

# Personalized Adaptive Accessibility

Krzysztof Z. Gajos



**HARVARD**

**School of Engineering  
and Applied Sciences**

- Health condition?
- Impairment?
- Disability
- Handicap?



MITO  
+1!

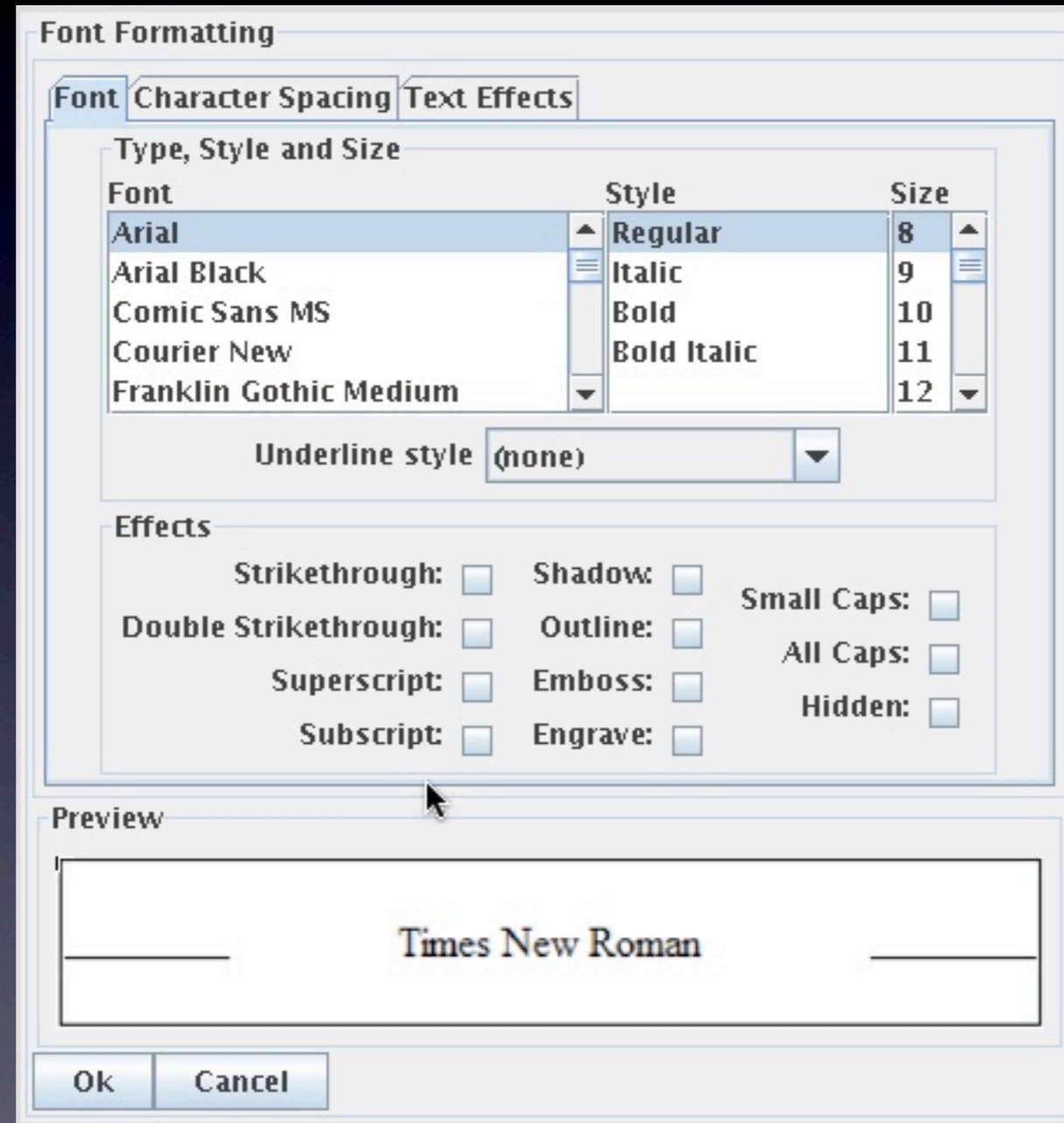


- Can a wheelchair user enter MIT?
- What are the social consequences of the current MIT “UI” for wheelchair users?





# Redesign





# Font Formatting

- Font
- Character Spacing
- Text Effects

## Type, Style and Size

Font	Style	Size	Underline style
Arial	Regular	8	<input checked="" type="radio"/> (none)
Arial Black	Italic	9	<input type="radio"/> Single solid
Comic Sans MS	Bold	10	<input type="radio"/> Double solid
Courier New	Bold Italic	11	<input type="radio"/> Dotted
Franklin Gothic Medium		12	<input type="radio"/> Dashed
Italic		13	<input type="radio"/> Wavy
Gautami		14	
Georgia		15	
Helvetica		16	
Latha		17	
Lucida Console		18	
Lucida Sans Unicode		19	
Microsoft Sans Serif		20	
Modern MS Sans Serif		21	
MS Serif		22	
Mv Boli		23	
Palatino Linotype		24	
Roman		25	
Script		26	
Small Fonts		27	

- ### Effects
- Strikethrough
  - Double Strikethrough
  - Superscript
  - Subscript
  - Shadow
  - Outline
  - Emboss
  - Engrave
  - Small Caps
  - All Caps
  - Hidden

Ok  
Cancel

## Preview

Times New Roman

# Font Formatting

## Font

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Font	Style	Size
Arial	Regular	8
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Courier New	Bold Italic	11
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Palatino Linotype		24
Roman		25
Script		26
Small Fonts		27
Symbol		28
Tahoma		29

### Underline style

- (none)
- Single solid
- Double solid
- Dotted
- Dashed
- Wavy

### Effects

- Strikethrough
- Double Strikethrough
- Superscript
- Subscript
- Shadow
- Outline
- Emboss
- Engrave
- Small Caps
- All Caps
- Hidden

## Character Spacing

### Scale

- 200%
- 150%
- 100%
- 90%
- 80%

### Spacing

	By
Normal	0
Expanded	1
Condensed	2
	3
	4
	5
	6
	7
	8
	9

### Position

	By
Normal	0
Raised	1
Lowered	2
	3
	4

Kerning for fonts

### Points and above

- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17

## Text Effects

### Animations

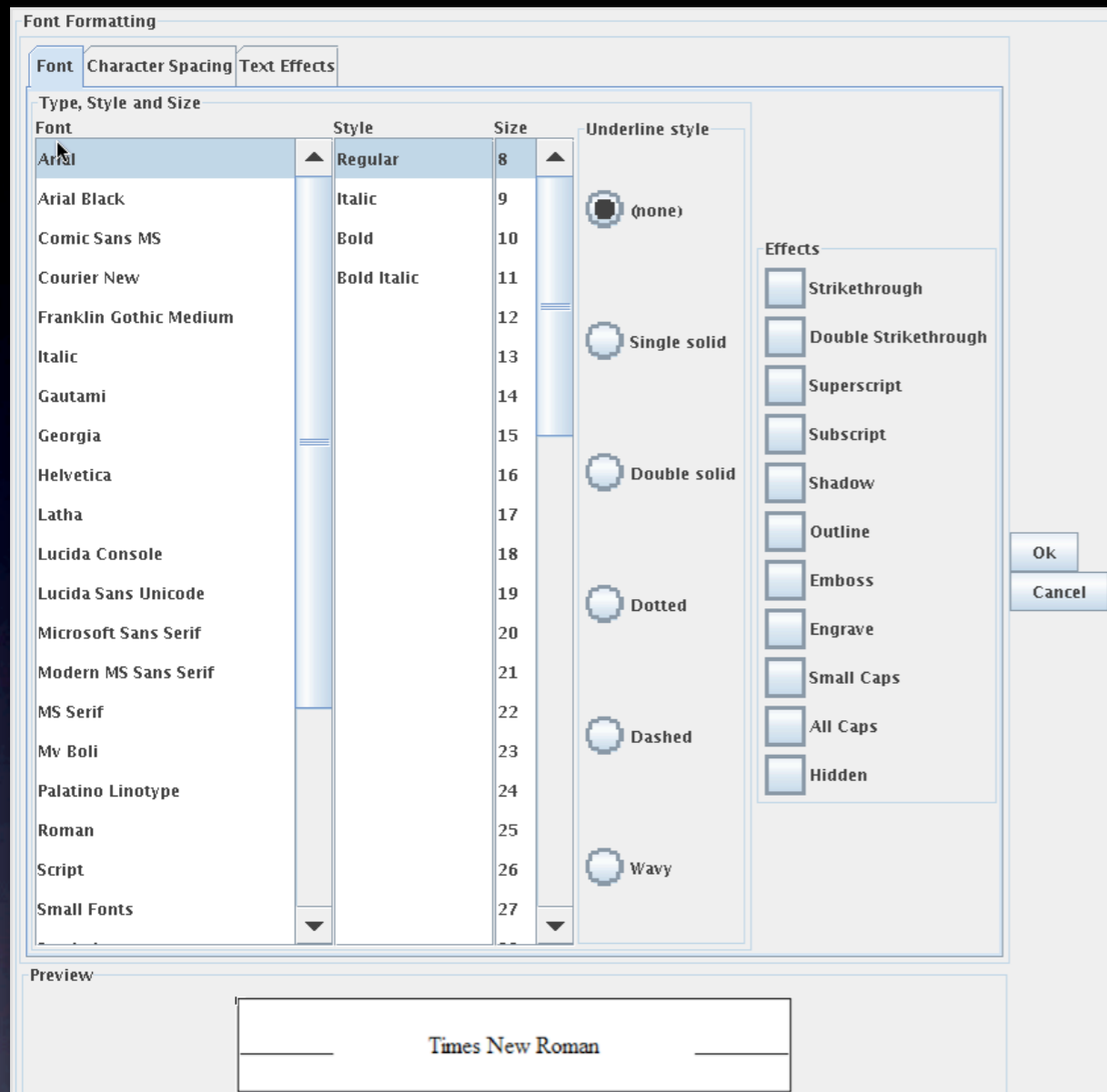
- (none)
- Blinking Background
- Las Vegas Lights
- Marching Black Ants
- Marching Red Ants
- Shimmer
- Sparkle Text

Ok

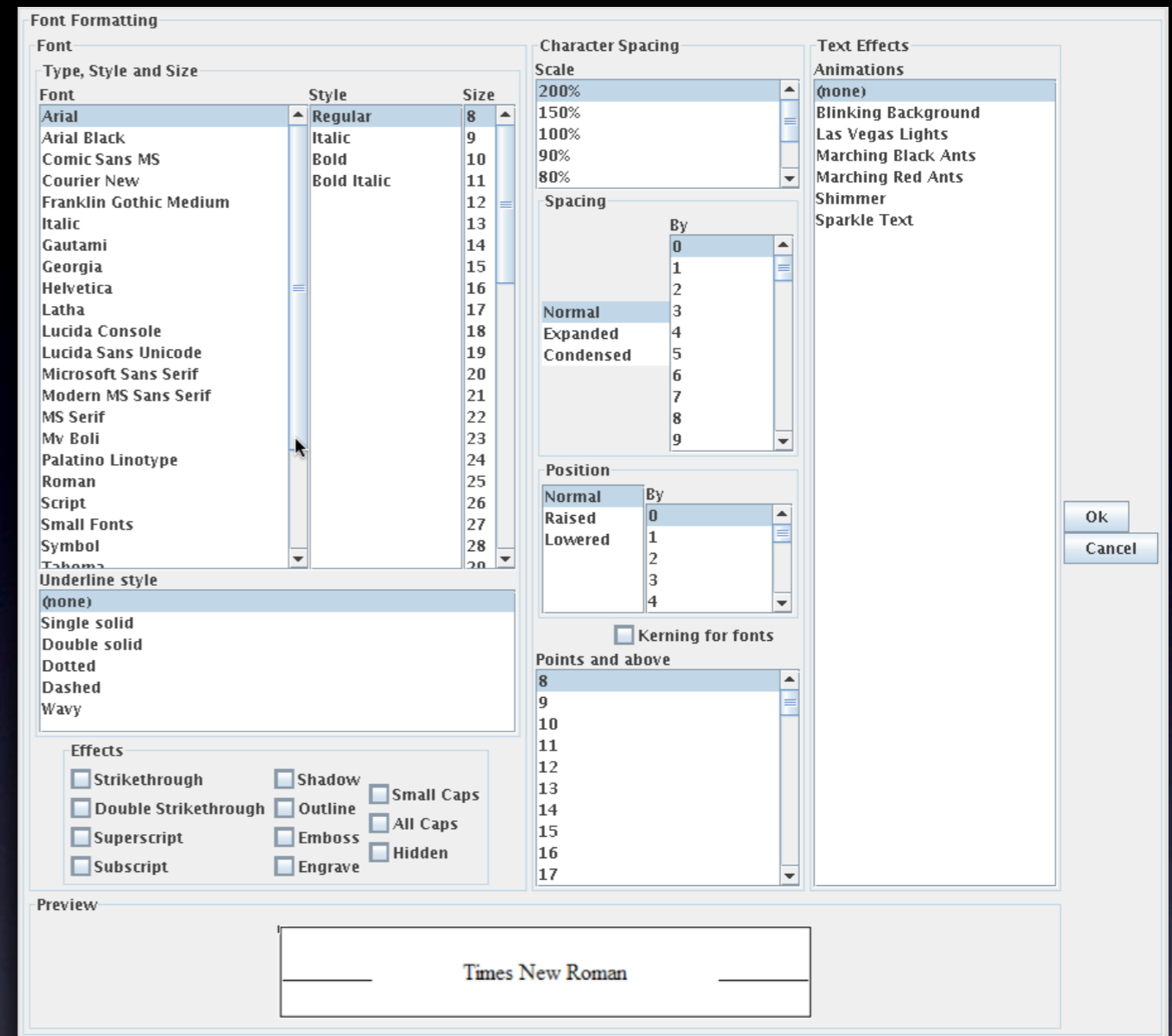
Cancel

## Preview

Times New Roman

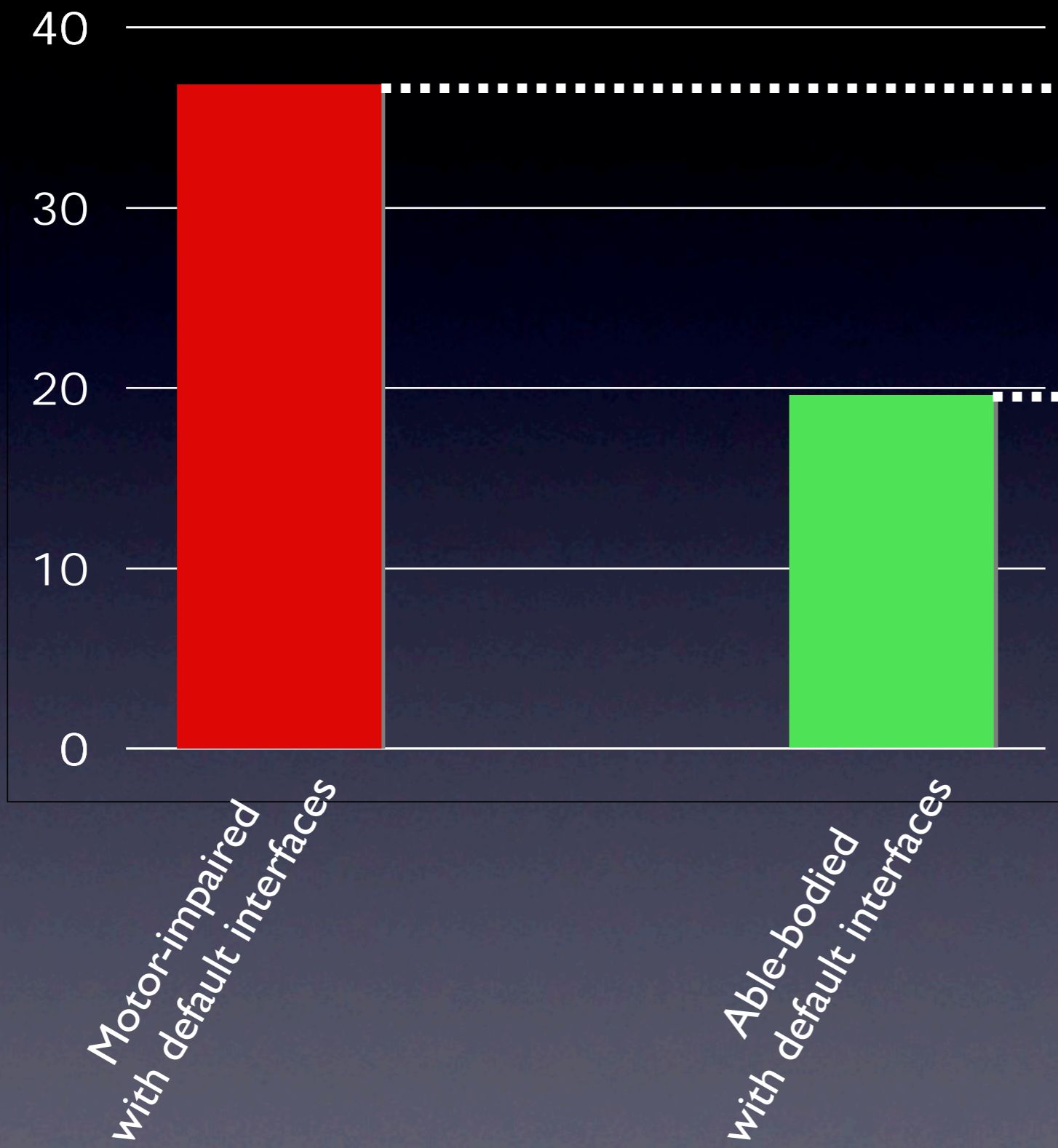


Impaired dexterity



Low strength

# Average Time to Complete a set of tasks

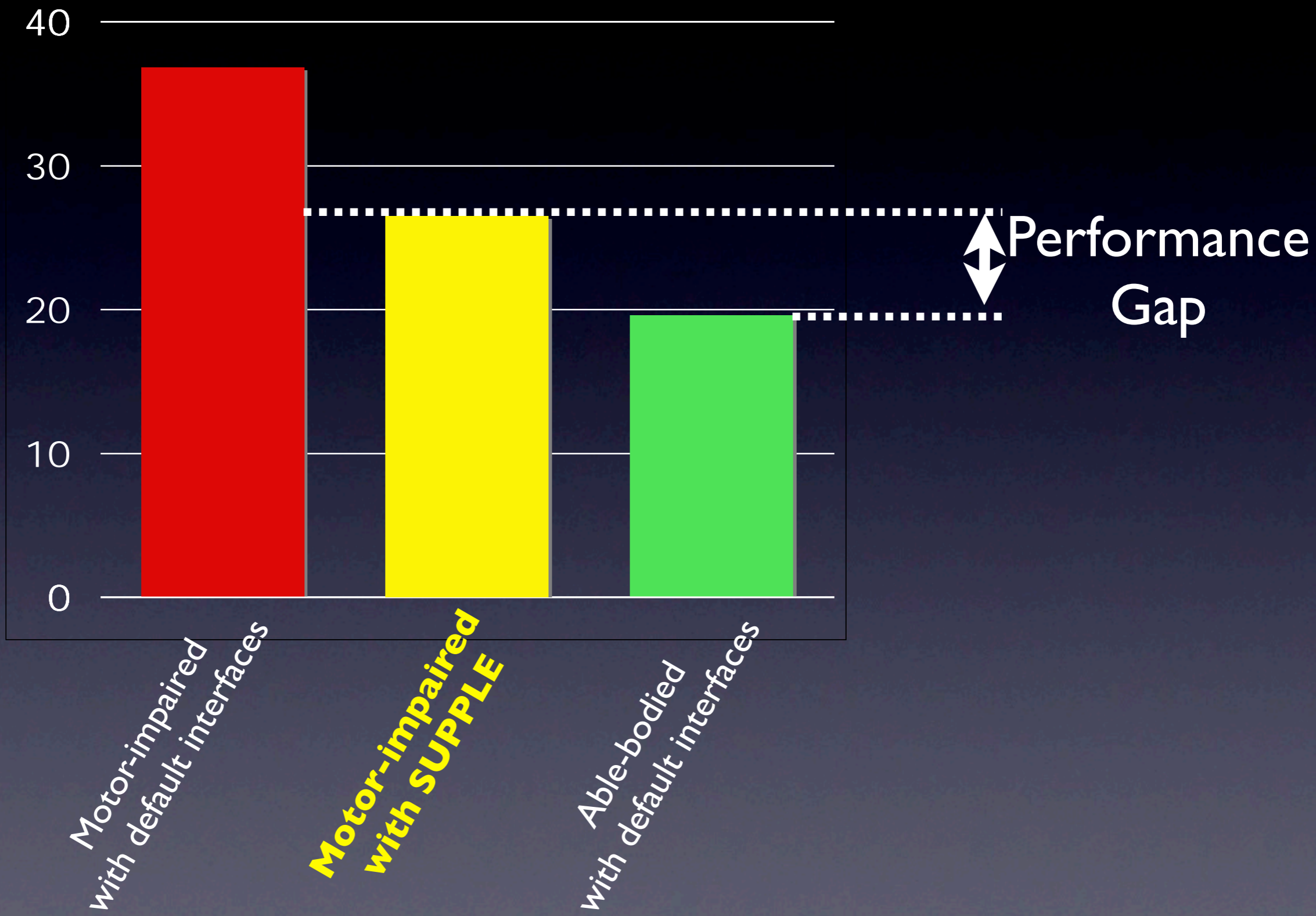


Motor-impaired  
with default interfaces

Able-bodied  
with default interfaces

Performance  
Gap

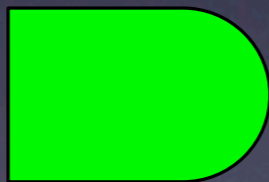
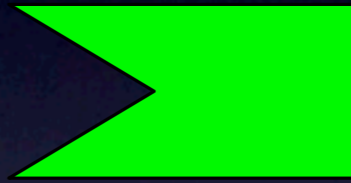
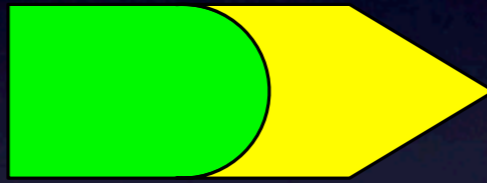
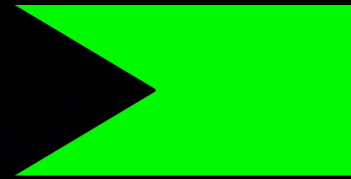
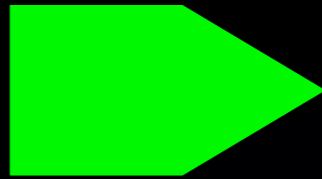
Average Time to Complete  
a set of tasks



# A Vision for a World Without Handicaps

- Interfaces share the burden of adaptation
- Accessibility solutions are **personalized**
- Accessibility solutions are **adaptive**
- Solutions can **scale** to millions of individuals

Interfaces share the  
burden of adaptation



Print  
Printer

Name: Canon Photo  
Status: Idle  
Type: Ink jet  
Where: Printer room

Page range: All (selected), Current Page, Pages  
Copies: Number of copies: 1, Collate (unchecked)

Print Content: Print what: Document, Print: All pages in range  
Zoom: Print what: 1 page, Scale to paper size: No Scaling

Ok Cancel

Print  
Printer

Name: Canon Photo, Epson Stylus, HP Deskjet, Lexmark Inkjet, Xerox Phaser  
Status: Idle  
Type: Ink jet  
Where: Printer room

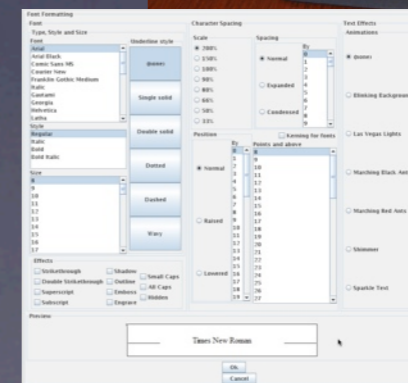
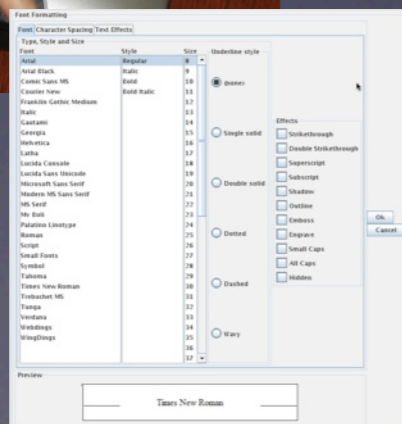
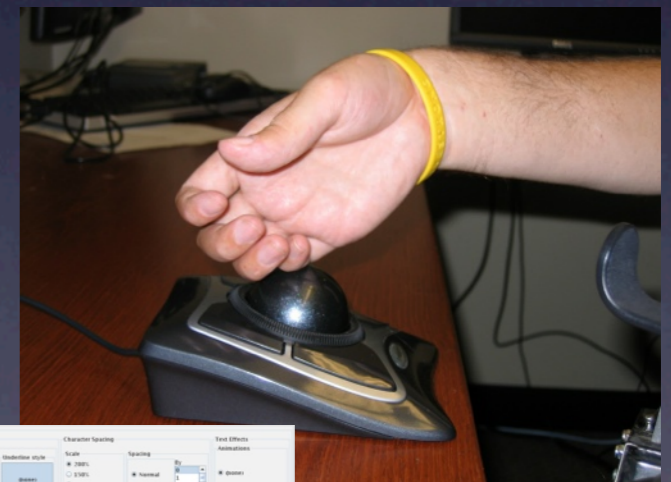
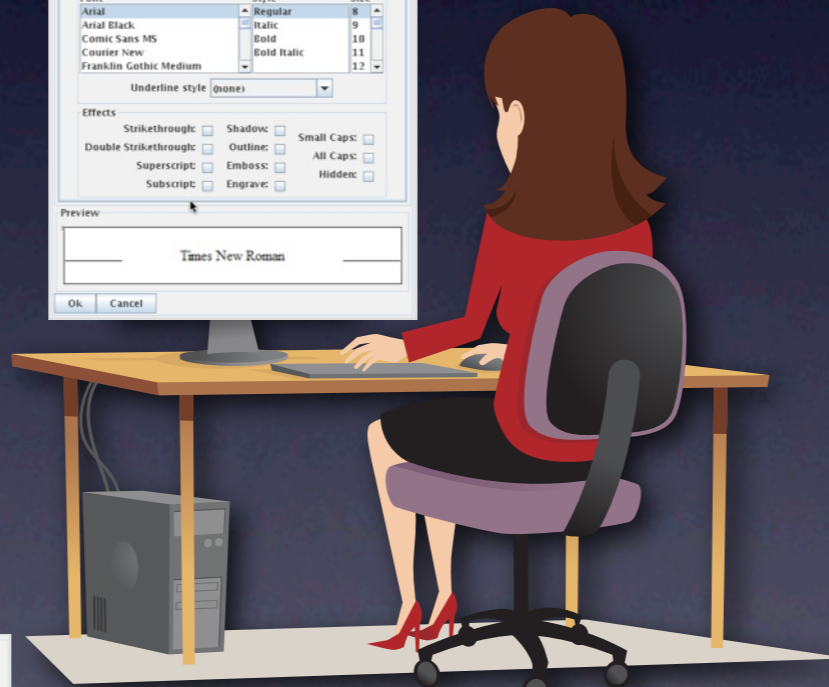
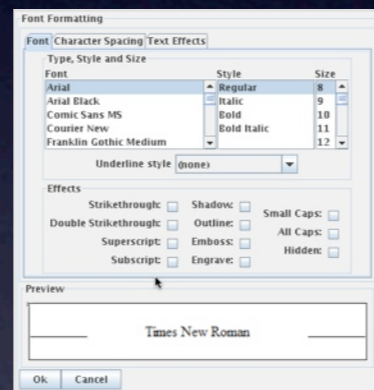
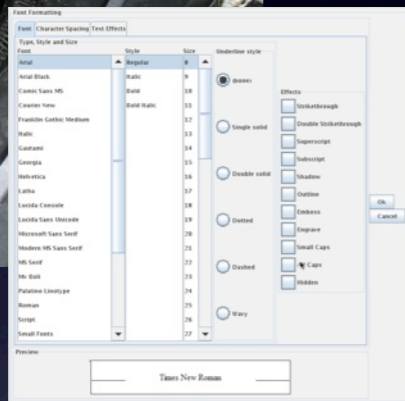
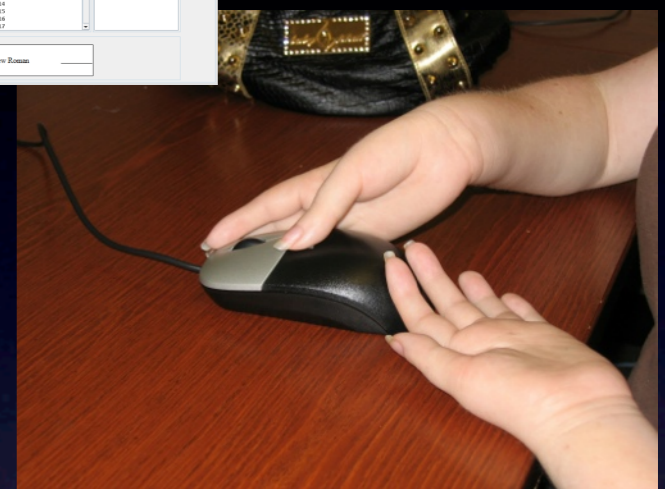
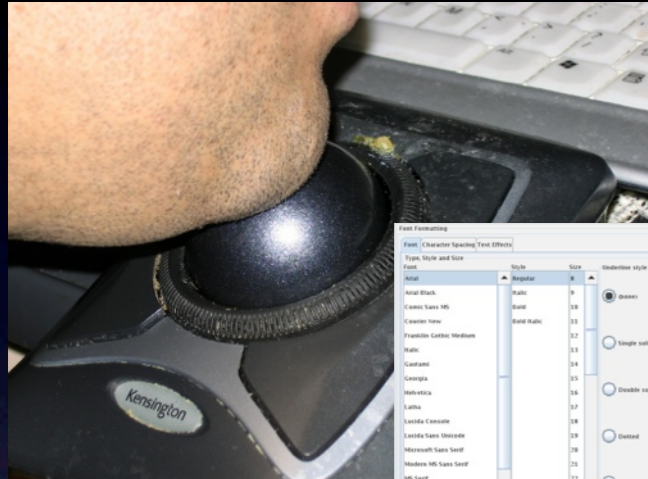
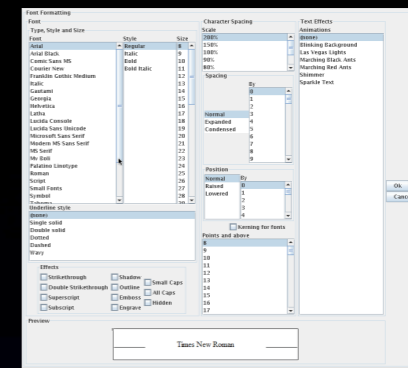
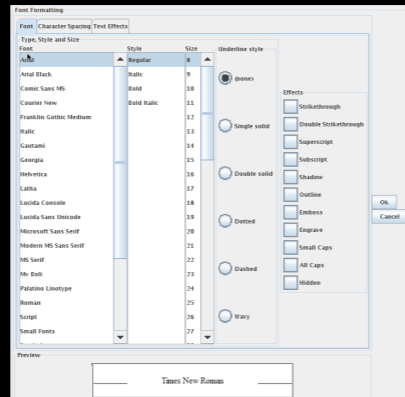
Print to File (unchecked)  
Manual Duplex (unchecked)

Page range: All (selected), Current Page, Pages  
Copies: Number of copies: 1, Collate (unchecked)  
Print Content: Print what: Document, Print: All pages in range (selected), Odd pages, Event pages  
Zoom: Print what: 1 page, 2 pages, 4 pages, 6 pages, 8 pages, 16 pages, Scale to paper size: No Scaling, Letter, Legal, Executive, A4

Ok Cancel







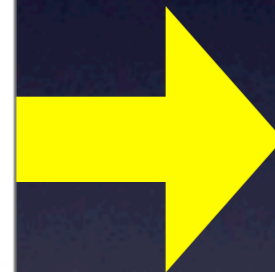
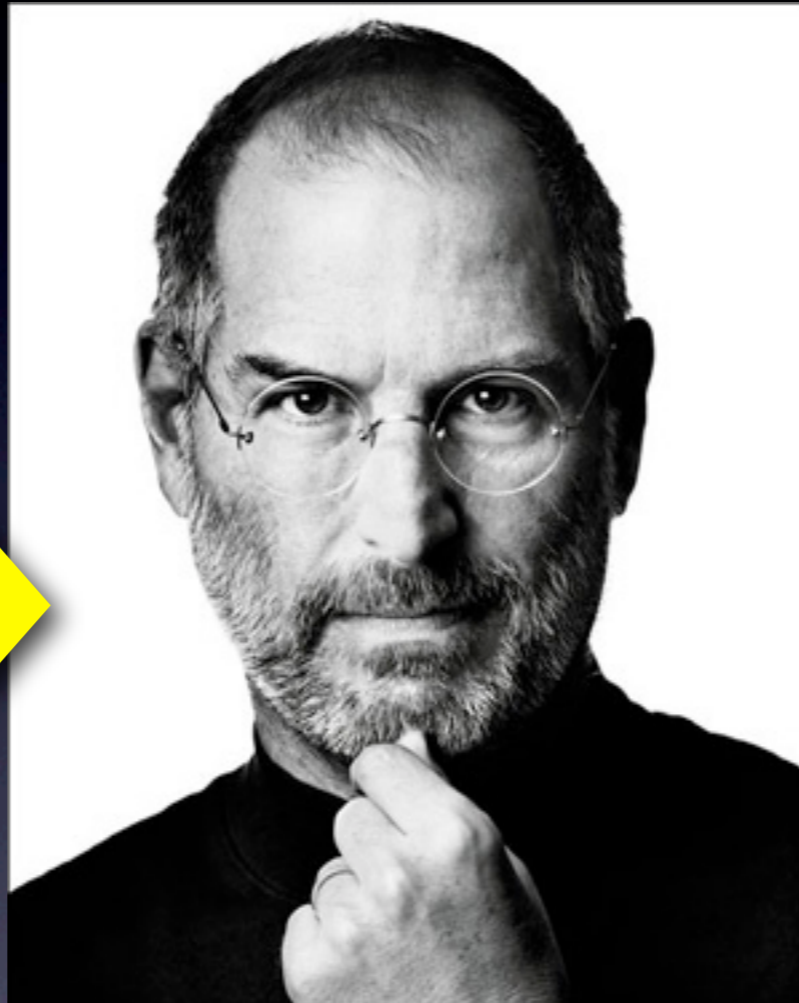
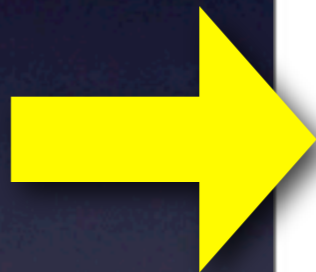
Solutions can **scale** to  
millions of individuals

***DESIGN***



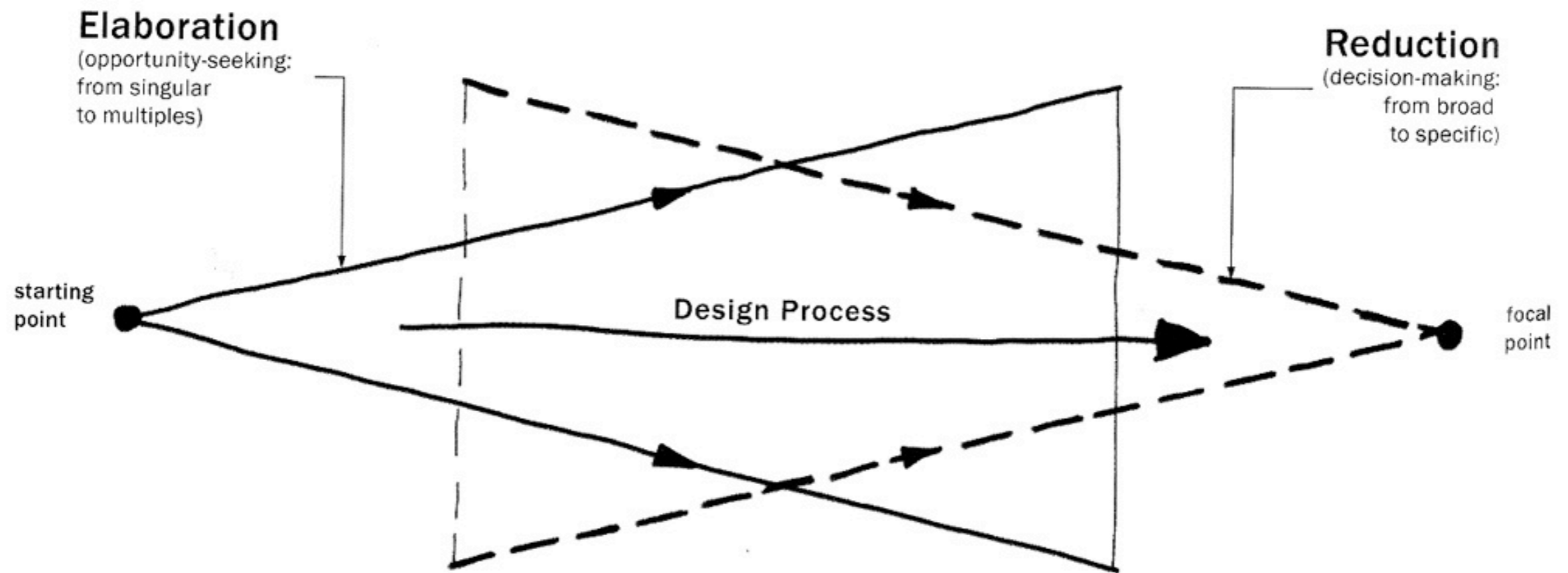
# Design by Genius

Specification



1955 -- 2011

# Design by Exploration



[Buxton, Sketching User Experiences]



Supple: Stereo Example

### Properties

#### Stereo

Power:

Volume



X-Bass:

#### Tape

Mode:  Tape 1

Tape 2

Reverse:

Dolby Noise Reduction:

< Play

Play >

Stop

Pause

Rewnd

FFwd

#### CD



Disc: 1

Track: 1

Play

Stop

Pause

Repeat:

Random:

#### Tuner

<< Seek

Frequency: 89

Seek >>

Band:  FM

AM

# Adaptation to Devices

The image illustrates the adaptation of a classroom control interface to various devices. The main desktop interface includes sections for Light Bank (Left, Center, Right), A/V Controls (Projector, Input, Power), and Vent. Overlaid on this are three mobile device screens: a tablet showing a menu with 'Light Bank', 'A/V Controls', and 'Projector'; a smartphone showing 'Light: <On>' and 'Level: <7>'; and another smartphone showing a 'SELECT' menu with options 6, 7, 8, and 9. A larger inset shows a detailed view of the A/V Controls section with checkboxes for Power and Screen, a dropdown for Input (Computer 1), and radio buttons for Vent (Off, Low, Med, High).



Folders

New Rename Delete Expunge

- Junk-E-Mail
- Unerwünscht
- Unbekannt2
- Deleted Messages
- Events
- INBOX
- Entwurf
- Papierkorb
- Gesendet
- Postausgang

Messages

New Reply Forward Delete Move

- 05.02 12:53 PM Lucy Dunne <lucy.dunne@gmail.com> [Announcements] ISWC 2008: Ca
- 01.02 08:30 AM uwgradevents@u.washington.edu [UWgradevents] Career Events for Gra
- 31.01 05:20 PM Varshavsky Alex <walex@cs.toronto.edu> Pervasive 2008 Late Breakin
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- 26.10 07:50 AM avi2008@cib.na.cnr.it AVI2008:CALL FOR PAPERS
- 29.01 07:22 PM Paul Robertson <paulr@csail.mit.edu> IWSAS merged to form new full c
- 07.06 08:50 PM Fang Chen <Fang.Chen@nicta.com.au> International Conference on Inte
- 04.04 08:29 AM Gulden Uchyigit <gu1@doc.ic.ac.uk> [agents] CFP: Special Issue on Per
- 04.01 06:47 AM P L Olivier <P.L.Olivier@newcastle.ac.uk> Diagrams: CFP: Smart Graphi
- 21.02 12:07 PM khai@cc.gatech.edu [Announcements] PERVASIVE 2005: Extended Work

Details

Details

Senders: khai@cc.gatech.edu  
 Date: Mon Feb 21 12:07:11 PST 2005  
 Recipients: announcements@ubicomp.org  
 Subject: [Announcements] PERVASIVE 2005: Extended Workshop Deadlines, Ad...

Content

<TEXT/PLAIN; charset=us-ascii>

\*\*\*\*\*ADVANCE PROGRAM / REGISTRATION\*\*\*\*\*

The advance program of PERVASIVE 2005 is now online  
<http://www.pervasive.ifi.lmu.de/program.html>

The early registration deadline is March, 14th 2005  
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 Registration for a workshop only is available.

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 opportunity to present your research results in one of  
 the following workshops:

W2:International Workshop on Software Techniques for Embedded  
 and Pervasive Systems (STEPS), 2005  
 (deadline extended to March 1st)  
<http://www.pervasive.ifi.lmu.de/workshop.html#W2>

Configuration

Status: Messages expunged.

Folders

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Junk-E-Mail
Unerwünscht
Unbekannt2
Deleted Messages

Messages

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31.01 05:02 PM Varshavsky Alex <walex@cs.toronto.edu> Pervasive 2008 Late Breakin
26.10.07 50 AM avi2008@cib.na.cnr.it AVI2008: CALL FOR PAPERS

Configuration

Rendering

Configuration

Accounts

Web.de IMAP
UW IMAP
Web.de POP3
.Mac (kgajos)
Fastmail

Details

Details

Account Details

Account Name: Web.de IMAP
Reply Address: supple@web.de
From Address: supple@web.de

Incoming Server

Protocol: imap
Encrypted:
Server: imap.web.de
User: supple
Password:

Outgoing Server

Authentication:
Encrypted:
Server: [#text: smtp.web.de
User: supple
Password:

Add Account Remove Account Save Switch to Account

Configuration

Status: Messages expunged.

AS merged to form new full c
ernational Conference on Inte
nts) CFP: Special Issue on Per
Diagrams: CFP: Smart Graphi
ASIVE 2005: Extended Work

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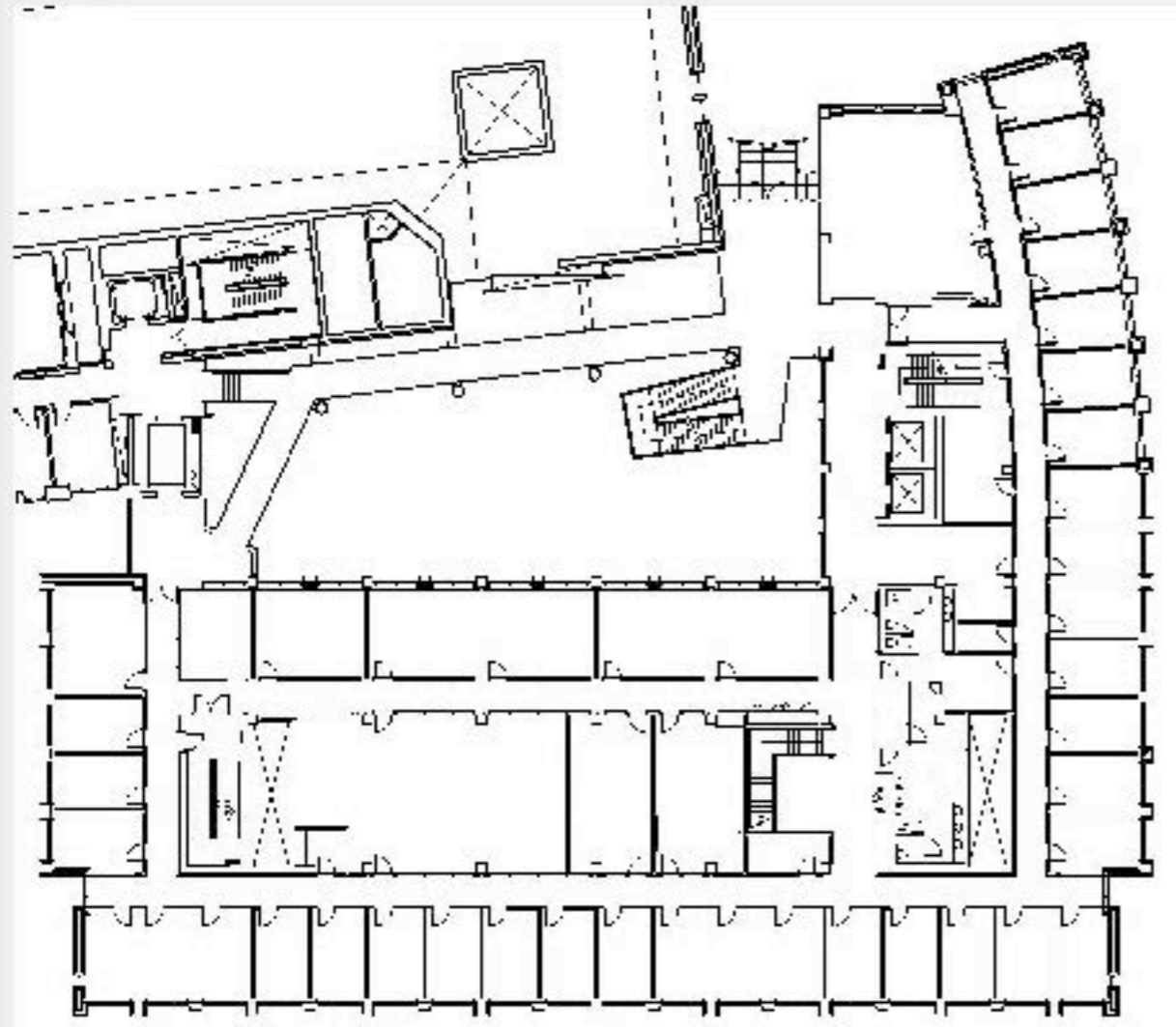
W2:International Workshop on Software Techniques for Embedded and Pervasive Systems (STEPS), 2005  
(deadline extended to March 1st)  
<http://www.pervasive.ifi.lmu.de/workshop.html#W2>

W3:PerGames 2005: Second International Workshop on Pervasive Gaming Applications

## Map Demo

Pick a location

The Map



Location: (824.0,240.0)

Info

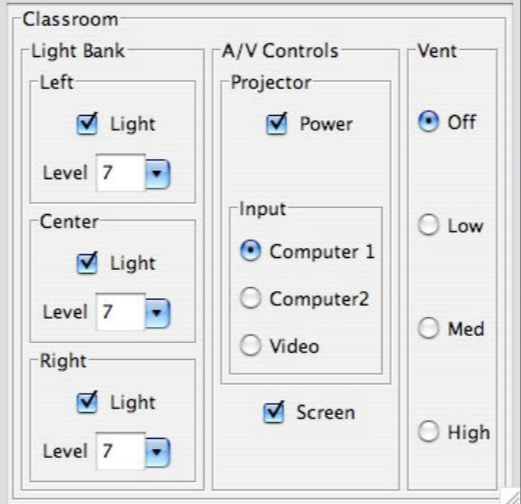
Photo

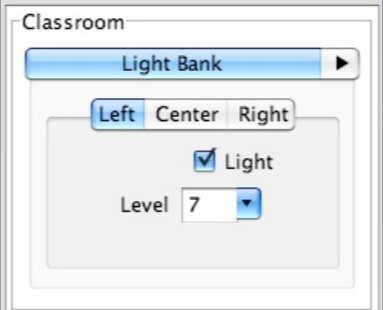


Name: Dan  
Office: 588

Accessibility solutions  
are **personalized**

# Evaluating Success

$$\text{cost}(\text{Classroom}) = 4$$
A screenshot of a software control panel titled "Classroom". It is divided into three main sections: "Light Bank", "A/V Controls", and "Vent". The "Light Bank" section has three sub-sections: "Left", "Center", and "Right". Each sub-section contains a checked "Light" checkbox and a "Level 7" dropdown menu. The "A/V Controls" section has a "Projector" sub-section with a checked "Power" checkbox, and an "Input" sub-section with radio buttons for "Computer 1" (selected), "Computer2", and "Video". Below the "Input" sub-section is a checked "Screen" checkbox. The "Vent" section has three radio buttons: "Off" (selected), "Low", and "Med".

$$\text{cost}(\text{Light Bank}) = 12$$
A screenshot of a software control panel titled "Classroom". It features a "Light Bank" section with a dropdown menu currently set to "Light Bank". Below this are three tabs: "Left", "Center", and "Right". The "Left" tab is selected, and within it, there is a checked "Light" checkbox and a "Level 7" dropdown menu.

# Concerns in UI Design

- Perceptual effort
- Cognitive effort
- Motor effort
- Aesthetics

# Concerns in UI Design

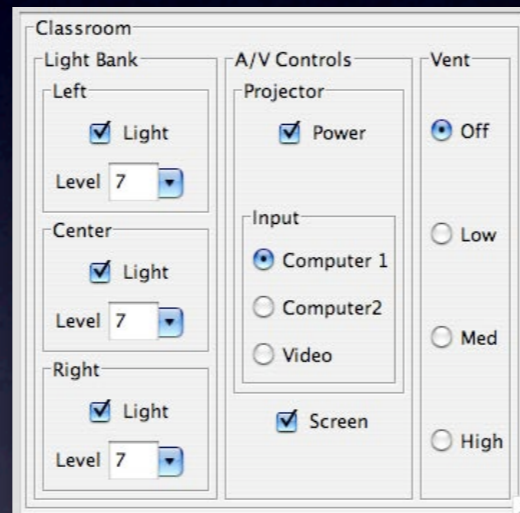
- Perceptual effort
- Cognitive effort
- **Motor effort**
- Aesthetics





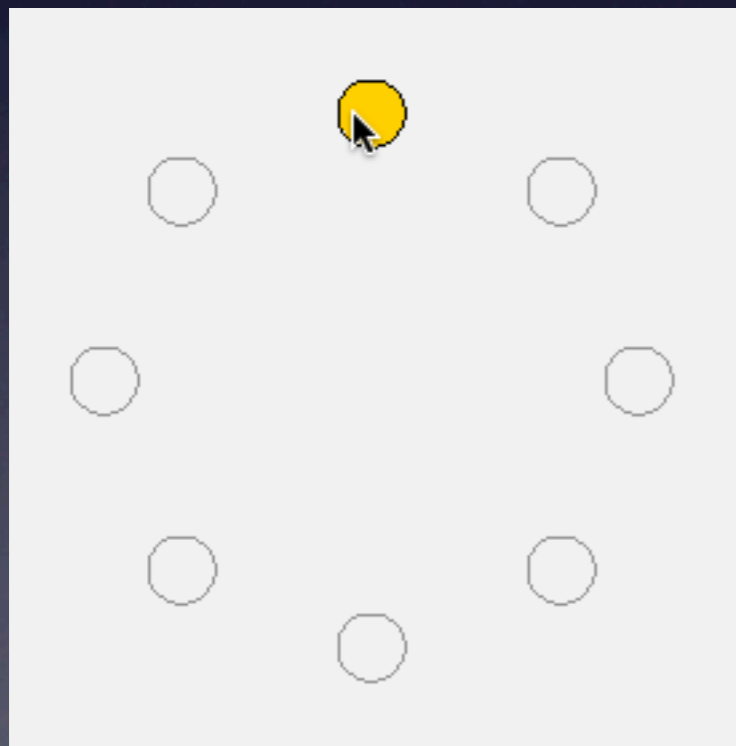
# Adapting to Motor Abilities

cost( ) = time

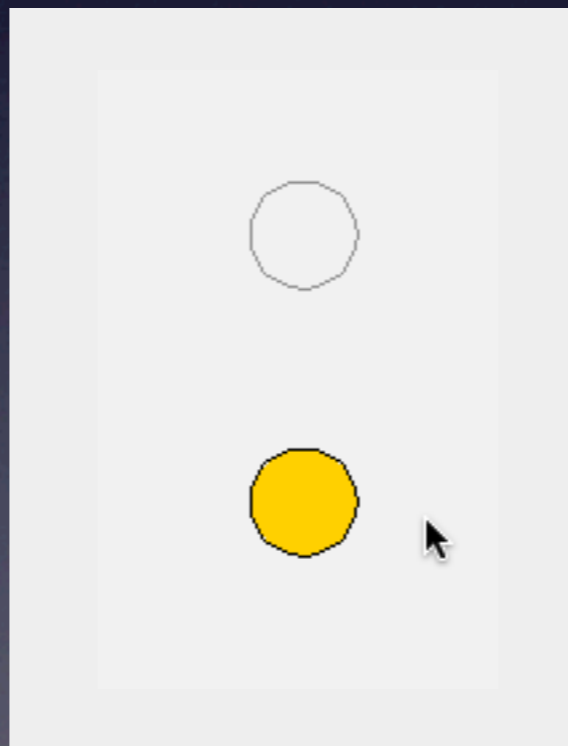


# Collect Motor Performance Data

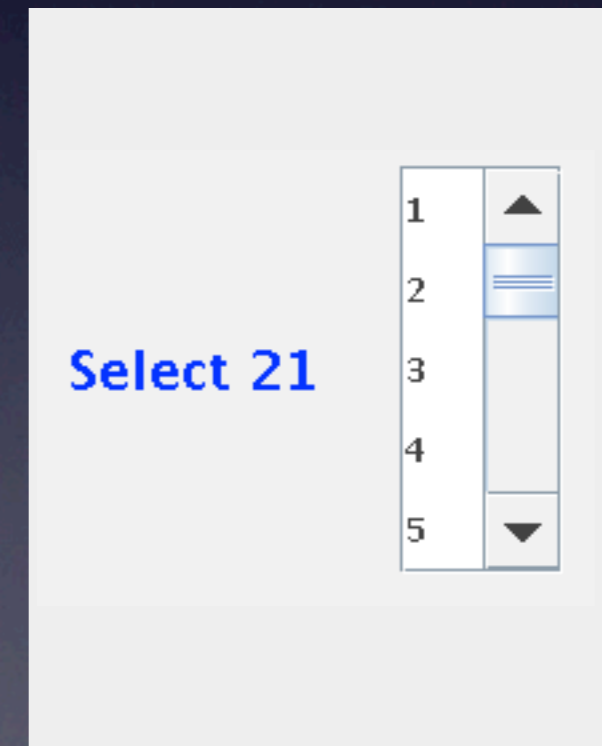
Pointing



Dragging



List Selection



Accessibility solutions  
are **adaptive**



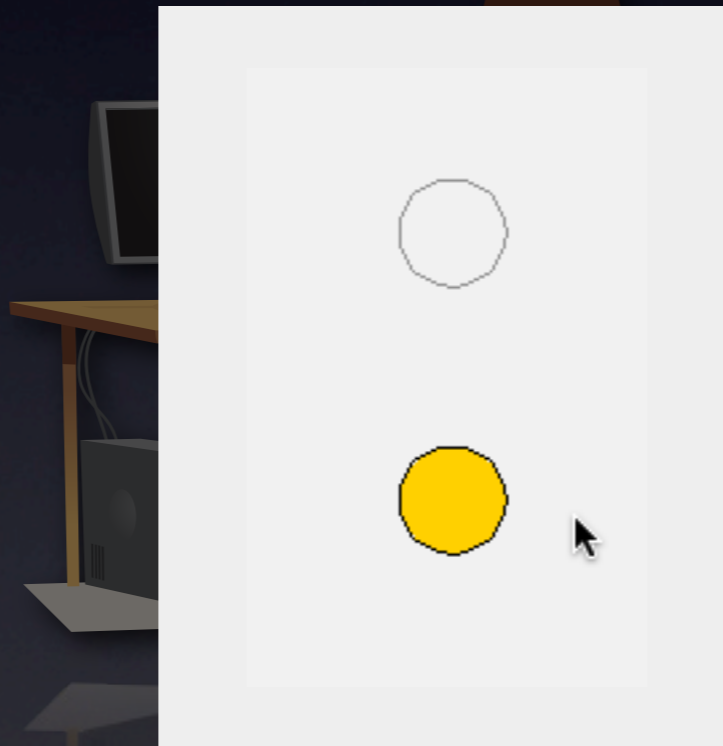
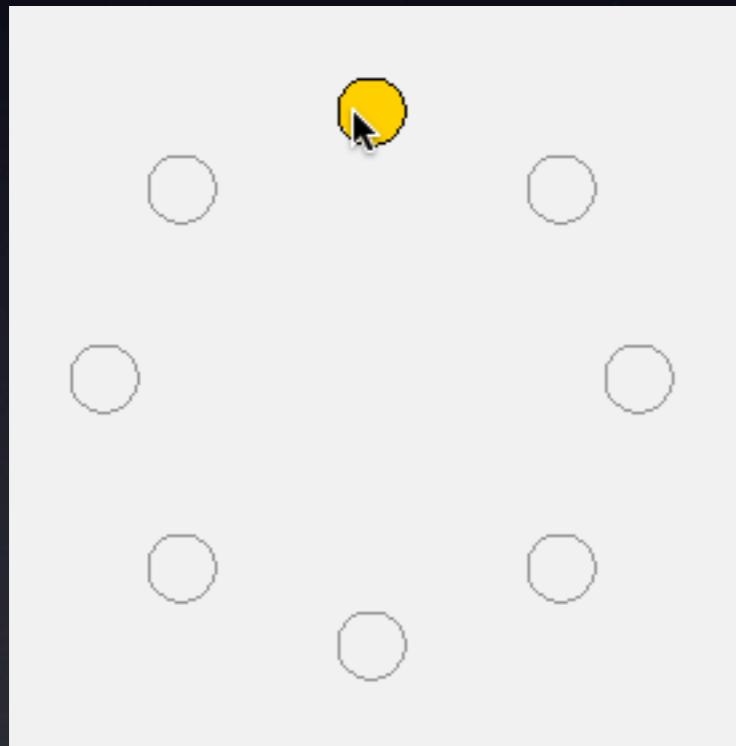
Pointing



Dragging

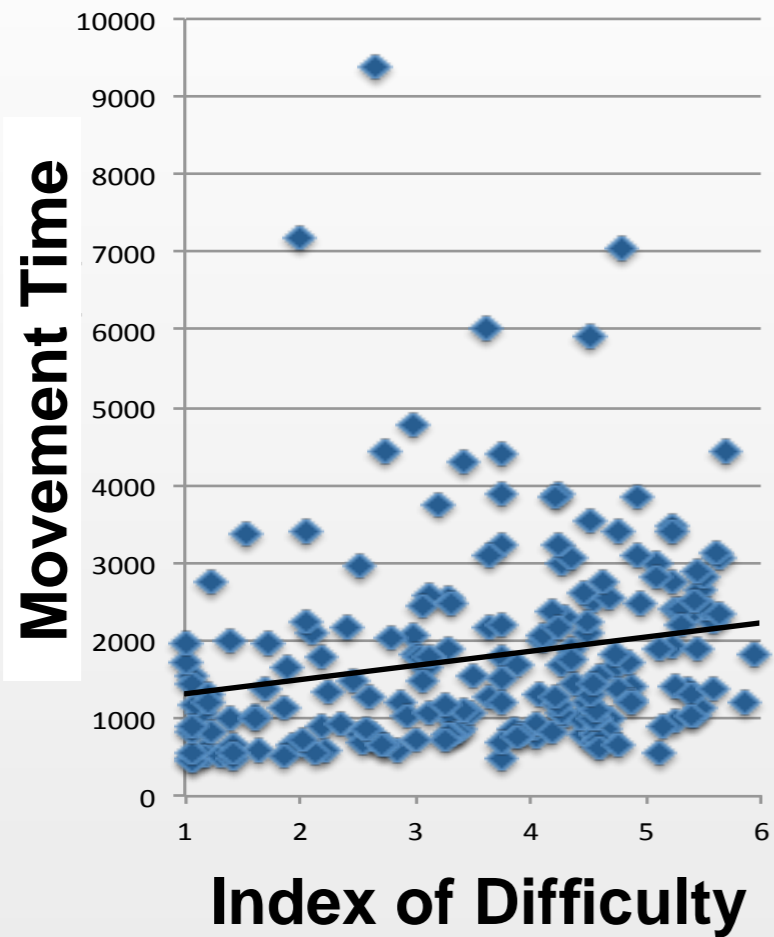


List Selection



# What we get in the wild

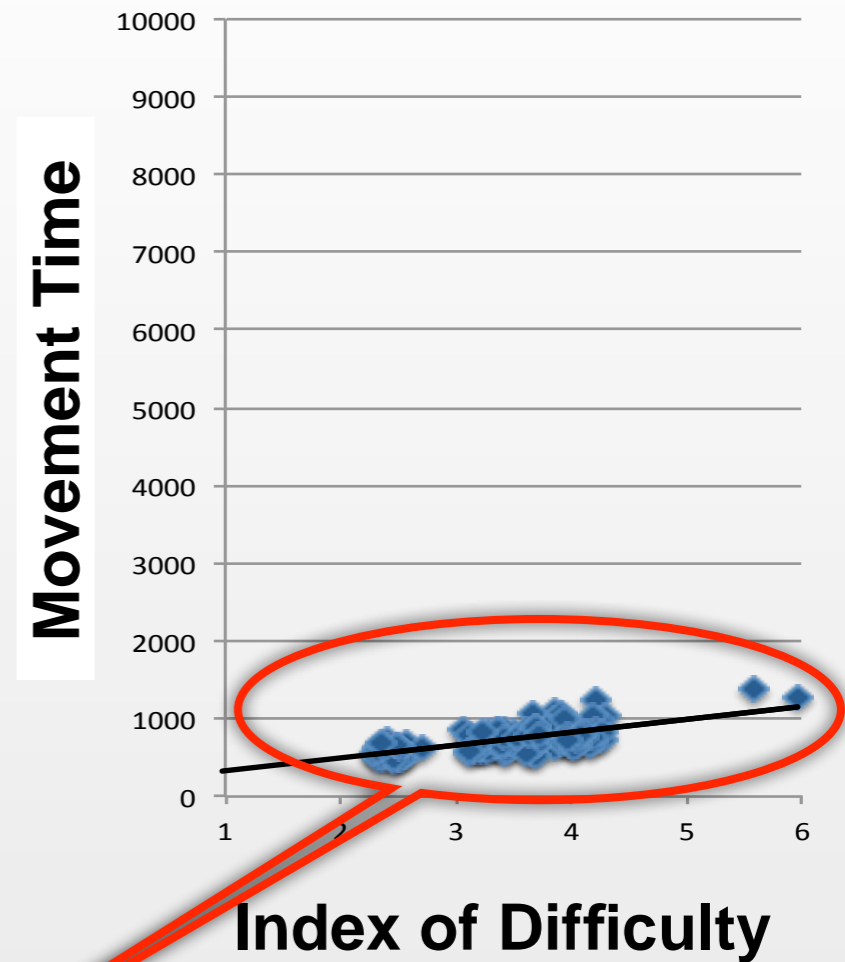
## In Situ Observations



≠

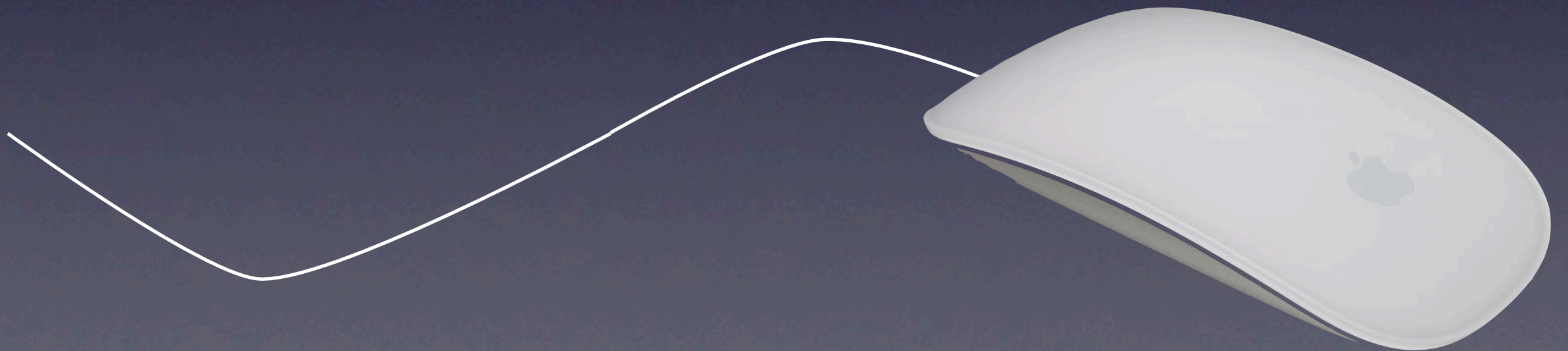
# What we want

## In Lab Observations



Deliberate, targeted movements

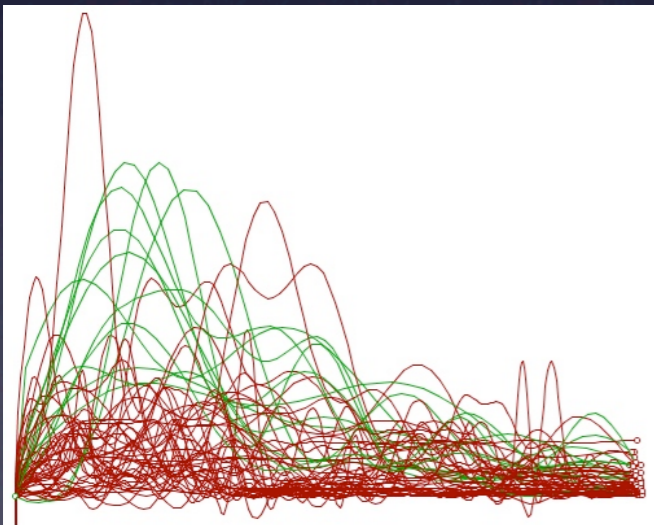
Deliberate,  
targeted  
movement?



# A Data-Driven Approach



Data from a formal experiment

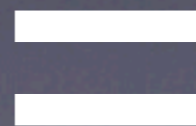


Data from in situ observations



[Elkan & Noto, KDD'08]

= classifier

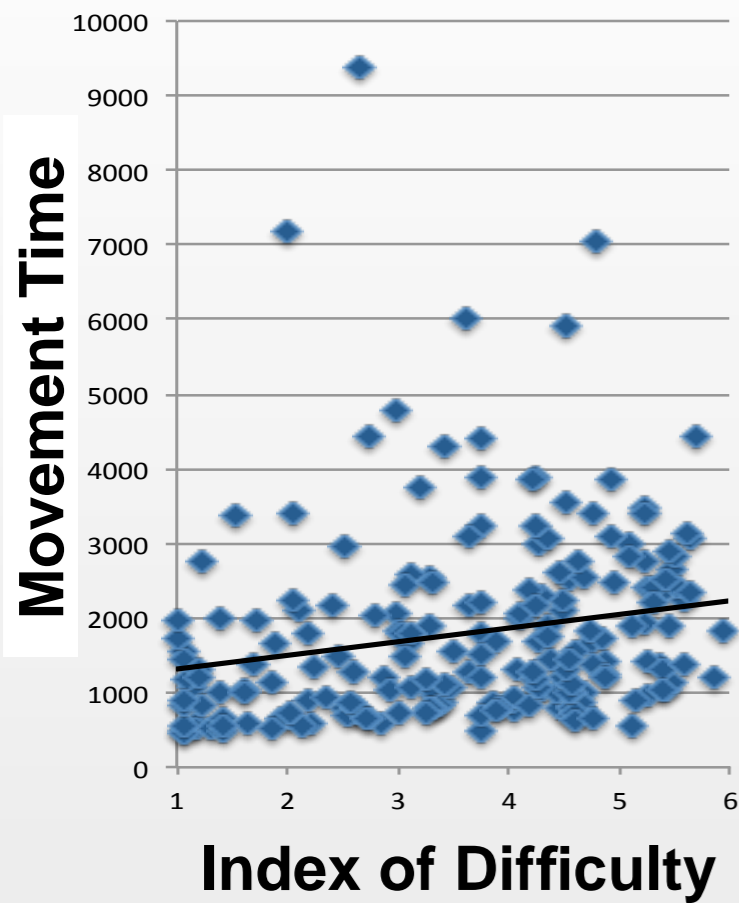


Mix of unlabeled +ve and -ve examples



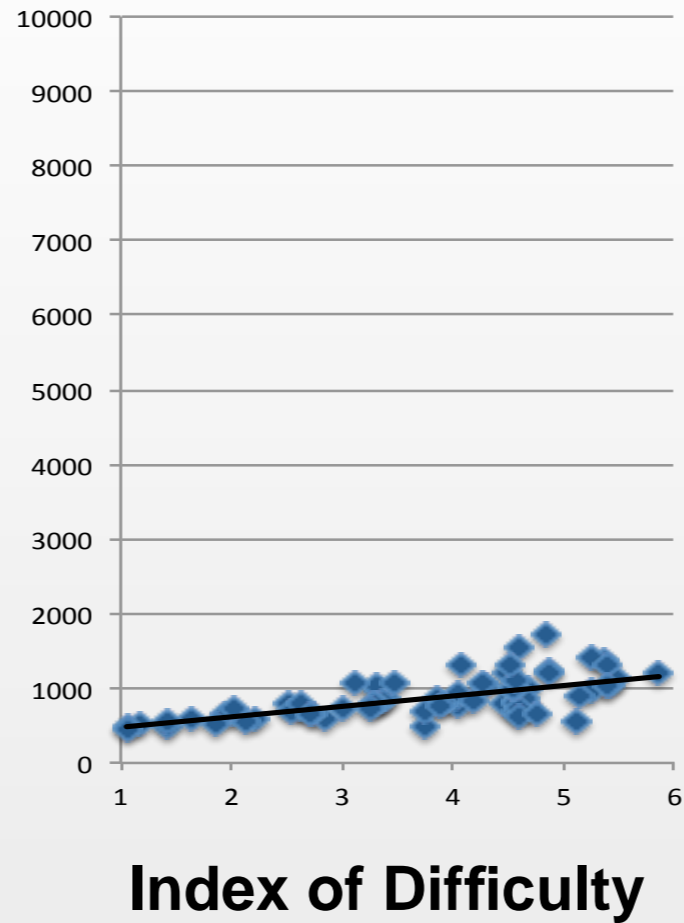
# Results

### In Situ Observations

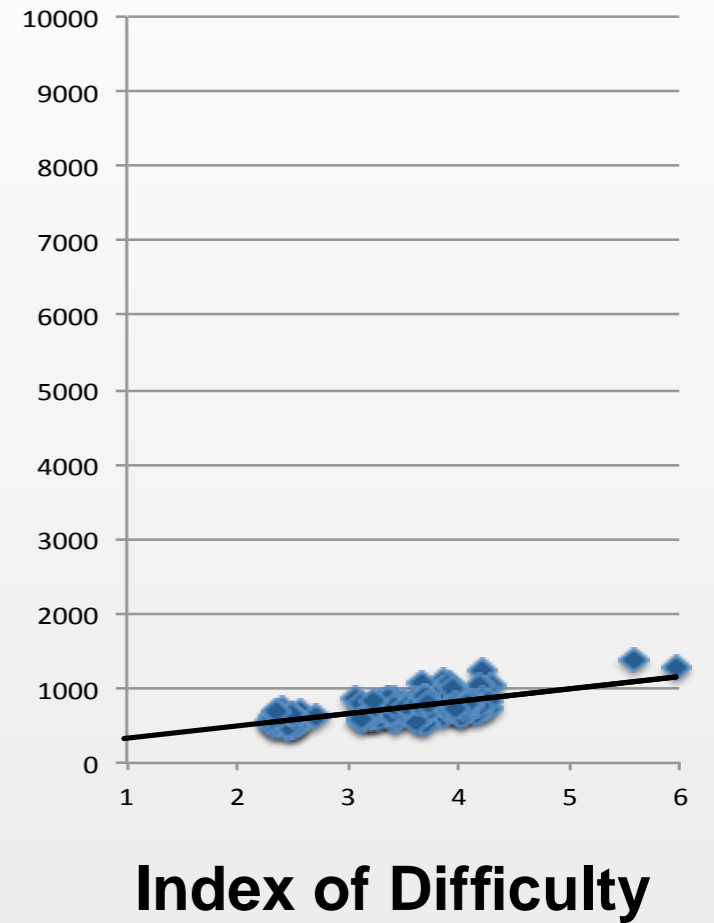


filter

### In Situ Observations Filtered

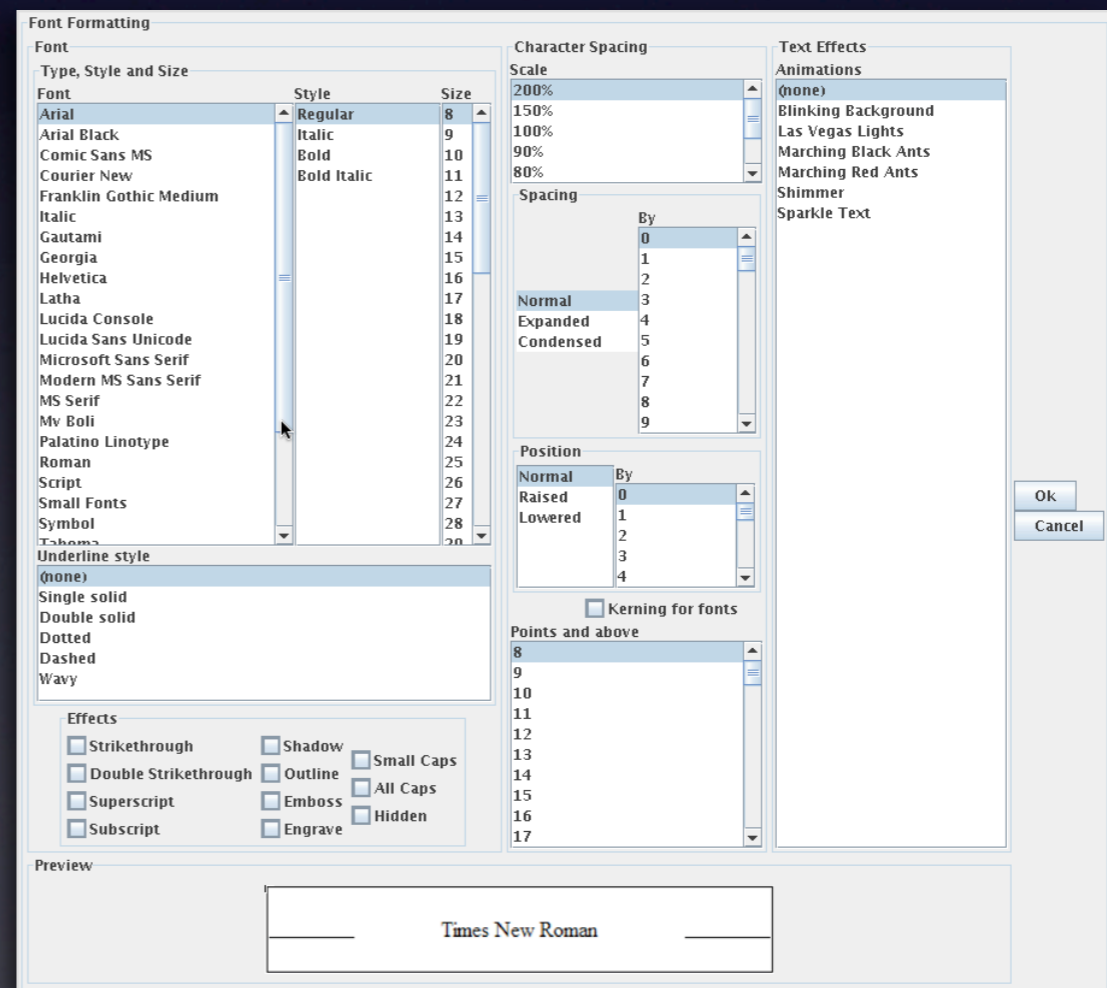
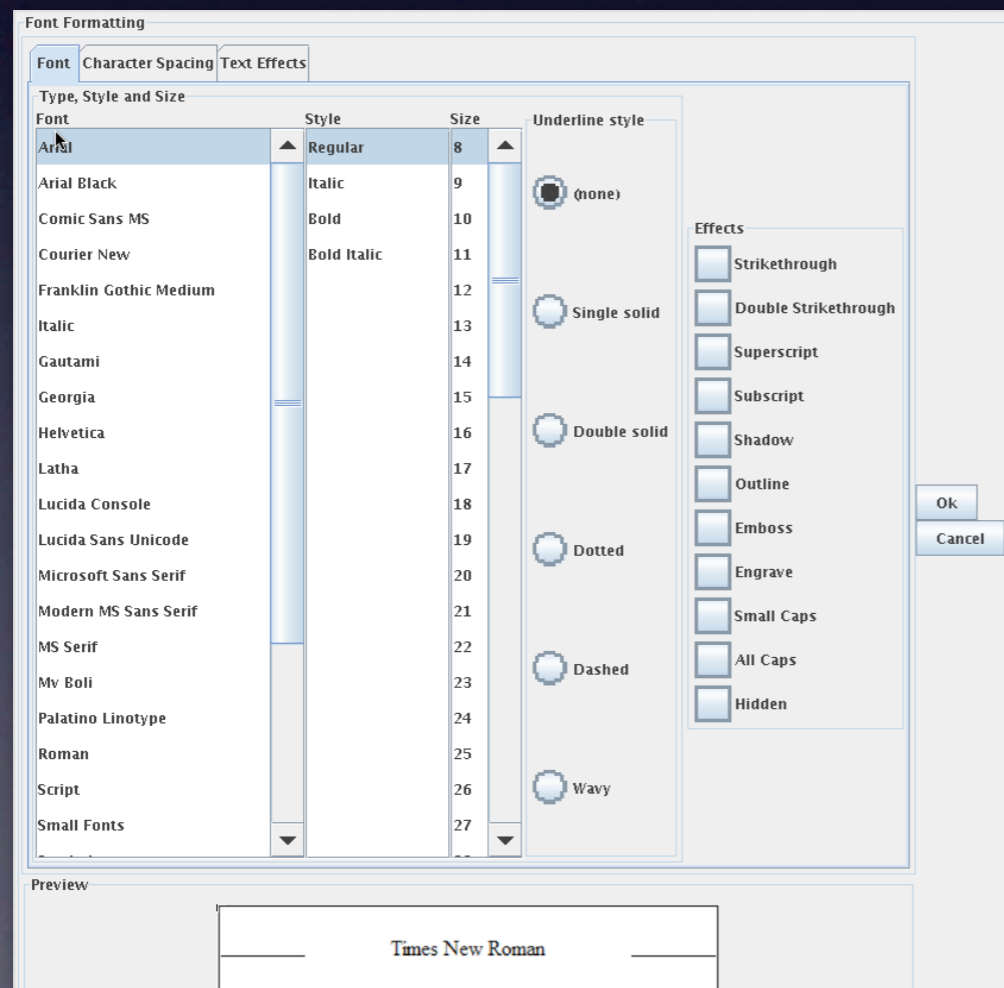


### In Lab Observations



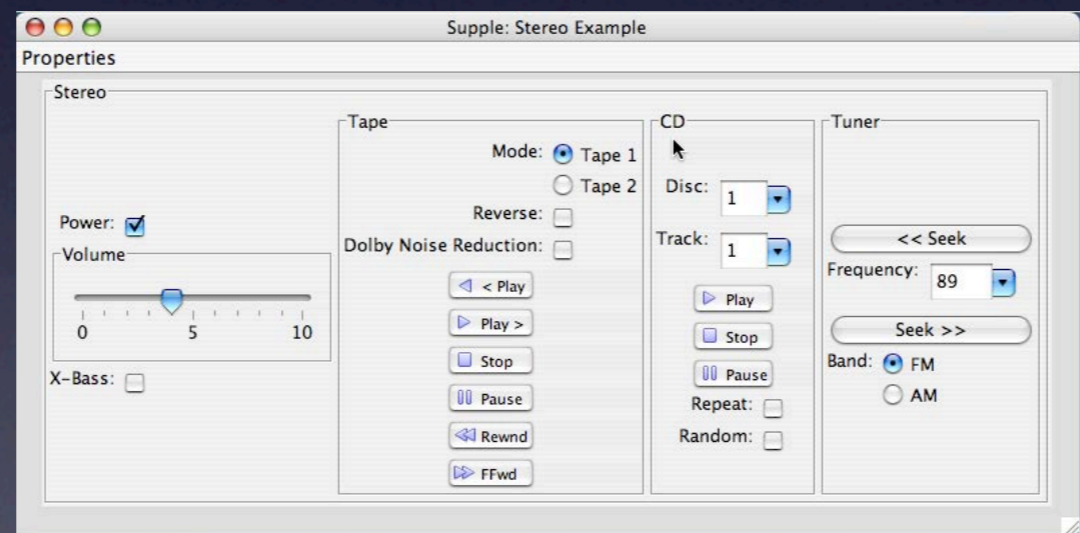
# A Vision for a World Without Handicaps

- Interfaces share the burden of adaptation



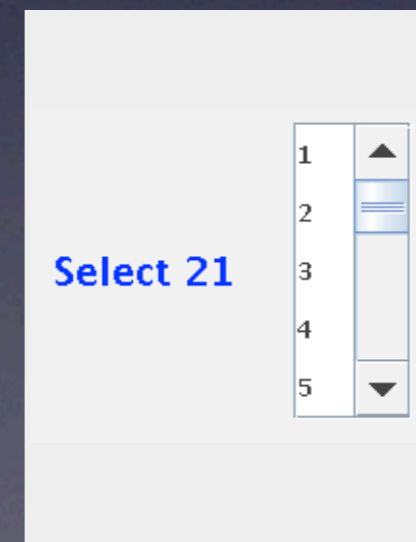
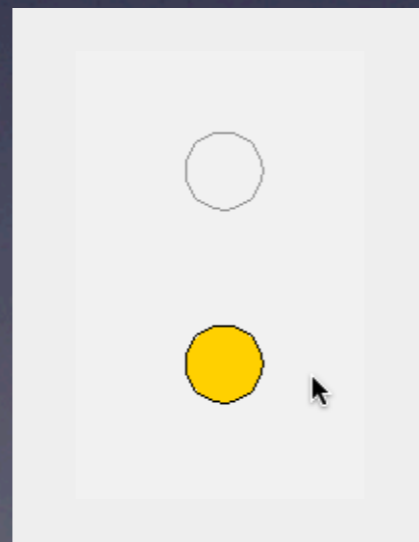
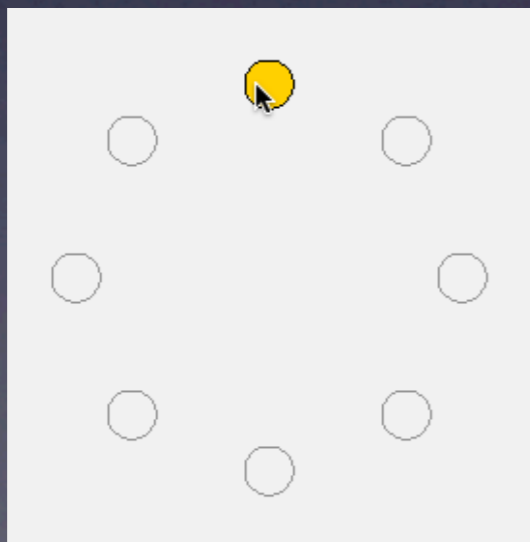
# A Vision for a World Without Handicaps

- Interfaces share the burden of adaptation
- Solutions can **scale** to millions of individuals



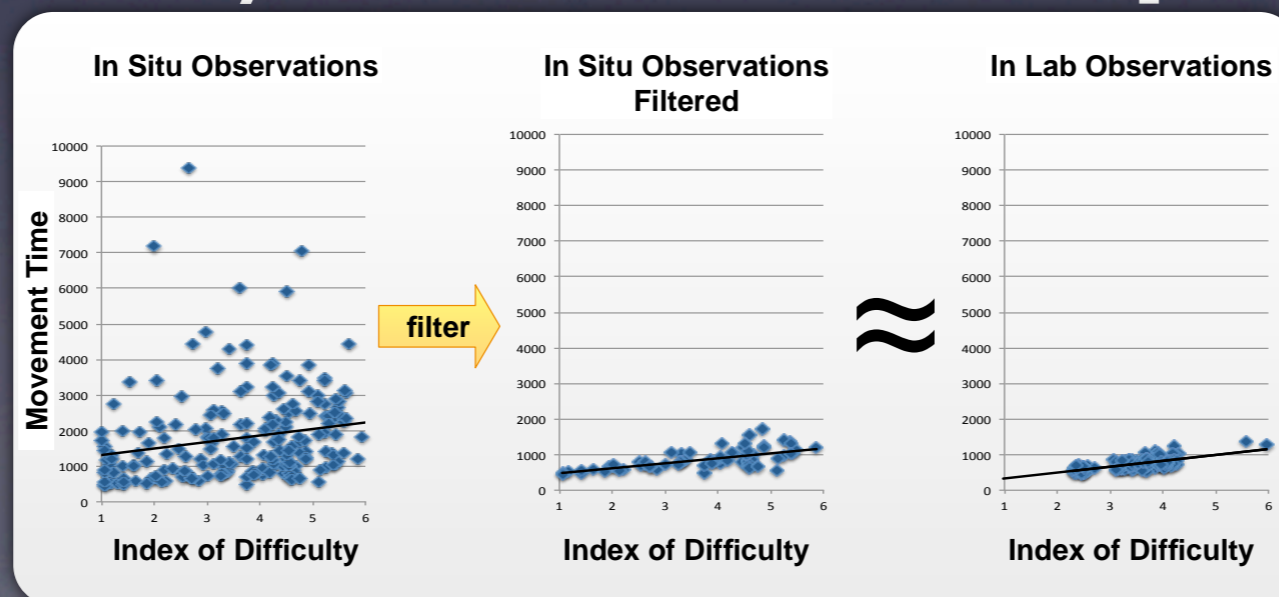
# A Vision for a World Without Handicaps

- Interfaces share the burden of adaptation
- Solutions can **scale** to millions of individuals
- Accessibility solutions are **personalized**



# A Vision for a World Without Handicaps

- Interfaces share the burden of adaptation
- Solutions can **scale** to millions of individuals
- Accessibility solutions are **personalized**
- Accessibility solutions are **adaptive**



How Else Can We Make  
The Design Process Scale?