

Towards a Unified Standards-based Information Architecture for Engineering Materials Data

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ABSTRACT

The engineering materials community relies on procedural testing Standards to define test conditions, specimen configurations, and post processing and reporting procedures. However, in the absence of corresponding data formats, test results are rarely conserved, and their value diminishes as the material pedigree, test conditions and results become disassociated. In an effort to address this issue, a recently concluded CEN Workshop demonstrated that procedural testing Standards are amenable to translation to computer readable formats (schemas and ontologies). Consequently, it is evident that through its extensive collections of testing Standards, the engineering materials community has access to a resource that offers a means to develop a unified, Standards-based information architecture from which a robust and sustainable data management infrastructure can be realized.

Keywords: engineering, alloy, standard, schema, ontology

INTRODUCTION

With the emergence of a semantic Web of data, the promise of new and improved opportunities for knowledge discovery, and demands from funding agencies and publishing houses for more responsible management of research data, there is a renewed interest in data management in many scientific disciplines. In the engineering materials sector this interest is further motivated by the challenge of integrated computational materials engineering (ICME), the realization of which is acknowledged to depend on the development of a global infrastructure or protocol for information exchange and interfacing of models [1]. While critical examination of the extent to which ICT is embedded in engineering materials research indicates a significant gap with other disciplines [2], the engineering materials community has identified an opportunity to transform its extensive collections of procedural

testing Standards into ICT Standards [3] and at the same time unify past activities to develop technologies to represent engineering materials [4][5] and processes [6].

CEN/WS ELSSI-EMD

CEN WS/ELSSI-EMD is a CEN Workshop started in 2009 with the objective of investigating the economics and logistics of Standards-compliant data formats for engineering materials test data. It has successfully demonstrated the ability to derive data formats from procedural testing Standards for engineering materials. The process of transforming procedural Standards into computer readable formats involves engaging stakeholders, establishing a credible business case, design, development and validation, aligning ongoing materials data Standardisation activities, and integrating the data formats into Standardisation processes.

Stakeholder Engagement

CEN Workshops have been introduced in response to a requirement for more agile Standardisation processes, especially in the domain of ICT Standards. They are typically short-term initiatives that last one or two years and deliver a CEN Workshop Agreement (CWA). Beyond the term of the Workshop, there is the possibility to pursue the recommendations of the CWA to normative status. Most importantly, the Workshop is designed to engage a broad representation of stakeholders (as registered participants). These stakeholders join the Workshop voluntarily as registered participants, who then approve, review, and revise work that is undertaken on their behalf by a group of paid experts. This model is very effective, yielding in a relatively short time prenormative Standards that respond to the needs of a broad range of stakeholders.

Standardisation

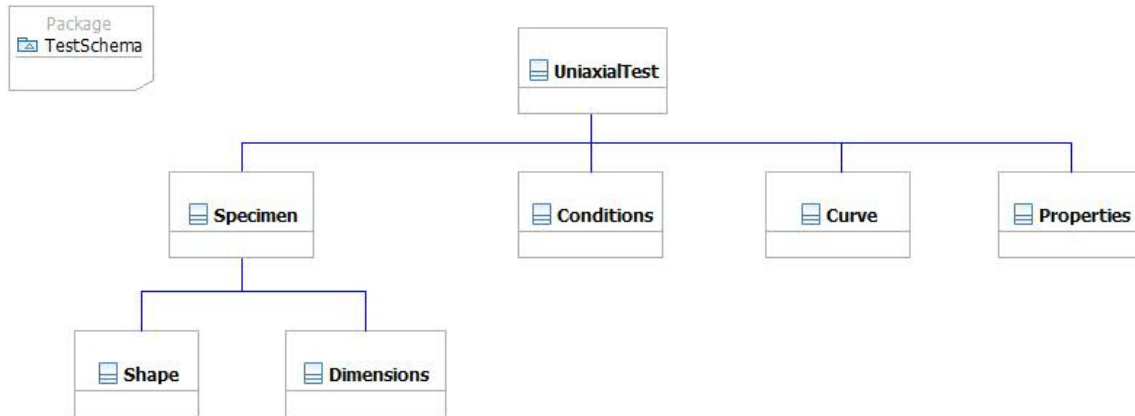
As is true for many disciplines, Standards for testing are necessary to ensure uniformity of procedures and the corresponding test results. In the engineering materials sector, Standards for mechanical testing have been developed and refined over many decades, and represent the accumulated knowledge and best practices of the materials testing community. The Standards describe terms and definitions, entities and their relationships with one another, and the rules governing the testing procedure. As part of the process of deriving data formats from Standards for mechanical testing, CEN WS/ELSSI-EMD needed to take investigate the corresponding publication and maintenance implications. From the outset, the possibility was pursued to assign permanent identifiers (in the form of HTTP URIs) to the data formats and to make the data formats freely available. Whilst ISO already offers such as service at <http://standards.iso.org>, the eligibility criteria as defined by ISO Council Resolution 6/2004 [7] proved too restrictive, and so CEN WS/ELSSI-EMD focussed its efforts on lobbying CEN to assign HTTP URIs. For the ESOs (European Standards Organizations), this form of publication represented a departure from their conventional publication mechanisms. Consequently, although the CWA is delivered [3], CEN WS/ELSSI-EMD remains open until such time as the publication issue is resolved.

Business Case

Engineering materials are key to manufacturing processes in many industrial sectors, and considerable resources are invested upstream and downstream in materials testing. Upstream, there is investment at both national and international level in materials research, which often involves testing. Downstream, companies in the industrial sector undertake numerous materials tests on a daily basis. In all cases, conservation of the data that are generated is necessary for reasons of validation, traceability, reuse, and re-evaluation. In this context, Standards-compliant data formats provide the means to conserve and exchange data efficiently. In order to examine the potential impacts of Standards-compliant data formats on engineering sector business processes, CEN WS/ELSSI-EMD undertook a survey of the impacts of a transition from paper-based to electronic reporting practices. Whilst the results of the survey indicated a majority in favour of a transition to electronic reporting, it was recognised that companies that have invested in the development of their own solutions would be disadvantaged.

Design and Development

The work focused on the ambient temperature tensile test defined by ISO 6892 Part 1 and demonstrated that procedural Standards are well-suited to translation to computer readable formats. It was found that the clarity and scope of the underlying Standard served very well the purpose of a software specification. Throughout the development process a close dialog was maintained with engineering materials experts, which as shown in the figure resulted in a robust platform independent model (UML diagram) from which schema and ontology reference implementations were derived.



CONCLUSION

As anticipated at the time the project was conceived, CEN WS/ELSSI-EMD has demonstrated the ability to derive data formats (schemas and ontologies) from procedural Standards for mechanical testing. Having proven the efficacy of deriving Standards-compliant formats for engineering materials data from procedural Standards, future actions are necessary to develop a Standards-based unified information architecture for engineering materials data and to facilitate a business process evolution that accommodates a transition to electronic reporting in the engineering materials sector.

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The financial support from the EC and EFTA for CEN WS/ELSSI-EMD is gratefully acknowledged.