Ideate, Model, Test.

Michael Cheung | 21W.749

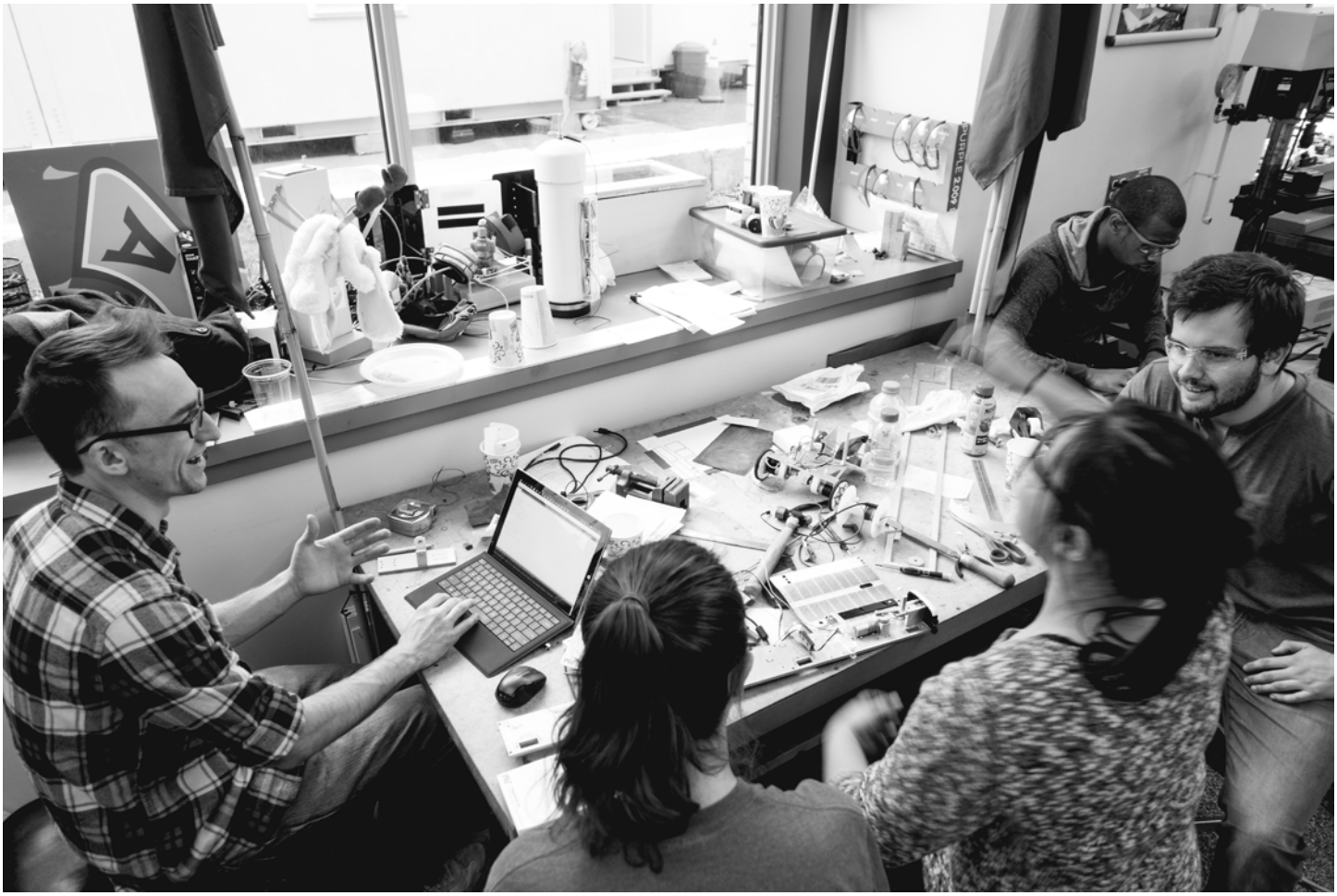
End-of-the-semester class presentations are usually pretty dry events. Busy PowerPoint slides, droning presenters – “excitement,” “magic” and “this made me want to switch majors” aren’t phrases often heard in the audience.

Then again, most class presentations don’t involve a live band, an audience of 3300, and an overall budget of half a million dollars.

Under the tutelage of Professor David Wallace, MIT’s senior capstone mechanical engineering product design class (known as 2.009) has steadily grown into a huge spectacle that attracts audience members from around the globe. It’s the closest thing you’ll find at MIT to the campus spirit-unifying atmosphere of a football game. Over the course of the 3+ hour event, 8 teams reveal the products they’ve been working on over the semester.

But while the presentations are exceptionally polished, with massive props and huge numbers of support staff behind the scenes (one presentation this year involved two people rappelling from the ceiling of the auditorium), the products don't start out that way. The theme of this year's presentation was "magic," but it wasn't magic that created these products – it was engineering, design, and good old-fashioned hard work.

While a product is a very tangible thing, every product starts out as an idea. And ideas are decidedly less tangible – they're fuzzy, often hard to express, and even harder to convince others. The dif-



ference between a great idea and a lousy idea isn't always clear when you're just verbally discussing it.

Apple's head designer Jony Ive recently described many university design programs as "tragic" – because "so many of the designers that we interview don't know how to make stuff, because workshops in design schools are expensive and computers are cheaper." He added that students were being taught to use computer programs to make renderings that could "make a dreadful design look really palatable".

The spirit of 2.009 couldn't be farther from that of the design programs that Jony Ive disparaged. 2.009's motto is "Ideate, Model, Test." Even though Computer-Aided Design (CAD) software is ubiquitous these days in mechanical engineering courses, a huge focus of 2.009 is trying to prove out ideas as quickly as possible. Often, making a computer 3D model isn't the best way to start an idea. Instead, fast and low-fidelity mock-ups (like rough cutting blocks of foam, or using quick-fabrication methods like laser cutting) can be better ways for exploring ideas.

It's not cheap to have such a big focus on physical models (one early build challenge cost $20k alone), but it's the right way to teach the product design process. At the beginning of the semester, students start with primitive "sketch models" to pitch their ideas. As ideas get cut and refined, so too do the manufacturing processes. 3D printers, waterjet cutters, CNC mills, thermoforming chambers – few manufacturing processes are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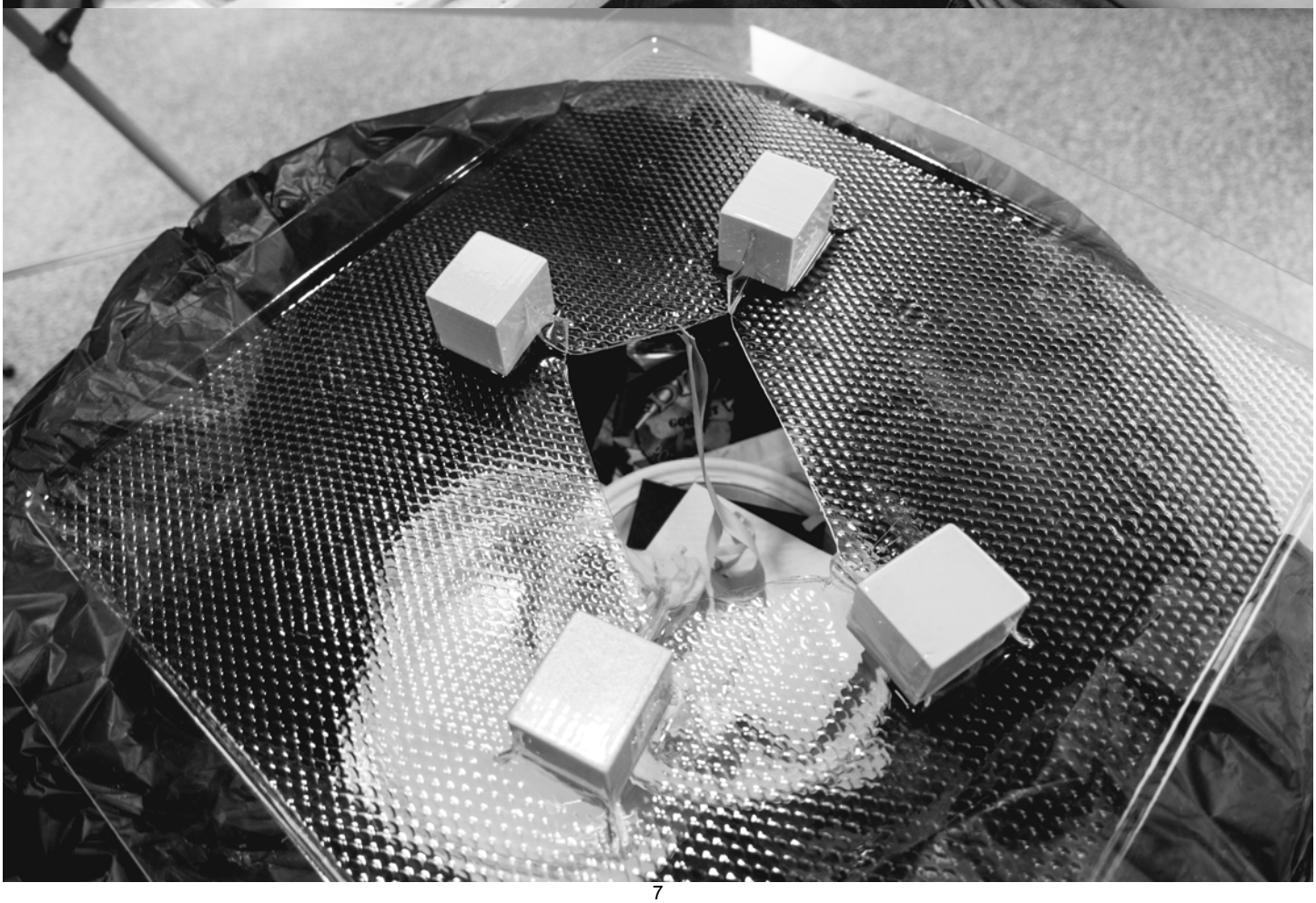
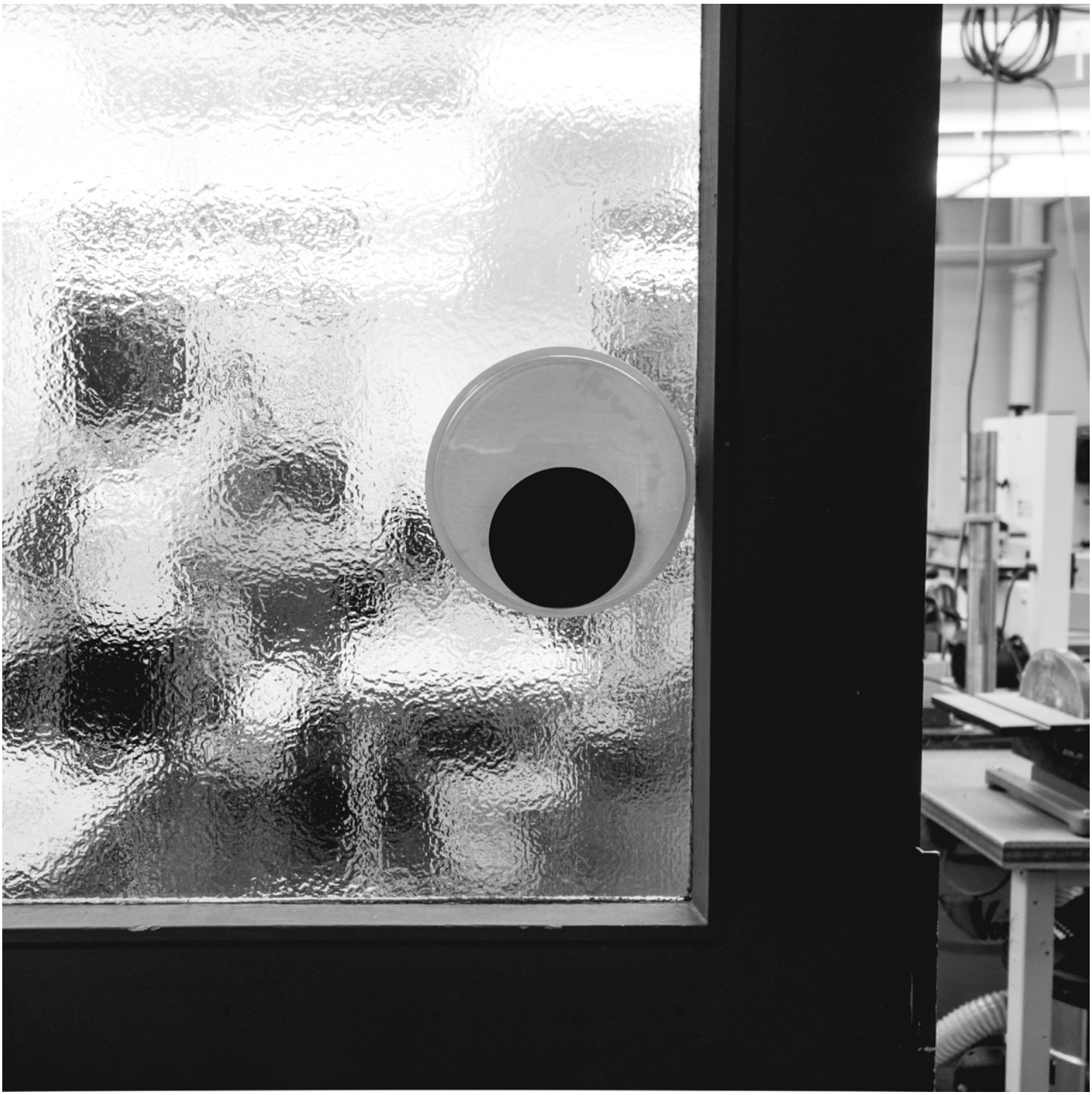
inaccessible to students.

Each team of 20 students gets a budget of $6500 for the three months of 2.009. Most teams will use all of this budget, and more. But the biggest cost isn't monetary, but in person-hours; students will regularly pull all-nighters and stay in lab til 3am (or later) before major deadlines throughout the semesters. One student's only sleep in 2 days was 45 minutes lying in the back of an ATV in a drafty loading dock.

The hours take their toll, but they're also reflected in the prototypes. Earlier on in the semester, Purple Team's sketch model, conceived and built in less than 24 hours, wow'd reviewers with its laser cut acrylic parts and working sensor proto-

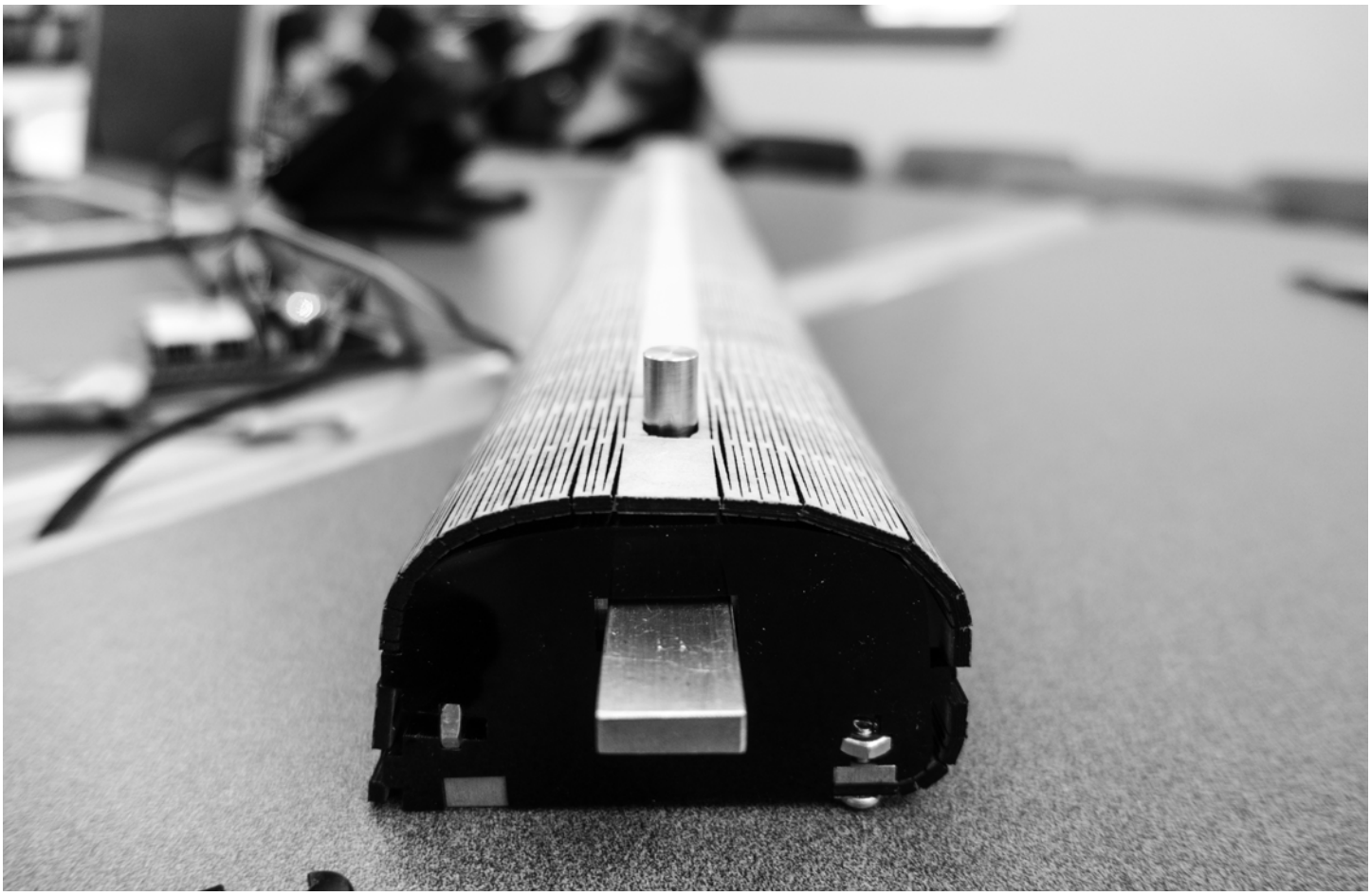


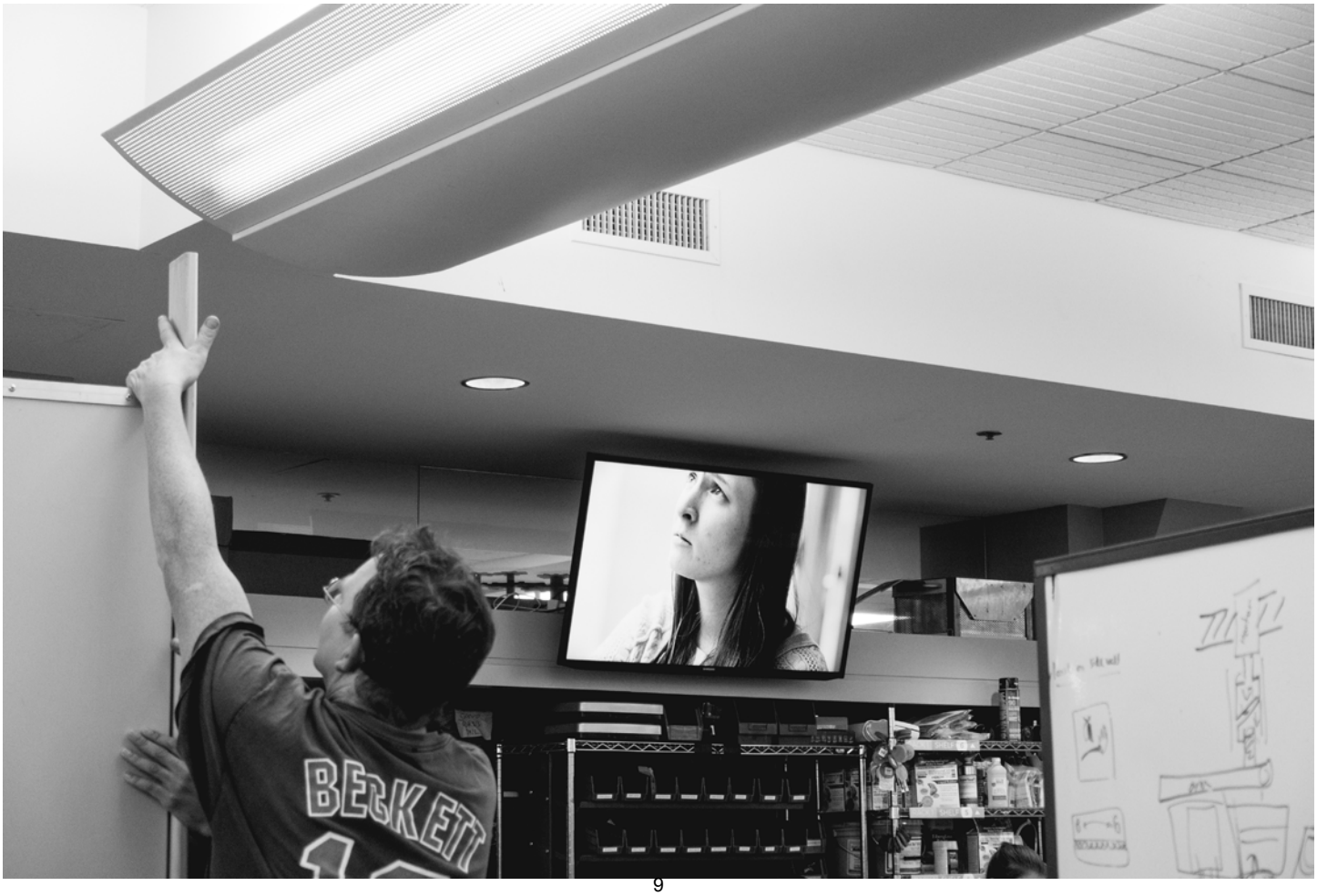


type. Purple is the only morning lab section, and its members joke that they're the "tryhard" team (perhaps coincidentally, in the course cartoon video the Purple team is represented by a nerdy rabbit).

For the Technical Review, however, the Purple Team is in decidedly worse shape. It's 1 hour until reviewers will be coming by to examine the prototype of its self-opening and locking door, and nothing is working. The team has split into several subteams: locking, opening, sensors, and enclosure. While the mechanisms are all machined and laser cut, the sensors are not properly detecting.

Josh Born and Eric Shirley, two of the team's stronger coders, sit with brows furrowed next to the door. After an hour

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of debugging, they're still not sure what is causing the microcontroller to intermittently shut itself off and restart. But there's no time left – the first round of reviewers is heading in. Purple team is forced to explain their progress so far without an actual working prototype, and the first round of reviews is disappointing.

By the second round of reviewers, the students have identified the problem – the motor for the opening mechanism is drawing too much power from the Arduino and causing it to reset. The solution – plugging the Arduino into a laptop during the demonstration – isn't ideal. A huge amount of work had gone into making sure the device could be battery-powered. But having something to show is at least better than having nothing but words. The prototype at least shows the mechanical progress and sensing progress that the team has made over the past two weeks.

The next few rounds of reviewers go much better. Having a working prototype makes all the difference, and Purple's presenters refine their pitches and explanations as they get more practice. One reviewer's comment that "why haven't you patented this yet?" reinvigorates the team just as energy is starting to dip.

By 11pm, the reviewers are finally all gone. The few stragglers from Purple team finish up cleaning up the lab space, and head home.

It's time to sleep.


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