

Conditions for Creative Research

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Creative research in society

Two apparently antithetic truisms:

- § Scientific research is in the first place a **creative enterprise**, based on methodological systematic, but often fed by serendipity. Research processes and their impact on society and economy are elusive and hardly to predict. **Pushing** for effective output would **undermine** the very working of science.
- § **Without requests** from publics (society, government, economy) and without their investments in scientific research there was **no organised, sustainable science** – hence there is good reason to expect and control for useful and effective science production.

Creative or 'Frontier Research' (transformative)

Term 'Frontier Research' reflects that

- § it is at the leading edge in developing new knowledge
- § it is intrinsically risky, in that it is often not yet clear which approach may eventually prove most fruitful;
- § there are no boundaries between disciplines, nor between basic and applied research; frontier research is concerned both with both new knowledge about the world and with generating potentially useful knowledge at the same time, and
- § by its very nature, it transcends national borders.



http://ec.europa.eu/research/future/pdf/hleg_fullreport_frontier_research_april2005.pdf

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Frontier research, normal science, innovation ...

Creative frontier research builds on and interferes with

- § Normal science: Tradition, routines as basis or point of departure of creative ventures
- § Innovation and growth: Medium-tech or no-tech competencies as relevant playground

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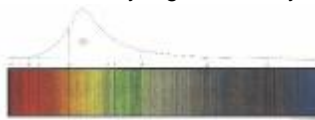
Joseph von Fraunhofer (1787 - 1826)



Researcher
discovery of "Fraunhofer Lines" in the sun spectrum

Inventor
new methods of lens processing

Entrepreneur
head of royal glass factory



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Institutional conditions for research creativity - the CREA project

§ Collaborative research project

- § Fraunhofer ISI (Thomas Heinze, [Stefan Kuhlmann])
- § Georgia Tech (Phil Shapira, Juan Rogers, Diana Hicks, Cheryl Leggon)
- § SPRU (Jacky Senker, Martin Meyer)

§ Funded by EC under the NEST Programme

- § NEST = New emerging science and technology
- § Time: 2005-2006

§ See: <https://www.crea.server.de>

CREA: Definitions

Creativity is...

"...the ability to come up with ideas or artifacts that are new, surprising and valuable" (Boden 2004)

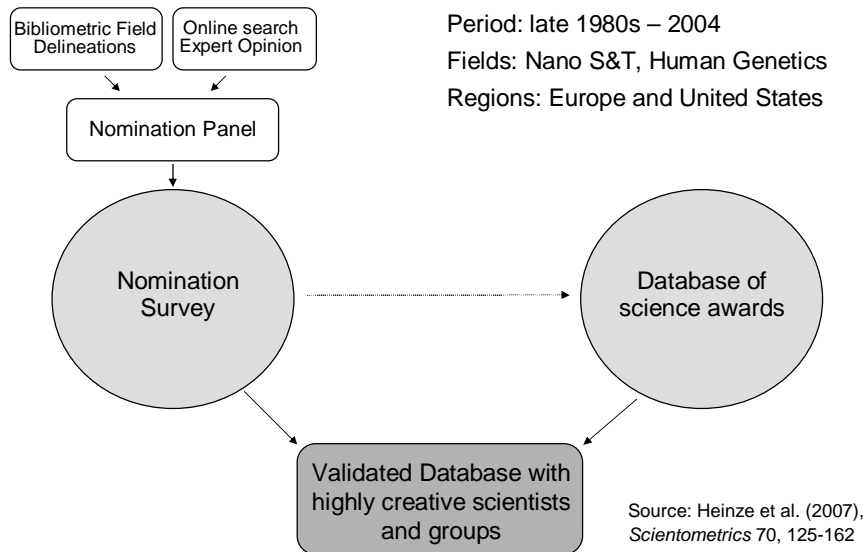
"...the ability to produce work that is both novel (original, unexpected), and appropriate (useful, meets task constraints)" (Sternberg 2003)

CREA: Typology of Creative Research Accomplishments

Type of creative accomplishment	Example
New theoretical concepts	Theory of Specific Relativity (EINSTEIN, 1905)
New empirical discovery	Biodiversity → Theory of Evolution (DARWIN, 1859)
New methodology	Factor Analysis → Theory of Mental Abilities (SPEARMAN 1904a, 1904b, 1927)
New instruments	Scanning Tunelling Microscopy → Nano S&T (BINNIG & ROHRER, 1982)
New synthesis	General Systems Theory BERTALANFFY (1949), ASHBY (1956), LUHMANN (1984)

Source: Heinze et al. (2007), *Scientometrics* 70, 125-162

CREA: Identificatiyng the Creative



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CREA: Sample of Creative Scientists & Groups

	Nano S&T		Human genetics	
	Europe	US	Europe	US
Multiple prize winners	9	5	10	1
Multiple nominations	7	21	0	3
Prize winner and nomination	16	17	5	9
Multiple prize winners and multiple nominations	3	4	0	0
Total highly creative scientists	22	29	14	11
Total scientists in database	224	204	150	111

Source: CREA Database 2005

è 20 case studies in US and EU on creative teams and events

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CREA: Probes (Examples)

Individual level

- Publication activity, Citation dynamics
- Network brokerage, Disciplinary breadth

Research group level

- Communication, Group leadership
- Group composition, Need for equipment or instrumentation

Organizational level

- Structure and size, Degree of centralization
- Clarity of research goals, Reputation and visibility

Institutional level

- Job mobility opportunities, Competition in research field
- Regulations for conduct of research

CREA: Group Level

Creative work flourishes under **facilitative group leadership**. Effective group leaders perform highly in various dimensions:

- Guide the group's work with a research vision (*within epistemic context, but also in broader intellectual and/or social movements*)
- Mobilize complementary capabilities into the group, either via new collaboration partners or recruiting
- Provide a non-hierarchical space of intellectual exchange where group members can conduct their research
- Help post-docs to attract funds so they can become self-sustaining

CREA: Group and Organizational Level

Creative research is most likely to be accomplished by **small research groups** that are embedded in an organizational **environment with variety of scientific skills and instrumentation**.

- Small group size allows group leader to be actively involved in research, fosters fruitful mentor-student relationships and provides flexibility to address new problems or ideas as they arise
- Environment with requisite variety is a seed bed that nurtures serendipitous findings and particularly conducive when fields complement each other

CREA: Organizational Level

Organizational environments with a **guiding research mission**, easy **interaction across disciplinary or thematic boundaries** and **flexible research funding** foster research creativity:

- Flexible funding examples: core funds, large and long-term individual research grants, variety of external funding sources
- Boundary spanning arrangements: lunchtime pattern, laboratory facilities, staircases, coffee rooms

CREA: Barriers to Research Creativity

Funding agencies

- Tend to fund "safe" science along established disciplinary boundaries
- Require preliminary results thereby impeding field change
- Jump on the bandwagon once the results of breakthroughs generate attention

Mechanisms reducing time for research

- Incessant proposal writing due to little core funding
- Rewarding scientific success with group growth

CREA: Conclusions

- § Nano S&T as opportunity structure for conduct of creative research (March: exploration [vs. exploitation], Bonaccorsi: proliferation)
- § Brokerage of knowledge domains has to do with research leadership (group and organizational level)
- § Productivity has to do with small work units and work environments that are rich in complementary skills and instrumentation
- § Topics for science policy agenda
 - § Funding structures that allow risk taking
 - § Avoid hierarchical management in research institutions
 - § Reward mechanisms in science

Beyond CREA

- § Prescriptive concept: Foster **engagement of “creative” in discourse** with interested public; public good “users” and producers; industries (hard and soft); public policymaking
 - § debating desirable “visions” of social and technological “functions” (Bonaccorsi), i.e. basic performances, to be created or facilitated by research
- § “Disabled persons of all countries, unite!” (Callon 2005*): **Self-organising “orphan” stakeholders** become step-wise “users” of frontier research as a **source of creativity and innovation**, turning weakness into strength

* In: Latour, B. & P. Weibel (eds.), 2005, Making Things public, Atmospheres of Democracy, Karlsruhe/ Cambridge, Mass.: ZKM/MIT