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A brief review of web visualisation challenges and achievements for Power Plant at EDF

Christophe MOUTON, EDF, France

christophe.mouton@edf.fr

Web-Wide Immersive 3D BoF, 1st August 2017

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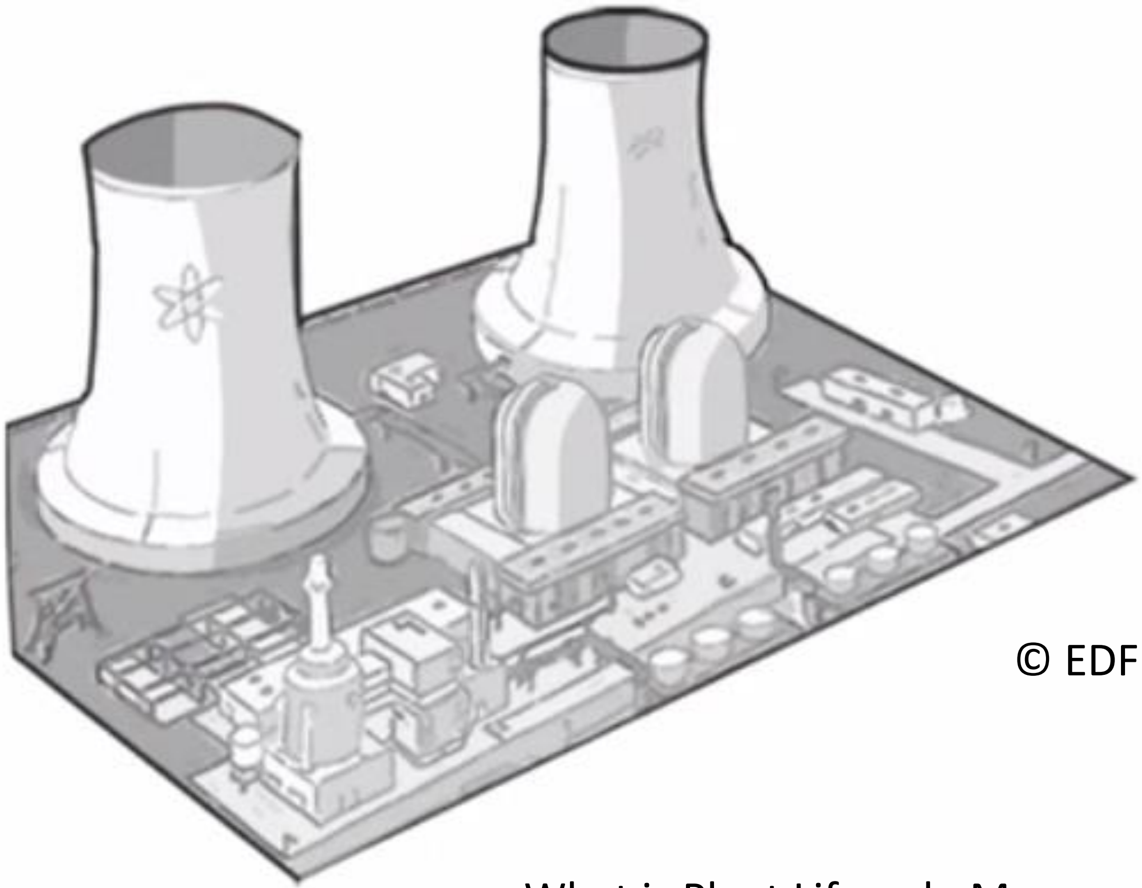
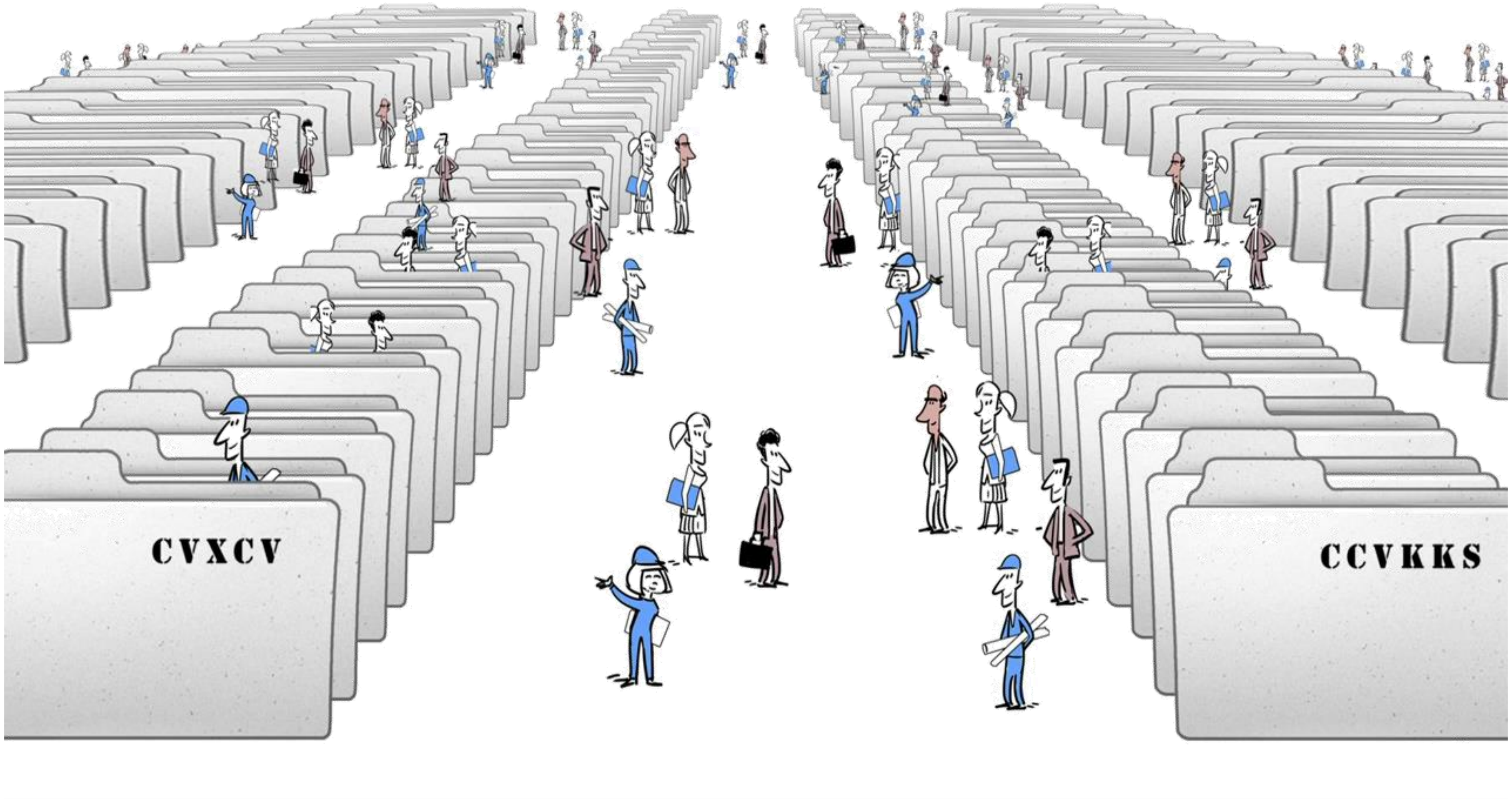
Power plant, an highly complex product

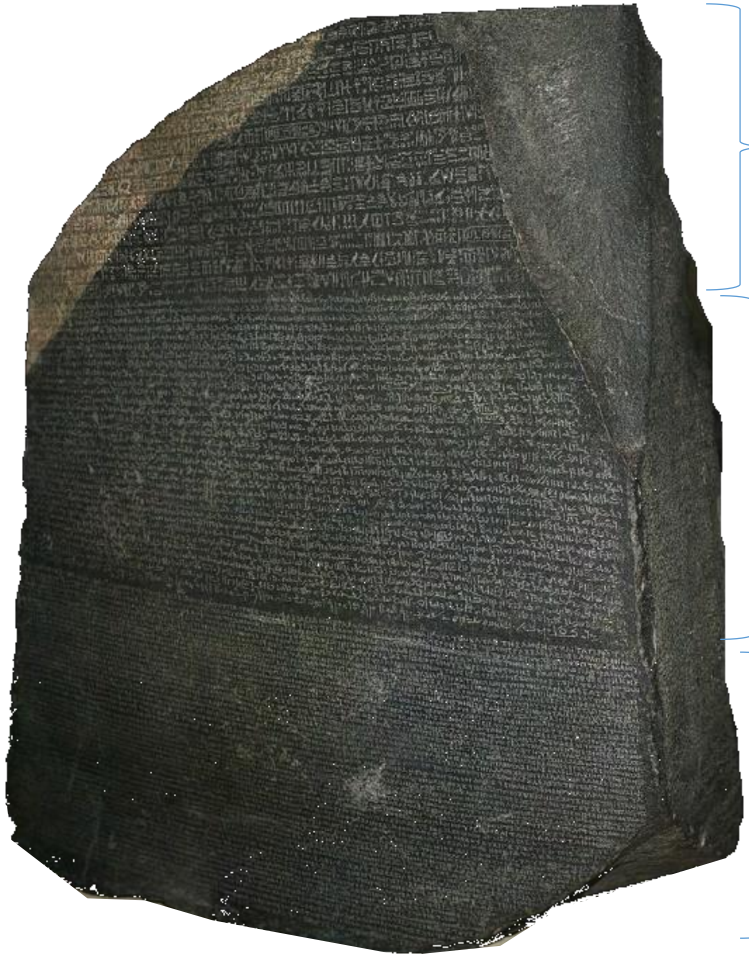


What is Plant Lifecycle Management? video URL

With millions of engineering documents and… their data!



Looking for the rosetta stone: 1D, 2D, 3D... for our engineers



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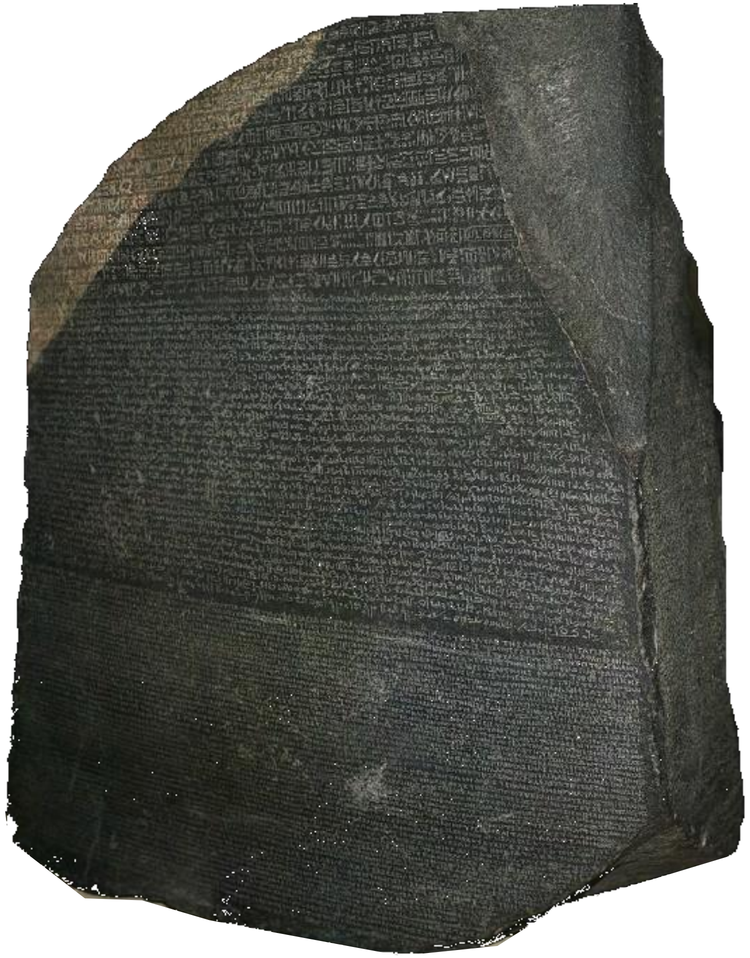
Hieroglyphic (14 lines)

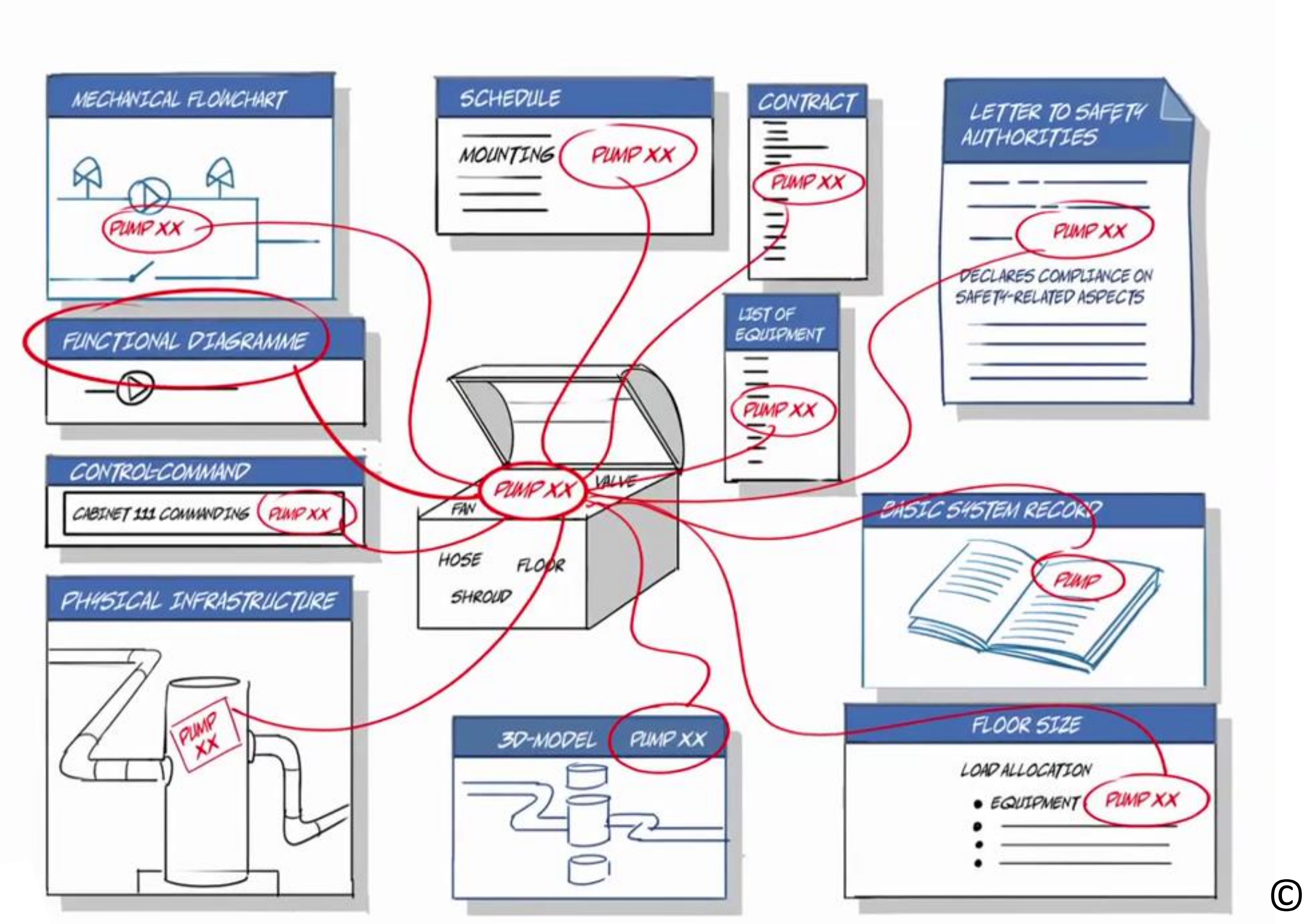
Demotic (32 lines)

Greek (54 lines)

http://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=117631&partId=1

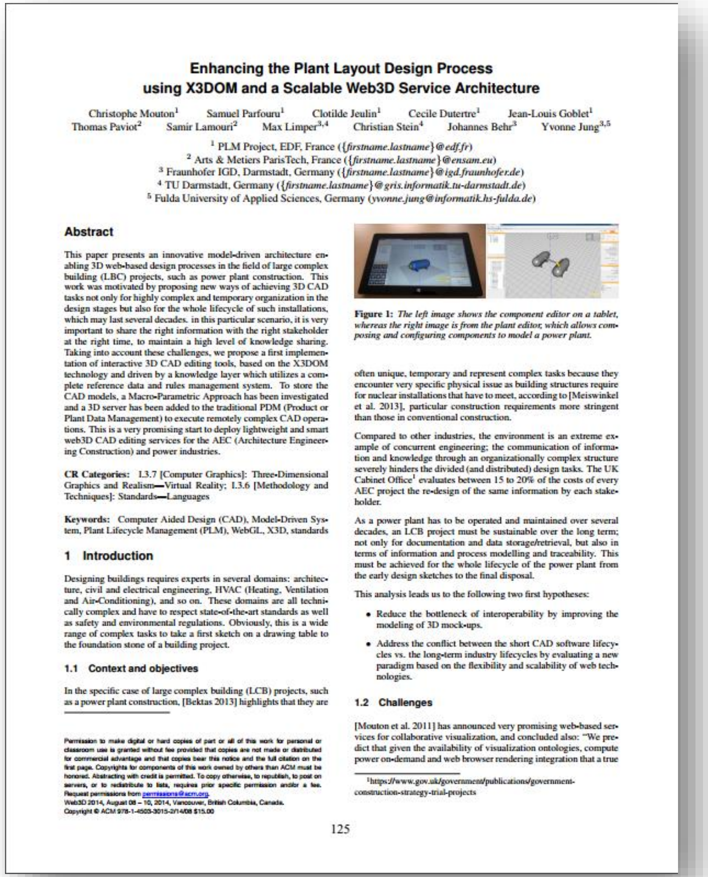
Let's build a digital rosetta stone for power plants!





What is Plant Lifecycle Management? : video URL

2014: first web 3D visualisation and online CAD editor demo



Enhancing the Plant Layout Design Process using X3DOM and a Scalable Web3D Service Architecture

Christophe Mouton[1] Samuel Parfouru[1] Clotilde Jeulin[1] Cecile Dutertre[1] Jean-Louis Goblet[1]
Thomas Paviot[2] Samir Lamouri[2] Max Limper[3,4] Christian Stein[4] Johannes Behr[3] Yvonne Jung[3,5]

[1] PLM Project, EDF, France ({firstname.lastname}@edf.fr)
[2] Arts & Metiers ParisTech, France ({firstname.lastname}@ensam.eu)
[3] Fraunhofer IGD, Darmstadt, Germany ({firstname.lastname}@igd.fraunhofer.de)
[4] TU Darmstadt, Germany ({firstname.lastname}@gris.informatik.tu-darmstadt.de)
[5] Fulda University of Applied Sciences, Germany (yvonne.jung@informatik.hs-fulda.de)

Abstract

This paper presents an innovative model-driven architecture enabling 3D web-based design processes in the field of large complex building (LBC) projects, such as power plant construction. This work was motivated by proposing new ways of achieving 3D CAD tasks not only for highly complex and temporary organization in the design stages but also for the whole lifecycle of such installations, which may last several decades. in this particular scenario, it is very important to share the right information with the right stakeholder at the right time, to maintain a high level of knowledge sharing. Taking into account these challenges, we propose a first implementation of interactive 3D CAD editing tools, based on the X3DOM technology and driven by a knowledge layer which utilizes a complete reference data and rules management system. To store the CAD models, a Macro-Parametric Approach has been investigated and a 3D server has been added to the traditional PDM (Product or Plant Data Management) to execute remotely complex CAD operations. This is a very promising start to deploy lightweight and smart web3D CAD editing services for the AEC (Architecture Engineering Construction) and power industries.

CR Categories: I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Virtual Reality; I.3.6 [Methodology and Techniques]: Standards—Languages

Keywords: Computer Aided Design (CAD), Model-Driven System, Plant Lifecycle Management (PLM), WebGL, X3D, standards

1 Introduction

Designing buildings requires experts in several domains: architecture, civil and electrical engineering, HVAC (Heating, Ventilation and Air-Conditioning), and so on. These domains are all technically complex and have to respect state-of-the-art standards as well as safety and environmental regulations. Obviously, this is a wide range of complex tasks to take a first sketch on a drawing table to the foundation stone of a building project.

1.1 Context and objectives

In the specific case of large complex building (LCB) projects, such as a power plant construction, [Bektas 2013] highlights that they are often unique, temporary and represent complex tasks because they encounter very specific physical issue as building structures require for nuclear installations that have to meet, according to [Meiswinkel et al. 2013], particular construction requirements more stringent than those in conventional construction.

Figure 1: *The left image shows the component editor on a tablet, whereas the right image is from the plant editor, which allows composing and configuring components to model a power plant.*

Compared to other industries, the environment is an extreme example of concurrent engineering; the communication of information and knowledge through an organizationally complex structure severely hinders the divided (and distributed) design tasks. The UK Cabinet Office[1] evaluates between 15 to 20% of the costs of every AEC project the re-design of the same information by each stakeholder.

As a power plant has to be operated and maintained over several decades, an LCB project must be sustainable over the long term; not only for documentation and data storage/retrieval, but also in terms of information and process modelling and traceability. This must be achieved for the whole lifecycle of the power plant from the early design sketches to the final disposal.

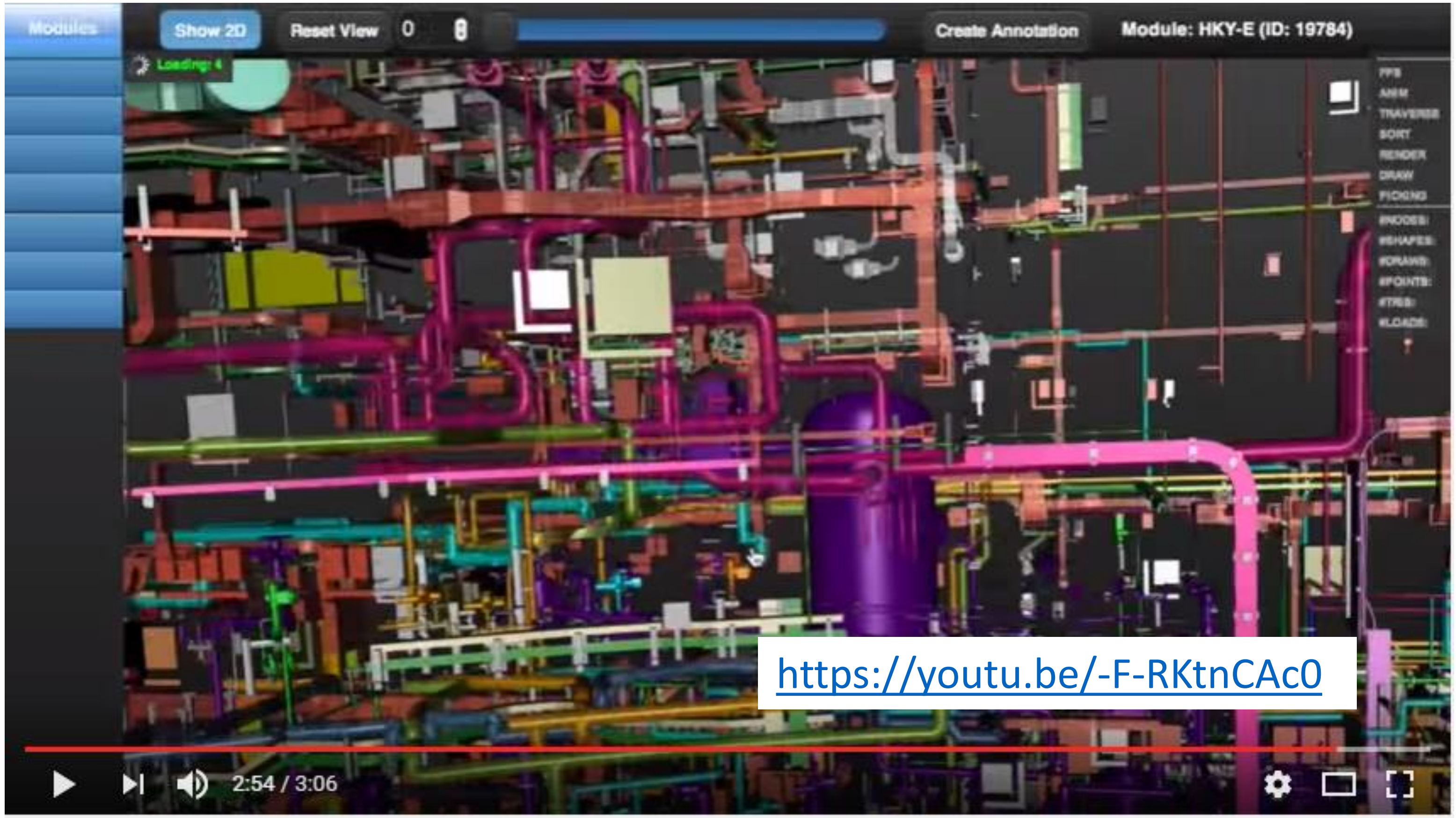
This analysis leads us to the following two first hypotheses:

- Reduce the bottleneck of interoperability by improving the modeling of 3D mock-ups.
- Address the conflict between the short CAD software lifecycles vs. the long-term industry lifecycles by evaluating a new paradigm based on the flexibility and scalability of web technologies.

1.2 Challenges

[Mouton et al. 2011] has announced very promising web-based services for collaborative visualization, and concluded also: "We predict that given the availability of visualization ontologies, compute power on-demand and web browser rendering integration that a true

[1]https://www.gov.uk/government/publications/government-construction-strategy-trial-projects



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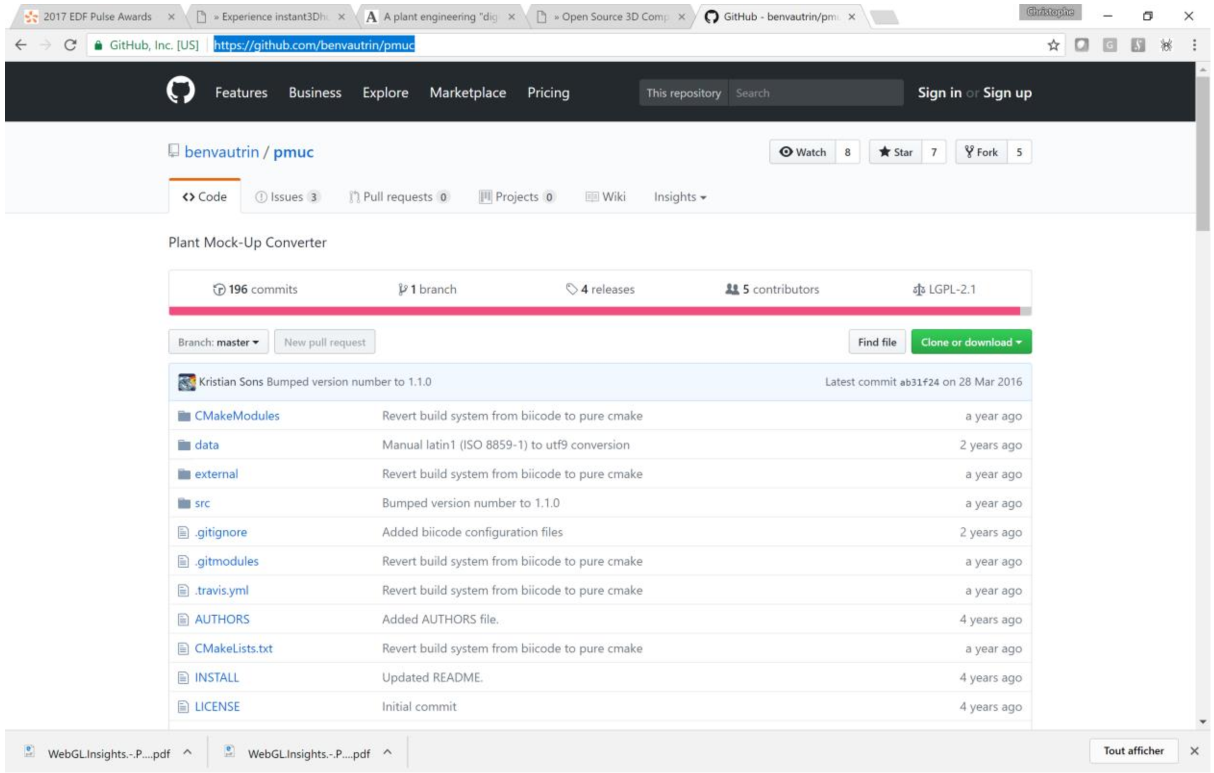
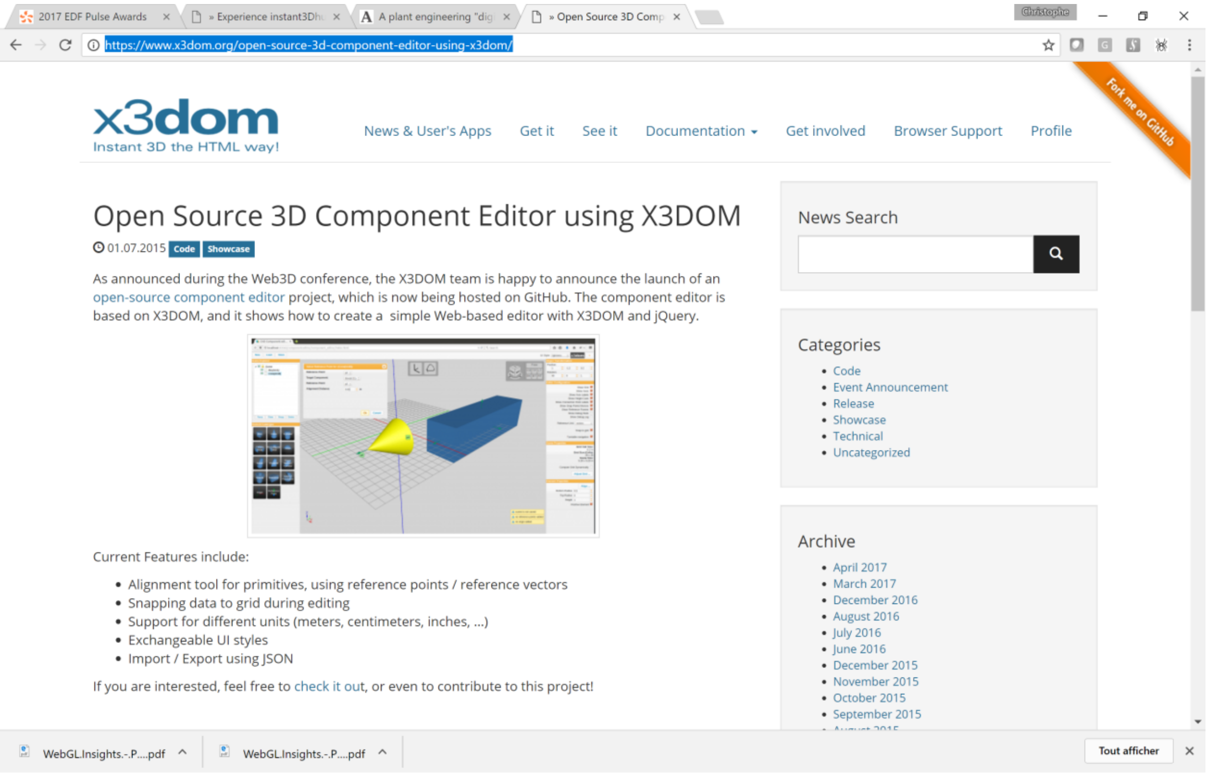
From proprietary RVM file format to X3D, Collada, IFC open ISO standards: the opensource Plant Mock-Up Converter PMUC URL
Available on GitHub



Opensource web CAD editor based on X3DOM
Available on GitHub URL



2015: first massive CAD web 3D visualization

webVis/instant3DHub - Visual Computing as a Service Infrastructure to deliver adaptive, secure and scalable user centric data visualisation

Johannes Behr[1] Christophe Mouton[3] Samuel Parfouru[3] Julien Champeau[3] Clotilde Jeulin[3]
Maik Thöner[1,2] Christian Stein[1,2] Michael Schmitt[1,2] Max Limper[1,2] Miguel de Sousa[1,2]
Tobias Alexander Franke[1,2] Gerrit Voss[1,2 *]

[1] Fraunhofer IGD, Darmstadt, Germany [2] TU Darmstadt, Germany [3] PLM Project, EDF, France

(a) Standard webVis UI elements with Instance Graph (IG) struct-tree views (b) Interactive high quality and secure visualisation via server-based ray-tracing and streaming (c) AR application with client-based composition of multi-buffer views

Figure 1: *Application examples using webVis / instant3DHub. The platform is able to deliver different kinds of browser-based visualisation applications, such as high-quality large model visualisation, CAD inspection, or augmented reality, while providing a straightforward and expressive tag set and API.*

Abstract

This paper presents the webVis / instant3DHub platform, which combines a novel Web-Components based framework and a *Visual Computing as a Service* infrastructure to deliver an interactive 3D data visualisation solution. The system focuses on minimising resource consumption, while maximising the end-user experience. It utilises an adaptive and automated combination of client, server and hybrid visualisation techniques, while orchestrating transmission, caching and rendering services to deliver structural and semantically complex data sets on any device class and network architecture. The API and Web Component framework allow the application developer to compose and manipulate complex data setups with a simple set of commands inside the browser, without requiring knowledge about the underlying service infrastructure, interfaces and the fully automated processes. This results in a new class of interactive applications, built around a canvas for real-time visualisation of massive data sets.

CR Categories: I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Virtual Reality; I.3.6 [Methodology and Techniques]: Standards—Languages

Keywords: Computer Aided Design (CAD), Model-Driven System, Plant Lifecycle Management (PLM), WebGL, X3D, ISO standards

*E-Mail: firstname.lastname@igd.fraunhofer.de / firstname.lastname@edf.fr

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1 Introduction

1.1 Context and objectives

Real-time rendering of 3D data is an essential requirement for an ever growing number of interactive applications. Massive progress in various fields of visual computing produces large digital replicas and digitally born models even faster, leading to new classes of real-time application programs. Bringing those applications to the web is a natural step towards reaching an even larger number of users, on a broader set of devices.

Therefore, the user experience of such applications is massively defined by how the 3D viewing of the data is received. How pleasant this experience is to the user depends on various qualities including refresh ratio, responsiveness, and pixel error.

While these qualities are generally impossible to guarantee, the currently common setup of technologies does not focus on optimizing the end-user experience but rather tries to minimize the application development and deployment process with common document formats like X3D [1]. This approach is suitable for simple applications and data sets, yet does not scale well for real applications with large numbers of identifiable objects and complex tessellated surfaces, which leads to unpleasant user experiences. This analysis leads us to the following three first hypotheses:

- Current scene-graph based visualization solutions are not built to scale with the input data.
- Output-driven visualization methods should lead to better user experience, scalability and resource usage.
- User intention and requirements are not reflected in common rendering systems.

[1] http://www.web3d.org/realtime- 3d/specification/version/V3.3

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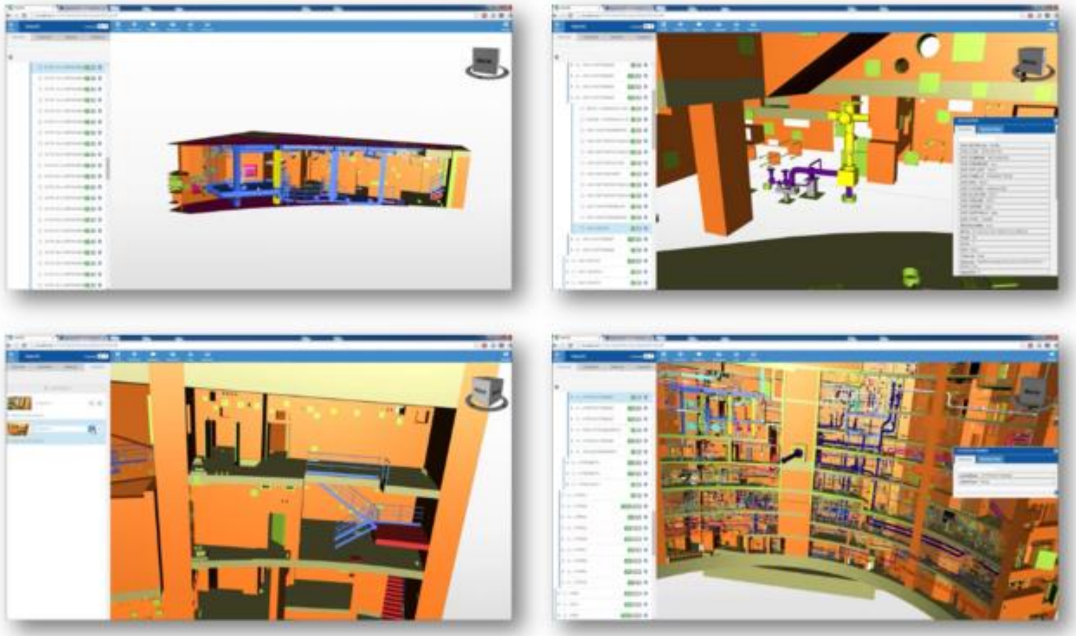

Figure 12: *Room-based clipping, picking in the PBS tree and displaying attributes in the scene, recorded points of view of a power plant mock-up (24,2 M triangles for 228000 groups of 400 000 PDMS primitives) with webVis in a WebGL-enabled web browser*

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So here we are:
a full web-based engineering portal

Presenting thousands of engineering documents and data…

1D, 2D, 3D and more…

In a web portal!

Thanks to neo4j graph database and webVis/Instant3DHUB pipeline

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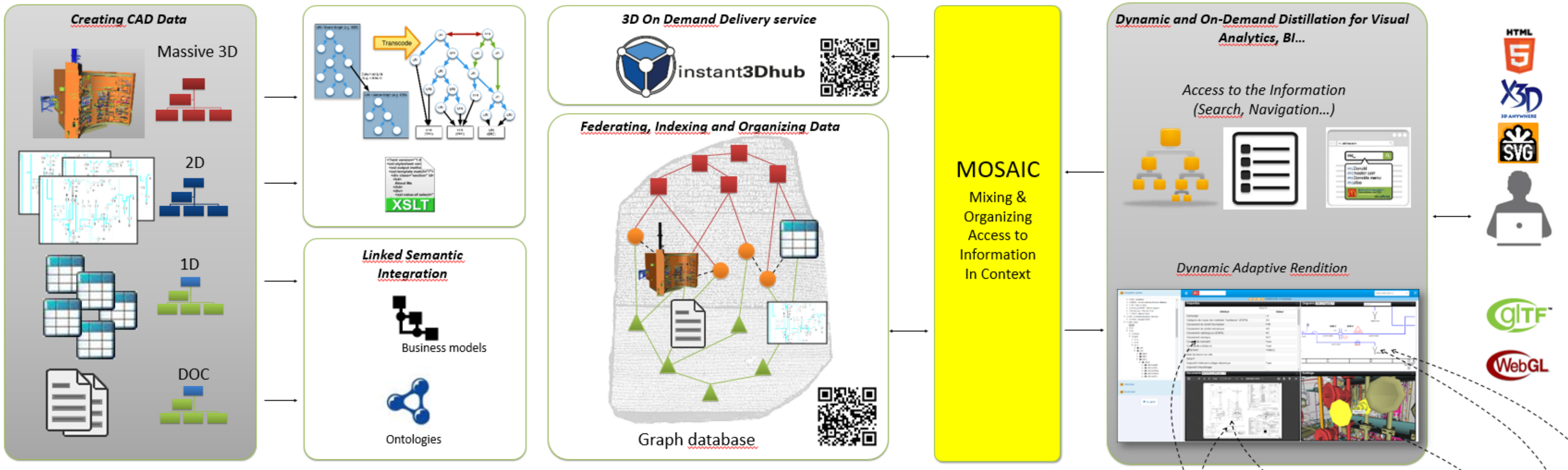
A Plant Engineering "Digital Rosetta Stone": Towards Data-centric Multidimensional CAD Web Portal

EDF
Samuel Parfouru, Christophe Mouton
PLM Project, EDF, France

Fraunhofer IGD
TECHNISCHE UNIVERSITÄT DARMSTADT
Max Limper, Johannes Behr
Fraunhofer IGD, TU Darmstadt
Germany

Engineering design phases in AEC and process industry projects produce large amounts of virtual CAD data that have to be linked together, specifically in the case of nuclear power plants, before being realized in the implementation and construction phases. In this poster we propose our "Digital Rosetta Stone" web portal founded on two innovative pillars: a graph database and its agile connection to MOSAIC, a Visualisation Analytics Engine integrating Visual Computing as a Service to mix 1D, 2D and 3D engineering data in a full data-centric and web-accessible way.



Linking Multidimensional CAD data

The foundation of this data-centric system is a "Digital Rosetta Stone" that links together engineering data thanks to a semantic index of all available information. The semantic indexing process maps several data sources e.g., 3D models, 2D P&ID (Piping and Instrumentation Diagram), piping isometrics drawings, PDF manufacturer documents complemented by classification schemes that are inferred from an advanced semantic business model dedicated to nuclear power plant design, and a specific "key": a coding system which names all the parts of the plant **[EPR 1998]**.

The architecture of the system is based on a graph-oriented database as shown in the above figure. The neo4j graph databasewas chosen for its capacity to store nodes of data, labels and relationships but also to allow the data manager or CAD teams to enrich in a pragmatic way, or simply add, new metamodels and classification schemes to existing ones without breaking and reloading the existing contents.

It offers a natural evolution of the structures of data and supports various paths for the users in terms of data exploration.

EPR. 1998. Creating a new data processing tool for designing the EPR. Nuclear Engineering International.

The MOSAIC (Mixing and Organizing Access to Information in Context) engine provides access to information with dynamic user perspectives in various dimensions. It supports synchronized displays through moving from one perspective to another and enriching one perspective with information of another. The system will also assist the user during navigation and data browsing, thanks to a semantic query engine. Queries may be explicit or implicit (derived by user interaction with the current perspective) as shown in the figure on the bottom-right corner of this poster.

For the 3D model exploration, the portal allows one to locate all or some parts of the model, to display engineering information directly in the 3D scene ("visually linked data") and to access to other resources via a simple hyperlink. This was successfully achieved thanks to the declarative 3D API of the VCaaS or MMV service presented in **[Behr et al. 2015]**.

BEHR, J., MOUTON, C., PARFOURU, S., CHAMPEAU, J., JEULIN, C., THÖNER, M., STEIN, C., SCHMITT, M., LIMPER, M., DE SOUSA, M., FRANKE, T. A., AND VOSS, G. 2015. webvis/instant3dhub: Visual computing as a service infrastructure to deliver adaptive, secure and scalable user centric data visualisation. In Proceedings of the 20th International Conference on 3D Web Technology, ACM, New York, NY, USA, Web3D '15, 39–47.

First Feedbacks and Conclusion

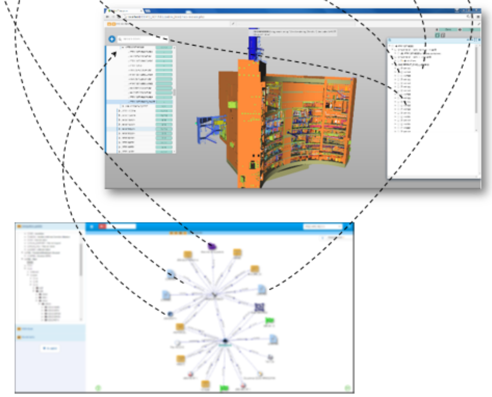
A prototype was implemented and the first experiments brought promising results to validate the capacity of such a portal to help the user to navigate into power plants multidimensionnal CAD data.

The neo4j graph database technology provides high-level performance to deal with millions of nodes and relationships because of the Big Data target of such tools [McColl et al. 2014]. It opens a large range of new ways of use.

The main challenges are right now to combine adaptive semantic visualization as highlighted in **[Nazemi et al. 2015]** and engineering semantic modeling based on CAD standards data.

We are confident that such agile development of engineering web portals will spread away in the industry and for the mass market, especially with the BIM, emerging SmartCities and new Internet of Things (IoT) markets.

NAZEMI, K., BURKHARDT, D., GINTERS, E., AND KOHLHAMMER, J. 2015. Semantics visualization definition, approaches and challenges. Procedia Computer Science 75, 75 – 83. 2015 International Conference Virtual and Augmented Reality in Education.



Thank you for your attention

Christophe.mouton@edf.fr

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