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Middle School Classroom Materials--Structure and Failure of Wood: A Computational and Micrographic Examination

Douglas Shattuck[1,3], David Adler[1], Markus Buehler[1], Vernon Robertson[2], and M. Shibata[2]

[1]Laboratory for Atomistic and Molecular Mechanics, Civil and Environmental Engineering Department, Massachusetts Institute of Technology, Cambridge, MA, USA;
[2]JEOL USA, Peabody, MA, USA
[3]Concord Middle School, Concord, MA, USA

Collaboration among academia, industry, and public education can develop state-of-the-art classroom curricula and collateral materials that present concepts and levels of detail heretofore unavailable in public schools.

National initiatives have focused on enhancing the quality of education in Science, Technology, Engineering, and Math (STEM). Massachusetts recently released its Draft Revised Physical Science and Technology/Engineering Standards and placed emphasis on concepts and experience over the more traditional content-based standards [1]. Material Science has risen to prominence in these standards and students are expected to understand the structure, properties, strengths and weaknesses of various materials they use to solve problems and achieve goals in the human-designed world. Moreover, these concepts will be incorporated in the comprehensive Science, Technology/Engineering (STE) exam – MCAS–required of all eighth graders by 2018.

Structural engineering and the design of bridges, skyscrapers, and tunnels have been an integral part of the STE standards since 2001. The classic approach to presenting this material has been to invite students to design and construct a bridge or tower of balsa and strength test if to failure. The new standards encourage students to know the properties of their materials at the macro- meso- and micro-scale and understand how they will responds to forces acting on them. Unfortunately, most communities are unable or are ill-equipped to provide and support the advanced technology needed to permit middle school children to conduct research into the dynamics of material systems.

Collaborative outreach among academic institutions, and vendors of advanced instruments can offer substantial benefit to public schools. Presented here in poster format is a computational and micrographic examination of the structure and failure of wood prepared with the assistance of MIT outreach and JEOL, USA. The audience is the middle school introductory engineering student and the poster is intended to summarize concepts presented in class.

This poster begins with a well-known local reference, the North Bridge in Concord, site of the first battle of the US War of Independence. To provide perspective, a cartoon diagrams illustrates increasing magnification of a woody stem to the submicroscopic level of cellulose and hemi-cellulose molecules. A visual molecular dynamic representation of the molecules show the helical nature of the material and a micrograph supplied by JEOL gives visual confirmation of the helical nature of the material at the meso-scale. Current research findings using computer simulation depict the mechanism by which wood fibrils absorb stress by uncoiling until they reach the point of failure. A dramatic frame depicts the ultimate fate of an excessively stressed structure. And finally, a cartoon portrays the direction Silva culture and genetic engineering might take in the future.

In addition to reinforcing concepts developed during research, construction, and testing of a model bridge, the lesson and its collateral material dramatically demonstrate the links among public school learning, academic research, and the private sector that supports them [2].

References:

[1] Massachusetts Department of Elementary and Secondary Education, Draft Revised Science and Technology/Engineering Standards, (January, 2014).
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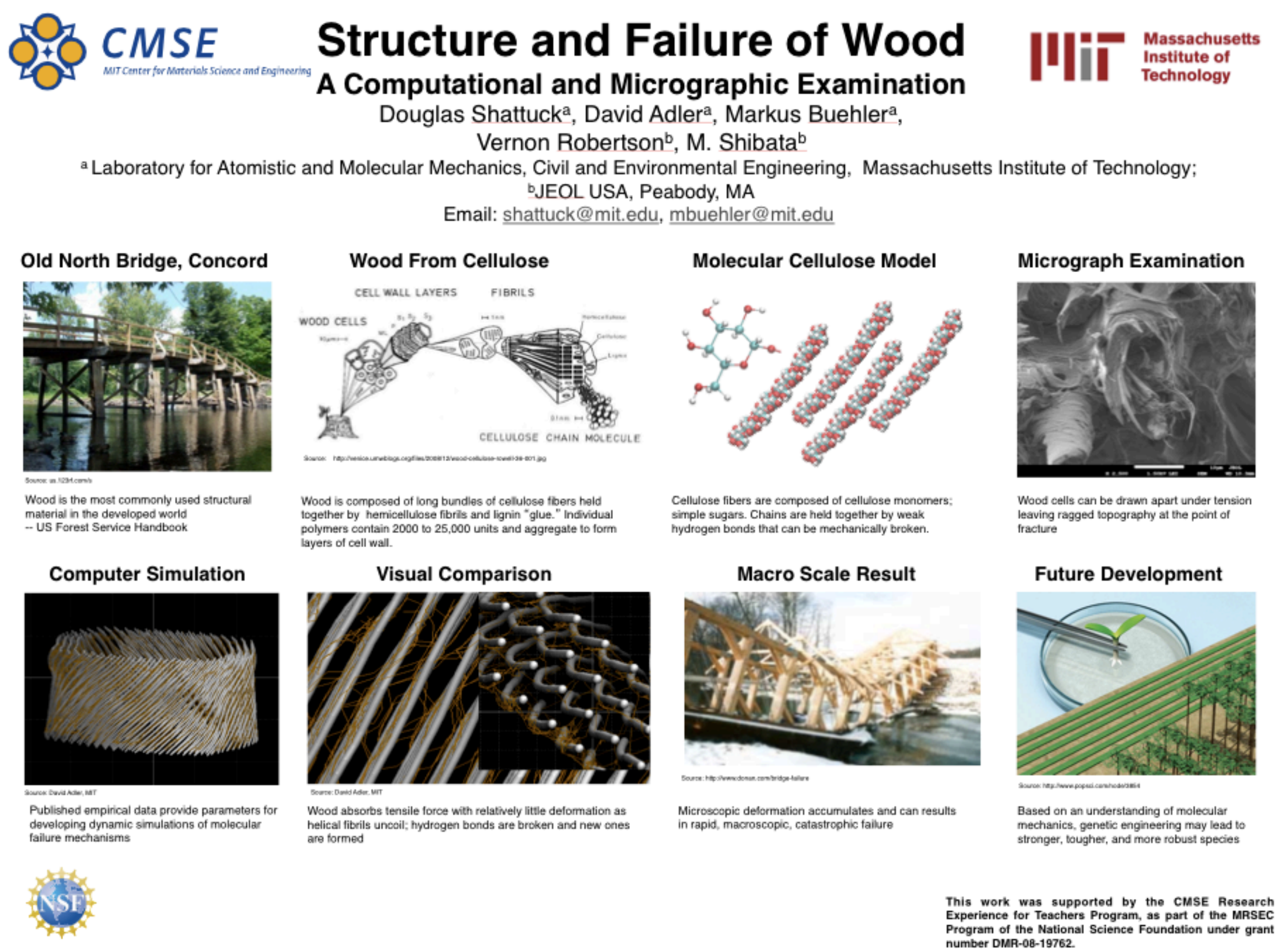

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