Research or Development?
A Short History of Research and Development as Categories

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What if the real issue is not basic *versus* applied research but research *versus* development? The first relates to an old political issue which, according to many, has lost most of its relevance today, while the second is, we think, a substantive issue which needs to be framed anew.

This paper is a short history of categories used to talk about science, technology and innovation seen through the lens of definitions used for statistical purposes. [1] We begin by asking what research is, and explain why, over time, research and development (R&D) reached and held the central place in discourses and policies on science, technology and innovation. Here, we outline how the D got into R&D. Then we offer a personal view on how research *or* (not *and*) development is the appropriate issue. We tell this story not from a supply-side view, which characterizes most studies on science, technology and innovation. Rather we tell the story from the viewpoint of those (society) who benefit from the results of research results, and ask: what is needed in order to support the market introduction of technological innovations with socioeconomic benefits: research or development – or something more?

Research

In 1906, James McKeen Cattell, editor of *Science*, published the first edition of a directory of researchers in the United States. It included 4,000 biographies on “men who have carried out research work”. No industrial researchers were included in the directory. To Cattell, research meant university research, above all “pure” research in the natural, medical and psychological sciences. At the time, whether it was called pure, fundamental or basic, research was discussed in terms of a dichotomy: basic *versus* applied research. The dichotomy is based on the intentions of the performer (seeking knowledge or applications) rather than on methodology or output. Twenty years later (1927), US

[1] This paper focuses on early experiments in the Unites States, for it is there (together with the United Kingdom and Canada) that the first thoughts emerged on categories for statistical purposes (see Godin, 2005).

President Hoover used numbers on both kinds of research for the first time, and made a plea for “pure” research as being the “soil” of civilization. Basic and applied research have been the two categories used to discuss research in the decades that followed.

Research is an academic’s category which, over time, replaced the categories “investigation” and “inquiry”. Basic research is a category invented by academics too, in this case to promote a view, that of the central role of science (and scientists) in “progress”. In fact, such a view is the spontaneous philosophy of scientists. Yet governments were not fools, at least some officials. In the 1950s, the director of the US Bureau of Budget, Harold Smith, suggested that Vannevar Bush’s *Science: The Endless Frontier* (1945), a “program” submitted to the President for funding basic research, should be renamed *Science: The Endless Expenditure*. Today, very few official surveys collect numbers on basic research, the definition of which is not believed to be appropriate to policy (Godin, 2003).

Very early on it was admitted that research, including basic research, was not appropriate to industry either. In the first survey of industrial research conducted by the US National Research Council in 1920, the organization used a liberal interpretation which let the questionnaire respondent decide what to include in research expenditures. Similar practices continued until the early 1940s. Yet industrialists in the early twentieth century adopted the category basic research with little hesitation. In the hands of the industrialists, the category served to persuade firms to set up laboratories. Research, or rather basic research, was said to be fundamental to industrial development.

Research and Development

A more appropriate category to industry is development – although in the 1920s and 1930s industrialists mainly talked of science or research and many ignored development, at least in public discourses. Yet the National Research Council's report mentioned above admitted that "research is frequently applied to work which is nothing else than development".

While research is an academic's category, development is an industrial category. It is composed of those activities which rely on engineering and which are devoted to developing prototypes of new goods and services: design, testing, scaling-up and pilot plants. Development as a category comes from biology and social evolutionism in the second half of the nineteenth century, and started to be used in industry in the late nineteenth-early twentieth century as the "evolution of industry which could be accomplished through research". Development gave its name to firms' divisions, previously called (experimental or technical) laboratories, which later got separated into research (applied research) and development (developing new products) divisions. [2]

Development got still more attention from the 1920s onward when many started talking of a spectrum (and a sequence) from basic research to applied research then to development – rather than the dichotomy basic *versus* applied. Such was the case in a classic in management literature from C. E. K. Mees of Kodak (1920), in Maurice Holland's research cycle at the National Research Council (1928), and in economic historian W. Rupert Maclaurin's "linear model of innovation" (1949). At a more aggregated (policy) level, industry came to be considered as part of the national "system" of research and, therefore, a place in the statistics had to be made for industrial activities proper. From the 1930s onward taxonomies of research developed with development as a subcategory, and the first numbers on development were collected beginning in the late 1940s as a subset of measurements of research activities.

After 1945, development shifted from being a subcategory of research (together with basic and applied research) to a separate category. At this point it would have been logical to distinguish between measures of research activity and measures of

[2] Since 1970, the OECD Frascati manual adds "experimental" to development in order to distinguish the concept from that of development in the sense of social and economic development, as in the acronym OECD.

development activity. Instead, officials coined the acronym R&D (research and development), and consequently continued to measure the combination of the two activities, starting with the report from the President's Scientific and Research Board in 1947. Two rather specious explanations are given for the merging of the two categories in government reporting. The first factor is accounting: the two activities were claimed to be interrelated, so firms did not have detailed accounting practices for separating the two, and therefore government agencies could not differentiate them for statistical purposes. A similar argument was made for drawing boundaries between development activities and production activities. This claim is more likely based on the tax code's distinction between corporate expenditures for generating knowledge (research) versus expenditures for generating products (development). The second factor is politics: merging the two activities had the effect of increasing the volume of expenditures devoted to research as shown in statistics. It helped the case of candidates looking for symbolic and popular support for public funding of research activity.

Research or Development

In 1965, in an article titled *The ABC of R&D*, David Novick from the RAND Corporation suggested, "We should stop talking about research and development as though they were an entity and examine research on its own and development as a separate and distinct activity". Largely due to the factors discussed above, Novick's suggestion was ignored.. The co-mingling of research and development expenditures, activities and results had the effect of giving priority to research over development in policies. While research, which corresponds to one third of R&D expenditures, has specific categories to discuss it (basic and applied), the bulk of the R&D expenditures – two thirds is devoted to development – has no category at all. The difference in emphasis may be that governments' funding of research has a large, articulate and influential interest group in university scholars, while there is no equivalent interest group for development.

And so it has remained throughout the following decades of policy deliberations. The research community has strenuously advocated for the maximum funding allocations to scientific research. The linear model of innovation and its progeny go so far as to suggest that all downstream socio-economic value from development and production is determined by the level of funding for research. This position conflicts with the facts. It is past time to consider a different approach. Following Novick (but for a different reason), we suggest that research, development and industrial production, need to be kept separate, at least for policy purposes. The value of technological innovation is understood by politicians and the public to mean goods and services with two types of benefits: social benefits to people's quality of life, and economic benefit to firms. These benefits result from the acquisition and use of innovative goods and services by consumers in the marketplace. These goods and services are delivered through the private sector, which invests in innovations that meet a verifiable "need". This is the "demand pull" side of what is known as the push-pull dichotomy. Despite this fundamental truth of the power of market demand to convert R&D into socio-economic benefits, "supply push" thinking dominates innovation theories and models (Godin & Lane, 2011).

From the "supply push" perspective, the intentions of the research sponsors or the academic investigators drive downstream knowledge used in development and production. Hence the debates regarding basic versus applied research. In the context of policies, these distinctions are irrelevant to the contributions of scientific knowledge to innovation for two reasons. First, scientific knowledge is necessary, but not sufficient, to generate innovation with socio-economic impacts. Regardless of the producer's intentions, some basic findings are adopted and some applied findings are not. Second, it is the knowledge adopter – not the knowledge producer – who determines whether and how research findings are used and then transformed through subsequent methods to eventually become innovations. The issue for the potential adopter of either research or development knowledge is relevance. For innovations defined as having socio-economic benefit, the only rational basis for relevance is utility to the adopter in the creation of wealth through sales of goods or services. Once products are launched in the marketplace as goods or services, their relevance is measured as the utility to the target customers who decide to expend resources to acquire the innovation.

This sequence of decisions to adopt, uptake or use knowledge lies on the demand side of the equation. Granted, the supply must be present to respond to the demand pull, but there is no “push” from the supply side that can induce knowledge use. Of course, the push side can market and promote. The pharmaceutical and cigarette industries are masters at advertising, but their ads still must always convey utility to – and ultimately convince use by – the buyer. To redirect the focus from supply push to demand pull, policy analysts need to define the mechanisms underlying the transformations of knowledge necessary to achieve socio-economic impacts and then measure these mechanisms accordingly.

The role of scientific research in advancing our understanding of nature is indisputable. However, the output of scientific research is knowledge in the form of a conceptual discovery – a novel finding that is freely and publicly disclosed in the scholarly literature (publication). It has no commercial value – until it is used. To progress toward a good or service with socio-economic value, the methods of engineering development are necessary to transform the conceptual discoveries of scientific research into knowledge in the form of an invention – a tangible prototype publicly disclosed, for example, as a legal claim (patent). Unfortunately, the methods of engineering development are also necessary but not sufficient to generate innovations as defined here. Invention patent applications simply describe a feasible means for reducing a concept to practical form. Yet that form is only a prototype requiring further refinement to gain commercial value. The critical point for policies is that scientific research and engineering development represent two distinct states of knowledge – both important but nascent states in the context of technological innovations (Lane & Flagg, 2010). The outputs from R and D need to be combined in order to become inputs for yet a third stage, that of industrial production. Industry conducts production activities, which are held as proprietary knowledge until the market launch of outputs in the form of finished goods and services. These goods and services at last have commercial value. Sales generate economic benefits through revenue collection which is distributed to employees, shareholders, suppliers and governments. Purchasing generates societal benefits through the functional utility of the goods and services to the end consumers. Although the term innovation is generally improperly applied in reference to the outputs from science and engineering – to R&D – in the policy literature, it is the outputs from industry that satisfy the definition of an “innovation” as commonly understood to represent socio-economic value.

Why do measurements fail to differentiate R methods from D methods? Why do indicators exclude the methods and imperfectly measure the outputs of industry (surveys of innovation)? Historically, the pervasive emphasis on scientific research by its champions has completely overshadowed the equally important contributions of engineering development. Furthermore, the “free market” bias often prevents public policies from even considering industrial production as being eligible to share in the stream of public revenues allocated to technological innovation. The supreme irony is that industry – private sector corporations and their employees – generate the majority of revenues collected through taxation and dispensed to the public and non-profit sectors through government programs. Nations that establish policies accounting for the mechanisms and indicators of all three, research, engineering development and industrial production, would be best positioned to lead innovation in the Twentieth-First Century.

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