

Rotunde, 10:15-11:00

Understanding impact

Dietmar Harhoff (Chair)

Wiljan van den Akker

Isabel Roessler

Toby Smith



Impact of Science

5-7 June 2019, Berlin

Understanding impact

Dietmar Harhoff (Chair)

*Director, Max Planck Institute for
Innovation and Competition, Germany*

Science Quality and the Value of Inventions

Dietmar Harhoff

Max Planck Institute for Innovation and Competition

Impact of Science – AESIS Conference

Allianz Forum, Berlin - June 6/7 2019



MAX-PLANCK-GESELLSCHAFT

- Inspired by: Tom Allen, Harvey Brooks, Ashton Carter, Lewis Branscomb, Rebecca Henderson, Mike Scherer ...
- Relating technology and science (and their knowledge bases) to each other offers interesting opportunities for learning about knowledge production and utilization
- Some research questions
 - **Is high-quality science more likely to be selected for technology development?**
 - **Does high-quality science (measured in science space) *lead to* high-value technology (measured in technology/commercial space)?**
 - **Does the combination of science from different fields (interdisciplinarity) make for „better“ technology?**

A New Look at the Path from Science to Technology



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The “Research Lens” – Example: WO2011075861A1

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(74) Agent: **E. BLUM & CO. AG**; Vorderberg 11, CH-8044 Zürich (CH).

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Published:

— with international search report (Art. 21(3))

— with sequence listing part of description (Rule 5.2(a))

Excerpt from the Search Report

[X][US2005069539](#) (COHEN BRUCE D [US], et al) [X] 1,2,12-15 * claims paragraphs [0008], [0044], [0125] - [0148] *;

[XP][WO2009155725](#) (ESBATECH AN ALCON BIOMEDICAL R [CH], et al) [XP] 12-14 * pages 2-5, 16-20 *;

[XP][WO2009155726](#) (ESBATECH AN ALCON BIOMEDICAL R [CH], et al) [XP] 12-15 * pages 14 - 16, 50 claims *

[I] - XIONG S ET AL, "ENGINEERING VACCINES WITH HETEROLOGOUS B AND T CELL EPITOPES USING IMMUNOGLOBULIN GENES", **NATURE BIOTECHNOLOGY**, NATURE PUBLISHING GROUP, NEW YORK, NY, US, (19970901), vol. 15, no. 9, doi:DOI:10.1038/NBT0997-882, ISSN 1087-0156, pages 882 - 886, XP000918882 [I] 1-16 * the whole document *

DOI: <http://dx.doi.org/10.1038/nbt0997-882>

[A] - HONEGGER A ET AL, "Yet Another Numbering Scheme for Immunoglobulin Variable Domains: An Automatic Modeling and Analysis Tool", **JOURNAL OF MOLECULAR BIOLOGY**, LONDON, GB, (20010608), vol. 309, no. 3, doi:DOI:10.1006/JMBI.2001.4662, ISSN 0022-2836, pages 657 - 670, XP004626893 [A] 1-16 * the whole document * * figure 4 *

DOI: <http://dx.doi.org/10.1006/jmbi.2001.4662>

[AD] - NAGATA S ET AL, "Removal of B cell epitopes as a practical approach for reducing the immunogenicity of foreign protein-based therapeutics", **ADVANCED DRUG DELIVERY REVIEWS**, ELSEVIER BV, AMSTERDAM, NL, vol. 61, no. 11, doi:DOI:10.1016/J.ADDR.2009.07.014, ISSN 0169-409X, (20090930), pages 977 - 985, (20090811), XP026666157 [AD] 1-16 * the whole document *

DOI: <http://dx.doi.org/10.1016/j.addr.2009.07.014>



Data Exercise in the Background

- Supported by Max Planck Digital Library – deep knowledge in bibliometrics, machine learning, Web of Science and Scopus data
- PATSTAT version 2017-04: 33.2 million NPL records
- 6.0 million records for EP/WO documents, 3.1 million from applicants, 2.9 million from examiners
- Many technical issues in matching and disambiguation, scaling

arXiv.org > econ > arXiv:1903.05020

Search or Article :

(Help | Advanced search)

Economics > General Economics

Science Quality and the Value of Inventions

Felix Poege, Dietmar Harhoff, Fabian Gaessler, Stefano Baruffaldi

(Submitted on 12 Mar 2019)

Despite decades of research, the relationship between the quality of science and the value of inventions has remained unclear. We present the result of a large-scale matching exercise between the universes of 4.8 million patent families and 43 million publication records. We find a strong positive relationship between quality of scientific contributions referenced in patents and the value of the respective inventions. We rank patents by the quality of the science they are linked to. Strikingly, patents in the top decile are twice as valuable as patents in the bottom decile, which in turn are about as valuable as patents with no direct science link. We show this core result for various measures of science quality and patent value. The effect of science quality on patent value remains relevant even when science is linked indirectly, i.e., through other patents. Our findings imply that what is considered "excellent" within the science sector also leads to outstanding outcomes in the technological or commercial realm.

Comments: 42 pages

Subjects: **General Economics (econ.GN)**; Digital Libraries (cs.DL)

Cite as: **arXiv:1903.05020 [econ.GN]**

(or **arXiv:1903.05020v1 [econ.GN]** for this version)

A New Look at the Path from Science to Technology



Some Descriptive Statistics

Table S1: Structure of the dataset

Scientific publications (1980-2012)	Total	Excluding social/humanities	Excluding self-references
Scientific publications	42 962 463	35 874 824	
Scientific publications in SNPL references	2 248 563	2 203 035	2 079 713
Scientific publications in SNPL references (within five years)	1 627 872	1 597 426	1 465 312
Patent families (1985-2012)	Total	EPO	USPTO
Patent family - SNPL reference combinations	6 962 239	1 009 481	6 177 977
Unique SNPL references	2 229 658	575 637	2 017 694
Patent families	4 767 844	1 960 772	4 442 742
Patent families with SNPL references	952 932	490 848	921 929

Notes: Observation counts in the dataset. Discrepancies originate from the different views on the data. The first part of the table also considers SNPL citations from the 1980-1984 range, whereas the second part does not.

A New Look at the Path from Science to Technology



MAX-PLANCK-GESellschaft

Some Descriptive Statistics

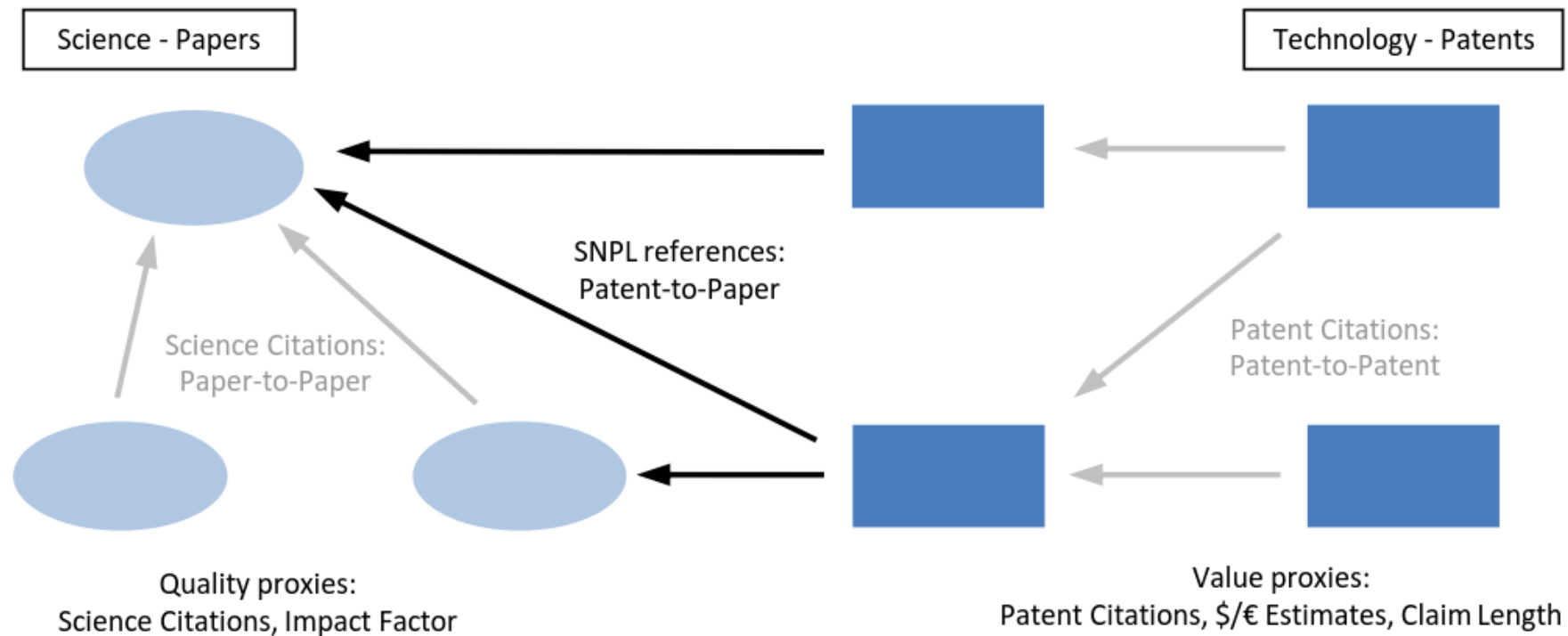
Table S2: Match quality

Office	Precision	Recall
EPO	0,99	0,96
USPTO	0,99	0,92
WIPO	0,99	0,97

Notes: Based on a manual validation exercise of 1000 NPL references per office, as reported in (15). Precision is the share of NPL reference matches that was correct. Recall is, when considering all NPL references that could have been matched, the share that were matched correctly.

A New Look at the Path from Science to Technology

Setting for the empirical analysis



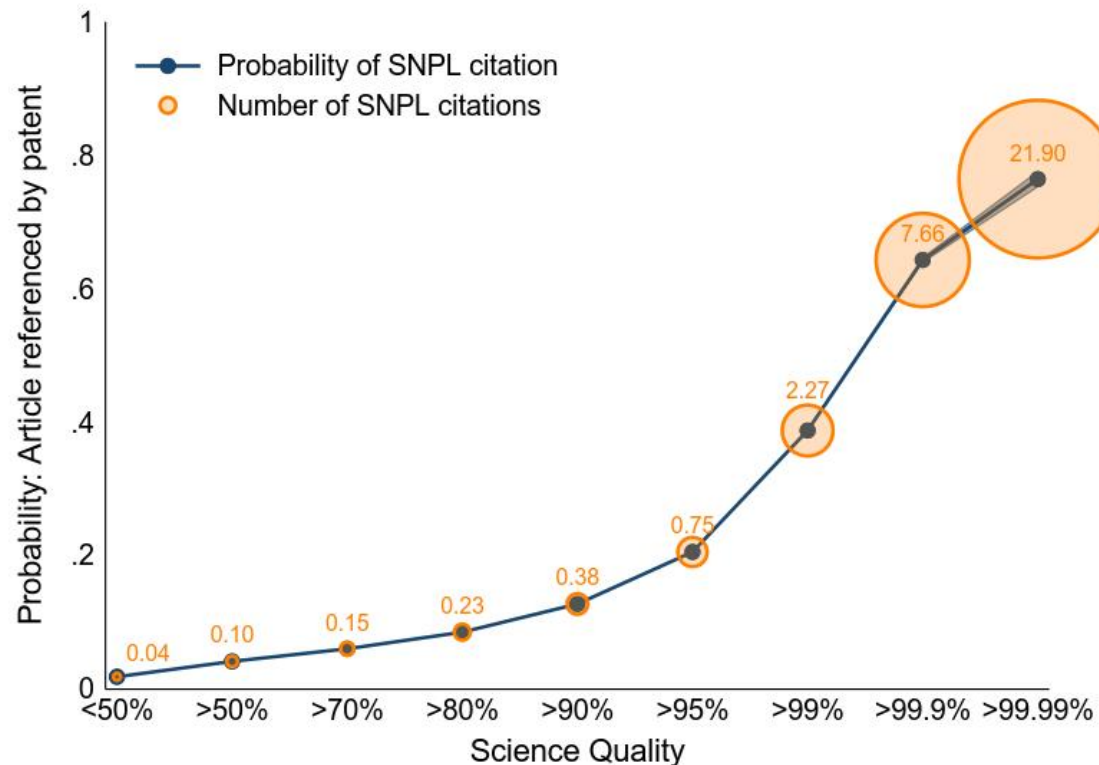
(a) Setting: The domains of science (left), technology (right) and patent-paper references

A New Look at the Path from Science to Technology

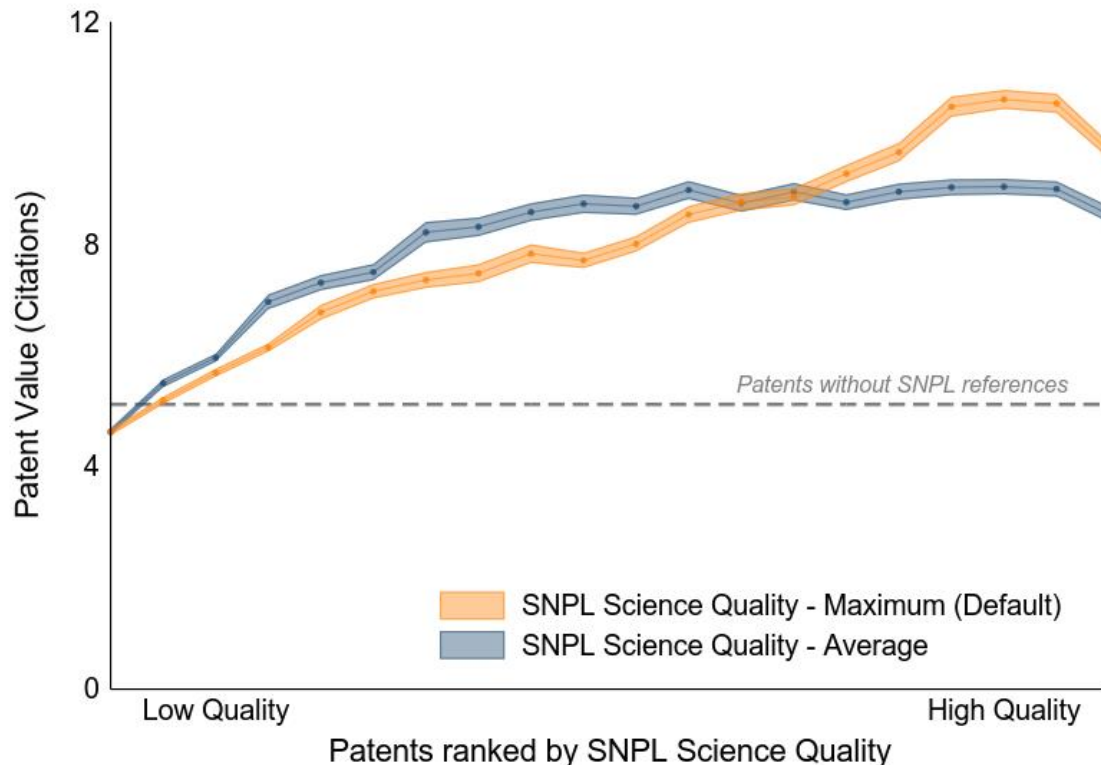


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Some results



(b) SNPL references by science quality



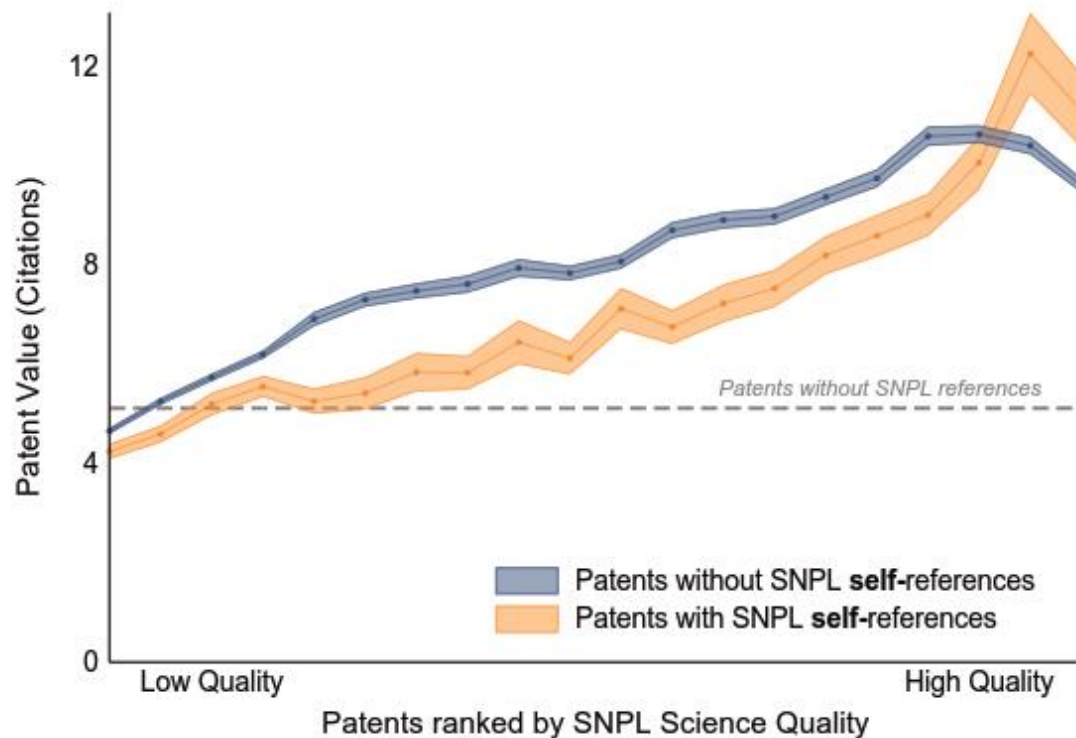
(c) Patent value by SNPL science quality

A New Look at the Path from Science to Technology

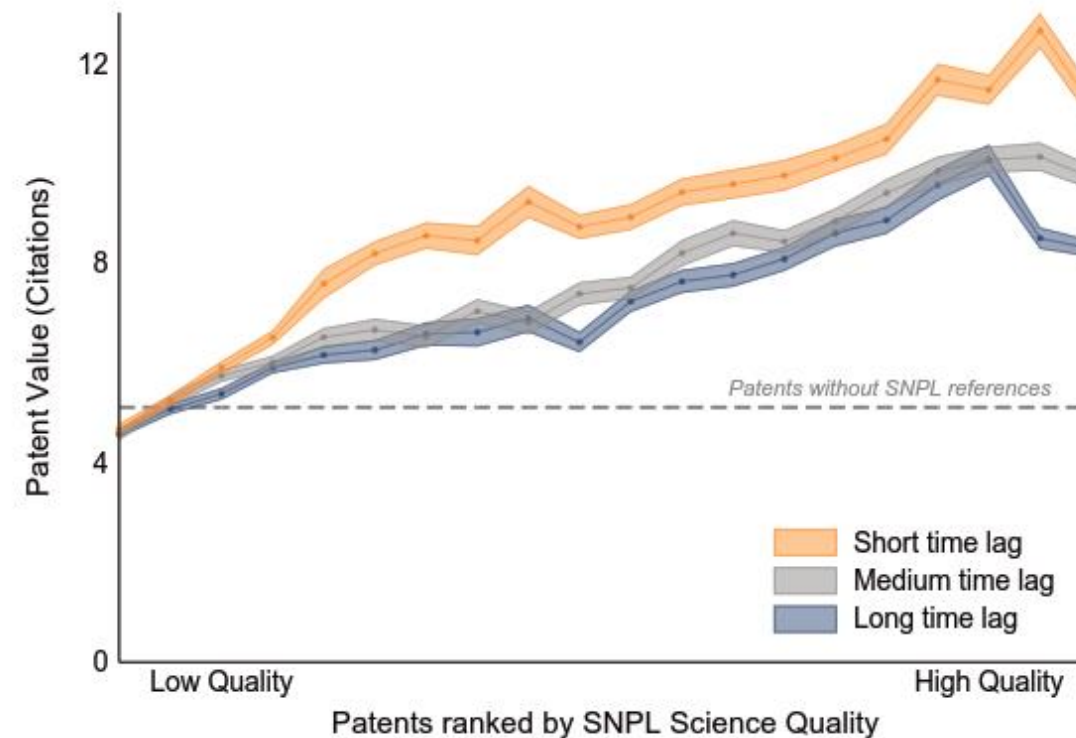


MAX-PLANCK-GESELLSCHAFT

Some results



(a) SNPL self-references

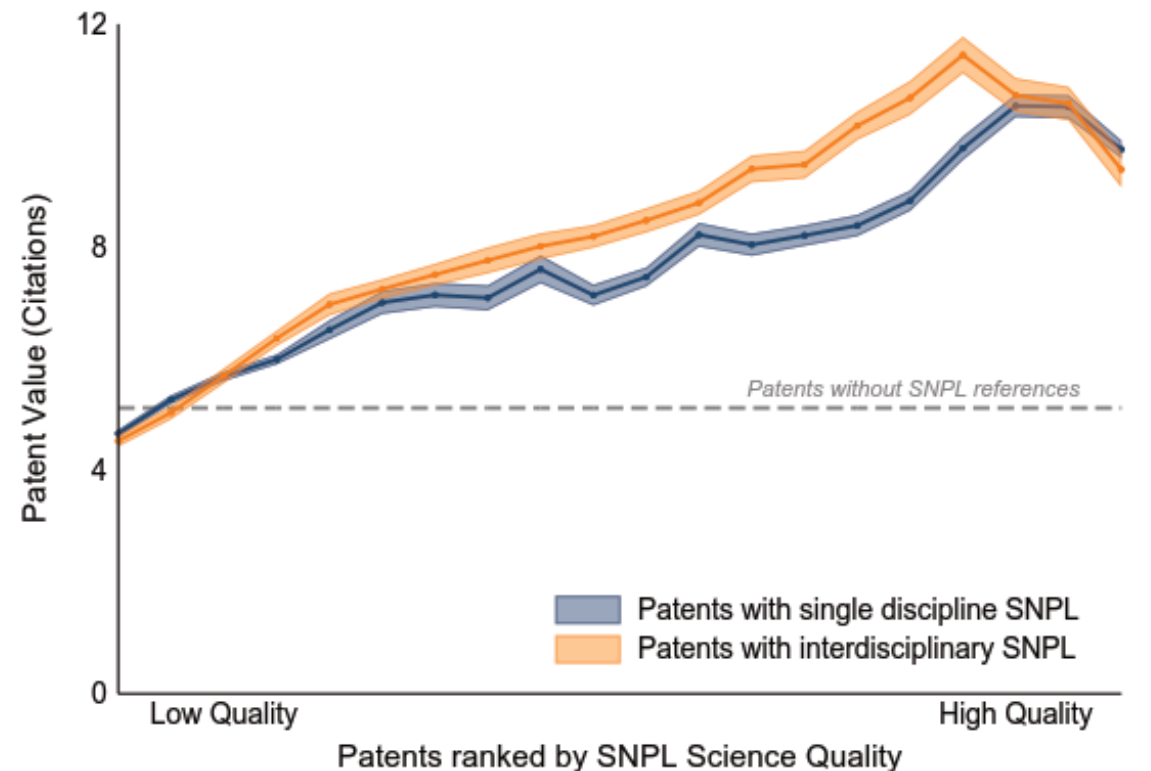


(c) Patent value by SNPL science quality and time

Interdisciplinarity

- patents with single discipline SNPLs appear to have lower value than patents with multiple discipline SNPLs
- to be explored further with other measures of inter-/multidisciplinarity

(b) Patent value and interdisciplinarity



A New Look at the Path from Science to Technology



MAX-PLANCK-GESELLSCHAFT

Some results

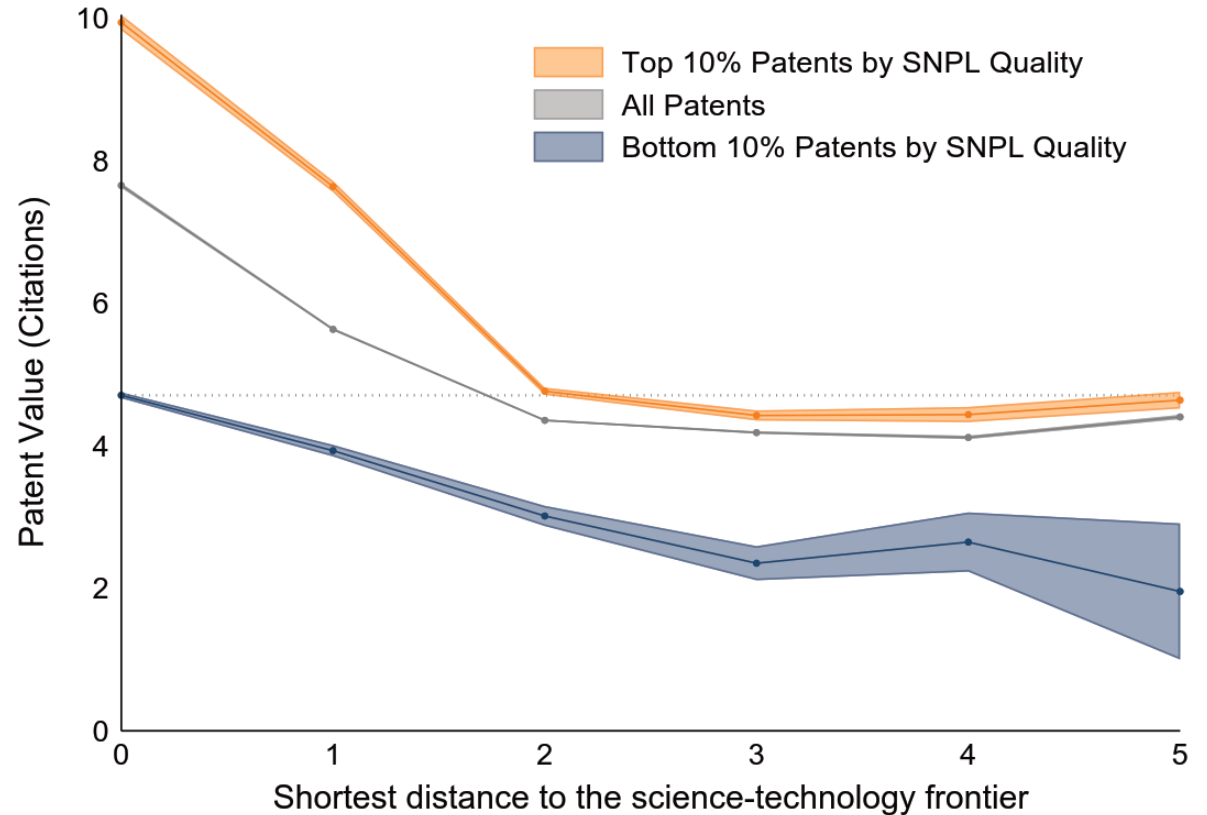
- Distance D = length of shortest path to a patent with SNPL reference (Ahmadpoor & Jones 2017)
- indirect citations (via another patent) are relevant
- science quality matters largely for distances $D=1$ and $D=2$

Notes: SNPL science quality is the maximum 3 year citation count across scientific publications appearing as SNPL references in a patent. Patent value is measured as the 5 year count of patent forward citations by US patents. Patent value and science quality are residualized using technology field \times first filing year FEs. Shaded areas show 95% confidence intervals around the respective means.

a) SNPL self-references of the highest-quality SNPL reference are considered. $N = 4,767,844$ patents (952,932 with SNPL references).

b) The distance to the science frontier (x-axis) is measured as the shortest path to a patent with SNPL references in the patent references network. For patents not at the science frontier, SNPL science quality is the maximum SNPL science quality in patents at the frontier to which they are linked. $N = 3,816,176$

c) Time-distance is measured as the lag between the first filing year of the patent and the publication year of the scientific publication in SNPL references with the the highest science quality. $N = 4,767,844$ patents (952,932 with SNPL references).



(b) Patent value by distance to the scientific frontier and SNPL science quality

- Citation measures as used in science are positively related to patent value.
- Trivial? Not in any way ...
- Technologists are not guided by citation statistics, but by profit expectations.
- Citations and these expectations coincide to some degree – that is a statistical accident.
- What to do with it?



Impact of Science

5-7 June 2019, Berlin

Understanding impact

Wiljan van den Akker

*Director of the Centre for the Humanities, Utrecht University &
Author Impact report LERU, Netherlands*

MOST STRATEGIC PROGRAMS

1. TEACHING

2. RESEARCH

3. SOCIETAL IMPACT

- **TEACHING IS OUR BIGGEST IMPACT**

- **TEACHING IS OUR BIGGEST IMPACT**
- **RESEARCH**
 - driven by curiosity
 - risk and (repeated) failure
 - unpredictability / serendipity
 - timespan – short / long
 - conceptually identical for all disciplines
 - range from fundamental to applied

IMPACT IS *NOT* A THIRD PART OF ACADEMIA

IMPACT IS *NOT* A THIRD PART OF ACADEMIA

WRONG WAY OF THINKING

LINEAR (TRL)

OUTPUT: 'LANDING' IN/ON SOCIETY

IMPACT IS A VITAL PART OF TEACHING + RESEARCH

RIGHT WAY OF THINKING

DYNAMIC (SRL INSTEAD OF TRL)

SOCIETAL STAKEHOLDERS FROM THE START

Societal Demands/Challenges:

Grand Societal Challenges

Health, demographic change [...]
Food security [...]
Secure, clean and efficient energy
Smart, green and integrated transport
Climate action, environment [...]
Europe in a changing world [...]
Secure societies

Sustainable Development Goals

- No poverty
- Affordable and clean energy
- Zero hunger
- Good health and well being
- Quality education & lifelong learning for all
- Gender equality
- Clean water and sanitation
- Decent work and economic growth
- Industry, innovation, infrastructure
- Peace, justice and strong institutions
- [...]

- **EVERY ACADEMIC HAS TO TELL A STORY**

WILJAN VAN DEN AKKER & JACK SPAAPEN:



• University of Amsterdam • Universitat de Barcelona • University of Cambridge • University of Copenhagen
• Trinity College Dublin • University of Edinburgh • University of Freiburg • Université de Genève
• Universität Heidelberg • University of Helsinki • Universitat Leiden • KU Leuven
• Imperial College London • University College London • Lund University • University of Milan
• Ludwig-Maximilians-Universität München • University of Oxford • Pierre & Marie Curie University
• Université Paris-Sud • University of Strasbourg • Utrecht University • University of Zurich

http://www.leru.org/files/publications/LERU_Position_Paper_Societal_Impact.pdf



Impact of Science

5-7 June 2019, Berlin

Understanding impact

Isabel Roessler

*Senior Project Manager, Centre for
Higher Education (CHE), Germany*



About the right language

Dr Isabel Roessler | CHE | 07 June 2019
Impact of Science Conference | Berlin

Creating an
impact is **not**
a question of
loudness.



HEI can focus on impact in general...

„We will therefore be located in the knowledge triangle and will design our teaching excellently, position our research according to expectations and contribute to innovation in the sense of social innovation.“

UAS rector

We take teaching or research, education and transfer as a triad, which we want to see together as a unity. We must do everything with a very high quality in order to achieve a certain level of excellence as a university. That is our objective at the moment.

UAS rector

We want knowledge not only to be generated.

More importantly: knowledge is applied. Knowledge is brought from the university into the environment, is applied to business, is applied in the municipality, is applied to social institution, is applied in politics, is applied in society. This transfer from A to B is done by us. This is how we build our reputation, make ourselves useful outside.

#UAS rector

...or can have impact in various smaller kinds



What: Teddy hospital

Impact: take away the fear.

Source: SVZ.de, zB Uni Kiel, Uni Münster

...or can have impact in various smaller kinds



Source: HS Bremen, Projekt „ThinkMusic!“

What: Culture for disadvantaged children

Impact: Access to culture, experience, overcoming cultural barriers

...or can have impact in various smaller kinds



What: Integration of Refugees

Impact: Enabling of a successful integration, increase of acceptance

Quelle: HS Magdeburg-Stendal

...or can have impact in various smaller kinds



What: Development of district concepts

Impact: Social and regional development

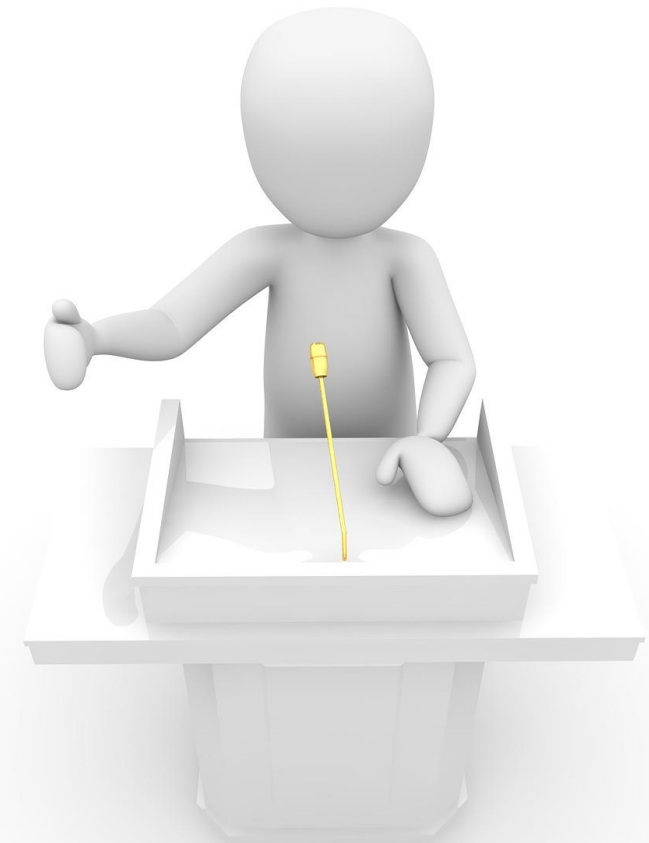
Source: MZ, zB HTWK Leipzig

Our lessons learned: Science has an impact.
Whether you like it or not.

- **Become clear** what you want to achieve
- **Think** about impact from the beginning on
- **Use indicators** to measure your work
- Make sure, that you are able to **address the target groups**

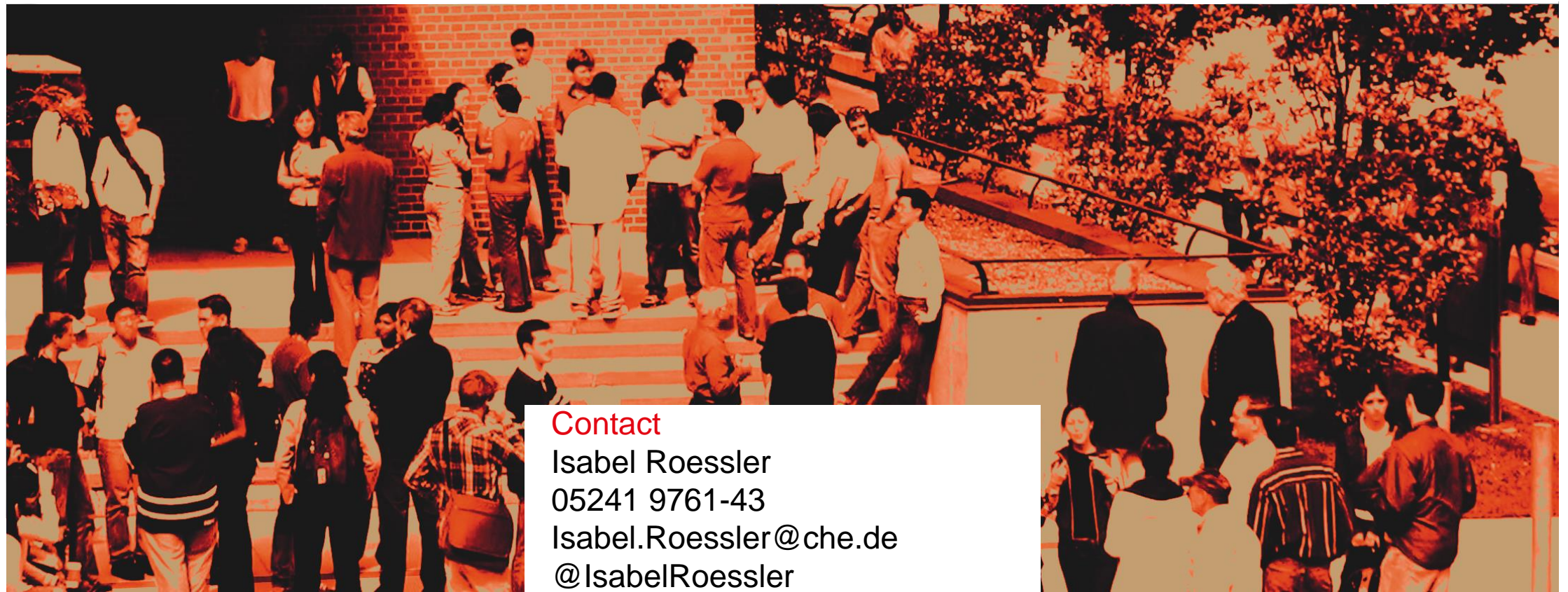
„If you want to have an
impact on other
people, you first have
to **talk** to them **in their**
language.“

Kurt Tucholsky



Today, a university education is open to almost everyone. Universities and politics must make a successful study possible.

We offer impulses and solutions.



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Impact of Science

5-7 June 2019, Berlin

Understanding impact

Toby Smith

*Vice President of Policy at the
American Association of Universities, USA*

WHAT IS IMPACT... AND WHY DO WE CARE?

Tobin L. Smith, Association of American Universities

Impact of Science 2019

Allianz Forum, Berlin, Germany

7 June 2019



**Association
of American
Universities**

WHY DO SCIENTISTS CARE ABOUT IMPACT?

WHY DOES THE PUBLIC CARE ABOUT IMPACT?

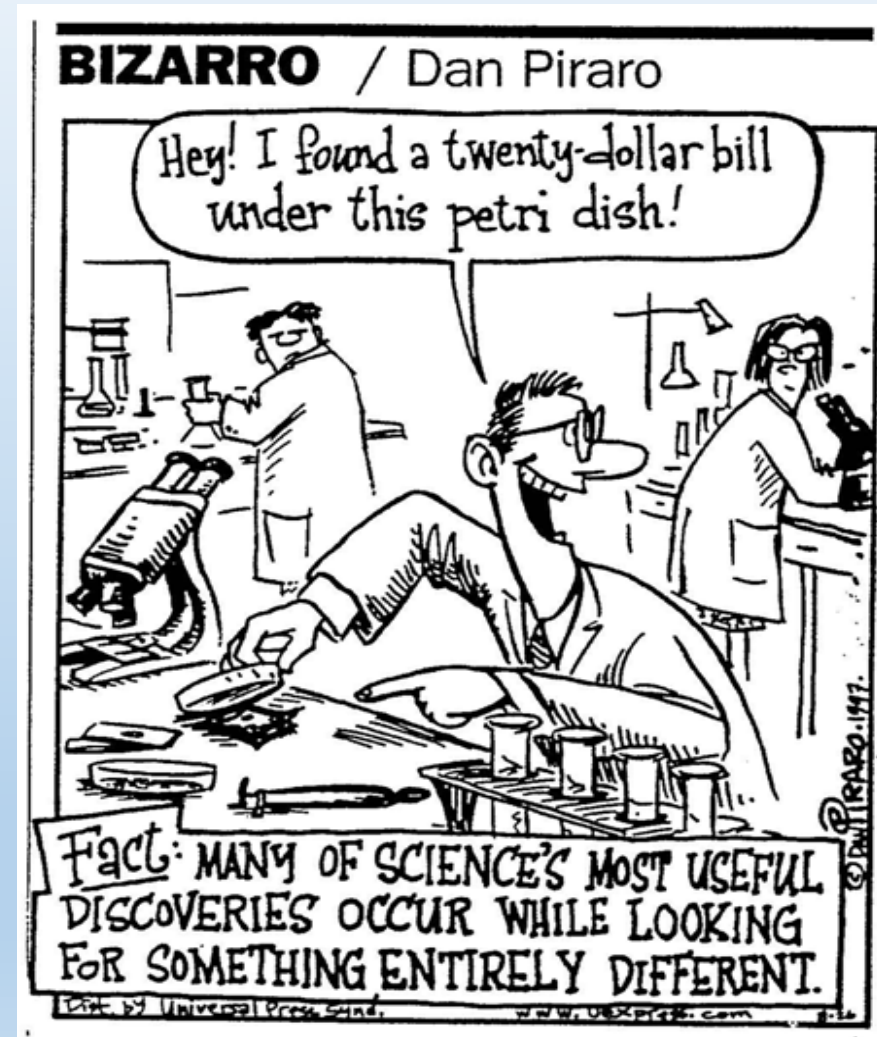
Governments View of Impact



By Cartoonist Sidney Harris in the American Scientist

Challenge in Demonstrating Impact

- Cannot easily predict scientific outcomes
- Societal value & impact are often not immediately known
- Full social & economic impacts are impossible to assess in the short-term
- Scientists & the public view & measure impact differently





AESIS
NETWORK FOR
FINANCING & EVALUATING THE SOCIETAL IMPACT OF SCIENCE

Annual International Conference

Impact of Science

Understanding causalities, correlations and pre-conditions for the different dimensions of societal impact of science

5-7 June 2019, Allianz Forum, Berlin, Germany

Research managers • Evaluators • Science Policymakers • Research Councils • Funding agencies



IMPACT IS IN THE EYE OF THE BEHOLDER

Historical Discussions Around Measuring Impact

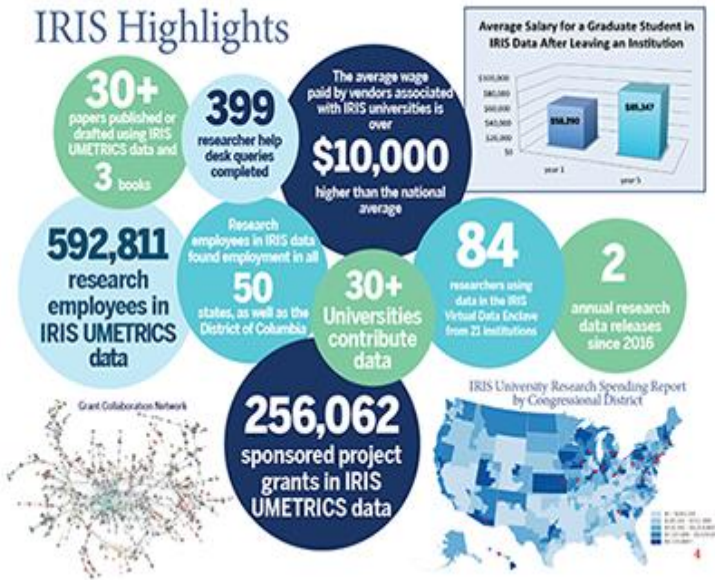


- *NSF Traces Study*
- *Bibliometrics*
- *Economic Impact*
- *Multipliers & ROI*



INSTITUTE FOR
RESEARCH ON
INNOVATION & SCIENCE

IRIS Highlights



REF2014
Research Excellence Framework

The research of **154**
UK universities was assessed



They made **1,911** submissions including:

- **52,061** academic staff
- **191,150** research outputs
- **6,975** impact case studies

The **overall quality** of submissions was judged, on average to be:

- ★★★★★ **30%** world-leading (4*)
- ★★★★ **46%** internationally excellent (3*)
- ★★★ **20%** recognised internationally (2*)
- ★ **3%** recognised nationally (1*)

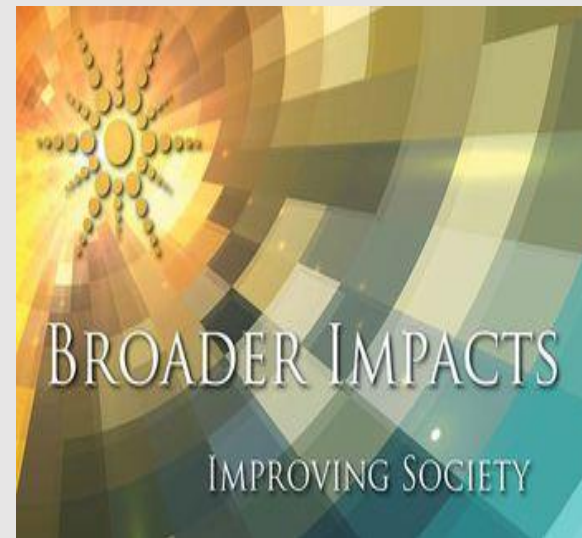
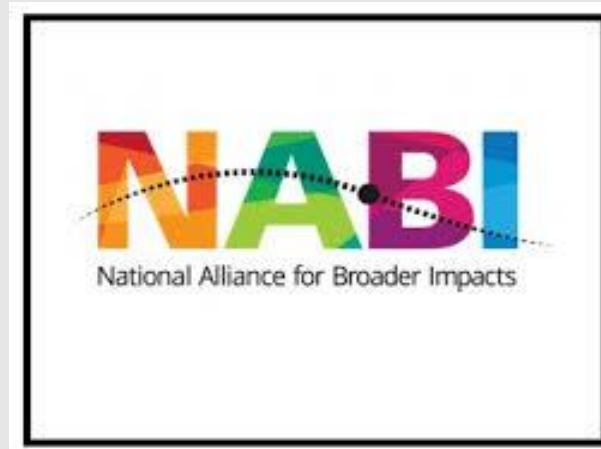


THE
GOLDEN
GOOSE
AWARD

DATA VS. CASE STUDIES AND IMPACT STORIES



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LOOKING BACKWARDS VS. FORWARDS

Direct vs. Indirect Impacts



DOD Research: Empowering and Supporting Our Troops in Combat



- INDIVIDUAL FIRST AID KIT:** Most soldiers carry a medical kit, but the Army's first aid kit was redesigned in 2004 as one of the Army's Top 10 Greatest Innovations. It's a compact, lightweight kit that's easy to use and is funded by the Army and supported by the 100th Anniversary of the American Red Cross.
- INTERCEPTOR BODY ARMOR:** Most soldiers wear a helmet and body armor, but the Army's new armor system that protects them in combat. This lightweight armor is the result of research funded by the Army's Research, Development and Engineering Design Research sponsored by the Materiel Command.
- JOINT PRECISION AIR DROP SYSTEM:** Improved air delivery of food and equipment drops to soldiers increases the survivability of troops in the field. This joint Army/Air Force research effort began in 2004.
- LASER DESIGNATOR:** Soldiers' weapons are equipped with laser sights to increase their accuracy in the field. Initial laser research was funded at Fort Belvoir in the 1980s and is now sponsored by the Army and Air Force.
- LUMINESCENT POLYMERS FOR EXPLOSIVE SENSING:** DOD sponsored research has resulted in the development of a new class of luminescent polymers that are capable of detecting hidden implanted explosive devices (IEDs).
- MILITARY RESEARCH:** Advances in processing, materials, and manufacturing have led to the development of more powerful, lighter, and more reliable weapons, sensors, and other systems. This research is funded by the Army and conducted at a variety of locations, including the Army Research Center for Chemical Research, the Army Research Center for Materials, the Army Research Center for Environmental Health, and the Army Research Center for Human-Computer Interaction.
- NIGHT VISION GOGGLES:** Image intensifiers employ the photocathode effect, allowing soldiers to see images in very low light. Current night vision technology is the result of several years of DOD basic and applied research.
- SOLDIER PERSONAL DIGITAL ASSISTANT:** Systems in the field are required to store and process information using a variety of technologies.
- GPS:** Basic research funded over several decades by the Army, Navy, and the Air Force (now DOD) led to the development of the global positioning system, which is the specific location of a vehicle anywhere in the world.
- WEARABLE SOLDIER RADIO:** The technology provides voice communication and links soldier's personal digital assistants for radio, video, and data. The research leading to this was funded by the Army's Research, Development and Engineering Design Research sponsored by the Army and Air Force.
- LITHIUM PRIMARY BATTERIES:** A lighter and longer-lasting battery for soldiers was developed as a result of basic research funded by DOD and applied research funded by the Army and Air Force.
- SOLDIER TRAINING:** Gaming technology and the simulation of battles are used to train soldiers for deployment and survival. This research is funded by the Army and conducted at a variety of locations, including the Army Research Center for Human-Computer Interaction, the Army Research Center for Environmental Health, and the Army Research Center for Materials.
- TRANSLATION DEVICES:** Highly accurate voice recognition technology allows soldiers to generate and interpret speech in other languages. These translation devices have been used in Iraq and Afghanistan. The original technology resulted from DARPA-sponsored research which is being improved by other DOD agencies.

Published by The Tech Times on the Future of American Innovation, www.futurism.com, July 2008.

AUTOMOTIVE APPLICATIONS OF BASIC RESEARCH

Federally funded research laid the foundation for many technological advances contained in the modern car.

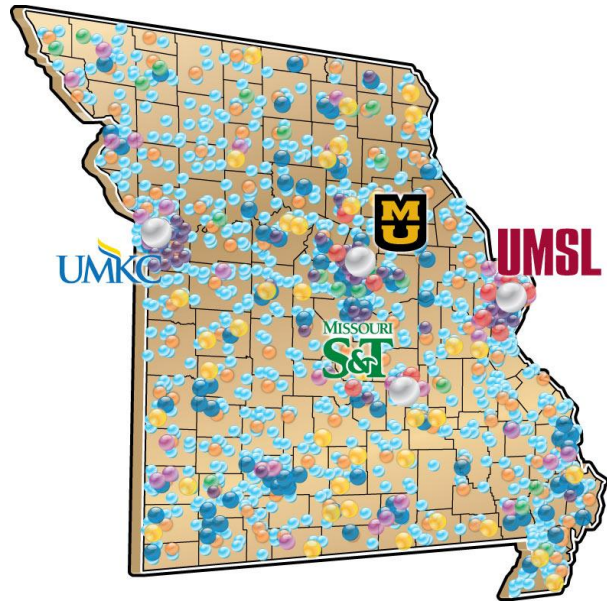


- LCD Monitors
- Speech Recognition Technology
- Lithium-Ion Batteries
- Catalytic Converters
- Synthetic Polymers
- Shatterproof Windshields
- Power Windows
- Center Brake Light
- Airbag Deployment Sensors
- CD Players
- GPS
- Semiconductors
- Remote Car Locks
- Extended Tire Life
- Car Bumpers

Produced by the Association of American Universities, Sept. 2010



All Politics is Local...
...All Impact is Local Too



UNIVERSITY OF MISSOURI
IMPACT

· THE ·
GREAT STATE
ROAD TRIP

See how Spartans are working to make a better tomorrow for Michigan.

MORE →

MICHIGAN STATE UNIVERSITY

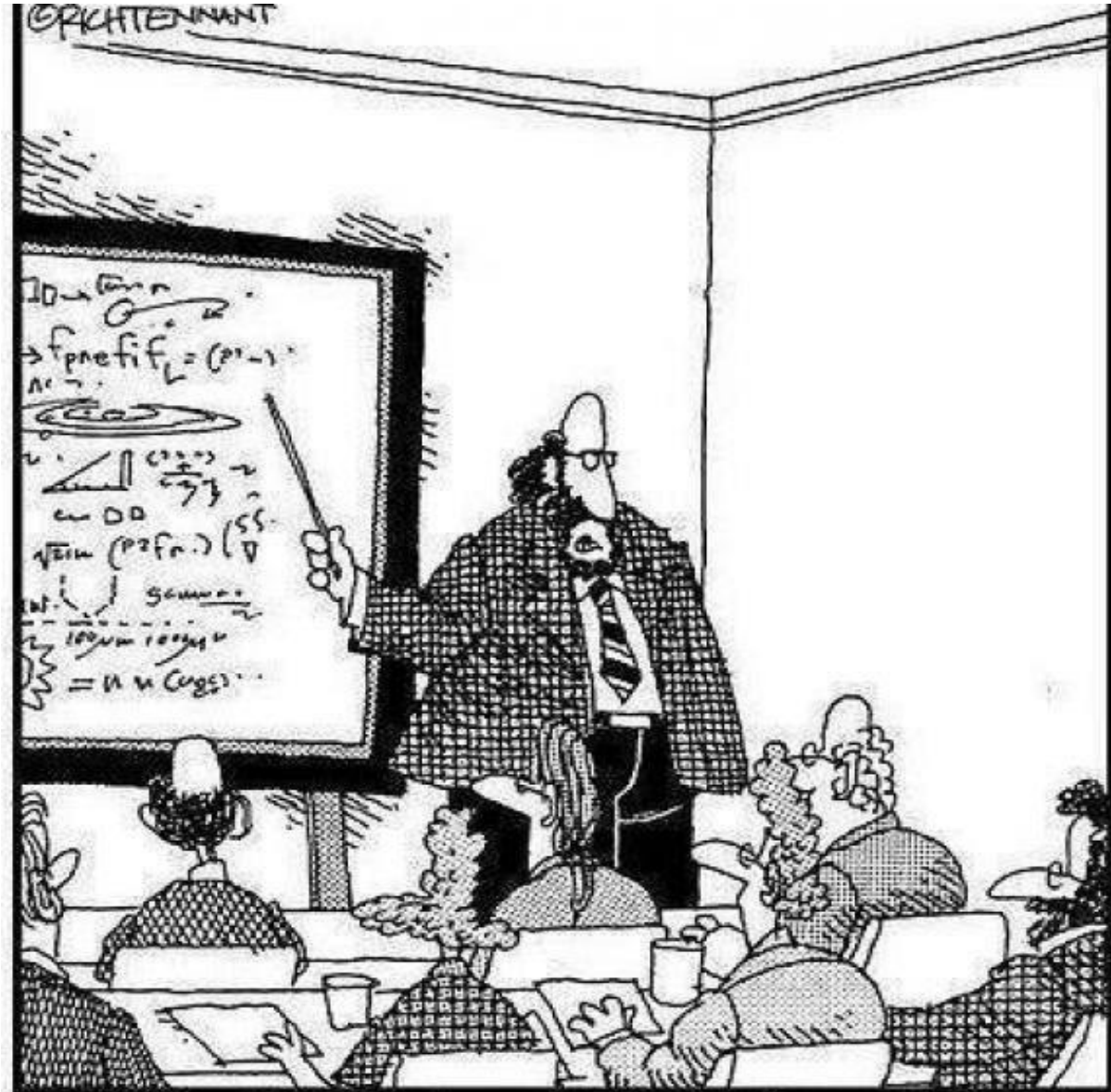
IOWA STATE UNIVERSITY
Extension and Outreach
Healthy People. Environments. Economies.



Questions

- Is there a right or wrong way to assess impact?
- Can you know at the outset which science will have the greatest impact?
- How do we train scientists to be better at understanding, explaining, and engaging with others about the impact of their science?

WHY DO WE CARE ABOUT IMPACT?



“Along with ‘Antimatter,’ and ‘Dark Matter,’ we’ve recently discovered the existence of ‘Doesn’t Matter,’ which appears to have no effect on the universe whatsoever.”



Association
of American
Universities

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@AAUnivesities



www.aau.edu