

# Technological Innovation In the 21st Century

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The National Academies  
Washington, DC  
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# Technological Innovation

1. *Why is everyone in a hurry?*
2. *Where are we?*
3. *What do we see?*
4. *Where have we been?*
5. *Where do we need to go?*
6. *How are we going to get there?*

# Technological Innovation\*

1. *Why is everyone in a hurry?*

2. *Where are we?*

3. *What do we see?*

4. *Where have we been?*

5. *Where do we need to go?*

6. *How are we going to get there?*

\*Well, it's not just  
Technological.

# *Why is everyone in a hurry?*

Sound bites

Poetry

Facts

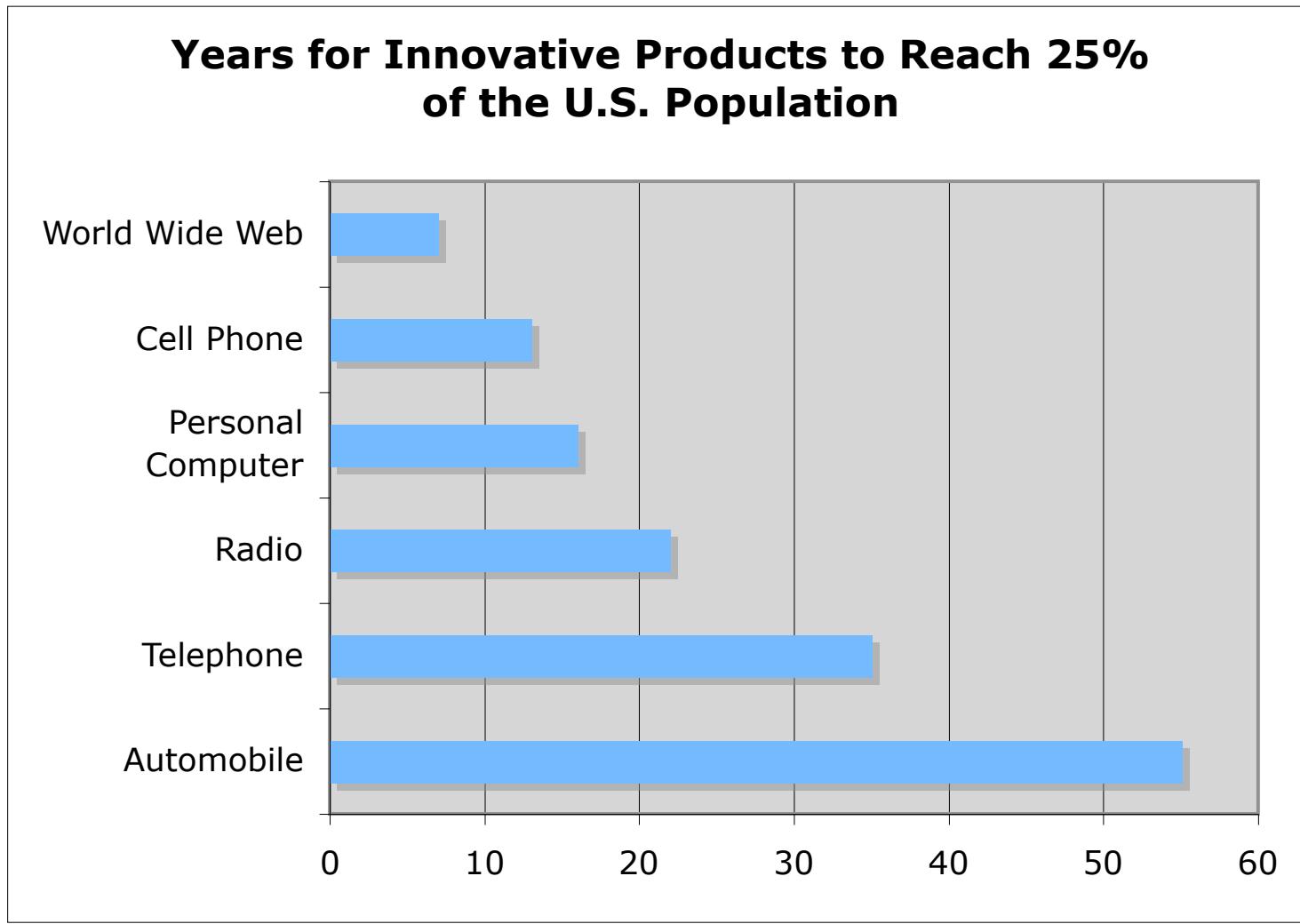
*“Innovate or Abdicate”*

-Sam Palmisano, CEO, IBM

*It doesn't matter whether you're a lion or a gazelle- when the sun comes up, you'd better be running.*

*-Richard Hodgetts*

# Why Everyone is in a Hurry.



# *Where are we?*

Four Facts

Three Consequences

One Principle

And an Irony

# Four Facts

- People everywhere are smart and capable.
- Science and Technology advance relentlessly.
- Globalization is a dominating reality.
- The Internet and World Wide Web are democratizing forces.

# Three Consequences

- Individuals must innovate.
- Companies must innovate.
- Nations and regions must innovate

# One Principle

## Competition drives Excellence and Innovation

- Competition among universities
  - For the best students, faculty, research, and scholarship
  - Merit-based awarding of research grants
- Competition among companies
  - To create new markets
  - To get to market first
  - To gain market share

# An Irony

In the 21st century Cooperation and Competition reinforce each other.

*What do we see?*

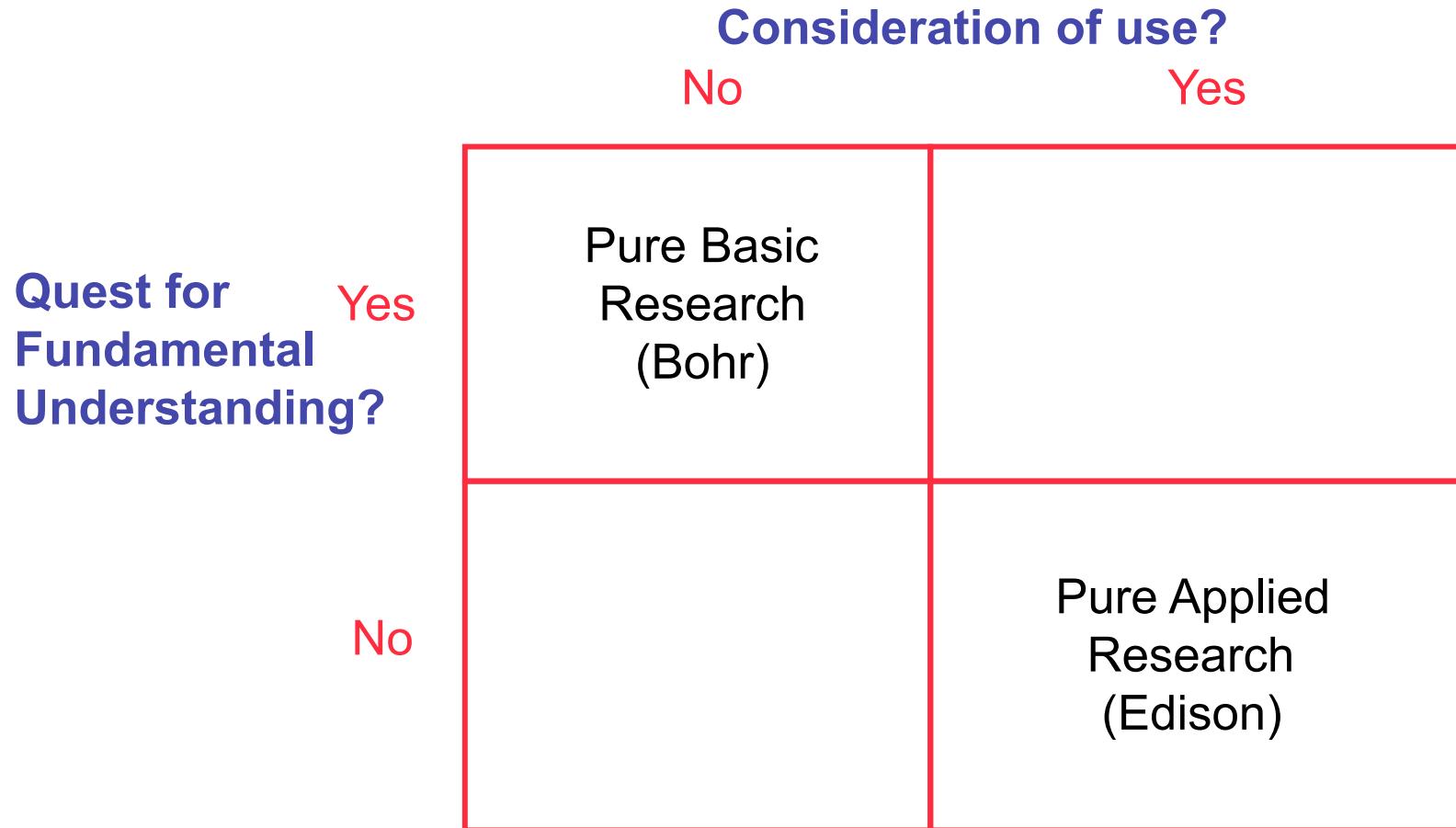
Research

People

R&D Funding

# R&D is increasingly performed in “Pasteur’s Quadrant”

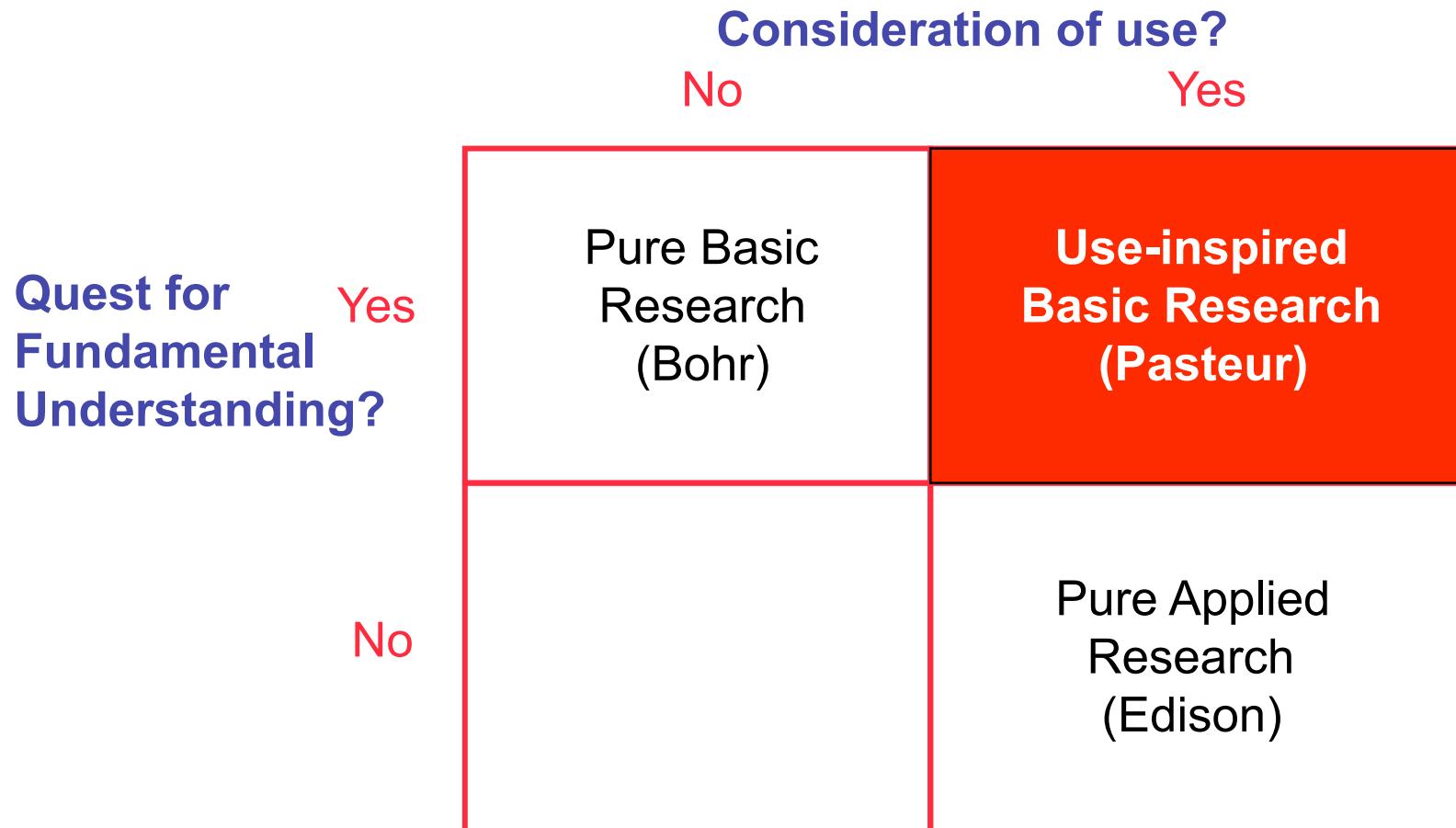
Research is inspired by:



Adapted from *Pasteur’s Quadrant: Basic Science and Technological Innovation*, Donald E. Stokes 1997

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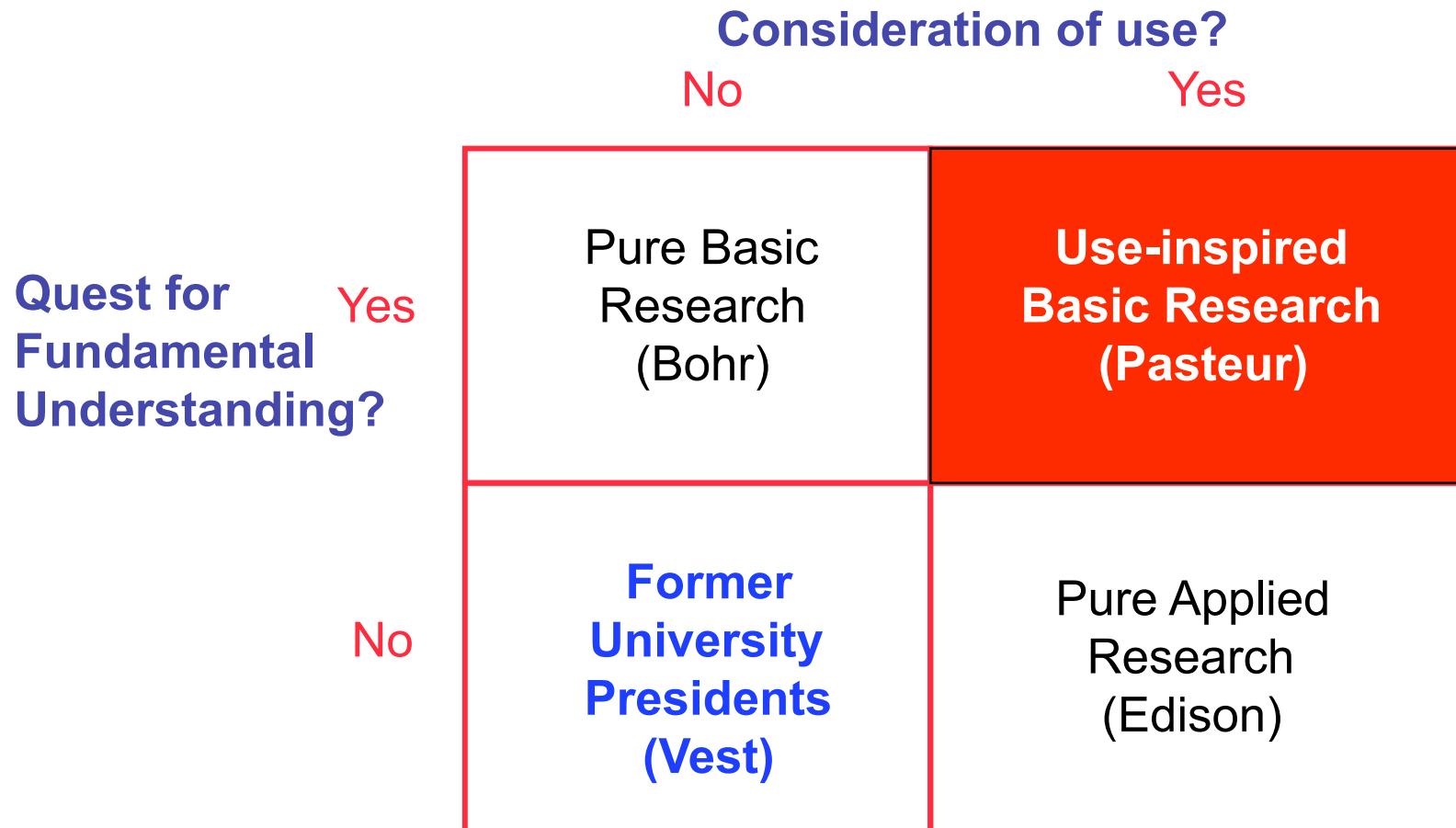
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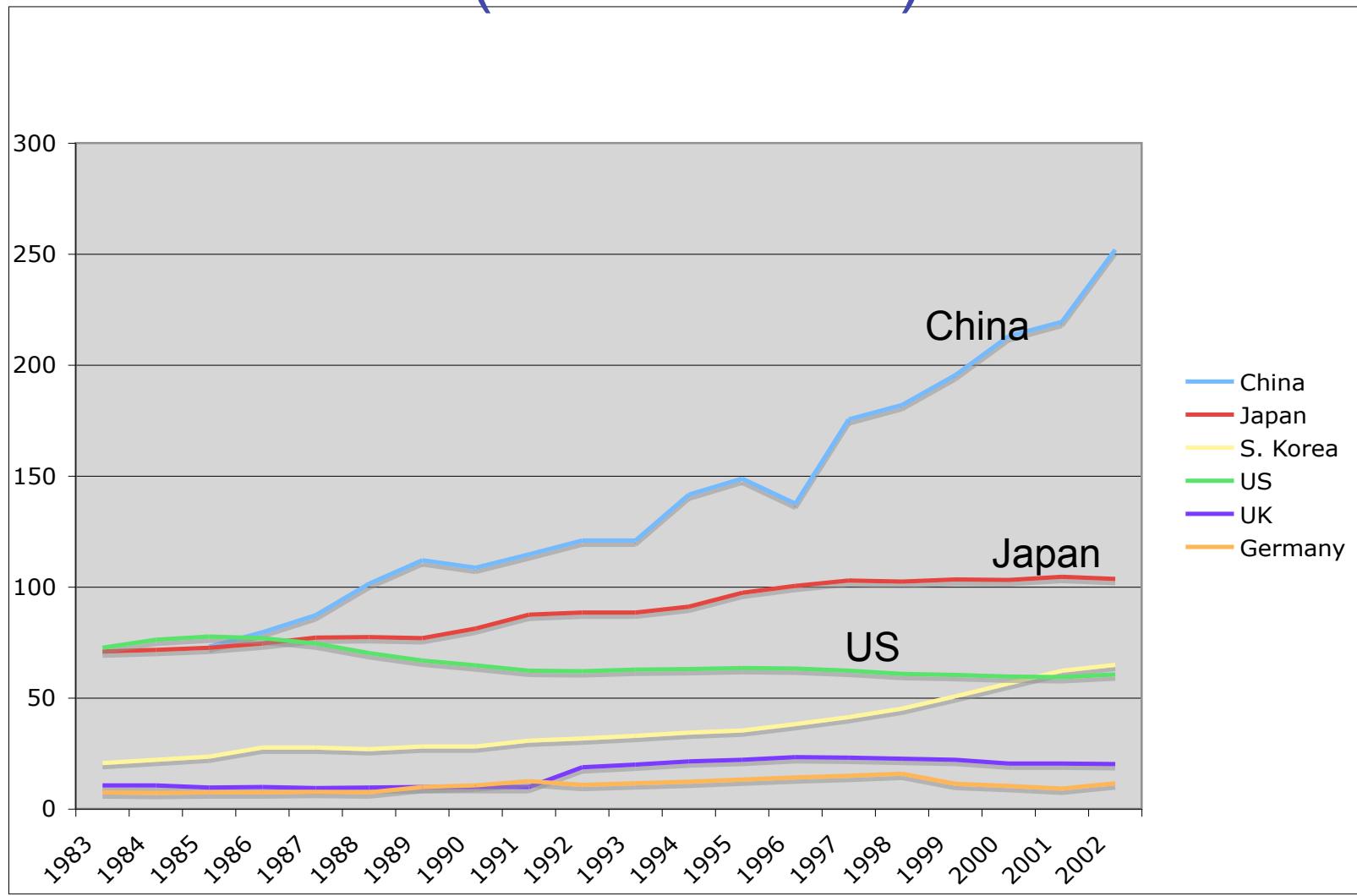
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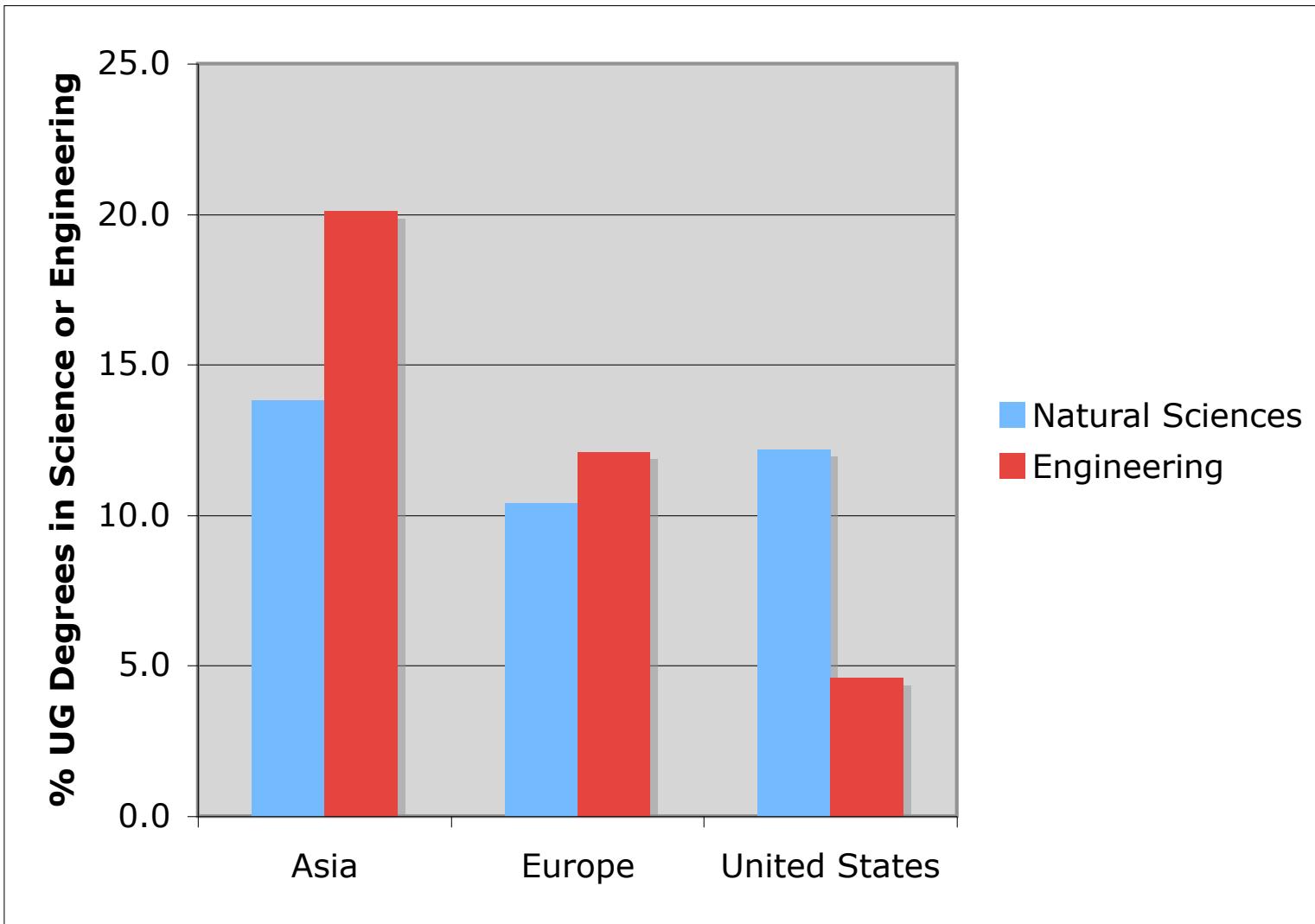
# First Engineering Degrees

## (China Rises.)



Source: Science and Engineering Indicators 2006, National Science Foundation, Washington, DC

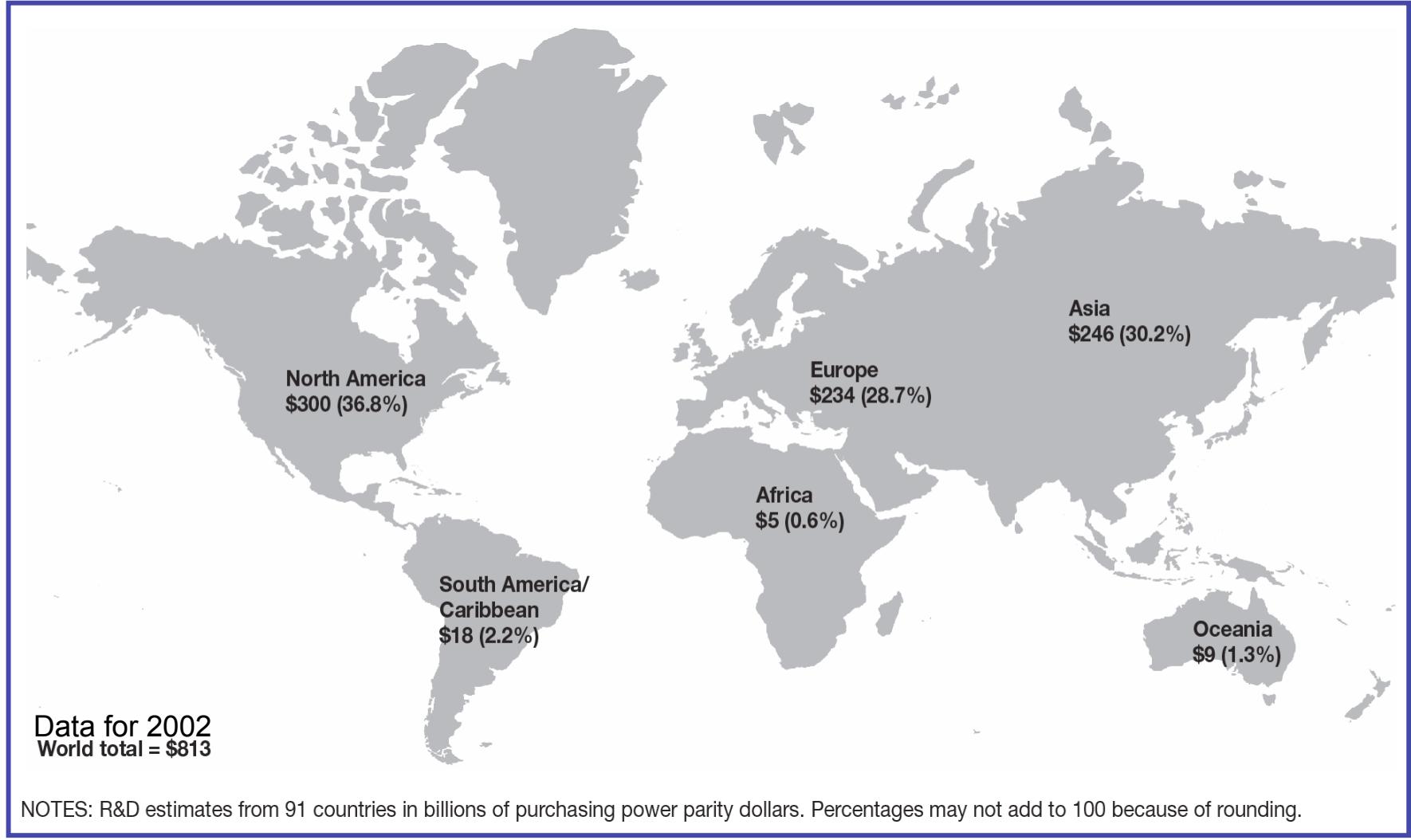
# S&E UG Degrees



Source: NSF Science and Engineering Indicators 2008

# Global R&D Investments

## R&D Expenditures and Share of World Total



Source: *Science and Engineering Indicators*, NSF 2008

*Where have we been?*

America's Innovation System from  
1945-2005

*A Brief history*

# The Vannevar Bush Report, 1945

## Primary Recommendations

- Universities should be the primary national Basic Research Infrastructure.
- Federal dollars do double duty:
  - Procure research results
  - Educate the next generation
- Award research grants based on competitive merit.
- Establish a National Science Foundation.

# The Bush Report's Economic Development Assumptions

- Linear

Basic Research --> Applied Research -->  
Product Development --> Market Products and Services

- *Laissez-faire*

Do basic research in universities and leave its commercialization to chance and market forces.

# From 1945 - 1985

- American research universities grew to excel.
- American companies dominated.
- Large corporations dominated.
- Corporations developed massive central research laboratories
  - Attracted outstanding university graduates
  - Conducted outstanding pure and applied research
  - Contributed to the S&T Commons

# Two Tectonic Shifts in the 1980s and 1990s

- **Japanese companies suddenly dominated manufacturing.**
- **American entrepreneurship expanded explosively.**

Comment

The Japanese Total Quality Movement was the Major Innovation of the 1980s.

It changed everything.

# Evolution of U.S. Corporate Innovation and R&D

- 1970s: Central Corporate Research Labs
- 1980s: R&D Absorbed and Transformed into Product Development
- 1990s: Purchase High-Tech Startups to acquire Innovation
- 2000s: Open Innovation Systems

# Evolution of U.S. University Research

- 1970s: The Engineering Science Revolution
- 1980s: Design, Manufacturing, Computer Science, Joint Management/Engineering
- 1990s: Life Science, Interdisciplinary, More “Use-Inspired”
- 2000s: These trends accelerating; more global cooperation

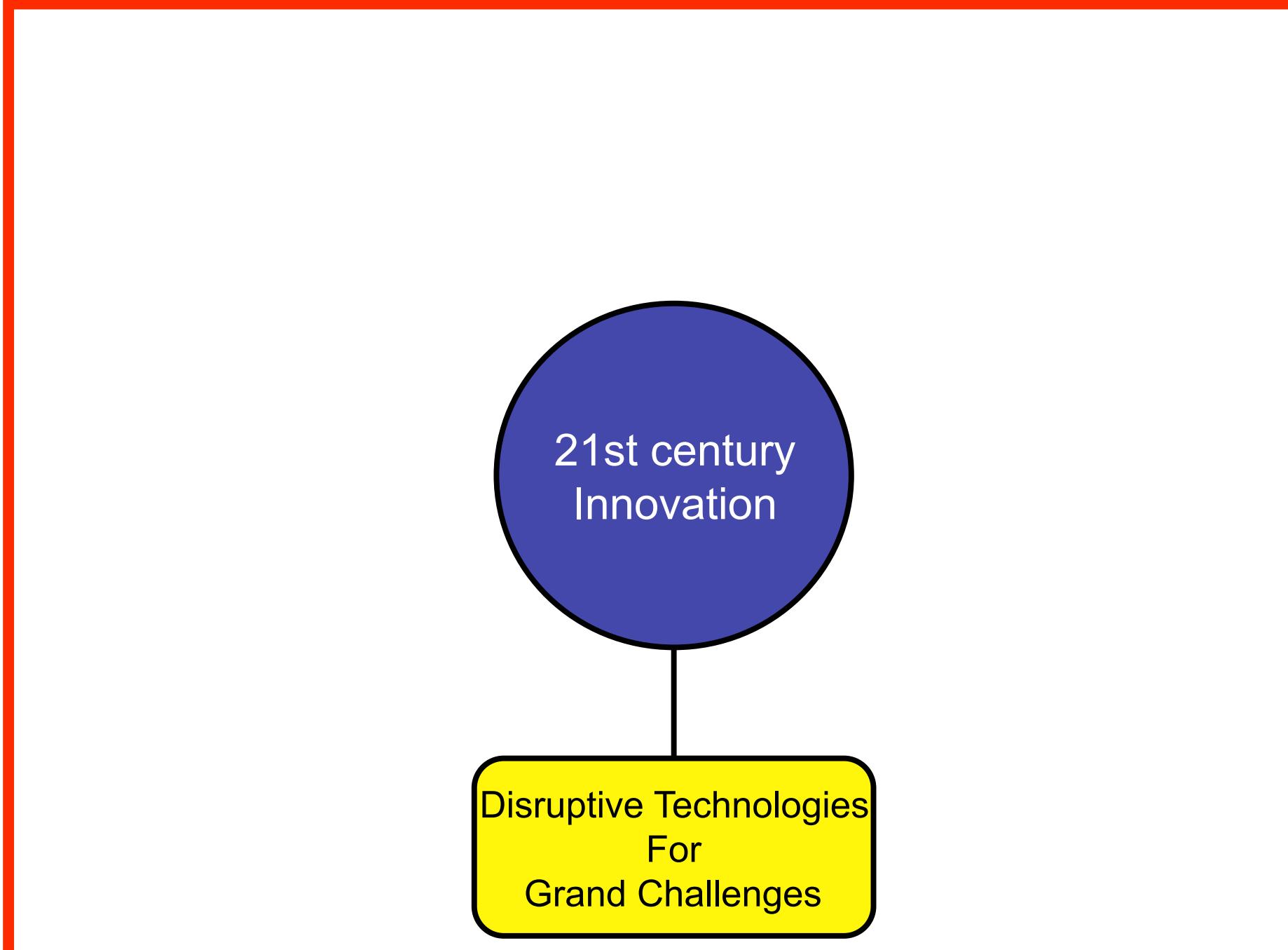
# *Where do we need to go?*

- Henry Chesbrough
- Clayton Christensen
- Michael Piore and Richard Lester
- John Hagel and John Seeley-Brown
- Judy Estrin
- Charles Weiss and William Bonvillian

*How are we going to get there?*

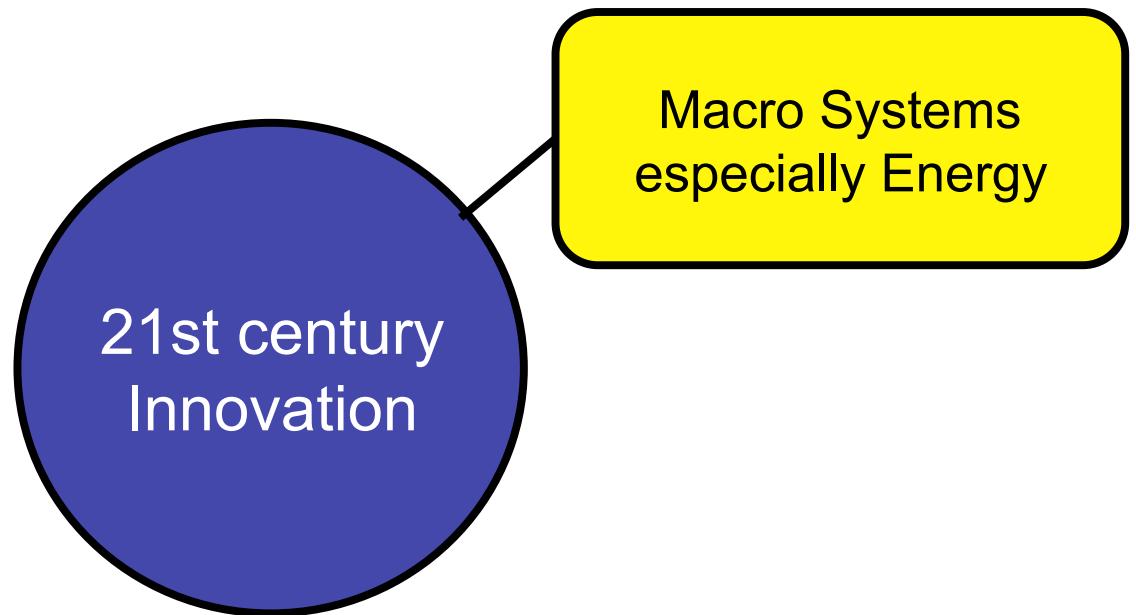
Life Sciences  
and  
Information Technology

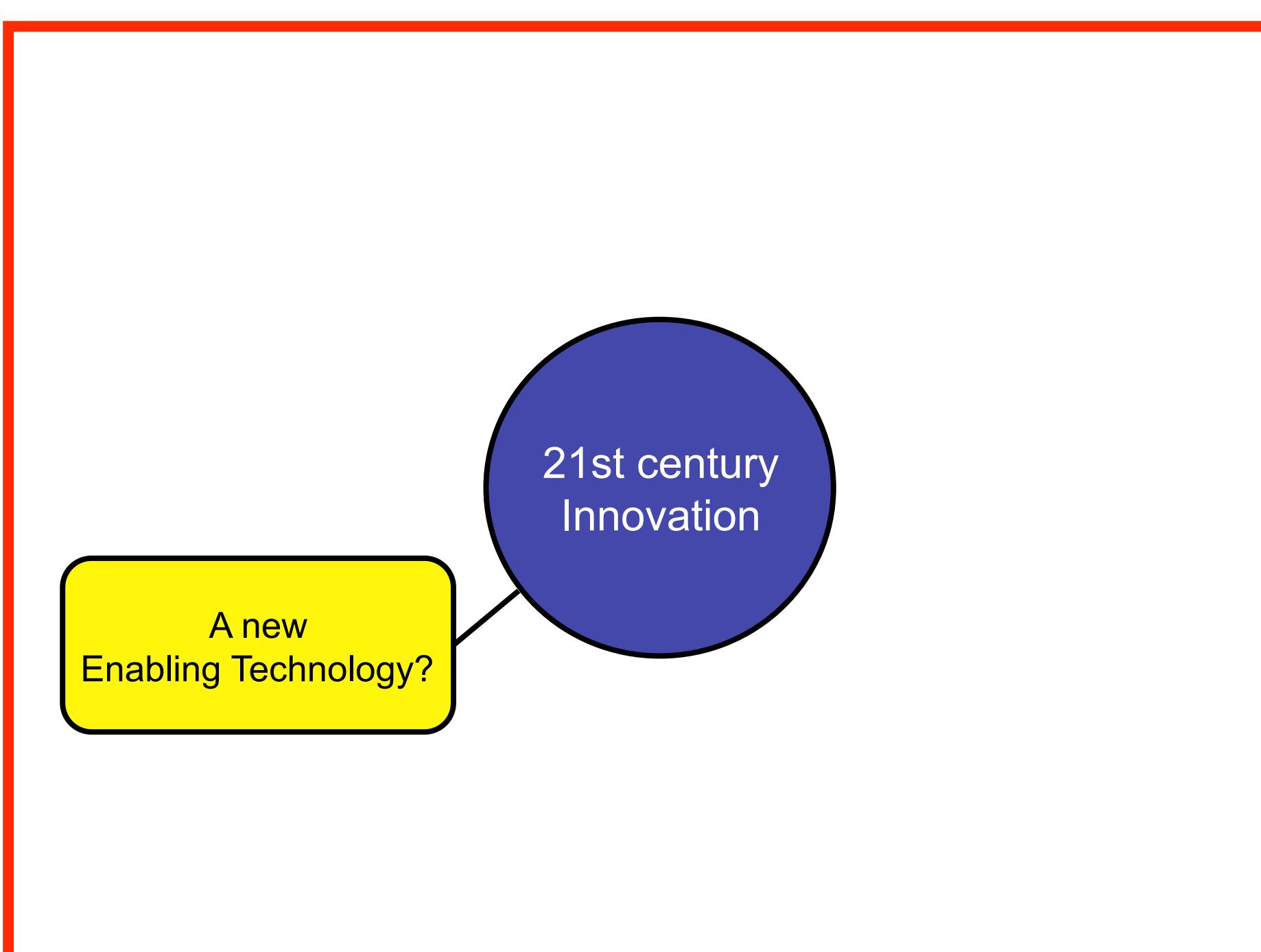
21st century  
Innovation



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Innovation

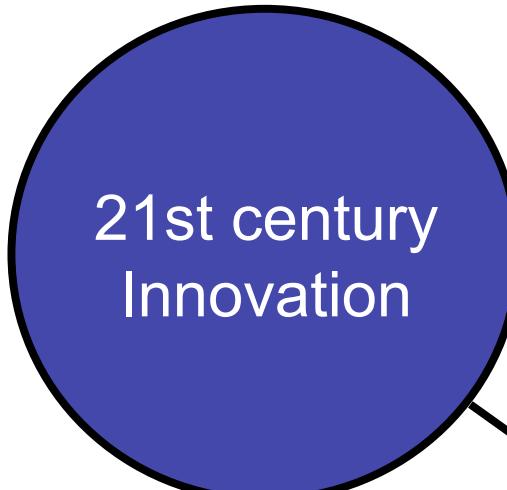
Disruptive Technologies  
For  
Grand Challenges





21st century  
Innovation

A new  
Enabling Technology?



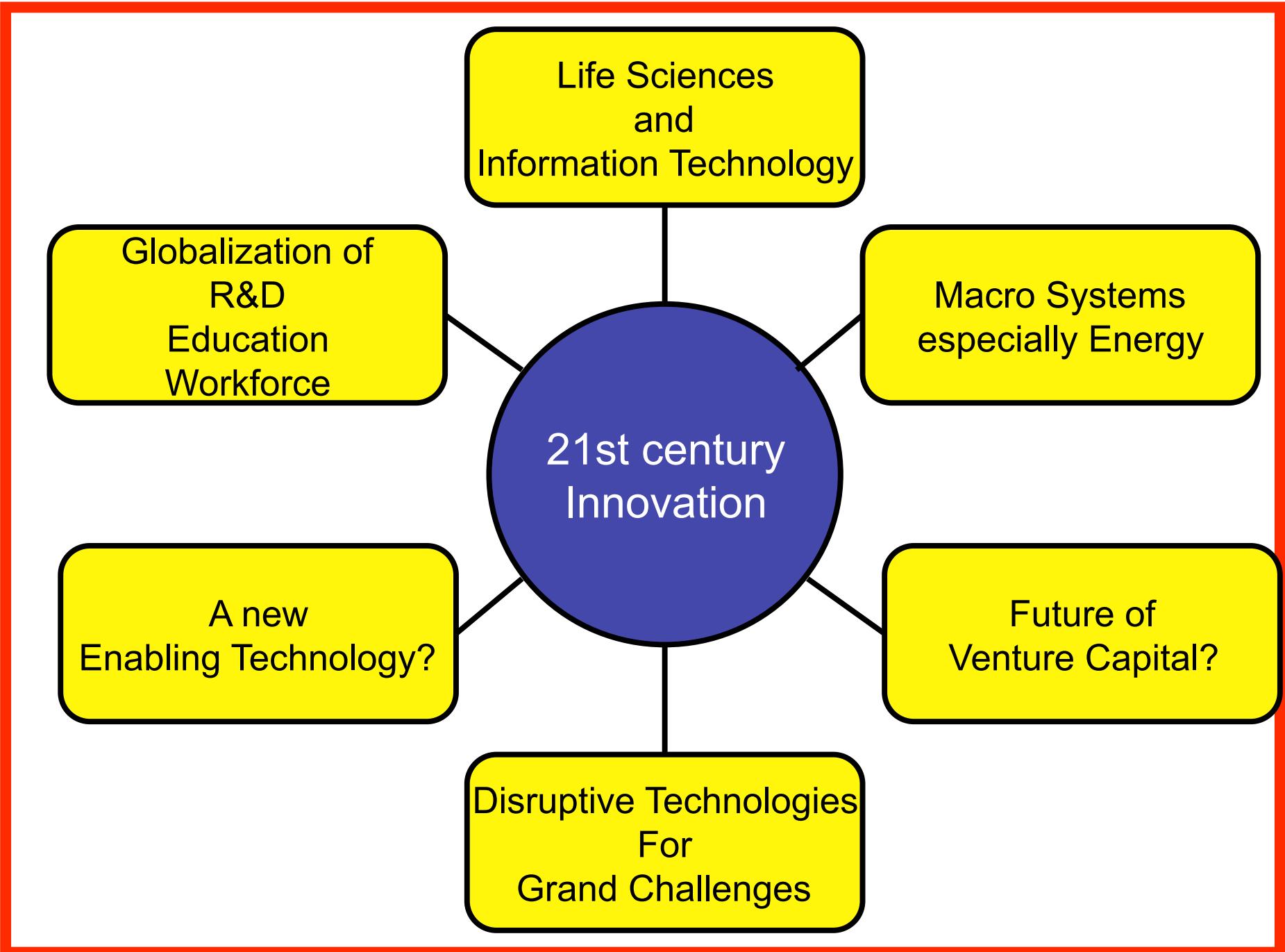
21st century  
Innovation

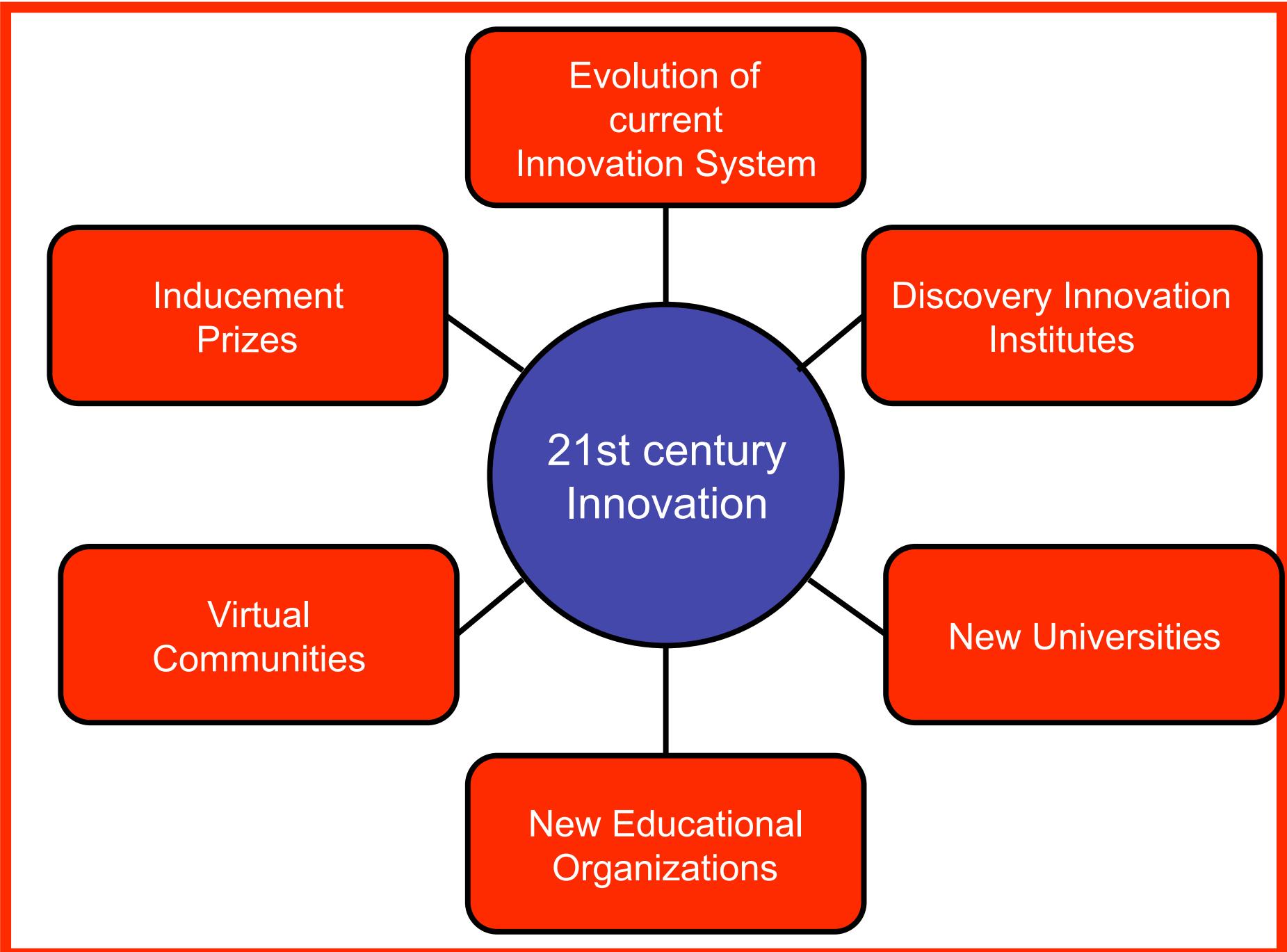


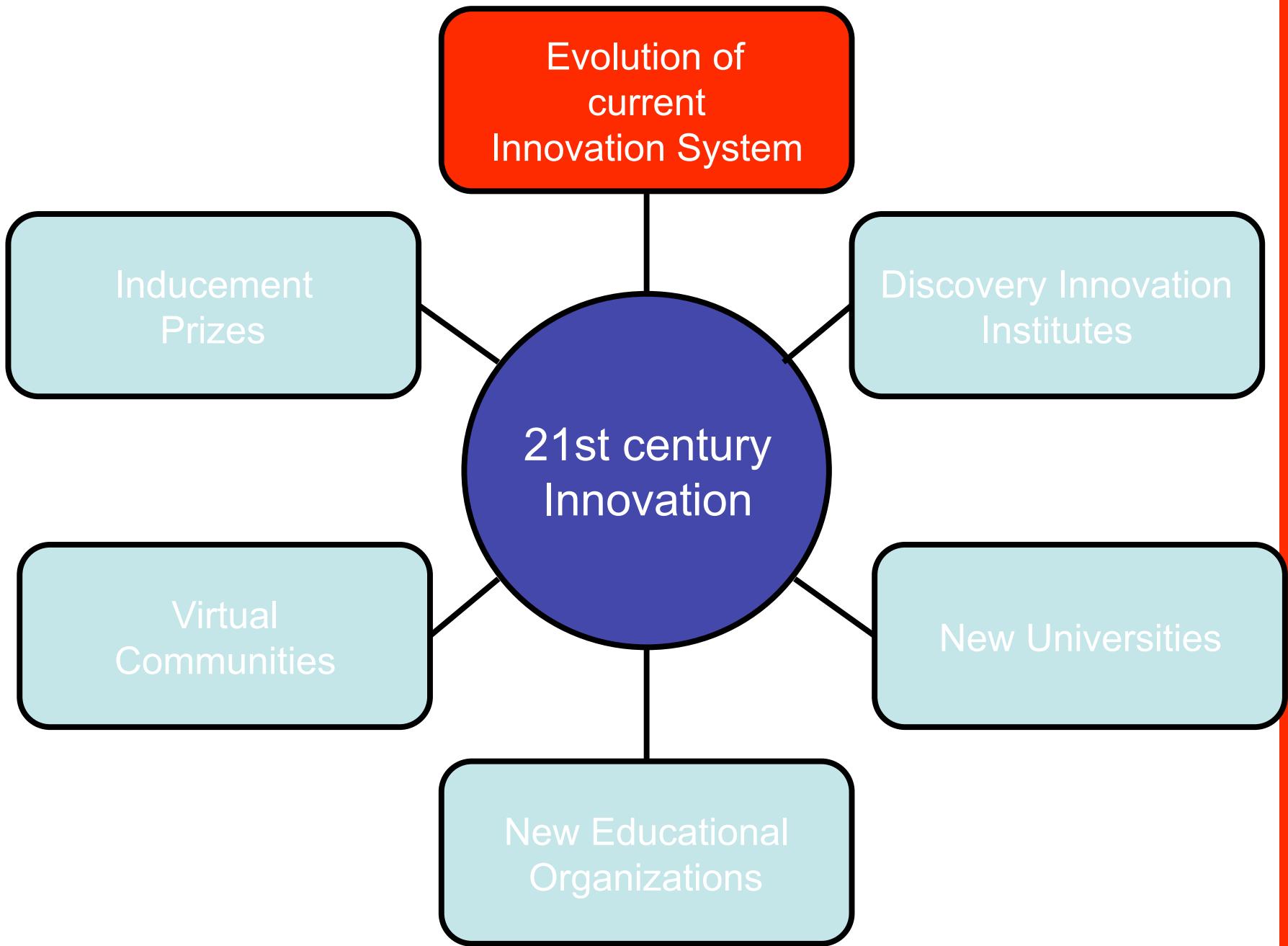
Future of  
Venture Capital?

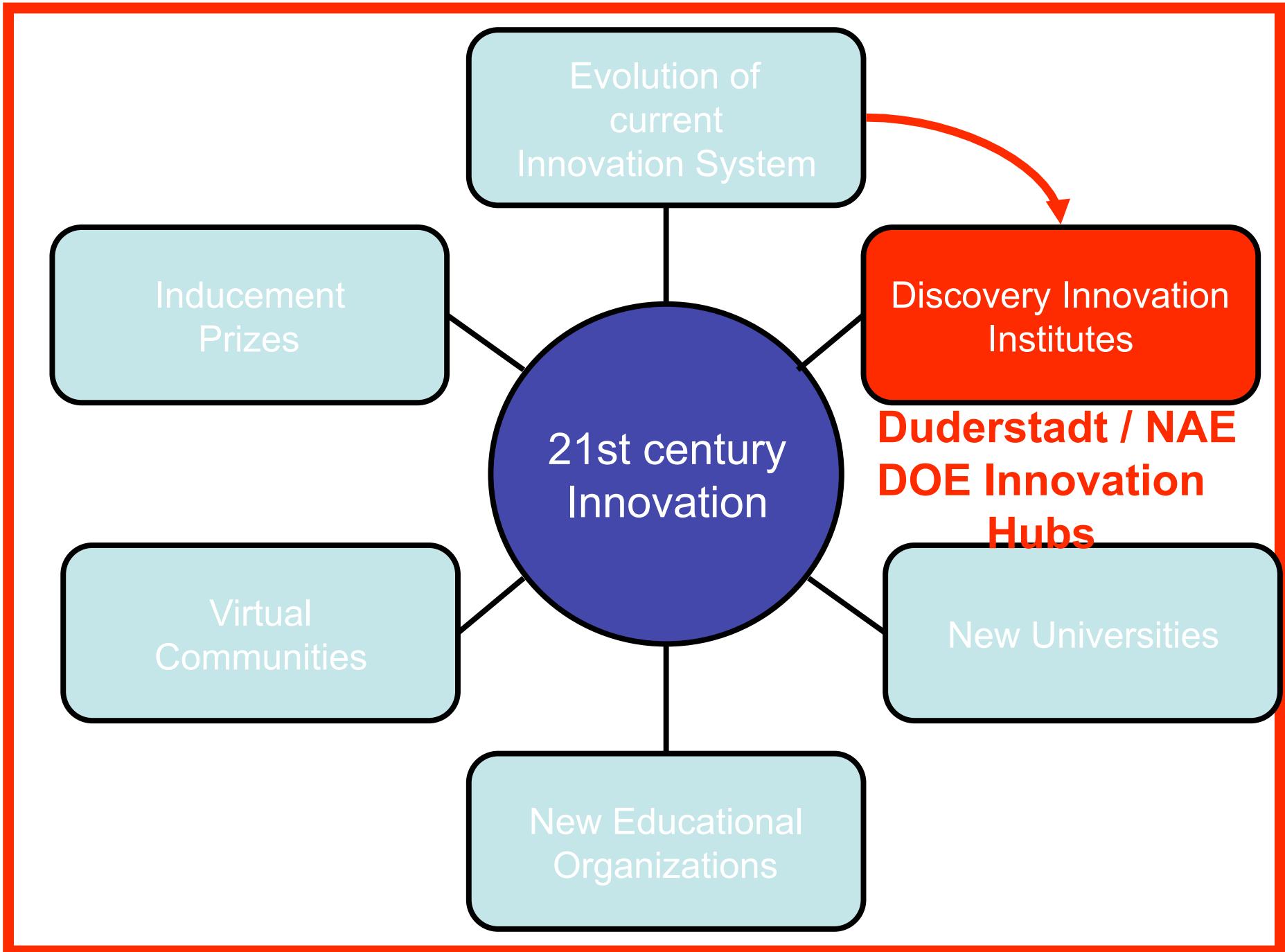
Globalization of  
R&D  
Education  
Workforce

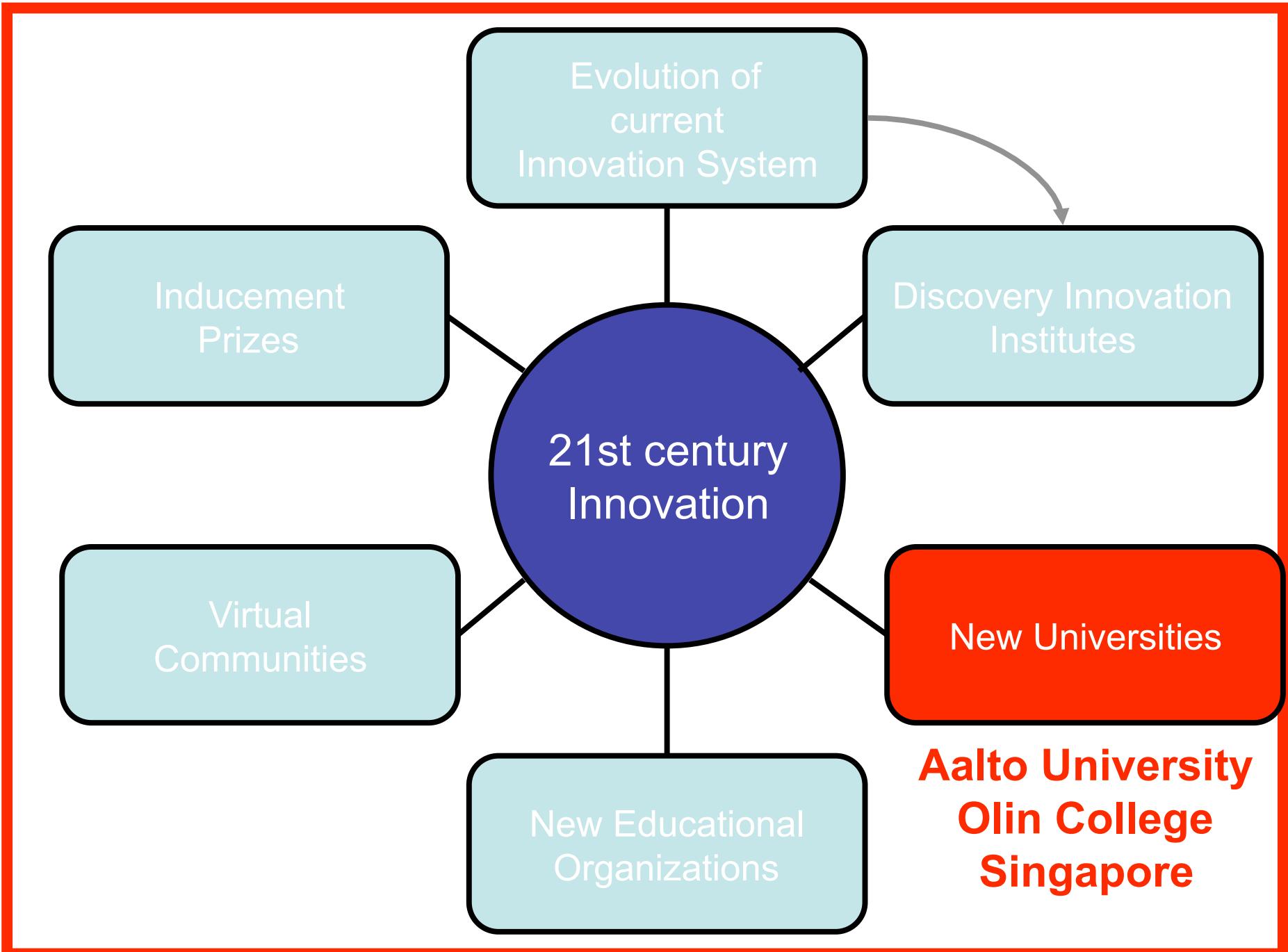
21st century  
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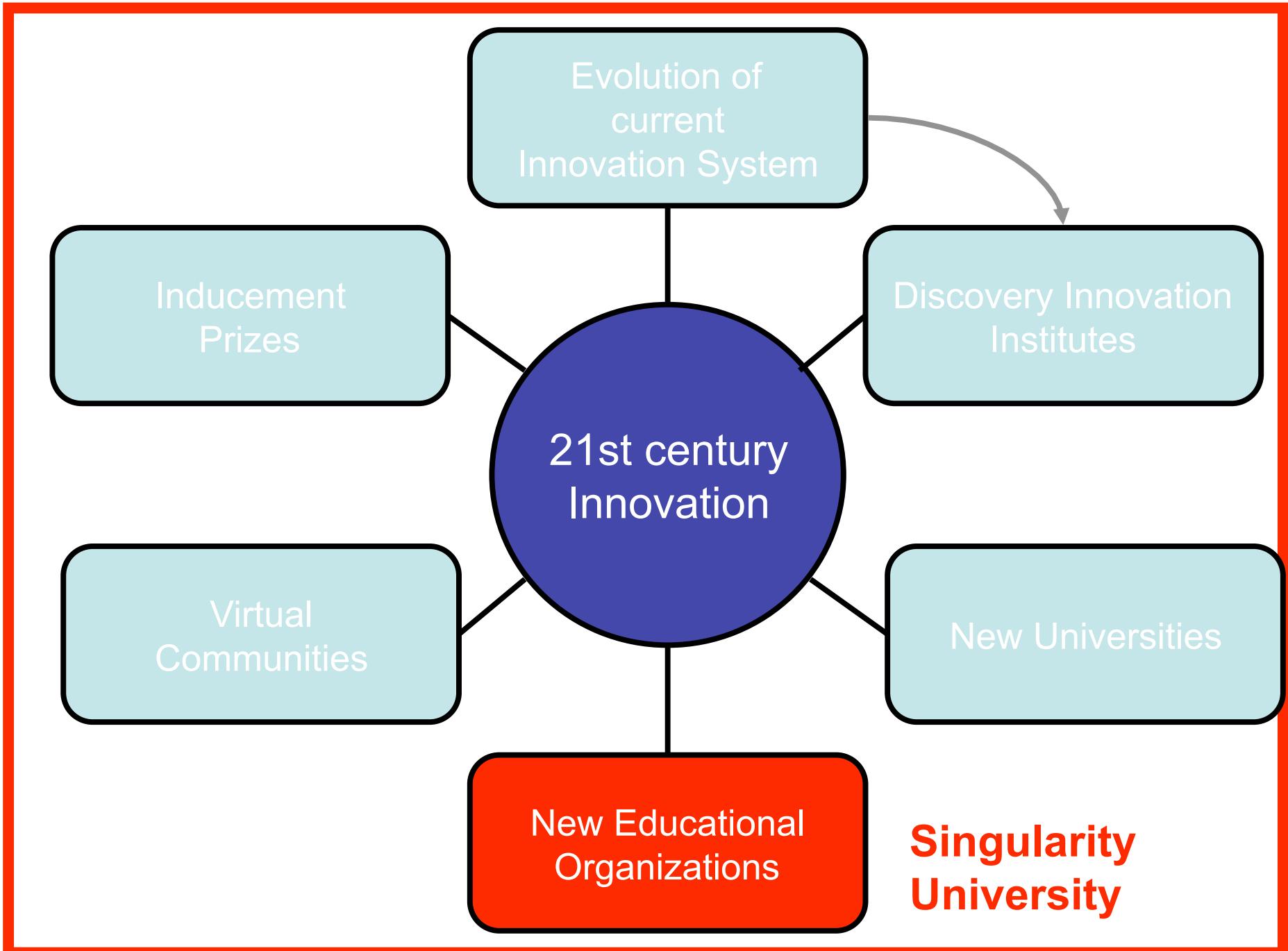


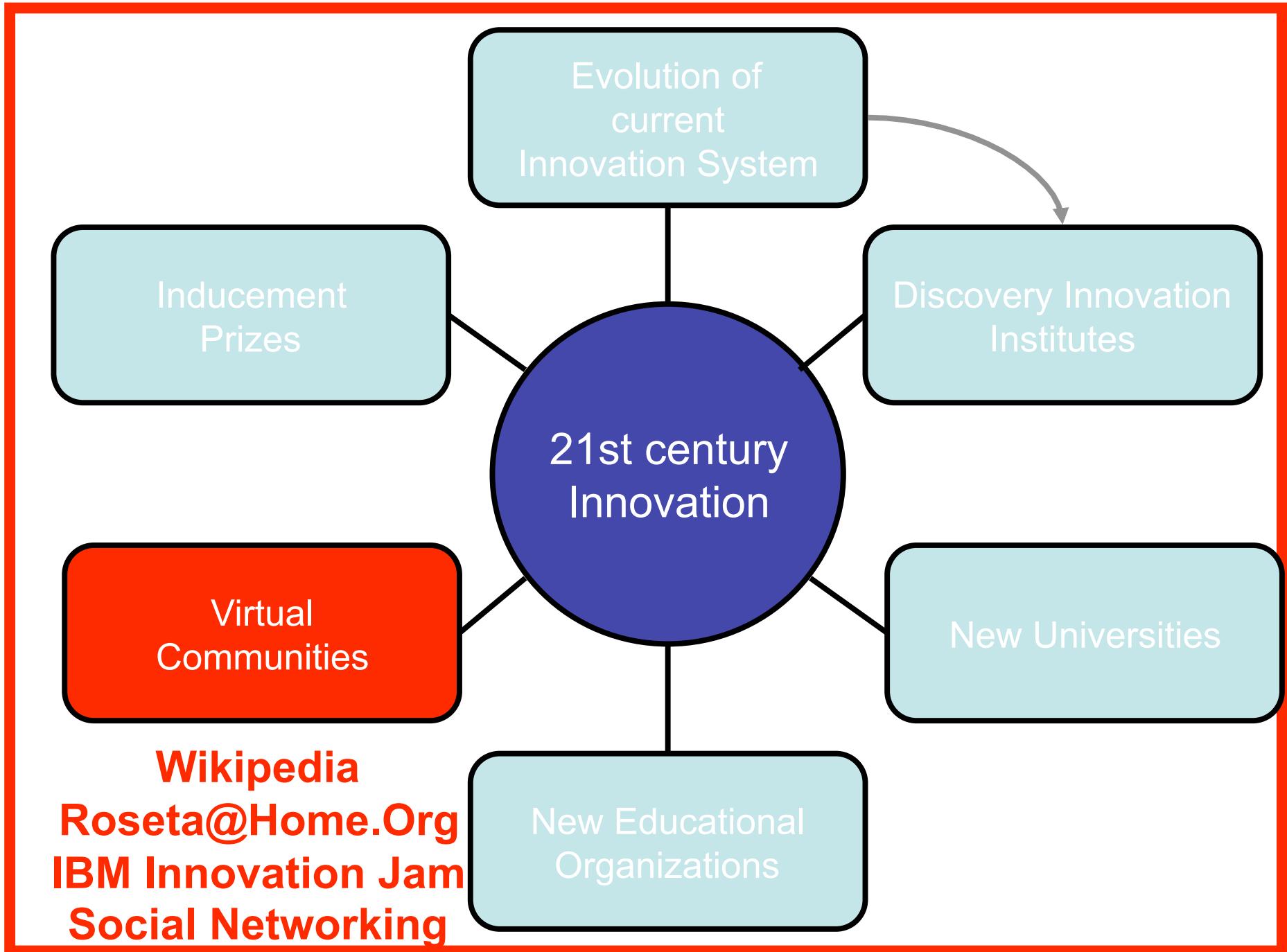




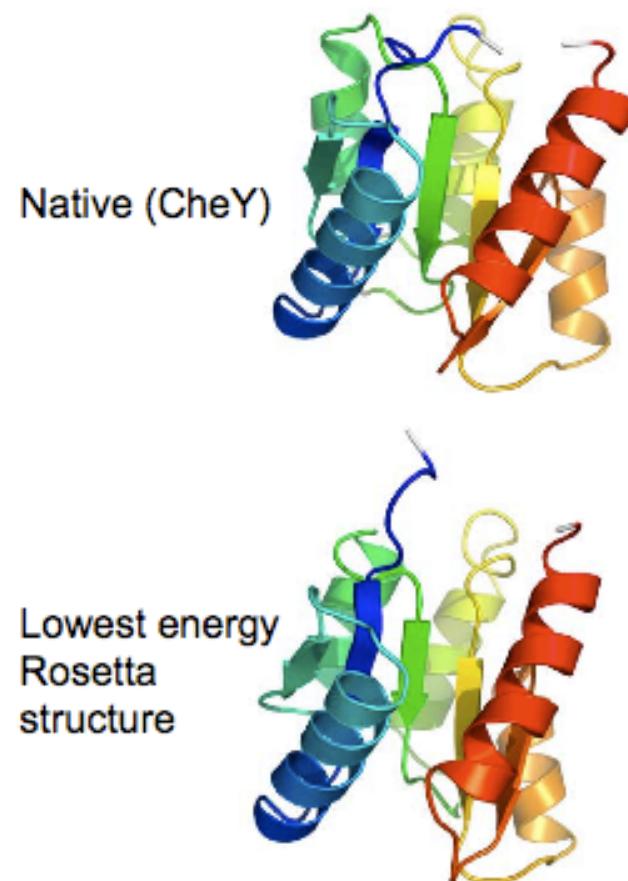
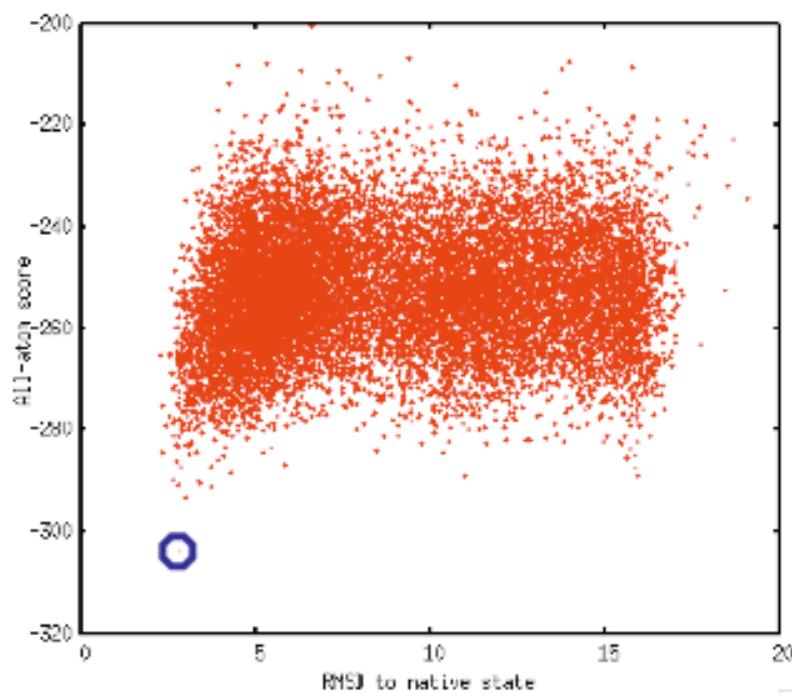




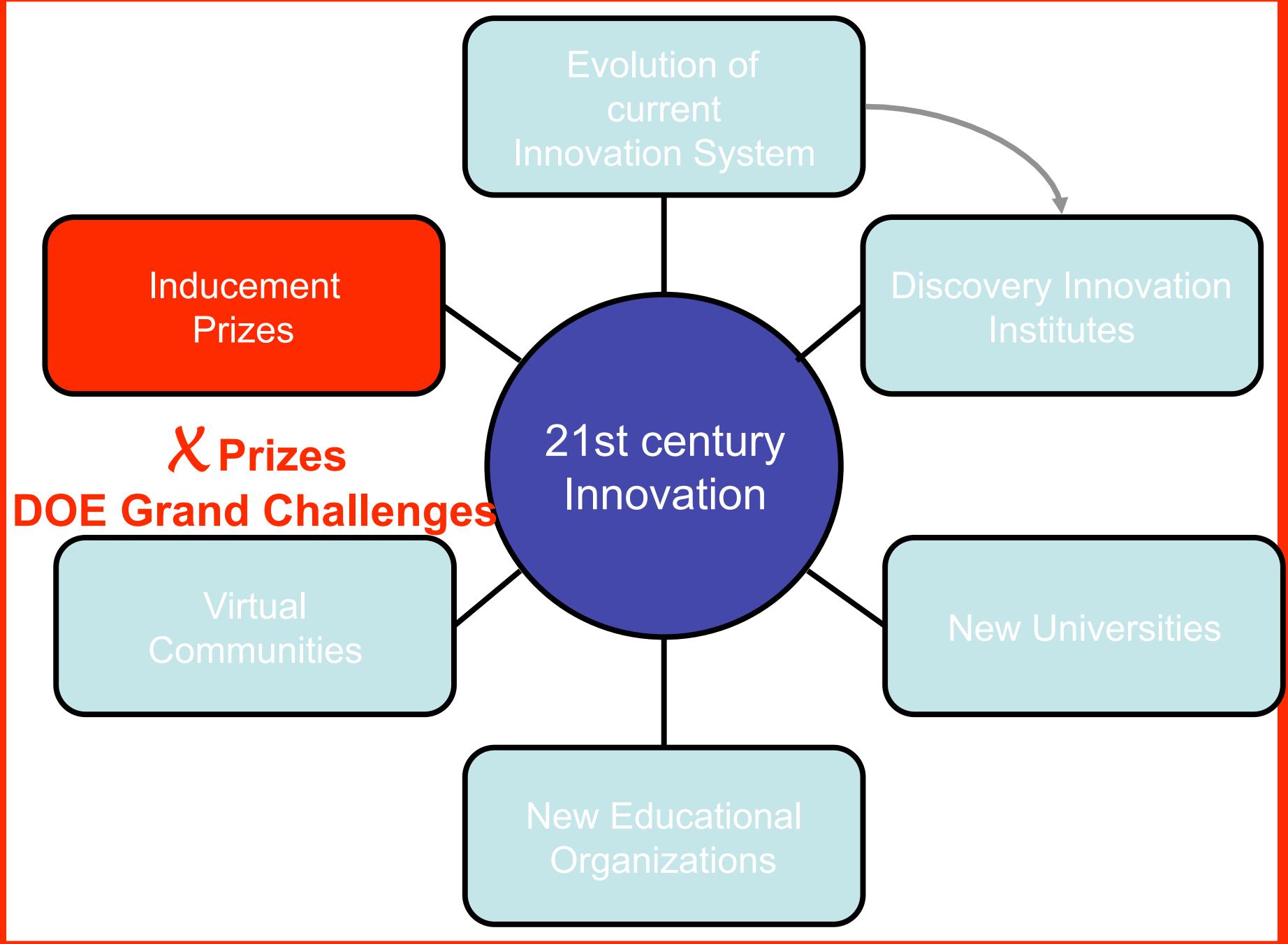


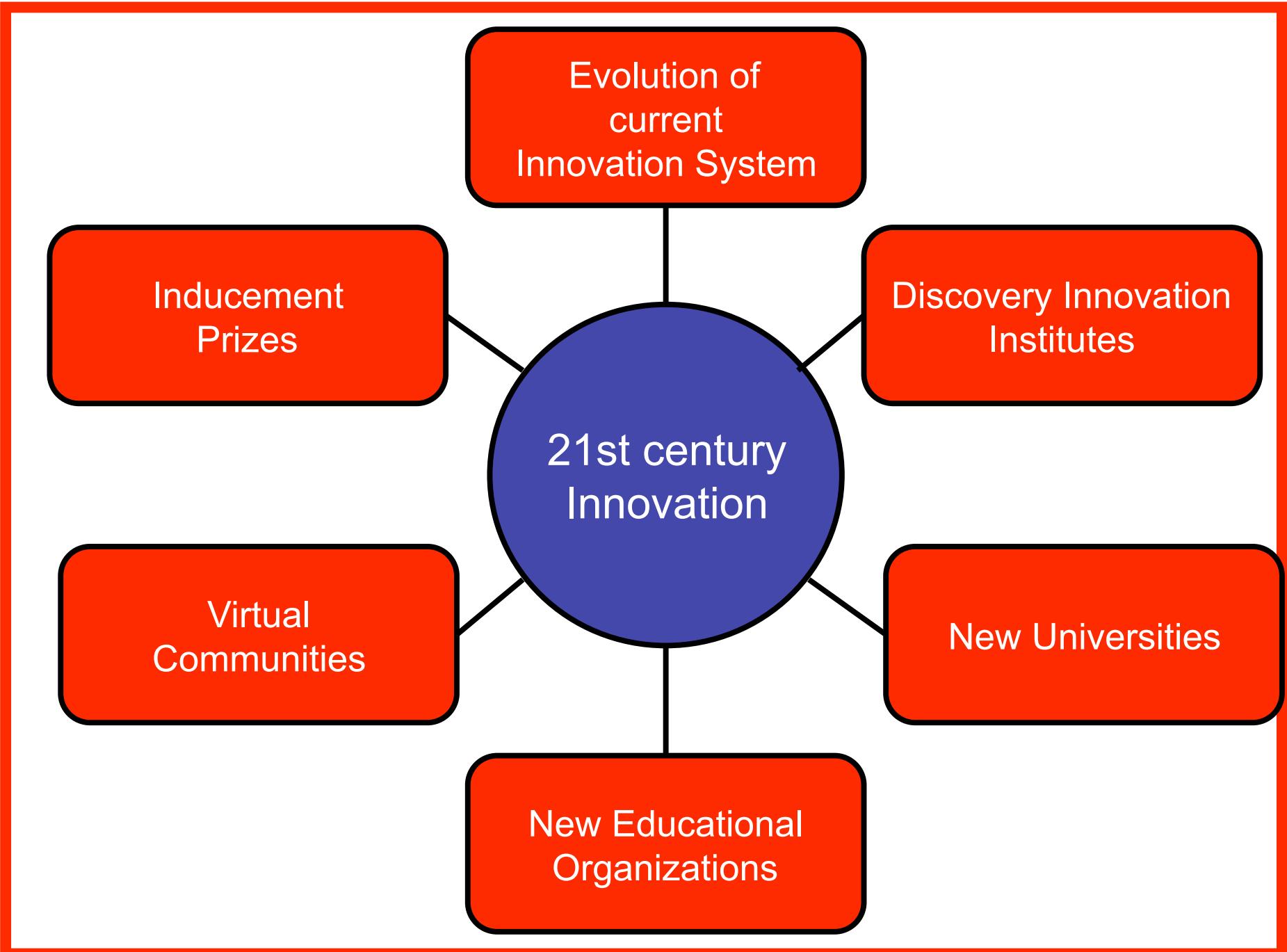


# Extensive conformational sampling with Rosetta@Home



source: Prof. David Baker, University of Washington

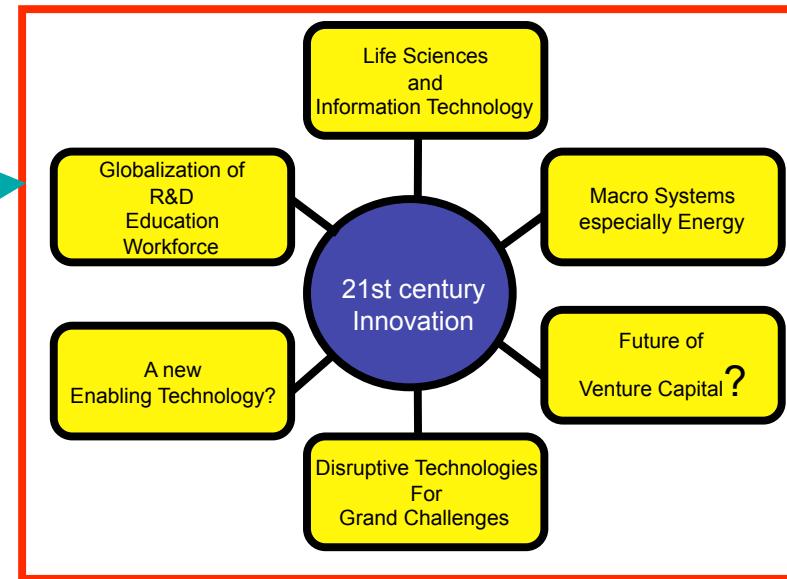




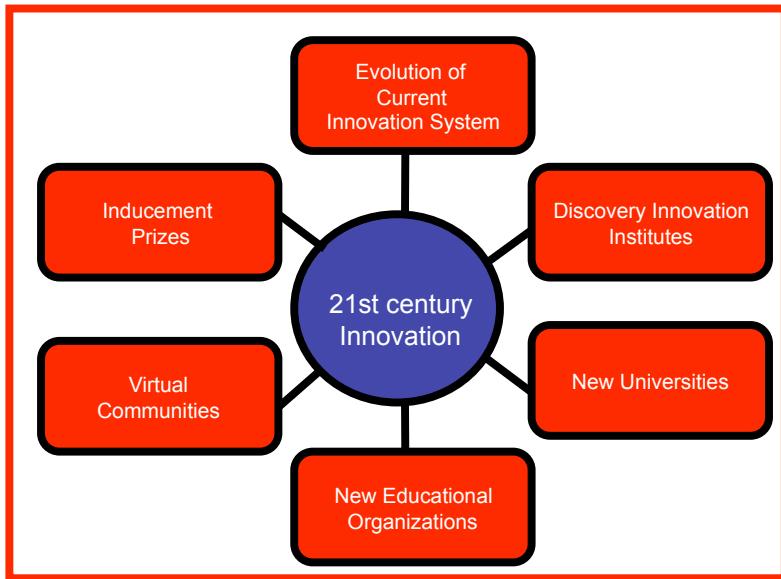
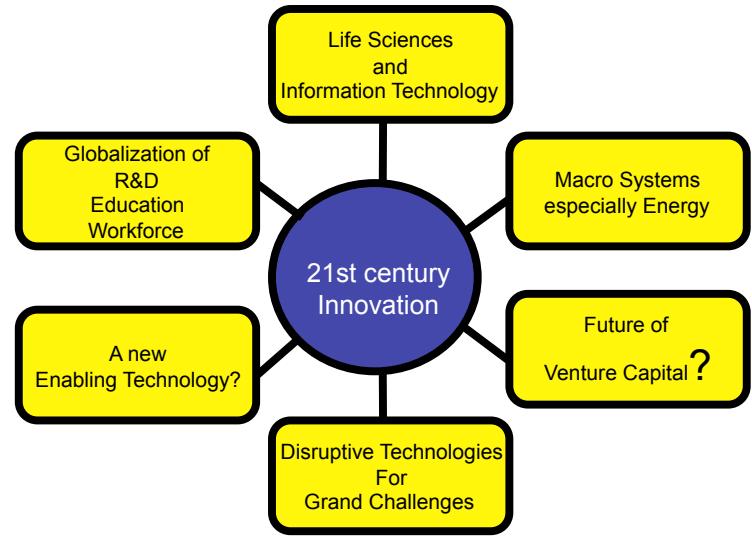
In closing ...

Relentless Change  
Grand Challenges  
Distributed Intelligence  
S&T Acceleration  
Globalization  
Internet Democracy

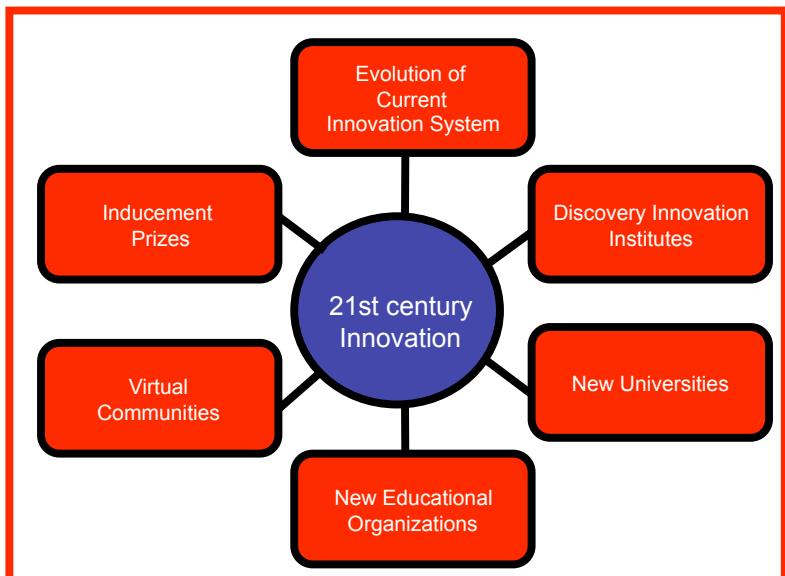
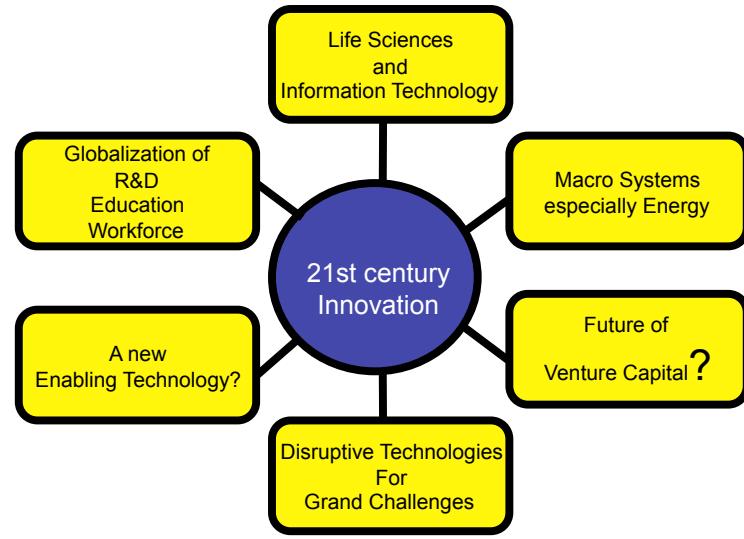
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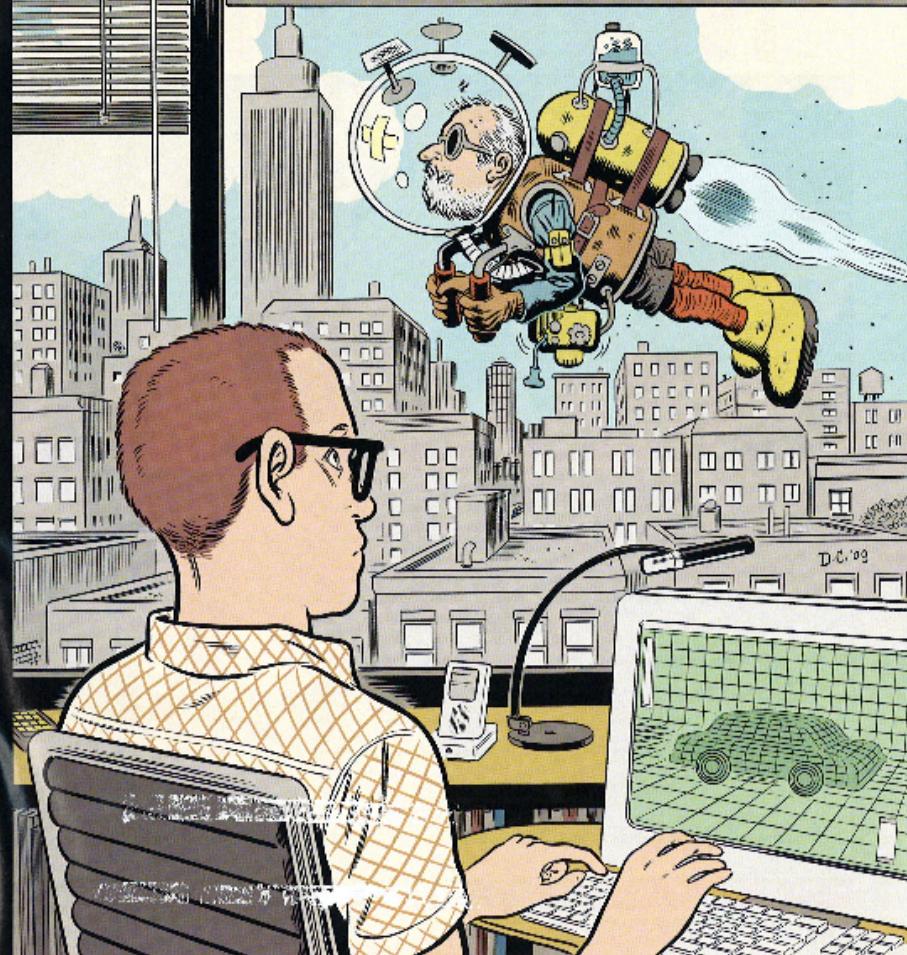
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Thank you.