4 Overview on Approaches to Multimedia Programming

Literature:

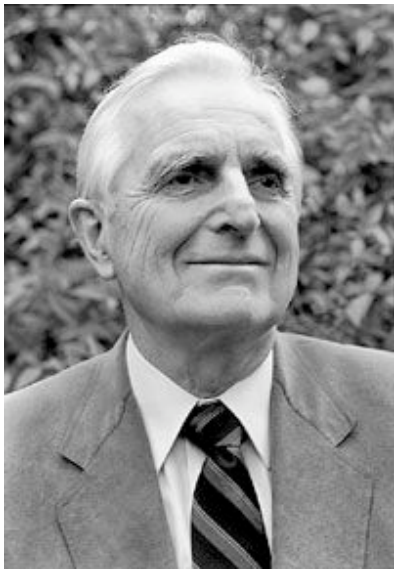
Alan Kay: Doing with Images Makes Symbols Pt 1 (1987)
Video lecture available at
http://www.archive.org/details/AlanKeyD1987

Mark Guzdial: History of Squeak
Lecture notes at http://coweb.cc.gatech.edu/cs2340/3608
http://wiki.squeak.org/squeak/3139

Ivan Sutherland's Sketchpad, 1963

- First object-oriented drawing program
- Master and instance drawings
- Rubber bands
- Simple animations

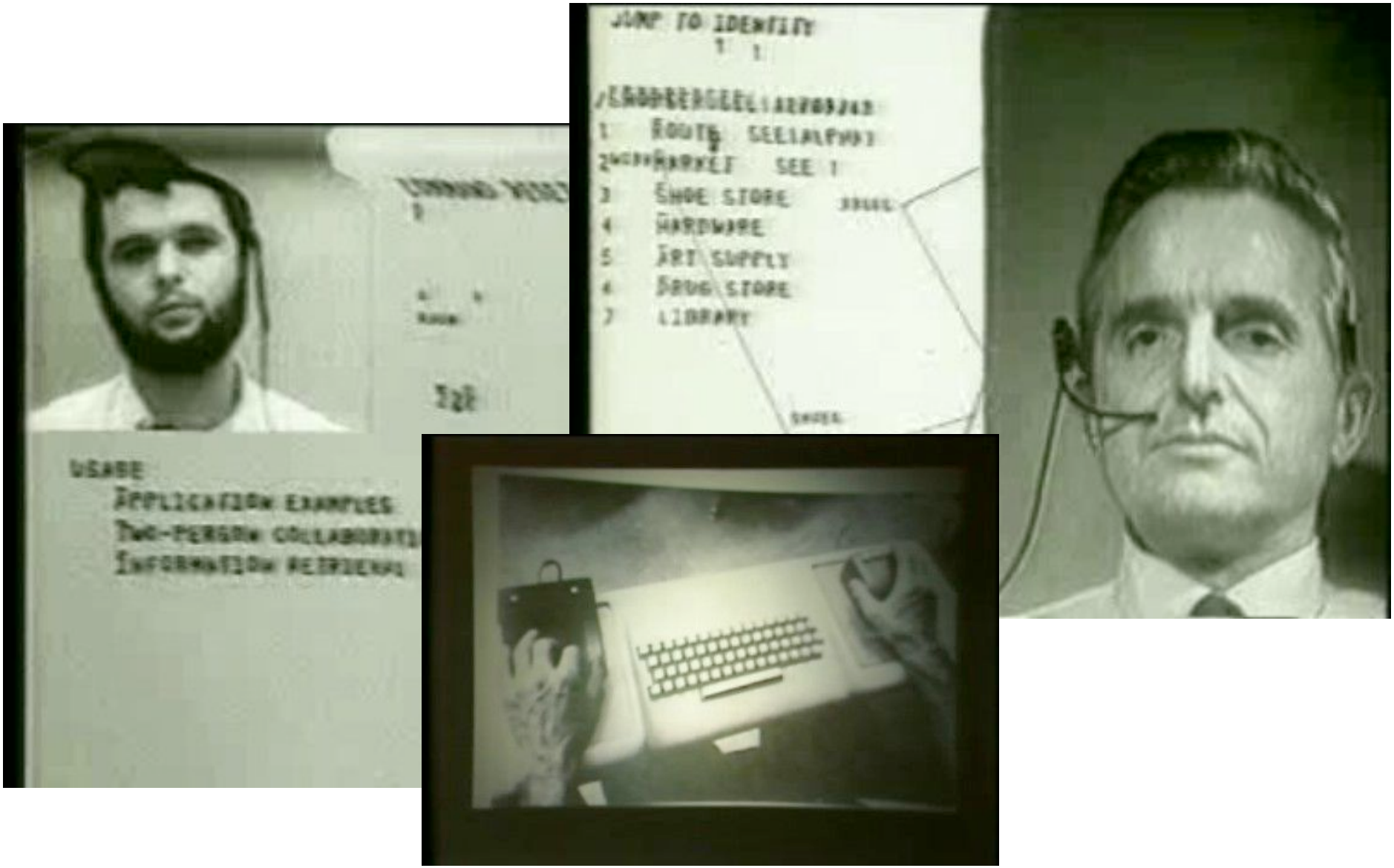
Douglas C. Engelbart 1962



- Born 1925, Ph.D. Berkeley 1955
- Influenced by Vennevar Bush's article "As We May Think" (1945)
- 1962: Research Project at SRI (Stanford Research Institute): "Augmenting Human Intellect: A Conceptual Framework"
  - Research support triggered by the "Sputnik shock" (1957)
- Basic ideas:
  - Computer supported learning
  - Computer supported collaboration
  - Seamless integration of computer interaction into workflows
- Development of the "NLS" (oNLine System)
  - Demonstrated 1968 in Brooks Hall, San Francisco
- 1970: Patent application for "X-Y pointing device" (mouse)

http://www.bootstrap.org/augdocs/friedewald030402/augmentinghumanintellect/ahi62index.html

NLS Demo 1968



Alan C. Kay

- U. Utah PhD student in 1966
  - Read Sketchpad, Ported Simula
- Saw “objects” as the future of computer science
- His dissertation:
  Flex, an object-oriented *personal* computer
  - A *personal* computer was a radical idea then
  - How radical?

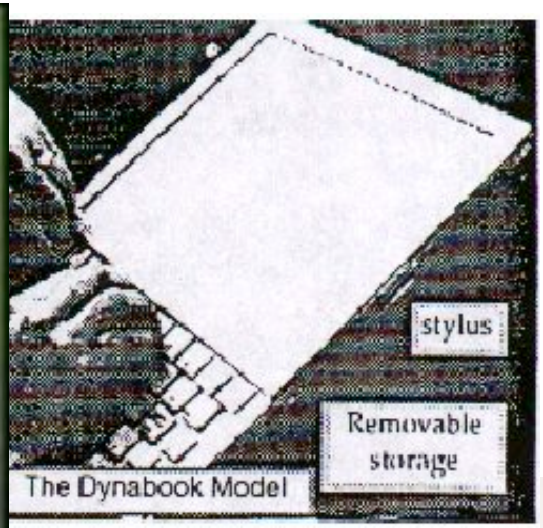
"There is no reason anyone would want a computer in their home."
(Ken Olsen, Digital Equipment Corp, **1977**)

Further stations of Alan Kay’s life:
– Stanford Artificial Intelligence Laboratory
– **Xerox PARC**
– Atari
– Apple
– Disney Interactive
– Viewpoints Research Institute
– Hewlett-Packard

from M. Guzdial

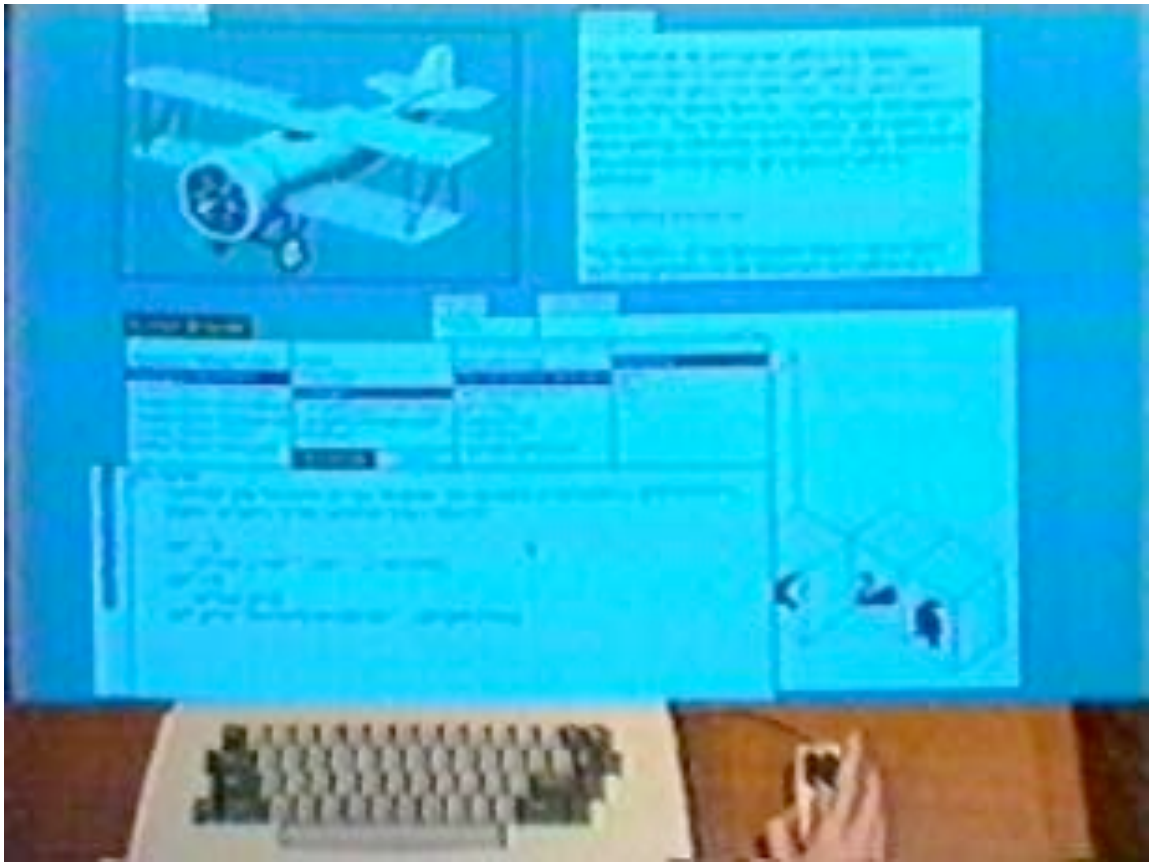
The Dynabook Vision

- Small, handheld, wireless(!) device – a new *medium*
- Can be used creatively by everybody, in particular children, for learning
- Xerox PARC Learning Research Group, early 70s



Tablet PC, 2004

Xerox PARC Learning Research Group: Smalltalk-72



- Object-oriented programming system
  - Mouse
  - Windows
  - Icons
  - Pop-up menus
- Uses simple object-oriented language “Smalltalk”
- Idea of user interface: Make computers easy to use for everybody
- Idea of language: make programming both more simple and more powerful (e.g. include *multimedia: sound*)

The Alto

- The machine the prototype of which impressed Steve Jobs so much that he decided to produce the Lisa/Macintosh kind of computers for the mass market (1979)
  - Graphical user interface
  - Networked via Ethernet
  - Programming language Smalltalk

Animation Software on the Alto

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4.1 Historical Roots of Multimedia Programming

4.2 Squeak and Smalltalk: An Alternative Vision

EToys: Visual Programming in Squeak

Introduction to Smalltalk

Multimedia in Squeak

4.3 Frameworks for Multimedia Programming

4.4 Further Approaches & Systematic Overview

Literature:

http://www.squeakland.org

Back to the Future: Squeak

- Smalltalk:
  - Developed 1972
  - Commercial versions from 1980 on
- 1995: Alan Kay, Dan Ingalls, Ted Kaehler at Apple
  - Build on Open Source Software strengths
    - » Use the distributed power of Internet-based programmers
  - Available Smalltalk versions had lost many media capabilities
- Later on, the Squeak team moves to Disney
  - “Its all about media”
- Multimedia in Squeak:
  - 16 voice music synthesis
  - 3-D graphics, MIDI, Flash, sound recording
  - Network: Web, POP/SMTP, zip compression/decompress

Basics of Squeak Interaction (1)

- Squeak assumes a three-button mouse
- Menus are invoked by clicking on objects
  - clicking on surface opens “world” menus
- “Red”
  - Windows: left-button click
  - MacOS: simple click
- “Yellow”
  - Windows: middle-button click
  - MacOS: option + click
- “Blue”
  - Windows: right-button click
  - MacOS: + click

(A different colour mapping...)

Basics of Squeak Interaction (2)

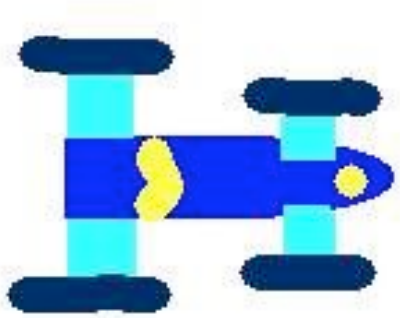
- Flaps:
  - Areas which can be opened or closed in a drawer-style
  - Often used as repositories (“parts-bins”)

- Collapsing windows:
  - A window can be collapsed or expanded

- Tiles:
  - Objects can be represented by “tiles”

Etoys: Example “Car Race” (1)

- Step 0:
  Create a new empty project
  - world menu -> open...
    -> morphic project
  - enter new project by double-click
- Step 1: Draw the things with which we want to play
  - Very simplistic bitmap-oriented painting tool
- Step 2: “Keep” the drawing
  - We get a Squeak object
    - » Free form, not square
  - Can be moved around



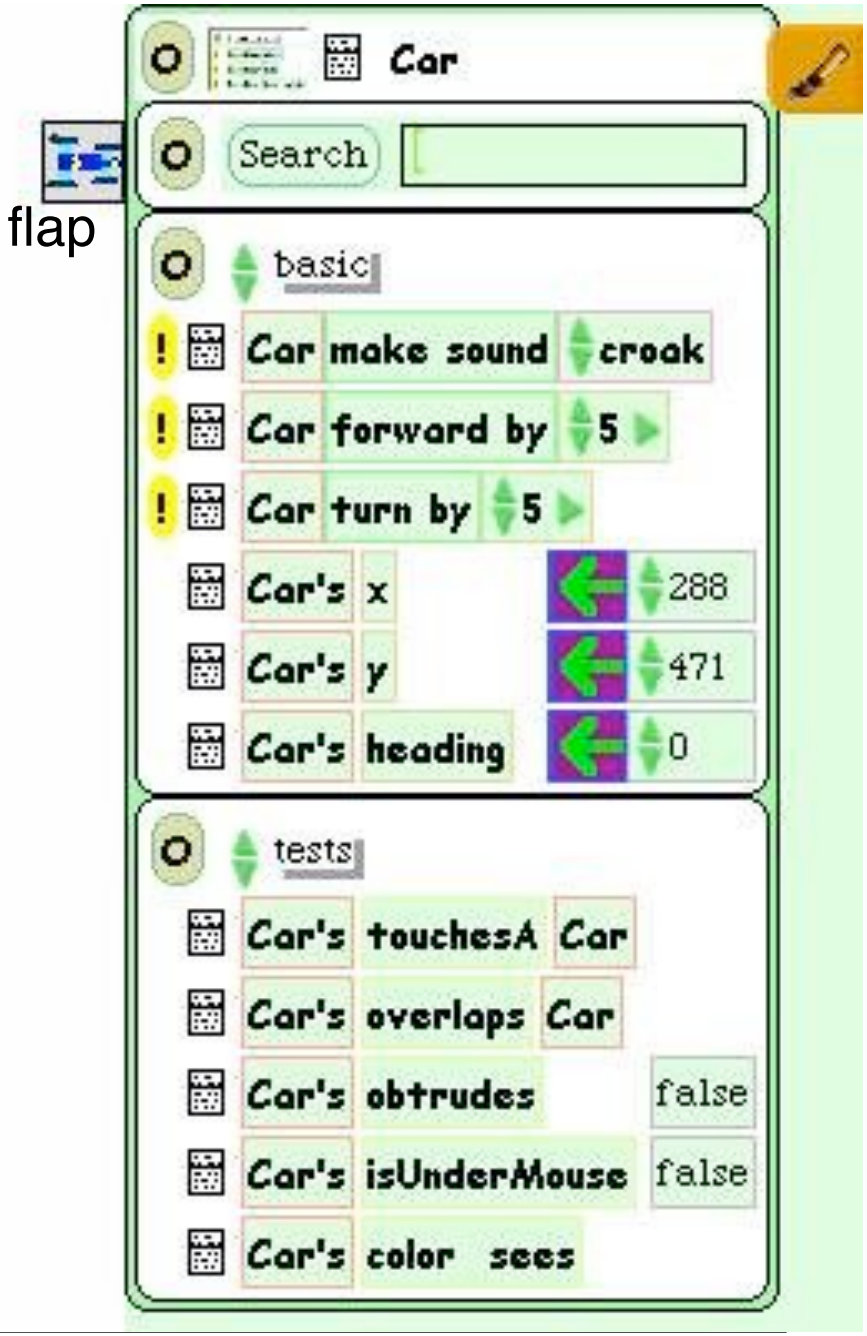
Note: Slides refer to Squeak 3.6, slight changes in version 3.8!

“Halo” of a Squeak Object

- The “halo” is a circular graphic menu which can be invoked on any object by a mouse click
  - “blue” click
  - special “playfield configuration” (preferences): invoked just by mouse over

Squeak Viewers

- Step 3: Create a viewer (e.g. via the object's halo)
  - Special flap for quickly showing and hiding the viewer
  - Rename sketch in viewer e.g. to "Car"
- Shows categories of properties and commands for objects
  - Categories: Object is derived from a subclass in a complex class hierarchy
  - Viewer can show many different categories in parallel
- Commands can be immediately executed (exclamation mark button)
  - Car can be moved, turned
    (Note: Orientation to be set in "rotate" mode to define direction of movement)



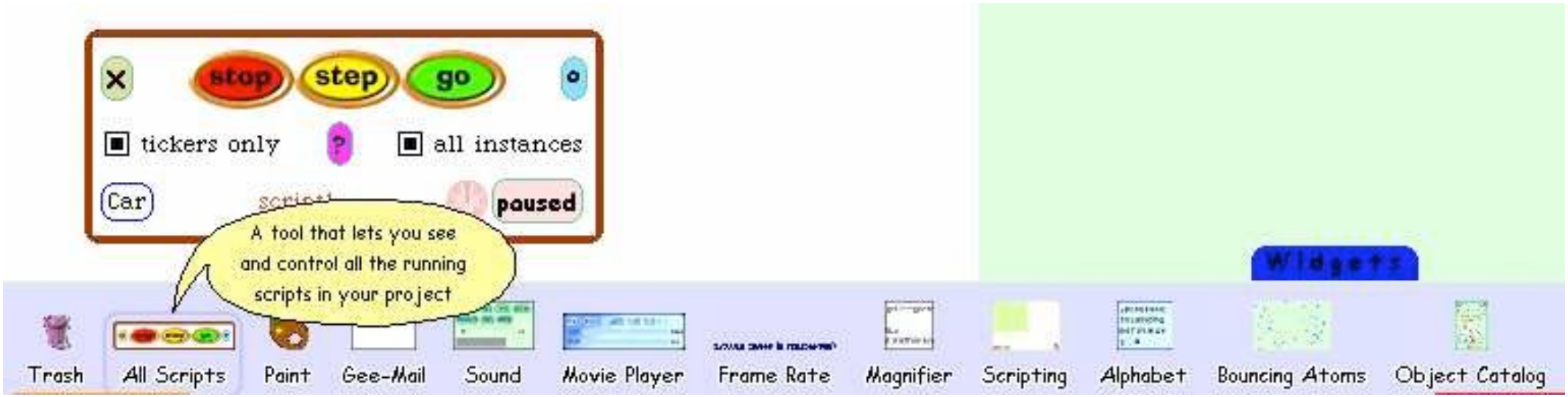
Squeak Scripts

- *Script*:
  - simple sequence of commands
  - executed under user control or automatically through a timer (“ticking”).
- Represented by windows
  - created by drag-and-drop
  - “Tiles” represent objects and actions
- Step 4: Create a script
  - “add new script” in viewer
  - drag “empty script” onto surface
- Step 5: Add forward command
  - drag it from the Car viewer
  - adjust the parameter(s)

tiles

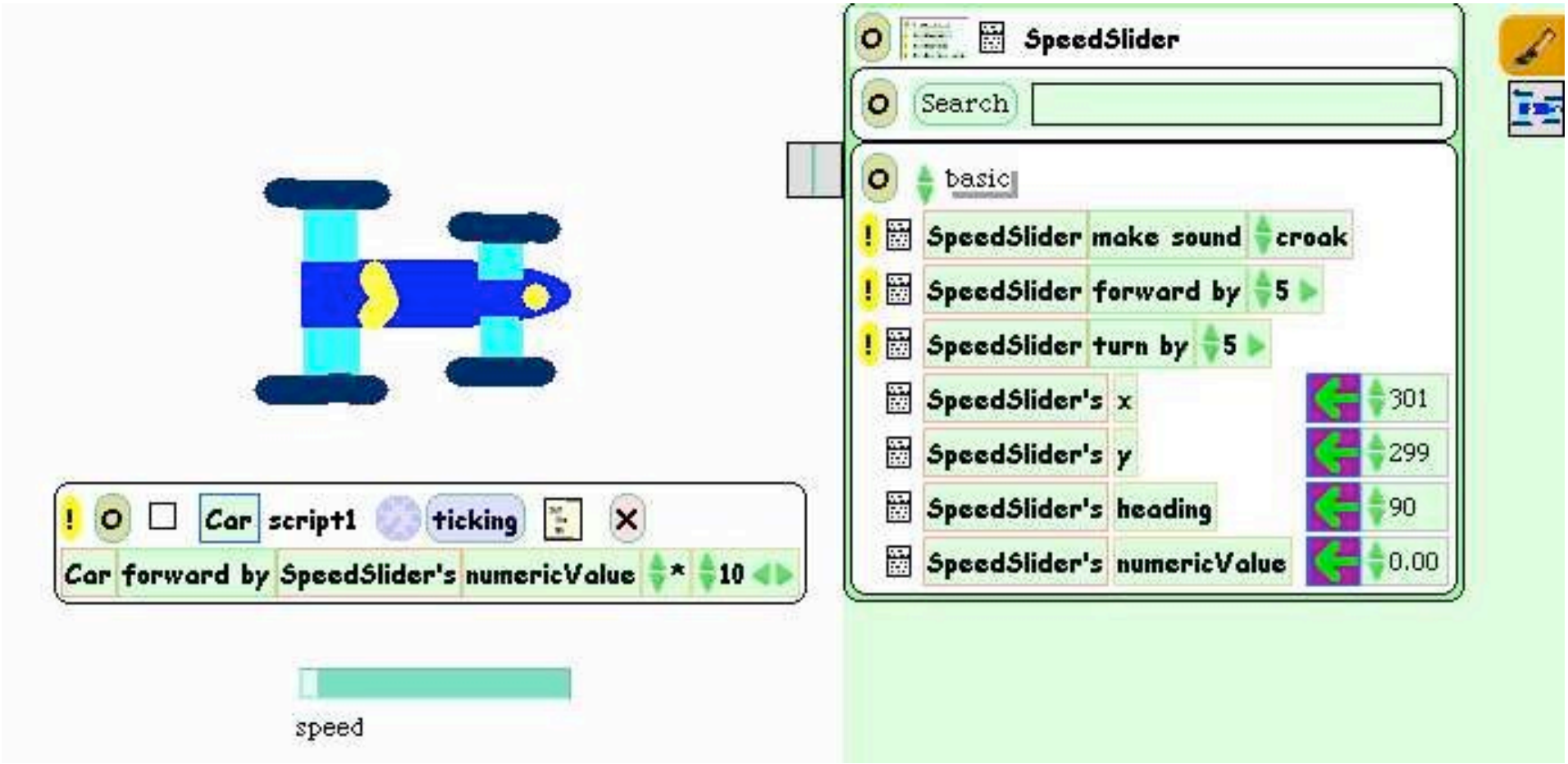
Running a Script

- Step 6: To control all scripts, use a new script control object.
  - To be found under the “Widgets” flap, like many other helpful tools
- All scripts of the project are simultaneously started and stopped through one button
  - Again just one drag operation to instantiate the object
- Example: Now car can be “driven” forward (till the border of the screen)



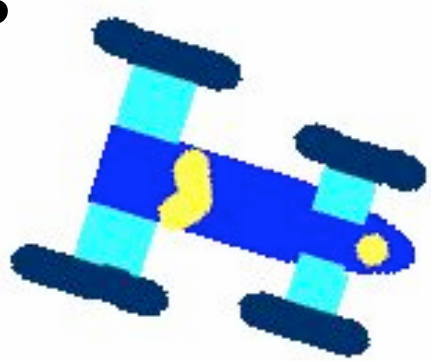
Object Interaction in Scripts

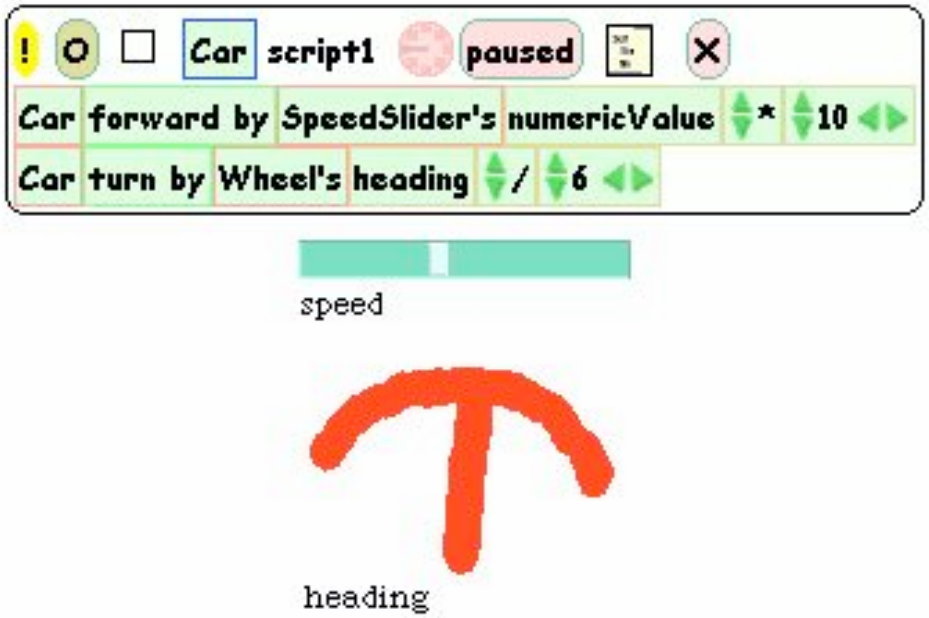
- Parameters of script commands can be computed from other objects' properties (by dragging the property onto the parameter location)
- Local adjustments can be added at the end (factor, offset etc.)



User Control through Graphical Objects

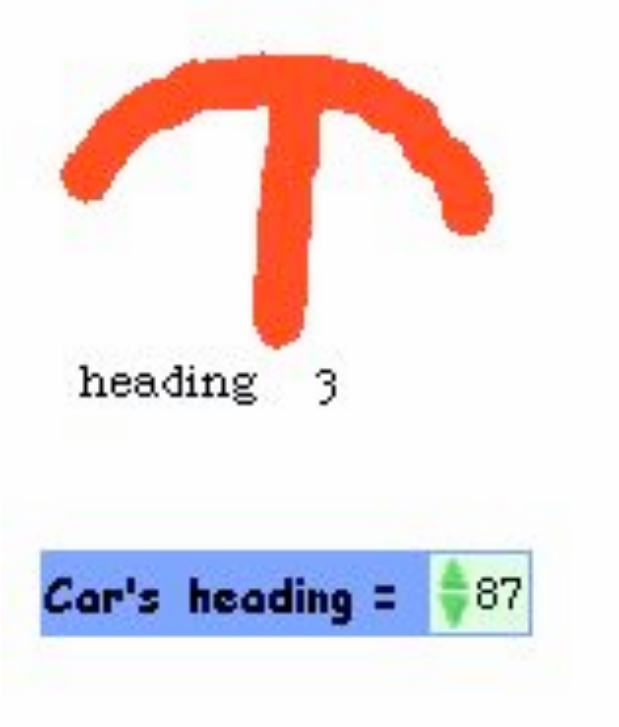
- Graphical manipulations can be used to control other objects
- Example:
  - Steering wheel graphics
    - » Drawn by hand
    - » Viewer attached
  - Rotated by user (e.g. through halo operations)
  - Heading of wheel is transferred to car
  - A “servo steering” i.e. a less sensitive transfer is recommendable





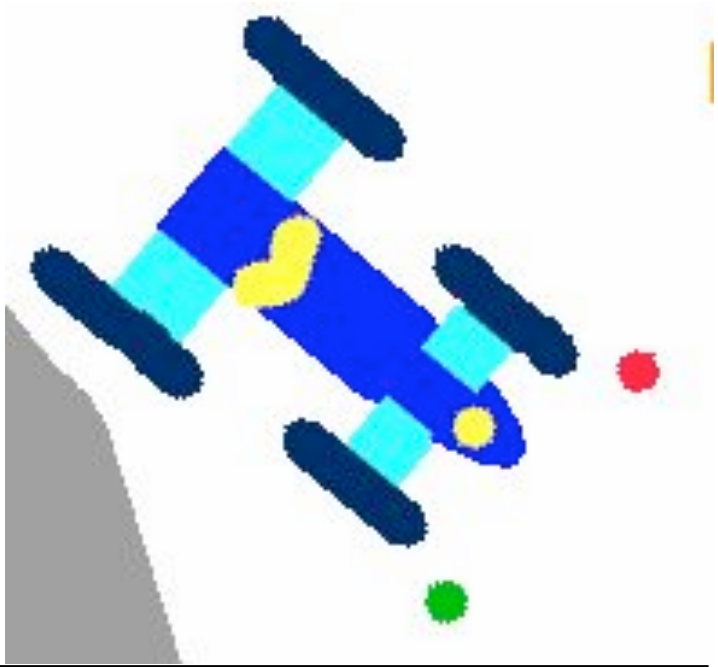
Watcher

- The values of object properties can be easily shown on the screen
  - Updated regularly and automatically
- Technically, this is an “Observer” mechanism
  - Hidden behind simple drag&drop interface
- Watcher:
  - Simple watcher (value), Detailed watcher (value plus label)
  - Can be obtained from menu left of property (in viewer)
  - Can be placed anywhere on screen

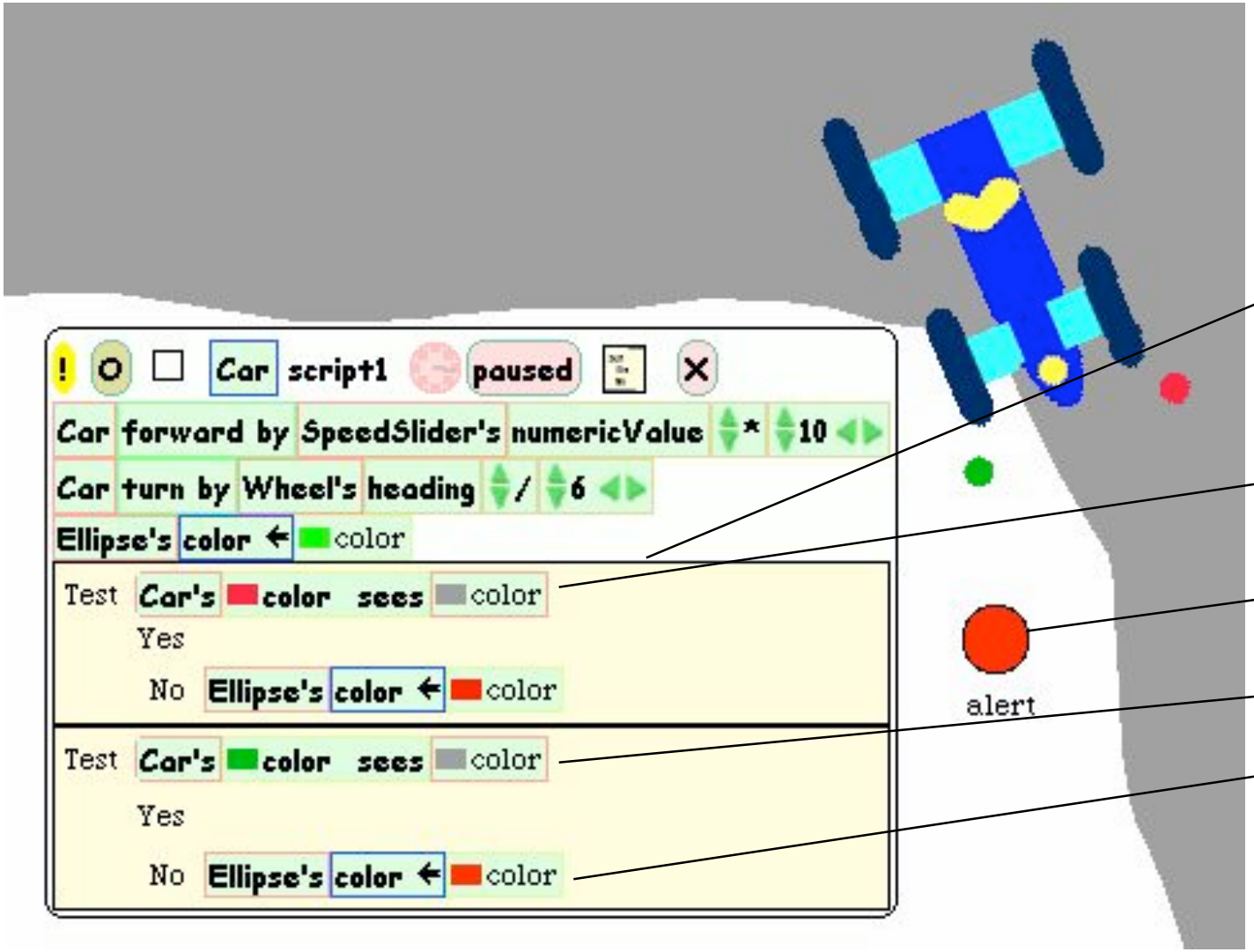


Sensors for Environment

- Squeak objects can easily observe where they are currently located
  - Through coordinates
  - Simpler: through colours
- *Sensors*:
  - Realizable as special parts of the graphics with a unique colour
  - “color x sees color y” test: Which colour is below the sensor?
- Example:
  - Grey road, car with two sensors
  - Alert lamp shall go red when one of the sensors is not on road



Example: Alert Lamp



Test tile

Test on left sensor

Alert lamp

Test on right sensor

Assignment (dragging the green-on-purple arrow right of properties)

Example: Auto-Steering

- Interaction among objects can be designed in control loops
- Example:
  - Car automatically moves forward
  - Sensor detects border of road
  - Car automatically steers to stay on the road
- Enables complex interactive learning experiences (setting up feedback loops)

Wheel control better removed at this stage?

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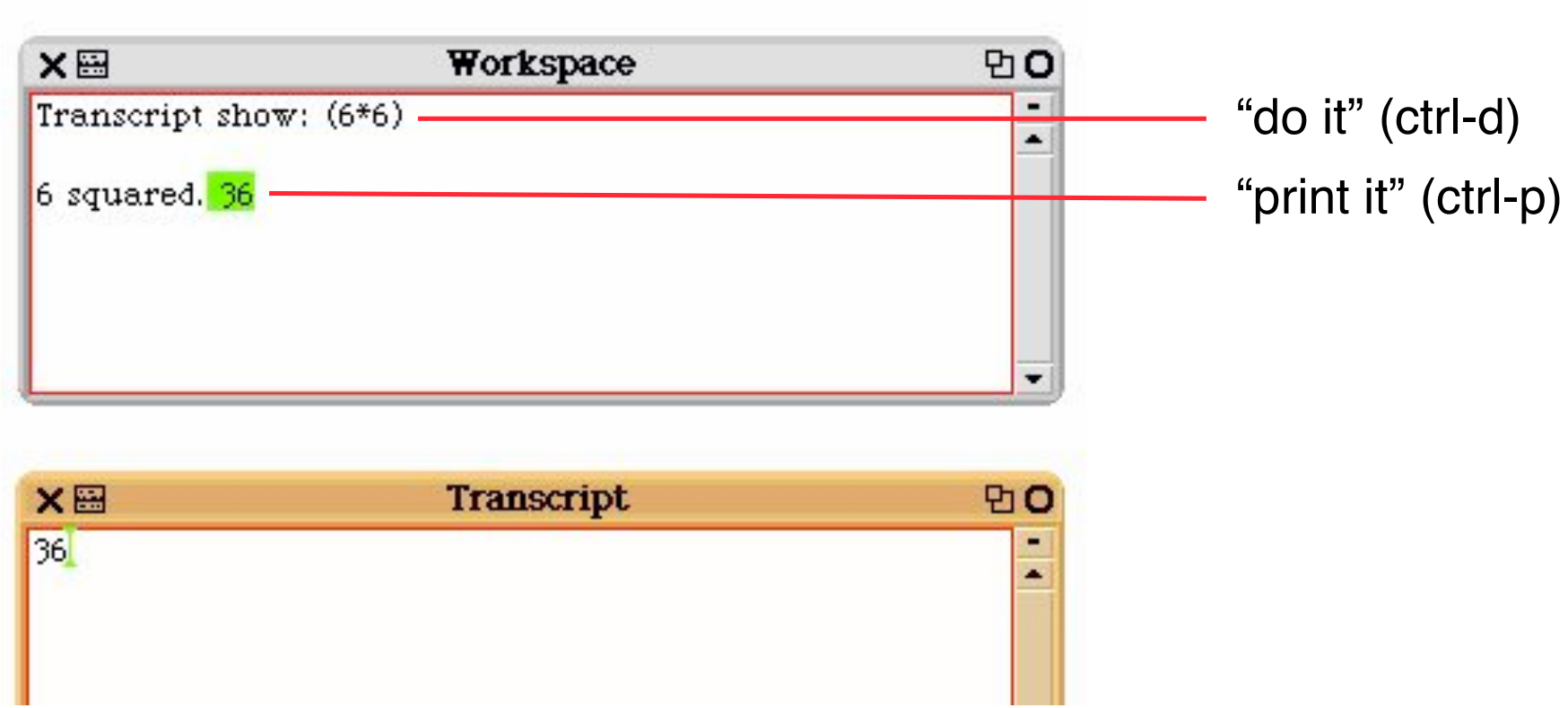
Literature:

http://www.squeak.org (tutorials)

Smalltalk Programming is Open & Interactive

- Smalltalk programs are always ready for execution, even small parts of the code can be evaluated instantly
- The interpreter state is saved/loaded in an “image” file.
- The full code of the runtime system can be inspected at any time.



Basic Rules of Smalltalk

- Every variable is an object.
  - There are no basic types which are not objects!
  - Even classes are objects!
- Code is always triggered by sending a message to an object.
- All methods return a value.
- There are three types of messages
  - Unary, e.g. `3 negated.`
  - Binary, e.g. `a + b.`
  - Keyword, e.g. `Transcript show: a.`
    - » `show` message with parameter `a` is sent to object `Transcript`
- All code is evaluated from left to right.
  - Unary messages first, then binary, then keyword messages
  - There are no operator precedence rules.
- Assignment evaluates right hand side and assigns the result to left hand side.

Smalltalk Blocks

- ```
  a := [2 + 3].
  a value.
  ```

  Result: 5

Assignment either by typing ":=" or by typing "_"

- ```
  c := [:a :b | a + b].
  c value: 5 value: 7.
  ```

  Result: 12
  (a multiple-part message)

- ```
  x := 3.
  y := 5.
  (x = y)
    ifTrue: [Transcript show: 'equal']
    ifFalse: [Transcript show: 'not equal'].
  ```

  Control flow realized by message passing mechanism
  ```

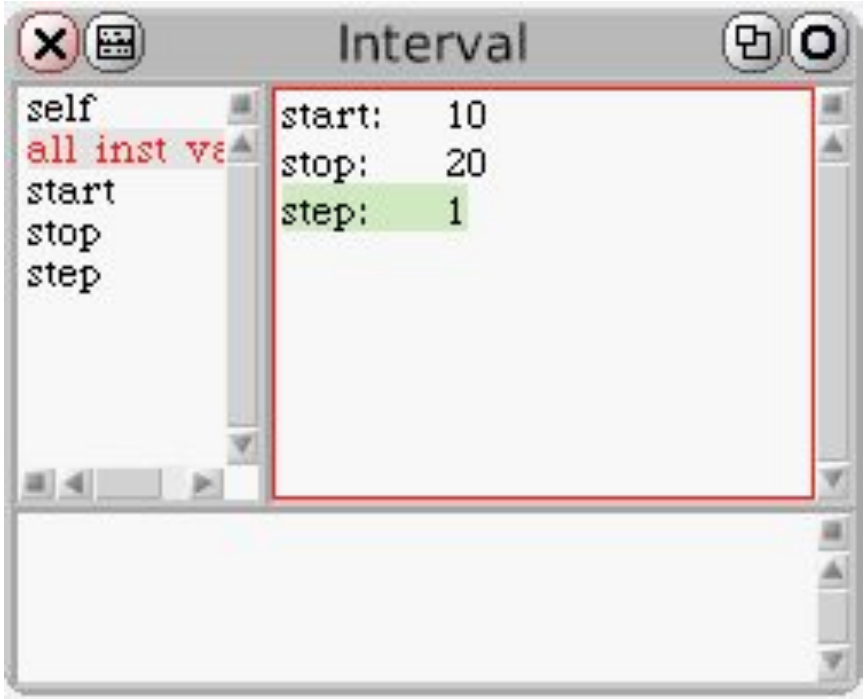
Interval Objects and Loops

- An Interval object:

```
a := 10 to: 20.
a inspect.
```

- Looping through the interval:

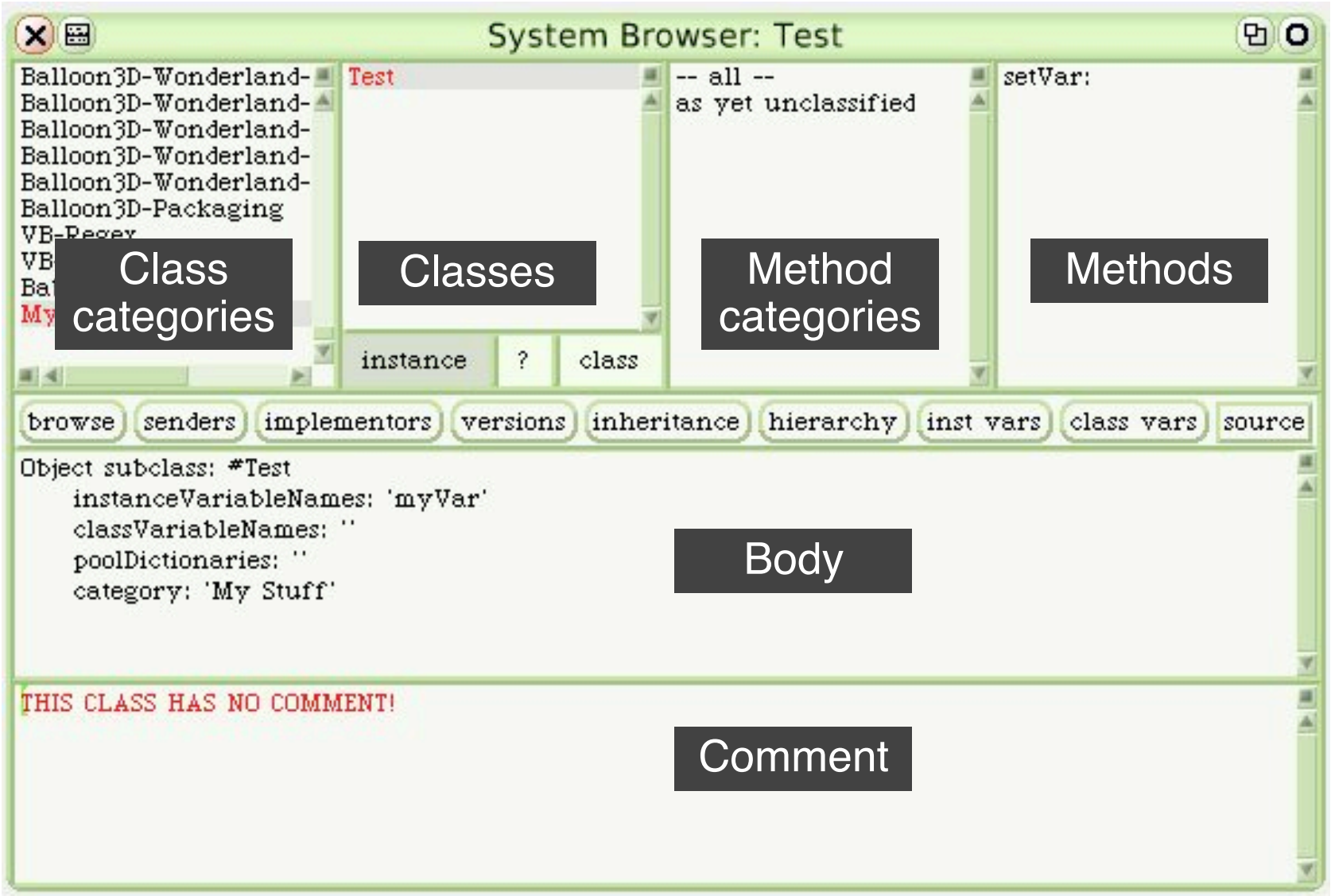
```
a do: [:i | Transcript show: i; cr].
```



Advanced Language Constructs in Squeak

- Infinite number precision
  - `1000 factorial / 999 factorial.` **1000**
  - `(1/3) + (2/3).` **1**
  - `Float infinity + 1.` **Infinity**
  - `Float infinity / Float infinity.` **NaN**
- Lazy evaluation
- High level iterators
  - `a := #(1 2 3).`
  - `a collect: [:x | x*2].` **#(2 4 6)**
  - `a reject: [:x | x odd].` **#(2)**

Browser Window



BankAccount Example

- Constructed interactively
  - Create new class template
  - Fill in instance variable (balance)
  - Fill in methods
    - » initialize
    - » deposit
    - » withdraw
- At any point in time, creation of objects and inspection is possible
- (Credits for the example: John Maloney)

Defining Classes: BankAccount

```
Object subclass: #BankAccount
  instanceVariableNames: 'balance'

balance
  ^ balance.
initialize
  balance := 0.
deposit: amount
  balance := balance + amount.
withdraw: amount
  (amount > balance)
     ifTrue: [^ self inform: 'No more money!'].
     balance := balance - amount.
```

BankAccount with History

- Extend class with history variable
  - Initialize with empty ordered collection

```
history := OrderedCollection new.
```

- Update history

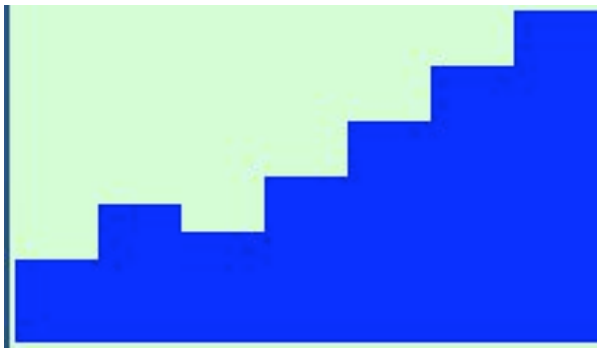
```
balance: newBalance
  balance := newBalance.
  history addLast: newBalance.
deposit: amount
  self balance: (balance + amount).
withdraw: amount
  (amount > balance)
   ifTrue: [^self inform: 'No more money!'].
  self balance: (balance - amount).
```

Graphical Object (Morph) for BankAccount

```
historyMorph
  "displays account history as barchart"
  | bars m |
  bars := history collect:
                    [:v | Morph new extent: 30@v].
  m := AlignmentMorph newRow
          hResizing: #shrinkWrap;
          vResizing: #shrinkWrap;
          cellPositioning: #bottomRight.
  m addAllMorphs: bars.
  ^m.
```

Make visible by:

```
acc historyMorph openInWorld.
```



Event Handling in Morphs

```
Morph subclass: #TestMorph
   category: 'My Stuff'

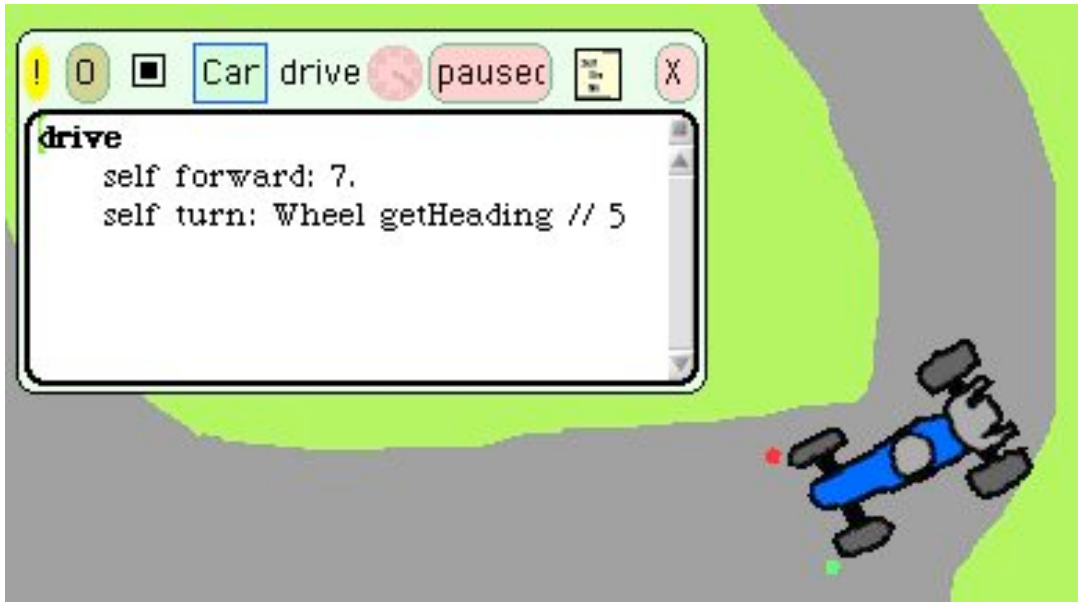
handlesMouseDown: evt
  ^ true

mouseDown: evt
  self position: self position + (10 @ 0).


TestMorph new openInWorld.
```

EToys and Smalltalk

- Squeak contains a full Smalltalk development system
- EToy scripts can be switched between iconic or textual representation
- EToy scripts are found in the browser hierarchy
- EToy scripts are just shortcuts in writing Smalltalk



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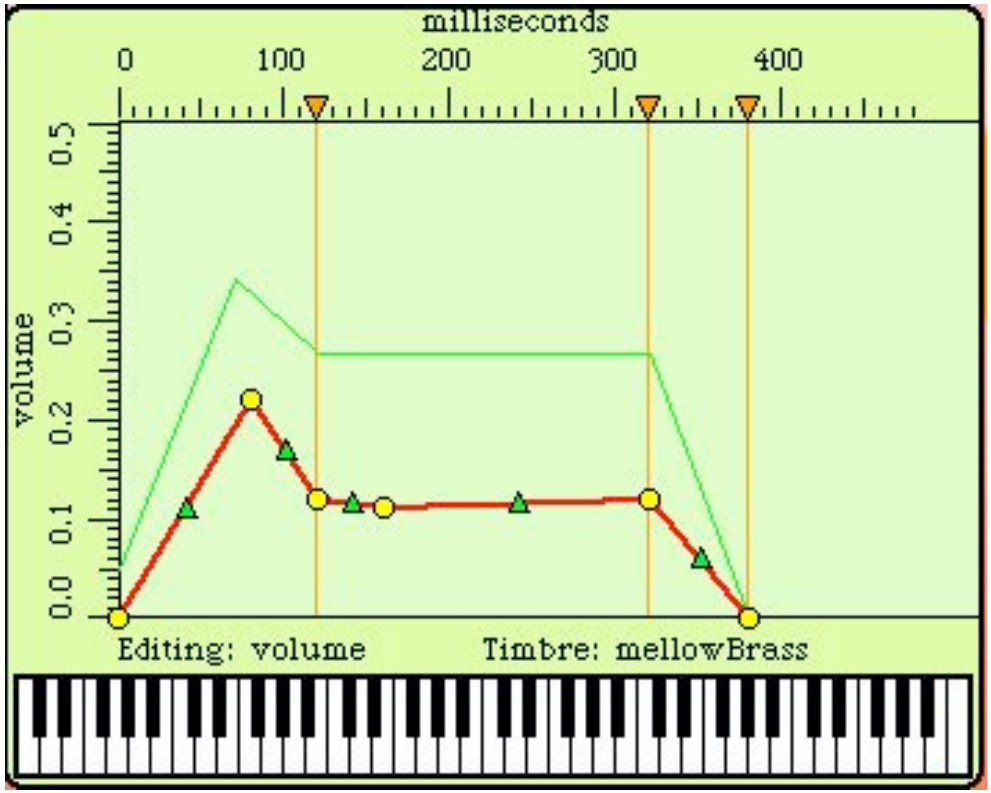
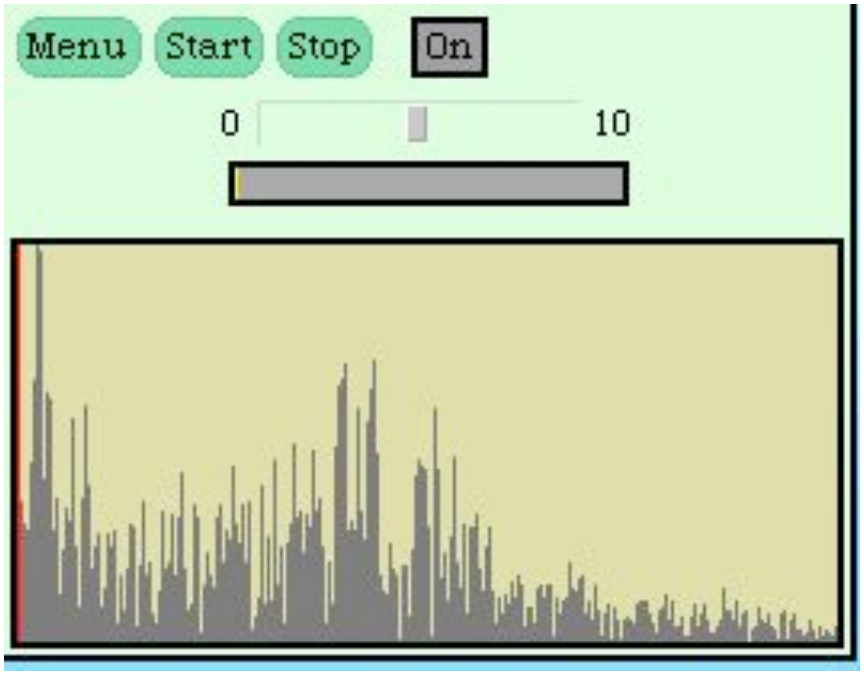
Wonderland: 3D Worlds in Squeak

- 3D objects can be moved around in intuitively simple manner
  - Prefabricated models
  - Simple self-drawn sketches (“Pooh drawings”)
- 3D objects are EToys.
- 3D objects can be manipulated with Smalltalk programs.

Squeak as a Multimedia Experimentation Platform

- Example: Sound in Squeak





Example: Playing Musical Notes in Smalltalk

```
instr := AbstractSound soundNamed: 'oboe1'.
note1 := instr soundForPitch: #c4 dur: 0.5 loudness: 0.4.
note2 := instr soundForPitch: #ef4 dur: 0.5 loudness: 0.4.
note3 := instr soundForPitch: #g4 dur: 0.5 loudness: 0.4.
(note1, note2, note3) play.
(note1 + note2 + note3) play.

song := AbstractSound noteSequenceOn: instr from: #(
    (c4 0.35 400)
    (c4 0.15 400)
    (d4 0.5 400)
    (c4 0.5 400)
    (f4 0.5 400)
    (e4 1.0 400)).
song play.
```