7 Development of Learning Applications

7.1 Structure of Development Processes
7.2 Preliminary Analysis
7.3 Design: Didactic Concept
7.4 Design: Storytelling
7.5 Design: Segmenting & Sequencing
7.6 Design: Interactivity & Adaptivity
7.7 Development Tools and Platforms

References:

http://www.nwlink.com/~donclark/history_isd/isdhistory.html
E-Learning and Design

At its best, e-learning is as good as best classroom learning. And at its worst, it is as bad as worst classroom learning. The difference is design.

(W. Horton, 2006)
Instructional Design

• “Instructional Design”
  – Broad meaning: All design activities related to instruction
  – Specific meaning: *Instructional Systems Design* (ISD)
    » Different approaches, some of them complex

• Instructional design
  – Translates high-level project goals into choices for technology and content
  – Directs development of content and selection of media
  – Orchestrates management decisions (budget, schedule)
ADDIE Model

Based on ideas from the early 1950s
Developed by FSU for the US Armed Forces
   – based on USAF’s previous “Five Step Model”
Incorporates other models (e.g. Dick & Carey)
Each step comprises:
   • Search for alternatives
   • Analyzing alternatives
   • Definition of decision criteria
   • Decision for a certain alternative
All the steps depend on good results in step 1 (analysis)!
Dick & Carey Instructional Design (1978)

http://www.nwlink.com/~donclark/history_isd/carey.html
ISD According to ADDIE in 19 Steps

Florida State University Five Phases of ISD (1975)
Non-Linear ADDIE Model
Minimalist Approach (Horton)
Iterations in Development

- Design
- Analyze
- Re-design
- Re-analyze
- Build
- Evaluate
- Re-build
- Re-evaluate

Concepts → Sketches → Details → Product

Horton 2006
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References:
  Niegemann et al. Kap. 3
  Horton Ch. 1
Application Areas of E-Learning

• Support for established learning processes
  – School, additional qualifications (e.g. foreign languages)
  – Mass market, standardized material
  – Differentiating through didactics and presentation

• Individual advanced qualification
  – Targeted mainly at private individuals
  – Mass market
  – Differentiating through didactics and presentation

• Corporate training
  – "Master-tailored" solutions
  – Quite dominant in literature (e.g. Schank)
  – Differentiating through precision on target, integration in enterprise, and didactics/presentation
Beispiel (Roger Schank) (1)

- There was this large German utility company.
- They had decided that e-learning was important to their future.
  - They told one of their HR guys to investigate and gave him a budget.
- After a while, they called out for help. (Remarkable.)
- Rules of thumb for building e-Learning:
  - Ask experts about what goes wrong in their companies.
  - Start people thinking about training as a kind of just-in-time remediation.
  - See e-learning as being about doing.
- Example: New hire training
  - Ask the expert, but what…
  - Development team: "What does a new hire need to know?"
    » Expert: "There is a new hire manual covering all that."
  - What was the problem with the question?
Beispiel (Roger Schank) (2)

• Contd.
  – Development team: "What should a new hire know how to do?"
    » Expert: (absurdly long list of things which are in the manual)
  – Development team (with help): "What is the biggest mistake that new hires make when they are first on the job?"
    » Expert: (lengthy explanations about complex software and how new hires cannot answer customer's questions when they are called…"
  – Development team: "What is it that new hires actually do?"
    » Expert: "They answer the phone about complaints."
  – Development team: "So you do not need a new hire training program at all!"
    » Expert: "We don't?"
  – Development team: "No, you need a program to train people to answer the phone and to do customer service."

• Think about what the customers need, **not** what they ask for !!!
Types of Analyses

- Problem analysis
- Requirements analysis
- Addressee analysis
- Knowledge and task analysis
- Resource analysis
- Cost analysis
Roger Schank's Five Questions

• What are employees having trouble doing properly?
• Can you tell me a story of when an employee did not know what to do and caused a big problem for the company?
• Under what circumstances do employees do the wrong thing, even though they have been told how to do the right thing?
• What problems are causing the company real trouble right now?
• What are the key things an employee needs to know how to do in this company?
Requirements Analysis

• Which competences of the addressees need to be trained?
  – Questionnaires
  – Interviews (with executive management)

• Determination of training requirements/needs
  (qualitative and quantitative)

• Types of requirements:
  – Normative need: Standards
  – Relative need: Comparison group
  – Subjective need: Individual statements
  – Demonstrated need: E.g. long waiting times
  – Anticipated need: Proactive about upcoming changes
  – Need based on critical incidents: Weakness analysis, failure analysis
Goals and Objectives

- Horton’s two questions about goals:
  - For your organization, what is the single most important measure of success? [3 words maximum]
  - How will your project help accomplish that goal?
- Learning objectives
  - Primary (top-level) objective
  - Derived tree of lower-level objectives

Good objectives are a mission-critical, sine-qua-non, must-have, make-or-break requirement for effective e-learning. [...] 

In my experience, well over half the failures of e-learning projects would have been prevented by clear objectives. 

(W. Horton 2006)
A Simple Structure for Objective Specification

- Template for objective:
  Teach ___________ (what)
  to ___________ (target group)
  who ___________ (prerequisites)

Objective

Teach how to shorten projects to mid-level managers who recognize the critical path of a project

Intent:
- Do
- Decide
- Create

Learners

Prerequisites:
- Skills
- Knowledge
- Attitudes

Horton
Types of Objectives

“By experiencing this lesson or topic, the learner will be able to

Primary objectives

• **Do** procedure X to accomplish Y
• **Create** or design an X that does Y
• **Decide** X, given Y

Secondary objectives

• **Believe** X
• **Feel** X about Y
• **Know** X about Y

”
Addressee Analysis

• Personal characteristics, in particular in corporate training
  – Previous knowledge and experience
  – Position and function within enterprise
  – Training history
  – Education level
  – Learning motivation, attitude towards learning goals
  – Personal preferences, priorities, and goals

• Intercultural aspects

• Handicaps

• Structure of addressee population:
  – Homogeneity
  – Intra-group relations
  – Social atmosphere
### Example: Learner Analysis (Horton)

#### Gantt chart readers

<table>
<thead>
<tr>
<th>ID</th>
<th>Course: Reading Gantt Charts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
<td>Entire course</td>
</tr>
<tr>
<td>Identification</td>
<td>RGC-Consumers-01 Version 1.1 – (2003.S.1)</td>
</tr>
</tbody>
</table>

#### Learners

<table>
<thead>
<tr>
<th>Description</th>
<th>Middle and upper managers who need to read and interpret Gantt charts. Typically supervise those who actually construct the Gantt charts. Portion of total audience: 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job function</td>
<td>General management duties, including management of complex projects</td>
</tr>
<tr>
<td>Time value</td>
<td>$100K per year</td>
</tr>
</tbody>
</table>

#### Learning goals

- **What do they hope to gain?**
  - Learn to interpret Gantt charts, especially how to use them to make better decisions regarding the scheduling and supervision of complex projects

- **Why do they take the learning?**
  - 65% To accomplish current job
  - 20% To qualify for new job
  - 15% Required by boss
  - 15% To make more money
  - 20% Curiosity & self-improvement
  - Other

#### When will they learn?

- Designated times
- 85% Normal/week hours
- 5% Evenings
- 10% Weekends
- Other

#### Where will they learn?

<table>
<thead>
<tr>
<th>Computer skills</th>
<th>Language skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>X Email</td>
<td>Chat and messaging</td>
</tr>
<tr>
<td>X Web browser</td>
<td>Install software</td>
</tr>
<tr>
<td>X Word processor</td>
<td>Writing macros</td>
</tr>
<tr>
<td>X Other desktop applications</td>
<td>Programming</td>
</tr>
<tr>
<td>Discussion forums</td>
<td></td>
</tr>
</tbody>
</table>

#### Geographic distribution

- All in one building
- All on one campus
- All in one city
- All in one country
- 80% over 24 time zones

#### Environment

- Space: No room for more than one piece of paper beside the computer
- Lighting: OK
- Noise: Normal office noise with frequent interruptions (every 10 minutes or so)

#### Hardware

- Processor: P2 100+ MHz
- Memory: 24 MB
- Display size: 800 x 600
- Colors: Thousands

#### Technology

- Disc: CD-ROM 4X
- Audio out: 16-bit
- Audio In: (none)
- Video In: (none)

#### Software

- OS: Windows 98
- Browser: IE 4+, NS 4+
- Players: Flash 4
- Applications: MS Project

#### Network connection

- Type: Intranet
- Broadband: 1 M
- Dialup: 0.2 M
- Wireless: 0.2 M

#### Experience

- 85% have seen Gantt charts, understand that they show project schedules, and perhaps recognize task bars.

#### Demographics

- Age range: 30-65
- Gender mix: 60% male
- Nationality: 65% US & Canada

#### Financial involvement

- Paid for time learning? Yes
- Costs they pay themselves: (none)
Knowledge and Task Analysis

• Observation of learning content from learner perspective
  – Determination of suitable learning strategies
• Collaboration with content experts
• Declarative knowledge:
  – Topics, structured, possibly hierarchically
  – “Mind-Mapping" may be helpful
• Procedural knowledge:
  – Activities:
    » Observable actions
    » Unobservable (mentale) actions
    » Mixtures thereof
  – Background knowledge
  – Cues

Source: infiniteminds.info
Resource Analysis

• Which resources are available?
  – Materials
  – Staff
    » Qualifications, relative to target platforms
  – Time
    » Work packages, milestones
  – Money
  – Rights on copyrighted material

• Problem:
  – Difficult to fully determine in advance
Costs Analysis

• Staff costs
  – Development
  – Project management
  – Administration
  – External consultants

• Hardware, software

• Rights

• Services

• Telecommunication

• Travel

• Rent

• Maintenance, repair

• Miscellaneous
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References:
  Niegemann et al. Kap. 4
  Klimsa Kap. 11
Design Decisions for Learning Applications

<table>
<thead>
<tr>
<th>Strategic-Didactic Decisions</th>
<th>General Design Decisions</th>
<th>Detailed Design Decisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Abstraction level</td>
<td>• Structure of material</td>
<td>• Layout</td>
</tr>
<tr>
<td>• Social form of learning</td>
<td>• Coding and modalities</td>
<td>• Icons</td>
</tr>
<tr>
<td>• Direction of communication flow</td>
<td>• Pedagogic methods</td>
<td>• …</td>
</tr>
<tr>
<td>• Locus of control</td>
<td>• Interaction design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Motivation design</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Technical basis</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Learning Activities

• Structure for learning activities according to Horton:

<table>
<thead>
<tr>
<th>Absorb activities</th>
<th>Do activities</th>
<th>Connect activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read, watch, listen</td>
<td>Excercise, experiment, discover</td>
<td>Link to prior learning, to work and life</td>
</tr>
<tr>
<td>• Presentations and demos</td>
<td>• Practice</td>
<td>• Ponder activities</td>
</tr>
<tr>
<td>• Stories by the teacher</td>
<td>• Discovery</td>
<td>• Stories by the learner</td>
</tr>
<tr>
<td>• Readings</td>
<td>• Games</td>
<td>• Job aids</td>
</tr>
<tr>
<td>• Field trips</td>
<td></td>
<td>• Research</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Original work</td>
</tr>
</tbody>
</table>

On which level would you place these design decisions (strategic, general, detailed)?
Transfer of Design Experience

- Good design: Creativity, intuition, experience, domain knowledge
  - Learning environments: Design by non-professional designers
- Encoding of design experience and design principles
- Architecture:
  - „Design Patterns“ (Christopher Alexander)
- Software Engineering
  - „Design Patterns“ (Gamma/Helm/Johnson/Vlissides 1998)
- Industrial Design
- Pedagogical Patterns
  - Pattern language by Oser/Baeriswyl 2001: “Choreographies of teaching
  - Various initiatives for pattern repositories (e.g. http://www.pedagogicalpatterns.org)
## Basis Models (Oser & Baeriswyl)

<table>
<thead>
<tr>
<th>Step</th>
<th>Learning Through Experience</th>
<th>Problem Solving</th>
<th>Concept Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Planning of actions</td>
<td>Problem presentation</td>
<td>Activation of pre-knowledge</td>
</tr>
<tr>
<td>Step 2</td>
<td>Performance of actions</td>
<td>Reformulation of problem task</td>
<td>Introduction of the new concept with an example</td>
</tr>
<tr>
<td>Step 3</td>
<td>First reflection, construction of meaning</td>
<td>Development of hypotheses</td>
<td>Development of characteristics of the new concept</td>
</tr>
<tr>
<td>Step 4</td>
<td>Generalisation of experience</td>
<td>Test of hypotheses</td>
<td>Active application of the new concept</td>
</tr>
<tr>
<td>Step 5</td>
<td>Abstraction of experience</td>
<td>Evaluation of solution</td>
<td>Application in other contexts</td>
</tr>
</tbody>
</table>

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### Operationalisation of Steps (Oser & Baeriswyl)

<table>
<thead>
<tr>
<th>Step</th>
<th>Indicators teacher</th>
<th>Indicators students</th>
<th>Control question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Planning of possible activities (e.g. setting of an experiment), inner representation of these actions in a context</td>
<td>Teacher announces an activity, gives instructions, clarifies goal of the activity, makes sure that students know what to do</td>
<td>Students prepare an activity, describe the planned procedure, explain the necessary steps</td>
</tr>
</tbody>
</table>
Structure of a Design Pattern

- NAME of the pattern
- ABSTRACT (short description of the pattern)
- PROBLEM (what kind of problem should be solved by using the pattern)
- ANALYSIS (what makes the problem to be solved a problem)
- KNOWN SOLUTIONS (are there alternative solutions?)
- RESEARCH QUESTIONS (open research questions concerning the pattern)
- CONTEXT (description of the context/s the solution is applicable to/not applicable to)
- CONDITIONS/RATIONALE (reasons for the applicability of this solution in the context)
- DISCUSSION/CONSEQUENCES (consequences of use, side effects, implementation issues)
- REFERENCES (documentation, URLs)
- RELATED PATTERNS (alternative patterns, patterns to discriminate…)
- AUTHOR/S
- REFERENCES

Rusman, van den Broek, & Ronteltap, 2003, cited according to Niegemann et al.
Bergin’s Fourteen Patterns

• Early Bird
• Spiral
• Consistent Metaphor
• Toy Box
• Tool Box
• Lay of the Land
• Fixer Upper
• Larger Than Life
• Student Design Sprint
• Mistake
• Test Tube
• Fill in the Blanks
• Gold Star
• Grade it Again Sam

http://csis.pace.edu/~bergin/PedPat1.3.html