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# A Consistent, Exhaustive Taxonomy of Inventive Activities

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## Abstract

A classification of scientific and technological activities is put forth here, based on taxonomy of Inventive Activities' features. In the end, a description of Research & Innovation ensues that is consistent and more complete than current ones. Then, the gauging of R & I activities may result more meaningful and precise.

## Preliminary definitions

Analyzing a crucial feature of the **Discoveries** [1] or **Inventions** - from the Latin word <<INVENIRE = to discover>> - by which mankind's rational knowledge grows, let us start from an irrefutably essential, basic characteristic of such Inventive activities:

- all of them aim at **|Reproducible • Results|**; therefore consisting of a search for **|General • Solutions|**.

Then, we can and must take into account the **|Science \_versus\_ Technology|** divide. For this analytical step to be introduced in a rational, sensible way, the distinction between the two momentous concepts had better be justified by discussing and clarifying the opposite criteria underlying each of the two, contrasting concepts. As little as one may analyze such a hypothetical couple of bases, a distinction immediately comes to mind: that between <<TRUE>> and <<USEFUL>>, whereby an approximate solution to a problem might be considered satisfying by an engineer but non by a scientist, and, conversely, scientists can even settle for precise, if useless solutions, which instead engineers will dismiss.

## The taxonomy

Once the general opposition between Science and Technology is accounted for, three couples of twin, contrasting features can be derived from the **|General • Solutions|** binary relationship:

1. "Conceptual" *versus* "Practical" [2] ;
2. "General" *versus* "Particular" [3] ;
3. "Questions" *versus* "Answers" [4].

Having defined these three opposite poles, the bases are set to establish a correspondent classification - nonetheless, NOTA BENE: (i) this classification and

(ii) the rule(s) by which it is generated are neatly distinguished ideas; indeed the etymology of the term <<Taxonomy>> (that derives from Ancient Greek) sums up two clearly distinct concepts; "ταξον- = category" and "νομια = to order".

## The resulting classification

Such an initial theoretical *milieu* offers original scope for a novel, and perhaps seminal classificatory investigation.

At this analytical stage, two points ought to be noticed:

A) the resulting classification is symmetrical, i.e., made up of an even number of categories, since the amount is proportional to a sum of pairs;

B) more specifically, the whole number of categories shall be eight (two to the third power). This may at first sight appear a counterintuitive, rather puzzling result. In fact the Inventive activities' categories which can sensibly be detected throughout the OECD statistics are currently a lesser, uneven number, five at most: 1) Basic Research; 2) Applied Research; 3) Experimental Development; 4) Engineering; 5) Technological Innovation. Among these, only the first one tells apart "conceptual" activities, while the others concern "practical" activities. This circumstance is a bit paradoxical, since the international effort - mainly driven by OECD - to measure national S&T pursuits was first addressed at collecting data on Scientific research.

## Technological, practical activities

1. **Finalised research on general questions.** The first category is made up by the S&T activity specified by triplet: **|practical • general • questions|**. This category overlaps with "Applied research".

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2. **Finalised research on particular questions.** A symmetrical category shall consist in the activity identified by triplet **|practical · particular · questions|** - i.e., "Experimental development", according to the Frascati Manual's definition of this search activity.
3. **Engineering.** The third category of our taxonomy, covers S&T activities producing **|practical · particular · answers|**. It consists in practical answers derived from rational - mainly scientific - knowledge.
4. **Technological innovation.** The fourth category, symmetrical to the third one, is made up by S&T activities which have produced: **|practical · general · answers|**, namely technological innovations.

#### Scientific, conceptual activities

5. **Contemplative science.** Then comes the category of S&T activities consisting in the investigation of **|conceptual · general · questions|** by devising scientific theories, discussing the conditions for their internal consistency and empirical content, deriving each one's empirical consequences, and the reciprocal compatibilities of all the competing conjectures, et cetera. This inventive activity obviously corresponds to what is very often referred to as Basic Research.
6. **Publishing.** The following, symmetrical category is connected to the circulation of Scientific Information, being mainly performed by scientists publishing and citing in scholarly journals **|conceptual · general · answers|** which scientists publish and cite in scholarly journals, and, besides, taking part in conferences, and so on and so forth.
7. **Experimental research.** The seventh category includes activities performed by researchers in order to investigate **|conceptual · particular · questions|** by looking for *new* specific empirical

evidence that may refute or tentatively corroborate scientific theories. This activity starts independently of the origins of such general conjectures, that can derive from whatever hint, with no need for prior "sound" empirical justifications. Then, the experiments which are the core of such scientific pursuits are driven by the theories themselves which are meant to be checked [5].

8. **Inductive research.** The last category is obviously symmetrical to the seventh one, being ruled by a logical relationship between conceptual search and empirical evidence which runs in the opposite way; therefore the **|conceptual · particular · answers|** are found out by investigating the properties possibly shown by *already given* sets of data. In the inductive research of course an essential role is played by the application of Probabilistic Statistics' methods.

#### Conclusions: research future perspectives

Thanks to a more in-depth understanding and analysis of Inventive activities, the discussion that has led to our proposed taxonomy may foster the introduction of novel measurement criteria and the definition of new R&I quantitative indicators. This way, as it happens in science, a basic, preliminary qualitative could in the end inquiry could prove extremely fruitful, by opening up uncharted territories for the theoretical sphere as well.

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