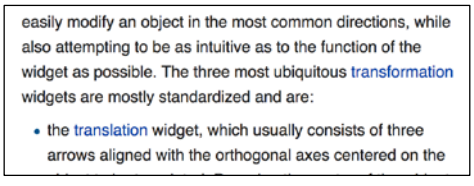
Direct Manipulation

and Instrumental Interaction

Direct Manipulation

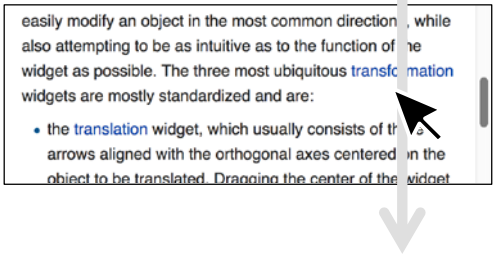
- Direct manipulation is when a *virtual representation of an object* is manipulated in a similar way to a real–world object.
- traced back to Ivan Sutherland's Sketchpad (see History lecture)
- proposed in 1983 by Ben Schneiderman

Indirect Manipulation




```
>scroll –down 500
```

Direct Manipulation



"Direct manipulation allows people to feel that they are directly controlling the objects represented by the computer." (Apple)

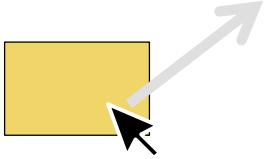
Direct Manipulation Principles

1. Continuous representation of task objects and actions.
2. Objects are manipulated by physical actions, not complex syntax
3. Fast, incremental, and reversible actions with effects on task objects immediately apparent.
4. Layered, self-revealing approach to learning

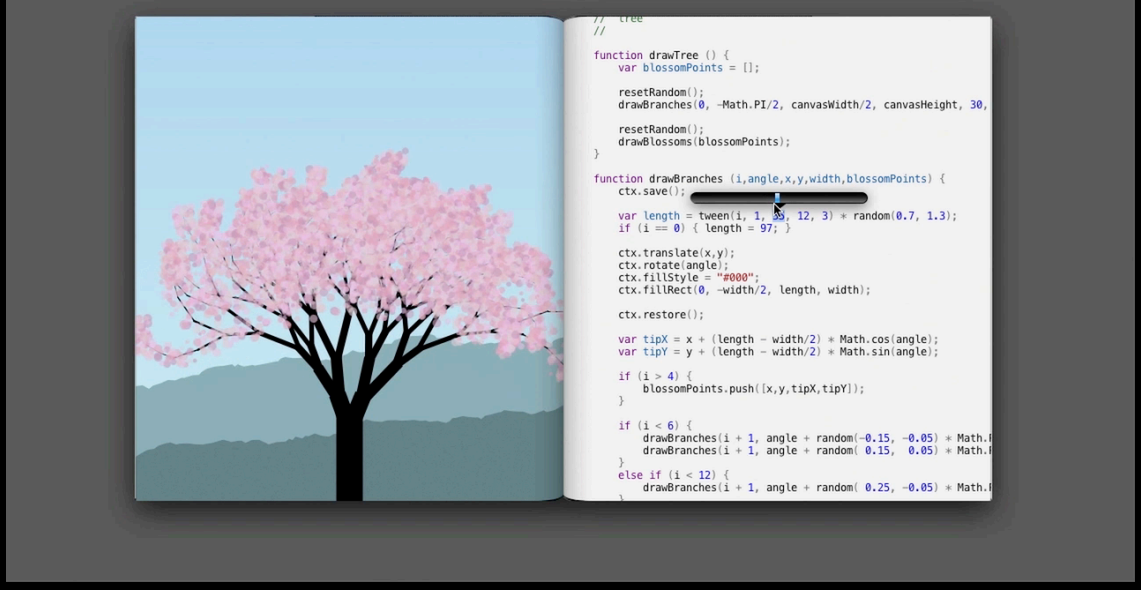
(from Schneiderman, 1983)

Benefit of Direct Manipulation

- While interacting with DM interfaces, users feel as if they are interacting with the *domain rather than with the interface*, so they *focus on the task rather than on the technology*. There is a feeling of direct involvement with a world of task objects rather than communication with an intermediary.



x: 120
y: 70



Bret Victor, Inventing on Principle (talk from CUSEC 2012)

– http://vimeo.com/36579366

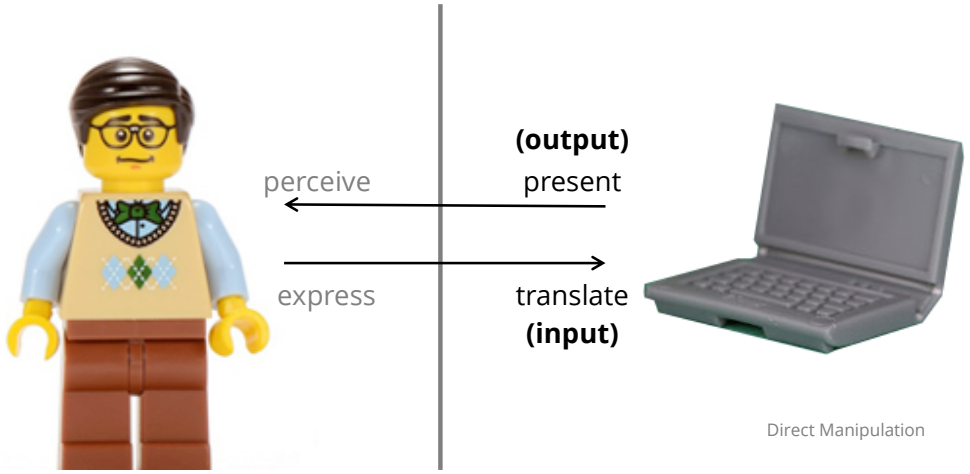
A GUI Doesn't Always Use Direct Manipulation

- Many commands are invoked *indirectly*
  - Menus, dialog boxes, toolbars are not really direct manipulation … they're "tools" that pull users away from objects of interest
- Many objects of interest are *hidden*
  - Text styles, page layout,
- Many objects in the interface *are not objects of interest*
  - Toolbar palettes

(Beaudoin-Lafon, 2000)

Look and Feel

- How manipulatable objects are **presented** in the interface → Look
- How user expression is **translated** into commands to manipulate objects → Feel



Interaction Model

"An interaction model is a set of principles, rules, and properties that guide the design of an interface. It describes how to combine interaction techniques in a meaningful and consistent way and defines the look and feel of the interaction from the user's perspective. Properties of the interaction model can be used to evaluate specific interaction designs." (Lafon, 2000)

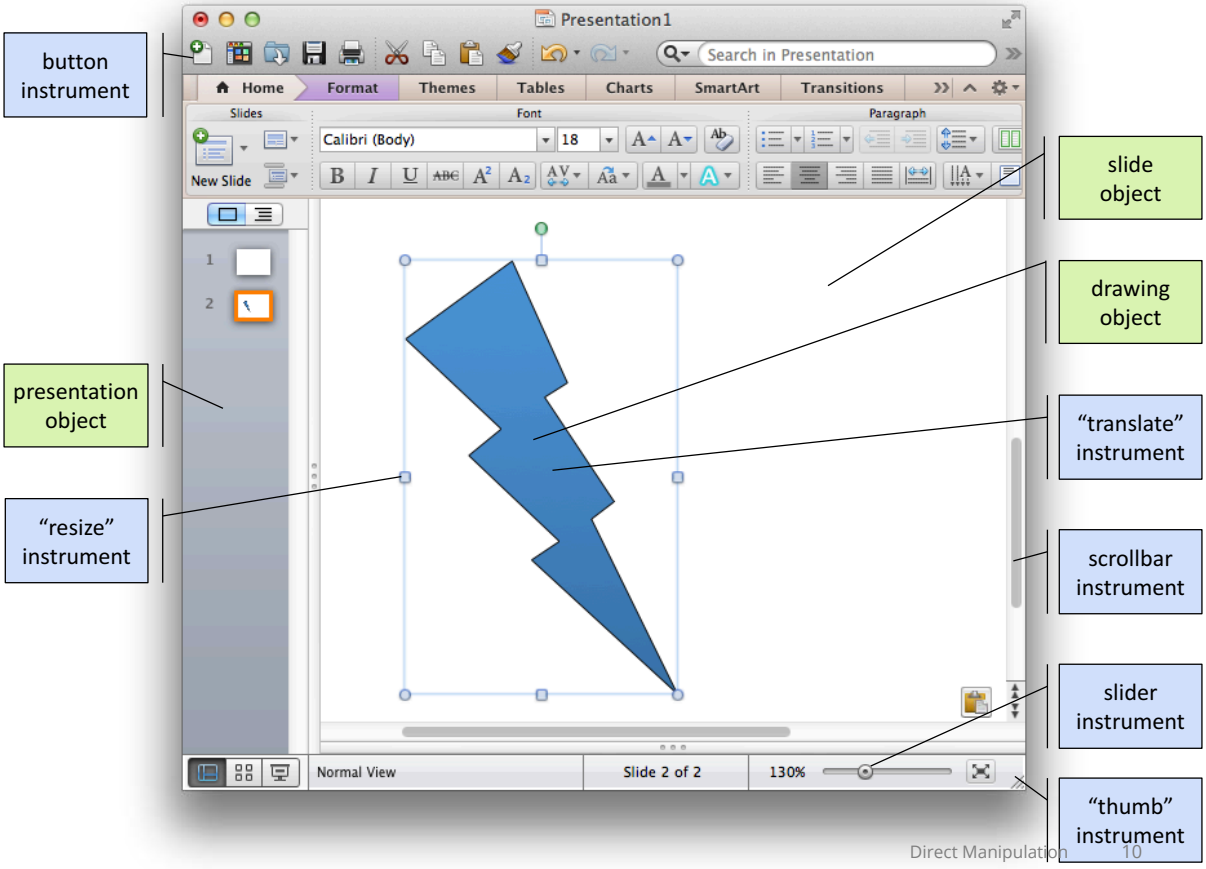
Beaudouin-Lafon, M. 2000. Instrumental interaction: an interaction model for designing post-WIMP user interfaces. Proceedings of CHI '00, 446-453. http://doi.acm.org/10.1145/332040.332473

Instrumental Interaction

"A model of interaction based on how we naturally use tools (or instruments) to manipulate objects of in the physical world."

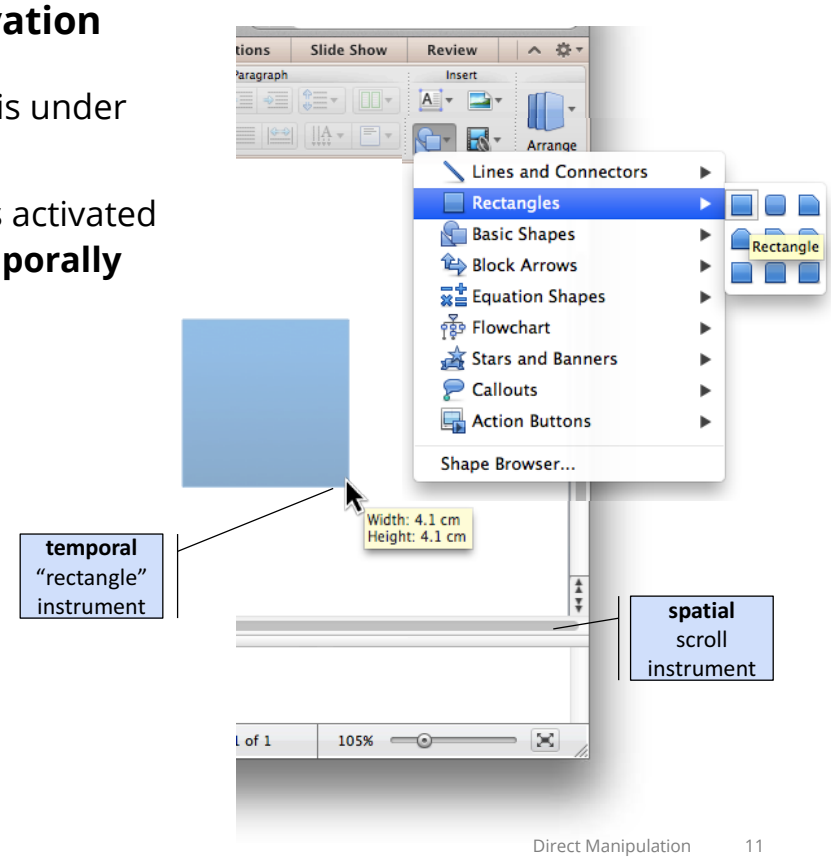
- Interfaces have *interaction instruments* and *domain objects*
  - **Interaction instrument**: a necessary mediator between the user and domain objects
  - **Domain objects:** the thing of interest, data and associated attributes, which is manipulated using an interaction instrument

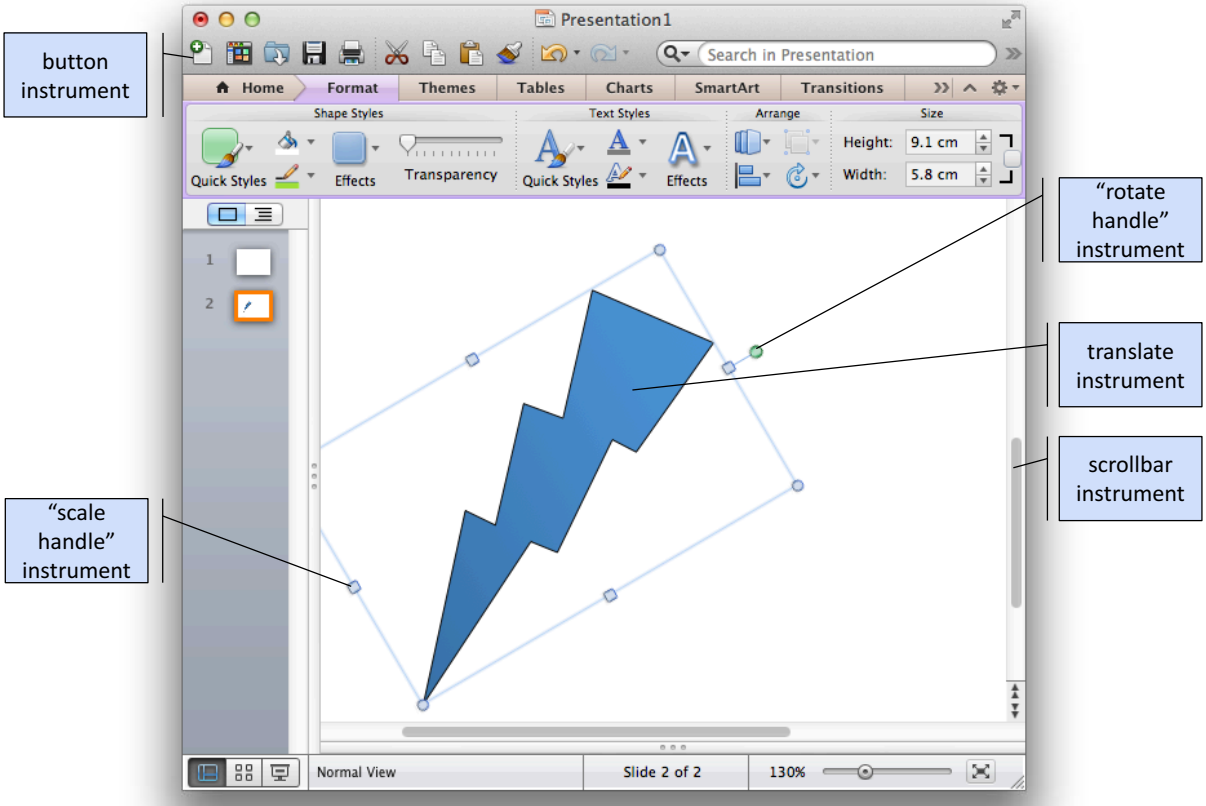
(Beaudoin-Lafon, 2000)

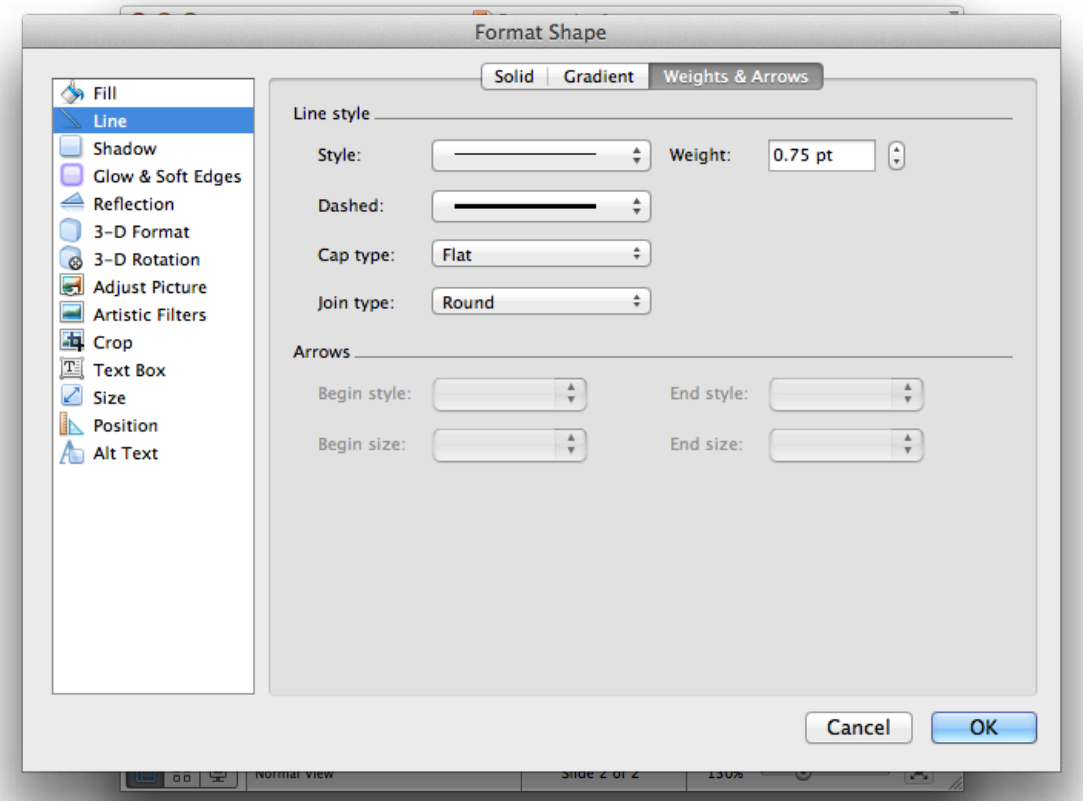


Instrument Activation

- When instrument is under user's control
- WIMP instruments activated **spatially** and **temporally**



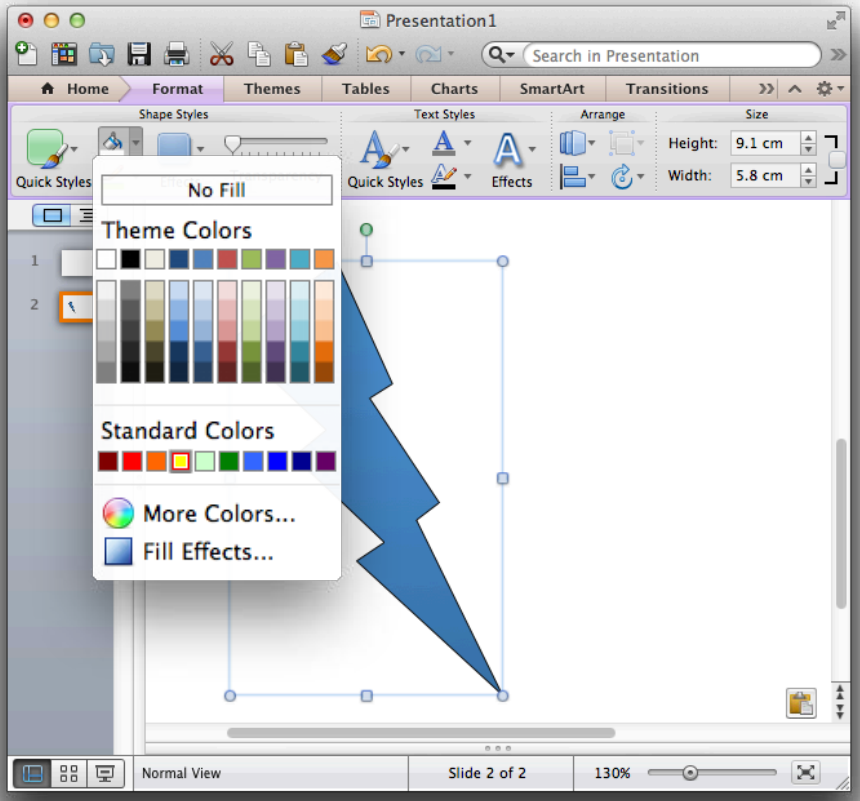




Reification and Meta-Instruments

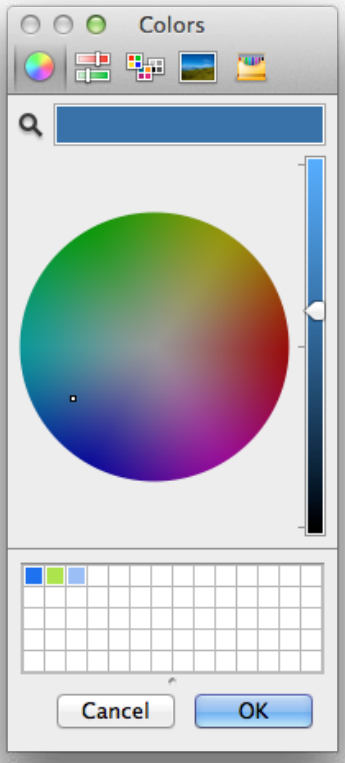
具象化

- **Reification:** turning concepts into something concrete
  - An instrument is the *reification* of a command
  - e.g. a scrollbar *reifies* scroll commands
- **Meta-instrument:** an instrument that acts on another instrument
  - the other instrument become an object of interest)
  - e.g. a pencil is an instrument to manipulate the object “paper”, but when the pencil tip breaks, the pencil becomes an object of interest manipulated by a sharpener *meta-instrument*
  - GUI examples?



Object Reification

- Turning attributes of a primary object into other objects of interest
  - e.g. colour swatch, font styles, shader materials



Evaluating Instruments

- Degree of **indirection**
  - Spatial/ temporal offset between instrument and action on object
- Degree of **integration**
  - Ratio of degrees of freedom of instrument to degrees of freedom of input device
- Degree of **compatibility**
  - Similarity of action on control device/instrument to action on object

Degree of Indirection

- 2D measure of spatial and temporal offsets of instrument
- Spatial Dimension
  - e.g. *near*: drag to translate, handles on to resize
  - e.g. *far*: scrollbar, dialog boxes
- Temporal Dimension
  - e.g *short*: direct dragging response
  - e.g. *ong*: waiting until after exiting dialog

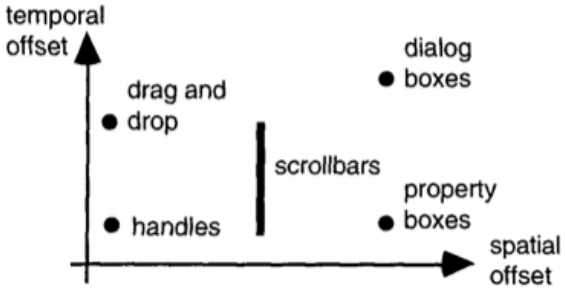
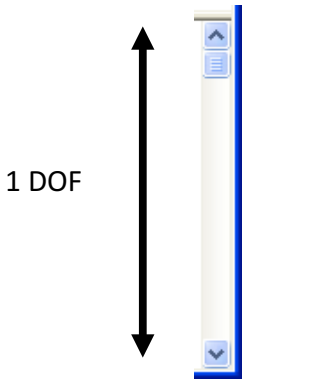


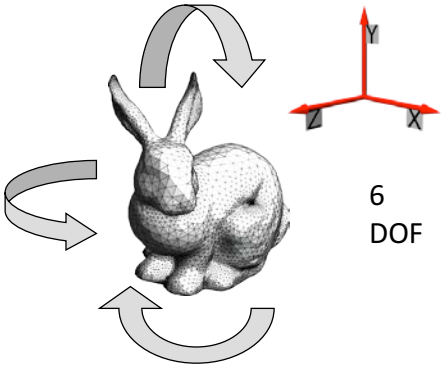
Figure 2: Degree of indirection

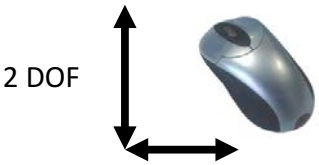
(image: lafon 2000)

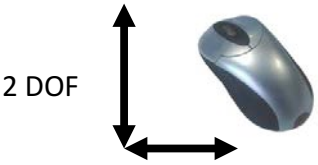
Degree of Integration

- the ratio between the number of degrees of freedom (DOF) of the instrument and the DOF captured by input device





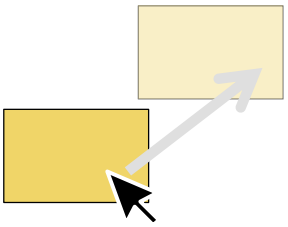




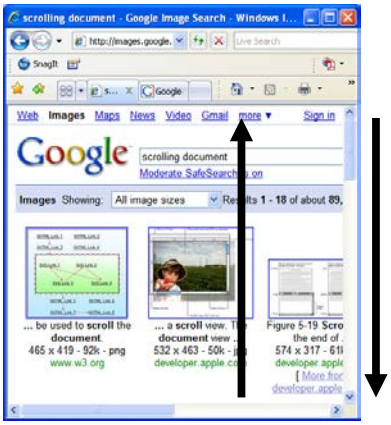
Degree of Compatibility

- the similarity between the physical actions on the instrument and the response of the object.

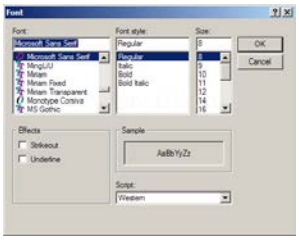
Dragging = high



Scrolling = medium



Dialog = low

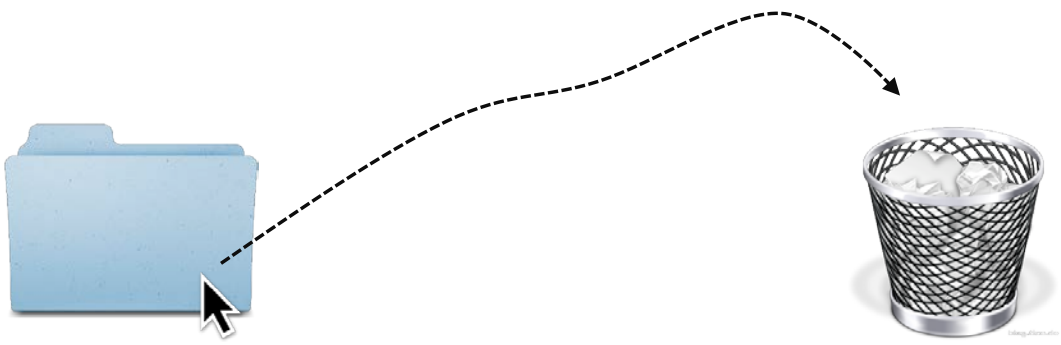


Direct Manipulation and Instrumental Interaction

- A direct manipulation interface allows a user to *directly* act on a set of objects in the interface.
- Direct means *instruments* are visually indistinguishable from *objects* they control
  - The actions on instrument/object entities are analogous to actions on similar objects in the real world.
  - The actions on instrument/object entities preserve the conceptual linkage between instrument and object.

Analogies

- “attempting to make affordances in the interface like affordances for analogous actions in the real world”
- Should build on existing experiences and intuitions to aid learning

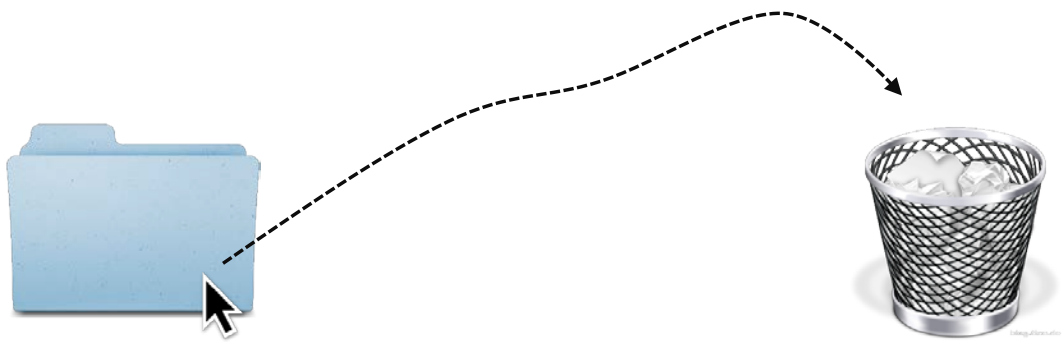


Analyzing an Analogy

Real World	*Common Language*	DM Interface
Object to be discarded	*Grammatical Object*	Icon of object to be discarded
Move hand to object	*Move to object location*	Move pointer to object
Pick up object with hand	*Acquire object*	Click to aquire object
Waste basket	*Waste Basket location*	Waste basket icon
Move to waste basket	*Move to waste basket location*	Drag to waste basket icon
Release object from hand	*Release object*	Release button to discard object

Implementing an Analogy

- A location with special meaning (the object)
- Another location with special meaning (the waste basket)
- Movement between locations



Direct Manipulation Issues

- Visually impaired users can't see the graphics; no linear flow for screen readers; physically impaired may have difficulty with required movements
- Consumes valuable screen space, forcing valuable information off-screen.
- Switching between keyboard and pointer is time consuming
- Analogies may not be clear
  - Users need to learn meaning of visual representations
  - Visual representations may be misleading