Fundamentals of Situated Interaction

Wendy Mackay, Michel Beaudouin-Lafon
23 September 2016

Seminar format

Discovering the principles of situated interaction:
- Instrumental Interaction
- Reification
- Polymorphism
- Reuse
- Substrates
- Human-computer partnerships
  (Reciprocal co-adaptation)

Class activities

- Lectures on key concepts
  (Michel & Wendy)
- Seminar presentations
  (30 min.)
  Present key concept from 3 papers
  Lead discussion

- Seminar presentations
  (30 min.)
  Present recent research
  Lead discussion

- Generative Deconstruction
  Deconstruct systems
  Generate novel design ideas

Course Schedule

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<tr>
<th>Date</th>
<th>Activity</th>
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<tr>
<td>16 Sept.</td>
<td>Instrumental Interaction</td>
<td>Building 640</td>
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<tr>
<td>23 Sept.</td>
<td>Human-Computer Partnerships</td>
<td>Room B109</td>
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<tr>
<td>26 Sept.</td>
<td>Presentations (Ph.D.) / Group exercise</td>
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<td>30 Sept.</td>
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<td>03 Oct.</td>
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<td>24 Oct.</td>
<td>Final Presentations &amp; discussions</td>
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Inria – Université Paris-Saclay
Grades

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<tr>
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<tr>
<td>Class participation</td>
<td>20%</td>
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<tr>
<td>Seminar Presentation</td>
<td>30%</td>
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<tr>
<td>Report &amp; iMuseum entry</td>
<td>50%</td>
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Additional activity: iMuseum

Read a paper with a novel interaction technique
- Find one key image
- Create an animated .gif
- Create a 3-5 step storyboard
- Write a summary of the novel aspect of the technique
- Identify related techniques
- Identify related references
- Identify commercial uses

Link: [https://hci-museum.inria.fr/WWW/](https://hci-museum.inria.fr/WWW/) or [hci-museum.org](http://hci-museum.org)

Assignment #1

Readings

Friday, 23 September 13h30

Read:


Assignment #2
Prepare Presentations

1. Prepare a 15-minute talk
   • choose three papers
     - choose one or two from InSitu/ExSitu
     - choose one or two from ACM/Digital Library
   • describe each technique (show video, if possible)
   • compare to each other and analyze:
     - how do they represent instruments? or not?
     - how are they co-adaptive? or not?

2. Prepare a 15-minute class discussion
   Suggest ideas for revising the techniques
to become co-adaptive instruments

Human-Computer Partnerships
or
Co-Adaptive Instruments

Computer hardware has changed dramatically over the past 40 years …
Computer capabilities are exploding

but human capabilities are not...

Bill Buxton: 'Moore's law vs. God's law'

Can computers augment human capabilities?

Key Research Challenge

How can we improve interactive systems, given today's ever-increasingly complex computational environment?
Situated Interaction

Focus on interaction
we cannot effectively model user behavior
without taking context into account

Human behavior is planned, but action is situated:
plans are a resource for action, not the action itself

Differentiate between measuring data
and understanding the complexities of context

Methodology

Generative theory
- understand co-adaptive interaction
- principles for creating co-adaptive instruments

Participatory design with creative professionals
- develop novel prototypes
- real-time interaction
- personal language creation
- long-term reusable patterns of interaction

Empirical studies
- controlled laboratory studies
- extended field studies

ExSitu focuses on:
reinventing interactive software
to support creative activities …

based on two key ideas
We have multiple relationships with computers.

- Computer as a *tool*
  I accomplish the task myself.

- Computer as a *servant*
  It accomplishes the task for me.

- Computer as a *medium*
  It lets me communicate with other people.

Competing views of the future:

- Artificial Intelligence
- or
- Human-Computer Interaction

Hollywood's view of Artificial Intelligence:

Contrast with Human-Computer Interaction view:
GUIs are a vindication… and a challenge

GUIs are a vindication… and a challenge

Human-Computer Interaction research fought hard to make interfaces easier to use

Today, novices easily accomplish simple tasks

Yet…

advanced research in interaction techniques is rarely adopted in commercial systems

Today, experts use inefficient techniques and are constantly forced to change their behavior

Graphical User Interfaces

Designed for executive secretaries to process documents in a completely different technology environment

Dates back to the 1970s to:

- copy handwritten notes
- check for mistakes
- format on letterhead

Problem:

Brilliant then, out-moded today

Desktops, the web and apps…

Require constant relearning:

- each new version introduces arbitrary changes
- each system requires slightly different interaction

Require high visual attention

Do not scale

Depend on specific devices
Smartphones are easy … but not powerful

What about creativity and expression?

We need to reassess human-computer interaction

- Early assumptions about graphical user interfaces no longer hold
- Everyone, not just experts manages increasing quantities of data
  faces information overload
  constantly relearns the details of interaction
- Redefine what we mean by “computer literacy”

Design Trade-offs

Goal:
- Simple things should be simple … complex things should be possible
Design Trade-offs

Fundamental challenge:
Balance trade-off between:
  - power of expression
  - simplicity of execution

Strategy: Combine two key concepts

- Instrumental interaction
  (Michel Beaudouin-Lafon)

- Co-adaptive phenomena
  (Wendy Mackay)

Instrumental Interaction in the physical world
Instrumental interaction

Two levels of interaction:
- interaction with the instrument
- mediation with the system

Michel Beaudouin Lafon (2000)

What makes an object an instrument?
Relationship between the user and the object

Magnetic guidelines

Reification of the alignment command

Power and simplicity
- Align command vs Align object
- Align (now) vs Align (and keep aligned)

Multiple shapes
- Horizontal, vertical, diagonal, circular, rectangular
- Distribute objects

Decomposition
- Create / Move / Add object / Remove object

Strategy: Combine two key concepts

Instrumental interaction
(Michel Beaudouin-Lafon)

and

Co-adaptive phenomena
(Wendy Mackay)
**Human-Computer Relationships**

Between **people** and **physical** tools:
- follow well-known physical principles
- users can learn them
- users can appropriate them

Between **people** and **computer** tools:
- follow arbitrary constantly changing rules
- users must learn, and relearn, and relearn them
- users break them when they try to appropriate them

**Focus on interaction, not interfaces**

How can we let users control interaction
in a flexible, reusable way,
developing expertise without constantly relearning skills?

Solution: **Co-adaptive Instruments**
- Separate interaction from data and functionality
- Interaction becomes a first-class object

**Co-adaptive phenomena**

Inspired by co-evolution in biology
- Organisms create their environment
even as they adapt to it

Anaerobic bacteria change the atmosphere
making it possible for aerobic bacteria to emerge

Users change spreadsheets from an addition tool
to a tool for exploring ‘what if’ scenarios
Key phenomenon: Co-adaptation

Users adapt to a new system
they learn to use it

Users adapt the new system to their own needs
they appropriate and change it

Co-adaptive Instruments

Worthwhile spending time and energy learning them

Complex tools become accessible
they can learn cognitive and sensori-motor skills
they can adapt to new situations

Move beyond
graphical user interfaces
to expert instruments

To do this:
Extract widgets from applications
to create personal instruments

Co-adaptive instruments

Creative activities require both especially when integrating physical and digital information

Create digital tools that are as intuitive, and learnable, as physical tools

Reciprocal Co-adaptation

People adapt their behavior to technology…they learn it
People adapt the technology for their own purposes…they appropriate it
Computers adapt their behavior to people…machine learning
Computers adapt human behavior…training
People have rich cognitive and sensory motor capabilities increasingly, so do computers. Why is the interface so limited?

Learning to play a musical instrument—from novice to virtuoso—the instrument becomes part of the body.

Physical tools follow the laws of physics we learn them we appropriate them

Computer tools follow the whims of programmers we learn, and relearn and relearn and then we break them!
Compare to learning software: every ‘upgrade’ changes the interface tools belong to the application, not the user.

Physical tools are defined through use.

Some tools are designed for a specific task.

Some tools are designed for a specific task but we also improvise.
People redefine physical tools … why not software?

Imagine if you could only hit a drum with the manufacturer’s drumstick?

Our vision:

Software tools should be incrementally learnable

People should choose and control their own tools

Software tools should be easy to appropriate

Octopocus: Learning complex gestures

Dynamic partnership: Progressive algorithms reveal intermediate recognition states
Octopocus: Learning complex gestures

Experts just do it

Novices hesitate … which activates:

feedforward shows current available gestures
feedback shows what the recognizer sees

Physical tools are easy to appropriate — software tools are not
Arpege: Learning chords on a multi-touch surface

Beyond one- and two-finger gestures: novice to expert transition
feedforward and feedback

Dynachord: Combining chords and gestures

Chord sequences for a larger chord vocabulary
Dynamic adjustment of parameters

Dynachord
Enter a chord with one hand to choose a color
Continuously adjust the color with the other hand
How can we help users choose and control their own tools?

Appropriation

Interaction designers usually assume that users will focus on their system and use it as intended.

Users often use systems in different ways:
- They may have a different mental model of the system.
- They may turn ‘mistakes’ into opportunities.
- ‘Bugs’ become ‘features’.

Anything that involves communication among people is usually adapted for new purposes.

How can we help users appropriate technology?

Creating a partnership in which the user defines the semantics of the interaction with the computer.

- **Interaction Browser**: Linking marks to actions.
- **Knotty Gestures**: Interacting while writing.
- **Musink**: Creating a user-defined language.
- **Façades**: User-reconfigurable interfaces.

Interaction browser: User-defined commands

Air traffic controllers annotate flight strips. Marks can be linked to RADAR and other computer functions. Users define what marks mean.
Striptic

Knotty Gestures

Knotty Gestures: Creating an interactive controller

Knotty Gestures

Interactive Paper

Draw a line with a ‘knotty gesture’ at the end

Choose “recording” to define the type of line

Draw a dot, define a command
Interact while writing
Interact with command later

Flights in my Hands: Coherence Concerns in Designing a Tangible Space for Air Traffic Controllers, (Letondal et al., CHI'14)
Knotty Gestures: Creating an interactive controller

Define where the recording will start

Slide the pen along the line to move forward or backward on the recording

Define an end point for the recording

This line acts as a base for attaching mathematical value sliders

The knotty gesture at the end defines the type
Any knot drawn on line lets the user select a mathematical function.

Knots may define ranges or act as traces of past interactions with specific values.

The extensions act as value controllers. Sliding the pen over the line moves through range of function values, shown on the pen display.
But recognition is not the only problem …

Recognition must be good enough
but users override and reinterpret
no single ‘correct’ interpretation
recognized and non-recognized gestures co-exist

Real question:
Can Musink support the creative process?
What are the design implications for Musink v2?

Semi-Structured Delayed interpretation

Key insights:
Spatial structure on paper
improves recognition
under user’s control
Recognition need not be immediate
users decide when to interpret
interpretation changes over time

Musink

Musicians create their own
musical languages on paper
…and go back and forth
between paper and computer

Musink
Define meaning of gestures over time

User decides
if and when
to interpret
each gesture
Create interactive annotations

Reclassify a ‘squiggle’ and turn it into a trill

From symbols to wave forms:
Interpret a tremolo gesture as a waveform by OpenMusic

Transform structures into software representations
Musink: Semi-structured, delayed interpretation

Users decide when and how each annotation should be interpreted by the computer.

- Score pointers
- Scoping gestures
- Textual elements
- Connectors

Façades: Reconfiguring interfaces

Users can adopt parts of any Linux interface and reconfigure it for specific needs. Grab three selections from GIMP and choose a brush and create a new, custom-made palette.

Substrates

Define the structures and rules. Ways to interpret the data.
Different structures
to facilitate interpretation

Paper Substrates: create own language & structure
Composers create new structures for interpreting and composing music

Composers create their own reusable structures
Paper Substrates

A substrate is both an instrument for interpreting a personalized language and an object in its own right.

Paper Tonnetz

Draw music based on musical relationships among pitches.
Paper Substrates | Composer create their own reusable musical structures

The composer starts with the bass part

establish relationships among them
Arrange and Link substrates to composition software.

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**Interactive Paper Substrates**

*to Support Musical Creation*

Jérémie Garcia, Theophonis Tsandillas, Carlos Agon & Wendy E. Mackay

INRIA, Université Paris-Sud, CNRS, IRCAM & Stanford University

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**Quid Sit Musicus**

Philippe Leroux

13th century musical scores
Each note indicates expression
Create human-computer partnerships

People
- adapt to technology – they learn it
- adapt the technology – they appropriate it

Computers should
- adapt to people – they learn (AI)
- adapt people’s behavior – they teach

Reciprocal Co-adaptation

People adapt their behavior to technology
… they learn it
People adapt the technology for their own purposes
… they appropriate it

Computers adapt their behavior to people
… machine learning
Computers adapt human behavior
… training