Theories and Applications of Social Science for Interactive Surfaces

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SurfNet Annual Workshop 2014

Social Science is a **HUGE** Field

Where to Begin??

(Highly) Relevant Theories for Interactive Surfaces

- ## Communication theories

  - Face-to-face communications

  - Non-verbal communication

- ## Small group behaviour

  - Interpersonal behaviour

- ## Environmental psychology

  - Intersection of psychology, architecture, and industrial design
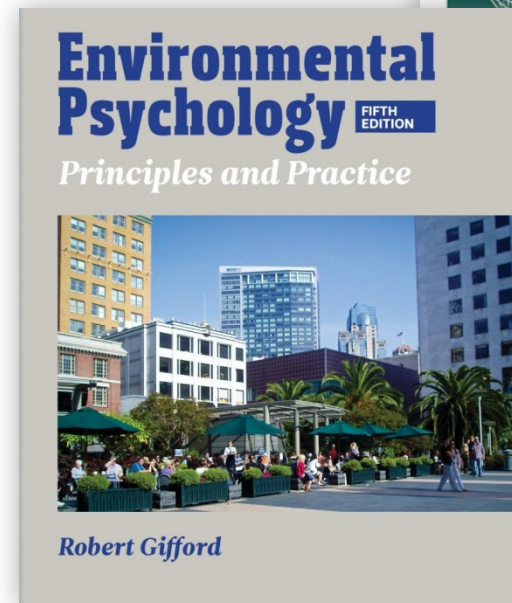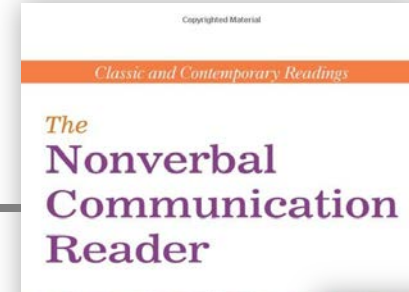
Particularly Influential Social Science Scholars

- **Edward T. Hall**
  - Proxemics

- **Robert Sommer**
  - Personal Space & Territoriality

- **Adam Kendon**
  - F2f behavioural patterns (body positioning, eye-gaze)

- **Michael Argyle**
  - Group process, function of non-verbal communication
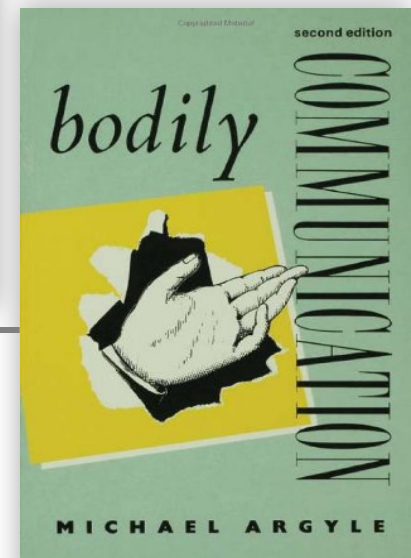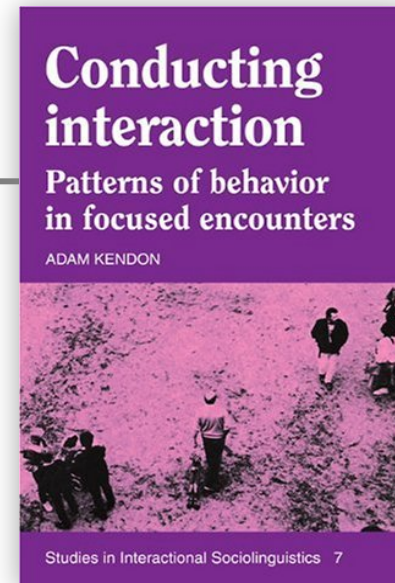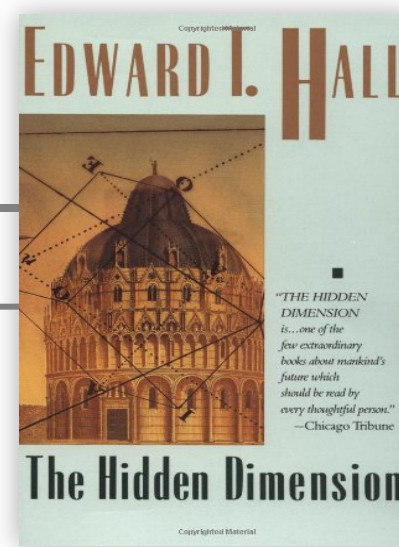
Goal of this Workshop

To demonstrate how existing social science theories can be applied to **human-computer interaction**, and **interactive surfaces** in particular

Will **NOT** be a comprehensive review of all relevant social science literature (not enough time!)

Outline of Workshop

- Functions of non-verbal communication

- Proxemics

  - **Application** of proxemics theory

    - Proxemics implications for multi-device interaction

    - Proxemics interaction with a wall display

- Territoriality

  - **Application** of territoriality theories

    - Territoriality in interactive tabletops

    - Territoriality in virtual reality environments

- Design activity and wrap-up

Two Major Types of Communication

- ## Verbal communication

  - Typically refers to spoken language between people
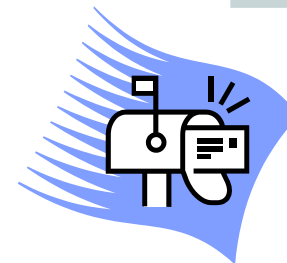
- ## Non-verbal communication

  - Augments and sometimes replaces verbal communication
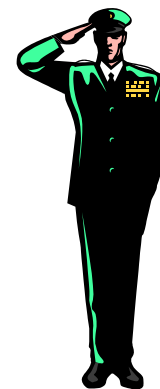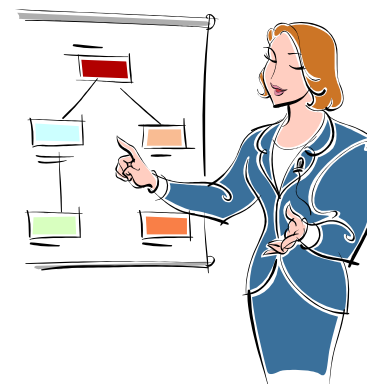
Non-Verbal Communication

- Examples non-verbal cues:

    - Facial expressions, direction of gaze, body posture and positioning, dress, and physical distance

- **Why** are non-verbal cues important for communication?

Non-Verbal Communication

- Examples non-verbal cues:

    - Facial expressions, direction of gaze, body posture and positioning, dress, and physical distance

- Non-verbal cues play two main roles in communication:

    - **Integrational** – behaviours that facilitate the process of communication

    - **Informational** – passage of information from one individual to another

Purpose of Non-Verbal Communication

- Argyle (1969) defines six main functions of non-verbal cues:

Integrational

- Mutual attention & responsiveness

  - eye-gaze, head nods, gestures

- Channel control

  - eye-gaze, head nods

- Feedback

  - head nods, facial expressions

Informational

- Illustrations

  - gestures, pointing meant to illustrate an object or action

- Emblems

  - gestures that replace a word (head shake or nod)

- Interpersonal attitudes

  - proximity, gesture, facial expression

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Proxemics

- A term coined by cultural anthropologist Edward T. Hall during the 1950's and 1960's to mean:

The study of how we use space

- More formally: The study of how humans unconsciously structure microspace - the distance between people in the conduct of daily transactions, the organization of space in his houses and buildings, and ultimately the layout of their towns (Hall, 1966)

Proxemics

Hall's Distance Zones

Public space

25 feet -

Social space

- 12 feet

Personal space

- 4 feet

Intimate space

- 1.5 feet
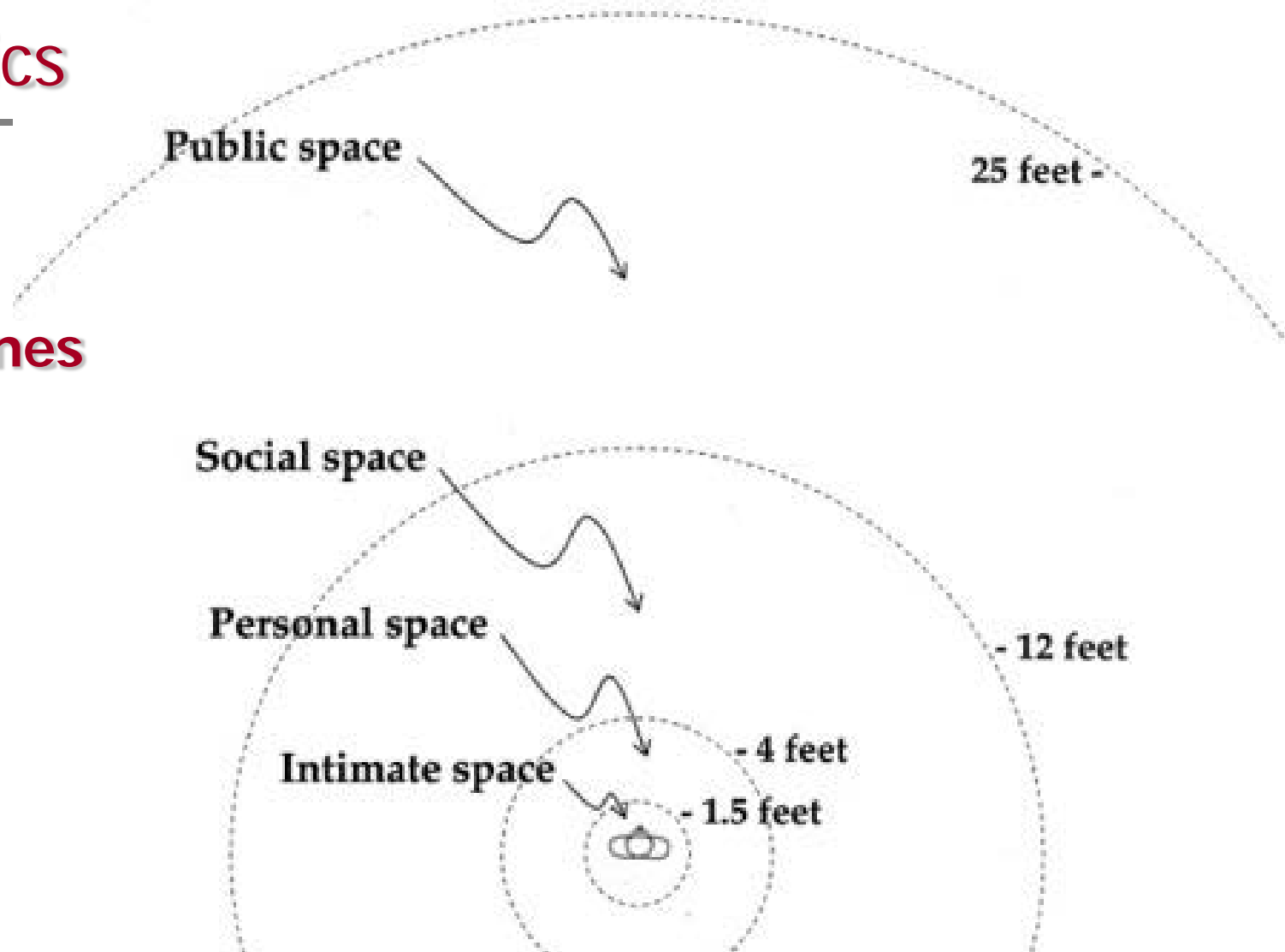
Source: Wikipedia

Hall's Distance Zones

- **Intimate Distance (touching – 18 in) – for embracing, touching, or whispering**

  - Close: embracing, comforting, protecting, wrestling

  - Far: dominance, intimate companionship

- **Personal Distance (1.5-4 ft) - for interactions among good friends**

  - Close: usually only loved ones are tolerated in this zone

  - Far: keeping someone at "arms length"

  - Used to hold discussions of personal interest and involvement

- **Social Distance (4-12 ft) - for interactions among acquaintances**

  - Close: impersonal business, working together or social chat

  - Far: more formal business and social discourse

  - Important to maintain eye contact, people can work independently

- **Public Distance (12+ ft) – used for public speaking**

  - Close: people more carefully choose their wording and grammar

  - Far: 30 feet is automatically set around VIPs like the president

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Application of Proxemics to Interactive Surfaces

I.   Support proxemics in human-human interaction with technology

-   Support proxemics behaviour when groups of people in a co-located environment are interacting with technology

II. Proxemics-based technology design

-   Design the technology itself to expect and respond to proxemics behaviour

-   Typically used in ubiquitous computing environments

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Application of Proxemics (Type I): Bumping & Stitching

"Bumping" (Hinckley, 2003)
Creating a shared, tiled display by physically touching multiple devices

path taken by the pen

transferred pictures
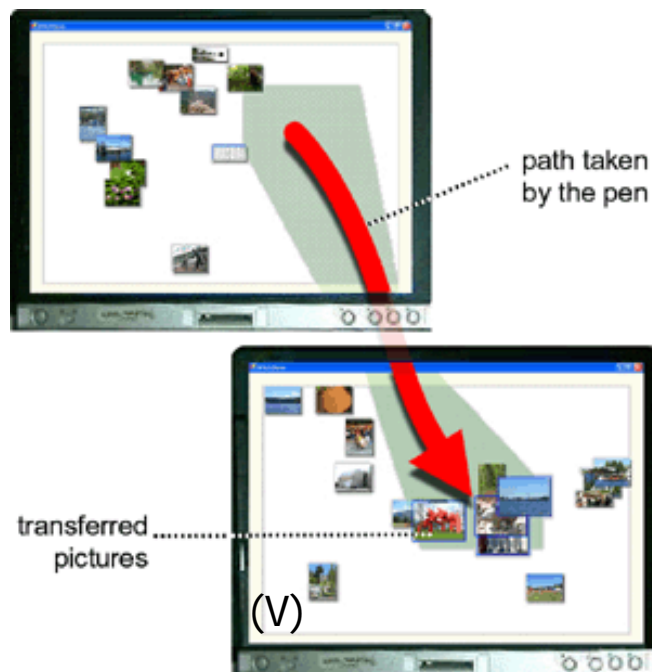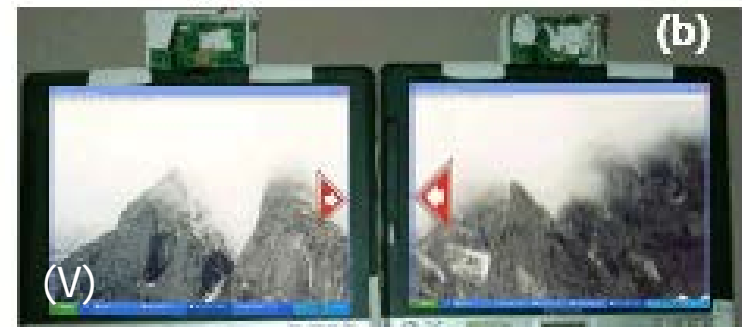
**"Stitching" (Hinckley et al., 2004)**
Creating a connected workspace by performing a continuous pen gesture across multiple devices

Application of Proxemics (Type II): Proxemic Interaction

- Makes use of the additional knowledge of device-device, user-device proxemic relationships (i.e., position, orientation, movement, and identity) to trigger and regulate interaction (Ballendat et al., 2010)
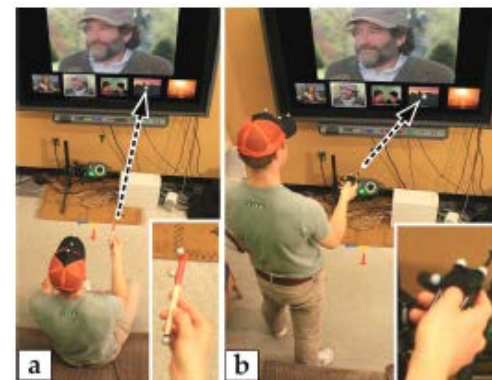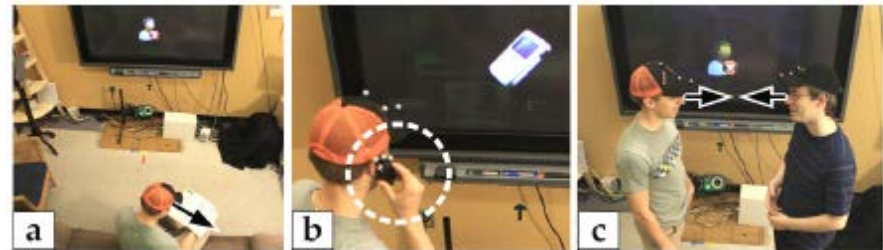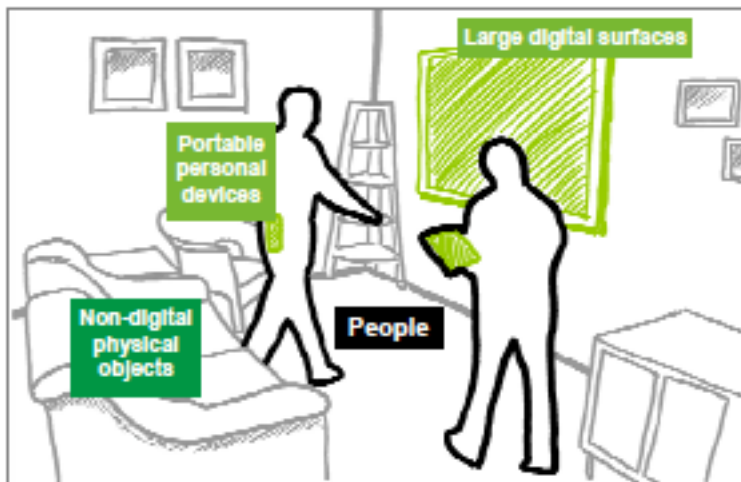
Application of Proxemics (Type II): Gradual Engagement

- Facilitates cross-device transfer as a function of proximity (Marquardt, 2012)

    - Communicate information exchange in 3 stages of increasingly gradual engagement: awareness of connectivity, reveal of
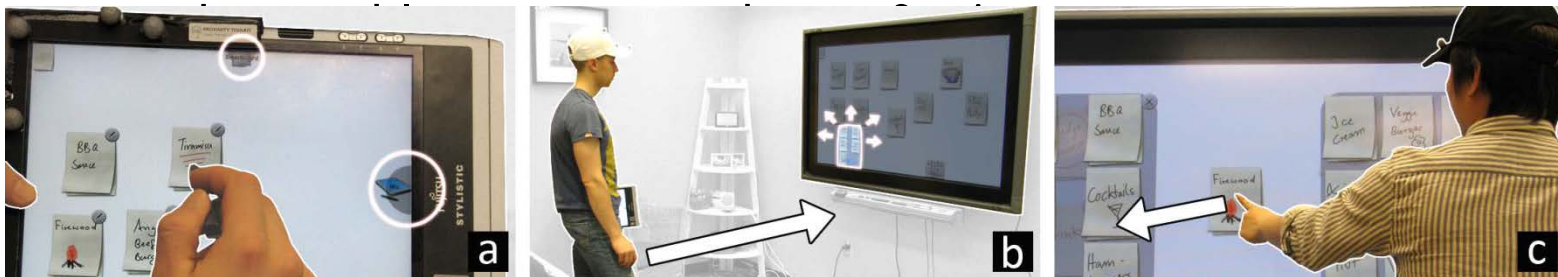
        ▪ which devices can communicate with one another,

        ▪ what information they contain that is exchangeable,

        ▪ and how information can be exchanged in a controlled manner

Application of Proxemics (Type II): Siftor (Vogel, 2013)

- An art installation using interactive digital projection

  - Tracks peoples' movements and translates them into different interactions (browsing, selecting, querying)

http://www.nonsequitoria.com/v.php?s=art&f=siftor

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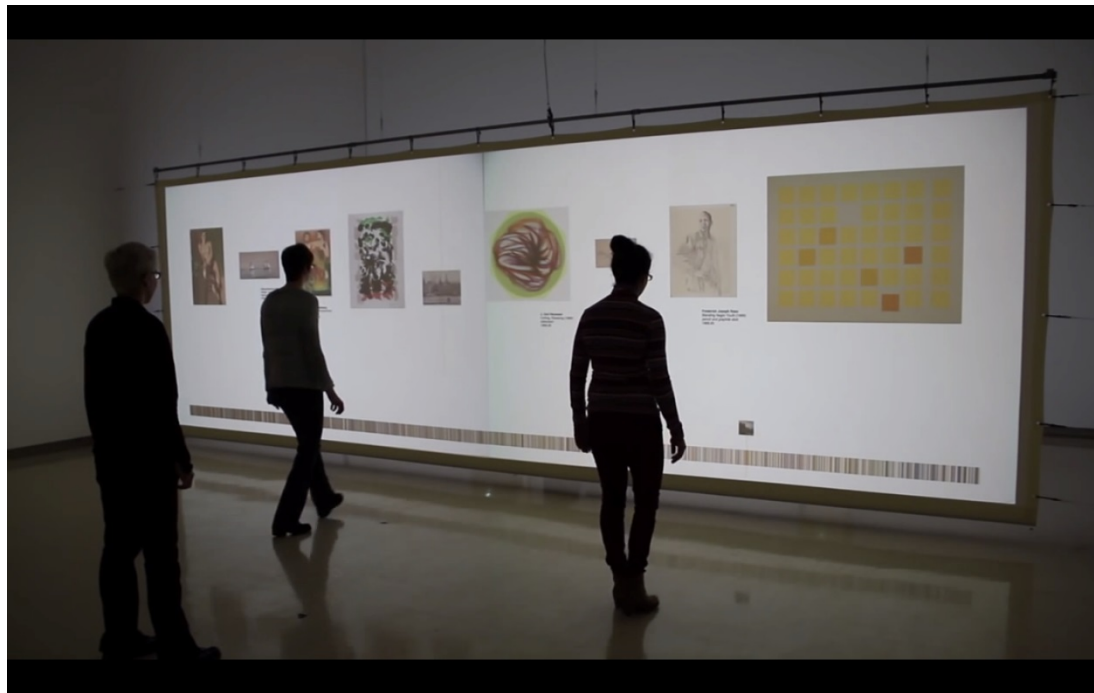
Application of Proxemics (Type II): Attention & Engagement

- Adaptive content in public interactive displays

  - Adjust what and how content is displayed (animated) in relation to passerby's proximity to display and movements
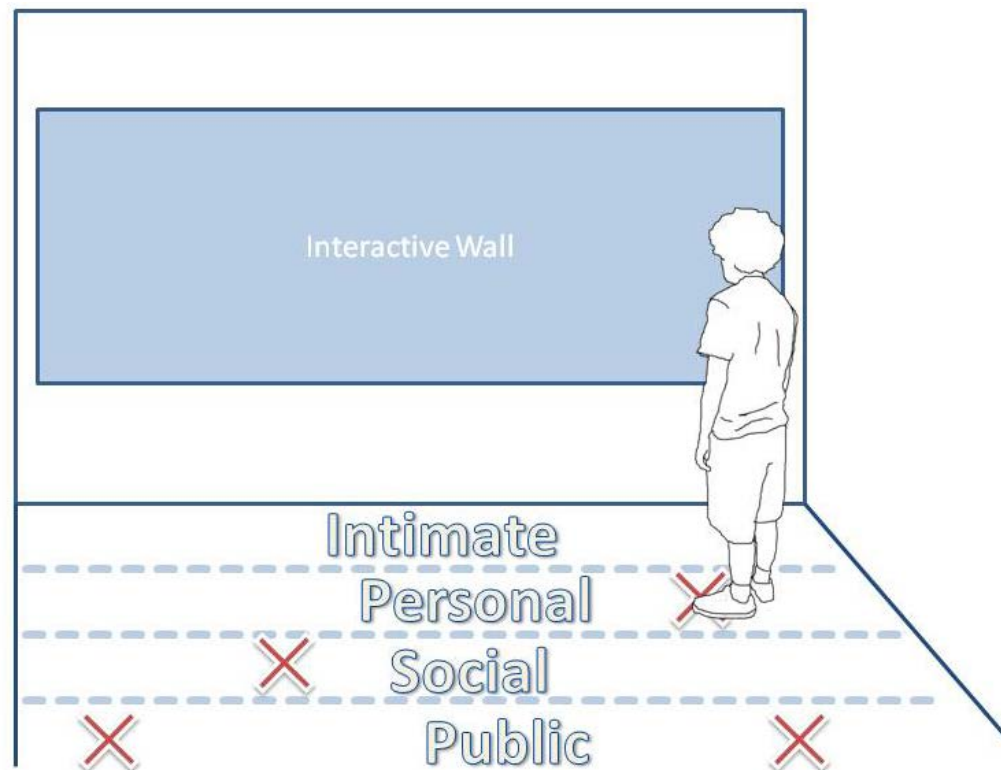
Human Territoriality

safesoundfamily.com/wp-content/uploads/2013/05/gated-home-security.jpg

www.policemag.com/_Images/photogallery/SHS-Crip5-salisbury-1.jpg

www.law.georgetown.edu/library/about/services-policies/images/studyTable_2.jpg

www.cerebralmatters.com/Blog/wp-content/uploads/2011/10/Napper-Helps-Promote-Sleep-On-Public-Transportation.jpg

Human Territoriality

"Human territoriality can be viewed as a set of behaviours and cognitions an organism or group exhibits, based on perceived ownership of physical space." (Fisher et al., 1984, p. 176)

Territories "range in size from chairs, seats, or sides of a table, to street blocks" (Taylor 1988, p. 89).

Design Can Affect Territorial Behaviour:

- "The occupant of a public territory is **at the mercy of a culture or spatial designer**. For example, [...] restaurants sometimes seat different parties overly close to one another. Thus **if the design of a public territory is bad** [...] **people will often have to rely heavily on other mechanisms**, such as nonverbal and verbal behaviors." (Altman, 1975, p.120)

Territoriality in Tabletop Collaboration

- Studies of traditional tabletop collaboration found that people establish **tabletop territories** on a shared tabletop workspace (Scott et al., 2004; Scott & Carpendale, 2010)

  - This finding corroborates other studies in the literature

- People tend to establish and maintain three types of tabletop territories:

  - **group**, **personal**, and **storage territories**

Establishment of Tabletop Territories

Group

Personal

Storage
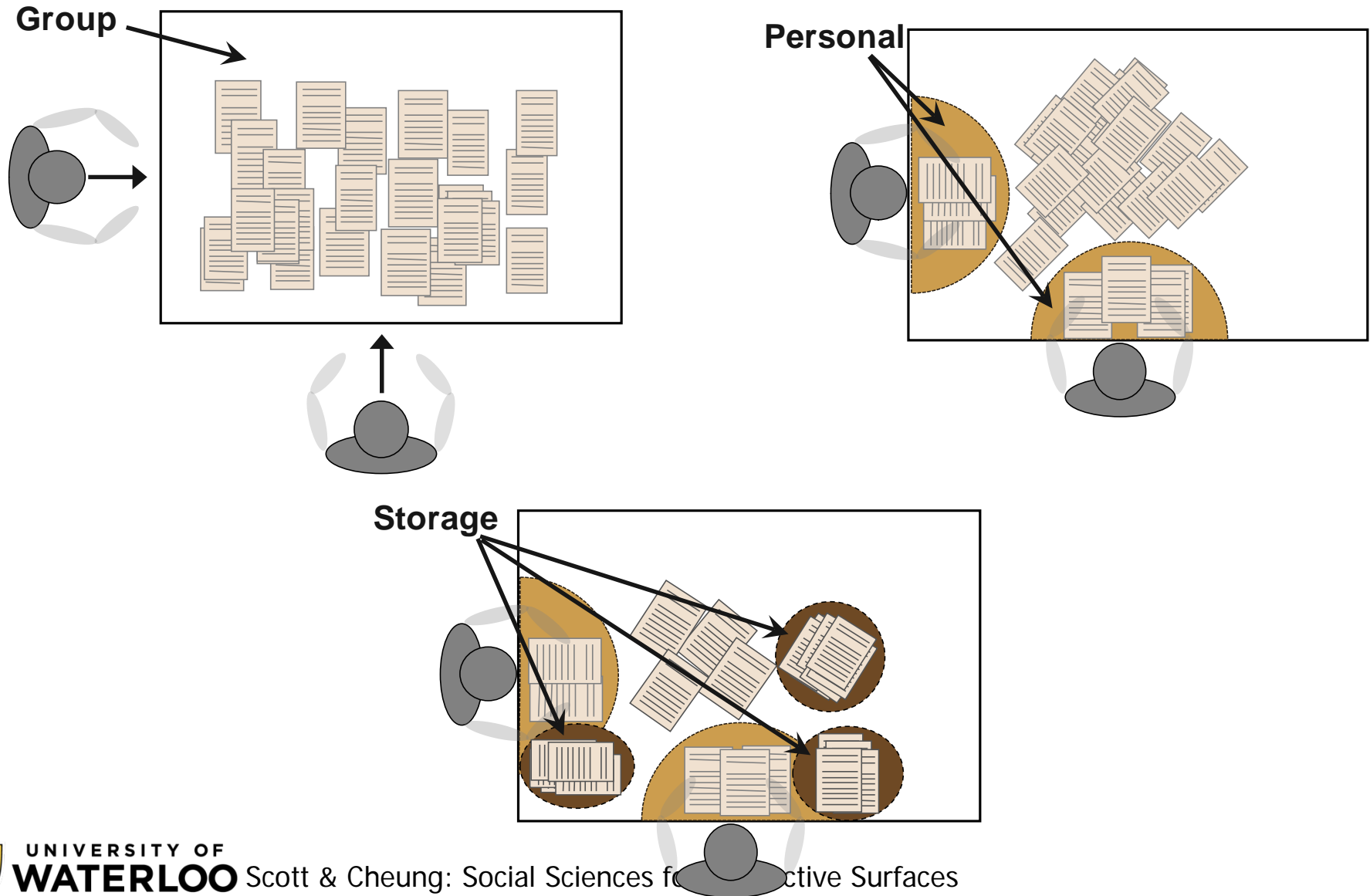
Task & Collaborative Benefits of Tabletop Territories

- Tabletop territories clarify which regions should be used for:

  - joint task work

  - assisting others

  - working independently in the group context

- Tabletop territories helps collaborators:

  - delegate task responsibilities

  - coordinate access to task resources

  - organize the task resources in the workspace

Application of Territoriality to Interactive Tabletops

- Mobile, resizeable tabletop containers provide digital storage territories

Storage Bins: Mobile, Flexible Storage Containers (Scott et al., 2005)

Interface Currents: Computationally Enhanced Interface Containers (Hinrichs et al., 2006)

Application of Territoriality to Interactive Tabletops

- Adaptive Personal Territories facilitates both joint and independent interaction on a shared tabletop museum exhibit (Klinkhammer et al. 2011)
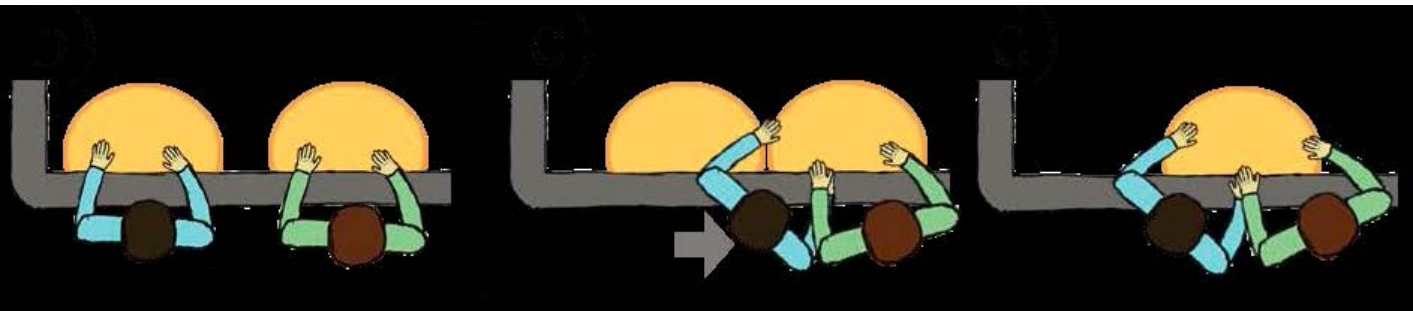
Application of Territoriality to VR Environments

- PhotoPortals applies concept of personal territories in virtual reality environment to minimize interference among people in the shared space (Kunert et al. 2014)

Activity: Redesigning Interface Currents

Scott & Cheung: Social Sciences for Interactive Surfaces (Hinrichs et al., 2006)
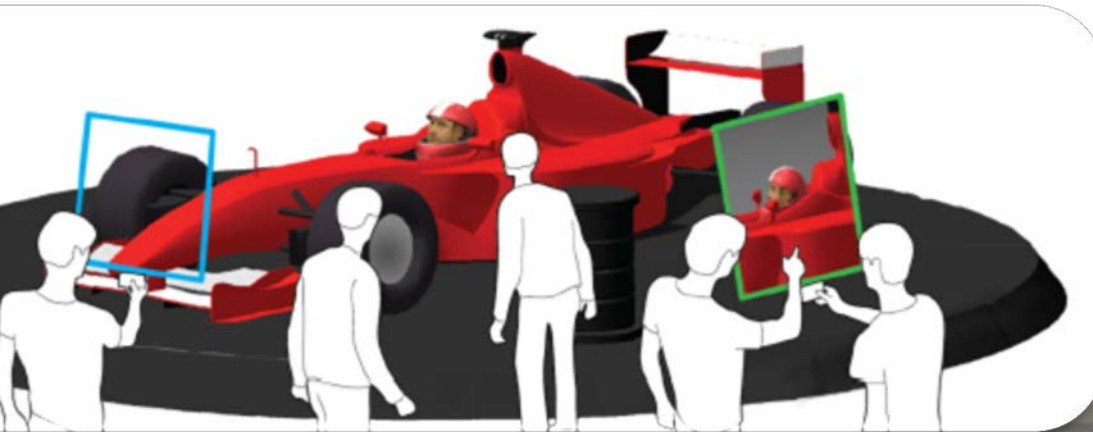
Activity: Redesigning Interface Currents

- Based on the theory we've just discussed, identify the design issue inherent to the existing Interface Currents concept?

- Work in groups to redesign the concept to better support social norms

Wrap-up

- Proxemics and territoriality are just a few of the **many** interesting social theories relevant to the design of interactive surfaces

- Hopefully this gave you some inspiration to apply social science theories in your own work

References

- Aiello, John R. (1987) Human Spatial Behavior. in Stokols, D. & Altman I. (eds.) *Handbook of Environmental Psychology*. New York: John Wiley & Sons.
- Altman, I. (1975). *The Environment and Social Behavior*. Monterey, California: Brooks/Cole Publishing Company.
- Argyle, M. *Social interaction*. London: Methuen, 1969
- Ballendat, T., Marquardt, N., & Saul Greenberg. (2010). Proxemic interaction: designing for a proximity and orientation-aware environment. In Proc. Of ITS 2010, 121-130.
- Hall, E.T. (1966). *The Hidden Dimension*, Double Day: Garden City, NY.
- Hall, E.T. (1974). Proxemics. In S. Weitz (ed.), *Nonverbal Communication: Readings with Commentary*, Toronto, ON: Oxford University Press.
- Hinckley, K. (2003). Bumping Objects Together as a Semantically Rich Way of Forming Connections between Ubiquitous Devices, UbiComp 2003 formal video program.
- Hinckley, K., Ramos, G., Guimbretiere, F., Baudisch, P., Smith, M. (2004). Stitching: Pen Gestures that Span Multiple Displays, In Proceedings of ACM Advanced Visual Interfaces (AVI 2004).
- Hinrichs, U., Carpendale, S., & Scott, S.D. (2006). Evaluating the Effects of Fluid Interface Components on Tabletop Collaboration. *Proc. of Advanced Visual Interfaces*, May 23-26, 2006, Venice, Italy, pp. 27-34.
- Kendon, A. (1967). Some functions of gaze-direction in social interaction. *Acta Psychologia*, 26, pp. 22-63.
- Kendon, A. (1990). *Conducting Interaction: Patterns of behaviour in focused encounters*. Cambridge University Press: New York.
- Klinkhammer, D., Nitsche, M., Specht, M. & Reiterer, H. (2011). Adaptive personal territories for co-located tabletop interaction in a museum setting. In *Proceedings of the ACM International Conference on Interactive Tabletops and Surfaces* (ITS '11). ACM, New York, NY, USA, 107-110.
- Kunert, A., Kulik, A., Beck, S. & Froehlich, B. (2014). Photoportals: shared references in space and time. In *Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing* (CSCW '14). ACM, New York, NY, USA, 1388-1399.
- Marquardt, N., Ballendat, T, et al. (2012). Gradual engagement: facilitating information exchange between digital devices as a function of proximity. In Proc. of ITS 2012, 31-40.
- Scott, S.D. & Carpendale, S. (2010). Theory of Tabletop Territoriality. In C. Müller-Tomfelde (ed.), *Tabletops - Horizontal Interactive Displays*, Springer (HCI Series), (ISBN: 978-1-84996-112-7), pp. 375-406.
- Scott, S.D., Carpendale, S., & Habelski, S. (2005). Storage Bins: Mobile Storage for Collaborative Tabletop Displays. *IEEE Computer Graphics & Applications*, 25(4), July/August 2005, pp. 58-65.
- Scott, S.D., Carpendale, M.S.T, & Inkpen, K.M. (2004). Territoriality in Collaborative Tabletop Workspaces. In Proc. of CSCW 2004, pp. 294-303.
- Taylor, R. B. (1988) Human Territorial Functioning: An Empirical Evolutionary Perspective on Individual and Small Group Territorial Cognitions, Behaviors, and Consequences. New York: Cambridge University Press.