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Departamento de Electrónica,  
Telecomunicações e Informática

# Direct Manipulation



# Interaction/ Dialog styles

```
emails_32YSM~
instruções_mex_c_matlab~
java-how-to.txt
java-how-to.txt~
matlab-install.txt~
Notas_implementação_ProjectoP00~
notas_ros.txt~
```

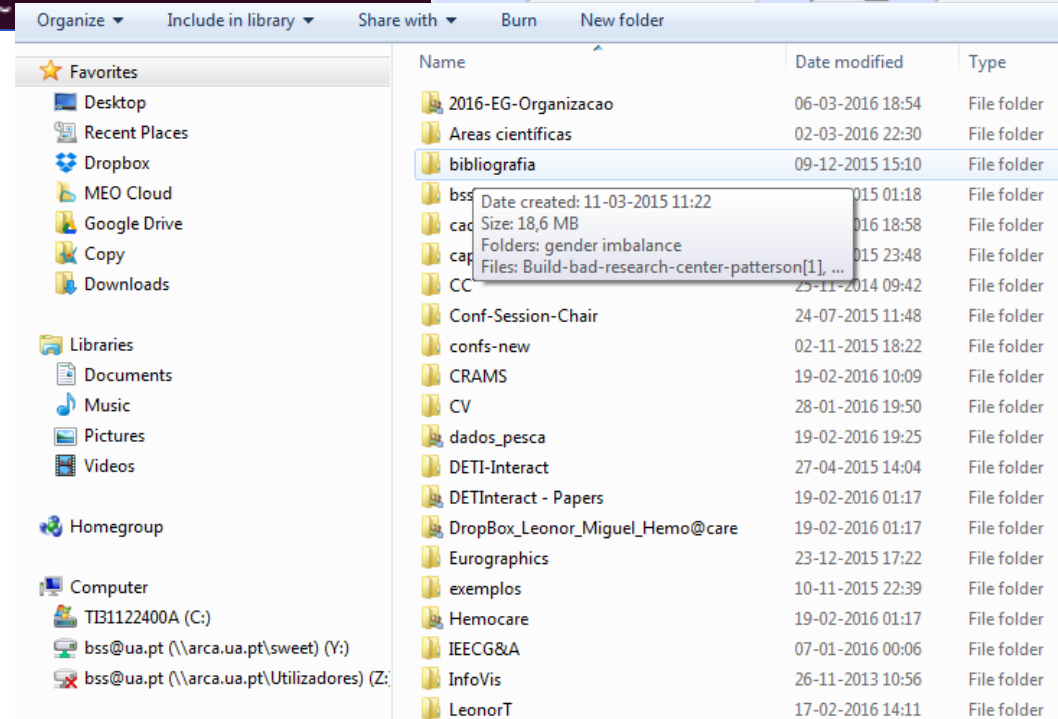
Name:

Address:

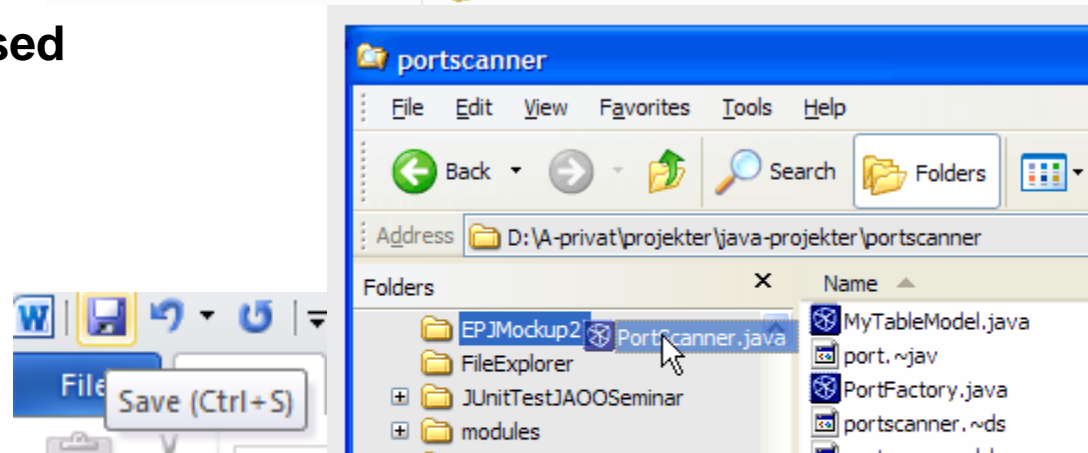
City:  State:  Zip:

## A possible classification:

- Menus
- Fill-in-forms
- Direct manipulation
- Function keys
- Question and answer
- Command languages
- Natural languages



Often two or more styles are used  
simultaneously



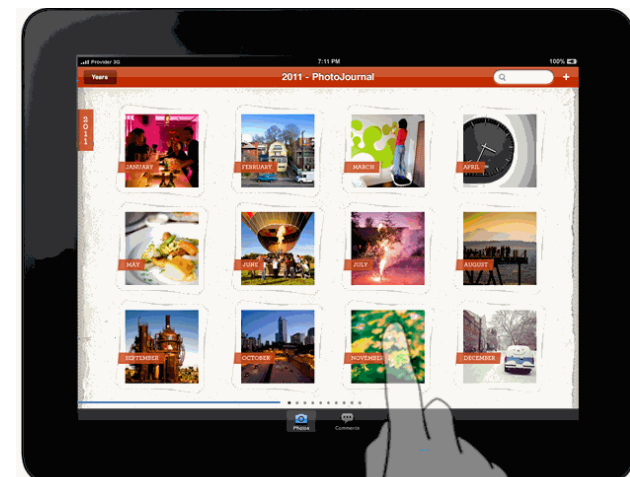
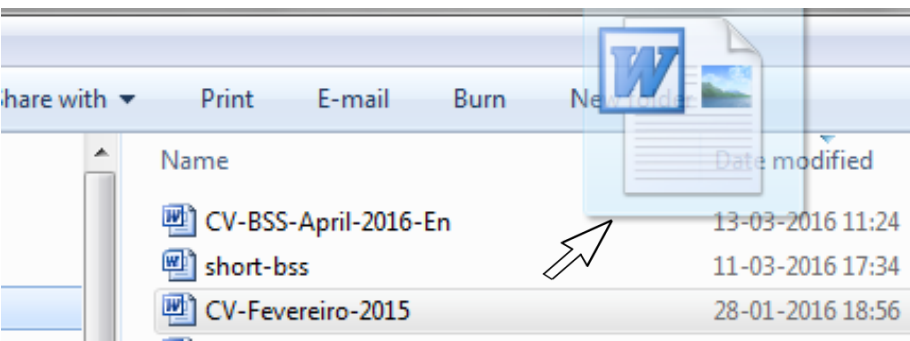
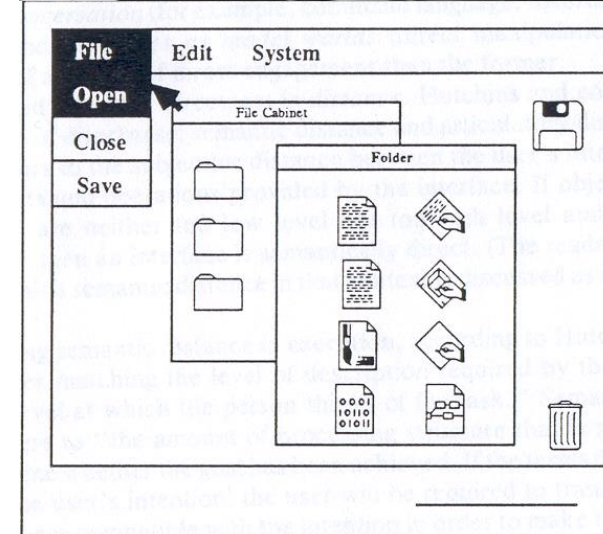
# Direct manipulation

(name coined by Shneiderman, 1982)

- Can be traced down to Sketchpad  
<https://www.youtube.com/watch?v=495nCzxM9PI>

- Actions are performed directly on visual representations of the objects
- It is characterized by:

- 1- Continuous representation of objects
- 2- Physical actions instead of command languages
- 3- Fast, incremental, reversible actions with visible results



Direct manipulation does not necessarily imply icons; however, in most situations they are involved

## 2 RELATED WORK

Despite the growing interest in usability related research in the VE community, not as many papers concerning usability evaluation exist, as compared to papers proposing new methods, techniques or systems. For instance, in a research recently conducted, we were able to find only a few studies directly comparing user performance while using VEs in desktops and systems including a HMD [Sousa Santos,2008] [Sousa Santos,2009]. Analyzing these studies, it can be observed that controlled experiments involving users have been the most used evaluation method, complemented in some cases with a questionnaire. We can also observe that most studies were performed in a general context (as opposed to applied to a specific situation), and that search and navigation were the chosen tasks in a significant part of them.

User studies have been considered an important method in other contexts, as Scientific Visualizations and Augmented Reality [Kosara,2003][Gabbard,2008]. We believe that they can, likewise, contribute to optimize VEs informing their design within a usability engineering approach; however, they can also be used to compare alternatives, validate solutions, and more fundamentally help seeking insight into why a particular solution is effective, thus allowing establish design guidelines.

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To study and compare usability issues concerning our low cost platforms we had to choose a context or use since usability cannot be defined in abstract. In fact, it is associated to users performing certain tasks [Nielsen,1993] (page 27) [Dix,2004] (page 192). Given that we had not a

Example: When a section of a text is selected and dragged elsewhere icons are not used, yet an action is performed on a visual representation of an object (text section)

Direct manipulation does not necessarily imply icons; however, in most situations they are involved



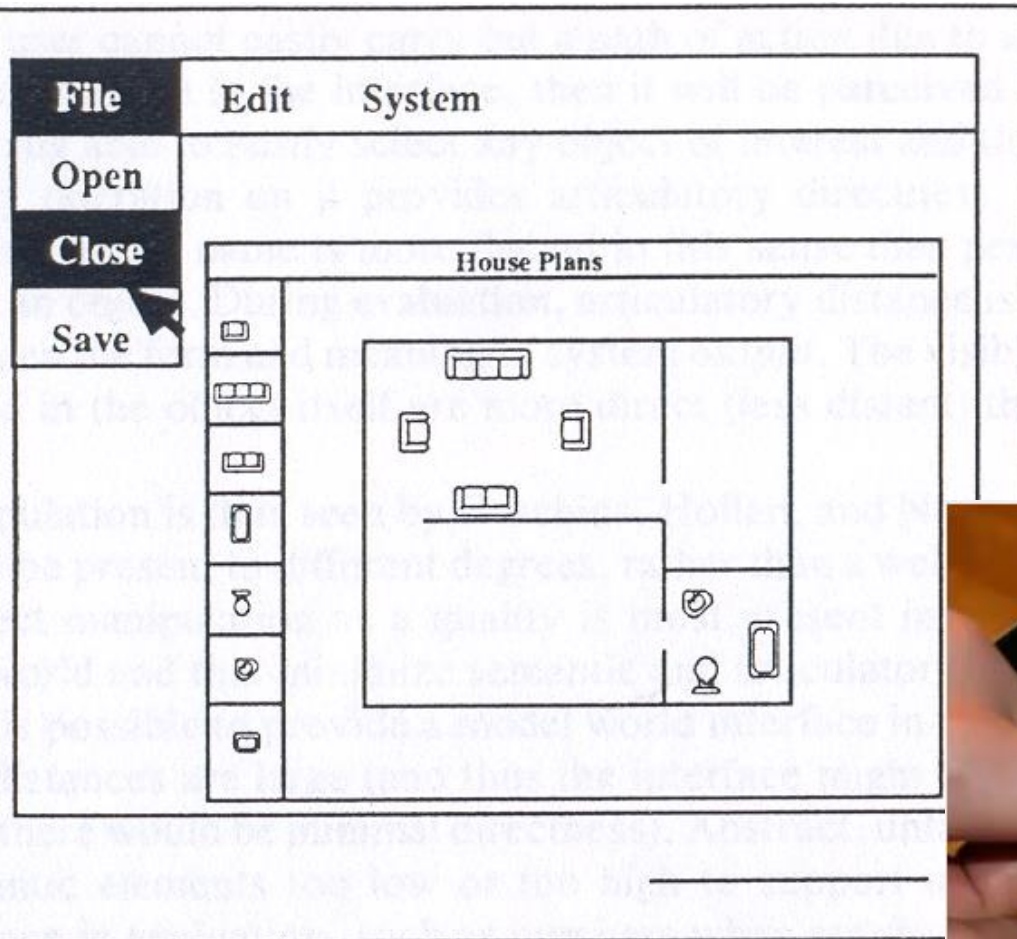
Another example:

On a mobile phone you can pinch out/in to zoom into an image or to zoom out

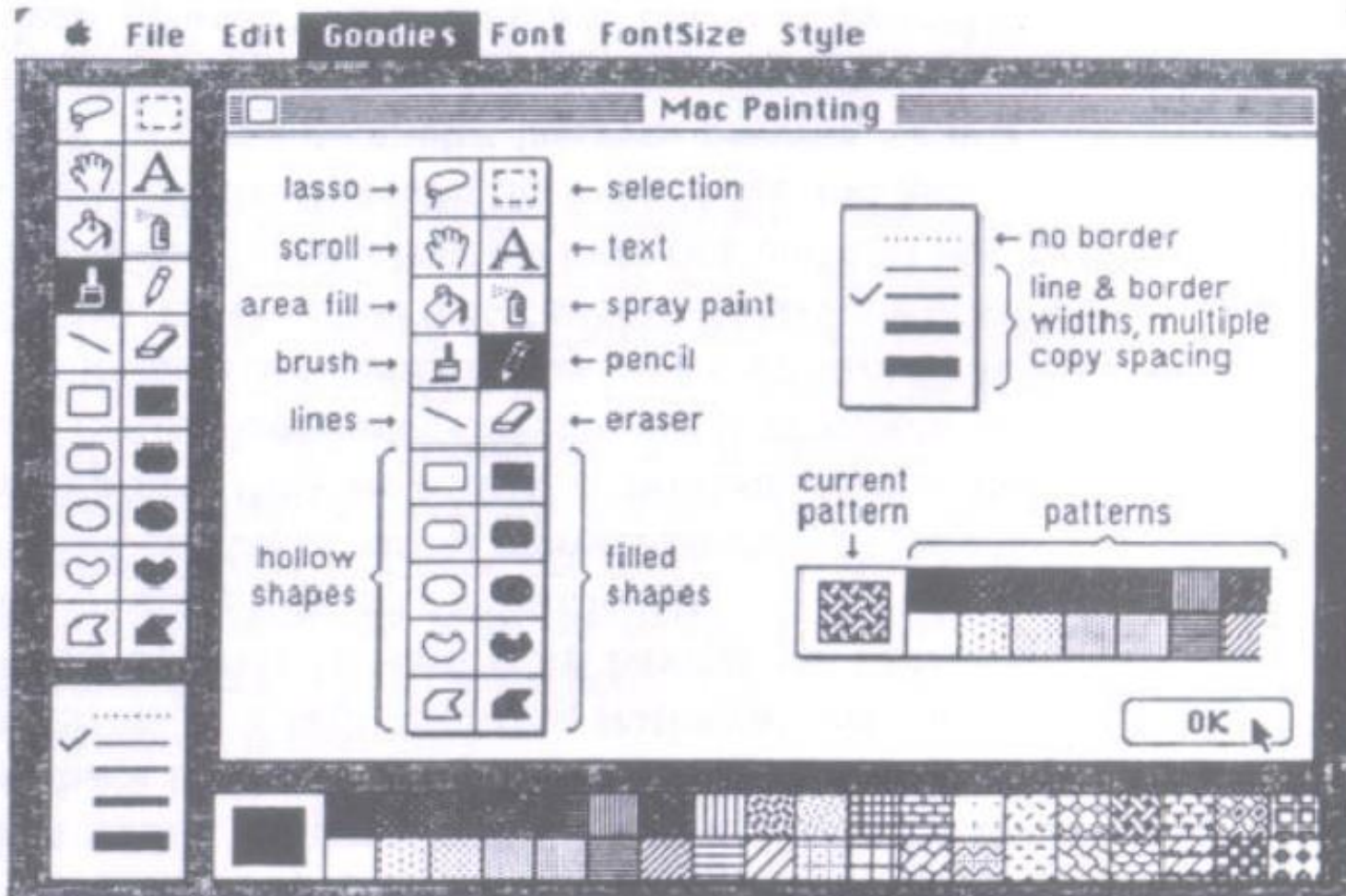
<https://www.nngroup.com/articles/direct-manipulation/>



Some applications are adequate to use direct manipulation:

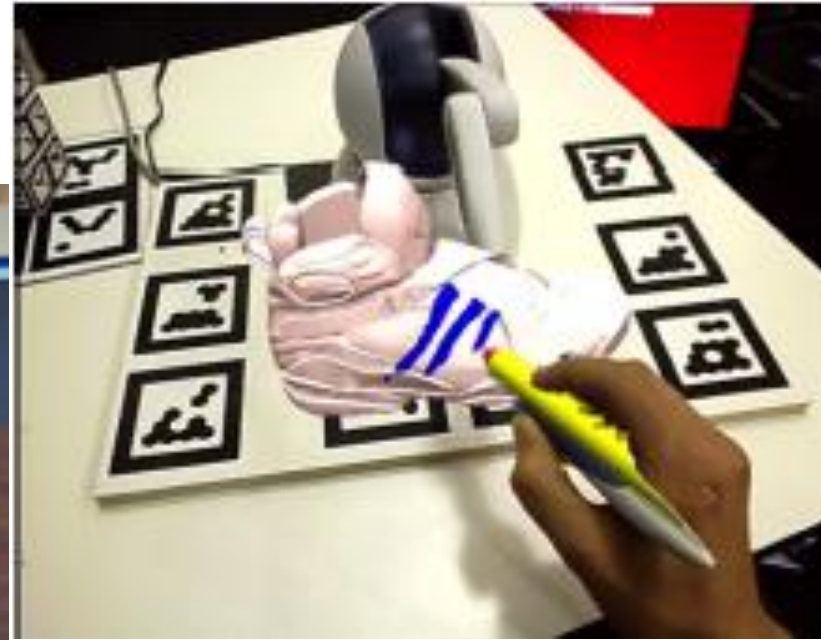


One of the earliest commercially available UI using Direct Manipulation (MacPaint)



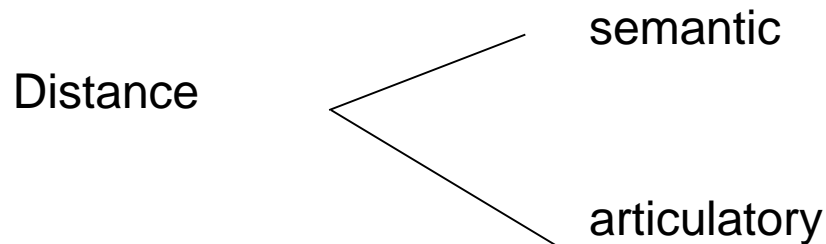
# Virtual and augmented reality

Take direct manipulation to another level





- It does not exist a “pure” direct manipulation User Interface (UI)
- Direct manipulation is a quality which may be present in different degrees
- According to Hutchins, Hollan e Norman (1986) a UI has the following aspects:

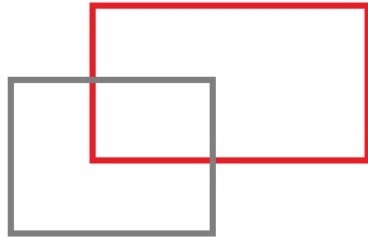
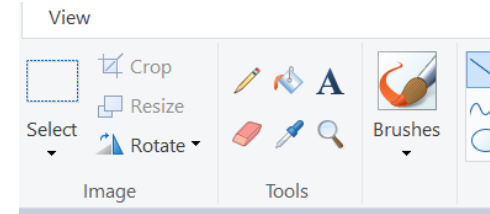
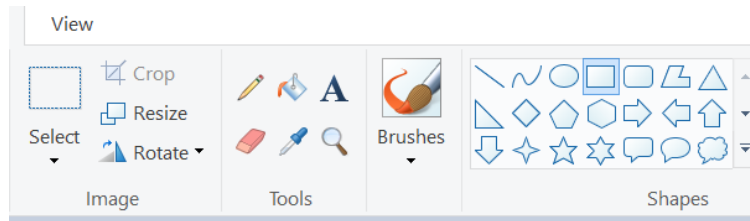


## Semantic and articulatory distance

- Semantic Distance – subjective distance between the user's goal and interface semantics
- Articulatory distance – distance between the meaning of the actions and their physical form

# Semantic Distance

If the objects and actions do not support the users' goals, semantic distance is high



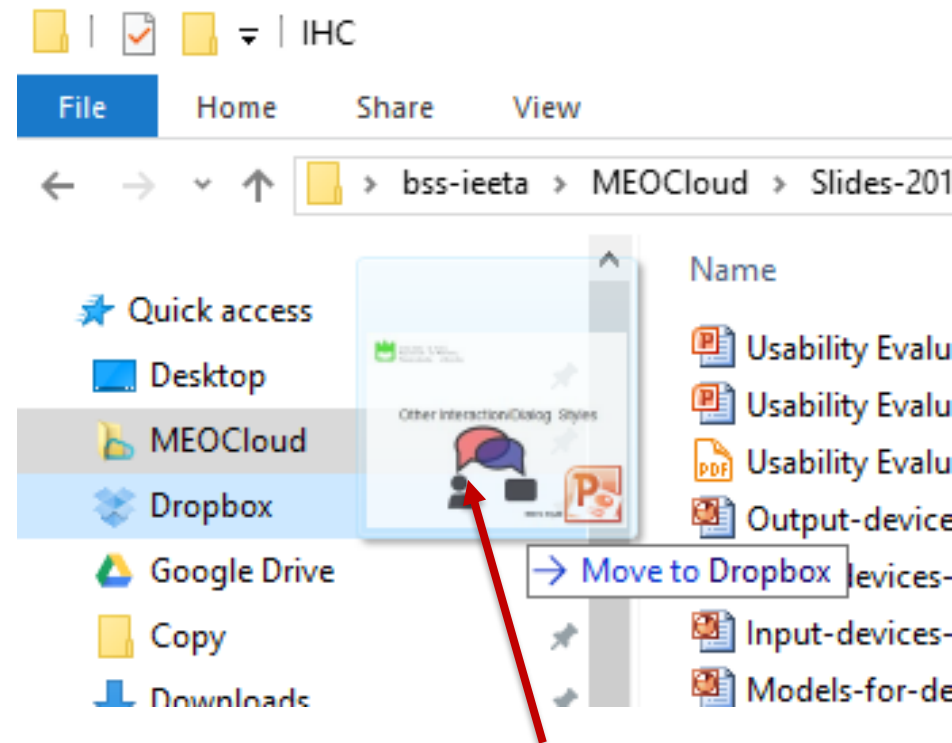
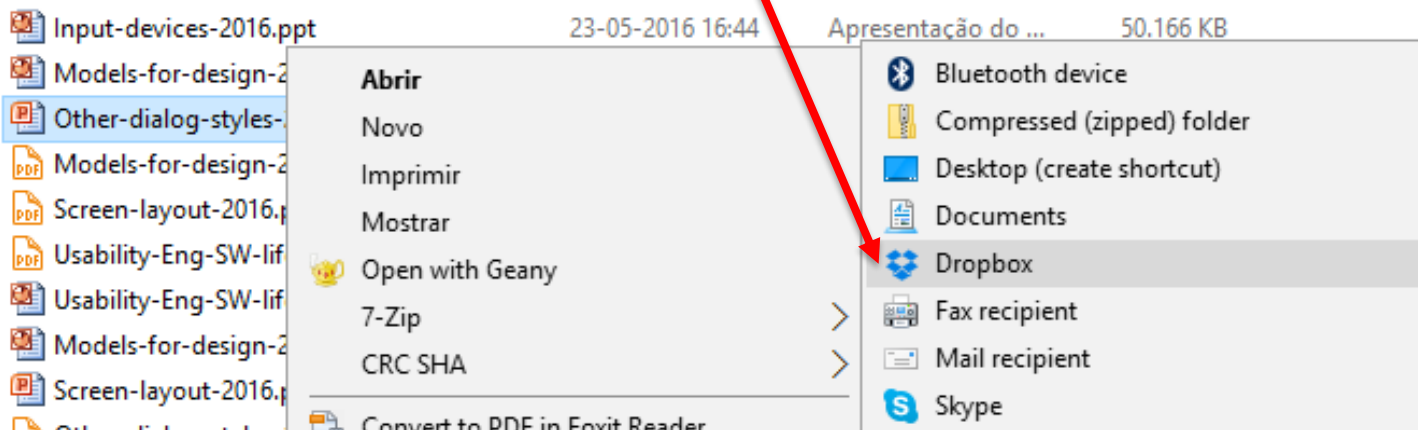
If the user wants to draw rectangles this application has a smaller semantic distance

,

## Articulatory Distance

When the physical way actions are performed is more similar to their meaning, articulatory distance is smaller

Selecting an option corresponds to a greater articulatory distance



Dragging an icon corresponds to smaller articulatory distance



- According to Wolfe Rhyne (1987) there are two relevant aspects in any user interaction:

### Object specification

name generation

visual correlation

### Action specification

name generation (write a name)

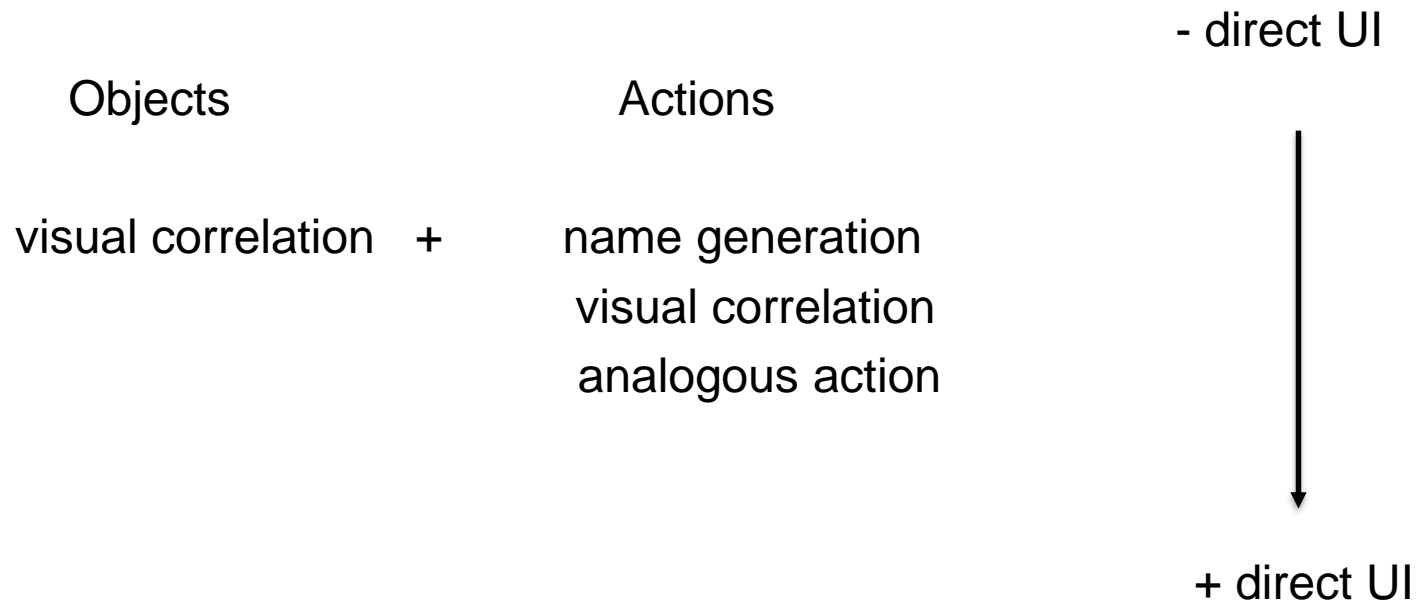
visual correlation (select)

gesture generation (draw a symbol)

analogous action

coded selection (write a command)

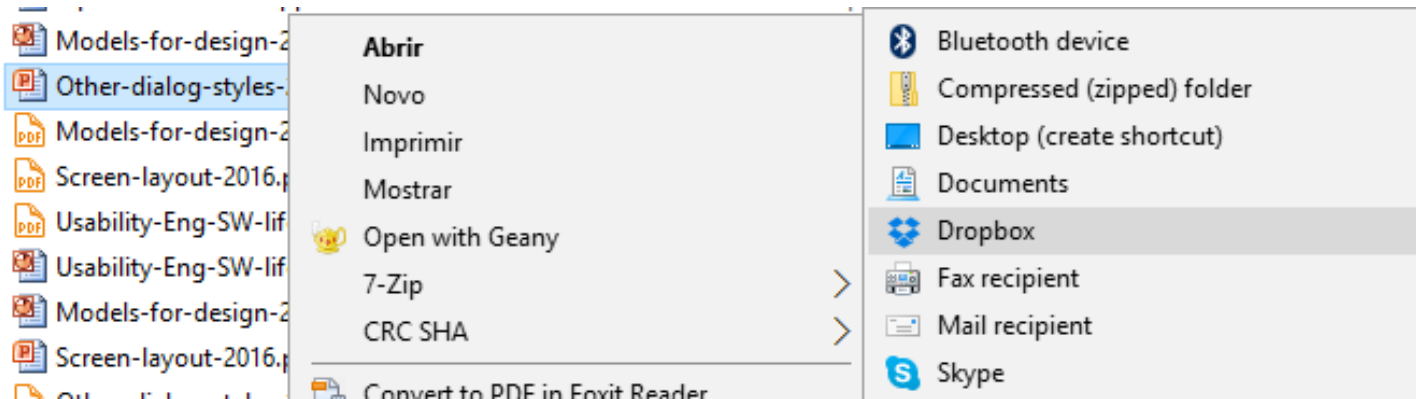
- Specifying objects by visual correlation implies the presence of direct manipulation
- How actions are specified defines the degree of direct manipulation





## Examples

```
bi@ub:~/Desktop$  
bi@ub:~/Desktop$ mv java-how-to.txt smartbike_paper/  
bi@ub:~/Desktop$  
bi@ub:~/Desktop$
```

Not direct manipulation UI: name generation + name generation



Direct manipulation UI:   
visual correlation + visual correlation

+ Direct manipulation UI:   
visual correlation + analogous action



# Main advantages and disadvantages of direct manipulation UIs

## Advantages (potential)

- Easy to learn and remember (are great for novices with good design)
- Direct, WYSIWYG (What you see is what you get)
- Flexible, easily reversible actions
- Immediate visual and context feedback
- May be less prone to errors

## Disadvantages

- Not auto-explanatory
- May be inefficient
- Repetitive tasks are not well supported
- Some gestures can be more error-prone than typing
- Difficult to draw recognizable icons (particularly for actions)
- Icons occupy more screen real estate than text





# User profile to whom direct manipulation is adequate:

## Knowledge and experience:

- Moderate system experience
- Moderate to high task experience
- Frequent usage of other systems
- Low computational literacy

## Work and task

- Low frequency of use
- Moderate training
- Optional usage
- Low structured tasks

# Direct Manipulation design: some guidelines

Minimize articulatory and semantic distance

Use general guidelines to design a usable UI:

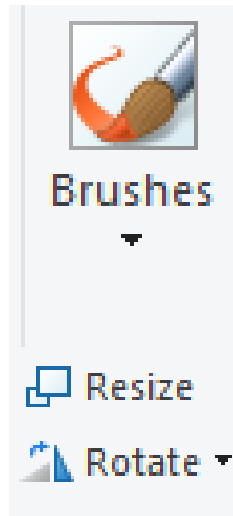
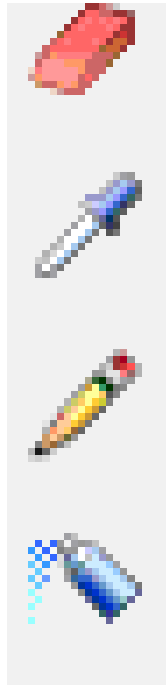
- Coherence
- Good conceptual model
- Feedback
- Adequate organization of functionality
- Adequate screen layout
- Adequate colour usage
- Adequate error handling
- Etc.

<https://www.interaction-design.org/literature/article/a-brief-history-of-the-origin-of-the-computer-icon>

# Use a coherent Icon scheme

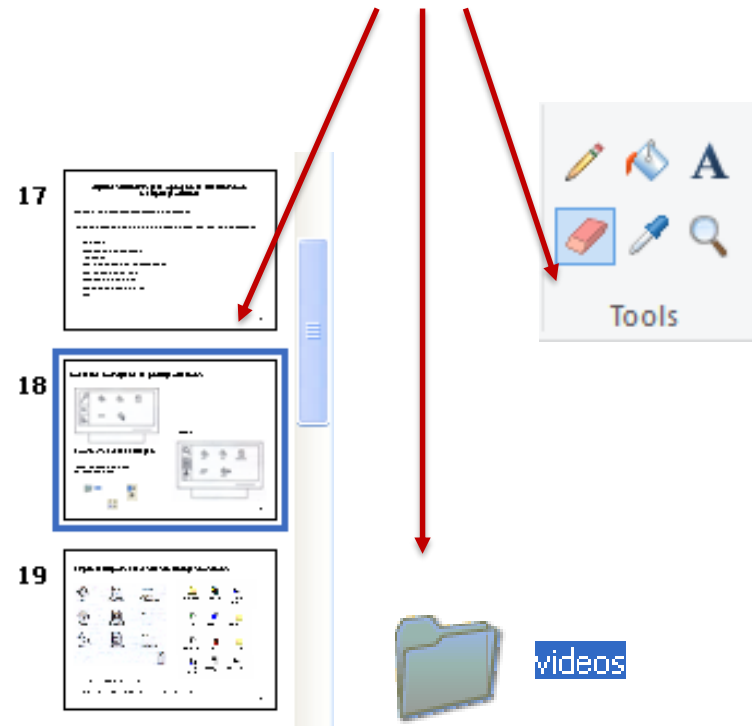
Different schemes:

better: same scheme

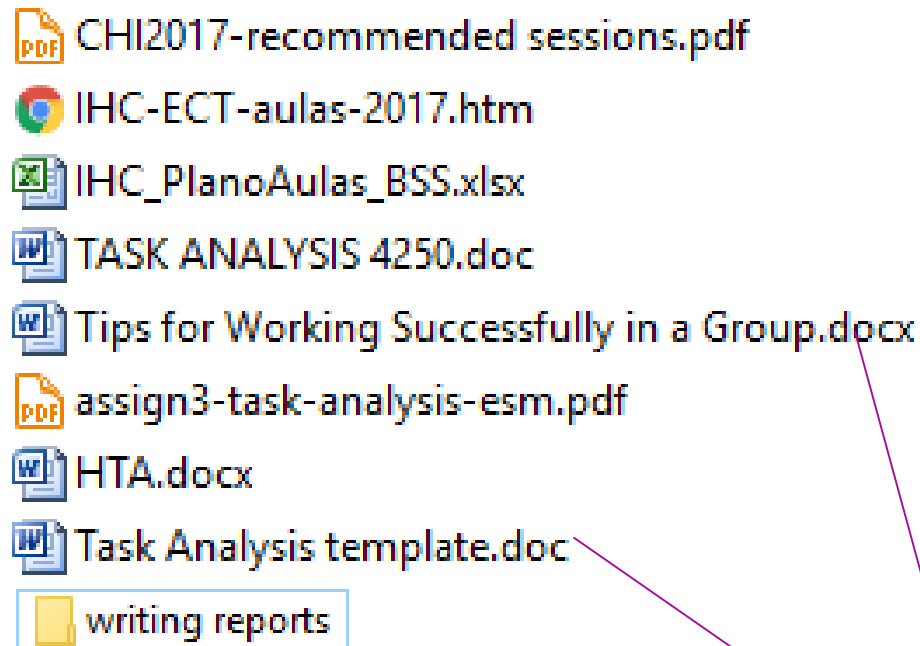


Adding names  
(+ recognizable)

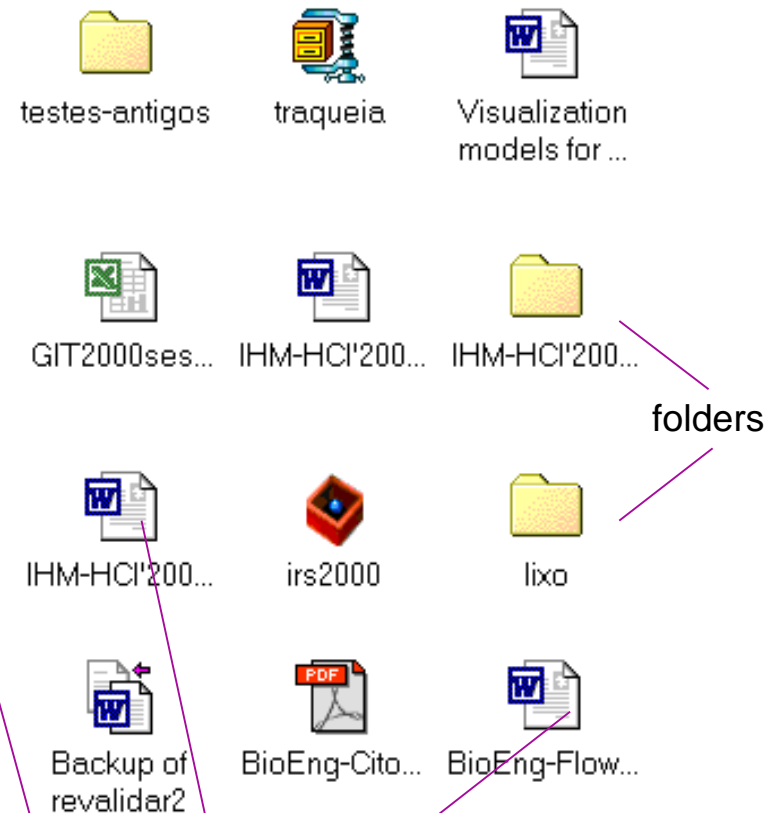
Visual selection feedback



## Express relation through icon similarity



folder

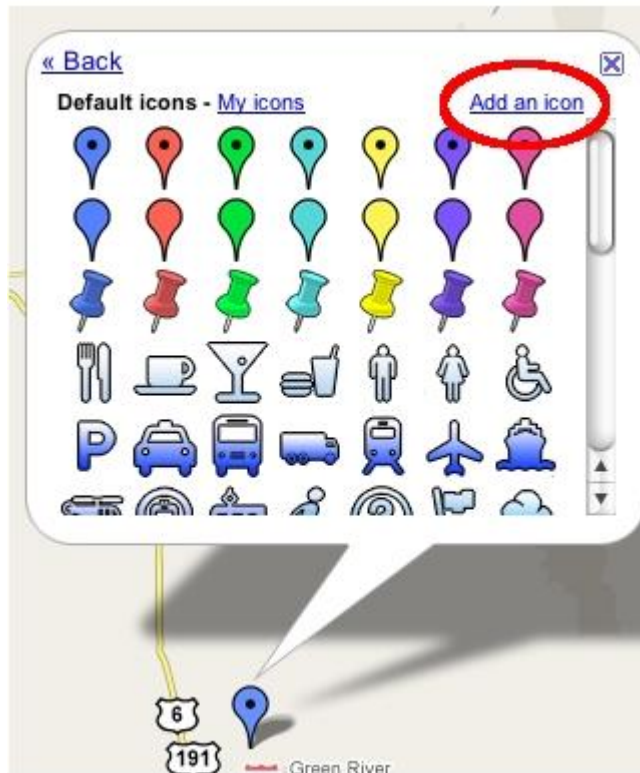


Same type of file

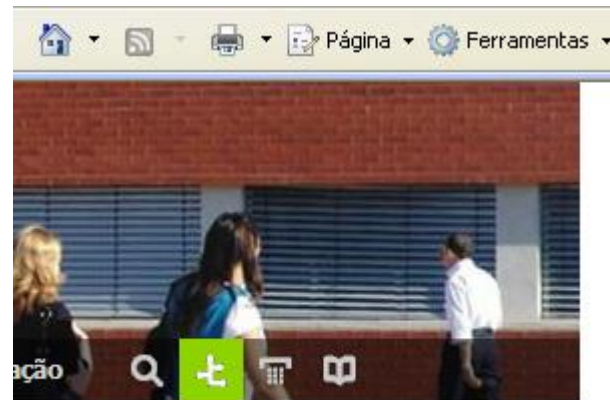
Coherence in the icons production scheme



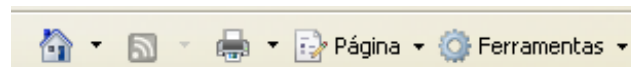
Add names to icons to make them more recognizable  
(recognition rather than recall)



Allow name definition



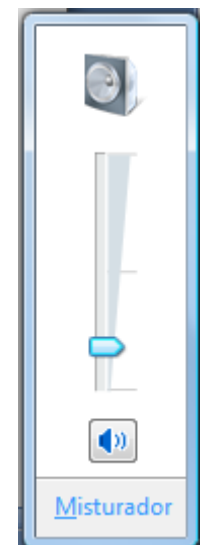
mapa do site









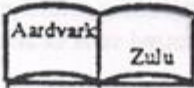

contactos



directório

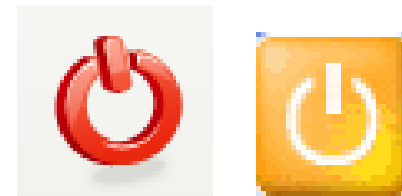


Icons must be conceptually and visually distinctive  
(recognition rather than recall)

	Dictionary	Phonebook
Conceptual similarity		
Conceptual distinctiveness		
Visual similarity		
Visual distinctiveness		



Best solution: conceptually and visually distinct



Conceptually similar icons



Icons should be specific/familiar not abstract/non-familiar  
(familiarity)

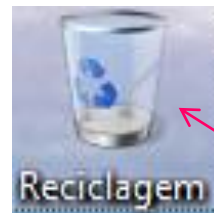
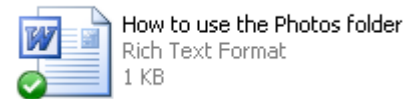


- ▼ This PC
  - > 3D Objects
  - > Desktop
  - > Documents
  - > Downloads
  - > Music
  - > Pictures



Familiar Icons?

## Express objects' attributes through icons (visibility of the system status)



synced

empty



In progress

## Direct manipulation - Concluding remarks

“It’s hard to imagine modern interfaces without direct manipulation ...

Augmented-reality and virtual-reality systems will push DM to even newer limits ...

Despite the many downsides, we still recommend a heavy dose of direct manipulation for most UIs”

<https://www.nngroup.com/articles/direct-manipulation/>

# Main Bibliography

- B. Shneiderman, C. Plaisant, M. Cohen, S. Jacobs, *Designing the User Interface- Strategies for Effective Human–Computer Interaction*, 5th ed., Addison Wesley, 2010
- H. Sharp, J. Preece, and Y. Rogers, *Interaction Design: Beyond Human-Computer Interaction*, 5th Edition Wiley, 2019
- M. Soegaard, Interaction Styles, *Interaction Design Foundation Encyclopedia*, 2<sup>nd</sup> edition,  
[http://www.interactiondesign.org/encyclopedia/interaction\\_styles.html](http://www.interactiondesign.org/encyclopedia/interaction_styles.html)