MITOPEN**COURSEWARE**
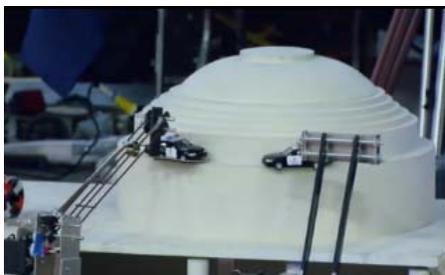MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Pivotal Concepts, Pivotal Videos

Robots place model police cars atop MIT's dome. Find out how in Motion, one of 47 STEM concept videos.

OCW has been publishing more video than ever before. We recently put up a collection of 47 short videos, the STEM Concept Videos. These videos are designed to help students understand pivotal concepts in undergraduate courses in science, technology, engineering, and mathematics. As conceived for the collection, a pivotal concept is one that:

- has importance in multiple disciplines
- is necessary for understanding higher-level coursework
- recurs throughout the curriculum for the same discipline

Examples of science concepts treated in the series are conservation of mass, Newton's laws, and equilibrium. Mathematics concepts include derivatives and integrals (as applied to motion or electric potential, for instance), differential equations (as used to describe enzyme kinetics, among other topics), and probability. Other videos address problem-solving processes and various techniques and applications of representation (torque, vectors, free-body diagrams, e.g.).
The video collection has three fundamental goals:

- to reinforce pivotal concepts and multidisciplinary themes from the first two years of a general engineering curriculum
- to provide opportunities for students to actively engage with content (as by presenting challenge questions for the students to consider after pausing the videos)
- to provide concrete examples from everyday life, or from the laboratory, of the utility of the concepts

The videos were created by MIT's Teaching and Learning Lab, originally as part of collaboration between MIT and the government of Singapore to establish a new university, the Singapore University of Technology and Design (SUTD). The idea was to create videos to supplement the newly designed SUTD curriculum, but the videos proved so useful that instructors incorporated them into their courses on the MIT campus, and students began to watch on their own.

These videos provide a wonderful resource for teachers and students interested in college-level science.

The stars of the videos? MIT faculty, instructors, postdocs, and graduate students!

People interested in how these videos were developed can read the paper presented by TLL researchers at the American Society for Engineering Education (ASEE) 2013 conference.

The videos do not constitute a course and are not listed in MIT's
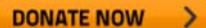
curriculum. Rather, they are published on OCW as a Supplemental Resource. OCW's collection of Supplemental Resources includes other video series, online textbooks, and other publications and learning tools.

New Courses
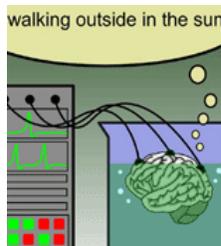
21M.235 Monteverdi to Mozart: 1600-1800

6.S096 Introduction to C and C++

- 6.849 Geometric Folding Algorithms: Linkages, Origami, Polyhedra
- CMS.615 Games for Social Change
- MAS.S63 Engineering Health: Towards the Tricorder

Updated Courses

24.211 Theory of Knowledge
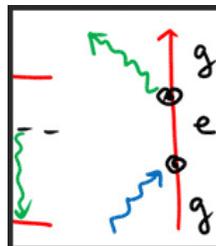
8.422 Atomic and Optical Physics II

- 8.04 Quantum Physics I
- 21H.380J People and Other Animals
- 21L.512 American Authors: Autobiography and Memoir

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OCW Educator

This image is taken from an animation, "Metamorphosis of the Cube," demonstrating foldings of polygons into convex polyhedra, and the reverse, unfoldings of convex polyhedra into polygons. (Animation by Erik Demaine, Martin Demaine, Anna Lubiw, Joseph O'Rourke, and Irena Pashchenko.)

Fold, Then Flip

Quiz question: What do medical stents, car air bags, origami sculptures, robotic arms, satellite solar arrays, and morphing computer graphics have in common?

Answer: Folding, of course!

Oh, yes, and algorithms, too!

OCW has just published *6.849 Geometric Folding Algorithms: Linkages, Origami, Polyhedra*, a course by Professor Erik Demaine, which explores the universe of folding in one dimension (linkages), two dimensions (origami), and three dimensions (polyhedra).

The course is itself folded in the sense that Professor Demaine flipped his classroom using videotaped "inverted lectures" that students watched outside class. Time in the classroom was devoted to answering student questions and to pursuing deeper investigations of the multifaceted course material. Professor Demaine also invited students to optional "open- problem sessions," at which students worked on cutting-edge problems in a collaborative spirit espousing the belief that "there are no bad ideas."

The course is a revealing example of the ways that video lectures can actually free up the instructor to engage with students in a more hands-on, thought-provoking way. The course publication on OCW includes all of the video lectures (from Fall 2010) and videos of the class sessions (from Fall 2012) as well.

Professor Demaine explains his thinking behind the course in his This Course at MIT page. The class sessions were shaped by forms that the students filled out online after watching the lectures, so Professor Demaine could prepare for the sessions to address student questions and incorporate the latest research, often with stunning computer graphics and animations.

Professor Demaine liked this format so much he flipped another course he teaches, *6.851 Advanced Data Structures*. As he says in the course description, "You interact with data structures even more often than with algorithms (think Google, your mail server, and even your network routers). In addition, data structures are essential building blocks in obtaining efficient algorithms."

A champion of open sharing, Professor Demaine published this course with full video lectures and a reflective This Course at MIT page on OCW. This allowed him to share a number of lessons he learned from his first flipped experience and to outline the

adjustments and improvements he made for his second.
You can see many other OCW's This Course at MIT pages here.
They are part of OCW's innovative Educator project.

Highlights for High School

Original webseries from MIT showcasing real science by real students. Served up fresh from the heart of innovation & the big bang of great ideas.

Do you ever wonder how to make real invisibility cloaks or what would happen if you cut the nerves from a squid brain to the skin? Then check out our friends, MIT+K12 Videos.

MIT+K12 Videos are made *for* students *by* students. MIT students write and host episodes of their free webseries, *Science Out Loud*, about their favorite science, technology, engineering, and math (STEM) topics for kids and kids-at-heart.

The videos are entertaining and educational and cover lots of great topics.

> Visit the MIT+K12 website

MITx News
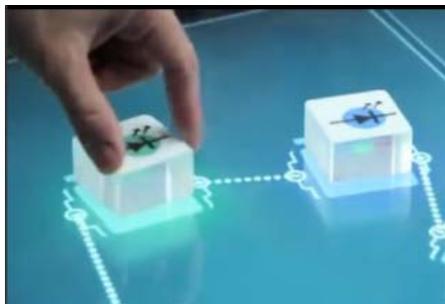
An example of an educational technology project.

We must be in a Golden Age of Educational Technology. Teachers can use any of a number of platforms to make learning materials available online, posting videos and animations as well as images and text. Rather than sit back and passively absorb (or just as often, not absorb) information, students can use technology to become active participants in their own education. They can learn by doing. They can attempt interactive problems that offer immediate feedback to see if they are on the right track. They can exchange ideas with each other on discussion forums. They can work on projects in teams that they join online.

It's amazing and wonderful . . . and overwhelming. What defines good design of educational technology? What are the ideas, processes and teams that can be harnessed to create powerful new learning technologies? And how do we create an ecosystem of designers, developers, and educators who can create and implement educational technologies effectively?

Those interested in the enterprise of educational technologies can answer these questions by enrolling in _11.132x Design and Development of Educational Technology_, a course taught by Professor Eric Klopfer on the edX platform starting on October 8 and running for six weeks.

This course examines educational technologies, outlines the theories that influenced their development, and examines their use. The course leads up to a final project–a kickstarter style pitch for a new educational technology. An advocate of active learning, Professor Klopfer likes to practice what he preaches: The course involves active weekly participation by the people taking it.

This course is one of a series of "EdTechX" courses being developed by the MIT Education Arcade.

The series is designed to help you build your understanding of the use and design of technologies for learning.

The second course in the series is _11.126x Introduction to Game Design_. It starts on October 22and runs for six weeks. The course emphasizes the basic tools of game design: paper and digital prototyping, design iteration, and user testing.

The final two courses in the series are slated to start in the spring and summer of 2015:

- _11.127x Computer Games and Simulations for Investigation and Education_
- _11.133x Implementation and Evaluation of Educational Technology_

> View all MITx on edX courses

Views From Our Supporters

"I loved how sir Gilbert Strang explained the basic ideas behind Calculus. I'm also astonished by the amount of free and reliable courses online."

- Mohammed, Independent Learner, Egypt

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