Proxemics & Social Navigation
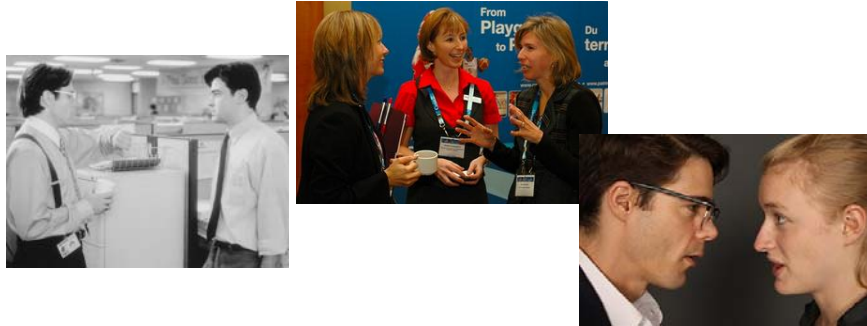
<Reid Simmons>
Illah Nourbakhsh

Team ordering for first presentation

- Day 1 (3 February, Wednesday)

- Day 2 (8 February, Monday)

Proxemics

- "Interrelated observations and theories of [hu]man's use of space as a specialized elaboration of culture" [Hall, 1966]
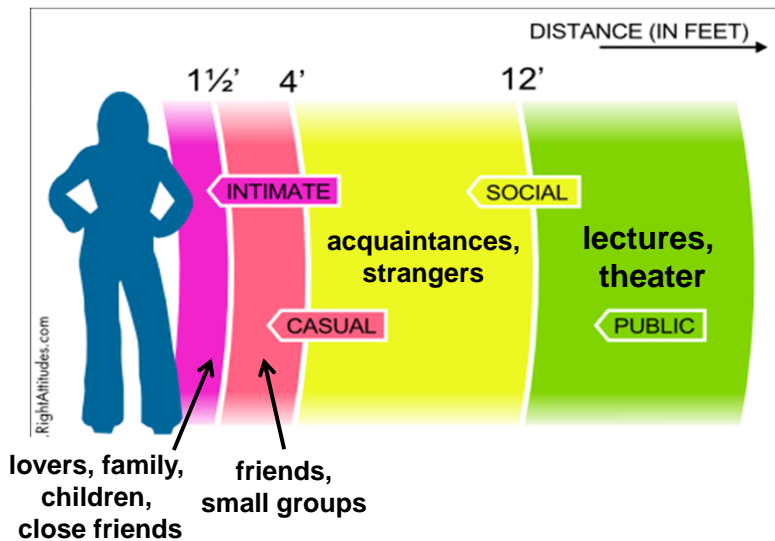

Personal Spaces for Social Interaction

lovers, family, children, close friends

friends, small groups

acquaintances, strangers

lectures, theater

DISTANCE (IN FEET)

1½' 4' 12'

INTIMATE

CASUAL

SOCIAL

PUBLIC

.RightAttitudes.com

Personal Space

- **Feel uncomfortable if others within personal space**
  - "egg-shaped," with more space in front
  - Exact size is culturally determined
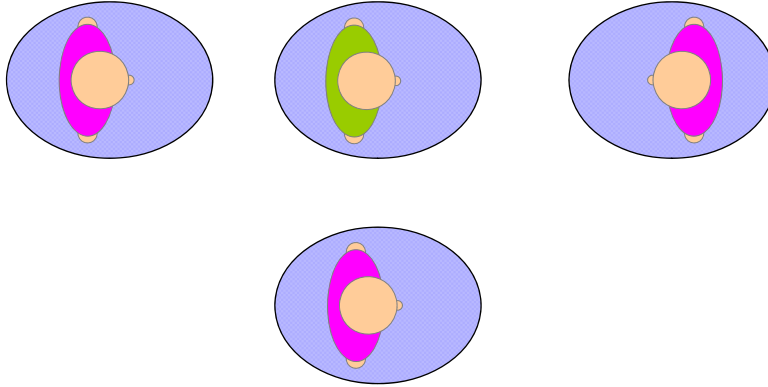
Measurement of Personal Space

- Break into your teams
- Create an NxN matrix of names
- One person approaches second person face on, until first person **begins** to feel uncomfortable
- Third person measures from **nose to nose**
- Fourth person records distance (in inches)
- Switch off until every person has approached every other person
- Analyze for
  (a) consistency of each person
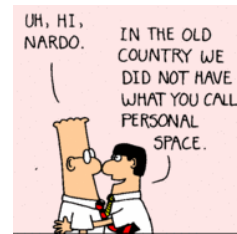 (b) consistency across group
- What factors can explain any differences?

Factors Affecting Personal Space

- **Interpersonal Relationships**
- **Gender**
- **Culture** *Lewis Model of Cultural Types*
  - Cool and decisive (*US, Germany*)
  - Accommodating and non-confrontational (*China, Japan*)
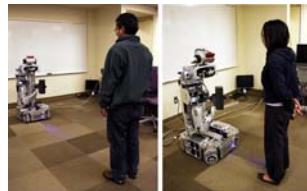 - Warm and impulsive (*Italy, Mexico*)

Proxemics and Robots

- One method people have for dealing with violated personal space is dehumanization – treating the intruder as inanimate
  - *Are robots seen as deserving of personal space, or are they treated as inanimate?*

Empirical Evaluation of HR Proxemics

- Based on several studies with many participants and different robots (Walters, Dautenhan, et al)

Approach Context	Mean (cm)	Lower Bound (95% CI)	Upper Bound (95% CI)
Interaction: Pass	60	57.6	62.7
Verbal	60	58.0	63.1
Physical	49	46.3	51.4
Appearance: Mechanoid	51	48.7	53.0
Humanoid	62	60.1	64.2
Initiative: Robot	57	53.4	61.1
Human	56	52.0	60.6
Direction: Front	58	54.1	62.5
Side	55	51.4	59.0
Preferences: Mechanoid	60	46.8	54.2
Humanoid	56	61.6	69.2
Short	61	53.6	61.4
Tall	55	54.8	62.1
Overall	**57**	**53.0**	**60.5**

Compares to:
51 cm for human
56 cm for "dummy"

Social Navigation

- Culturally determined conventions that guide our movement through (peopled) space
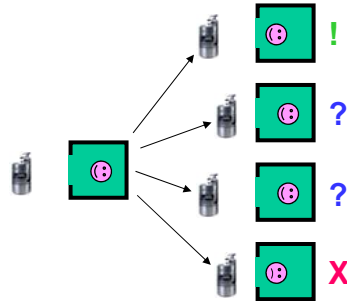
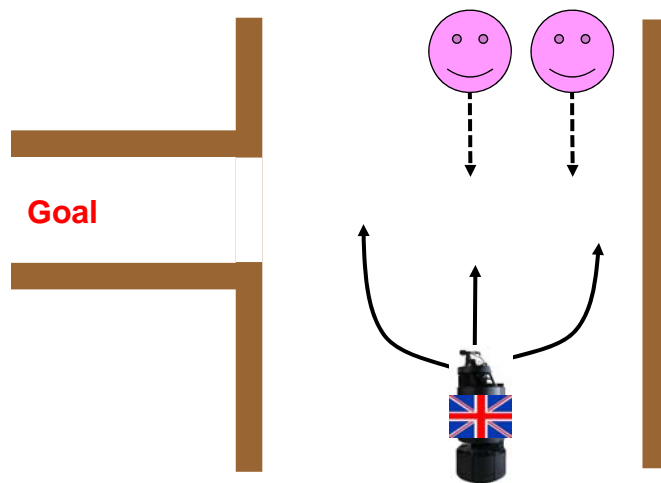- *Why do we use social conventions?*

Riding Elevators

"Wait until everyone gets off before getting on"
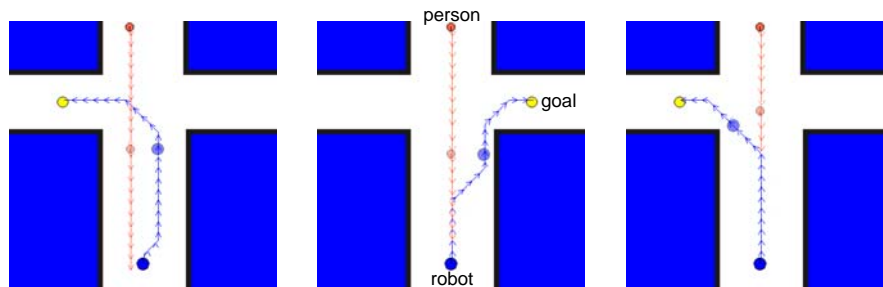
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X

- Need to model people's *intentions*
  – Only partially observable (*ambiguous*)

Passing in Corridors
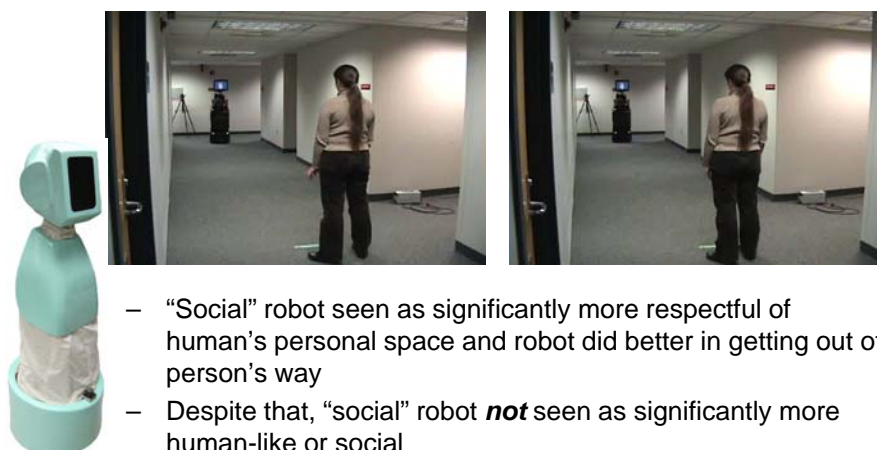
Goal

Passing in Corridors

- **Treat Problem as Constrained Optimization**
  - Include task constraints (e.g. minimize distance, time) and social constraints (e.g. avoid personal space, pass on right)
  - Replan continually to deal with uncertainty

Passing in Corridors

- "Social" robot seen as significantly more respectful of human's personal space and robot did better in getting out of person's way
- Despite that, "social" robot *not* seen as significantly more human-like or social
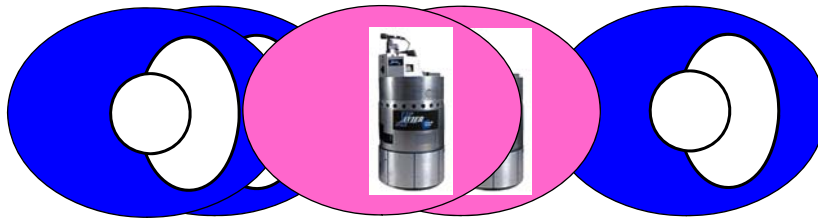 - *due to both lack of social cues and confusing cues!*
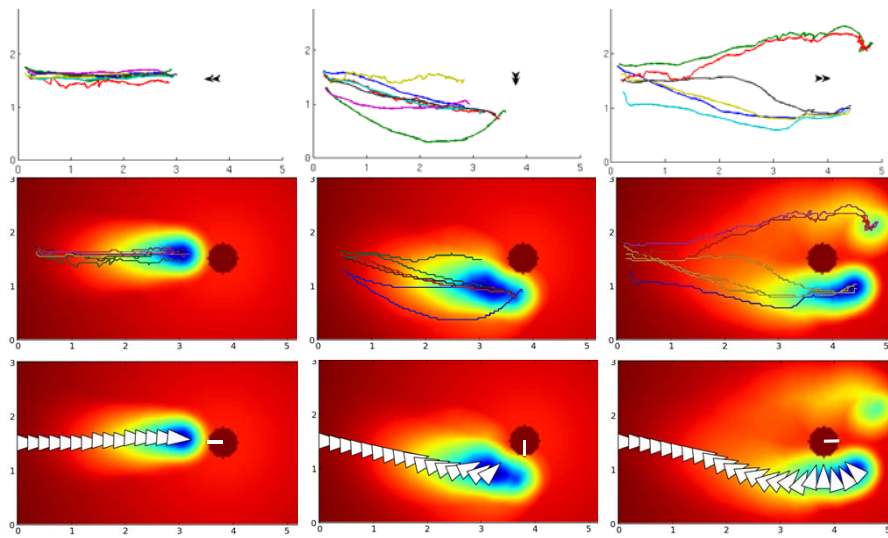
Waiting in Line

- Standing in Line
  - How to detect end of the line?
  - How much space to leave in front?
  - When to move forward?

An Impatient Robot…

Approaching People

User Study of Social Approaching

- **User Attitudes**
  - Social robot seen as more intelligent and social in both back-facing and side-facing conditions
  - Social robot seen as more attentive to personal space and social conventions in back-facing condition
  - Women found social robot more attentive to personal space and social conventions, under all conditions