LECTURE 6

DESIGN BY SYMMETRY

by

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Gresham lectures so far

- Problems with devices
  - mobile phones, microwaves, ticket
    machines, aeroplanes, calculators, programming
    languages, user manuals...
  - All problems avoidable

Overview

- Symmetry
- Affordance
- Symmetry + Affordance
  = Successful design

Reflection symmetry

- \( f(x) = x^2 \)
- \( f(x) = f(-x) \)

Rotational symmetry

- \( \text{SW} \)
- \( \text{Recycle} \)

Beauty

- Symmetric faces are attractive
- Evolution favours symmetry
- Culturally deep aesthetic significance

Simplicity

- Symmetry is one of the best tools for simplicity
- If \( f(x) = f(-x) \), you only need half the information
### Definition
- *S*-symmetry occurs when a property of an object remains unchanged through an *S*-transformation of the object.
- Transformation = reflection, rotation, rhythm, period, scaling...

### Notes
- Trivial symmetries arise when the property is a constant or the transformation is an identity.
- Property = invariant, conservation law, permutation... e.g., \( f(x, y) = f(y, x) \)

### Isn't symmetry obvious?
- Translation
- Scale
- Scale symmetry = “zoom in”
- Numerosity

### Science basics
- Chemistry
- Mathematics \( x=2 \) or \( x = 2 \)
- Noether’s Theorem
- Geometry

### Curie’s Principle
- Any symmetry in the cause leads to a symmetry of the effect.
- The symmetry group of the cause is a subgroup of the symmetry group of the effect.

### Natural computation
- Scale symmetry

### Vision & eco'pey
- Objects may afford some or several sorts of action
- A set of natural or “easy” relations
- Brain “detects invariants” or “resonates” despite changes in “sensations”

*J. J. Gibson, 1979*

### Marr
- Removes implementation bias
- Detection of invariants is information processing

### Definitions of Affordance
- “the presentation of a system conveys information about the actions that can be performed by the user of that system”
  
  *Amodeus glossary*
Perceived, cultural, or what?

- The design of artifacts should naturally invite task-appropriate usage
  - Bill Gaver
- An object's sensory characteristics intuitively imply its functionality and use
  - Usability First

Design

- A [Web] page's "link affordance" rate
  - Robert Bailey
- Design[s] should also suggest (that is, afford) their functionality
  - Jenny Preece
- What sort of operations and manipulations can be done to a particular object
  - Don Norman
  - University of Cincinnati, Ecological Discussion Group

A new affordance

- The symmetries that apply under the actions relevant to the activities or tasks performed with the object
- Affordance is user interface symmetry
- ... extends to user manuals

Some examples...

- TV, VCR & remote controls
- MS Word
- DM, VR
- Pencils
- Digital clocks
- More!
  - WAP, manuals, ...

Key concepts

- Symmetry
- Natural computation
- Affordance

Graphical user interfaces

- Design by Symmetry
Direct manipulation

- Familiar Euclidean symmetries
  (except in Word!)
- Reversible and incremental actions

A pencil

- Two main symmetries:
  - Rotational symmetry along long axis
  - Approximate reflectional symmetry about its centre

Other pencil symmetries

- "pencilness"
- colour
- colour of the lead
- cheap ones fail to uphold many symmetries

New design ideas

- indefinitely unchanged
  = inexhaustible lead
- the propelling pencil

Symmetry & error

- It does not matter what angle a pencil is grabbed at
- It is easy to make end-end errors grabbing a pencil

Insights

1. Symmetries provide freedoms the way an object can be used
2. Approximate symmetries provide opportunities for errors
3. Deliberate control of symmetry can train users (kids’ pencils)

So...

- Some symmetries are interesting, others not
- Not all symmetries are useful affordances
- Some affordances lead to new designs (e.g., propelling pencil)
- Affordances raise design trade-offs

Programming symmetries

- Large classes of state transformed but behaviour is practically unchanged
- Referential transparency (see last Gresham lecture) is a symmetry

User interfaces

- A huge number of states for the implementation
- Small mental models for the user
- The user must rely on symmetries

The user interface presents symmetries to the user...

A digital alarm clock

- Digit (e.g., a 7 segment LED)
- Pushbutton

State structure

Interface & state structure

Time & alarm

- TIME
  - 1 2 2 0
- ALARM
  - 0 7 0 0

Make the clock smaller?

- At home
  - 1 2 2 5

Fix broken symmetry

Resolve ambiguity

- TIME or ALARM
  - 1 2 3 0

Replace “or” with a knob

- TIME ⊕ ALARM
  - 1 2 3 5
Abandon affordance?

[Image of a machine or device]

Analogue affordance

Design principles

- Modeless (temporal symmetry)
- *etc*

Conclusions

- Almost all design problems are caused by failure to exploit symmetry

- Affordance was a useful, but vague concept

- A symmetry-based conception of affordance is constructive
References


See also http://www.uclic.ucl.ac.uk/harold/gresham