1 Example Technology: Macromedia Flash & ActionScript

1.1 Multimedia authoring tools - Example Macromedia Flash

1.2 Elementary concepts of ActionScript

- Scripting in General + „History“ of ActionScript
- Objects and Types in ActionScript
- Animation with ActionScript

1.3 Interaction in ActionScript

- Handling of Mouse Events
- Classical Model-View-Controller Programming

1.4 Media classes in ActionScript

Literature:

- Colin Moock: Essential ActionScript 2.0, O'Reilly 2004

Creating a “Graphically Enhanced” User Interface

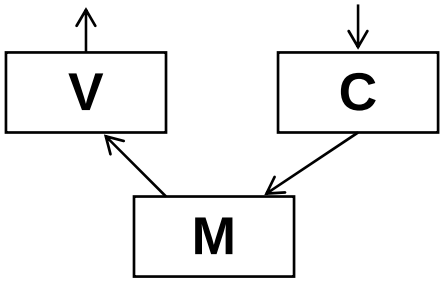
- Traditional programming
  - Example: Account with credit and debit function

- Additional “multimedia” features:
  - Auto-highlighting buttons
  - Visualization of money transfer direction
  - Visualization of “low” warning

The Account Class

```
class Account {

  var saldo:Number = 0;
  var num:Number;

  function Account(accnum:Number) {
      num = accnum;
  }

  function debit(n:Number) {
      saldo -=n;
  }

  function credit(n:Number) {
      saldo +=n;
  }

  function getNumber():Number {
      return (num);
  }

  function getSaldo():Number {
      return (saldo);
  }
}
```

Model-View-Controller (MVC) Paradigm



- Model:
  - Business model, mostly independent of user interface
  - Observable by arbitrary objects (application of *Observer* pattern)
- View:
  - Representation on user interface
  - Observes the model
  - Asks required data from the model
- Controller:
  - Modifies values in the model
  - Is driven by user interactions, therefore bound to elements of interface
  - Handles events mainly by calling methods of the model

Observer Design Pattern

- Classical design pattern, made publicly conscious by Gamma/Helm/Johnson/Vlissides
- Integrated into many frameworks, e.g. Java standard library (SDK)
- Idea:
  - *Observable* is a class from which any class is derived which shall notify other objects of changes
  - *Observer* is an interface through which objects can be notified of changes
    - » Providing a callback method *update*
  - Observable provides a method *notifyObservers* to actually inform observing objects
  - Observers have to register (*addObserver*)

How to Realize an Observer Mechanism?

- Approach 1: Look for an existing standard mechanism
  - ActionScript: Contains standard class library
  - Possible solution: Use **`mx.events.EventDispatcher`**
  - However: Only little documentation, not fully identical
- Approach 2: Re-implement the pattern
  - Not difficult for ActionScript, just port the Java library source code
  - Own class library can be defined as a local package or at a central location
- Approach 3: Look for somebody who has already re-implemented the pattern
  - For ActionScript 2 e.g. Colin Moock, author of "Essential ActionScript 2.0“
- For approaches 2 and 3:
  - Add classes for new extensions to own programming environment
  - Either extend standard class library
  - Or add subdirectories in project folder
    - » For next slides: To be put in “util” subdirectory

Excerpt from util.Observable

```
import util.*;

/**
 * A Java-style Observable class used to represent the "subject"
 * of the Observer design pattern. Observers must implement the Observer
 * interface, and register to observe the subject via addObserver().
 */
class util.Observable {
  // A flag indicating whether this object has changed.
  private var changed:Boolean = false;
  // A list of observers.
  private var observers:Array;

  /**
   * Constructor function.
   */
  public function Observable () {
    observers = new Array();
  }

  /**
   * Adds an observer to the list of observers.
   * @param   o   The observer to be added.
   */
  public function addObserver(o:Observer):Boolean {
...
```

Source Code for util.Observer

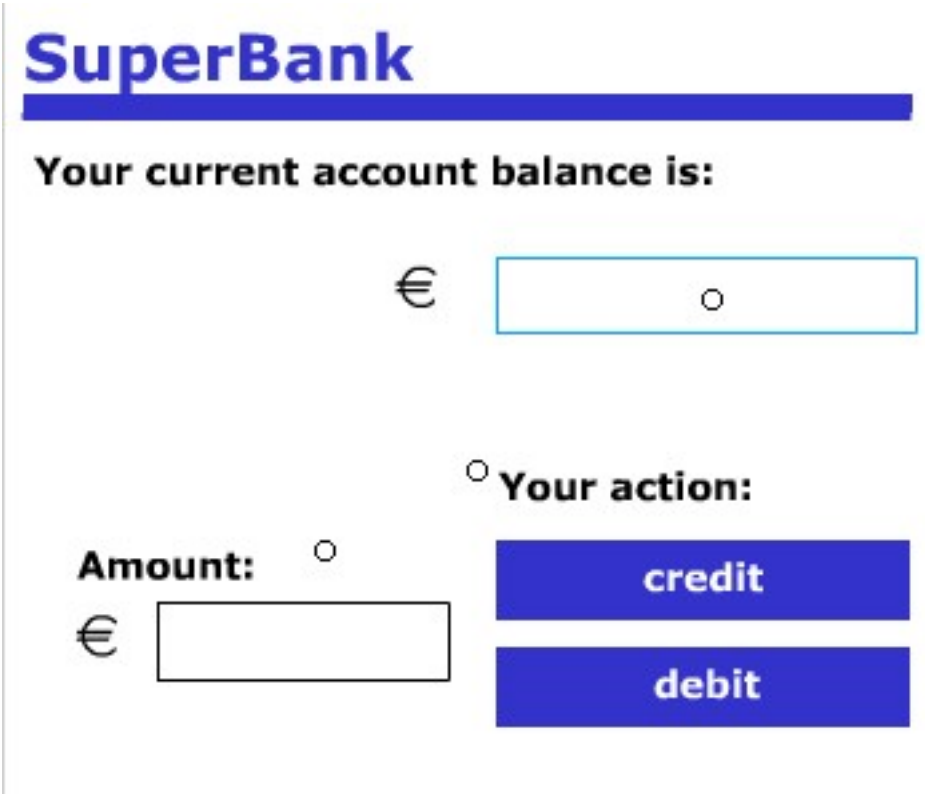
```
import util.*;

/**
 * The interface that must be implemented by all observers of an
 * Observable object.
 */
interface util.Observer {
  /**
   * Invoked automatically by an observed object when it changes.
   *
   * @param   o   The observed object (an instance of Observable).
   * @param   infoObj   An arbitrary data object sent by
   *                    the observed object.
   */
  public function update(o:Observable, infoObj:Object):Void;
}
```

Model: Observable Account Class

```
import util.*;

class Account extends Observable {

   var saldo:Number = 0;
   var accNum:Number;

   function Account(an:Number) {
       accNum = an;
   }

   function debit(n:Number) {
       if (n < 0) return;
       saldo -=n;
       if (n <> 0){
             setChanged();
             notifyObservers(false);
       }
   }

   function credit(n:Number) {
       if (n < 0) return;
       saldo +=n;
       if (n <> 0){
             setChanged();
             notifyObservers(true);
       }
   } ...
}
```

View: User Interface Design

- Main output form is a (dynamic) text field
- However:
  - Text fields cannot carry ActionScript code
  - Text field cannot be easily associated with AS class
- How can we stay object-oriented?
- Idea: Add a specific view object which just refers to the visible text field object



Class AccountView

```
import util.*;
class AccountView implements Observer {
   private var saldo_txt:TextField;
   private var lowWarning_mc:MovieClip;
   private var myAccount:Account;
   private var saldo:Number;
   private function animSaldo() {
        saldo = myAccount.getSaldo();
        saldo_txt.text = String(saldo);
        if (saldo < 0)
               lowWarning_mc.gotoAndPlay("startAnim");
        else
               lowWarning_mc.gotoAndStop("stopAnim");
   }
   public function AccountView(t:TextField, l: MovieClip, a: Account) {
        saldo_txt = t;
        lowWarning_mc = l;
        myAccount = a;
        myAccount.addObserver(this);
        animSaldo();
   } …
```

More Animation...

- Extending AcountView to cover an animation for money transfers:
  - Add **`credit_mc, debit_mc`** as constructor parameters and local variables
- Call animation when update is issued by model
  - Depending on direction of money flow as given by info object

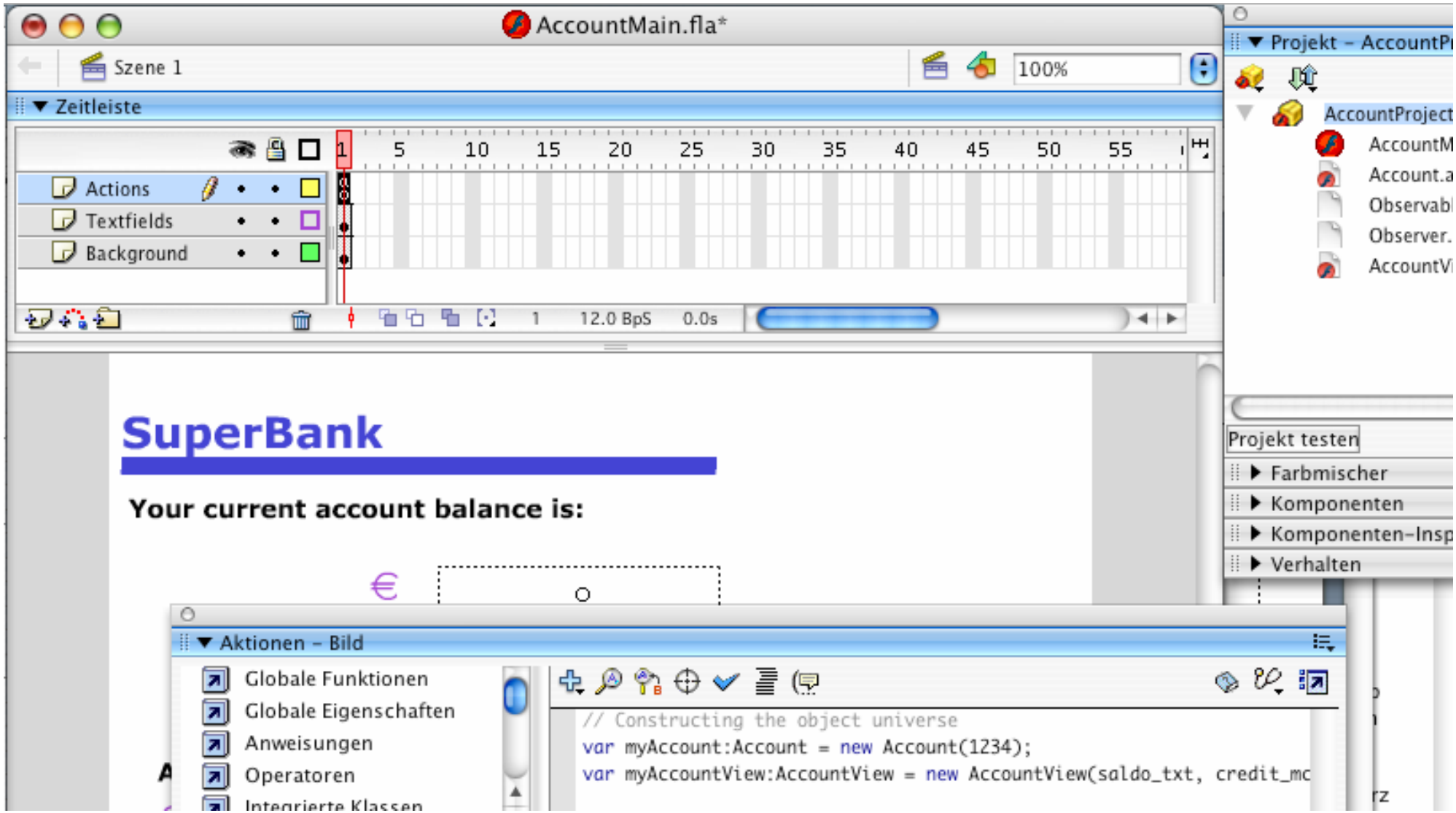
```
public function update
        (o:Observable, infoObj:Object):Void {
   var credit:Boolean = Boolean(infoObj);
   if (credit)
        credit_mc.gotoAndPlay("startAnim");
   else
        debit_mc.gotoAndPlay("startAnim");
   animSaldo();
}
```

Controller: User Event Handling

- Using Flash's built-in **`Button`** class makes highlighting easy.
- Event handling code (example "credit", "debit" is similar):

```
on (release) {
  var amount:Number = Number(amount_txt.text);
  if (isNaN(amount) or (amount < 0)) {
     amount_txt.text += "?";
  }
  else {
     myAccount.credit(amount);
  }
}
```

Constructing the Objects in Main Timeline



Alternative: Extending a TextField Object

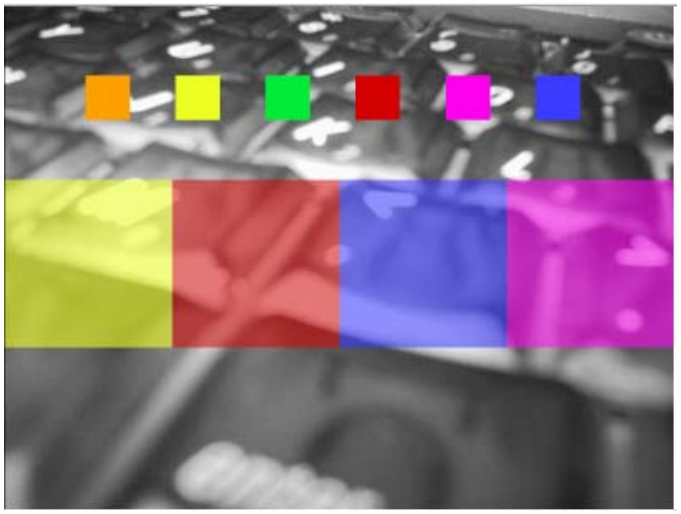
- **`saldo_txt`** is a TextField object generated in the authoring tool
- Text fields cannot be linked to ActionScript classes
- A method can be added as follows (in main timeline):

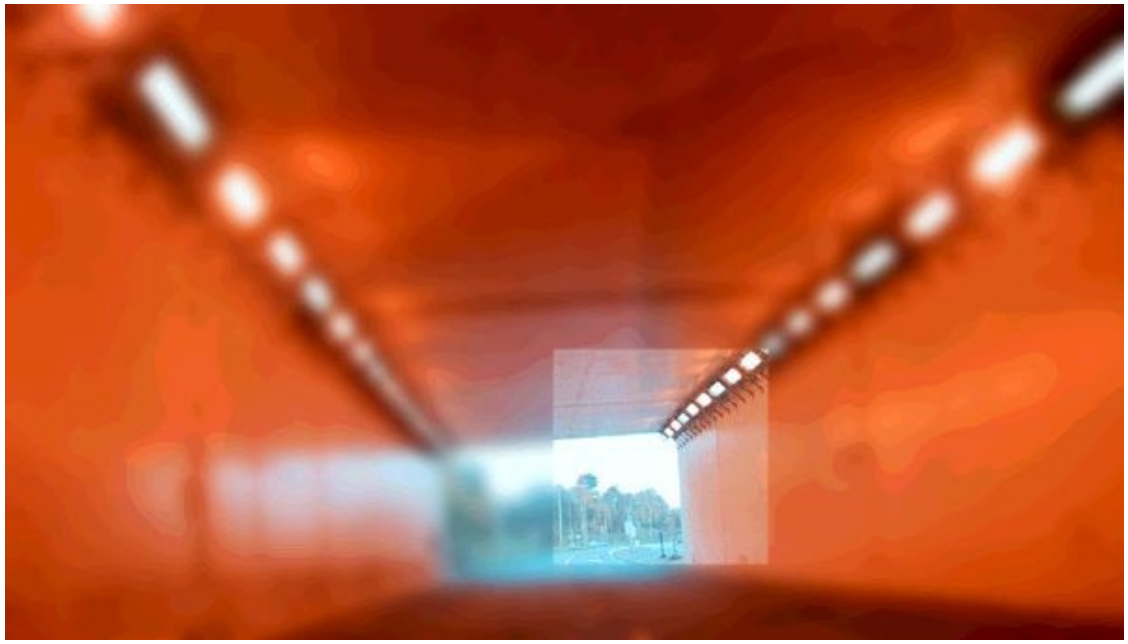
```
saldo_txt.update = function(){
  var saldo: Number = myAccount.getSaldo();
  saldo_txt.text = saldo;
  if (saldo < 0)
     lowWarning_mc.gotoAndPlay("startAnim");
  else
     lowWarning_mc.gotoAndStop("stopAnim");
}
```

Further Literature (German)

- Ein schönes deutschsprachiges Buch mit ästhetisch ansprechenden Beispielen:

  Brendan Dawes, Flash ActionScript für Designer:
  DRAGSLIDEFADE, Markt&Technik 2002





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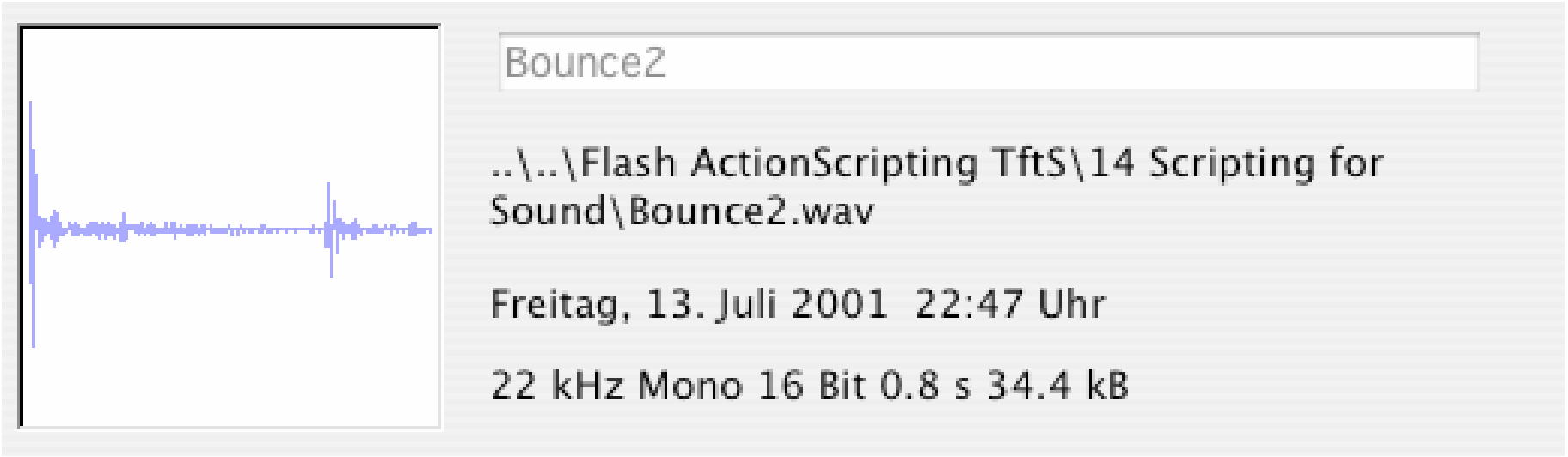
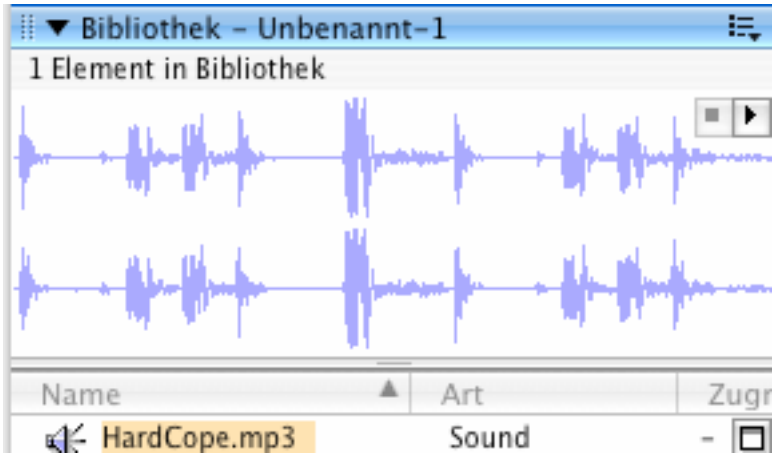
Literature:

Derek Franklin, Jobe Makar: Flash MX 2004 actionscript, Macromedia Press 2004

Sounds in the Library

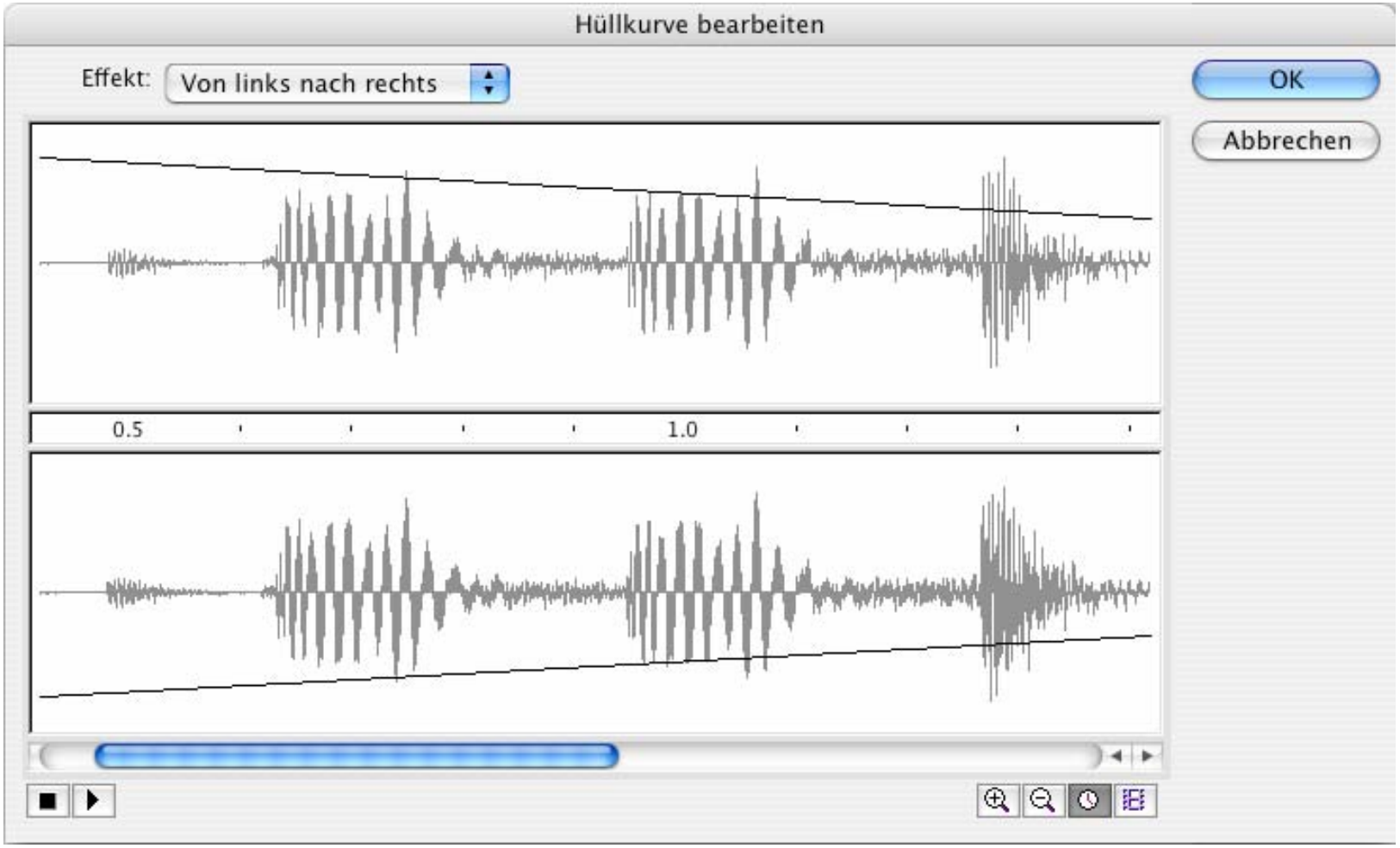


- Sounds are imported from a file (in Flash essentially WAV, MP3, AU)
  - Flash command: File -> Import -> Import into Library
- Sounds in the library are the raw material to be used in further design



Sound Processing in Authoring Tool

- Some simple effects can be created graphically



Sound Objects in Time-based Animations

- Sound object:
  - Encapsulates a (pre-produced) sound clip
- A sound object is associated with a specific timeline
  - Sound is played as the time in the timeline progresses
  - There may be many sounds in one presentation
    - » Main timeline
    - » Individual movie clip instance timelines
  - Sounds are mixed together
- Association of sound instance (from library) to timeline
  - Either graphically (e.g. dragging sound onto frame)
  - or using ActionScript method **`attachSound()`**

ActionScript Syntax for Sound Objects

- Creating a sound object:

  ```
  var soundObjectName:Sound = new Sound(TargetClip);
  ```

  Example:

  ```
  var mySound:Sound = new Sound(myMovieClip_mc);
  ```

  Omitting the *TargetClip:* Definition of global sound

- A Sound object is a *handle* like the Color object
- Controlling the sound's volume:

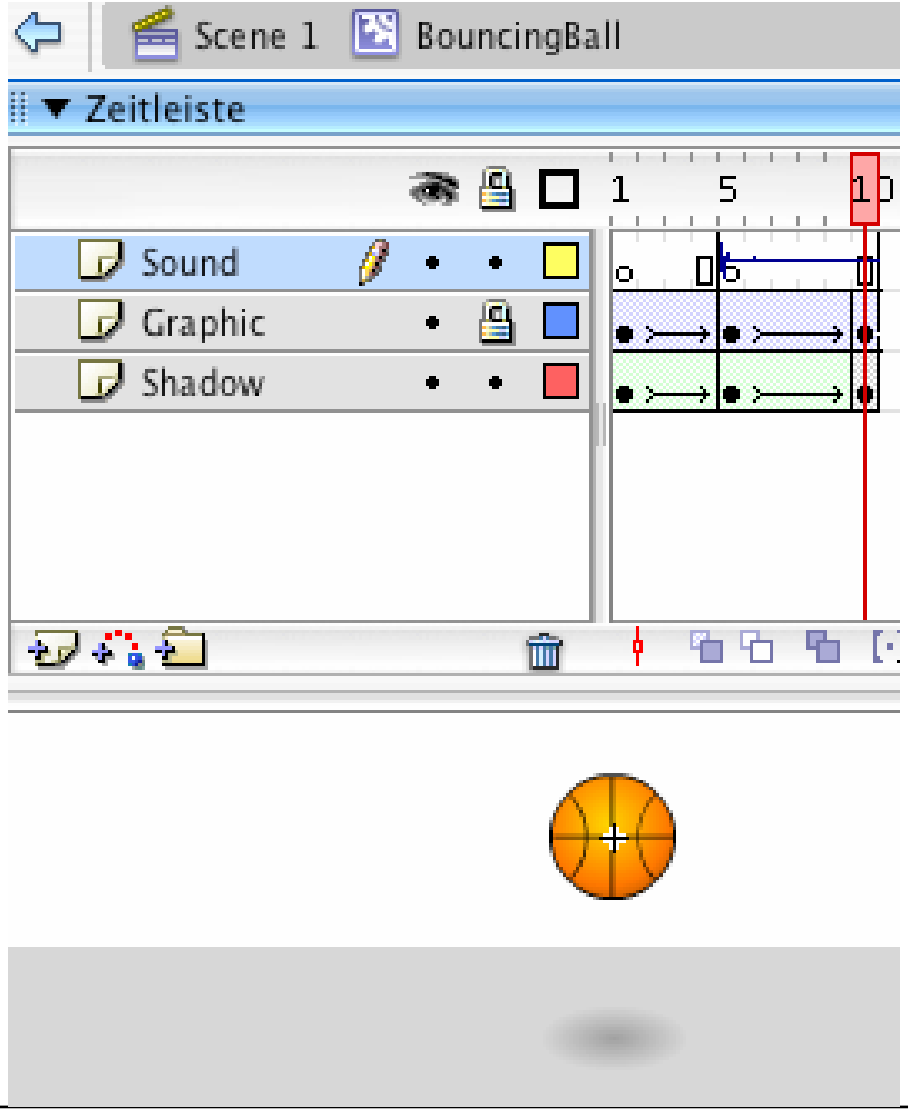
  ```
  mySound.setVolume(50);
  ```

- Attaching a library sound:

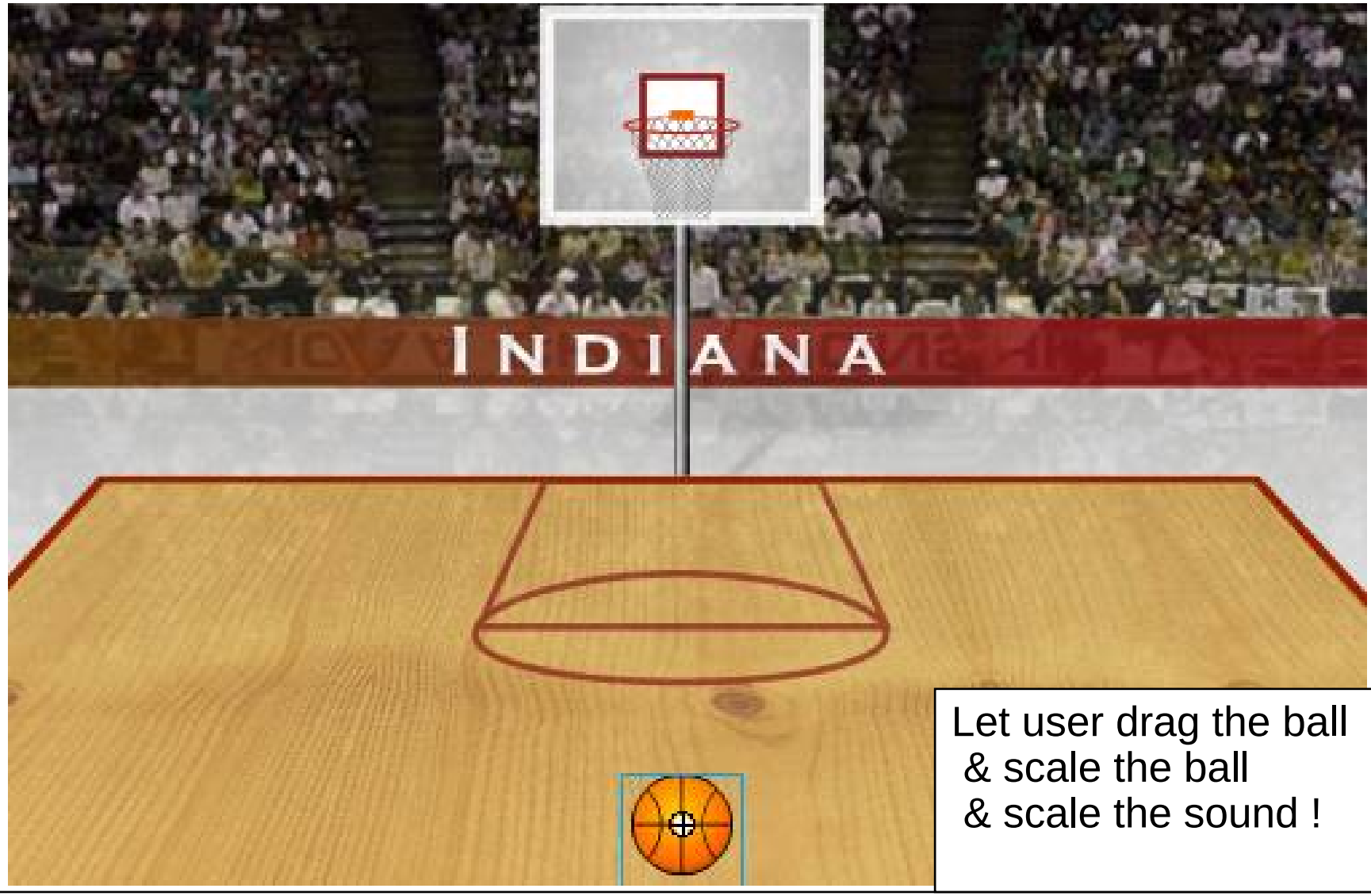
  ```
  mySound.attachSound("rockMusic");
  ```

Example: A Bouncing Basketball

- Library contains the sound of the bouncing ball
- Movement of ball and coordinated change of shadow realised by tweening
- At the frame where ball touches ground (frame 5), sound is activated
  (e.g. through the object inspector)
- Sound is played from frame 5 till end of clip
  - Works well only with short sounds



Dragging the Ball over the Court



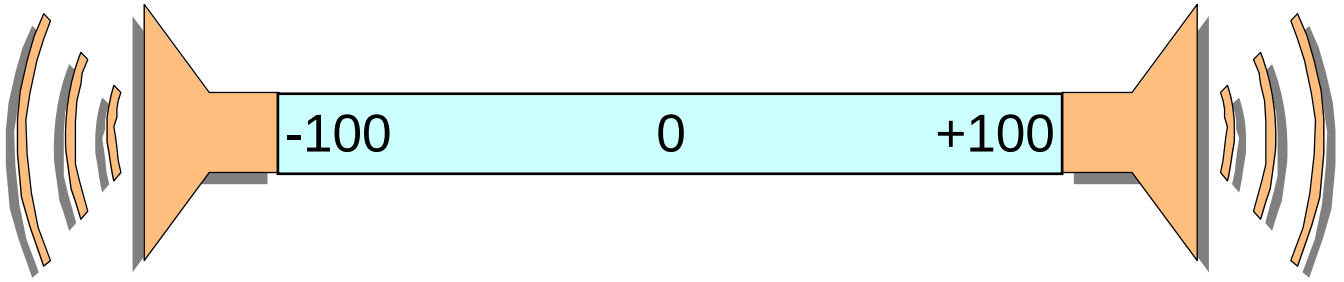
Let user drag the ball
& scale the ball
& scale the sound !

Dynamic Adjustment of Volume (and Scale)

```
var   bounce:Sound = new Sound(basketball_mc);
var   leftBoundary:Number = 60;
var   rightBoundary:Number = 490;
var   topBoundary:Number = 220;
var   bottomBoundary:Number = 360;
var   boundaryHeight:Number = bottomBoundary - topBoundary;

this.onMouseMove = function() {
  if (_xmouse > leftBoundary && _ymouse > topBoundary &&
        _xmouse < rightBoundary && _ymouse < bottomBoundary) {
     basketball_mc.startDrag(true);
     var topToBottomPercent = ((((_ymouse - topBoundary) /
       boundaryHeight) * 100) / 2) + 50;
     bounce.setVolume(topToBottomPercent);
     basketball_mc._xscale = topToBottomPercent;
     basketball_mc._yscale = topToBottomPercent;
  } else {
     stopDrag();
  }
}
```

Stereo Effect: “Panning”



- Panorama position or “balance”:
  - Relative volume of left and right stereo channel
  - Controls the perceived location of a monaural audio signal
- ActionScript (Class **Sound**):

  Method **`setPan(`*`relativeValue`*`)`**
  - Only left channel: –100
  - Only right channel: +100
  - Centered: 0

Example: Stereo Effect for Basketball

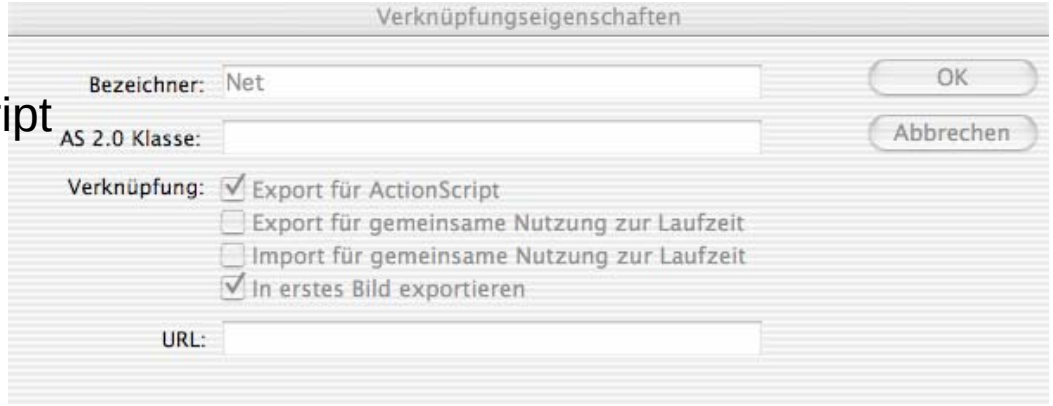
- Sound of bouncing ball draggable with mouse to left and right
  - According adjustment of sound balance

```
var   leftBoundary, rightBoundary,
      topBoundary, bottomBoundary...
var   boundaryHeight:Number = bottomBoundary - topBoundary;
var   boundaryWidth:Number = rightBoundary - leftBoundary;
var   quadrantSize:Number = boundaryWidth / 2;
var   centerPoint:Number = rightBoundary - quadrantSize;

this.onMouseMove = function() {
  if (_xmouse > leftBoundary && _ymouse > topBoundary &&
       _xmouse < rightBoundary && _ymouse < bottomBoundary) {
      ...;
      var panAmount =
       ((_xmouse - centerPoint) / quadrantSize) * 100;
      bounce.setPan(panAmount);
  }...
```

Dynamically Selected Sounds

- Sounds can be attached at runtime dynamically
  - as global sound and to movie clips
- Prerequisite in Flash:
  - Export library sound for ActionScript



- Attaching a sound from library:

  Class **`Sound: attachSound(”library name");`**
- Playing the sound:

  Class **`Sound: start(starttime, repetitions); //time in secs`**

  Class **`Sound: stop();`**

Example: Random Basketball Sounds

- On mouse click: Random number between 0 and 2
  - 0: score for “North Carolina” --> sound “boo” (Sound0)
  - 1: score for “Indiana” --> sound “cheer” (Sound1)
  - 2: no score --> sound “referee whistle” (Sound2)
  - Sound names chosen such that names can be computed from number (variable **dynaSounds**)
- In case of score:
  - Play “net sound”
  - Show basketball score animation (**`score_mc`**)
  - Update score fields of respective team (***`team`*`_txt`**)

Code for Random Basketball Sounds

```
var dynaSounds:Sound = new Sound();
var netSound:Sound = new Sound ();
...
this.onMouseDown = function() {
  var randomSound = random(3);
  dynaSounds.attachSound("Sound" + randomSound);
  dynaSounds.start(0, 1);
  if(randomSound == 0) {
     northCarolina_txt.text = Number(northCarolina_txt.text)
       + 2;
     netSound.attachSound("Net");
     netSound.start(0, 1);
     score_mc.gotoAndPlay("Score");
  } else if(randomSound == 1) {
     indiana_txt.text = Number(indiana_txt.text) + 2;
     netSound.attachSound("Net");
     netSound.start(0, 1);
     score_mc.gotoAndPlay("Score");
  }
}
```

Code for Silencing the Dynamic Sounds

- Sound to be switched off when any key is pressed:
  - *Listener* concept used
    (appropriate for events broadcasted to many recipients)

```
this.onKeyDown = function() {
   dynaSounds.stop();
}
Key.addListener(this);
```

Playing Video from Animations

- Embedding video information into animation
  - Leads to very large files (SWF files in the case of Flash)
- External video clips:
  - Editable separately with specialized software
  - Progressive download: play during loading
  - Video played at its own frame rate, not at the rate of the animation
- Support for external video in Flash (MX 2004):
  - FLV (Flash Video) format
  - Converters from most well-known video formats to FLV exist
  - Special *Media Components* for easy integration of video
    - » MediaDisplay
    - » MediaController
    - » MediaPlayback (= MediaDisplay + MediaController)
  - Media component can also play back MP3 audio

Flash Components

- *Software component:* “A ***software component*** is a unit of composition with contractually specified interfaces and explicit context dependencies only. A software component can be deployed independently and is subject to composition by third parties.”
  ECOOP 1996, Workshop on Component-oriented Programming
- *Flash component:* A reusable unit of Flash design and ActionScript programming with clearly specified parameters and methods. A Flash component encapsulates a ready-made solution that can be incorporated into third-party Flash applications.
- Components delivered with Flash (MX 2004, examples):
  - User Interface components:
    - » Button, CheckBox, ComboBox, DataGrid, DateChooser, Label, ProgressBar, ScrollPane. TextArea, TextInput, Window, ...
  - Data components:
    - » DataHolder, DataSet, WebServiceConnector, ...
  - Manager:
    - » PopUpManager, Depth Manager, ...
  - Media Components ...

Example Flash Component: Date Chooser

- Layout and basic behaviour pre-defined
- Component inspector allows customization, e.g.
  - Definition of string representation for days, months
  - Disabled days (not chosable)
  - Start day of week
- API allows dynamic ActionScript-based adaptation
  - E.g. setting selected date
- Components generate events

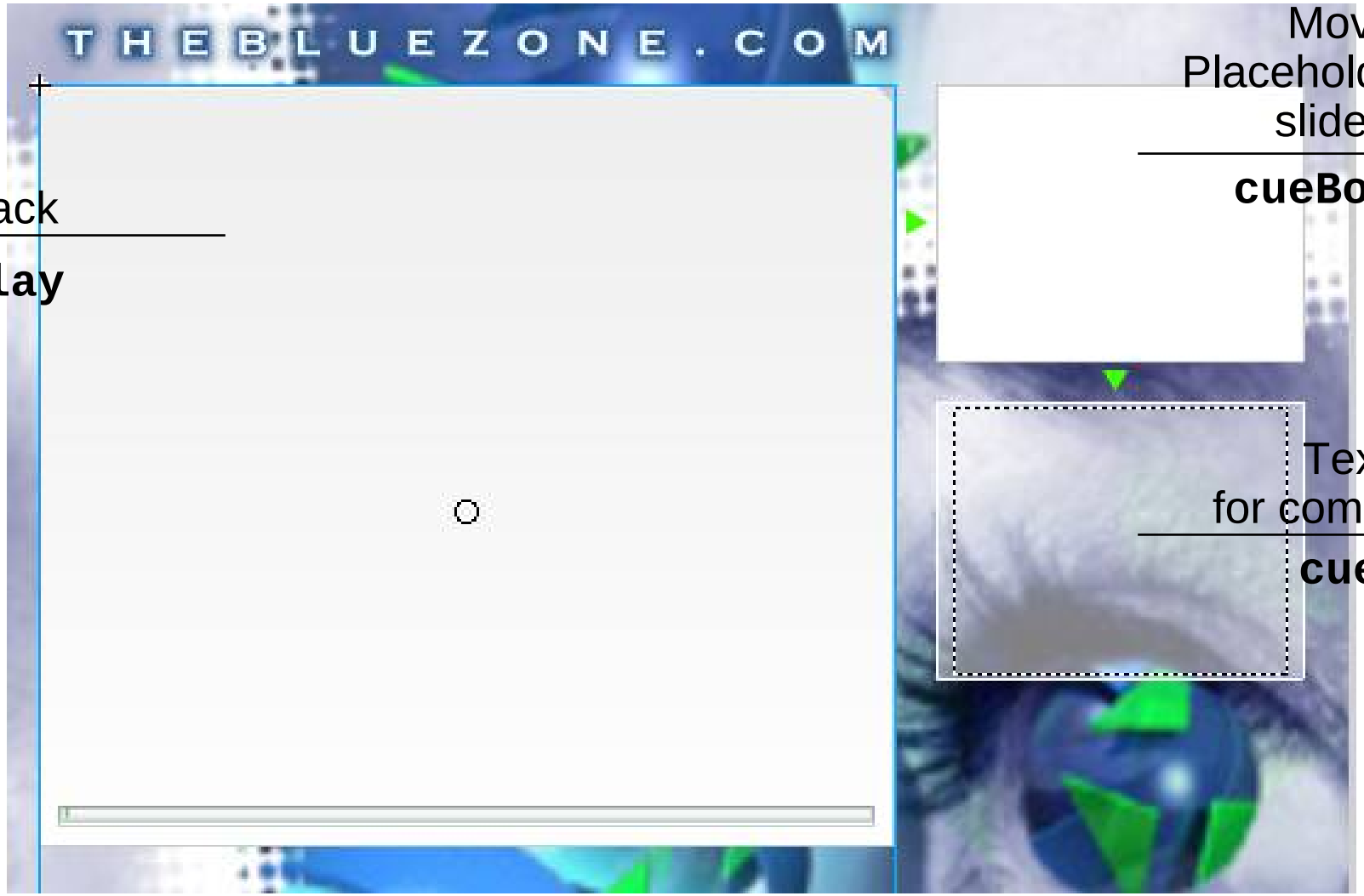
Events Generated by Media Components

- Various events are reported by Media Components to the surrounding application for flexible reaction:
  - Adjustments like change of volume
  - Media events like reaching end of media
  - User-defined events when reaching specific positions *(cue events)*

- Reaction to media events requires *Listener* objects, e.g.

```
var myListener:Object = new Object();
myListener.volume = function() {
  // actions to react on volume change
}
myMediaComponent.addEventListener("volume", myListener);
```

Example: Video with Event-Triggered Animation



Media Playback

`display`

MovieClip Placeholder for slide show

`cueBox_mc`

Text field for comments

`cue_txt`

Cue Points

- A *cue point* marks a specific point in time during media playback.
  - Cue points can be defined independently of the movie (in ActionScript)
  - When reaching a cue point, an event is fired which can be handled by ActionScript.

```
display.addCuePoint("0", 1);
display.addCuePoint("1", 8);
display.addCuePoint("2", 14);
display.addCuePoint("3", 31);
display.addCuePoint("4", 35);
display.addCuePoint("5", 53);
display.addCuePoint("6", 56);
display.addEventListener("cuePoint", displayListener);
displayListener.cuePoint = function(eventObj:Object){
   var index = Number(eventObj.target.name);
   loadMovie("cue" + index + ".jpg", "cueBox_mc");
   cue_txt.text = cueTextArray[index];
}
```

Example for Cue Points

- Names of cue points chosen in a way such that conversion to number gives an index
- Two arrays of information to be displayed in the two extra windows
  - Still pictures
  - Text information

cue2.jpg

“Fluffy is crammed into dial-up pipe”

cueTextArray[2]

Flash Pattern: Names and Numbers

- **Problem:** Indexing and computing an index requires numbers to identify information instances. Storage in files and symbol identifiers require strings to identify information instances.
- **Solution:**
  - When a string is required to be used as an index: Choose a string representing a number and convert to number when required with function **`Number()`**
  - When a number is required to be used as a string: Compute an appropriate String by concatenating a base string with the number. Choose file names and identifiers appropriately.
- **Known Uses:**
  - String-to-Number: Cue point names in above example
  - Number-to-String: File names for Cue*X* pictures in above example; Sound names in Basketball example