

# Fast And Robust Interface Generation for Ubiquitous Applications

**The SUPPLE Project**

*University of Washington, Seattle*

Krzysztof Gajos, David Christianson,  
Raphael Hoffmann, Tal Shaked, Kiera Henning,  
Jing Jing Long, and Daniel S. Weld

Automatic, On The Fly  
Fast And Robust Interface  
Generation for Ubiquitous  
Applications

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# Motivation



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⇒ Adapt to **device characteristics**



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- Current interfaces: complex & “One size fits all”  
⇒ Adapt to **users** and **tasks**

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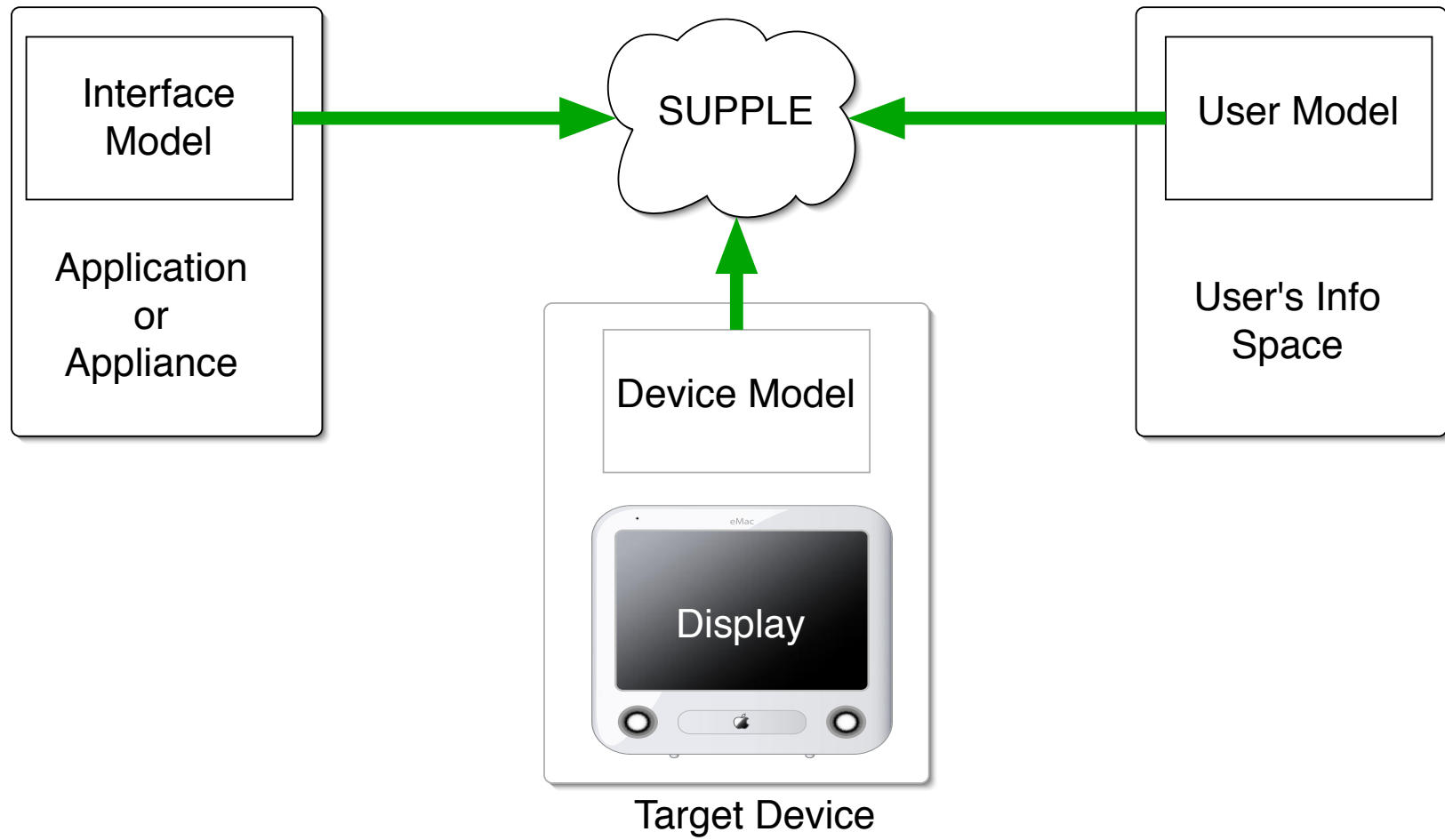
- Variety of display devices & interaction contexts makes hand-designed interfaces expensive
  - ⇒ Adapt to **device characteristics**
- Current interfaces: complex & “One size fits all”
  - ⇒ Adapt to **users** and **tasks**

⇒ Automatic interface generation is a scalable solution

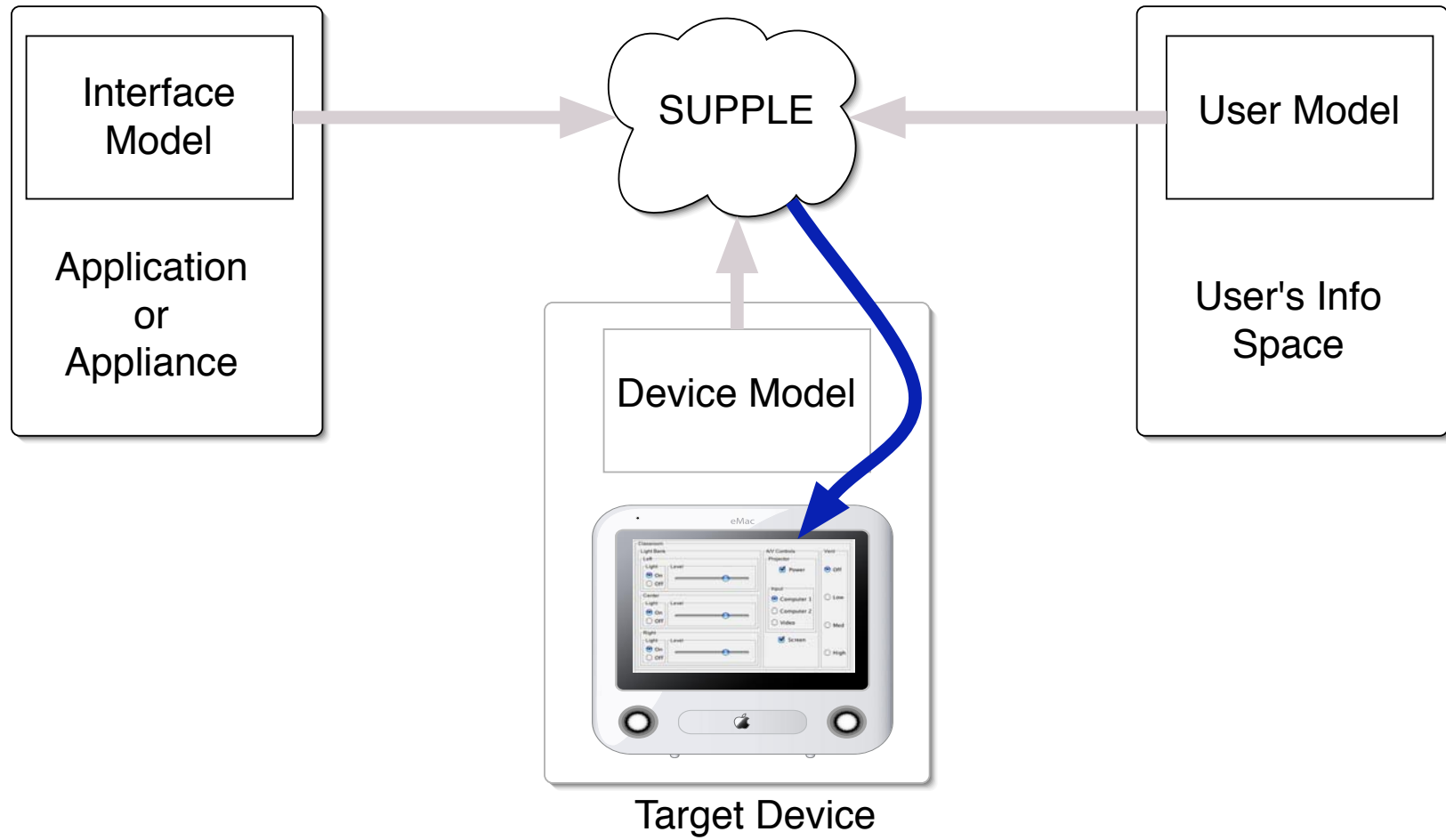
# Approach

- Develop abstract representation for:
  - Interfaces
  - Display devices
  - Users
- Automatically generate interfaces from the abstractions

# SUPPLE Architecture



# SUPPLE Architecture



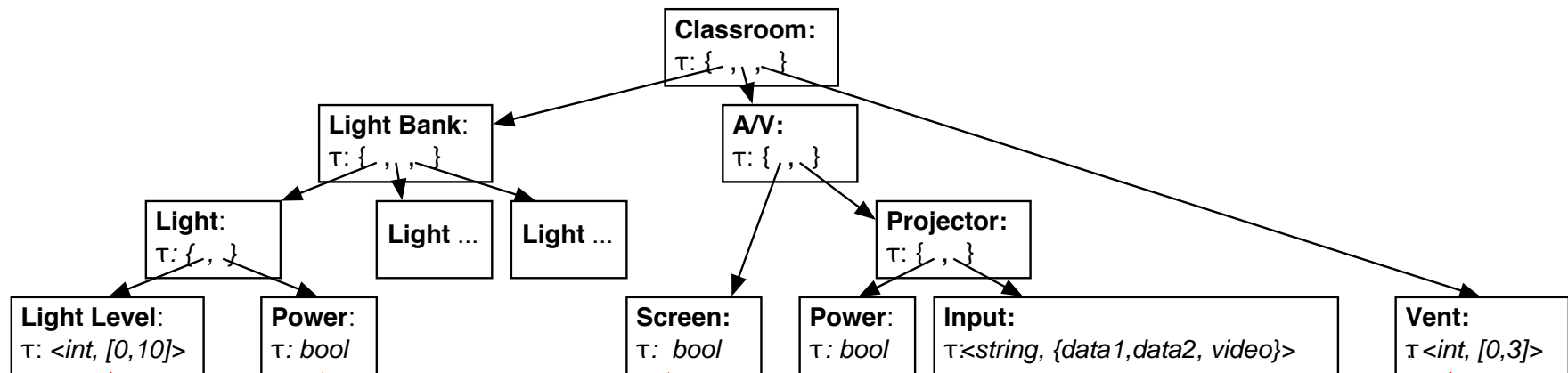
# Road Map

- Motivation
- Modeling user interfaces in SUPPLE
- User interface generation as optimization
- Automatically adapting user interfaces
  - A preliminary user study
  - Adaptation in SUPPLE
- Customization support in SUPPLE
- Conclusions

# Modeling User Interfaces

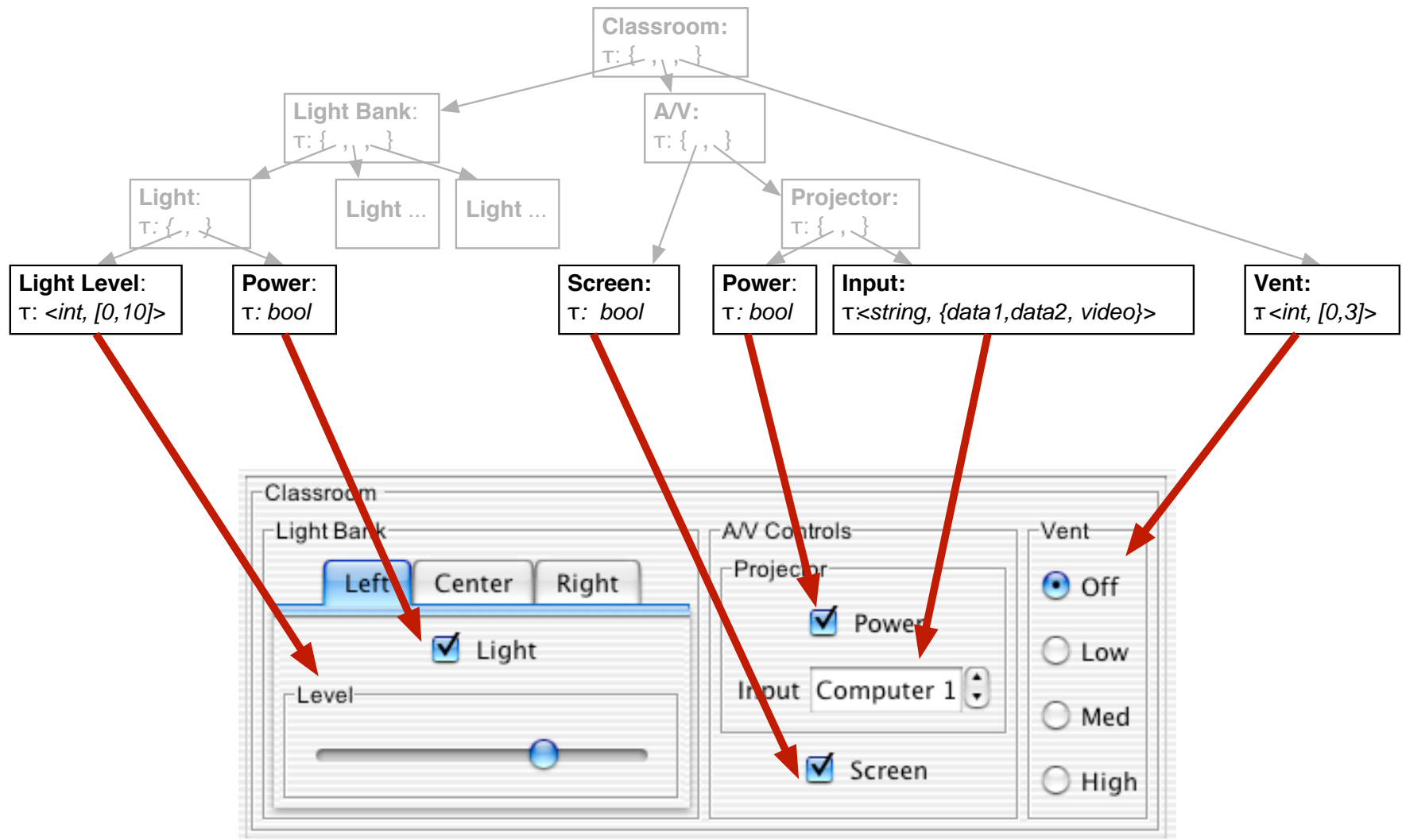
- simple types: `int|float|string|bool`
- media types: `image|interactiveMap`
- containers:  $\{\tau_i^{i \in 1 \dots n}\}$
- derivative types:  $\langle \tau, \mathcal{C}_\tau \rangle$
- vectors: `vector( $\tau$ )`
- actions:  $\tau_1 \rightarrow \tau_2$

# Modeling User Interfaces

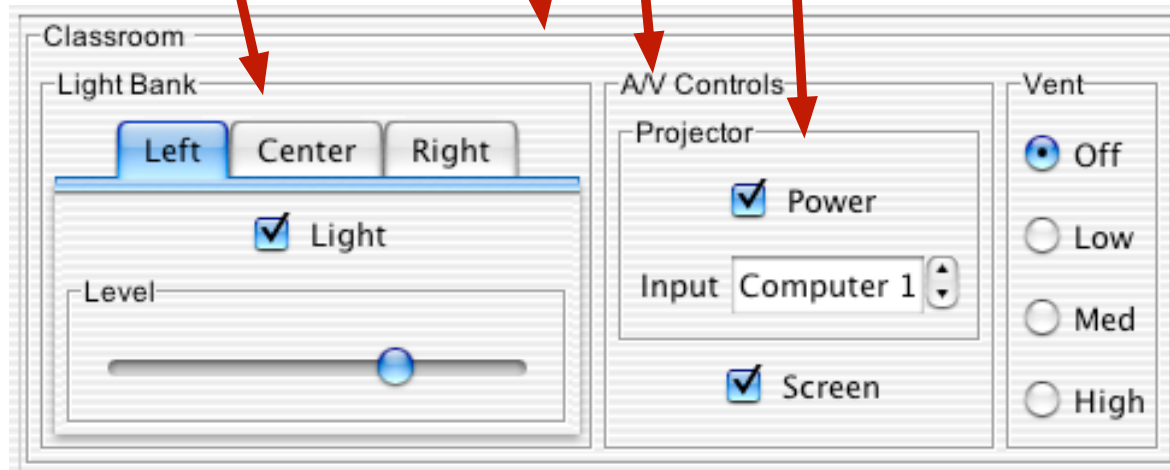
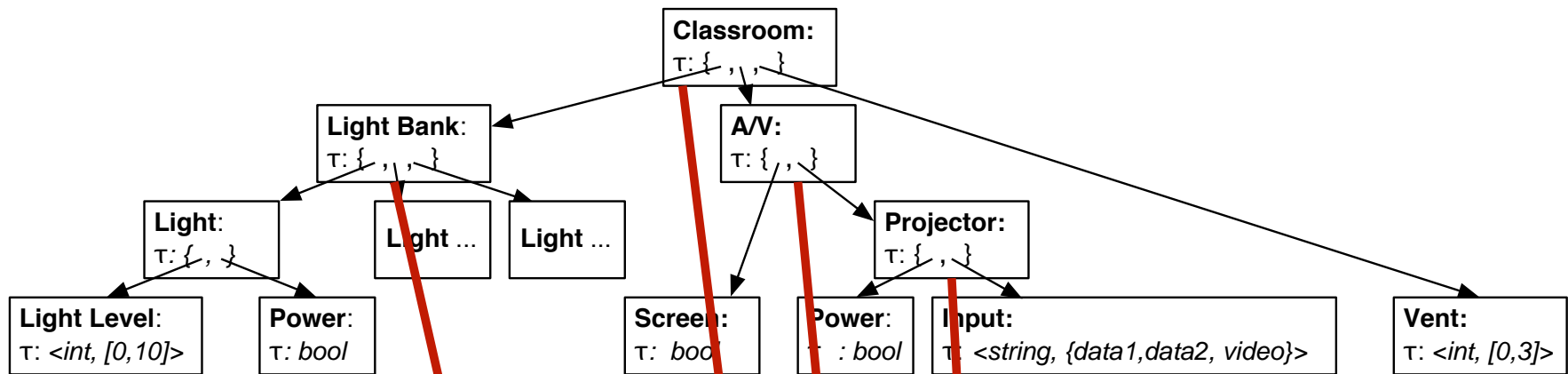




# Modeling User Interfaces



# Modeling User Interfaces



### Properties

#### Folders

- New Folder
- Junk-E-Mail
- New Folder 1
- New Folder 2
- Unerwünscht**
- Unbekannt
- INBOX
- Entwurf
- Papierkorb
- Gesendet
- Postausgang

- New
- Rename
- Delete
- Expunge

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Configuration

#### Messages

- 25.04 04:40 PM NOLP Gartner <NOLP@FREEZE@BIDEWELL.COM>
- 25.04 05:36 AM Suzette Schulz <CHWIZOKAIVQ@ADSVISION.COM> Sandy, check it out
- \* 25.04 05:25 AM Elsie Bassett <BECEZKRWTRH@ACCESSIBLEINFO.COM> No Obliiii gation
- \* 24.04 10:00 PM Fred Pace <jbibktyesnamt@beveragebooks.com> Professional Loans w
- \* 24.04 02:36 PM OEM on Sale <zvrjhn@hurting.com> Get 96% Dis.counted OEM Microsc
- 24.04 06:01 AM Stephen Hood <Vern@be-lax.com> What do you think
- 24.04 04:35 AM Vito Aguirre <Guidry@ilovethemovies.com> Lose it
- 24.04 03:19 AM Meghan <hwdwysowbypek@jornaldiario.com> Swiss meds
- 24.04 02:42 AM Perdue <HMHTV@merseymail.com> , who do u want 2 win?
- 23.04 04:42 PM Thekla Upchurch <mira53.mcclimons@freemail.com.ua> Heisse News**
- 23.04 02:05 PM Anthony Wright <dhsainsyfmvwt@visitweb.com> Hi :D

- New
- Reply
- Forward
- Delete
- Move

#### Details

**Details**

Senders: Thekla Upchurch <mira53.mcclimons@freemail.com.ua>  
Date: 23.04 04:42 PM  
Recipients: Olaf <supple@web.de>  
Subject: Heisse News

**Content**

Flatratesex, für nur 14,99 Euro kannst Du Dir einen monat lang über 200  
Private Livecams  
anschaun, dazu noch unzählige Bilder und Videos, ohne 0190 ohne versteckte  
Kosten.  
Der absolute Hammer !

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Status:

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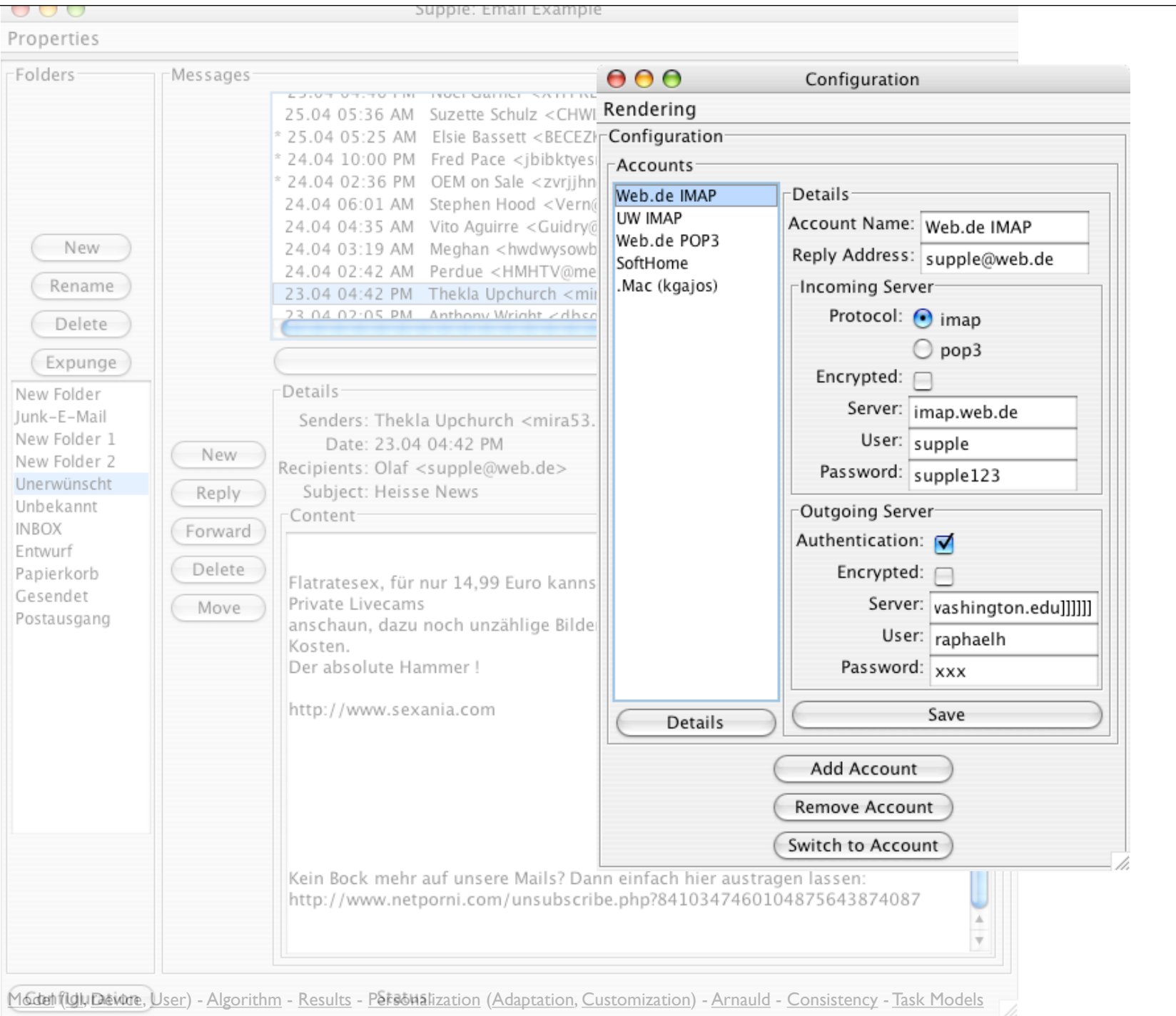
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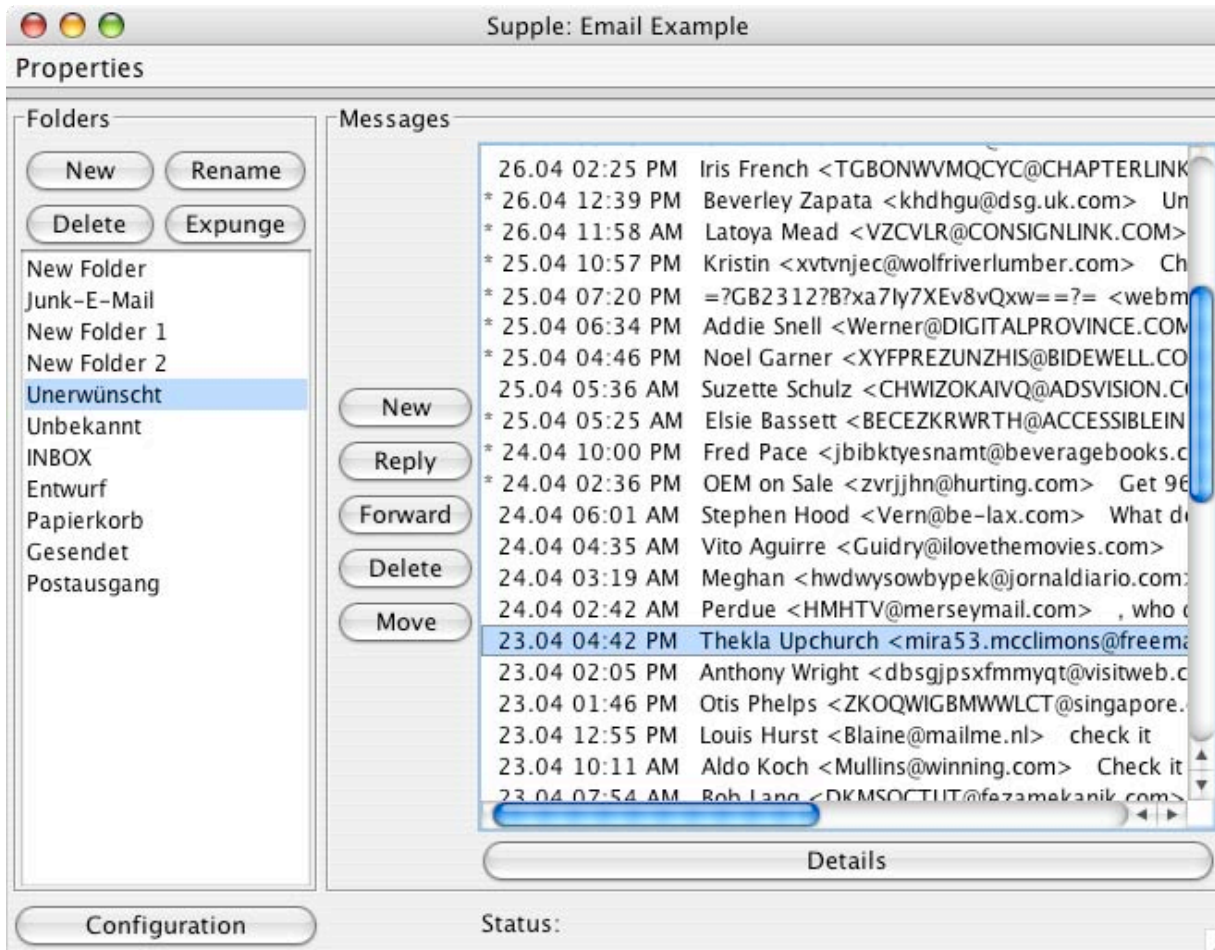
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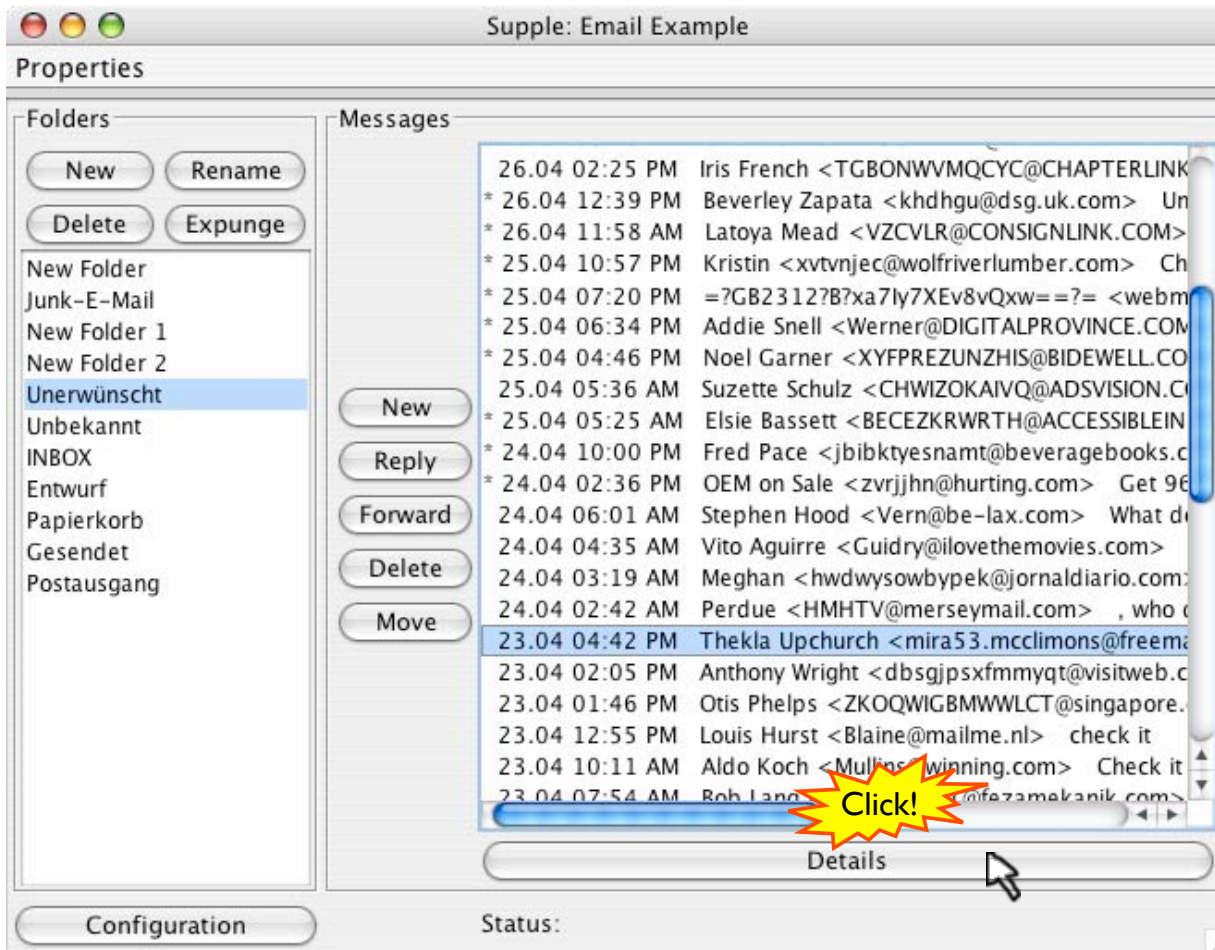
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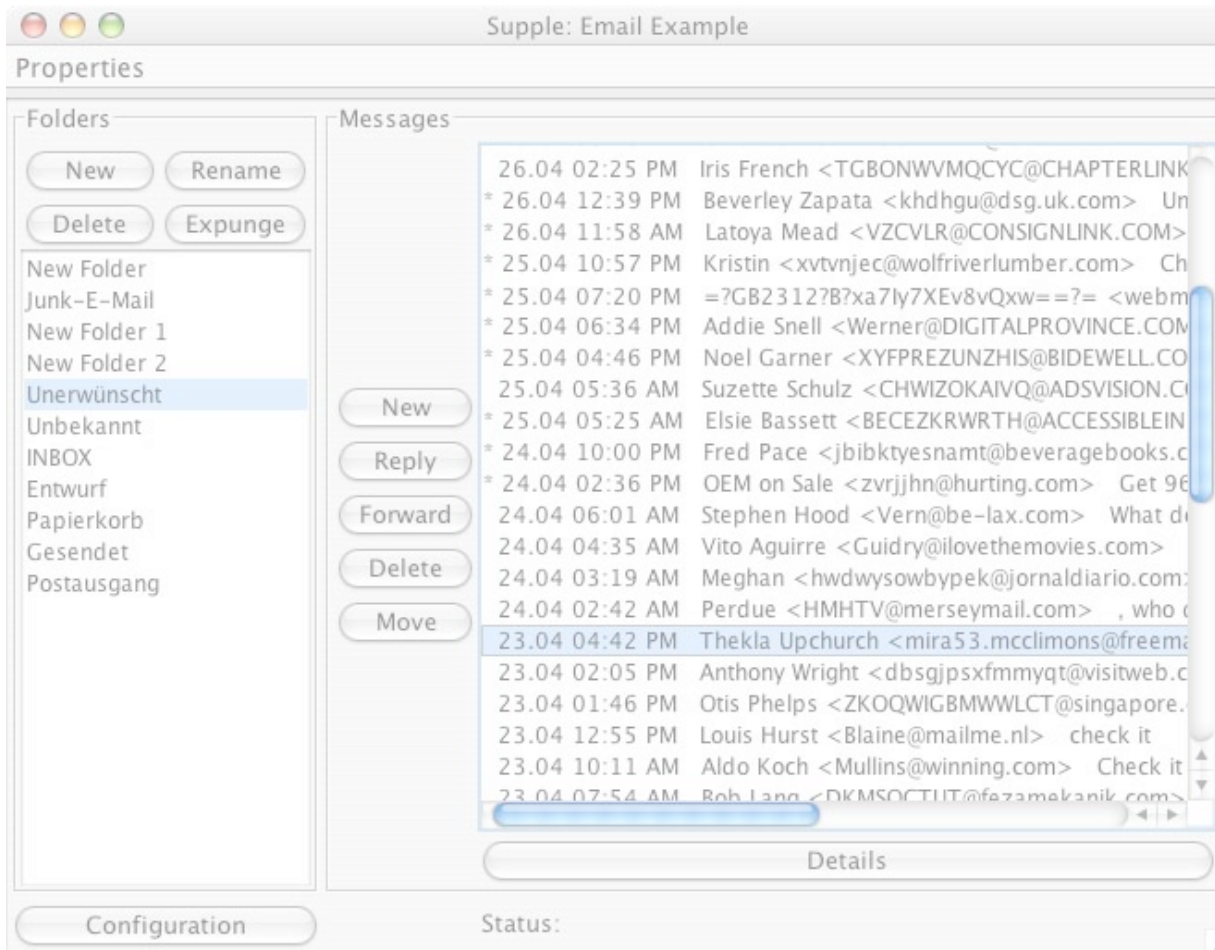
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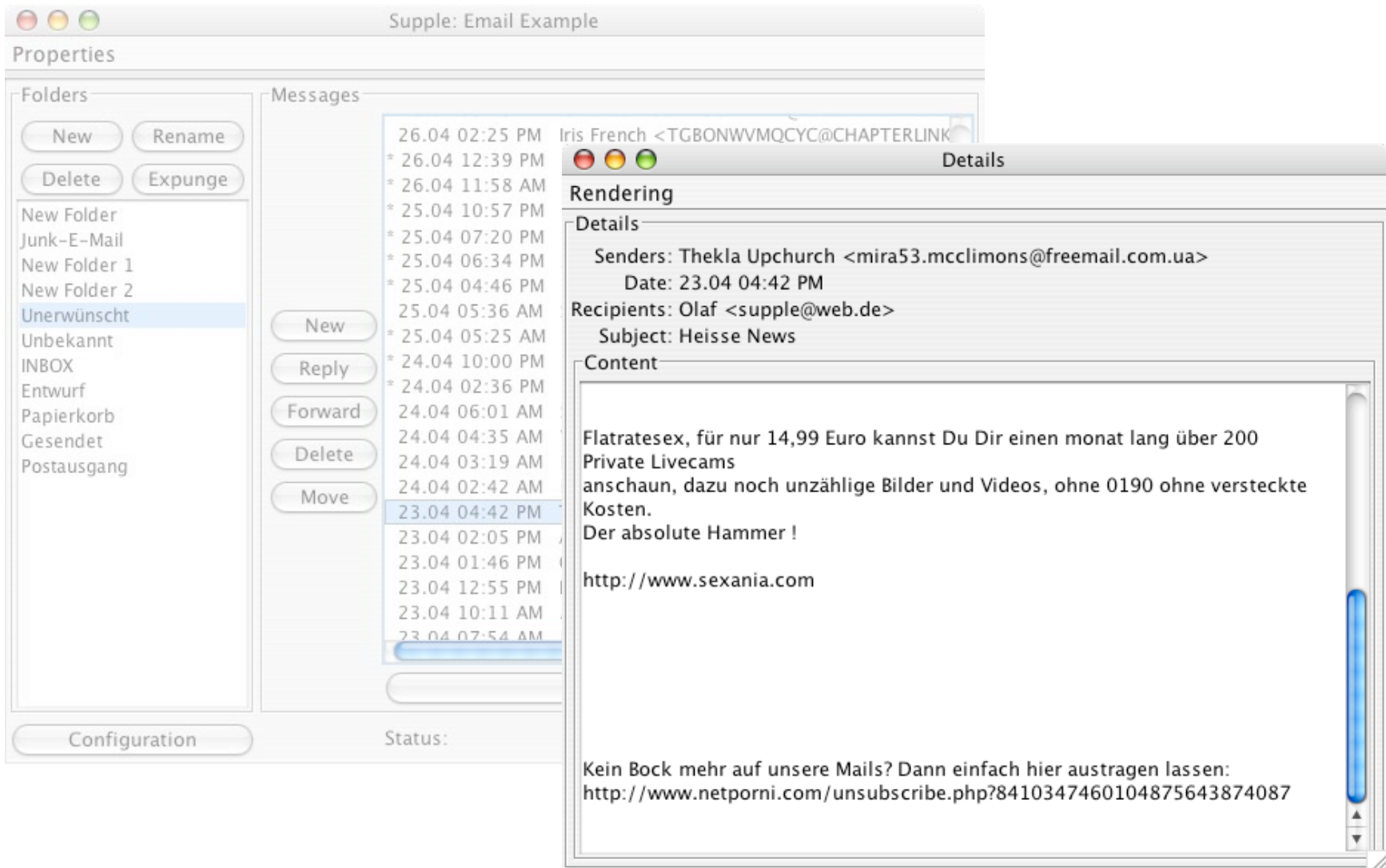












# Media Types

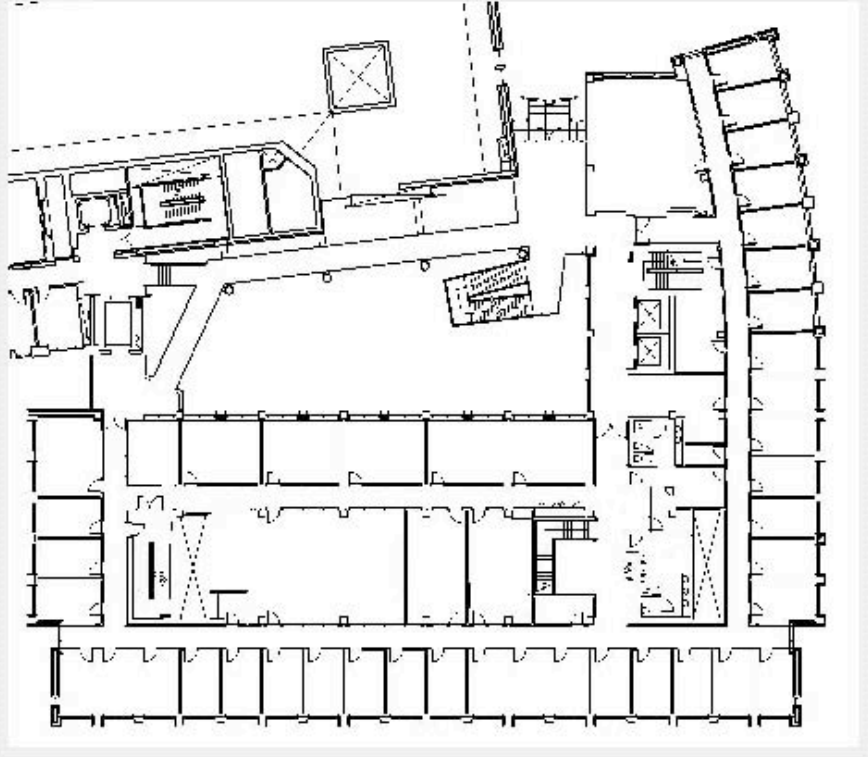
Supple: Map Demo

Properties

Map Demo

Pick a location


The Map



Location: (847.0,240.0)

Info

Photo



Name: Dan  
Office: 588

# Subtyping

SUPPLE | UW CSE

Properties

Amazon Search


Search: digital cameras

Search

Search Results

Understanding Exposure: How to Shoot Great Photographs with a Film or Digital Camera  
Shooting Digital: Pro Tips for Taking Great Pictures with Your Digital Camera  
How To Do Everything with Your Digital Camera by Dave Johnson  
**50 Fast Digital Camera Techniques by Chris Maher**  
202 Digital Photography Solutions : Solve Any Digital Camera Problem in Ten Minutes  
TechTV's Digital Camera and Imaging Guide by Les Freed  
Amphoto's Complete Book Of Photography: How to Improve Your Pictures With Your Digital Camera  
Learn the Canon EOS Digital Rebel Camera for 5 Bucks (Learn...for 5 Bucks)  
Get The Most From Your Digital Camera by Simon Joinson  
Portable Electronics Product Design & Development : For Cellular Phones, PDA's, and More

Details



Product: 50 Fast Digital Camera Techniques  
Price: \$24.99

More details

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 Author: Chris Maher  
 Price: \$24.99  
 Publisher: Wiley

Details



Product: Canon PowerShot A95 SMP Digital Camera  
 Price: \$379.95

Features

- Highly advanced 5.0-megapixel digital camera with 3x optical/4.1x digital/12x combined zoom
- 14 shooting modes, with special Scene Modes for spectacular shots in special situations
- New, larger 1.8-inch vari-angle LCD monitor for easier image preview and review
- 9-point AiAF plus FlexiZone AF/AE for off-center subjects
- New Print/Share button for easy direct printing and downloads

# Road Map

- Motivation
- Modeling user interfaces in SUPPLE
- User interface generation as optimization
- Automatically adapting user interfaces
  - A preliminary user study
  - Adaptation in SUPPLE
- Customization support in SUPPLE
- Conclusions

# User Interface Generation as Optimization

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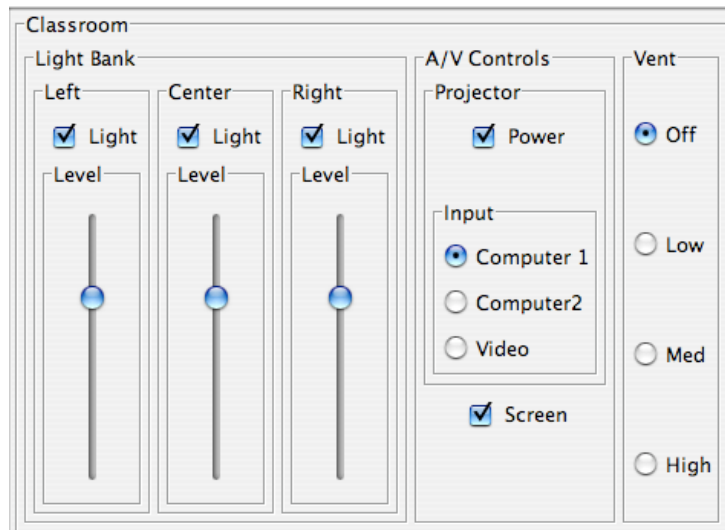
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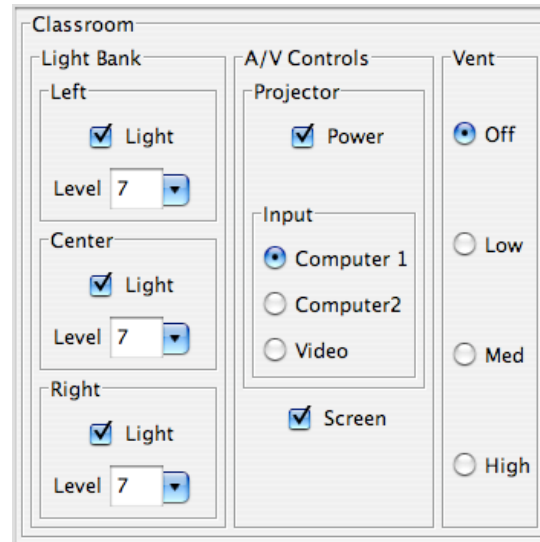
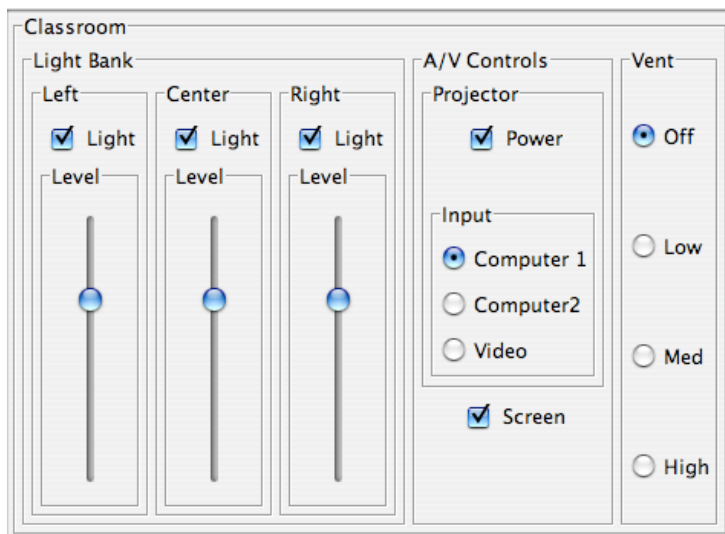
# User Interface Generation as Optimization

- **Flexible** with respect to screen size
- **Versatile:** Same algorithm for different devices
- Allows new concerns to be included in the rendering process, e.g.:
  - Cross-device **consistency**
  - **Adaptation** to usage patterns

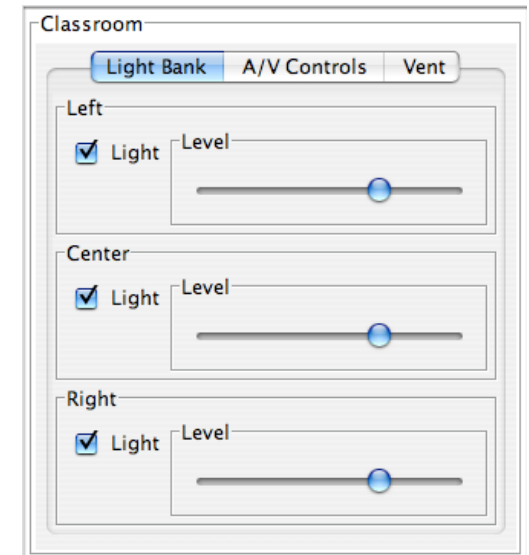
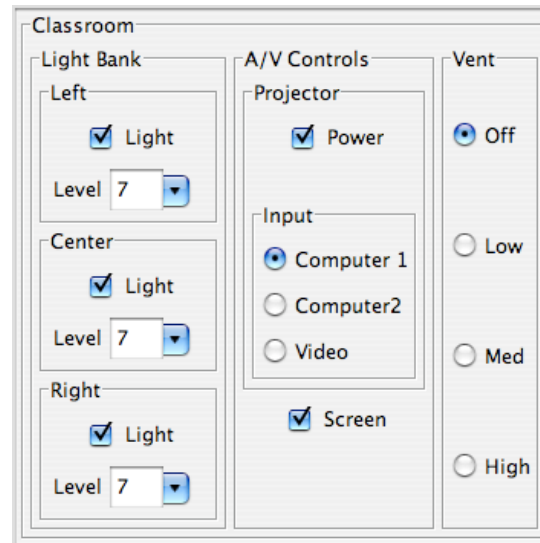
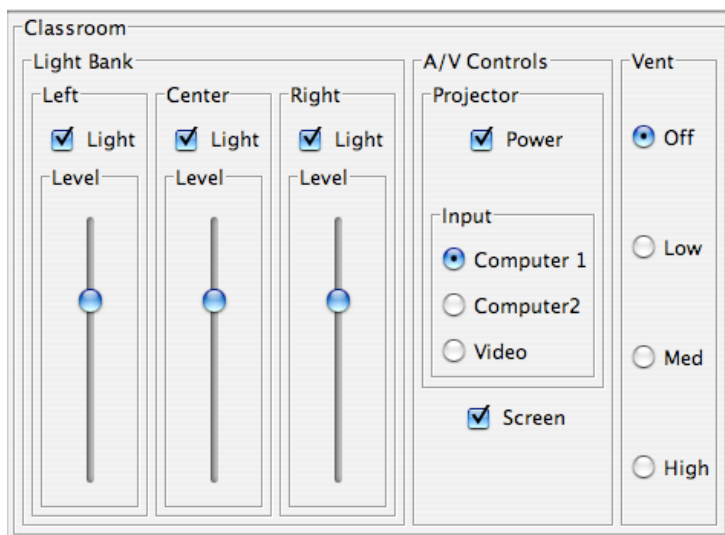
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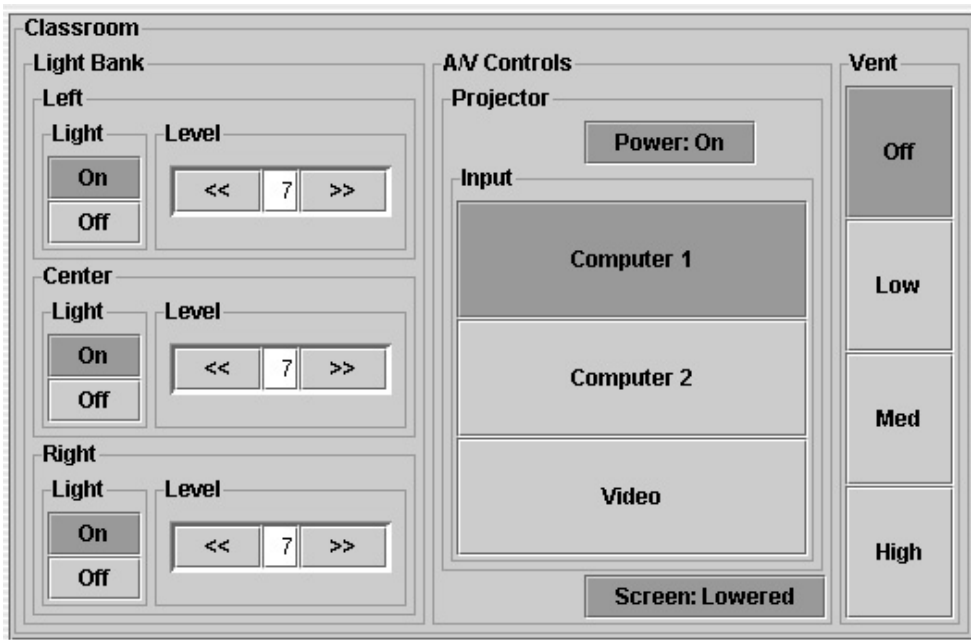
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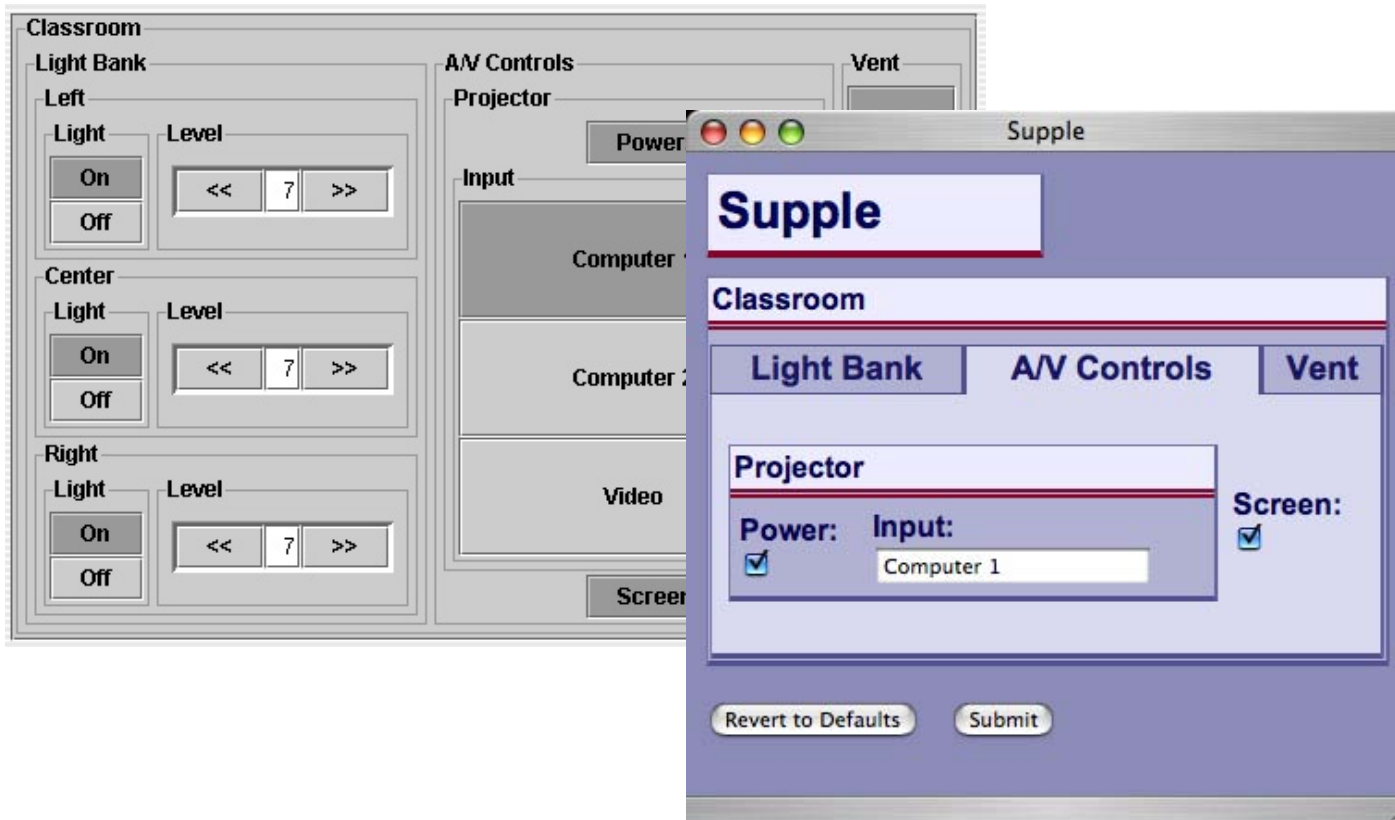
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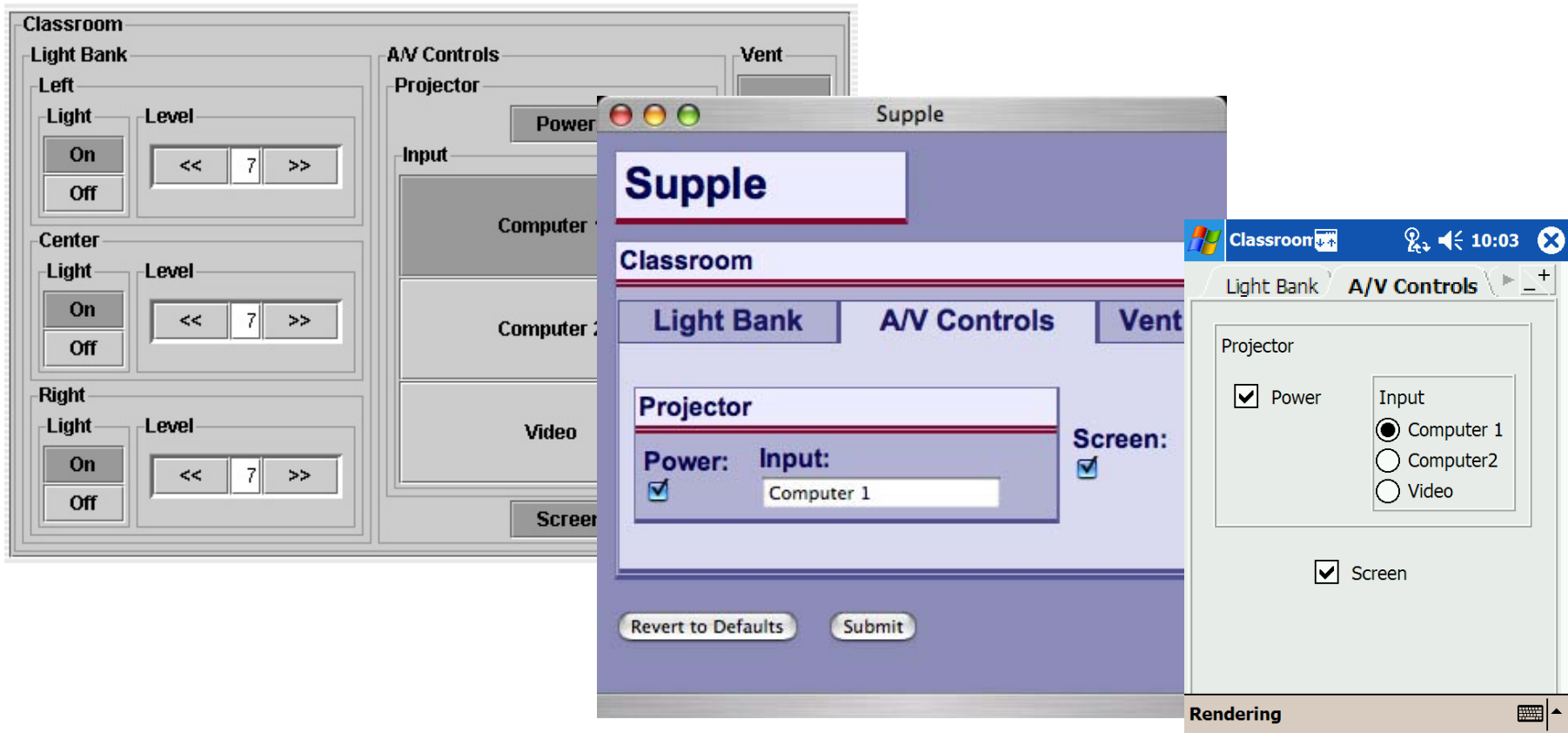
# Single Algorithm -- Many Devices



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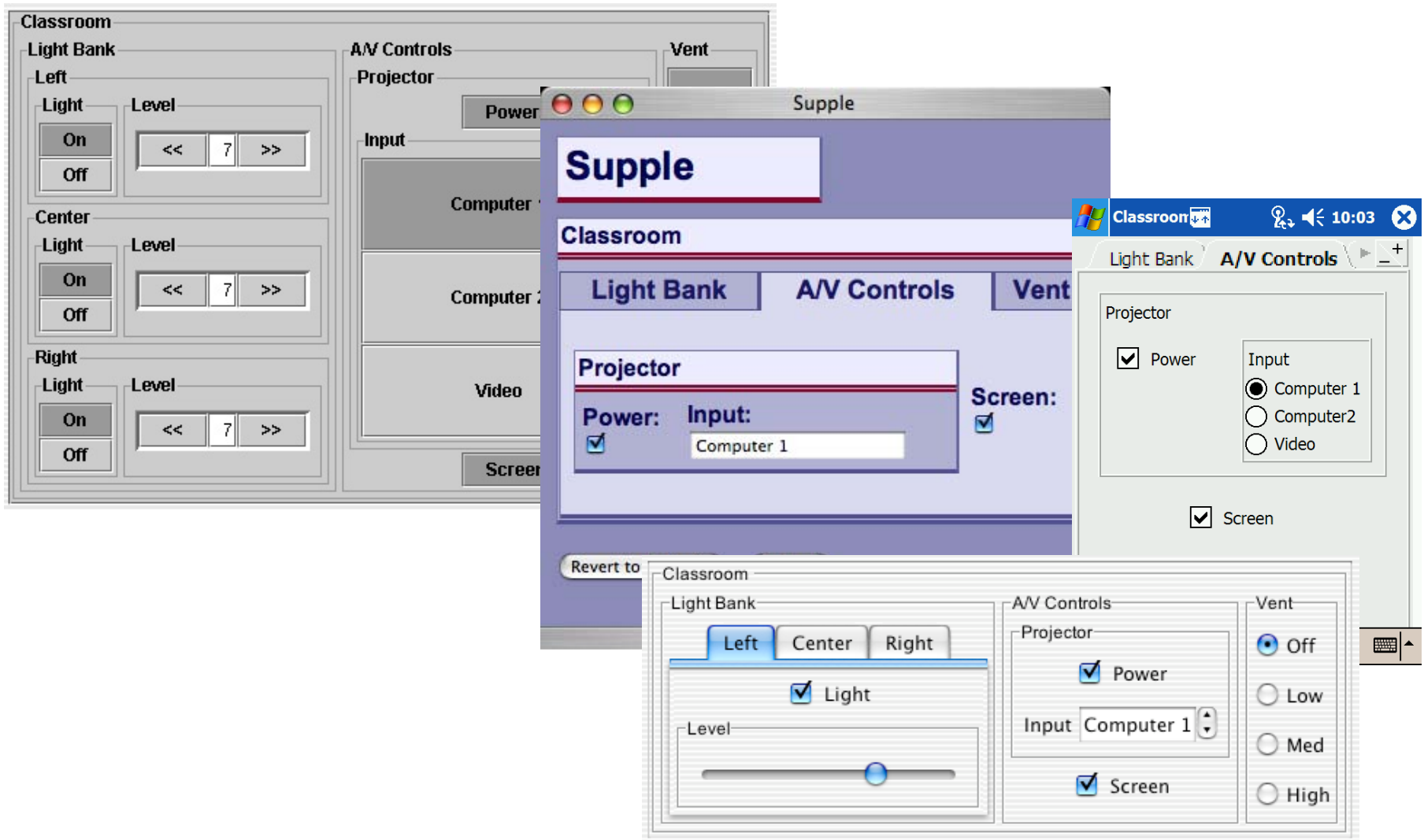


# Single Algorithm -- Many Devices





# Single Algorithm -- Many Devices



# Single Algorithm -- Many Devices

The image displays a complex software interface for classroom management, illustrating a single algorithm controlling multiple devices. The main interface is divided into several sections:

- Classroom Light Bank:** Controls for Left, Center, and Right light banks, each with an On/Off button and a Level slider (set to 7).
- A/V Controls:** Includes a Projector section with Power (checked), Input (Computer 1), and Screen (checked) options.
- Vent:** Controls for Vent, with options for Off, Low, Med, and High.

A secondary window titled "Supple" is overlaid, showing a simplified view of the Classroom and Projector controls. The Windows taskbar at the top right shows the "Classroom" application icon, system icons, and the time 10:03.

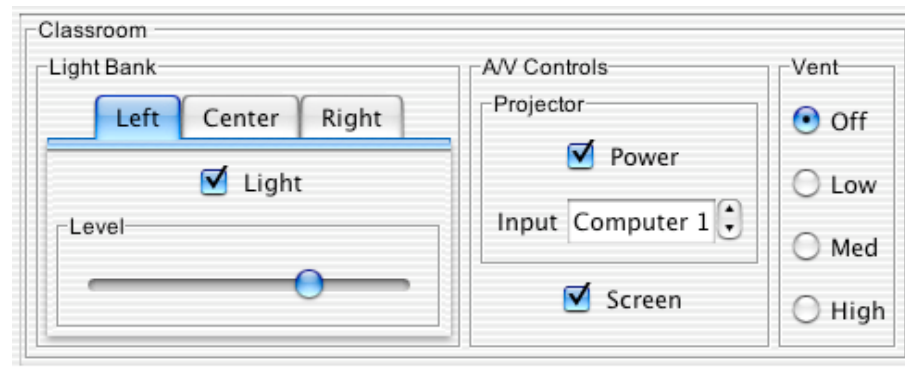
Three mobile device screens are shown at the bottom left, displaying simplified versions of the interface:

- Classroom:** Shows Light Bank, A/V Controls, and Projector status.
- Light Bank:** Shows Light: <On> and Level: <7>.
- SELECT:** A menu with options 6, 7, 8, and 9.

Additional interface elements include a "Center" and "Right" section with a "Light" checkbox and a "Level" slider, and a detailed "A/V Controls" panel with "Power" (checked), "Input" (Computer 1), and "Screen" (checked) options.

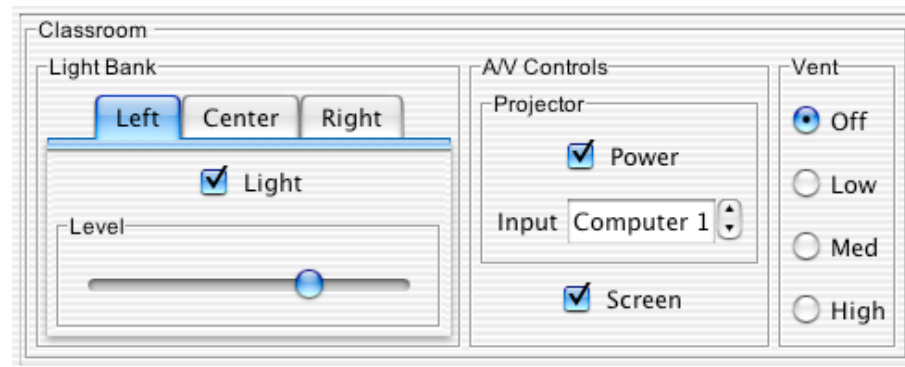
# Adapting To Usage Patterns

SUPPLE with  
an empty  
trace

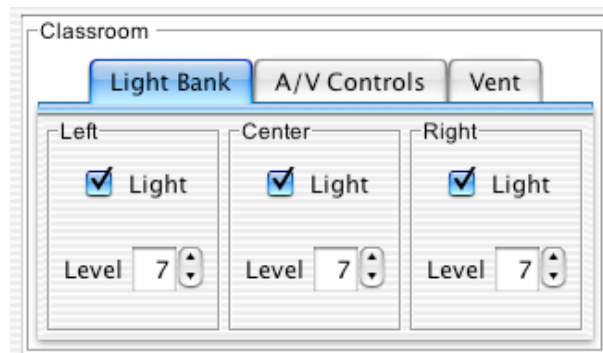


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SUPPLE with a  
“lights-heavy”  
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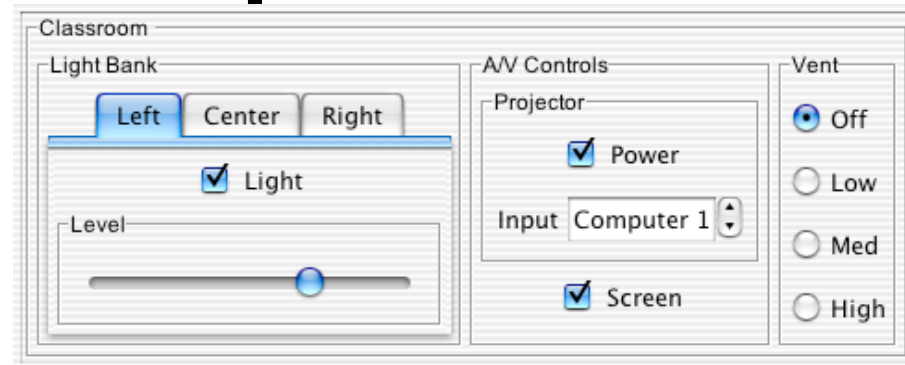


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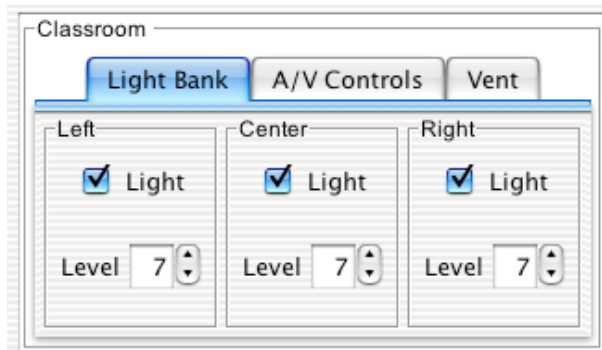
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# Adapting To Usage Patterns By Complete Makeover

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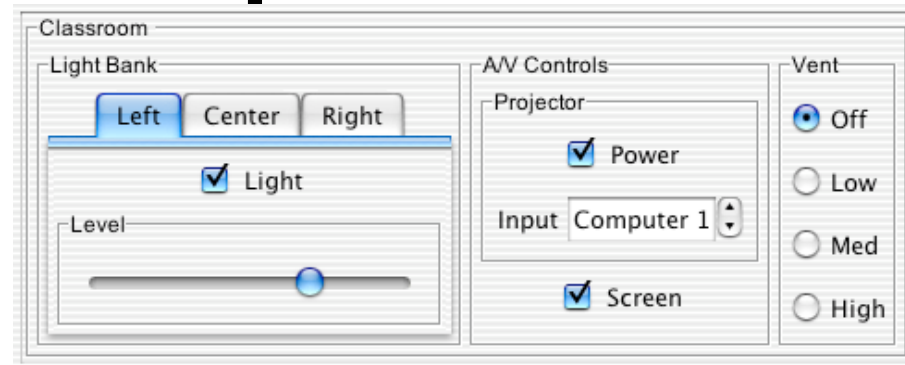


SUPPLE with a  
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trace



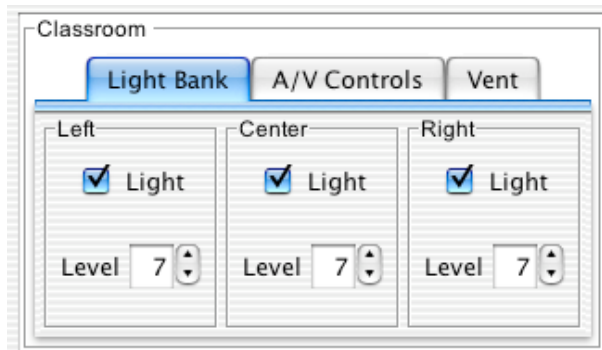
# Adapting To Usage Patterns By Complete Makeover

SUPPLE with  
an empty  
trace

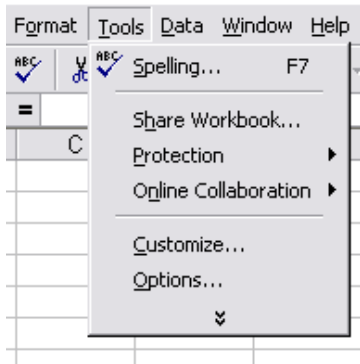


Is this the only way to adapt?

SUPPLE with a  
“lights-heavy”  
trace

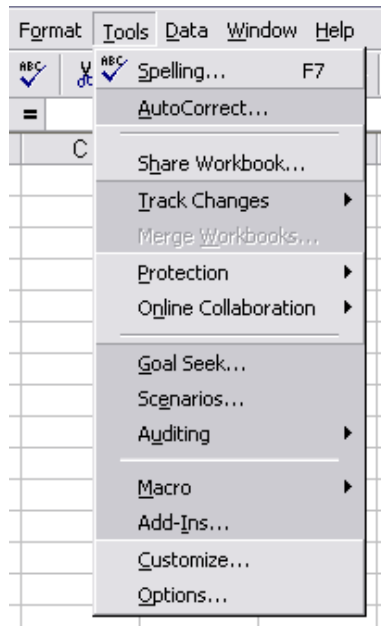


# Content Eliding

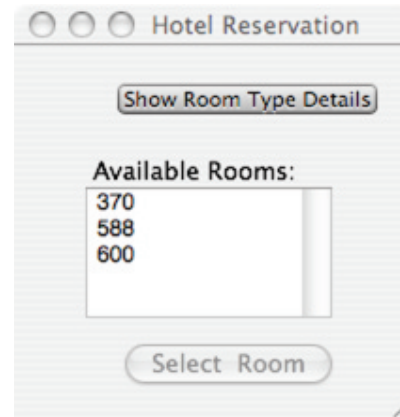
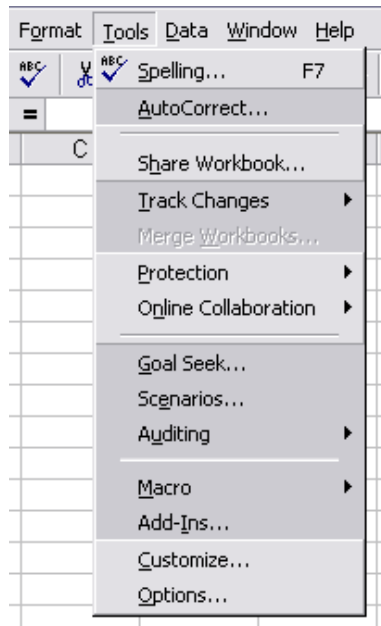




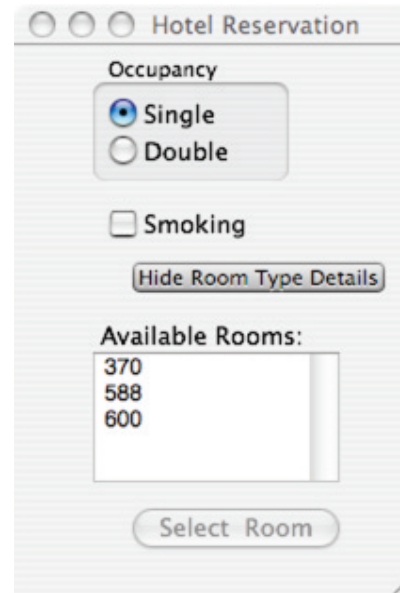
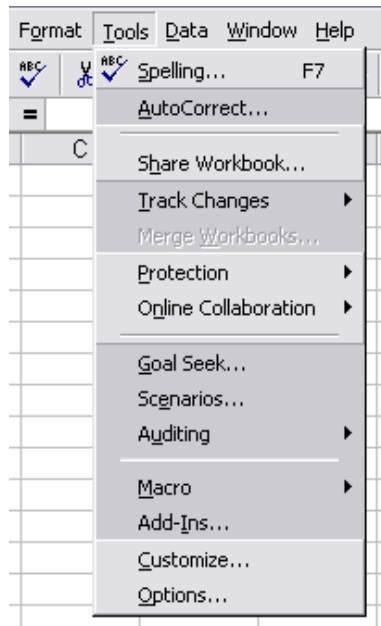
# Content Eliding



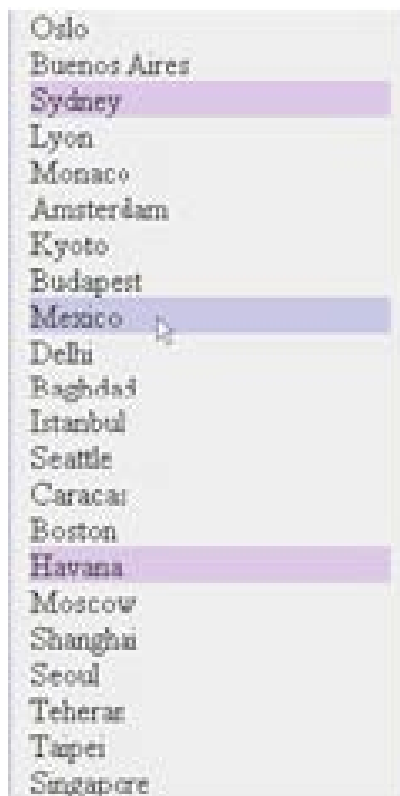
# Content Eliding



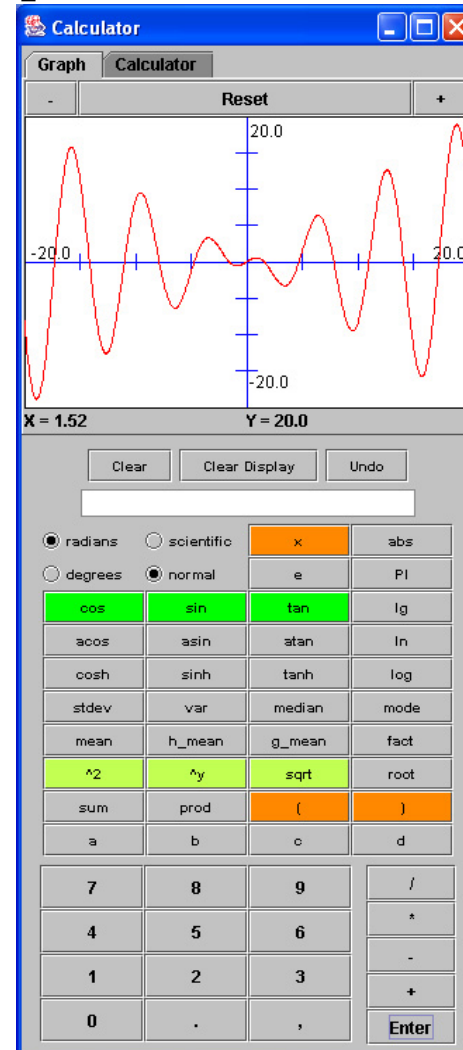
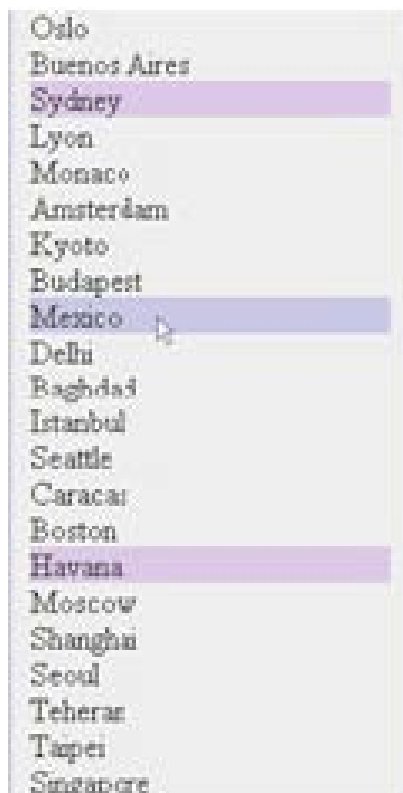
# Content Eliding



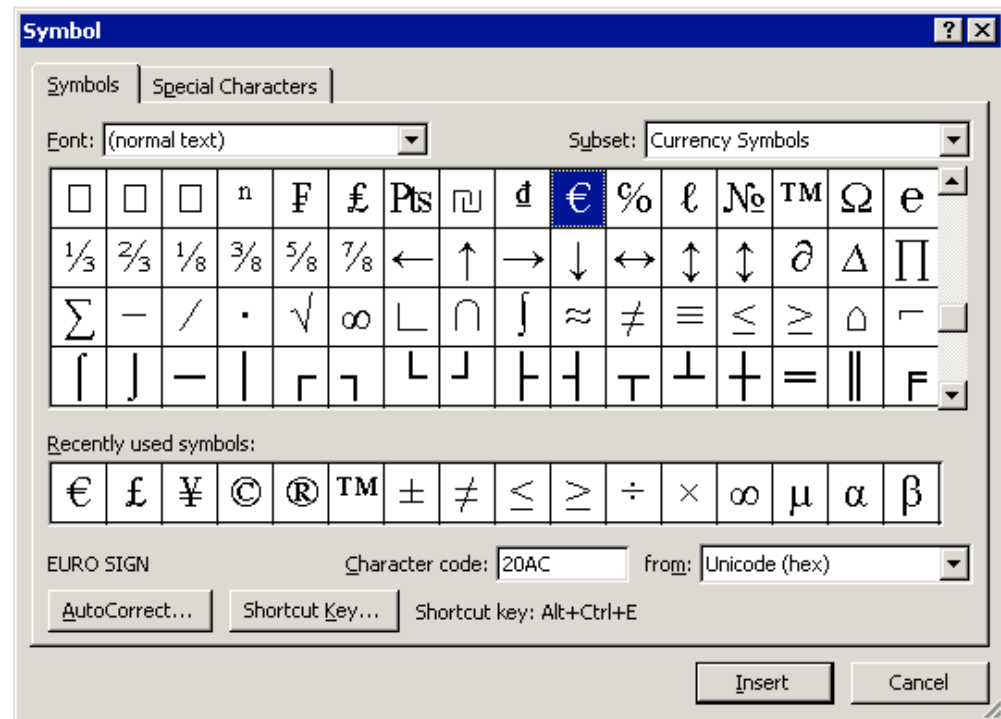
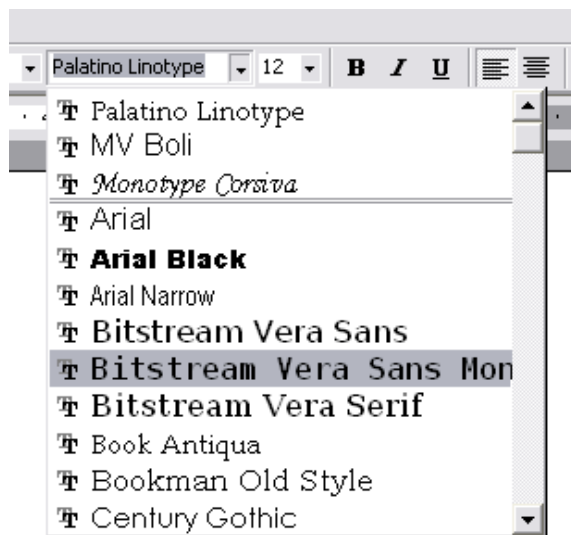
# Visual Popout



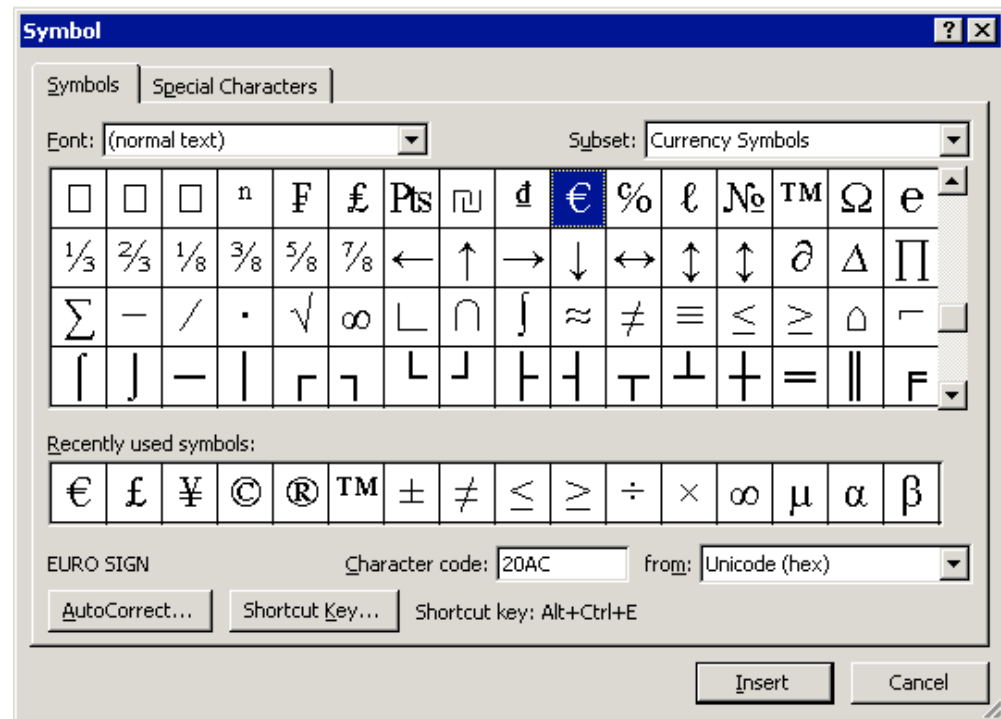
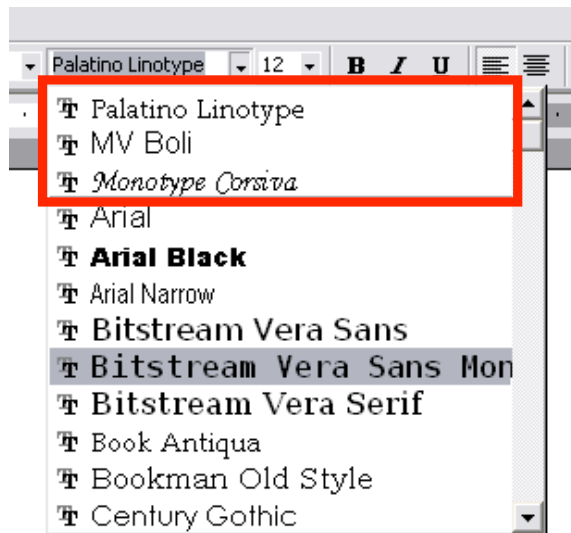
# Visual Popout



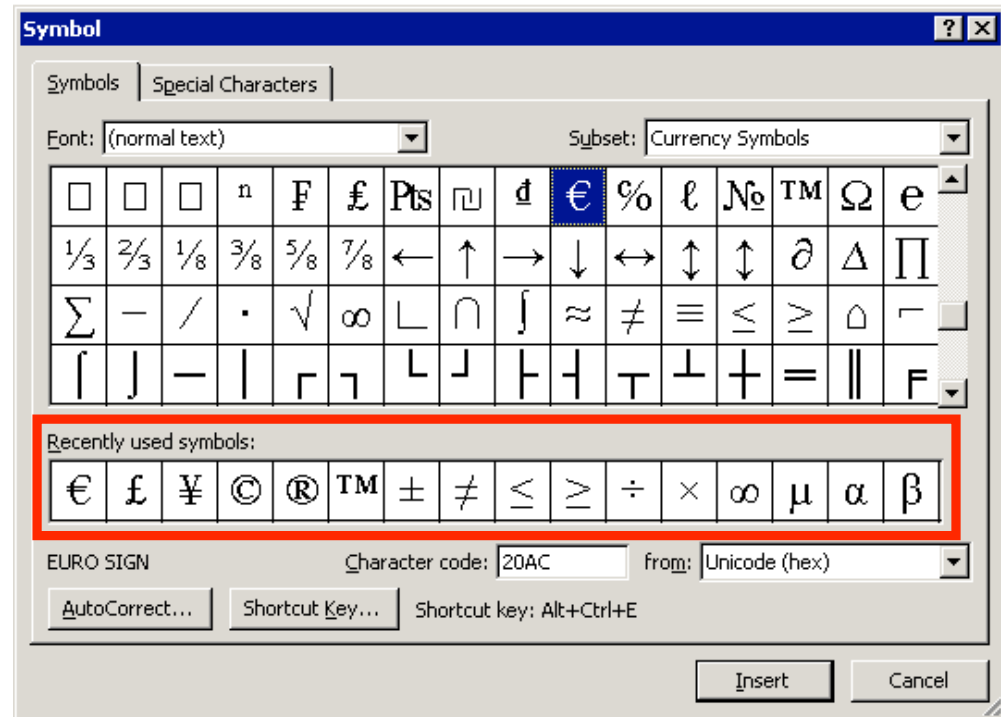
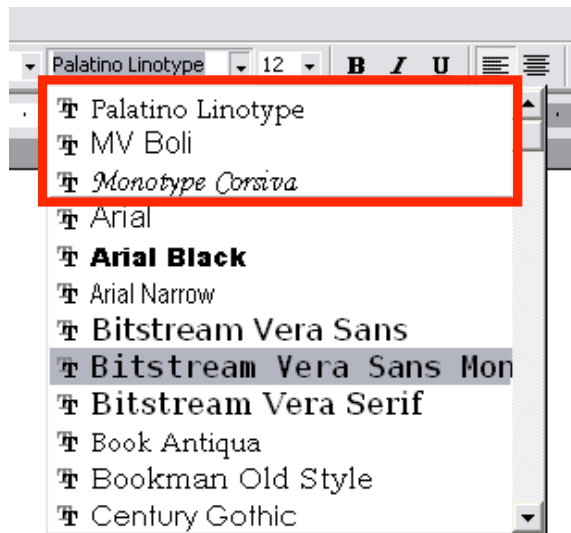
# Split Interfaces



# Split Interfaces

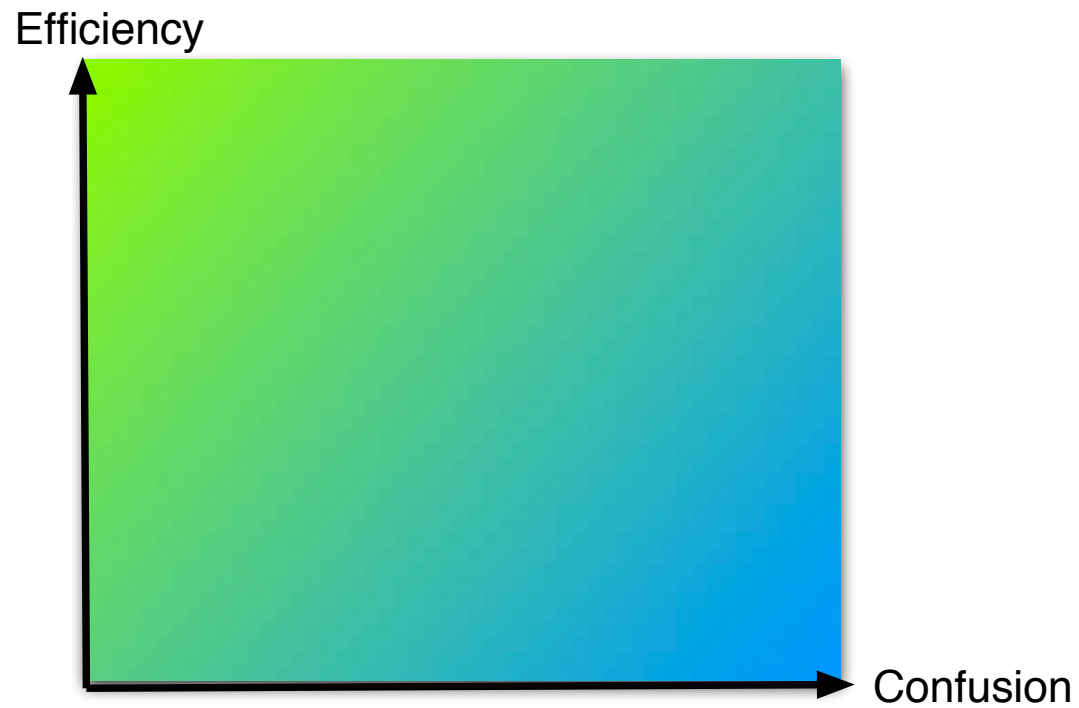


# Split Interfaces





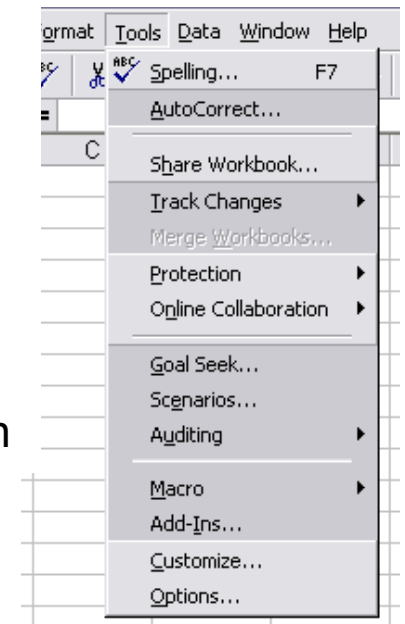
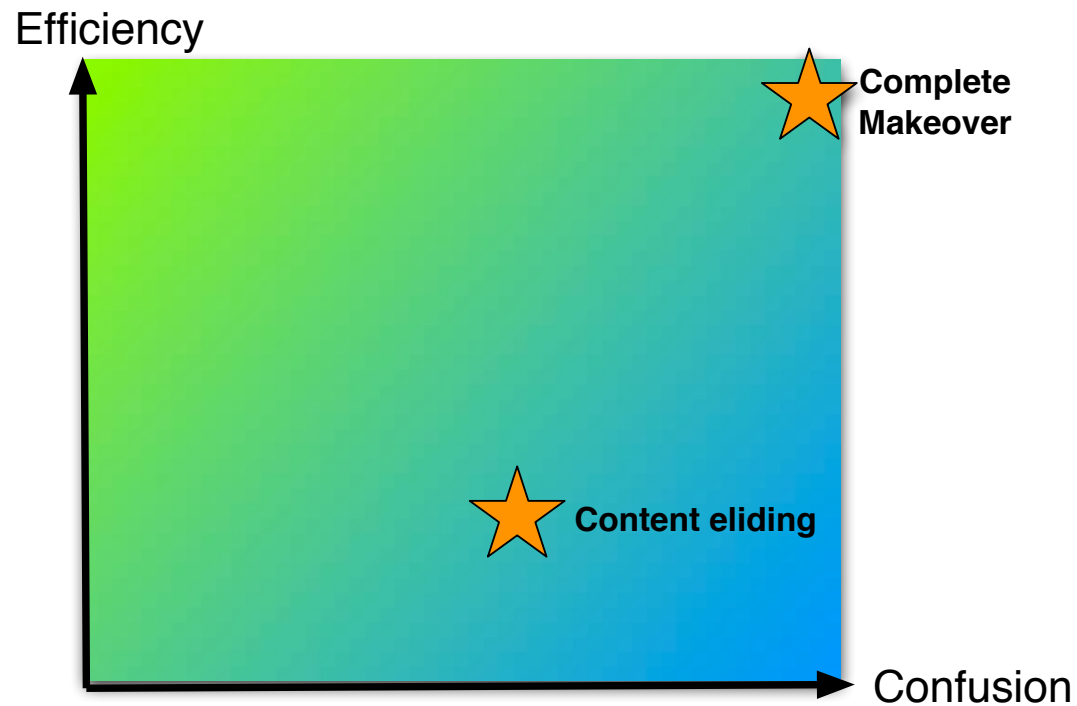
# Adaptation Strategies



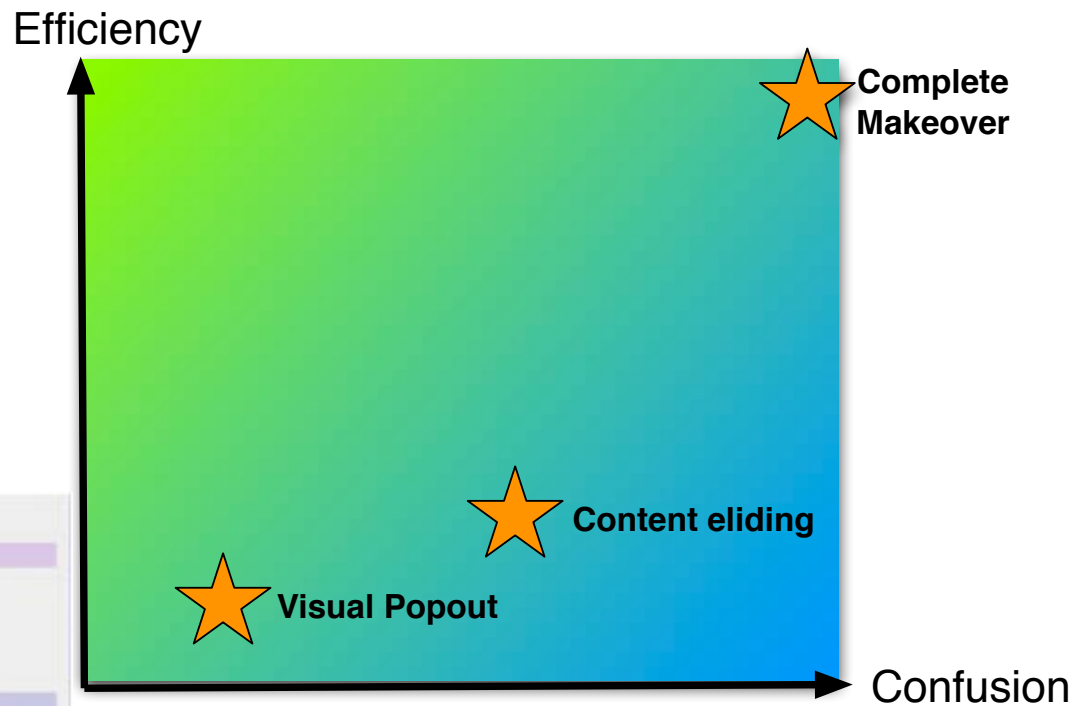
# Adaptation Strategies



# Adaptation Strategies

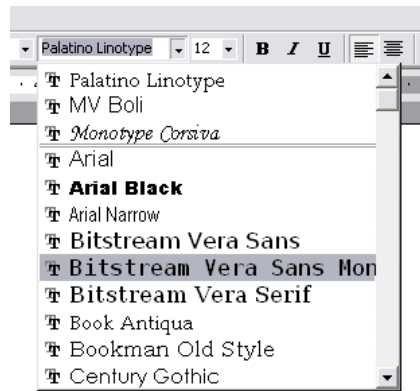


# Adaptation Strategies

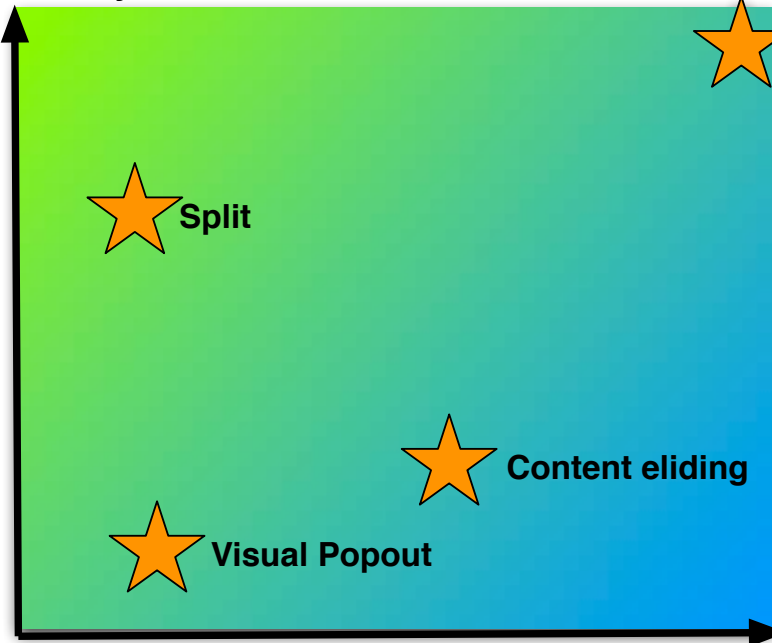


- Oslo
- Buenos Aires
- Sydney
- Lyon
- Monaco
- Amsterdam
- Kyoto
- Budapest
- Mexico
- Deli
- Baghdad
- Istanbul
- Seattle
- Caracas
- Boston
- Havana
- Moscow
- Shanghai
- Seoul
- Teheran
- Tapei
- Singapore

# Adaptation Strategies



Efficiency



Complete Makeover

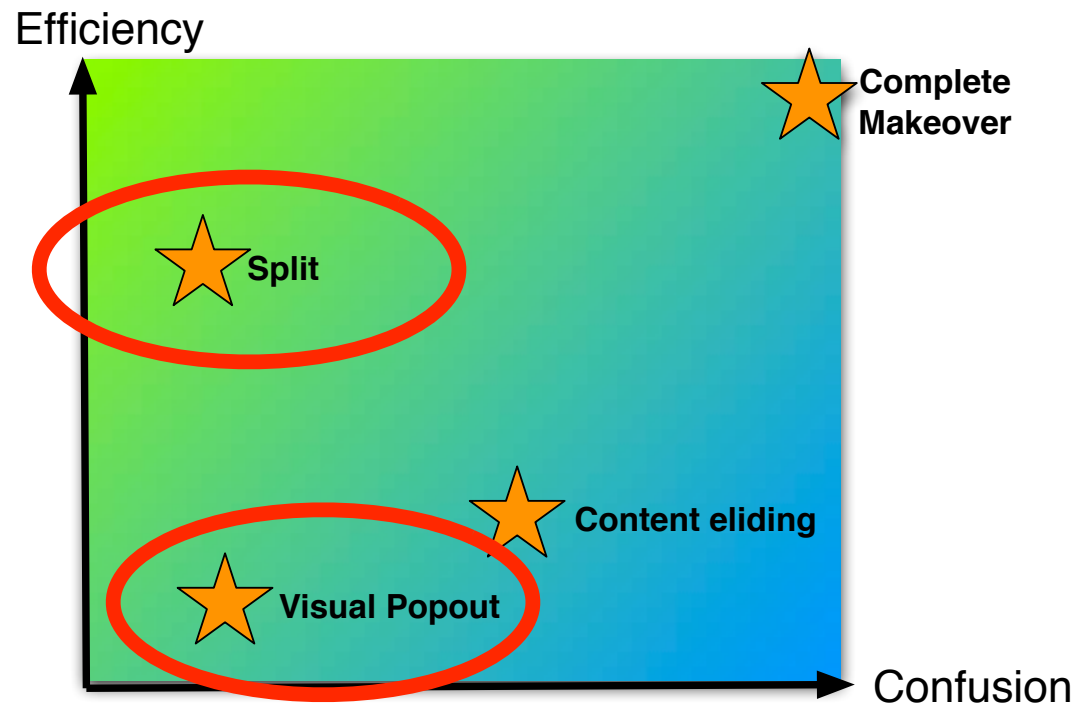
Split

Content eliding

Visual Popout

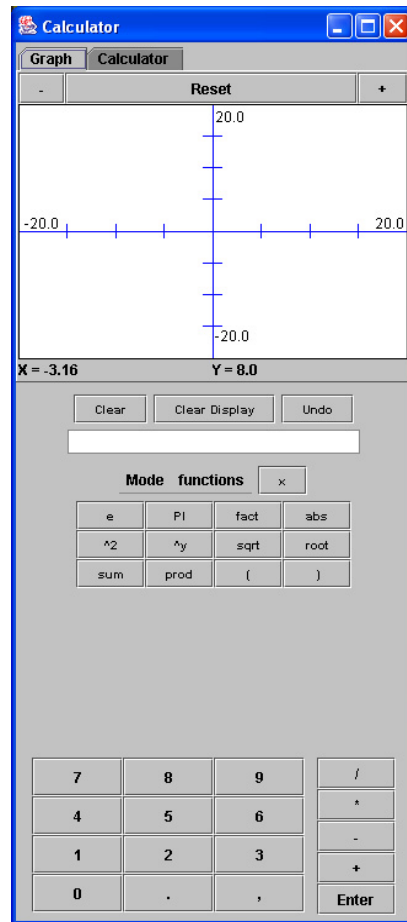
Confusion

# Adaptation Strategies



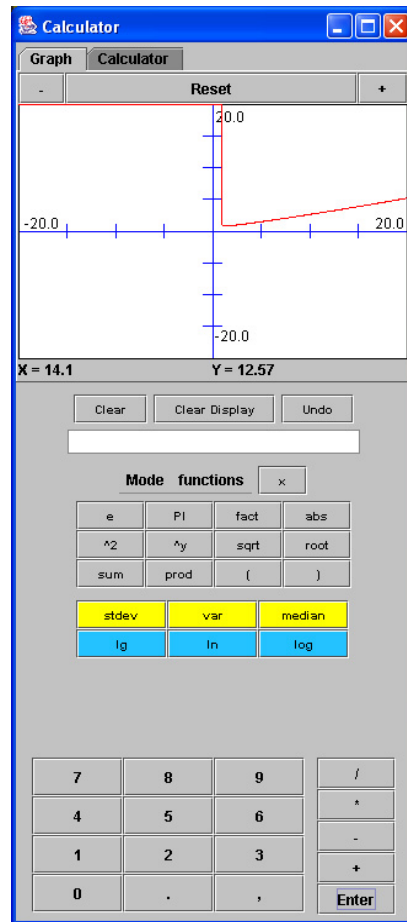
# Preliminary User Study

Split  
Interface



# Preliminary User Study

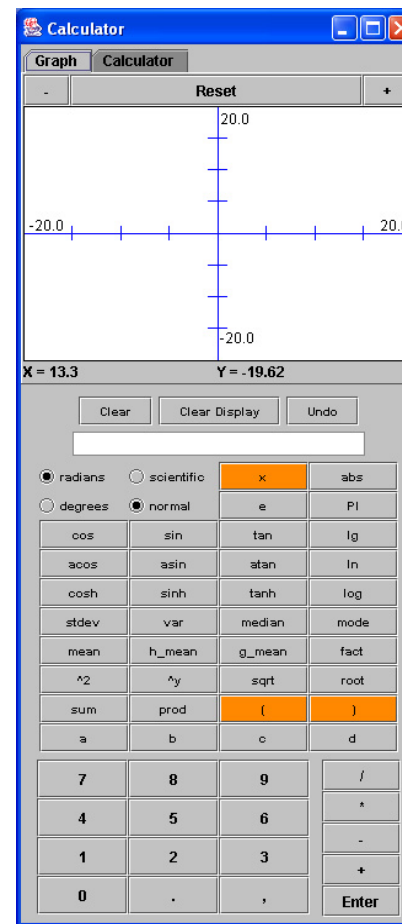
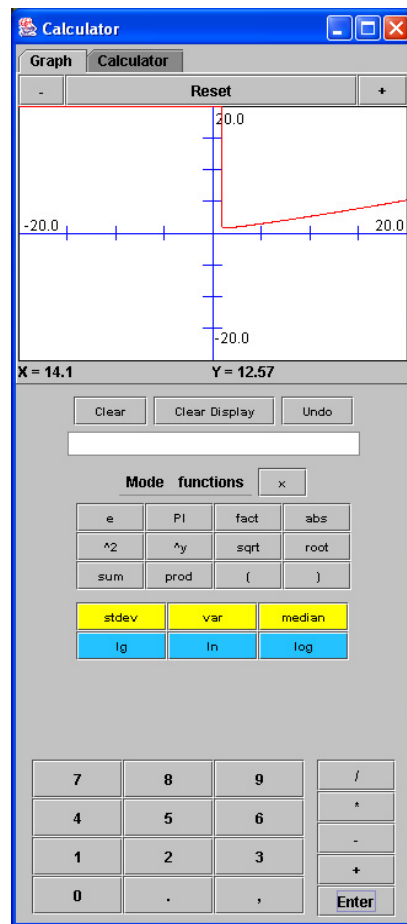
Split  
Interface





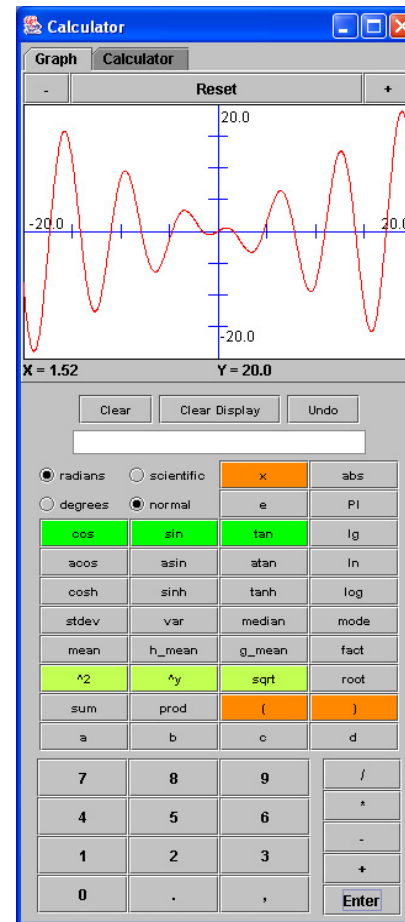
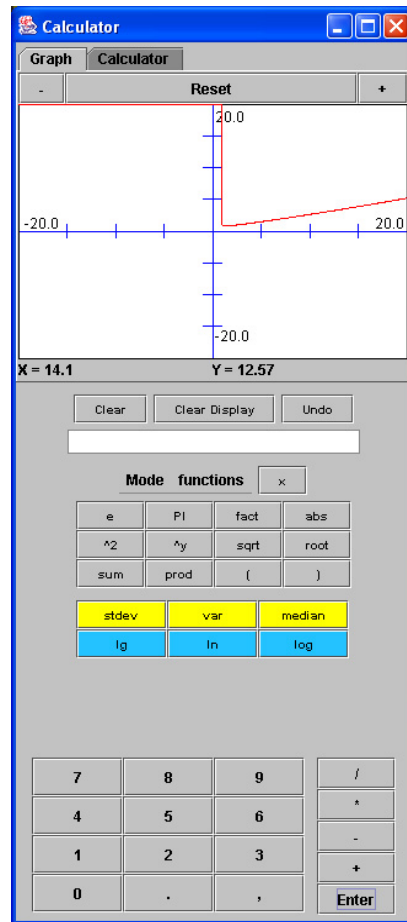
# Preliminary User Study

Split  
Interface



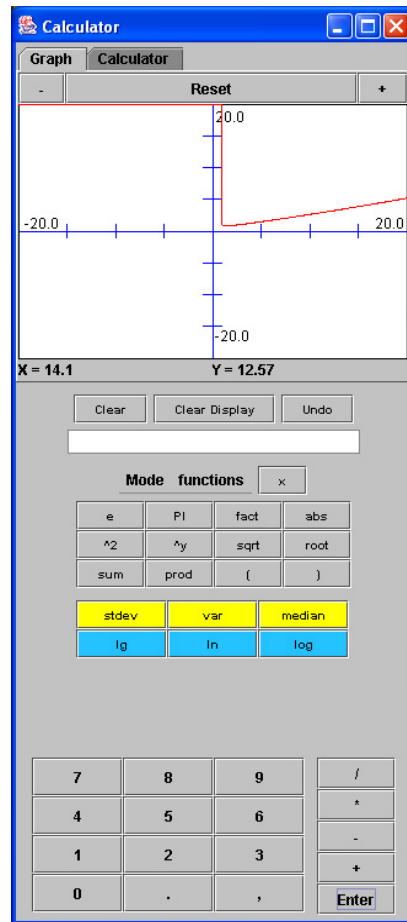
# Preliminary User Study

Split  
Interface

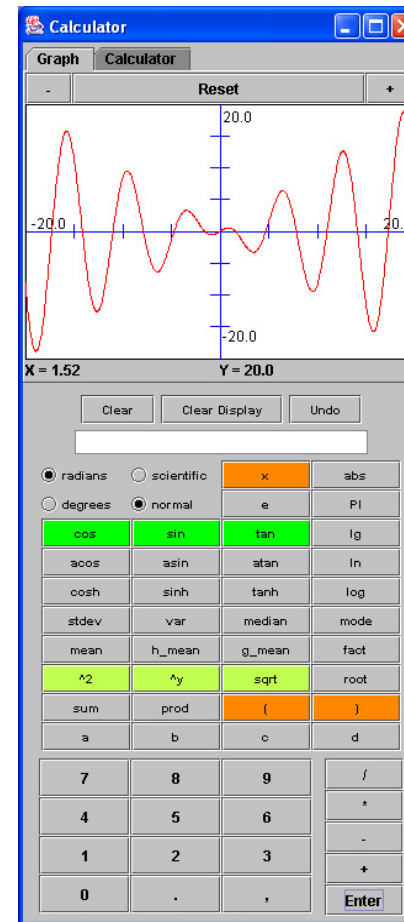


# Preliminary User Study

Split  
Interface



Visual  
Popout  
Interface



# Preliminary User Study Results

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- **Split Interface** strongly preferred over non-adaptive

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# Preliminary User Study Results

- **Split Interface** strongly preferred over non-adaptive
- Both adaptive interfaces slightly **faster** than non-adaptive
- But: **Visual Popout** interface often found distracting

# Sneak Peak: Followup Study

*with Mary Czerwinski and Desney Tan*



# Sneak Peak: Followup Study

- In a different setting, we tested three adaptation strategies including Split Interface and Visual Popout Interface

*with Mary Czerwinski and Desney Tan*

# Sneak Peak: Followup Study

- In a different setting, we tested three adaptation strategies including Split Interface and Visual Popout Interface
- Users strongly **preferred** and were significantly **faster** using **Split Interface**

*with Mary Czerwinski and Desney Tan*

# Sneak Peak: Followup Study

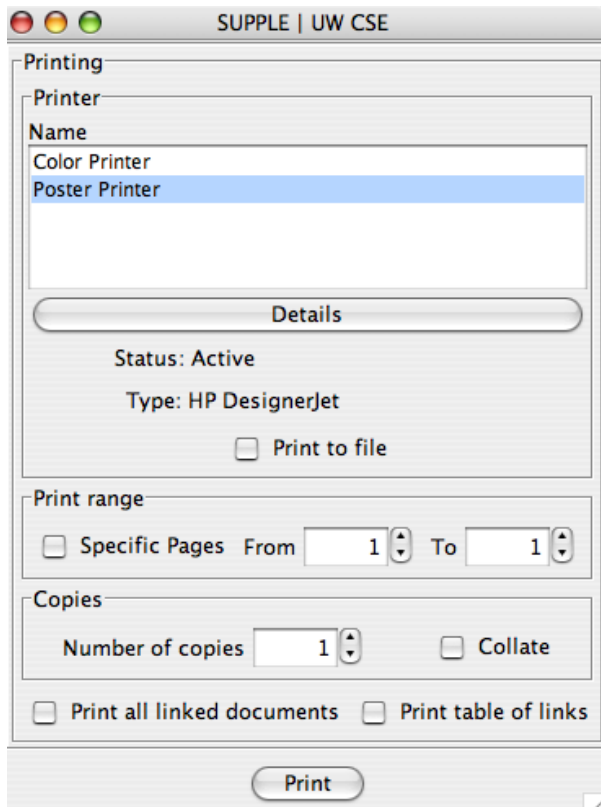
- In a different setting, we tested three adaptation strategies including Split Interface and Visual Popout Interface
- Users strongly **preferred** and were significantly **faster** using **Split Interface**
- Users strongly **disliked** **Visual Popout Interface**

*with Mary Czerwinski and Desney Tan*

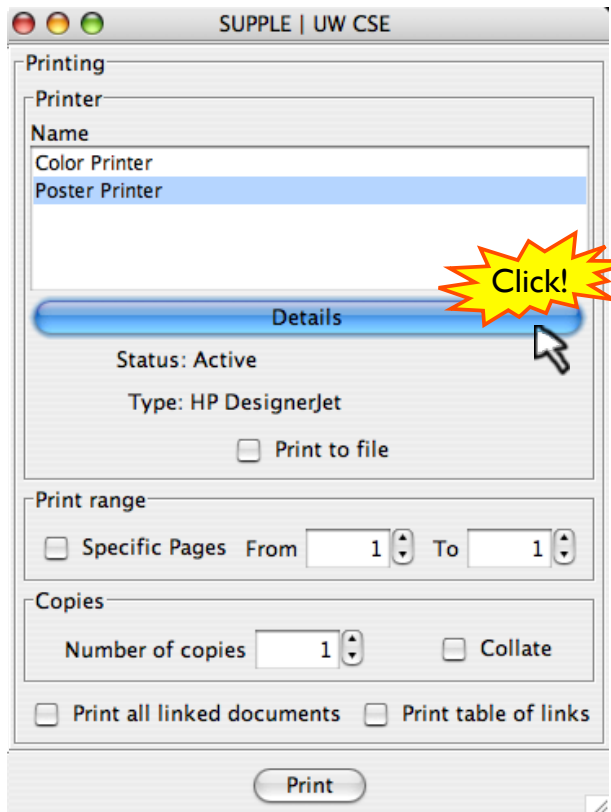
# Split Interfaces in SUPPLE

- Adapting by promoting hard-to-reach but frequently used functionality

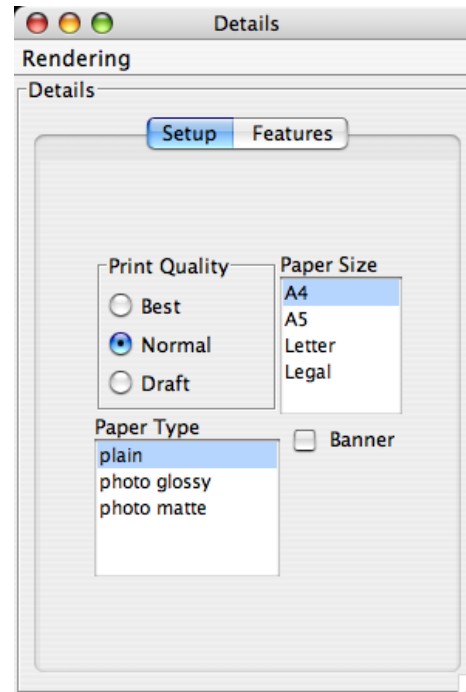
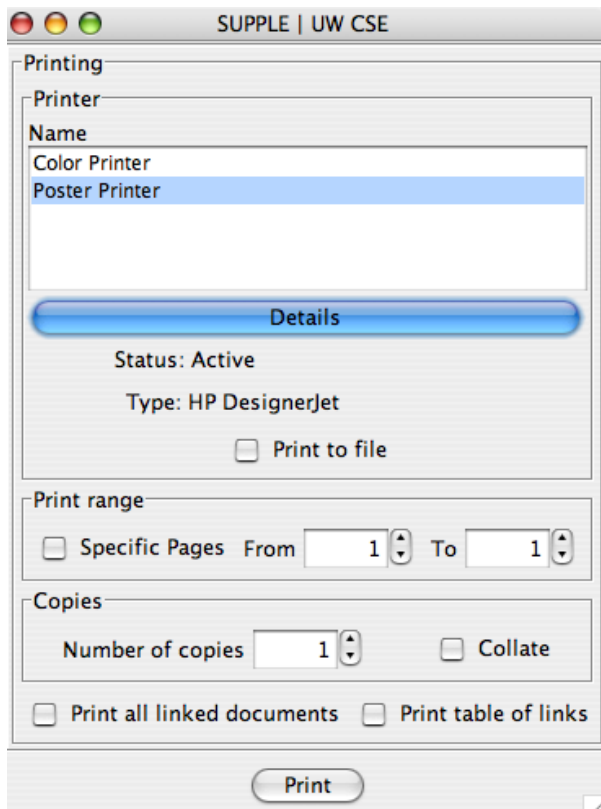
# Split Interfaces in SUPPLE



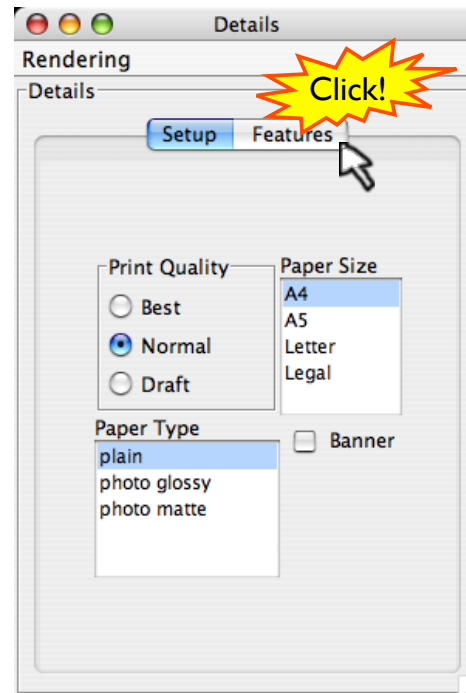
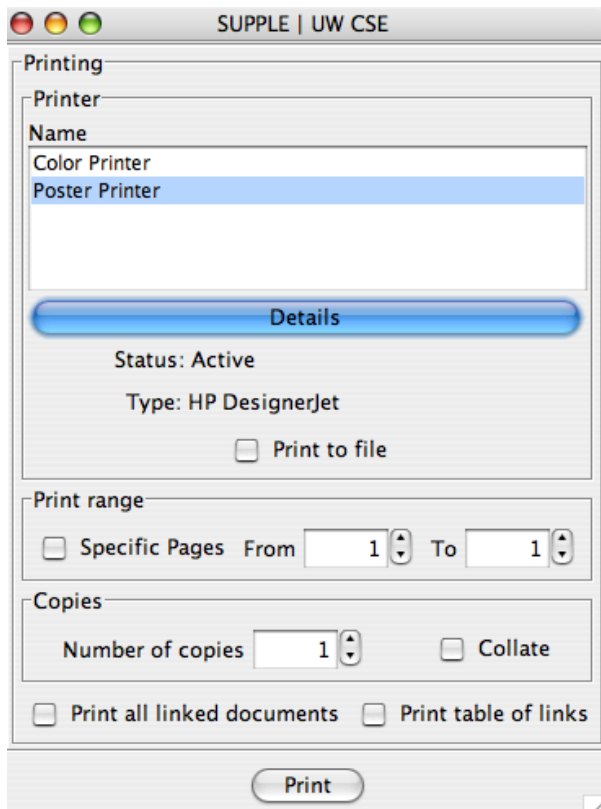
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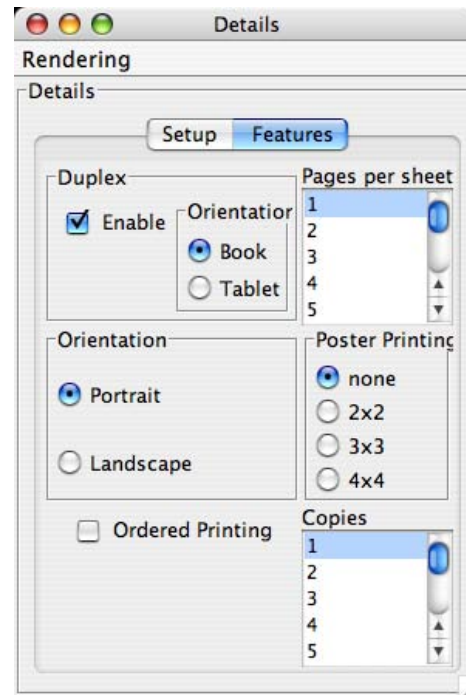
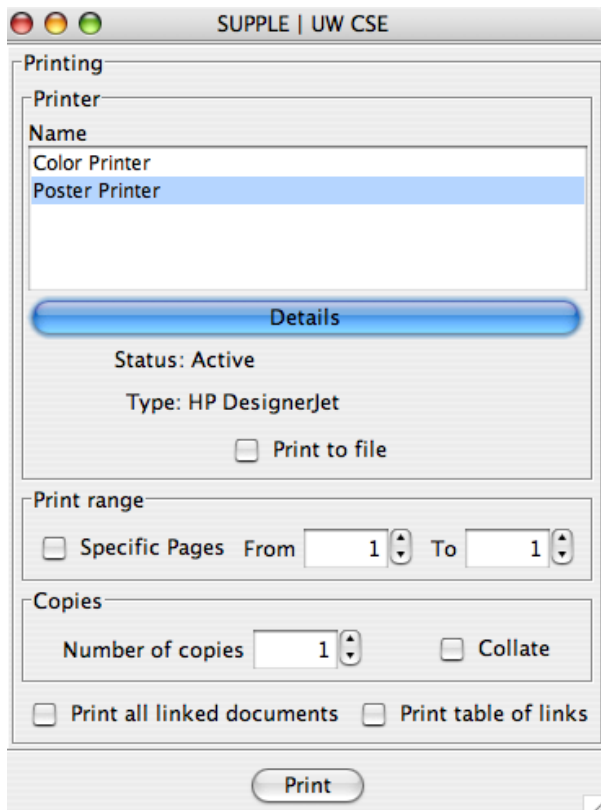


# Split Interfaces in SUPPLE

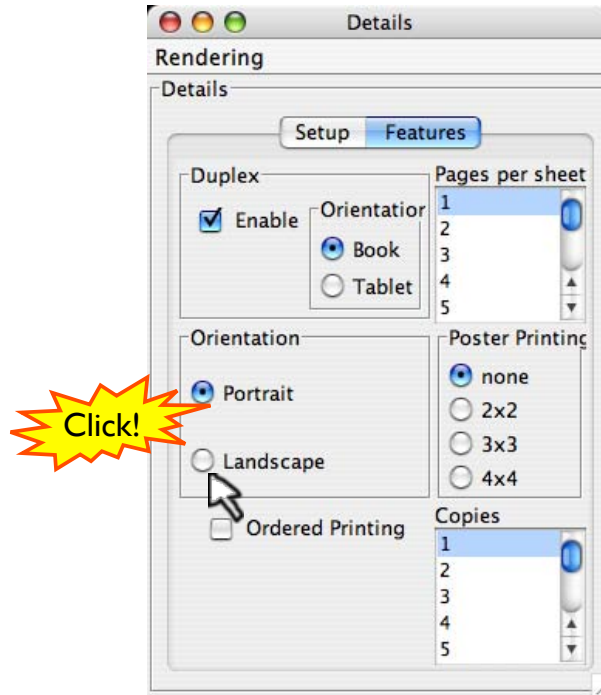
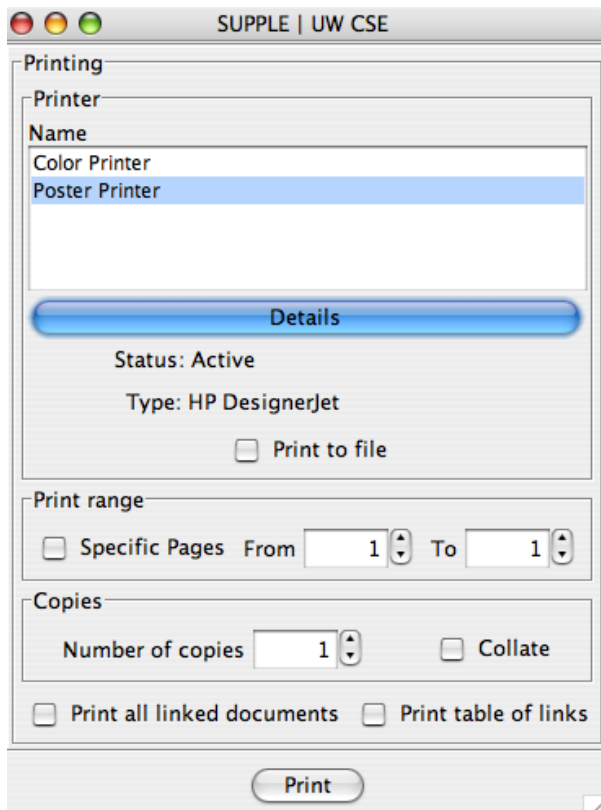




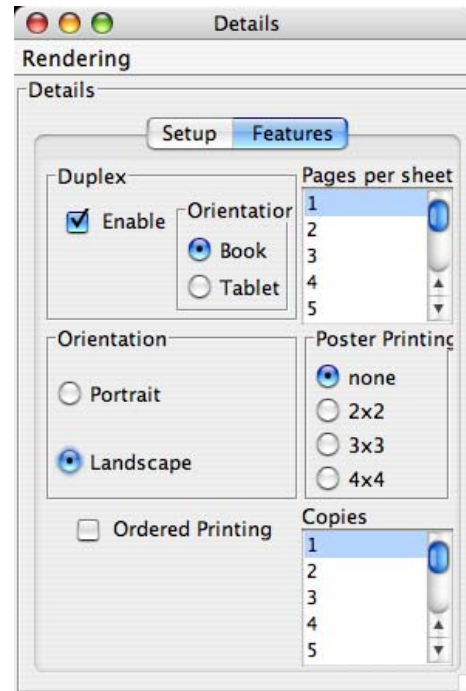
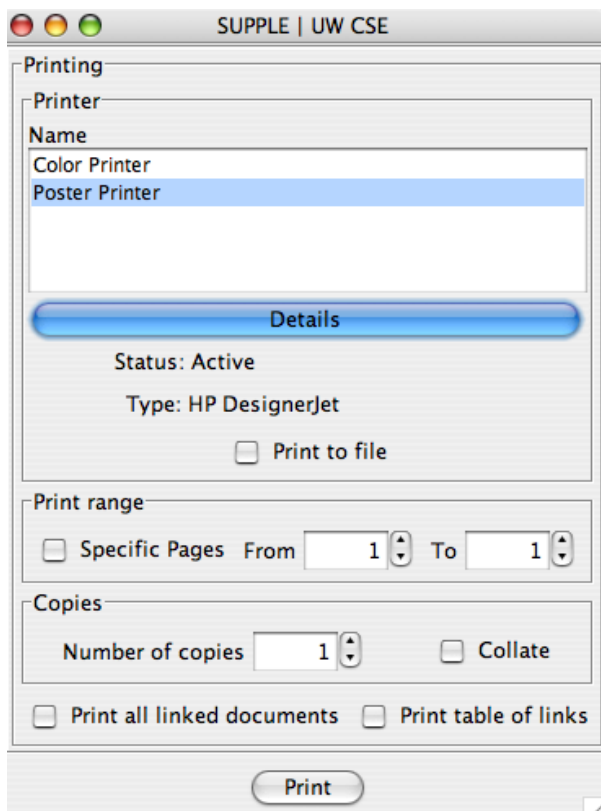
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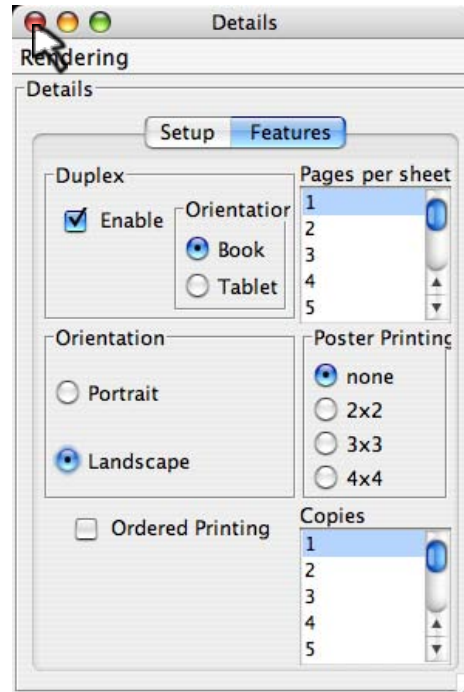
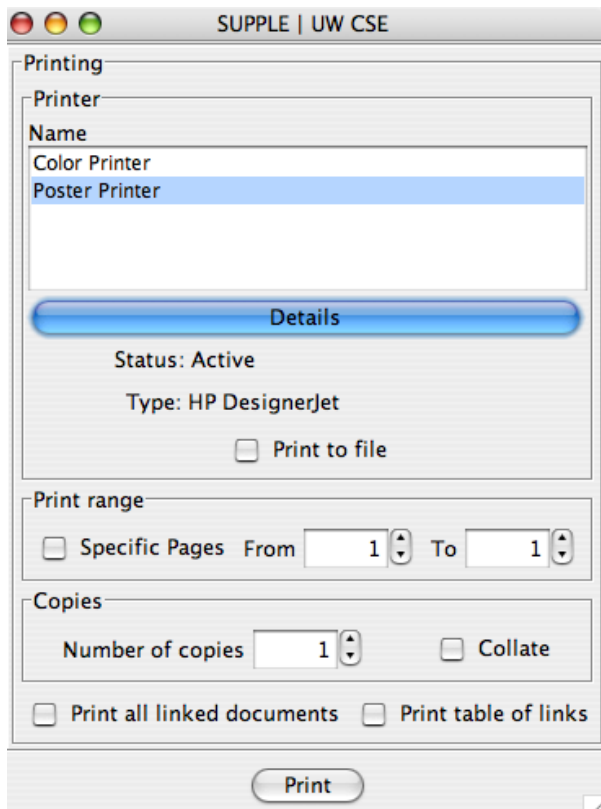
# Split Interfaces in SUPPLE



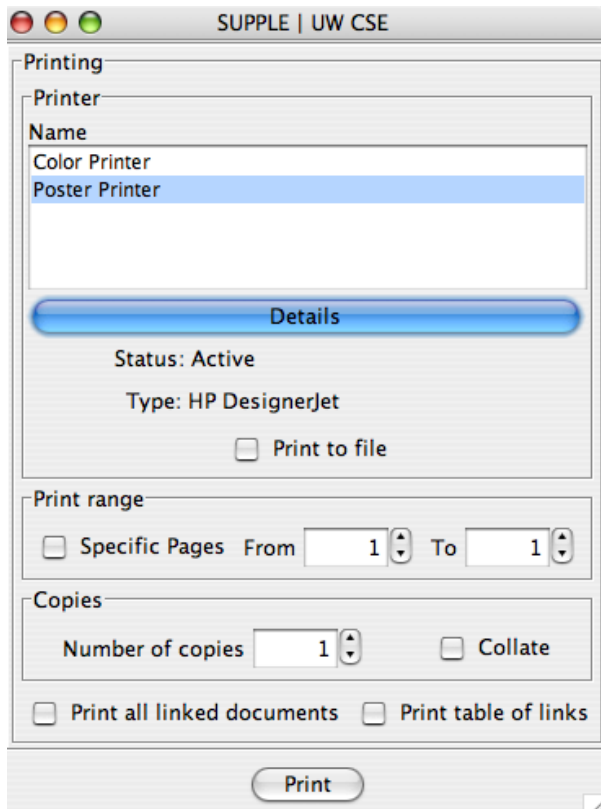
# Split Interfaces in SUPPLE



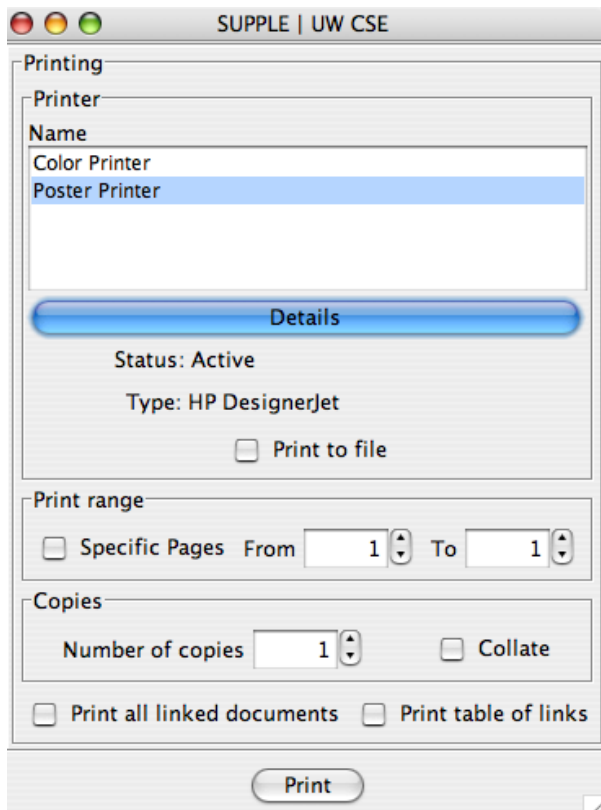
# Split Interfaces in SUPPLE



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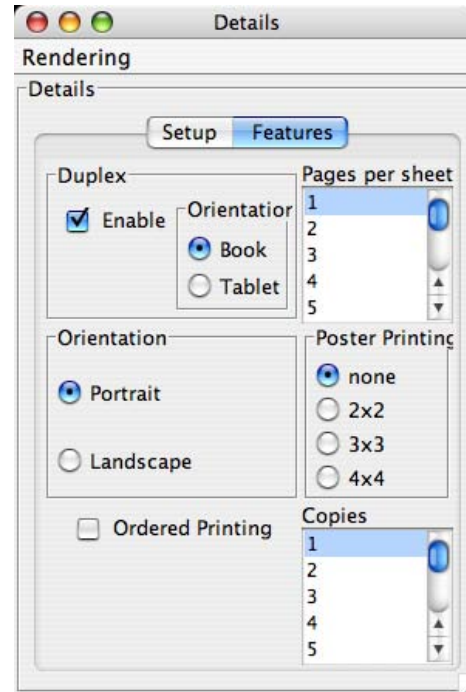
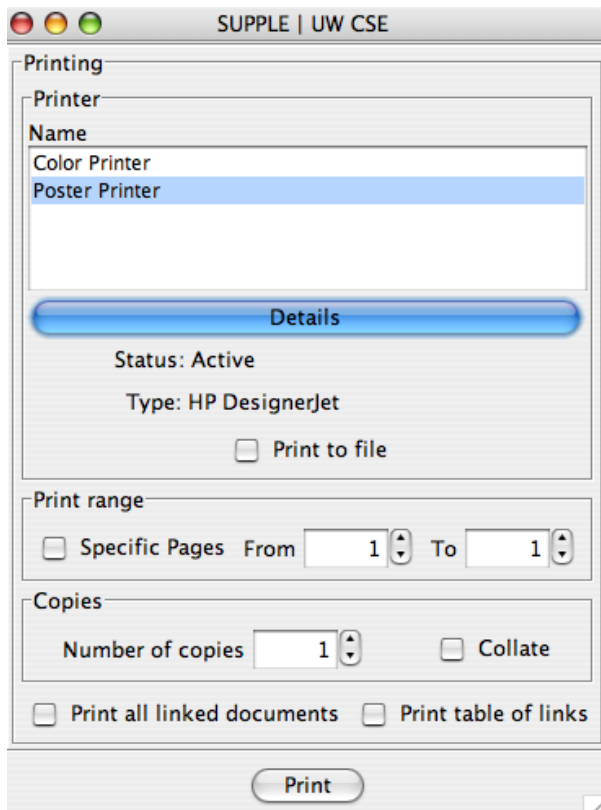


# Split Interfaces in SUPPLE

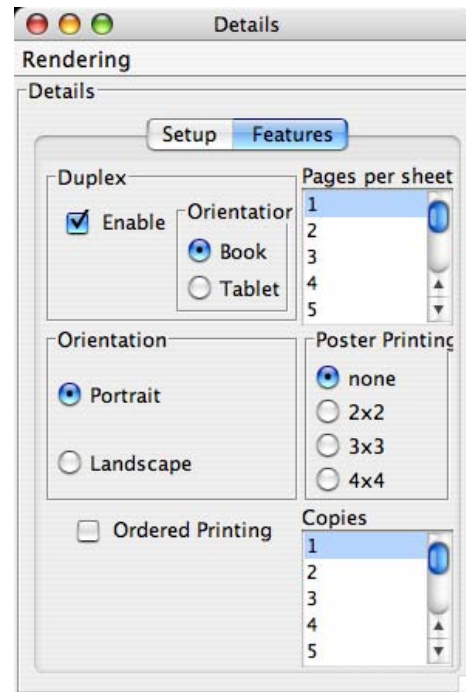
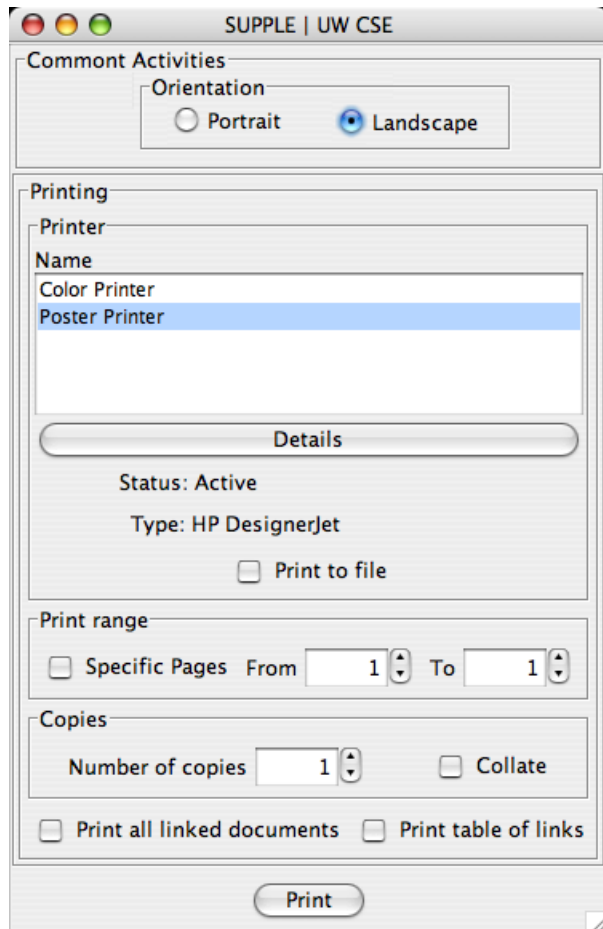


Four extra clicks  
required just to print in  
landscape mode!

# Split Interfaces in SUPPLE

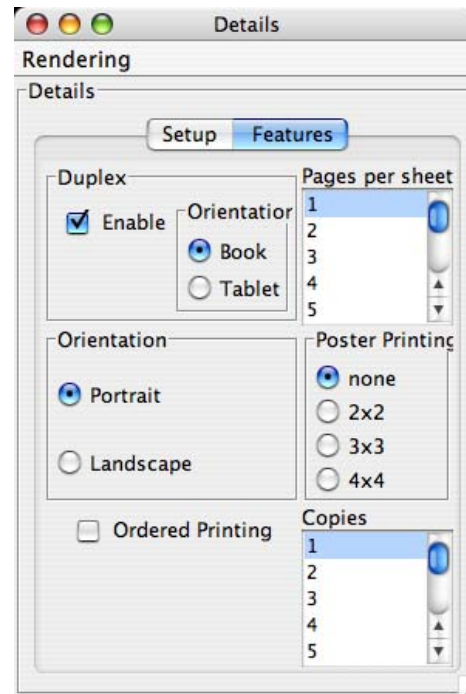
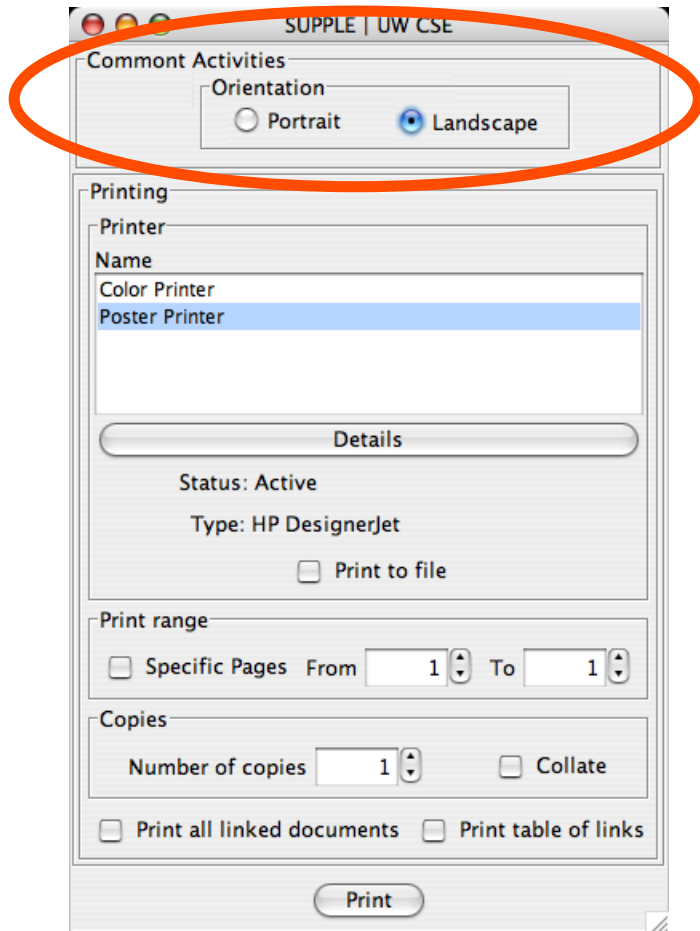


# Split Interfaces in SUPPLE





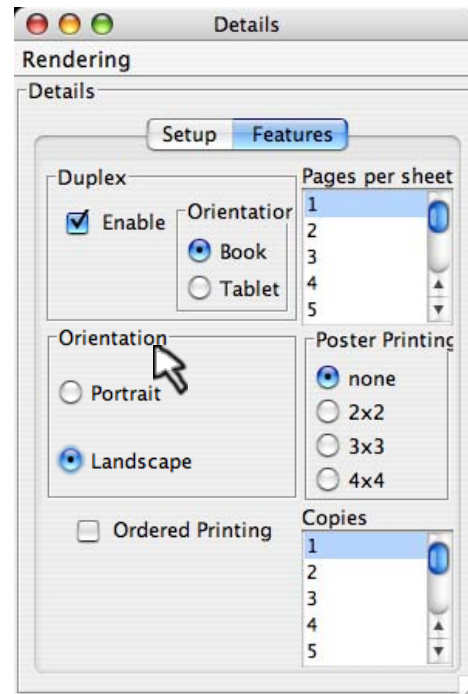
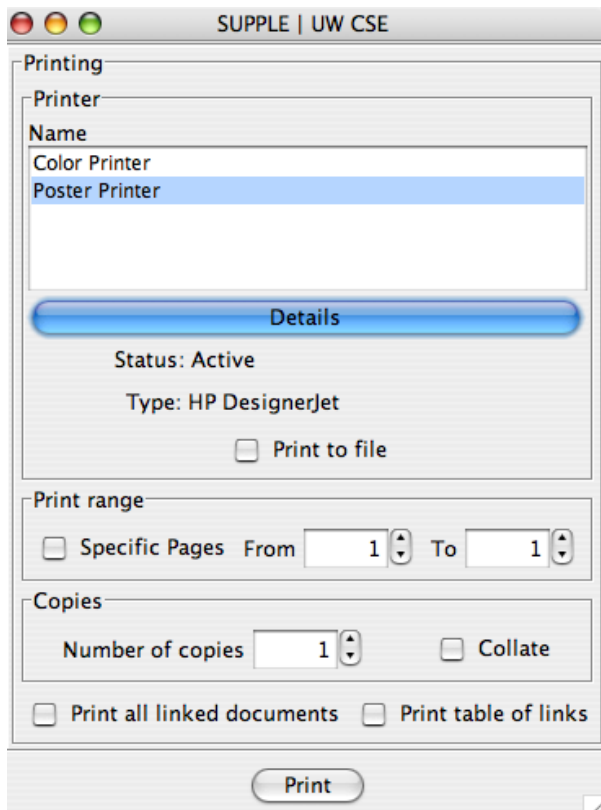
# Split Interfaces in SUPPLE



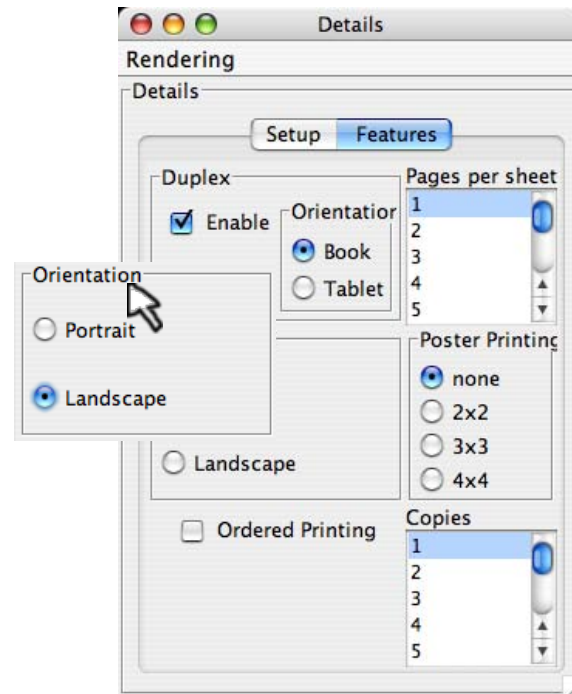
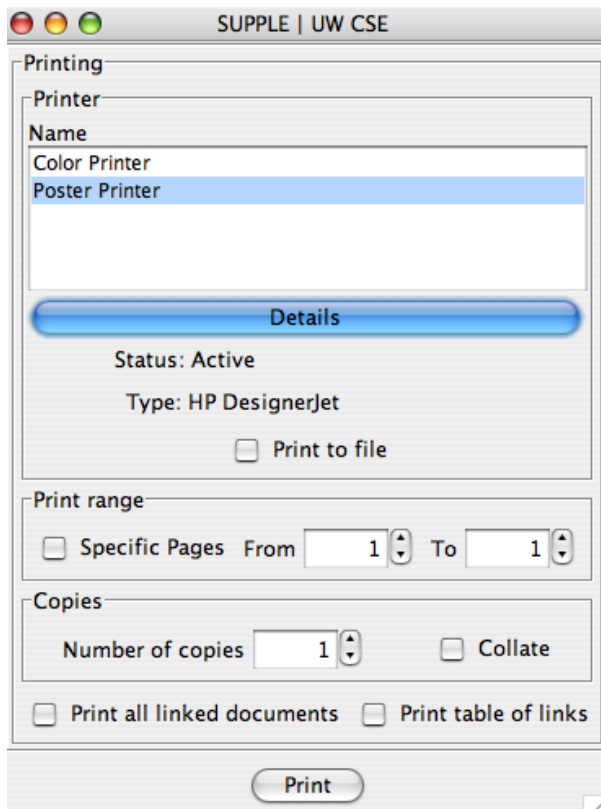
# System- Vs. User-Initiated Adaptation: Customization

- Customizing any part of the interface with drag and drop
- Out of order undo
- Generalization

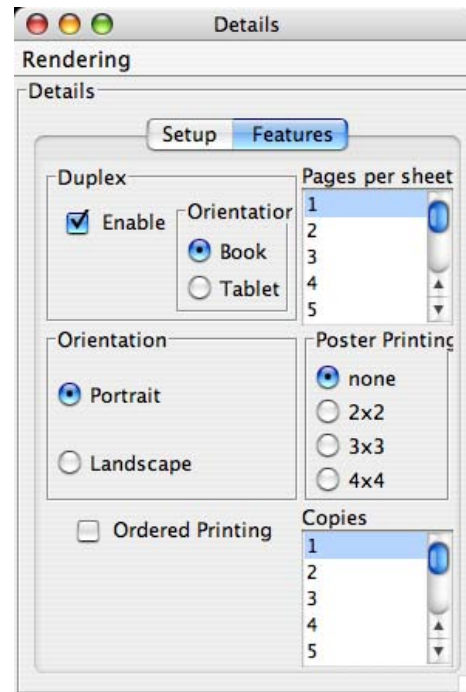
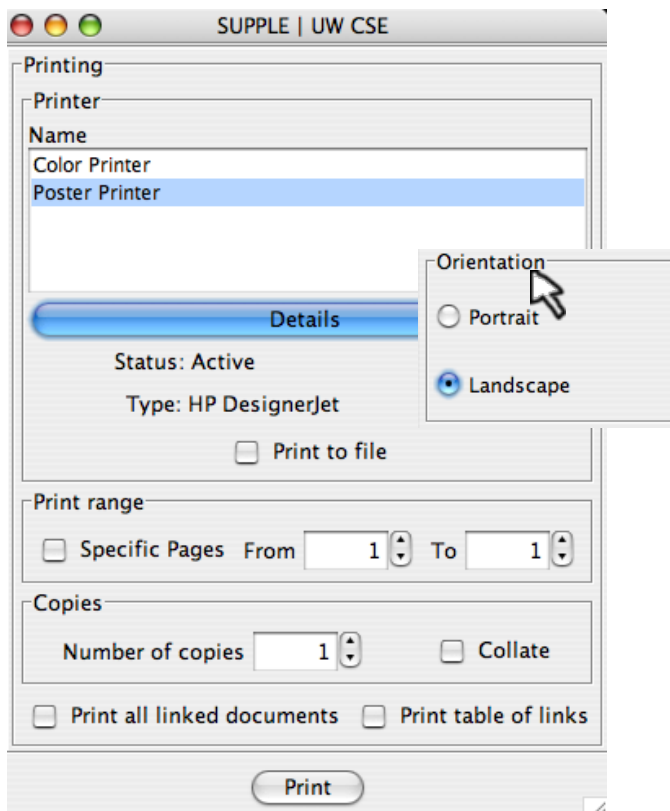
# Customization



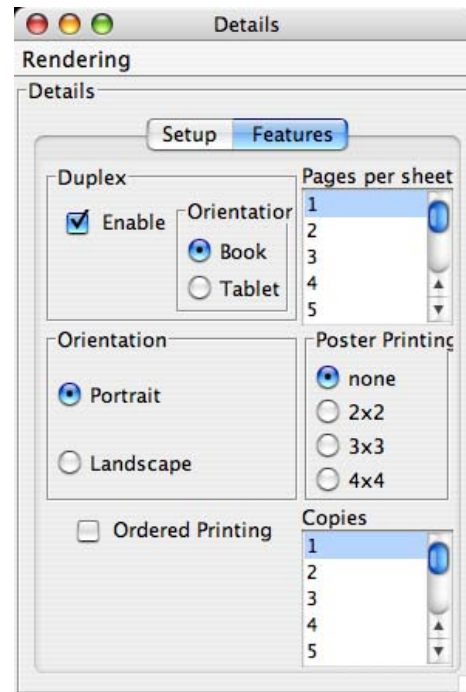
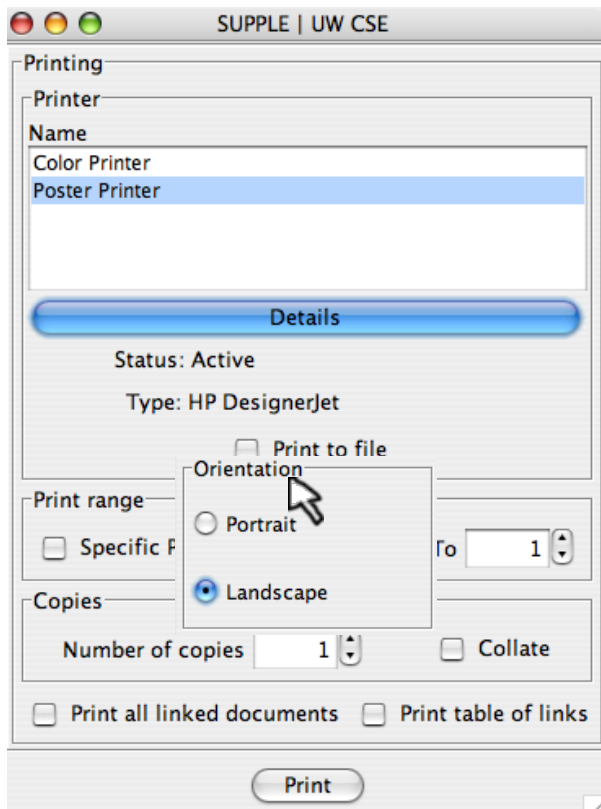
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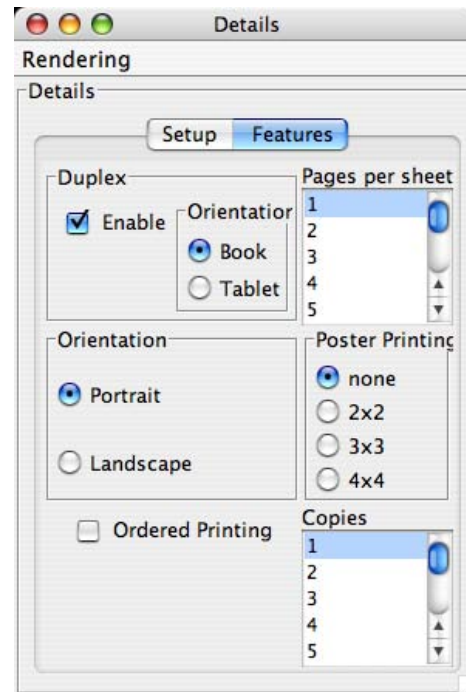
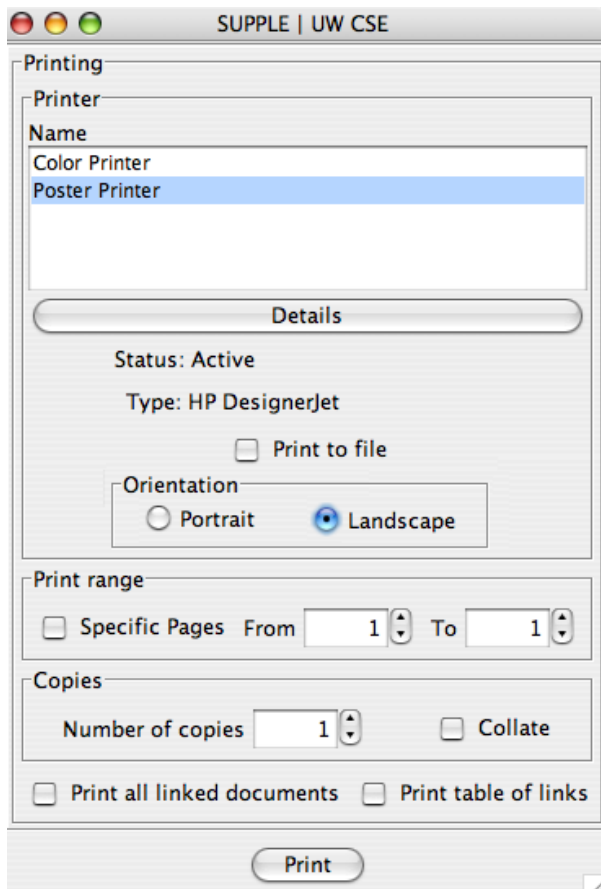
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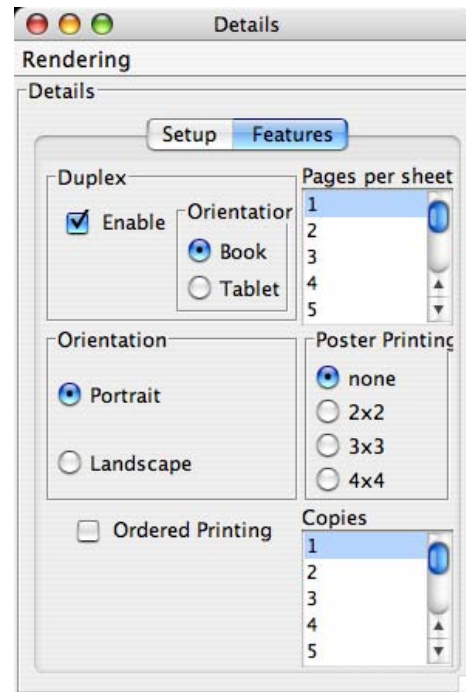
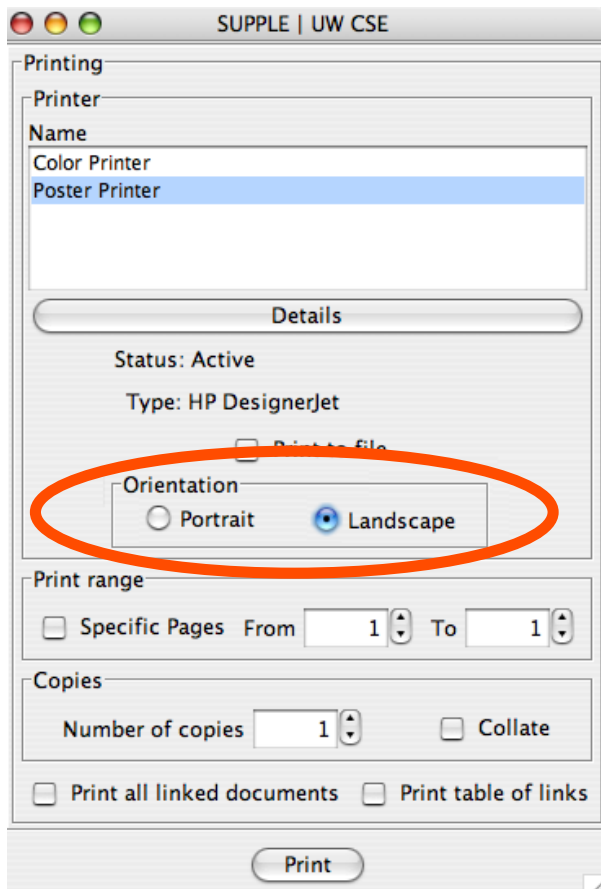
# Customization



# Customization



# Customization





# Road Map

- Motivation
- Modeling user interfaces in SUPPLE
- User interface generation as optimization
- Automatically adapting user interfaces
  - A preliminary user study
  - Adaptation in SUPPLE
- Customization support in SUPPLE
- Conclusions

# Conclusions

- A powerful, flexible and practical tool for automatically generating user interfaces for multiple devices
- Adaptation and customization offer the possibility of creating custom-made UIs for each user
- Support for distributed operation and caching makes it practical even on small devices

**Can I Have It?**

# Can I Have It?

**Yes!**

- We are awaiting permission to release SUPPLE as an **open source** toolkit
- Visit SUPPLE web site to sign up for the user's mailing list

# Contributors



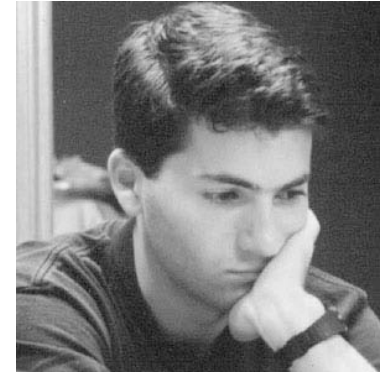
Daniel Weld



Dave Christianson



Raphael Hoffmann



Tal Shaked



Kiera Henning



Jing Jing Long




Anthony Wu



me

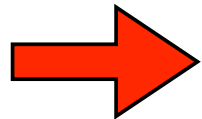
# More Information

- **SUPPLE:**  
<http://www.cs.washington.edu/ai/supple/>  
: supple interfaces
- **Krzysztof Gajos:**  
[kgajos@cs.washington.edu](mailto:kgajos@cs.washington.edu)
- **Daniel Weld:**  
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