DESIGN ENGINEERING INTERACTION
A MISSING LINK IN THE EVOLUTION OF HUMAN-COMPUTER INTERACTION

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Habilitation à Diriger des Recherches
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challenges in HCI

designing

crafting
design theories
technology
craftsmanship

understanding

using
challenges in HCI

designing

crafting

design theories

technology

craftsmanship

understanding
the golden age of a young research field

Stuart Card - keynote @ CHI ’12

“How to ground the field, accelerate its progress, and make it cumulative by fashioning theories and incorporating them into practice”

Technology develops by combinatoric evolution and we need to understand how HCI works with technology, to focus on technological and theoretical progress all together in order to successfully take on the new “golden age” that HCI is entering now.
interaction design and software technology

designing interaction techniques

engineering interactive systems

MaggLite principle: “draw it, connect it and run it.”

Prototype and test advanced user interfaces by applying the MaggLite Post-WIMP Toolkit: Draw It, Connect It and Run It.

While developers and UI designers can quickly and interactively design, produce rich graphical effects, whereas traditional components we call interaction design.

The MaggLite Post-WIMP Toolkit: interaction design and software technology.

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ABSTRACT

The MaggLite Post-WIMP Toolkit: interaction design and software technology.

INTRODUCTION

Additional Keywords and Phrases

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interaction design challenges technology
interaction design challenges technology
interaction design challenges technology

1. When interaction design is driven by technology

2. When interaction design is constrained by technology

3. When interaction design improves technology
when interaction design is driven by technology

**designing with limitations**

[TorusDesktop - CHI’11]

**designing for features**

[BiPad - CHI’12]

**identifying limitations**

[left-over windows - IHM’12]
when interaction design is driven by technology

TorusDesktop

objetive : target agnostic pointing technique

solution : revisit cursor wrapping

accessing targets in real systems
detecting user’s intentions

---

[biPad - CHI’12]

[torusDesktop - CHI’11]
when interaction design is driven by technology

**.designing with limitations**

[TorusDesktop - CHI’11]

**.designing for features**

[BiPad - CHI’12]

**.identifying limitations**

[left-over windows - IHM’12]
when interaction design is driven by technology

BiPad

objective: bimanual interaction in mobility

solution: design space and multiple designs

designing with limitations

designing for features

handheld devices
multitouch capabilities

BiPad - CHI’11

BiPad - CHI’12

[TorusDesktop - CHI’11]

[BiPad - CHI’12]

[left-over windows - IHM’12]
when interaction design is driven by technology

designing with limitations

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**Design with limitations**

[TorusDesktop - CHI’11]

**Designing for features**

[BiPad - CHI’12]

**Identifying limitations**

[left-over windows - IHM’12]
when interaction design is constrained by technology

**performance issues**

[SpiraList & SnailList - NordiCHI’06 & Interact’07]

**openness and interoperability issues**

[Gliimpse - UIST’11]
when interaction design is constrained by technology

**Performance issues**

[SpiraList & SnailList - NordiCHI’06 & Interact’07]

**Openness and interoperability issues**

[Gliimpse - UIST’11]
when interaction design is constrained by technology

performance issues

input hardware advanced graphics vs limited hardware/libraries

SpiraList & SnailList - NordiCHI'06 & Interact'07

openness and interoperability issues

objective manipulating large lists on mobile devices

code view: new layout and F+C data presentation

manipulating large lists on mobile devices

with E. Lecolinet

performance issues

input hardware advanced graphics vs limited hardware/libraries
when interaction design is constrained by technology

.performance issues

.openness and interoperability issues
When interaction design is constrained by technology

**Gliimpse**

**objective** : improve markup language editing  
**solution** : in-place & on-demand animations

**openness and interoperability issues**

- components inspection
- linking components

---

SpiraList & SnailList - NordiCHI'06 & Interact'07

Evaluation

Revision

DESIGN OF INTERACTION ENGINEERING OF INTERACTIVE SYSTEMS

- performance issues

- openness and interoperability issues

Gliimpse with P. Dragicevic & F. Chevalier

- components inspection
- linking components

[Gliimpse - UIST’11]
when interaction design is constrained by technology

**DESIGN OF INTERACTION ENGINEERING OF INTERACTIVE SYSTEMS**

- performance issues
- openness and interoperability issues

**Gliimpse**

What you gliimpse is what you get

with P. Dragicevic & F. Chevalier

[Gliimpse - UIST’11]

[SpiraList & SnailList - NordiCHI’06 & Interact’07]

- performance issues
- openness and interoperability issues

**components inspection**

**solution**

- in-place & on-demand animations

**Pierre Dragicevic**
INRIA

**Stéphane Huot**
LRI - Université Paris-Sud & CNRS, INRIA

**Fanny Chevalier**
OCAD University
Gliimpse

**objective**: improve markup language editing

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.openness and interoperability issues

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when interaction design is constrained by technology
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[Gliimpse - UIST’11]
when interaction design improves technology

integration of new designs

replication and new design opportunities
when interaction design improves technology

integration of new designs

[Rhythmic Interaction - CHI’12]

replication and new design opportunities

[BiPad - CHI’12]

Rhythm Hotkey

Recall Rate (%)
Rhythmic Interaction

objective: explore rhythmic patterns as an input method

solution: design, feasibility & technology

integration of new designs
standard input devices
universal recognizer
when interaction design improves technology

integration of new designs

replication and new design opportunities

Evaluation
Revision

DESIGN OF INTERACTION TECHNIQUES

RECALL RATE (%)

Recall Rate (%)

0 20 40 60 80 100

1 (day 1) 2 (day 1) day 2

[BiPad - CHI’12]

[Rhythmic Interaction - CHI’12]

[BiPad - CHI’12]
**BiPad** (again)  
*with J. Wagner & W. E. Mackay*

**objective** : bimanual interaction in mobility

**solution** : design space, design & **toolkit**

---

**replication and new design opportunities**  
“real-world” applications **toolkit**

---

**when interaction design improves technology**
when interaction design improves technology

integration of new designs

replication and new design opportunities

[Rhythmic Interaction - CHI’12]

[BiPad - CHI’12]
Interaction design challenges technology

.when interaction design is driven by technology

.when interaction design is constrained by technology

.when interaction design improves technology
engineering unleashes interaction design
engineering unleashes interaction design
engineering unleashes interaction design

when technology defines possible designs

when technology enables the evaluation of designs

when technology integrates designs
when technology defines possible designs

Design of Interaction Techniques

Engineering of Interactive Systems

.building blocks and combination
[FlowStates - IHM’09]

.interoperability and extension
[jBricks - EICS’11]
when technology defines possible designs
FlowStates

with C. Appert, P. Dragicevic & M. Beaudouin-Lafon

objective: prototyping advanced interaction

solution: state-transition (SwingStates) & data-flow (ICon)

building blocks and combination

⇒ describing = programming
adaptability and dynamicity
**FlowStates**

With C. Appert, P. Dragicevic & M. Beaudouin-Lafon

**Objective**

- Prototyping advanced interaction

**Solution**

State transition (SwingStates) & data-flow (ICon)

**Building blocks and combination**

Describing = Programming

Adaptability and dynamicity

When technology defines possible designs

---

### Code Snippet

```java
public class Zoom extends IConEvent {
    protected double dZ;

    public void setSlotDZ(double dz) { dZ = dz; }
    public double getSlotDZ() { return dZ; }
    public boolean occurs() { return dZ > 0; }
}

public class Pan extends IConEvent {
    private double dX;
    private double dY;

    public double getSlotDeltaX() { return dX; }
    public double getSlotDeltaY() { return dY; }
    public void setSlotDeltaX(double dx) { dX = dx; }
    public void setSlotDeltaY(double dy) { dY = dy; }
}
```

---

### Diagram

- **SwingStates**
  - Events
    - Control
      - keyboard
      - space
      - pointer
    - ICon

- **IConStateMachine**
  - "zoom"
  - "pan"
when technology defines possible designs

[FlowStates - IHM’09]

.building blocks and combination

[FlowStates - IHM’09]

.interoperability and extension

[jBricks - EICS’11]
jBricks

**objective**: rich graphics & advanced interaction in multi-surface environments

**solution**: separation of concerns

interoperability and extension

separate graphics and interaction
several levels of combination
When technology defines possible designs...
Prototyping when technology defines possible designs

-building blocks and combination

-interoperability and extension

[FlowStates - IHM’09]

[jBricks - EICS’11]
when technology enables the evaluation of designs
when technology enables the evaluation of designs
when technology enables the evaluation of designs
when technology enables the evaluation of designs
when technology integrates designs

(toolkit or application level)

[Rhythmic Interaction, BiPad - CHI’12]

(opening closed systems)

[Metisse - Chapuis and Roussel, UIST’05] [FlowStates - IHM’09]
when technology integrates designs

[Rhythmic Interaction, BiPad - CHI’12]

[Metisse - Chapuis and Roussel, UIST’05] [FlowStates - IHM’09]
when technology integrates designs

[Design of Interaction Techniques]

-Evaluation-

Prototyping

[toolkit or application level]
[Rhythmic Interaction, BiPad - CHI’12]

-opening closed systems

[Metisse - Chapuis and Roussel, UIST’05] [FlowStates - IHM’09]
when technology integrates designs
Design of Interaction Techniques

Integration
Evaluation
Prototyping

Engineering of Interactive Systems

Engineering unleashes interaction design

.when technology defines possible designs

.when technology enables the evaluation of designs

.when technology integrates designs
the cycle of Designeering Interaction
“Consider a reaction graph with \( N \) molecular species, polymer sequences of A, and B monomers of diverse lengths. Call this initial \( N \) the actual. Now ask the organic chemist to draw all the reactions that these \( N \) species might undergo [...]. It may well be that the products of some of these single-step reactions will not be among the initial \( N \) in the "actual" but will be new molecular species. Call the set of new molecular species reachable in a single-reaction step from the actual, the adjacent possible. [...] The initial plus its adjacent possible can be considered a new actual, which will then have a new adjacent possible.”
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“[…] we like to think of breakthrough ideas as sudden accelerations on the timeline, where a genius jumps ahead fifty years and invents something that normal minds […] couldn’t possibly have come up with. But the truth is that technological (and scientific) advances rarely break out of the adjacent possible; the history of cultural progress is, almost without exception, a story of one door leading to another door, exploring the palace one room at a time. But of course, human minds are not bound by the finite laws of molecule formation, and so every now and then an idea occurs to someone that teleport us forward a few rooms, skipping some exploratory steps in the adjacent possible. But those ideas almost always end up being short-term failures, precisely because they have skipped ahead.”
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“There can be no sudden leaps upward – no precipitous increases in ordered complexity. Second, there can be no going downhill – species can’t get worse as a prelude to getting better. Third, there may be more than one peak – more than one way of solving the same problem, all flourishing in the world.”
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Périphériques d’entrée : quelques exemples

Dispositifs hybrides entrée/sortie

Voice as sound

Souris, tablettes, joystick, trackball

surfaces interactives

Souris, tablettes, joystick, trackball

Potentiomètres

Claviers, boîtiers

Vitesse de la souris. Plus on va vite, plus le temps d’activation est court.

Mais si il est trop petit on est obligé de le repérer sur l’écran.

Capteurs de position et de reconnaissance de la parole

Ecrans tactiles, crayons optiques

Périphériques d’affichage

Evénements

Ecran lisible, un pixel par une impulsion souris. La réponse est instantanée.

Si l’écran est trop grand, l’instruction doit être représentée par des événements cédant la place à d’autres.

Le nombre d’impulsions que peut envoyer le périphérique est limité.

De même, la distance parcourue est limitée.

ID de l’objet cible, indice de difficulté.

L’idée est de choisir le meilleur périphérique pour une distance donnée.

Autres modalités/périphériques de sortie

CDGain, X Window, Mac OS X et Windows

Différenciation de la qualité de l’interface.

Phénomènes progressifs.

Metier : PHANTOM Omni, 6DOF, 3.3N (SensAble)

Avec le temps, l’interface se crée spontanément.

Vital (CEA LIST)

Recommandations et modèles de tests.

Properties of Instruments

Meta-instruments include menus and tool palettes used to tailor instruments to particular tasks, e.g. turning a power-tool into a sharpener, which operates on the shifted domain object, the power tool.

Such “meta-instruments” can help interface designers who face difficult choices when defining properties of instruments.

PhantomOmni 6DOF 3.3N (SensAble).
example of adjacent possible: the Wiimote
example of adjacent possible: the Wiimote
example of adjacent possible: the Wiimote

Low-cost Multi-Point Interactive Whiteboard using the Wiimote

Johnny Chung Lee
Human-Computer Interaction Institute
Carnegie Mellon University
Engelbart, augmenting human intellect (60s)

Kay, a personal computer for children of all ages (70s)

Weiser, integrating computers seamlessly into the world (late 80s)
ex: Dynabook [Kay, 70s]
ex: Dynabook [Kay, 70s]

- Xerox Alto (the interim Dynabook) (73)
- SmallTalk (71)
- MVC (79)
- WIMP

Dynabook

Adjacent Possible
ideas and the adjacent possible
ideas and the adjacent possible
the adjacent possible of a toolkit
provide = atomic parts

WIMP

SATIN

[Hong & Landay - UIST’00]

FlowStates

.widgets

.callbacks

.strokes interpreters

.gestures recognizers

.strokes

.gestures

.state machines

.data-flow devices

.abstract events
enable = extension, combination, reuse and interoperability

extension
  .inheritance
  .creation

combination
  .structural
  .logical

reuse
  .extensions
  .combinations

interoperability
  .internal
  .external
perspectives: tools for designeering interaction

system and programming languages

creative prototyping: sketching interaction, not interfaces

adaptability for end-users
perspectives: tools for designeering interaction

system and programming languages

creative prototyping: sketching interaction, not interfaces

adaptability for end-users
perspectives: tools for designeering interaction

system & programming languages

- system and programming languages
  - creative prototyping: sketching interaction, not interfaces
  - adaptability for end-users
  - low-level language/libraries

  ➞ combination and interoperability unifying the levels
perspectives: tools for designeering interaction

system & programming languages

low-level language/libraries

- combination and interoperability
- unifying the levels
perspectives: tools for designeering interaction

system & programming languages

system and programming languages

- low-level language/libraries
  - combination and interoperability
    - unifying the levels

[Metisse - Chapuis & Roussel, UIST’05]
system & programming languages

- low-level language/libraries
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perspectives: tools for designeering interaction

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    - combination and interoperability
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combination and interoperability
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perspectives: tools for designeering interaction

System and programming languages

Creative prototyping: sketching interaction, not interfaces

Adaptability for end-users
perspectives: tools for designeering interaction

sketching interaction, not interfaces

system and programming languages

creative prototyping: sketching interaction, not interfaces

adaptability for end-users

rapid and iterative design

structural and logical combinations unifying the levels of prototyping

[Apple XCode]

[Denim - Lin et al, CHI’00]
perspectives: tools for designeering interaction

sketching interaction, not interfaces

- rapid and iterative design
  - structural and logical combinations unifying the levels of prototyping
perspectives: tools for designeering interaction

.system and programming languages

.creative prototyping: sketching interaction, not interfaces

.adaptability for end-users
adaptability for end-users

interaction as a first-class object
  ➔ interaction manipulation
  interaction transformation
perspectives: tools for designeering interaction

adaptability for end-users

interaction as a first-class object

interaction manipulation

interaction transformation
perspectives: tools for designeering interaction

adaptability for end-users

interaction as a first-class object

→ interaction manipulation

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interaction manipulation
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