

Manufacturing and Innovation: The GE Perspective

Stephan Biller
April 4, 2013



Market-focused R&D

- First U.S. industrial lab
- Began 1900 in Schenectady, NY
- Today: 3000 technologists, 6+ sites
- Founding principle ... improve businesses through technology



Cornerstone of GE's commitment to technology

GE Global Research

Market-focused R&D



Global Research Center
Niskayuna, NY



India Technology Center
Bangalore, India



China Technology Center
Shanghai, China



Global Research Europe
Munich, Germany



**Advanced Manufacturing &
Software Technology Center**
Ann Arbor, MI



Global Software Center
Silicon Valley, CA



Brazil Technology Center
Rio de Janeiro, Brazil

- ~2,200 scientists/engineers, nearly two-thirds PhDs.
- 3,522 US patents filed by GE in 2012
- One of the world's most diversified industrial research organizations, providing innovative technology for all of GE's businesses

A tradition of innovation



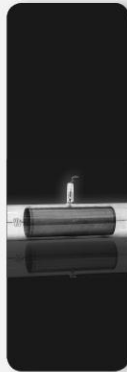
1879
Carbon
Filament
Incandescent
Lamp



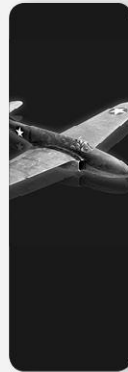
1895
World's
Largest
Electric
Locomotive



1920
Portable
X-Ray
Machine



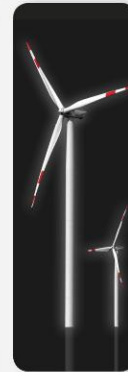
1921
The
Magnetron



1941
Entering the
Jet Age



1998
Lightspeed™
CT Scanner



2002
Wind Power



2003
Evolution®
Locomotive



2009
Vscan™



2010
WattStation™



2012
Durathon™
Battery

Global environment

Materials ... rising costs & supply constraints

Production ... overcapacity in most industries

Labor ... increasing costs in the developing world



Product development ... shorter cycle times, more price points

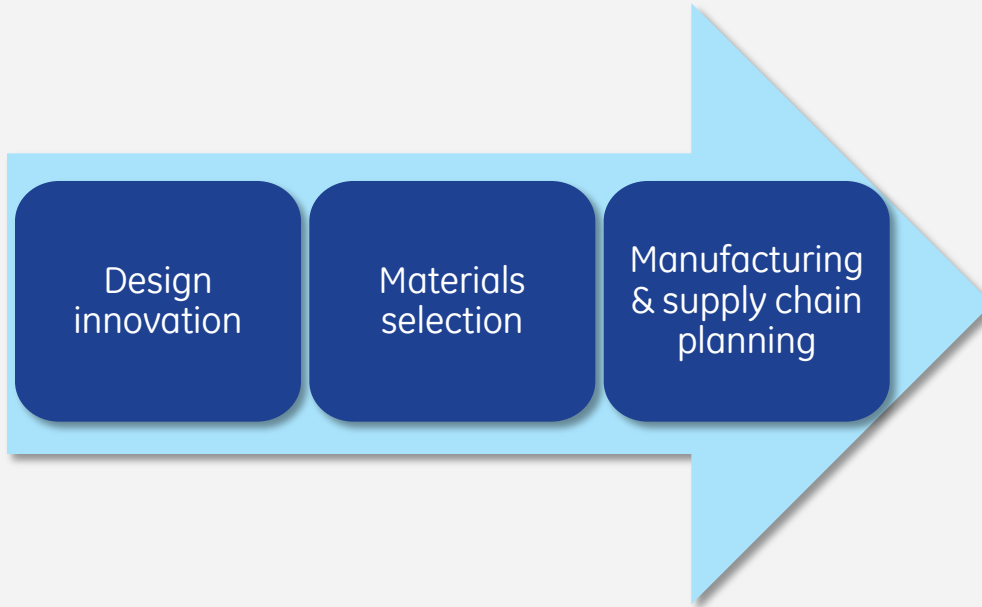
Must innovate differently



Rethinking Industrial R&D

Old

Design dictates materials and manufacturing selection



- Mostly sequential process
- Few interactions
- Limits design options

New

Manufacturing and materials differentiate product design



- Non-sequential process
- Creates interactions
- New degrees of freedom

Infusing technology into manufacturing



Carbon Fiber Composites



Novel Casting Technology



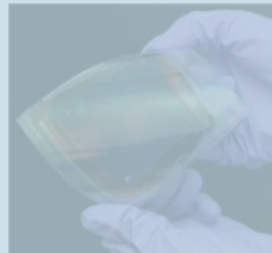
Hybrid Laser Welding



Microwave Brazing



Nano Spray Coatings

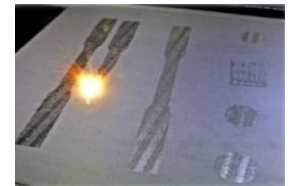


Printable Diodes

2x-7x decrease in material
30-50% increase in yield

Growing Trends / Recent Focus Areas:

- Additive Manufacturing
- Smart Manufacturing



Billet vs. Additive Manufacturing

Conventional



Start with a pre-formed billet, which gets formed and machined.

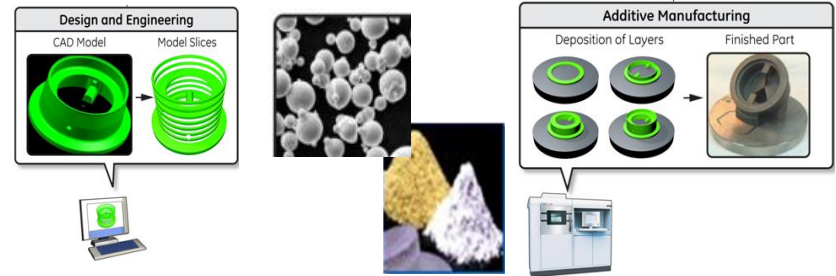
Material properties unchanged and cannot be location specific

Limited to known set of geometries

Design constrained by manufacturing

Requires extensive tooling

Additive



Start with a powder or wire and produce part layer upon layer upon layer.

Build material properties as part is built ... location specific

More complex geometries possible

Allows for faster iterations between design, materials and manufacturing

Minimal tooling required

**Material properties created during manufacturing
→ Ability to tailor by location**



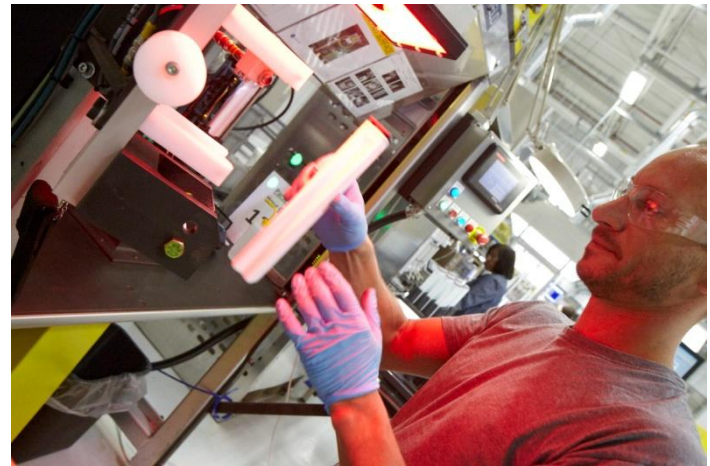
Inventing new technology

Advanced Batteries

Disruptive technology for
Transportation ... rail, marine,
road, mining

Growth opportunity for
telecommunications,
uninterruptible power supplies,
smart grid

Novel chemistry and materials
creating a \$1B business



Durathon Battery Plant

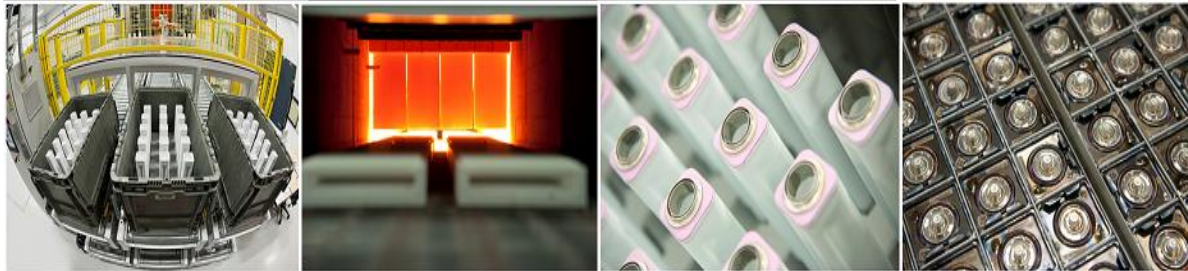
- 10,000+ sensors measure temperature, humidity, air pressure and machine operating data.
- The swipe of a finger can prevent machine malfunctions and adjust processes.



The result? Continuously improving efficiency & quality at speed like never before.

Supply Chain Execution Durathon Battery Plant

Battery performance
can.....

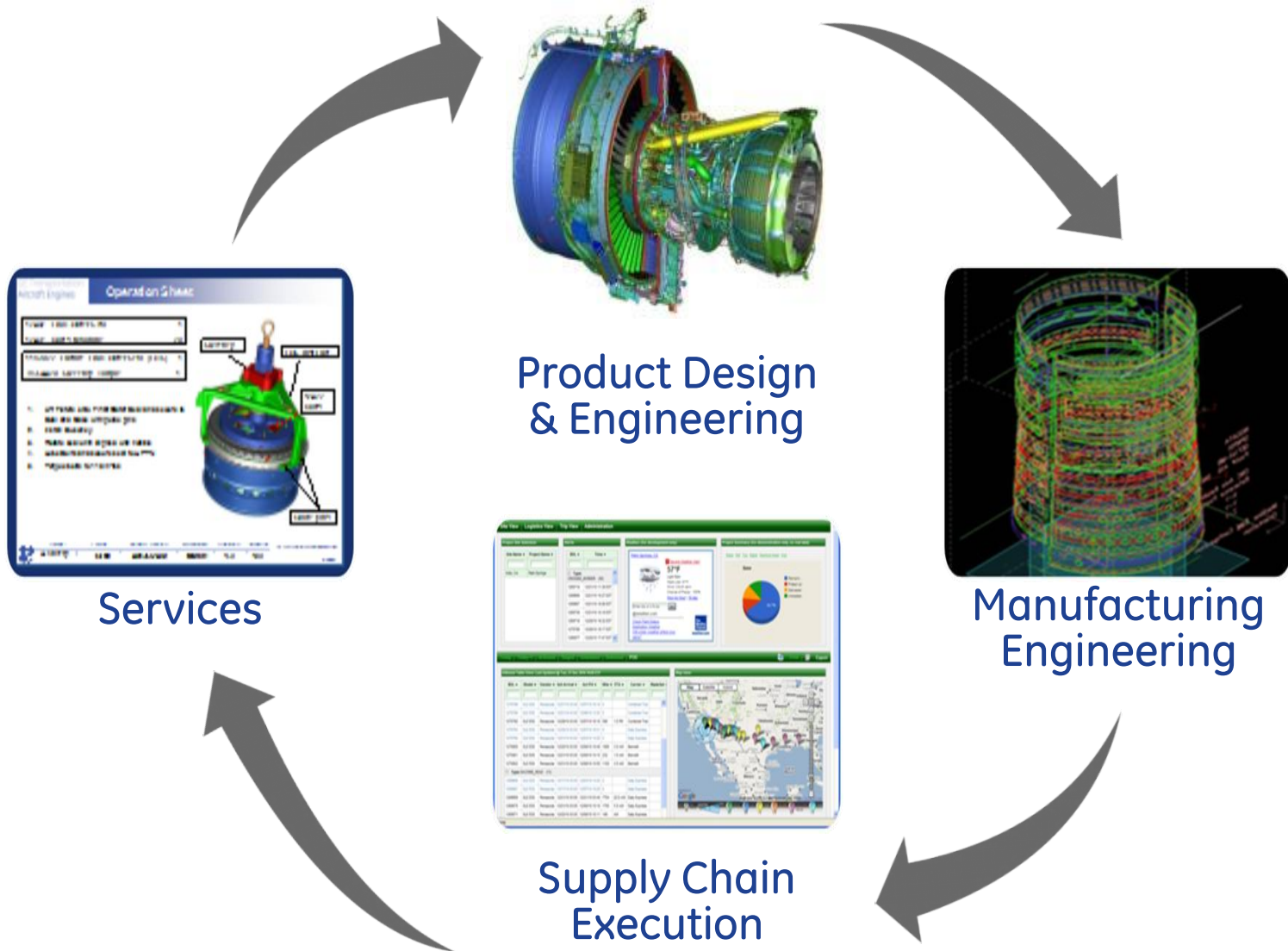


..... be traced back to
batches of powder

..... and analyzed at every step in between.

Powered by data, reimagined battery manufacturing.

Smart Manufacturing:



GE at Work in the Capital Region

GE Healthcare ... Digital X-ray Detector
Production Facility at the RPI Tech Park
150 people

GE Transportation ... Battery Plant in
Schenectady
>350 jobs, 100 more to be added

GE Energy ... Renewable Energy
Headquarters in Schenectady
650 jobs

GE Global Research ...
100 new hires in past three years



GE Healthcare Detector facility
LEED Gold certified



GE Battery Plant

**Investments in technology
created >1,000 jobs**