A Systems Approach to a Research University’s Research and Innovation Strategy

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What I’d like to share with you

- Key SE process applied to a university’s strategy
- Georgia Tech: A research university
  - Brief overview
  - Research strategy – a systems focus
  - Some examples
- Atlanta: Innovation Ecosystem
- Related UARC research at Georgia Tech
- Summary
Key SE processes

• System description
• Requirements
• Risk management
• Technical leadership

Conjecture: How this is done differs in “bottom up” organizations like research universities
<table>
<thead>
<tr>
<th>Attribute</th>
<th>Systems Engineering Approach</th>
<th>Research Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>End product description</td>
<td>Grand challenge description</td>
</tr>
<tr>
<td>Requirements</td>
<td>Decompose into statements of what is needed; define known approaches for addressing them</td>
<td>Decompose into statements of what is needed; define open research issues to address in order to eventually achieve needs</td>
</tr>
<tr>
<td>Risks</td>
<td>Select technical viable approaches with predictable cost and schedule</td>
<td>Promote risk taking in exploration, experimentation, and evaluation of novel ideas; pursue accelerated maturation using a risk management approach</td>
</tr>
<tr>
<td>Team Leadership</td>
<td>Disciplined management approach, often directive</td>
<td>Anticipatory; influence and support others</td>
</tr>
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# SE Methods We Use at Georgia Tech

<table>
<thead>
<tr>
<th>System Description</th>
<th>Grand Challenges</th>
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<tbody>
<tr>
<td>Requirements</td>
<td>Roadmaps</td>
</tr>
<tr>
<td>Risk Management</td>
<td>Test Beds, Experimentation, &amp; Maturation Focus</td>
</tr>
<tr>
<td>Technical Leadership</td>
<td>Faculty Leaders Supported by Senior Administrators</td>
</tr>
</tbody>
</table>
Georgia Tech – an interconnected graph

Academics and Research
- College of Architecture
- College of Business
- College of Computing
- College of Science
- College of Engineering

Applied Research
- Georgia Tech Research Institute (GTRI)
- Market Focused Translational Research

Economic Development
- Enterprise Innovation Institute
- Advanced Technology Development Center
- Venture Lab

Professional Education
- Global Learning Center
- On Site, On Demand
- Savannah, France, Ireland, China . . .
Georgia Tech’s Innovation Assets Span Discovery to Commercial Innovation

Increasing Breakthrough Potential | Increasing Technology Maturity

Enterprise Innovation Institute

Increasing Commercial Maturity

College Based Research

Interdisciplinary Research Institutes

Georgia Tech Research Institute

Discovery Research | Use-Inspired Basic Research | Applied Research | Technology Maturation & Deployment
Core Research Areas:
*High-Impact, Real-World Research with Translational Focus*

- Big Data
- Bioengineering and Bioscience
- Electronics and Nanotechnology
- Energy and Sustainable Infrastructure
- Manufacturing, Trade, and Logistics
- Materials
- National Security
- Renewable Bioproducts
- People and Technology
- Public Service, Leadership, and Policy
- Robotics
- Systems
An example of a grand challenge

Reference: Organics Electronics Industry Organization,
http://www.oled-info.com/why-organic-electronics-better
A Roadmap for U.S. Robotics
From Internet to Robotics
2013 Edition

Henrik I Christensen, Georgia Tech
Roadmap V2.0

- Outlines
  - Where are the business needs & drivers?
  - What are the gaps we need to address?
  - What R&D do we need to conduct to close the gaps?
- Increase the number of jobs and grow the economy!
- Educate the future workforce
System-Level Experimentation (SLE)

Campaigns of experiments to explore system alternatives through innovative combinations of technologies, process, and organizations in a future environment.

Increases ability to discover game-changing applications

Risk mitigation in innovation experiments

Decompose into subsystem components, explore alternatives, & conduct requirements analysis

- $C_1, R_{1,m}$ – preceded solution
  - Risk reduction methods: Implement per engineering process

- $C_2, R_{m+1,n}$ – applicable technical solution but team experience lacking
  - Risk reduction methods: Build prototype to gain team experience

- $C_3, R_{n+1,p}$ – promising but unproven, technical solution
  - Risk reduction methods: Experiment with research products

- $C_4, R_{p+1,r}$ – no mature technology, but research programs exist
  - Risk reduction methods: Utilize technology scouting program

- $C_5, R_{r+1,s}$ – no known solution
  - Risk reduction methods: Use innovation competitions to discover useful solution approaches

Increasing technical risk

Leadership Model

described in publication at [http://www.research.gatech.edu/evpr/crosstalk](http://www.research.gatech.edu/evpr/crosstalk)

### Achieving Results

(measurable) outcomes expected of the organization

<table>
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<tr>
<th><strong>Serving Others</strong></th>
<th><strong>Building Community</strong></th>
<th><strong>Improving Culture</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Be authentic</td>
<td>Create shared vision</td>
<td>Seek effectiveness</td>
</tr>
<tr>
<td>Listen actively</td>
<td>Communicate frequently</td>
<td>Improve continuously</td>
</tr>
<tr>
<td>Think boldly</td>
<td>Build positive relations</td>
<td>Foster healthy competition</td>
</tr>
<tr>
<td>Act courageously</td>
<td>Pursue inclusive excellence</td>
<td>Experiment often</td>
</tr>
<tr>
<td>Encourage constantly</td>
<td>Facilitate interdisciplinarity</td>
<td>Learn from failures</td>
</tr>
<tr>
<td>Stay accountable</td>
<td>Provide incentives</td>
<td>Celebrate successes</td>
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### Strategic Alignment

— strategy, vision, mission, values
Something is happening in Midtown Atlanta. Georgia Tech’s city-centered campus has become one of the nation’s leading destinations for corporate research centers. Over the last decade, Tech Square, the eight-square-block area in Midtown designed to facilitate private and public research ventures, has attracted the corporate research centers of 12 Fortune 500 companies, including AT&T, Panasonic, and Coca-Cola, as well as hundreds of small technology startups. And just recently, NCR, one of the largest U.S. electronics companies, moved its global headquarters from the suburbs to Tech Square, bringing along 3,600 employees.

Why Today’s Corporate Research Centers Need to be in Cities

Harvard Business Review

https://hbr.org/2016/03/why-todays-corporate-research-centers-need-to-be-in-cities
Innovation Centers

innovation centers are physical spaces and/or teams set up by organizations in a global tech hub, with the goal of leveraging the startup, industry and academic ecosystems that these hubs provide.
Corporate Innovation @ Georgia Tech

In Tech Square:
• Panasonic Innovation Center
• ThyssenKrupp Research and Innovation Center
• AT&T Foundry
• Home Depot Technology Center
• CONA Development & Innovation Lab
• Southern Company Energy Innovation Center
• Delta Air Lines Innovation Center
• Anthem Innovation Studio
• Emerson “Helix” Innovation Center
• Keysight Technologies Software Design Center
• UCB Solution Accelerator

Adjacent to Campus:
• Stanley Black and Decker Digital Accelerator
• Worldpay (HQ) Fintech Startup Accelerator Program
• NCR Hosted Solutions Lab
• Coca-Cola External Technology Acquisition (HQ)
Our best innovators are our students!
Student Driven Innovation

- GE Smart Grid Challenge
- InVenture Prize
- Capstone Design Expo
- Convergence Innovation Competition
- Georgia Tech Research & Innovation Conference
- Entrepreneurs Without Borders
- and many more
Transitioning SERC Core Research: “-ilities Tradespace”

**RESEARCH**
Integrate MBSE and MDAO

**RESEARCH**
Scenario Based Needs Context

**RESEARCH**
Flexible workflows

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**TRANSITION**
“Executable” Model Based Systems Engineering enabled through Modeling and Simulation

**TRANSITION**
High Performance Computing enables forecasting operational impacts on design decisions

**TRANSITION**
Customized, repeatable, and automated workflows for data analytics and decision making
GT SERC Research is Integrated into GT Education Programs

GT Systems Engineering Education

**PROFESSIONAL MASTER’S IN APPLIED SE**
**DOMAIN SPECIFIC SE COURSES**
**SE SHORT COURSES**

- Research Integrated and Applied in all courses via faculty & mentors
- Building MBSE & MDAO Foundations
- Pushing Boundaries of MBSE

Methods & Tools Drive Capstone Projects:

- US Coast Guard Tradespace Analysis Tool for Future Arctic Communications
- Atlanta Smart Cities Project Decision Aids
- Georgia Watershed Mgmt. Monitoring UAV
- GT: Community Resilience via Distributed Microgrids
- Children’s Health Care of Atlanta “ECMO” System
- Decision Aids for Georgia’s Aquarium Modernization
- AAA: Connected Vehicle Network Security
Summary

• Systems engineering principles are useful in supporting a breadth of research of a major university

• Implementation of systems engineering functions may differ from stereotypical industry use

• Strategic leadership approaches must accommodate and support faculty-led research
THANK YOU!