Engineering Afternoon at NIST: The REAL Initiative
Thursday, November 8, 2012

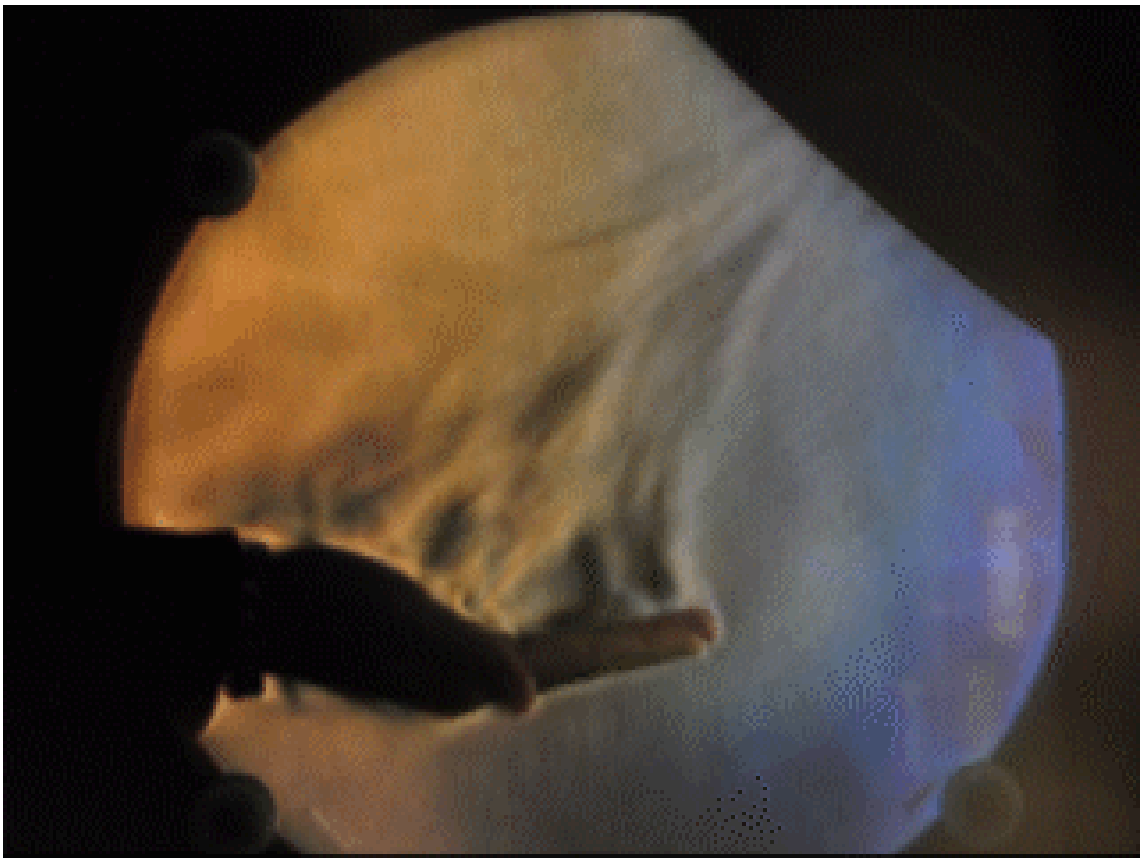
Teachers arrive at NIST after a long day in the classroom – but they're always eager to learn more about science and engineering research that they can use with their students. In the first Engineering Afternoon at NIST, two NIST engineers, Matt Staymates and Jeff Davis, use the teachers as guinea pigs to test an idea, the Research and Engineering in an Afternoon Lesson (REAL) Initiative. The REAL Initiative is designed to give students a real world problem and the tools to solve it, and then give them the opportunity to work together in teams with engineers to do so.

The basic idea is that two NIST engineers, in this case Matt and Jeff, would come to your class and work with teams of students as they solve different parts of the larger problem. In addition to working on the problem, students would be able to work alongside engineers, and have an opportunity to learn about engineering as a career.

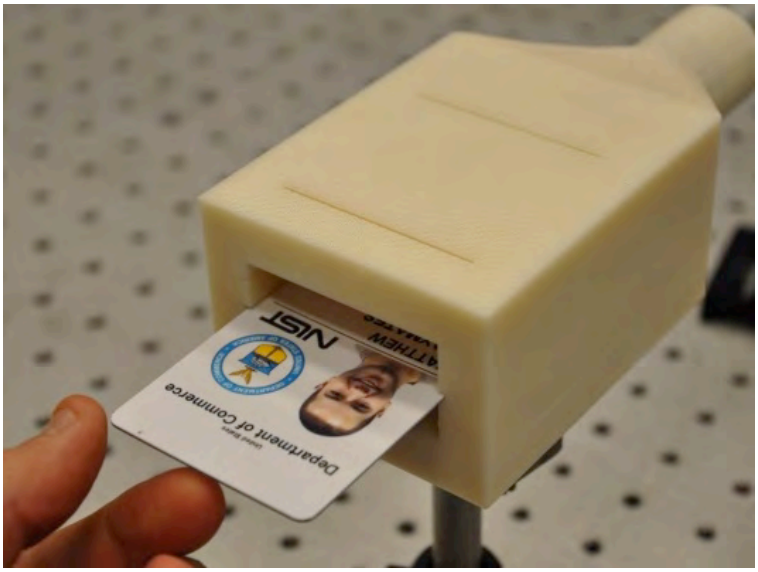
REAL Initiative Mission Statement: We will develop a 2 - 3 hour program that engages students in actively solving a problem or making unique measurements by applying fundamental engineering principles, tools and techniques.

The Afternoon starts with time to mingle and enjoy snacks; time to visit with other teachers and share ideas. Teachers from Montgomery County middle schools and high schools are present.

Then it's off to see Matt's lab where they are studying trace aerodynamic sampling of contraband materials (explosives or narcotics) in non-contact trace detection systems.



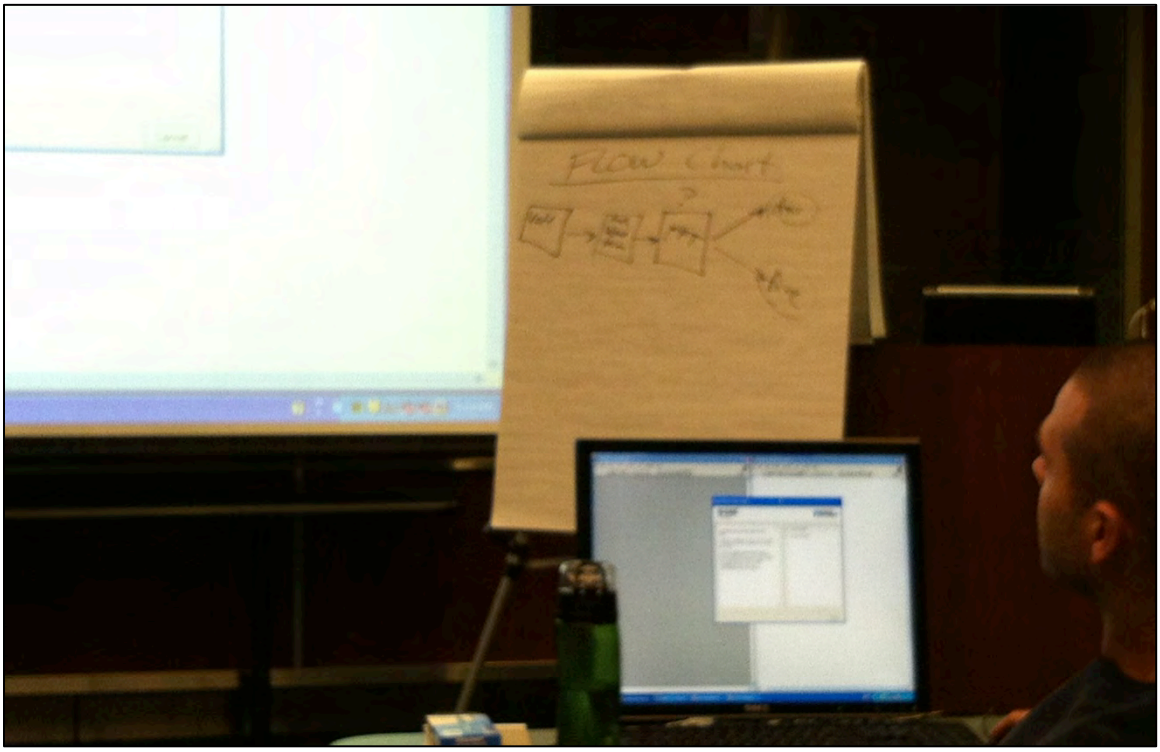
Trace detection systems are designed to screen people, personal items, and cargo for particles that have contaminated surfaces. As shown above using vapor sampling with an in-house designed schlieren optical system that allows visualization of the refractive index gradients in transparent media (like air). This picture shows the heat rising from a human hand, illustrating the incredible sensitivity of the system. This optical technique is useful for studying airflow physics and understanding how high-velocity air jets interact with surfaces.



In another example, Matt and his colleagues, including his wife, Jessica, have developed an ID sampler: this is a prototype system that screens a photo ID or badge for explosive residues by interrogation with high-velocity air jet impingement. The screened subject inserts their own ID into the system, therefore contaminating the ID with their own residues first. Currently, integration of advanced biometric identification along with anti-counterfeiting technology into this design is being carried out.

Teachers return to the classroom to work on design of a soundproofing system as part of the prototype lesson. Teachers are broken into two groups, one to work with Matt on designing a computer program that takes the inputs and delivers the outputs. The others work with Jeff on design of a test rig to determine which type of material would best insulate a room so that a band could practice without disturbing those in the next room.

Jeff guides teachers in design of the experimental matrix for testing two materials while…



…Matt works with teachers to write the code for testing the system. An essential part of an engineer's work is the flow chart, which guides their experimental design.

Here Jeff introduces the teachers to the materials available.

And here teachers dive in and begin to build an apparatus for testing their materials. One of the advantages of this program: the presenters bring all the materials.

At some point, the two teams must communicate to make sure they're both on the same track, so Yuri comes from the programming team to explain to the build team what his team is doing. At the same time, a couple of teachers go from the build team to the programming team to share their progress and make sure everyone's working in the same direction.

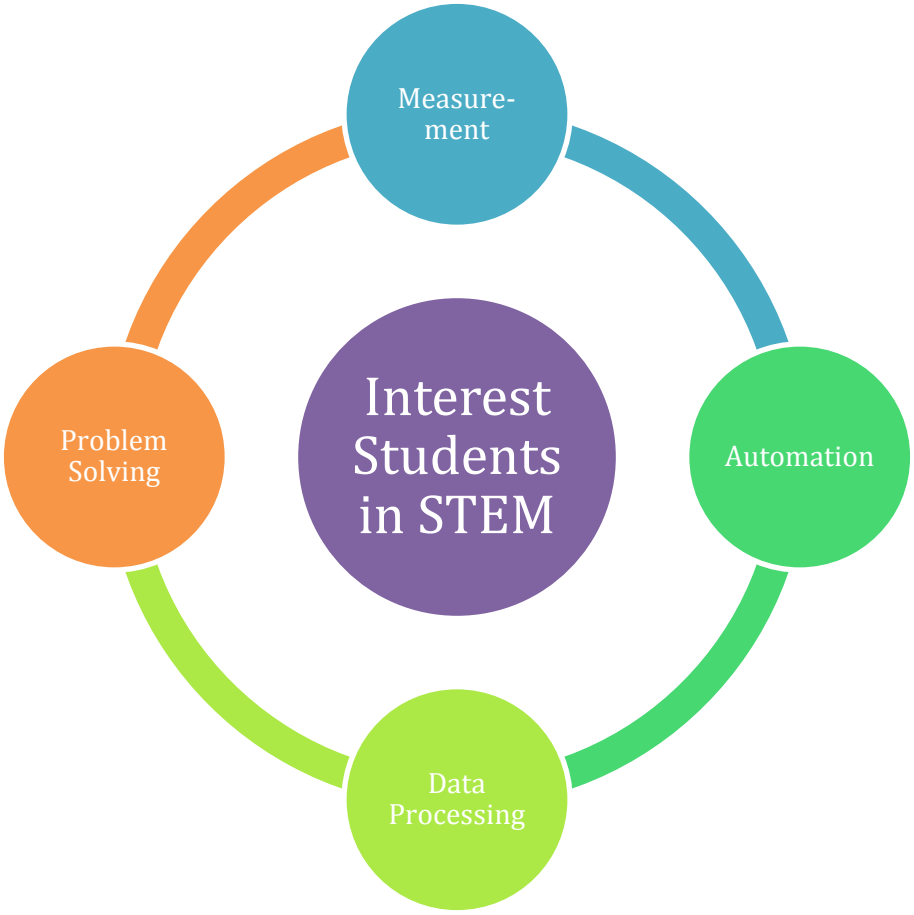
And then everyone gathers to put the two parts together and do the testing. It's decided that multiple trials of each set of materials will be done since each trial takes a very short time – and besides, as any measurement scientist knows, the more measurements you make, the greater the confidence in the results. Switching the panel choices takes the most time so it's decided to take multiple trials of each set before changing them, even though experimentally it might be better to test each material once, switch materials, test once etc. However, in this case time is a constraint so a faster, simpler test method is used. A blank with no material is run at the beginning and end of the experiment to make sure the experimental setup is working properly.

The data is taken and then the decision has to be made as to how best to represent the data so as to understand the results. It's decided to use a percentage of the sound blocked as a good way to compare the sets of materials. Why are some materials better sound insulators than others? That's not important to engineers; they just want to do the assigned job!

And so the experiment is done; turns out that combinations of Foam Acrylic and Wood Foam worked just about the same, according to a T test. Even better, teachers have been exposed to the engineering design process and had a chance to provide input to Matt and Jeff regarding how this Research and Engineering in an Afternoon Lesson could be implemented in the classroom.

During the following discussion on how to take this prototype lesson and make it ready for prime time exposure in a classroom, teachers have suggestions including engaging students by starting off with a YouTube video of wave motion, developing a paper version of the icons in LabView, having an already-built apparatus for the panels to speed up the panel exchange time, and use of green materials. Both teachers and engineers finish the evening with lots to think about!

Lessons learned: engineers are problem solvers and work to find the best solutions for complex, constrained problems. To solve complex problems, engineers break them down into a series of simpler problems; the process of doing this is what they are trying to teach. This is the kind of work that Matt and Jeff do every day as research engineers at NIST in building instruments for x-rays (Jeff) and for aerodynamic sampling (Matt).



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The REAL Initiative

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