Declarative Integration of Interactive 3D Graphics into the World-Wide Web

Principles, Current Approaches, and Research Agenda

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Introduction
Outline

- Declarative 3D Principles
- Declarative 3D Frameworks
  - Evaluation Platforms: X3DOM and XML3D
  - Declarative 3D Essentials
  - Level of Integration and Polyfill Approach
- Declarative 3D Agenda
- Conclusions
Principles of Declarative 3D
Declarative 3D Principles

- Following the Established Principles of the Web
  - Separation of structure from content
  - Separation of content from style
  - Use of the Document Object Model (DOM)
- 3D Content Creation and Reuse
- Platform Independence
- Efficiency and Scalability
- Security and Digital Rights Management
- Accessibility and Usability
- Leveraging Web Development Infrastructure
Declarative 3D Frameworks
X3DOM: History

- **2004:** X3D: ISO Standard; Plugin integration model
  
  13.2 Declarative 3D scenes
  Embedding 3D imagery into XHTML documents is the domain of X3D, or technologies based on X3D that are namespace aware.

- **2008:** First experiment by Philip Taylor, W3C: [http://philip.html5.org](http://philip.html5.org)
  X3D in DOM, no DOM manipulation (Canvas3D for rendering)

- **2009:** [x3dom](http://x3dom.org) by Fraunhofer IGD, Based on code of Taylor:
  Full DOM integration. Maps to Native, X3D-Plugin, WebGL or Flash
  Utilizes HTML/JS/CSS for scripting and interaction
  **HTML-Profile:** Reduced complexity and implementation effort

- **2011:** W3C Declarative 3D Community Group

- **2012:** Component-Plugins: Volume, GEO, CAD, Geo2D, …
X3DOM: Showcases
XML3D

- Designed from scratch
  - Granular data compositing
  - Data structures aligned with VBOs
  - Consistent resource handling, XML3DRepo
    - [Doboš, Web3D2013]
- Integrated dataflow concept (Xflow)
  - Skeleton animation, Image Processing, Augmented Reality
    - [Klein, Web3D2013]
  - Can be mapped to HW (GPU, River Trail, WebCL?)
- Available on Github:
  - https://github.com/xml3d/xml3d.js
XML3D

Designed from scratch
Granular data compositing
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Can be mapped to HW (GPU, River Trail, WebCL?)
Declarative 3D Essentials

- Extracted 15 essentials for HTML/DOM-based 3D graphics
- For instance:
  - Use CSS 3D Transforms for transformations
    ```html
    <div>
      <dec3d style="border: 1px solid black;">  
        <div style="transform: scale3d(2, 2, 2);"> ...
      </div>
    </div>
    </dec3d>
    </div>
  ```

- How tight can we integrate 3D with web technology?
Level of Integration (LOI)

- LOI 0: Classical integration using plug-ins
- LOI 1: Dedicated element in the DOM + API (WebGL)
- LOI 2: Scene description integrated in the DOM
- LOI 3 and LOI 4: Tight integration with CSS
Polyfill Approach

- What is Polyfill?
- UA requirements:
  - DOM: Polyfill Layer must be able to access and monitor changes in related DOM elements
  - Events: The UA must support registration, firing, and extending UI events
  - CSS: Supporting scene management though custom CSS properties
  - CSS 3D Transforms: Extending for optimal performance
  - TypedArrays: …
  - …
Proposed Declarative 3D Polyfill Runtime Architecture
Declarative 3D Agenda
Declarative 3D Agenda

- Encourage Participation
- Clear Definition of Use Cases and Requirements
- Clear Technical Specification
- Outreach and Exemplar Applications
- W3C Working Group Proposal
Conclusions
Conclusions

- Declarative vs. Imperative
- Need more participation from the Web3D community
- Ultimate goal: 3D for everyone and everywhere

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