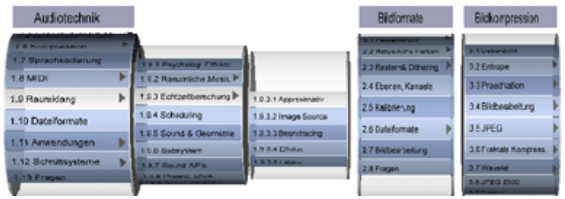
Collapsible Cylindrical Trees:

A Fast Hierarchical Navigation Technique



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Outline

- Motivation
- Related Work
- Collapsible Cylindrical Trees (CCT)
  - Navigation and Interaction
  - Tree Size and Presentation Aspects
  - Implementation
- Conclusion & Future Work

Motivation

- Hierarchies: important structure
  - Organizational and web structures, product catalogs, part hierarchies, table of contents…
  - Mostly trees (or convertible to trees)
  - Many medium-sized hierarchies
- Not only display, but fast navigation crucial
- CCT initially developed for web hierarchies
  - Focus on *usable* tree visualization & navigation
  - Comprehensible 3D navigation technique

Related Work

- 2D-Tree visualization
  - 2D Layouts, H-trees, radial & balloon views, tree-maps, onion graphs… [Herman et al. 2000]
  - Problems: performance, viewability, usability, screen space usage
  - Menus: long item lists, large mouse movements
- 3D-Techniques for larger hierarchies
  - *Cone trees* [Robertson et al. 91] & augmented solutions
  - Object occlusion, bad text readability, interaction

Related Work

- *Navigation Cones* in LyberWorld [Hemmje et al. 94], successor *visual trees*
- Focus+Context extensions to 2D and 3D visualization
  - Hyperbolic browser [Lamping & Rao 96], hyperbolic cone trees [Munzner 97]
  - Problems: interaction, performance, usability
- 3D Web navigation techniques [Benford 99]
  - Large hierarchies, structure vs. interaction, cognitive difficulties of 3D navigation

Collapsible Cylindrical Trees

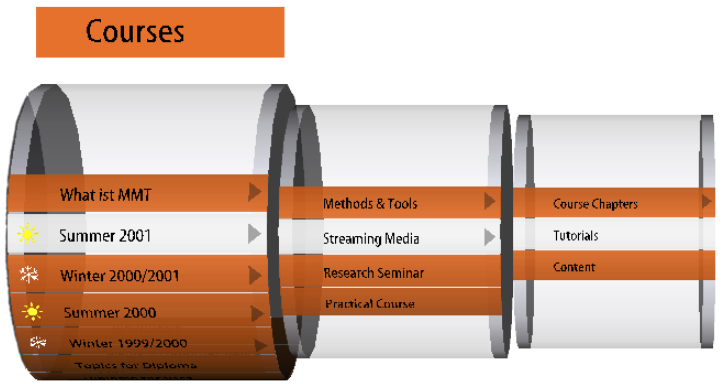
- 3D Visualization and interaction technique for medium-sized hierarchies
  - First two tree levels plus chosen path

CCT - The Model

- Tree with finite list of nodes
  - Associated attributes: label, action,color, icon …
  - Intermediate nodes p have set of children C
- Cylindrical Mapping
  - For every p child nodes C are mapped on *facets* of a rotating cylinder
  - Facets evenly spaced, unnecessary removed, not evenly distributed
  - Endless cylinder concept (if $count(C) > num_f$)

CCT - The Model

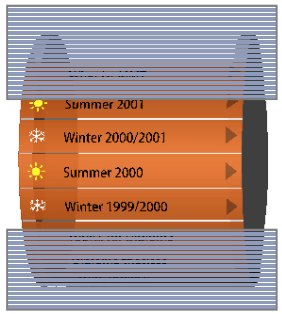
- Nested cylinders *Telescope Metaphor*
  - For every p on level $l=i$ a smaller cylinder with C of p is constructed
  - All $l=i+1$ sub-cylinders are nested and hidden within the $l=i$ cylinder
  - *x-axis* for tree depth
  - Siblings of C displayed along *y-axis*



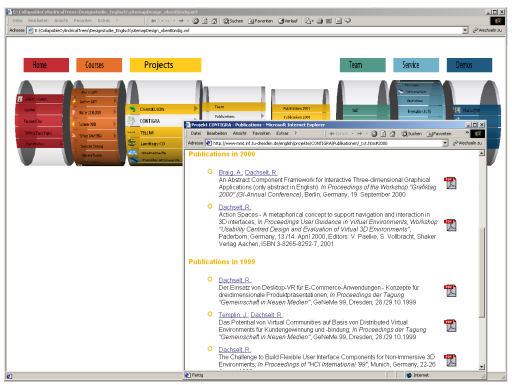
- Parallel display of all $l=1$ cylinders
  - Squeeze or x-scale all other cylinders, same screen space

CCT - Navigation and Interaction

- Navigating the tree structure without clicks
  - Move mouse in upper or lower region → rotation
  - Branch node facets provide tree expansion functionality, mouse rollover and movement to the right
  - Short vertical & horizontal axis-aligned mouse movements



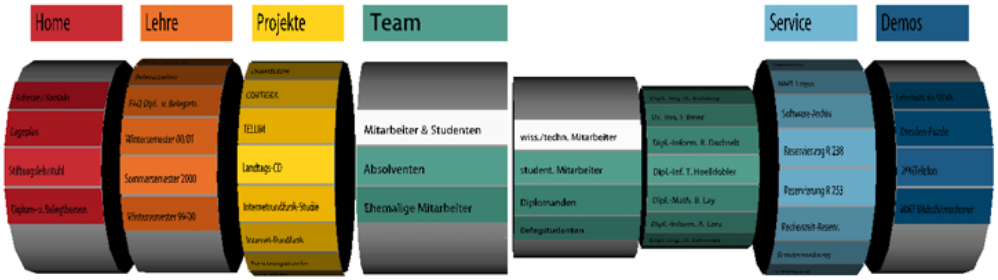
- Performing an action on a node: 1 click

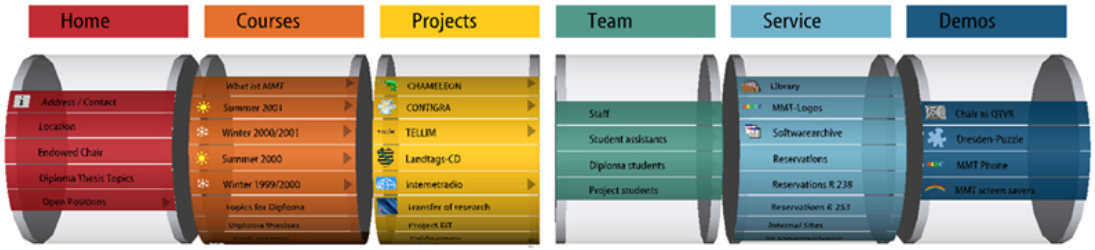


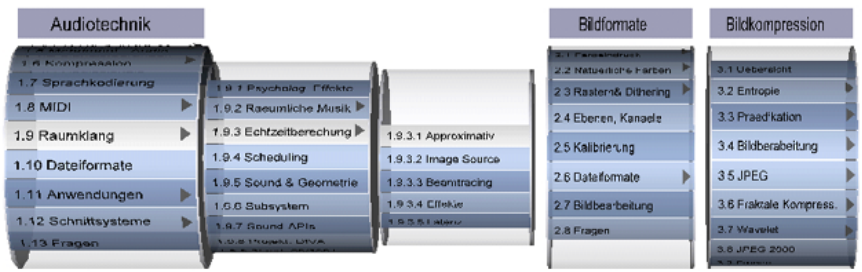
CCT - Tree Size and Presentation

- Size
  - Number of root children limited $num_{rc} \leq 7$
  - For $l \geq 1$ high branching degree (good: $num_f = 20$)
  - High tree depth (good: $d = num_{rc} - 1 = 6$)
  - Breadth instead of depth encouraged (except top)
  - Typical values: few hundreds to thousand nodes
- Presentation Aspects
  - Cylinder radius, width, color; scale; facet number
  - Facet color, icon, text, indicator for branch nodes

CCT - Tree Size and Presentation





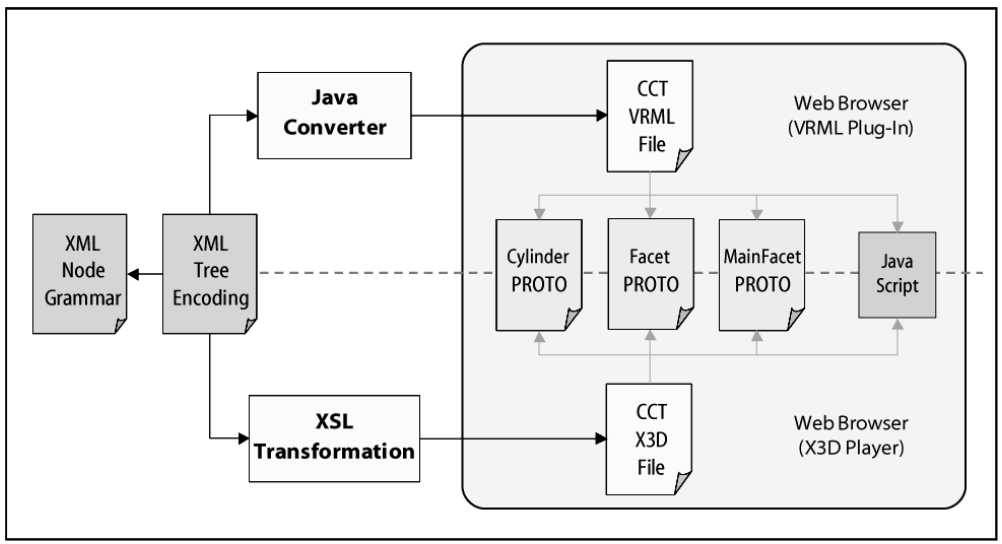


CCT - Implementation

- Internal tree representation with XML

```
<!ELEMENT NODE (NODE*)>
<!ATTLIST NODE
  label CDATA #REQUIRED
  target CDATA #IMPLIED
  color CDATA #IMPLIED
  icon CDATA #IMPLIED>
```

- VRML97
  - Web-Prototype
- Shockwave3D
- (Java3D)



Conclusion & Future Work

- Main CCT Characteristics
  - Tree visualization *AND* fast & intuitive interaction
  - Useful balance of detail and context: dynamical expanding & collapsing sub-hierarchies
  - Comprehensible layout, fixed sizes and viewpoint → maximum display quality and readability
  - Resemblance with traditional menu systems → almost no training, intuitive interaction
  - Restricted number of root children, medium-size

Conclusion & Future Work

- Research context
  - Example 3D Widget of *Contigra* Framework
  - Component-oriented 3D graphical applications
  - www.contigra.com
- Future Work
  - Enhanced implementations
  - Evaluation and usability testing (online course)
  - Investigate more complex hierarchies

References

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