Christoph Mandl


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Innovation and Research Programmes, Time for Uncoupling: 13 Theses

For some time now, the terms innovation and research have been used as if they were synonymous.
The European Commission asserts, "Research and innovation help deliver jobs, prosperity and quality of life".[1]
The Austrian Government conveys as the purpose of the Österreichische Forschungsförderungsgesellschaft mbH: "Aufgabe der Gesellschaft ist die Förderung von Forschung, Technologie, Entwicklung und Innovation (FTE) zum Nutzen Österreichs."[2]
TAFTIE, the European Association of national innovation agencies alleges: "The members of TAFTIE make a major contribution to strengthening Europe's economic performance by supporting product, process, and services innovation by implementing their countries' national and – many times – international research, development and innovation programmes."[3]
This close linkage between innovation and research is quite common not only at institutional level but also at programme level: "In den Basisprogrammen der FFG erhalten Unternehmen auf Antrag für ihre Forschungs- und Entwicklungsprojekte finanzielle Unterstützung. Die Basisprogramme legen damit den Grundstock für eine rasche und unbürokratische Innovationsförderung. Mit den Strukturprogrammen optimiert die FFG die Voraussetzungen für eine effektive Kooperation aller Akteure im Innovationssystem. Sie forcieren die Zusammenarbeit von Partnern aus Wissenschaft und Wirtschaft von Innovationsnetzwerken bis hin zu Forschungskooperationen."[4]

In a recent press release, Commissioner for Research, Innovation and Science Máire Geoghegan-Quinn of the European Commission said: "Investment in research and innovation is the only smart and lasting way out of crisis and towards sustainable and socially equitable growth. We are offering researchers and innovators €6.4 billion for cutting-edge projects. Translating research into new technologies, products and services is at the heart of the package. This initiative aims to boost the whole innovation chain from 'research to retail'."[5]

But this prevalent mental model[6] about the relationship between research and innovation that shimmers through these various statements is not appropriate in describing the complex interdependence between these two crucial societal processes. Worse still, the erroneous assumption that research and innovation are part of an innovation chain 'from research to retail' lays the ground for erroneous economic policy, education policy, and science policy.

"Modern innovation research rejects the idea that innovation simply flows from some earlier process of scientific or technological discovery – the so-called 'linear model' of innovation. Instead, it stresses the interactive and dynamic character of innovation. Innovation is systemic. In addition to the independent decision-making at the level of the enterprise or the network, it depends critically on broader factors including the institutional and organisational framework, regulatory systems, infrastructures, the processes which create and distribute scientific knowledge and, not least, the social and cultural context." Such has been stated in the Five-Year Assessment of the European Union Research Framework Programmes.[7]

It is helpful to visualize the difference between the linear model of innovation and the systemic model by using the Causal Loop Diagram – the CLD.[8] The linear causal relationship as expressed by Máire Geoghegan-Quinn and many others looks something like this:

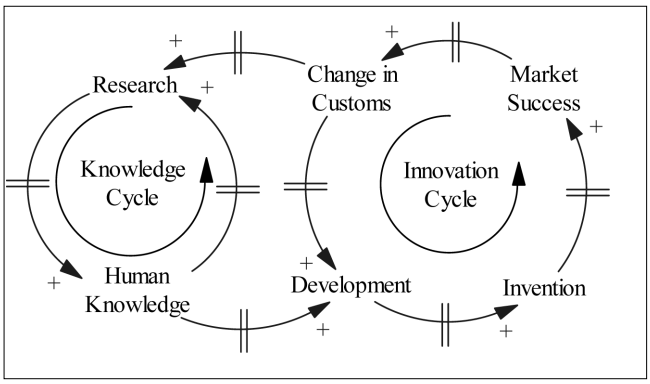
Figure 1: Linear Model of Innovation

[1] See European Commission, Research and Innovation: Building Europe's future, July 2010, http://europa.eu/pol/rd.
[2] See 73. Bundesgesetz: Forschungsförderungs-Strukturreformgesetz § 3. (1), Bundesgesetzblatt für die Republik Österreich, July 2004.
[3] See http://taftie.org.
[4] See Österreichische Forschungsförderungsgesellschaft, Förderprogramme der FFG, http://www.ffg.at/content.php?cid=5.
[5] See the press release dated 19/07/2010 on „€6.4 billion for smart growth and jobs – Europe's biggest ever investment in research and innovation".
[6] A very good book on mental models is Philip Johnson-Laird, Mental Models: Toward a Cognitive Science of Language, Inference and Consciousness. Harvard University Press 1983.
[7] See European Commission, Five-Year Assessment of the European Union Research Framework Programmes 1999-2003, Directorate-General for Research 2004.
[8] See http://en.wikipedia.org/wiki/Causal_loop_diagram.

In this CLD each arrow denotes the causal influence of the activity where the arrow is rooted on the activity where the arrow is pointing at. Additionally, the "+" denotes that the causal influence is positive, e.g. more Basic Research leads to more Applied Research, etc. With such a model in mind statements like "the whole innovation chain from research to retail" and "an economy needs applied research but not basic research to thrive" make sense but as the model is invalid this is also the case for conclusions drawn from the model.

A systemic model of innovation looks more like this:

Figure 2: Systemic Model of Innovation



In this CLD each double line across an arrow denotes a time delay of the causal influence. Even though the claim is not that this systemic model is true, it has greater explanatory power than the linear model. Unlike the linear model the above causal loop diagram can explain why in the long run research is needed, why the differentiation between basic and applied research is insignificant, why higher research spending does not guarantee greater market success, why at least in some instances market success does not need research, why more than 2 and one-half centuries passed from the first demonstration that citrus fruits prevent scurvy until citrus use was mandated in the British merchant marine, despite the importance of the problem and unambiguous evidence supplied by controlled experiments[9], or why it took from 1964 when Leonard Kleinrock published his PhD Thesis on Communication Nets until late 1994 when the Internet started to become a market success. Furthermore, only a systemic model can explain important phenomena of innovation like Path Dependence[10] and Tipping Point.[11]

Research, Innovation and Invention

To grasp the fundamental error that lays behind the linear model it is necessary to establish a precise meaning of research and of innovation. These two processes are certainly related albeit not in a simple "if more research then more innovation" world view. Additionally, policy makers tend to blur the important distinction between a new product or service and an innovation because they do not differentiate between an innovation and an invention.

Innovation is ... [12]

- A new way of doing something or "new stuff that is made useful"
- The introduction of something new, in customs, rites, etc
- A change in customs
- Something new, and contrary to established customs, manners, or rites
- The process that translates knowledge into economic growth and social well-being

Invention is ... [13]

- The creation of something in the mind
- A creation (a new device or process) resulting from study and experimentation
- A new composition, device, or process
- The conception of a new and useful article, machine, composition, or process
- A unique object produced through the process of imagination and experience
- The creation of a new technology, item, or process, as opposed to its application in widespread use
- The human creation of a new technical idea and the physical means to accomplish or embody the idea

Research i s... [14]

- Attempt to find out in a systematically and scientific manner
- Systematic investigation to establish facts
- Inquiry: a search for knowledge
- Diligent inquiry or examination to seek or revise facts, principles, theories, applications, et cetera
- Laborious or continued search after truth
- Investigation intended to extend the limits of human knowledge
- A carefully planned and performed investigation, searching for previously unknown facts
- A study done to answer a question

In 2004, a seminal article on innovation was published[15], important enough to cite some of its content:
"In his Theory of Economic Development[16], the economist Joseph Schumpeter distinguished between inventions – the creation and establishment of something new – and innovations, inventions that become economically successful and earn profits. Schumpeter's definition of invention intentionally includes fixation, and thereby highlights the elusive nature of innovation with its connotation of influence and success.
In the world of technology, invention depends on the construction of new devices through human ingenuity. Inven-

9 See Frederick Mosteller, Innovation and evaluation, Science Vol 211, pp 881-886, 1981.

10 See Chapter 10 Path Dependence and Positive Feedback, in John Sterman, Business Dynamics – Systems Thinking and Modeling for a Complex World, McGraw-Hill 2000.

11 See Chapter 9 S-Shaped Growth: Epidemics, Innovation Diffusion, and the Growth of New Products, in John Sterman, Business Dynamics – Systems Thinking and Modeling for a Complex World, McGraw-Hill 2000.

12 See define:innovation at http://www.google.com.

13 See define:invention at http://www.google.com.

14 See define:research at http://www.google.com.

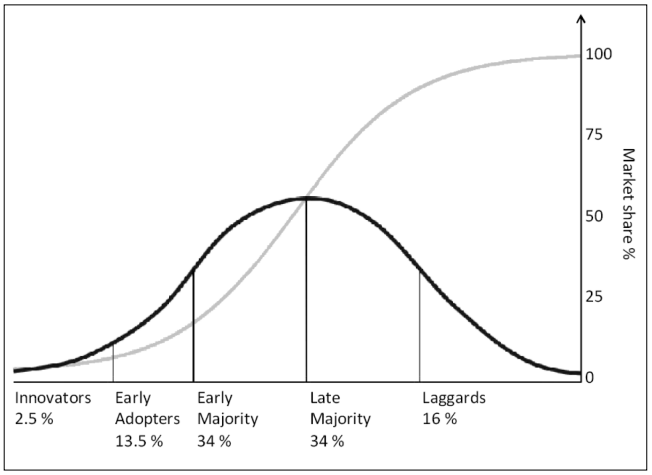
15 Douglas Erwin and David Krakauer, Insights into Innovation, Science Vol 304, pp 1117-1119, May 2004.

16 Joseph Schumpeter, The Theory of Economic Development, Harvard University Press 1926.

tion is coupled to the selective mechanisms of fixation within the marketplace. Yet the persistence of some new feature is a weak predictor of cultural impact. Enter innovation, which encompasses the testing of inventions in the marketplace. Such testing leads to the worldwide success of a technological gadget (wireless networks, for example). The question is, How do innovations arise?
Economists have long debated whether innovation is driven by demand or supply, mirroring a similar debate among evolutionary biologists about whether the environment is the cause of evolution or whether organisms construct their own environments through evolution. Some evolutionary biologists argue that organisms actively contribute to the construction of their own environments and influence their own selection regimes. Hence, invention and innovation feed back upon each other in a complex dynamic that blurs the familiar boundaries between environment and organism, development and selection."

Interdependence between Research and Innovation

Both, research and innovation are processes but they differ significantly in their purposes and in the people involved. The purpose of research is to extend the limits of human knowledge. The purpose of innovation is to create something new that becomes economically successful and earns profits. The people involved in extending the limits of human knowledge are the researchers. Yet, the people involved in innovation are not only those who create something new but also those who make something new into an economic success.
For that reason, innovators and inventors are quite different groups of people. While inventors create something new, the innovators are those who actually buy something new and thus create its economic success. The importance of these real innovators – and not those Geoghegan-Quinn was referring to when she stated, that the Commission is offering researchers and innovators 6.4 billion Euro for cutting-edge projects – in innovation is by and large disregarded. It is due to the contribution of Everett Rogers[17] that the crucial societal role of innovators has become apparent. Rogers identified five different groups of people in the diffusion of innovations:



Sometimes an invention is of immediate value to the buyers in its current environment and so can be defined as innovative. Alternatively, an invention may become innovative only later, when there is a change in the environment. In both cases, the invention becomes an innovation because it forms the basis of a series of subsequent adaptive radiations. Invention need not imply innovation, which often depends on additional environmental events. Often inventions are recognized after the fact – sometimes long after they have emerged.

13 Theses on Innovation and Research Programmes and their Evaluations

These insights into innovation and into the non-linear interdependency between research, innovation, and invention as visualized in Fig. 2 give rise to the following 13 theses.

Thesis 1 on the purpose of research and of innovation:
The purpose of research is to extend the limits of human knowledge – which may or may not lead to an invention – but it is not innovation. The purpose of innovation is an invention with value to the buyers and thus with market success but it is not research. These two processes are fundamentally different – yet they feed back upon each other in a complex dynamic and are therefore profoundly supportive to each other but often with great time delays.
Thesis 2 on uncoupling research and innovation:
The knowledge cycle and the innovation cycle – see Fig. 2 – are so fundamentally different that it is neither effective nor efficient to mingle them into one single cycle particularly because of the time delays in the causal effects. To be effective, any funding programme needs to focus either on research and the knowledge cycle, or on the innovation cycle – but not on both.

Thesis 3 on applied research:
All research is applied in the sense that extending the limits of human knowledge has the potential to be of benefit to society.[18] However, like in any evolutionary process it cannot be foreseen which human knowledge will become when and how of value to society. Therefore, when a researcher strives to extend the limits of human knowledge her or his project should not be evaluated by the question if this research is more (or less) applied than other research.

Thesis 4 on innovation:
Innovation need not be research based. When someone buys an invention, she or he does so because it is of value to her or him and not because it is research based. Therefore, an innovation project should not be evaluated by the question if it is research based.

Thesis 5 on evaluation of research projects:
The evaluation of a research project needs to focus on the question if the project has the potential to extend the limits of human knowledge. It is of no importance for the evaluation if the research project translates into market success.

[17] See Everett Rogers, Diffusion of Innovations, Free Press 2003.
[18] This statement is substantiated by W. Brian Arthur in his book The Nature of Technology: What It Is and How It Evolves, Free Press 2009.

Thesis 6 on evaluation of innovation projects:
The evaluation of an innovation project needs to focus on the question if the project has the potential to be a market success. It is of no importance for the evaluation if the innovation project is based on research.

Thesis 7 on assessment of research programmes:
The assessment and monitoring of a research programme needs to focus on the question if the funded research projects have extended or will extend the limits of human knowledge. It is irrelevant for the assessment if these research projects translate into market success as they rarely do at least not directly and not in the short run.

Thesis 8 on assessment of innovation programmes:
The assessment and monitoring of an innovation programme needs to focus on the question if the supported innovation projects were or will be a market success. For the assessment it is unimportant if these innovation projects are based on research.

Thesis 9 on funding research:
The most effective way to extend the limits of human knowledge is to fund those researchers who have the potential and the capacity of extending the limits of human knowledge.

Thesis 10 on funding innovation:
The most effective way to initiate the creation of something new that becomes economically successful is to foster the purchase of the invention through means like direct funding of the buyers, tax reduction, regulations (emissions regulations, for example), building infrastructure (renewable energy plants, for example), and pricing externalities. Funding development and invention does not necessarily foster innovation but reduces the financial loss if the invention does not become a market success.

Thesis 11 on funding research and innovation:
For research to happen it needs funding as no market for research exists. For innovation to happen it needs market success. Thus innovation including development and invention as part of the innovation cycle always pays for itself but sometimes with great time delay.

Thesis 12 on knowledge transfer:
Knowledge is inseparable from humans.[19] Thus, the most effective way for research to support innovation is to transfer people from research organizations to organizations which strive to develop an invention that earns profits, and vice versa.

Thesis 13 on science policy:
Any science policy that disregards Theses 1-12 is not as effective and efficient as it could be and is therefore not Pareto efficient.[20]

[19] This idea was first put forward by Michael Polanyi in his book Personal Knowledge – Towards a Post-Critical Philosophy, University of Chicago Press 1962.

[20] See for example http://en.wikipedia.org/wiki/Pareto_efficiency#Pareto_efficiency_in_economics.

■ **Christoph Mandl,** School of Business, Economics and Statistics, University of Vienna,
E-Mail: christoph.mandl@univie.ac.at