Research to Innovation: Insights and Opportunities

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Research to Innovation

Recent Trends in Innovation

UCI Beall Applied Innovation

US-India Context and Opportunities

Conclusions

Research to Innovation





NSF, 1950

NSB, 1951

- New knowledge leads to societally useful innovations
- Tremendous acceleration after the industrial revolution
- Rise of science and engineering research ecosystem after the 2nd world war



Science offers a largely unexplored hinterland for the pioneer who has the tools for his task. The rewards of such exploration both for the Nation and the individual are great. Scientific progress is one essential key to our security as a nation, to our better health, to more jobs, to a higher standard of living, and to our cultural progress.

Global R&D Expenditures

WORLD OF R&D 2022



GLOBAL GROSS EXPENDITURES ON R&D (GERD)										
Global rank	Country	GDP Billions US\$, PPP	2020 R&D Share GDP	GERD Billions US\$, PPP	GDP Billions US\$, PPP	2021 R&D Share GDP	GERD Billions US\$, PPP	GDP Billions US\$, PPP	2022 R&D Share GDP	GERD Billions US\$, PPP
1	United States	19,847	3.04%	603.3	21,038	3.06%	643.8	22,131	3.07%	679.4
2	China	23,010	2.00%	460.2	24,851	2.04%	507.0	26,243	2.10%	551.1
3	Japan	5,225	3.40%	177.6	5,350	3.30%	176.6	5,521	3.30%	182.2
4	Germany	4,239	3.10%	131.4	4,370	3.13%	136.8	4,571	3.13%	143.1
5	South Korea	2,188	4.35%	95.2	2,282	4.40%	100.4	2,357	4.50%	106.1
6	France	2,832	2.25%	63.7	3,011	2.22%	66.8	3,128	2.19%	68.5
7	India	8,443	0.80%	67.6	9,246	0.70%	64.7	10,031	0.65%	65.2
8	United Kingdom	2,798	1.73%	48.4	2,988	1.74%	52.0	3,138	1.75%	54.9
9	Russia	3,876	1.25%	48.5	4,058	1.25%	50.7	4,176	1.25%	52.2
10	Brazil	2,989	1.16%	34.7	3,145	1.16%	36.5	3,192	1.16%	37.0

Total Global R&D: ~\$2.5T

Source: R&D Magazine

Need for Innovation has Never Been Greater

UN Sustainable Development Goals

Sustainable Development Goals



Source: UN

Innovation Impact?



Peak Innovation

Total factor productivity measures innovation. It peaked in the 1940s and was strong through 1970. Each bar shows a 10-year average prior to the year shown (2014 bar is for 2001–2014).



MIT Technology Review

Growth The great innovation debate

More V

Fears that innovation is slowing are exaggerated, but governments need to help it along

Derint edition | Leaders > Jan 12th 2013

Divergence of opinions:

Camp A: Innovations of late 20th - early 21st century period are not as impactful as those in the mid 19th - early 20th century periods

Camp B: Best is yet to come --- it takes time for society to absorb new technologies

Camp C: There is a measurement problem and GDP is a flawed measure of progress

It is Getting Harder to Innovate

Figure 2: Aggregate Evidence on Research Productivity



Note: Research productivity is the ratio of idea output, measured as TFP growth, to research effort. See notes to Figure 1 and the online data appendix. Both research productivity and research effort are normalized to the value of 1 in the 1930s.

Source: Are Ideas Getting Harder to Come by, Bloom et al, 2017

Research: Pasteur's Quadrant

Quest for Fundamental Understanding



"research in an area of basic scientific ignorance that lies at the heart of a social problem" - G. Holton

Consideration of Use

Source: D. Stokes, 1997

Linear Model of Research to Innovation is Wrong

Linear model: basic research discovery to technology development to commercialization

Reality: numerous, interconnected feedback loops and iterations between basic research, prototypes, development and commercialization

Historical examples go back to the industrial revolution era where the inventions preceded science, e. g., thermodynamics came after steam engines



Technology Innovations Increasingly have a Combinatorial Nature



Combining Old and New



Mukherjee et al (2017)

Second Machine Age and Emerging Technologies





Source: McKinsey

AI, GPT and GPT

GatesNotes THE BLOG OF BILL GATES

A NEW ERA

The Age of AI has begun

Artificial intelligence is as revolutionary as mobile phones and the Internet.

By Bill Gates March 21, 2023 • 14 minute read

General Purpose Technologies

- Widespread use
- Potential for improvement
- Innovation in complementary sectors

Examples: printing press, steam engine, electrification, computers, internet

GPTs are GPTs: An Early Look at the Labor Market Impact Potential of Large Language Models

Tyna Eloundou¹, Sam Manning^{1,2}, Pamela Mishkin*¹, and Daniel Rock³

¹OpenAI ²OpenResearch ³University of Pennsylvania

March 20, 2023

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	Contents lists available at ScienceDirect	RESEARCH
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Could machine learning be a general purpose technology? A comparison of emerging technologies using data from online job postings *

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Can We Systematically Accelerate the Process of Research Driven Innovation?

NSF Innovation Corps Program

Research advances + Lean startup principles + Experiential education for faculty and students

Heart of the program: 100 customer interviews

NSF Innovation Corps Program



Value Creation Best Practices: C. Carlson

Less than 10% of company and national R&D has substantial value for stakeholders

Value creation playbook by C. Carlson

NABC Framework – **Need**, Approach, **Benefit**/Costs, **Competition**

Technologies + market/societal need + key insight + multidisciplinary collaboration

Value creations forums – team feedback in an NABC framework

An **iterative** process to create an important innovation as against solving an interesting problem

Design Thinking

Major trend in improving product/service design

Human centered design

Stanford D-School, IDEO

ARPA-H

Potential for application to the research process



NSF New TIP Directorate

Today	Tomorrow
 Largely investigator-driven 	 Users / beneficiaries engaged in shaping, conducting research
 Primarily academic research teams 	 Multi-sector teams – academia, industry, government, civil society, communities of practice
 Stream of discoveries improve prosperity, resilience, quality of life 	 Important societal and/or economic problems drive research pursuits
"Technology / supply push"	Market / demand pull"

Research Funding Approaching \$800M UCI Output Capacity New Faculty ~500 Industry Demands Talent, Innovation, The Future

Solutions Require Clusters, Partnership, Proficiency **Translational Proficiency**

Maximizing Impact Potential



Commercialization Model

RADiCal



Team Scholarship Accelerator Lab



About Team Resources Q

Team Scholarship at UCI https://tsal.uci.edu/

Dimensions of Team Science

- Diversity of team members
- Disciplinary integration
- Team size
- Goal alignment
- Permeable boundaries
- Geographic proximity
- Task interdependence

"a new interdisciplinary field ... aims to better understand ... team-based research and practice and to identify the unique outcomes of these approaches ..." (Stokols et al. 2018) **Big Challenge and Aspirational Goal**

Accelerate and optimize the research-innovation-technology-society interconnected system to assist people and society to flourish.



US-India Context

Two largest democracies, major economies, no language barrier

Large community of Indian immigrant engineers and scientists in the US

US educated engineers and scientists in Indian universities and industry

Shared interests in energy-climateenvironment, health, security, technologies



Prime Minister Narendra Modi of India and President Biden said in May that they would begin talks about critical technology. Doug Mills/The New York Times

AAU Taskforce on US-India collaboration

US-India Opportunity

Strategic, sustained collaborations between US and Indian research universities

Leveraging the large and deep venture and innovation communities on both sides

Shared understanding of interests and benefits to US and Indian participants

Careful mix of in-person visits and distance collaborations

Lessons learnt from recent collaborations in agriculture, renewable energy, public health, ...

Building Collaborative Teams

Leveraging team science principles and best practices

Identification and teaming of complementary expertise across institutions

Senior scholars, innovators, and leaders to help build trust and confidence

Involving graduate students early in the project development

Involving venture and innovations experts early in the project formulations

Sharing success stories

Comments

Ideas

Questions?

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