

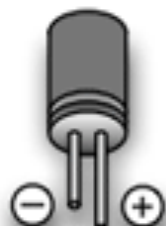
Embedded Systems

Cathode -
Anode +

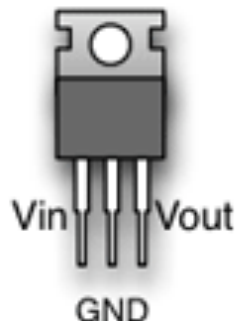
LED



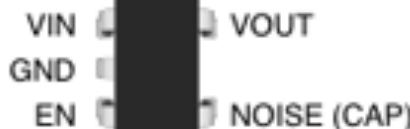
CAPACITOR



REGULATOR
(e.g. LM78xx)



Marked by
color or
dot



Resistor

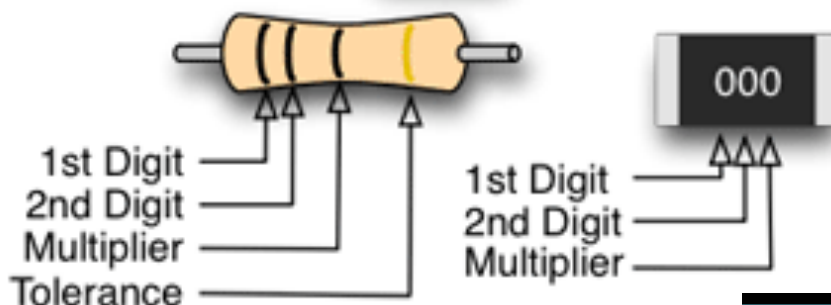
Digit Multiplier Tolerance

Silver	-	0.01	±10%
Gold	-	0.1	±5%
Black	0	1	-
Brown	1	10	±1%
Red	2	100	±2%
Orange	3	1k	-
Yellow	4	10k	-
Green	5	100k	±0.5%
Blue	6	1M	±0.25%
Violet	7	10M	±0.1%
Gray	8	-	-
White	9	-	-

DIODE



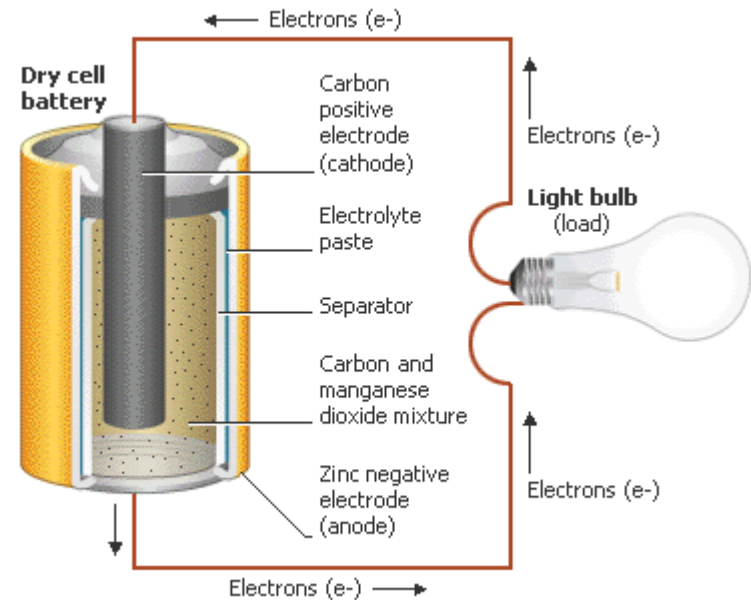
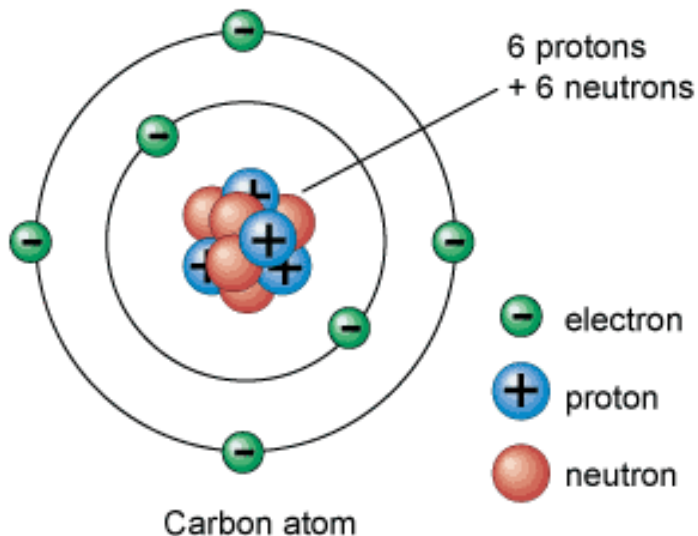
Nuts + Volts



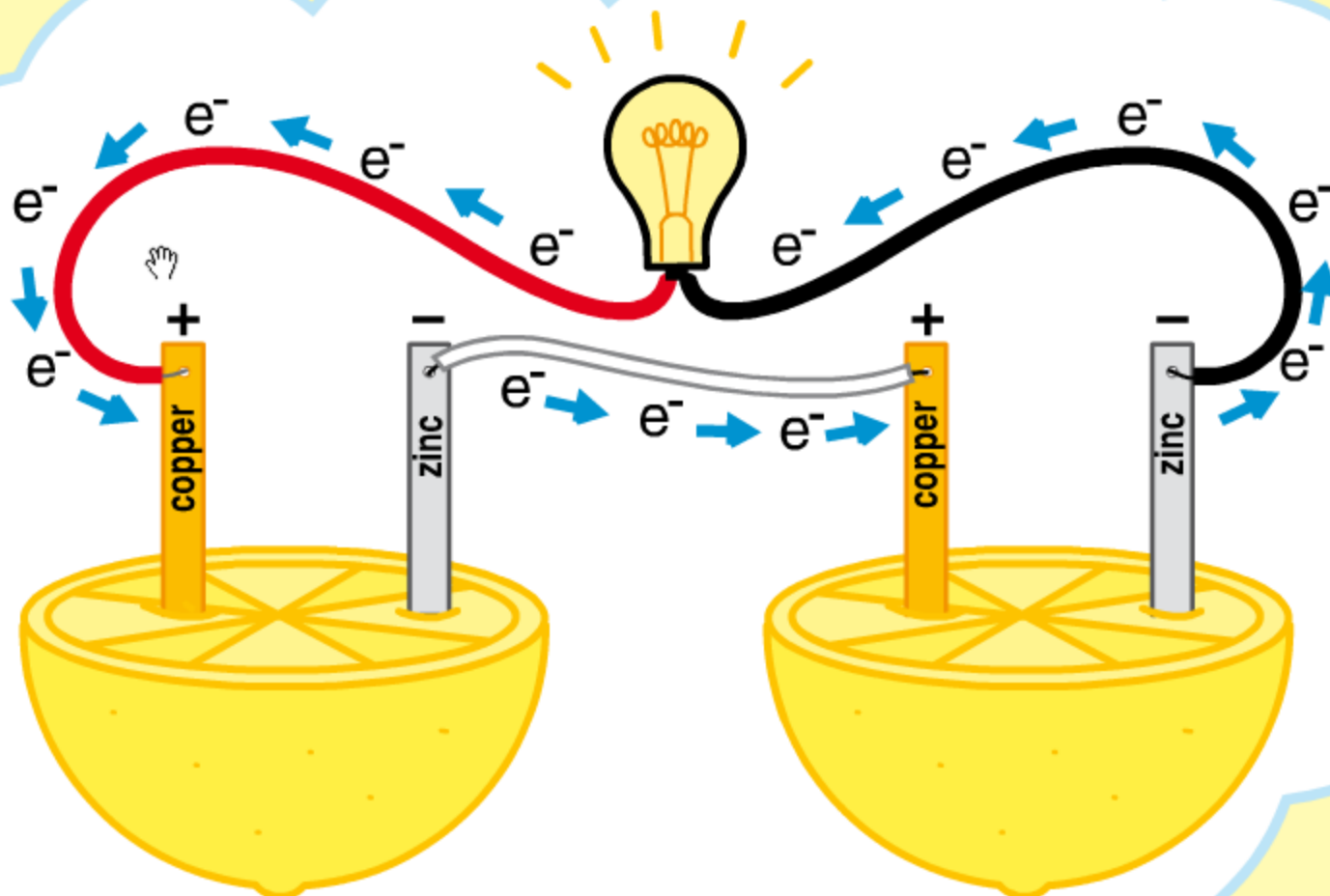
Theory, Components, Circuits

Electronics and Chemical Energy

An **Electron** is a stable subatomic particle with a charge of **negative** electricity, found in all atoms and acting as the primary carrier of electricity in solids.



Metals, or conductive materials, allow electrons to move from atom to atom

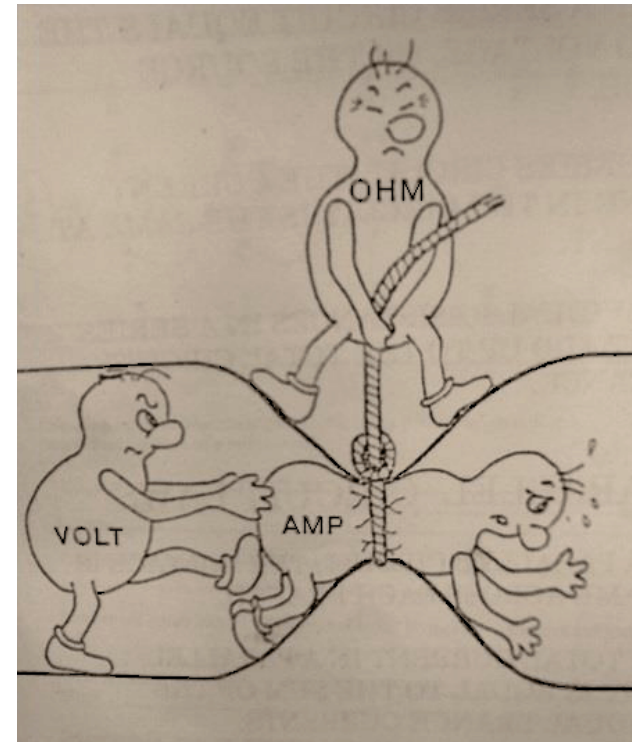
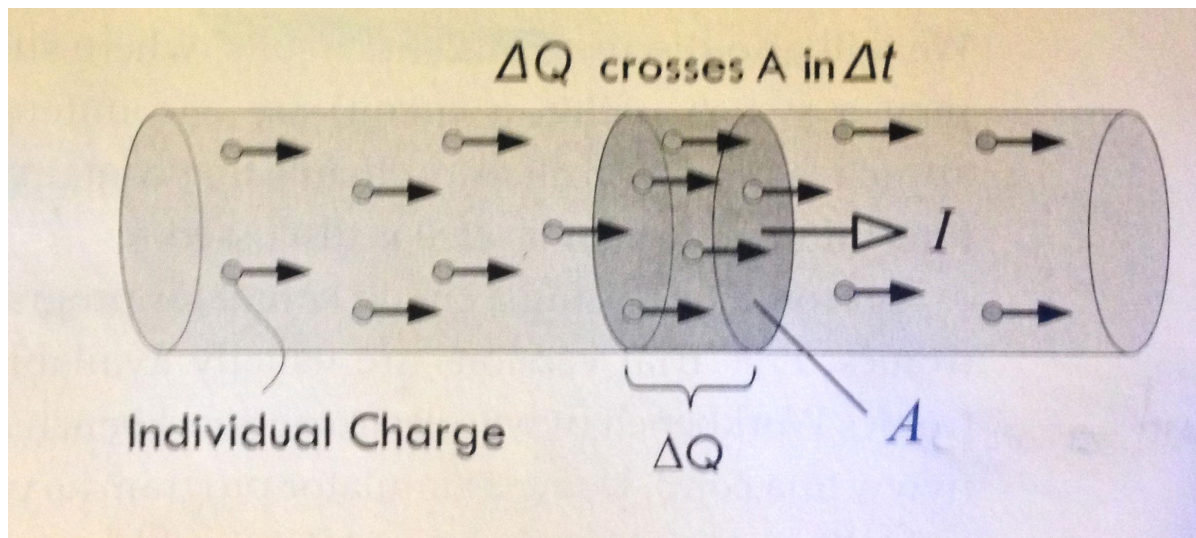


This age old experience works because the metals immersed in a aqueous solution or solvent, allowing them to flow.

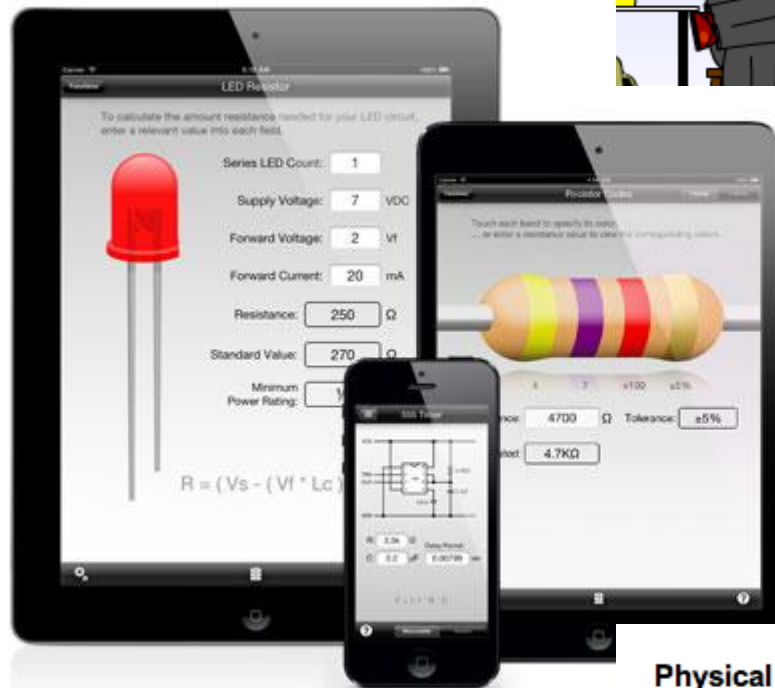


Electrical Current is the total charge that passes through some cross-sectional area per unit time.

- Voltage: measurement: **volt**
- Current: measurement: **amp**
- Resistance: measurement: **ohm**



A Few Resources



CIRCUIT
PLAYGROUND



Physical Computing

A collection of resources, examples, and lecture notes for the physical computing courses at ITP.

**Q: HOW IS THAT
RELEVANT TO ME?**

A:

A:

**Q: HOW IS THAT
RELEVANT TO ME?**

A: You are harnessing this energy for creative and productive purposes.

A:

Q: HOW IS THAT RELEVANT TO ME?

A: You are harnessing this energy for creative and productive purposes.

A: The innovation of how this energy is harnessed effects:

Q: HOW IS THAT RELEVANT TO ME?

A: You are harnessing this energy for creative and productive purposes.

A: The innovation of how this energy is harnessed effects:
Technological Progression

Q: HOW IS THAT RELEVANT TO ME?

A: You are harnessing this energy for creative and productive purposes.

A: The innovation of how this energy is harnessed effects:
Technological Progression
Emerging and Current Academic Fields

Q: HOW IS THAT RELEVANT TO ME?

A: You are harnessing this energy for creative and productive purposes.

A: The innovation of how this energy is harnessed effects:

Technological Progression

Emerging and Current Academic Fields

Job markets

Q: HOW IS THAT RELEVANT TO ME?

A: You are harnessing this energy for creative and productive purposes.

A: The innovation of how this energy is harnessed affects:

Technological Progression

Emerging and Current Academic Fields

Job markets

Interactions and Interfaces within contemporary society

COMPONENTS: I/O DEVICES

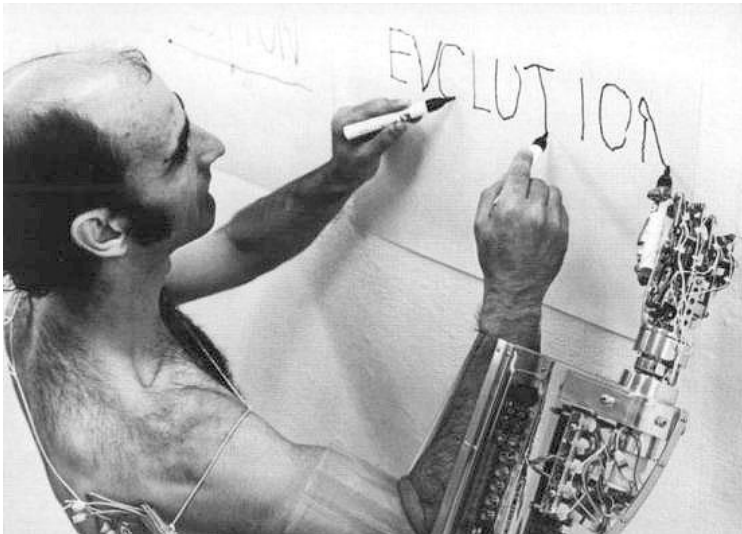
I/O = Input Output

a device that converts variations in a physical quantity, such as pressure or brightness, into an electrical signal, or vice versa

- LEDs
- LCD
- Speakers
- Buzzers
- Motors
- Solenoids
- Antennas

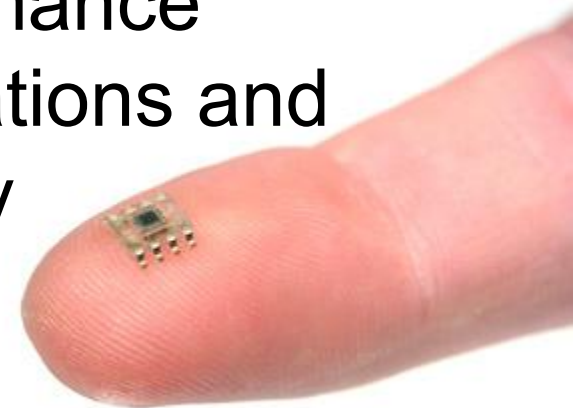
HOW ELECTRICAL ENERGY IS HARNESSSED

- Components
- Input/Output Devices
- Integrated Logic Circuits



HOW THIS AFFECTS INNOVATION

- Miniaturization
- New materials
- Lower Cost
- Democratized Innovation
- Enhanced performance
- Regulations and Privacy



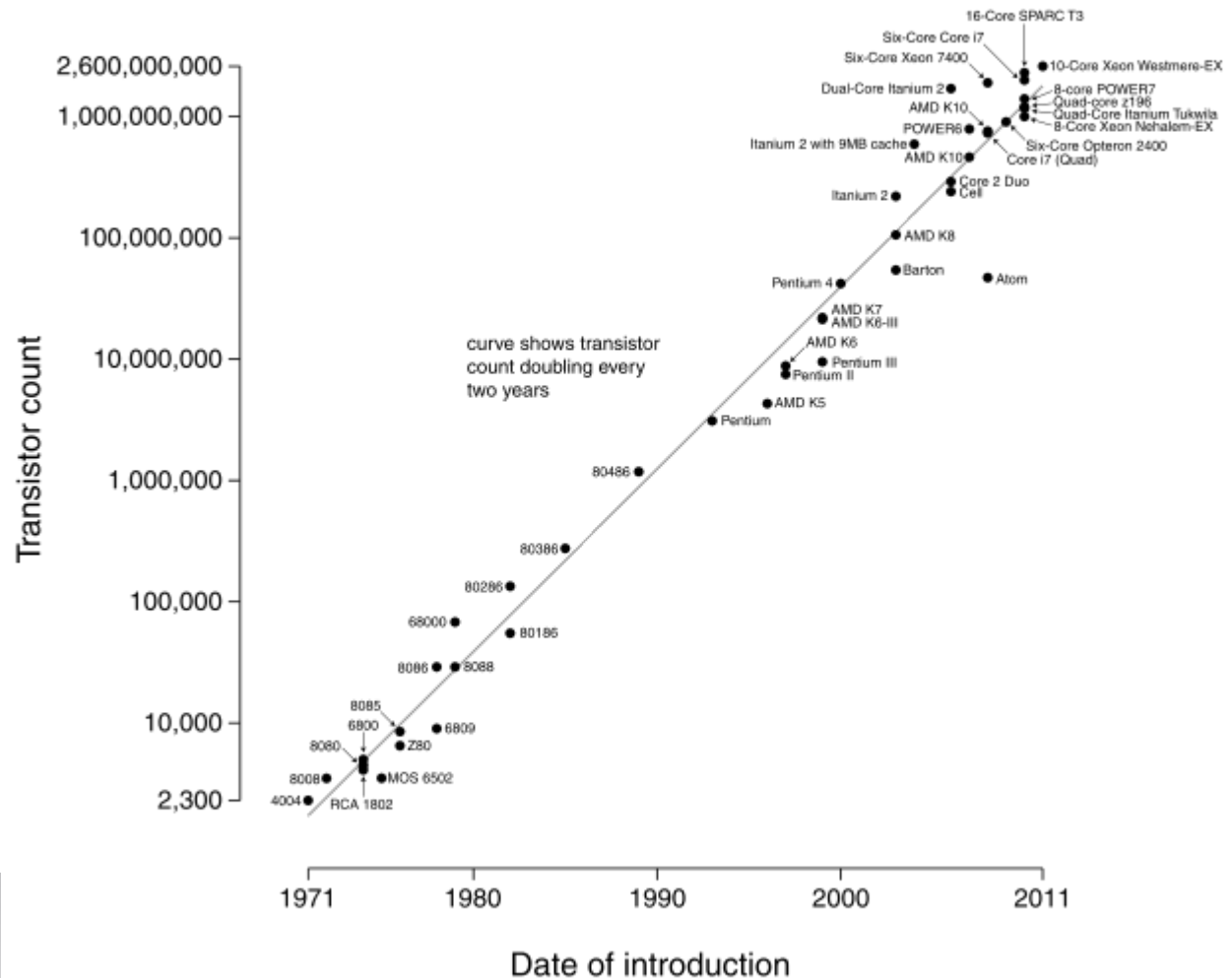
Landscape

Moore's Law, The Singularity

Moore's law is the observation that, over the history of computing hardware, the number of transistors on integrated circuits doubles approximately every two years.



Microprocessor Transistor Counts 1971-2011 & Moore's Law



Ray Kurzweil and The Singularity



[Ray Kurzweil TED Talk - Singularity University](#)

1 The accelerating pace of change ...



2 ... and exponential growth in computing power ...

Computer technology, shown here climbing dramatically by powers of 10, is now progressing more each hour than it did in its entire first 90 years

COMPUTER RANKINGS

By calculations per second per \$1,000

Analytical engine
Never fully built, Charles Babbage's invention was designed to solve computational and logical problems



Colossus
The electronic computer, with 1,500 vacuum tubes, helped the British crack German codes during WW II



UNIVAC I
The first commercially marketed computer, used to tabulate the U.S. Census, occupied 943 cu. ft.



Apple II
At a price of \$1,298, the compact machine was one of the first massively popular personal computers

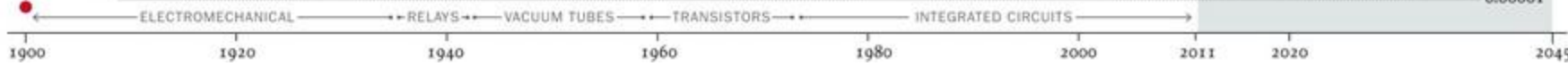
3 ... will lead to the Singularity

2045
Surpasses brainpower equivalent to that of all human brains combined

Surpasses brainpower of human in 2023



Surpasses brainpower of mouse in 2015



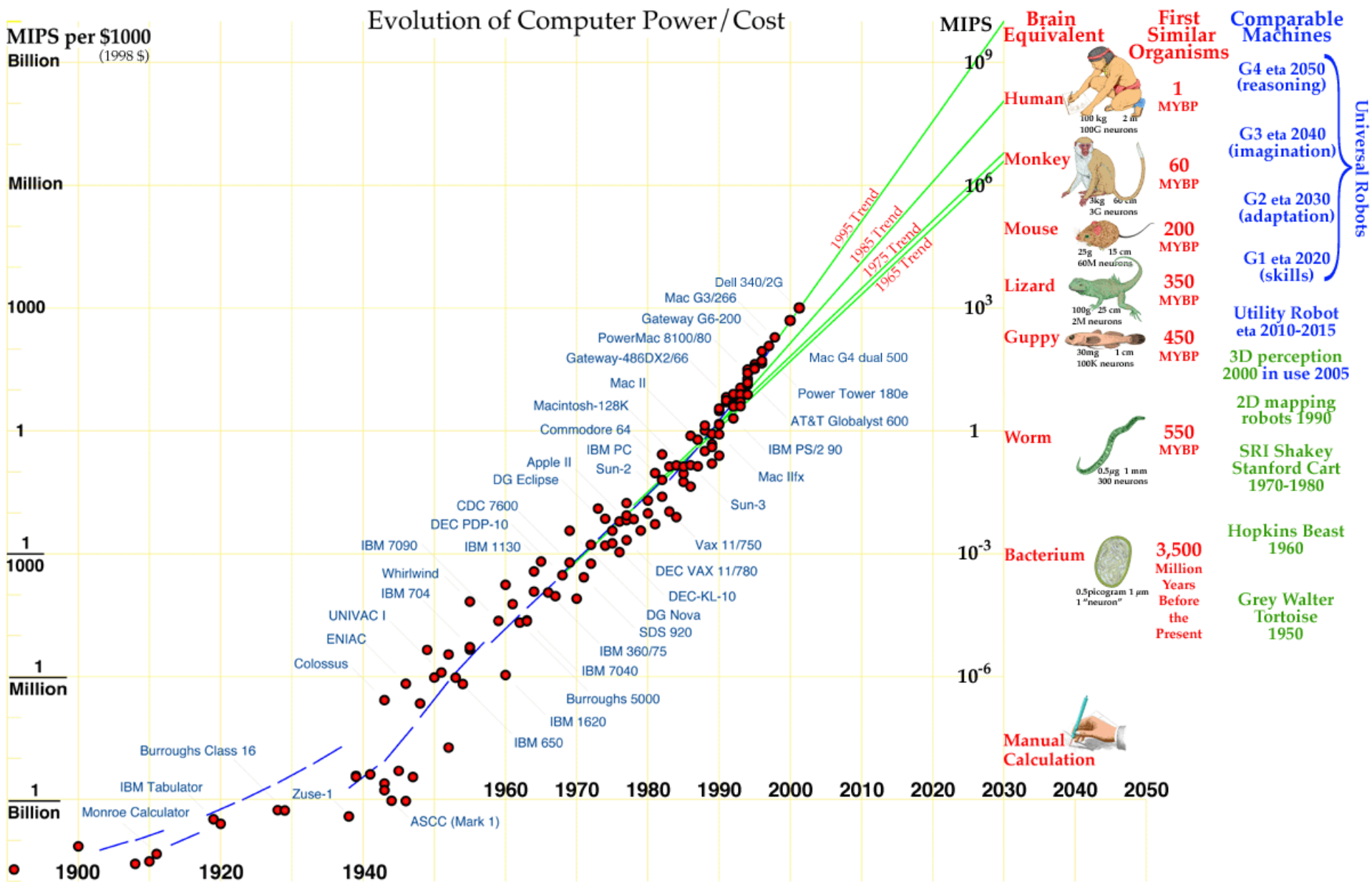


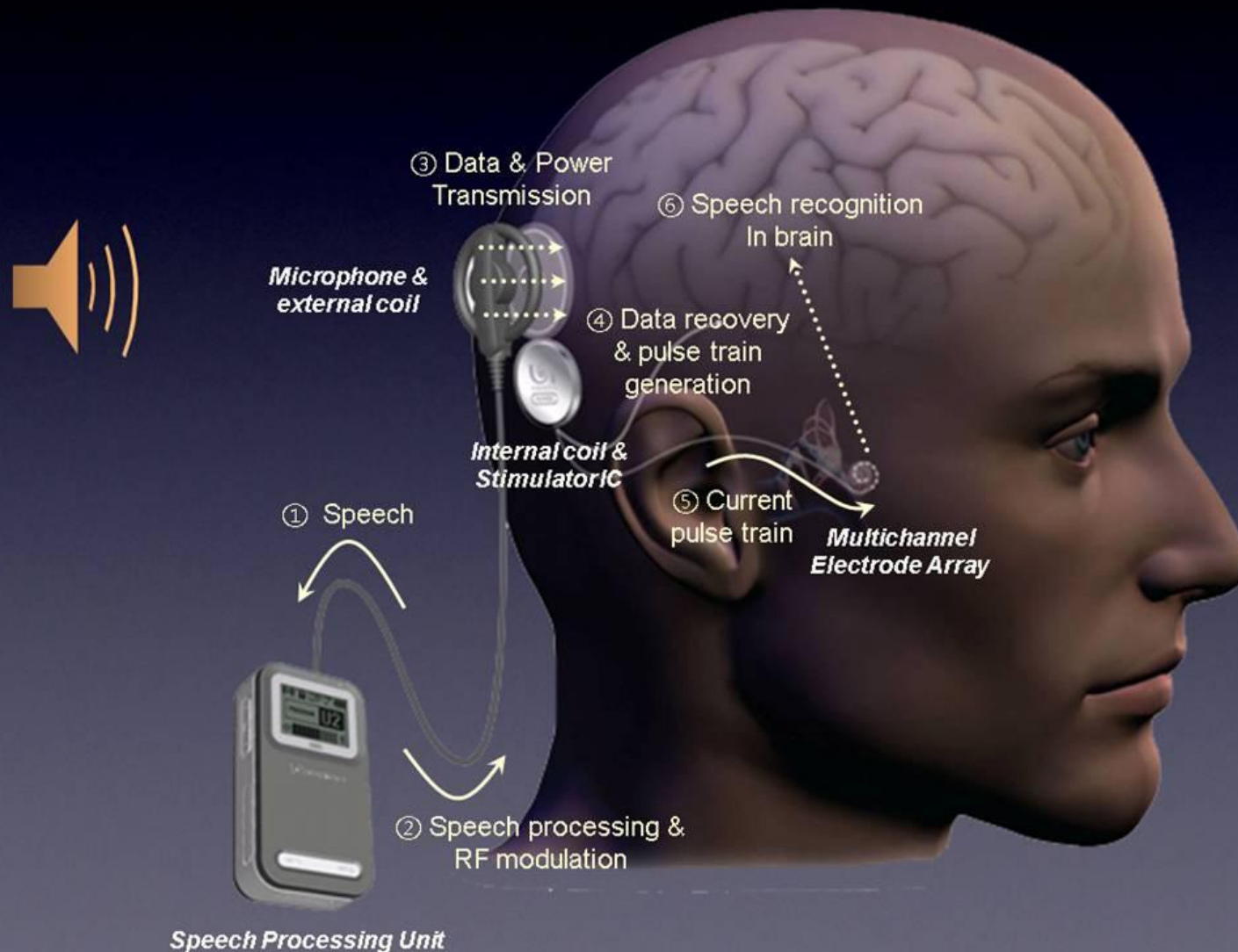
Image Source: [Singularity Point: Heaven or Hell](#)



MEDICINE

Implants, Brain Imaging, Biopolitics

IMPLANTS and NANOTECHNOLOGY



Articles

- [Aimee Mullins: My 12 pairs of legs](#)
- [Teen's inexpensive 3D-printed prosthetic could aid amputees in the third world](#)
- [How 3D Printing Gave This Man His Life \(and Face\) Back](#)

SCIENCE

Machines, Biomimicry, Research

NASA Mars mission

The Curiosity rover is designed to travel Mars studying climate and geology. The rover is looking for signs of carbon, the building blocks of life. Some of the rover's features:

Robotic arm

Used to examine and manipulate soil and rocks. It also has two scientific instruments, one uses X-rays to determine materials' composition and the other is a magnifying camera

Laser

Burns small holes in rocks and soil up to 23 feet away and identifies chemical elements

Color cameras

Stereo mastcams on either side of the rover's mast take color pictures and movies in 3-D

UHF antenna

Primary transmission antenna

Plutonium power source

A nuclear battery that converts heat into electricity

Neutron detector

Detects water in rocks and soil

Photo courtesy of NASA

Weather station

Records wind speed/direction, air pressure, humidity, temperature and UV radiation

Radiation detector

Measures radiation from the sun, supernovae and other sources

Inside:

Chemistry lab

Analyzes rock and soil samples for organics

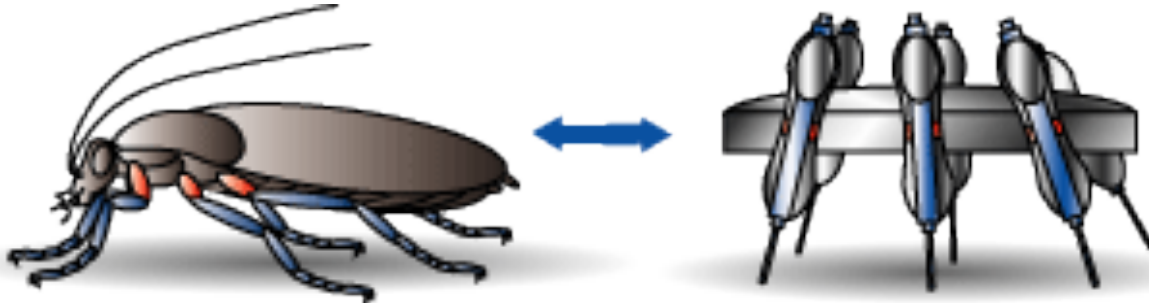
Mineral detector

Shines an X-ray beam at a rock or soil sample to identify types of minerals

SOURCE: NASA

AP

Biomimicry / Biomimetics



Robert Full: Robots inspired by cockroach ingenuity

FILMED FEB 2002 • POSTED JUN 2008 • TED2002

A poster for a TED Talk titled "Taming Complexity" by Robert Full. The poster features the Caltech logo in the top left and the TED logo in the top right. The main title "Taming Complexity" is in a large, bold, serif font. Below it, the subtitle "Appear Hopelessly Complex No Detailed History of Design Plans" is in a smaller, bold, serif font. The poster is divided into three columns, each with a title and an image. The first column is titled "84 Joint Motions" and shows a black and white photograph of a cockroach. The second column is titled "230 Muscles" and shows a yellow and orange illustration of a cockroach's leg. The third column is titled "100,000,000 Neurons" and shows a purple and pink illustration of a cockroach's brain. At the bottom left, it says "TED 11" and at the bottom right, it says "2002".

Research

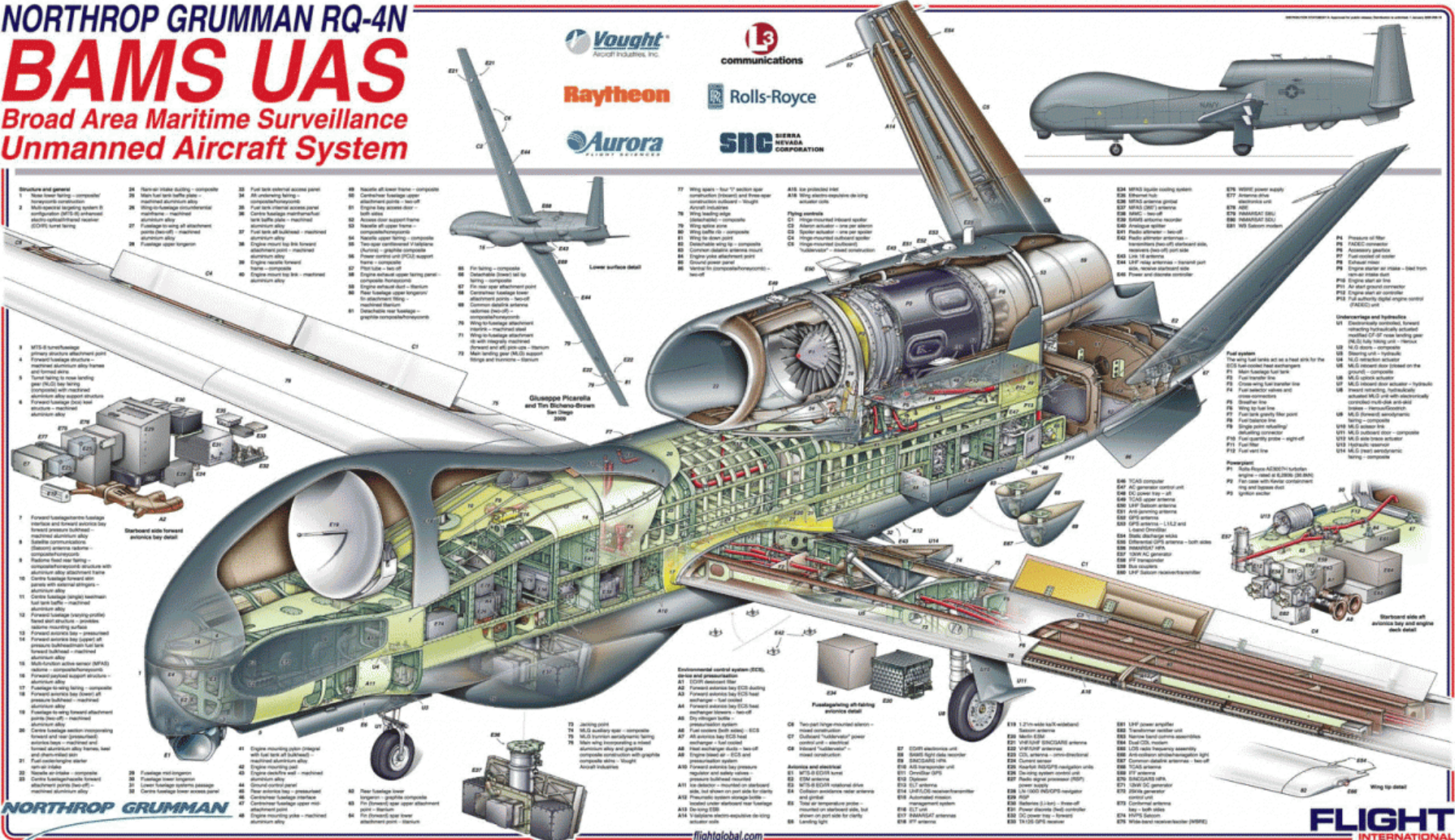
- [BIOMIMICRY/BIMIMETICS:
GENERAL PRINCIPLES AND
PRACTICAL EXAMPLES](#)



NORTHROP GRUMMAN RQ-4N

BAMS UAS

Broad Area Maritime Surveillance Unmanned Aircraft System



MILITARY

IDE, UAV, Modern Warfare

Image Source: [DIY Drones: The Leading Community for Personal UAVs](#)

Modern Warfare

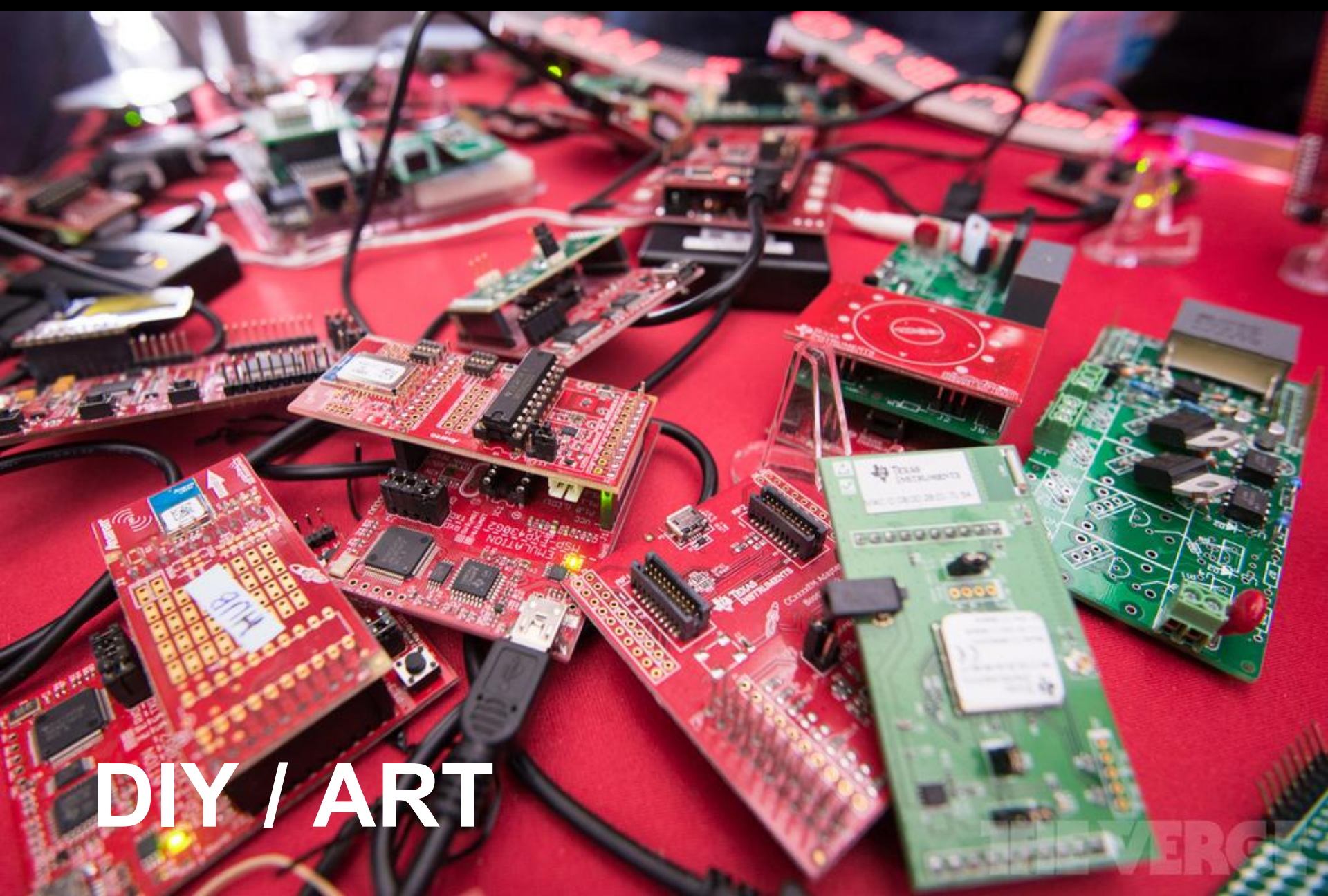
- [How Unmanned Drones are Changing Modern Warfare](#)
- [CIA: Drones Document Count Would Damage National Security](#)
- [Drones: A New Chapter in Modern Warfare](#)

Gaming, Mobile

Gaming, Mobile







DIY / ART

3D Printing, Maker Faire, Democratized Innovation

3D-PRINTING



[Robohand](#) is focused on developing open-source designs for mechanical finger prosthetics. Thanks to Makerbot generously providing two Replicator 2's to the project, we are now exploring the ways in which 3D printing can be applied to our efforts

DEMOCRATIZED INNOVATION



Click for list
of makers



Class Sequence

EMBEDDED SYSTEMS

Nuts and Volts

- electricity
- components

Science

- machines
- biomimicry
- haptics?

Medicine

- implants
- biopolitics

Military

- IDE
- UAV
- NextFest: smart fabrics
- modern warfare

Consumer (game, mobile)

- iPhone 5s/c fingerprint
- Kinect
- gesture tv

DIY / ART

- 3D printers
- production
- Maker Faire
- Art
- computational fashion