UNIVERSITY OF HARTFORD

Science Fiction to Science Fact

A look at the Past, Present, and Future of Prosthetic Devices

Matthew Parente, MS, PT, CPO, FAAOP

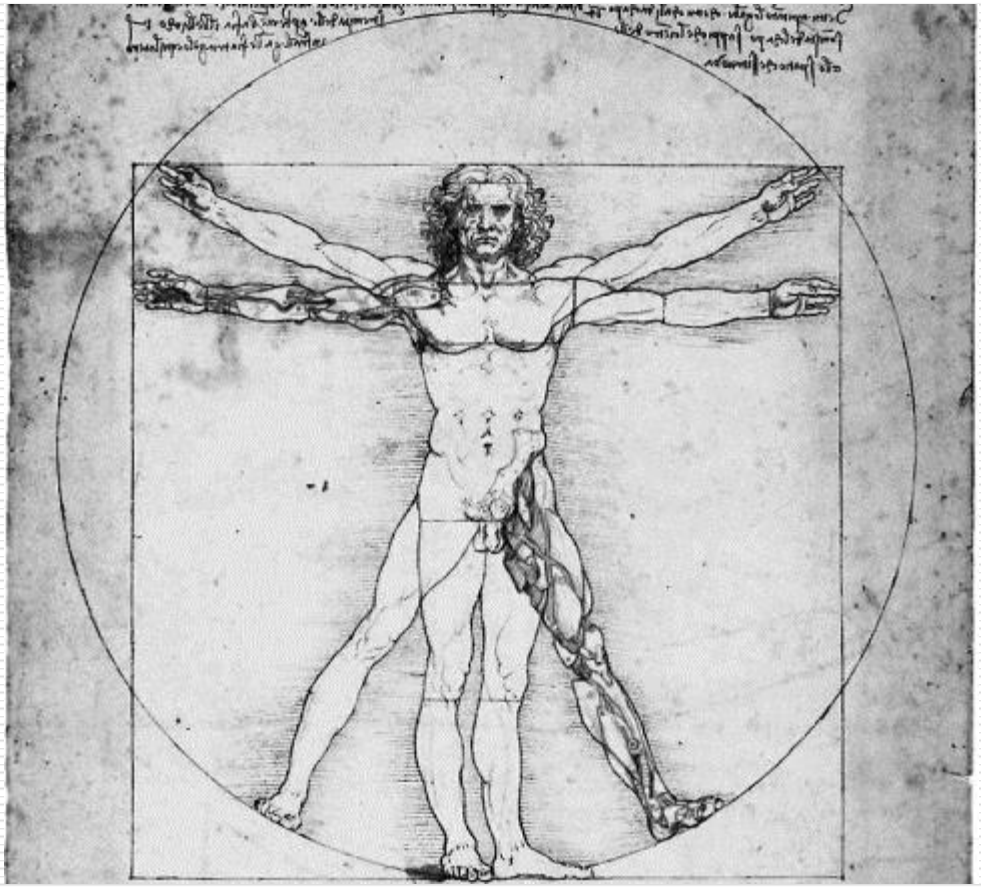
What is this all about?

Prosthesis

Orthosis

Do they have the anatomy?

Where Art Meets Science



https://charidimosart.wordpress.com/page/12/

What do we need to know?

- Knowledge of:
  - Anatomy
  - Biomechanics
  - Material Science
  - Physiology
  - Psychology
  - Computer science
  - Physics
  - Tissue mechanics
  - Rehabilitation science
  - Research
  - Engineering & Design
  - Marketing
  - Statistics

How do we do it?

Situational

Patient

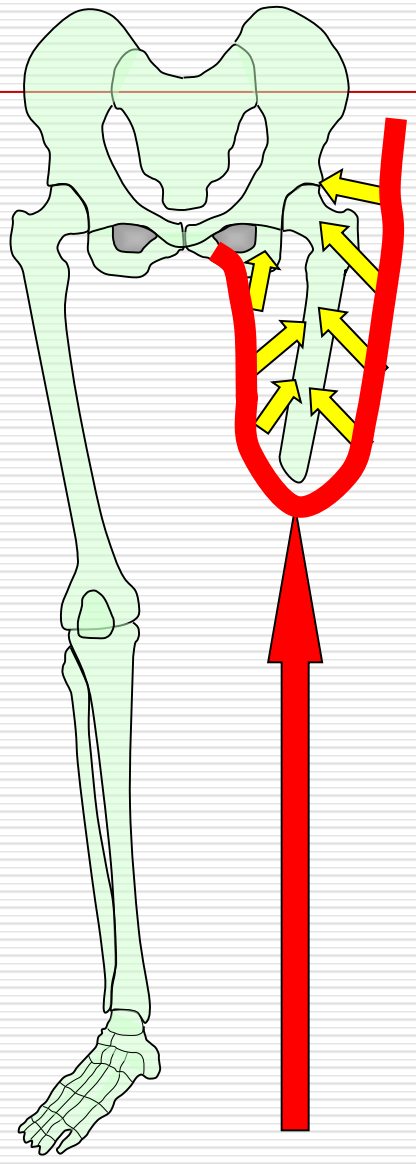
Specific

Problem

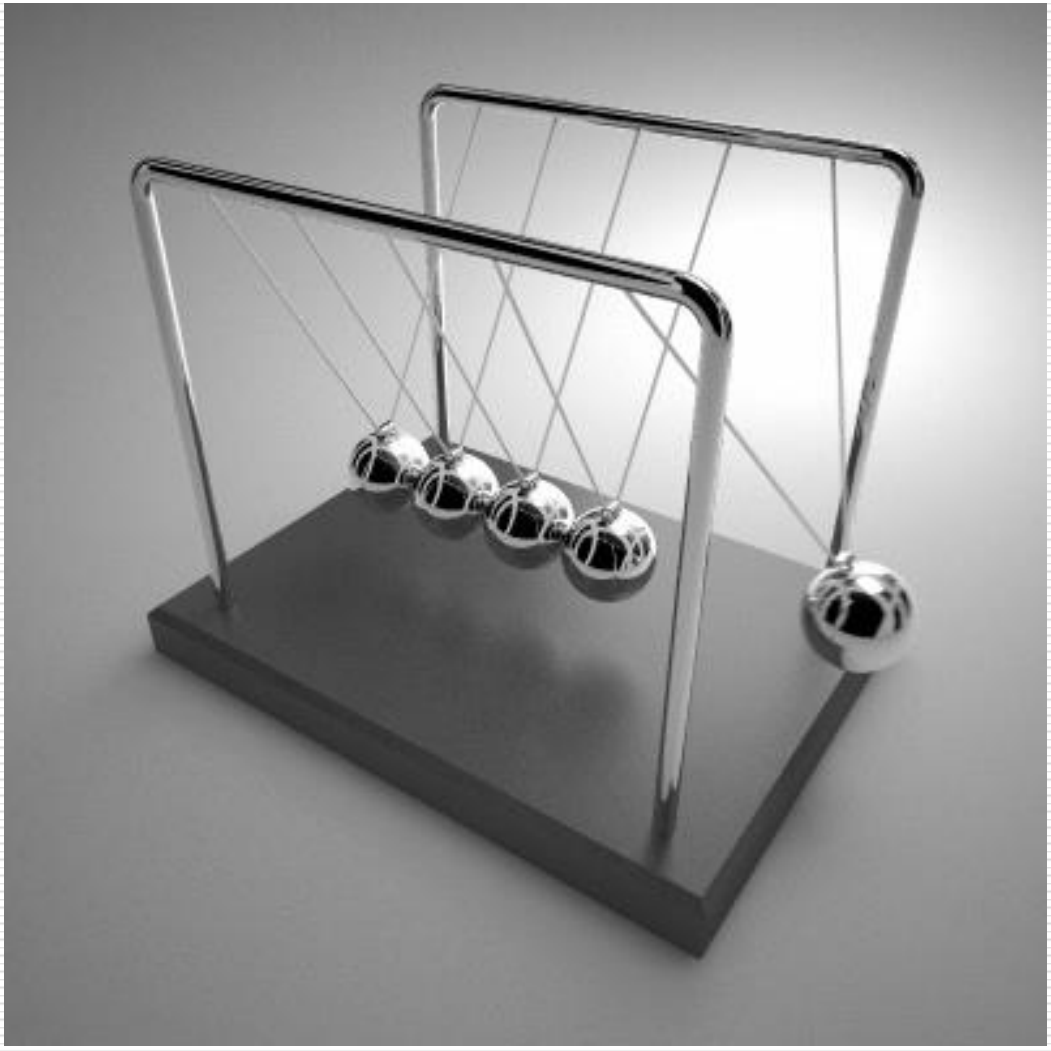
Solving

Prosthetic Goals

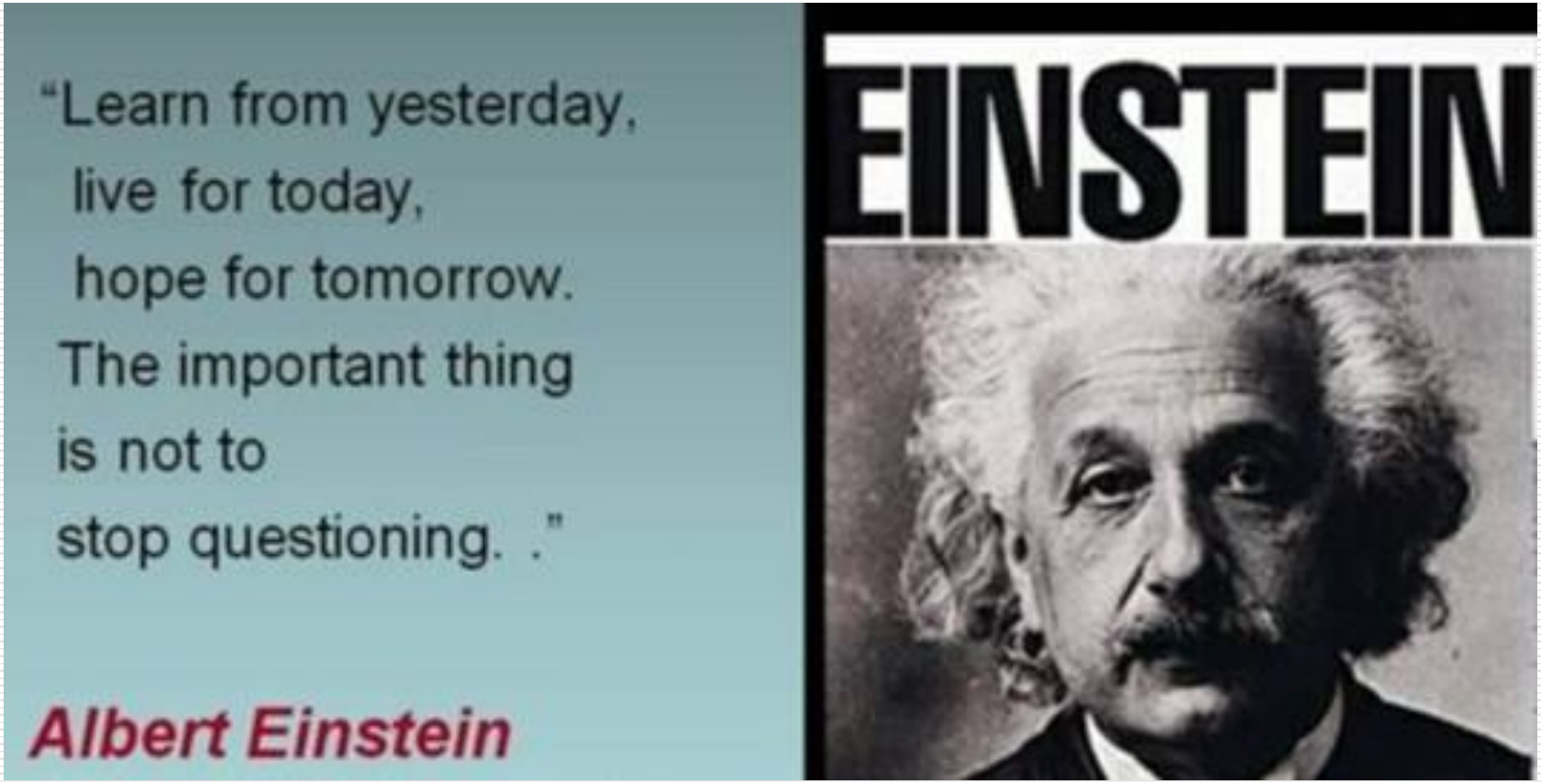
- Replace structural support of skeletal system
- Transfer forces through the residual soft tissue to the femur
- Stabilize the bony anatomy in a natural position for posture and force production
- Restore function

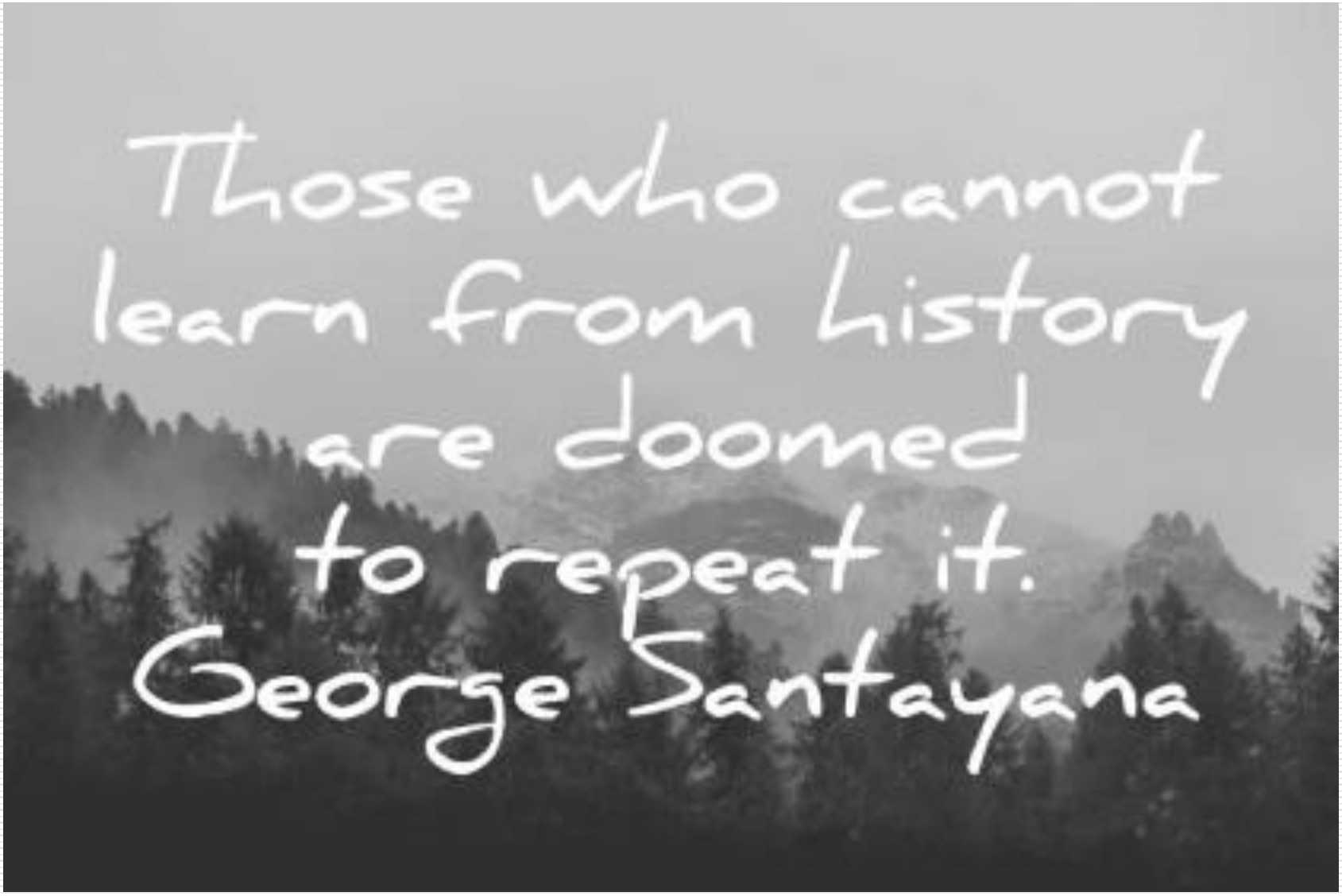


Newton’s Cradle



Inspiration




Those who cannot
learn from history
are doomed
to repeat it.
George Santayana

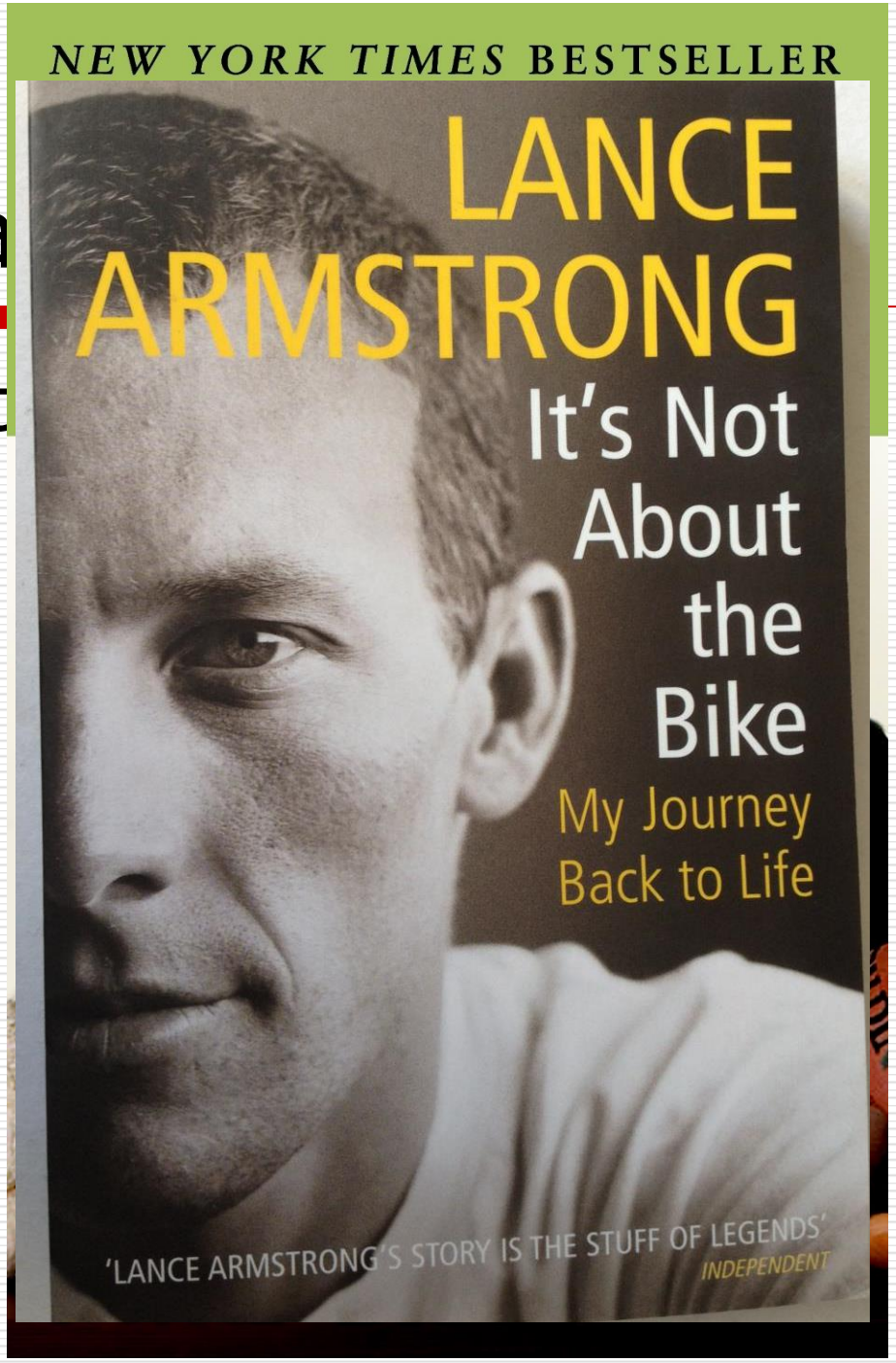
THERE IS NO INSTANCE OF A NATION BENEFITTING FROM PROLONGED WARFARE.

Sun Tzu


"IN THE MIDST OF
CHAOS,
THERE IS ALSO
OPPORTUNITY."
- SUN TZU
Inspirationfeed.com

Inspira

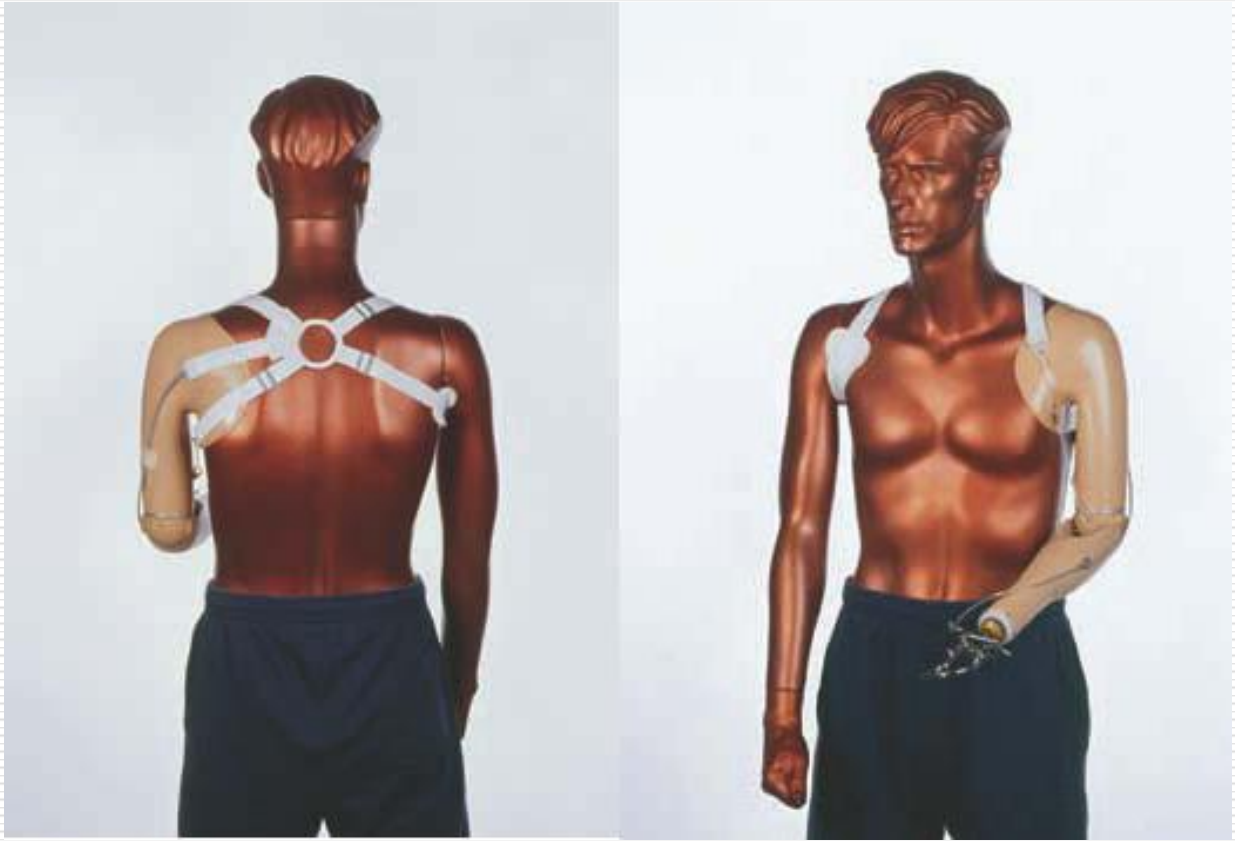
- Look t




112
254
447


USA
200

Back to the bike…



http://professionals.ottobock-export.com/cps/rde/xchg/ottobock_export_en/hs.xsl/232.html

Back to the bike…

ARTIFICIAL LEGS

WE ARE INCORPORATING, IN THE SECOND EDITION OF OUR SURGICAL INSTRUMENT CATALOGUE, ARTIFICIAL LEGS

This line was omitted from the first edition for the reason we had not at that time determined what was the best practical leg made. We are now furnishing the medical profession the MOST DURABLE, UP TO DATE ARTIFICIAL LEG.

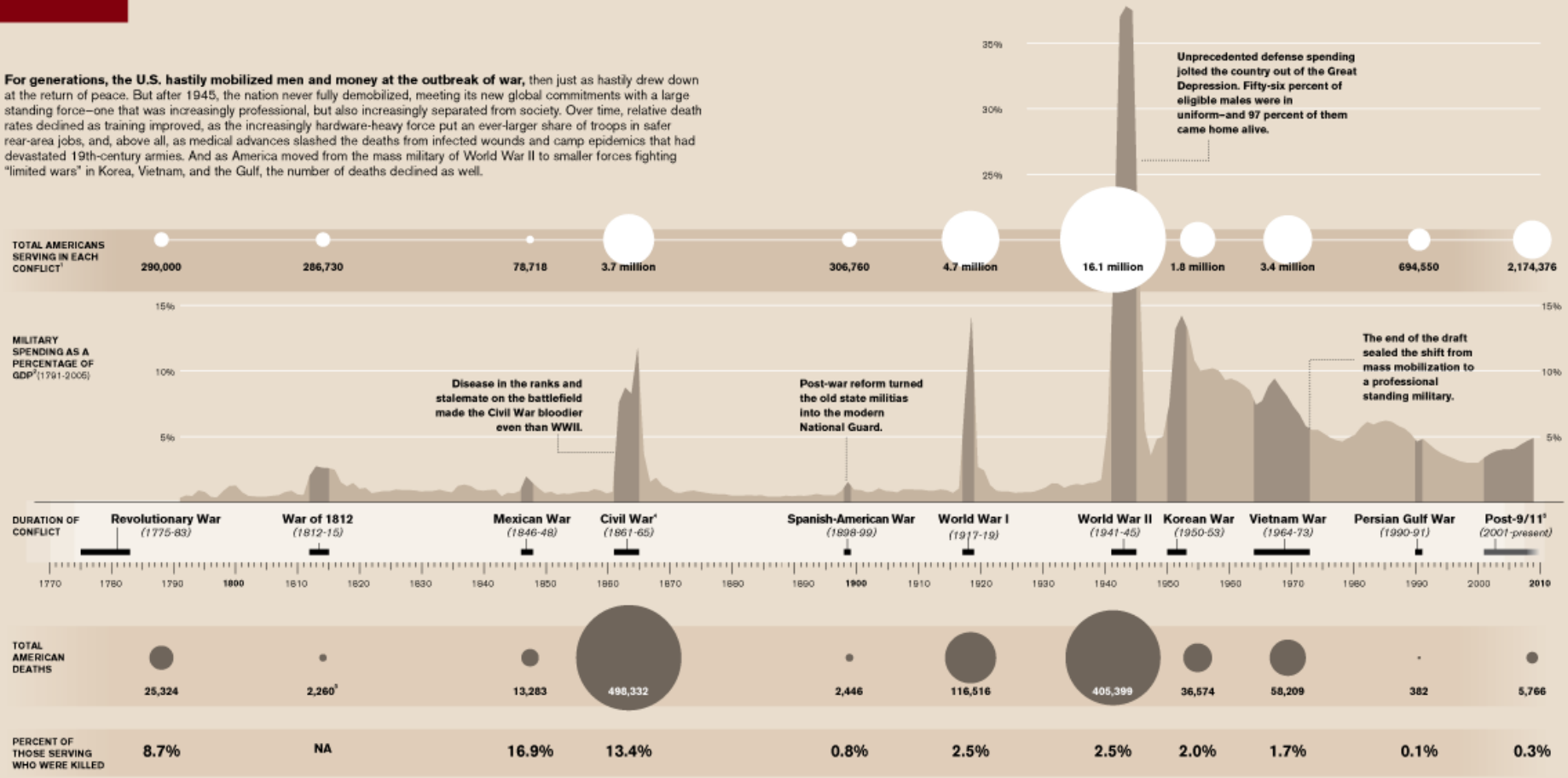
OUR LEGS EMBODY THE LATEST AND MOST RELIABLE IMPROVEMENTS

Cover Story

BY THE NUMBERS

235 Years of War

For generations, the U.S. hastily mobilized men and money at the outbreak of war, then just as hastily drew down at the return of peace. But after 1945, the nation never fully demobilized, meeting its new global commitments with a large standing force—one that was increasingly professional, but also increasingly separated from society. Over time, relative death rates declined as training improved, as the increasingly hardware-heavy force put an ever-larger share of troops in safer rear-area jobs, and, above all, as medical advances slashed the deaths from infected wounds and camp epidemics that had devastated 19th-century armies. And as America moved from the mass military of World War II to smaller forces fighting "limited wars" in Korea, Vietnam, and the Gulf, the number of deaths declined as well.



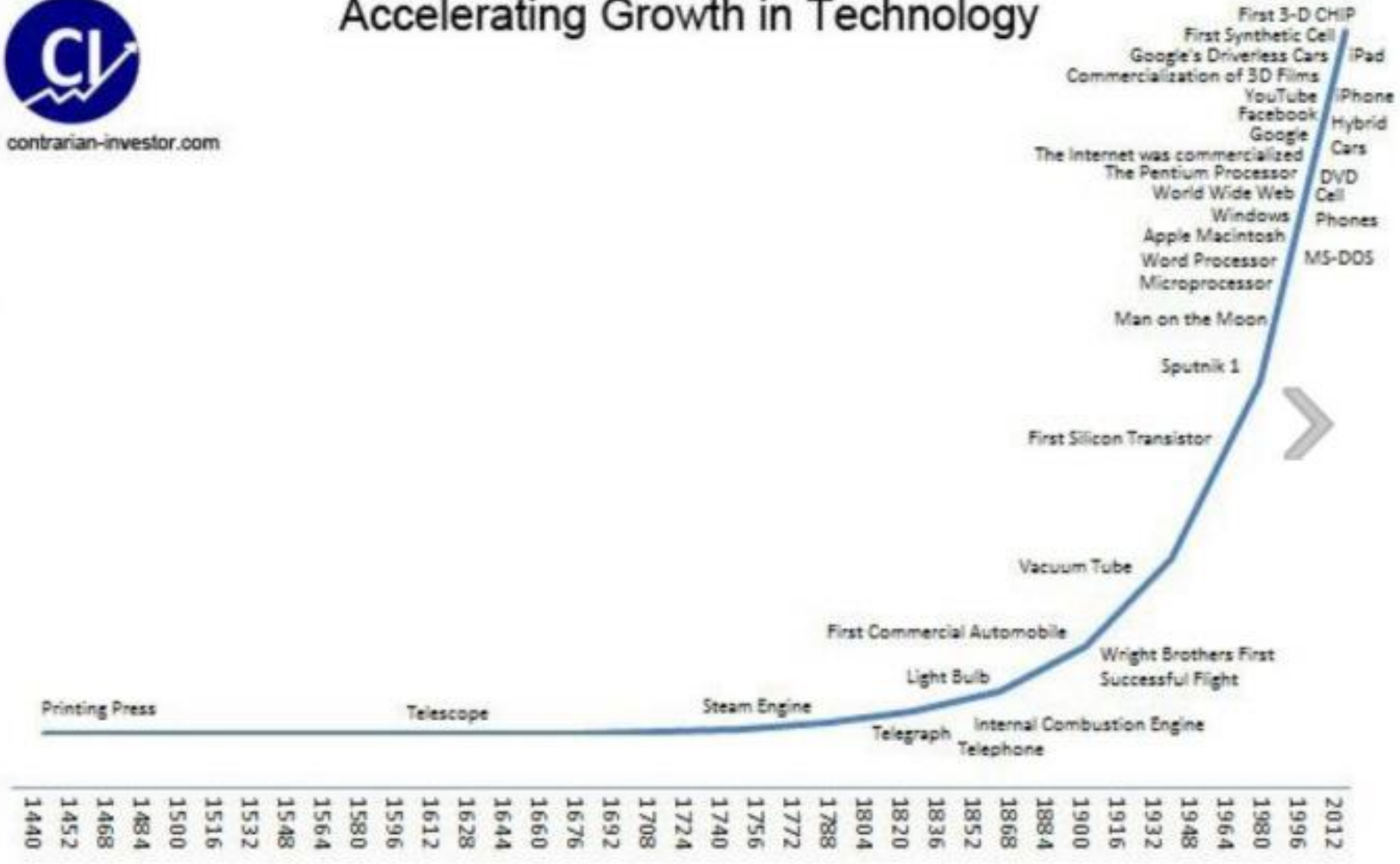
NOTES: [1] Revolutionary War and Civil War personnel figures are estimates. Post-1945 figures include only personnel serving in-theater, not all personnel serving worldwide during the conflict. [2] Defense spending based on Treasury Department figures for War Department and Navy Department outlays for 1789-1939 and on Defense Department figures for total national defense outlays (including Energy Department and other non-DOD spending) for 1940-2010. [3] Noncombat deaths from the War of 1812 (disease, accidents, etc.) are not available. [4] Civil War data for "total serving" and "total deaths" include both Union and estimated Confederate figures; spending data is Union only, because of difficulties in adjusting for hyperinflation of Confederate currency and loss of records. [5] Post-9/11 deaths as of November 2010; post-9/11 total serving as of August 2010.

SOURCES: Department of Defense; Oxford Companion to American Military History; Economic History Services (www.eh.net); Historical Statistics of the United States (Cambridge University Press).

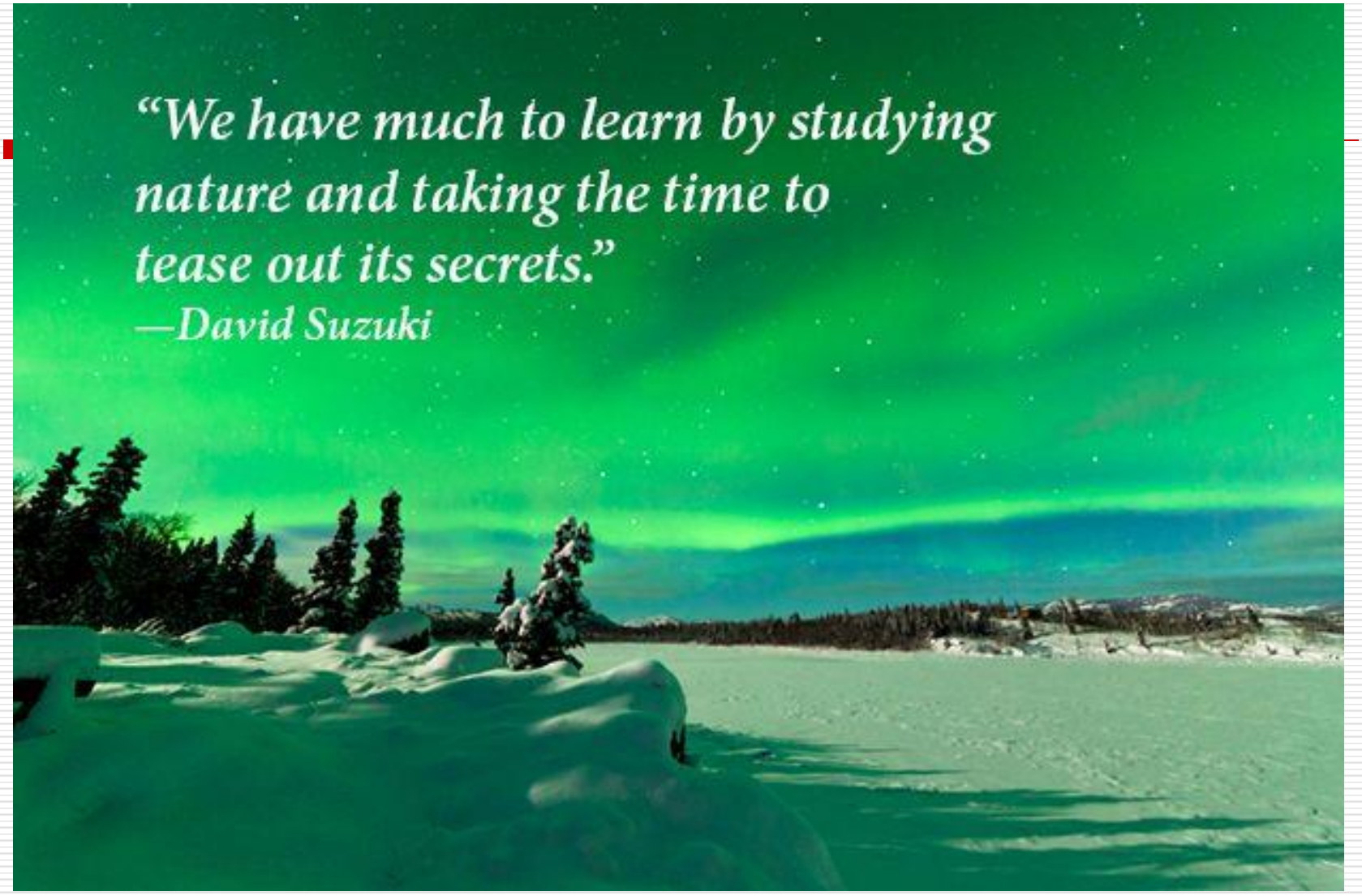
Graphic by SYDNEY J. FREEDBERG JR. and RYAN MORRIS

contrarian-investor.com

Accelerating Growth in Technology



From: seekingalpha.com/article/453871-the-promise-of-accelerating-growth-in-technology

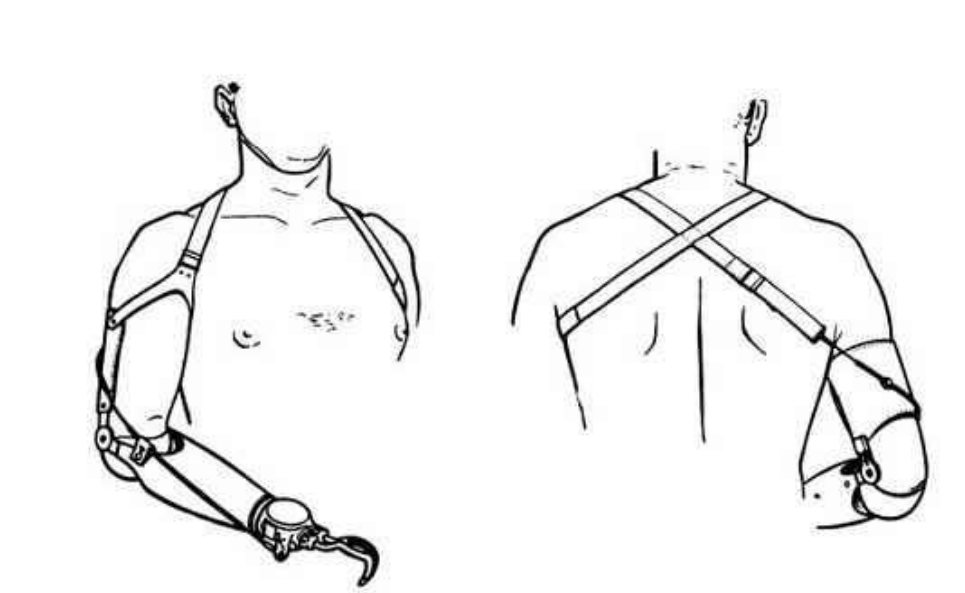

"We have much to learn by studying nature and taking the time to tease out its secrets."
—David Suzuki

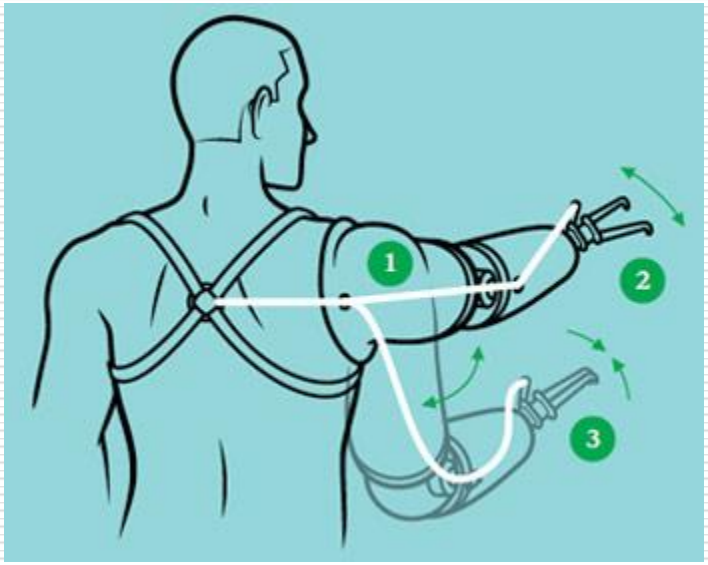
Wood & Leather

Early 1900's Mechanical Hand

WWI German Prosthetic Arm

Body-Powered Prosthesis

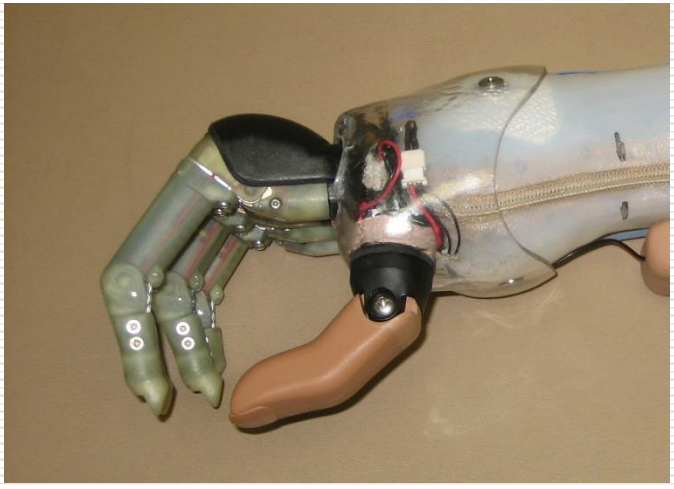


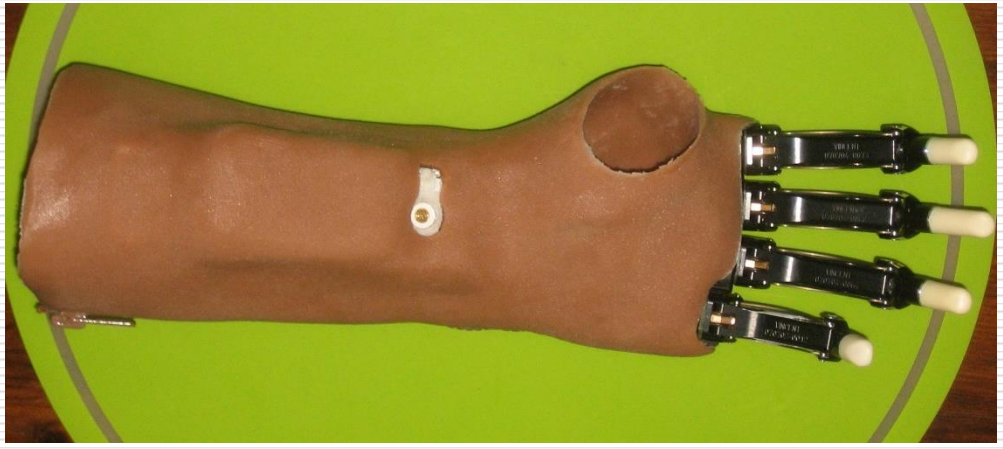


CAD (Insignia)

CAM

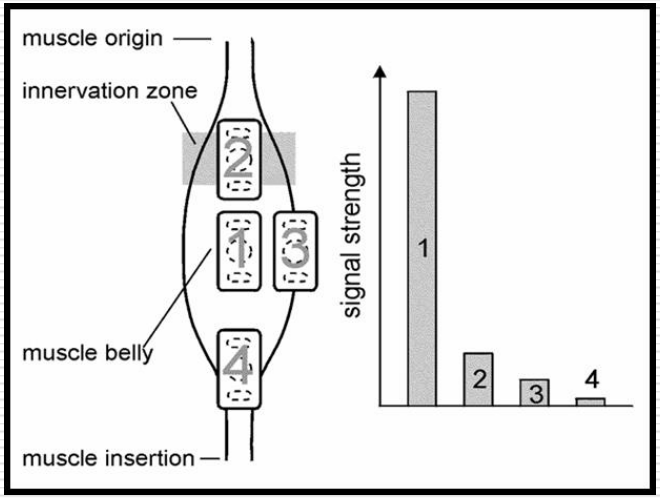
Carbon, Silicone, & Composites



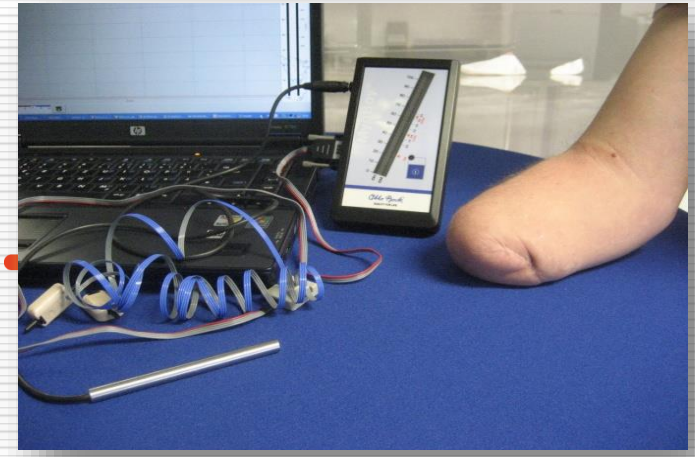


Traditional Myoelectric Control

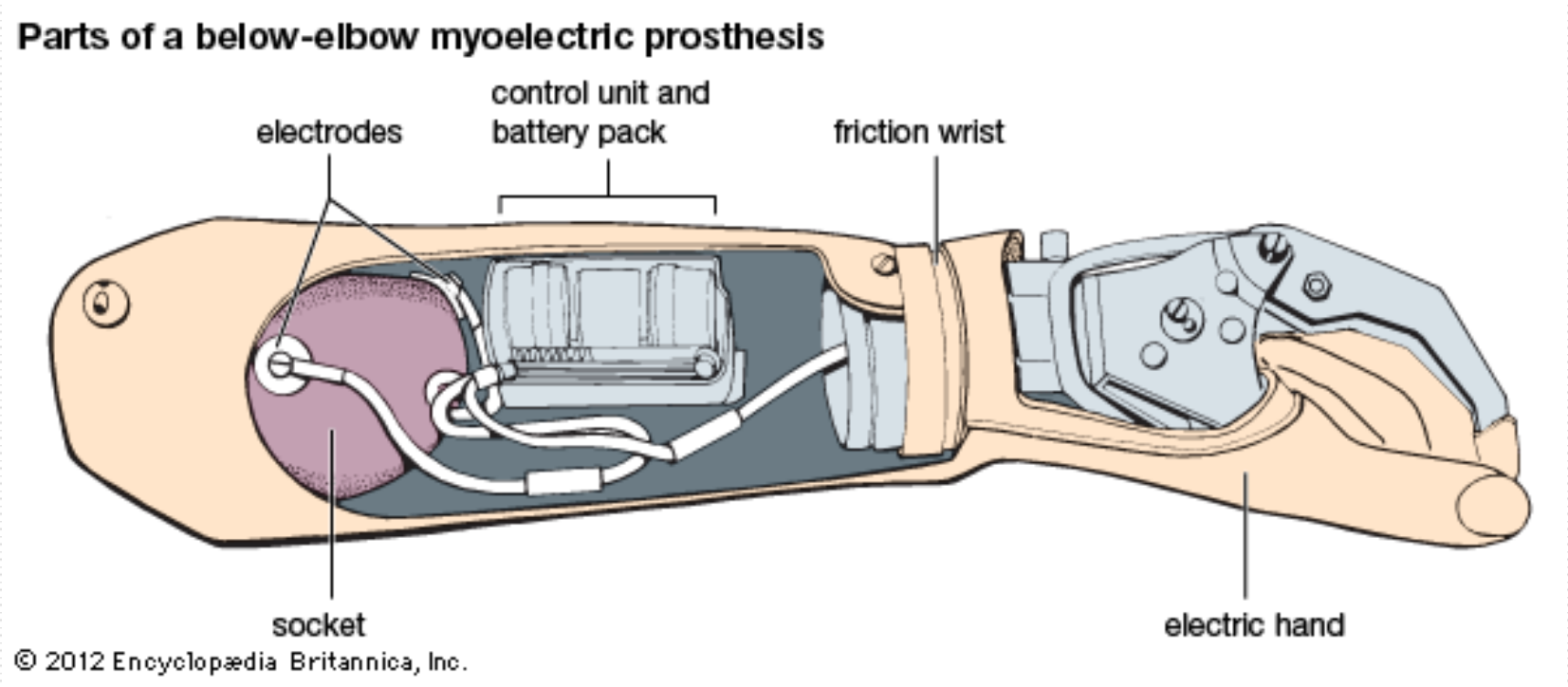
Myoelectrode Position

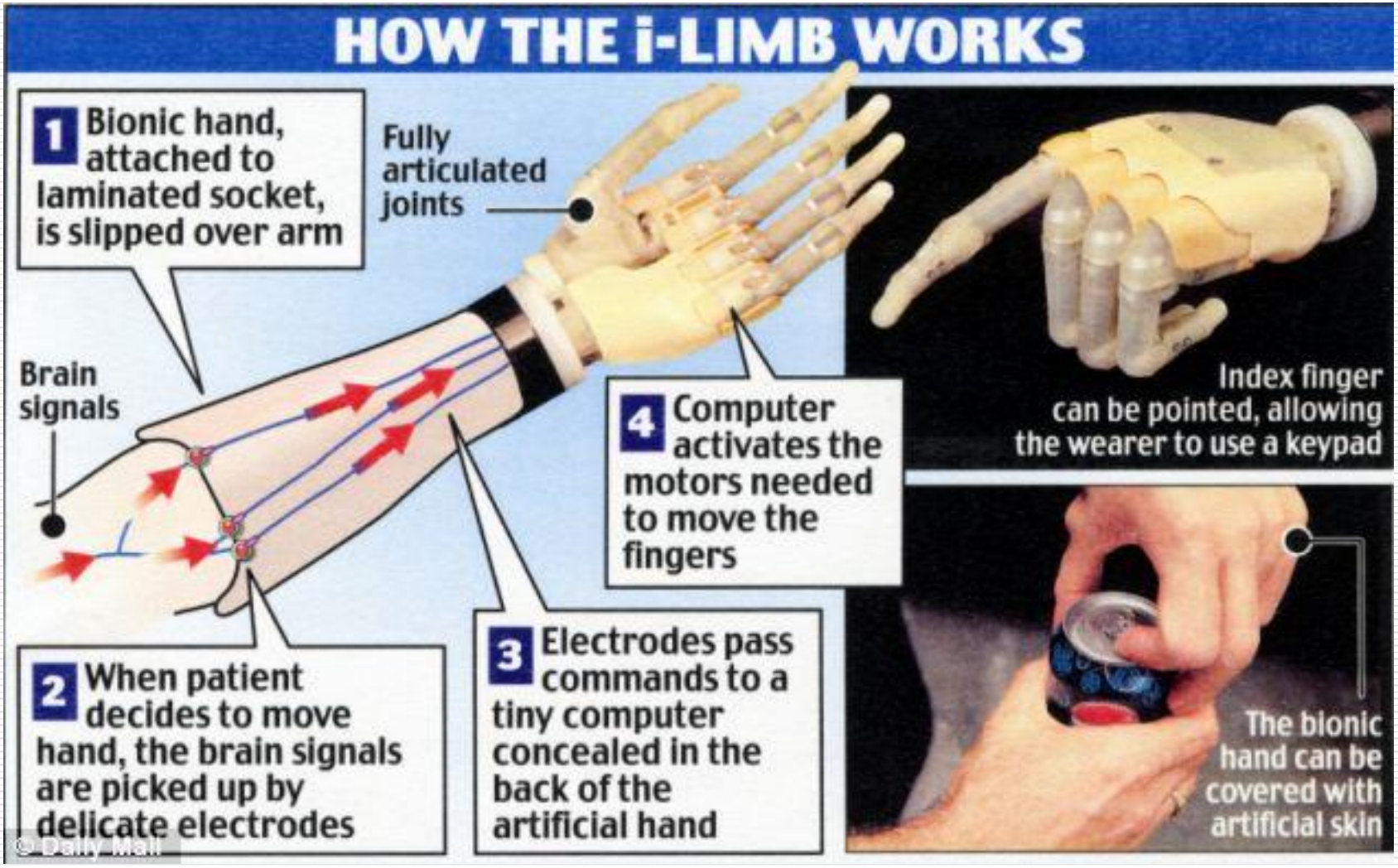


Fit of Socket

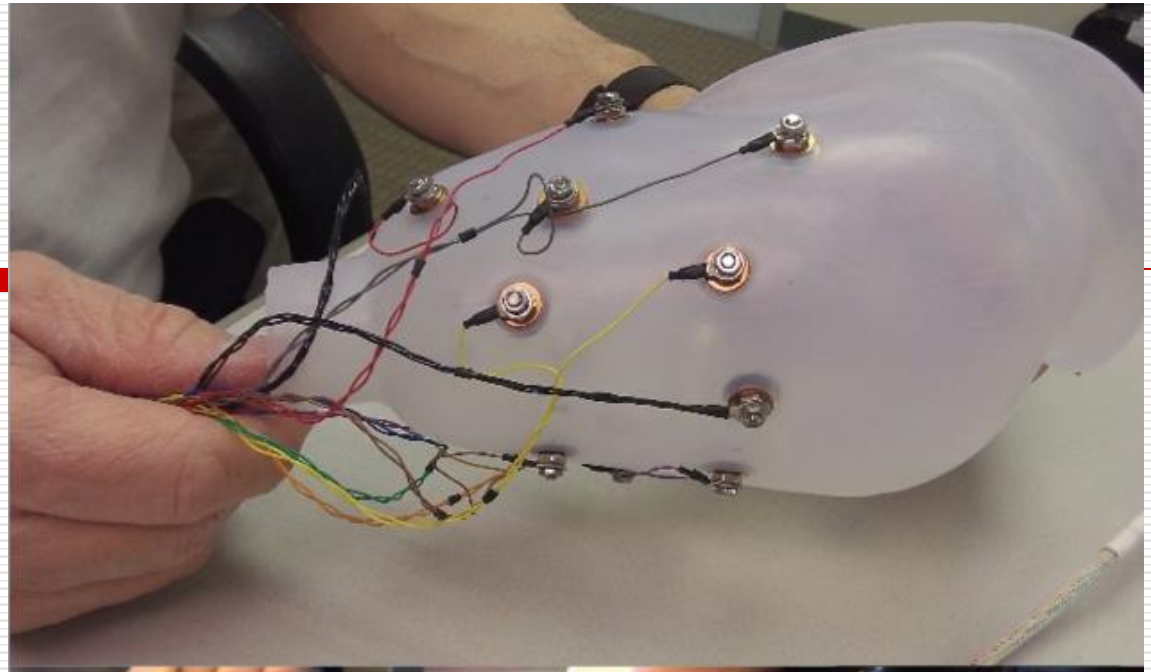


Traditional Myoelectric Prosthesis

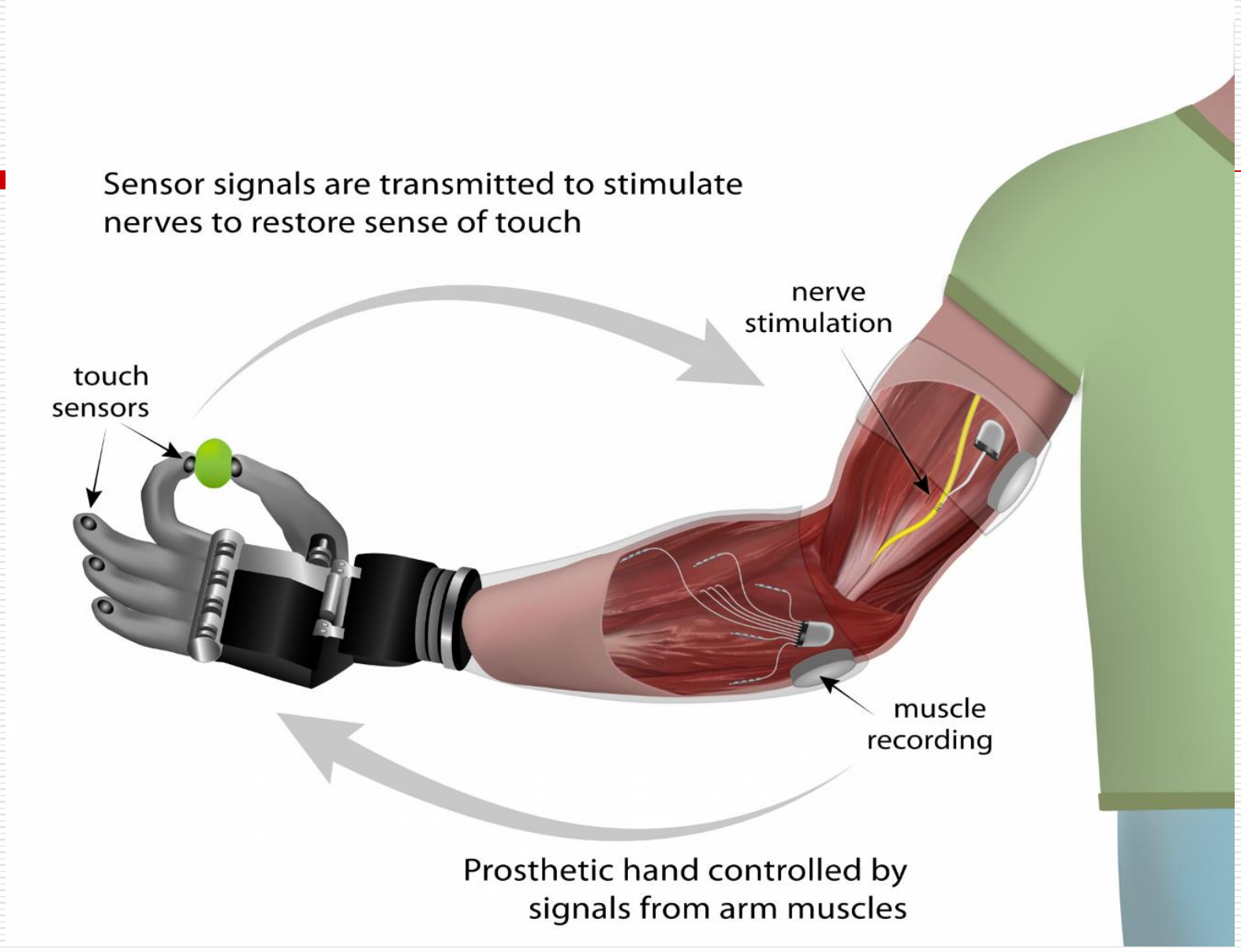



HOW THE i-LIMB WORKS
1 Bionic hand, attached to laminated socket, is slipped over arm
Fully articulated joints
Brain signals
2 When patient decides to move hand, the brain signals are picked up by delicate electrodes
3 Electrodes pass commands to a tiny computer concealed in the back of the artificial hand
4 Computer activates the motors needed to move the fingers
Index finger can be pointed, allowing the wearer to use a keypad
The bionic hand can be covered with artificial skin
© Daily Mail

i-Limb




bionic


Sensor signals are transmitted to stimulate nerves to restore sense of touch
nerve stimulation
touch sensors
muscle recording
Prosthetic hand controlled by signals from arm muscles

Multi Articulating hands

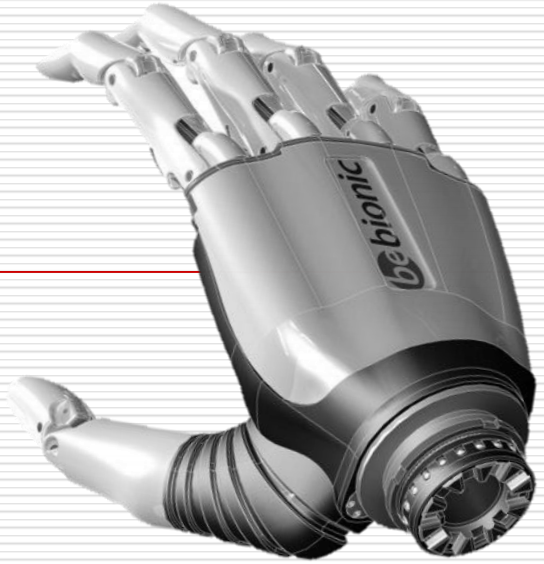
- I-Limb Quantur
- BeBionic
- Vincent Hand
- Michelangelo

Michelangelo

- Very fast
- Powered positional thumb
- Natural appearance
- Natural relaxed hand posture
- Flexi-wrist
- Multiple grasp patterns

Hanger CLINIC

BeBionic



- Thumb position determines grip pattern
- Individually powered fingers
- Many programmable grip patterns
- Small size now available

BebBionic

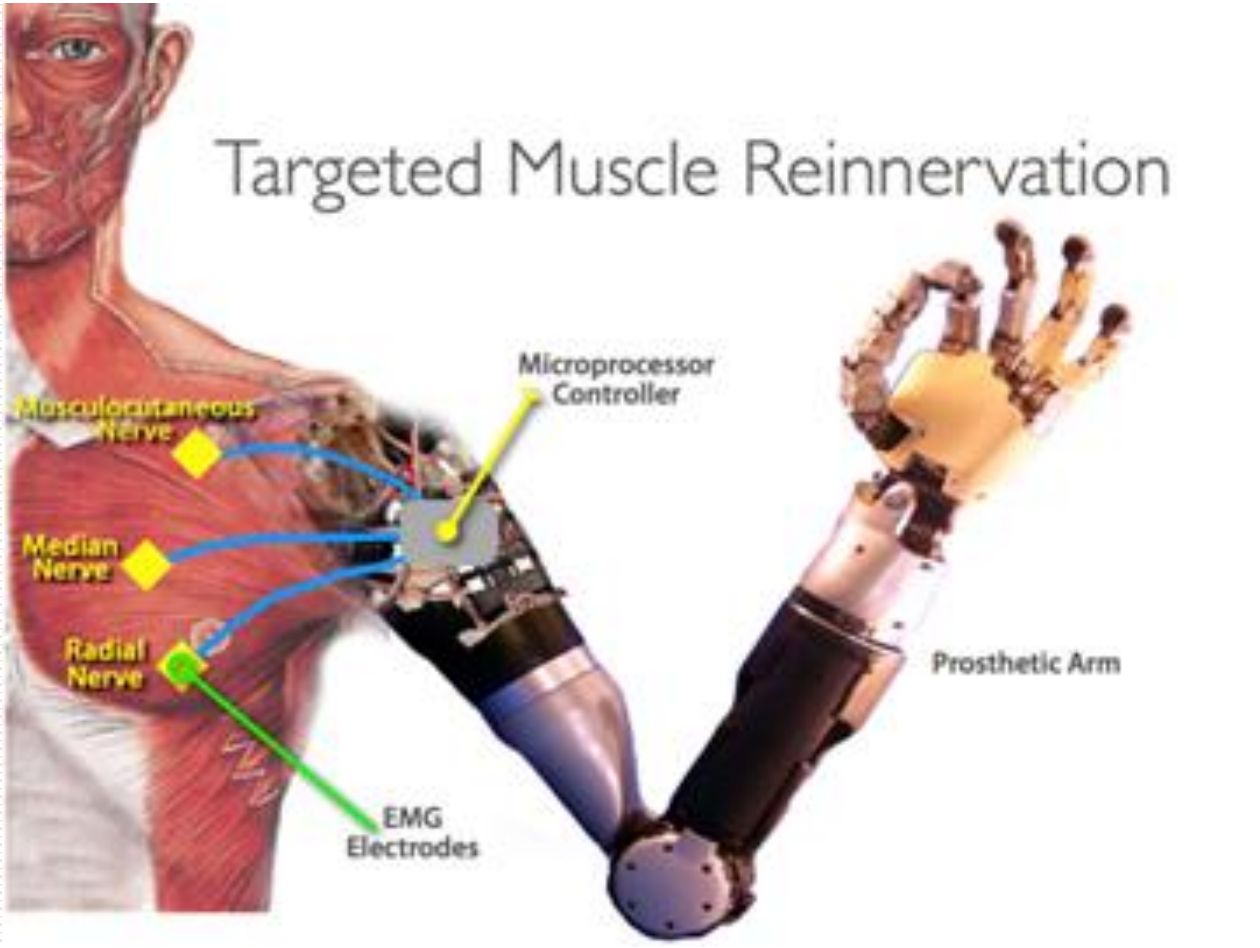
- 14 Grip patterns
- Can be used without glove
- 4 wrist options
  - MultiFlex
  - Flexion
  - Quick disconnect
  - Short version

Hanger CLINIC

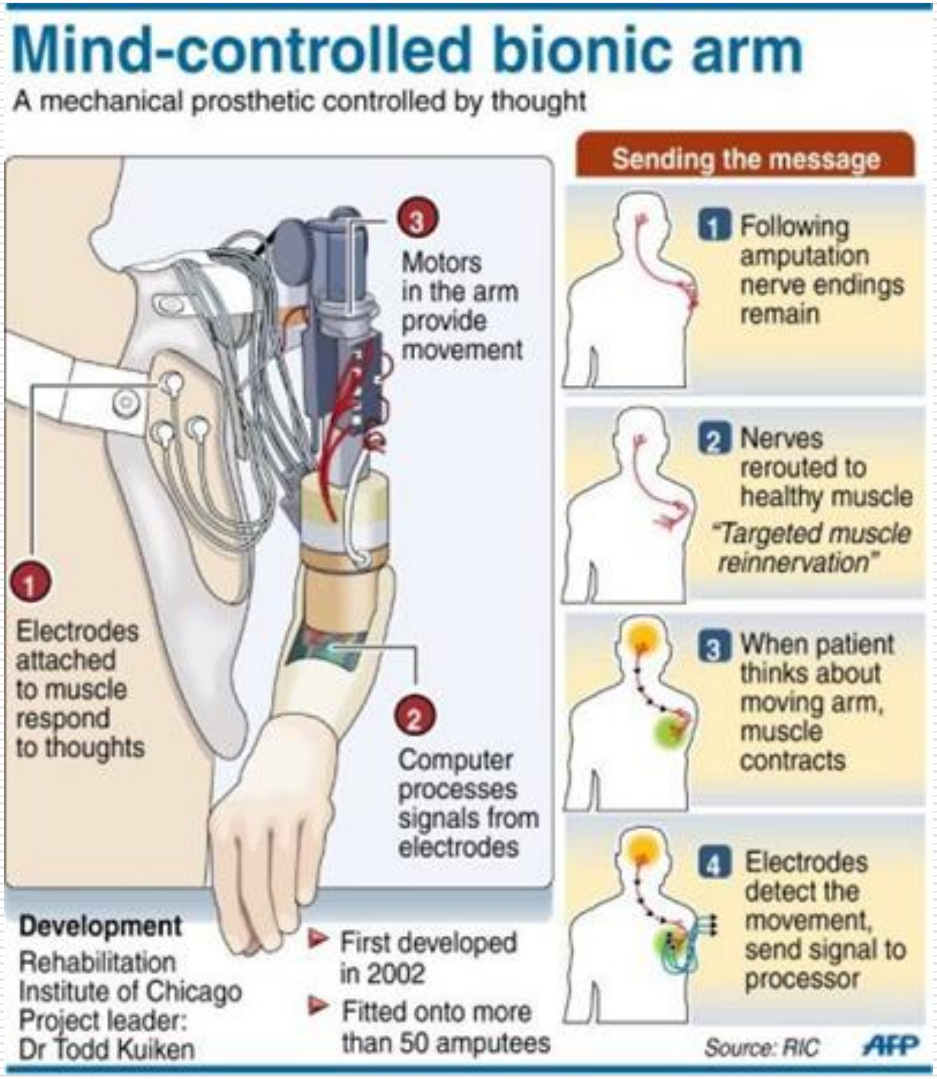
I-Limb

- 5 powered digits
- Manually positional thumb
- 24 different grasp patterns
- Can create custom gestures
- Pulsing feature to increase grip strength
- Powered rotational thumb
- Flexion wrist option
- Now with gesture control

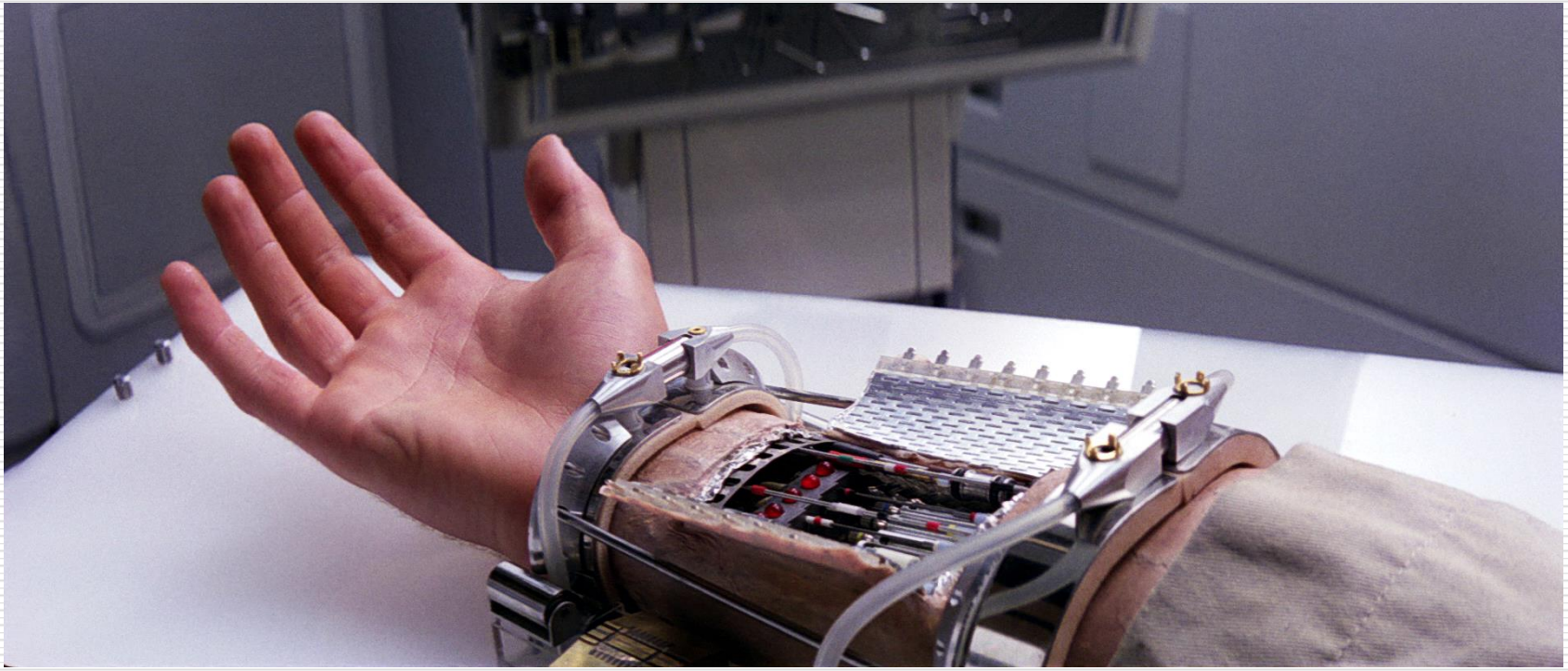
Targeted Muscle Reinnervation



Mind-controlled Prosthesis



Luke Arm

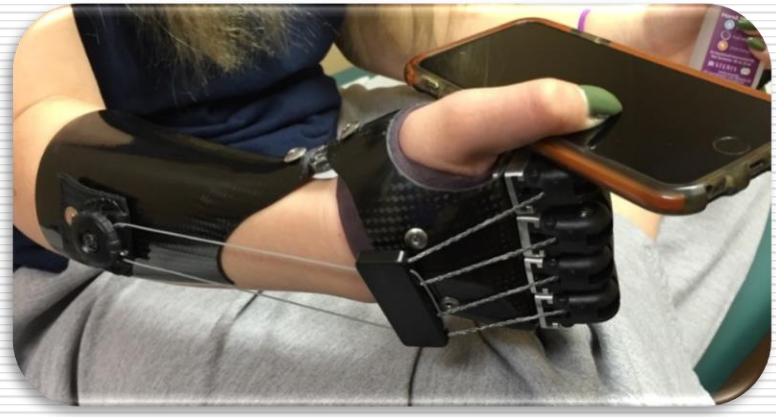


Luke Arm

- Requires TMR
- Has multiple degrees of freedom :
  - The shoulder configuration offers **10 powered** degrees of freedom.
  - The humeral configuration offers **8 powered** degrees of freedom.
  - The radial configuration offers **6 powered** degrees of freedom.
- Has multiple configurations for control:
  - EMG IMU (Inertial Measurement unit)
  - Pressure Transducers Pressure switch
  - Rocker switch Linear Transducers

3-D Printed Hands

New Designs



Hanger CLINIC

Design process start to finish

artial Hand
D design
lb
romwell, CT

Hanger CLINIC

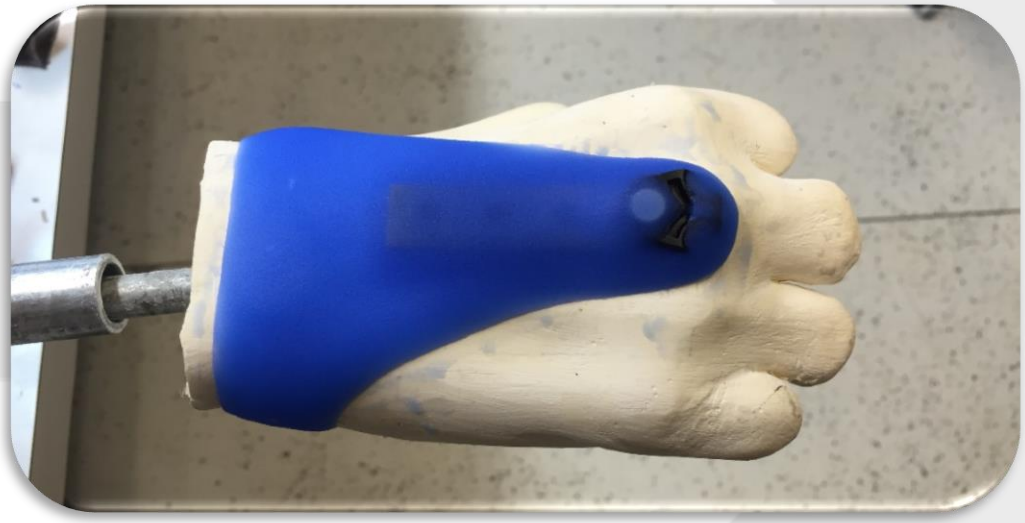
OPTIONS AVAILABLE FOR SILICONE INTERFACING

- Zippers
- Anchors
- Multi-durometer
- Multi-color
- Embedded reinforcement
- Variable thickness
- Endless color options
- Embedded electrodes
- Tattoos
- Embedded technology

Hanger
Empowering Human Potential

PREPARING THE SILICONE

- Clean up trim-lines
- Remove any imperfections
- Cure in oven for 8 hours at 130 Degrees



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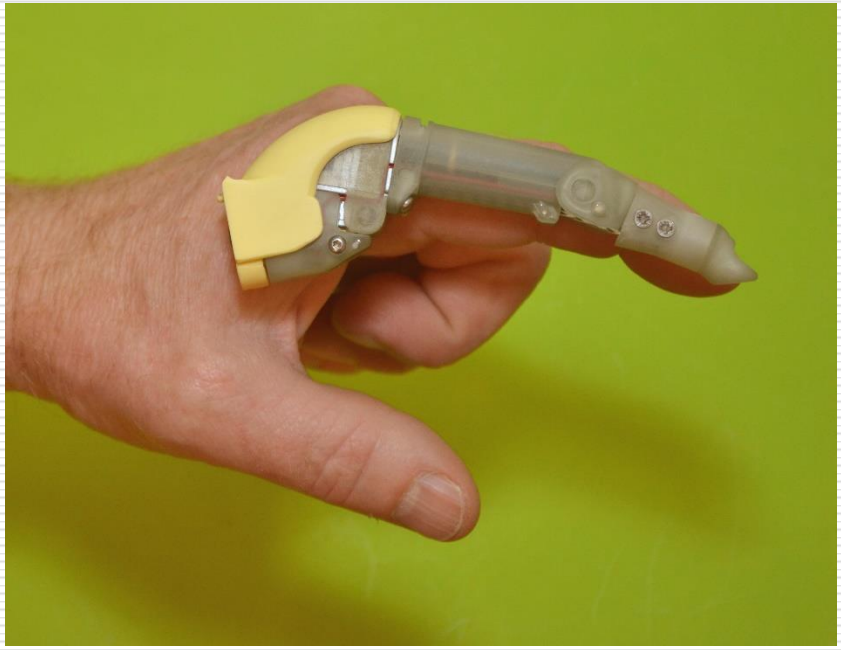
Empowering Human Potential

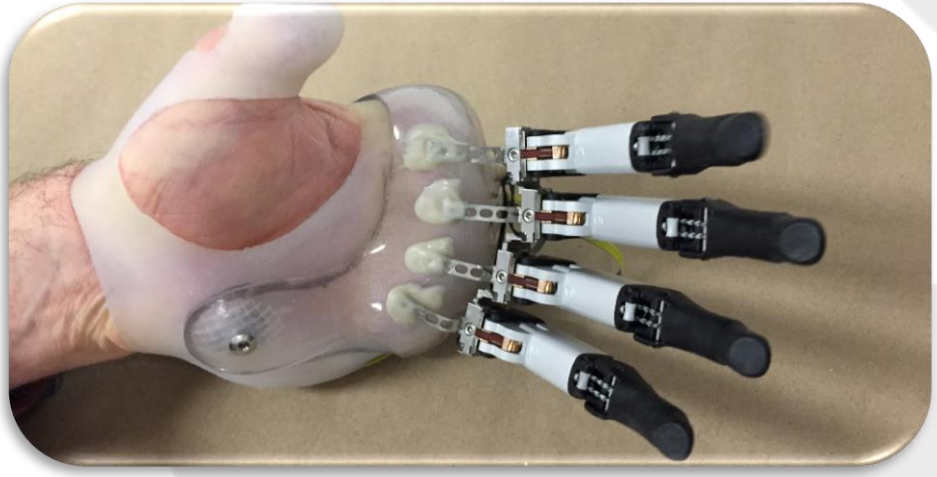
Electric Fingers

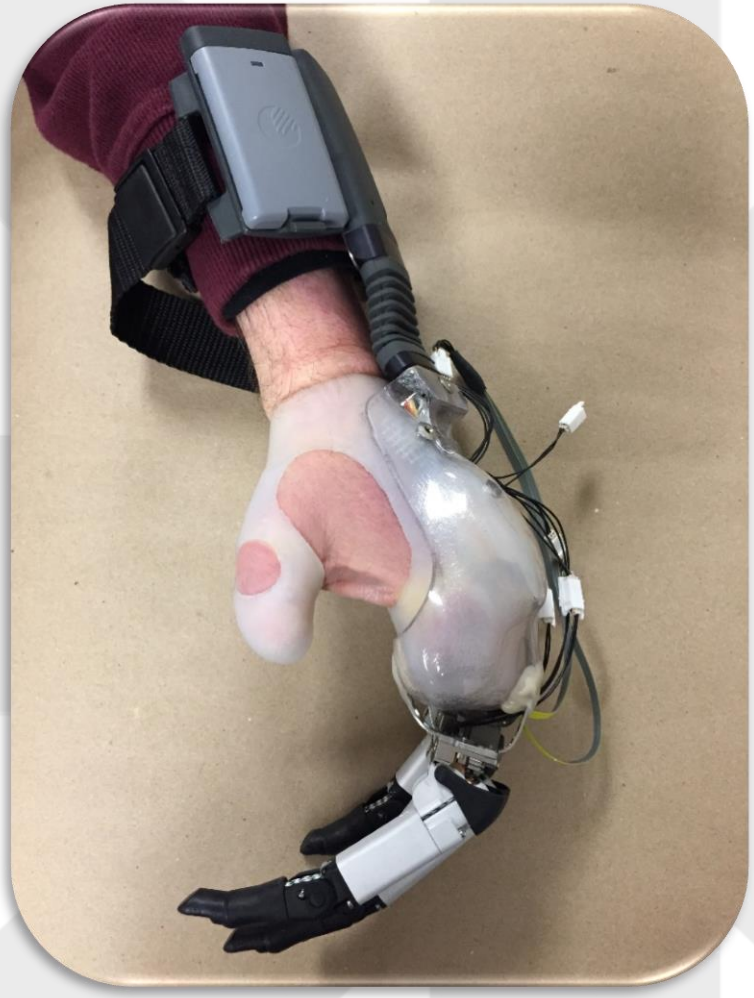
ProDigits



Vincent Finger

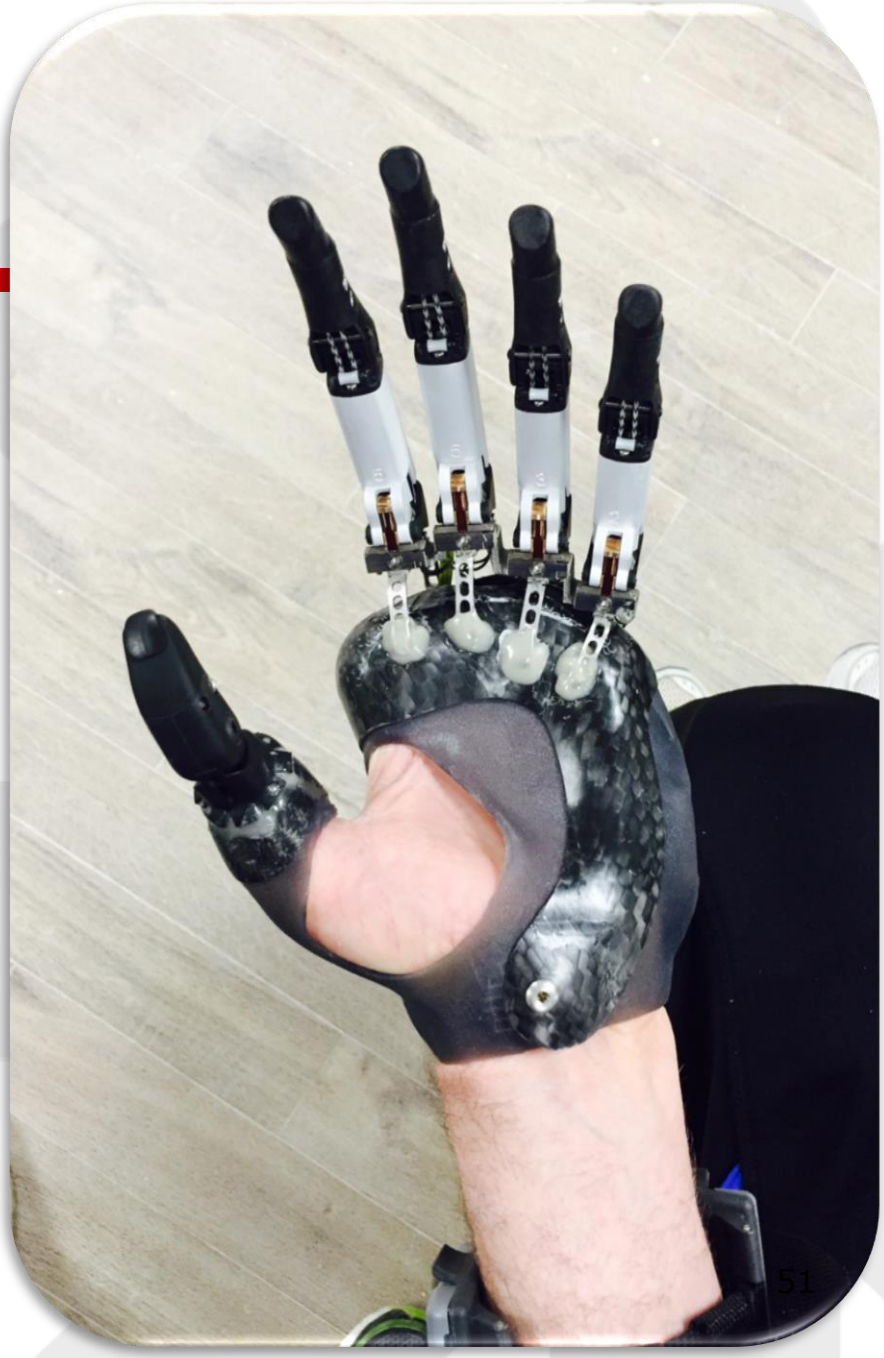
PARTIAL HAND DESIGN





Hanger
Empowering Human Potential

FINAL FABRICATION



Hanger
Empowering Human Potential

Thank You!

We Learn...

10% of what we read,

20% of what we hear,

30% of what we see,

50% of what we see and hear,

70% of what we discuss,

80% of what we experience,

95% of what we teach others.

- William Glasser

Special Thanks

- Abby Hoffman-Finitis, Med, CP
  - Assistant Professor, University of Hartford, MSPO Program
- Matthew Mikosz, CP
  - National Upper Extremity Specialist, Hanger Clinic