Feedforward in Interaction: A Case Study of Feedforward for a Glimpse of its Potential in Interaction Design

Richard Chulwoo Park,
Woohun Lee

ID KAIST WonderLab
Seriously, which one is a switch for the restroom?
Problem of Affordance

**Breaking Affordance: Culture as Context**
Oshlyansky Lidia, Thimbleby Harold, Cairns Paul

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<td><strong>US</strong></td>
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**US style switch**

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**UK style switch**

Contrast tendency in Western culture between US and UK

**Alternative Approaches to the design of four-burner stoves**
Errol R. Hoffmann, Alan H.S. Chan

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Four most nominated designs

No stereotypical mappings
Problem of Affordance

Breaking Affordance: Culture as Context
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Alternative Approaches to the design of four-burner stoves
Errol R. Hoffmann, Alan H.S. Chan

In this circumstances, how can designers possibly afford people?
What if we provide a clue to the user?

Feedforward, widely known as *Preview*
Feedforward provides clear and instant information that tells users what the result of their action will be.

Crossing the Bridge over Norman’s Gulf of Execution: Revealing Feedforward’s True Identity
Jo Vermeulen, Kris Luyten, Elise van den Hoven, Karin Coninx (CHI 2013)

OctoPocus: A Dynamic Guide for Learning Gesture-Based Command Sets
Olivier Bau & Wendy E. Mackay (UIST 2008)

Fig. 3: OctoPocus displays three gestures and commands. Tracing copy causes paste to disappear and cut to get thinner.
**System Prototype Consideration**

- A real scale human factor (Rinnai RSF-CA24G\(^1\))
- Alters as little as possible. A light fixture in a gas stove hood uses as a guide of feedforward

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System Prototype

- Projector
- Capacitive sensors
- Potentiometer
- Arduino Mega
- PWM
- Infrared sensors
- Eye tracker
- Light fixtures and a hood
- PC

Diagram showing a system prototype with various components labeled.
Gas Stove System

- Out of Range
- Hovering
- Touched
- Ignition

- Time: after the action
- Before: before the action
- During: during the action
- Details: information details
- Veiled: veiled
- Unveil: unveil functionality

Brightness

- 0cm
- 15cm
**Experiment**

**Primary user study**

20 Participants

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<tr>
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<td>TOUCH Session</td>
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(a) Primary test for exploring effectiveness of Nunchi

**Effectiveness** (time, accuracy, comfort), Subjective user experience and intuitiveness

*Minimum 3 hours intervals between session for learnability & effect of prior experience*
**Experiment**

### Primary user study

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(a) Primary test for exploring effectiveness of Nunchi

**Additory user study with eye tracking**

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(b) Eye tracking test for exploring user eye behavior

**Effectiveness (time, accuracy, comfort), Subjective user experience and intuitiveness**

**Concentration and dispersed attention in relation with mental demand**

*Minimum 3 hours intervals between session for learnability & effect of prior experience*
**User Study**

<table>
<thead>
<tr>
<th>Quantitative Experience</th>
<th>Gesture &amp; Behavior</th>
<th>Subjective Experience</th>
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<tbody>
<tr>
<td><strong>QUESI</strong></td>
<td><strong>Camera observation</strong></td>
<td><strong>Interview</strong></td>
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<tr>
<td>(questionnaire for measuring the subjective consequences of intuitive use)</td>
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<td>-Hurtienne &amp; Naumann 2010-</td>
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**QUESI subscales**

- Subjective mental workload
- Perceived achievement of goals
- Perceived effort of learning
- Familiarity
- Perceived error rate
Performance and Satisfaction

The prototype was not significant improve performance.

But satisfaction of subjective user experience was significantly better.

Results of Performance

Results of User Experience
Performance and Satisfaction

The prototype was not significant improve performance.

But satisfaction of subjective user experience was significantly better.

*Task performance: $t_{124(6)} = 5.462, p<.05$ ; $t_{124(6)} = 5.145, p<.05$; QUESI: $t_{40(4)} = 8.13, p<.05$ ; $t_{40(4)} = -6.47, p<.05$.
Unfamiliar vs Familiar stage of interface

User’s performance improved when they memorized the mapping.

The users tended to rely more on the system with the prototype.

- Enhancement rate: Conventional(14.9%) > Touchable(9.7%) > Hover-able(8.0%)
- Subjective mental workload scores: Conventional(8.24) < Touchable(11.76) < Hover-able(12.00).
Eye movement and attention

*due to dimensional differences and inconsistent eye tracker calibration, the result may seem distorted and inaccurate, but it is reasonably valid for comprehending the tendency differences*
- Support natural behavior
  Users perceive the systems as a familiar interface, not as a new manipulation technique

- Perceived mistake and confidence
  “I have tried to remember (mapping of the system) but I have failed and I was confused. But with feedforward, when I miss-grabbed the knob, I didn’t feel as a mistake.” P4

- Perceived task completion time, mental demand, and action state
  Hoverable < Touchable < Conventional system

- Typical mid-air gesture drawbacks
  “It takes time to get used to hovering... I prefer haptic interface because it feels secure.” P6
Interaction Technique

First few trials (avg. 1-3)
Cognitive stage

After adaption
Autonomous stage

Exploring

Foreground Interaction
Searching technique

Assuring

Background Interaction
Building confidence

Interaction States

(a) Conventional System

(b) Touchable System

(c) Hove-able System

Subjective Mental Workload / Perceived Sensory Time

Task Completion Time

None

Weak confidence

Positive assurance

Good for peripheral (not tasks oriented) artifact/activity and for new features
Power relation

Confidence versus inability of control less

How much power the system should take control, and in what way designers can balance between, comfort of automation and security of total control?

Csikszentmihalyi, M., 1990. Flow: The psychology of optimal performance
Complexity of interactivity

“how do we lead them to less stressful way to learn and adapt to things?”

Feedforward as a guide in complex life

Interpersonal aspect in interaction design
Erikson, E.H., 1993. *Childhood and society*

“it (technology) didn’t make much of difference (between conventional and the prototype), but I felt that I can manipulate it entirely dependent to the system by trust.” P3
Daejeon, Korea

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