human Factors and Ergonomics Society lists 120 graduate programs related to human factors in the *Directory of Human Factors/Ergonomics Graduate Programs in the United States and Canada*. Forty-three percent are doctoral programs, most of which are housed either in Industrial Engineering (41%) or Psychology (39%) departments. The remaining doctoral programs reside in departments such as Cognitive Science, Environmental Medicine, Design and Environmental Analysis, or Kinesiology; other programs are of an interdisciplinary nature and are housed in the graduate school. Of the Industrial Engineering programs, the majority (61%) offer concentrations through optional coursework rather than specific degrees in human factors or cognitive science.

Only two of Michigan Tech's benchmark universities offer doctoral programs in Cognitive Science or Human Factors: Rensselaer (Cognitive Science) and Georgia Tech (Human Factors). Georgia Tech offers a Human Factors concentration at the bachelor degree level. None of our benchmark universities offers an interdisciplinary program combining both fields.

4. Projected Enrollment

We anticipate that two students will enter the program by Fall, 2010. Thereafter, we expect 3 new students per year. Within 6-7 years the program will have between 12 and 15 students and an average of 3 new Ph.D. students will complete the program annually.

HF Ph.D. Enrollment	2009-10	2010-11 (Year 1)	2011-12 (Year 2)	2012-13 (Year 3)	2013-14 (Year 4)	2014-15 (Year 5)	2015-16 (Year 6)	2016-17 (Year 7)
Attrition = 25%>yr.3 Planning	Planning & Recruiting							
New Students		2	2	3	3	4	4	4
Returning Students			2	4	6	7	10	11
Total Enrollment		2	4	7	9	11	14	15
Ph.D.s Awarded					1	1	2	3

Three students will be supported as GTAs; ten students will be supported by external research funds; the remainder will be self-supported. External funding is anticipated to come primarily from US Department of Defense (see page 2), but also the National Science Foundation and National Institutes of Health. The result will be approximately two Ph.D. students per full-time graduate faculty member.

5. Scheduling Plans

The program will be a regular on-campus offering, with inception planned for Fall, 2010. The 2009-2010 academic year will be used for student recruiting. All core courses will be offered regularly (either annually or biennially), beginning Fall, 2010.

6. Curriculum Design

The core courses in the program (see *Program Description*, above) are designed to provide students, particularly from engineering and computer science, with fundamental understanding of human behavior, expertise in conducting research with human subjects, and an overview of the concepts, tools, and applications of Human Factors psychology. These eight core courses will be taken during the first 3 semesters in the program and will be taught by Cognitive and Learning Sciences faculty.

Areas of Specialization
Upon completion of the core courses, students will identify an area of specialization, from which they will select at least 18 credits to ensure sufficient depth and expertise to conduct dissertation research. Potential areas of specialization include the following:
• Human Performance
• Human-Computer Interaction
• Adaptive Automation/Biosensors
• Educational Technology
• Environmental Design
• Transportation/Geospatial Systems
• Manufacturing Systems
• Construction

Comprehensive Exam
To obtain doctoral candidacy status, students must pass a comprehensive written examination. The comprehensive exam is taken after all required courses and course-based electives are completed. It must be passed within five years of starting the ACSHF program and at least two semesters prior to the dissertation defense. The exam will consist of four sections with questions covering the following topics: 1) applied cognitive science/cognitive psychology, 2) human factors/human performance, 3) research methodology/statistics, and 4) a specialty topic within ACSHF. Each section may contain multiple questions evaluating whether the student is capable of concept integration and application at the doctoral level. Questions for the first three sections will be provided by ACSHF faculty. A committee comprised of three faculty members of the student's choosing will supply questions for the specialty area. The student's answers will be graded by a minimum of two faculty members. Passage is required on all four sections to be considered a doctoral candidate. If a student fails one section, a remediation project to compensate for an area deficiency will be developed by relevant faculty in coordination with the student's advisor. If a student fails two or more sections, the exam is considered failed *en toto*. The student must retake and pass the entire exam at the next scheduled administration. If a student fails to pass all sections of the exam upon retaking it, he/she may be asked to withdraw from the program and may be awarded a master's degree in lieu of the doctorate, if the requirements for the master's degree have been met.

Doctoral Dissertation

Dissertation Committee and Proposal Process
Once a student has doctoral candidacy status, he/she may officially form a dissertation committee. Students must submit a form signed by all committee members declaring the make-up of the committee. Any changes to committee membership must be made in writing. The committee should have four members, two of whom must be faculty within the Department of Cognitive and Learning Sciences and one faculty member from outside the ACSHF Program. One committee member must be designated as the committee chair. Once the chair is satisfied with the student's dissertation proposal, a proposal defense may be scheduled. The defense consists of an oral presentation before the committee. All committee members must sign-off on the proposal indicating their approval before the student may begin any data collection.

Oral Dissertation Defense
When the research is complete and the committee chair is satisfied with the manuscript, the student should send the dissertation to all other committee members to prepare for the defense. The dissertation defense is public, in that any member of the university committee may attend. The defense must be advertised a minimum of two weeks in advance of the scheduled defense date. All committee members must be present at the defense. After the defense presentation and a period of questioning from committee members, the committee will hold a private vote on two items. The first is whether the defense was passed (yea or nay). The second item is the status of the dissertation manuscript (accepted without revisions, accepted with minor revisions, or not accepted/needs extensive revisions).

7. New Course Descriptions

PSY 5860 Human Factors II (3) – An overview of the tools and techniques used by human factors researchers and practitioners. Topics include task analysis, link analysis, human error in systems, workload analysis, and physiological assessment techniques.

PSY 5210 Advanced Statistical Analysis and Research Design I (4) – An overview of research ethics, experimental design, proposal writing, and univariate statistics such as tests and ANOVA.

PSY 5220 Advanced Statistical Analysis and Research Design II (4) – A continuation of PSY 5210 covering multivariate and nonparametric statistics such as MANOVA, ANCOVA, Multiple Regression, factor analysis, and Chi Square.
PSY 5300 Human Performance (3) – An overview of factors contributing to human performance in human-machine systems. Topics include cognitive workload, attention, fatigue, aging, stress, and perceptual limitations.

PSY 5400 Ergonomics and Biomechanics (3) – An overview of the physical aspects of user-centered design. Specific topics include anthropometry, repetitive strain injuries, and physical workload evaluation.

PSY 5610 Automation (3) – An overview of the changing role of human users in automated systems. Topics include levels of automation, automation trust issues, automation uses and misuses, and the role of automation in human performance.

PSY 5620 Displays and Alarms (3) – An overview of display and alarm display design principles for human-machine systems. Topics include visual, auditory, and tactile display design, masking and alarm detection, and the cry wolf effect and alarms.

PSY 5910 Independent Research (3) – Study of a specific cognitive science or human factors problem.

PSY 5880 Current Issues in Human Factors (1) – An overview of the state of the field of human factors, trends, ethics for human factors practitioners, and career development.

PSY 6991 Special Topics in Human Factors (3) – Study of special topics in human factors as designed by section title.

PSY 6990 Special Topics in Cognitive Science (3) – Study of special topics in cognitive science as designed by section title.

PSY 5998 Research Project I (3) – Proposal and data collection phases of an independent research project.

PSY 5999 Research Project II (3) – A continuation of PSY 5998, analysis and public presentation of research results.

PSY 6999 Dissertation Research (10) – Fundamental and applied research in cognitive science and human factors psychology. Taken by doctoral students in partial fulfillment of the PhD research requirement.

Other Courses (catalog descriptions are in Appendix B)
PSY 5010 Cognitive Psychology
PSY 5100 Applied Cognitive Science
PSY 5060 Behavioral Neuroscience
PSY 5160 Sensation and Perception
PSY 5850 Human Factors I
BE 5110 Neuroengineering

BE 5700 Biosensors
BL 4470 Analysis of Biological Data
CE5404 Transportation Planning
CE 5410 Intelligent Transportation Systems
CS 4760 Human-Computer Interactions
CS 4811 Artificial Intelligence
CS 5811 Advanced Artificial Intelligence
ED 5510 Special Studies in Educational Technology
EE 4250 Communication Theory
EE 4257 Digital Image Processing
EE 5530 Wireless Digital Communication
EH 4400 Motor Control
EH 4420 Motor Learning and Development
EH4500 Biomechanics of Human Movement
EH 5350 Special Topics in Kinesiology
FW 4130 Biometrics
MA 4720 Design and Analysis of Experiments
MEEM 4660 Data Based Modeling & Control
MEEM 4705 Introduction to Robotics and Mechatronics
MEEM 5602 Process and Product Design and Improvement

8. Library and Other Learning Resources

Access to scholarly materials is absolutely essential at a research institution such as Michigan Tech, particularly for faculty mentoring doctoral students through high-quality, funded research. The Van Pelt library currently subscribes to 23 journals that are core to the Applied Cognitive Science and Human Factors program. In addition, the library has supporting journal holdings in engineering, computer science, exercise science, general psychology, and teacher education.

Enhancing our electronic database search engine PsychFirst is required. Michigan Tech currently offers database search access to psychology publications from only the preceding three years. Access to a more complete database and subscriptions to additional journals beyond our current holdings will be essential for both faculty and graduate students. This will require the availability of PsycINFO and PsycARTICLES.

Subscriptions to nine additional journals is essential to the program (see Appendix C).
New library costs include (*costs were estimated in consultation with Ellen Seidel)*:

$3000.00 one-time allotment for the library to purchase core monographs in the area of cognitive and human factors psychology, allowing the purchase of approximately 90 hard and softcover items.
$5782.00 for nine additional journals.
$7200.00 (annual cost) provides full database search capability of the psychology literature (through PsycINFO in journal, book, and book chapter, and dissertation records, 1887– present, and PsycARTICLES records, 1988–present, to all faculty and students.
Additional Interlibrary loan costs will be generated for the library.

9. Computing Access Fee

Graduate students in the program will pay the standard Computing Access Fee to utilize the current undergraduate computing lab for Psychology majors.

10. Faculty Curriculum Vitae (complete vitae provided upon request)

Cognitive & Learning Sciences Faculty:

Susan L. Amato-Henderson, Ph.D.
Associate Professor of Psychology
PhD, University of North Dakota
Psychology and law (eyewitness memory, credibility assessment, field sobriety testing); career and educational interests and decision making; self efficacy (your belief in your ability to do well

in a given situation or setting); service learning as a teaching tool; outcome assessments; experimental design and statistical analysis

J. Christopher Brill, Ph.D.
Assistant Professor of Psychology, Cognitive & Learning Sciences
PhD, University of Central Florida
Tactile communication, mental workload, cognitive resource theory, multi-modal display and alarm design, spatial audio, human performance assessment, motion and simulator sickness, Sopite Syndrome (motion-induced drowsiness)

William S. Helton, Ph.D.
Assistant Professor, Department of Cognitive & Learning Sciences
PhD, University of Cincinnati
Engineering (human factors) psychology, environmental psychology, neurophysiological measures of cognition, psychometrics (stress and workload), skill acquisition in humans and working dogs

Kedmon N. Hungwe, Ph.D.
Assistant Professor, Cognitive & Learning Sciences
PhD, Michigan State University
Learning and development; educational policy & practice; educational media/technology

Rosalie P. Kern, Ph.D.
Associate Professor of Psychology, Department of Cognitive & Learning Sciences PhD, Central Michigan University
Emotion, attention, and memory; decision making; perceptions of sexual harassment; psychology and law (trial consulting); experimental design and statistical analysis

Adjunct Faculty:

Jason Carter, Ph.D.
Chair & Assistant Professor of Exercise Science, Health and Physical Education Adjunct
Assistant Professor, Cognitive & Learning Sciences
Adjunct Assistant Professor, Biological Sciences
PhD, Michigan Technological University
Regulation of arterial blood pressure, the vestibulosympathetic reflex in humans, autonomic and cardiovascular adaptations to microgravity and exercise

Michele Miller, Ph.D.
Associate Professor of Mechanical Engineering
PhD, North Carolina State University
Precision engineering, microelectromechanical systems, engineering education

Amlan Mukherjee, Ph. D.
Assistant Professor of Civil Engineering
Member, Michigan Tech Transportation Institute
Engineering-Environmental (inter-disciplinary program)
PhD, University of Washington
Planning and decision making in construction management using situational simulations, information visualization, transportation infrastructure management, simulations of complex systems, system dynamics, expert novice cognition (especially among construction managers)

Michael Neumann, Ph.D.
Professor & Chair of Biomedical Engineering
Adjunct Professor of Electrical Engineering
PhD Case Institute of Technology, MD Case Western Reserve University Biomedical instrumentation, biomedical sensors, microfabrication technology and perinatal medicine

Robert Pastel, Ph.D.
Assistant Professor, Computer Science
PhD, University of New Mexico

Human-computer interaction and human-robot interaction

Jindong Tan, Ph.D.
Assistant Professor of Electrical and Computer Engineering
PhD, Michigan State University
Computer engineering, mobile robotics

11. Available/Needed Equipment Facilities

The department of Cognitive and Learning Sciences operates or has access to seven dedicated laboratories.

Human-Robot Interaction Laboratory in Advanced Technology Development Center equipped with unmanned aerial and ground robot vehicles, including 6 ground active-robots, 10 ground Romba robots (Irobot), and 2 remote-controlled helicopters, sensors (laser range finders, sonar systems, visual capture systems), computers, and a wide-scale sensor network for environmental sensing.

Virtual Reality Laboratory in Rehki equipped with a GeoWall 3-d projection system, World Viz virtual reality system, magnetic and optical tracking equipment, head-up displays, computers, and interface equipment (joysticks, steering wheels, data-gloves).

Human Fatigue and Vigilance Laboratory in Chemical Sciences equipped with MindWare Technologies Biomedical Signal Processing Systems, Respironics Actigraphy System, Companion III Transcranial Doppler Sonography Unit, Seeing Machines Eye-tracker, Arrington Eye-tracker, and computers programmed with Superlab software.

Multimodal Interface Laboratory in Chemical Sciences equipped with a 24 Channel Vibrotactile Laboratory Display System, a 8 Channel Vibrotactile Laboratory Display System, a 8 Channel Wireless Vibrotactile Display System, and computer programmed with SuperLab software.

Emotion and Memory Laboratory in Chemical Sciences equipped with computers programmed with SuperLab software and other specialized programs.

Detection of Deception Laboratory in Chemical Sciences equipped with video recording equipment, computers, and a polygraph unit.

Educational Technology Laboratory in Academic Office Building equipped with computers, Vernier Software and Technology, including sensors for use with our Vernier interfaces. No additional equipment will be necessary to initiate the program. Additional space needs are addressed below in Section 13.

12. Program Costs

Additional recurring costs are associated with implementation of this program (Appendix A). Three new graduate assistant lines to support teaching of introductory psychology courses will be necessary during the first five years of the program. New human factors faculty will be necessary to support existing faculty with undergraduate teaching obligations and to teach the required core courses in the program. New faculty should have expertise in the following areas:

Applied Cognitive Science - Cognitive Ergonomics or Human-Computer Interaction
Human Factors Psychology - Visual Performance and Display
Quantitative Psychology; I/O Psychology: Simulation and Training or Team Performance

Two new faculty members will be needed when the program is initiated (Fall, 2010). The third faculty member (in Quantitative Psychology) will be added in the third year of the program, as externally funded research funds result in greater demands on the time of existing faculty.

Additional ongoing funds for library journals and online journal access will also be needed (see #8, above). The addition of these faculty members will enable the program to accommodate up to 15

students (approximately 2 Ph.D. students per full-time faculty member).

13. Space

Currently, each faculty member has an office and a 100 square foot room for research. The department also rents a 1000 square foot high bay facility for HF research. Other Human Factors programs typically provide approximately 1000 square feet of lab space per faculty member, with space increasing to nearly 2000 square fee for faculty with external funding. In addition, nearly all programs at other institutions have a dedicated teaching laboratory averaging 700 square feet (Appendix B).

We currently have 1438 square feet consisting of faculty offices, laboratories, a reception area, and a small conference room. This space is satisfactory for an undergraduate program with modest research activity, but additional space is essential if the program is to be successful. The Department of Cognitive and Learning Sciences has no excess space. New faculty will require office space and research facilities in order to carry out their research and scholarship obligations. Graduate students will also need office space. Without additional space, the Ph.D. program cannot be implemented. We are requesting approximately 10,000 square feet of space.

A breakdown of this space request is provided in the table below:

Allocated Use	**Approximate Size (Sq Ft)**
7 Faculty Offices (144 sq ft each)	1008
7 Laboratory Suites (1000 sq ft each)	7000
2 GTA Offices (250 sq ft each; 2-3 students in each)	500
Reception/Common Area	400
Seminar/Conference Room	500
Graduate Teaching Laboratory	600
Total:	**10,008**

14. Policies, Regulations and Rules

No additional policies, regulations, or rules beyond those mandated by the Graduate School.

15. Accreditation Requirements

Accreditation is not necessary for this program.

16. Internal Status of Proposal

Dept. of Cognitive & Learning Sciences, March 24, 2008 ,Date Approved_____

Dean, College of Sciences and Arts, April 14, 2008 ,Date Approved_____

Provost, _____,Date Approved_____

Graduate Faculty Council November 4, 2008 ,Date Approved_____

University Support Units, _____,Date Approved_____

University Senate, _____,Date Approved_____

Academic Affairs Officers, _____,Date Approved_____

Board of Control, _____,Date Approved_____

17. Planned Implementation Date

Fall, 2009, for planning, faculty recruiting, and student recruiting. First students begin Fall, 2010.

APPENDIX A Courses and Potential Faculty Assignments

Course Number	Course Title	Amato	Brill	Helton	Hungwe	Kern	Adjunct Faculty	New Hires
PSY 5100	*Applied Cognitive Science*			x		x		x
PSY 5850	*Human Factors I*		x	x				
PSY 5860	*Human Factors II*		x	x				
PSY 5210	*Advanced Statistical Analysis and Design I*	x	x	x		x		x
PSY 5220	*Advanced Statistical Analysis and Design II*			x				x
PSY 5010	*Cognitive Psychology*		x			x		x
PSY 5160	*Sensation and Perception*		x					
PSY 5060	*Behavioral Neuroscience*	x	x	x			x	x
PSY 5300	Human Performance		x	x			x	x
CS 5760	Human-Computer Interaction and Usability						x	
PSY 5400	Ergonomics and Biomechanics						x	x
ED 5510	Educational Technology				x			
PSY 5610	Automation			x				x
PSY 5620	Displays and Alarms		x					
PSY 5880	Current Issues in Human Factors		x	x				x
PSY 6991	Special Topics in Human Factors		x	x				x
PSY 6990	Special Topics in Cognitive Science			x		x		x

Note: Required courses are listed in italics; elective courses are in plain text. An “x” indicates the person is qualified and may teach the course. Actual course assignments will be determined at the time of implementation.

APPENDIX B Existing Courses with Catalog Descriptions

PSY 5010 Cognitive Psychology
A systematic survey of classical and contemporary research topics in human information processing and learning. Topics include models of cognition, perception/pattern recognition, attention, the nature of mental representation and processing; the architecture of memory, imagery, concepts, and prototypes; reasoning, decision making, problem solving, and cognitive development.

PSY 5100 Applied Cognitive Science
Survey of applied human information processing literature, detailed review of recent developments in applied cognitive science, and exaination of the purposes, role and scope of cognitive engineering.

PSY 5060 Behavioral Neuroscience
Advanced topics in the field of behavioral neuroscience and neuroergonomics. Topics may include motor and sensory systems and complex motivated behaviors such as vigilance, attention, adaptive automation, and fatigue countermeasures.

PSY 5160 Sensation and Perception
Examination of basic sensory mechanisms and perceptual phenomena. Sensory mechanisms reviewed will include vision, audition, olfaction, gustation, vestibular system and touch.

PSY 5850 Human Factors I
Advanced concepts critical to the design of human-technological systems, such as capitalizing upon human capabilities and compensating for human limitations. Topics may include perceptual and motor abilities, human error and cognitive engineering.

BE 5110 Neuroengineering
Brief overview of neuroanatomy, neurophysiology, and neurobiology followed by introductions of more advanced topics including neural tissue engineering, neural/electrode interfaces, and functional electrical stimulation.

BE 5700 Biosensors
This course introduces the student to the fundamentals of biosensor development and applications. It provides an understanding of biological components, immobilization methods, transducers, and fabrication techniques.

BL 4470 Analysis of Biological Data
Methods and techniques of analyzing quantitative biological data and of designing biological experiments.

CE5404 Transportation Planning
Introduction to urban transportation planning, travel characteristics, demand forecasting techniques, corridor studies, traffic impact studies, and public transit planning and operations.

CE 5410 Intelligent Transportation Systems
Introduction to ITS, concepts, technologies, activities, and deployment issues. Topics include advanced traffic management, traveler information systems, commercial vehicle operations, vehicle control systems, ITS applications in public transit, and rural ITS.

CS 4760 Human-Computer Interactions
Principles of design and implementation of user interface (UI). Topics include: UI design principles, evaluation, tools and theory. Students receive direct experience with designing, implementing, and evaluating UIs. Requires completion of a group project.

CS 4811 Artificial Intelligence
Fundamental ideas and techniques that are used in the construction of AI problem solvers. Topics include knowledge representation, problem solving, heuristics, search heuristics, inference mechanisms, expert systems, and language understanding.

CS5760 HCI Evaluation and Usability Testing

Current issues in human-computer interaction (HCI), evaluation of user interface (UI) design, and usability testing of UI. Course requires documenting UI design evaluation, UI testing, and writing and presenting a HCI survey, concept or topic paper.

CS 5811 Advanced Artificial Intelligence
Course topics include current topics in artificial intelligence including agent-based systems, learning, planning, use of uncertainty in problem solving, reasoning, and belief systems.

ED 5510 Special Studies in Educational Technology
Individual or group studies of specially selected issues or problems in educational technology. Credit may be granted for scholarly work under the supervision of departmental-approved, authorized University
faculty members that results in an acceptable scholarly product_research reports, curricula, computer program, or other.

EE 4250 Communication Theory
Introduces the mathematical theory of communication science. Topics include baseband and digital signaling, bandpass signaling, AM and FM systems, bandpass digital systems, and case studies of communication systems.

EE 4257 Digital Image Processing
Image formation, enhancement and reconstruction. Applications in medical imaging, computer vision, and pattern recognition.

EE 5525 Wireless Digital Communication
Principles of wireless communications systems. Projects may include cell phones, computer networks, paging systems, satellite communications, radio, television and telemetry.

EH 4400 Motor Control
Designed for upper level undergraduates or graduates with a basic neuroscience background. Students learn the basics of how the neural and muscular systems coordinate human movement. This will require an integration of biomechanics, molecular and cellular neurophysiology, cognitive neuroscience, and sensory motor skills.

EH 4420 Motor Learning and Development
Designed for upper level undergraduates or graduates with a basic neuroscience background. Students learn the basics of how humans learn to control muscles and coordinate movement (motor learning), and how motor behavior progressively changes throughout a life cycle (motor development).

EH4500 Biomechanics of Human Movement
An in-depth view of the biomechanical properties of the musculoskeletal system. The course provides detailed analyses of the kinetics of human movement, material properties of the component tissues, and dynamic processes of adaptation to stress and strain of the system.

EH 5350 Special Topics in Kinesiology
Selected additional topics in kinesiology for advanced students based on interests of faculty and students. Interested students should contact the Exercise Science, Health and Physical Education department.

FW 4130 Biometrics
Application of statistical and mathematical methods to ecological issues. Subjects include exploratory data analysis, monitoring programs and development of prediction equations.

MA 4720 Design and Analysis of Experiments
Covers construction and analysis of completely randomized, randomized block, incomplete block, Latin squares, factorial, fractional factorial, nested and split-plot designs. Also examines fixed, random and mixed effects models and multiple comparisons and contrasts. The SAS statistical package is an integral part of the course.

MEEM 4660 Data Based Modeling & Control

System modeling from observed data for computer-aided design and manufacturing, providing differential equation models. Analysis of manufacturing and dynamic systems, computer routines for modeling, forecasting with accuracy assessment, and minimum mean-squared error control. Underlying system analysis, including stability and feedback interpretation, periodic and exponential trends. Illustrative applications to real-life data.

MEEM 4705 Introduction to Robotics and Mechatronics
Cross-discipline system integration of sensors, actuators, and microprocessors to achieve high-level design requirements, including robotic systems. A variety of sensor and actuation types are introduced, from both a practical and a mathematical perspective. Embedded microprocessor applications are developed using the C programming language.

MEEM 5602 Process and Product Design and Improvement
System modeling and analysis from observed data for computer-aided design and manufacturing, providing differential equation models. Computer routines for modeling, forecasting with accuracy assessment and minimum mean-squared error control. Underlying system analysis, including stability and feedback interpretation, periodic and exponential trends. Uses illustrative applications to real-life data, including team projects.

APPENDIX C Library Holdings and Needs

Journals in J. R. Van Pelt Library

Accident Analysis and Prevention
Applied Cognitive Psychology
Applied Ergonomics
Behavioral and Brain Sciences
Cognition
Cognitive Psychology
Cognitive Science
Emotion
Ergonomics
Journal of Environmental Psychology
Journal of Experimental Psychology: Applied
Journal of Experimental Psychology: General
Journal of Experimental Psychology: Human Perception and Performance
Journal of Experimental Psychology: Learning, Memory and Cognition
Journal of Mind and Behavior
Journal of Occupational and Environmental Hygiene
Medicine and Science in Sports and Exercise
Memory and Cognition
National Academies in Focus / National Academy of Sciences
Physiology and Behavior
Psychological Bulletin
Psychological Science
Research Quarterly for Exercise and Sport

Journals Needed: Essential

Aviation Space & Environmental Medicine	$ 215
Cognition and Emotion	$1, 395
Human Computer Interaction	$ 619
Human Factors	$ 457
International Journal of Human-Computer Interaction	$ 940
Perception and Psychophysics	$ 365
Total	**$3, 991**

Journals Needed: Important

International Journal of Aviation Psychology	$ 645
Mind, Culture and Activity	$ 375
Theoretical Issues in Ergonomics Science	$ 771

Total	**$1, 791**
Other Needs: Essential	
Online Search Database	$7, 000
Total	**$7, 000**

APPENDIX D Costs and Revenue

Program Costs

One-time start-up costs:

Marketing and Recruiting	$10,000
Library monographs	$ 3,000
Total one-time costs	$13,000

Continuing costs:

Beginning Year 1 (2010-11)	
New faculty (salary + fringes)	$164,000
New journals	$ 5,782
Library online search	$ 7,000
Graduate assistantships (2)	$ 40,000
Beginning Year 2	
Graduate assistantship (1)	$ 20,000
Beginning Year 3	
New faculty (salary & fringes)	$ 82,000
Total annual costs, as of 2012-13	$319,000

Program Revenue

Continuing revenue:

Beginning Year 1 (2010-11)	
External research funding	$ 75,000
By Year 5 (2014-15, with 8 CLS faculty)	$300,000
Indirect cost return	$168,000
Part-time instructional costs assumed by GTAs	$ 27,000
Total annual revenue, as of 2014-15	$327,000

By year three, the investment in the new program of about $300K annually (3 faculty lines and 3GTA-ships) will result in an increase of external research funding by approximately the same amount. Enrollment in the program will have increased by three PhD students per year. By year five (2014-15), the program is projected to become revenue neutral, if not profitable. By year seven, the program will produce three PhD graduates annually, while remaining profitable.

APPENDIX E **Space Needs**

Research Space Survey Summary

Institution	Office Space per Faculty Member (Sq Ft)	Lab Rooms per Faculty Member	Lab Space per Faculty Member (Sq Ft)	Dedicated Teaching Lab (Sq Ft)
Univ. of Central Florida	144-180	1-3	420-700 (unfunded); increase to 1500-3500 for funded projects	2 labs, each with 45 computers (1972 sq ft total)
Old Dominion University	168-180	1-2	500-600 (unfunded); increase to 1500-2000 for funded projects	Info Not Available
Clemson Univ.	144-180	3-5	1000-2000 (regardless of funding)	Info Not Available
Univ. of Cincinnati	240-280	4-6	1000-2000 (regardless of	1 lrg room 400 sq ft,

			funding)	plus 5-6 rooms 120 sq ft each (approx. 1000-1200 total)
Univ. of West Florida	144-180	1-3	400-600 (regardless of funding)	1200 sq ft
George Mason Univ.	300	1-3	200-400; plus shared lab spaces (e.g., simulation rooms, neuroergo testing)	500 sq ft
Virginia Tech	144	1-3	300-400 (regardless of funding), plus shared spaces	300 sq ft with 25 computers
Georgia Tech	360	3-6	1500-3000; plus shared spaces (regardless of funding)	800 sq ft with 30 computers
Average for Institutions Surveyed:	**226 Sq Ft**	**3 Rooms**	**1030 Sq Ft (unfunded); 1928 Sq Ft (with funding)**	**717 Sq Ft**

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