

**Innovation:
The History of a Category**

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Abstract

Innovation is everywhere. In the world of goods (technology) certainly, but also in the realm of words. Innovation is discussed in scientific and technical literature, in social sciences such as sociology, management and economics, and in the humanities and arts. Innovation is also a central idea in the popular imaginary, in the media and in public policy. How has innovation acquired such a central place in our society?

This paper looks at innovation as category, and suggests an outline for a genealogical history. It identifies the concepts that have defined innovation through history, from its very first meaning as novelty in the Middle Ages to the most recent interpretations in sociology and economics. The paper suggests a genealogical history of innovation through the following three concepts: Imitation → Invention → Innovation.

We have a “violent Fondness for change, and greater Eagerness after Novelties”, B. Mandeville, *The Fable of the Bees*, 1732.

Introduction

Innovation is everywhere. In the world of goods (technology) certainly, but also in the realm of words: innovation is discussed in the scientific and technical literature, in social sciences like history, sociology, management and economics, and in the humanities and arts. Innovation is also a central idea in the popular imaginary, in the media, in public policy and is part of everybody's vocabulary. Briefly stated, innovation has become the emblem of the modern society, a panacea for resolving many problems, and a phenomenon to be studied. As H. Nowotny defines our epoch: it is a fascination and quest for innovation (Nowotny, 2008; 2006). The quest for innovation is so strong that some go so far as to suggest that drugs like Ritalin and Adderall, used to treat psychiatric and neurological conditions, should be prescribed to the healthy as a cognitive enhancement “technology” for improving the innovative abilities of our species (Greely et al., 2008).

This suggests three questions. First, **why** has innovation acquired such a central place in our society or, put differently, where precisely does the idea of innovation come from? To many, innovation is a relatively recent phenomenon and its study more recent yet: innovation has acquired real importance in the twentieth century. In point of fact, however, innovation has always existed. The concept itself emerged centuries ago. This suggests a second question: why did innovation come to be defined as **technological innovation**? Many people spontaneously understand innovation to be technological innovation. The literature itself takes this for granted. More often than not, studies on technological innovation simply use the term innovation, although they are really concerned with technological innovation. However, etymologically and historically, the concept of innovation is much broader. How, when and by whom did its meaning come to be “restricted” to technology? Third, why is innovation generally understood, in many milieus, as **commercialized innovation**? It is hard today to imagine technology without thinking of the market. One frequently hears

of innovations that are marketed by firms, but other types of innovation are either rapidly forgotten or rarely discussed. By contrast, every individual is to a certain extent innovative; artists are innovative, scientists are innovative, and so are organizations in their day-to-day operations.

To answer these three questions, this paper looks at innovation as a **category** and at its historical development. The paper is not a history of innovation itself (or innovations), neither a contextual history. It looks rather at the representations of innovation and the discourses held in the name of innovation, namely since the term first appeared in the Middle Ages: how the public, innovators themselves, and academics, and particularly the theories of the latter, have understood innovation and talked about it.

This paper offers very preliminary ideas toward a **genealogical history** of the category “innovation”. It identifies the concepts that have defined innovation through history, and that have led to innovation as a central category of modern society. It concentrates on the “creative” dimension of innovation. This dimension got into innovation in the twentieth century. At the very beginning, innovation was rather concerned with change, broadly understood, and had nothing to do with creativity. Innovation as change will be dealt with in another paper (Godin, 2009b).

The paper is programmatic in the sense that it suggests a program of research or outline for such a genealogical history, a history that remains to be written. In the *Archeology of Scientific Reason*, M. Foucault asked “Comment se fait-il que tel concept soit apparu et nul autre à sa place?”, (Foucault, 1969: 39-40) that is, under what conditions does a word come to mean what it signifies for us today? To Foucault, a genealogy is a study of descent rather than origins: the details and accidents, the forces and struggles that accompany every conceptual beginning and its further “solidification” (Foucault, 1984).

In a recently-launched project on the intellectual history of innovation, of which this paper is the first in a series, a genealogical study is framed through concepts, their uses and their context.¹ As Q. Skinner suggested, words are markers of the social understanding of the world, and the emergence of new words is a marker of changes in society's values (Skinner, 1988). Put differently, a new word "marks the moment when [a] change had become obvious enough to need a term to express it" (Smith, 1925: 69-70).

Innovation, or the new, does not exist as such. It is constructed through the eyes and through discourses. The genealogical study suggested here rests on six elements. It starts with the study of words (or terms), their genesis and transformation, and the cluster of concepts involved in speaking about innovation: invention, ingenuity, imagination, creativity, etc. Second, it looks at the meanings of the concepts developed. Such meaning usually goes from vagueness – firstly as a concept in construction where multiple terms are used, often interchangeably, and then with an implicit definition – to a relative stabilization. Third, discourses held in the name of the concepts are identified. The discourses on innovation have been generally of three kinds: innovation as a factor for change in society, innovation as progress,² and innovation for its own sake, such as for personal recognition, prestige or professional identity. Fourth, the values on which innovation relies are analyzed, since they often involve an "essential tension" and lead to the development of dichotomies, such as tradition *versus* innovation (Kuhn, 1959; Shils, 1981). This part of the analysis calls on central categories of thought in Western history. Fifth, the theories and conceptual models developed to explain innovation are studied, from the very early "psychological" models to more recent sociological and economic ones. The sixth and final element in the genealogical history of innovation is the study of the context in which the

¹ As J.G.A. Pocock suggested, before conducting a sociology of ideas, one has to understand "what the ideas were that were in use at a particular time, what in fact they said and implied, and on what commonly accepted assumptions and methods they were based" (Pocock, 1989: 106).

² Progress in civilization (evolutionists, anthropology), in well-being (sociology), in growth (economics), in knowledge and the control of nature (philosophy).

category emerged: economy (trade), politics (the courts), and culture (expressiveness, awareness of history).

This paper advances three hypotheses in order to guide a genealogical history of innovation as category. The first hypothesis starts with the idea that innovation is about **novelty** (arising from human creativity), as etymology, dictionaries and history suggest. As such, innovation is of any kind, not only material or technological. In this sense, innovation as category has a very long history. However, over time the conjunction of two factors gave preeminence to technological and commercialized innovation in representations: 1) the culture of things and its capitalistic corollary: industrial development through technology, 2) academics, the study of technology, and the conceptual frameworks that followed for policies in science and economic growth. In fact, there is a dialectics here between reality and language. Events and changes in the world gave rise to new categories; the latter in turn brought to light changes in the world and, in doing so, contributed to these changes.

The second hypothesis is that the history of innovation as “creativity” is that of three concepts (and their derivatives): **Imitation → Invention → Innovation**. Certainly, a lot has been written on imitation (literary theory and art theory), as well as invention (history, sociology, management and economics of technology). But no one has ever brought the two concepts together in a genealogical history, and neither has anyone looked at their contribution to the category innovation. Through Western history, imitation and invention have been contrasted, or are in tension. The dichotomy reaches its resolution with the idea of innovation in the twentieth century, particularly the idea of innovation as process: invention and imitation are two sequential steps in the process leading to innovation.

The third hypothesis is about innovation as a **break with the past**. Innovation and the discourses on innovation serve to make sense of modern practices and values. On the one hand, innovation represents continuity with the past. It is continuity in

the sense that innovation is about novelty, an idea that was present in many forms before innovation took on a central place in representations, as we will see. It is also continuity in the sense that innovation is, to many, concerned with technological invention, which is a dominant understanding of what invention came to mean over time. However, on the other hand innovation is a break with the past in the sense that it suggests that invention *per se* is not enough. There has to be use and adoption of the invention, namely innovation, in order for benefits to accrue.

At this stage of the project, the first two parts of this paper (imitation, invention) are based on secondary sources. The third part (innovation) is composed entirely of original research and constitutes the core of the paper. It identifies the theories on innovation proper, and their emergence over the twentieth century. The period covered in this paper ends around 1970-90, which was when innovation developed its current understanding in representations, and when the literature on innovation exploded.³

Imitation

Imitation is a concept of Greek origin. McKeon (1936) has documented how Plato's philosophy is entirely concerned with imitation and its many senses and opposites: appearances (or images) – *versus* reality; falsity – *versus* truth. To Plato, even physical objects are imitations, compared to God and true nature. But it is through Aristotle that the concept of imitation got its main influence. To Aristotle, (practical) arts imitate nature (*mimesis*). Such an understanding of art gave rise to *imitatio* as the central problem of art, with pejorative overtones, then to imitation as inspiration (Abrams, 1953; Nahm, 1956). As M. H. Abrams has stated, the mimetic orientation was the most primitive aesthetic theory (Abrams,

³ The author wants to thank the following colleagues for comments on a first draft of this paper: Irwin Feller, Paul Forman, Denise Lemieux, Pamela Long, Pierre Lucier, Christine Macleod, Reijo Miettinen, Helga Nowotny, Jean-Jacques Salomon.

1953: 8).⁴ Art imitates the world of appearance. The “artist” extracts the form of the natural world and imposes it upon an artificial medium (Abrams, 1953: 11). In fact, “wherever the Renaissance theorist turned, he usually found the concept of invention somehow subordinated to the imitation of nature” (Kushner, 1980: 144).

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However, according to most theories, imitation is only “instrumental toward producing effects” (Abrams, 1953: 14). In their quest for social status, artists debated for centuries on how to distance themselves from a conception of their work as mere copying. As E. T. Bannet suggested recently, imitation is a literary mechanism for the production of difference (Bannet, 2005). Until the mid-eighteenth century, imitation was presented as a positive practice, not one that was distrusted or pejorative. To rhetoricians, imitation is a method for teaching (Clark, 1951). To Renaissance artists, imitation certainly makes use of nature as model, or exemplar. However, it is not slavish or mechanical imitation, but selective borrowing and creative copying. Similarly, while humanist writers in the Renaissance make use of past authors (antiquity) as models, it is *aemulatio*, and the writer enriches the tradition. In fact, the artist, the poet and the writer in the Renaissance were not yet being judged for originality (Force, 2005; Cole, 1995; Wittkover, 1965), but rather for interpretation. There was little sense of copyright – although accusations of plagiarism abounded (Hathaway, 1989; White, 1935).

And so it is with science and arts. To Francis Bacon, one comes closer to real knowledge of nature by imitating nature. As he described his experimental method in *Magna Instauratio*: “these things are quite new; totally new (...): and yet they are copied from a very ancient model, the world itself and the nature of

⁴ On the representation of art before the Greek “theory” of *mimesis* – art as “presentification” of the divine rather than a human creative act –, see Vernant and Zeitlin (1991).

⁵ On the different of meaning of imitation of nature in art, see Lovejoy (1927) and Lovejoy and Boas (1935). In history, the “naturalist presumption” is a widespread idea: what humans do, in literature, arts, crafts and science is a (continuation or) perfection of nature (Close, 1969). To many, above all philosophers, nature is generally considered as more primitive and more authentic. Nature functions as a cultural value and social norm. Nature has a moral authority (Bensaude-Vincent and Newman, 2007; Daston and Vidal, 2004).

things and of the mind”.⁶ In the world of trade and goods, imitation is also positively appreciated. M. Berg and H. Clifford have documented how imitations served as substitutes for imported commodities in eighteenth-century Britain (Berg, 1999; Clifford, 1999). Imitation was a way to give access to luxury goods (decorative goods, clothing, household wares) to the people, through “semi-luxuries”. In the case of the decorative arts over the same period, R. Benhamou has documented the contribution of imitation to lowering the costs of original products (Benhamou, 1991). Briefly stated, imitation is taken for granted and is a common practice. Imitation brings advantages to the people; it represents economic opportunity.

In more recent history, R. R. Nelson and S. G. Winter (1982), in a classic of the literature on technological innovation, suggested imitation as one of two strategies available to firms, the other being innovation. As early as 1966, T. Levitt from Harvard Business School suggested the same idea: “because no single company can afford even to try to be first in everything in its field”, a company is compelled “to look to imitation as one of its survival and growth strategies” (Levitt, 1966: 65). In fact, to Levitt “the greatest flow of newness is not innovation at all. Rather, it is imitation”. He was referring to the fact that when “competitors in the same industry subsequently copy the innovator [a given firm or industry which has produced something that has never been seen before], even though it is something new for them, then it is not innovation, it is imitation” (Levitt, 1966: 63). A company creates “its own imitative equivalents of the innovative products created by others”.

Not only, then, is imitation a good practice, but imitation has often been portrayed as being invention itself. The view in the Middle Ages of the work of artisans is that of art learned by imitating nature, but in so doing, the artisan changes nature, as claimed by the alchemists (Newman, 1989). Equally, in Renaissance literary

⁶ On Bacon’s description of his utopian laboratory (Salomon’s house) as imitation of nature, see his description of instruments in *New Atlantis* (1627).

theory and visual arts, one finds recurrent descriptions of imitation as rediscovery of the old, as something “new” to copy, as something never seen before. Here, “the charge of lies [imitation] is turned to an argument for the truth of poetic imagination” (Rossky, 1958: 69). An argument frequently evoked is that imitation requires work, experimentation, judgment and imagination. All these descriptions in literature, arts and crafts generally refer to an idea that has been very influential among many authors in defining invention, and subsequently innovation, as we will observe below: that of **combination**. Imitation is invention because, when combining elements from nature, it combines the best of them, and by so doing improves nature. Combination “creates a whole that is more perfect than nature”; it is as nature ought to be (Wittkower, 1965: 148). Equally, in combining previous schools of thought, the combination surpasses the work of past authors. *Compilatio*, a “wide literary activity which encompassed various genres in the Middle Ages” (and after), is combination of others’ material into a new work, a *unio* (Hathaway, 1989: 41).

But let’s continue with imitation as invention in other areas. In the sixteenth and seventeenth centuries, patents (and their precursors in the fifteenth century: letters and privileges) were not granted to inventors, as they are today, but to importers of existing inventions, as a way to develop the local economy (Macleod, 1988; Popplow, 1998; Hilaire-Perez, 2000). They were accompanied by laws restricting the mobility of artisans who possessed unique skills or techniques (Epstein, 1988). In addition, premiums and prizes were awarded by societies of arts to imitations of existing foreign goods (Berg, 1999). Similarly, in consumer goods of eighteenth-century Britain, imitation was perceived as invention because it resulted in new commodities, introduced improvements in quality (design), and brought diversity and variety (Berg, 1999; 2002; Clifford, 1999; Benhamou, 1991). Due to a culture of taste, the goods or commodities and their aesthetic qualities evoke the distinctive and the exotic, but also the latest technology and modernity.

Now, if we turn to the twentieth century, we clearly observe that imitation gave rise to, and was often used as a term for, diffusion. As I discuss below, contemporary theories on innovation now include diffusion (or use) as a step in the innovation process. In this process, diffusion is really imitation, and the word appears in early theories, from the French sociologist Gabriel Tarde in the 1890s to the economic literature on technological innovation in the 1980s. As a matter of fact, in the sociological literature of the 1940-60s, an innovator is not an inventor but a user, defined as to time: the first user of an invention. Equally, imitation gave rise to the idea of “adoption” as innovation itself: in recent theories on and measurements of technological innovation, adopting an existing technology is a behaviour considered just as innovative as inventing (OECD, 2005), and not as mere imitation, as Levitt has suggested.⁷ As F. Redlich put it, while not “genuine” (or primary) innovation, innovation by imitation is nevertheless (derivative and subjective) innovation, as opposed to copying (Redlich, 1951).

In summary, imitation has rarely been separated from invention. To many, imitation has close links to invention, and even constitutes invention itself. However, with time imitation came to be contrasted to invention. Starting from the mid-eighteenth century, imitation was regarded as mere copying, while originality became the criterion for real invention.

Invention

Invention is a term that comes from rhetoric. In classical rhetoric, invention was the first of five divisions of the rhetorical art. Invention is composed of guidelines to help speakers find and elaborate language. In *De Inventione*, Cicero (106-43 BC) defined invention as the “discovery of valid or seemingly valid arguments to render one’s cause probable”. However, in the history of rhetoric, invention as so

⁷ See also the much cited concept “absorptive capacities”: the capacity of a firm to assimilate and apply (imitate) other firms’ innovations (Cohen and Levinthal, 1990).

conceived has been eclipsed by one or more of the four other divisions (arrangement, style, memory and delivery).

Invention as a term in other domains really came to be used in the mid-fourteenth century as finding or discovery, namely with regard to knowledge, or science (knowing). It came to be applied to making as well, in poetry (literary criticism), then in visual arts. From the sixteenth century, invention was used more and more to apply to newly-created things (artifacts). Let's look at the history of this evolution.

From late medieval Europe, the idea of invention spread everywhere, to different degrees and under different terms. A whole cluster of words is used to name the new, as the list below indicates. Certainly, as M. Kemp has noted, in the Renaissance, there was “no unanimity in usage of *divino*, *ingegno*, *fantasia*, *immaginazione* and *invenzione*” (Kemp, 1977: 397). Equally, the term or terms associated with a specific field in the following list are not exclusive to that field, but are those that came to gain preeminence in that field (for a complete list of the vocabulary, see the Appendix). One thing is clear: in the sixteenth and seventeenth centuries, the idea of novelty is everywhere and becomes very much a (positive) cultural value:

- Philosophy: *praxis*⁸
- Literary theory and visual arts: imagination, originality, creation
- Arts and crafts (engineering): *ingenium*, invention
- (Natural Philosophy and) science: discovery, experiment, scientific change
- History: change, revolution, progress
- “Evolutionists”: ⁹ growth, development, evolution, variation, mutation

⁸ In philosophy, *praxis* has not really been theorized because of the emphasis on mind (Arendt, 1968; Lobkowic, 1957). It slowly begins to be become an issue, quite imperfectly according to many, with expressiveness (J. G. Herder), utilitarianism (free will), existentialism (life, will, consciousness), pragmatism (experience, inquiry), and the philosophy of action (Bernstein, 1971).

⁹ Following Bowler (1983), I group together under evolutionists: early geology, early paleontology, natural history, and biology.

- Anthropology: culture (or cultural) change
- Sociology: action, social change
- Psychology: attitude change; creativity
- Management and politics: organizational change
- Economics: entrepreneurship, technological change, innovation

Nowhere is the idea of novelty more present than in science. In the sixteenth and seventeenth centuries, science was frequently discussed as an active search or hunt (*venatio*), a very old metaphor (Eamon, 1994; Hadot, 2004). The scientific literature of the seventeenth century is full of the term “new”, as L. Thorndike has documented (Thorndike, 1957), as well as the term “revolution” (Cohen, 1985).¹⁰ Equally, the idea of progress is a major one during the Renaissance, the Enlightenment and subsequently (Bury, 1932; Zilsel, 1945; Sarton, 1962; Rossi, 1970: 63-99; Crombie, 1975; Bock, 1978; Nisbet, 1980; Marx, 1987; Spadafora, 1990).

Change became a preoccupation of study in many emerging scientific disciplines, from sociology (A. Comte, H. Spencer) and history (A. Ferguson) to natural philosophy, or the sciences. Geologists, natural historians and biologists from the eighteenth century are the “men of science” who have taken change most seriously. Certainly, at that time, change as the natural process for the development of life on earth was seen as preordained, even through the nineteenth century: God is the designer of all things and their development; the linear chain of being is constructed as leading invariably to man (Lovejoy, 1936). But evolutionists, since before Darwin, have discussed change – as either linear, or cyclical or catastrophic (in the case of the earth formation), and as spontaneous generation and degeneration, then natural selection (in the case of biological species) (Bowler, 1983; 1993). The evolutionists also developed influential sequential theories of how life and societies evolve (life-cycle theories), based on

the model of the embryo (birth, growth, maturity). Evolution, development, variation and mutation are only some of the key terms used here.

Whatever its name, the new is not without its opponents. The *Querelle* between the ancients and the moderns, in literature and philosophy but also in science and education, is that between imitating (and surpassing) the ancients *versus* a totally new enterprise (Jones, 1936). This is perhaps the first systematic debate in history about the new as opposed to tradition. In science, there is also the opposition with religion. An argument frequently evoked here is that of minimizing novelty, and portraying science as “new, but not so new”: the purpose of scientific knowledge is to reveal the nature God has created; science talks about what is real, not magic or superstition. However, even among scientists themselves, scientific invention is resisted (Cohen, 1952; Barber, 1961; Kuhn, 1962; 1963). As with imitation, invention is perceived in different ways. It is often distrusted and qualified as esoteric. Similarly, hypothesis, as coming from the imagination and as the major faculty behind scientific invention but a source of error for the rationalists, is said to be in need of control, namely a method, as Bacon suggests (Park, 1984).¹¹ Otherwise it leads to excesses, delusions and distortions, or to rhetoric and eloquence.

The defenders of invention often have an ideological aim: to distinguish oneself (identity) and to justify one’s activities (image of scientists, inventors and writers), for purposes of patronage, among other things. Hence, the construction of oppositions portraying tradition and the like as static (transmission from generation to generation; irrational and arbitrary) versus invention and the like as cumulative and progressive.¹²

¹⁰ Friedman and Karlsson have recently computed the exponential use of the word “novel” in titles of the current scientific literature, and have concluded: “in the morning hours of 7 February 2020 all science will be novel” (Friedman and Karlsson, 1997).

¹¹ On the role of hypothesis (imagination) in science, see Laudan (1981), Park, Daston and Galison (1984).

¹² Frequently heard oppositions are: Good *versus* bad imagination; imitation *versus* originality; science *versus* art; knowing *versus* imagining; objectivity *versus* subjectivity; books *versus*

Over time, invention in science came to share the vocabulary of writers with the term **discovery**. In fact, for some time, invention meant finding as well as making, and was applied without qualification to both activities. Discovery also meant both. Later, a distinction was made between the two concepts: discovery referred to facts or things that already exist out there and that one finds out, while invention combines and makes new things, including scientific theories (Wyman, 1929; Kneale, 1955). However, since social constructivism (Hacking, 1999), the term “construction” seems to be the preferred term, applying to both scientific discoveries and technological inventions.

Literature and visual arts are other fields where the idea of novelty is widespread. Contrary to science, with its emphasis on facts and method and its negative assessment of imagination (Southgate, 1992), the “power of imagination” is rehabilitated. In fact, literary theory and visual arts (painting, sculpture) in the Renaissance adapted invention from the literature on rhetoric (then from poetry) to a psychological process of **imagination** (Lee, 1940; Bundy, 1930; Spencer, 1957; Bond, 1935; 1937; Rossky, 1958). Although imagination was, as in science, portrayed for a time as in need of control, namely judgment and rules (Costa Lima, 1988), the real boundary work of the artist is against imitation: imitation (as combination) is stigmatized as *eclectici*. Real art is free and creative imagination (Cassirer, 1932: chapter 7; Abrams, 1953; Williams, 1961; Engell, 1981; Mason, 2003). The passive role (reproducing) of imagination in medieval usage (as opposed to *fantasy* which combines) turned into an active faculty with the Romantics. *Originality* came to define the artist (Mann, 1939; Mortier, 1982; Quint, 1983; McFarland, 1985), and the metaphor of **creation** – already present in Greek mythology (Prometheus) – entered the vocabulary (Nahm, 1947, 1956; Tigerstadt, 1968; Mason, 1988). Certainly, originality, as with imitation and invention, carries negative connotations as well. Until the nineteenth century, in

observation; hypotheses *versus* data; tradition *versus* modernity; good *versus* bad effects of technology (benefits *versus* disasters).

social usage for example, an original person was bizarre, eccentric, ridiculed.¹³ However, originality with the following two meanings gained credence over time. Originality means origin, or source (authorship), and this meaning would be influential, as discussed below, in the case of technological invention. It also means a distinctive quality of work, or novelty, unlike the imitation of the ancients, for example. As such, originality came to characterize the *genius*, an important figure in the Renaissance and to the Romantic authors. Genius as a concept has a long history. First defined as spirit (which gave inspiration), it came to mean innate talent or ability (*ingenium*), then a person with superior creative powers, to which the Romantic conception has added the idea that genius defies rational analysis (Smith, 1925; Zilsel, 1926; Tonelli and Wittkower, 1968-70; Murray, 1989; Goodey, 2004).

Ingenuity was also a key concept for the artisan from the Middle Ages onward. In fact, the artisan, first of all alchemists, through their art created new things in their opinion, and for the first time made art a creative force rather than only an imitative entity or mirror-like representation (Newman, 2004).¹⁴ Equally, in Renaissance painters, ceramists and sculptors really thought they were creating new things, not only practicing an imitative art (Smith, 2004). This creative power over nature gave rise to the figure of the inventor, a genius or hero who, as to scientists and artists, was not without opponents. As a matter of fact, it took time for inventors to be admitted to the pantheon of great men. Up to the beginning of the nineteenth century, and again after the commercialization of technological inventions on a large scale at the end of this same century, the inventor was anonymous. As C. MacLeod has discussed for Great Britain: inventors were merely the agents of providence in “discovering” inventions in accordance with the divine plan. The inventor was simply born at the right time and place, and was

¹³ On a very interesting sociological study of originality *versus* convention, see N. Elias on Wolfgang Amadeus Mozart (Elias, 1993).

¹⁴ On the contribution of magic and alchemy (and the books of secrets: receipts, formulas, instructions, experiments as tests, or trials) to the status of the arts and artisans, see White (1975), Newman (2004; 1989); Eamon (1994).

the last link in a causal chain (Macleod, 1996; 2006; 2007 Macleod and Tann, 2007; Macleod and Nuvolari, 2006).

While the idea of invention came to share its place with discovery in science (Branigan, 1981), and with imagination in literature and visual arts (Engell, 1981; Mason, 2003), it gradually and increasingly came to be identified preeminently with mechanical or **technological invention**, first of all in crafts and arts such as architecture, navigation, metallurgy and the military. Early in the Renaissance, the term invention was applied to *ingenious* things like “machines, artifices, devices, engines, methods”, for which a whole literature developed – treatises, histories and encyclopedias (Rossi, 1970; Long, 2001) – and for which the word *technology* subsequently became the category.¹⁵ In the nineteenth century, engineering and works on bridges, tunnels and railways, then electrical systems add important inventions to the technological landscape (Chandler, 1977; 1990; Beniger, 1986; Hughes, 1983).

This alignment of the term invention with technological invention was helped by the conventionalization, or institutionalization, of technological invention through privileges and patent laws from the late fourteenth and fifteenth centuries onward (Macleod, 1988; Cooper, 1991a; Popplow, 1998; Hilaire-Perez, 2000). That invention as idea is itself an invention – a social invention – is now well admitted. A scientific theory is invention because a system for attributing authorship to an individual exists, namely the scientific publication. The scientific publication developed, in fact, as a mean to resolve priority disputes (Merton, 1957; 1961; Branigan, 1981; Gross, 1989; Iliffe, 1992; Biagioli and Galison, 2003). Similarly, the patent system is the institutional mechanism for deciding what a technological invention is and who owns it (Rae, 1967; Macleod, 1988). As anthropologist O. T. Mason, curator at the US National Museum, put it in 1895: “The public

¹⁵ On the history of the term technology, from *technique* to *artifact*, see: Morère (1966), Guillerme and Sébastik (1968), Salomon (1984), Frison (1992; 1993), Marx (1994; 1997), Schatzberg (2006).

recognition and reward of invention may itself be said to have been invented” (Mason, 1895: 15).

It is through the patent system as institution that the criteria for a technological object’s identity are negotiated and invention is defined (Cooper, 1991b; Cambrosio et al., 1990): in fact, all technological inventions are defined here, whether it is patented or not. Ever since the first modern patent laws in the late eighteenth century, three criteria have characterized technological invention (Lubar, 1990). First, originality as to quality of work, or novelty. Applications are examined for novelty before a patent is granted. Gone is the idea of imitation: transformations and improvements to existing goods are more and more difficult to patent. Originality is the norm. A technological invention, to qualify as such, has to be substantially new. With time, what constitutes novelty is increasingly settled through the judicial system, which arbitrates competing claims. The second criterion is originality as to origin, or priority. Here, patents institutionalized the then-emerging idea of intellectual property (authorship), whose roots date from the Middle Ages (Long, 2001). Patent laws add property rights to inventions.¹⁶ The third criteria suggested for the patented invention is utility, and this is crucial for understanding invention as technological invention.

E. Zilsel, in his seminal study on the idea of genius, documented a shift in the idea of genius during the Renaissance. From being applied to the output of the artist, genius became something attributed to the artist as person, a subjectivization of the idea (Zilsel, 1926). However, in the larger context of innovation, as discussed in this paper, it is the opposite which is observed. As patents attest, the qualities previously attributed to the genius or artist (like originality) become those attributed to the commodity.

¹⁶ Copyright laws have followed a similar but distinct development. Early privileges for printed editions of books were basically for printers, not authors. Rights to writers developed after patent laws. However, and contrary to patents, originality is a requirement of copyright only in the sense that it originates in the copyright claimant, not that it is original in the sense of novelty.

Over time, technological invention obtained a relative “monopoly” in the vocabulary of invention because of the **culture of things**, or material culture – and patents are witness to this phenomenon. The origins of this culture goes back to the Renaissance: due to commercial exchanges, exploration and travel (Cook, 2007; Smith and Findlen, 2002), natural and artificial objects have been what is valued in arts, science, and real life. This is not to say that technical invention had no opponents, quite the contrary. Before the nineteenth century, technical invention commonly carried negative connotations, because of the many technical, managerial and financial difficulties of projects and “projectors” (Godin, 2009b). Another aspect of this opposition is the resistance to technology in the workplace. From the industrial revolution in Great Britain to the debate on technological unemployment and displacement in the United States in the 1930s, many questioned the benefits of machines, and refused, often violently, the introduction of new processes in industry (Stern, 1937; Pearson, 1979; Berg, 1980; Randall, 1986; Bix, 2000).

Over time, the culture of things has developed and owes its existence to many factors. One such factor is the “consumer revolution” (Berg and Clifford, 1999; Thirsk, 1979): the sixteenth century and after brought new consumer goods to the people. These new goods were a response to expressed needs for a better existence, an old motive, as L. Dresbeck (1979) and L. White (1971) have discussed with respect to the Middle Ages, but also in response to taste (a moral idea, then an aesthetic one), and its manifestation in luxuries and semi-luxuries as novelties (Berg, 1999). The emergence of economic thought in the seventeenth century, with its emphasis on gain, wealth and material prosperity, is witness to this phenomenon (Dumont, 1977). A second factor is what came to be called the “industrial revolution” and the use of technologies in industrial processes (Toynbee, 1884; Ashton, 1948; Hudson, 1992; Coleman, 1992; Hardy, 2006). Then, a third “revolution”, or innovation, occurred at the end of the nineteenth century and the beginning of the twentieth century: (large) firms began setting up research laboratories as a way to accelerate industrial development (US National

Research Council, 1941; Noble, 1977). As A.N. Whitehead put it long ago, “the greatest invention of the nineteenth century was the invention of the method of invention”. Men have invented a method for (systematic and cumulative) invention (Whitehead, 1925: 120; see also Lippman, 1934). By 1920, there were approximately 300 industrial research laboratories in the United States alone, and twenty five years later industrial research accounted for more than two-thirds of national expenditures devoted to research and development (R&D) in many countries. Along with the patent system discussed above, the development of industries based on the research laboratory and the commercialization of technological inventions on a large scale were major factors contributing to a conception of invention as technological invention.

Briefly stated, technological inventions got increased attention because they have **utilitarian** value (Long, 2001; Hilaire-Perez, 2000; Macleod, 1988) – as opposed or contrasted to Ancient knowledge, as it was often said from Bacon onward. They contribute to politics: technology and arts, such as painting, sculpture, and architecture, serve as political and military power, and as manifestations of power (displays of grandeur, wealth and magnificence). They also contribute to “social progress”. From the medieval guilds (Epstein, 1988) to the mercantilists (Johnson, 1930), from the Enlightenment to the twentieth century, the literature is full of mentions of progress and utility from technological inventions with regard to contributing to character (virtue) of the individual, to social well-being, and to civilization. Finally, technological inventions as power over nature serve commerce, trade and manufacturing – activities seen positively at the time, as A. O. Hirshman (1977) has documented. From the nineteenth century onward, these beliefs led to narratives on modernity and technologies from everyone: from “ordinary people” to intellectuals (Marx, 1964; Kasson, 1976; Nye, 1997; 2003; Noble, 1998; Hard and Jamison, 1998; Rieger, 2005).

Things and utility have a place in science too. First, the new sciences of the seventeenth century increasingly relied on the study of objects of nature.

Observation, namely the collection of objects and the compilation of data, and measurement, with techniques or technologies as instruments, are the keywords here. There is a rehabilitation of curiosity, which was a vice to Christian writers like Augustine (Eamon: 1994 58-66, 301-318) and others before him, but which became a quality of the *virtuoso*, that is, the cultivated gentleman (Houghton, 1942), giving rise to one of the most central concepts of science, that of objectivity (Harrison, 2001; Daston, 1995).¹⁷ Things like marvels, wonders, rarities and exotics (Daston and Park, 1998) also find a place in cabinets of curiosities, as precursors to museums (Findlen, 1994; Impey and MacGregor, 1985).

Second, there are also calls, for which F. Bacon is the main exponent, for more useful knowledge in science, namely for the mechanical arts and artificial objects.

¹⁸ To Bacon, “the real and legitimate goal of the sciences is the endowment of the human life with new inventions and riches” (*Novum Organum*, 1620: aphorism no. 81). Bacon is followed by R. Boyle as one of the most serious defenders of his views, and by the scientific academies (Briggs, 1991; Ochs, 1985).¹⁹ That mixed mathematics and mechanical arts have utility, that machine technology benefits the public and industries becomes an argument for the promotion of science and for securing patronage (Cochrane, 1956; Keller, 1972; Stewart, 1998; 1992).

Innovation

Novation is a term that first appeared in law in the thirteenth century. It meant *renewing* an obligation by changing a contract for a new debtor. The term was rarely used in the various arts and sciences before the twentieth century –

¹⁷ There is very good literature on the history of objectivity from L. Daston, P. Galison, S. Schaeffer and S. Shapin (see also Poovey, 1998; Shapiro, 2000). From this literature, one could develop a genealogical history of objectivity in three steps as follows: curiosity → matters of fact → objectivity.

¹⁸ The fascination with machines entered science very early, via the mechanical philosophy. The metaphor of the clock for explaining different aspects of nature is one of the most well-known examples in the scientific literature. On the analogy of knowing to making (machines), see Crombie (1994: chapter 14).

although “new” was, as mentioned above. Create and invent were preferred words for man’s productive power and creative abilities. N. Machiavelli (*The Prince*, 1513) and F. Bacon (*Of Innovations*, 1625) are among the very few individuals having devoted early pages to innovation, using the term as such, and to the resistance of people to innovation.²⁰ There has also been a controversy on innovation, the first of its kind, in religion in mid-seventeenth century England (Godin, 2009b). All these writings and debates were concerned with innovation as change, not creativity.

In fact, as with imitation and invention, innovation was pejorative for a while. Until the eighteenth century, a “novator” was still a suspicious person, one to be mistrusted. Before the twentieth century, there had been two episodes in history where innovation was opposed. The first was in political and religious matters. Because of tradition, political change was negatively received, and because of orthodoxy, innovation was considered heresy; thereafter innovation was identified with the introduction of anything deviant in political affairs and in the Church. The second episode was during the eighteenth century, when inventors started making money from their inventions. Projectors, as the innovators were then called, became objects of satire by many authors because of insufficient science, bad management and fraud.

In this section, I document how innovation gradually came to resolve the tension between imitation and invention, at least at the theoretical level. Until innovation took on a central place in theories on social and economic change, imitation and invention (under different terms, as discussed above) were seen as opposites, as was the case in social practices. In the eighteenth century, for example, originality was contrasted to copying and plagiarism (imitation) in authorship (Woodmansee, 1984; Long, 2001). Equally, under patent laws, property (of the first inventor) gave rise to accusations of theft (imitation) (Macleod, 1988; Hilaire-Perez, 2000).

¹⁹ One should also include here the reformers of learning like S. Hartlib, J. Dury, W. Petty and J. Evelyn in England (Houghton, 1957; Jones, 1936).

Similarly, the very first theories on innovation explicitly contrasted imitation to invention. While previous theories of invention were of a “psychological” kind and focused on inspiration, imagination and genius (Bundy, 1927), the end of the nineteenth century saw the emergence of new theories for explaining novelty, and these were of a social kind. The first such theories arose in anthropology.

Anthropology made very few uses of the term innovation. Innovation was nevertheless what anthropologists of the late eighteenth and early nineteenth century studied as **culture change**: changes in culture traits, but also inventions in agriculture, trade, social and political organizations (law, customs, religion, family) and technology. It is impossible to examine all of the voluminous literature produced on culture change in this paper; neither is it possible to analyze to what extent the theories that were produced really studied change as a process. However, one debate deserves mention here. Many anthropologists framed the discussion in terms of invention versus diffusion (as imitation) to explain stages of civilization. This gave rise to what came to be called the diffusion controversy (Smith et al., 1927). On one side were evolutionists, to whom invention stems from multiple centers and occurs independently in different cultures. Parallel inventions, as they were called, reflect the psychic unity of human nature, and differences in culture reflect steps of the same process, or varying speeds of evolution.²¹ Primitives were considered to be at an arrested stage of development. An associated discussion here was whether there was convergence between cultures, or divergence.²²

²⁰ On Bacon and novelty, see Whitney (1986). On Machiavelli and innovation, see Pocock (1975).

²¹ Precursors on parallel inventions are evolutionists in archeology (G. de Mortillet) and paleontology (multiple centers, discontinuous invention: R. Owen, G. S. Mivart, H. F. Osborn), historians (W. Robertson on parallel invention, but at different rates), and philologists.

²² Convergence refers to things originally different that have become the same, and divergence to things originally the same that have become different. For the first discussion of the principle of limited possibilities of divergence, see Goldenweiser (1913).

At the opposite end were diffusionists, to whom man is essentially uninventive.²³ Culture emerges from one center, then diffuses through borrowings, migrations and invasions.²⁴ This gave rise to a whole literature on culture areas (culture circles in Germany), where diffusion is due to geographic contiguity (O. T. Mason, G. Holmes, A. L. Kroeber and C. Wissler).

Until about the mid-twentieth century, evolutionism was the framework anthropologists used to study culture change. Then acculturation, as the study of cultural change resulting from contacts between different cultures, developed (Redfield et al., 1936; Barnett et al., 1954). Anthropologists stopped looking at diffusion as mere imitation contrasted to invention: diffusion is inventive adaptation. Among anthropologists, one author stands apart: H. G. Barnett (Godin, 2009a). Barnett developed a comprehensive theory of innovation, defined as “any thought, behavior, or thing that is new because it is qualitatively different from existing forms” (Barnett, 1953: 7). To Barnett, everyone is an innovator, but he could not find a precise and thoroughgoing analysis of how innovation occurs in the literature. Most studies, he said, concentrated on technological invention – and his use of the term innovation is motivated by the desire to eliminate this bias. From ethnological researches in ethnic groups and religious cults, he developed such a theory. However, Barnett had no followers among anthropologists. We have to turn to sociologists, and then economists, to find the systematic development of studies on innovation.

The first theory of innovation comes from the French sociologist Gabriel Tarde in the late nineteenth century (Tarde, 1890; 1895; 1898; 1902). Tarde’s sociology distinguished statics from dynamics,²⁵ and was interested in explaining **social**

²³ According to M. Harris (1968), diffusionists were responsible for the invention/diffusion dichotomy in anthropology, while evolutionists (like E. B. Tylor and L. H. Morgan) were said to admit both invention and diffusion. To J. Stewart, there are three dichotomies in the debate: unilinear/multilinear evolution, invention/diffusion, parallel invention/convergence (Stewart, 1955).

²⁴ Precursors to diffusionism are evolutionists in biogeography (one center, then migration: A. R. Wallace and J. D. Hooker), and biology (C. Darwin and the common ancestor to men).

²⁵ With this distinction, Tarde foreshadowed J.A. Schumpeter in economics.

change (or social evolution): grammar, language, religion, law, constitution, economic regime, industry and arts. Tarde made widespread use of the term innovation (and novation) as novelty, but with no explicit definition. In fact, he used a whole cluster of terms to discuss social changes: invention, ingenuity, novelty, creation, originality, imagination, discovery and initiative.

Tarde's theory of innovation was threefold: invention → opposition → imitation.

²⁶ Inventions give rise to imitation – imitations of a limited number of inventions, because of the opposition or competition between the new and the old inventions.

²⁷ The success of an invention (i.e.: imitation) depends on other inventions (or opposition between inventions) and social factors. To Tarde, invention is the combination of previous or elementary inventions (i.e.: imitation). Invention comes from individuals (not necessarily great men), and is socially influenced. To Tarde, invention is the driving force of society, but society is mainly imitative: custom, fashion, sympathy, obedience and education. Imitation is to society what heredity is to biology, and vibration to electricity.

One had to wait for E. M. Rogers (1962) for other such broad theories of innovation in sociology. As to *praxis* in philosophy, and culture change in anthropology, the extent to which sociologists have really studied change is a matter of debate. Certainly, social change has been studied in sociology, from A. Comte, H. Spencer, P. Sorokin and their grand stages theories based on the life-cycle metaphor, then T. Parsons,²⁸ then studies like social movements as a source of social change, or the study of “development” in developing countries (Watson, 1953; Boskoff, 1957; Nisbet, 1969; Eisenstadt, 1973). However, to many critics over time sociologists have been concerned with imitation (as socialization) rather

²⁶ The French sociologist A. Espinas (1897), his praxeology and his discussion on animal societies (ants) was a source for Tarde's model of individual initiative followed by imitation.

²⁷ On Tarde's theory of opposition, see Tarde (1897).

²⁸ To Parsons, the social sciences may be all classified as “sciences of action”. However, a theory of social change “is not possible in the present stage of knowledge” (Parsons, 1951: 486).

than with creative action (Hield, 1954; Joas, 1996; Berk and Galvan, 2009).²⁹ The study of individual creativity was left to psychology.³⁰ Be it as it may, one thing is sure: sociologists with an interest in technology, to whom we now turn, took change seriously.

What the subsequent theories of innovation have done is put an end to the contrast between imitation and invention. From the 1920s onward, invention came to be understood as a process (both diachronic and synchronic). Theories now combine invention and imitation in a sequence, that is, a linear “model”: invention is followed by imitation. The first such theories came from sociologists (Godin, 2009e). The Americans W. F. Ogburn and S. C. Gilfillan were forerunners, but in fact rehearsed many arguments of the nineteenth century (McGee, 1995; Macleod, 2007: chapter 6 and 9). Both positioned themselves against the views of anthropology and its theories of evolution by stages, because “the achievements have not been up to the high hopes” and have been disproved (Ogburn, 1922: 57), and against “great men” theories in philosophy and history. To Gilfillan, the great man or genius as hero is a mythology for historical origin “to increase the cohesion of the group and its loyalty to its living leaders” (Gilfillan, 1935: 77-78).

³¹

Ogburn and Gilfillan started looking at inventions, above all technological inventions, as causes of cultural change or social change (social organizations and

²⁹ For example, to R.K. Merton innovation (as rejection of institutional means to social goals or norms) is (one of four types of) deviant behavior. See R.K. Merton (1938). On a refinement of Merton’s thesis and a more constructive view of innovation, see Dubin (1959). H. Joas (1996) argues that there has been no real theory of creativity in sociology. He is right. To many sociologists, action is rationality rather than creativity. “Creativity” is non-rational: a residual, a deviation. But from a genealogical perspective, the authors and the theories Joas discusses (Durkheim, Weber, Tonnies, Simmel, Parsons) are steps or precursors, not “metaphors” as he called them, and should be studied in a genealogical history of innovation.

³⁰ Following N. Machiavelli, W. Pareto has contrasted types of individual as to whether they are innovative (foxes) or conservative (lions) (Pareto, 1935). However, he did not devoted analyses to the process of innovation itself.

³¹ The role of genius in civilization was an idea widely debated in philosophy (W. James *versus* G. Allen), in history (T. Carlyle *versus* the Spencerians, the Hegelians and the Marxists), in science (F. Galton on heredity *versus* A. de Candolle), and Tarde has previously positioned himself on the question. In anthropology, it was discussed in terms of great civilizations and the diffusion of culture to other parts of the world.

behaviours).³² To Ogburn, “the use of material things is a very important part of the culture of any people” (Ogburn, 1922: 4). What he observed was the growth and acceleration of material culture, as would be documented quantitatively by American sociologist H. Hart from the 1930s to the 1960s (Hart, 1931; 1957; 1959), and its enormous consequences on society, or social change, a field he studied for over thirty years. Ogburn developed the concept of the cultural lag to account for this process. There is an increasing lag between the material culture (technology) and the rest of culture (adaptive culture) due to inertia and lack of social adaptation. Hence the need for control and adjustment, forecasting and planning.

To the sociologists, technological invention is a combination of prior art and ideas, and a complex of diverse elements: design, science, material, method, capital, skill and management (Gilfillan, 1935: 6). It is a social process rather than an individual one. Certainly “without the inventor there can be no inventions” (Gilfillan, 1935: 78), but “the inventors are not the only individuals responsible for invention” (Gilfillan, 1935: 81). Social forces like demographic (race) and geographic factors, and “cultural heritage” play a part. Secondly, technological invention is social in a second sense: it is cumulative (or evolutionary), namely the result of accumulation and accretion of minor details, modifications, perfectings, and minute additions over centuries, rather than a one-step creation (Gilfillan, 1935: 3).³³ Finally, technological invention is social in a third sense: it is more and more systematic. It comes from organized research laboratories specifically dedicated to this end. Recalling industrialists’ discourses of the time, the sociologists observed a movement from the independent inventor to organized research in industrial laboratories (Gilfillan, 1935: 52-54, 63; Hart, 1931: 552-562).

³² To anthropologists, technology is rather an effect (a sign of civilization) to be explained.

³³ In sociologists’ hands, this idea became a *leitmotif*, although one had to wait until the 1980s and after for empirical studies of what came to be called technological “development”. For an early discussion of technological development among sociologists, see Jewkes et al. (1958: chapter 8).

What place does the term and category of innovation take in sociological theories? In studying the literature, one observes a move from multiple terms used interchangeably to innovation according to an implicit definition, then to explicit definitions. In the voluminous literature produced by Ogburn, the most frequent terms are the combined one invention/discovery and technology. There is no use of the term innovation until it appears occasionally in both a paper from 1941 (Ogburn, 1941: 3, 14, 18) and the 1950 edition of *Social Change* (Ogburn, 1950: 378), and then in the title of a chapter (plus p. 710) from the fourth edition of *Sociology* (Ogburn and Nimkoff, 1964). Similarly, Gilfillan made no use of the term, but twice (Gilfillan, 1935: 59; 1937: 20). In the meantime, however, the term began to appear among other sociologists, at first concurrently with other terms, like technological change (Stern, 1927, 1937; Chapin, 1928; Davis, 1940). Then one finds more widespread use of the term (Hart, 1931; Nimkoff, 1957), and entire theories devoted to innovation (Rogers, 1962).

Innovation, in the hands of Ogburn and his contemporaries, meant many things. One was simply novelty (Kallen, 1930). In this sense, the use of the term is rare, and is without real consequences for sociological theories. A second meaning is social change (Stern, 1927), and this meaning includes more than technological invention, that is, **social invention** as repeatedly suggested by Ogburn and some others (Bernard, 1923; Chapin, 1928: chapter 11; Weeks, 1932), or *social experiments* (Chapin, 1917).³⁴ However, with time, Ogburn and others sociologists focused more on technological invention, although two authors on scientific innovation deserves mention (Ben-David, 1960a; 1960b; 1964: 470-76; 1966; Mulkay, 1969; 1972a; 1972b; 1975; Mulkay and Turner, 1971).³⁵ A third meaning is the use of (technological) inventions – and their social effects (Stern, 1937). For example, to sociologists an innovator is not one who invents but adopts an invention for the first time. This gave rise to studies on diffusion and to

³⁴ See also the (short-lived) literature on “technicways” (Odum, 1937; Davis, 1940). On organizational innovation, see below.

³⁵ To a certain extent, studies on scientific growth (development and diffusion) are concerned with innovation. For example, see Crane, 1972.

a whole literature, often of a quantitative nature, with geometrical laws of diffusion (Chapin, 1928). This meaning of innovation as technological **invention used and adopted** is the common sociological understanding of innovation, although a fourth meaning would soon be used as well, following the economists' definition (see below): technological invention as commercialized by industry (Jewkes et al. 1958).

Despite this understanding, explicit definitions of innovation are rare among sociologists. The early few definitions that exist differ considerably. Certainly, they all refer to the idea of novelty, but they differ in the sense that some include the act itself (combination), others the impacts of innovation, still others the subjective perception of it:

- Hart (1931): making new working adjustments (combination) among material and socio-psychological culture
- Ogburn (1941): inventions that have served to transform the environment profoundly
- Rogers (1962): an idea, procedure or object perceived as new by its adopter

What characterizes the sociological literature is that innovation is described as an activity and as a process where both the production of an invention and its use are discussed rather than contrasted (Nimkoff, 1957). Invention and imitation (as adoption or diffusion) are steps in a linear sequence (Table 1).

Innovation as process is also how economists understand the category. However, economists add their own stamp to the idea: innovation is the commercialization of (technological) invention. And unlike the definitions of sociologists, this definition came with time to be accepted among economists, and by others, including the sociologists.

Table 1.
Sociologists' Sequences of Innovation

Tarde (1890)	Invention, imitation, opposition
Ogburn (1920)	Invention (and diffusion), maladjustment (lag)/adjustment
Bernard (1923)	Formula, blue print, machine ³⁶
Chapin (1928)	Invention, accumulation, selection, diffusion
Ogburn and Gilfillan (1933)	Idea, trial device (model or plan), demonstration, regular use, adoption
Gilfillan (1935)	Idea; sketch; drawing; model; full-size experimental invention; commercial practice
Gilfillan (1937)	Thought, model (patent), first practical use, commercial success, important use
US National Resources Committee (1937)	Beginnings, development, diffusion, social influences
Ogburn and Nimkoff (1940)	Idea, development, model, invention, improvement, marketing
Ogburn (1941)	Idea, plan, tangible form, improvement, production, promotion, marketing, sales
Ogburn (1950)	Invention, accumulation, diffusion, adjustment
Rogers (1962)	Innovation , diffusion, adoption ³⁷
Rogers (1983)	Needs/problems, research, development, commercialization, diffusion and adoption, consequences

The study of change is not the traditional concern of economics. Historically, economics is concerned with equilibrium rather than dynamics (Veblen, 1898; Weintraub, 1991). Although the concepts of work (labour), production and growth held central place in early economic theories, the study of economic change is not a fundamental concept in economics, as culture change is in anthropology or as social change is in sociology. Change really got into economics with the study of technology as a cause of economic growth. Karl Marx was a forerunner here (Sweezy, 1968; Rosenberg, 1976a). To Marx, changes in techniques of production gave rise to modern industry. Machines gave

³⁶ For social invention, the stages are: theory, rules, organizations and institutions.

³⁷ Adoption itself is composed of steps, or stages, as first suggested and popularized by Beal and Bohlen (1955): awareness, interest, evaluation, trial, adoption.

rise to 1) the capital-goods sector, and to 2) increases in productivity in other sectors of the economy. Machines were also a major factor in social change, through crisis, then through revolution.

However, it is to mainstream economists that we owe the first interest in technological innovation, then called **technological change**, as the use of technological inventions in industrial processes. This literature is often minimized and contrasted to the later literature from evolutionary economists. However, from a genealogical point of view, this literature was a first step toward the study of technological innovation in economics. It was here that (some) interest in technology began among economists.

Increased interest in technological change can be traced back to the years following the Great Depression, when the bicentennial debate on the role of mechanization on employment reemerged. The issue of technological unemployment gave rise to a series of theoretical classifications of technologies (as to whether they are labour-saving, capital-saving or neutral) as part of larger discussions on economic theory (Pigou, 1924: 629-638; Hicks, 1932: 121-125; Robinson, 1938). The theoretical discussions of the time were very brief (with the exception of Cambridge economist J. Robinson), until resurrected in the 1960s under the name “induced innovation”. In fact, the literature on induced innovation is probably the first to make extensive use of the term innovation in economics. In the meantime, the study of technology developed in the 1930s via the measurement of productivity: increases in productivity as an indicator of technology usage. Many quantitative studies were published by the US National Bureau of Economic Research (F.C. Mills, H. Jerome) and public organizations like the US Bureau of Labor Statistics and the US Work Projects Administration. Subsequently, formalization of the measurement developed through what was called the production function.

The production function is an equation suggested in the late 1920s that links the quantity produced of a good (output) to quantities of inputs (Cobb and Douglas, 1928; Douglas, 1948). There are at any given time, or so argue economists, inputs (labour, capital) available to the firm, and a large variety of techniques by which these inputs can be combined to yield the desired optimal output. The production function came to be interpreted as representing technological change, a precursor term to technological innovation in economics. Economists interpreted movements in the curve of the production function as technological change (the substitution of capital for labour), while others equated labour productivity with technology (technological change is likely to result, all other things being equal, in increased labour productivity), paving the way for R. Solow's influential paper which equated the residual in the production function with technology (Solow, 1957). Then economists started correlating R&D with productivity measures. Beginning in the late 1950s, a whole literature developed, analyzing the contribution of research to industrial development, and to performance, productivity and economic growth, first from mainstream economists.

The term technological change, already used by sociologist B. J. Stern in 1937, was popularized by economic historian W. R. Maclaurin from MIT in his pioneering program of research into the economics of technological change in the 1940s and 1950s (Godin, 2008). Before Maclaurin, the term technological change appeared sporadically in the economic literature, together with technological (or technical) progress or advancement, and meant the substitution of capital for labor as factors in industrial production. In the late 1930s, the US Works Projects Administration, as part of a project on Reemployment Opportunities and Recent Change in Industrial Techniques, started using the term technological change regularly to discuss changes in employment due to technology. Then in the early 1940s, Maclaurin gave the term a new meaning concerned with the development and commercialization of new products, rather than the use of technical processes

in production.³⁸ By the early 1950s, Maclaurin was using both the term technological change and technological innovation. This would characterize the literature for the coming decades.

It is through evolutionary economics, among them J.A. Schumpeter, that innovation really got into economics. To Schumpeter, capitalism is creative destruction: disturbance of existing structures, and unceasing novelty and change (Schumpeter, 1928; 1942; 1947). In his view, innovations are responsible for this phenomenon. Schumpeter identified five types of innovation (Schumpeter, 1912: 66) – in fact, this classification comes from D. Ricardo:³⁹ 1) introduction of a new good; 2) introduction of a new method of production; 3) opening of a new market; 4) conquest of a new source of supply of raw materials or half-manufactured goods; and 5) implementation of a new form of organization.

Part of the explanation for the use of the term innovation in the economic literature has to do with a reaction against historians and against the term invention. Following others, Schumpeter distinguished innovation from invention. To Schumpeter, “innovation is possible without anything we should identify as invention and invention does not necessarily induce innovation” (Schumpeter, 1939: 84). Invention is an act of intellectual creativity and “is without importance to economic analysis” (Schumpeter, 1939: 85), while innovation is an economic decision: a firm applying an invention or adopting an invention.⁴⁰ However, it took time for the category to gain acceptance. In the early 1960s, the category was still not widely accepted. To economist F. Machlup, “we shall do better without the word innovation” (Machlup, 1962: 179). To others, the term is in need of a more rigorous definition, because it “has come to mean all things to all men” (Ames, 1961: 371). J. Schmookler, after having defined innovation (Schmookler,

³⁸ Nevertheless, for many years most economists continued to focus on technological change as processes (used in production), rather than as products (for final consumption).

³⁹ On some of Schumpeter’s borrowing from the German and Austrian economic literature, see Streissler (1994) and Reinert (2002).

1966: 2), has never used the term but rather invention and technical change. In the 1970s, the skepticism continued: the “use of the term innovation is counterproductive”, claimed the authors of a survey conducted for the US National Science Foundation, because each individual has his or her interpretation (Roberts and Romine, 1974: 4).⁴¹ For many years, the terms used in the economic literature were rather invention, technological change (and its variants: technical advance and technical progress) and sometimes automation.

Schumpeter is usually credited in the economic literature, particularly by evolutionary economists, as being the first theorist on **technological innovation**. This deserves qualifications. Certainly, Schumpeter did develop influential ideas on technological innovation as a source of business cycles, for example. However, Schumpeter did follow the literature on technological change and the production function for defining technological innovation as new combinations of means of production: innovation as change in the factors of production (input) to produce products (output) (Schumpeter, 1939: 87s; Lange, 1943). Second, as Maclaurin (1953) has stated, Schumpeter never developed a theory of technological innovation. To Schumpeter, the entrepreneur (and, in a next stage, the large firm) is responsible for technological innovation. But how?

It is really the economic historian Maclaurin, as the very first economic theorist on technological innovation, who launched the economic study of industrial research and the commercialization of technological inventions (Godin, 2008). Studying technological change in its economic dimensions was the task to which Maclaurin devoted himself entirely from the early 1940s onward. To Maclaurin, the study of technological change is concerned with factors responsible for the rate of technological development in industry, and for conditions that are more conducive to technological progress. From historical analyses of how the process

⁴⁰ Ten years earlier, the British economist and civil servant Josiah Stamp made a similar distinction (Stamp, 1929; 1934). For the distinction among German and Austrian economists prior to Schumpeter, like A.F. Riedel, see Streissler (1994).

of technological change takes place, Maclaurin broke down this process into distinct and sequential steps, from fundamental research to production engineering, and then to diffusion.

Over time, authors from business schools and economists developed theories or conceptual models of technological innovation as a process from invention to diffusion, similar to those of the sociologists (Table 2). ⁴² In these theories, technological innovation was defined as a step (the ultimate step) of a process starting with invention – and defined as **commercialized innovation**. The formal definition of this comes from Maclaurin, originally as the first commercialization of a new or improved product or process (Maclaurin, 1953: 105) – then as the whole process, from invention to commercialization to diffusion. From the 1950s, scholars in technological innovation studies, first among them Carter and Williams (1957; 1958; 1959), then “evolutionary” economists (Freeman, 1971; 1974; SPRU, 1972; Nelson and Winter, 1982) developed these ideas further.

In referring to diffusion, the term imitation continued to be used until the 1980s in the economic literature among its most serious students (Brozen, 1951; Mansfield, 1961; Posner, 1961; Schmookler, 1966; Rosenberg, 1976b; Mansfield et al., 1981; Nelson and Winter, 1982), while the term was no longer used by sociologists after Tarde, who turned to the term diffusion. However, to many economists, imitation or diffusion had a low status in the study of technological innovation. Then interest in diffusion (as opposed to invention) reached economists from the 1980s onward. A series of studies appeared suggesting that diffusion was as important to economic progress as invention itself, if not more so.

⁴¹ The same diversity of opinions characterizes the responses to current surveys of innovation from national statistical bureaus.

⁴² The steps in the theories of Table 2 vary from psychological steps to organizational steps (development of new products) to economic steps (production and diffusion).

Table 2.
Management and Economists' Sequences
of Technological Innovation⁴³

Mees (1920)	Pure science, development, manufacturing
Epstein (1926)	Idea, sketch, drawing, test, use
Holland (1928)	Pure science research, applied research, invention, industrial research [development], industrial application, standardization, mass production
Usher (1929)	Elaboration of the concept, primary synthesis, critical revision ⁴⁴
Jewett (1932)	Plan (design), control (tests), preliminary small-scale operation, tool-made model, large scale production
Stevens (1941)	Fundamental research, applied research, test-tube or bench research, pilot plant, production (improvement, trouble-shooting, technical control of process and quality)
Bichowsky (1942)	Research, engineering (or development), factory (or production)
Maclaurin (1947)	Fundamental research, applied research, engineering development, production engineering, service engineering ⁴⁵
Furnas (1948)	Exploratory and fundamental research, applied research, development, production
Mees and Leermakers (1950)	Research, development (establishment of small-scale use, pilot plant and models), adoption in manufacturing
Brozen (1951a)	Invention, innovation , imitation
Brozen (1951b)	Research, engineering development, production, service
Maclaurin (1953)	Pure science, invention, innovation , finance, acceptance
Usher (1954, 1955)	Perception of an unsatisfied need, setting of the stage, primary act of insight, critical revision and development
Carter and Williams (1957)	Basic research, applied research, pilot plant, development, production
Enos (1958)	Invention, development, application
Ruttan (1959)	Invention, innovation , technological change
Ames (1961)	Research, invention, development, innovation
Enos (1962)	Invention, securing financial backing, establishing an organization, finding a plant, hiring workers, opening markets, production and distribution
Machlup (1962)	Basic research, inventive work, development, plant construction
Scherer (1965)	Invention, entrepreneurship, investment, development
Schmookler (1966)	Research, development, invention
Mansfield (1968; 1971)	Invention, innovation , diffusion
Myers and Marquis (1969)	Problem solving, solution, utilization, diffusion
Rothwell and Robertson (1973)	Idea generation, project definition, problem solving, design and development, production, marketing
Utterback (1974)	Generation of an idea, problem-solving or development, implementation and diffusion

⁴³ Mees, Holland, Jewett and Stevens are “industrialists” (managers or consultants). They appear in the list because of their “innovativeness” and/or influence on business schools and economists.

⁴⁴ This was only one of Usher’s descriptions of the process. Others are: 1) technologies, consequences, adaptation; 2) discoveries and inventions, synthesis (concept, device), construction (design); 3) problem, setting of the stage, achievement (configuration).

⁴⁵ The last term was added in 1949 (Maclaurin, 1949).

Theories combining both production (of goods) and distribution have a long history in economic thought, from Quesnay's *tableau économique* to A. Smith, D. Ricardo and K. Marx, then the System of National Accounts. From the 1940s, such theories were applied to technological innovation. The most popular and influential is what came to be called the “linear model of innovation” (Godin, 2006c). The theory suggests that technological innovation starts with basic research, then goes through applied research, then development, and then production and diffusion. Such an understanding of technological innovation has been very influential on science policy after 1945.

While innovation as technological innovation and as commercialized innovation came to dominate the literature, other conceptions of innovation developed elsewhere. The category of social innovation (or rather social invention) as such had few followers but, beginning in the 1920s, researchers have studied (institutional or) **political innovation**: innovation in public institutions such as schools (with P. Mort from Columbia University as the most active researcher) and government agencies (Chapin, 1928: chapter 11; McVoy, 1940; Walker, 1969; Mohr, 1969).⁴⁶ Up to then, most innovation studies have concentrated on individuals. Then, management and business schools have developed the study of **organizational innovation**. First, and following Schumpeter, entrepreneurial change in firms became a topic of study for which programs of research developed, for example that of A. H. Cole's Research Center in Entrepreneurial History (1948-58) at Harvard University (Cole, 1959; Aitken, 1965). Second, the study of innovative behaviours of organizations developed, such as organizational structure and management style, mainly following T. Burns and G. M. Stalker – the latter a psychologist – (Burns and Stalker, 1961; Hage and M. Aiken, 1970; Zaltman et al., 1973; Wilson, 1966).

Third, the management of research activities, which has been a concern for industrialists and managers since after World War I (Mees, 1920), gained

⁴⁶ For a survey of early works, see Savage (1985).

increased attention because they contribute to firms' performance (productivity, profits, market share). In this context, (technological) innovation came to be understood as *efficiency*: value for money, or the output coming from investments in R&D. Scientific and technological *productivity*, or the volume of discoveries and inventions coming from R&D laboratories, became a subject of study in its own right. Psychologists were among the firsts to get into this kind of study (Pelz and Andrew, 1966; Myers and Marquis, 1969). However, it is to the management of technology (previously called the management of scientific research), together with accounting (Anthony and Day, 1952) and research evaluation (Rubenstein, 1957; Quinn, 1959; 1960; Hodge, 1963; Horowitz, 1963; Yovits et al., 1966; Lipetz, 1965; Seiler, 1965; Dean, 1968), that we owe the study of innovation as efficiency. Researchers began looking at the organizational climate and conditions most conducive to scientific and technological productivity, and at the incentives required to encourage **creativity**. Creativity and productivity became one. In fact, in the 1960s creativity, a concept of psychological origins, had become a buzzword, and came to be applied to many facets of industrial research (Steiner, 1965).⁴⁷

⁴⁷ Very rarely have psychologists made use of innovation as a category, except in studies of organizations (West and Rickards, 1999). They preferred creativity. A genealogy of the concept of creativity would have to look at genius, then talent (or ability), then intelligence, then creativity. In fact, the very early studies on imagination from the Middle Ages to the Enlightenment were psychological in kind. However, it was only in the mid-twentieth century that psychologists themselves started studying creativity (Guilford, 1950). The word creativity itself emerged at about this time, although create and creation had existed for centuries, as the literature on poetry and art attests (Tatarkiewicz, 1980; Kristeller, 1983), and creativeness emerged in 1820. To the psychologists, "eminent men", artists, inventors and scientists, were perfect representatives of creative individuals or geniuses. Creativity was defined here by way of measurement: measuring the attitudes of individuals and performances to test scores, but also, increasingly, counting the volume of output produced, or productivity. Beginning with a study published under a pseudonym in the *American Journal of Psychology* in 1928, the period in which an individual is more productive (the "creative years" as it was called) became a serious topic of discussion (Nelson, 1928). The most active psychologists here were A. Roe, C. W. Taylor, M. I. Stein, H. C. Lehman and W. Dennis. Many of the studies focused on the study of creativity of personnel in organizations. A favorite study group was scientists and engineers. Creativity as productivity gave rise to a whole literature on the counting of scientific papers produced by scientists (Godin, 2006a). These studies were generally funded by government departments, for example the US Office of Naval Research, the Air Force, NASA, the US National Institute of Health, and by industries and their associations like the US Industrial Research Institute. Then, in the 1950s and subsequently, sociologists also got into the study of scientific productivity and its relationship to recognition and the reward system (B. N. Meltzer, D. Crane, H. Zuckerman and R. K. Merton, S. Cole and J. S. Cole, P. D. Allison, J. S. Long, J. S. Scott). Let us add that the first "psychological"

What role did policy play in all this? A major one, indeed. Over the twentieth century, innovation was in fact a *policy-driven* concept. Psychologists, sociologists and researchers from management, business schools and economics acted as consultants to governments, and were concerned with offering policy recommendations for “social engineering”, productivity and economic growth based on their theories, the more recent ones being conceptual frameworks like the knowledge-based economy, the information economy, the new economy, and national innovation system (Godin, 2009c). Over the last sixty years, economists, including “evolutionary” economists, have been the experts most solicited by governments. The first among the consulting experts and academic “think tanks” were researchers from the US National Bureau of Economic Research (NBER) (Alchon, 1985) and RAND (Hounshell, 2000),⁴⁸ then the Science Policy Research Unit (SPRU) at Sussex University, Brighton, UK, and the Policy Research in Engineering, Science and Technology (PREST) group at Manchester University, UK. In the 1990s, centers on innovation multiplied, such as the Fraunhofer ISI in Germany and the Maastricht Economic Research Institute on Innovation and Technology (MERIT) in the Netherlands.

Innovation is also a political concept in another sense. From its very beginning in the 1960s, science policy has been concerned with funding scientific research, with technological innovation as the expected *output* (Godin, 2007b). Over time, the terms used came to reflect this very first goal. What was called science policy in the 1960s became science and technology policy in the 1970s, then innovation policy in the 1990s (Lundvall and Borras, 2005; Branscomb and Keller, 1998: chapters 5 and 18). However, there has never been a “policy for science” period, as many authors argue (OECD, 1963: 18; 1972: 37; Elzinga and Jamison, 1995),

theories on technological inventors were from economic historian A. P. Usher (1929) and US patent examiner J. Rossman (1931). Rossman is also responsible for a very early survey of industrial incentives to invention (Rossman, 1935). Rossman’s book is also a good indicator of creativity as buzzword: by the third edition of his book (1964), first published in 1931, J. Rossman added *Industrial Creativity* to the previous title *The Psychology of the Inventor*.

only a “science for policy” one, during which public research and universities were urged to contribute to technological innovation (Godin, 2009d). ⁴⁹ Science policy has always been concerned with applying science to public goals. From its very beginning, science policy, whether implicit or explicit, was constructed as a means to achieve social, economic and political goals.

In this quest for technological innovation, statistics has been the best way to establish evidence. In the academic literature, technological innovation began to be measured via patents in the 1910s, culminating in the works of economist J. Schmookler in the 1950s (Schmookler, 1966). Then, it appeared to many that patent counts measure invention, not (commercialized) innovation. Then expenditures devoted to R&D came to be used as a proxy, thanks to the systematic data collected in the then recently-launched survey series from the US National Science Foundation. This practice then spread to other countries via the so-called OECD Frascati manual (Godin, 2005). R&D is not a bad proxy of technological innovation in reality, since two-thirds of R&D expenditures are devoted to the D (development of new technologies) (Godin, 2006b). Yet an official study concluded otherwise. In 1967, the US Department of Commerce published a study, known as the Charpie Report, which was the first governmental survey of technological innovation *per se* (US Department of Commerce, 1967). It showed that R&D does not constitute the main source of technological innovation. In light of the literature on technological innovation from the 1980s onward (Freeman, 1994), it appears that the study was correct. But at the time, it was criticized by economists and statisticians (Mansfield, 1971; Stead, 1976), among other things because of the definitions and categories used (Kamin et al, 1982) and because the numbers on which the study relied were “rule of thumb figures”, so qualified by the authors of the study themselves. Nevertheless, the

⁴⁸ On an early publication on innovation from these two think tanks, see US National Bureau of Economic Research (1962).

⁴⁹ The literature on science policy often contrasts two periods. The first period – policy for science – was concerned with funding science for its own sake, the golden age of university funding according to many researchers, while the second period – science for policy – in which we now live, is one where research is supported mainly to achieve political and socioeconomic goals

report was quite influential. It contributed to conventionalizing a definition of innovation as technological innovation and as a process leading to commercialized innovation. More than twenty years later, the OECD published the first edition of a methodological manual for measuring innovation, known as the Oslo Manual (OECD, 1991), which used essentially the same definition as that in the Charpie Report. The manual, now in its third edition, serves national statisticians in surveying firms and their innovation activities in a standardized manner.

Conclusion

In its history, innovation has been broadly conceived and defined. Innovation concerns any kind of novelty: artistic, scientific, technological, organizational, cultural, social or individual. As the American anthropologist O. T. Mason put it in 1895, “invention is finding out originally how to perform any specific action by some new implement, or improvement, or substance, or method (...). Every change in human activity, made designedly and systematically, appears to be an invention” (Mason, 1895: 13-14). To Mason, invention “consists in things and institutions, mental acts involved, rewards and benefits, powers and material of nature invoked” (Mason, 1895: 7; 15). It includes “not only things, but languages, institutions, aesthetic arts, philosophies, creeds, and cults” (Mason, 1895: 410).

Innovation, broadly defined, has given rise to many theories and has been recognized as a key characteristic of the artist (S.T. Coleridge), the inventor (A. P. Usher), the scientist (J.-B. David; M.J. Mulkay),⁵⁰ the entrepreneur and the firm (J.A. Schumpeter). Innovation has also to a certain extent been recognized as a key characteristic of the individual – in psychology, if not in philosophy and sociology. Some biologists even attribute innovation to animals (Reader and

⁵⁰ On a series of early papers on innovation in science covering many disciplines, see the special issue of *Scientific American* (1958).

Laland, 2003), as H. Bergon attributed it to nature in *L'Évolution créatrice*, published one hundred years ago (1907).

Historical Conceptions of Innovation

- | | |
|--------------------|--|
| 1. Imitation | 8. Organizational Change ⁵¹ |
| 2. Invention | 9. Political Innovation |
| 3. Discovery | 10. Creativity |
| 4. Imagination | 11. Technological Change |
| 5. Ingenuity | 12. Technological Innovation |
| 6. Cultural Change | 13. Commercialized Innovation |
| 7. Social Change | |

Over this same history, innovation came to be defined as **useful** innovation. According to the sociologist, when used and adopted, an invention becomes an innovation; to the economist, invention is innovation when commercialized. Here, the focus of both sociologists' and economists' theories was technological innovation. In the collective imaginary, in public representations, in policy, and in social studies, innovation came spontaneously to be identified with technological innovation. As sociologist E.M. Rogers put it: "the adoption of a new idea almost always entails the sale of a new product" (Rogers, 1962: 261). Many factors contributed to this shift: the political and economic context, the industrial and consumer revolutions, the impacts of technologies on individuals and societies, technology as a source of economic growth and productivity and, above all, the institutionalization of technological invention via patent laws, and industrial development through R&D laboratories. To many, innovation thus became an industrial and economic affair. The innovation surveys conducted by

⁵¹ And organizational innovation.

governments, of which the OECD Oslo Manual is the emblem, are witness to this orientation: the measurement of innovation concerns innovation in firms only.

One observes a dialectics here between reality and language. With the changes in the world came changes in ideas and categories. For example, the material culture contributed to the rise of innovation as a central category and to a representation of innovation as technological and commercialized invention. In turn, categories, as part of representations, discourses, laws and policies, theories and statistics make events visible, bring to light novelties and changes in the world, and contribute to these changes. To paraphrase D.A. Schon, innovation came to be seen as the instrument of growth, and growth as the occasion for and object of innovation (Schon, 1967: 54).

Innovation as a (widely-used) category during the twentieth century is witness to a certain context or era - capitalism - and to changes in political values. As J. Farr put it, "to understand conceptual change is in large part to understand political changes" (Farr, 1989: 25). Until early in the twentieth century, invention, ingenuity and imagination were discussed as symbols of civilization and as attributes of geniuses, and their contribution to the progress of the race. Then, the growing role of organizations in the twentieth century led to changes in values. If there was to be increasing economic efficiency, there had to be innovation - through organizations and the mobilization of their employees' creative abilities.

⁵² Such were the discourses of managers as well as policy-makers. Theorists from many disciplines started studying innovation in terms of the effects of technological innovation on the economy and society. To sociologists, gone was the lonely inventor as a hero or genius. It was a myth created by past authors. Innovation is rather a social process. To economists, gone was invention without market value. It is a subject for the historian. To the policy-maker, gone was (or should be) research with no application. The golden age between the state and the funding of the basic scientist, although short-lived, is finished. Innovation as a

⁵² For a similar shift in context and its impact on statistics on science, see Godin (2007a).

category in the twentieth century expresses precisely these political changes: a demarcation with past understandings, values and practices. The category's previous meanings or predecessors (invention, ingenuity, imagination, etc.) came to be subsumed under "innovation", and the creative abilities of an individual placed in the service of organizations, industrial development and economic growth.

Innovation is the last of a series of terms imagined to give meaning to modern practices. Certainly, innovation is, to a certain extent, continuity with the past, in the sense that more often than not it refers to technological invention. However, it is also a break with the past: invention *per se* is not enough (Levitt, 1963). In fact, many ideas and inventions fail, according to the history of technology. There has to be use of the invention, namely innovation, in order for benefits to accrue. This is the first aspect of the break. Another concerns the production of invention. While it was the individual, or genius, who was the source of invention in previous representations, innovation places emphasis on the firm. And there is a third aspect of the break: benefits deriving from invention concern economics, not culture or civilization.

There are now many people trying to broaden the understanding of innovation as technological innovation. One now hears discourses on "social innovation", meaning either major advances in the social sciences (Deutsch et al., 1971; 1986), policy/institutional reforms for the betterment of society (Gabor, 1970), or solutions to social needs and problems, coming from the community sectors among others (Goldenberg, 2004; Mulgan, 2007; Mulgan et al., 2007). ⁵³ Calls for do-it-yourself innovation, user-led innovation, open innovation and "democratizing innovation" are in the same vein: technological innovation comes from many sources, not only the research laboratory, but also users (Chesbrough,

⁵³ Recently, R. R. Nelson has re-labeled "institutions" as "social technologies" (Nelson, 2008; Nelson and Sampat, 2001). Nelson's "rhetorical move" is motivated (to my mind) by his insistence on trying to persuade economists to better integrate the role of institutions in economic theories. The term "technology" may convince economists more than "institution" does. In the

2003; Hippel, 2005; Flowers, 2008). One also hears discourses on the “creative class”, which includes the “bohemians” such as artists and designers (Florida, 2002), and the “creative industries”, as a category in need of statistical, economic and policy recognition (Bakhshi et al., 2008).⁵⁴ The OECD Oslo Manual itself, in its latest edition, has broadened the definition of innovation to include organizational and marketing innovation, although this is limited to firms. However, projects are now in progress for measuring innovation in the public sectors in the near future.

The main goal of the promoters of these new ideas is ensuring that policy-makers takes account of non-technological aspects of innovation in their policy. Whether the ideas will have an impact on the current understanding of innovation remains to be seen. For the moment, they certainly contribute to extending the discourses on, and the fascination with, innovation to more spheres of society, and mobilizing more people in the name of innovation.

1970s, S. Kuznets already was using “social technology” and “social innovation” in this sense (Kuznets, 1978).

⁵⁴ On a recent tentative to introduce the term innovation in the field of fine arts, see Oakley et al (2008).

Appendix.
The Vocabulary of Innovation

(ACT)	(SOURCE)	(EFFECTS)
Imitation	Inspiration	Culture
Invention	Ingenuity	Civilization
Discovery	Curiosity	Evolution
Experiment/Investigation	Imagination	Modernity/Progress
Initiative	Reason (logic)	Advancement
<i>Praxis</i> /action		Improvement
Change	Associated terms: originality, freedom, expression, will, choice opinion	Development Revolution Novelty
Creation/Creativity		
Production (tive)		
Novation/Innovation		

The following concerns TECHNOLOGICAL INNOVATION

Art/craft	Craftsman	Useful
Artificial	Artisan	Practical
Project	Maker	Improvement
Mechanics	Architect	Growth/Productivity
Machine/Machinery	Projector	Performance
Tool/Instrument/ Device/Engine	Undertaker	Competitiveness
Technique	Technician	Leadership
Technology	Engineer	Benefits
Automation/Mechanization	Entrepreneur	Gain
Capital/Equipment	Business/Industrious	Output
Constructing/Manufacturing	Merchant	Efficiency/ Effectiveness
Product/Process	Laboratories	Power/safety/ Comfort
Methods		Prosperity
Fabricating (<i>fabrica</i>)/Making		Well-being/ Wealth
Applications		Returns
		Employment
		Savings
		Standards (or conditions) of living
		Leisure

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