
A NEW SCHEME FOR INNOVATION. AN ESSAY

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SUMMARY

A new model is proposed for innovation based on science and technology, illustrated by a tetrahedron. The model includes five key actors: Government, Academia, Industry, the Inventor and the Citizen. It is crucial that all actors develop an open collaboration and multiply the exchanges between themselves to promote a climate for inclusive innovation. One original element of the tetrahedron is the recognition of citizen participation, since he/she is, as a consumer, the first one to experience the fallouts (good and evil) of any innovation. Similarly, because of his role in science dissemination, the science journalist

must be recognized as an ideal key citizen in the assessment of the social values of any innovation or invention. At the center of this model is the free and universal access to scientific and technological information for all. A critical element of the innovation process, clearly illustrated in the tetrahedron model, is that social responsibility and ethics are the concern of all actors. All actors must be driven by this fundamental spirit, as the ultimate objective of any innovation is to provide, maintain or improve the quality of life for all citizens, an objective which is placed at the summit of the pyramid.

Introduction

It is generally accepted as evidence, almost a postulate, that investments in Education, Science and Technology (S&T) are important inputs in the innovation process, which today are recognized as one of the key factors to promote economic development and

prosperity. It is still true as abundantly observed in rich and in emerging countries. The expression S&T refers to the full range of social, natural, physical, health and life sciences, as well as engineering disciplines. No wonder, then, that many analyses on science policy and the origin of technological innovation

have been dedicated to find the road to the 'El Dorado of Innovation' that will create employment and wealth. It has been believed for years that innovation (see Figure 1 for definitions and examples to differentiate basic terms) derives directly and logically from basic research and technological development

(R&D) to the market. Nothing more distant from the real truth. This process that originally was conceptualized as being linear has evolved and has become a more complex process involving the market, organization, suppliers and others. It rarely follows a linear path. The magic recipe is not simple and easy. That

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UN NUEVO ESQUEMA DE LA INNOVACIÓN: UN ENSAYO

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RESUMEN

Se propone un nuevo modelo para la innovación basado en la ciencia y tecnología, ilustrado por un tetraedro. El modelo incluye cinco actores clave: Gobierno, Academia, Industria, el Inventor y el Ciudadano. Es crucial que todos los actores desarrollen una colaboración abierta y multipliquen los intercambios entre ellos a fin de promover un clima de innovación inclusiva. Un elemento original del modelo del tetraedro es el reconocimiento de la participación del ciudadano, dado que él/ella, como consumidor, es el primero en experimentar las consecuencias (buenas y malas) de cualquier innovación. Igualmente, debido a su papel en la diseminación de la ciencia, el perio-

dista científico debe ser reconocido como un ciudadano clave ideal para determinar el valor social de cualquier innovación o invento. En el centro de este modelo se ubica el acceso libre y universal a la información científica y tecnológica, para todos. Un elemento crítico en el proceso de innovación, claramente ilustrado en el modelo del tetraedro, es que la responsabilidad social y la ética conciernen a todos los actores. Todos los actores deben ser guiados por ese espíritu fundamental, ya que la finalidad última de cualquier innovación es proveer, mantener o mejorar la calidad de vida de todos los ciudadanos, un objetivo que está colocado en el vértice de la pirámide.

UM NOVO ESQUEMA DA INOVAÇÃO: UM ENSAIO

Michel Bergeron, Mayra de la Torre e Oscar Harasic

RESUMO

Propõe-se um novo modelo para a inovação baseada na ciência, ilustrado por um tetraedro. O modelo inclui cinco atores chave: Governo, Academia, Indústria, o Inventor e o Cidadão. É crucial que todos os atores desenvolvam uma colaboração aberta e multiplique os intercâmbios entre eles a fim de promover um clima de inovação inclusiva. Um elemento original do modelo do tetraedro é o reconhecimento da participação do cidadão, devido a que ele/ela, como consumidor, é o primeiro em experimentar as consequências (boas e ruins) de qualquer inovação. Igualmente, devido a seu papel na disseminação da ciência, o jornalista científico deve ser reconhecido como um

cidadão chave ideal para avaliar o valor social de qualquer inovação ou invento. No centro deste modelo está localizado o acesso livre e universal à informação científica e tecnológica, para todos. Um elemento crítico no processo de inovação, claramente ilustrado no modelo do tetraedro, é que a responsabilidade social e a ética concernem a todos os atores. Todos os atores devem ser guiados por esse espírito fundamental, já que a finalidade última de qualquer inovação é prover, manter ou melhorar a qualidade de vida de todos os cidadãos, um objetivo que está colocado no vértice da pirâmide.

DISCOVERY is the *demonstration of an unknown* phenomenon (gravity by Newton; presence and action of bacteria by Pasteur)

INVENTION is a *new medium* (technology, system, and method) to reach an objective (electric bulb by Edison)

INNOVATION is defined as the *application of known idea(s)* conducing to its effective exploitation and is usually the combination of science, engineering, and entrepreneurship. It can be realized only when all conceptual links of the chain coincide (laser applications, pasteurization).

Figure 1. A glossary of basic terms.

explains why governments and international institutions have presented so many reports on strategies and plans to encourage innovation. (for review see Aguirre and De Fonseca, 2005; Marone and González de Solar, 2007; Aguirre-Bastos and Fröhlich, 2009; Reddy, 2011). The present essay is not intended to be a review but to propose a broader scheme that includes essential actors which are not normally taken into consideration and are generally omitted.

Jorge Sábato made the fundamental observation that some factors are always present in economically developed societies. He proposed in 1979 (Sábato, reedited 2004) a model (Figure 2) postulating that S&T-based innovation proceeds from the interaction between three major players: government, scientific sector and institutions (mainly academia in developing countries), and the production sector (industry). Innovation appears when

there are interactions (articulations) between them: the S&T infrastructure producing knowledge, the industrial sector providing new industrial products, and government facilitating granting mechanisms to both the industrial sector and the academic world. The expression ‘open innovation’ is now widely used.

For Aguirre and De Fonseca (2003), “the generation of innovation de-

pends to a large extent on how different actors interact with each other as elements of a collective system of knowledge creation and use, named the ‘national system of innovation’ (NSI)”. They insisted, like Sábato and many analysts, on the necessity to institutionalize and reinforce the continuity of exchanges between all actors. A recent report (2010-2011) from the World Eco-

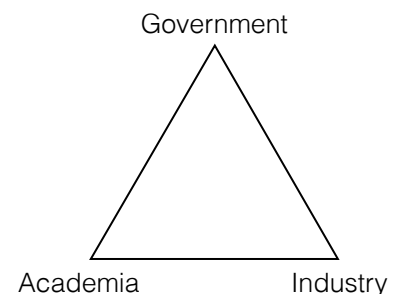


Figure 2. The Triangle of Sábato.

conomic Forum confirmed once again the merits of this relationship but, unfortunately, highlights it with a negative demonstration of data: Latin American countries rank low in regards to R&D investment from governments, industry-universities collaboration, the number of scientists and engineers graduated, and the number of patents registered.

The Sábato triangle (Figure 2) is obviously very schematic and too elementary but has enjoyed some success because of its simplicity. Marone and González de Solar proposed in 2007 a model to complement the Sábato triangle. They called their model the CCR (Creativity, Critical mind, Rigor) triangle (Marone and González de Solar, 2007). Actually, their model is inspired by the historic thinking process behind research and recalls the basis of any scientific activity, be it that of an inventor or that of a research scientist. First there is the idea or the hypothesis and the subsequent solid demonstration of its existence. That method was brilliantly described in 1865 by Claude Bernard in his book *Introduction à l'Étude de la Médecine Expérimentale* (Bernard, re-edited in 1973). As pointed out by the authors of the CCR model, this also presupposes the existence in a given society of a solid education system environment which trains and produces those rigorous scientific minds.

In spite of its frequent use in both policy studies and for policy making, the Sábato triangle (and its modifications) ignores two

other actors, the inventor (or the scientific investigator) and the civil society. In its *Declaration of Panamá* (2005), the Interciencia Association insisted on the key role of the participation of the civil society, considering that innovation should be an element immersed in our culture, and the necessity “to have open access to a local and international technological work force and knowledge in order to develop and encourage a wide system for innovation to include the local communities to encourage inclusive innovation, i.e. oriented to solve local problems in their communities”.

The *Declaration of Panamá* went even further by strongly suggesting that “the access to scientific information should be considered as a new fundamental right, emblematic of this new millennium”. This is particular-

ly true in our knowledge-based societies where the access to scientific information is so crucial in our daily decisions. Since freedom of the press has been accepted as a fundamental pillar of democracy, science journalism should logically be considered as a fundamental pillar of our knowledge-based democracies. It is why there must be present in each national civil society a specialized citizen, the science journalist, who is a key player and a major contributor to S&T dissemination. Cooperation based on information sharing is generally considered a powerful mean towards progress and integration.

The Tetrahedron of Innovation based on Science and Technology

The model that we propose for a System of Innova-

tion based on S&T is illustrated by a tetrahedron (Figure 3). At the center is the free and universal access to the public domain of scientific and technological information which contains the data produced by the scientific community. The model includes the three key actors identified in the Sábato triangle (Government, Academia and Industry), to which are added two other key actors, namely the Inventor and the local Citizen; each one occupying an equally essential vertex of the tetrahedron. Furthermore, the model shows, above the pyramid, the ultimate objective which is the quest to improve the quality of life for all citizens.

The Government, the first vertex of the pyramid, has a major responsibility in promoting and favoring the regulatory framework to create the fiscal and legislative environment for the industrial sector, tax incentives, financial stimuli to private venture capital and R&D investment, legal protection of intellectual property, and technology services such as a national metrology institution for reliable measurements and tests which are trusted and accepted internationally. A strong local engineering capacity should be developed and is necessary in the private or public industrial sectors, and both must be endowed with appropriate R&D facilities. The Government has a shared responsibility in creating and sustaining the academic institutions which will educate and train future scientists, engineers and technologists. The Government must also pro-

Dynamics of Innovation Science-Technology-Society

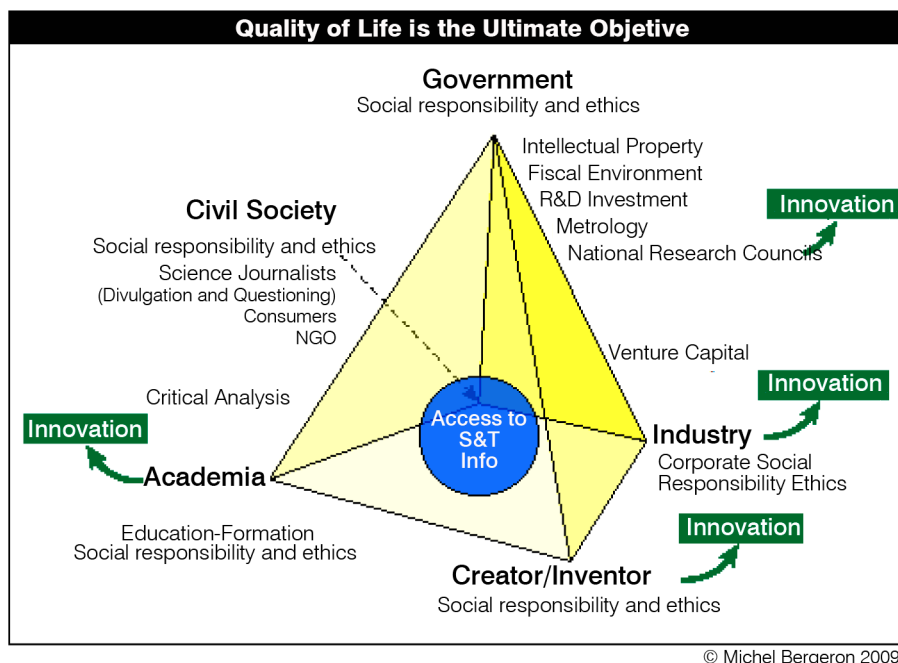


Figure 3. The tetrahedron of innovation based on science and technology. The new scheme for innovation is illustrated by a tetrahedron. At the center is the free and universal access to S&T information that contains the data published in the public domain by the scientific community. The model includes five key players: Government, Academia, Industry, the Inventor and the Citizen. Each actor occupies an equally essential vertex of the tetrahedron. Of note, the science journalist constitutes a key citizen-player because of his specific role in the divulgate, dissemination and the ultimate objective which is improving the quality of life for all citizens.

mote and establish research laboratories in academic institutions in order to carry out basic research. This will develop investigative abilities and entrepreneurship skills and will also promote the links with the production sector.

The Academic sector (universities, research institutes), located at the second vertex of this model, is essential to deliver education and practical training to produce those creative and rigorous minds described in the CCR model. They are the people who have the ideas, knowledge and abilities to recognize opportunities to design the products, processes and services to make our lives easier, safer and healthier. That type of inquisitive education is important for the engineers and scientists who will be recruited by the production sector and will continue their career in industry as entrepreneurs. Moreover, these university graduates will keep carrying out in their milieu a spirit of creativity and of critical analysis which will influence the whole society, as well as the government legislative and executive powers.

The Industry or Production sector, the third vertex, is the ideal place to promote creative thinking and to innovate. In fact, many companies started with the specific aim to develop and commercialize one or more inventions to materialize innovations. The Edison's story is the most eloquent example of this. Indeed, successful companies pursue intensive research in finding new products, processes or services to remain competitive by means of new patents. If they stop innovating or show no entrepreneurship, they are bound to decline. *Apple* is a great example of constant innovation.

The Inventor is the fourth vertex of our model of innovation. The history of sci-

ence and technology has shown that many inventions did not originate from industry or academia. Thousands of patents are owned by individuals who created new ways to solve problems or create new products or services to reach specific goals. The government, academic and industrial sectors are often more than happy to collaborate on these inventor's ideas. This approach, as mentioned above, is now referred to as 'open innovation' (Chesbrough, 2006). Many companies have shown flexibility in outsourcing their R&D activities and are collaborating with different partners. They use external ideas as well as internal ideas (Banerjee *et al.*, 2010; Trucco *et al.*, 2010). This approach is also well accepted in academia, which has established new mechanisms to provide support to the research professors on its premises and to protect their patents. Many spin-off companies have risen from these efforts and represent a substantial source of shared revenues as a result of those profitable links between academia and industry with the government collaboration.

The Citizen, the basic constituent or element of the civil society, is the fifth vertex of the pyramid and must be considered an equally essential actor, but not in general in the planning stage of a NSI, because citizens do not possess the expertise. As consumers, they appear to be passive actors since they will be experiencing the consequences (good and evil) of any innovation. After all, unforeseen side effects may appear only at a later stage, after its implementation. The citizen may become an active player 'after the fact'. A public debate inside the civil society might have to take place, even sometimes at the planning stage, when the solutions to local problems are expected to create difficulties. This is

why we believe that the science journalist should be considered as a key player because of his specific role in science dissemination, awareness and its appropriation by the citizens. Scientific journalists do not only disseminate and explain scientific information; they initiate and stimulate the debate on the social values of any prospective innovation and act as agents of change in this cultural process. Such debate must also involve interdisciplinary expertise in evaluating sociological, environmental, medical and even religious aspects. Thus, decisions taken under these circumstances have a better chance to be accepted by the civil society since they are oriented to solve local problems. A point to remember: members of governments, professors, scientists as well as employees of the private and public sectors are also citizens but unfortunately they are often forbidden to act because of confidentiality issues or intellectual property rights.

A critical element of the innovation process, too often omitted but clearly illustrated in our model, is that social responsibility and ethics constitute and are part of the duties and concern of all actors involved. Experts, political authorities and journalists all have the duty of intellectual rigor, to tell 'the true and the false' and to follow the ethical rules in place. All actors must be driven by this fundamental spirit as the ultimate goal of any innovation, as shown at the top of the pyramid, which is to provide, maintain or improve the quality of life for all citizens, women and men.

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