

**PSYC 530 Cognitive Engineering: Human Factors in Systems**  
*Fall 2017*

**Time:** 4:30 pm – 7:10 pm Thursdays

**Place:** ARCH Lab

**Instructor:** Carryl L. Baldwin  
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**Office Hours:** 2:00-2:50 Wednesdays or by appointment (email).

**Prerequisites:** An experimental psychology class or consent of instructor.

**Objectives:**

This course is designed to prepare incoming Human Factors and Applied Cognition graduate students (although students in other programs are also welcome to enroll) by providing them with a basic background on the role of *human cognitive capabilities and limitations* in the design of products, work places, and large systems. The goal is to understand how perceptual and cognitive theories can be applied to diverse systems, from the relatively simple (mobile devices, computers, software interfaces, etc.) to the complex (air-traffic control, aircraft cockpits, robotics, automated systems, etc.). The emphasis is on theories and findings on human performance, rather than the design of systems per se, although implications for design are continually analyzed.

Human factors is both a science and an approach to the design of systems. This course considers the scientific basis for human factors, particularly in relation to modern systems. The science of human factors considers various human characteristics and abilities, both physical and cognitive that are brought into play when people use machines. New approaches to understanding human performance based on neuroscience—the new field of *neuroergonomics*—are also introduced. The goal of human factors is to design systems that match technology with human capabilities and limitations. The course has two objectives: (1) to examine several domains of human performance, with an emphasis on the information-processing approach to human perception and cognition; and (2) to investigate the role of human performance capacities and limitations in modern human-machine systems. Because modern human-machine systems increasingly make use of *automation* (computer assistance), another focus of the course will be on understanding the cognitive processes involved in human-automation interaction. The aim is to understand how certain perceptual and cognitive characteristics of human operators, for example the limited capacity of working memory or decision-making biases, influence the effectiveness of the performance of real-world systems.

**Structure of Course**

Each class will consist of lectures and participatory discussion, with the latter increasing over time as fundamental issues are further outlined in the lectures. For most of the classes, I will assign a journal article to be read each week and to be discussed in class, in addition to the

chapters in the required text. I will lecture on each of several domains of human performance research, with appropriate references to applications to actual systems. The second half of the course will consist of student presentations and discussions of specific topics related to human performance in systems.

**Attendance Policy:** Although I do not grade on attendance, this is a graduate level course and I expect (barring unforeseen circumstances) to see you in class each week.

**GMU Honor Code:** George Mason University has a code of Honor that each of you accepts by enrolling as a student. You should read and become familiar with this code at <http://mason.gmu.edu/%7Emontecin/plagiarism.htm>. The expectation is that all of the work you do for this class will be the work of one individual. However, you are fully encouraged to discuss the readings and topics raised in this class with your fellow students.

**Official Communications via GMU E-mail:** Mason uses electronic mail to provide official information to students. Examples include communications from course instructors, notices from the library, notices about academic standing, financial aid information, class materials, assignments, questions, and instructor feedback. Students are responsible for the content of university communication sent to their mason e-mail account, and are required to activate that account and check it regularly.

**Students with Disabilities:** If you are a student with a disability and you need academic accommodations, please see me and contact the Disability Resource Center (DRC) at 703-993-2474. All academic accommodations must be arranged through that office.

**Class Cancellations & Make-up:** If the University closes (e.g., due to inclement weather) classes will be canceled. In the event of any other unscheduled emergency cancellation, you will be notified via email and Blackboard posting as soon as possible. Make-up classes will be scheduled in a manner deemed most appropriate by the instructor and in discussion with all members of the class.

**Exam Make-up Policy:** You may take a test after the scheduled date only if you (a) receive my permission before the day of the test, or (b) have a valid excuse (e.g., a note from a doctor.). Papers will not be accepted beyond the due date. Homework assignments will not be accepted late.

## Grading System:

### Examinations:

Exams:	2 at @ 100	= 200
	<b>Examination total = 200<sup>1</sup></b>	

### Assignments

Group Assignments	4 @ 25	= 100
Participation in discussions and in-class exercises		= 80
Literature Review Paper	1 @ 100	= 100
Literature Review presentation	1 @ 40	= 40
Presentation of Journal Article	1 @ 20	= 20
Journal Article Activity	1 @ 20	= 20
	<b><u>Assignment Total = 360</u></b>	
	<b>TOTAL POINTS 560</b>	

## Grading Policy<sup>1</sup>:

Grades are based on a point system as indicated above. You may determine your standing in the course at any time by adding up the number of points you have received and dividing this number by the total number of points you could have earned for those items. The percentage score will be translated into a letter grade based on the following scale.

## Grading Scale:

	A = 94- 100%	A- = 90- 93 %	
B+ = 87-89	B = 84-86 %	B- = 80-83	
C+ = 77-79	C = 74-76 %	C- = 70-73	
D+ = 67-69	D = 64-66 %	D- = 60-63;	< 60 % = Failing

## Topics

History of human factors and the systems approach  
Allocation of function  
Signal detection  
Vigilance  
Attention, perception, and displays  
Memory  
Decision-making  
Multitasking and mental workload  
Neuroergonomics  
Human performance in automated systems

Note that because of time limitations not all aspects of human cognition that are relevant to human-machine systems will be considered, e.g., motor skills, language, stress and human

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<sup>1</sup> Exams must be taken on the date scheduled unless extenuating circumstances warrant an exception. All exceptions are at the discretion of the instructor and arrangements for makeup exams must be made in advance of the exam. Documented medical emergencies of the student or an immediate family member warrant an exception to the advance notice policy.

error, etc. However, those of you who are interested in these or related domains of human cognition can nevertheless choose to study these as part of your term paper.

### **Overview of Assignments: (More detail to be posted on BB)**

- 1. Mental Models of Autonomous Systems (3-4 people per group)** – Define a mental model and utilize a method to determine how people develop a mental model of an autonomous system (i.e., robot, drone, self-driving car, etc.). Present the results of your project in class.
- 2. TG Exploration – Video Assignment (3-4 people per group)** – from the HFES.org website choose a Technical Group (TG) that either a) seems to pertain to your interest area, or b) you have never heard of before and were surprised to find. After choosing the TG, find a proceedings article (2012 or newer) from that TG and make a short video (5-7 minutes) describing the TG and the main findings of the article. Upload the videos onto the course Blackboard website. Watch all peer videos and make substantive comments on at least two.
- 3. Analyze a workstation or Process – Group Assignment (3-4 people per group)** using information you have gained from the text and class lectures and discussion conduct an analysis of a complex workstation or process. What HF principles does it follow/violate? How well is it designed, what could be improved? Are there any potential safety hazards? Present the analysis and possible redesign in class. (7-10 minutes)
- 4. Accident Investigation Video Assignment– Group Assignment 2 (3-4 people per group)** Choose a major accident (to be preapproved by instructor) and investigate what happened. What antecedent factors and conditions contributed? Analyze the incident in terms of one of the error taxonomies or models of human error discussed in the class/text. What if any steps have or should be implemented to ensure a similar even does not occur in the future? (Obtain prior approval for your topic to make sure not everyone chooses the same incident). Make a video of your analysis (7-10 minutes). Upload the videos onto the course Blackboard website. Watch all peer videos and make substantive comments on at least two.

### **Reading Schedule and Exam/Assignment Date Calendar**

August 31:	History of Human Factors The Systems Approach and Function Allocation Information Processing and Engineering Psychology Mental Models	<b>Ch. 1, (Proctor &amp; Vu, 2010)</b>
September 7:	Signal detection theory	<b>Ch. 2, (Swets, Dawes, &amp; Monahan, 2000) (Cooke, 1994) (T. D. Wickens, 2002)</b>

September 14:	Attention and perception Vigilance	<b>Ch. 3, (Parasuraman, 1979) Head &amp; Helton (2012) See, Howe, Warm, &amp; Dember (1995)</b>
September 21:	Memory	<b>Ch. 7, (Baddeley, 2003) Engle (2002) (Beggiato, Pereira, Petzoldt, &amp; Krems, 2015) <u>Assignment 1 due – Mental Model – class discussion</u></b>
September 28:	(Asynchronous class) Human Factors & Accident Investigation	<b>(Reason, 2000)</b>
October 5:	Humans and automation	<b>Ch. 12, (Parasuraman &amp; Manzey, 2010) (Parasuraman &amp; Riley, 1997) (Pop, Shrewsbury, &amp; Durso, 2015)</b>
<b><u>Exam 1</u></b> – covers Chapters 1,2,3,7 & 12, associated Readings & Assignments		
October 12:	Assignment 2: TG Scavenger hunt is due (asynchronous class, BB assignment) Human Factors & Ergonomics Society Conference-Austin, TX	
October 19:	Spatial Displays, Spatial Cognition & Navigation	<b>Ch. 4 &amp; 5, Wickens &amp; Carswell (1995) Kato &amp; Takeuchi (2003) Buzzell et al. (2013)</b>
October 26:	Multitasking and mental workload	<b>Ch. 10, Wickens (2008) (Warm, Parasuraman, &amp; Matthews, 2008) (Rasmussen, 1983)</b>
November 2:	Decision making	<b>Ch. 8, Kahneman &amp; Tversky (1974) <u>Assignment 3 – Workstation /System Analysis due (Class Discussion)</u></b>
November 9:	Neuroergonomics	<b>Ch. 11, Parasuraman &amp; McKinley (2014) (Dehais et al., 2014) LAST DATE FOR APPROVAL OF TERM PAPER TOPIC!</b>
November 16:	<b><u>Assignment 4 – Accident Investigation Analysis due</u> (in class discussion)</b>	
November 23:	<b>Thanksgiving Break – No class</b>	
December 5:	Literature Presentations & Course wrap up – Future Trends	

(Final Literature Review papers due)

December 11-12: University Reading Days

December 19: Final Exam 4:30-7:15 pm

## READINGS

### Required Text

Wickens, C. D., Hollands, J. G., Parasuraman, R., & Banbury, S. (2013). *Engineering Psychology and Human Performance*. 4<sup>th</sup> edition. Pearson.

### Required Readings

Baddeley, A. (2003). Working Memory: Looking Back and Looking Forward. *Nature Reviews Neuroscience*, 4(10), 829-839.

Beggiato, M., Pereira, M., Petzoldt, T., & Krems, J. (2015). Learning and development of trust, acceptance and the mental model of ACC. A longitudinal on-road study. *Transportation Research Part F: Psychology and Behaviour*, 35, 75-84. doi: 10.1016/j.trf.2015.10.005

Buzzell, G. A., Roberts, D. M., Baldwin, C. L., & McDonald, C. G. (2013). An electrophysiological correlate of conflict processing in an auditory spatial Stroop task: The effect of individual differences in navigational style. *International Journal of Psychophysiology*, 90(2), 265-271. doi: 10.1016/j.ijpsycho.2013.08.008

Cooke, N. J. (1994). Varieties of knowledge elicitation techniques. *International Journal of Human - Computer Studies*, 41(6), 801-849. doi: 10.1006/ijhc.1994.1083

Dehais, F., Causse, M., Vachon, F., Régis, N., Menant, E., & Tremblay, S. (2014). Failure to Detect Critical Auditory Alerts in the Cockpit: Evidence for Inattentional Deafness. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 56(4), 631-644. doi: 10.1177/0018720813510735

Kato, Y., & Takeuchi, Y. (2003). Individual differences in wayfinding strategies. *Journal of Environmental Psychology*, 23(2), 171-188.

Parasuraman, R. (1979). Memory load and event rate control sensitivity decrements in sustained attention. *Science*, 205(4409), 924-927.

Parasuraman, R., & Manzey, D. H. (2010). Complacency and bias in human use of automation: an attentional integration. *Human Factors*, 52(3), 381.

Parasuraman, R., & Riley, V. (1997). Humans and automation: Use, misuse, disuse, abuse. *Human Factors*, 39(2), 230-253.

- Pop, V. L., Shrewsbury, A., & Durso, F. T. (2015). Individual Differences in the Calibration of Trust in Automation. *Human Factors: The Journal of Human Factors and Ergonomics Society*, 57(4), 545-556. doi: 10.1177/0018720814564422
- Proctor, R., & Vu, K.-P. (2010). Cumulative Knowledge and Progress in Human Factors (Vol. 61, pp. 623). Palo Alto: Annual Reviews, Inc.
- Rasmussen, J. (1983). Skills, rules, and knowledge signals, signs, and symbols, and other distinctions in human performance models. *Systems, Man and Cybernetics, IEEE Transactions on*, SMC-13(3), 257-266. doi: 10.1109/TSMC.1983.6313160
- Reason, J. (2000). Human error. *The Western Journal of Medicine*, 172(6), 393.
- See, J. E., Howe, S. R., Warm, J. S., & Dember, W. N. (1995). Meta-analysis of the sensitivity decrement in vigilance. *Psychological Bulletin*, 117(2), 230-249.
- Swets, J., A., Dawes, R., M., & Monahan, J. (2000). Better Decisions through Science. *Scientific American*, 283(4), 82. doi: 10.1038/scientificamerican1000-82
- Warm, J., Parasuraman, R., & Matthews, G. (2008). Vigilance Requires Hard Mental Work and Is Stressful. *Human Factors*, 50(3), 433.
- Wickens, C. D., & Carswell, C. M. (1995). The Proximity Compatibility Principle: Its Psychological Foundation and Relevance to Display Design. *Human Factors: The Journal of Human Factors and Ergonomics Society*, 37(3), 473-494. doi: 10.1518/001872095779049408
- Wickens, T. D. (2002). *Elementary signal detection theory*. (Chapters 1 & 2), New York : Oxford University Press.

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<sup>i</sup> The instructor reserves the right to give additional assignments and readings.