

# 16-899D Special Topics: Principles of Human-Robot Interaction

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12 Units

*Tuesday/Thursday 9:00 – 10:20AM, NSH 3002, 28 August through 6 December  
(plus final at unknown time)*

This course focuses on the emerging field of human-robot interaction, bringing together research and application of methodology from robotics, human factors, human-computer interaction, interaction design, cognitive psychology, education and other fields to enable robots to have more natural and more rewarding interactions with humans throughout their spheres of functioning. This course is a combination of state-of-art reading and discussions, focused team exercises and problem-solving sessions in human-robot interaction, and a special team project resulting in the implementation of a human-robot interaction system for the specific application focus of Quality of Life Technologies. This project may be prototypes using your choice of robotic technological systems, and a specific systems will be made directly available to you: the Telepresence Robot Kit (TeRK).

This new area of inquiry brings together diverse areas of expertise, and so this course will include significant numbers of guest lectures by top researchers in human factors and in education-psychology (University of Pittsburgh) as well as design, human-computer interaction, drama and robotics (Carnegie Mellon University).

Prerequisites: This is a graduate course intended for those considering serious research in human-robot interaction, with a special emphasis on robotic systems and technologies appropriate for such interaction systems. The course project may involve significant programming, and thus a solid mastery of computer programming languages is a prerequisite for this course as well as a solid understanding of research methodologies. The programming assignments will be team-based as part of the course project; thus, those with less than the required programming skills may consider this course but will need to team together with students who have more programming experience.

Text: There is no text for this course, although a number of textbook sections and many articles will be assigned and read as part of this course. Reading and responses to reading questions is an absolutely significant part of the work intended to be completed for this course.

Method of Evaluation: This course will be evaluated based on the following student responsibilities and deliverables:

- **In-class Participation:** This course is in-class intensive; we have expended considerable effort to line up an interesting set of guest speakers, and so an important class requirement is attendance of those guest speakers' presentations, followed by active discussions with the speakers. This is the most qualitative of all evaluation components, but I care about your ability to engage and probe the speakers; this enriches the class considerably.
- **Reading Assignments:** The readings for this course are diverse, including a sampling of works from design, cognitive psychology, HCI, computer science, robotics, etc. In many cases, the relevant reading is assigned to be done in time for a guest speaker's presentation, so that you can get the most out of the speakers' presentations. In other cases, the readings serve as a backdrop to in-class discussions. Doing the reading late, in either case, is not appropriate. For each reading, a simple set of questions will also be distributed, and answers to these questions are to be emailed to me before the class

session begins. Answers should be generated individually- do not work in teams on these. These answers are graded on a pass/fail basis and demonstrate that you took the time to read the assignment. The answers cannot be turned in late or partly done; *partial completion or late completion registers as a fail for that particular assignment*. Please email me your answers in plain text, not as sophisticated attachments.

- Group Semester-long Projects: This represents the majority of your out-of-class work for the semester. You will perform this work in teams of 2 to 4 (to be decided based on class size), consistent throughout the semester. After forming teams early in the class, each team will select a scenario and application for which they will design a human-robot interactive system to address issues of quality of life for elderly or disabled populations. Each team will document their design and prototyping process, as described below. This abbreviated “process documentation” will exist on a web site to be designed by each team. In addition to the creation of the process documentation web site, each team will make two in-class presentations, and all projects will be featured in a final PHRI open house to be held at the end of the semester, which will be attended by faculty of the NSF Quality of Life Technologies program. If these faculty admire your work, they may do things like throw money at you to truly realize your project, hire you for the summer, sponsor you, or just say “good job” to you, *et cetera*.

The final presentation and open house shall include a working prototype of the interaction system, which may or may not include audience participation. The range of possible *working prototypes* is very broad, from a wizard-behind-the-curtain mockup to a fully programmed interaction system on a Personal Exploration Rover, Telepresence Robot Kit or other technology platform you are free to choose/build/borrow/purchase. The intended form of the working prototype will be selected and approved early in the semester.

The web-based process documentation shall include:

- Problem statement and measures of success / evaluation criteria
  - Design and User research results
  - A study in form/morphology and material for the physical embodiment
  - A study of interaction sequences / storyboarding
  - Preliminary mockup evaluation results (base this on testing with classmates, friends)
  - Open design and open source for final working prototype system
  - Slides from both in-class presentations and final poster for the open house
  - Bibliography of sources investigated/used for this inquiry
- Final Examination: A simple essay-based final examination will give me an opportunity to evaluate your ability to synthesize and analyze the various themes, trends and patterns observed through the semester and how you will apply this to future work in creating HRI systems. This will be open-book and focus mainly on your “lateral thinking” skills.

## Course Topics

- A Interaction and Design: rhetoric, tropes, form, communication
- B Interaction and Cognition: cognitive psychology, HCI, methodologies for evaluation
- C Human Factors: humans and automation
- D Social Robotics and Quality of Life Technologies
- E Human-Robot Interaction as Drama
- F Cognitive Technologies for HRI: perspective-taking, social perception
- G Case Studies and Projects
  - NASA lunar robotics
  - Quality of Life project samples
  - Robot receptionist
  - Educational robotics
  - Urban search and rescue robotics
- H Socio-ethical Consequences of HRI

*Field trips to visit HRI instantiations (To be scheduled):*

*Quasi at the Entertainment Technology Center)*

*The Aethon Tug at Magee Women's Hospital*

*Raven at the National Aviary*

*One or more additional selected QoLT industrial partner tour*

## Schedule

Wk	Date	Topic	Work Due
1	Tue 28 Aug	Course requirements Semester-long project remarks Course motivation	
1	Thu 30 Aug	<b>Illah speaks about Burke</b>	Burke, Barnlund
2	Tue 4 Sep	The Wicked Problem ; A Survey of Forms in interactive robotics	Dourish
2	Thu 6 Sep	HCI methods and HRI; TeRK intro	Kiesler, Clark
3	Tue 11 Sep	QoLT Center Details Sheridan; Project work	Sheridan (sans social)
3	Thu 13 Sep	Initial project ideas... discussion on Sheridan, Clark; Project discussion	Draft Project Statement Due
4	Tue 18 Sep	<b>Carl DiSalvo or Illah</b>	Carl's thesis; Chapter 2: agency
4	Thu 20 Sep	education and HRI: RASC study	
5	Tue 25 Sep	<b>PER hands-on affective choreography</b>	Mobot (available on-line); Final Project Statement due
5	Thu 27 Sep	Mobot ; 5 minute project proposals delivered to class	Fulk
6	Tue 2 Oct	Illah in Argentina; no class	
6	Thu 4 Oct	Illah in Argentina; no class	Trafton et al. (Perspective Taking mandatory, the other voluntary)
7	Tue 9 Oct	<b>Aaron Steinfeld</b> , RADAR and NavLab	Steinfeld
7	Thu 11 Oct	QUASI demo at ETC Carpool...	[work on project!]
8	Tue 16 Oct	Telepresence and space; NASA's vision	[work on project!]
8	Thu 18 Oct	Project mid-term presentations	[work on project!]
9	Tue 23 Oct	tbd	Mid-term Course Reviews
9	Thu 25 Oct	tbd	Broz proposal selections
10	Tue 30 Oct	NASA: P2P HRI	no readings
10	Thu 1 Nov	Mobot, v2.0	Piaget, selected sections
11	Tue 6 Nov	PER: the whole process, design to education; RASC	PER, RASC
11	Thu 8 Nov	check-in on projects	no readings
12	Tue 13 Nov	Marek Mchalowski: Keepon and social	Technically Speaking (read,

		rhythm	but not questions to answer)
12	Thu 15 Nov	tbd	Sheridan (social), Arras Gershenfeld (questions under Arrasetal)
13	Tue 20 Nov	Socio-Ethical Issues in HRI The Business Side	Brenda Laurel (Computers as Theatre)
13	Thu 22 Nov	<b>Holiday: Thanksgiving!</b>	
14	Tue 27 Nov	Office Hours for projects	no class, office hours!
14	Thu 29 Nov	Project work and status	
15	Tue 4 Dec	Project Final Presentation	
15	Thu 6 Dec	Project Final Presentation	
n	? Dec, ?time?	Final Exam: in-class ; open-book	?location?

## Project

The first deliverable is a written **project statement** from your team that includes the following ingredients:

- Team member names

- Project name

- First draft of the problem statement (crisp description of the problem and solution)

- Measures of success: how will we determine how successful your project is at end?

You will also very informally describe your project topic to the class on the class period when you turn in your statement, both during Draft Due deadline and at the final due date.

The **Project Mid-Presentation** is a progress check mid-semester regarding your project. You will be asked to make a brief presentation regarding your current project status. Plan on 15 minutes of speaking and 15 minutes of Q&A, and plan to use the projector. This presentation should include:

- Tour of the web site in-progress, where the problem statement should be on-line and the studies in form and interaction design should *not* be empty. Bibliography should be populated as well.

- Explanation of what background research you have done thus far (similar products, similar design processes, journal articles, papers, interviews, etc.) and how this has shaped your design process.

- Description of plans for the rest of semester, and what you hope to unveil at semester's end.

## Reading List

*This is a partial list in-progress; do not forget to look on the website for web-downloadable readings.*

*A Grammar of Motives*, Burke. Introduction (pp. xv – xxiii), Substance (pp. 29 – 35).

“Communication: the context of change,” Barnlund. pp. 6 – 24.

Kiesler. Reading on website.

“Omit the Unimportant,” Rams.

“Block.” – referenced by Forlizzi

*Order and Meaning in Design*, Muller. Chapter 1 (pp 13-19), Chapter 3 (Product Form, pp 54-78), Chapter 4 (Ordering Elements, pp 105-123), Chapter 5 (Form Creation, pp 147-152), Chapter 7 (Semantic Solution Space, pp 323-331).

*Humans and Automation: system design and research issues*, Sheridan. Chapter 1 (pp. 2-13, Introducing human factors), Chapter 2 (pp 23-27, AHS), Chapter 3 (pp 54-68, Analysis and design process), Chapter 6 (pp 115-129, Supervisory control), Chapter 9 (pp 163-181, Social issues of humans and automation).

“On the Study of Technology and Task: A variable-based approach,” Nass & Mason. Ch. 3 (pp 46-67) in *Organizations and Communication Technology*, Fulk & Steinfield.

“Fostering Common Ground in Human-Robot Interaction,” Kiesler.

“Grounding in Communication,” Clark & Brennan.

“Facial Engagements,” Goffman. pp 137-154.

*Where the Action Is, Foundations of embodied interaction*, Dourish. Chapter 1 (pp. 1-23, History of Interaction), Chapter 2(pp 40-53, Tangible computing), Chapter 4 (pp 99-126, Embodied Interaction).

“Interface Lessons for Fully and Semi-Autonomous Mobile Robots,” Steinfeld.

“Human-Robot Teaming for Search and Rescue,” Nourbakhsh et al.

“The Mobot Museum Robot Installations: A Five Year Experiment...” Nourbakhsh et al.

Chapter 2: Agency. Carl DiSalvo's PhD thesis, in progress.

“Enabling Effective Human-Robot Interaction using Perspective-Taking in Robots,” Trafton et al.

“Children and robots learning to play hide and seek,” Trafton et al. **(optional reading)**

“Assistive Robotics and an Ecology of Elders Living Independently in Their Homes,” Forlizzi et al.

“It’s just a Matter of Common Sense”: Ethnography as Invisible Work, Forsythe

“Industrial Soap Operas, Fables, and Morality Tales: Ethnographic Video and Design Implementation,” Johnston

"Planning for Human-Robot Interaction: Representing Time and Human Intention," Allison Bruce, read Intro, Motivation, Related Work 3.1, Technical approach 4.1, Previous Work 5.1 and 5.2.

"A Survey of Socially Interactive Robots: Concepts, Designs and Applications," Fong et al.

*Piaget's theory of cognitive development*, Wadsworth. Chapter 1 (pp. 9-19, Schemata) and Chapter 8 (pp. 113-134, Summary).

*Technically Speaking: Why all Americans need to know more about technology*, Nat'l Academy of Engineering, pp 1-10, pp 13-23.

"To Mindstorms and Beyond, evolution of a construction kit for magical machines," Martin et al., Chapter 1 of *Robots for Kids, Exploring new technologies for learning*, edited by Druin & Hendler.

"PETS: A Personal electronic teller of stories," Montemayor et al., Chapter 3 of *Robots for Kids, Exploring new technologies for learning*, edited by Druin & Hendler.

"The Robotic Autonomy Mobile Robotics Course: Robot design, curriculum design and educational assessment," Nourbakhsh et al.

"The Personal Exploration Rover: Educational assessment of a robotic exhibit for informal learning venues," Nourbakhsh et al.

*Computer as Theater*, Laurel. Selection chapters, tbd, of this book.

"The march of the robot dogs," Robert Sparrow, *Ethics and Information Technology* 4:305-318, 2005.

"Do we want to share our lives and bodies with robots? A 2000-people survey," Arras & Cerqui.

*When Things start to Think*, Gershenfeld. Pp. 3-10 (Digital Evolution), pp 169-184 (The Business of Discovery)

"Interaction challenges in human-robot space exploration," Fong & Nourbakhsh

Jean Scholtz, tbd ; other USAR reading