General Motors Grant Kickoff Meeting

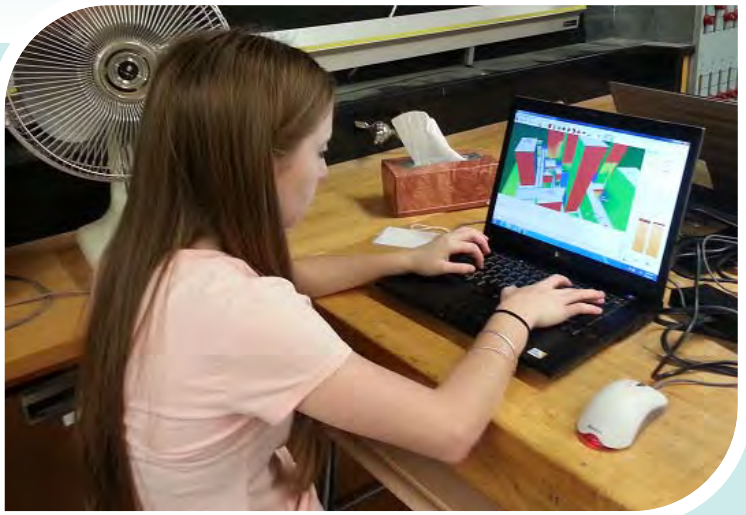
November 29, 2017

Teaching and Learning Engineering Design with a "Smart" CAD

The Concord Consortium
The Virtual High School

Vision

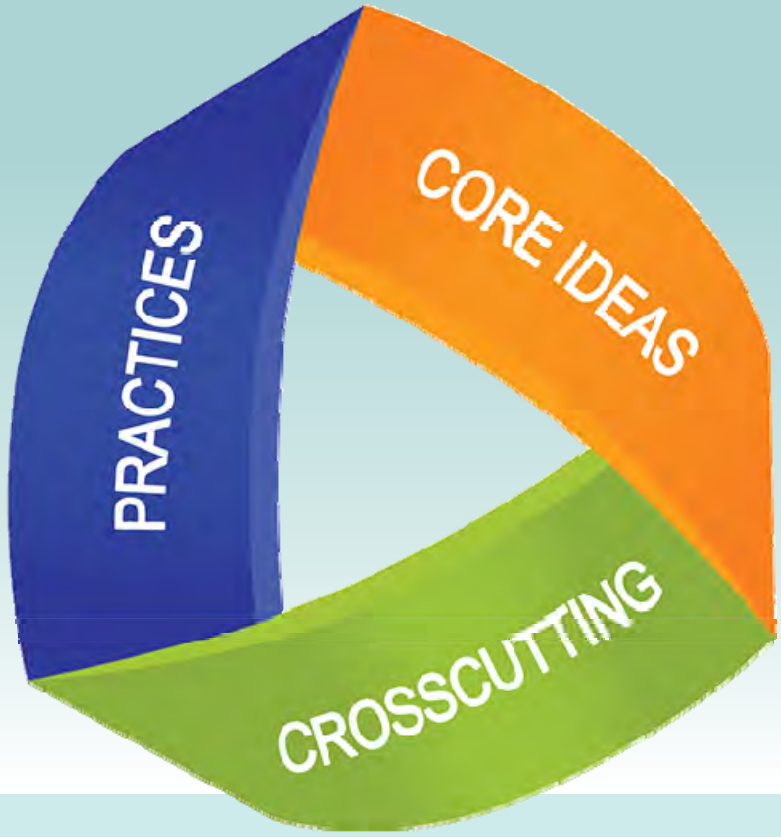
Empower millions of students worldwide to meet the sustainability challenge with engineering skills for solving real-world energy problems



Background: K-12 engineering education

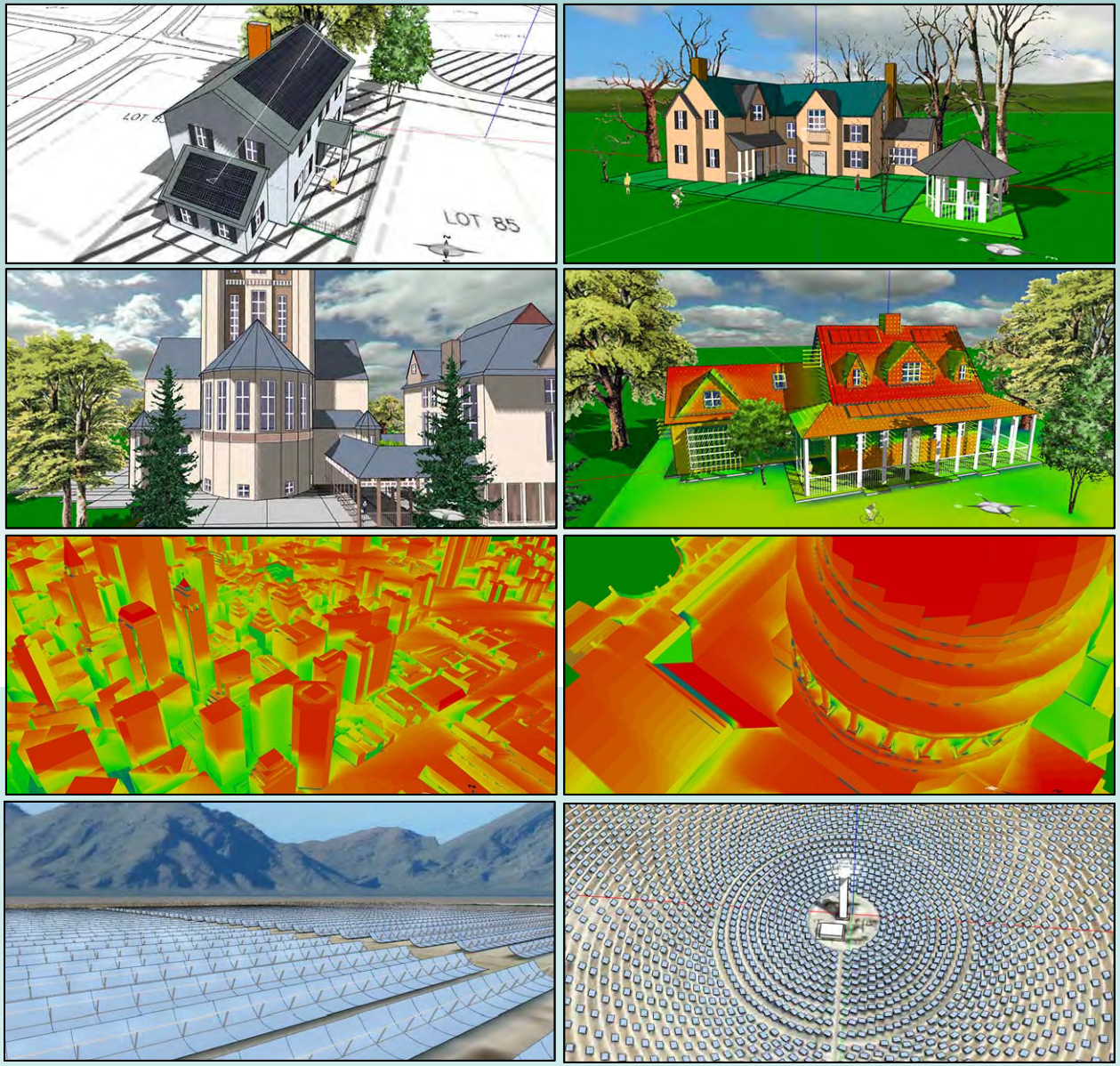
Engineering education is part of the Next Generation Science Standards (NGSS) that has been adopted by 19 states and DC. Engineering design, alongside with scientific inquiry, are now considered as two of the most important STEM skills *for all*.

Teaching engineering design in the grassroots level can help produce more engineers and create more jobs.



Engineering education perfectly integrates three-dimensional learning required by NGSS

Situate engineering education in the renewable energy revolution with a CAD platform



http://energy3d.concord.org

Focused engineering areas

- Architecture
- Building science
- Renewable energy
- Urban design
- .....

Renewable energy sub-areas

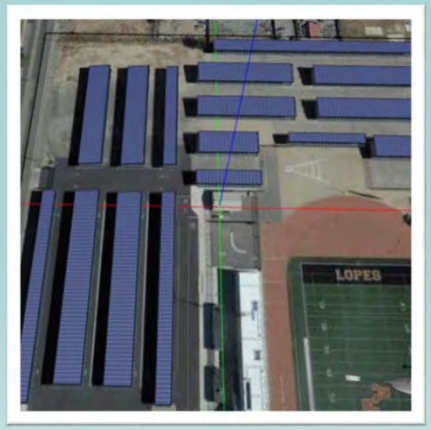
- Passive solar
- Photovoltaics (PV)
  - Rooftop systems
  - Ground-mounted arrays
  - Solar canopies
  - Solar curtain walls
  - Solar trackers
- Concentrated solar power (CSP)
  - Power towers
  - Parabolic troughs
  - Parabolic dishes
  - Linear Fresnel reflectors
- Solar updraft towers*
- Solar water heaters*
- Battery banks and microgrids*
- .....

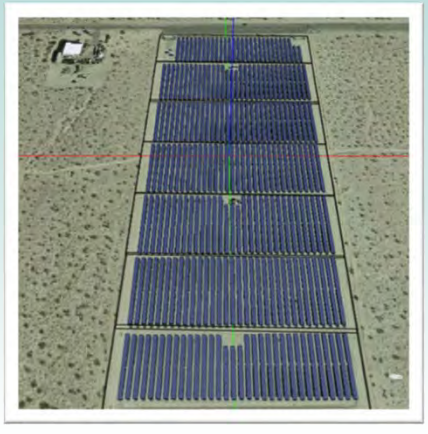
A global design lab based on Google Maps

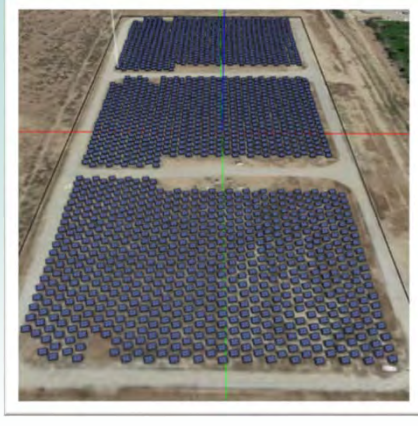
Energy Minecraft?

Global coverage: Weather data for 617 regions in 189 countries

Integrated design environments

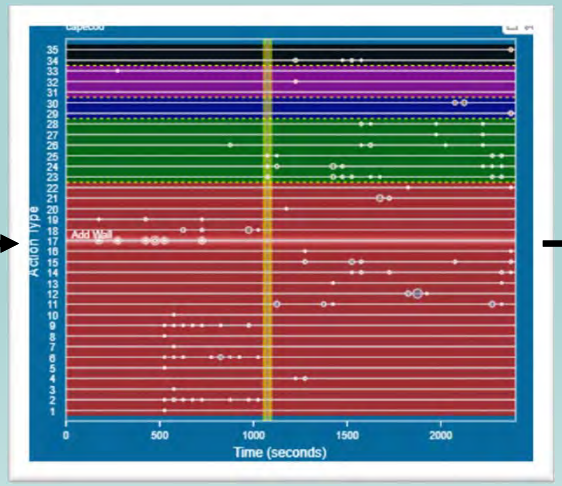




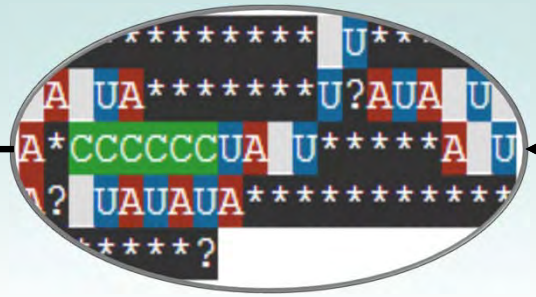


Why Energy3D?

Programmable intelligent agents generate adaptive feedback to guide students just in time based on mining their action and artifact data in real time, with the goal to supplement teachers with "AI teaching assistants" that offload some instructional burdens during the implementations of complex engineering design projects.



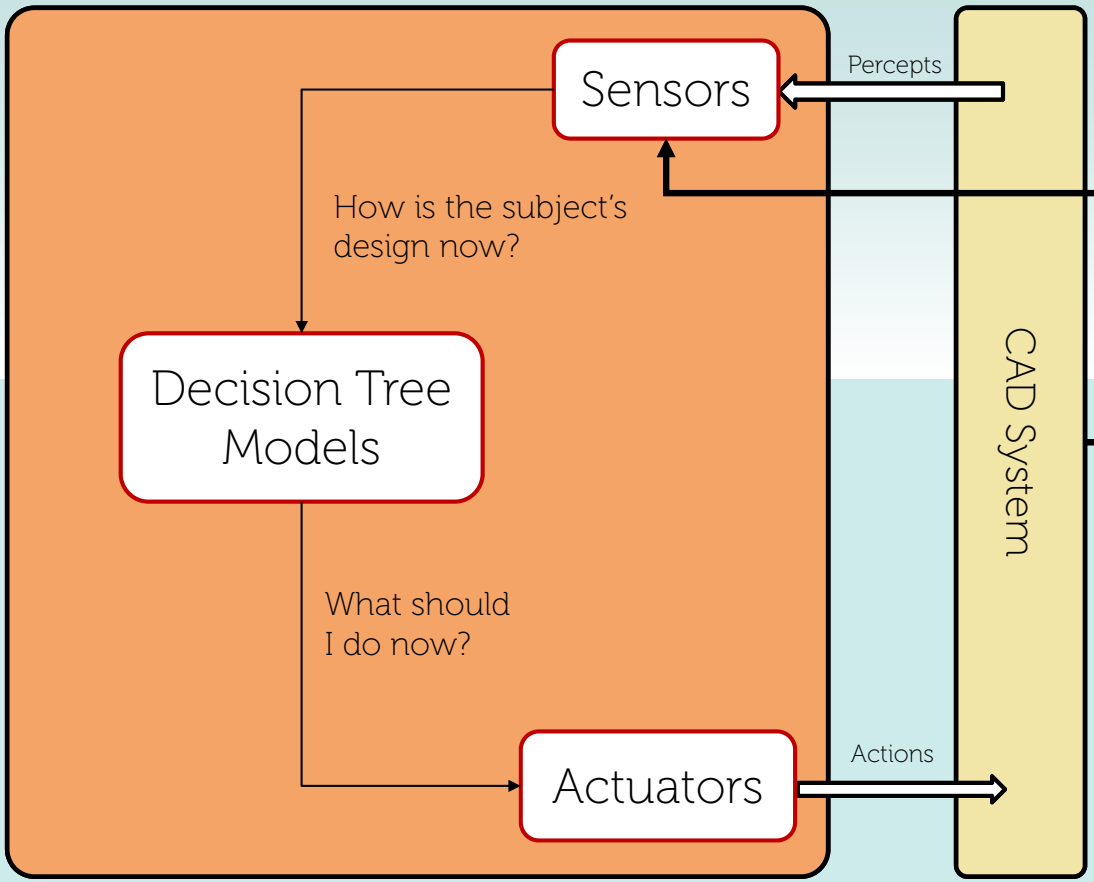
A scatter plot visualization of an event sequence for process mining



"Design DNA" sheds light on design intelligence

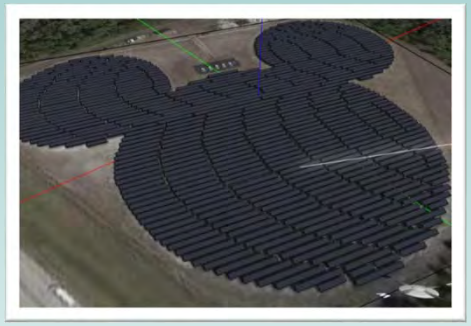
We are inventing an AI technique to convert an event sequence into a text string and recognize patterns using methods such as regular expressions, allowing us to computationally assess student work with machine learning algorithms borrowed from bioinformati natural language processing, etc.

An Intelligent Agent to Guide Design



Now imagine the possibilities ahead

The exciting trend of integrating PV with other structures or purposes (BIPV, IIPV, LIPV, "solar honey", co-location, etc.) calls for creative design.



For example, people do not want boring solar carports or canopies – NIMBY!

Can they be designed to look more attractive and meaningful?

Challenging students to design solar arrays acceptable by majority may provide an excellent opportunity for STEAM education and solar innovations.

The 2018 goal: Disseminate the Solarize Your World Curriculum in New England

January 2018 - April 2018

- Pilot test of the beta version of intelligent agents for conceptual learning with 50 students. A comparison study (with and without the support of agents) is being planned for Stoughton High School in Massachusetts in December or January.

- Further tests within the Solarize Your School and Solarize Your Home design activities with another 150 students planned in March or April.

The purpose is to collect firsthand student data for the upcoming professional development workshop for teachers.

May 2018 - August 2018

- Recruit 25 STEM teachers from New England for a three-day professional development workshop, with the focus on how to work with the built-in intelligent agents. Additionally, they will learn how to program their own agents within Energy3D using a simple visual programming interface.

- As renewable energy engineering will be the context, these teachers will also go through training for teaching renewable energy concepts and technologies, which are the essential parts of the Solarize Your World Curriculum.

September 2018 - December 2018

- Collaborate with the Virtual High School (VHS) to produce online course materials to support more teachers to implement the Solarize Your World Curriculum. This collaboration will allow the project to scale up to a large number of schools through VHS's networks of 600+ member schools.

- Collaborate with GM to disseminate the results of this project through journal publications, conference presentations, and maybe some bold projects (see the next pages for details).

Publication and presentation plans

Journal articles

- Science and Children – An article to show how elementary school students and teachers can benefit from the materials of this project (data collected through the collaboration with elementary schools in the Acton-Boxborough district).
- Science Teacher – An article to show how teachers from multiple disciplines can collaborate to foster integrated STEAM education using our material (data collected through the collaboration with Stoughton High School).
- Physics Teacher – An overdue article to introduce Energy3D to physics teachers.
- The Earth Scientist – An article to present Energy3D as a tool for teaching engineering in Earth science or environmental science classes.
- Advances in Engineering Education – An article to show how Energy3D can be used in college classrooms to teach everyone engineering concepts and skills (data collected through the collaboration with Purdue University and the University of Minnesota).

Conference presentations

NSTA, ASEE, STEM Forum and Expo, NAAEE, AERA, NARST, ISTE

Collaborate with General Motors

- GM provides site data (energy use or production)
- GM attend the teacher workshop
- Jointly present at conferences
- Co-author papers
- Finale: Make a newsworthy story in 2018?

Let's work together to make this happen!

The New York Times

Imagine the following headlines

Children design solar arrays near airport that spell General Motors' renewable energy ambition

General Motors works with schools to show commitment to renewable energy in midair

General Motors sponsors school design contests for cool solar carports

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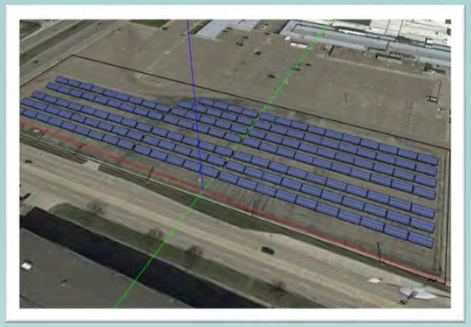
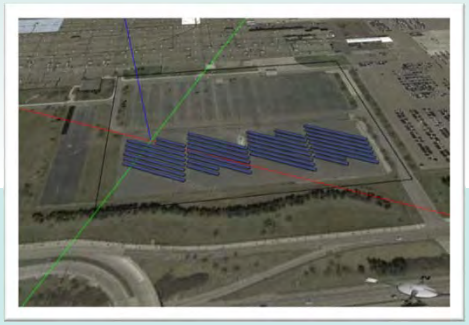
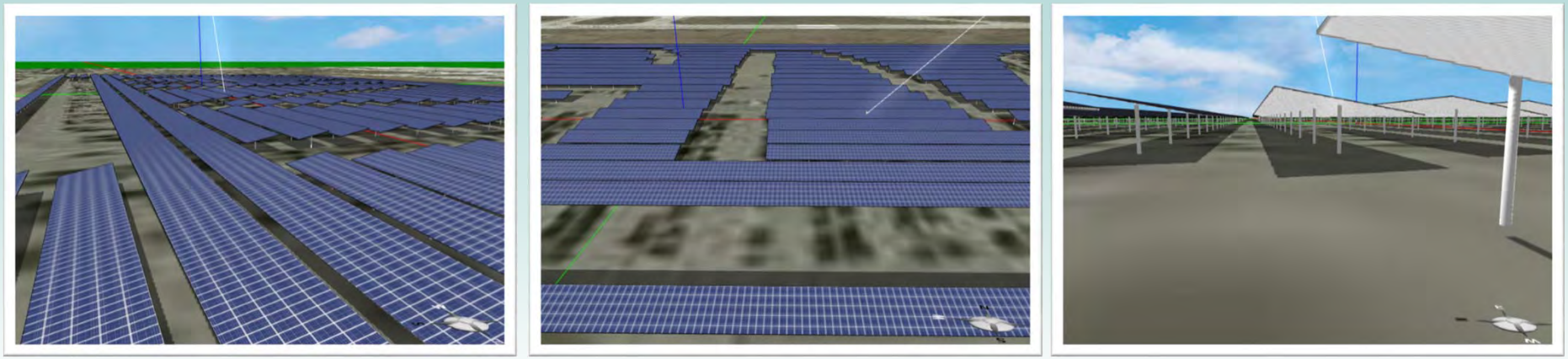




Thank you!



Virtual walk-through allows people to “experience” a design before it is built.