



Biomedical Engineering

(WE DO COOL THINGS)

Sarah Sandock, Josh Kolz, Kenneth Xu, John Renfrew
University of Wisconsin, Madison
Biomedical Engineering Department

Engineering at UW-Madison

- Biomedical Engineering: BME
- Chemical Engineering: CBE
- Civil Engineering: CEE
- Computer Engineering: CompE
- Electrical Engineering: ECE
- Engineering Mechanics: EM
- Engineering Physics: EP
- Geological Engineering: GLE
- Industrial and Systems Engineering: ISyE
- Materials Science and Engineering: MS&E
- Mechanical Engineering: ME
- Nuclear Engineering: NE

Biomedical Engineering

What is BME?

- The interface of the human body with medical technologies and devices

Why BME?

- Interest in research
- Strong focus on Invention & Design
- Highly multidisciplinary

What does it take?

- Have a curiosity about how things work
- Like challenges and be good with problem solving
- Be comfortable working with modern technology
- Be interested in medicine, biology, and technology
- Be reasonably good at math, science, and writing

Specialties

Tissue/Materials



Biomechanics



Bioinstrumentation



Medical Imaging



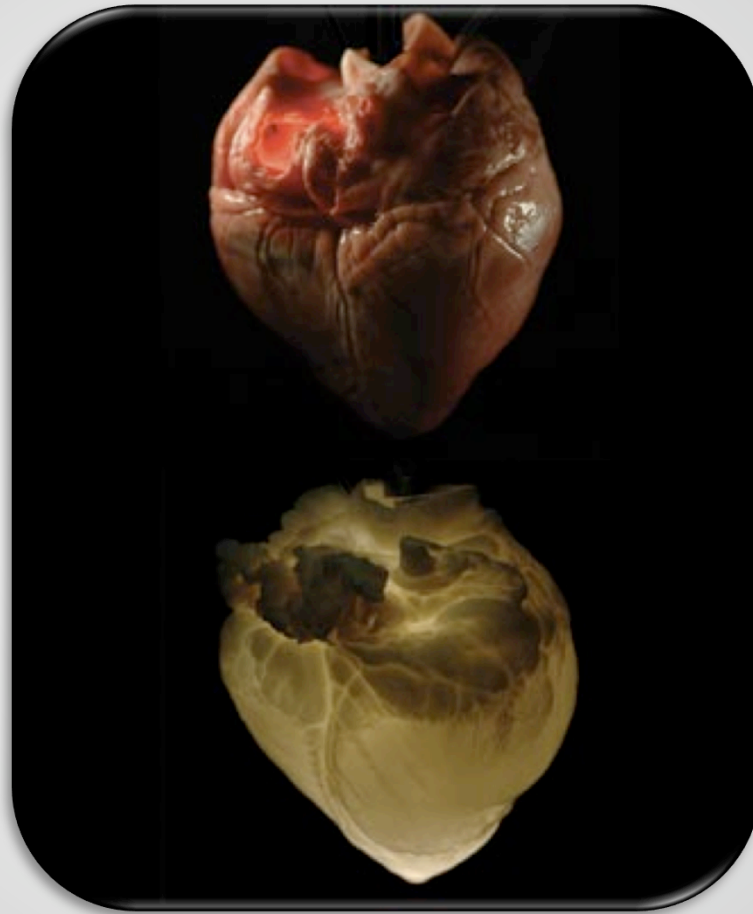
BME? → SPECIFICATION → OUR PROJECT → WHAT'S NEXT?

Biomaterial & Tissues



- Broad Definition: Manipulation of biological matter at the cellular and molecular level
- AKA: biological engineering, bioengineering, cellular engineering, material engineering, protein engineering, genetic engineering, and many more...
- Goal: to develop biological substitutes to restore, maintain, or improve function of the human body
- Examples: Lab-grown organs (skin, heart, blood vessels), living machinery (biofuel production in micro-organisms), stem cell engineering (transplants), biocompatible materials (heart valves, fillings, surgical equipment)

Biomaterial & Tissues



Decellularized Heart
(Biomaterials and Tissue Engineering)

Biomechanics



- Broad Definition: **Mechanics of the human body**
- Includes: **Mechanical engineering, solid mechanics, orthopedics, ergonomics, modeling, programming**
- Goal: **Apply engineering mechanics to understand biological processes and improve interactions**
- Examples: **Orthopedic devices (prostheses, fixatives), vascular remodeling, muscle mechanics with injury, mechanical stability testing, implant mechanics**

Biomechanics



Click for video

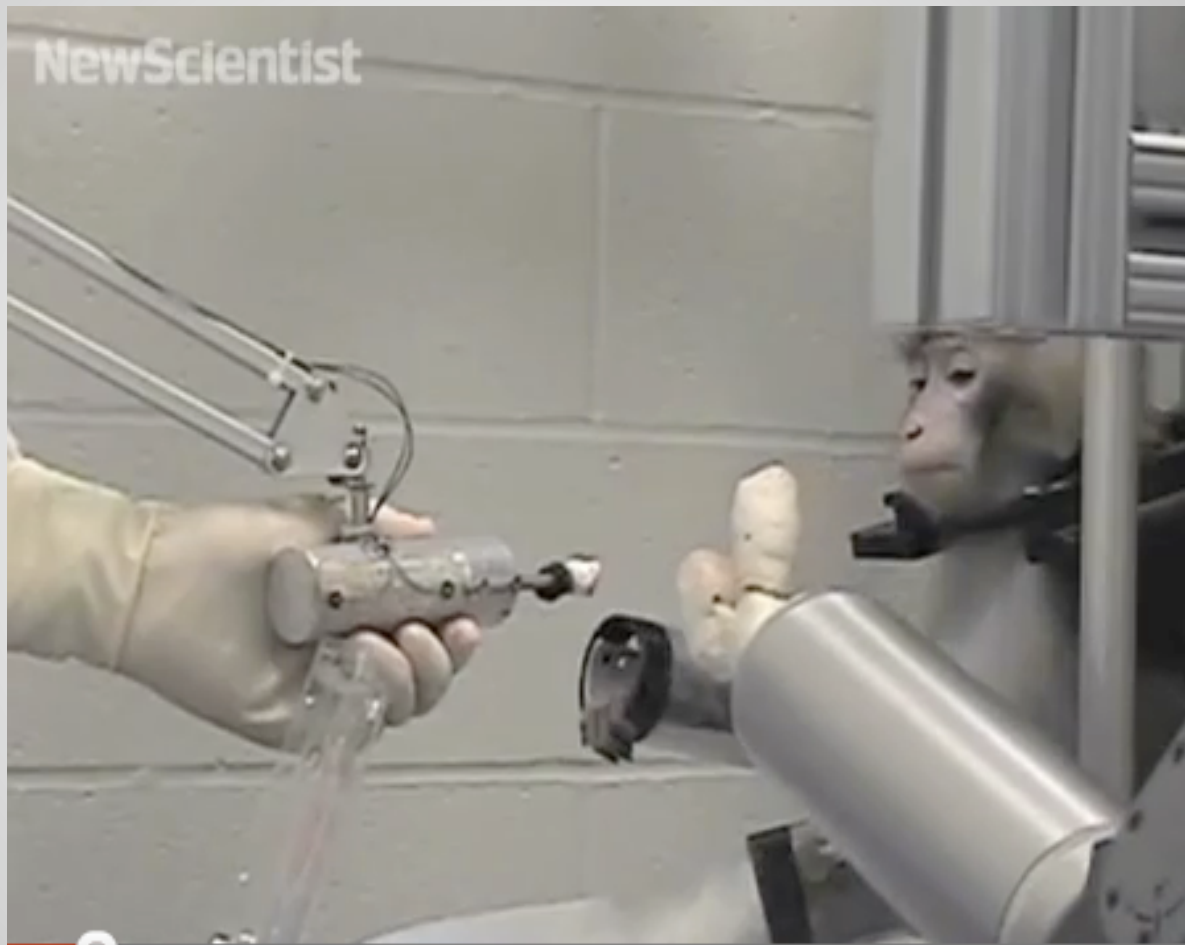
BME? → [SPECIFICATION](#) → OUR PROJECT → WHAT'S NEXT?

Bioinstrumentation



- **Broad Definition:** Electronics and circuitry to monitor and interact with the human body
- **Includes:** Mechanical engineering, electrical engineering, circuit design, signal analysis, modeling, programming, neuroengineering, ergonomics
- **Goal:** Apply technology to develop devices used in diagnosis and treatment of disease
- **Examples:** Electrocardiogram, cardiac pacemaker, blood pressure measurement, kidney dialysis, ventilators, microtechnology, bionic prosthetics

Bioinstrumentation



[Click for video](#)

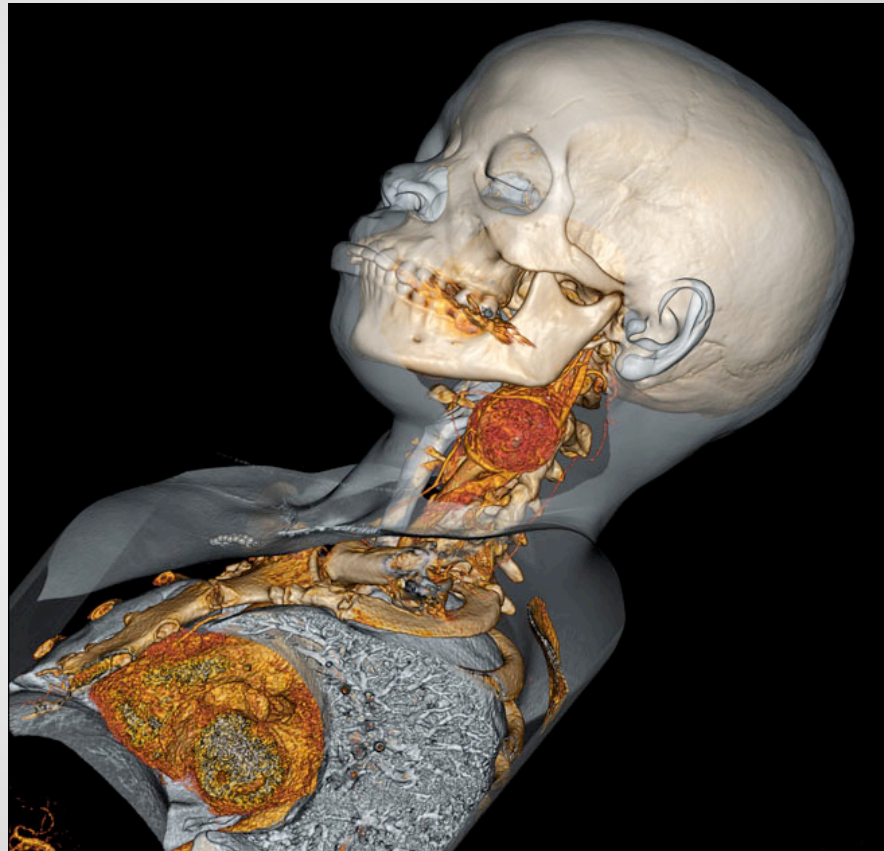
BME? → [SPECIFICATION](#) → OUR PROJECT → WHAT'S NEXT?

Medical Imaging



- Broad Definition: Anatomical imaging for diagnostic information through the application of engineering, physics, and computer technology
- Includes: electrical engineering, circuit design, signal analysis, modeling, programming, ergonomics, physics
- Goal: Non-invasive diagnostic and functional capabilities
- Examples: MRI, PET, CAT, X-ray, ultrasound

Medical Imaging



[Click for link to video](#)

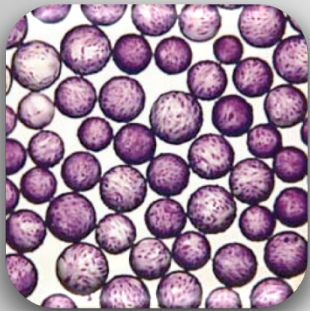
Design Projects



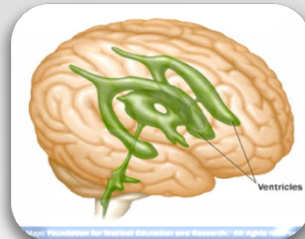
↕	Level ↕	Team Members ↕	Project Title	↕ Keyword ↕	Engineering Specialty ↕	Medical Specialty ↕	Skills Required ↕
3	301	4	Expandable nasogastric tube	nasogastric_tube	Biomaterials	Medicine	Human Subjects, Biomaterials
5	301	4	Water resistant boot for walking casts	cast_boot	Biomechanics	Medicine	Mechanics, Use of fabric/materials
6	301	4	Generation of an accessible and versatile hypoxia chamber	hypoxia_chamber	Biomaterials, Tissue Engineering	Cardiology	Imaging, Cell Biology, Biomaterials
9	301	4	Head holder for MR-guided drug delivery testing	head_holder	Biomechanics	Radiology	Mechanics, Imaging
11	301	4	Device for tracking head motion in an MRI simulator	head_tracker	Bioinstrumentation	Psychiatry, Medical Imaging	Software, Electronics, Human Subjects, Imaging
14	301	4	Developing a 3D model of the tongue and mouth to assess pressure generation when swallowing	mouth_model	Biomechanics	Geriatrics, Medicine	Mechanics, Human Subjects
20	301	4	Engineering World Health (EWH) infant respiratory rate monitor	EWH_respiratory_monitor	Bioinstrumentation	Pediatrics	Electronics
21	301	4	Digital beam attenuator	beam_attenuator	Bioinstrumentation, Biomechanics	Radiology, Medical Imaging	Software, Electronics, Mechanics, Animal Experiments, Imaging
22	402	4	3-dimensional culture system for Schwann cells	culture_system	Tissue Engineering	Medicine, Neurology	Imaging, Cell Biology, Tissue Engineering
23	402	2	Step rate monitor for treadmill	treadmill	Biomechanics, Bioinstrumentation	Orthopedics, Rehabilitation	Software, Electronics, Mechanics
24	402	4	Design of factor to optimize skin response to vibration	tactile_stimulator	Biomechanics, Bioinstrumentation	Rehabilitation	Electronics, Mechanics, Human factors
25	402	4	Microfluidic platform for culture and live cell imaging of cellular microarrays	microfluidic_platform	Biomaterials, Tissue Engineering	Medicine	Cell Biology, Biomaterials
26	402	3	BioMEMS photomask aligner	photomask_aligner	Biomechanics, Tissue Engineering	Miscellaneous	Mechanics, Imaging, Cell Biology
27	402	3	Silicone oil applicator for medical devices	oil_applicator	Biomechanics, Biomaterials	Anesthesiology	Mechanics, Biomaterials, product development engineering
28	402	3	A new vascular clamp for robotic partial nephrectomy	vascular_clamp	Biomechanics	Urology	Mechanics
29	402	3	Embouchure assistive device	embouchure_device	Biomechanics	Rehabilitation	Mechanics, Human Subjects
30	402	4	Self measuring orthopedic drill system	orthopedic_drill	Biomechanics, Bioinstrumentation	Orthopedic Surgery	Mechanics
31	402	3	Digital Braille watch	Braille_watch	Bioinstrumentation	Rehabilitation	Software, Electronics, Mechanics
32	402	5	Development of a biocidal surgical drain	drain_tube	Biomaterials, Tissue Engineering	Surgery	Animal Experiments, Cell Biology, Biomaterials
33	402	4	MRI-compatible step dynamometer	MRI_dynamometer	Biomechanics	Medical Imaging	Mechanical design, human subjects
34	402	5	Standing paraplegic operating room device	paraplegic_device	Biomechanics	Rehabilitation	Electronics, Mechanics, Human Subjects
35	402	4	Automated uretero-intestinal anastomosis with absorbable staples	absorbable_staples	Biomaterials, Biomechanics	Urology	Mechanics, materials
36	301	3	Surgical device that creates a capsulorhexis during cataract surgery	cataract_device	Biomechanics	Ophthalmology	Mechanics

BME? → SPECIFICATION → [OUR PROJECTS](#) → WHAT'S NEXT?

Design Projects



Cancer Cell Scaffold
(Tissue/Materials)



Intracranial Pressure Sensor
(Bioinstrumentation + Biomechanics)

Neuromodulation Stimulator
(Bioinstrumentation)



Medical App for iPhone
(Bioinstrumentation)

Quad Vital Monitor
(Bioinstrumentation)

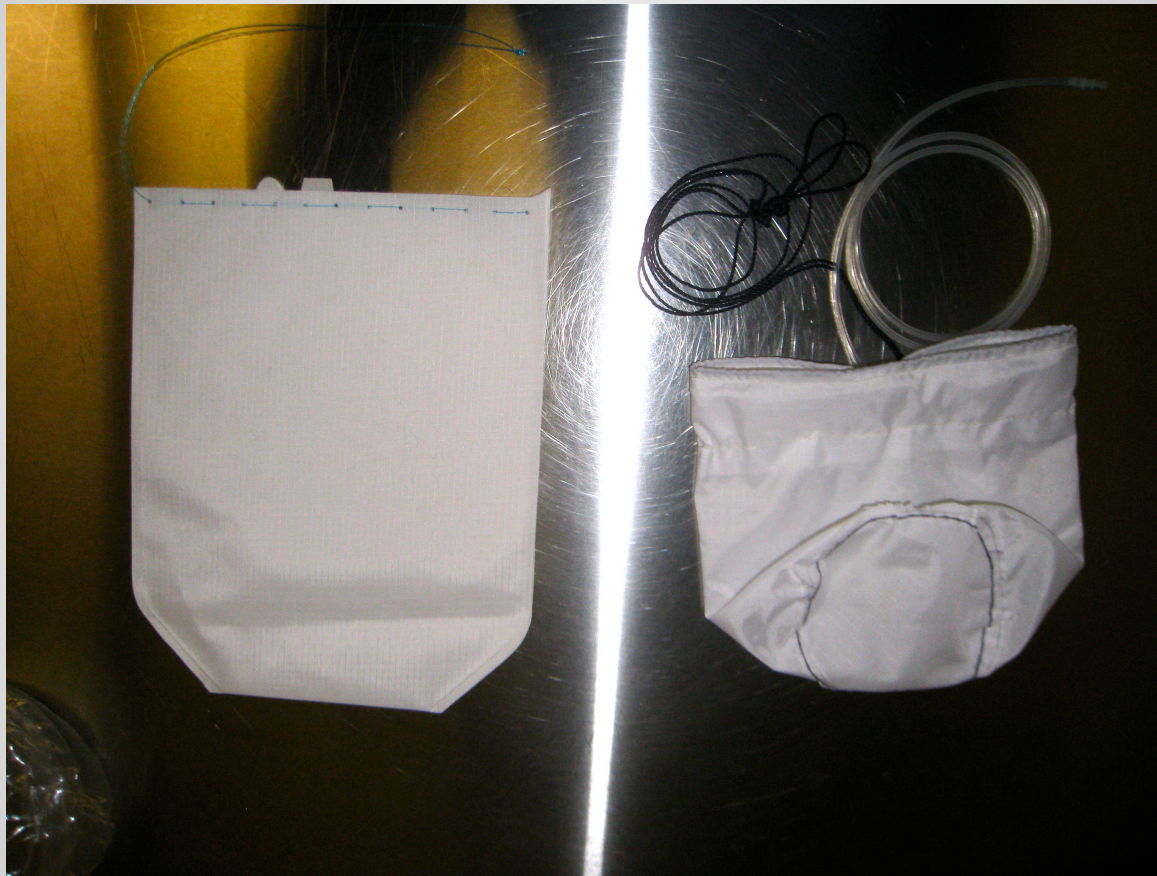


Drill-Stop Device
(Bioinstrumentation + Biomechanics)



Specimen Retrieval Bag
(Biomechanics + Tissue/Materials)

Design Projects



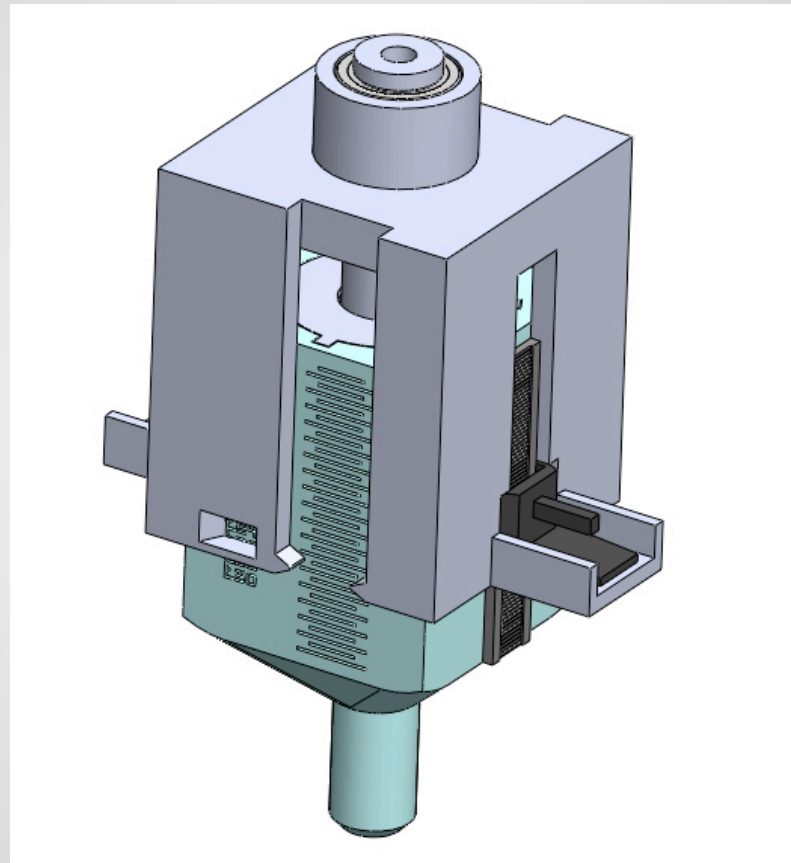
Specimen Retrieval Bag
(Biomechanics + Tissue/Materials)

Design Projects



Video: Specimen Retrieval Bag
(Biomechanics + Tissue/Materials)

Design Projects



Drill-Stop Device
(Bioinstrumentation + Biomechanics)

Design Projects



Video: Drill-Stop Device
(Bioinstrumentation + Biomechanics)

Outside Projects



Physiology Research
(Lab Work)



Stem Cell Research
(Lab Work)



iGEM
(Genetic Engineering
Int. Competition)



Internship/Co-ops
(Industry Experience)



**Developmental
Biology Research**
(Lab Work)



REU Programs
(Summer Lab Work)



Biomaterials Research
(Lab Work)

Outside Academics



Triathlons
(Seriously)



Planking
(Yes)



Intramural/Club sports
(Basketball, Football, Frisbee)



Greek Life
(Fun Fun Fun)



Study Abroad + Travel
(Take time off)



Social Lives
(You can ask)



Gaming
(FTW)

What's Next?

Continuing Education:



Graduate School
(Masters, PhD, Academia)



Medical School
(Doctor, Surgeon, MD-PhD)



Business/Law School
(Management, Patent Attorney)

Industry:



Entrepreneurial Pursuits
(Inventing, Start-up, Small BioTech)



Practicing BME
(Bioinstrumentations, Imaging, Biomechanics, Tissues/Materials)



Unrelated Fields
(Anything really)

How do I prepare?

Junior: Take as many APs as possible, I (Nicolet Grad.) strongly recommend: Chemistry, Physics, Biology, Stats, Calc BC, Programming, Economics

Senior:

- Pass your AP exams!
- Identify your interest

Freshman
in College:

- Join a research laboratory
- Join a club
- Apply to BME (one of few majors that requires)
 - Pre-req classes (basic Sci./Engr.)
 - GPA > 3.5 (most likely to be accepted)
 - Verbalize you interest (essay)

Great Resources

- BME department website:
<http://www.engr.wisc.edu/bme.html>
- Archive of past design projects:
<http://bmedesign.engr.wisc.edu/websites/archives.php>
- Application/requirements for BME:
<http://www.engr.wisc.edu/current/coe-egr-general-college-requirements.html>
<http://www.engr.wisc.edu/bme/bme-admissions.html>
- More on research opportunities:
<http://www.engr.wisc.edu/current/egr-undergraduate-research-opportunities.html>
- More detail on specialties (more that were not discussed):
<http://www.engr.wisc.edu/bme/bme-research-engineering-and-technology.html>



References

Pictures

- <http://www.nature.com/news/specials/2008/gallery/images/456858aa.jpg> (decellularized heart)
- http://www.intelligenttrainingsystems.com/gs_media/image/articles/davinci_264.jpg (biomech)
- <http://www.wired.co.uk/magazine/archive/2010/05/start/pixar-pioneered-3d-graphics-meet-radiology> (imaging)
- <http://www.flickr.com/photos/davidhobby/4946660026/> (bionic arm)
- <http://www.educationinturkey.net/wp-content/uploads/2011/05/Alabama-Medical-Schools.jpg> (med school)
- <http://www.thebestcolleges.org/wp-content/uploads/2011/06/law-school.jpg> (law)
- <http://www.schoonerchantal.com/Labwork.jpg> (phD)
- <http://stefano.burbui.com/jpg/business-startup1.jpg> (startup)
- http://media.philly.com/images/600*450/20110704_inq_hs1burn04-a.JPG (engineer)

Sources

- <http://www.engr.wisc.edu/bme.html>
- <http://www.engr.wisc.edu/bme/bme-research-engineering-and-technology.html>