"Innovation Studies":
The Invention of a Specialty (Part II)

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"Innovation Studies": the Invention of a Specialty

The study of technological innovation is over one hundred year old (anthropology, history, sociology, management, policy and economics). However, over the last twenty years or so, "innovation studies" has become a label used by many to name research concerned specifically with the economics, policy and management of technological innovation. What are the origins of this specialty? There is no linear history, but two completely different traditions. Part I was concerned with the American tradition on 'technological change' while Part II (this paper) concentrates on the European tradition ('innovation studies').

Abstract

Innovation has become a very popular category over the twentieth century. However, few have stopped to study the origins of the category and to critically examine the studies produced on innovation. This paper conducts such an analysis on one type of innovation, namely technological innovation.

The study of technological innovation is over one hundred years old. From the early 1900s onward, anthropologists, sociologists historians, and economists began theorizing about technological innovation, each from his own respective disciplinary framework. However, in the last forty years an economic and "dominant" understanding of technological innovation has developed: technological innovation defined as commercialized invention. This paper documents the origins of this representation of innvoation and the tradition of research to which it gave rise: "innovation studies". More specifically, it analyzes what distinguishes this tradition from that concerned with technological change as the use of inventions in industrial production, and looks at why such a tradition originated in Europe.

> Innovation is far too important to be left to scientists and technologists. It is also far too important to be left to economists or social scientists (Freeman, 1974: 309).

"Innovation Studies":
The Invention of a Specialty (Part II) [1]

Introduction

In 1974, British economist Christopher Freeman reported that few economists "have stopped to examine" technological innovation (Freeman, 1974: 16). This is a much repeated statement in the literature on technological innovation. Economists would have come late to the study of technological innovation. But late compared to when and to whom? From a long-term perspective, the statement deserves qualification. Whether one looks at A. Smith, John Rae or William Stanley Jevons, economic writings on invention and the use of machines in production, although often short, did in fact exist (Macleod, 2008), and 'art' as a production factor was discussed among the mercantilists early on (Johnson, 1930). Furthermore, at the time of Freeman's writing, the systematic study of technological innovation existed for many decades among economists. Leaving aside economic historians like A. P. Usher and W. Rupert Maclaurin, there was an economic tradition named technological change, as a precursor to the term technological innovation.

The economic tradition regarding technological change is concerned with innovation as technological invention used (introduced) in the industrial production process (Godin, 2010a). It is not concerned with the origins of technological innovations. It is not alone. The tradition simply follows the sociologists and others, who focus on the use (adoption) of inventions, whatever their origin. At the time, among economists, only economic historians like Maclaurin and his colleagues at MIT got into the so-called "black box", but Maclaurin soon got forgotten, although his ideas have remained influential for decades, in obliterated form (Godin, 2008).

[1] A first draft of this paper was presented at several places in the last two years: 'The Rhetoric of Innovation in Contemporary Society', University of Helsinki, 7-8 February 2010; Freeman Center Seminar Series, University of Sussex, Brighton, 22 October 2010; 'EXPLORE Workshop', Lund, 7-8 December 2010.

The tradition on technological change is of American origins. It emerged in the 1930s; it was quite productive (number of papers) in the following decades, and it remains alive and well today. The economists involved in this tradition are mostly if not entirely 'mainstream' economists. The tradition is fundamentally quantitative. It uses the existing framework of neo-classical economics, its theory and method – above all econometrics and the 'production function' – to study technological innovation. The issues are those of established economic theory: factors of production, market structure, economies of scale, etc. There is no real interest in developing a distinctive and comprehensive theory of technological innovation.

At the opposite end of the spectrum, a second tradition developed starting in the early 1970s. It is concerned with innovation as the commercialization of technological inventions. Here lies Freeman's point and originality. He was in fact inventing a second tradition, different from the first. Some Americans paved the way, as discussed below, but the tradition owes its origins mainly to Europeans, among them Chris Freeman. Unlike the first tradition, this tradition did not benefit from (or insert itself into) a then-well-developed conceptual framework. Instead it developed its own. At least four characteristics define this European tradition, as contrasted with the American one. First, it is descriptive rather than econometrical, and "institutional" in focus. Second, it studies product innovation as well as, if not more than, process innovation. Third, it has a major concern with policy issues. Fourth, one of its tasks has been to develop a theory of technological innovation.

Recently, papers have appeared that map the field of technological innovation studies (often called "innovation studies"), its founders, its basic ideas and its contemporary authors. In general, these stories are linear: from Schumpeter as 'father' (ancestor) of technological innovation studies to today's field. This paper suggests rather that an examination and history of the field of technological innovation studies should take into consideration the existence of two specialities (which have become traditions), each with its own community of researchers and with a different agenda. A (brief) history on the

origins of the first tradition, that of American origin, has been conducted in a previous paper (Godin, 2010a). There, I showed how interest in *invention* among economists gave way to interest in *technological change*. The next step occurred with the study of *technological innovation*, the focus of this paper.

This paper is a study on the European tradition as an invention or "original" construction and examines why it emerged in Europe. Given the "breath" of this tradition, as Richard Nelson put it to me, the paper is restricted to a limited aspect of the tradition: the representation of innovation and its source. For over 2,500 years, innovation has been understood as the "introduction of change" in individual behaviors, social practices and groups or organizations' activities (Godin, 2012b). However, from the 1970s it came to be restricted to technology and commercialization in the school or tradition studied here, a representation which became hegemonic in the following decades.

I use Chris Freeman as a case-study. In this paper, I study him as the 'founder' (or one of the builders) of the second tradition. I examine his 1974 book *The Economics of Industrial Innovation*, and the additions made to it in the second edition (1982). The latter has remained a much cited work ever since its publication. In it, Freeman invented a new tradition based on a new representation of innovation, and for years many students returned to this book to study the field and the ideas involved.

Freeman's Representation of Innovation

To Freeman, technological innovation is "an essential condition of economic progress and a critical element in the competitive struggle of enterprises and of nation-states". It is also important for improving the quality of life (Freeman, 1974: 15). Given the centrality of technological innovation to modern society, Freeman's purpose in *The Economics of Industrial Innovation* is the study of the "system" behind the phenomenon, namely "the professionalized industrial R&D [research and development] system". He identifies three characteristics of this system over time: its growing complexity, the increased scale of

processes, and the specialization of research work (Freeman, 1974: 25, 33). [2] To Freeman, research is conducted in professional specialized laboratories, as opposed to the past when research was unorganized and much more a trial-and-error affair. This is a familiar description, suggested by industrialists and historians since the beginning of the twentieth century. However, these people spoke of the institutionalization of research, not its professionalization as Freeman did. As a matter of fact, professionalization refers to the social process by which an occupation transforms itself into a body, group or association with qualifications and identity credentials (like diplomas, journals and grants, in the case of scientists). This is not what Freeman was interested in, despite his use of the term. Freeman was rather interested in institutionalization: when and how research and scientists got into organizations, in the present case industries.

Be that as it may, to Freeman the twentieth century is the growth period of the "research-intensive sector" and saw the rise of a "research-intensive economy": "the balance has gradually shifted towards a more research-intensive economy, and a higher rate of technical change. It is the contention of this book that this is one of the most important changes in twentieth-century industry" (Freeman, 1974: 277). To the increase in scale and "professionalization", Freeman adds the idea that technology relies increasingly on science, giving rise to what Freeman called "science-related technologies". Together, these three characteristics of the R&D system strongly suggest the need to "monitor and control the direction and pace of technical change" (Freeman, 1974: 31).

To Freeman, the monitoring and controlling of technology "depends upon understanding, and an important part of this understanding relates to economic aspects of the process, such as costs, return on investment, market structure, rate of growth and distribution of possible benefits" (Freeman, 1974: 32). Freeman deplores the "elementary state of our present knowledge" (Freeman, 1974: 32). To Freeman, invention and innovation are "outside the framework of economic models, or more strictly, exogenous variables". It

[2] In 1982, the three characteristics were presented as follows: the scientific character of technology, its complexity, and the division of labour (specialized laboratory).

remains a residual (Freeman, 1974: 17), a black-box (Freeman, 1974: 27). Freeman's objective is to open the black box and look at the technological innovation "process".

What is innovation? In a footnote, Freeman brings in the following definitions: "Technical innovation or simply innovation is used to describe the introduction and spread of new and improved products and processes in the economy and technological innovation to describe advances in knowledge" (Freeman, 1974: 18). However, the book is fundamentally concerned with following a definition of innovation as distinct from invention, a distinction which Freeman attributes to Schumpeter and states as follows: "An *invention* is an idea, a sketch or a model for a new or improved device, product, process or system (...). An *innovation* in the economic sense is accomplished only with the first commercial transaction" (Freeman, 1974: 22). This is an important distinction to which I return below.

Having offered a rationale (the importance of technological innovation for society, and the poor state of knowledge we have on the phenomenon) and a definition of innovation (as commercialized technological invention), Freeman conducts his analysis in three steps (parts). Part I of the book looks at "science-related technologies" based on a "historical approach" designed to illustrate the three basic aspects of the R&D system: growing complexity, increased scale of processes, and specialization of research work. It documents the rise of "new research-based industries" (also called "research-intensive industries" in chapters 7 and 8) in chemicals (including oil refining), nuclear energy, synthetic materials and electronics (radio, television, radar, computers and electronic components). "It is the contention of this book that the[se] industries (…) represent the most important trends of technical change" (Freeman, 1974: 37). Freeman admits that readers may wish to skip this historical part, but they should do so at their own peril (Freeman, 1974: 33).

Having studied the professionalization of the R&D process in Part I, Freeman next turns to how it has changed the behaviour of firms. Part II offers empirical evidence designed to "support or refute" theories of technological innovation in relation to firms. Freeman

looks at factors which lead to success and failure in technological innovation, the size of firms most conductive to technological innovation, the difficulties of decision-making given the inherent uncertainty and risk of technological innovation, and the strategies available to firms for coping with this uncertainty. Here, he offers the rudiments of an 'evolutionary' alternative to neo-classical economics: firms do not maximize and are not rational optimizers, but rather adapt continuously to changes in the environment (technical change and market competition).

Part III concentrates on government and policies. Freeman discusses public funding of R&D and changing priorities. He compares research expenditures of a "military-industrial complex" type and big science since World War II to emerging demands and values on technological innovations more oriented toward consumers' needs. He suggests that "a more explicit policy for science and technical innovation is increasingly necessary" (Freeman, 1974: 31) for "assisting firms" and for technological innovation of a more social nature, rather than an implicit policy, or worse, "*laissez-innover*".

A Construction

Every theory or theoretical essay is a construction in many senses. Sociology generally focuses on the determinants (individual and social) that are necessarily involved a scientist's invention or innovation. In this paper, I look rather at construction in the sense of creative imagination: combining existing ideas (or things) to produce new ones, as the early psychology of imagination suggested, as many still define innovation today and as Freeman does (Freeman, 1974: 167-69; 253). Freeman used previous knowledge of many different sources and scope (combination), to which he added a new perspective (novelty), using certain sources – and ignoring others – to ground his ideas (legitimization):

- Combinations: selecting previous and existing knowledge.
- New perspectives: bringing forth new ideas and a new conceptual framework.

- Legitimizations: rationalizing and giving identity to the tradition with reference to key authors.

Freeman's book is a wonderful work of combination. Freeman made use of his own previous works at the British National Institute for Economic and Social Research (NIESR) and the Science Policy Research Unit (SPRU), sometimes verbatim, including his contractual works for international organizations like the OECD and UNESCO. He brings together the latest findings of the literature: almost everything new on the topic from economics and management studies. He discusses academic as well as government reports and surveys. And he uses different methods: history, surveys and statistics. Many of these borrowings he acknowledges from the very beginning of the book. What he does not and could not do was anticipate the outcome or impact of the combination in future years.

Freeman starts with what he calls "a historical approach". He may have got this approach from Schumpeter, to whom studies of a historical type are more appropriate than those of classical economics for the analysis of technological innovation. "What we really need", once stated Schumpeter, "we are more likely to find in general economic histories", above all "monographs on individual industries" (Schumpeter, 1939: 221). There were also some examples dealing with this approach from an influential conference held in 1960 at the University of Minnesota and sponsored by the US National Bureau of Economic Research (NBER, 1962).

Freeman's history is not an internal history of technology in the sense of A. P. Usher or L. Mumford. Neither is it the kind of history conducted by Maclaurin and his colleagues at MIT, who looked back at very early fundamental research as the ultimate source of technological innovation (Godin, 2008). According to Freeman himself, his historical outline is "very sketchy and is intended to give the background" to recent developments

(Freeman, 1974: 45). [3] It is history designed to give the reader a perspective on what comes next: the study of firms. It is contextual history designed to support a point of view, an economic point of view. According to Freeman, it is history "from the standpoint of the economist" where "attention is concentrated on costs, patents, size of firm, marketing and time lags" (Freeman, 1974: 39). Using the secondary literature, Freeman brings together findings on the development of several technologies: process innovations in chemicals, oil refineries and nuclear energy, synthetic materials and electronics. In part I, Freeman discusses, among other things, issues such as the role of the "inventor-entrepreneur" and the transition to the corporate R&D laboratory, the increasing dependence of technology on science, the role of government funding, the wide scope of applications of new technologies, the product-life cycle, the firm's optimum level of R&D funding (or "threshold" as he called it), and its measurement (the ratio of R&D to sales). Statistics on patents are used throughout the chapters as empirical evidence and as a measurement of "first commercial production" and diffusion (imitation lags). Comparisons between European and American firms also abound.

Part II combines four approaches to conceptualizing the technological innovation "process" in firms and generalizing the results of Part I. One is the theoretical and empirical discussions on factors of success in technological innovation, a task pioneered more than thirty years previously by W. Rupert Maclaurin in the United States ("technological change"), then C. F. Carter and B. R. Williams in England (industrial "application or use" of science and technology). In a study conducted for the Science and Industry Committee of the British Association for the Advancement of Science, the two writers looked at "technically progressive" firms and identified the characteristics that make them innovative (Carter and Williams, 1957). Similarly, Freeman studied the characteristics of successful (and unsuccessful) commercialization of invention and put to the test what he called the "one-sided" theories on the role of either technical knowledge or demand. He did so by making use of a then-recent SPRU study conducted between 1968 and 1971 that examined 58 technological innovations (the SAPPHO project). He

[3] Schumpeter had described his own history similarly, as "comments or sketches" aimed at presenting "mere illustrations and indications" (Schumpeter, 1939: 222). The first to discuss the study of "invention" as best realized through case studies rather than statistics was sociologist S.C. Gilfillan (1935).

concluded that supply and demand complement each other. Second, Freeman got into the debate on what was then called the "Schumpeterian hypothesis" on firm size: whether the small or the large firm is most responsible for technological innovation. Using OECD and US National Science Foundation data and a study he conducted for the Bolton committee on 700 firms and 1,100 technological innovations, Freeman concluded that small firms have a comparative advantage in the early stages of invention and in radical inventions, while large firms tend to predominate in the later stages and in scaling up.

The third kind of work on which Freeman's study of firms builds is management and evaluation. He discusses the uncertainty and risk of technological innovation which make forecasting costs and future incomes impossible and failures inevitable. Most of the early work on this question was conducted at RAND in the United States in the late 1950s and early 1960s, and Freeman uses and updates (some of) this work. The last element of the combination was the most speculative at the time: the adaptive strategies of firms as opposed to the pure rationality of neo-classical economics. Again, Carter and Williams's were concerned precisely with firms' strategies – although with a different framework – and their typology on progressiveness was not unknown to Freeman. Freeman rather makes use of the then-emerging work by R. R. Nelson and his American colleagues which culminated in Nelson and Winter (1982).

Finally, Part III of the book, on policy and government, essentially makes use of OECD statistics to discuss recent trends in public funding of R&D (Freeman et al., 1971). Freeman also makes use of then-recent experiments in citizens and users' involvement in the development of technological innovations, like those of the US Office of Technology Assessment, in order to suggest new avenues for policy.

With this threefold combination, Freeman's book was in fact the last of a series of combinations at the time. In 1951, the first conference on technological innovation was held at Princeton University, where a combination of disciplines studied the *Quantitative Description of Technological Change*: the disciplines of economics, sociology and history. Ten years later (1960), a second conference on *The Rate and Direction of*

Inventive Activity, although less diverse in terms of disciplines, discussed different approaches: classical economics (factors of production, structure of the industry, role of supply and demand), decision-making and management (information and uncertainty), and elements of what would become part of the tradition Freeman 'invented'. Finally, some years later, two works appeared which were the very first studies explicitly combining the tradition on technological change with new elements that would soon define the second tradition: the books by Nelson, Peck and Kalachek (1967), and Mansfield (1968). These two syntheses combined micro and macro economic perspectives in a way not different from that of Freeman (more on this below).

Freeman's combination is that of an author who masters his field of study: he brings together the newest and most recent ideas to discuss technological innovation, as a survey does. Most if not all of the issues raised would be discussed in the next 35 years – a more successful outcome than that of the book that emerged from the 1960 conference (mainly cited for K. Arrow and R.R. Nelson, at least among researchers from the tradition studied in this paper). At the same time, Freeman's combination is selective. The literature and the issues are chosen precisely for what allows Freeman to construct a new tradition. The new perspectives introduced to frame the construction are witness to Freeman's rhetorical move.

New Perspectives

I highlight only two perspectives from Freeman and the tradition. This is certainly a biased selection. Two considerations drove my selection. First, the perspectives are macro, and explain many micro perspectives one would find missing in my analysis. Second, they clearly distinguish this tradition from the first one on technological change. The two perspectives are:

- A representation of innovation as commercialization. This explains the study of the innovation process, from invention to diffusion.

- A consideration of policy issues. This gave rise to an applied or policy-oriented specialty.

I have deliberately not included the 'institutional' perspective, a major one according to the promoters of the tradition. As a matter of fact, a lot has been written on the institutional perspective as a distinctive trait of the tradition. To many authors in the tradition, this perspective serves to distinguish the tradition from the literature produced by mainstream economists (Nelson, 1993; 2008; 2009). It gave rise to a whole literature on a National Innovation System. This perspective is certainly absent from the econometric approach of the first tradition. In the present case, the perspective is mainly descriptive, although it makes use of statistics. In fact, another distinctive trait of the tradition is that researchers conduct their own surveys (like the SAPPHO project at SPRU in the early 1970s) rather than using only official statistics (this has changed recently with national innovation surveys conducted by governments and their statistical bureaus).

Innovation as Commercialization

The study of technological invention introduced in industrial production is the bread and butter of the (first) tradition on technological change. In this tradition, technology being used represents technological innovation – but without using the term (the tradition talks of technological change rather than innovation). This is in fact one meaning of innovation. It is widely shared by many researchers, including sociologists.

The tradition on technological change emerged in the 1930s, when the issue of technological unemployment of the previous century re-emerged (Godin, 2010a). Technologies were sources of unemployment, so many then said, but to others they were sources of productivity for firms too. Economists started measuring labour productivity (assumed to be due to changes in factors of production) as an indicator of technology: an increase in labour productivity is an indicator of technology used in industrial production. Economists from many horizons (governmental organizations like the US Works Projects Administration, non-profit organizations like the US NBER) contributed dozens of

studies. Such a focus on productivity was quite "original". Until then, it was profit not productivity that was the focus of mainstream economics. Thereafter, academics formalized the discussion using the production function (an equation linking the quantity produced of a good or output to the inputs) to analyze the issue, producing hundreds of papers.

Given the early scientific productivity of this tradition, we could discuss Freeman's statement that "economists have made a deferential nod in the direction of technological change" (Freeman, 1974: 16). However, one thing is certain: technological change was concerned with a meaning of and a representation of technological innovation different from Freeman's. Technological innovation in the first tradition was concerned with process innovation (Godin, 2010a). The second tradition specifically gave greater place in its analyses to product innovation. [4]

Freeman (and his followers) brought a "balance in coverage of process and product innovations" to the field (Freeman, 1974: 37). Indeed, in the historical part, Freeman documented both processes (in the chemical industry) and products (in synthetic materials and electronics, and their use as processes). This was a fruitful innovation. [5] The focus on products led to examining firms as suppliers of technological inventions rather than as users or adopters: how firms invent new products, what are the conditions for success and the difficulties encountered in introducing technological inventions to the market, is there an optimal size for innovating, what strategies are available to the firm, etc.

The interest in technological innovation as product innovation provided the seed for defining technological innovation as commercialization: a firm bringing a new product to the market for the first time. To Freeman, technological innovation is not the use of

[4] Products and processes are often discussed in term of a dichotomy. However, one industry's new product often becomes another industry's process. As Pavitt once put it: "product innovations in capital and intermediate goods automatically become process process innovations in the industries and services that buy them" (Pavitt and Walker, 1976: 20; see also Scherer, 1982b).

[5] On early studies on innovation as product (or consumer) innovation (within a completely different framework), see Dernburg (1958), Lancaster (1966) and Usher (1964).

technological inventions in production (technological change) but the commercialization of technological inventions – for either consumers (as products) or firms (as processes). While productivity (ensuing from the use of technological invention in industrial production) was the major issue to the technological change tradition, the issue became the market (the commercialization of the technological invention). However, at the time Freeman was not interested in studying market share, profits, etc. ensuing from commercialization. He merely wanted to open the "black box" and look at how firms generate and commercialize new products. This gave rise to studies on diffusion of technological inventions and innovation as a 'sequential' process over time (a third meaning of innovation in the literature).

When Freeman reported that Schumpeter had defined innovation as commercialization (see p. 10 above), he was in fact putting words in Schumpeter's mouth on which he himself wanted to focus. To Freeman, "technical innovation is defined by economists as the first *commercial* [Freeman's emphasis] application or production of a new process or product" (Freeman, 1974: 166). [6] Yet, application (use or introduction of an invention or change into a firm) and commercialization (introduction of a product to the market) are two different things. To Schumpeter innovation is not (first) commercialization but "any doing things differently" (Schumpeter, 1939: 84). Schumpeter has not discussed his five types of innovation – new commodities, new methods, new forms or organization, new sources of supply, and new markets – in terms of commercialization (only the first, as "standard case", is discussed in such terms). He has rather formalized his idea using the vocabulary and method of the technological change tradition – the production function – combining factors of production in a new way (Schumpeter, 1939: 87-88) – in the sense of application or introduction of change. To Schumpeter the entrepreneur innovates in the sense that he combines – not commercializes. Freeman's definition is witness to the fuzzy meaning of innovation at the time.

[6] See also Freeman, 1979: "Innovation is defined (as it usually is, following Schumpeter) as the commercial introduction and exploitation of an invention" (Freeman, 1979: 211).

It was not Schumpeter but Maclaurin who first defined innovation as commercialization in the late 1940s (Godin, 2008). In the following decade, this understanding was relatively 'common' among economists, [7] but not theorized yet. Following some few authors (like W.F. Mueller and J.L. Enos at the NBER conference) and public organizations (UK Advisory Council on Scientific Policy, 1964; OECD, 1966; 1968; US Department of Commerce, 1967; UK Central Advisory Council on Science and Technology, 1968; Pavitt, 1971; Layton, 1972), Freeman studied technological innovation as commercialized invention. [8] He was transforming an old meaning of technological innovation ('introduction' of technological invention in firms) and extended it ('commercialization' of technological invention) to theorize about it and build a new tradition. Freeman adopted the view of the inventor turned businessman (commercializing a new product) rather than that of the adopter (uing a new product) as the tradition on technological change did.

Freeman did make a limited use of the literature on technological change to discuss innovation, including process innovation. [9] To Freeman, this literature was not really concerned with innovation but imitation. For example, when discussing firms' strategies, Freeman minimized and contrasted "the traditional strategy [use of invention as] essentially non-innovative, or insofar as it is innovative it is *restricted* [my italics] to the adoption of process innovations, generated elsewhere but available equally to all firms in the industry" (Freeman, 1974: 257). To Freeman, innovation "excludes simple imitation or 'adoption' by imitators" (SPRU, 1972: 7). This is totally different from previous understandings going back to the beginning of the twentieth century century – and

[7] As an economist of the time put it: "Innovation is used here and in the rest of this essay to mean inventions that are introduced into the market place, a usage different from Schumpeter's but probably closer to the common meaning" (Nutter, 1956: 522). That this understanding was 'common' does not mean that there were no alternative representations (technological change) or that the category was uncontested.

[8] Freeman's first use of such a meaning goes back to the early 1960s (Freeman, Young and Fuller, 1963: 38). See also Freeman (1971: 1)

[9] Nevertheless, Freeman uses "technological change" regularly in a loose sense, as many did and still do: changes in technologies (new technologies). He also adapted "technological change" into "technical change", and would in many later papers use the term interchangeably with innovation. He also talked of "function", a term widely used in the tradition on technological change: R&D "function" (Freeman, 1974: 25), "function" of technology critic (Freeman, 1974: 308-9) and information "function" (Freeman, 1974: 274). Schumpeter also has used "function" regularly: entrepreneur function, production function, managerial function, social function (Schumpeter, 1939).

before: anthropologists, sociologists and classical economists studied innovation as use or diffusion of invention – and Freeman's representation of innovation remains controversial today (Godin, 2012b). More than a decade before Freeman, Carter and Williams in their pioneering studies of industrial innovation suggested the opposite: a firm "may be highly progressive [innovative] without showing much trace of originality [research]. It may simply copy what is done elsewhere (…). It is nonsense to identify progressiveness with inventiveness" (Carter and Williams, 1957: 108). Schumpeter has also suggested that innovations "need not necessarily have occurred in the industry under observation, which may only be applying, or benefiting from, an innovation that has occurred in another" (Schumpeter, 1939: 89, footnote 1). References could be multiplied, including authors who have defined innovation as 'adoption'. In the end, innovation as 'imitation' got into the official measurements.

On another concern of the technological change tradition, Freeman certainly started his discussions of chemical processes as being "fundamental to the growth of *productivity* [my italics] and of the economy" and used some input and output measurements as empirical evidence (Freeman, 1974: 43). However, this is all the use he made of productivity, a central concept of the tradition on technological change. Rather, what Freeman used from the literature on technological change is essentially related to firm size. Some writers, among them the Americans J. Schmookler and F. M. Scherer, for several years worked to validate (or invalidate) the late "Schumpeterian hypothesis" concerning the role of large firms in technological innovation (or rather R&D). Freeman makes some (but only some) references to these authors (see also Freeman, 1971), so he was not ignorant of the tradition on technological change. However, in choosing not to discuss part of this tradition, not ignoring it completely but certainly minimizing it, he was constructing a new perspective, one that became a new tradition.

In fact, there exist at least two strategies for inventing a new tradition: contrasting it to a previous one, or ignoring the previous tradition. The tradition on technological change had already produced a voluminous series of studies at the time of Freeman's book, particularly on gains in productivity from the use of technological invention in industrial

production. Freeman did not discuss these findings. [10] He recommends what he calls a "direct" measurement of innovations (counting their number based on lists) as an indicator, [11] rather than productivity gains, which is not mentioned at all. The aim in using this indicator is identifying "first commercial production", in line with what economists' interest is or should be (Freeman, 1974: 166, 174), rather than invention as R&D expenditures and patents document (Freeman, 1974: 91-96; 199; 206-209; see also Freeman, 1971). [12] Ironically, productivity issues would later come back more strongly in the tradition in another form: national productivity as an indicator of competitiveness between countries. Similarly, unemployment issues will continue to be discussed in the tradition as well (Freeman, Clark and Soete, 1982).

In his introduction, Freeman deplored the fact that economists had not studied technological innovation and had retained it only as a residual (Freeman, 1974: 16-17, 32). This deserves qualification. Certainly, it is true for R. Solow – who got into the field by accident – and his much cited (because formalized) paper. Nevertheless, there was for some decades a literature on technological change, as mentioned above, of American origins, whose several authors worked to reduce the residual in the 1960s. It is on his evaluation of these efforts that, in the 1982 edition of his book, Freeman offers, finally, a reason for rejecting the tradition: "most economists have given up now on the purely statistical attempts to aggregate the production function and the disaggregation of the components of technical change". To Freeman, the accuracy of these estimates was poor (Freeman, 1982: 196). Freeman's cherished statisticians were rather the English and left-

[10] R. R. Nelson used a different strategy. He criticized the first tradition explicitly on many occasions since the late 1970s, contrasting it to the second one. However, Nelson's polarity refers to "method" only: the first tradition (he does not use this term) is characterized by formal theorizing (statistical and logical) as distinct from the second, which is rather appreciative theorizing (empirical and interpretative). But there is one more difference: the object of study and the meaning of innovation (use of invention vs. commercialization of invention). In matters of method, I would rather suggest a threefold distinction: mathematical, descriptive (rather than interpretative), and historical. Each is typical of a specific community: technological change, innovation studies, and economic historians. The historical approach is largely absent from the first two traditions.

[11] Lists of (important) innovations is a type of data available from surveys. The first such lists were published in the 1930s (US National Research Council), followed by Carter and Williams in the late 1950s. Freeman originally suggested the idea as after-thought on output indicators in the OECD Frascati manual that he wrote (OECD, 1962: 37) then to UNESCO (Freeman, 1969: 25).

[12] In 1982, one more rationale was offered: technological innovation as a measurement of R&D efficiency (output) or "cost-effectiveness" (Freeman, 1982: 53-54).

wing scientist J. D. Bernal and his measurements of a national "budget of science" and the OECD – although he takes pains to document the limitations of the organization's statistics. [13] Freeman's statistics are descriptive statistics, either absolute or comparative (Freeman, 1974: 175) rather than econometric. In his negative evaluation of econometrics, Freeman was quite severe. The tradition was in good shape at the time of his book, it has continued since and is alive and well today, as demonstrated by the voluminous working paper series (started in 1979) of the Productivity Program of the US National Bureau of Economic Research, directed by Z. Griliches until 1999. [14]

Secondly, many researchers at the US RAND Corporation and at the NBER conference of 1960 (as well as sociologists Jewkes et al., 1958) had already started to open the "black-box", as Nelson pointed out at the time (NBER, 1962: 9). Certainly, the researchers have opened the black box of invention not that of innovation, as S. Kuznets deplored (Godin, 2010a). [15] Nevertheless, invention is part of what the second tradition called the innovation 'process'. Freeman extended this analysis to innovation and the role of market uncertainty. [16]

Thirdly, a few years after the NBER conference, a group that called itself the *Inter-University Committee on the Microeconomics of Technological Change*, members of which were A. Conrad, Z. Griliches, E. Mansfield, J. Markham, R. Nelson, M. J. Peck, F. M. Scherer and J. Schmookler, got a grant from the Ford Foundation to conduct studies on technological change. This enabled the group of young American economists (most of them present at the 1960 conference) to meet from time to time. The work culminated in a 1966 conference held in Philadelphia, attended by most of the Americans who would work on technological change issues in the coming years.

[13] Freeman also cherished new techniques like project evaluation, operation research and planning (technology assessment).
[14] Productivity issues may be criticized from a theoretical point of view, as Nelson did regularly. However, the issues remain, together with the tradition responsible for them, essential to writing a history of the field and for understanding the emergence of the second tradition.
[15] Two exceptions from the conference were W.F. Mueller and J.L. Enos.
[16] At about the same time as Freeman (late 1960s), researchers at Manchester had started conducting similar analyses as Freeman's (Langrish et al., 1972). On precursors on risk and technological innovation, see Lange (1943) and Strassman (1959).

It is this network that produced two early combinations of (what we may now identify as) two traditions. These combinations or syntheses have remained exceptions in the technological change tradition, but they are similar in scope to that of Freeman some years later. One is Nelson, Peck and Kalachek's *Technology, Economic Growth and Public Policy* (1967). The authors discussed what has been learned from the analysis of technological change, added perspectives on the industrial process of technological invention and diffusion of technological innovation, and ended with unemployment issues. Many of Freeman's ideas are discussed here, from product innovation to the role of users in the experimentation stage. The other synthesis is Mansfield's *The Economics of Technological Change* (1968). Mansfield brought together the latest findings on technological change and productivity, on technological unemployment, on management of R&D and the diffusion of technological innovation, and added perspectives on public policy. His discussion was framed into a highly influential sequential model: invention (R&D) → innovation (first use) → diffusion (spread of use). To this was added: → impact (unemployment) → policy.

As long as Freeman's purpose was not to write history, his 'selective' combination was in a sense 'normal'. This is what conceptual construction is. However, it is more problematic when such a selection comes from 'histories' of the field. In the last few years, papers have appeared that attempt to 'map' the field of technological innovation studies and identify the classic authors behind current research (Martin, 2008; Fagerberg and Vespagen, 2009). Such studies are definitely witness to the fact that this field is becoming 'mature' enough to look back at its own scientific production. At the same time, these studies help to provide or to strengthen the identity of a community of scholars around key ideas and authors. However, the danger is that such assessments may function as promotional material for a particular representation of innovation. These studies portray the field as a linear progression from Schumpeter to a neo-Schumpeterian (or "evolutionary") tradition, without discussing the first tradition as such nor most of the authors involved. [17] I will come back to Schumpeter below.

[17] Neither Martin nor Fagerberg pretend to offer a "historical" analysis of the field. However, they list the most popular (cited) authors by dates and the categories they use to organize this list are historical.

Policy as Application

The second perspective Freeman brought to the field was the national policy dimension, consideration of which is relatively absent in the first tradition but which contributed to Freeman's representation of innovation as technological and commercialized. This is, to my mind, one of the main characteristics of the second tradition. It explains why this tradition developed in Europe. As a matter of fact, efforts towards developing a national science policy first emerged in England, and led to the setting up of advisory committees as early as 1915 and more systematically in the 1940s (Gummett and Price, 1977; Gummett, 1980). The demands of scientists for national coordination got a supplementary hearing in the following decade. In the late 1950s, a whole discourse developed in Europe about 'lags' and 'gaps' in science and technology between Europe and the Unites States. This fed the OEEC and the OECD efforts to promote the development of science policies among European countries (OEEC, 1959; OEEC, 1960; OECD, 1963a), and to measure trends in R&D and the outcome of policies (OECD, 1962). The route through which discourses on national policies developed is definitively from England to the OECD. As a matter of fact, the first Director General for Scientific Affairs at OECD was Alexander King, who had been the UK Advisory Council on Science Policy (ACSP)'s first secretary, created in 1947.

To the OECD, technological innovation became a means to economic growth, productivity and market shares (OECD, 1966; 1970). The then-fashionable model was (and still is) the United States. Adopting American technology and producing more innovative products would improve firms' productivity and open new markets to European firms. The European discourses on lags and gaps, largely fed by the OECD, got into technological innovation studies early on and still continues to be discussed today. [18] To a certain extent, SPRU, founded by Freeman in 1966, was a 'spin-off' from the OECD. Freeman had acted as consultant to the OECD from the early 1960s. He wrote the

[18] Freeman has used the concepts (together with that of 'disparity') regularly in the 1960s in his study conducted at the British National Institute for Economic and Social Research, some of them financed by the OECD (Freeman, Young and Fuller, 1963; Freeman and Hirsh, 1965; Freeman, Harlow and Fuller, 1965; Freeman, 1968; Freeman and Ray, 1969). See also Freeman, 1971.

first edition of the Frascati manual (OECD, 1962), then co-produced a policy paper for the first ministerial conference on science (OECD, 1963b) and a methodological study on measuring science (Freeman and Young, 1965). Thereafter, Freeman remained a consultant to the organization (as well as to UNESCO) and participated as expert in many committees responsible for OECD policy reports. Many of his concepts owe to work with this organization. [19]

Together with some other public organizations in England and the United States, the OECD is responsible for one of the the full-length discussion of technological innovation – as commercialized invention. Between the early 1960s and 1974, namely between Freeman's first thoughts on technological innovation and his book, the representation of technological innovation as commercialized innovation has 'matured' and governments have been a major contributor to the diffusion of the representation (Godin, 2012a). Many authors in sociology, management and political science were developing new definitions, but there was no accepted and standardized definition. The OECD and governments have selected one of these definitions (commercialization), because of its relevance to policy issues (market shares). As a matter of fact, among the early titles published on technological innovation, those from public organizations are all concerned with technological innovation as commercialized invention (Arthur D. Little, 1963: 6; OECD, 1966: 9; 1968: 14; US Department of Commerce, 1967: 8; UK Central Advisory Council on Science and Technology, 1968: 1; Pavitt, 1971: 19; Layton, 1972: xi). [20] These reports have contributed to crystalling a representation on which Freeman could theorize. [21]

[19] In addition to 'gap' (called 'disparity' in Freeman and Young (1965) produced for the OECD), Freeman's concept of 'research-intensive industries' was first suggested in his report to the first OECD ministerial conference on science (OECD, 1963b), and 'explicit' (and 'direct') policy, as discussed below, had precursors in the organization too (OECD, 1963a; OECD, 1966).

[20] The discussion of innovation as commercialization goes hand in hand with that of competitiveness in terms of market shares of new products.

[21] Freeman has never cited any source for his (early) conception of technological innovation as commercialized invention (see Freeman, Young and Fuller, 1963: 38; Freeman, 1971: 1). Then, in 1974, he had attributed it to Schumpeter. However, in 1972, Freeman cited a government source (the UK Central Advisory Council on Science and Technolgy, 1968) as authority (SPRU, 1972: 7).

These public reports also carried a policy perspective and Freeman was following in these footsteps when he suggested that technological "innovation may be regarded as the ultimate aim [and output] of most applied research and experimental development" (Freeman 1969) and necessitates public support. Yet, according to Freeman over seventy-five percent of public R&D is devoted to national security and prestige types of R&D (nuclear, military, space). In contrast, there is low priority accorded to welfare and environment. To Freeman, the preferential treatment of public R&D to technological innovation of a "non-economic nature" (the "military-industrial complex") is due to an advocacy process ("habit, lobby and prestige", as he put it), rather than "any sophisticated project evaluation techniques" or "elaborate calculations of return on investment" (Freeman, 1974: 286-87). To Freeman, "there is a failure in the market mechanism and also of the political mechanism in relation to technical change in consumer goods and services" (Freeman, 1974: 308). Freeman believed that "new factors are at work" which could and should change the priorities. These new factors were the reduction of tensions between the superpowers, the change in public opinion and social values, and the emergence of new problems.

There was a need for "a social mechanism for stimulating, monitoring and regulating innovation, which does not yet exist in any country" and a need for greater "public participation in the process of consumer-oriented innovations", stated Freeman (Freeman, 1974: 308). Freeman argued for "consumer sovereignty" in relation to technological innovation, a concept first used by the OECD (OECD, 1972: 7). Users of technology (buyers and consumers) should have a say in designing technology. To this end, he offered several suggestions and "coupling mechanisms" like standards and regulations (including on advertising), "direct stimulus" for designs and product development, public representation on committees and, above all, technology assessments. Furthermore, to Freeman, "national science priorities" should be established to support science and technology based on "its contribution to social welfare" (Freeman, 1974: 307). "Present R&D project selection techniques are biased overwhelmingly towards technical and short-term competitive economic criteria (…). [They] should take into account aesthetic

criteria, work satisfaction criteria, environment criteria and other social costs and benefits which today are almost excluded from consideration" (Freeman, 1974: 309).

As I have mentionned above, researchers from the second tradition contrast their own tradition to the black-box of mainstream economists. They developed one more contrast: neo-classical economics *versus* evolutionary economics. Neo-classical economists focus on prices and equilibrium to explain firm's (rational) behaviour, while evolutionary economists look at the adaptive response of firms to changes in their environment (Freeman, 1974: 253-55; 281-82). In policy matters, the former is said to explain and justify the government's role in the economy on the basis of market failures, while the latter looks at a more complex set of institutions and rules (Nelson, 2009). [22] However, recent studies have documented that there is much less difference here between the two traditions than commonly assumed (Schroter, 2009). Certainly, there is one characteristic shared by the two traditions: their normative and prescriptive orientation. This is clearly evident in Freeman's vocabulary (italics are my emphasis): "Quite different priorities *should* be established in the last part of the twentieth century and national policy *should* be concerned to promote other kinds of innovation" (than those "largely determined by the Cold War") (Freeman, 1974: 41): reallocation of R&D resources [23] "*must* therefore be the main concern of national policy for science and technology" (Freeman, 1974: 41), better coupling with the users of innovations, and improvements in consumer goods and services must become priorities (Freeman, 1974: 41-42).

While the policy perspective distinguishes the tradition from that on technological change, as I have argued here, it thus also makes the field an application-oriented specialty. [24] As reflected in the journal *Research Policy* and the many books published at

[22] Sometimes this set is called "historical" or "historical context" (Freeman, 1974: 255), but I prefer institutional or contextual. Certainly, the context and institutions have a history, but most of the analyses of the tradition are not historical, except in the sense discussed above (p. 12-13). More often than not, history (of a rather recent time span by the way) comes after the conceptual work in "innovation studies", as a background or residual piece of evidence, although placed first in books and papers.

[23] From the military to environment, energy, natural resources, transport, quality of life and underdevelopment.

[24] The most active researchers on science policy in the early years of SPRU were Keith Pavitt and R. Rothwell with W. Zegveld. Pavitt, as well as Jean-Jacques Salomon in France, have worked at the OECD before starting an academic career.

Edward Elgar, every discussion on technological innovation includes policy recommendations. Whether the policy perspective drives the conceptual construction and representation of academics on technological innovation or *vice versa* is difficult to say precisely. One thing is certain: given that many researchers work both in academia and public organizations as consultants, both perspectives go hand in hand and the ideas travel in both directions (Miettinen, 2002).

Legitimization

Two authors contributed substantially to Freeman's framework in 1974. The conceptual construction begins by using F. Machlup's "wide definition of knowledge industries" (Freeman, 1974: 18), as covering the "generating, disseminating, and applying advances in technology" (Freeman, 1974: 20). It allows Freeman to suggest the idea of an "R&D system" (first suggested in a paper produced for UNESCO in 1969). There is no explicit definition of what a system is, but one understands that it means a complex whole and process responsible for "the ultimate source of economic advance" (Freeman, 1974: 20): production of new products and processes, management and marketing, diffusion (including education and training) and interaction with science (Freeman, 1974: 20-21). Above all, Freeman's system refers to a "professionalized system" whose "growth is perhaps the most important social and economic change in twentieth-century industry" (Freeman, 1974: 21).

The use of Machlup's approach is interesting, as it is totally foreign to the first tradition. Machlup's vision is a broad one, looking at both technological invention and its diffusion, and it would come to characterize the institutional perspective of the second tradition (Godin, 2006; 2010c). Furthermore, Machlup's systemic analysis of the knowledge system in terms of flows of measurable quantities of input and output (his table is reproduced in Freeman' book on p. 22-23) became that of the second tradition – as well as that of later studies on research evaluation. Freeman's appendices (over 70 pages) are entirely devoted to reproducing parts of OECD and UNESCO manuals on measurements of input and output, manuals to which he contributed. Freeman's use of

Machlup is also interesting because the latter had been criticized early on by economists precisely for not being in the 'mainstream' tradition – in turn, Machlup has criticized econometrics early on (Godin, 2010a). For example, in 1963 Nelson stated: "Machlup is concerned principally with identifying and quantifying the inputs and outputs of the knowledge-producing parts of the economy and only secondarily with analyzing the function of knowledge and information in the economic system" (Nelson, 1963). [25] Despite criticism in America, this kind of analysis and the descriptive statistics suggested by Machlup became very influential among European researchers.

However, it was not Machlup but Schumpeter who got pre-eminence in the second tradition. On many issues, Freeman gives credit to Schumpeter: Schumpeter "gave innovation pride of place in his models" (Freeman, 1974: 22); "we owe to Schumpeter the extremely important distinction between inventions and innovations" (Freeman, 1974: 22); Schumpeter "rightly pointed out the crucial role of the entrepreneur" (Freeman, 1974: 22). Nevertheless, in the end Freeman did not defer to Schumpeter. Schumpeter was treated like any other author – he is discussed on one page only and his name does not even appear in the index. Freeman deplored the fact that Schumpeter treated innovation as exogenous to economics (Freeman, 1974: 22); "still less did he have any concept of science policy" (Freeman, 1974: 22). Yet, to Freeman, the R&D system "can be subjected to economic analysis" – in line with Machlup's suggestion: "For the economists, it is obviously desirable to examine the operations of this R&D system from the standpoint of its efficiency in employing scarce resources [input-output]" (Freeman, 1974: 26). The resistance to looking at R&D in this sense led to neglecting the study of the whole process of innovation. To correct the situation, Freeman suggested a series of specific questions of an economic nature (Freeman, 1974: 26-27).

This critical (or balanced) use of Schumpeter in the emerging stage of the tradition would soon begin to change. The 1982 edition of Freeman's book contained a "new chapter on unemployment" (presented as such in the acknowledgments, p. vii). However, the chapter

[25] Nelson was then working within the mainstream framework, as most American economists did. See Nelson (1964).

is more than this. It gives central place to Schumpeter and elects the label "neo-Schumpeterianism" as defining the tradition. Although Schumpeter "had relatively little to say about unemployment and wages" Freeman stated (Freeman, 1982: 209), he nevertheless made "an outstanding original contribution": "more than any other twentieth-century economist [Schumpeter] attempted to explain cycles in economic growth largely in terms of technical innovation" (Freeman, 1982: 207). "Major structural crises, or adjustment" led by technical innovations explain economic growth and employment. These innovations were seen as major ones (discontinuous), together with the minor innovations that follow and form clusters. To Freeman, such would be a "neo-Schumpeterian interpretation" of the post-war boom (Freeman, 1982: 208).

Freeman then complemented (one more combination) this interpretation on autonomous invention and entrepreneurship, or supply, with an opposite one on demand, as developed by J. Schmookler, and concludes: "science and technology would tend to dominate in the early stages, whilst demand tends to take over as the industry becomes established" (Freeman, 1982: 211). Following A. Phillips, Freeman thereafter discovered two models in Schumpeter – and brought forth two schematic representations (Freeman, 1982: 212-13): one in which science and technology are exogenous (1912), and the other in which they are endogenous (1942). [26] He next added diffusion to the models (and contrasts it to the previous diffusion theory, like E. Mansfield's studies of the 1960s which put the emphasis on the adopters' profit rather than suppliers): innovators are attracted by potential profits too. The result is that, over time, innovations tend to focus increasingly on cost-reducing process rather than new products (a recurrent topic of the tradition on technological change). This is a source of unemployment – hence Freeman's interest in products rather than processes as sources of employment.

Over time, Schumpeter has become THE starting point of technological innovation studies in the second tradition, as though he stood alone (Godin, 2008). This reductionist view is present elsewhere in the academic literature. For example, J. M. Staudenmaier's

[26] Freeman (1974: 214) makes a lot of such a short essay-type chapter from 1942 (Schumpeter, 1942: chapter 12). Freeman, following others, rather offers a personal construction which goes further than Schumpeter's own thought.

survey of the history of technology as seen through papers published in *Technology and Culture* states that "the term 'innovation' appears to have originated in a tradition of economic analysis" (Staudenmaier, 1985: 56). Freeman himself, as mentioned above, attributed the "important" distinction between invention and innovation to Schumpeter and suggested that it "has since been generally incorporated into economic theory" (Freeman, 1974: 22). There is also the sequence: invention → innovation → diffusion, which is (wrongly) attributed regularly to Schumpeter. [27]

History is quite different. From its very beginning, the study of technological innovation was represented by a plurality of voices. The above ideas developed over time, many authors having incrementally contributed to their construction, both before and after Schumpeter. There has been no direct (or explicit and continuous) tradition of research from Shumpeter to the early technological innovation studies – Maclaurin is an exception – but rather a resurrection or "renaissance" (Freeman, 2003). And it is Maclaurin's ideas which are resurrected, in obliterated form, as much as those of Schumpeter. It is interesting to note that the very first survey of the field made no reference to Schumpeter – but did refer to Maclaurin (Nelson, 1959). [28] Similarly, the early students who studied technological innovation in the second tradition (before the tradition existed as such), like Carter and Williams (1957), Jewkes et al. (1958) and Langrish et al. (1972), as well as Freeman himself (Freeman, 1971; SPRU, 1972), did not cite Schumpeter. As a matter of fact, they did not need Schumpeter at all to discuss many of the issues that would occupy the second tradition, above all the commercialization of technological invention. When some did cite Schumpeter, it was to discuss his very general and later hypothesis (or speculation) on the size of firms (Nelson, Peck and Kalachek, 1967; Mansfield, 1968) – on this issue Freeman used Galbraith in his early works rather than Schumpeter (Freeman, 1971). It is these studies together with the early contributions of Americans

[27] See M.J. Peck and I.R. Siegel in NBER (1962: 317; 445) and Rosenberg (1976: 67). In Freeman (1994: 480), Freeman talks of the "Schumpeterian concept" of "diffusion". Schumpeter was rather concerned with "imitation" and followers among entrepreneurs, not diffusion (a term he uses only once) of innovations through the economy and society. Schumpeter has not studied diffusion but has jumped from innovations to their effects on the economy (business cycles). Schumpeter may have had the "idea" of diffusion, but not the "concept".

[28] To be honest, this survey was concerned with invention not innovation. However, Maclaurin was concerned with the latter.

beginning in the mid-1950s [29] that constitute the missing link in recent "histories" of the field, which focus on Schumpeter and jump too quickly right to "neo-Schumpeterianism".

At the same time as Schumpeter was taking central place in analyses of the second tradition, other authors really got eclipsed. I have already mentioned the absence of references to the tradition on technological change as well as to the historical tradition (or approach) from Maclaurin. The latter was killed (literally) by the first tradition for being a historiographer and not an econometrician (on Maclaurin's suicide, see Godin, 2008). The second tradition 'killed' Maclaurin a second time. Certainly, Freeman cites Maclaurin (Maclaurin, 1949) – as some others did at the time in footnotes – but for his work on the history of radio (Freeman, 1974: 112, 115) and not for his "theory" (or model as most researchers called the linear view of technological innovation) which has nevertheless remained influential for decades. Sociologists on technological innovation merited the same neglect. W. F. Ogburn is not cited at all (Godin, 2010b). Only Jewkes et al. as sociologists are cited – because they are concerned with firms.

Why was Schumpeter resurrected? There is nothing wrong with resurrecting a forgotten author. One may find in a lost author the framework and ideas he seeks for his own construction. However, it may also have to do with identity, originality and legitimacy. Having no established conceptual framework on which to build its case, as the first tradition did – the second tradition itself is the 'inventor' of the framework – authors have used the old to justify the new. They have elected Schumpeter, made of him an authority and a symbolic father and invented a genealogy (widely shared in handbooks, surveys – or mappings – and "histories" – or stories – of the tradition). [30] Together with 'killing' other authors, the field could pretend to an autonomous status. 'Big names' like Schumpeter, often help 'sell' one's own idea, more so if they were poorly esteemed in their own time. Without doubt, Schumpeter is an original author among economists. But

[29] A.A. Bright, Y. Brozen, J.L. Enos, B. Gold, W.R. Maclaurin, W.F. Mueller, N. Rosenberg, W.C. Scoville, P. Strassman and some others.
[30] Other symbolic fathers in the tradition are V. Bush (see Godin, 2006) and F. List (see appendix).

many more contributors would have to be added to a story (and history) of thoughts on technological innovation to make it 'scientific'.

But let's go on from Schumpeter. The new chapter from the 1982 edition of Freeman's book was concerned with another topic. It doubled the space accorded to policy in the previous Part III of the book. "The emergence of new technologies and their assimilation (...) is not a smooth continuous process", stated Freeman: it is uneven over time, between industries, and between countries (Freeman, 1982: 220). What does this mean? Policy must come to the rescue: "the promotion of major new technological systems and of *productivity* [my italics] based on technical change may be an important means to help restore the economic health of the mature industrialized countries" (Freeman, 1982: 220). To Freeman, following a then-recent OECD document in which he participated as expert (OECD, 1980), three "sets of technology policies seem particularly relevant": encouraging firms to take up radical inventions/innovations, improving the diffusion of technological innovations, and importing foreign technology.

To Freeman, government policy should be explicit (deliberate) policy rather than implicit. The vocabulary used to discuss such an explicit policy is normative and prescriptive, as in 1974: policy is *relevant, important, meritorious, essential, useful* ... (Freeman, 1982: 220-22). To support his case, Freeman's vocabulary makes use of 'universals' (values no one would debate, like social welfare): technology as a strategy (the only one) for improving the income of the population and reducing unemployment (Freeman, 1982: 224).

Conclusion

Freeman developed a synthesis (combination) of previous findings on innovation and introduced a national framework. Until then, innovation was discussed in disciplinary terms (sociology concentrating on social groups, economics and management focusing on firms). Following governments' discussions of innovation, Freeman introduced a national perspective: Freeman introduced a national perspective: technological innovation is good

not only for individuals and groups as sociologists study, or firms as management analyse, but source of economic growth for a nation as a whole; and there is a need for policy to support the innovators. Certainly, Freeman's perspective remains selective. His synthesis is biased toward certain ideas (minimizing innovation as adoption) and emblematic authors like Schumpeter (for reasons of legitimacy), his representation of innovation is "restricted" to technological innovation and is firm-centered, and over time the tradition on "innovation studies" has had little concern with social issues. Nevertheless, the attention devoted to policy gave the tradition a national perspective and, consequently, got a government hearing.

With *The Economics of Industrial Innovation*, Freeman launched a whole tradition of research on technological innovation. SPRU researchers would continue on Freeman's perspective, and would soon be imitated by other groups worldwide. Certainly the tradition has evolved considerably since Freeman's book, and Freeman himself has been a major contributor to this development. However, the root of the tradition as it now exists was (to many extents) established in this book. [31]

Many issues of the story remain to be studied. This paper is only a beginning to the history and sociology of the specialty. What this paper has left to others to study is following Freeman's book through time: by whom was it used and cited (this is easily done with bibliometrics) and for what purposes and with what impact on the ideas of the tradition (this is more time-consuming but more enlightening). What deserves serious analyses too is documenting what the research issues of the tradition really owe to Schumpter and/or to a Schumpetarian interpretation. To what extent is Schumpeter cited as pope with no real use of his works in the citing paper. [32] Dozens of economists parade every year at the annual conference of the International Schumpeter Society, but go back to their regular work without making use of Schumpeter's ideas. Equally, what remains to be documented is the co-production of ideas between Freeman (and others in the specialty) and policy-makers and the extent to which policy issues and organizations like

[31] For an overview of the tradition today, see Fagernberg et al. (2005).
[32] G.M. Hodgson has already made a similar argument: Schumpeter's name is widely invoked as "spiritual symbol" and "father" (Hodgson, 1993: 150).

the OECD have driven the analyses. A sociological analysis of the specialty would be most welcomed, particularly for the study of the specialty's place among the other specialties concerned with science, technology and innovation, among them history and sociology.

At the same time as being an (academic) innovator, Freeman has been an advocate, or "innovative ideologist" as Quentin Skinner would say (Skinner, 2002a: chapter 8-10; 2002b, chapter 4). Freeman wrote in response to existing theories and promoted or defended a new point of view: innovation is the commercialization of technological invention, the method of study is descriptive (contextual I would add, not really historical), and policy has a large role to play in the analysis, which gave the field its normative dimension. While the tradition regarding technological change grew out of issues of technological unemployment and productivity, the second tradition developed from interest in management and policy interest, as much as from purely economic interest: opening the black box to help society (government?) get more out of technological innovation. Innovation as technological innovation emerged out of the instrumentalization of innovation for policy purposes (Godin, 2012a). However, there is continuity between the two traditions too. Like the first tradition, this one focuses on innovation as technological innovation, on firms and on economic growth as the ultimate outcome. Compared to the field today, few issues were missing in Freeman's work (as with the 1960 conference) – except globalization, a 'recent' phenomenon. In this sense, and despite (or precisely because of) their limitations, the recent studies which map the field are witness to what 'innovation studies' and the community really are: economics, management and policy.

In recent years, 'innovation studies' has been used to name the field by many researchers of the second tradition. As such, the labelling suggests a monopoly, as if the tradition covers all that concerns innovation, while it rather studies it from a particular perspective. Different perspectives on innovation exist (like Shavinina, 2003), but these are eclipsed in the tradition. Few critical discussions are conducted in the tradition on what innovation is but, as Freeman did, a particular definition is brought forth from the start. 'Innovation

studies' specialize on technological innovation in organizational settings (firms). To take just one example: both the recent *Oxford Handbook of Innovation* (Fagerberg et al., 2005) and the literature on National Innovation Systems (Freeman, 1987; Lundvall, 1992; Nelson, 1993) gravitate around the firm and the market: how best to facilitate the commercialization and use of technological inventions. The institutional (and social) aspects of the innovation system are studied for their contribution to the innovative performance of firms. Social issues remain a residual (a residual similar to the one Freeman criticized earlier) and are relegated to others to study.

Whatever its name, 'innovation studies' may have hegemony perhaps, but no monopoly. This hegemony owes its existence to two factors. One is the fact that researchers in the specialty have appropriated the term innovation, while others do not use it as a distinctive marker, although they are concerned to different degrees with innovation too. The other factor is the official (government) discourse, which understands innovation as technological innovation, thus legitimizing the understanding of 'innovation studies' and making it dominant.

Limiting ourselves to technological innovation (and putting aside the voluminous literature on innovation broadly defined; see Godin, 2012b), there have been three traditions of 'innovation studies' in economics: historical (Godin, 2008), technological change (Godin, 2010a) and technological innovation (this paper). The last two share similar assumptions, although they carry different perspectives. In this sense, they have both contributed to a shared representation of innovation among policy-makers and the public. Nevertheless, the two traditions live in (almost) total ignorance of each another. Each has emerged on a different continent, and continues to inhabit that continent – with few exceptions.

References

A.D. Little (1963), *Patterns and Problems of Technical Innovation in American Industry*, report submitted to the NSF, C-65344, Washington.

Carter, C. F., and B. R. Williams (1957), *Industry and Technical Progress: Factors Governing the Speed of Application of Science*, London: Oxford University Press.

Dernburg, T.F. (1958), Consumer Response to Innovation: Television, in T.F. Dernburg et al. (eds.), *Studies in Household Economic Behavior*, New Haven: Yale University Press: 3-49.

Fagerberg, J., D. C. Mowery and R. R. Nelson (2005), *The Oxford Handbook of Innovation*, Oxford: Oxford University Press.

Fagerberg, J., and B. Verspagen (2009), Innovation Studies: The Emerging Structure of a New Scientific Field, *Research Policy*, 38: 218-33.

Freeman, C. (1968), Chemical Process Plant: Innovation and the World Market, *National Institute Economic Review*, 45: 29-51.

Freeman, C. (1969), *Measurement of Output of Research and Experimental Development: A Review Paper*, Paris: UNESCO.

Freeman, C. (1971) *The Role of Small Firms in Innovation in the United Kingdom*. Report to the Bolton Committee of Enquiry on Small Firms, London: HSMO.

Freeman, C. (1974), *The Economics of Industrial Innovation*, Harmondsworth: Penguin Books.

Freeman, C. (1979), The Determinants of Innovation: Market Demand, Technology, and the Response to Social Problems, *Futures*, June: 206-15.

Freeman, C. (1982), *The Economics of Industrial Innovation*, second edition, Cambridge (Mass.): MIT Press.

Freeman, C. (1994), The Economics of Technical Change, *Cambridge Journal of Economics*, 18: 463-514.

Freeman, C. (2003), *A Schumpeterian Renaissance?*, SPRU Electronic Working Paper Series, Paper no. 102, Brighton: University of Sussex.

Freeman, C., J. Clark and L.L.G. Soete (1982), *Unemployment and Technical Inovation: a Study of Long Waves in Economic Development*, London: Frances Pinter.

Freeman, C., C.J.E. Harlow and J.K. Fuller (1965), Research and Development in Electronic Capital Goods, *National Institute Economic Review*, 34: 40-91.

Freeman, C., and S. Hirsh (1965), The United States Electronics Industry in International Trade, *National Institute Economic Review*, 34: 92-97.

Freeman, C., C.H.G. Oldham and C.M. Cooper (1971), The Goals of R&D in the 1970s, *Science Studies*, 1 (3): 357-406.

Freeman, C., and G.F. Ray (1969), The Diffusion of New Technology: A Study of Ten Processes in Nine Industries, *National Institute Economic Review*, 48: 40-100.

Freeman, C., and A. Young (1965*), The Research and Development Effort in Western Europe, North America and the Soviet Union: An Experimental International Comparison of Research Expenditures and Manpower in 1962*, Paris: OECD.

Freeman, C., A. Young and J. Fuller (1963), The Plastics Industry: A Comparative Study of Research and Innovation, *National Institute Economic Review*, 26: 22-49.

Gilfillan, S.C. (1935), *The Sociology of Invention*, Cambridge (Mass.): MIT Press.

Godin, B. (2006), The Linear Model of Innovation: The Historical Construction of an Analytical Framework, *Science, Technology, and Human Values*, 31 (6): 639-667.

Godin, B. (2006), The Knowledge-Based Economy: Conceptual Framework of Buzzword?, *Journal of Technology Transfer*, 31 (1): 17-30.

Godin, B. (2008), In the Shadow of Schumpeter: W. Rupert Maclaurin and the Study of Technological Innovation, *Minerva*, 46 (3): 343-360. A slightly different version, particularly a conclusion on Maclaurin's suicide, is available at http://www.csiic.ca/innovation.html

Godin, B. (2010a), "*Innovation Studies": the Invention of a Specialty* (Part I), Project on the Intellectual History of Innovation, Montreal: INRS.

Godin, B. (2010b), Innovation without the Word: William F. Ogburn's Contribution to the Study of Technological Innovation, *Minerva*, 48 (3): 277-307.

Godin,B. (2010c), The Knowledge Economy : Fritz Machlup's Construction of a Synthetic Concept, in R. Viale and H. Etzkovitz (eds.), *The Capitalization of Knowledge: A Triple Helix of University-Industry-Government*, Edward Elgar, Edward Elgar: 261-90.

Godin, B. (2012a), How Innovation Got Technological and Commercialized, in in C. Newfield(ed.), *Can Rich Countries Still Innovate*, Duke University Press, Forthcoming.

Godin, B. (2012b), καινοτομία: An Old Word for a New World, or the De-contestation of a Political and Contested Concept, in Karl-Erik Sveiby, Pemilla Gripenberg and Beata Segercrantz (eds.), *Challenging the Innovation Paradigm*, London: Routledge, Forthcoming.

Gummett, P. (1980), *Scientists in Whitehall*, Manchester: Manchester University Press.

Gummett, P.J., and G.L. Price (1977), An Approach to the Central Planning of British Science: The Formation of the Advisory Council on Science Policy, *Minerva*, 15: 119-43.

Hodgson, G.M. (1993), Joseph Schumpeter and the Evolutionary Process, in G.M. Hodgson, *Economics and Evolution*, Ann Arbor: University of Michigan Press: 139-51.

Jewkes, J., D. Sawers and R. Stillerman (1958), *The Sources of Invention*, London: Macmillan.

Johnson, E. A. (1930), The Mercantilist Concept of 'Art' and 'Ingenious Labour', *Economic History*, 2: 234-53.

Lancaster, K. (1966), Change and Innovation in the Technology of Consumption, *American Economic Review*, 56 (1-2): 14-23.

Lange, O. (1943), A Note on Innovation, *Review of Economic Statistics*, 25 (1): 19-25.

Langrish, J., M. Gibbons, W.G. Evans and F.R. Jevons (1972), *Wealth from Knowledge: Studies of Innovation in Industry*, London: Macmillan.

Layton, C. (1972), *Ten Innovations: An International Study on Technological Development and the Use of Qualified Scientists and Engineers in Ten Industries*, London: Allen & Unwin [published version of a study commissioned by the UK Central Advisory Council for Science and Technology in 1968].

Maclaurin, W. R. (1949), *Invention and Innovation in the Radio Industry*, New York: Macmillan.

Macleod, C. (2008), Want not Watt: Analyzing Invention from the Peripheries of Nineteenth-Century British Economics, *Business Archives*, 97: 39-54.
Mansfield, E. (1968), *The Economics of Technological Change*, New York: Norton.
Martin, B. (2008), *The Evolution of Science Policy and Innovation Studies*, Working Paper, Center for Technology, Innovation and Culture, University of Oslo.
Miettinen, R. 2002. *National Innovation System: Scientific Concept or Political Rhetoric*. Helsinki: Edita.
National Bureau of Economic Research (NBER) (1962), *The Rate and Direction of Inventive Activity: Economic and Social Factors*, Princeton: Princeton University Press.
Nelson, R. R. (1959), The Economics of Invention: A Survey of the Literature, *Journal of Business*, 32 (April): 101-27.
Nelson, R. R. (1963), Role of Knowledge in Economic Growth, *Science*, 140 (3566), May 3: 473-74.
Nelson, R. R. (1964), Aggregate Production Functions and Medium-Range Growth Projections, *American Economic Review*, 54 (5): 575-606.
Nelson, R.R. (2009), Building Effective Innovation Systems versus Dealing with Market Failures as Ways of Thinking about Technology Policy, in D. Foray (ed.), *The New Economics of Technology Policy*, Cheltenham: Edward Elgar: 7-16.
Nelson, R. R. (2008), What Enables Rapid Economic Progress: What Are the Needed Institutions?, *Research Policy*, 37: 1-11.
Nelson, R. R., M. J. Peck and E. D. Kalachek (1967), *Technology and Economic Growth and Public Policy*, Washington: Brookings Institution.
Nutter, G. W. (1956), Monopoly, Bigness, and Progress, *Journal of Political Economy*, 64 (6): 520-27.
OECD (1962), *Proposed Standard Practice for Surveys of Research and Development,* Paris: OECD.
OECD (1963a), *Science and the Policies of Government*, Paris.
OECD (1963b), *Science, Economic Growth and Government Policy*, Paris: OECD.
OECD (1966), *Government and Technical Innovation*, Paris: OECD.
OECD (1970), *Gaps in Technology: Comparisons Between Member Countries in Education, R&D, Technological Innovation, International Economic Exchanges*, Paris.
OECD (1971), *Science, Growth, and Society: A New Perspective*, Paris: OECD.
OECD (1972), *Innovation in Social Sectors*, Committee for Scientific and Technological Policy, Internal document, SPT(72)8.
OECD (1980), *Technical Change and Economic Policy*, Paris: OECD.
OEEC (1959), *Report of the Working Party no. 26 of the Council*, C (59) 215, Internal document.
OEEC (1960), *Co-Operation in Scientific and Technical Research*, Paris: OEEC.
Pavitt, K. (1971), *The Conditions for Success in Technological Innovation*, Paris: OECD.
Pavitt, K., and W. Walker (1976), Government Policies towards Industrial Innovation: A Review, *Research Policy*, 5: 11-97.
Rosenberg, N. (1976), Problems in the Economist's Conceptualization of Technological Innovation, in *Perspectives on Technology*, Cambridge: Cambridge University Press: 61-84.

Scherer, F. M. (1982), Inter-Industry Technology Flows in the United States, *Research Policy*, 11 (4): 227-245.
Schumpeter, J. A. (1939), *Business Cycles: A Theoretical, Historical, and Statistical Analysis of the Capitalist Process*, Volume 1, New York: McGraw Hill.
Schumpeter, J.A. (1942), *Capitalism, Socialism and Democracy*, New York: Harper, 1962.
Schroter, A. (2009), *New Rationales for Innovation Policy? A Comparison of the Systems of Innovation Policy Approach and the Neoclassical Perspectives*, JENA Economic Research Papers no. 33, Max Planck Institute of Economics, Jena.
Shavinina, L. V. (ed.) (2003), *The International Handbook on Innovation*, Amsterdam: Elsevier.
Skinner, Q. (2002a), *Visions of Politics*, volume 1, Cambridge: Cambridge University Press.
Skinner, Q. (2002b), *Visions of Politics*, volume 3, Cambridge: Cambridge University Press.
SPRU (1972) *Success and Failure in Industrial Innovation: A Summary of Project SAPPHO*. London: Centre for the Study of Industrial Innovation.
Strassman, P. (1959), *Risk and Technological Innovation: American Manufacturing Methods during the Nineteenth Century*, Ithaca (NY): Cornell University Press.
Staudenmaier, J. M. (1985), *Technology's Storytellers: Reweaving the Human Fabric*, Cambridge (Mass.): MIT Press.
UK Advisory Council on Scientific Policy (1964), *Annual Report 1963-1964*, Department of Education and Science, London: HMSO.
UK Central Advisory Council on Science and Technology (1968), *Technological Innovation in Britain*, London: HMSO.
US Department of Commerce (1967), *Technological Innovation: Its Environment and Management*, Washington: USGPO.
Usher, D. (1964), The Welfare Economics of Invention, *Econometrica*, 31: 279-85.