Flexible Visual Authoring Using Operation History

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Digital authoring

Precise and complex editing

Collaboration, dissemination of content

Experimentation

- Undo lowers the cost of mistakes

Revisiting history

- Storing and retrieving state

Hierarchical authoring

- Grouping, structure, selections

Operations and selections today

Uses of **history**

- System activity logs, instrumentation (not our focus)
- Operation history, undo
- Version control
- Tutorials

Uses of **selections** and **grouping**

- Efficient editing of sets of items (multiple selections)
- Hierarchical modeling, CAD

Motivation

Address limitations of standard techniques

- Undo - sequential
- Selections - not persistent
- Grouping – rigid structure expensive to modify

Thesis:

Reusing operations, selections, and groups from a document's history can improve interaction for the end user.

Enhancing authoring and review

Visualizing history for non-linear interaction

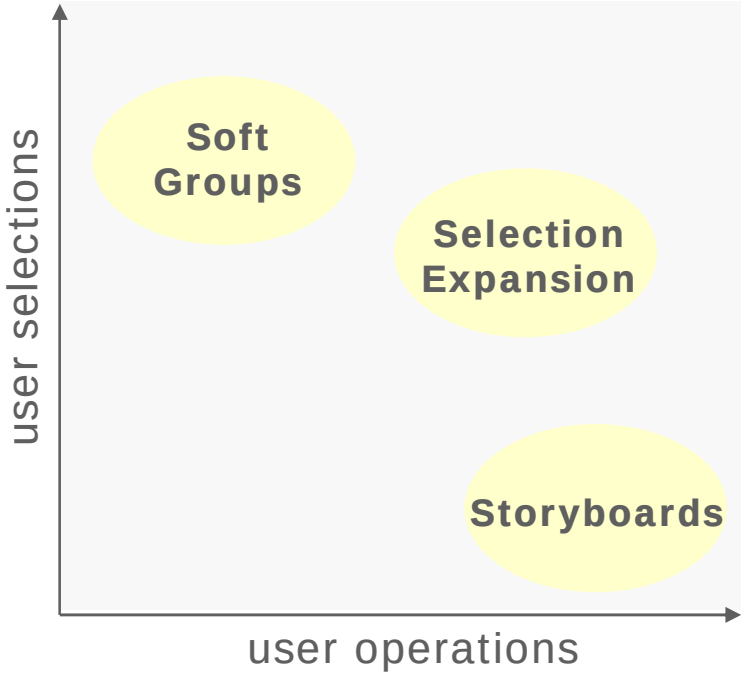
Storyboards: Interactive Visual Histories

Reusing complex selections for efficiency

History-Based **Selection Expansion**

Enabling bookmarking for flexible grouping

Soft Groups: Multiple Selection Authoring and Reuse



Thesis context

Demonstrate techniques in context of **visual authoring**

- Features in Inkscape vector graphics editor

Human component

- Evaluations with beginner- and intermediate-level users
- Iterative design

Talk outline

Interactive Storyboards

Visualizing history for non-linear interaction

Selection Expansion

Reusing complex selections for efficiency

Soft Groups

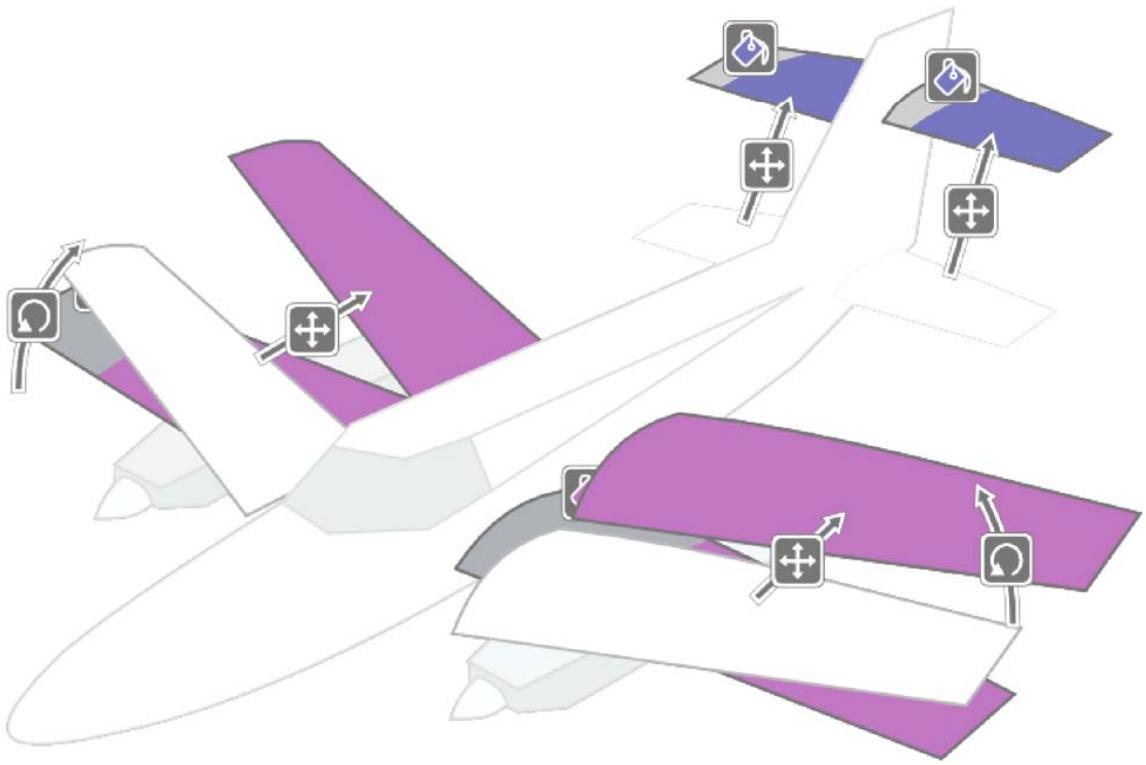
Flexible authoring of multiple selections

Interactive Storyboards

Visualizing history for non-linear interaction

Selection Expansion

Soft Groups



Motivation: Visual histories

Enable flexible **browsing** of history

- Design a more intuitive interface to document's editing history
- Show history in spatial context

Enable flexible **manipulation** of history

- Interface to selective undo

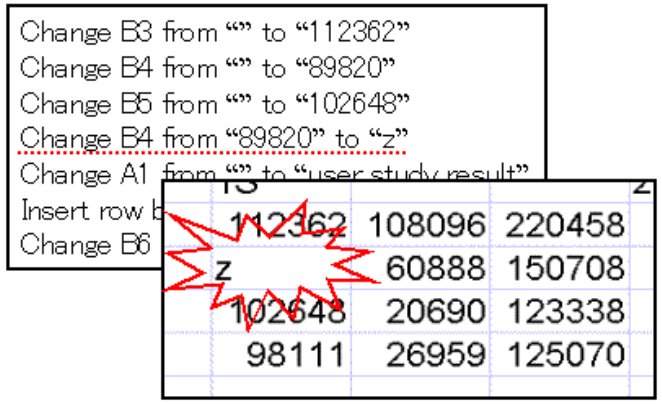
Related work: Undo

Undo

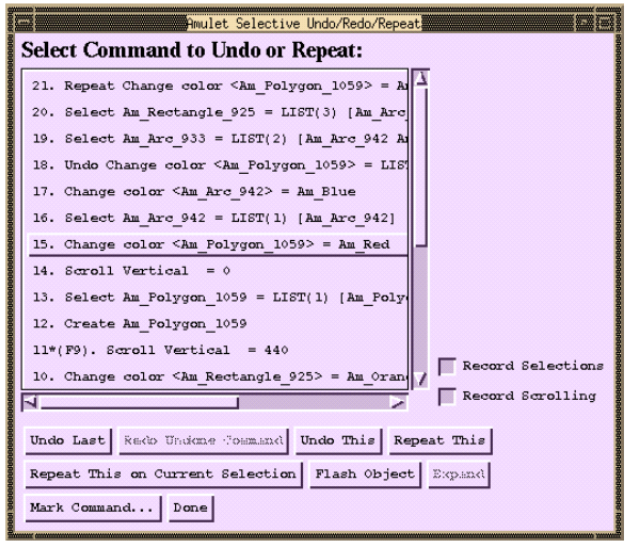
- Revisit history
- Undo arbitrarily far back
- Sequential

Selective undo

- Text
- Spreadsheets
- Graphics



[Kawasaki and Igarashi 2004]

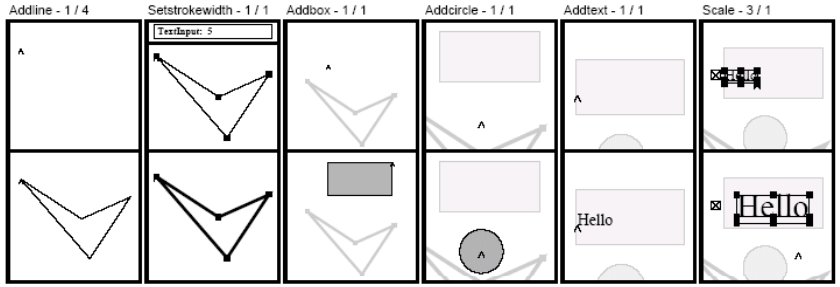


Amulet [Myers *et al.* 1997]

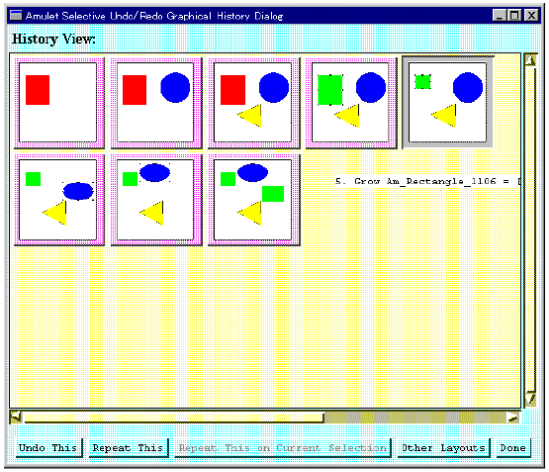
Related work: Graphical histories

Snapshots

Editable graphical histories



[Kurlander and Feiner 1990]

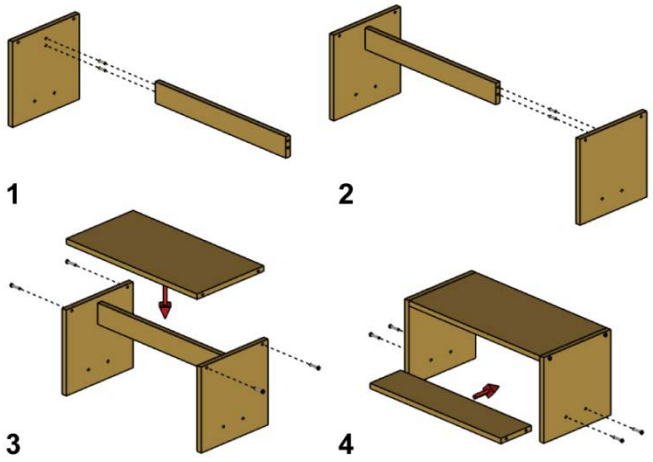


[Meng *et al.* 1998]

Film and schematic storyboards

Assembly diagrams

[Goldman *et al.* 2006]



[Agrawala *et al.* 2003]

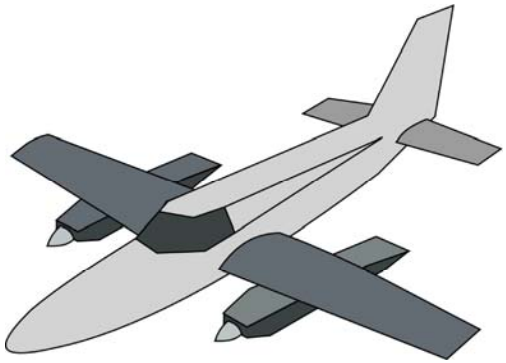
Our storyboard visualization

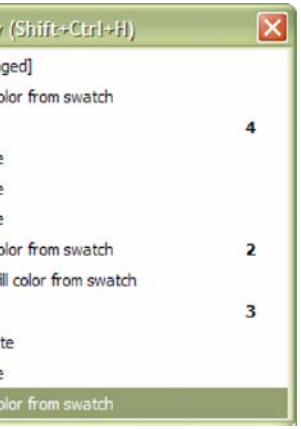
Graphically represents user editing actions

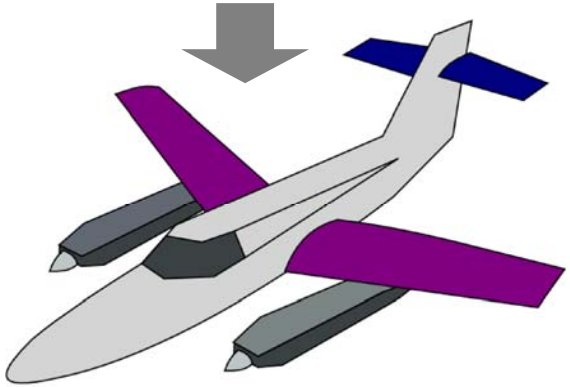
- Assembly instructions for a document

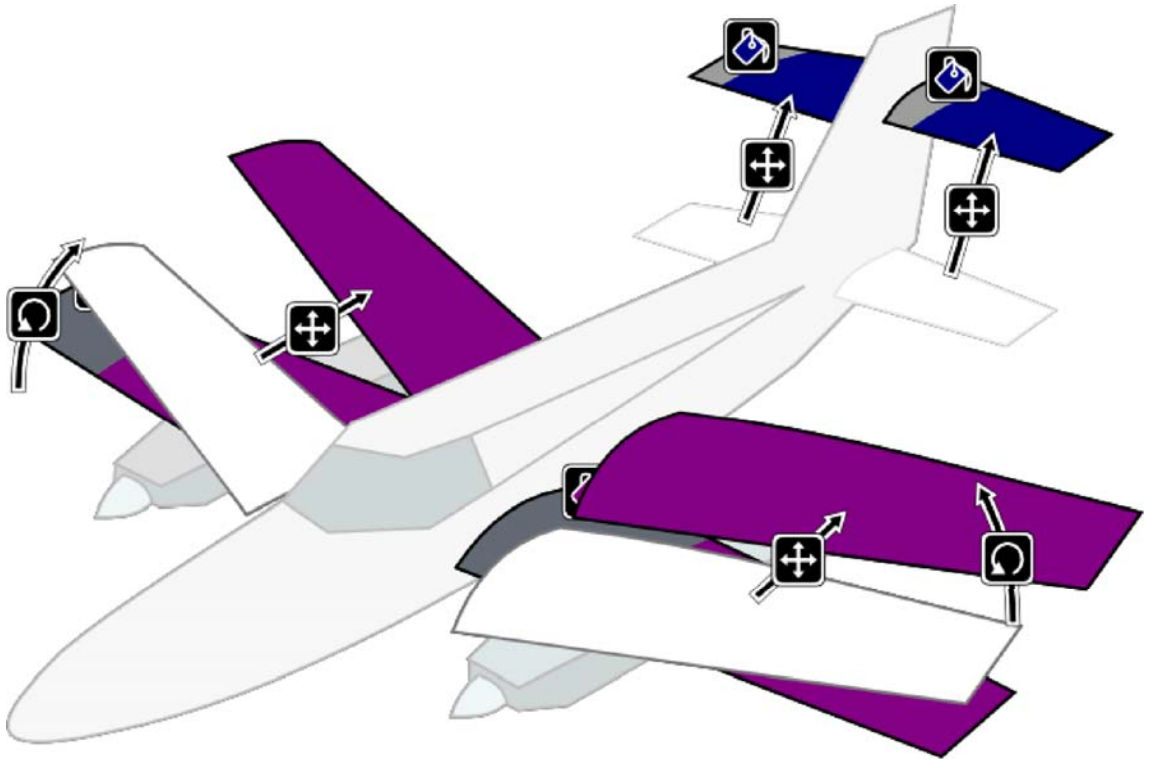
Shows actions in context: **action depictions**

- Must be descriptive, intuitive, and easy to select




Undo History (Shift+Ctrl+H)
[Unchanged]
Set fill color from swatch
Rotate 4
Move
Move
Move
Set fill color from swatch 2
Set fill color from swatch
Move 3
Rotate
Move
Set fill color from swatch





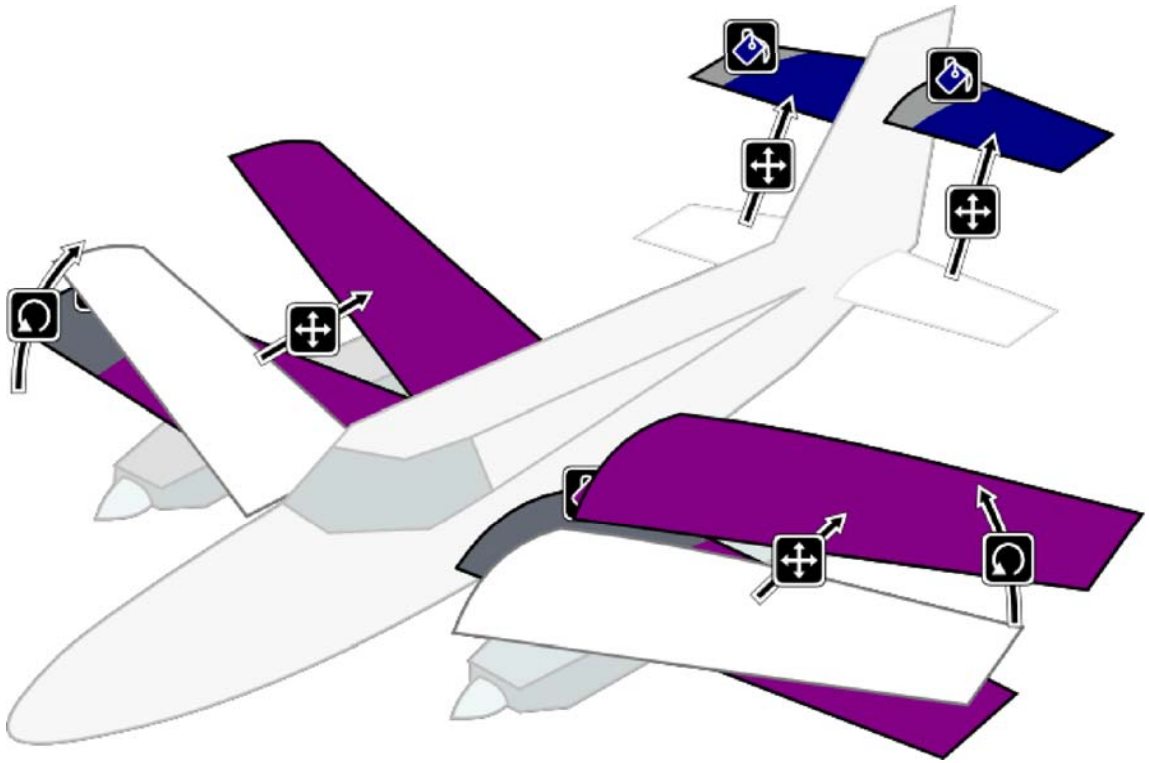
Our storyboard visualization

Graphically represent user editing actions

Show actions in context: **action depictions**

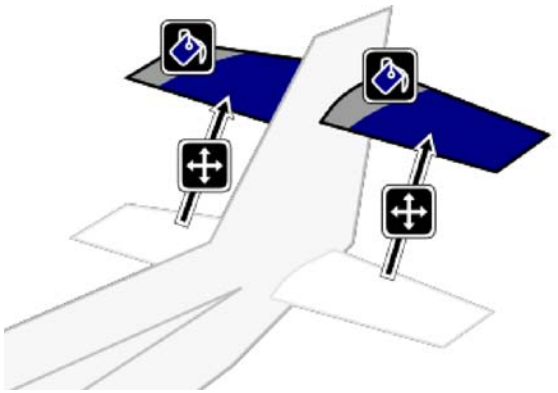
Design considerations

Discrete events
Before and after
In-place visualization
Summarization
Figure-ground separation



Applications

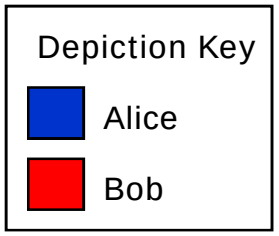
Selective undo

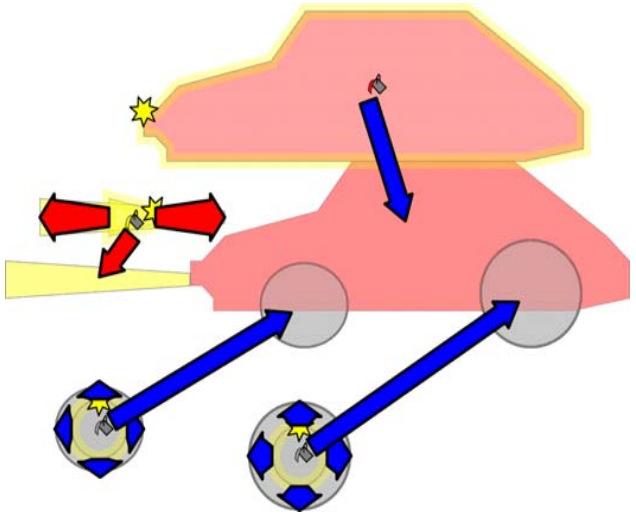


- User selects an action to undo
- Consider all later actions on the same object
- Cancel only those that are dependent
  - Spatial transforms: {translate, rotate}
  - Appearance changes: {fill change, stroke change}
  - Shape modifications: {scale, control point edit}

Collaborative editing

- “Track changes”
- Asynchronous editing by multiple users





Evaluation

Goals

- Record users' impressions after using storyboards for one hour
- Evaluate selective undo interface

Design

- 12 beginner-level users of 2D drawing programs
- Background interview, interactive tutorial
- Recreate a "typical" drawing

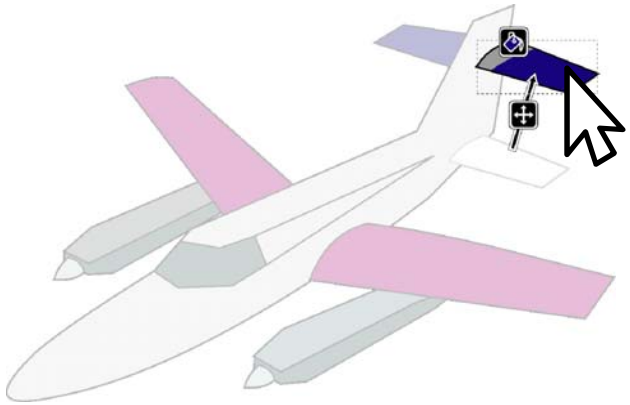
User feedback

- **Strengths**
  - Free experimentation
  - Spatial memory cues
  - Persistent history
- **Limitations**
  - Clutter, scalability

Addressing clutter

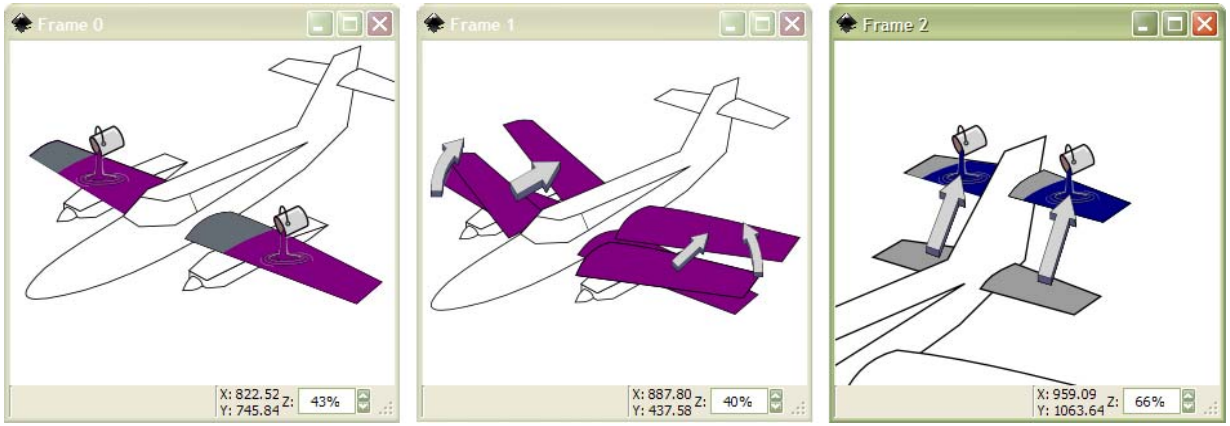
Per-object history

- “Magic lens” limits storyboard view



Multi-frame storyboard

- Multiple frames in a storyboard
- Multiple actions per frame



Summary: Interactive Storyboards

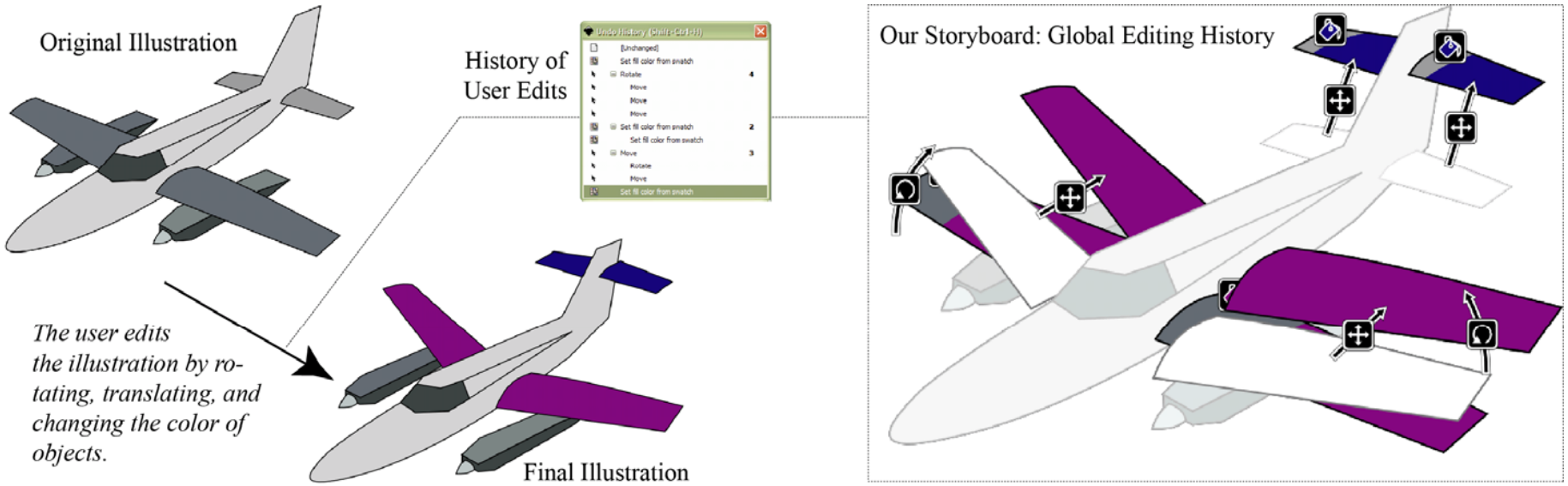
Interactive storyboards for visualizing history

- Browsing history in spatial context

Composite, per-object, and multi-frame storyboards

- Selective undo application

Collaborative editing

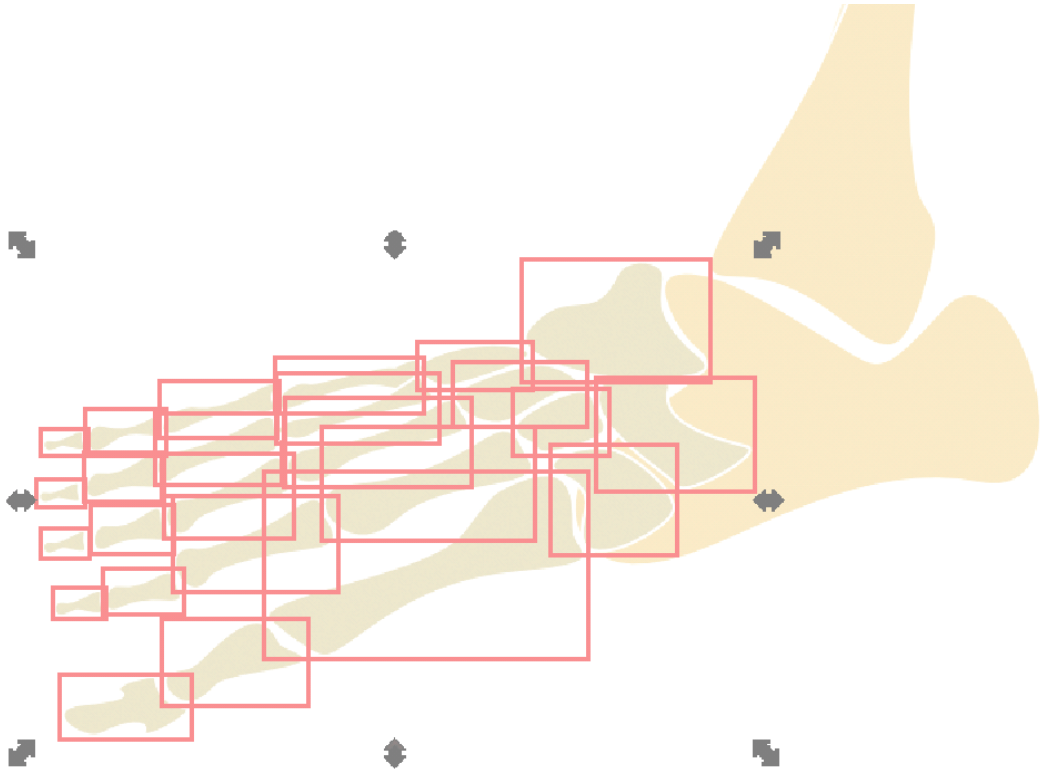


Interactive Storyboards

Selection Expansion

Reusing complex selections for efficiency

Soft Groups



Motivation: Selection reuse

Multiple selections are fundamental in editing

- Edit the same set of objects together
- Reselecting the set can be repetitive, laborious
  - Esp. with overlapping, occluding objects

Groups

- Intuitive, easy to build hierarchy
- An item cannot belong to more than one group at a time
- Ungrouping/regrouping expensive

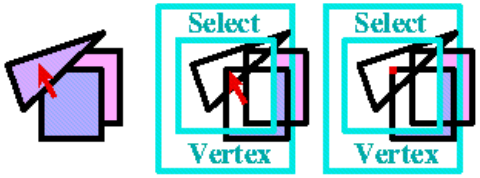
Related work: Selecting content

Transparency filters

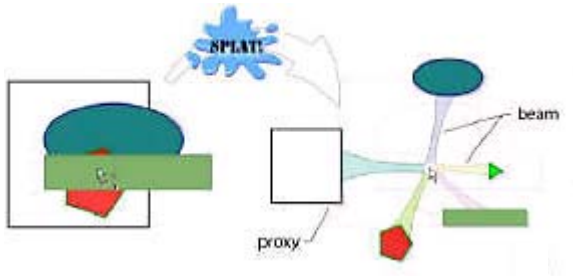
- Multiblending [Baudisch and Gutwin 2004]
- Context-aware free-space transparency [Ishak and Feiner 2004]

Physical interaction metaphors

- “Paper peeling” windows [Beaudoin-Lafon 2001]
- Exposé [Apple 2003]



Magic Lens [Bier *et al.* 1993]



Splatter [Ramos *et al.* 2006]

Related work: Complex selections

Generalizing selections

- Selection guessing [Miller and Myers 2002]
- Selection classifier [Ritter and Basu 2009]
- Interactive query relaxation [Heer *et al.* 2008]

Related work: Adapting user interfaces

Resize/rearrange menus to reduce target acquisition time

- Fisheye menus [Bederson 2000]
- Flexcel [Thomas and Krogsæter 1993]

Dynamically organizing menu items – frequency, recency

- [Greenberg and Witten 1985]
- [Mitchell and Shneiderman 1989]
- Split menus [Sears and Shneiderman 1994]

Selection expansion

Hypothesis:

Items that have been edited together are likely to be edited together again.

From an initial selection, **expand** to a larger set

Base the expansion on **frequency** of use

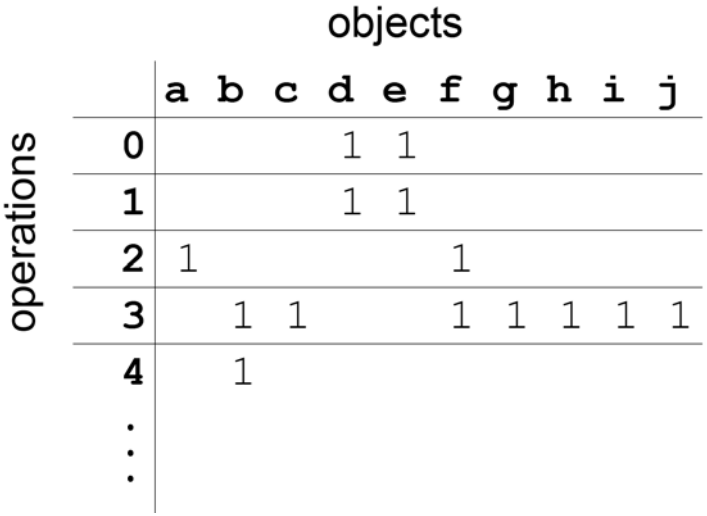
Greedy expansion strategy

User makes a selection (query)

Look in operation history for single best item to add

- Candidates = items that have been edited with the query set
- Pick the item appearing most frequently

Expand the selection by one

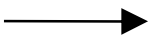


A simple example

User's initial selection is {e}

Excerpt: Operations affecting {e}:

operations \ objects	a	b	c	d	e	f	g	h	i	j
0				1	1					
1				1	1					
10				1	1	1	1			
11					1		1			
20				1	1	1	1			
24				1	1					
30					1		1			
32					1					



Compressing the matrix:

operations \ objects	a	b	c	d	e	f	g	h	i	j
0				3	3					
10				2	2	2	2			
11					2		2			
32					1					

Query = {e}

Candidate object d:

Frequency = 5

objects

operations	a	b	c	d	e	f	g	h	i	j
0				3	3					
10				2	2	2	2			
11					2		2			
32					1					

Candidate object f:

Frequency = 2

objects

operations	a	b	c	d	e	f	g	h	i	j
0				3	3					
10				2	2	2	2			
11					2		2			
32					1					

Candidate object g:

Frequency = 4

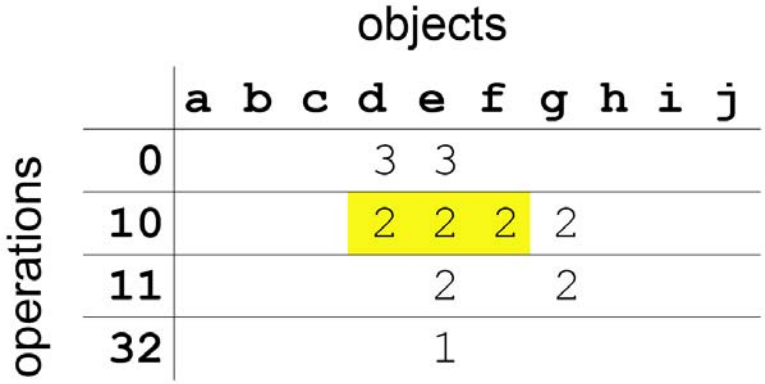
objects

operations	a	b	c	d	e	f	g	h	i	j
0				3	3					
10				2	2	2	2			
11					2		2			
32					1					

Query = {e,d}

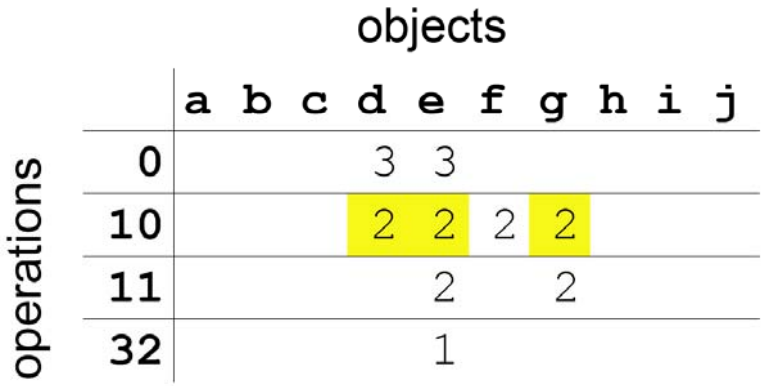
Candidate object f:

Frequency = 2



Candidate object g:

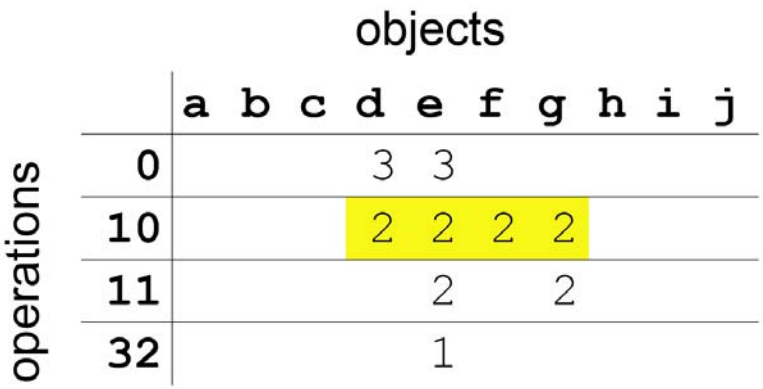
Frequency = 2



Query = {e,d,f}

Candidate object g:

Frequency = 2



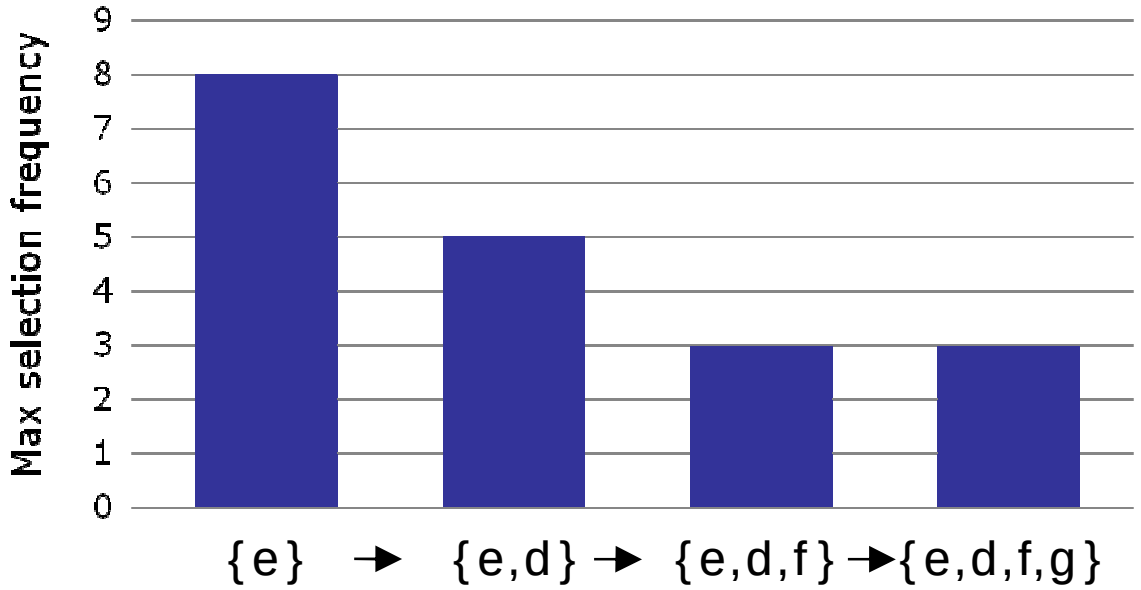
Three expansions:

{e} → {e,d} → {e,d,f} → {e,d,f,g}

Larger expansion steps

For efficiency, merge steps when we can

Look for plateaus in maximum selection frequency

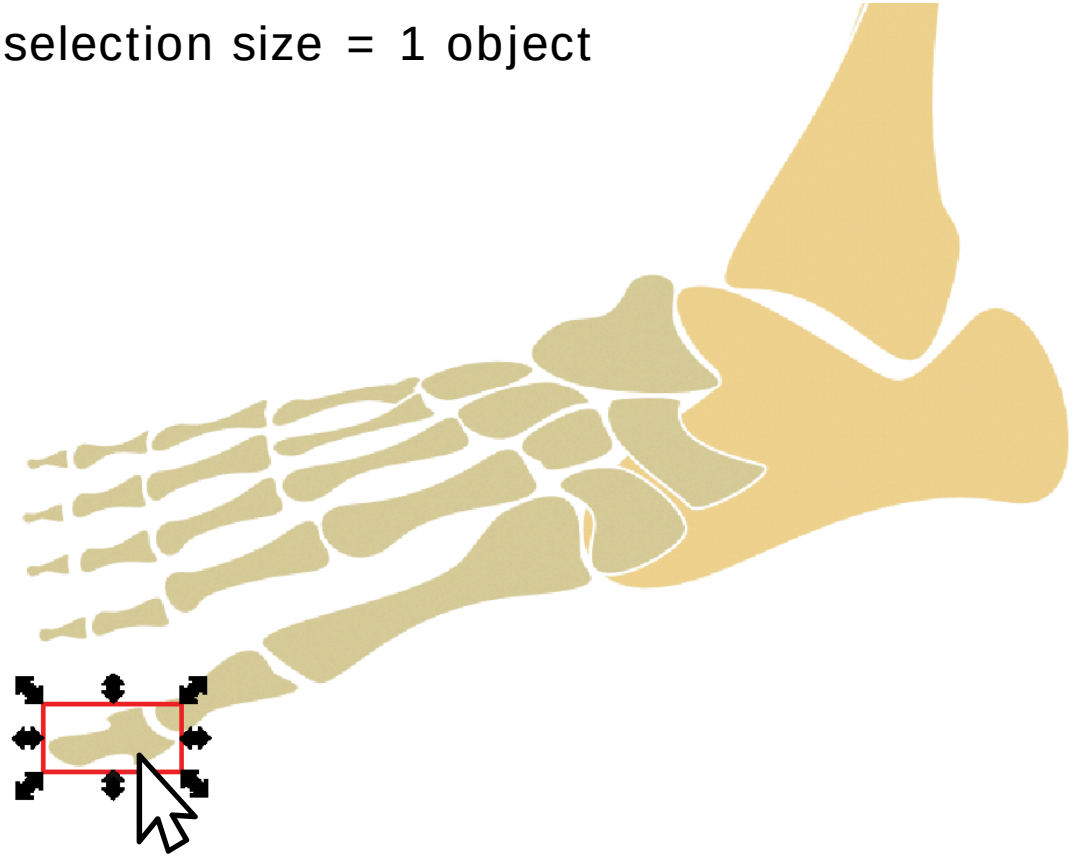


Two expansions:

{e} → {e,d} ⟶ {e,d,f,g}

Implementation: QuickSelect

selection size = 1 object



Evaluation of QuickSelect

Eleven subjects

- Recruited from general population
- All familiar with at least one 2D drawing program (not Inkscape)

Apparatus

- Controlled lab setting
- Modified version of Inkscape

Two-part study

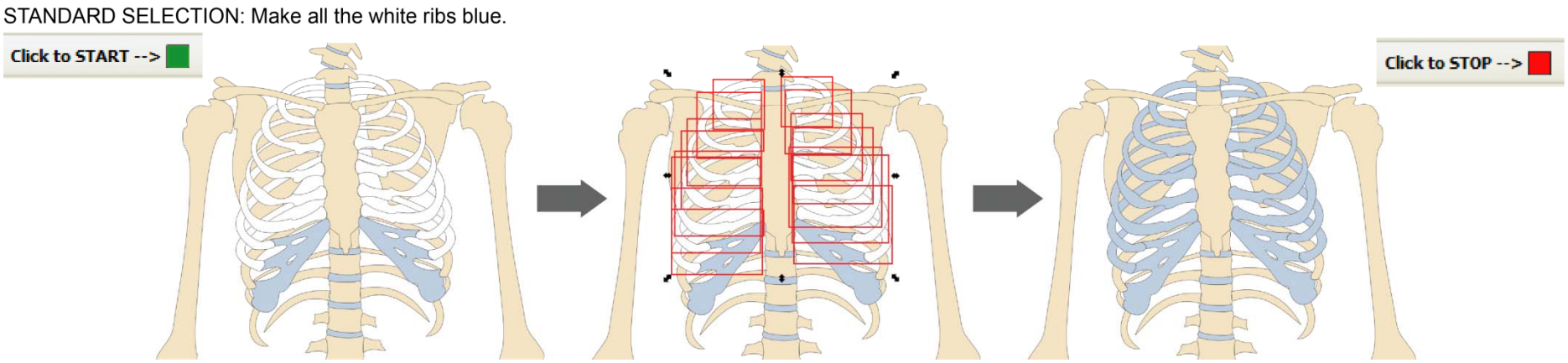
1. **Selection reuse with existing histories**
   - Evaluate how QuickSelect affects selection speed and accuracy
2. **Selection reuse in free drawing**
   - Record users' subjective preferences in unconstrained drawing

Study 1: Existing histories

Two **conditions**: standard selection, QuickSelect

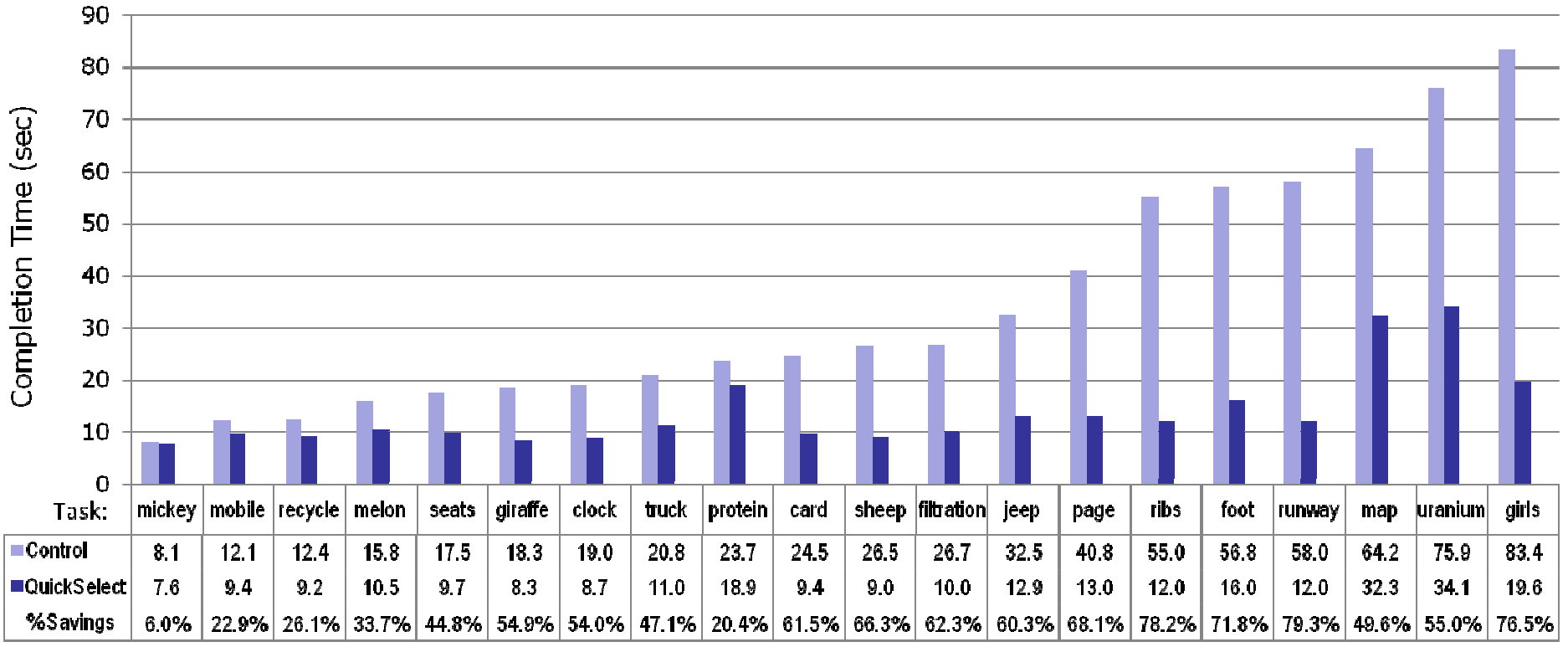
20 **tasks**: edit existing drawings

Procedure:



Hypothesis: QuickSelect will reduce time to complete the trials and reduce number of editing errors.

Results of Study 1



Task:	mickey	mobile	recycle	melon	seats	giraffe	clock	truck	protein	card	sheep	filtration	jeep	page	ribs	foot	runway	map	uranium	girls
Control	8.1	12.1	12.4	15.8	17.5	18.3	19.0	20.8	23.7	24.5	26.5	26.7	32.5	40.8	55.0	56.8	58.0	64.2	75.9	83.4
QuickSelect	7.6	9.4	9.2	10.5	9.7	8.3	8.7	11.0	18.9	9.4	9.0	10.0	12.9	13.0	12.0	16.0	12.0	32.3	34.1	19.6
%Savings	6.0%	22.9%	26.1%	33.7%	44.8%	54.9%	54.0%	47.1%	20.4%	61.5%	66.3%	62.3%	60.3%	68.1%	78.2%	71.8%	79.3%	49.6%	55.0%	76.5%

Increasing complexity of task

Study 2: Free drawing

Try selections in a more realistic setting

Procedure

- Recreate “typical” drawing described during interview
- Unstructured drawing with prompts to try different selections
- No measure of success

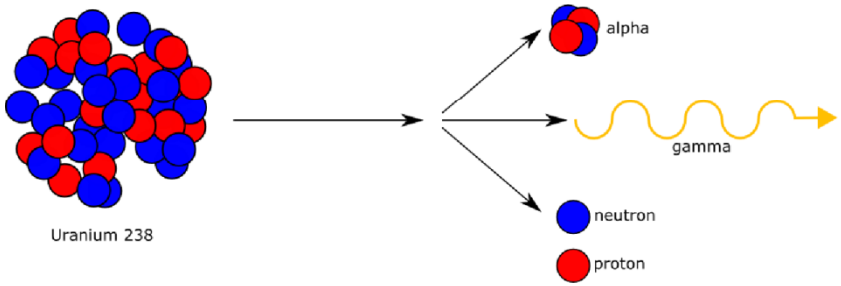
Feedback

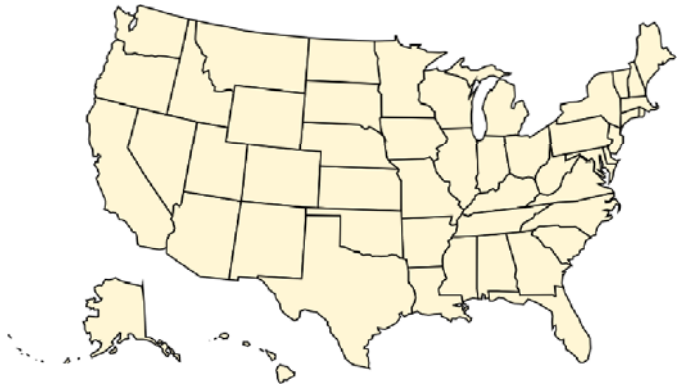
- Easy to learn and use
- Perceived improvement in speed
- Perceived improvement in accuracy
- Study 2 more convincing about applicability

Observations

Strengths of QuickSelect

- Performance savings larger for more complex designs
- Re-selecting occluded content
- Re-selecting objects of differing size





Limitations

- Predictability and error handling
- Combining selection tools
- Additional expansion heuristics

Summary: Selection Expansion

Reuse of multiple selections

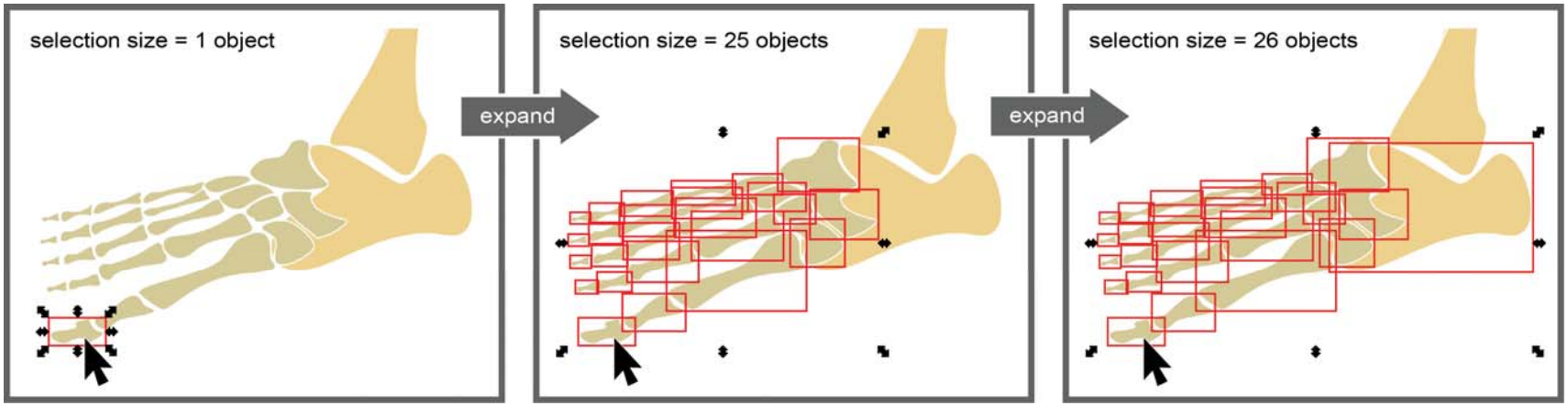
Simple yet effective history-based strategy

Easy to learn and apply

Selection reuse can increase efficiency

- Greater savings for more complex designs

Expansion behavior can be difficult to predict ⟶ soft groups



Interactive Storyboards

Selection Expansion

Soft Groups

Flexible authoring of multiple selections

Motivation: Flexible grouping

Groups

- Easy to use, membership in only one group at a time

Selections

- Membership created as needed, ephemeral

Selection expansion

- Reuse selections from history, lacks predictability

Related work

- Selecting, grouping, tagging
- Flexible grouping - ScanScribe [Saund et al. 2003]
- Relation building from history [Pedersen and McDonald 2008]

Soft groups

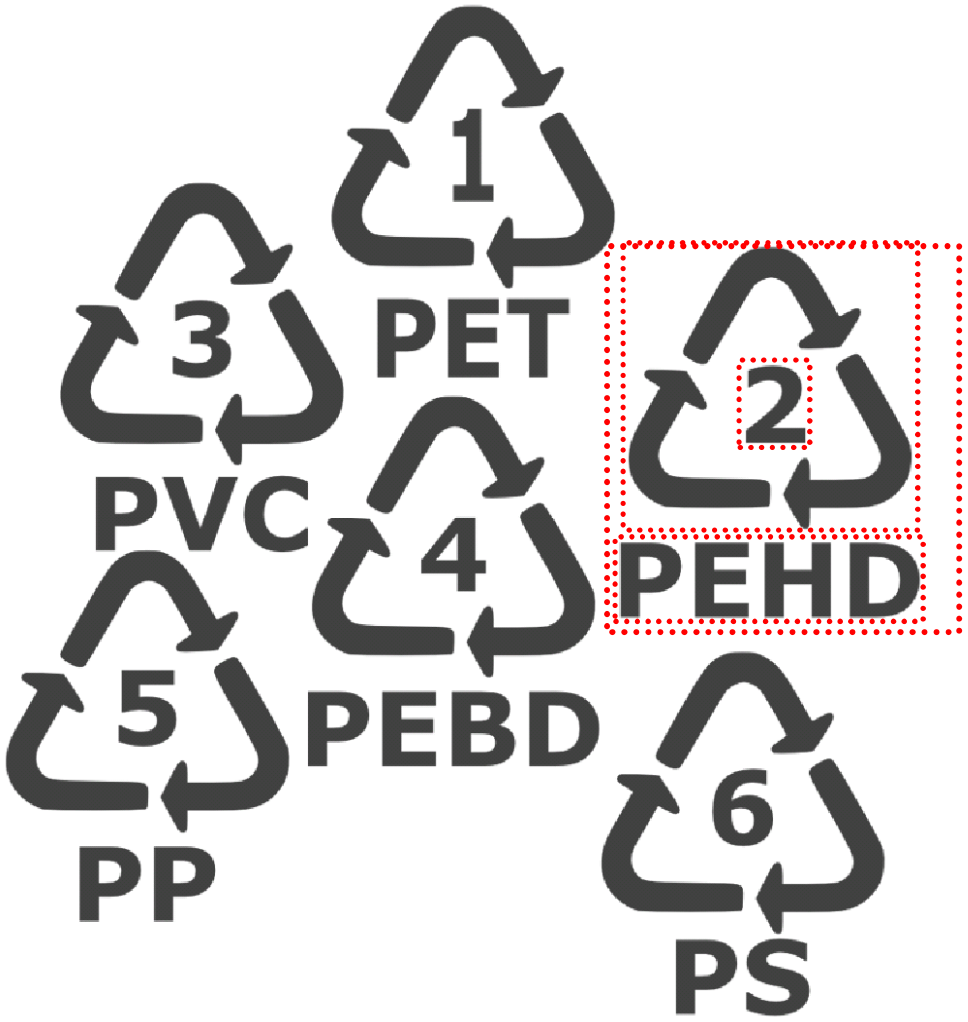
Users **bookmark** multiple selections they wish to reuse
Like groups, soft groups are **persistent** and **reusable**

An item can belong to more than one soft group

Like selections, soft groups appear **on demand**
Retrieval interaction similar to selection expansion
Expansion steps determined by user

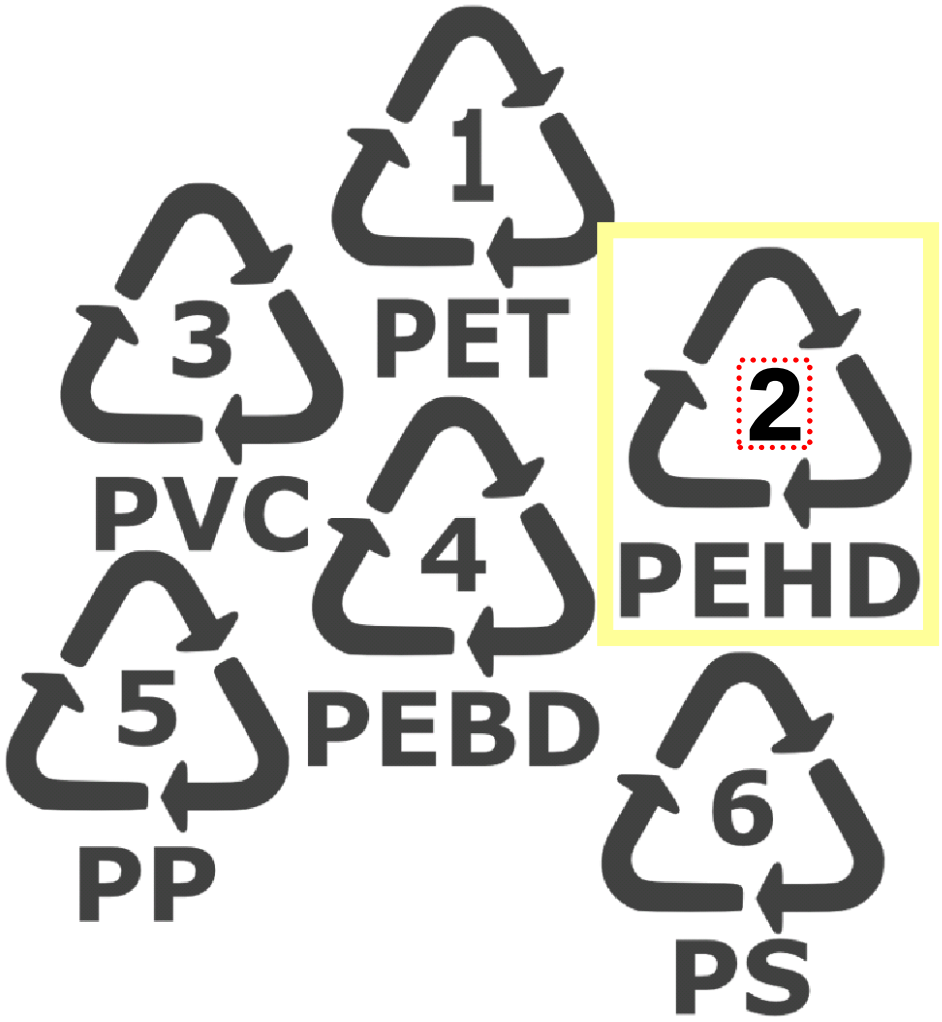
Group creation

Create Soft Group



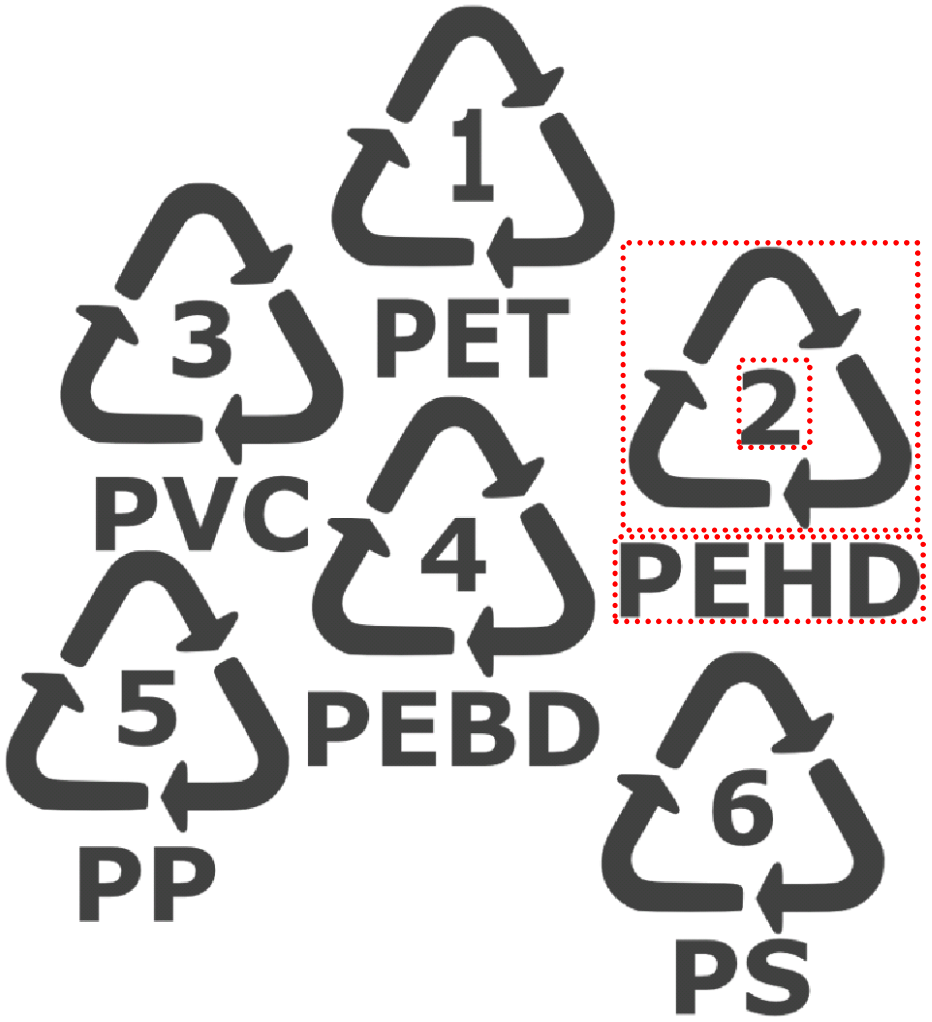
Group creation

Create Soft Group



Group retrieval

Retrieve Soft Group



Exploratory evaluation

Goals

- Get user feedback on ease of learning and use
- Compare soft groups to standard selection and grouping
- Compare soft groups to selection expansion

Nine beginner- to intermediate-level users of 2D software

Procedure:

- Recreate “typical” drawing described during interview
- Unstructured drawing with no measure of success
- First, asked to try soft groups
- Second, introduced to selection expansion

Observations from user study

Strengths of soft groups

- Straightforward use, easy to learn
- Spatial memory cues: “visual reminder”
- Improves efficiency of authoring
  - Fixed cost to creating soft groups but faster retrieval

Limitations

- Error handling
- Visibility, responsiveness

Comparison to selection expansion

- QuickSelect “seems faster” than soft groups
- Intermediate users concerned about cost of correcting QS
- SG offer more control

Summary: Soft Groups

Bookmarking selections for reuse

Complementary alternative to standard selection and grouping

Persistent like standard groups

Appear on demand like standard selections

Easy to learn and use

Users preference divided by experience

- Beginners: efficiency of selection expansion
- Intermediate-level users: control of soft groups

Summary of thesis contributions

Presented three uses of **history for the end user**

- **Interactive Storyboards**
- **Selection Expansion** (QuickSelect)
- **Soft Groups**

Demonstrated in the context of **vector graphics editing**

User evaluations suggest **increased efficiency and flexibility** in editing

Applications and open challenges

Prototyping

- Selection reuse for faster prototyping and testing of variations
- Storyboards lower the cost of experimentation

Collaboration

- Recorded history for collaborators

Education

- Storyboards as tutorials

Future work

- Other domains
- Expert users
  - Longer-term observation
  - Keystroke-level modeling

Conclusions

Bigger picture:

Mining operation history to enhance HCI

Demonstrated history-based techniques for improving
authoring and **review** processes

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