

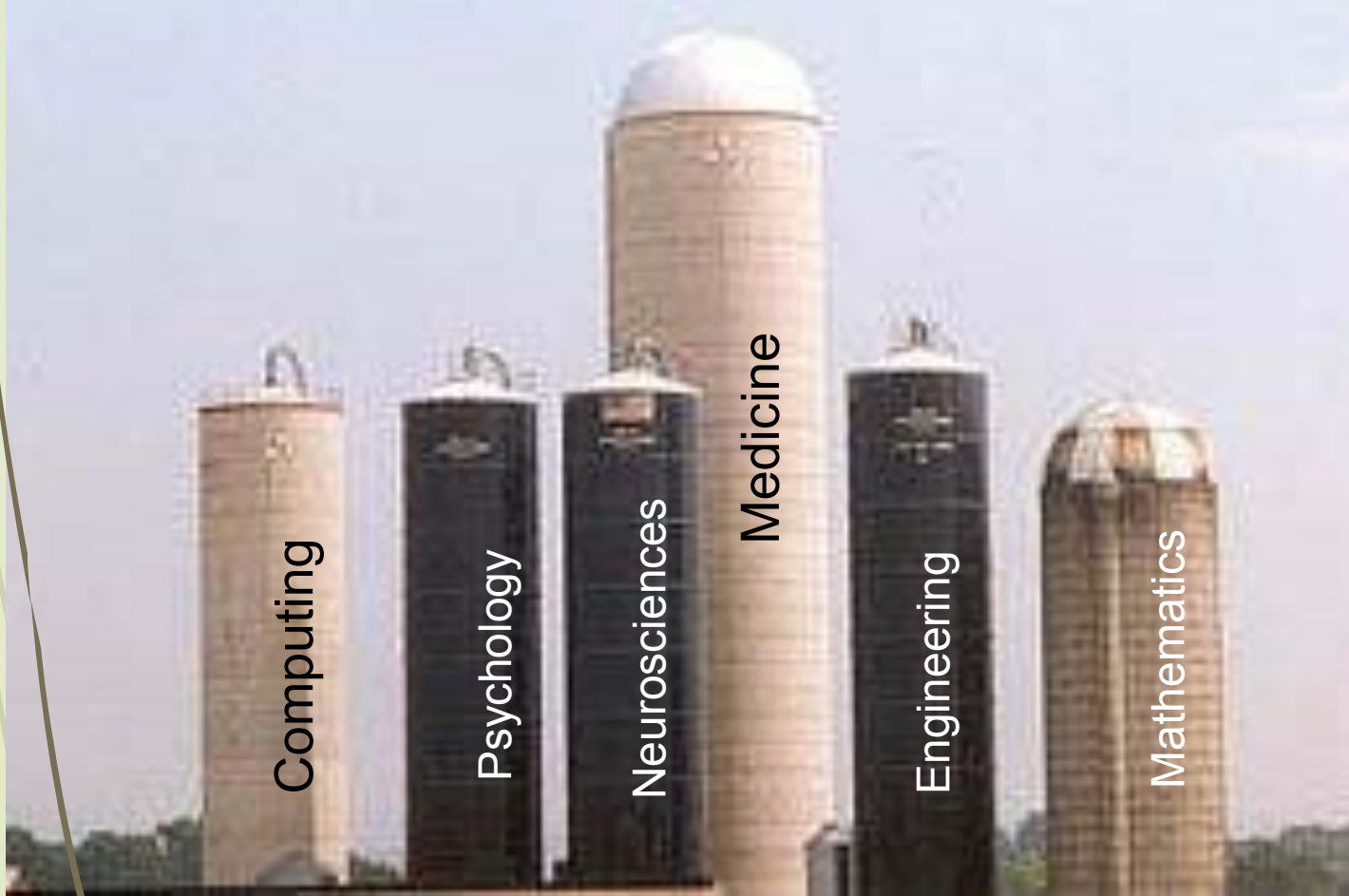


Smart Health at the National Science Foundation

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Siloed Sciences





Reasons to Collaborate

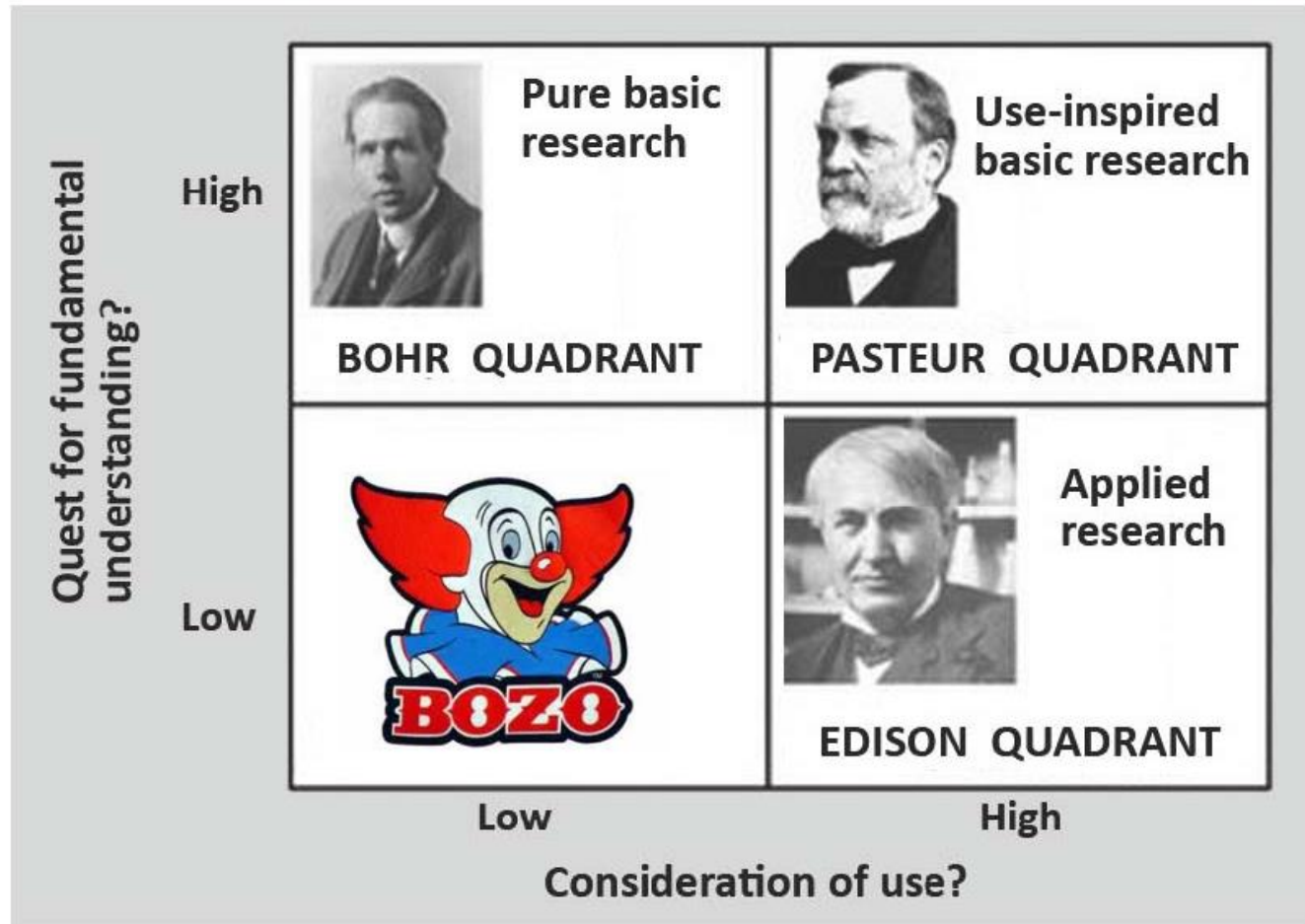
- “Wicked problems” – can’t be solved by a single discipline
 - Access to expertise or particular skills
 - Access to equipment, resources, or funding
 - Enhancing trainee education
 - **Impact**
- 



Computer and Information Science and Engineering (CISE)

- Health, medical and rehabilitation research can be found in many areas in NSF and within the mission of several cross-directorate initiatives
- It is a case of use-inspired basic research. The scientific advances in basic science can be in computing, information science and/or engineering. The benefit to health research is important, but second to the advances in basic science.
- Major homes for this research:
 - Smart and Connected Health
 - Cyber-physical Systems
 - National Robotics Initiative 2.0
 - Smart and Autonomous Systems
 - Core Programs

Pasteur's Quadrant



Donald E. Stokes, *Pasteur's Quadrant – Basic Science and Technological Innovation*, Brookings Institution Press, 1997



Smart & Connected Health (SCH) Program: Connecting Data, People and Systems NSF

Goal: *To support the development of technologies, analytics and models supporting next generation health and medical research through high-risk, high-reward advances*

- Work must include & address:
 - ✓ A key health problem
 - ✓ Address science and technology research gaps
 - ✓ Include a research team with appropriate expertise in the major areas involved in the work
- Activities should **complement** rather than duplicate core programs of NSF & NIH as well as those of other agencies (ex. Agency for Healthcare Research and Quality / Veteran's Administration)

SCH Model

- ✓ Take a coordinated approach that **balances theory with evidenced-based analysis** and systematic advances with revolutionary breakthroughs;
- ✓ Seek **cross-disciplinary collaborative research** that will lead to **new fundamental insights**; and
- ✓ Encourage **empirical validation of new concepts** through research prototypes, ranging from specific components to entire systems.





Smart Health Research Areas

Health Information Infrastructure

Infrastructure to enable connections

- Integration of EHR, contextual, clinical and patient data
- Access to information, data linkages
- Tools to enhance smart health research

Connected Data

Reasoning with heterogonous data under uncertainty

- Heterogeneous and messy data
- Data fusion and optimization
- Datamining, machine learning, deep learning
- Inference, visualization, decision support system

Connected Systems

Multifunctional devices connected to systems

- Closed and human-in-the loop systems
- Tools for connecting systems within systems
- Enhancing knowledge flow across the entire system

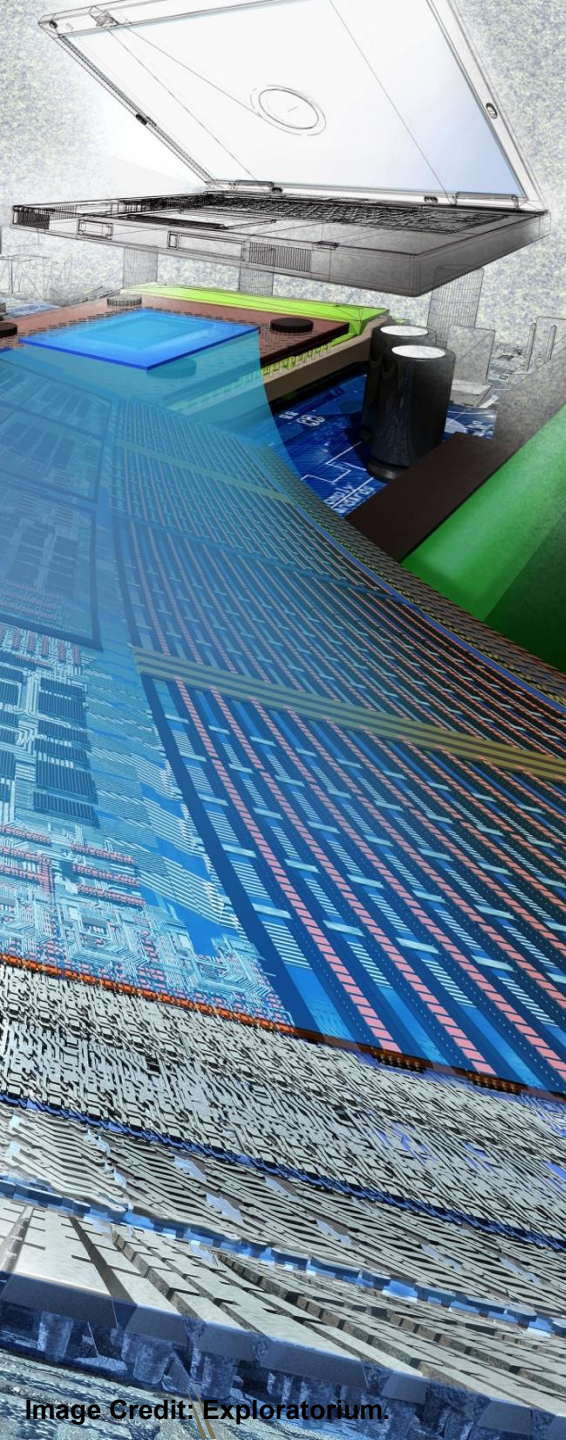
Connected People

Effective, multidirectional flows of information and support

- Enhancing communication between providers, patients and caregivers
- Assistive technologies embodying computational intelligence



Cyber Physical Systems CPS



What are Cyber-Physical Systems?

Deeply integrating computation, communication, and control into physical systems

Characteristics of CPS

- Pervasive computation, sensing and control
- Networked at multi- and extreme scales
- Dynamically reorganizing/reconfiguring
- High degrees of automation
- Dependable operation with *potential* requirements for high assurance of reliability, safety, security and usability
- With / without human in-the-loop

Application Domains



Transportation

- Faster and safer aircraft
- Improved use of airspace
- Safer, more efficient cars
- Manned and un-manned



Energy and Industrial Automation

- Homes and offices that are more energy efficient and cheaper to operate
- Distributed micro-generation for the grid



Healthcare and Biomedical

- Increased use of effective in-home care
- More capable devices for diagnosis
- New internal and external prosthetics

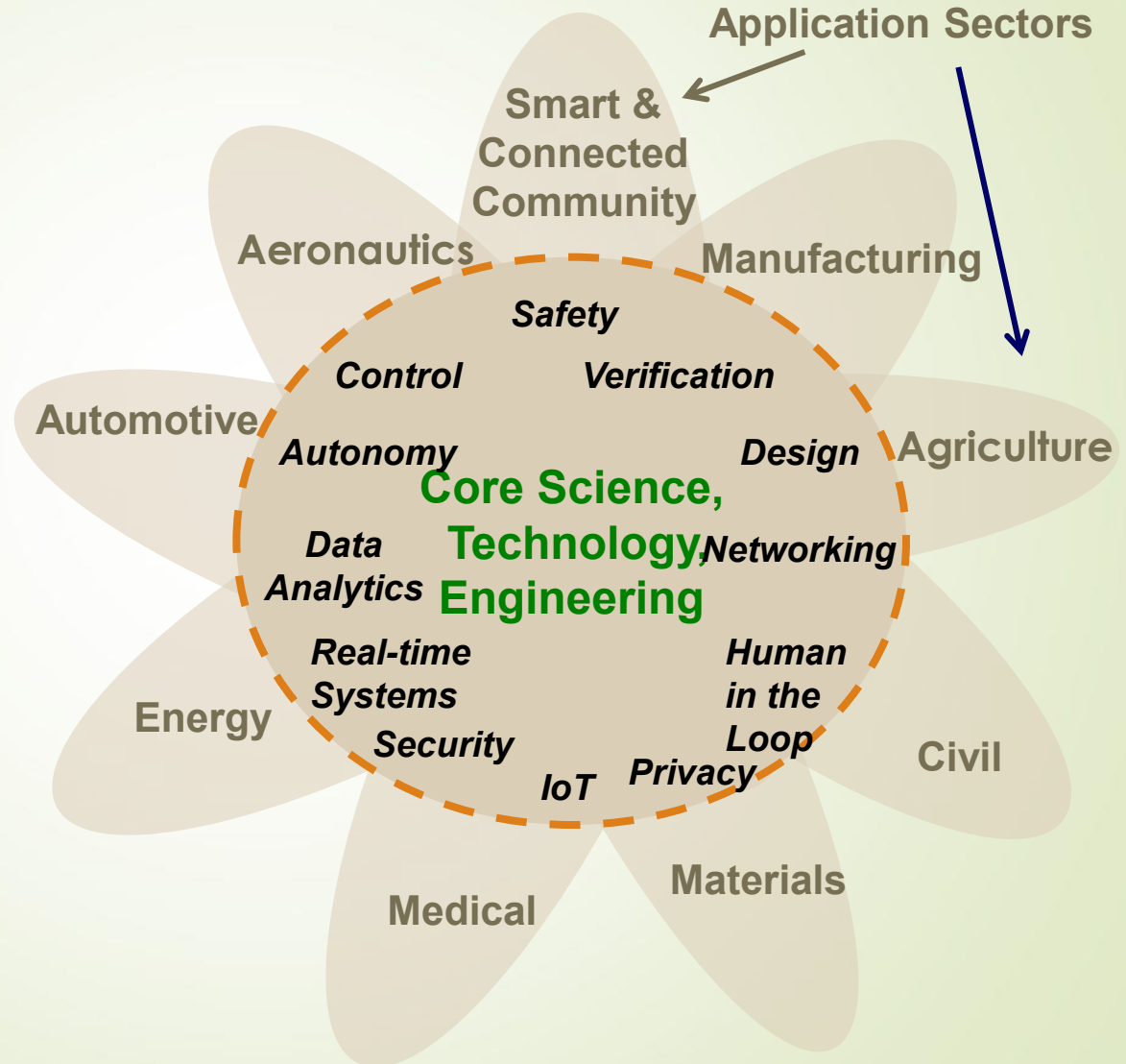


Critical Infrastructure

- More reliable power grid
- Highways that allow denser traffic with increased safety

NSF CPS Research Model

- Abstract from sectors to more general principles – and apply these to problems in new sectors
- Build a new CPS community
- Multiple agency participation (DHS, DoT, NIH, and NASA)





Smart & Connected Communities (S&CC)



A Long-term Research Agenda for Smart & Connected Communities



Growing an international multidisciplinary, multi-sector research and education community

8/11/2018



S&CC Vision

Smart & Connected Communities (S&CC) is a vision in which the **effective integration** of **data sources**, networked computing systems, and sensors with **people**, decision-making, and physical infrastructure will enable more **livable, workable, and sustainable communities**—*regardless* of place or scale—broadly and inclusively improving quality of life for **all** citizens in a **diverse** and **heterogeneous** society. The impacts will be far reaching, with potentially transformative applications in areas including transportation, energy, health, environment, education, public safety, emergency response, and others.

NSF “Big Ideas”

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Better understanding the changing Arctic is one item on a new list of big ideas that should shape the National Science Foundation's work.

NASA/Kathryn Hansen

NSF director unveils big ideas, with an eye on the next president and Congress

By Jeffrey Mervis | May. 10, 2016 , 3:30 PM

NSF “Big Ideas”

RESEARCH IDEAS

- Harnessing Data for 21st Century Science and Engineering
- Shaping the new Human – Technology Frontier
- Understanding the Rules of Life: Predicting Phenotype
- The Quantum Leap: Leading the Next Quantum Revolution
- Navigating the New Arctic
- Windows on the Universe: The Era of Multi-messenger Astrophysics

PROCESS IDEAS

- Growing Convergent Research at NSF
- Mid-scale Research Infrastructure
- NSF 2050
- INCLUDES

*Video of NSB presentation and discussion is at:

http://www.tvworldwide.com/events/nsf/160505/globe_show/default_go_archive.cfm?gsid=2957&type=flv&test=0&live=0

(the presentation/discussion starts about 20 minutes into this video)

Useful Website: www.nsf.gov

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Effective Research is a Relay between basic and applied science



Questions or Comments?

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