Multimedia-Programmierung

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Deutsch und Englisch

- Im Hauptstudium sind viele aktuelle Materialien nur in englischer Sprache verfügbar.
- Programmiersprachen basieren auf englischem Vokabular.
- Austausch von Materialien zwischen Lehre und Forschung scheitert oft an der deutschen Sprache.
- Konsequenz:
  - Die wichtigsten Lehrmaterialien zu dieser Vorlesung (v.a. Folien) sind in englischer Sprache gehalten!
  - Der Unterricht findet (noch) in deutscher Sprache statt.

Multimedia Programming

- Creative Designers of multimedia content (e.g. using Macromedia Flash):
  - "Many Flash users avoid to program in Flash. They are afraid of the jump into the 'unknown' area of programming."

    Cover text of
    B. Dawes: Flash ActionScript for Designers: Drag Slide Fade
- Traditional programmers with interest in multimedia (like the author of these slides):
  - Multimedia programming is a special case of general programming
    - » Why are then new development environments and even programming languages developed (like Macromedia Flash)?
- Questions (to be covered in this lecture):
  - Is there a need for bridging between graphical design and programming?
  - Are systems like Flash necessary, or are they just a way to avoid hiring programmers?
  - What is the most efficient way of developing multimedia applications?

What we will cover – and what not

- This lecture does ***not*** cover:
  - Treatment of multimedia data on low system levels (operating system, networks)
  - Production of media products which are consumed in a linear, non-interactive way (like movies)
- The focus of the lecture is on:
  - Graphical representation and (2D-)animation
  - Interaction, including multi-user applications
  - Integration of computer graphics with other kinds of media
  - Development process in team work using the most recent software technologies (agile development, model-driven development)
  - The application area is programming of games
- The example development environment is:
  - Macromedia Flash MX 2004 Professional, ActionScript 2.0
    (not yet Flash 8, not yet ActionScript 3.0!)
- Other development environments will be covered as well (e.g. Squeak, Java frameworks)

Organisatorisches (1)

Ausnahmsweise auf Deutsch:

- Die Lehrveranstaltung (2V+4Ü) ist eine Mischung aus:
  - Vorlesung (10 Doppelstunden)
  - Klassische Übungen (7 Aufgaben, vsl. 4 Hausaufgaben)
    - » Achtung: Doppeltermine (4 Stunden!)
  - ***Umfangreiche*** Projektarbeit in kleinen Gruppen

    ... plus eigene Freiarbeit
- Im Zeitraum 14.5.–19.7. findet die Projektphase statt:
  - Einteilung in kleinere Projektgruppen (je 6 Teilnehmer)
  - Ergebnispräsentation am Ende der Vorlesung (*vor* den Ferien)
- Leistungsnachweis durch:
  - Erfolgreiche Teilnahme an der Projektphase
    - » Erfolgreiche Zwischen- und Endpräsentationen
    - » Einhaltung der Meilensteine
    - » Erfolgreiche Fertigstellung der Projektaufgabe (“Web-fertig”)
  - Abgabe von (ca. 4) Einzel-Hausaufgaben

Organisatorisches (2)

- Einteilung in zwei Übungsgruppen
  - Montag bzw, Freitag, jeweils ganzer Vormittag
- Terminalserver für Windows wird benutzt:
  - Bei vorhandener Kennung aus vorhergehenden Lehrveranstaltungen (z.B. “Digitale Medien”) Benutzbarkeit sicherstellen (Passwort!). Falls Paßwort zurückgesetzt werden muss, Email an Andreas Pleuß.
  - Alle angemeldeten Teilnehmer ohne bisherige Kennung erhalten automatisch neue Kennung in der Übung
- Einbringung in mündliche Prüfung des Fachgebiets MM für Medieninformatik-Studierende (A bei Informatik)
  - Achtung MM-interne Regelung (nicht in der Prüfungsordnung): Mindestens 50% der eingebrachten Stunden müssen bei MM aus Vorlesungen stammen!
  - 4 SWS Übungen einzubringen v.a. bei 18-SWS-Prüfung empfehlenswert

Kreatives Software-Engineering in der Praxis bei sd&m

- Besuchstag bei sd&m
  - Projektvorstellungen
  - U.a. auch zu Onlinepartal, Multimedia im Netz
- **Ort:** sd&m AG, Offenbach (bei Frankfurt)
- **Termin:** Montag, 7. Mai; 13:00 – 19:00 Uhr
  Abfahrt (Bus) ca. 08:30 Uhr
- Kosten für Fahrt und Verpflegung werden von sd&m getragen
- Details und Anmeldung bei Andreas Pleuß
- Einsendung von Bewerbungsunterlagen
  => Möglichkeit für Einzelinterviews

Outline (Preliminary)

1. Example technology: Macromedia Flash & ActionScript
   - 1.1 Multimedia authoring tools - Example Macromedia Flash
   - 1.2 Elementary concepts of ActionScript
   - 1.3 Interaction in ActionScript
   - 1.4 Media classes in ActionScript
2. Development process for multimedia projects
   - 2.1 Classical models of the software development process
   - 2.2 Special aspects of multimedia development projects
   - 2.3 Example: The SMART process
   - 2.4 Modeling of multimedia applications
   - 2.5 Agile development/Extreme Programming for multimedia projects
3. Introduction to computer game programming
   - 3.1 Computer games: History and classification
   - 3.2 Principles of game design
   - 3.3 Design and animation of game characters
   - 3.4 Physical laws in games
4. Overview on approaches to multimedia programming
   - 4.1 History of multimedia programming
   - 4.2 Squeak and Smalltalk: An alternative vision
   - 4.3 Frameworks for multimedia programming
   - 4.4 Summary and trends

1 Example Technology: Macromedia Flash & ActionScript

The Expectations

"I like to think that if Rembrandt or Monet were alive today, they would be using Macromedia Flash MX and would be amazed by the level of creative expression they could achieve. Flash is a paintbrush that advances exponentially every year [...]."

Gary Grossman, Director of Engineering, Macromedia Inc.

The Purpose of Multimedia Authoring Tools

- Multimedia programs are complex:
  - Usage of special libraries
    - » (2D) graphics primitives
    - » Converters for media formats
    - » Playback components
  - High data volume
    - » Requires special techniques like streaming, caching, …
  - Synchronization issues
    - » Some streams in stepwise synchronicity (e.g. audio track for video)
  - Interaction techniques
    - » Flexible reaction to user actions
- Multimedia content is often created by non-technical people
- Authoring tools
  - Try to hide much of the complexity (using standard patterns and libraries)
  - Development environment accessible to non-technical people

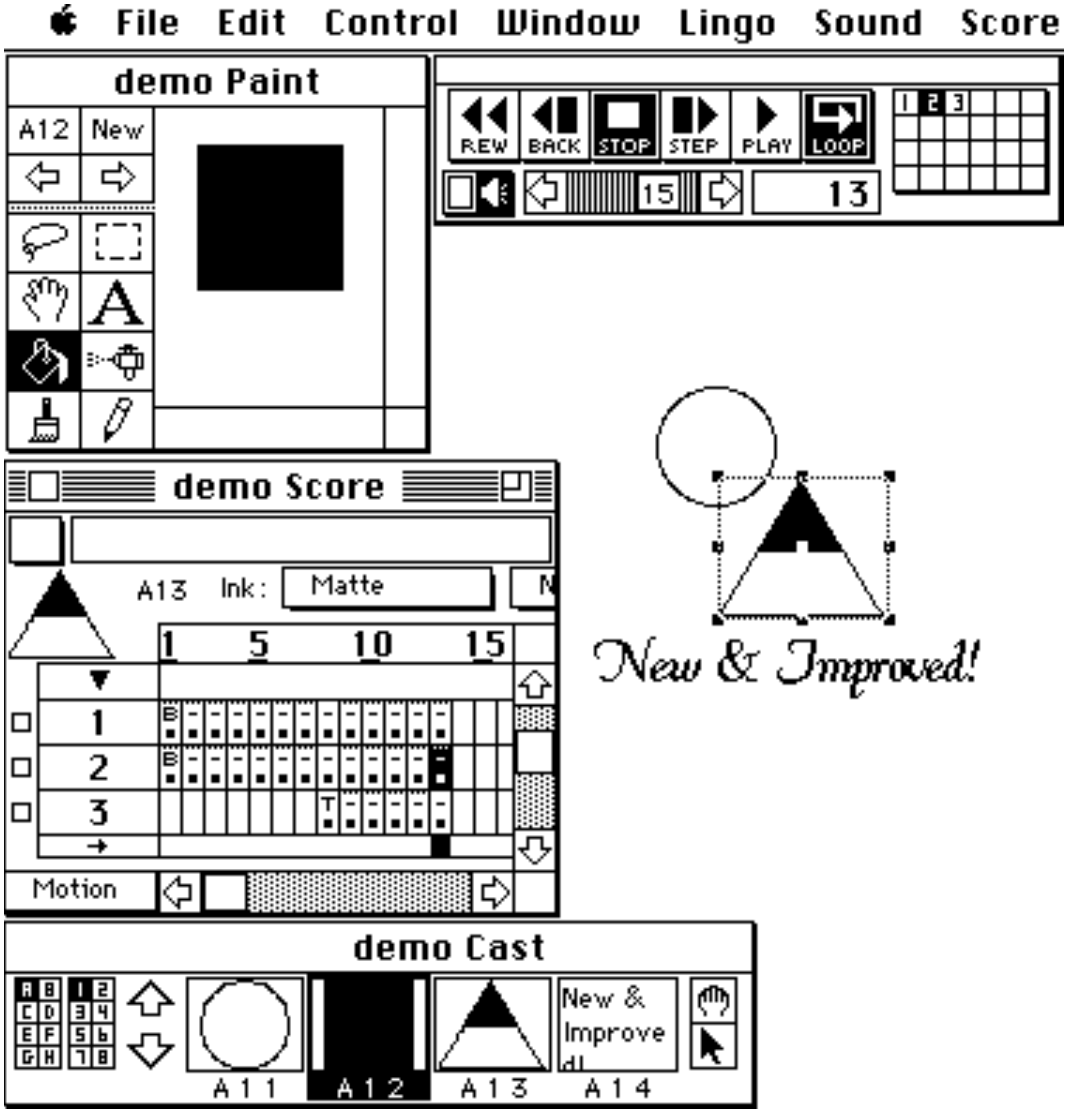
Macromedia Inc.: History

- 1984: *Macromind*
  (Jamie Fenton, Marc Carter, Mark Pierce)
  - *VideoWorks* (Joe Sparks)
    - » first timeline metaphor?
  - 1988: *VideoWorks* renamed to *Director*
- 1991:
  - Merger between *Macromind* and *Paracomp*
    - » 3D modeling tool *Swivel 3D*
  - Merger between *Macromind-Paracomp* and *Authorware*
    - » Courseware authoring tool *Authorware*
- 1996: New CEO *Rob Burgess* changes focus to Web publishing
  - HTML authoring tool *DreamWeaver*
- 1997:
  - Macromedia acquires *FutureWave Software*
    - » Key product *FutureSplash* renamed *Macromedia Flash*
- 2001:
  - Merger between Macromedia and *Allaire Systems* (*ColdFusion* server)
- 2005:
  - Adobe acquires Macromedia and its product portfolio

Not to be confused with the Munich-based training company “Macromedia” !

VideoWorks screenshot

- 1985-88



Flash: History

- Jonathan Gay:
  - Software developer for *Silicon Beach Software* (starting in high school...)
  - Involved in various ground-breaking Macintosh applications: Airborne!, DarkCastle (1987), SuperPaint II, IntelliDraw (drawings with behaviour)
- 1993: Foundation of *FutureWave Software*
  - Goal: Develop sketching software (*SmartSketch*) for the new “pen computer” and the PenPoint operating system from the company GO
  - GO (and later EO) computers failed
- 1995-96: *SmartSketch* becomes *FutureSplash Animator*
  - Ported to Macintosh and Windows
  - Extended with 2D animation features
  - From the beginning targeted at delivery over the Web
  - Well accepted by important customers (e.g. Microsoft, Disney)
- 1996: FutureWave bought by Macromedia
  - FutureWave Splash becomes *Macromedia Flash 1.0*

EO

Flash vs. Director

- Director:
  - 10 years older than Flash
  - Designed for development of interactive CD-ROMs
  - Integrated programming language *Lingo*
  - Oriented towards bitmap graphics
  - Starting from Version 7: integration of Flash content
- Flash:
  - Designed for content delivery over the Internet *(streaming)*
  - Oriented towards vector graphics
  - Early versions (up to version 3) extremely simple in their interaction possibilities, later versions with increasing support for scripting
  - Early usage of Flash heavily criticized for bad usability
    - » Flash intros, breaking with Web paradigms (Jakob Nielsen 2000)
  - Current usage trends:
    - » rich media content (e.g. video), advanced interactive Web sites

Shockwave Plugins

- Shockwave:
  - General name for Web plugins playing Macromedia content
- *Shockwave for Director:*
  - Often simply called *Shockwave* plugin!
  - Plays content created with Director (Shockwave Movies)
  - File types: .dcr, .dir, .dxr
  - MIME type:
    application/x-director
- *Shockwave Flash*
  - Often called *Flash* plugin, different from Shockwave plugin!
  - Plays content in SWF (Shockwave Flash) format
  - File types: .swf, .spl (from FutureSplash)
  - MIME types:
    application/x-shockwave-flash
    application/futuresplash

Shockwave Flash (SWF)

- SWF is often pronounced as “swiff”
- File format for execution-ready presentations
  - Proprietary compiled format of Flash presentations
  - Flash browser penetration over 95%
  - Can be produced by various programs, not only Macromedia Flash
    - » E.g. open-source, multi-platform scripting language SSWF http://sswf.sourceforge.net/
- Specifications of SWF format:
  - Older versions were publicly available, now developer-licensed product
- Players exist for many platforms:
  - PDAs
  - Mobile phones
    - » The pioneer 2003: *i-Mode* system from NTT DoCoMo
    - » 2006: *Flash lite* licensed by many mobile phone manufacturers (e.g. Nokia, BenQ/Siemens, LG)
  - Digital music players
  - Set-top boxes, public displays, car navigation systems, ...
  - Generic Java player applets (older versions only)

1 Example Technology: Macromedia Flash & ActionScript

1.1 Multimedia authoring tools - Example Macromedia Flash

Background: History, Context

Flash Authoring Tool: A Quick Tour

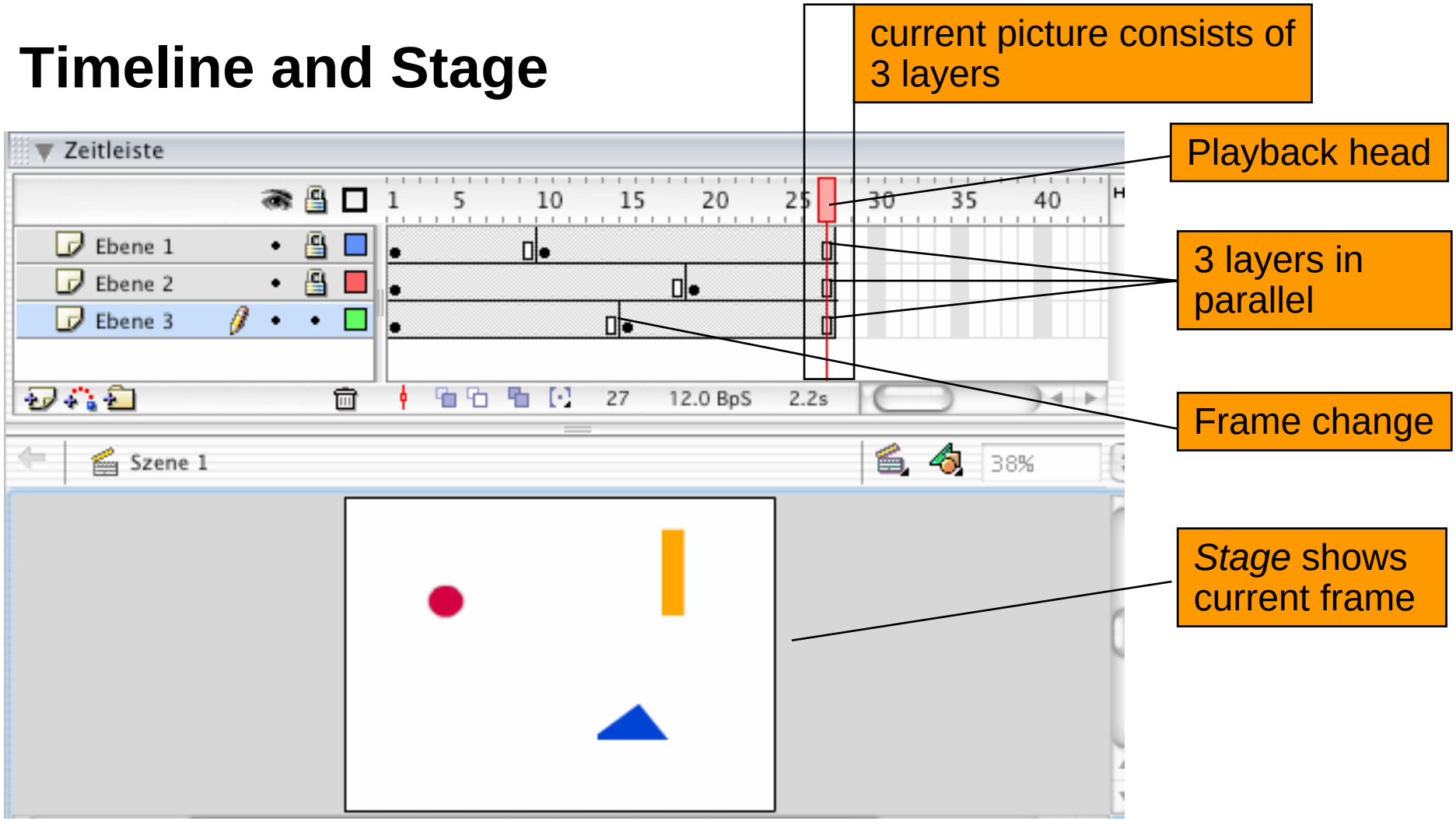
SWF Format

1.2 Elementary concepts of ActionScript

1.3 Interaction in ActionScript

1.4 Media classes in ActionScript

Timeline and Stage

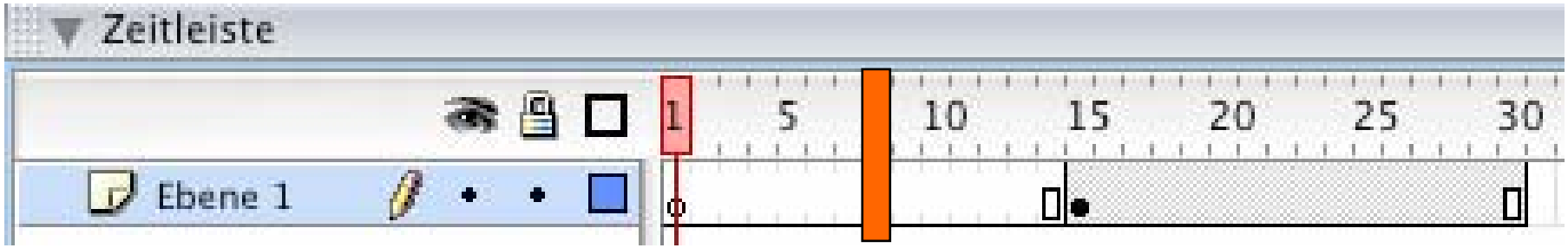


3 dimensions (2 plane dimensions plus time) mapped to 2D screen:

– 2D-frame (stage), no time
– time plus layers, no frame content

} combined

Timeline Symbols



Frame no. 8

- The timeline contains *frames* (Bilder)
- *Key frames (Schlüsselbilder)* are defined explicitly (drawn by hand)
  - Representation in Flash:
    hollow dot = empty key frame
    black dot = key frame with content
- Default treatment of frame sequences: repeat last frame
  - Grey bar: Sequence of identical frames
  - Square: Last frame of a sequence
  - Changes in key frame affect all subsequent frames till next key frame!

Animation: Change of Pictures over Time

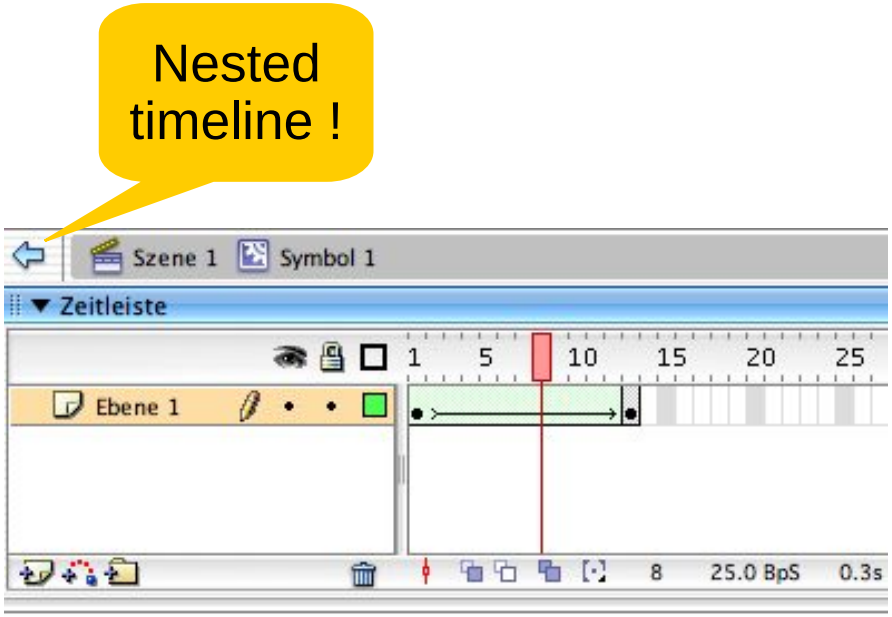
- The suggestion of continuous change or movement:
  - Created by small changes from picture to picture
  - At least 12 frames per second, better more (25 and more)

- Single picture animation:
  - One graphic picture (drawn by hand) per frame
  - In Flash: Sequence of key frames

- Interpolation *(tweening):*
  - Sequence of frames defined by first and last frame
  - “In-between frames” generated automatically (interpolated)
  - “Tweening” possible with respect to several properties
    - » Size, location, orientation, colour of individual object *(motion tweening)*
    - » Shape of object *(shape/form tweening)*

Hierarchical Timelines

- Each object can bring its own timeline
  - Instances of library symbols bring a copy of the timeline defined for the symbol
- Main timeline may be structured hierarchically into a tree of timelines
- Each instance of a symbol can move individually through its timeline
  - ActionScript code (see next lecture) can be added to navigate within timeline



1 Example Technology: Macromedia Flash & ActionScript

1.1 Multimedia authoring tools - Example Macromedia Flash

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1.2 Elementary concepts of ActionScript

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SWF

- The Macromedia Flash file format (SWF) (pronounced “swiff”) delivers vector graphics and animation over the Internet to the Macromedia Flash Player.
  - Pure delivery format
- Design goals:
  - On-screen display
    - » Designed for rendering
  - Extensibility
    - » Tagged format
  - Network delivery
    - » Compact binary format
  - Simplicity
  - Scalability regarding power of hardware
  - Scriptability
    - » Stack machine code compatible to “ActionScript” language

Structure of a SWF File

- Tagged structure of objects
- Two categories of tags:
  - Definitions of content (shapes, bitmaps, sounds and so on):
    - » Each definition tag assigns a unique *character id*
    - » Definitions stored in *dictionary*
  - Control:
    - » Control the flow of the movie (timelines, actions)
    - » Create and manipulate instances of characters
- Built-in features (selection):
  - Layered display
  - Shapes, fill, line, edges, gradients, shape morphing
  - Bitmaps
  - Fonts and text
  - Buttons
  - Sound, video

Example SWF (1)

- Tools for viewing SWF in readable form

  E.g. *KineticFusion*: Conversion to XML-based language RVML (proprietary)
  (Rich Vector Markup Language)

```
<?xml version="1.0" encoding="UTF-8" standalone="yes" ?>
<!-- <!DOCTYPE Movie SYSTEM 'dtd/RVML.dtd'> -->
<Movie version='6' width='550' height='400' rate='12'
   backgroundColor='white' compressed='Yes'
   xmlns='http://www.kineticfusion.org/RVML/1.0'>
   <Definitions>
      <Shape id='Main.Shape_1' bounds='bounds(197.0, 263.3, 298.95, 310.45)'>
         <FillStyles />
         <LineStyles>
            <LineStyle index='1' width='1.0' color='rgb(208,208,208)' />
            <LineStyle index='2' width='1.0' color='rgb(208,208,208)' />
         </LineStyles>
         <Edges>
            <Move x='197.5' y='309.95' />
            <SetStyle line='2' />
            <Line x='298.45' y='309.95' />
            <Line x='260.95' y='263.8' />
            <SetStyle line='1' />
            <Line x='197.5' y='309.95' />
            <ColorFill color='rgb(0,51,204)' />
            <SetStyle line='0' mainFill='0' rightFill='0' />
            <Move x='298.45' y='309.95' />
            <SetStyle mainFill='1' />
            <Line x='260.95' y='263.8' />
            <Line x='197.5' y='309.95' />
            <Line x='298.45' y='309.95' />
         </Edges>
      </Shape>
...
```

Example SWF (2)

```
  <Timeline frameCount='27'>
    <Frame frameNo='1'>
      <Place name='Main.Shape_1' depth='2' />
      <Place name='Main.Shape_2' depth='3'>
        <Transform scaleX='2.5459' scaleY='0.724'
           translateX='-626.35' translateY='11.5' />
      </Place>
      <Place name='Main.Shape_3' depth='4' />
    </Frame>
    <EmptyFrame blankFrames='8' />
    <Frame frameNo='10'>
      <Replace name='Main.Shape_4' depth='4' />
    </Frame>
    <EmptyFrame blankFrames='4' />
    <Frame frameNo='15'>
      <Remove name='Main.Shape_1' depth='2' />
      <Place name='Main.Shape_5' depth='1' />
    </Frame>
    <EmptyFrame blankFrames='3' />
    <Frame frameNo='19'>
      <Remove name='Main.Shape_2' depth='3' />
      <Place name='Main.Shape_2' depth='2' />
    </Frame>
    <EmptyFrame blankFrames='8' />
  </Timeline>
</Movie>
```

1 Example Technology: Macromedia Flash & ActionScript

1.1 Multimedia authoring tools - Example Macromedia Flash

Background: History, Context

Flash Authoring Tool: A Quick Tour

SWF Format

1.2 Elementary concepts of ActionScript

Scripting in General + „History“ of ActionScript

Objects and Types in ActionScript

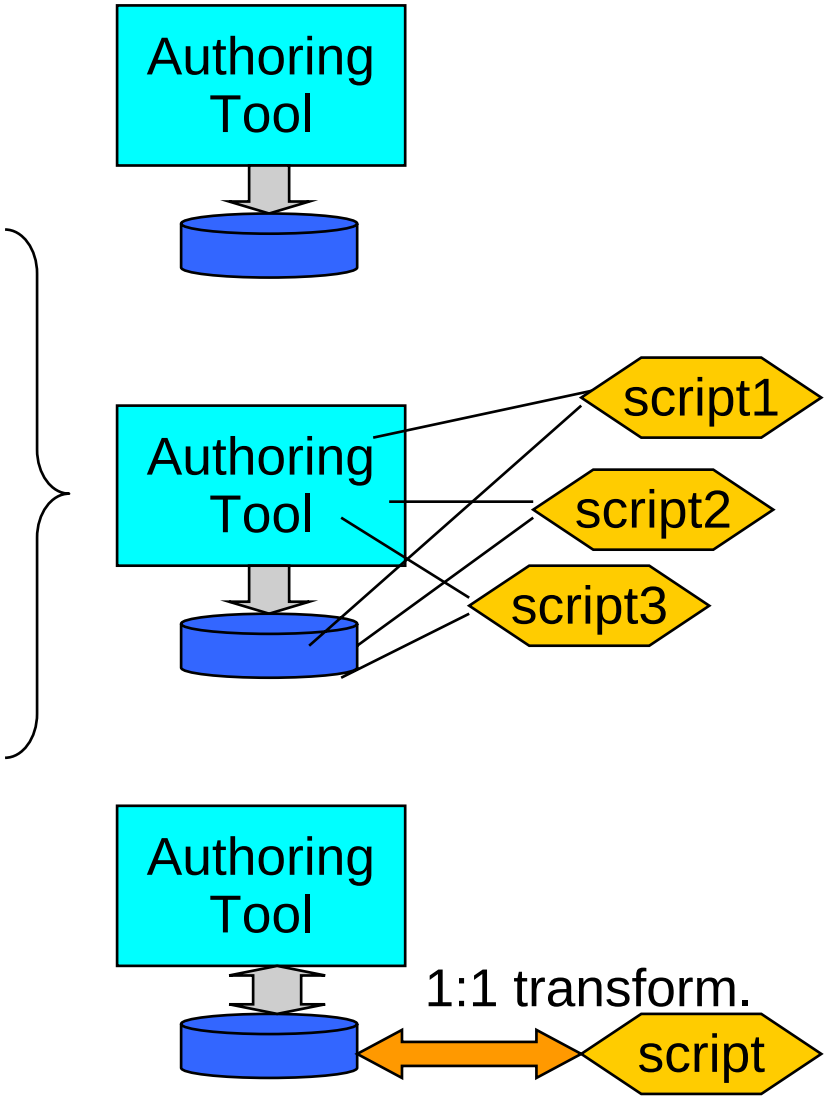
Animation with ActionScript

1.3 Interaction in ActionScript

1.4 Media classes in ActionScript

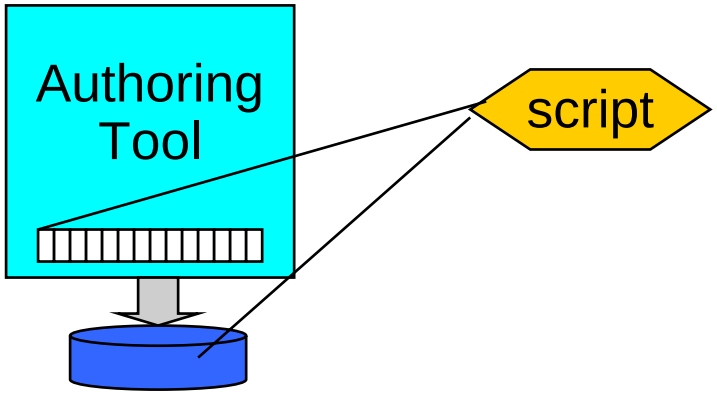
Scripting Languages for Authoring Tools (1)

- *Script-less authoring:*
  Purely graphical authoring tool
  Scripts/programming avoided
- *Integrated scripting:*
  Scripts added at various places
  in the authoring environment
  to enhance expressiveness;
  scripts are *context-dependent*
- *Separated scripting:*
  Separate script files in addition to the
  file produced with the authoring tool;
  scripts are *self-contained*
- *Script-based development:*
  Authoring tool as a comfortable view
  onto a program (script);
  Whole application can be written as
  a script in a formal language

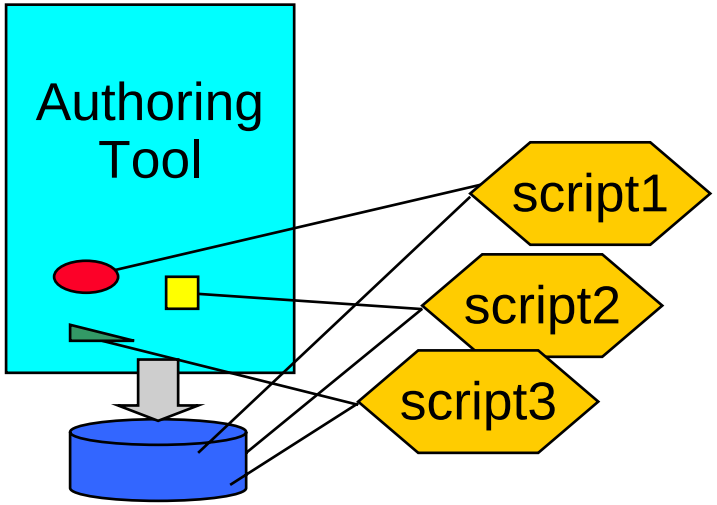


Scripting Languages for Authoring Tools (2)

- *Control-flow based scripting:*
  Scripts called at certain places
  in (global) timeline of animation



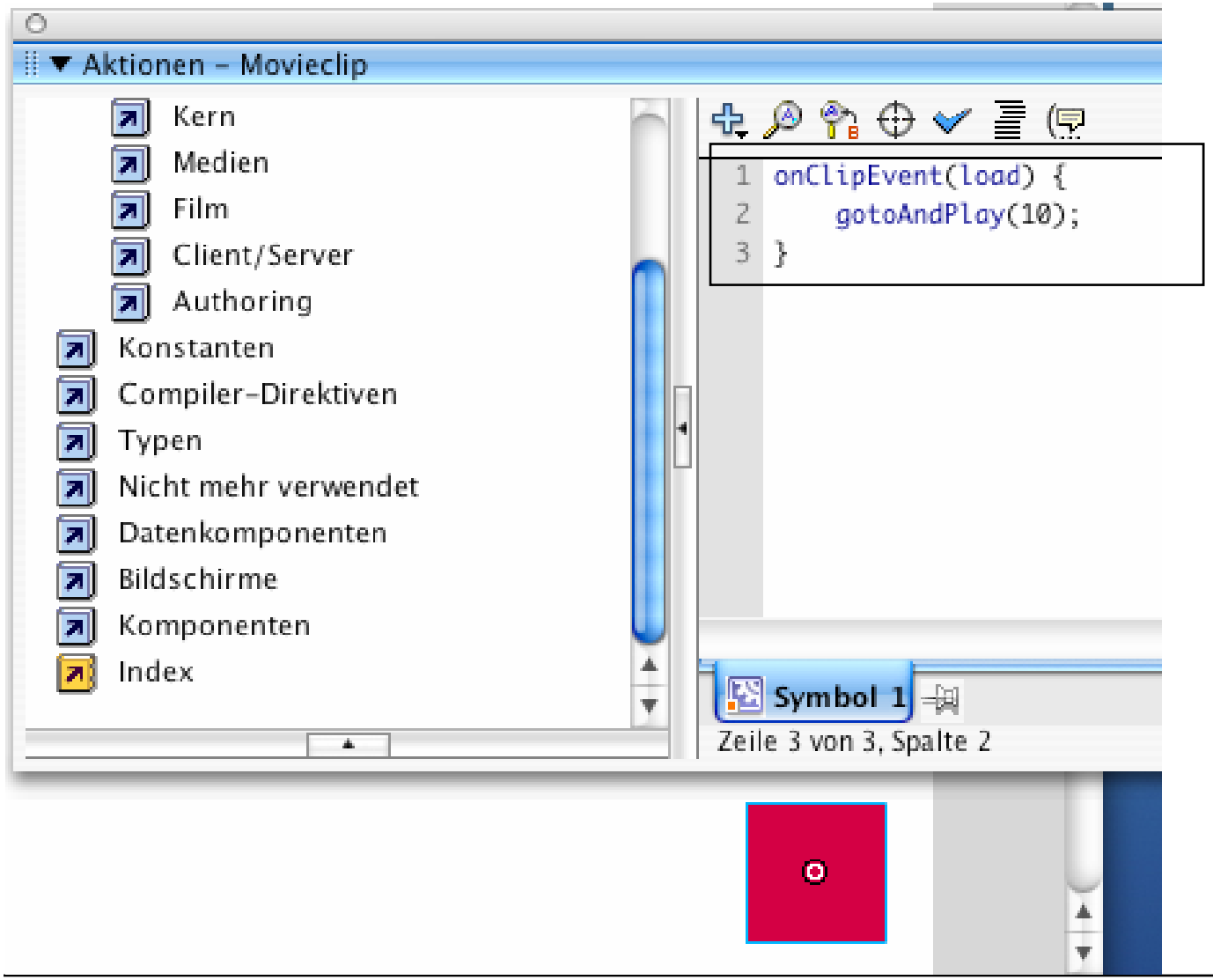
- *Object-based scripting:*
  Scripts are allocated to individual
  animation objects and called
  as *event handlers*



Flash Software Versions

- Flash 1 to 3:
  - Only very limited interaction
  - No scripting at all (script-less)
- Flash 4:
  - Beginnings of ActionScript (integrated scripting)
- Flash 5:
  - ActionScript 1.0 (integrated control-flow and object-based scripting)
  - Execution very slow
- Flash 6 = Flash MX:
  - Improved execution speed
  - Custom object classes (object-based programming)
  - Prototype objects, inheritance, no classes yet
- Flash 7 = Flash MX 2004
  - ActionScript 2.0
  - Separated scripting
  - Java-like syntax, full class concept (object-oriented programming)
- Most recent versions (2006): Flash 8, ActionScript 3.0
  - *Not used for this lecture/tutorials*

Example of Object-based Scripting in Flash



Integrated script: event handler

Example of Separated Scripting and Object-Oriented Programming (ActionScript 2.0)

```
class Account {
  private var saldo:Number = 0;
  private var num:Number;
  public function Account(accnum:Number) {
     num = accnum;
  }
  public function debit(n:Number) {
     saldo -= n;
  }
  public function credit(n:Number) {
     saldo + =n;
  }
  public function getNumber():Number {
     return (num);
  }
  public function getSaldo():Number {
     return (saldo);
  }
}
```

ActionScript 1.0 and ActionScript 2.0

- ActionScript 1.0 (AS1)
  - Simple scripting language
  - Not built for large-scale programming
  - Implicit typing (inferred from variable name and value)
  - Object-based
- ActionScript 2.0 (AS2)
  - Only from Flash MX 2004 and Flash player 7 upwards!
  - Based on the ECMAScript standard (proposal 4)
  - Very similar to Java (Object-oriented)
  - Multiple classes, each defined in its own source file
  - Strict explicit typing
  - Case sensitive

> "ActionScript 2.0 can be called an object-oriented programming language, whereas previous versions were more modestly referred to as an object-*based* programming language, and that was only with the Flash MX version." William B. Sanders