Beyond Einstein:
New Jersey’s* Contributions to World Science and Technology

* also New York City and Philadelphia

Michael G. Littman
Mechanical and Aerospace Engineering
Princeton University
Since 1664 …

• What radical innovations originate and thrive in NJ ?

• Who are the key people ?

• How has society changed ?
Since 1664 …

• What radical innovations originate and thrive in NJ?

• Who are the key people?

• How has society changed?

For this talk …

• List NJ innovators, innovations, and organizations

• Select the most significant

• Group them

Common theme emerges – NJ contributions to origin and development of electric power and information networks is extensive
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Common theme emerges – NJ contributions to origin and development of electric power and information networks is extensive
Edward Sorel – “People of Progress” – 20th Century

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Christian Schussele – “Men of Progress” – 19th Century

Christian Schussele – “Men of Progress” – 19th Century

Register base-plate signed by Alfred Vail in 9 places – note on bottom ...."This lever and roller were invented by me in the sixth story of the New York Observer office, in 1844, before we put up the telegraph line between Washington and Baltimore... I am the sole and only inventor of this mode of telegraph embossing writing. Professor Morse gave me no clue to it... and I have not asserted publicly my right as first and sole inventor, because I wished to preserve the peaceful unity of the invention, and because I could not, according to my contract with Professor Morse, have got a patent for it. "
First Grouping

- Ideas
- Inventions
- Industries
First Grouping

- Ideas
- Inventions
- Industries

Ideas

Joseph Henry
- strong electromagnet

Albert Einstein
- theory of relativity

John von Neumann
- stored-program
- digital computer
Ideas

Joseph Henry
strong electromagnet

Albert Einstein
theory of relativity

John von Neumann
stored-program
digital computer
At the time of ... my original experiments on electro-magnetism ..., I was urged by a friend to take out a patent, both for its application to machinery and to the telegraph, but this I declined, on the ground that I did not then consider it compatible with the dignity of science ... In this perhaps I was too fastidious. – J. Henry 1876

The release of atom power has changed everything except our way of thinking...the solution to this problem lies in the heart of mankind. If only I had known, I should have become a watchmaker. – A. Einstein 1945

It would appear that we have reached the limits of what it is possible to achieve with computer technology, although one should be careful with such statements, as they tend to sound pretty silly in 5 years. – J. von Neumann 1949
All residents of Princeton NJ

Daniel Chester French Statue of Joseph Henry at Princeton University

Horse-shoe Electromagnet

Electric Motor
POWER

Telegraph
INFORMATION

NUCLEAR POWER

NUCLEAR WEAPONS

Memory used for program and data

Memory

Control Unit

Arithmetic Logic Unit

Accumulator

Input

Output

INFORMATION

Memory used for program and data

NEUTRON

NUCLEAR POWER
Inventions

Edison
  Phonograph

Bardeen, Brattain, Shockley
  Transistor

Townes, Schawlow
  Laser

All residents of Princeton NJ

Daniel Chester French
  Statue of Joseph Henry at Princeton University

Horse-shoe Electromagnet
Inventions

Edison
Phonograph

Bardeen, Brattain, Shockley
Transistor

Townes, Schawlow
Laser
How society changed

Archival recordings of voice and music - as significant as photography

Miniature electronic devices; portable, rugged, fast, instant on

Optical storage of digital data; Optical transmission of data
Menlo Park, NJ
West Orange, NJ

Murray Hill, NJ

New York, NY
Murray Hill, NJ

Lasers can provide light in a narrow beam of high intensity and pure color. They were first operated in 1960 and revolutionized technologies from communications to surgery and led to everyday items like CD players.

Celebrate the Century - 1960s
One invention leads to another – carbon button microphone leads to the phonograph
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Edison Transmitter – Compressing carbon grains reduces resistance which increases current – transforms sound undulations into current undulations.
Edison’s Patent
Drawing of Carbon Microphone

Edison Transmitter – Compressing carbon grains reduces resistance which increases current – transforms sound undulations into current undulations.
Edison’s Patent
Drawing of Carbon Microphone

Rotating Tin Foil Cylinder
Recorder
Sharp pin deforms the foil

Pin to compress granules
Carbon granules

Reproducer
Blunt pin follows deformations

Edison’s Patent
Drawing of Phonograph
Industries

Edison
Electric Power

Sarnoff and Armstrong
Radio & TV

J. P. Morgan and T. N. Vail
Telegraph & Telephone

L. H. Baekeland
Bakelite – first plastics

Edison’s Patent
Drawing of Carbon Microphone
Industries

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Bakelite – first plastics
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Telegraph & Telephone

L. H. Baekeland
Bakelite – first plastics

Alpine NJ – First FM Radio Tower
<table>
<thead>
<tr>
<th>R &amp; D Laboratories</th>
<th>Industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edison Laboratories</td>
<td></td>
</tr>
<tr>
<td>Menlo Park, NJ</td>
<td>Edison</td>
</tr>
<tr>
<td>RCA Laboratories</td>
<td></td>
</tr>
<tr>
<td>NYC; West Windsor, NJ</td>
<td>Electric Power</td>
</tr>
<tr>
<td>Bell Laboratories</td>
<td></td>
</tr>
<tr>
<td>NYC; Murray Hill, NJ</td>
<td>Sarnoff and Armstrong</td>
</tr>
<tr>
<td></td>
<td>Radio &amp; TV</td>
</tr>
<tr>
<td></td>
<td>J. P. Morgan and T. N. Vail</td>
</tr>
<tr>
<td></td>
<td>Telegraph &amp; Telephone</td>
</tr>
<tr>
<td></td>
<td>L. H. Baekeland</td>
</tr>
<tr>
<td></td>
<td>Bakelite – first plastics</td>
</tr>
</tbody>
</table>
R & D Laboratories

Edison Laboratories
   Menlo Park, NJ

RCA Laboratories
   NYC; West Windsor, NJ

Bell Laboratories
   NYC; Murray Hill, NJ

Manufacturing

Edison Lamp Works
   Harrison, NJ

RCA Vacuum Tubes
   Harrison, NJ

Western Electric Company
   Kearny, NJ

General Bakelite Company
   Perth Amboy, NJ
Second Grouping

- Capturing
- Communicating
- Computing

Manufacturing

Edison Lamp Works
Harrison, NJ

RCA Vacuum Tubes
Harrison, NJ

Western Electric Company
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General Bakelite Company
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Second Grouping

- Capturing
- Communicating
- Computing

Capturing

Edison – Phonograph - Sound
Kinetoscope - Movies

Jansky – Radio Astronomy
Penzias & Wilson – Big Bang

Boyle & Smith – CCD
Digital Photography
Capturing

Edison – Phonograph - Sound
Kinetoscope - Movies

Jansky – Radio Astronomy
Penzias & Wilson – Big Bang

Boyle & Smith – CCD
Digital Photography
WHY isn't your motion picture show making you the great big money you read about? How is it that the man in the next block can show the same pictures you do—and take the crowds away from you? We'll tell you. It's all in the machine—you need an

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Orpheum Music Hall

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THE ORIGINAL AND ONLY
“The Great Train Robbery,” directed by Edwin S. Porter in 1903, was one of the first commercially successful story films. This box-office hit became part of the Western genre.

CELEBRATE THE CENTURY – 1900s

filmed in Milltown NJ
"The Great Train Robbery," directed by Edwin S. Porter in 1903, was one of the first commercially successful story films. This box-office hit became part of the Western genre.

Celebrate the Century - 1900s

filmed in Milltown NJ
On April 27, 1933, Karl Jansky reported that he had received cosmic radio signals. An American physicist and radio engineer with Bell Telephone Laboratories, Jansky had confirmed Maxwell's theory of scalar electromagnetic radiation. In 1951, while investigating static that had interfered with short wave radio transmissions, Jansky recorded a repeating signal of unknown origin. Thus was born the modern science of radio astronomy.
CCD invented at Bell Labs (Murray Hill NJ) by Willard Boyle and George Smith
Communicating

Telegraph & Telephone
Bell

Radio & TV
RCA

Satellites
Bell and RCA
J. R. Pierce

CCD invented at Bell Labs (Murray Hill NJ)
by Willard Boyle and George Smith
Communicating

Telegraph & Telephone
Bell

Radio & TV
RCA

Satellites
Bell and RCA
J. R. Pierce

TIROS 1 – first weather satellite
RCA Astro Labs in East Windsor, NJ
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RCA Astro Labs in East Windsor, NJ

ECHO 1 – first communications relay
Bell Labs – Holmdel, NJ

TELSTAR – first television pictures
and telephone calls
Bell Labs – Murray Hill, NJ
Computing

Computer
John von Neumann

UNIX
Dennis Ritchie
Ken Thompson

C Programming Language
Dennis Ritchie

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Computer
  John von Neumann

UNIX
  Dennis Ritchie
  Ken Thompson

C Programming Language
  Dennis Ritchie

Stamp issued in 1996
50th anniversary of ENIAC
Universities

Computer
  Princeton and Penn

Telegraph
  NYU

Radio & Laser
  Columbia

Stamp issued in 1996
50th anniversary of ENIAC
<table>
<thead>
<tr>
<th>PEOPLE</th>
<th>Nobel Prizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electromagnet</td>
<td>Henry</td>
</tr>
<tr>
<td>Relativity</td>
<td>Einstein</td>
</tr>
<tr>
<td>Computer</td>
<td>Von Neumann</td>
</tr>
<tr>
<td>Laser</td>
<td>Townes, Schawlow</td>
</tr>
<tr>
<td>Electric Lamp</td>
<td>Edison</td>
</tr>
<tr>
<td>Phonograph</td>
<td>Edison</td>
</tr>
<tr>
<td>Transistor</td>
<td>Bardeen, Brattain, Shockley</td>
</tr>
<tr>
<td>Satellite</td>
<td>Pierce</td>
</tr>
<tr>
<td>CCD</td>
<td>Boyle, Smith</td>
</tr>
<tr>
<td>UNIX &amp; C</td>
<td>Ritchie, Thompson</td>
</tr>
<tr>
<td>Radio &amp; TV</td>
<td>Sarnoff, Armstrong</td>
</tr>
<tr>
<td>Electric Power</td>
<td>Edison</td>
</tr>
<tr>
<td>Motion Picture</td>
<td>Edison</td>
</tr>
<tr>
<td>Bakelite</td>
<td>Baekeland</td>
</tr>
<tr>
<td>PLACES</td>
<td></td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>Menlo Park</td>
<td>Phonograph, Electric Light</td>
</tr>
<tr>
<td>West Orange</td>
<td>Motion Pictures, Later Phonograph</td>
</tr>
<tr>
<td>Princeton</td>
<td>Von Neumann Computer</td>
</tr>
<tr>
<td>Harrison</td>
<td>Lamps, Vacuum Tubes</td>
</tr>
<tr>
<td>Kearny</td>
<td>Telephone manufacturing</td>
</tr>
<tr>
<td>West Windsor</td>
<td>Color TV</td>
</tr>
<tr>
<td>East Windsor</td>
<td>Satellite design and construction</td>
</tr>
<tr>
<td>Trenton</td>
<td>Wire Rope for Brooklyn and GW Bridges</td>
</tr>
<tr>
<td>Murray Hill</td>
<td>Transistor, Laser, CCD, UNIX</td>
</tr>
<tr>
<td>Holmdel</td>
<td>Satellite, Radio Astronomy</td>
</tr>
<tr>
<td>Morristown</td>
<td>Telegraph tests</td>
</tr>
<tr>
<td>NYC</td>
<td>Central Station Electricity</td>
</tr>
<tr>
<td>Philadelphia</td>
<td>ENIAC Computer</td>
</tr>
<tr>
<td>Perth Amboy</td>
<td>Bakelite</td>
</tr>
</tbody>
</table>
A few final observations and two questions ….

NJ technologies are transformational. They changed the way we live our lives.

NJ (and NYC and Philadelphia) nurtured many radical innovations (Radio, TV, Telephone, Electric Power, Transistor, Computer, Laser, Plastics). These objects and systems are the core of our modern INFORMATION AND POWER NETWORKS.

It is a great history of early stage radical innovation

Two Questions – “Why NJ?” and “Why not NJ?”