3drepo.io: Building the Next Generation Web3D Repository with AngularJS and X3DOM

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http://github.com/3drepo
3D Repo is an open source collaborative 3D repository for the construction industry

A multi-award winning open source 3D version control software

Enables coordinated management of large scale 3D data over the Internet

One of very few cloud-based solution on the scale required by the industry

Facilitates cost savings & time efficiencies across a wide range of user applications
“The one who makes the biggest mistake wins”

- Industry expert
UK Government Initiative

- Construction Strategy Plan mandates the use of collaborative 3D technology by 2016, see http://digital-built-britain.com
  - Intelligent 3D models to inform and communicate project decisions
- Reduction of costs and carbon emissions in construction by 20%
- International ROI on BIM software is 10-25%

The UK Cabinet Office mandates the use of collaborative 3D tech in construction by 2016

Graphisoft introduces ArchiCAD for Virtual Building & parametric models

Autodesk introduces BIM process for virtual collaboration specific to construction

UK Cabinet Office mandates the use of BIM by 2016 and commits £50m in public funding

Autodesk develops AutoCAD for 2D drawings & automated processing

Boeing 777 is designed entirely in 3D using Catia software by Dassault Systèmes, running on 8 mainframes & 2,200 workstations

Autodesk launches subscription-based AutoCAD 360 for Web, iOS & Android

BIM expected to become mainstream, with cloud at center stage & VR spread among consumers
Deliberate vendor lock-in

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Lack of interoperability
Industry Foundation Classes ISO 16739

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Contributions

1. Practical solution for 3D VC on the web
2. Improved NoSQL schema for commercial BIM 3D
3. Novel REST API
4. Demonstration of use cases
5. Evaluation of jQuery vs AngularJS for 3D
6. Open source implementation
Related Work

BIM Server
XML3DRepo
Plant Layout Design
Instant3DHub

[Beetz et al. 2010]
[Doboš et al. 2013]
[Mouton et al. 2014]
[Behr et al. 2015]

Autodesk BIM 360
Graphisoft BIM Server
Trimble Connect
Esri CityEngine
Architecture Overview

3drepo.io
AngularJS

- 2-way data binding
- Client-side parsing & routing
- DOM decoupled from app logic

- Controllers manage dynamic parts of a web page
- Scope contains a set of variables to control output

- Compilation step loops over all directives
- Set watch to monitor changes on scope

jQuery

- DOM manipulation via events/functions
- Listener triggers event

- Changing element attributes via setAttribute()
- Browser query selector
- Direct modifications in 3D scene
New Map DB Node
New Federation DB Node
New Metadata DB Node
Ground investigations to begin at Trinity Burial Ground

The A63 Castle Street scheme will see a new phase of the project starting week commencing 2 March 2015.

Investigative work is due to start at Trinity Burial Ground, near the Mytongate junction on Castle Street. The investigations are needed so that specialists can evaluate the condition of the graves, and conduct ground surveys. This will allow plans to be made in the event that planning permission is granted for the A63 Castle Street improvements.

Approximately one third of the Burial Ground will be affected by the proposed scheme, and this early phase of work has been allowed after permission was granted from Holy Trinity Church and the Diocese of York. To ensure the work is carried out respectfully, a secure fence will be put up around Trinity Burial Ground and areas will be screened off. The work will involve removal of low lying bushes, ground surveys, and the temporary removal of some of the grave monuments.

The investigations will be carried out by specialist contractors and overseen by archaeologists. Any monuments removed will be managed carefully, placed into safe storage and replaced once work has been completed. At this stage the work carried out will initially be ground surveys, should any human remains need to be exhumed, they would be treated sensitively and with respect.

Subject to receiving planning permission, the main exhumation work is expected to start in 2016/17.

If anyone has any further enquiries about the work, or if people do think they have ancestors who may be buried in Trinity Burial Ground, please contact the project team by calling 0113 2835805 or emailing them at A63castletstreet.hull@highways.gsi.gov.uk

Trinity Burial Ground

The proposed scheme will affect approximately one third of Trinity Burial Ground, which is located off Castle Street (refer to diagram). This additional space is required to enable us to construct one of the slip roads for the Mytongate junction improvement proposed as part of the scheme.

This will mean the burials and monuments within this area of the burial ground will need to be relocated to enable construction of the scheme.

We will ensure that the road improvement works impacting the Trinity Burial Ground are managed respectfully, with full care and consideration to human remains, surviving monuments, historic architecture and addressing the concerns of living descendants. The burial ground is consecrated ground and we are in close dialogue with representatives from Holy Trinity Church and the Diocese of York to ensure that all appropriate measures and permissions are in place for the planned works.

Research of the available records suggests that up to 16,000 burials may be located within the affected area of the burial ground. Human remains from this area will be exhumed before the main construction programme. This will involve the controlled removal of human remains by a team of trained archaeologists and cemetery exhumation specialists. We expect this work would not start until 2016/17, with plans to undertake preliminary ground investigation and evaluation surveys in advance. Some of the remains may subsequently be analysed to help provide information about life in Hull during the eighteenth and nineteenth centuries.
10k spheres
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        scope.$watch('onLights[' + attrs.id + ']', function(value) {
            if (value)
                element.attr('diffusecolor','red');
            else
                element.attr('diffusecolor','white');
        }, true);
    }

    return {
        link: link
    };
})

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**Table 1:** Comparison of different data transmission formats for their speed of delivery and bandwidth requirements.
Rest API (XML3DRepo vs 3drepo.io)

XML3DRepo
/:id/:type
/:type/:id

3drepo.io
/login [POST]
/login [GET] Returns OK (200) if logged in, Unauthorized (401) otherwise
/:account/:project [GET] Returns the whole project page
/:account/:project/:uid.:ext [GET] Returns a specific asset with a Unique ID uid where ext specifies the file format
/:account/:project/revision/:branch/:rid [GET]
/:account/:project/revision/:branch/:rid/:sid [GET]
Scene Graph Optimization
Scene Federation
Wayfinding User Study
Conclusions

• AngularJS + X3DOM + 3D Repo
• Database schema improvements
• Novel simplified REST API
• Experiments show that:
  AngularJS becomes impractical for complex scenes
  Suffers from fixed overhead on scene manipulation
  Once compiled, outperforms jQuery
• SRC provides a balance of requests/file size
3D Diff
We’re hiring!