Overview and Motivation

- How do we create a UI or HCI experience well suited to professionals within a specific domain?
  - Some answers for those with disabilities, young, or elderly
- Professions are treated as ‘normal’ HCI business
  - Very specific needs in many professions
  - Mass market software not well matched
  - New devices not well matched
- Bespoke software often has poor UX
- We will explore a range of techniques and research approaches which look to address these issues in one discipline
Example of a Specific Domain: Architecture/Engineering/Construction

- Design and build incredibly complex structures

The Wave in Vejle (T Molvig)

Burj Khalifa
A/E/C Characteristics

- 10% of GDP in most countries
- Conservative, low risk (?)
- Low profit (2-3%)
- High variability in skills
- Many low paid labourers
  - Unattractive jobs
  - Dangerous
- A few high paid professionals
- Many bespoke software tools
  - > 4,500 in late 90’s
A/E/C Characteristics

- University trained
  - Architect, Structural Engineer, HVAC Engineer

- Polytech trained
  - Project Manager, Site foreman, Plumber, Electrician

- Trades trained
  - Labourer

by Paul Keleher
A/E/C Characteristics

- Multi-disciplinary teams
- Complex coordination and collaboration
  - 10,000 or more workers on site in large projects
  - Logistics management challenges
A/E/C Characteristics

- Unique terms and language
- Unique symbols
- Country specific nomenclature
Visualisation
Construction Informatics

- “Construction informatics is an applied science that studies the construction specific issues related to processing, representation and communication of construction specific information in humans and software.” (Turk 2006)

  - HCI traditionally has received very little attention in this field
Design Review & Coordination
Design Review & Coordination

Construction Informatics and HCI
Design Review & Coordination
Project Background

- **Design critique tool**
  - Without the need to be co-located
  - Not restricted to a particular view point
  - Annotation
  - Comments

- **Large interactive display system (LIDS)**
  - Back projected – no shadows
  - Driven by mouse and keyboard
    - Similar to displaying power point slides on a screen
  - Can be integrated with Mimio Whiteboard Digitizer
    - Use Mimio pen to write on surface of the LIDS
Motivation

- Using LIDS in a presentation
  - Architectural designs in CosmosCreator
  - Mouse/keyboard
    - Difficult to control
    - Not facing the audience
  - Mimio pen
    - Blocks the screen

- Idea of our project
  - New kind of interaction mode with the Mimio pen
    - Easy to control
    - Will not block the screen
Descriptive Menus Scenario
Improved user interface
For Educational Use Only
Gesture-based Interfaces

- Motivation?
  - Mouse is fastest interaction device
  - So why gestures?
Motivation?

- So why gestures?
  - Natural and intuitive communication
  - Expressive communication
  - ‘Clean’ communication
  - Mobile/smartphone interactions
  - Overcoming physical handicaps
  - Human-robot interactions
  - Adjunct to speech
  - ???
Site workers also need design information

- A tough environment for computer interaction
  - Thick gloves
  - Mud, grease, concrete dust

by Paul Keleher
Traditional UI Interference

- Unnatural interactions when exploring a large projection of a design
- Motion sensors are unwieldy and/or tether user to one place
An Exemplar for Construction

- Pre-calculated fly-throughs vs. Interactive exploration
Kinect to Architecture

IVCNZ 2011, Auckland, NZ
22 September 2020

Presented by
Robert Amor
Department of Computer Science
in association with
Leroy D'Souza, Isuru Pathirana and Dermott McMeel
What is an appropriate gesture?

- Natural to user
  - Non fatiguing
  - Full body due to technology

- Iterated over a range of arm, leg, body postures
<table>
<thead>
<tr>
<th>Gesture</th>
<th>Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point forward</td>
<td>Move forward</td>
</tr>
<tr>
<td>Step forward</td>
<td>Move forward</td>
</tr>
<tr>
<td>Step backward</td>
<td>Move backward</td>
</tr>
<tr>
<td>Point up</td>
<td>Move to an upper storey</td>
</tr>
<tr>
<td>Point down</td>
<td>Move to a lower storey</td>
</tr>
<tr>
<td>Point left/right</td>
<td>Pan camera left/right</td>
</tr>
<tr>
<td>“Hold-up” pose</td>
<td>Calibrate user to system</td>
</tr>
<tr>
<td>Push hand forward</td>
<td>Select</td>
</tr>
<tr>
<td>Cross arms</td>
<td>Return to starting position</td>
</tr>
<tr>
<td>Cross arms (hold for 2 seconds)</td>
<td>Return to model selection</td>
</tr>
</tbody>
</table>
Gestures adapted for each user

- Naïve approach used fixed distances to trigger a gesture
- Testing identified poor performance
- Adapted to individual users

0.2 x User Height
Avatar in the scene?
Ease of use and accuracy

Gestures

- Cross
- Point to pan camera
- Back
- Down
- Up
- Forward (Leg)
- Forward (Hand)
- Point to browse models
- Push

Percentage

Easy to use
Accuracy
Responsiveness and memorability
Fatigue

The chart shows the percentage levels of fatigue for various gestures:

- Cross
- Point to pan camera
- Back
- Down
- Up
- Forward (Leg)
- Forward (Hand)
- Point to browse models
- Push

The y-axis represents the gestures, and the x-axis represents the percentage of fatigue.
User Elicited Hand Gestures for VR-based Navigation of Architectural Designs

Karim Cissé, Aprajit Gandhi, Danielle Lottridge, Robert Amor

School of Computer Science
University of Auckland, New Zealand

14 August 2020
Navigating Complex 3D Environments
Leap Motion and Oculus Rift setup
**Gesture Development Process**

- **Interview Professionals** (6)
  - Primary and alternate gestures
- **Filter Gestures**
  - Elicited Gestures (64)
  - Popularity; Physical demand; Recognisability; Intuitiveness; Fit
- **Evaluation Study** (12)
  - Selected Gestures (8)
Mid-Air Hand Gesture Set

(a) Move forward;
(b) Move forward double speed;
(c) Move backwards;
(d) Move up a floor;
(e) Move down a floor;
(f) Rotate right;
(g) Rotate left;
(h) Main menu.
Gesture Usability Ratings

![Bar chart showing ratings for different gestures.](image)
Mean Self-Reported Task Load, Raw-TLX

- Mental demand
- Physical demand
- Temporal demand
- Performance
- Effort
- Frustation

Perceived Workload
Conclusions

- Design professionals identified domain and task specific gestures
- Developed a coherent mid-air gesture set
- Accurately recognised by Leap Motion controller
- Participants rated them as memorable, intuitive and physically non-demanding
- Identified need to reassess the rotate gesture
- Identified need for more gestures
- Identified need for social interaction features
Construction Informatics Specific Issues
Collaborative Approaches
Appropriate Interactions
### Appropriate Details Modelled

<table>
<thead>
<tr>
<th>VR Image</th>
<th>Construction Photograph</th>
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<tbody>
<tr>
<td><img src="image1.png" alt="Image 1" /></td>
<td><img src="image2.png" alt="Image 2" /></td>
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<td>2004.12.20. (~6 days)</td>
<td>2004.12.28. (~5 days)</td>
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</tr>
<tr>
<td>2005.02.03.</td>
<td></td>
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</tbody>
</table>
Level of Detail and Information space navigation

**Metope East VI.**

Type: Statue

ID: N.I. 3920 A
Dimensions: h. 145; w. 114.5; h. of plinth: 22; d. of relief (at plinth): 29.5-31.5.

Condition: Restored from fifty-nine fragments. Several parts missing of background, frame (side borders and fascia restored in wood), and relief.

Description: The metope shows a frontal chariot pulled by a team of four horses. The pole horses face the viewer, while each trace horse turns its head to the side. The whole far apart of the animals is in full relief and projects from the background, against which are sculpted both the hind legs and the tail.
Multi-criteria decision making
Augmented Reality
More robust consultation

http://www.youtube.com/nextspacenz#p/a/u/0/NBD2QWyBvlg
Smarter Infrastructure Interactions

3D Catchment View

3D Property View – for home owner, inspectors,

3D Operations View

Visual Water- South East Water (Melbourne) - Nextspace
Devices on site!
Summary

- Specific domains require a unique UI or HCI experience
- Professions are not ‘normal’ HCI business
  - Very specific needs in many professions
  - Mass market software not well matched
  - New devices not well matched
- HCI provides a practice to investigate suitable UX
References

References