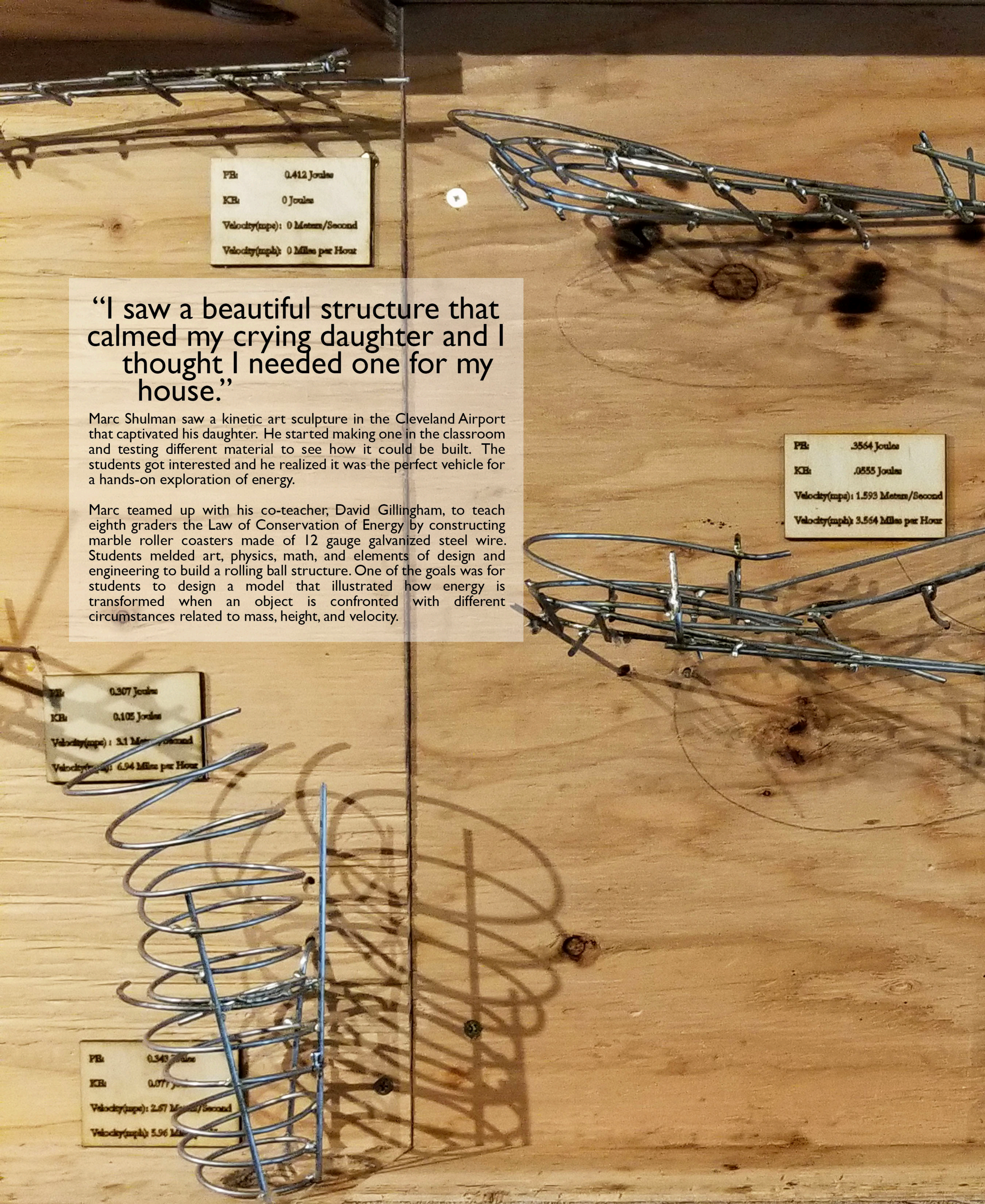


"I saw a beautiful structure that calmed my crying daughter and I thought I needed one for my house."

Marc Shulman saw a kinetic art sculpture in the Cleveland Airport that captivated his daughter. He started making one in the classroom and testing different material to see how it could be built. The students got interested and he realized it was the perfect vehicle for a hands-on exploration of energy.

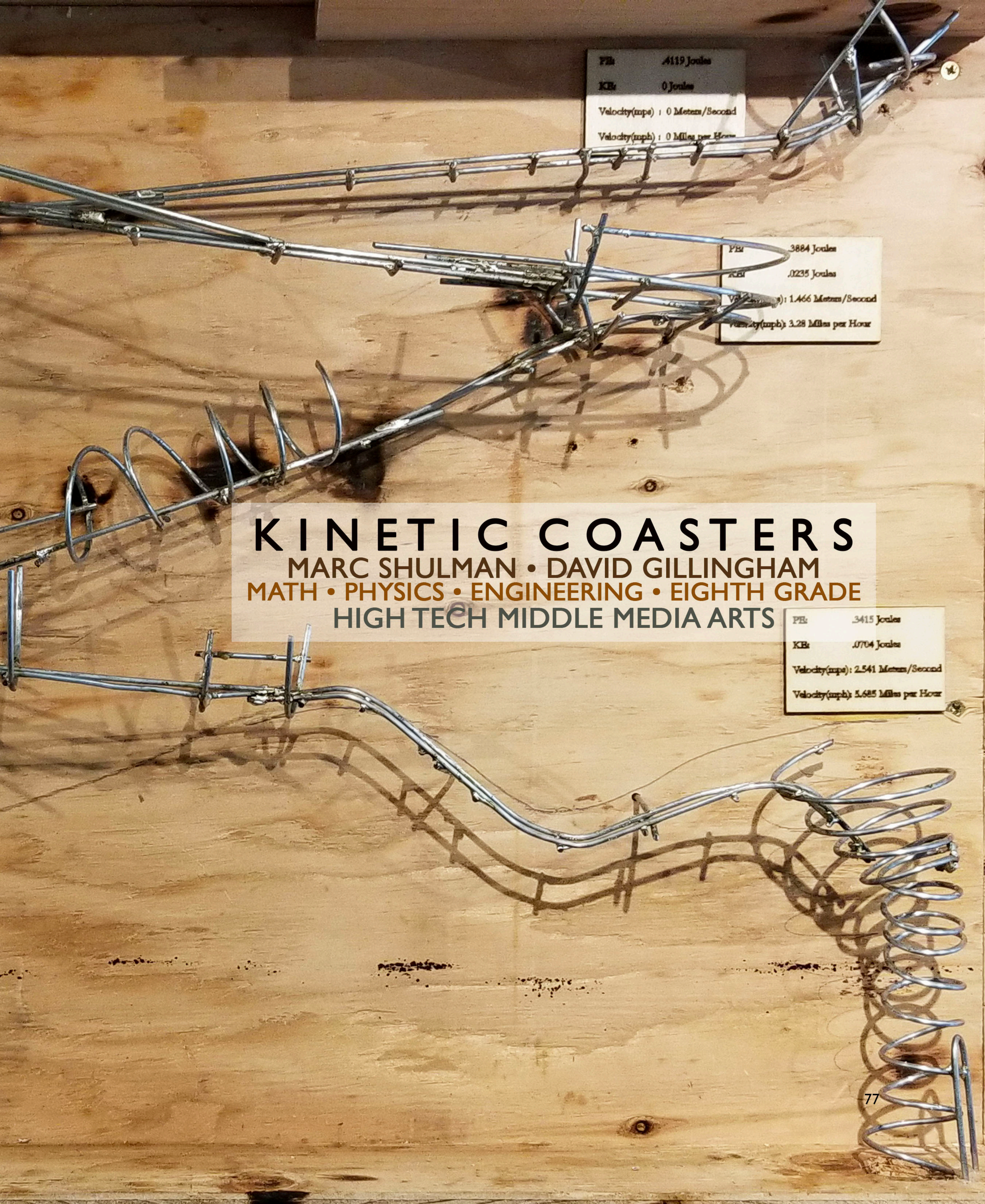
Marc teamed up with his co-teacher, David Gillingham, to teach eighth graders the Law of Conservation of Energy by constructing marble roller coasters made of 12 gauge galvanized steel wire. Students melded art, physics, math, and elements of design and engineering to build a rolling ball structure. One of the goals was for students to design a model that illustrated how energy is transformed when an object is confronted with different circumstances related to mass, height, and velocity.

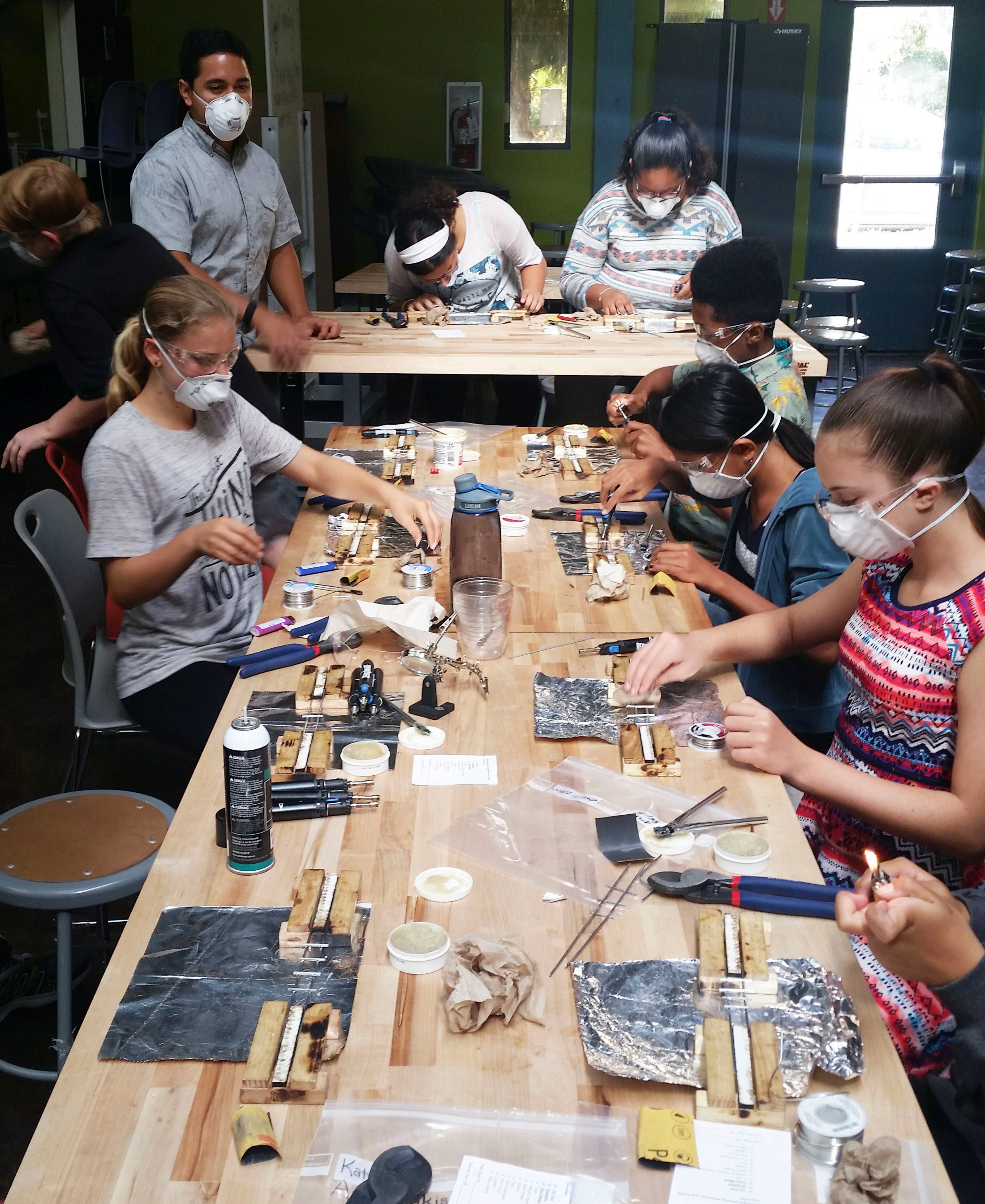
KINETIC COASTERS

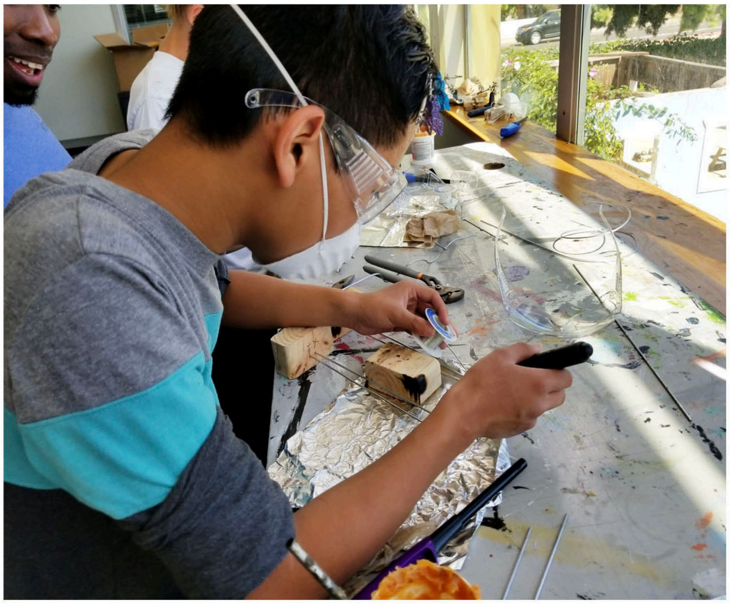
MARC SHULMAN • DAVID GILLINGHAM

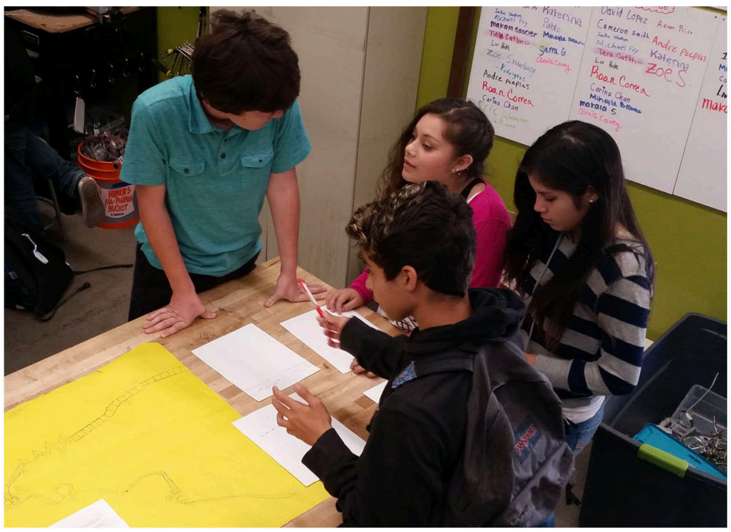
MATH • PHYSICS • ENGINEERING • EIGHTH GRADE

HIGH TECH MIDDLE MEDIA ARTS




HUSKY
DANGER





LEARNING GOALS

- To understand the law of energy conservation, potential and kinetic energy, energy transformations
- To understand and measure acceleration and velocity
- To understand centripetal force and radial acceleration
- To solve multi-step algebraic equations
- To do unit conversions
- To develop engineering design skills
- To become competent in the technical skills of soldering, brazing, precise metal forming
- To write, edit, revise, and illustrate technical documentation

Throughout the design and construction process, students explored the dynamic nature of energy and performed calculations to determine how much kinetic energy, potential energy, and velocity the marble possessed at each significant moment in their roller coaster.

Students were also tasked with creating a poster that illustrated the technical process and mathematical thinking involved in designing and building their structure. The final products were assembled in a permanent installation in the school.

ASSESSMENT

Assessment was rooted in the student work itself, and took place informally. The teachers met with each group regularly, asking them to explain how they had made their structure and why, and posing hypothetical questions about what would happen if variables such as the shape of the structure or the weight of the ball or velocity were changed.

SCAFFOLDING AND DIFFERENTIATION

Many students needed individual or small group support in the procedural elements of the project, i.e., how to solve complex equations. Academic coaches created graphic organizers to help break this process into steps, and supported students with practice and repetition. The conceptual understanding came from hands-on experimentation of trying multiple variations of ball size and weight, slope of structure, and velocity.

Marc and David grouped students in ways that they could help each other with their strengths. For example, a student who had deep conceptual understanding, but could not solve equations well, would be paired with a student who could easily do math on paper but struggled to explain it conceptually.

EXHIBITION

Students held two exhibitions. The first was a process exhibition halfway through the project, so students could get feedback and parents could interact with their designs. At the final exhibition eight weeks later, the structures were installed on a wall, so interaction was more difficult because of the crowd. Instead, students used their classroom to create a hands-on workshop to teach parents and other attendees the skills they had learned. They created a schedule of workshops that participants could sign up for, including brazing, welding, wire forming, how to calculate force and acceleration, and how to calculate velocity and energy.