Northeastern University

Proposal for New Program

Master of Science in Human Factors

Department of Mechanical and Industrial Engineering (MIE)

College of Engineering

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Master's program in Human Factors

The new graduate program, the Master of Science in Human Factors, is developed to meet the current and projected demand for workforce trained in human factors. Human Factors is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and other methods to design in order to optimize human well-being and overall system performance. Human factors use knowledge of human abilities and limitations to design systems, organizations, jobs, machines, tools, and consumer products for safe, efficient, and comfortable human use.

The program allows flexibility for students to train for industry and government jobs and to acquire rigorous human factors' skills and research experience. While the core courses of the program come from the College of Engineering, the elective courses come from diverse disciplines spread across various colleges at Northeastern. The program is built by leveraging existing well- established courses inside and outside the college. Minimal additional cost and effort will be required to run the core and elective courses of the program.

The program addresses the growing need for engineering professionals trained in advanced human factors who can utilize Human Factors theories, procedures and empirically derived knowledge into understandable and actionable information for use in the design and evaluation of a wide variety of products and systems. The key sectors that are demanding human factors professionals include transportation, healthcare, robotics, manufacturing, computer, consumer products, social, organizational and military issues,etc

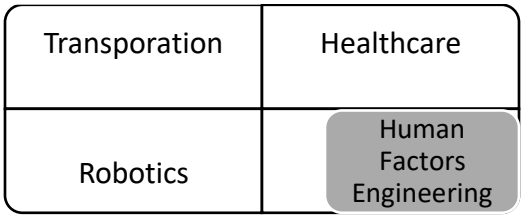
Executive Summary

The Department of Mechanical and Industrial Engineering (MIE) at College of Engineering (COE) at Northeastern University proposes a new graduate program, the Master of Science in Human Factors, to meet the current and projected demand for workforce trained in human factors. The program allows flexibility for students to train for industry and government jobs and to acquire rigorous human factors' skills and research experience. While the core courses of the program come from the College of Engineering, the elective courses come from diverse disciplines spread across various colleges at Northeastern. The program is built by leveraging existing well- established courses inside and outside the college. Minimal additional cost and effort will be required to run the core and elective courses of the program.

Program Description

This program addresses the growing need for engineering professionals trained in advanced human factors who can utilize Human Factors theories, procedures and empirically derived knowledge into understandable and actionable information for use in the design and evaluation of a wide variety of products and systems. The key sectors that are demanding human factors professionals include transportation, healthcare, robotics, manufacturing, computer, consumer products, social, organizational and military issues, as shown in

Figure 1.



The core courses of the proposed MS in Human Factors program are built on the foundations of human factors and ergonomics, probabilities and statistics, etc. Topics from these foundation areas are integrated to create human factors for engineering applications. Students can select their elective or breadth courses from a wide range of fields. The program seeks to prepare students for a comprehensive set of human factors-related professional positions.

Contribution to the University's Mission

The proposed program MS in Human Factors contributes significantly to Northeastern's emphasis on translational education and interdisciplinary education and research. The program will produce professionals who can apply the fundamental knowledge of human factors, probabilities, statistics, and to solve practical problems using human factors approaches in a broad range of areas including transportation, healthcare, consumer products, robotics, manufacturing and social, organizational management. Furthermore, the program will produce students rigorously trained in human factors techniques to feed into University's interdisciplinary PhD programs as well as the growing job market for Human Factors professionals at the Masters level. The program creates another attractive pathway for Northeastern's undergraduate students to pursue a BS/MS option and it opens additional avenues for university-industry partnerships through human factors projects, co-op positions and internships.

Program Clientele Analysis

The International Ergonomics Society defines Human Factors as "...the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and other methods to design in order to optimize human well-being and overall system performance." Human Factors has become an important technical professional field and is considered essential to improving business performance, decision making, and gaining an edge over competitors.

Unique opportunity for Northeastern: These growing trends in human factor implementations across various fields and the rising demand for workforce with human factors skills creates a unique opportunity for Northeastern University to train human factors professionals through the MS in Human Factors program.

Evidence for program demand for ability to attract high quality students: The College of Engineering at Northeastern, historically and more so in the past five years, has attracted highly qualified applicants for their MS programs. The Graduate School of Engineering received more than 7,500 applications to their MS programs in FY16 (for Fall 2015 & Spring 2016 entry). Riding on the brand name of Northeastern's College of Engineering, one can confidently expect a sizable pool of highly qualified applicants for the MS program in Human Factors. This application pool will likely come both from international and

domestic students. Empirically, this is already evident from the exponential rise in the number of NU engineering grad and undergrad students enrolling into human factors - related courses such as Human Factors Engineering.

Competition from other programs: Responding to the perceived and palpable demand for human factors professionals, a few universities have created MS programs in human factors, engineering psychology, ergonomics science. The website https://www.hfes.org/ features many, if not all, such programs across the nation. Proliferation of these programs notwithstanding, supply is lagging far behind the demand growth for professionals trained in human factors. Locally, the competition comes from Tufts University's Graduate Program: Master of Science in Human Factors, and Bentley University's Master's in Human Factors and Information Design. Nationally, the competition comes from programs at US institutions including University of Michigan, University of Central Florida, University of Wisconsin in Madison, Virginia Tech., Clemson, to name a few. In spite of these competing human factors programs, Northeastern's MS in Human Factors program can expect to experience overwhelming demand from applicants from government agencies (such as The Volpe National Transportation Systems Center), healthcare systems, and industry partners, considering that Boston is a hub of information technology for human factors professionals. Northeastern's MS in Human Factors program should also stand apart due to its graduate co-op opportunities and the experiential learning model.

Impact on existing programs at Northeastern: The MS in Human Factors program will have a positive and synergistic impact on existing programs. It draws its core and elective courses from the existing pool of courses offered by several departments and colleges at Northeastern. The program creates demand rather than competition for these existing courses. For example, the program can increase demand for courses that are typically taken by students from MS in Industrial Engineering, MS in Engineering Management, and MS in Information Systems programs. MS in Human Factors will allow also the Graduate School of Engineering to offer such a degree program a for students enrolled in other MS programs in the College of Engineering, the College of Science, and perhaps other Colleges. In addition, MS in Human Factors program allows students to acquire rigorous ergonomics skills and research experience to continue with a doctoral program in one of Northeastern's Colleges. Overall, no existing program is expected to lose students, as students are recruited into the proposed MS in Human Factors Program.

While the proposed MS in Human Factors aims to produce professionals who specialize in Human Factors though they can pursue careers in other sectors as well, the MS in Human Factors is designed to produce general human factors professionals with breadth for a variety of sectors include transportation, healthcare, robotics, manufacturing, computer and software design, design of consumer products, etc. While the applicants to the MS in Human Factors predominantly will come from an engineering background, some will likely also come from backgrounds in psychology and allied areas as well as computer science.

It is also worth mentioning that this MS program would help to attract stronger HF students to work on some of the research projects needing these skills in the Healthcare Systems Engineering Institute; this has been an ongoing challenge for the Institute. Many Boston-area hospitals are disappointed with their perceived lack of local graduates with the types of human factors training useful in healthcare, patient safety, healthcare IT, etc. Therefore,

this new MS program in HF is expected to have a positive impact on such existing programs.

Educational Objectives and Curriculum

Educational objectives: The MS in Human Factors program is designed to help students acquire knowledge and skills to:

• Discover opportunities to improve systems, processes, and enterprises through human factors knowledge
• Apply human factors methods to solving complex problems involving human factors and ergonomics issues
• Work with technology teams to design and build complex human factors systems
• Use tools and methods for human factors and ergonomics to generate analyses and reports
• Create integrated views of human factors from multiple sources of an enterprise
• Understand and explain results of human factors studies
• Design and develop human factors projects

Admissions criteria and process: To be eligible for admission to MS in Human Factors program, a prospective student must hold a Bachelor of Science degree in engineering, science, mathematics, psychology, health science or an equivalent field. Applications to the MS in Human Factors program will be processed by the Graduate School of Engineering. The program director will review the applications and offer admission to applicants that meet the admission standards defined in terms of GPA, GRE and TOEFL scores, recommendation letters, and human factors-related work experience. The Program Director will communicate his or her decision to the Graduate School of Engineering for a final review and follow through the admission process. The admissions requirements of the program will be defined within the framework of policies and guidelines set forth by the College of Engineering and the University Graduate Council.

Degree requirements

Credit hour requirements: To graduate from the program students are required to complete a total of 32 SH. Students take 24 SH of core courses and 8 SH of elective courses or 8 SH MS thesis. In addition, 4 SH elective(s) can be replaced by a 4 SH project.

Degree Requirements	With Thesis	With Project	Course Work Only
Core courses	16 SH	16 SH	16 SH
Electives courses	8 SH	12 SH	16 SH
MS Project	-	4 SH	-
MS Thesis	8 SH	-	-
Minimum semester hours required	32 SH	32 SH	32 SH

Core Courses: Students are required to take the following core courses (16 SH):
IE 7315: Human Factors Engineering (4 SH)
IE 6500 Human Performance in Sociotechnical Systems
IE 7280: Statistical Methods in Engineering (4 SH)
EMGT 5300: Engineering/Organizational Psychology (4 SH)

These core courses are designed to give students a solid foundation in human factors, cognitive, physical, behavioral, physiological, social, developmental, affective, and motivational aspects of human performance.

Elective courses: Depending on the options (i.e., Thesis, Project or Coursework-only – see Table above), students are required to complete up to additional 16 SH from the following elective courses list. These courses provide students with knowledge and understanding of descriptive, prescriptive human factors as applied to a specific field of interest such as transportation, healthcare and robotics. Alternatively, students can select their electives to prepare themselves for a doctoral program by taking advanced courses in mathematics, statistics etc. The following is the list of approved elective courses offered by different academic units distributed across different colleges and departments.

College of Engineering (COE)

IE 5630 - Biosensor and Human Behavior Measurement (4 SH)
CIVE 7388 - ST: Urban Informatics and Processing (4 SH)

College of Social Sciences and Humanities (CSSH)

ECON 7200 – Topics in Applied Economics (3 SH)
ECON 7251 – International Finance (3 SH)
ECON 7271 – Industrial Organization (3 SH)

College of Science (COS)

PSYC 5180 - Quantitative Methods 1 (3 SH)
PSYC 5181 - Quantitative Methods 2 (3 SH)
PSYC 6130 - Affective Computing (4 SH)
PSYC 7300 Advanced Quantitative Analysis (3 SH)
PSYC 7301 Research Methodologies Psychology (3 SH)

Bouvé College of Health Sciences (Bouvé)

PT 5600 - Ergonomics and the Work Environment (3 SH)
EXSC 5220 - Advanced Exercise Physiology (3 SH)
EXSC 5210 - Physical Activity and Exercise (3 SH)

Khoury College of Computer Sciences (KCCS)

CS 5340 - Computer/Human Interaction (4 SH)
CS 6350 - Empirical Research Methods (4 SH)

College of Arts, Media and Design (CAMD)

ARTG 5600- User Experience Design Studio – Principles (4 SH)
ARTG 5610- Design Systems (4 SH)
ARTG 5630- Design Research Methods
ARTG 5640- Prototyping for User Experience Design (4 SH)
ARTG 6310- Design for Behavior and Experience (4 SH)
ARTG 5150- Information Visualization Principles and Practices (3 SH)

ARTG 5310- Visual Cognition (4 SH)
ARTG 5330- Visualization Technologies (4 SH)
ARTG 6320- Design of Information-Rich Environments (4 SH)
GSND 6240- Exploratory Concept Design (4 SH)
GSND 6250- Spatial and Temporal Design (4 SH)
GSND 6330- Player Experience (4 SH)
GSND 6340- Biometrics for Design (4 SH)

Description of core and elective courses is presented in Appendix A.

Project: In place of an elective course, students can undertake a 4-credit hour human factors project under the supervision of a faculty member from the above colleges. The project should address a human factors problem using human factors approaches and/or techniques. The project could be either sponsored by industry or defined by a faculty advisor.

MS Thesis: In lieu of elective courses, students can undertake an 8-credit MS thesis under the supervision of a faculty member from the colleges. The thesis topic should cover one or more of the areas from the above. The thesis should train students for research in human factors and/or prepare them for a doctoral program related to human factors.

Minimum academic standards: There are no academic standards required in addition to the university requirements.

Requirements as applicable: All MS in Human Factors students who receive financial support from the university in the form of a research, teaching, or tuition assistantship must complete an 8-semester-hour thesis. Students who complete the thesis option must make a presentation at a thesis defense before approval by the departments and colleges. All students in the program must complete a minimum of 32 semester hours of approved course work (exclusive of any preparatory courses) with a minimum GPA of 3.000.

Tracks: This program starts with Human Factors Engineering, but is expected to expand to the the following interdisciplinary tracks as follows:

- Human Factors in Engineering Track (COE)
- Human Factors in Psychology Track (COS)
- Human Factors in Healthcare Track (Bouvé)

Further, it is expected to include more tracks (such as Human Factors in Information Sciences) with the growth of the program. For each track, students are allowed to take up to 24 SH (courses only), 20 SH (project), and 16 SH (thesis students) from their colleges, respectively.

Curriculum requirements: The curriculum documentation checklist, new programs curriculum requirements form, and pattern of attendance from have been completed and are included with this proposal package.

Curriculum requirements for completion: These requirements were described above.

Program assessment: The program director and advisory committee will develop a rubric of metrics for key performance indicators of the course and program objectives. Using this

rubric, the program director and the advisory committee will assess course and program activities and experiences.

Once the students are admitted into the program, core outcomes of each course will be assessed through direct and indirect assessment methods. The program director will develop survey instruments to get anonymous student feedback on courses they take. These surveys will be conducted for all core courses and for a random sample of elective courses. In addition, the outcomes for the courses will be assessed through TRACE evaluations. The survey results will be summarized in an outcome rubric for each course to assess the core outcomes of the course. This assessment will be conducted each year until the program reaches maturity and stability, expectedly by the end of the fifth year of the program.

The overall program outcomes will be assessed through many standard graduate program metrics such as application volume, acceptance rate, yield, graduate rate, placement statistics, and competency match between curriculum and industry needs. The program will also monitor the students' co-op positions and co-op employers' feedback to gauge the program outcomes. Furthermore, the program will conduct surveys for graduating students and the employed alumni in the field to get their feedback on the program performance. This feedback from the graduating students and employed alumni will be translated into recommendations for the program improvement. This assessment will be conducted annually to address curricular issues and co-op and employment issues. A comprehensive program review will be conducted at the end of the fifth year of the program.

The program director and the advisory committee will conduct comprehensive curriculum assessment at the end of the fifth year of the program. By reviewing formative course evaluations and program evaluations, program director and advisory committee will identify and address issues related to knowledge and skill gaps, course prerequisites, course sequences, and other barriers to student learning. The assessment methods and schedule are summarized in **Table 1**.

Table 1 Program Assessment

Assessment Method	**Year 1 (AY 17/18) Formative Assessment**	**Year 2 (AY 18/19) Formative Assessment**	**Year 3 (AY 19/20) Formative Assessment**	**Year 4 (AY 20/21) Formative Assessment**	**Year 5 (AY 21/22) Summative Assessment**
Admission Data Review	Spring	Spring	Spring	Spring	Spring
Student Feedback on Courses	Summer	Summer	Summer	Summer	Summer
TRACE Evaluations	Summer	Summer	Summer	Summer	Summer
Co-Op Student Survey	Fall	Fall	Fall	Fall	Fall
Co-Op Employer Survey	Fall	Fall	Fall	Fall	Fall

Graduate Student Exit Survey	Spring	Spring	Spring	Spring	Spring
Employed Alumni Survey	.Fall	Fall	Fall	Fall	Fall
Curriculum assessment	Summer	Summer	Summer	Summer	Summer
Overall Program Performance Evaluation	Summer	Summer	Summer	Summer	Summer

Resources

Minimal additional resources are required. The MS in Human Factors program is built by leveraging the existing well-established courses. The arrival of future new human factors faculty should also strengthen the MS in Human Factors in terms of courses, projects, and MS theses.

Appendix A. Course descriptions at NEU

College of Engineering (COE)

IE 7315 - Human Factors Engineering

Offers students an opportunity to acquire the necessary knowledge and skills to recognize and analyze existing or potential human factors problems and to identify, design, and possibly implement feasible solutions. Includes introduction to human factors and ergonomics; engineering anthropometry and biomechanics; physiology related to human factors and workstation design; cognition and information processing; decision making, attention, and workload; human error and accidents; human-machine interface design; controls and displays; and human factors applications in transportation, aerospace, consumer product design, and so forth. Prereq. Restricted to students in the College of Engineering and in the College of Science.

IE 6500 Human Performance in Sociotechnical Systems

This course is concerned with the integration of sociotechnical (human-machine) systems in order to improve productivity, efficiency, safety, and quality of work life. In particular, this involves designing of jobs, machines, operations, and work environments in systems and organizations so that they are compatible with human capabilities, characteristics and limitations. The course covers a wide range of sociotechnical systems and is focused on human performance, human system integration, and evaluation. A variety of sociotechnical systems and interactions will be discussed, including transportation, healthcare, manufacturing and service industries, human-computer and human-robot interaction, etc.

IE 5630 - Biosensor and Human Behavior Measurement

Emphasizes the measurement of human behavior in complex human-machine interaction. Topics include introduction of complex human-machine interactions; research methods in complex human-machine interactions; various kinds of human psychophysiological signals/cues, including physiological cues, facial expressions, eye-gaze movement, head movement, contextual cues; human cues and behavior relationship; transducers and

measurement for these human cues/signals; basic principles of biosensors; general classification of biosensors; current technologies for building biosensors; conventional transducers and new technologies including micro-/nanotechnology; general systematic design process for biosensors; application of biosensors to understand human behavior in human-machine interactions. Also introduces the latest relevant research advancements in sensor fusion, affective computing, and emotion recognition.

IE 6200 Engineering Probability and Statistics

Studies fundamental concepts of probability. Topics include events, sample space, and discrete and continuous random variables; density functions, mass functions, cumulative probability distributions, and moment generating functions; expectation of random variables; common discrete and continuous probability distributions including binomial, Poisson, geometric, uniform, exponential, and normal; multivariate probability distributions, covariance, and independence of random variables; sampling and descriptive statistics; and parameter estimation, confidence intervals, and hypothesis testing. Also introduces analysis of variance. Prereq. Knowledge of multivariate calculus; engineering students only.

IE 7280 Statistical Methods in Engineering

Discusses statistical models for analysis and prediction of random phenomena. Topics include review of descriptive statistics and hypothesis testing, linear models, both regression and ANOVA. Introduces design of experiments. Covers experiments with single and multiple factors of interest, and considers experiments with high-order experimental restrictions. Prereq. IE 6200 with a grade of C or MATH 7241 with a grade of C; restricted to students in the College of Engineering and in the College of Science.

EMGT 5300 - Engineering/Organizational Psychology

Offers an analysis of the purpose and functioning of organizations as the basic networks for achieving goals through coordination of effort, communication, and responsibility. Studies the role and function of engineering organizations based on modern behavioral science concepts as well as the application of psychology to industry relative to human relations, group dynamics, tests and measurements, personnel practices, training, and motivation. Examines the evolution of the learning organization and its role in the management of R&D and technology, the influence of the rapid changes in technology, and the globalization of the marketplace through group-oriented case studies.

CIVE 7100: Applied Time Series & Spatial Statistics

Offers an interdisciplinary course covering the fundamentals of time series and spatial statistics with applications in engineering, science, and business. Introduces analysis and forecasting methods for time series, spatial, and spatiotemporal data. Discusses classical time or frequency domain methods, as well as recent techniques motivated from computer science, physics, statistics, or engineering. Case studies relate to ongoing research and to real-world examples. A demo project is selected by the instructor based on discussion with individual students. A computer-based final project can be tailored to student interests in environmental engineering, sustainability sciences, security threat assessments, social sciences, business, or management science and finance.

CIVE 7388 Special Topics in Civil Engineering: Urban Informatics and Processing
The course aims to deliver a comprehensive review of urban informatics in civil and infrastructure engineering research. The course will include discussion in the usage of these data and will provide hands-on opportunities to extensively analyze, comprehend, and visualize five types of datasets: construction and infrastructure development; urban mobility and traffic; sensors in built environments; geo-social networks; and social media. Extensive data sets will be provided for practices. Python will be the main platform for analysis and visualization.

College of Computer and Information Science (CCIS)

CS 5340 Computer/Human Interaction

Covers the principles of human-computer interaction and the design and evaluation of user interfaces. Topics include an overview of human information processing subsystems (perception, memory, attention, and problem solving); how the properties of these systems affect the design of user interfaces; the principles, guidelines, and specification languages for designing good user interfaces, with emphasis on tool kits and libraries of standard graphical user interface objects; and a variety of interface evaluation methodologies that can be used to measure the usability of software. Other topics may include World Wide Web design principles and tools, computer-supported cooperative work, multimodal and "next generation" interfaces, speech and natural language interfaces, and virtual reality interfaces. Course work includes both the creation and implementation of original user interface designs, and the evaluation of user interfaces created by others. *Prereq. Knowledge of C programming language/UNIX; restricted to students in the College of Computer and Information Science.*

IS 4300 - Human Computer Interaction

Studies the principles of human-computer interaction and the practice of user interface design. Discusses the major human information processing subsystems (perception, memory, attention, and problem solving), and how the properties of these systems influence the design of interactive systems. Reviews guidelines and specification languages for designing user interfaces, with an emphasis on tool kits of standard graphical user interface (GUI) objects. Introduces usability metrics and evaluation methods. Additional topics may include World Wide Web design principles and tools; wireless/mobile device interfaces; computer-supported cooperative work; information visualization; and virtual reality. Course work includes designing user interfaces, creating working prototypes using a GUI tool kit, and evaluating existing interfaces using the methods studied. *Prereq. CS 3500.*

CS 6350 - Empirical Research Methods

Presents an overview of methods for conducting empirical research within computer science. These methods help provide objective answers to questions about the usability, effectiveness, and acceptability of systems. The course covers the basics of the scientific method, building from a survey of objective measures to the fundamentals of hypothesis testing using relatively simple research designs, and on to more advanced research designs and statistical methods. The course also includes a significant amount of fieldwork,

spanning the design, conduct, and presentation of small empirical studies. Prereq. Junior, senior, or graduate standing; restricted to students in the College of Computer and Information Science.

Bouvé College of Health Sciences (Bouvé)

EXSC 5210- Physical Activity and Exercise

Studies the general principles of physical activity and exercise prescription, measurement, and testing. Offers students an opportunity to learn the fundamental concepts and techniques to measure physical activity, exercise, and related testing procedures through a hands-on approach. Topics include the use of questionnaires and activity monitors to measure physical activity; measurement of body composition, fitness, muscular strength, and endurance; and clinical exercise testing. The fundamental concepts of exercise prescription and use of measurement techniques taught in this course are applicable to careers in physical therapy, exercise physiology, and as a physician assistant. Requires prior completion of EXSC 4500 or equivalent undergraduate course or permission of instructor.

EXSC 5220- Advanced Exercise Physiology

Covers the advanced study of concepts, principles, and research in the field of exercise physiology. Discusses advanced concepts in the muscular/neuromuscular, cardiovascular, ventilatory, endocrine, and metabolic responses to exercise and exercise training. Specific study of the physiological control mechanisms regulating these systems are also addressed during periods of rest, acute exercise, and following chronic exercise training.

PT 5600 - Ergonomics and the Work Environment

Builds upon the public health definition that ergonomics is the applied science that optimizes overall human-systems performance and well-being within the work environment. Emphasizes a public health approach suited for healthcare professionals building on their strengths and training in analytical diagnostic skills and interventions, ranging from primary to tertiary approaches. Covers topics including epidemiology, job hazard analysis, and intervention methods and research. Offers students an opportunity to obtain the knowledge and skills to improve the physical ergonomic factors in a workplace in order to increase the health and well-being of workers. *Prereq. Senior or graduate standing.*

College of Science (COS)

PSYC 5180 - Quantitative Methods 1

Presents first course in a two-course sequence that surveys a variety of quantitative methods used in experimental psychology. Prereq. Psychology PhD students only or permission of instructor.

PSYC 5181 - Quantitative Methods 2

Continues PSYC 5180. Presents second course in a two-course sequence that surveys a variety of quantitative methods used in experimental psychology. Prereq. PSYC 5180; psychology PhD students only or permission of instructor.

PSYC 6130 - Affective Computing

Studies affective computing—computing that relates to, arises from, or influences emotions. Offers an overview of the theory of human emotion (how it arises from and influences cognition, the body, and the social environment) and computational techniques for modeling human emotion processes as well as for recognizing and synthesizing emotional behavior. Discusses how these can be applied to application design. Offers students an opportunity to gain a strong background in the theory and practice of human-centered computing as it relates to games, immersive environments, and pedagogical applications. Brings together students from different disciplines to work together and learn from each other. Prereq. Restricted to students in the College of Computer and Information Science and in the College of Science. Cross-listed with CS 6130.

PSYC 7300 Advanced Quantitative Analysis

Covers selected advanced methods of quantitative analysis used in experimental psychology. Specific topics vary by semester. Prereq. Psychology PhD students only or permission of instructor.

PSYC 7301 Research Methodologies Psychology

Introduces students to a range of conceptual and methodological issues in the conduct of experimental psychology research by department faculty members. Specific course content depends on which faculty members conduct the course in a given semester. Prereq. Psychology PhD students only or permission of instructor.

College of Arts, Media and Design (CAMD)

ARTG 5150 - Information Visualization Principles and Practices

Introduces information visualization from theoretical and practical perspectives. Defines the information visualization domain and advances principles and methods for the effective visual representation of data. Contextualizes the field from a historical perspective. Presents the perceptual and cognitive tasks enabled by visualizations. Studies an extensive range of visualization models. Illustrates good and bad practices in visualization with real-world examples. Introduces concepts in computer programming in an information visualization context.

ARTG 5310 - Visual Cognition

Introduces human visual cognition as it applies to information design and visualization. Focuses on perception, attention, pattern recognition, information acquisition, memory, and creation of mental models. Explores reasoning, cognition, decision making, and problem solving in relation to visual artifacts. Prereq. Senior or graduate standing.

ARTG 5330 - Visualization Technologies

Introduces programming languages that allow computational analysis and digital delivery of dynamic information. Examines implications of environmental and personal sensor data sources, mobile collection and analysis of data, real-time networked data sets, and social use of shared data visualization tools. Students who do not meet course restrictions may seek permission of instructor or program coordinator. May be repeated once.

ARTG 5600 - Experience Design Studio 1—Principles

Offers students hands-on project development of systems, artifacts, communication, environments, or service offerings with a focus on the unique personal experience of the audience exposed to the project. Experience design is a holistic approach to design that utilizes investigation into the human experience in specific situations to improve its quality, given an understanding of human goals, needs, and desires. This course provides a context for a cohesive experience through interaction, movement, and understanding, which builds on previous knowledge of audiences and applications. Presents students with design methods and processes for experience design by developing a semester long project. Offers students an opportunity to develop competency in tools used to create the various elements that create the context for experiences in specific situations and events including interaction, artifact, and environment design. Prereq. Graduate standing, also undergraduate seniors with permission of instructor; understanding a design process and knowledge of studio critique practices is recommended.

ARTG 5610 - Design Systems

Explores a systems-based perspective on our environment and in doing so addresses questions that are fundamental to design practice: What is a system, and what are the different types? How do we observe, analyze and represent systems? What interactions can we have with systems and what are the different types of interaction? The course explores structures and processes for the design of systemic relationships between people, artifacts, environments, and activities. Systems may be physical, virtual, social, or a combination and examples could be healthcare services, learning environments, transportation systems, event organizations, food services, etc. Through discussion, writing, diagramming. and project exercises, students have an opportunity to learn principles of systems theory and explore the connection between design methods and systems thinking. Prereq. Graduate standing, also undergraduate seniors with permission of instructor.

ARTG 5630 - Design Research Methods

This course introduces designers to the many research tools that can be used to inform design as well as to ideas about how and when to deploy them effectively. It includes qualitative and quantitative methods, performance ethnography and design improvisation, trend research, cultural diversity, formal and structural research practice, tactical discussions of design research process, and case studies drawn from areas as unique as computer games, museum information systems, and movies.

ARTG 5640 Prototyping for User Experience Design

Explores tools, technologies, and processes to create prototypes of artifacts, environments, and interactive systems for experience design projects. Offers students the opportunity to learn, use, experiment with, and test prototypes using a wide range of state-of-the-art prototyping technologies to further their understanding of multiple strategies and techniques of prototyping for experience design. Tools and techniques change over time but typically include laser cutting, 3D printing, CNC machining, electronics prototyping, augmented reality, machine tools and 2D forming, fast prototyping, and hand tools.

ARTG 6310 - Design for Behavior and Experience

Examines the potential of interfaces as mediators between information and users. Explores iterative prototyping and research methods to analyze patterns of behavior and implications of interface on effective communication. Utilizes observation, empathy, ethnography, and participatory design methods to offer students an opportunity to increase their understanding of audiences' and stakeholders' motivations and expectations. Prereq. Information design and visualization MFA students only.

ARTG 6320 - Design of Information-Rich Environments

Explores methods of information organization, presentation, and navigation in physical space. Introduces concepts of wayshowing and embodiment and examines the bridging of physical and virtual spaces through the use of mobile and locative technologies. Encourages collaborative studio projects exploring interventions in public or urban environments and in exhibit-based learning environments. Prereq. Information design and visualization MFA students only.

GSND 6240 - Exploratory Concept Design

Explores the process of designing new modalities of interaction utilizing novel uses of established technology, e.g., pervasive and affective technologies. Focuses on philosophy and practice of creating and evaluating experimental interactions. Recontextualizes gameplay concepts through permutations of basic elements such as controls, platforms, cameras, interfaces, etc. Leverages constraints as vehicles to push the boundaries of accepted design. Explores four key approaches to experimental interaction through course projects and assignments: discovering, examining, and exploring potential new technologies and interaction principles; rapidly designing and prototyping experimental interactions; pitching, justifying, and explaining designs and prototypes to others; and addressing new technologies and forms of interaction from a research perspective, focusing on their larger implications and potential impact on play.

GSND 6250 - Spatial and Temporal Design

Explores the development and understanding of spaces used by people in 3D and 2D virtual environments. Uses an iterative process of making, criticizing, experiencing, and analyzing spatial form; compositional ideas for form making; and critical thinking. Offers students an opportunity to develop the arbitrary, yet necessary, mind-set needed to make assumptions about aesthetic spatial values and expected player behaviors. Analyzes the connection between spatial-aesthetic elements and their effects on players' psyches. Experiments with how spaces, textures, shapes, and colors can support different synchronous moods. Explores how to shape spaces that fit the rational, emotional, and behavioral profile of different types of players. Applies concepts learned from architecture and game-level design to extend students' creative and critical abilities.

GSND 6330 - Player Experience

Focuses on topics of player psychology—cognition; memory; emotions; attention; and game-focused theories such as engagement, fun, user experience, player-need-satisfaction model, and flow. The development cycle of any game relies on the understanding of the players, the target market of the game product. Covers game usability engineering and game-specific evaluation methods, such as play testing, rapid iterative testing and evaluation (RITE), play-heuristic evaluation, and retrospective play reviews. Offers

students an opportunity to learn how to analyze qualitative and quantitative data and to apply parametric and nonparametric statistical evaluation methods, qualitative data coding and analysis, and descriptive statistics. Requires students to apply visualization techniques of data and reporting.

GSND 6340 - Biometrics for Design
Covers the domain of psychophysiological testing. Introduces theory and research in major areas of human psychology, including cognition, emotions, and attention. Studies the principles, theory, and applications of psychophysiological assessment inside and outside interactive digital entertainment. Offers students an opportunity to understand the basics of eye tracking—eye movements, fixations, saccades. Applies methods of data collection, clearning, and analysis for both physiological and eye-tracking data. Covers all issues of using such measurements, including validity of conclusions and confounding variables. Covers the process of triangulation and repotting in-depth along the entire process of the game production life cycle.

College of Social Sciences and Humanities

ECON 5110 - Microeconomic Theory
Presents a survey of microeconomic theory at the beginning graduate level. Topics include theories of the consumer, firm, and market (including input and output markets), welfare economics, and market failures. Includes applications of theory to public policy questions in such fields as industrial organization and public finance. Requires knowledge of undergraduate microeconomic theory.

ECON 5140 - Applied Econometrics
Offers an intensive study of econometric techniques applied to cross-section, time-series, and panel data. Applies the fundamentals of econometrics to analyzing structural economic models, forecasting, and policy analysis. Computer applications and an empirical research project are an integral part of the course.

ECON 5291 - Applied Development
Focuses on major macroeconomics policy questions for developing countries in an open economy context. Combines theoretical foundations with institutional analysis and empirical evidence. Begins by developing a macroeconomic framework to analyze short-term macroeconomic adjustment and concludes with long-term growth, emphasizing the effects of financial integration and capital account regulations on macroeconomic performance in developing countries. Approaches macroeconomic policy issues from a political economy perspective on macroeconomics. Empirical data and country experiences help assess the validity of theoretical propositions and explain the complexity of development trajectories. Requires previous course work in macroeconomic theory.

ECON 5292 - Gender and Development Economics
Examines topics at the intersection of women's empowerment and economic development from an economic perspective. Introduces potential explanations for the gender inequalities

in the context of developing countries as well as the role of public policy in addressing such disparities. Studies microeconomics topics such as education gaps, fertility, family planning, HIV/AIDS, marriage dynamics and intrahousehold allocation of resources, female labor outcomes and migration, as well as conflict and domestic violence. Offers students an opportunity to apply basic economic theory associated with each topic as well as the research methodologies used in recent empirical papers. Students with an econometrics background have a better understanding of the empirical papers. Requires previous course work in microeconomic theory and in statistics.

ECON 7200 - ST: Health Econ & Health Care ECON 7200
Presents an application of microeconomic and macroeconomic theory, as well as quantitative methods, to a variety of social issues, both domestic and international. May be repeated without limit.

ECON 7240 - Workshop in Applied Econometrics
Offers an intensive, hands-on application of econometrics to research problems in economics, using current econometric software packages. Both cross-section and time-series techniques are used and applied to different areas of economics, such as global economics, labor economics, urban economics, public finance, policy evaluation, and so on. Students are expected to complete a written applied econometrics project and present the results to the class.

ECON 7251 - International Finance
Introduces students to international finance and equips them with tools and methods to study and analyze international economic issues and problems. Topics include the foreign exchange market, balance of payments, international investment and banking, monetary and fiscal policy in an open economy, economic integration and monetary unification, the international monetary system, and optimum currency areas. Each student is required to write a short paper on a current problem in international finance.

ECON 7271 - Industrial Organization
Analyzes the market structure of industries and strategic behavior by businesses, and the effect that these have on economic performance. Draws on economic theory, empirical evidence, and case studies. Also includes a brief discussion of governmental policies such as antitrust, regulation, and public ownership/privatization.

POLS 7704 (CIVE 7110) - Critical Infrastructure Resilience
Explores the growing vulnerability of our human-made built environment to a range of risks. Using the new paradigm centered on the concept of resilience, examines how best to safeguard the critical foundations that provide transport, communications, water, energy, and other essential functions in the face of disasters, growing urbanization, climate change, and globalization. Identifies solutions that are scientifically credible, informed by data and sound engineering principles, while concurrently grounded in an understanding of social and policy imperatives.

D'Amore-McKim School of Business

BUSN 6280 - How Executives Shape and Lead Innovation and Enterprise Growth
Focuses on different types of innovation (technical, market, business model, and organizational), the role of executive leadership, and enterprise growth in technology-intensive industries. Offers students an opportunity to apply a strategic management framework to industry leaders through case studies. Students are then asked to apply the framework to the future growth of their own organizations and the career path they seek in that growth.
3.000 Credit hours
3.000 Lecture hours
Levels: Graduate
Schedule Types: Lecture

BUSN 6295 - Mindful Leadership in Global Strategy
Aims to provide the insight and tools needed to manage global strategy effectively and to become a catalyst for successful change. Organized on the Western conception of mindfulness, or active thinking, which focuses on contextual understanding, perspective taking, and process awareness as applied to translating strategy into action, leveraging team performance, and catalyzing successful change. Today's global organizations need skilled and mindful executives. Although cultural understanding and skills are important competencies, global leaders also need to be aware of how their organizations' administrative heritage that evolved in their home countries influences global operations.
3.000 Credit hours
3.000 Lecture hours
Levels: Graduate
Schedule Types: Lecture

BUSN 6365 - Business Analytics
Provides an overview of data collection, organization, analysis, interpretation, and presentation techniques used by contemporary organizations. Students use multiple software tools to collect, prepare, manage, analyze, evaluate, understand, critique, visualize, and present data sets of various types. Offers students an opportunity to obtain essential skills, tools, and techniques required to understand data sets, both large and small, from sources internal and external to an organization. This understanding can then be used to support datacentric decision making and create a measurable improvement in business performance. Businesses run on data, and employees at all levels must know how to properly use and interpret data to support their roles within a company.
3.000 Credit hours
3.000 Lecture hours
Levels: Graduate
Schedule Types: Lecture

Appendix B

Human Factors Programs Institutions

Bentley College
http://www.bentley.edu/graduate/ms-programs/hfid
Tufts University
http://engineering.tufts.edu/me/graduate/msHumanFactors.htm
The Georgia Institute of Technology
http://psychology.gatech.edu/research/engineering
University of California
http://www.cla.csulb.edu/departments/psychology/ms-human-factors/
University of Illinois at Urbana-Champaign
http://provost.illinois.edu/programsofstudy/2009/fall/programs/graduate/human_factors.html
Iowa State University
http://www.vrac.iastate.edu/hci/
University of Minnesota
http://humanfactors.design.umn.edu/ms_phd.html
North Carolina State University
http://psychology.chass.ncsu.edu/psg/
Ohio State University
https://engineering.osu.edu/graduate/ise
Clemson University
http://www.clemson.edu/cbbs/departments/psychology/graduate/
Texas Tech University
https://www.depts.ttu.edu/psy/humanfactors/masters.php
George Mason University
http://humanfactors.gmu.edu
University of Wisconsin-Madison
https://www.engr.wisc.edu/department/industrial-systems-engineering/academics-2/ms-in-industrial-engineering/
Virginia Polytechnic Institute and State University
http://www.ise.vt.edu/academics/graduate/ms/hfee/
University of Toronto
http://www.cla.csulb.edu/departments/psychology/ms-human-factors/

Appendix C

Curriculum at Other Institutions

MIT
(HF in Aerospace engineering)
Human Factors Engineering (MIT Course Number: 16.400 / 16.453)

Bentley College
(MS in HF in information design)
Foundation in Human Factors
Usability Testing and Assessment Programs
Managing a User-Centered Design Team
Advanced User Interface Design
Ethnography
Research Methods
Prototyping and Interaction Design
Research Methods for Human Factors Internship

Tufts University
(MS and BS in Human Factors/Engineering Psychology)
HF in Product Design
Human-Machine System Design
Research & Analytical Methods in HF
Advanced Probability and Statistics I & II
User Interface Design

University of Massachusetts Lowell
(HF group in MIE)
Introduction to Ergonomics and Industrial Hygiene
Occupational Biomechanics
Human Factors
Methods in Work Analysis
Occupational Safety Engineering
Occupational Biomechanics Lab
Advanced Biomechanics
Healthy Work Organization
Epidemiology of Musculoskeletal Disorders
Exposure Data Analysis
Macroergonomics
Accident Prevention Principles

University of California
Human Factors I
Human Factors II
Human Factors III
Advanced Research Methodology I

Advanced Research Methodology II
Advanced Research Methodology III
Human Cognition and Learning
Physiological Psychology
Sensation and Perception
Human Performance
Advanced Human-Computer Interaction
Human Factors Professional Issues
Visual Performance
Human Computer Interaction
Ergonomics in High Tech
Animation in CBI
Ergonomics
Organizational Psychology I
Advanced Social Psychology

University of Central Florida
Ergonomics
Occupational Biomechanics
Human & Organizational Factors
Behavioral Issues in Injury Prevention
Probability and Statistics
Ergonomics Internship
Engineering Design

Georgia Institute of Technology
Biomechanics and Human Performance
Biopsychology Core
Cognitive Core
Engineering Psychology I
Engineering Psychology II
Human Abilities
Psychomotor & Cognitive Skills
Research Design
Sensation & Perception
Seminars in Engineering Psychology

University of Illinois at Urbana-Champaign
IE 340: Human Factors
AVI 358 - Human Factors in Human-Machine Systems
AVI 456 - Human Performance and Engineering Psychology
CS 591 HCI: Seminar on Human-computer Interaction
CS 565: Topics in Human Computer Interaction
CS 465: Principles of User Interface Design
LIS 351A: The Design of Usable Information Interfaces
PSYC 358: Human Factors

Iowa State University
Human factors engineering using biomechanics
Work physiology
Engineering psychology
Work design
Industrial safety
Human-computer interaction

University of Michigan
Human Factors Engineering Short Course

University of Minnesota
Human Factors Foundations
Cognitive Human Factors
Physical Human Factors
Statistics
Experimental Design
Research Ethics Training

North Carolina State University
Human Factor in Systems Design
Occupational Biomechanics
Human Performance Modeling
Occupational Safety Engineering
Musculoskeletal Mechanics
Human-Computer Interaction
Systems Safety Engineering
Environmental Stress, Physiology & Performance
Ergonomic Performance Assessment
Human Information Processing
Upper-Extremity Biomechanics
Cognitive Engineering
Brain-computer Interfaces

Ohio State University
Cognitive Systems Engineering
Experimental Design
Artificial Intelligence I
Artificial Intelligence II
Cognitive Engineering: Research and Design Methods
Decision Analysis
Expert Systems
Human-Computer Interaction
Human Error
Human Interaction with Intelligent Systems

Models in HF Engineering
Organizational Psychology
Psychology of Perception
Psychology of Decision Making
Psychology of Learning and Memory
Work Physiology and Biomechanics in Workplace Design
Occupational Safety: Analysis and Design of Work Environments
Biomechanics Research Practicum
Advanced Topics in Biomechanics and Musculoskeletal Disorders
Risk Assessment Tools for Occupational Musculoskeletal Disorders
Cognitive Systems Engineering
Engineering Mechanics
Ergonomics in Product Design
Exercise Physiology
Exercise Physiology II

Pennsylvania State University
Engineering of Human Work
Engineering of Cognitive Work
Experimental Design
Human/Computer Interface Design
Safety Systems Engineering
Mechanics of the Musculoskeletal System
Human Reliability Analysis
Statistical Analysis
Probability

Clemson University
Quantitative Methods and Research Design
Human Factors Psychology
Cognitive Psychology
Human Perception and Performance
Ergonomics
Human-Machine Systems Engineering
Design of Human-Computer Systems
Advanced Seminar in Quantitative Methods
Advanced Physiological Psychology

Rice University
Foundations of Human Factors
Foundations of Cognition
Foundations of Social Psychology
History and Systems
Human-computer interaction
Methods in human factors
Texas Tech University

Ergonomics and Design
Work Physiology
Occupational Biomechanics
Safety Engineering
Loss Assessment and Control
Cognitive Engineering
Human Factors in Engineering & Design
Design of Experiments
Decision Theory and Management Science
Productivity and Performance Improvement in Organizations
Simulation Models for Operations Analysis
Total Quality Systems

George Mason University
PSYC 667 - Behavior in Small Groups and Teams
PSYC 668 - Personality: Theoretical and Empirical Approaches
PSYC 703 - Social Bases of Behavior
PSYC 702 - Biological Bases of Human Behavior
PSYC 530 - Cognitive Engineering: Cognitive Science Applied to Human Factors
PSYC 645 - Research Methods in Human Factors and Applied Cognition
PSYC 734 - Seminar in Human Factors and Applied Cognition

Virginia Polytechnic Institute and State University
ISE 5604 Human Information Processing
ISE 5605 Human Factors System Design I
ISE 5614 Human Physical Capabilities
ISE 5615 Human Factors Research Design I
ISE 5644 Human Audition and Auditory Display Design
ISE 6604 Human Factors in Visual Display Systems
ISE 6624 Advanced Topics in Human Factors

University of Wisconsin-Madison
Physical Ergonomics
Cognitive Ergonomics
Macroergonomics

University of Toronto
Design of Workplaces
Experimental Methods in HF Research
Analytical Methods in HF Research
Human-Automation Interaction
Engineering Psychology and Human Performance
Analysis and Design of Cognitive Work
Human Computer Interface Design for Complex Systems
Human Factors Integration
Human Factors in Transportation