LOOKING TO YOUR FUTURE

March 16, 2013 Presentation
To the
4th Annual Undergraduate Research Conference

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Overview

- First, We Need Some data
- The Future... Tinkering and Shaping
- The Future of Public Research Universities
- The Future of R&D
- The Future of Big Data
- The Future of Visualization
- The Future of Networking and Collaboration
- The Future of UGR @UTK
First, We Need Some Data

- How many of you:
  - Have invited friends, family, faculty?
  - Are doing this for the first, second, third, or fourth time?
  - Have worked with faculty mentors outside your academic discipline?
  - Have participated in cohort learning?
  - Have studied abroad?
  - Have been to ORNL?
  - Have seen/heard/met a Nobel Laureate?
  - Have gone to a professional conference?
  - Have presented at a professional conference?
  - Have been brave and walked up to introduce yourself to some deity in your field and talked about your UGR?
  - Have published in *Pursuit*?
  - Have published in a conference proceedings?
  - Have published in a scientific or scholarly journal?
  - Belong to a professional society?
  - Have business cards/belong to Linked In?
  - Have reached out to faculty at other universities?
  - Have applied to graduate school?
  - Have talked about your UGR in your application to graduate school?
  - Want to get a Ph.D.?
  - Want to mentor undergraduates?
The Future... We Are Always Tinkering and in Search of 1.2 Gig watts for the DeLorean

**Doc Brown:** This is it. This is the answer. It says here that a bolt of lightning is going to strike the clock tower at precisely 10:04 pm next Saturday night! If we could somehow harness this lightning... channel it into the flux capacitor... it just might work. Next Saturday, we’re sending you back to the future!
The Future... We Absolutely Should Be Tinkering to Change the Future for the Better

“The vast possibilities of our great future will become realities only if we make ourselves responsible for that future.” --- Gifford Pinchot

- In 1896, the NAS forms the National Forest Commission (precursor to USFS)
- Pinchot family endows the Yale School of Forestry
- Establishes the Society of American Foresters
- Establishes the National Conservation Association
- Early thinking about TVA-like systems
- Anti clear-cutting
- Family establishes the Pinchot Institute for Conservation
- Conservation ethic & sustainability

- 1865-1946
- YALE UNIVERSITY
- FRENCH NATIONAL SCHOOL OF FORESTRY
- 28TH GOVERNOR OF PA
- 1ST CHIEF OF THE U.S. FOREST SERVICE
"But what has made our universities the greatest in the world is not the quality of our undergraduate education--- as important as that is---but our ability to fulfill one of the other central missions of the leading universities: the production of new knowledge through the discoveries that change our lives and the world."

The Future of Public Research Universities

- Association of American Universities (AAU)
- Association of Public And Land Grant Universities (APLU)
- National Research Council (NRC) of the National Academies,
  - National Science Board (NSB) of the NSF
The Future of Public Research Universities

Dew, JR (2012) in World Future Review

World Future Society
The Future of Public Research Universities

“Research universities may experience a crisis in retaining their research faculty and infrastructure. This, in turn, will reduce their ability to sustain their traditional approach to instruction in lower –division courses, which depends heavily on graduate students.

“However, the brand recognition at research universities is so strong that they should have little difficulty attracting the numbers of students necessary to sustain operations. In addition, they have a large number of alumni that will continue to contribute to the institution as the economy recovers. The research universities also have athletic programs that operate at or near profitability since they play heavily televised Division One football, which is the one area of collegiate athletics that pays for itself.”

Dew, JR (2012) in World Future Review
“Research universities may experience a crisis in retaining their research faculty and infrastructure, which will in turn reduce their ability to sustain their traditional approach to instruction in lower-division courses, which depend heavily on graduate students.

“However, the breadth of recognition at research universities is so strong that they should have little difficulty attracting the numbers of students necessary to sustain operations. In addition, they have a large number of alumni that will continue to contribute to the institution as the economy recovers. The research universities also have athletic programs that operate at or near profitability since they play heavily televised Division One football, which is the one area of collegiate athletics that pays for itself.”


Grade: TBD
Predicts the past
Too short a time horizon
Traditional assumptions
Not granular
Many forcing functions absent
The Future of R&D

Bush, V (1945) “Science the Endless Frontier: A Report to the President on a Program for Postwar Scientific Research”

The Future of R&D

- R&D 3% of GDP
- Future Years Defense Program Model
- R&D Tax Credit
- More research awards
- Reform of regulatory burden
- Agency strategic plans
- High-risk, high-reward investment strategy
- Support research universities... people and infrastructure
- Entrepreneurship at universities
- Innovation ecosystems at universities
- National labs and industry
- Government-university-industry partnerships

The Future of R&D
The Future of R&D: PCAST
(20 members: MIT, UT Austin, Michigan, Princeton, Maryland, RPI, Yale, Northwestern, UCSD, Wash U., Harvard, Cal Tech, Honeywell, Google, Microsoft, Hummer-Winblad, Alta Partners)

http://www.whitehouse.gov/administration/eop/ostp/pcast

- Networking & IT
- Agriculture preparedness
- US Research enterprise
- Innovation in drug discovery
- Spectrum
- Advanced manufacturing
- Nanotechnology
- Undergraduate STEM
- Ecosystems and economy
- Advanced manufacturing
- Networking and IT
- Health information technology
- Energy technologies
- K-12 STEM
- Influenza vaccine
- Nanotechnology
- H1NI
The Future of R&D: NSTC
(26 members: POTUS, VPOTUS, 19 S&T agencies, councils, Smithsonian Director)

http://www.whitehouse.gov/administration/eop/ostp/nstc

- Our Changing planet
- 21st century grid
- Arctic research
- Science for an Ocean Nation
- National Network for Manufacturing Innovation
- Networking and IT R&D
- Deepwater Horizon Spill
- National Nanotechnology Initiative
- Interagency public access
- National strategic plan for advanced manufacturing
- Coordination on STEM investment
- Open innovator’s tool kit
- National aeronautics R&D
- Trustworthy cyberspace
- Materials genome
- Open innovation
The Future of R&D: 19 S&T Agencies Strategic Plans

- NSF
- NIH-NIEHS
- DOE
The Future of R&D: Global View

The Future of R&D: Global View

The Future of R&D: Global View

The Future of R&D: Global View

The Future of R&D: Global View


Grade: A+

- Predicts the future
- Reasonable time horizon
- Deep, informed assumptions
- Highly granular
- Forcing functions included
The Future of R&D: Global View

The Future of R&D: Global View

The Future of Big Data: This is Big!

http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation

The Future of Big Data: This is Big!

Very approximately:

- You generate around 100 GBs of data daily
- > 1 exabyte ($10^{18}$ bytes) of data is generated world-wide every day
- > 1 yottabyte ($10^{21}$ bytes) of digital data exists in the world today
- this is equivalent to around 100 million 16GB iPads

http://wikibon.org/blog/big-data-statistics/
The Future of Big Data: This is Big!

http://www.mckinsey.com/insights/business_technology/big_data_the_next_frontier_for_innovation

- Actuaries
- Economists
- Computer Scientists (Software & Visualization)
- Epidemiologists
- Industrial Engineers
- Mathematicians
- Mathematical Scientists
- Mathematical Technicians
- Operations Research Analysts
- Statisticians
- Data Analytics

Data storage has grown significantly, shifting markedly from analog to digital after 2000

**Global Installed, Optimaly Compressed, Storage**

- **Overall Exabytes**
  - 2000: 100
  - 2007: 256

**Data Type**
- **Analog**
  - 2000: 45
  - 2007: 5

**Digital**
- 2000: 55
- 2007: 251

**Detail**
- % of storage
  - 2000: 75%
  - 2007: 84%

**Computation capacity has also risen sharply**

**Global Installed Computation to Handle Information**

- **Overall 10^12 Million Instructions per Second**
  - 1980: 5
  - 1990: 40
  - 2000: 100
  - 2007: 200

**Computation Type**
- **Pocket Calculators**
  - 1980: 25
  - 1990: 20
  - 2000: 5
  - 2007: 1

- **Supercomputers**
  - 1980: 20
  - 1990: 100
  - 2000: 1000
  - 2007: 2000

- **Video Game Consoles**
  - 1980: 1
  - 1990: 10
  - 2000: 100
  - 2007: 1000

- **Personal Computers**
  - 1980: 1
  - 1990: 10
  - 2000: 100
  - 2007: 1000

**Hilbert & Lopez (2011) in Science**

Leading social scientists have recognized that we are living through an age in which “the growth of wealth, the essence of power, and the creation of total cultural output depen[d] on the technological capacity of societies and individuals...” with “information technologies as the central capacity” (1). Despite this weight, most evaluations of society’s technological capacity to handle information are based on other economic constructs and measures, such as the economic value of related products and services (2). Previous work shows how increasing inclusion takes a more direct approach to quantify the amount of information society possesses with its information and communication technologies (ICT). After pioneering work in the 1990s and 2000s, the growth of digital content far outstripped the capacity of traditional infrastructure to support it. We argue that the new forms of digital content pose a challenge to the very concept of information...
The Future of Big Data: Google


http://www.wired.com/wiredenterprise/2012/10/ff-inside-google-data-center/all/

http://www.wired.com/wiredenterprise/2012/10/google-data-center-secrets/

- Twelve or more data palaces around the globe
- Total storage??
- 20 petabytes/day
- Index 20 billion web pages a day
- 3 billion search queries daily
- Storage for 425 million Gmail users
- Distributed file systems and object-based storage
- Spanner
The Future of Big Data: Oakville/Knoxridge

NSF-funded data access

NSF-funded math-biology-computation

NSF-funded XSEDE computational workhorse

DOE-Funded fastest computer in the World
The Future of Visualization: This is Essential

http://www.edwardtufte.com/tufte/

http://flowingdata.com

Great brain food

Cool resource
The Future of Visualization: Global Talk

http://senseable.mit.edu/nyte/

24 Hours of Two Way International Phone Call Traffic Involving NYC

24 Hours of Two Way IP Traffic Involving NYC
The Future of Visualization: ORNL

EVEREST Room

EVEREST: Exploratory Visualization Environment for Research in Science & Technology

Supernova Collapse--- Dr. Tony Mezzacappa
The Future of Academic Networking and Collaboration

SciVal Scopus: 20,000 journals

SciVal R&D Data Mining
The Future of Networking and Collaboration
The Future of Networking and Collaboration

Collaboration Networks

Strength of Internal and External Collaborations
The Future of UGR@UTK

“What’s past is prologue…”

“Undergraduate education in research universities requires renewed emphasis on a point made by John Dewey almost a century ago: learning is based on discovery guided by mentoring (and cohort experiential learning) rather than on the transmission of information. Inherent in inquiry-based learning is an element of reciprocity: faculty can learn from students as students are learning from faculty.”
The Future of UGR@UTK

- Expand EUReCA
- Move to later in April
- Stronger role in CUR
- Coordination with other experiential learning activities (e.g., Chancellor’s Honors Committee, Office of National Scholarships & Fellowships, Office of Service Learning, Center for Leadership & Service, CIE)
- Student-Faculty Portal (e.g., UGR Craig’s List)
- UROP/IROP endowments
- Pursuit and web access
- Fellowships through AY
- Formal office in Blount Hall
- Student leadership (USRA)
- Annual awards for student researchers and faculty mentors
- 100% full time staff support
- Tie to Top 25 Strategic Plan for Research
Questions & Conversations?

If you have follow-up questions, then please contact me:

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My cell is (806)252-6444