

# **School of Systems and Enterprises:** **SE Transformation through Research**

# STEVENS

## Institute of Technology



SYSTEMS ENGINEERING  
Research Center

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# Stevens Institute of Technology

Founded in 1870





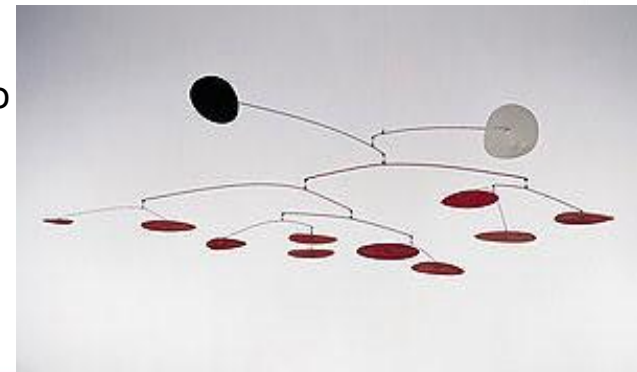


# Stevens Institute of Technology

## 140 Years of Legacy

- First Institute of mechanical engineering with science based studies and liberal technical education
  - ASME was launched at Stevens in 1880
- 1897 classmates launched U.S. automobile industry. Charles S. Mott, Co-founded General Motors. Harry T. Wilson pioneered designs of Chrysler automobiles and engines
- Radio industry launched by Louis A. Hazeltine (1906) who invented the first commercially feasible radio receiver selling 10 million sets in the 1920's. At Stevens, Hazeltine worked with faculty member, Irving Langmuir, who later won the Nobel Prize
- Electronics industry boosted by Eugene McDermott (1919) who launched Texas Instruments in 1951. Quote from McDermott's valedictory address

“Success when she comes to perch on our banners will see us in partnership with our Alma Mater.”
- New art form developed by McDermott's classmate, Alexander Calder, who



# Stevens Institute of Technology

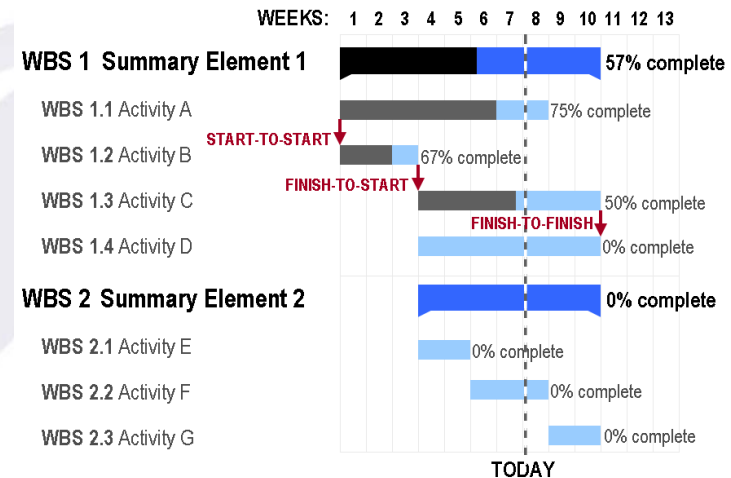
## 140 Years of Legacy

- Neutrino discovered by Frederick Reines (1939) who won the 1956 Nobel Prize in Physics.
- Internet and email advanced by pioneering work of David Farber (1956), (one of the fathers of the internet) and Stevens Professor of Physics, Stephen J. Lukasik, who became Director of ARPA when ARPANET was launched.
- Following Sputnik, U.S. space race advanced by Robert F. Garbarini (1940), who had oversight of all un-manned, science oriented space programs of NASA, including Ranger, Mariner, Pioneer, Lunar Orbiter and Surveyor I which took photos of the Moon.
- Caleb B. Hurtt (1953) became President and CEO of Martin Marietta where he led Titan I Missile Project, Apollo's application program, and Manned Space Center.
- Al Fielding (1939) invents Bubble Wrap and launches new industry with Sealed Air Corporation.





- Frederick Winslow Taylor graduated from Stevens in 1883
  - FATHER OF SCIENTIFIC MANAGEMENT
- Gantt graduated from Stevens in 1884
  - INVENTOR OF THE GANTT CHART



And today...

# Institutional Priorities and Critical Thrust Areas

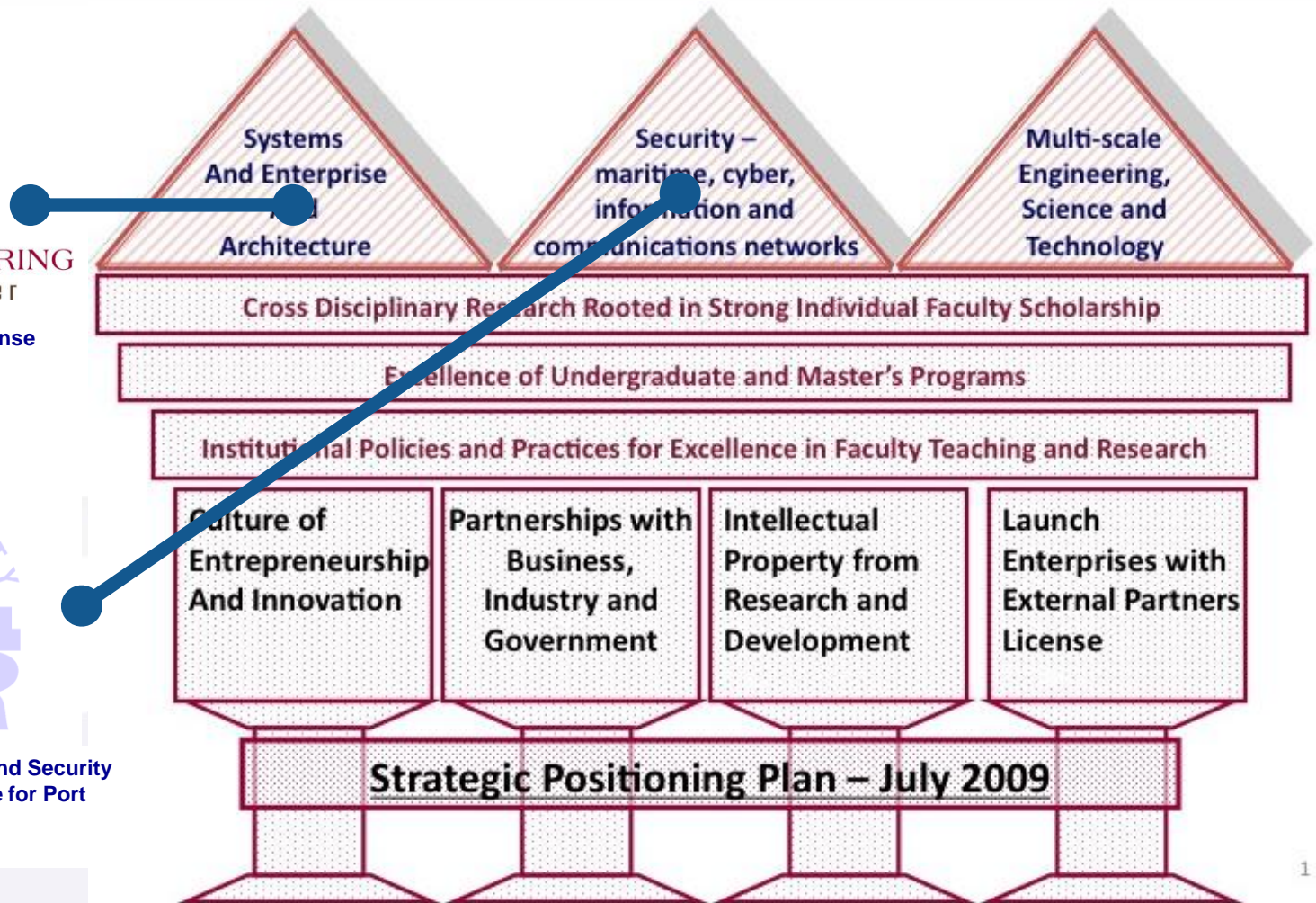


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SERC – A Department of Defense  
UARC



CSR – A Department of Homeland Security  
National Center of Excellence for Port  
Security



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# Systems Engineering Research Center

**STEVENS**  
Institute of Technology

**USC**  
UNIVERSITY  
OF SOUTHERN  
CALIFORNIA

  
**AUBURN**  
UNIVERSITY

  
**UMASS**

  
**UCSD**

  
UNIVERSITY OF  
MARYLAND

  
**AFIT**  
The Air Force Institute of Technology

 **Fraunhofer**

  
**NPS**  
PRAESTANTIA PER SCIENTIAM

**PENN STATE**  
 **Great Valley**

  
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**MISSOURI**  
**S&T**

**T M**

 **UAHuntsville**  
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

 **SMU**

 **TEXAS TECH UNIVERSITY**

**PURDUE**  
**UNIVERSITY**

  
UNIVERSITY Carnegie Mellon  
PENNSYLVANIA 1900

 **Georgia Institute**  
**of Technology**

 **UNIVERSITY of VIRGINIA**

 **Wayne State University**

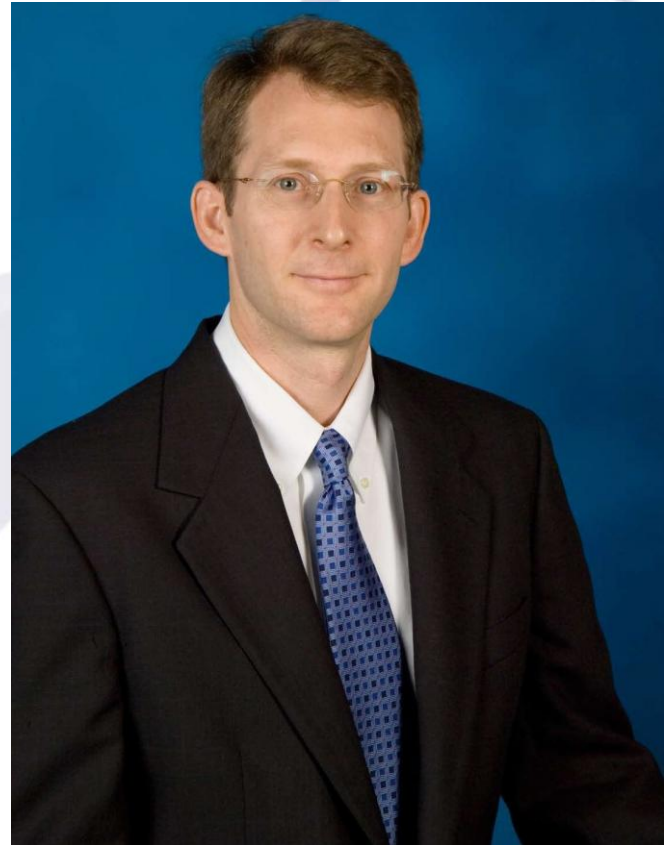
  
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 **SSE** School of  
Systems & Enterprises



## Research Strategy

**Dr. Jon Wade**  
**Associate Dean for Research,**  
**SSE**



- Systems Criticality & Trends
- SSE Research Strategy
- SSE Research Focus Areas
- Current Status



# 20<sup>th</sup> Century Technology



“I think the next century (21st) will be the century of complexity.”

- Stephen Hawking



Energy



Water

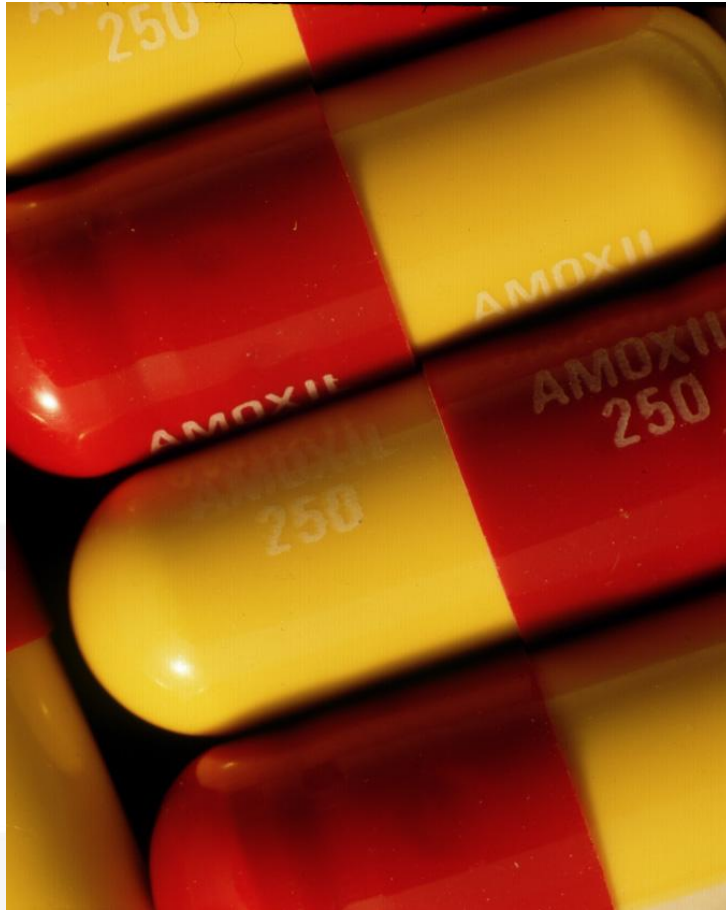




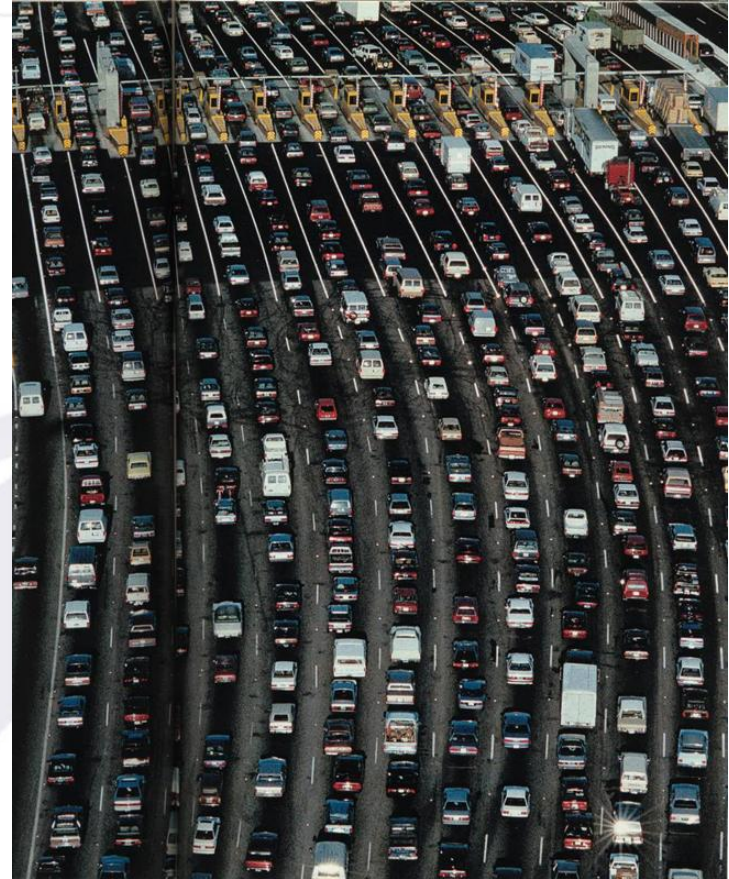
Agriculture



Fishing



Medicine



Transportation



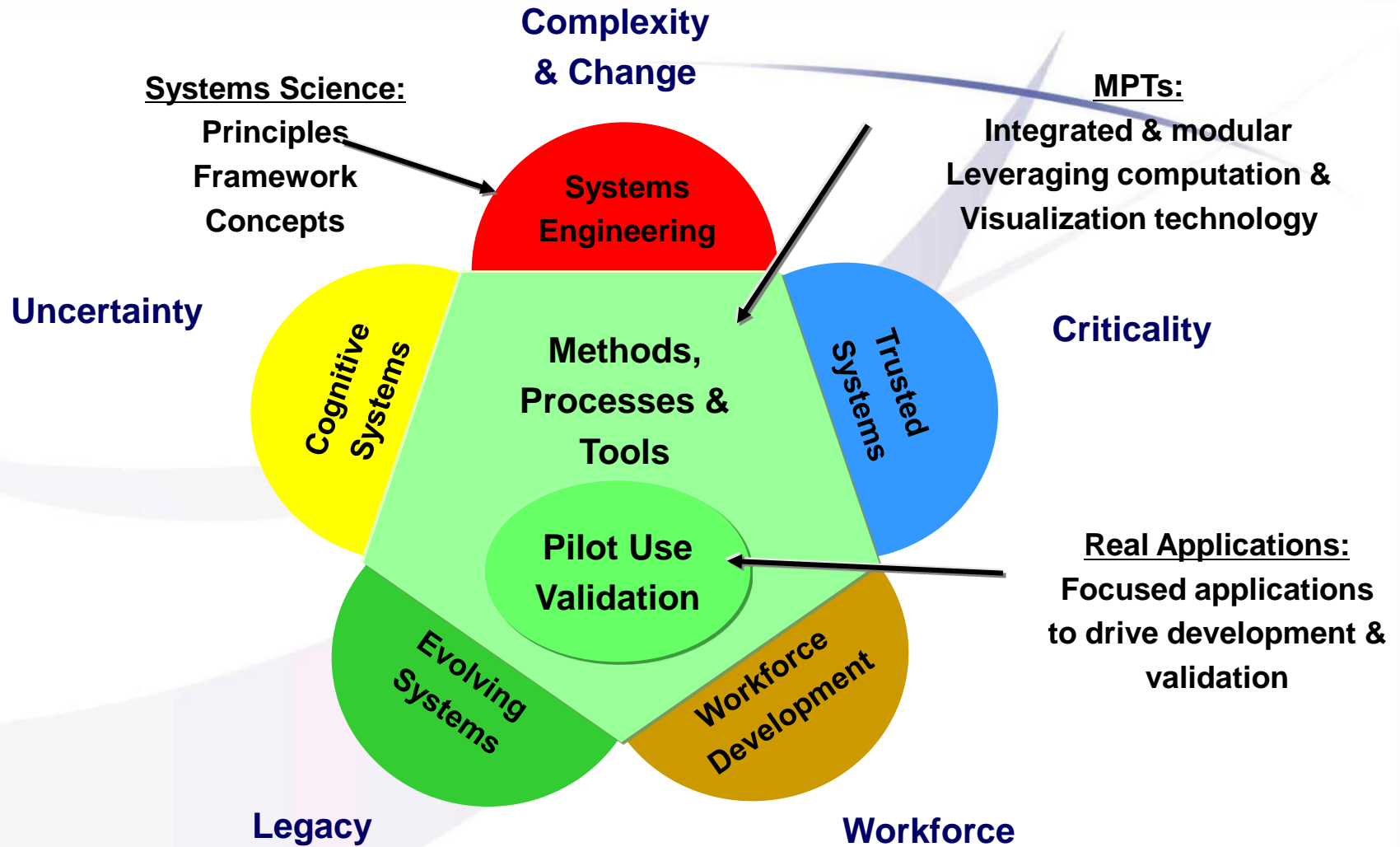
- Our critical challenges are systemic; the solutions must also be systemic.
- Solutions to these challenges are not just desired; they are required.
- A new component will not solve the problem. There are no silver bullets. There are not even any silver guns.
- Systems expertise is critical to success.



1. **Complexity:** adaptive & emergent
2. **Change:** time compression
3. **Uncertainty:** mission & environment
4. **Criticality:** essential to day to day life
5. **Legacy:** unplanned, ill-suited & growing
6. **Workforce:** great diversity, youth are perhaps best equipped for change & virtualization

# SSE Research Strategy

# Systems Research Areas





# 1. Cognitive Systems: Embracing Complexity

Complexity reflects the degree of difficulty in accurately predicting the behavior of a system:

Complexity  $\approx$   
f {# & variety of components,  
# & variety of interactions,  
non-deterministic behaviors}

Software & networking have caused a combinatorial explosion in the first two factors;

The human element greatly impacts the third

# The Networked Universe





This is complicated



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# This is Complex



**Embracing Complexity  
requires  
a paradigm shift in understanding**



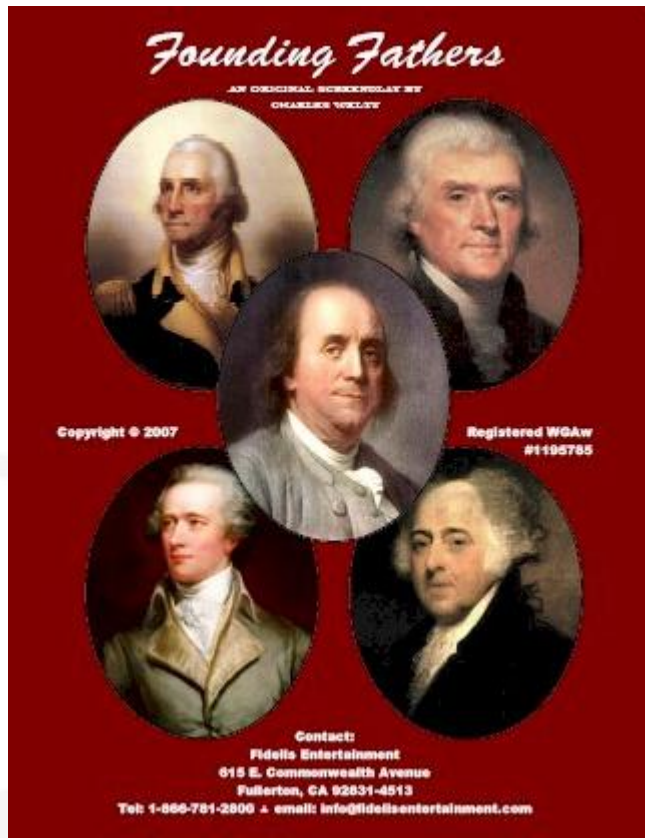
**From how the  
system *deterministically* works  
to how the  
system *stochastically* behaves**



*Definition:* Systems that can autonomously and rapidly response to changes in their operating environment using some level of cognitive ability (Self-adaptation, contextual self-awareness, experiential learning).

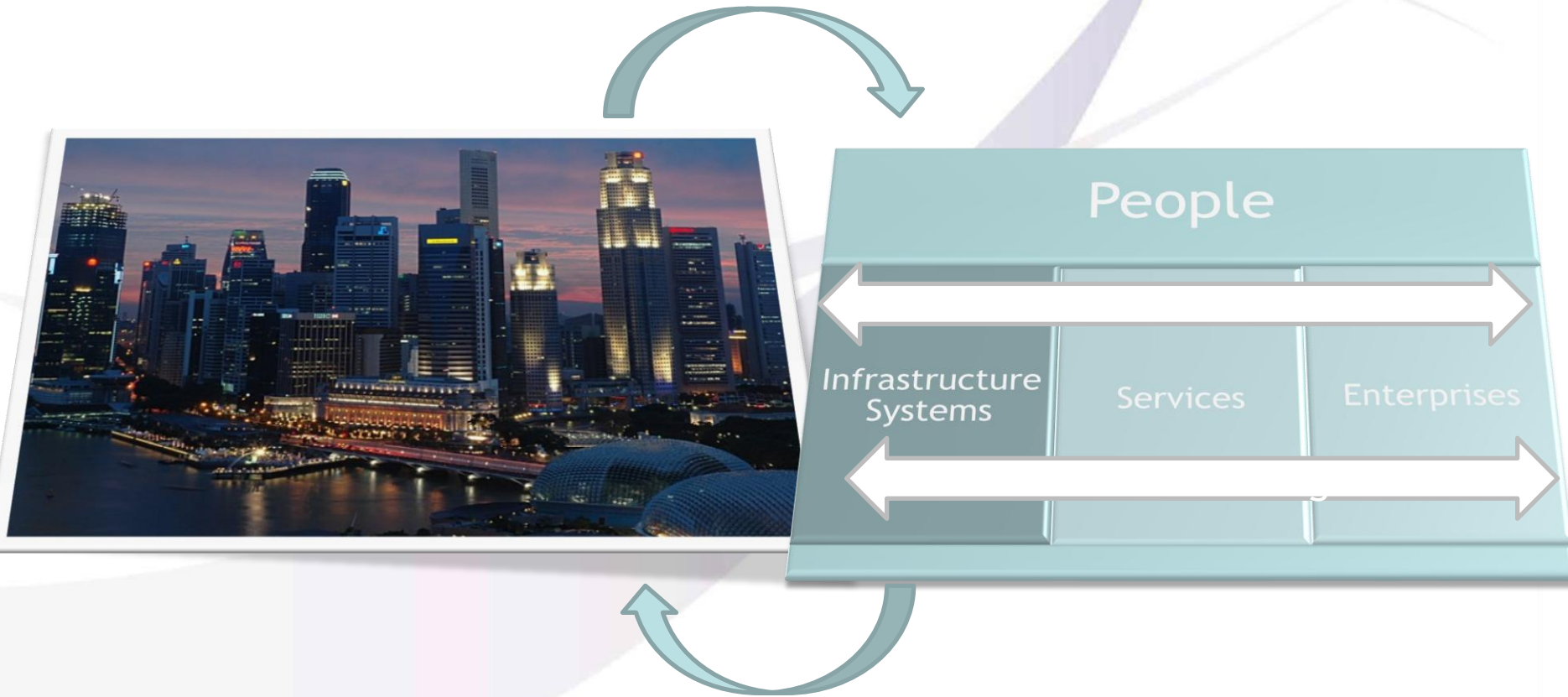
They are probabilistic, not deterministic; emergent behavior is the rule.

# Cognitive System Example





# Cognitive Cities: Towards Learning and Self-Adaptive Urban Systems and Enterprises



## **5. Workforce Development: Integrated, Experiential Learning**

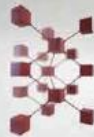
# What's More Effective?





# Experience Accelerator





Experience Accelerator

An Interdisciplinary Student Competition

# \$10,000 FOR A GAME DESIGN?

Yes, if it can accelerate how engineers and technical leaders gain experiences critical to the development of complex systems.

*Provide experience of downstream impacts from early conceptual and architectural decisions*

*Show how the system performs in its operational environment*

**Assemble  
your team and  
start today!**

Register at:  
[www.experience-accelerator.org](http://www.experience-accelerator.org)

## PRIZES

Grand Prize \$10,000  
2nd Prize \$5,000  
3rd Prize \$2,500

## IMPORTANT DATES

Kick-Off Webinar:  
**Jan 29, 2010**  
Submission Deadline:  
**May 7, 2010**

We challenge you to develop an Experience Accelerator in the form of an innovative serious game that enables future technical leaders to experience the demands of developing and deploying complex systems in the course of hours instead of years. Imagine a 'flight simulator' for complex systems developers!



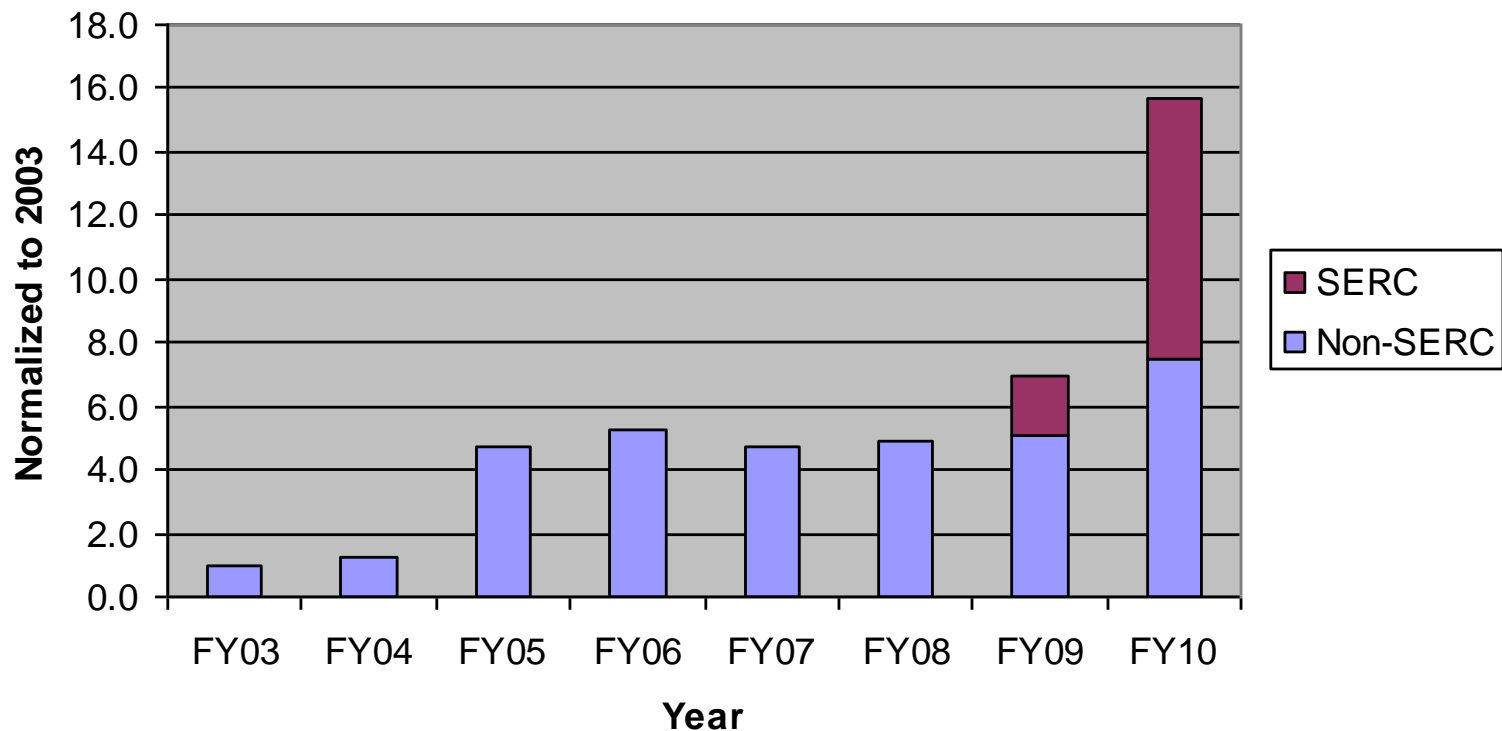
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# Current Status



## Normalized Research Expenditure Growth (FY2003 = 1.0)





200

230

260

290

320