

*National Academies Webinar, May 22, 2017*  
*Government-University-Industry Research Roundtable*

# **Highly Integrative Basic and Responsive (HIBAR) Research: Partnerships for Discovery & Innovation**

Dan Sarewitz  
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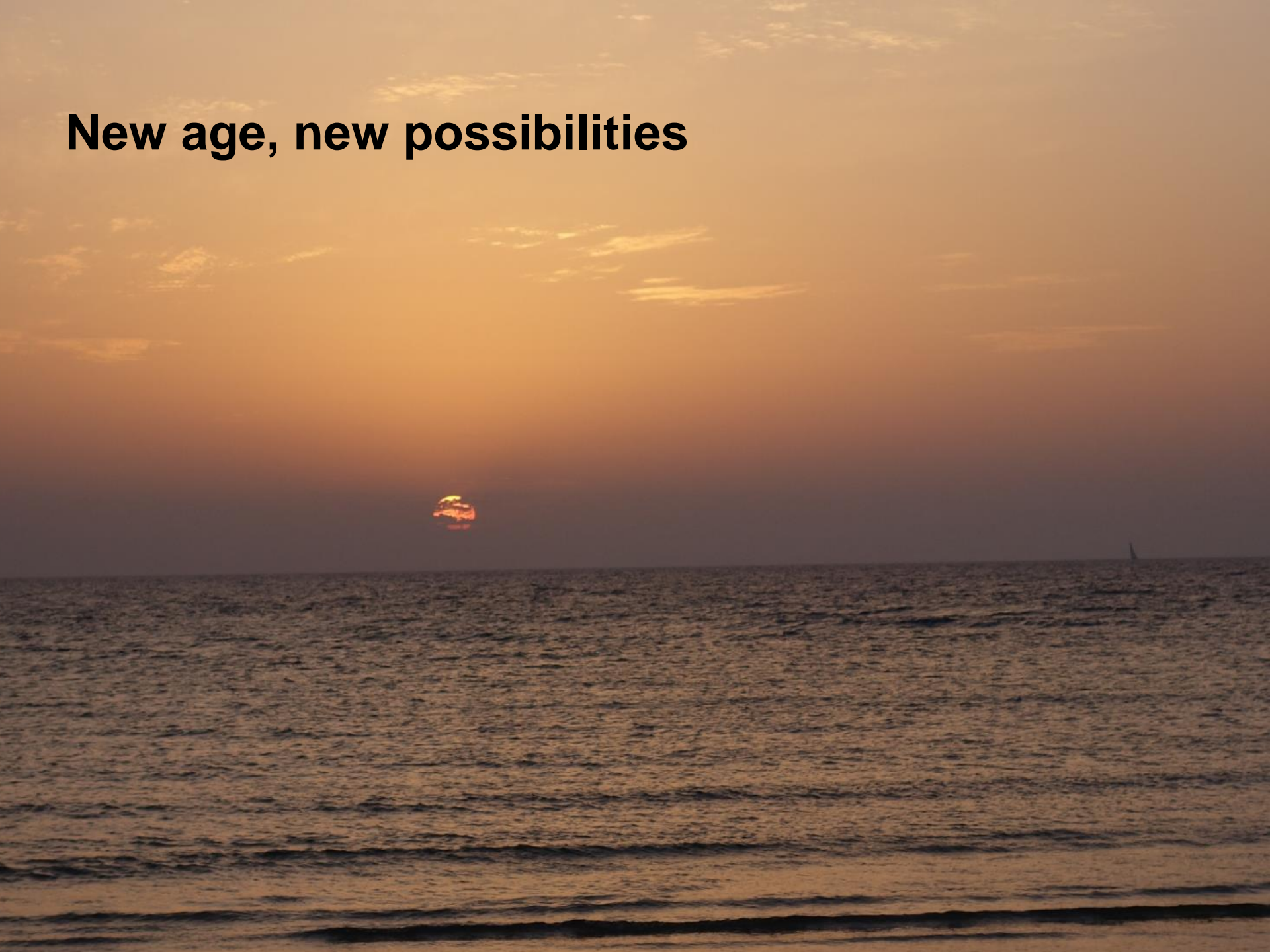
Professor of Science & Society,  
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Dept of Computer Science  
Member, National Academy of Engineering



**New age, new possibilities**





# NAE GRAND CHALLENGES FOR ENGINEERING

NATIONAL ACADEMY OF ENGINEERING

## Grand Challenges

BILL & MELINDA  
GATES foundation

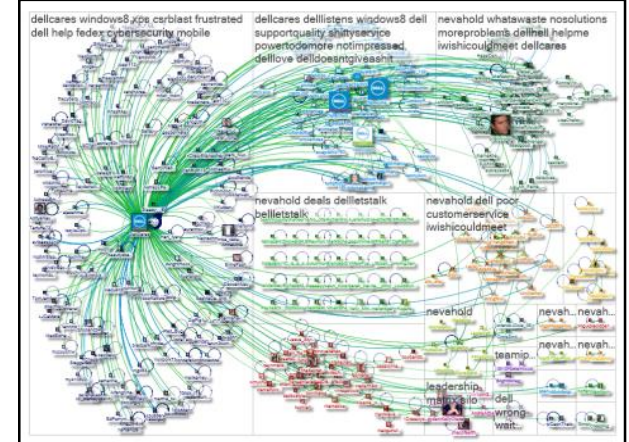
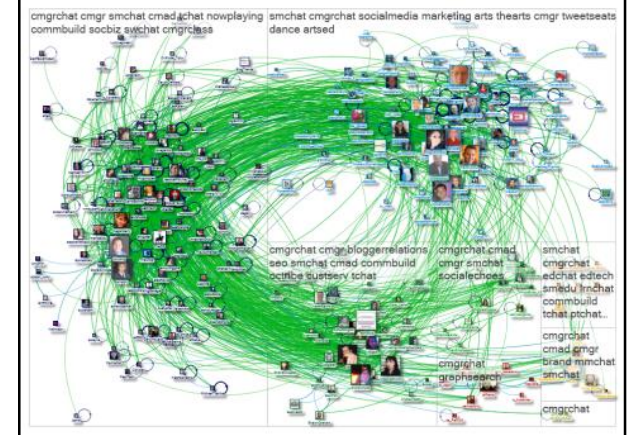
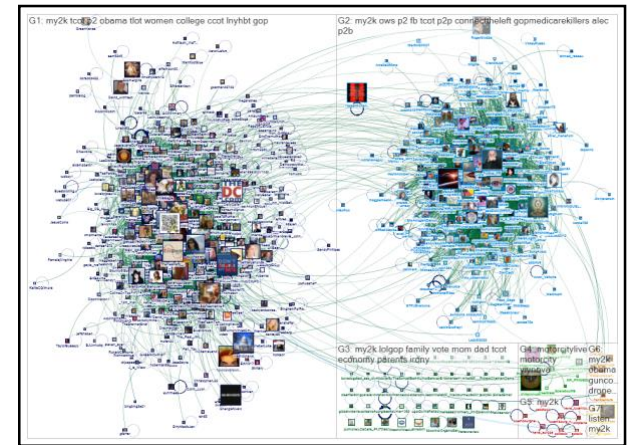
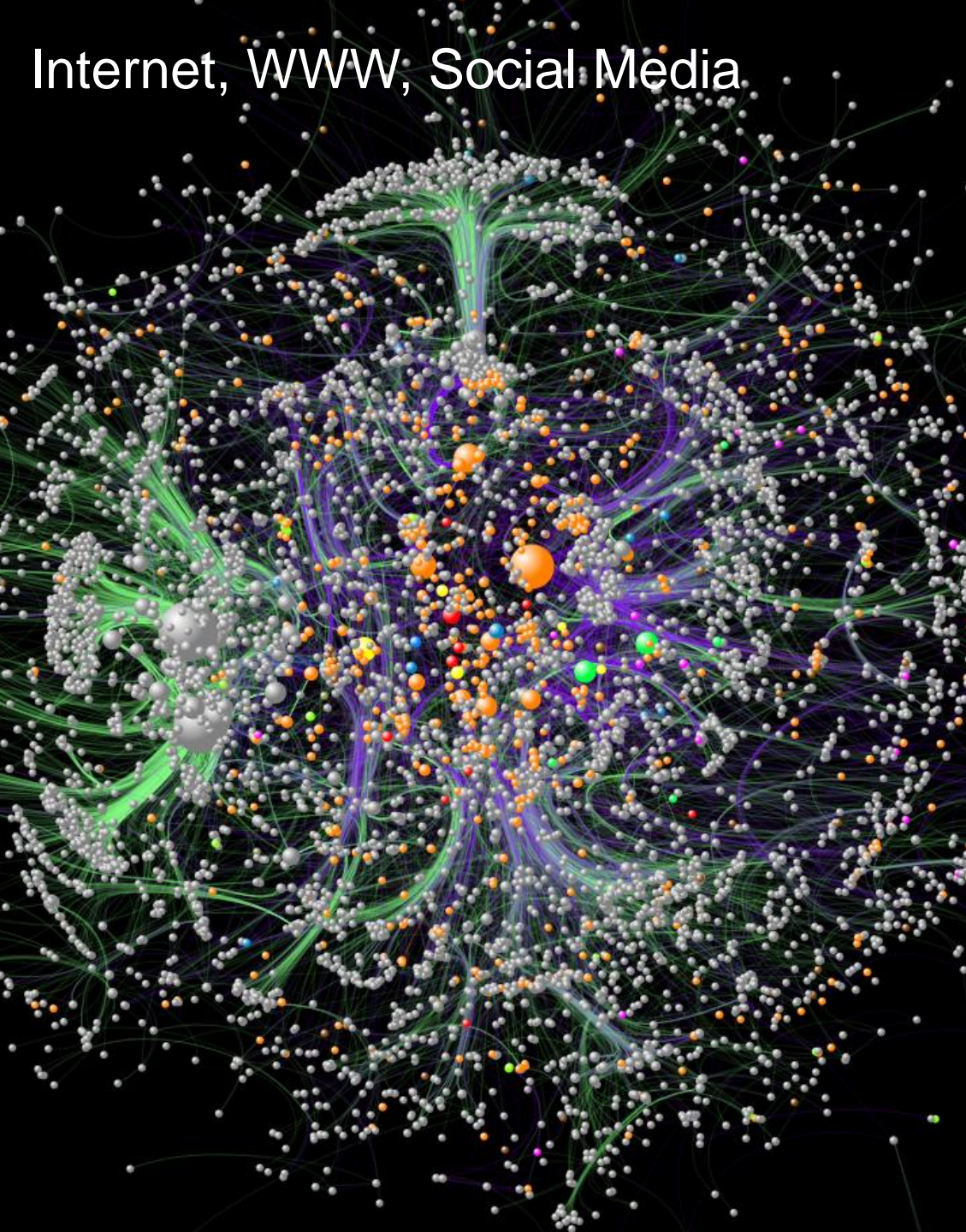
Solving global health and development problems for those most in need



## SUSTAINABLE DEVELOPMENT GOALS



# Internet, WWW, Social Media



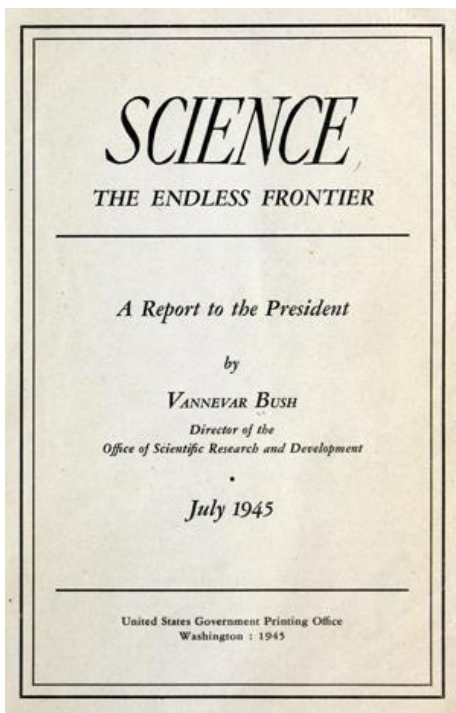
# Raised research ambitions



**R**esponsive  
**A**nd  
**B**asic  
**I**ntegrative  
**H**ighly

Research: Engaging Theory with Practice for Transformative Solutions

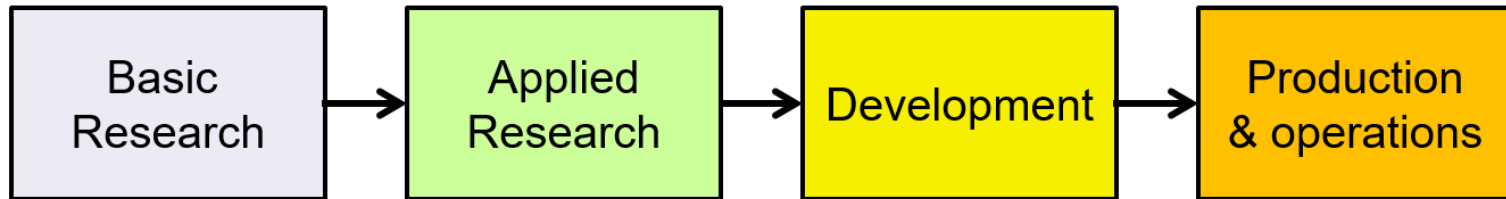
- New knowledge & problem-solving
- Combines academic research methods & practical application
- Engages the efforts of academic & real-world experts



# The Lie We Still Love . . .

“Scientific progress on a broad front results from the free play of free intellects, working on subjects of their own choice, in the manner dictated by their curiosity for exploration of the unknown . . . basic research is the pacemaker of technological progress . . . There must be a stream of new scientific knowledge to turn the wheels of private and public enterprise.”





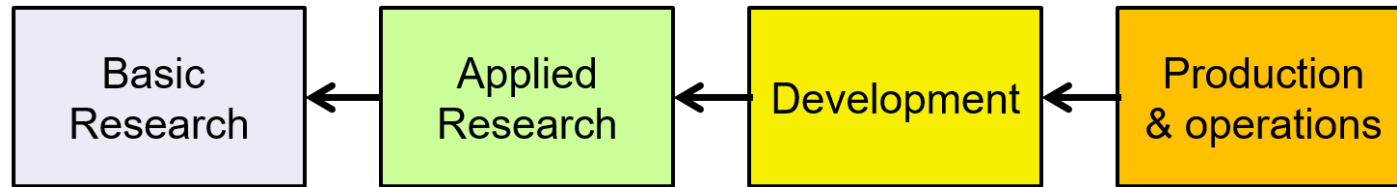
**Everyone knows that the linear model of innovation is dead.**

That model represented the innovation process as one in which technological change was closely dependent upon, and generated by, prior scientific research. It was a model that, however flattering it may have been to the scientist and the academic, was economically naive and simplistic in the extreme.

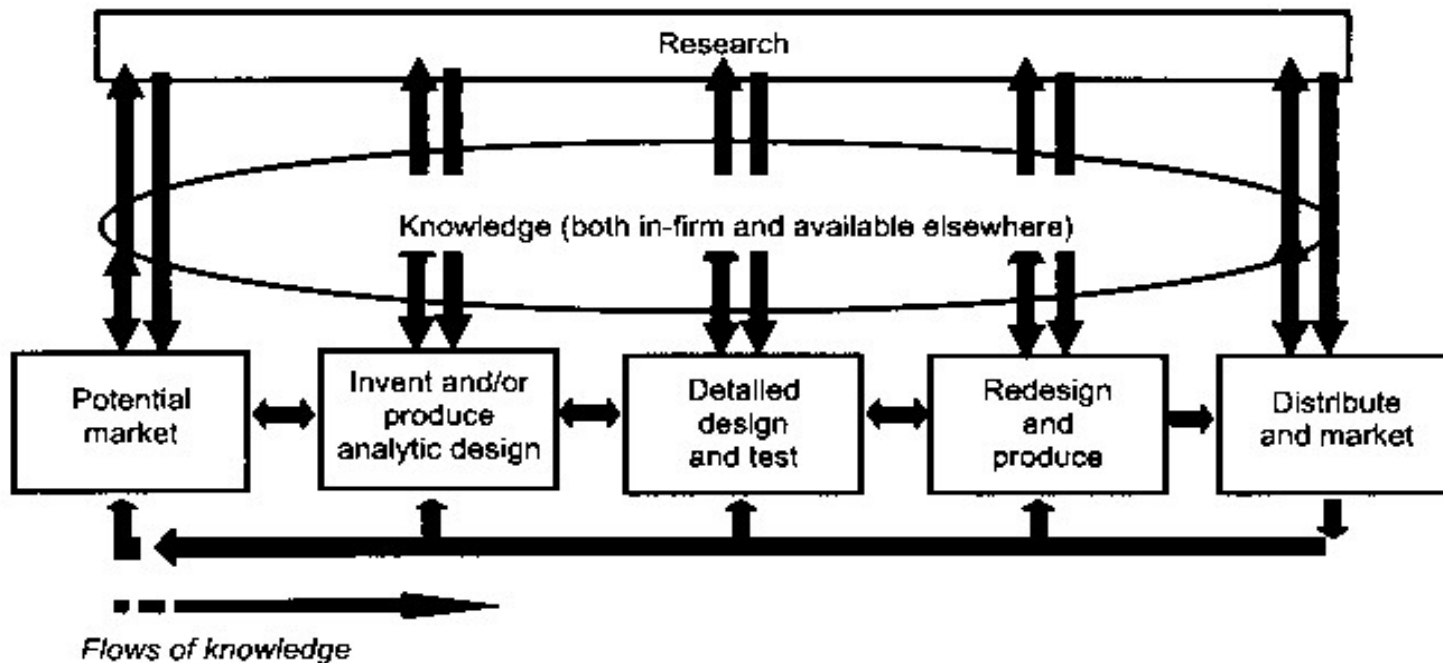
~Nathan Rosenberg, 1994

# Many alternatives have been proposed

Reverse Linear, Tom Allen, 1977



Chain-Link Model of Innovation, Kline, 1986



There are not such things as applied sciences,  
only applications of sciences.

--Louis Pasteur, 1871

		Considerations of use?	
		No	Yes
Quest for fundamental understanding?	Yes	Pure basic research (Bohr)	Use-inspired basic research (Pasteur)
	No		Pure applied research (Edison)



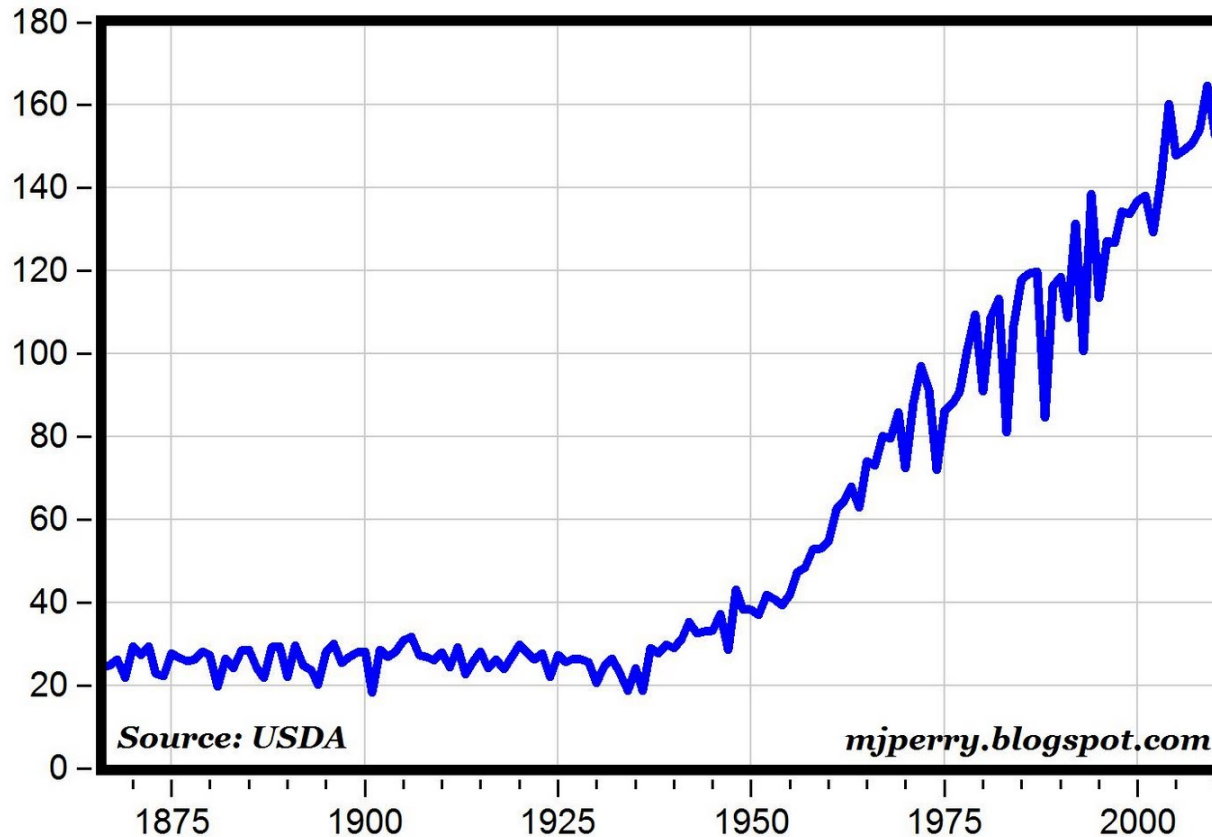
# CAES

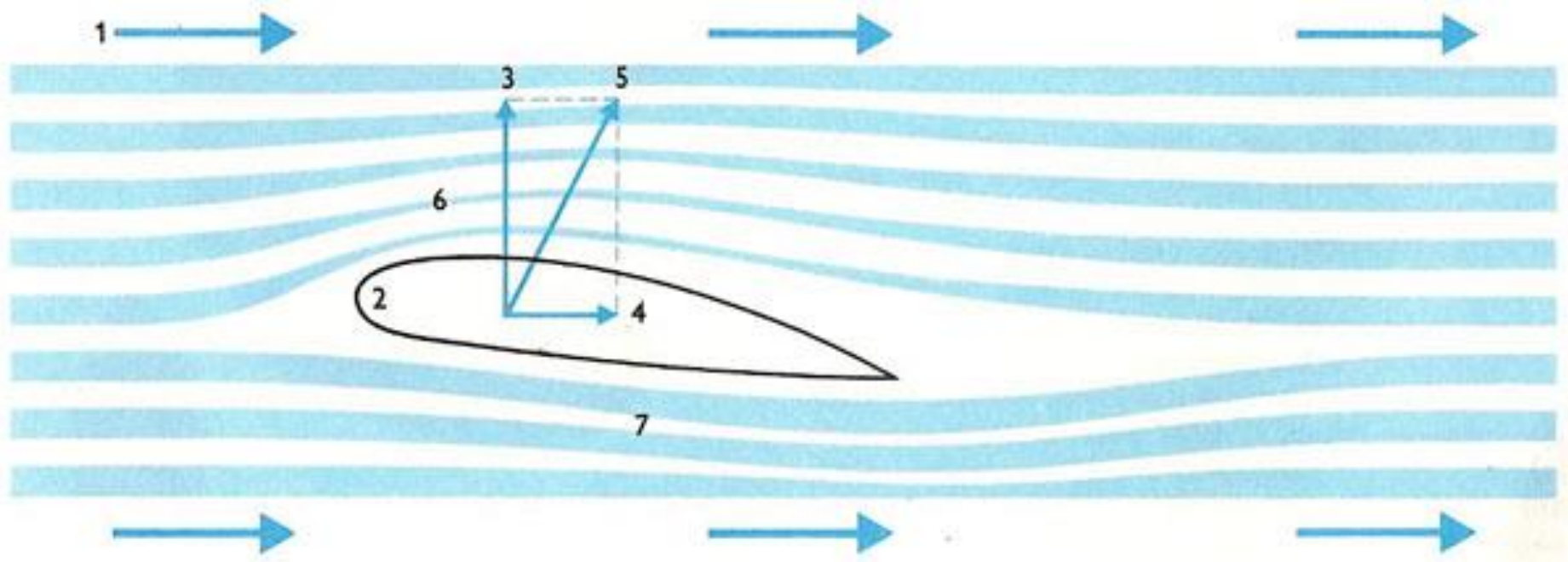
The Connecticut Agricultural Experiment Station

*Putting Science to Work for Society since 1875*

## U.S. Corn: Yield per Acre 1866 to 2010

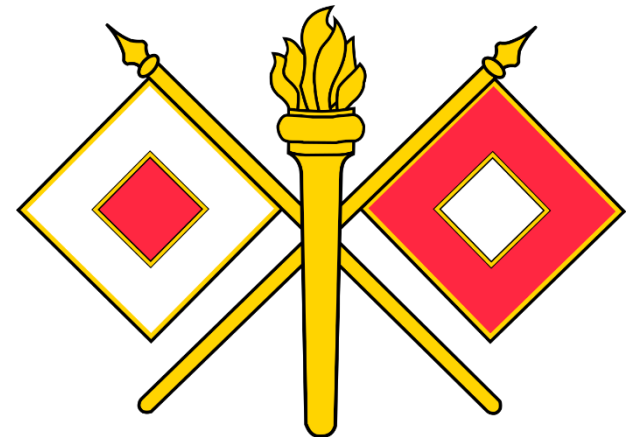
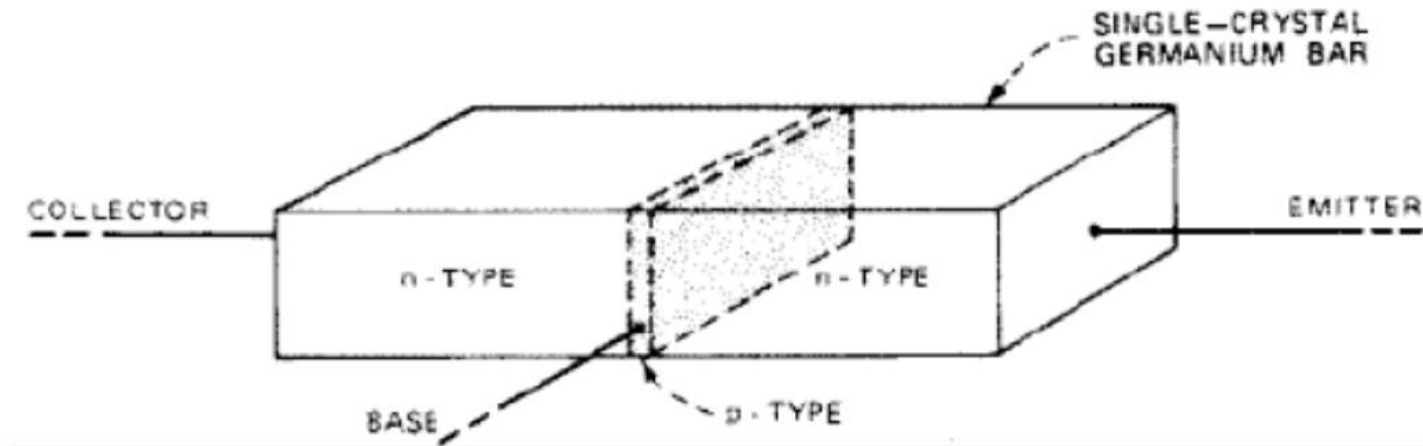
*Bu./Acre*

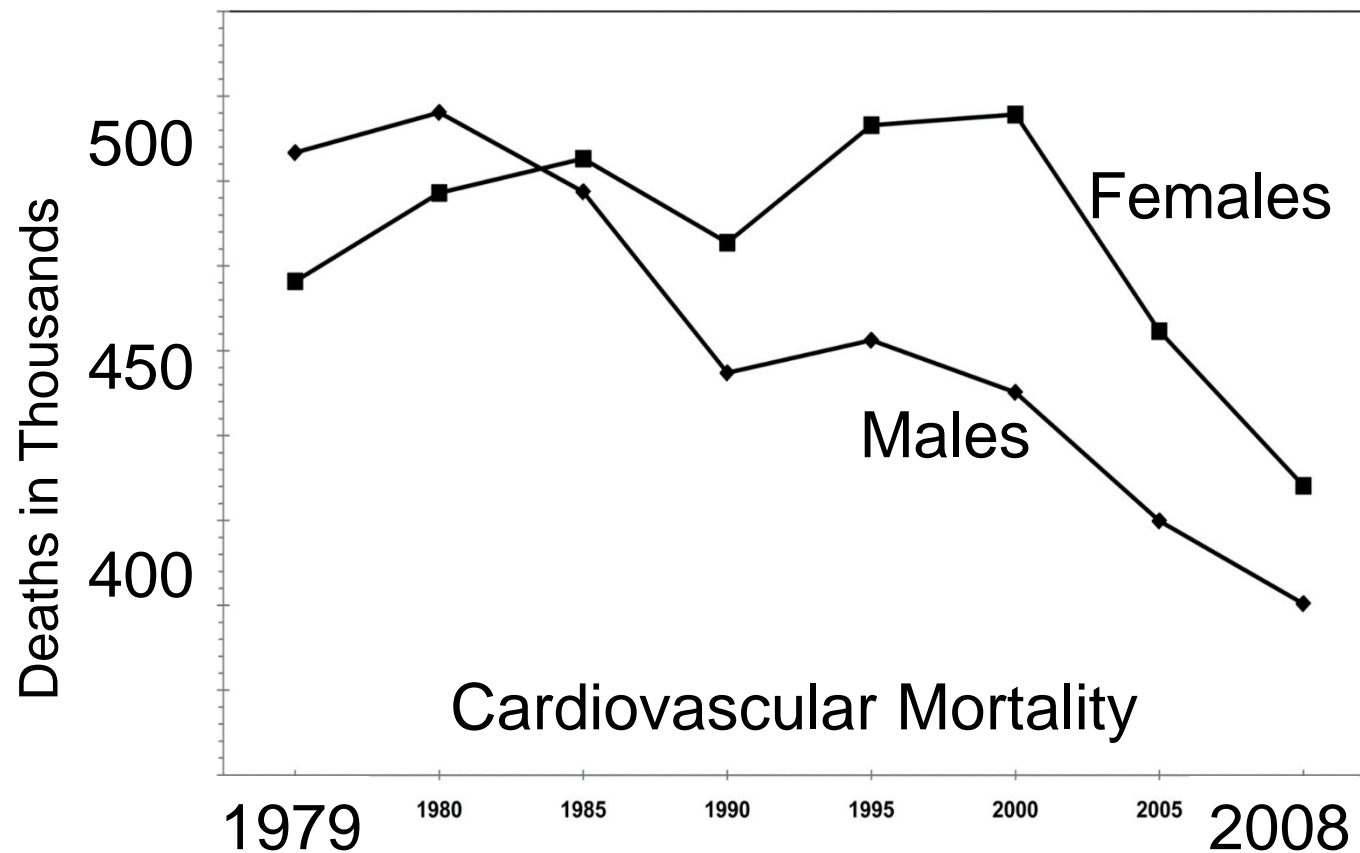






# Bell Laboratories





Variable	Criteria	Spectra of Research Attributes	
		Disconnected from Users ←	→ Connected with Users
Knowledge	Expertise	<b>Epistemic</b>	<b>Experiential</b>
	Relevance	<b>General</b>	<b>Contextual</b>
	Disciplinary Focus	<b>Singular, narrow</b>	<b>Transdisciplinary, Diverse</b>
	Uncertainty	<b>Reduce Uncertainty</b>	<b>Manage Uncertainty</b>
	Goals for Research	<b>Exploratory</b>	<b>Outcome Oriented</b>
Learning & Engagement	Learning	<b>Theoretical</b>	<b>Social, Practical</b>
	Knowledge Exchange	<b>Narrow</b>	<b>Iterative, Influential</b>
	Network Participation	<b>Homogeneous</b>	<b>Heterogeneous</b>
	Social Capital	<b>Negligible</b>	<b>Significant</b>

**HIBAR in Here**



A widely accepted definition of **basic research** has come to focus on the absence of a concern with practical applications .... This is unfortunate, indeed bizarre.

~Nathan Rosenberg and Richard Nelson, 1994,  
*American Universities and Technical Advance in Industry*

# Why we need HIBAR: The Crisis in Quality

## Why Most Published Research Findings Are False

John P. A. Ioannidis

### Summary

There is increasing concern that most current published research findings are false. The probability that a research claim is true may depend on study power and bias, the number of other studies on the same question, and, importantly, the ratio of true to no relationships among the relationships probed in each scientific field. In this framework, a research finding is less likely to be true when the studies conducted in a field are smaller; when effect sizes are smaller; when there is a greater number and lesser preselection of tested relationships; where there is greater flexibility in designs, definitions, outcomes, and analytical modes; when there is greater financial and other

factors that influence this problem and some corollaries thereof.

### Modeling the Framework for False Positive Findings

is characteristic of the field and can vary a lot depending on whether the field targets highly likely relationship or searches for only one or a few true relationships among thousands

## Genomic responses in mouse models poorly mimic human inflammatory diseases

Junhee Seok<sup>a,1</sup>, H. Shaw Warren<sup>b,1</sup>, Alex G. Cuenca<sup>c,1</sup>, Michael N. Mindrinc<sup>d</sup>, Daniel R. Richards<sup>d</sup>, Grace P. McDonald-Smith<sup>e</sup>, Hong Gao<sup>a</sup>, Laura Hennessey<sup>f</sup>, Shari Honari<sup>f</sup>, Ernest E. Moore<sup>g</sup>, Joseph P. Minei<sup>h</sup>, Joseph Cuschieri<sup>i</sup>, Paul E. Avery<sup>j</sup>, B. Nathens<sup>m</sup>, Timothy R. Billiar<sup>l</sup>, Michael A. West<sup>n</sup>, Marc G. Jeschke<sup>o</sup>, Nicole S. Gibran<sup>l</sup>, Bernard H. Brownstein<sup>q</sup>, Carol Miller-Graziano<sup>k</sup>, Steve E. Laurence<sup>g</sup>, Rahme<sup>t</sup>, Stephen F. Lowry<sup>r,2</sup>, Ronald V. Maier<sup>l</sup>, Lyle L. Moldaw<sup>u</sup>, Wenzhong Xiao<sup>a,t,3</sup>, Ronald G. Tompkins<sup>t,3</sup>, and the Inflammation and Host Response Program<sup>4</sup>

<sup>a</sup>Stanford Genome Technology Center, Stanford University, Palo Alto, CA 94305, Department of

## Raise standards for preclinical cancer research

C. Glenn Begley and Lee M. Ellis propose how methods, publications and incentives must change if patients are to benefit.

Efforts over the past decade to characterize the genetic alterations in human cancers have led to a better

understanding of the biology of cancer. However, clinical trials in oncology have the highest failure rate compared with other therapeutic areas. Given the high unmet need in oncology, it

is imperative that investigators must reassess their approach to translating discovery research into greater clinical success and impact.

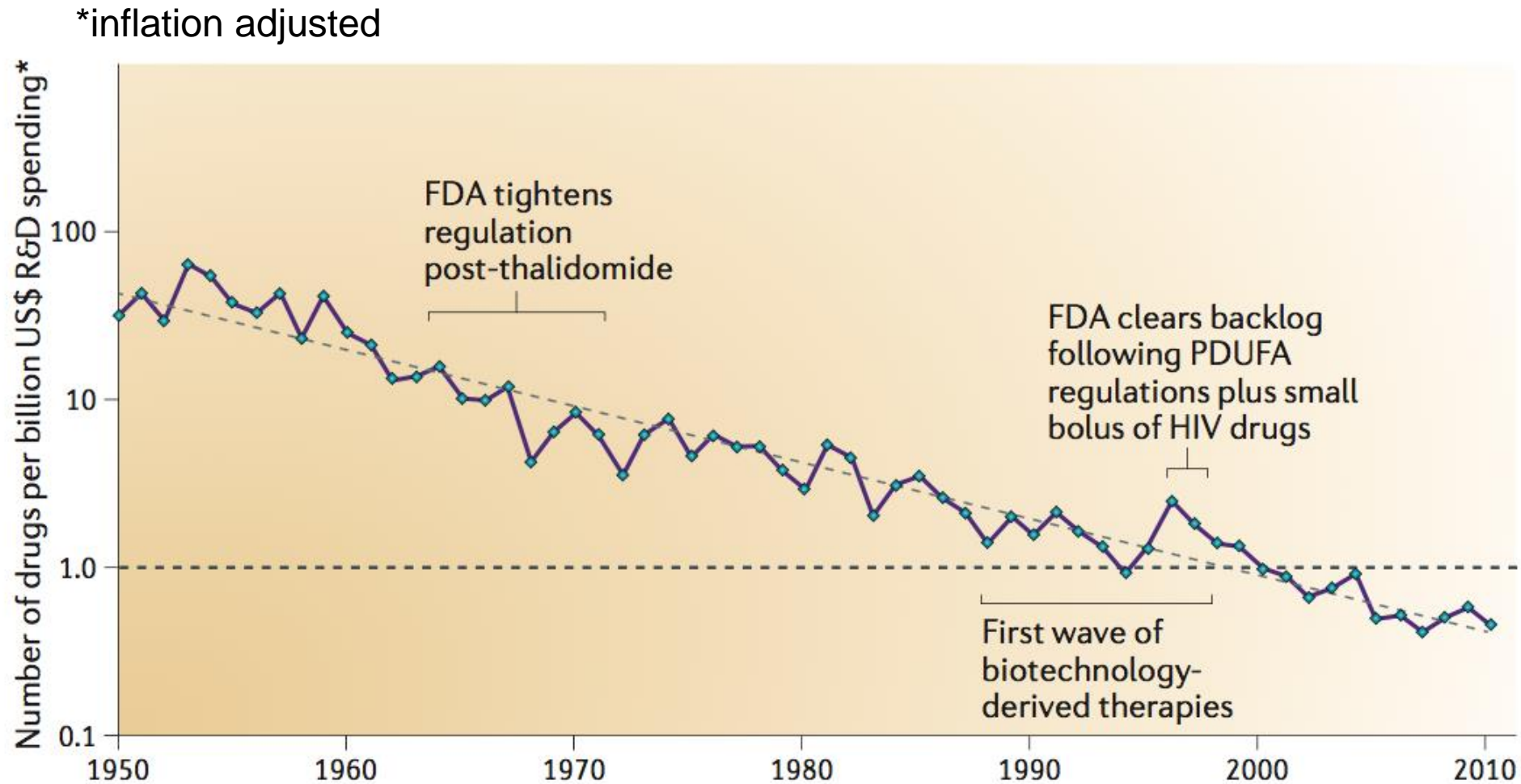
## RIGOR MORTIS


HOW SLOPPY SCIENCE  
CREATES WORTHLESS  
CURES, CRUSHES HOPE,  
AND WASTES BILLIONS

RICHARD HARRIS




# Why we need HIBAR: The Crisis in Public Value



A photograph of a pond surrounded by tall, dry reeds. Several ducks are visible in the water. In the background, there is a wooden fence and a grassy area with trees. A large green text box with a black border is overlaid on the image.

# **A**ppplied & **B**asic **C**ombined

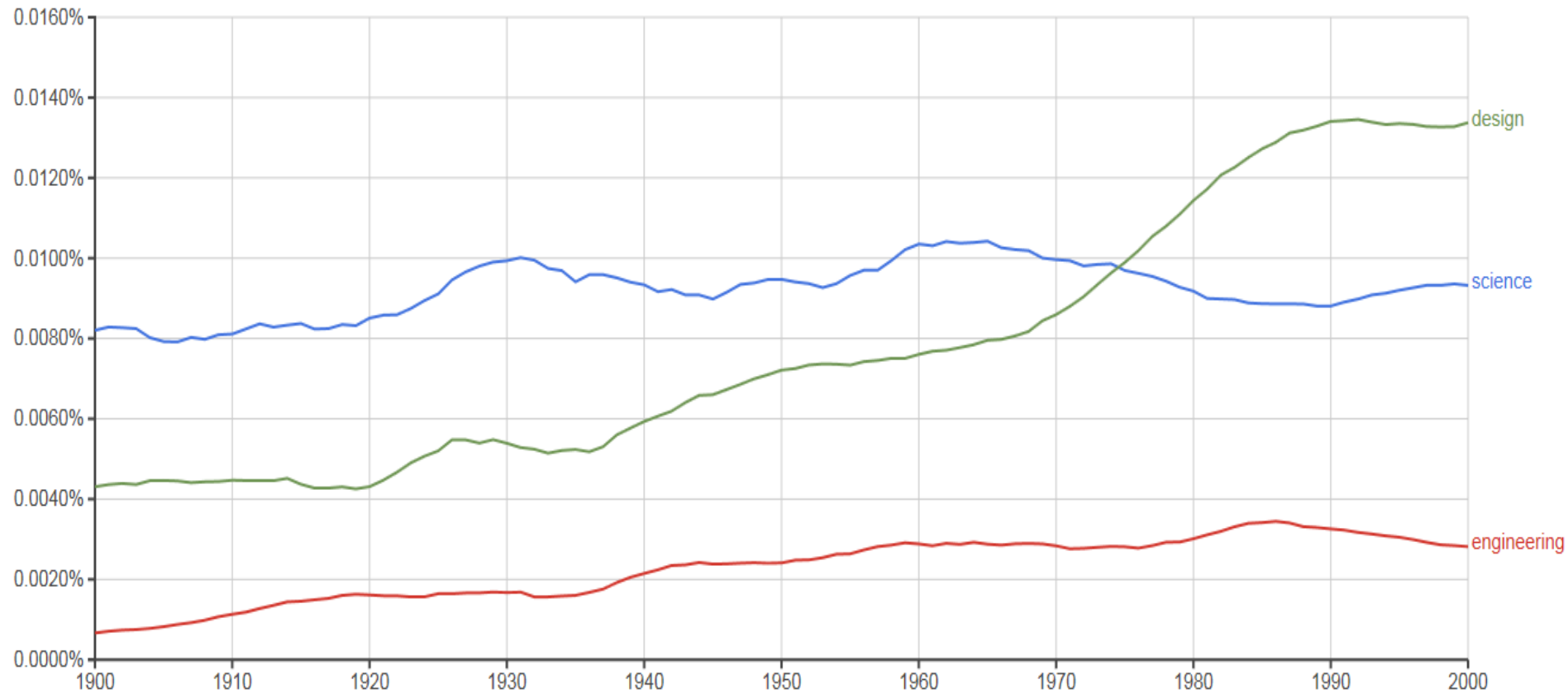
Combining applied with basic research  
produces more rapid progress in both



Blending  
**S**cience, **E**ngineering & **D**esign  
produces higher-impact research

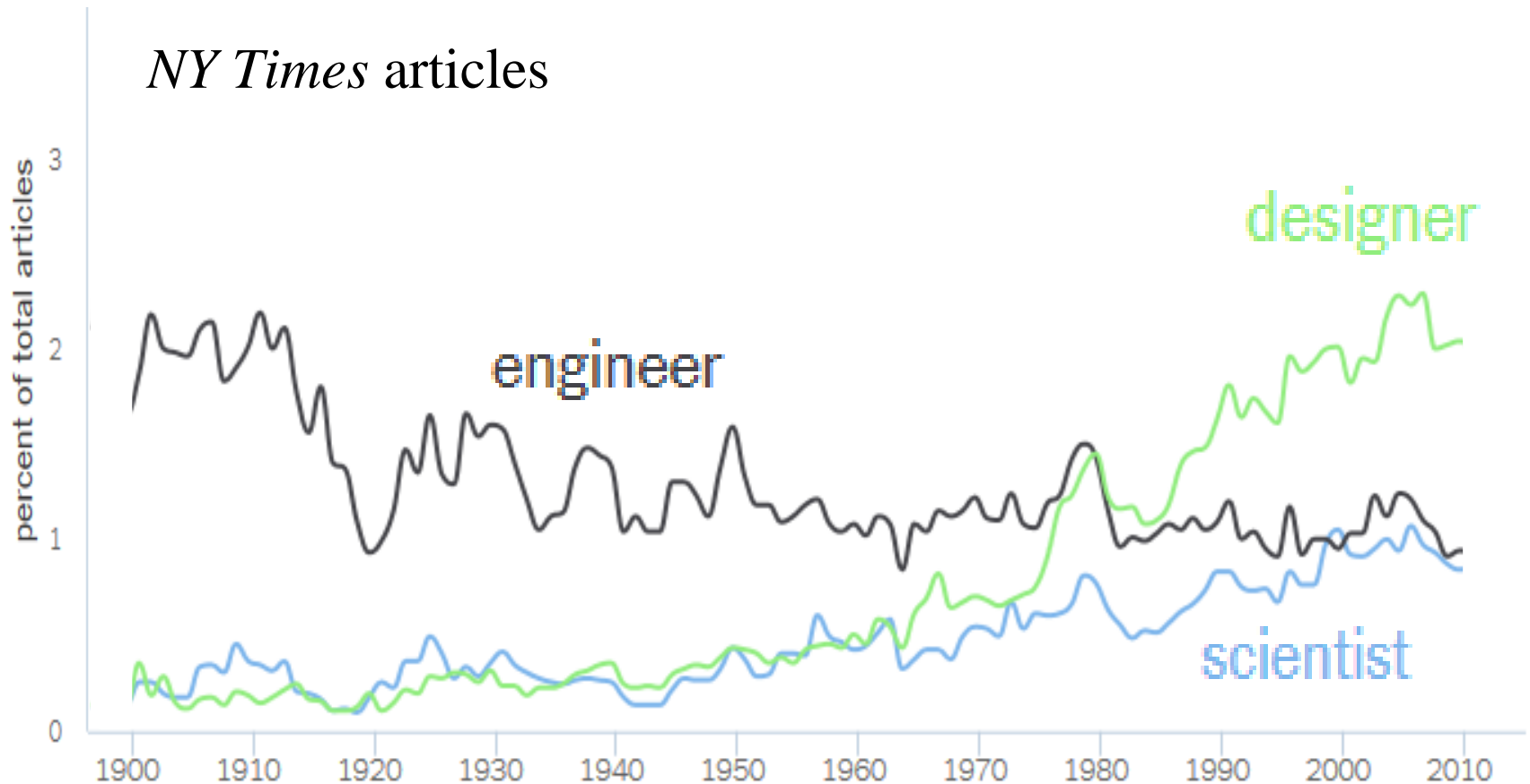
# Science, Engineering, Design

Google books Ngram Viewer




<https://books.google.com/ngrams>

# Scientist, Engineer & Designer



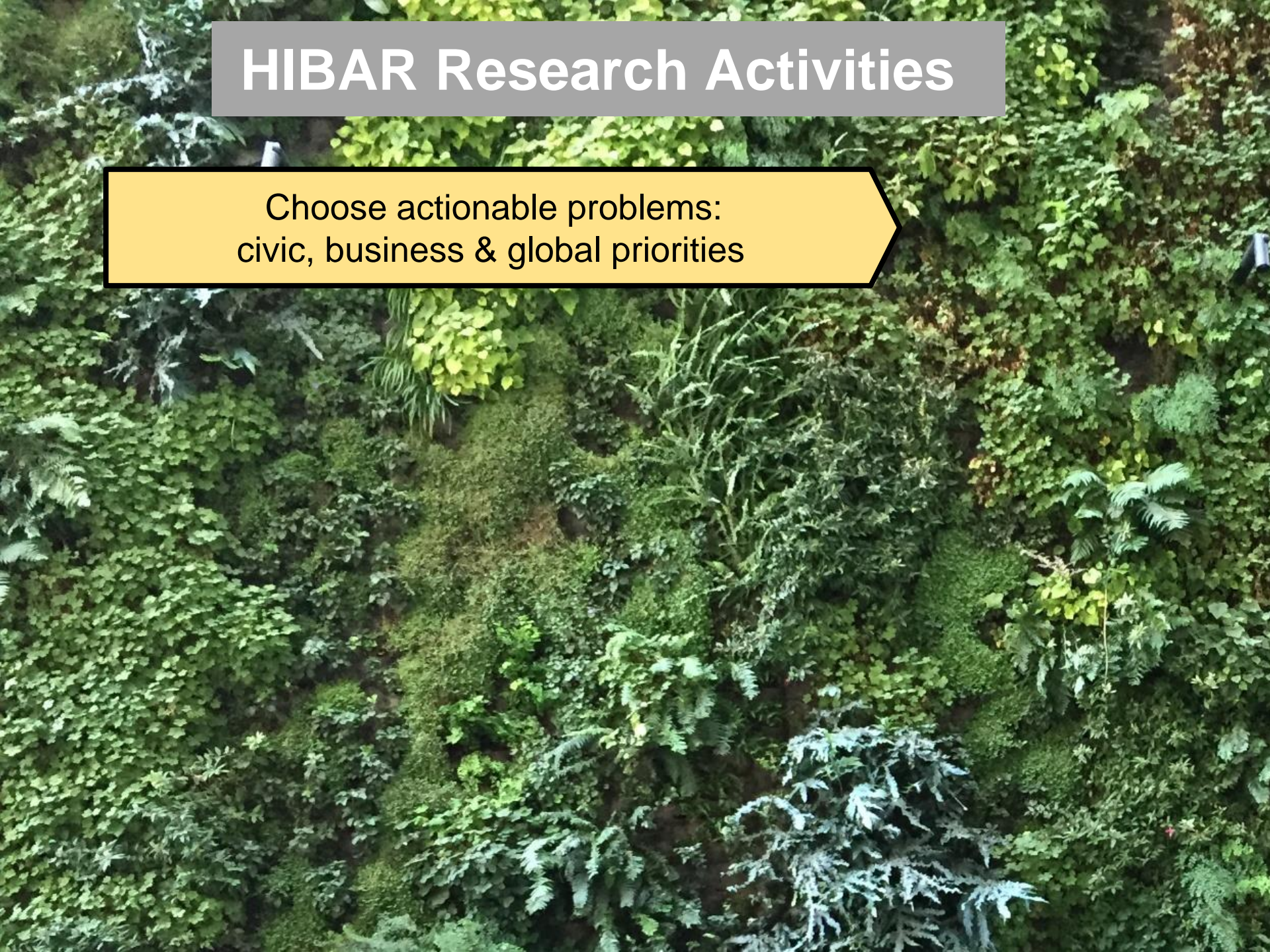
<http://chronicle.nytlabs.com/>



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# HIBAR Research Activities

Choose actionable problems:  
civic, business & global priorities



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Solutions

Theories

# Reduction of cholera in Bangladeshi villages by simple filtration

Rita R. Colwell<sup>\*†‡</sup>, Anwar Huq<sup>\*†</sup>, M. Sirajul Islam<sup>§</sup>, K. M. A. Aziz<sup>§</sup>, M. Yunus<sup>§</sup>, N. Huda Khan<sup>§</sup>, A. Mahmud<sup>§</sup>, R. Bradley Sack<sup>¶</sup>, G. B. Nair<sup>§</sup>, J. Chakraborty<sup>§</sup>, David A. Sack<sup>§</sup>, and E. Russek-Cohen<sup>||</sup>

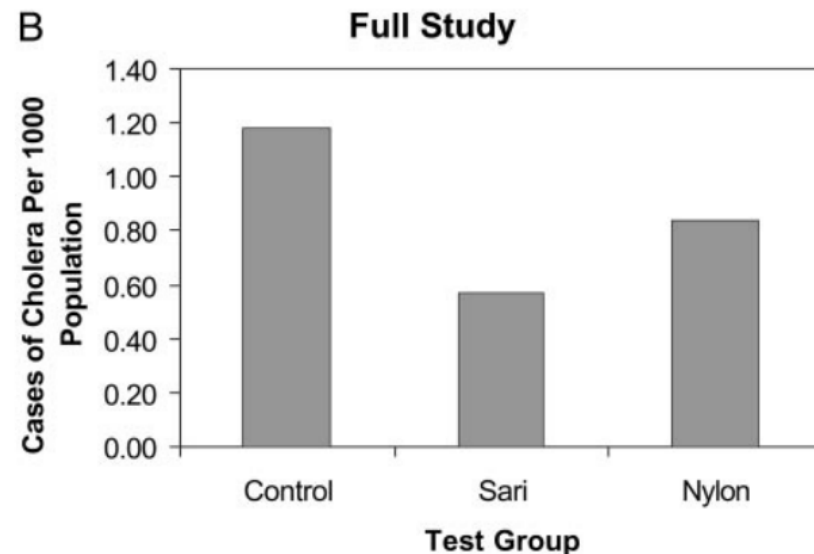
<sup>\*</sup>Center of Marine Biotechnology, University of Maryland Biotechnology Institute, Baltimore, MD 21202; <sup>†</sup>Department of Cell Biology and Molecular Genetics, University of Maryland, College Park, MD 20742; <sup>§</sup>International Centre for Diarrhoeal Disease Research, Dhaka, Bangladesh; <sup>¶</sup>Department of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD 21205; and <sup>||</sup>Biometrics Program, Department of Animal and Avian Sciences, University of Maryland, College Park, MD 20742

Contributed by Rita R. Colwell, December 5, 2002

Based on results of ecological studies demonstrating that *Vibrio cholerae*, the etiological agent of epidemic cholera, is commensal to zooplankton, notably copepods, a simple filtration procedure was developed whereby zooplankton, most phytoplankton, and particulates  $>20\ \mu\text{m}$  were removed from water before use. Effective deployment of this filtration procedure, from September 1999 through July 2002 in 65 villages of rural Bangladesh, of which the total number of villages was 100, resulted in a significant reduction in the number of cases of cholera.

that  $\approx 10^4$  to  $10^6$  *V. cholerae* O1 can produce clinical cholera. Patchiness in copepod distribution, often species specific in an aquatic environment (21), can result in significant variation in the number of copepods in water taken directly from a river for drinking.

Village populations of Bangladesh depend on untreated surface water for household use, especially during times of flooding when water from ponds and rivers is used by some villages. This source of drinking water for reasons of taste, or a local belief that “quality” water is “natural.”



# HIBAR Research Culture Change

Invite practitioner talks & visits  
Teach science, engineering & design methods  
Be ambitious & produce something small soon

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Change policies: Hiring, Promotion, Tenure  
Encourage research communications  
Recognize successful researchers

# HIBAR Research Culture Change

The **HIBAR Research Alliance** will:

- Explain the value of HIBAR research
- Correct common misunderstandings
- Facilitate success in HIBAR research projects
- Reduce impediments for HIBAR research
- Encourage grant allocation, promotion & tenure

It builds on APLU's & GUIRR's previous work

More info: [www.APLU.org/HIBAR](http://www.APLU.org/HIBAR)

Contact: [alliance@hibar-research.org](mailto:alliance@hibar-research.org)

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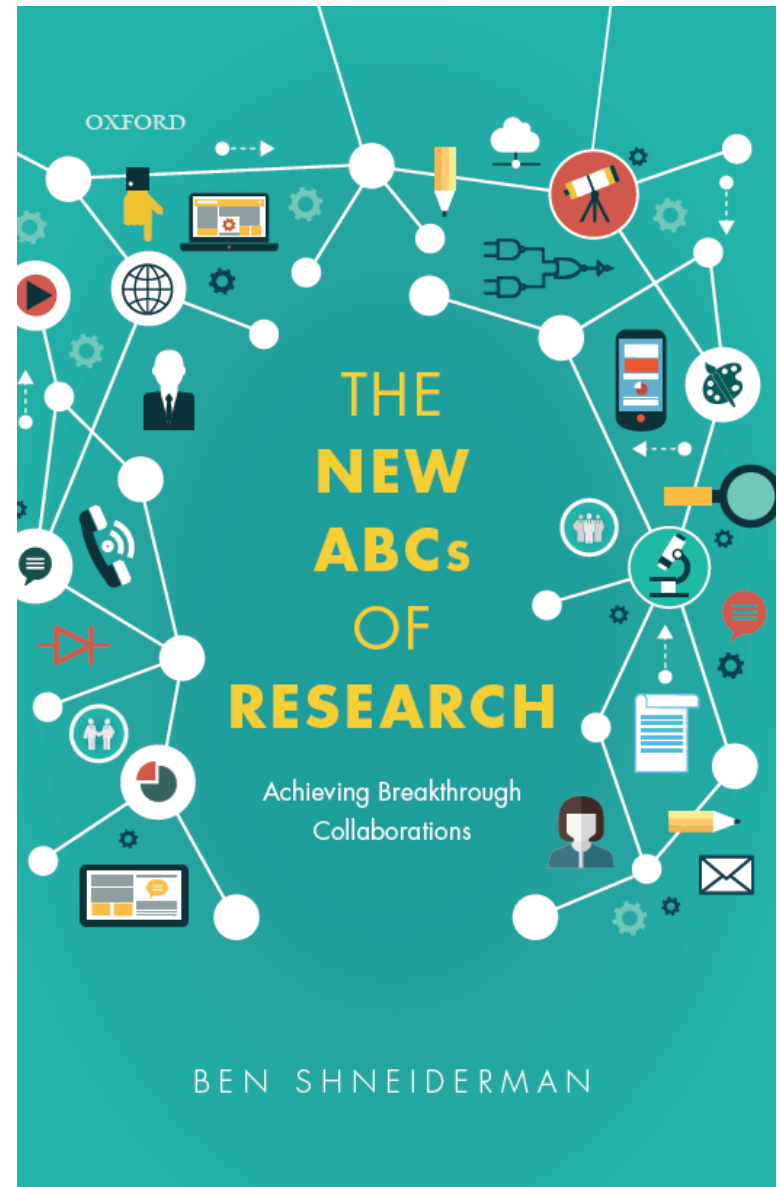


# Saving Science

Science isn't self-correcting, it's self-destructing. To save the enterprise, scientists must come out of the lab and into the real world.

Daniel Sarewitz

Science, pride of modernity, our one source of objective knowledge, is in deep trouble. Stoked by fifty years of growing public investments, scientists are more productive than ever, pouring out millions of articles in thousands of journals covering an ever-expanding array of fields and phenomena. But much of this supposed knowledge is turning out to be contestable, unreliable, unusable, or flat-out wrong. From metastatic cancer to climate change to growth economics to dietary standards, science that is supposed to yield clarity and solutions is in many instances leading instead to contradiction, controversy, and confusion. Along the way it is also undermining the four-hundred-year-old idea that wise human action can be built on a foundation of independently verifiable truths. Science is trapped in a self-destructive vortex; to escape, it will have to abdicate its protected political status and embrace both its limits and its accountability to the rest of society.



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**I**ntegrative  
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Research: Engaging Theory with Practice for Transformative Solutions.



*The National  
Academies of* | SCIENCES  
ENGINEERING  
MEDICINE

GOVERNMENT-UNIVERSITY-INDUSTRY  
RESEARCH ROUNDTABLE

Next event: Washington, DC  
June 27, 2017 GUIRR Conference