This work was done for and encouraged by the IEEE-USA R&D Policy Committee; however, the conclusions and recommendations have not yet been approved by this committee.
US Economic Facts

• 2011 GDP = $15.1 trillion; Estimated 2013 GDP = $16.3 trillion
• Current GDP Growth Rate = 2.1 percent
• 2012 Federal Income = 2.47 trillion or 15 percent of GDP
• 2012 Federal Expenditures = $3.80 trillion or 24 percent of GDP
• Outstanding Public Debt = $16.7 trillion or $52,000 per person
• 16 percent or 49.7 million live below the poverty line ($11,702/$23,201)
• The jobless rate is between 7.7 and 11 percent of workforce
• 12 percent of the employed workforce is seeking full-time employment
• Tuition charges at public universities have increased from 4 percent of 1970 median family income to 10 percent of 2009 median family income
• The Gini Coefficient, a measure of income inequality, has increased 30 percent since 1980
• Middle class income is stagnant or decreasing - the inflation-adjusted income of a typical family has dropped to mid-1990 Levels

TAKE AWAY: WE NEED A 3.5 PERCENT GDP GROWTH RATE AND A BALANCED FEDERAL BUDGET
## 2013 Projected Spending by Federal, State & Local Gov’ts
Source: usgovernmentspending.com  Projected 2013 GDP = $16,355 billion

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>FEDERAL</th>
<th>STATE</th>
<th>LOCAL</th>
<th>TOTAL</th>
<th>% GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PENSIONS</strong></td>
<td>$878.5 B</td>
<td>$190.8 B</td>
<td>$43.5 B</td>
<td>$1,112.8 B</td>
<td>6.80%</td>
</tr>
<tr>
<td><strong>HEALTH CARE</strong></td>
<td>$916.1B</td>
<td>$498.3 B</td>
<td>$134 B</td>
<td>$1,182.4 B</td>
<td>7.23%</td>
</tr>
<tr>
<td><strong>EDUCATION</strong></td>
<td>$136.1 B</td>
<td>$270.9 B</td>
<td>$518.1 B</td>
<td>$820.6 B</td>
<td>5.02%</td>
</tr>
<tr>
<td><strong>K-12</strong></td>
<td>$59.9 B</td>
<td>$6.4 B</td>
<td>$464.3 B</td>
<td>$426.2 B</td>
<td>2.61%</td>
</tr>
<tr>
<td><strong>POST HS</strong></td>
<td>$16.6 B</td>
<td>$219.6 B</td>
<td>$43.1 B</td>
<td>$279.3 B</td>
<td>1.71%</td>
</tr>
<tr>
<td><strong>OTHER</strong></td>
<td>$59.6 B</td>
<td>$44.8 B</td>
<td>$10.7 B</td>
<td>$115.2 B</td>
<td>0.71%</td>
</tr>
<tr>
<td><strong>DEFENSE</strong></td>
<td>$901.4 B</td>
<td>$1.2 B</td>
<td>0</td>
<td>$902.6 B</td>
<td>5.52%</td>
</tr>
<tr>
<td><strong>WELFARE</strong></td>
<td>$422.3 B</td>
<td>$180 B</td>
<td>$98.9 B</td>
<td>$646.8 B</td>
<td>3.95%</td>
</tr>
<tr>
<td><strong>PROTECTION</strong></td>
<td>$62.8 B</td>
<td>$91 B</td>
<td>$188.9 B</td>
<td>$342.7 B</td>
<td>2.10%</td>
</tr>
<tr>
<td><strong>TRANSPORTATION</strong></td>
<td>$114.2 B</td>
<td>$111.6 B</td>
<td>$144 B</td>
<td>$308.9 B</td>
<td>1.89%</td>
</tr>
<tr>
<td><strong>GENERAL GOVT</strong></td>
<td>$28.1 B</td>
<td>$31.7 B</td>
<td>$54.6 B</td>
<td>$113.6 B</td>
<td>0.69%</td>
</tr>
<tr>
<td><strong>OTHER SPENDING</strong></td>
<td>$96.2 B</td>
<td>$86.2 B</td>
<td>$355.3 B</td>
<td>$488.4 B</td>
<td>2.99%</td>
</tr>
<tr>
<td><strong>INTEREST</strong></td>
<td>$247.7 B</td>
<td>$49.8 B</td>
<td>$65 B</td>
<td>$362.5 B</td>
<td>2.22%</td>
</tr>
<tr>
<td><strong>TOTAL SPENDING</strong></td>
<td>$3,803.40 B</td>
<td>$1,511.30 B</td>
<td>$1,602.20 B</td>
<td>$6,281.3 B</td>
<td>38.4%</td>
</tr>
<tr>
<td><strong>FEDERAL DEFICIT</strong></td>
<td>$901.4 B</td>
<td></td>
<td></td>
<td>$901.4 B</td>
<td>5.51%</td>
</tr>
<tr>
<td><strong>GROSS PUBLIC DEBT</strong></td>
<td>$17,547.9 B</td>
<td>$1,153.5 B</td>
<td>$1,848.4 B</td>
<td>$20,549.8</td>
<td>125.65%</td>
</tr>
</tbody>
</table>
Only Two Issues to Debate

• Appropriate Level for Federal Spending as Percentage of GDP: Current Thinking Is 18 Percent
• Number of Years to Reach Balanced Budget: Current Thinking Is 10 Years
TAKE AWAY: THERE ARE NO FREE LUNCHES FOR THE NEXT 10 YEARS.
Vision for Federal R&D

The US GDP annual growth rate will exceed 3.5 percent and lead to a job creation rate by firms exceeding the 2005 rate of 3 million jobs/year. Electrical engineers will continue to make innovations that (1) drive long waves of economic growth and (2) lead to incremental product and process advancements that create US jobs.
Definition of Innovation

Innovation is the introduction of something new; from the perspectives of economics and public policy, innovation is advancements in technology, management or business practices – or all three - that lead to sustainable private sector job creation.

TAKE AWAY: INNOVATION IS ABOUT JOB CREATION IN THE PRIVATE SECTOR
Innovation In Economic System

Inputs
• Labor
  • Management
  • Engineering
  • Workforce
• Capital
  • Private
  • Public
• Technology
  • ExistingTech
  • R&D
    • Private
    • Public
• Infrastructure

R&D System

R&D Outputs
• Universities
  • Papers
  • Citations
  • Patents & Licenses
  • Conference Presentations
  • More R&D Funding
  • Graduates
• Government Labs
  • Mission Success
  • Papers
  • Patents
  • Licenses
  • Presentations

Outcomes
• Innovation
  • Competitive Companies
  • Start-Up Companies

Take Away: Shift Emphasis From R&D Inputs and Outputs to Innovation Outcomes
Properties of High Innovation Rate

• Most Occur in Economic Ecosystems
  • High People Density
  • High Professional Diversity
    • Scientists
    • Business People
    • Engineers
    • Venture Capitalists
    • Start-Up Experience
    • Intellectual Capital Law
  • Facilitates Interactions
• Focus on Intersection of Disciplines
• Innovation Management Strategy
  • Risk-Taking
  • Innovation Outcome Focus
  • Non-Hierarchical

Take Away: Use Federal R&D to grow multiple, self-sustaining economic ecosystems and emphasize high risk, high-payoff, multi-disciplinary projects
Two Major Classes of Innovation

• Long or Schumpeterian or Kondratieff Waves: 35-50 Years in Duration
  • Electric Power
  • Electronic Communications and Internet
  • Automobile
  • Semiconductor Devices
  • Software

• Very Rapid Incremental Advancements in Existing Technology: Months to Few Years in Duration
  • Integration of Product Design and Manufacturing
  • Making Products Smart by Embedding Microelectronics

Take Away: We Need Big Breakthroughs and Incremental Improvements; History Suggests EE and CE Will Be Major Drivers of Both
EE, CE & CS Have Earned Special Consideration as Economic Drivers

- Educate More of Population on Fundamentals of EE, CE & CS
- Need More EE, CE & CS Courses Crossing Other Disciplines
- Need More EE, CE & CS University Presidents and Provosts
- Promote EE, CE & CS to Prospective Students

**Take Away:** We Need Leaders Who Recognize the Importance of EE and CE
Economic Sinks: Three Sectors with Negative Productivity Growth

1. **Healthcare @ 18% of GDP – Larger Than Federal Budget Less Healthcare**

2. **Federal and State Governments @39 % of GDP**

3. **Public Education @ 5% of GDP Funded by Taxes**

**Take Away:** We aren’t likely to get GDP growth rate above 3.5 percent until healthcare, public education and government spending are under control.
# Proposed 2013 Federal R&D Budget

<table>
<thead>
<tr>
<th>Agency</th>
<th>2013 Proposed</th>
<th>Agency</th>
<th>2013 Proposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defense</td>
<td>$71.204 billion</td>
<td>H&amp;HS</td>
<td>$31.400 billion</td>
</tr>
<tr>
<td>NASA</td>
<td>$9.620 billion</td>
<td>Energy</td>
<td>$11.903 billion</td>
</tr>
<tr>
<td>NSF</td>
<td>$5.904 billion</td>
<td>Agriculture</td>
<td>$2.297 billion</td>
</tr>
<tr>
<td>Commerce</td>
<td>$2.573 billion</td>
<td>Transportation</td>
<td>$1.076 billion</td>
</tr>
<tr>
<td>EPA</td>
<td>$0.580 billion</td>
<td>Veterans Affairs</td>
<td>$1.166 billion</td>
</tr>
<tr>
<td>Education</td>
<td>$0.398 billion</td>
<td>Homeland Security</td>
<td>$0.729 billion</td>
</tr>
<tr>
<td>Others</td>
<td>$1.852 billion</td>
<td>Total</td>
<td>$140.82 billion</td>
</tr>
</tbody>
</table>

$40 Billion spent at universities

$45 Billion spent at government-owned laboratories

$55 Billion spent at companies

*Take Away: We Need Our Federal R&D Investment to Produce More Economic Growth*
### Comparison of Labs and Universities

<table>
<thead>
<tr>
<th>Quality Needed</th>
<th>Lab</th>
<th>University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diversity of Staff or Faculty</td>
<td>weak</td>
<td>strong</td>
</tr>
<tr>
<td>Non-Hierarchical Structure</td>
<td>weak</td>
<td>strong</td>
</tr>
<tr>
<td>Ease of Establishing Teams</td>
<td>strong</td>
<td>weak Individual Investigator</td>
</tr>
<tr>
<td>Innovation Culture &amp; Vision</td>
<td>weak mission focus</td>
<td>weak publish focus</td>
</tr>
<tr>
<td>Innovation Incentives</td>
<td>weak</td>
<td>weak</td>
</tr>
<tr>
<td>Partnership Incentives</td>
<td>weak</td>
<td>weak</td>
</tr>
<tr>
<td>Risk-Taking</td>
<td>weak</td>
<td>weak</td>
</tr>
<tr>
<td>Big Problem Focus</td>
<td>weak</td>
<td>weak</td>
</tr>
<tr>
<td>Trust</td>
<td>moderate</td>
<td>weak</td>
</tr>
</tbody>
</table>

**Take Away:** Turning Universities and government-owned Labs into Innovation Machines is a major task and will require pressure.
Federal R&D Accountability

• Hold Agencies Accountable for Turning R&D into Innovation
• Hold Performers of Federal R&D Accountable for Turning R&D into Innovation
  – Companies
  – Universities
  – Government-Owned Laboratories

TAKE AWAY: ACCOUNTABILITY WILL HELP FEDERAL R&D PRODUCE MORE ECONOMIC GROWTH
We propose that NIH spend 10 percent of its R&D budget on healthcare services productivity growth, healthcare cost reduction and disease prevention and that Department of Education spend its R&D budget on increasing the productivity and quality of education.
We propose that any educational institution receiving federal R&D funds be required to offer education options that can be pursued for no more than $10,000 for a four-year education.
We propose that companies employing an electrical or computer engineering or computer science student in a co-op or intern position be permitted to pay one term of that student’s tuition for each term of work and take that tuition payment as a tax credit.
We propose that government-owned laboratories be required to (1) employ 1 percent of their total workforce as electrical or computer engineering students in co-op or intern positions and (2) pay one term of each student’s college tuition for each term of work.
We propose that each university receiving federal R&D funds be required to use 10 percent of its federal R&D funds to promote innovation by establishing and nurturing an economic ecosystem that spins off entrepreneurs and small companies. We recommend that states match the federal innovation investment at each of its public universities. We also recommend that the innovation history of a university be a consideration in selection of university projects to fund by any federal agency.
We propose that each government-owned laboratory be required to use 10 percent of its federal R&D funds to promote innovation by establishing and nurturing an economic ecosystem that spins off entrepreneurs and small companies. We also recommend that the innovation history of a government-owned laboratory be a consideration in selection of which government-owned laboratory to fund by any federal agency.
We recommend that the Federal Government task a panel of distinguished scientists and engineers from universities to identify the top 20 most important research inventions and resulting innovations in the past 25 years from each government-owned laboratory. This effort should be updated every five years.
We propose that the H1B Visa Program establish a special category for immigrant entrepreneurs called H1BE and that this program be open to any foreign-born scientist, business-person or engineer who meets H1B requirements and wishes to come to the US to start a new company. However, if after 5 years an H1BE immigrant has not started a new company that employs 20 or more people, they will not be eligible for receipt of a green card.
Summary Of Take-Aways

- **We need a 3.5 percent GDP growth rate and a balanced federal budget**
- **Innovation is about job creation in the private sector**
- **Shift emphasis from R&D inputs and outputs to innovation outcomes**
- **Use federal R&D to grow multiple, self-sustaining economic ecosystems and emphasize high risk, high-payoff, multi-disciplinary projects**
- **We need big breakthroughs and incremental improvements; history suggests EE and CE will be major drivers of both**
- **We need leaders who recognize the importance of EE and CE**
- **We aren’t likely to get GDP growth rate above 3.5 percent until healthcare, public education and government spending are under control**
- **We need our federal R&D investment to produce more economic growth; accountability will help**
- **We need universities and government-owned laboratories to become nuclei for economic ecosystems**
QUESTIONS?
SUGGESTIONS?