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The Evolving R&D Model: International Trends and U.S. Competitiveness

Global R&D Trends – Implications for Materials Science

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President and Chief Executive Officer

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Advances in materials and engineering have changed the balance of power

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50,000 BCE

Cro-Magnons overwhelm the Neanderthal

Shaping of stone and bone (ceramics later)

6000–1800 BCE

Rise of city-states with armies in Asia, Europe & Mesopotamia

Copper and bronze

1500 BCE (?)

Kingdoms and empires in Asia, Near East and Southern Europe

Iron and steel

1300–1800 CE

European wars and colonial expansion

Gunpowder and firearms

1850 CE

Modern warfare

Mass production of iron and steel

1945 CE

Nuclear weapons

Graphite, uranium and plutonium

1956–2000 CE

Submarine-launched ballistic missiles

Molybdenum, tantalum, niobium and tungsten

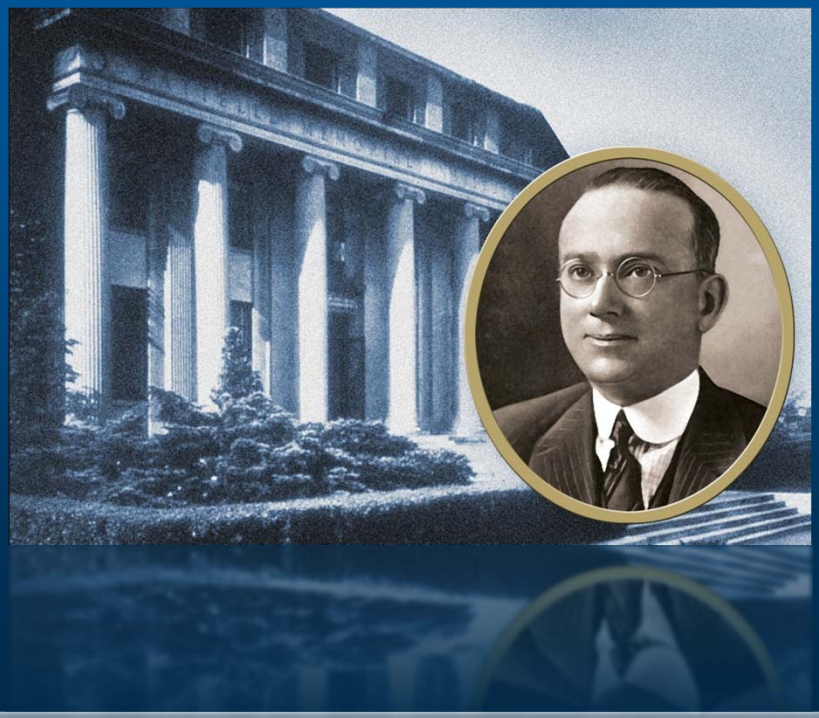
2000 CE

Network-centric warfare

Silicon, electronic and photonic materials

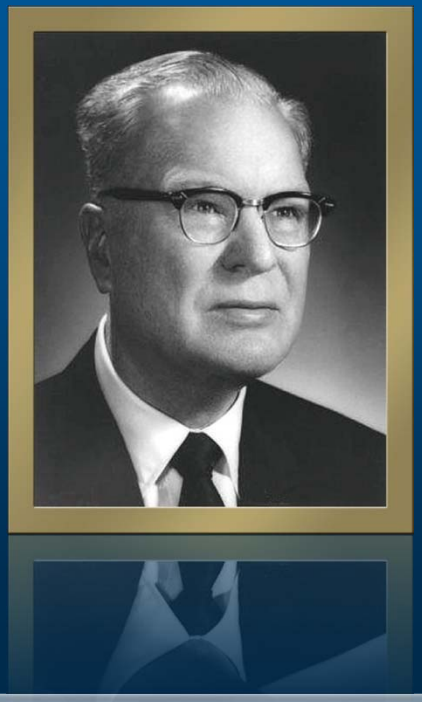
1929

Battelle Founded



1940s

Xerography



1965

First Major Lab Contract

Pacific Northwest NATIONAL LABORATORY



1970s–80s

UPC, Compact Disk, Cruise Control


1990s

Lab Management Leader

BROOKHAVEN NATIONAL LABORATORY

OAK RIDGE National Laboratory

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

2000s

Further Growth and International Expansion

NBACC

UK National Nuclear Laboratory

INL Idaho National Laboratory

Lawrence Livermore National Laboratory

Solving today's and tomorrow's challenges requires materials science

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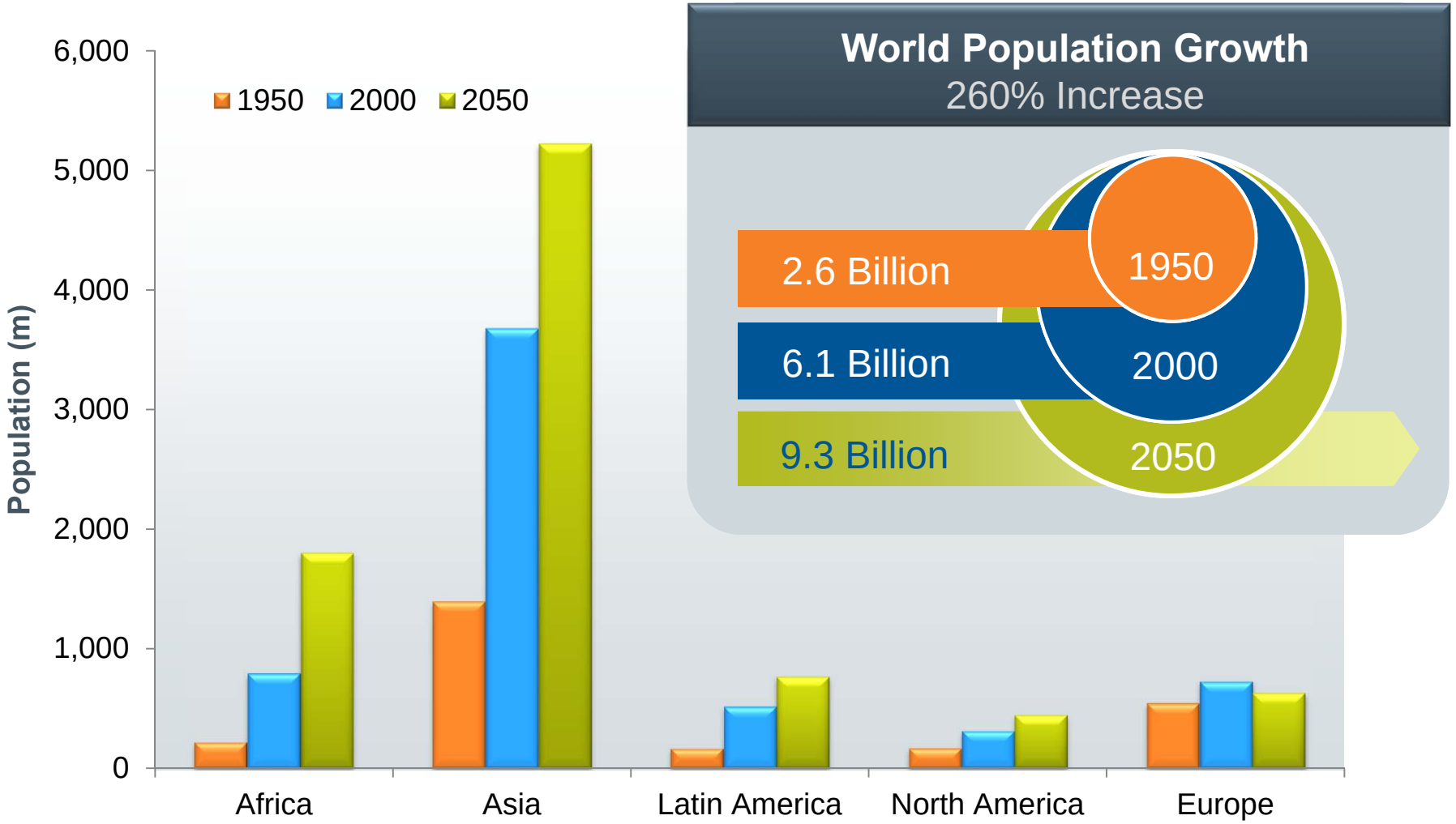
- Drug and biologic delivery systems
- RareCyte cancer detection
- BrainGate neural interface
- Fiber-optic technology
- Cost effective energy solutions
- Liquid bottle screener
- Armored vehicles and boats

How Battelle approaches today's global challenges

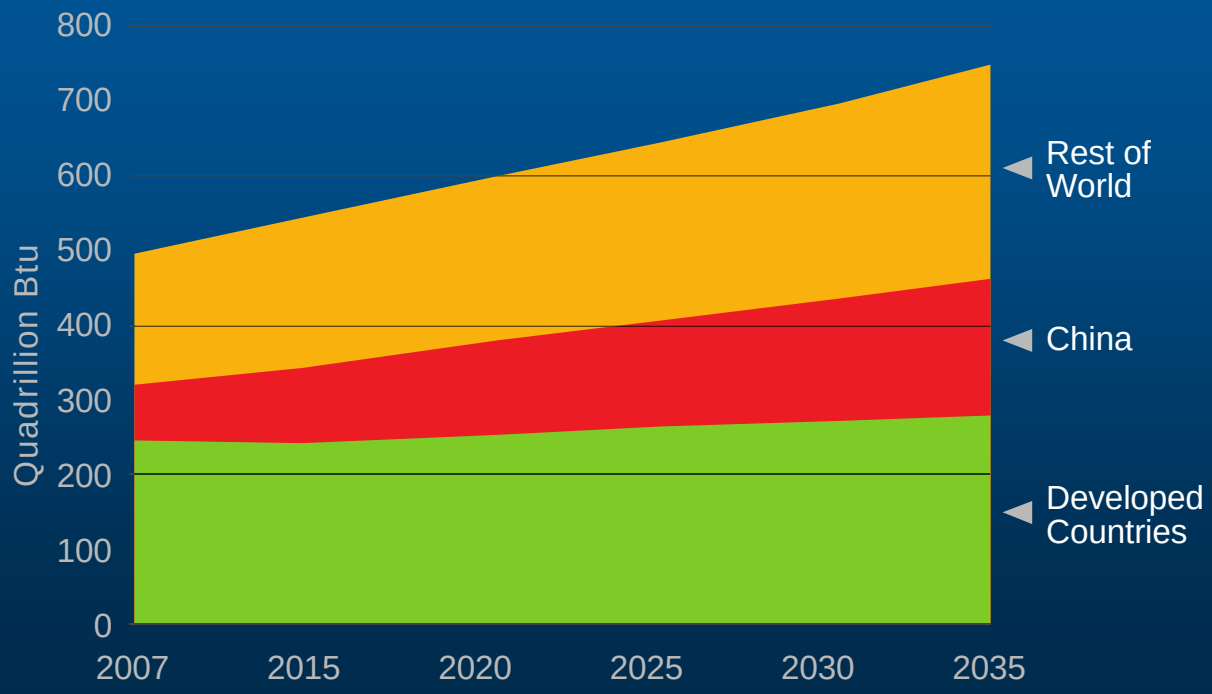
The world is undergoing unprecedented population changes



Source: Scientific American and United Nations and Population Reference Bureau

Global energy demand poses many challenges

Global Energy Consumption



Source: IEA & World Energy Outlook

The global health care crisis has led to uncontrollable and spiraling costs

Emerging infectious diseases (e.g. SARS, influenza, biothreats)

Global aging is unprecedented

Rapid increases in chronic diseases (obesity, heart disease, diabetes, cancer, etc.)

It is increasingly expensive and difficult to develop and market new drugs

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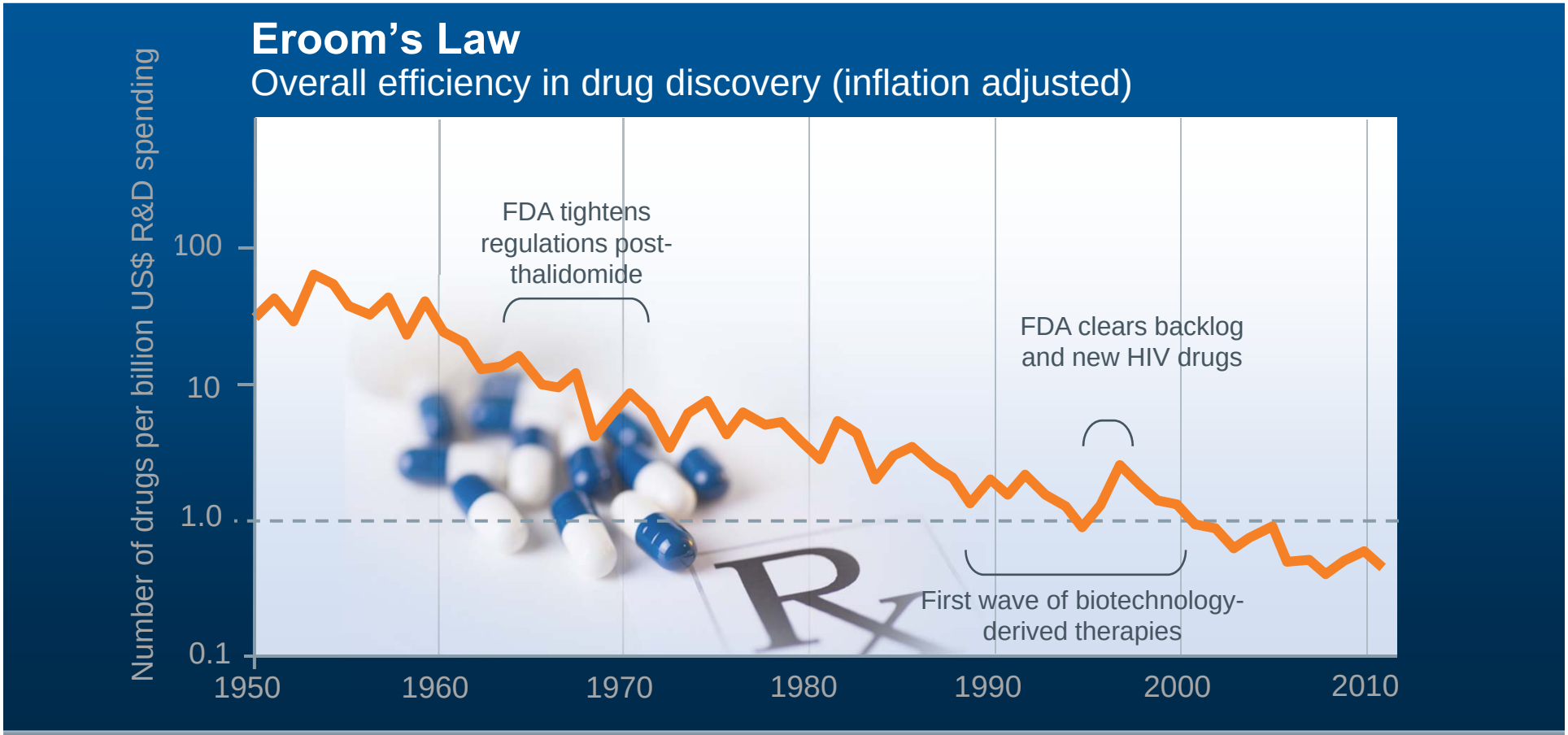

Source: NIH and Science Magazine
Inflation adjusted

The evolution of U.S. R&D

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1865-1900	1900-1940	1940-1990	1990+
Era of the Heroic Inventor	**Industrializing Innovation**	**Nuclear Weapons/ Big Science**	**Globalization**
• Self trained – Edison – Bell – Eastman	• Corporate research labs – Kodak – DuPont – Immigration	• U.S. leads world with big science – NSF & DoD – National Labs • Expansion of corporate research – Bell – Xerox • Venture capital	• R&D no longer sole domain of U.S. • Open and systematic innovation • R&D moved beyond product to process and business model innovation

Innovation still starts with an innovator and a good idea

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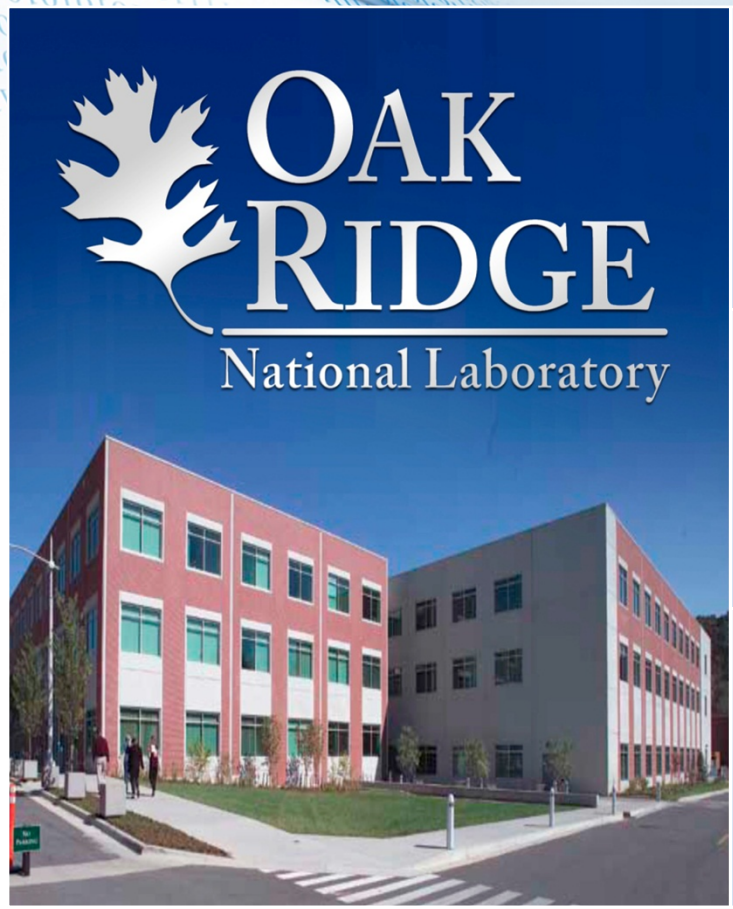
Sheffield University's Advanced Manufacturing Research Centre is a high-speed, high-performance machining breakthrough to take metals technology into the 21st century

- **Ti alloys → exotic metals → composites → nuclear materials**
- **Works with about 60 the world's leading aerospace and advanced manufacturing companies**
- **Similar centers opening in United States, Asia, Europe and Australia**

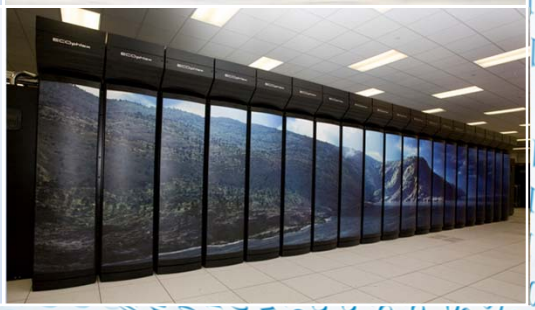
Business innovations led to the world's most powerful computing complex



DOE Titan
#1
Fastest Computer in the World and Third in Energy Efficiency

NSF Kraken
#25
National Science Foundation's most powerful computer

NOAA Gaea
#40
National Oceanic and Atmospheric Administration's most powerful computer



The iPad is an example of how innovation is constantly changing

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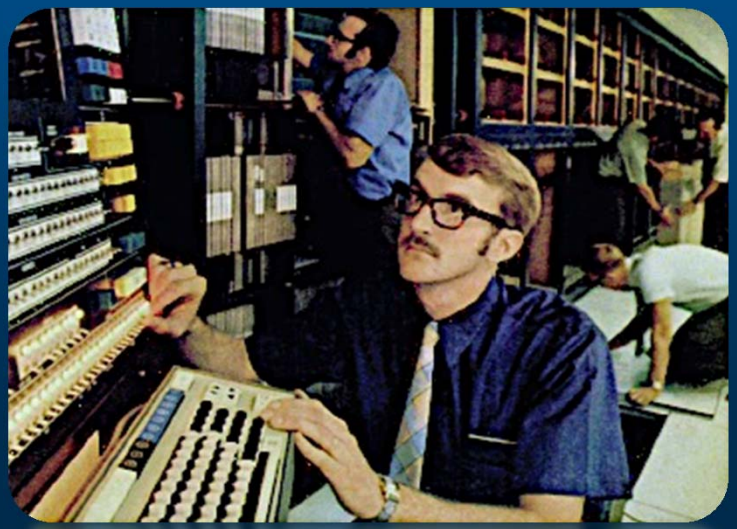
Old Mainframe Versus New Handhelds

ILLIAC IV Super Computer 1975

150 MFLOPS
$31 Million



Apple iPad2 2010

169 MFLOPS
$499

Source: Peter Leyland and Wired Magazine

The U.S. has traditionally led big science projects

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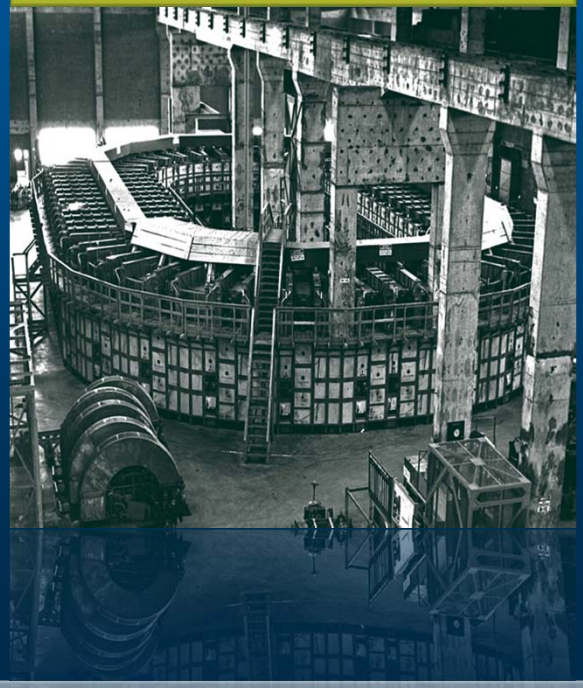
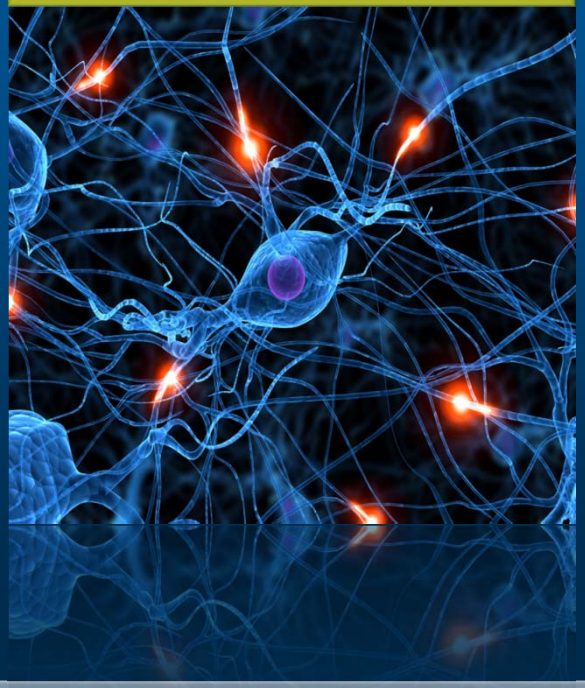
Manhattan Project



Space Race

Human Genome



What country will be best positioned to solve tomorrow's materials science challenges?

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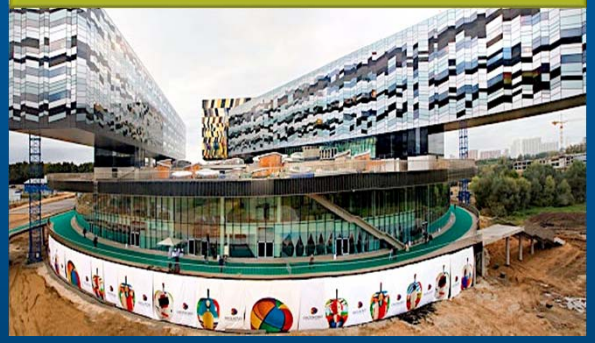
Skolkovo in Russia



Large Hadron Collider in Europe

ITER in France

RIKEN Computational Science in Japan

Biopolis in Singapore

While science is expensive, we need to evaluate spending priorities

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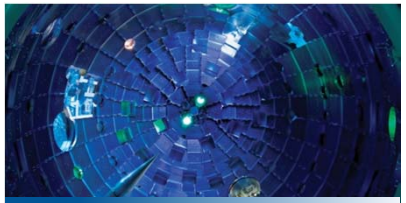
$1B National Synchrotron Light Source II (NSLS II)

NSLS II

$2B Spallation Neutron Source (SNS)

SNS

$2.5B Halloween Candy



NIF

$4B National Ignition Facility (NIF)

$7B 2012 Campaign Contributions

LHC

$7B Potato Chips

$10B Large Hadron Collider

Source: Milken Institute and Center for Responsive Politics

Education is key to economic prosperity so we need to inspire all young people

U.S. Educational Attainment	Median Weekly Earnings in 2011	Unemployment Rate in 2011
Less than a high school diploma	$451	14.1%
High school diploma	$638	9.1%
Some college, no degree	$719	8.7%
Associate's degree	$768	6.8%
Bachelor's degree	$1,053	4.9%
Master's degree	$1,263	3.6%
Professional degree	$1,665	2.4%
Doctoral degree	$1,551	2.5%

Source: Bureau of Labor Statistics, U.S. Department of Labor

Battelle is also playing a leading role in the transformation of education

Ohio STEM Learning Network

Achieve

UDACITY

BHEF BUSINESS-HIGHER EDUCATION FORUM™

At Battelle, innovation still starts with an inventor and a good idea, but now includes...

- Not just technical, but new business and process innovations
- Potentially going beyond the R&D cycle to manufacturing
- A portfolio approach to R&D, capital, and venture investments in increasingly complex deals
- Leading the development of STEM education and related concepts