Principles of Human-Robot Interaction

AI

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Ancestry of Interaction Studies

Barnlund

- p. 7: the Assumptive World
- p. 8: context as all-important

Terry Winograd's trajectory an an example

Pitfalls for Interactive Communication

Barnlund, p.12 ..

- verbal – nonverbal discrepancy
- attitude of infallibility
- manipulative purpose
- one-way communication
- threatening context
- evaluative context

The Delight of Radical Surprise


MUSEUM
OF
NATURAL


CAUTION

Formalizing Interaction: Burke (xv – xxiii)

Act Scene Agent Agency Purpose

Formalizing Interaction: Burke (xv – xxiii)

Act Scene Agent Agency Purpose

Ambiguity and casuistry: xviii and xx-xxi

Group Challenge: Pentad applied to an interactive robot

Roomba-like home cleaning robot

Museum tour guide robot

AIBO-like robot entertainment dog

The Robot Design Challenge

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Dourish

- Robot interface
  - later in this slide set
- Embodiment/situatedness
  - Hide-and-seek
  - Embodiment deleterious example?
- Brooks and embodiment-architecture
  - "Use the world as its own best model"
  - Philosophy ; Descartes vs. Heidegger?

Evolving Toward Physical Interaction

- Text-based computer interaction
- narrow; single-threaded & synchronous; symbolic
- Graphical computer interaction
- parallel/peripheral; somewhat asynchronous; visual metaphor
- Animate but sessile robot
- multimodal; more asynchronous/episodic; palpable/continuous

Animate but sessile...

Evolving Toward Physical Interaction

- Electrical
- Symbolic
- Textual
- Graphical
- *Marble answering machine*

Social Mobile Robot

- Invasive: shared physical space
- extended interaction context: the human social-physical frame
- social communication as a co-habitant
- incidental & opportunistic interaction
-
- Asynchronous; episodic
- demands intentional transparency
- active communication acts
-

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Social mobile robot...





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Points of Departure

- Mobile robots are unlike standard computers
- More like independent agents; less human augmentation
- Computers can represent real things; robots *are* real things
- Robots push back on the world
- Mobile robots differ from standard physical artifacts
- "…uncertainty, randomness, free will or independence so strikingly absent in well-designed machines" – Grey Walter
- Invasive in human social space
- Need to reflect or externalize their internal states and intentions

Challenges in Social Robotics

- **Perception & Representation**
- Perceptual competency for spatial and social context
- **Locomotion & Manipulation**
- Physical competency, expressiveness, terrainability
- **Behavior & Communication**
- Social competency, deliberation and interaction in social spaces using time, intention, perceptual action

The 'Wicked Problem'* in HRC

Problem Identification

Every solution exposes new aspects of the problem.

Satisficing

There is no clear stopping criterion nor right or wrong.

Uniqueness

Each problem is embedded in a distinct physical and social context making its solution totally novel.

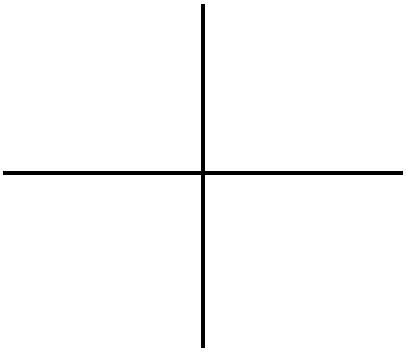
**Horst Rittel*

Tools for HRC

1. The Science & Technology of Interaction
   - modeling, reasoning, execution
   - perception, actuation
2. Physical and Interaction Design
   - morphology, behavior
3. Evaluation: HCI, Human Factors, Education
   - formative & summative techniques

An Analytical Cross of Interaction

Prof. Dick Buchanan, from Burke, Barnlund, etc.



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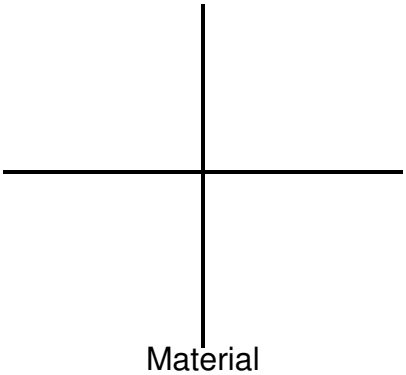

Material
(product itself)

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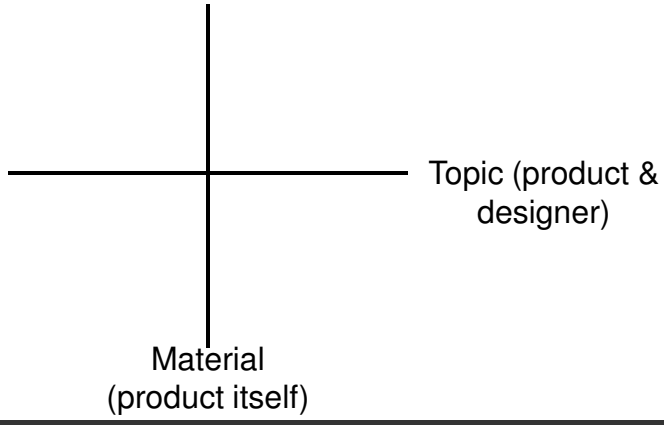

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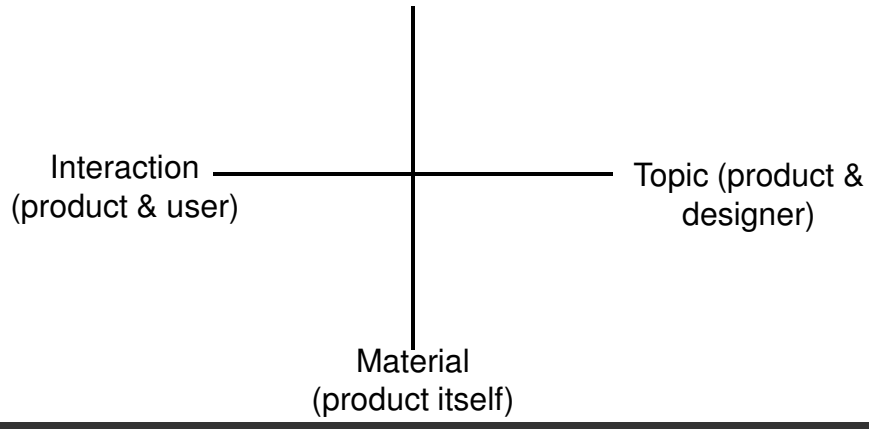

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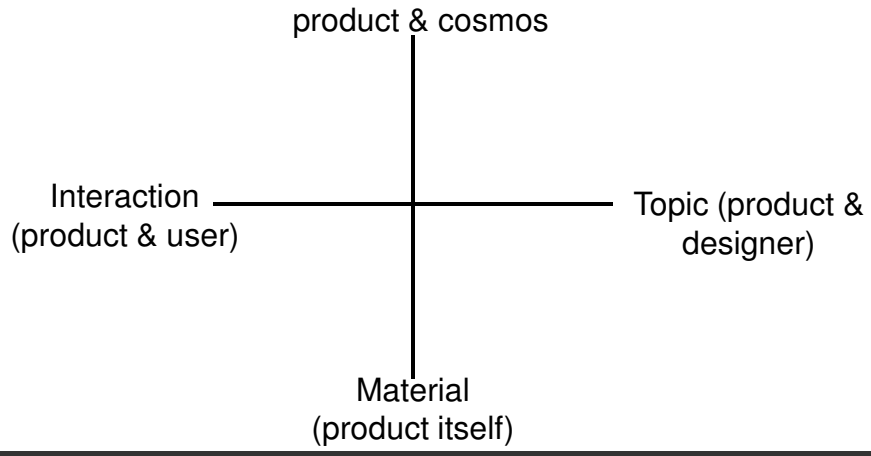


Group Challenge: Cross applied to Korean National Archival Music robot

Social Robots Project

Guiding Question:

How do motion, expression and attention impact human-robot interaction?

Experimental Design

To conduct full factorial experiments based on social science protocols to find statistically significant correlations between motion, expression and attention.

Facial expressions on *Vikia*

- References Delsarte's systematic coding of facial expressions, gestures, postures, etc. for conveying emotion and attitude
- Facial expressions rendered in animated graphic form to allow for iterative design changes and assessment of [non]anthropomorphic

Poll Experiment

- **Question:** How do expressiveness and attention impact willingness to interact with a robot?
- **Task:** Robot tries to ask people a series of questions
- **Design:** 2x2 factorial (control for day and time)
- Independent variables: face, real-time tracking
- Dependent variable: person stops and answers

Poll Experiment - Context

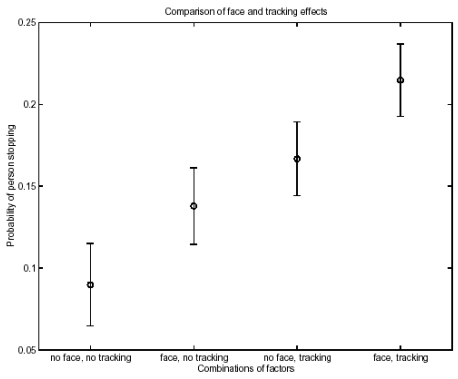
Poll Experiment - Results

Table 1: F-tests of factors.

Source	P-Value	Confidence
Main effects		
Tracking	0.002	$> 99\%$
Face	0.042	$> 95\%$
Interactions		
Face x Day	0.014	$> 95\%$

Poll Experiment - Results

Using face tracking for social inferences



Findings

- Being expressive is significantly better than not being expressive; same with moving; both is even better
- Robots can be threatening or annoying
- Challenge: Actively engage, but selectively!

Models for Social Inference

Using human trajectories for social inference