WHICH RESEARCH ORGANIZATION MODEL PROMOTES BREAKTHROUGH INNOVATION?

R&D MANAGEMENT CONFERENCE 2021, 7TH-8TH JULY ONLINE: INNOVATION IN AN ERA OF DISRUPTION

Adæquate Consulting

HYPOTHESES

Research has a key role to play to support the transition to the "next world".

Even if Research leads to a better understanding of the laws of nature, its ultimate purpose is innovation*.

Technological applications of research give humanity more freedom : thanks to the vaccine, we can get out of the sacrificial dilemma "distancing or covid-19".

For the transition, we need **breakthrough innovations** resulting from research.

* Héraud, J.A. and Popiolek, N. 2021. L'organisation et la valorisation de la recherche - problématique européenne et étude comparée de la France et de l'Allemagne. P.I.E. PETER LANG SA, Éditions Scientifiques Internationales, collection Business and Innovation.

"Chance only favors prepared minds".

Pasteur (1854)

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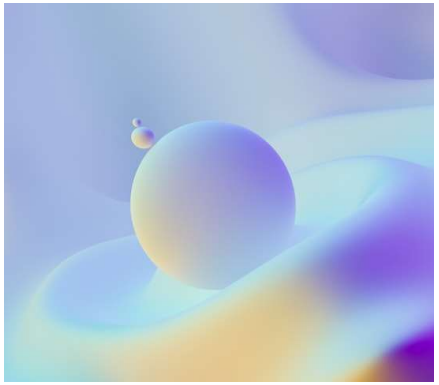
PRESENTATION PLAN



Research and innovation models

We are interested in breakthrough innovations

We look at the historical construction of an analytical framework to describe the innovation process.

This framework is insufficient to analyze – and improve - the creative process in the fields of science and technology.

Our methodology

We focus on the researchers' reasoning

To improve creativity, what type of model is possible?

Our approach is empirical. **It is based on interviews with researchers from academic and industrial laboratories**.

Our results

They apply to a wide variety of fields of activity

We highlight on concrete cases, the value of cross-fertilization between basic and applied research.

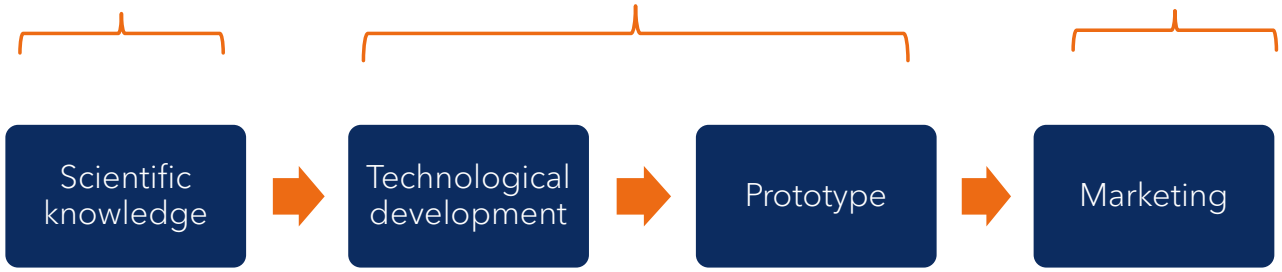
RESEARCH AND INNOVATION MODELS

THE HISTORICAL CONSTRUCTION OF AN ANALYTICAL FRAMEWORK

SCIENCE-PUSHED MODEL OF INNOVATION

- It expresses the idea that most **innovations are the consequence of scientific discoveries** - and related technological developments - that open the way to new economic applications.
- One of the issues with such a vision is that the **process of creativity** in Science & Technology (S&T) appears completely exogenous from a socio-economic point of view.
- **There are fixation biases** in each area of knowledge that **hinder the creativity.**

The creativity is considered separately in 3 different **silos of knowledge**.
This hinders the creativity.

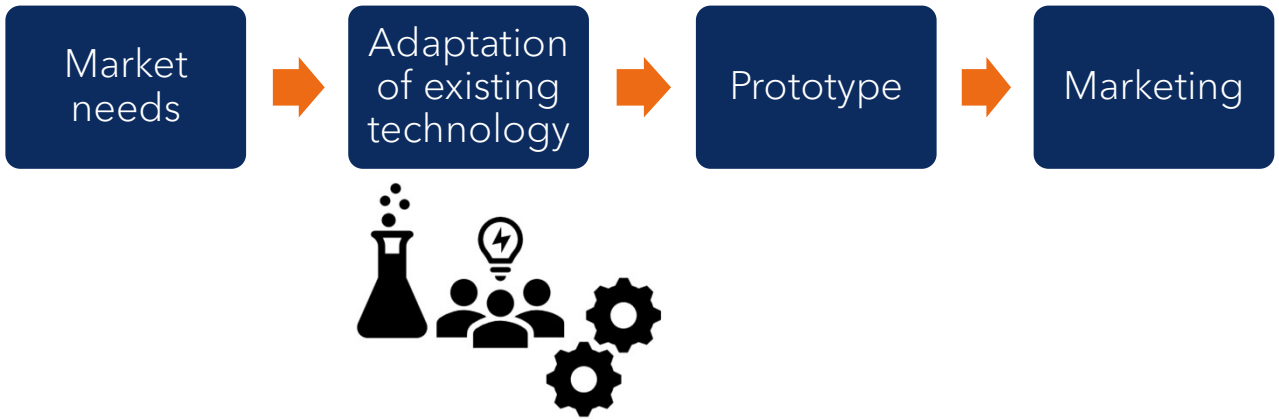


Schumpeter.1 in the beginning of the 20th century

DEMAND-DRIVEN MODEL OF INNOVATION

- It expresses the idea that in most of the cases, **innovations were introduced on the basis of market considerations**, not triggered by scientific supply of knowledge.
- If the new economic good can be designed without developing a new technological system, it is better. **If necessary, science can be driven by a firm in order to achieve the given economic goal**.
- The issues with such a vision are that the process supposes the demand exists and **it does not leave enough freedom for researchers to be creative.**

The innovator has more an economic vision than a technological passion. There is little room for creativity in the field of S&T knowledge.



Schumpeter.2 after war and Jacob Schmookler ,1966

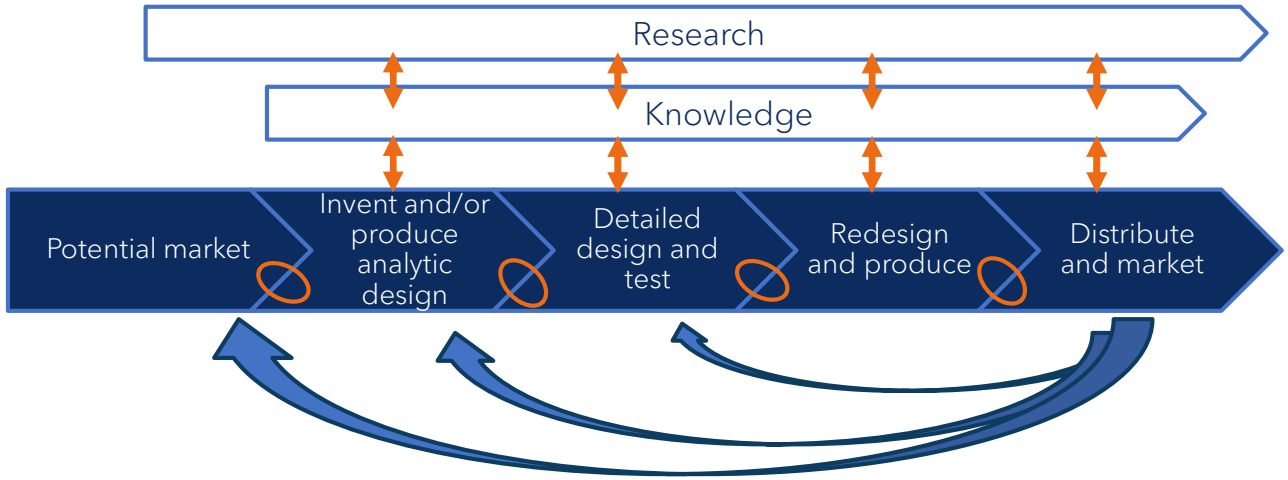
CHAIN-LINKED MODEL OF KNOWLEDGE CREATION AND INNOVATION

- It exhibits a lot of **feedback loops** between the different stages of the process going down from the first idea to the complete realization.

- The necessity to find a solution forces the involved actors to **look for some information already available** in the general stock of knowledge (books, data bases, individual skills, etc.), **or to push the research in the relevant domain if no ready-to-use solution is available**.

- **Can we go further in interactions to promote breakthrough innovation?**

Part of the creativity of the innovation process comes from the interactions.
But what about breakthrough innovation?



Kline & Rosenberg,1986

OUR QUESTIONS

- Why do interactions between the different fields on knowledge increase creativity?
- What type of model is promoting creative interactions?

OUR METHODOLOGY

TO ADDRESS THESE QUESTIONS, WE FOCUSED ON THE REASONING OF RESEARCHERS

INTERVIEWS WITH RESEARCHERS

- **Successful collaboration experiences** were analyzed from semi-structured interviews with researchers from:
  - Research Organizations (PROs): CEA, Brgm, Cnrs, Ifpen, Inserm, Paris-Saclay University;
  - Industrial R&D laboratories: Atos, Decathlon, TotalEnergies, Microsoft,Thales;
  - Association, R&D hub…

Archambault, V., and Popiolek, N. Dir. 2020. Modèles et pratiques de couplage entre Sciences et industrie pour favoriser l'impact de la Recherche. Histoires de Sciences & Entreprises. Collective publication. Preface: A. Fert, Nobel Prize in Physics. Paris : Presses des Mines.

Le Masson, P. (2020). « Quels modèles pour une recherche à double impact ? », in : Archambault, V. et Popiolek, N., (Dir) (2020). *Histoires de sciences & entreprises*, Vol. 4 : *Séminaire « Favoriser l'impact de la recherche »*. Paris : Presses des Mines, (47– 79).

Taverdet-Popiolek, N. 2021. "Economic Footprint of a Large French Research and Technology Organisation in Europe: Deciphering a Simplified Model and Appraising the Results." Journal of the Knowledge Economy.

QUESTIONS ABOUT THEIR REASONING

- The questions focused on researchers' reasoning in the exploration of the unknown.
- How do they explore the unknown ?
  - PROs (basic science): the ability to ask new questions, to look in another direction, to get out the reality, to test new hypotheses… (see Poincaré or Einstein)
  - Industry (applied science): the ability to develop new skills, to invent new technologies and promote breakthrough innovations which are desirable for society...
- Why does collaboration help them to be more creative? Under what conditions?

Hadamard J., 1945. *The psychology of invention in the mathematical field*, Princeton (N.J.), Princeton University Press.

Hatchuel A., Reich Y., Le Masson P., Weil B., Kazakçi A. O., 2013. "Beyond models and decisions: situating design though generative functions", International Conference on Engineering Design, ICED'13, Séoul.

Holton G., 1981. *L'imagination scientifique*, Paris, Gallimard.

ONE EXAMPLE

Fert, A. (2007). "The origin, development and future of spintronics." Nobel lecture, 2007. Stockholm.

BASIC SCIENCE - SOLIDS PHYSICS LABORATORY

He was exploring a new scientific concept: the spintronics that controls the movement of electrons by acting on their spin.

Fert was looking for an industry laboratory to test the new concept.

Albert Fert,
Nobel Prize in physics*

Alain Friederich
R&D engineer

TECHNOLOGY - CENTRAL RESEARCH LABORATORY - THOMSON COMPANY

He was developing a new technology: Molecular Beam Epitaxy (MBE) allowing the deposit of ultra-thin layers of semiconductor materials

Friederich was seeking to push the MBE technology in original ways.

- Fert could study magnetic multilayers and test his concept.
- Friederich expanded his range of technology by exploiting a new phenomenon that had never been observed or modeled before.

STRONG SCIENTIFIC IMPACT
The discovery of Giant Magnetoresistance in1988

STRONG SOCIO-ECONOMIC IMPACT
Breakthrough innovations for industry
(automotive, computers, mobile phones…)

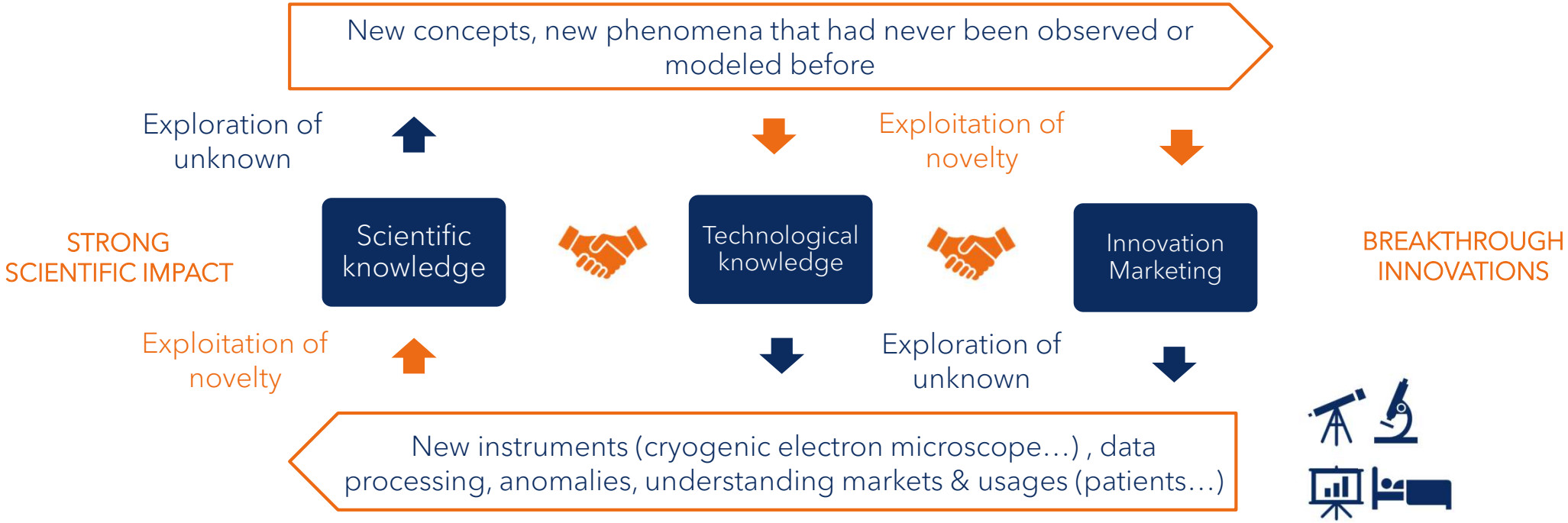
* The interview was conducted in Thales offices by Pascal Le Masson and the author.

RESULTS : SUMMARY OF ALL INTERVIEWS

FOR A WIDE RANGE OF ACTIVITIES

RELATIONSHIPS BETWEEN RESEARCH AND INDUSTRY

When the different areas of knowledge meet to work together while retaining their freedom and independence, a win-win process is set up.



THE VALUE OF INDEPENDENCE IN KNOWLEDGE STRUCTURES

- The meeting was neither the result of a "supply-demand" relationship (responding to industry demand) nor the result of chance ("serendipity").
- It was due to recognition, or even to joint construction, of an experience that could interest both parties but for different reasons (scientific progress for one, new technological possibilities for the other).
- We could illustrate with concrete examples, the value of independence in knowledge structures*.

* Hatchuel, A., Le Masson, P., Reich, Y., Subrahmanian, E., 2018. "Design theory: a foundation of a new paradigm for design science and engineering". Research in Engineering Design, Springer Verlag, 29 (1), pp.5-21.

CONCLUSION

- The interviewees related successful collaborations that led double impact. But some collaborations have failed.
- Despite the benefits of synergies between science and industry, for bypassing fixation biases and promoting creativity, interviewees revealed several obstacles.
- Moreover we must be concerned about the impact of technology on the environment and health: the planes (physical equations & engineering know-how) given us the freedom to fly … but the aircraft traffic is noisy and emits CO_2.

THE MAIN OBSTACLES

Unsynchronized clocks between fundamental and applied research

Funding of fundamental research and risk coverage

Cultural gap

Confidentiality and IPR issues…

- Invent new solidarities and forms of collegiality

Inability to look outside the mainstream

Inability to open new ways of thinking

Unavoidable fixations and biases…

- Invent tools to assess the quality of exploration

Risk of mutual disempowerment in the face of the negative impacts of S&T

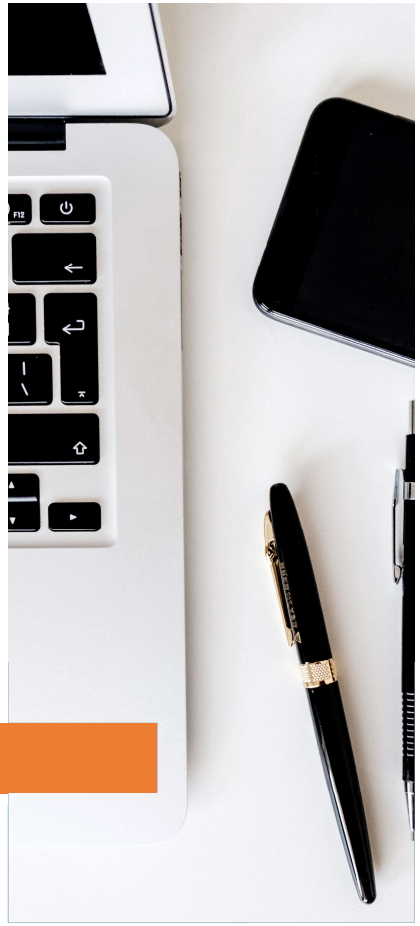
Risk of unsustainable impact…

- Invent new forms of joint responsibility between science & industry

THIS HAS IMPLICATIONS ON RELATIONSHIP GOVERNANCE STRUCTURE

THANKS FOR YOUR ATTENTION !

QUESTIONS ?



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