Standards, tools and best practices for the ethics assessment of innovation and technology development plans

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Annex 4

A reasoned proposal for a set of shared ethical values, principles and approaches for ethics assessment in the European context

Deliverable 4.1

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1 INTRODUCTION

This brief report investigates the specific demands placed on practices of the ethics assessment by different innovation and technology development plans and projects, as performed by, for example, research ethics committees (RECs) for engineering at universities, in industry or elsewhere. We focus on the ethical impact assessment (EIA) approach as described in SATORI Deliverable D4.1. However, we also address the limitations of EIA and propose alternative methods of ethics assessment. This report does not analyse the institutional setup of ethics assessment in relation to innovation and technology development plans and projects. We will map and analyse actors engaged in the development of these plans and projects in the broader report on proposals for the institutional structure of ethics assessment in the EU and its nation states (4.3.2).

In this study, we perceive innovation as an integrated process of various steps,[1] a process to create a design based on needs and demands. This approach also refers to innovation and technology development plans. Therefore, we distinguish three stages of the innovation and technology development plans:

1. Basic research
2. Applied research
3. Innovation – development

Next to the three main stages of innovation and technology development plans, we differentiate a more distinct class of projects whose aim is to develop and implement plans and programs in relation to engineering and innovation.

By *research* we understand “the conception or creation of new knowledge, products, processes, methods and systems”[2] or a “systematic study directed towards more complete scientific knowledge or understanding of the subject studied.”[3] Next to research, we include *development* perceived as a “systematic use of the knowledge or understanding gained from research for the production of materials, devices, systems, or methods, including design, development, and improvement of prototypes and new processes. It excludes quality control, routine product testing, and production.”[4]

In this study of the ethics assessment of innovation and technology development plans and projects, we apply the so-called *chain-linked model of technological innovation* (CLM) by Kline & Rosenberg (1986) (Figure 1).

[1] Conway S., Steward F., “ Managing and shaping innovation”, Oxford University Press, 2009, [p. 10].
[2] Frascati Manual, OECD, “Proposed Standard Practice for Surveys on Research and Experimental Development”, 2002.
[3] AAAS, “Definitions of Key Terms”, http://www.aaas.org/page/definitions-key-terms
[4] AAAS, “Definitions of Key Terms”, http://www.aaas.org/page/definitions-key-terms

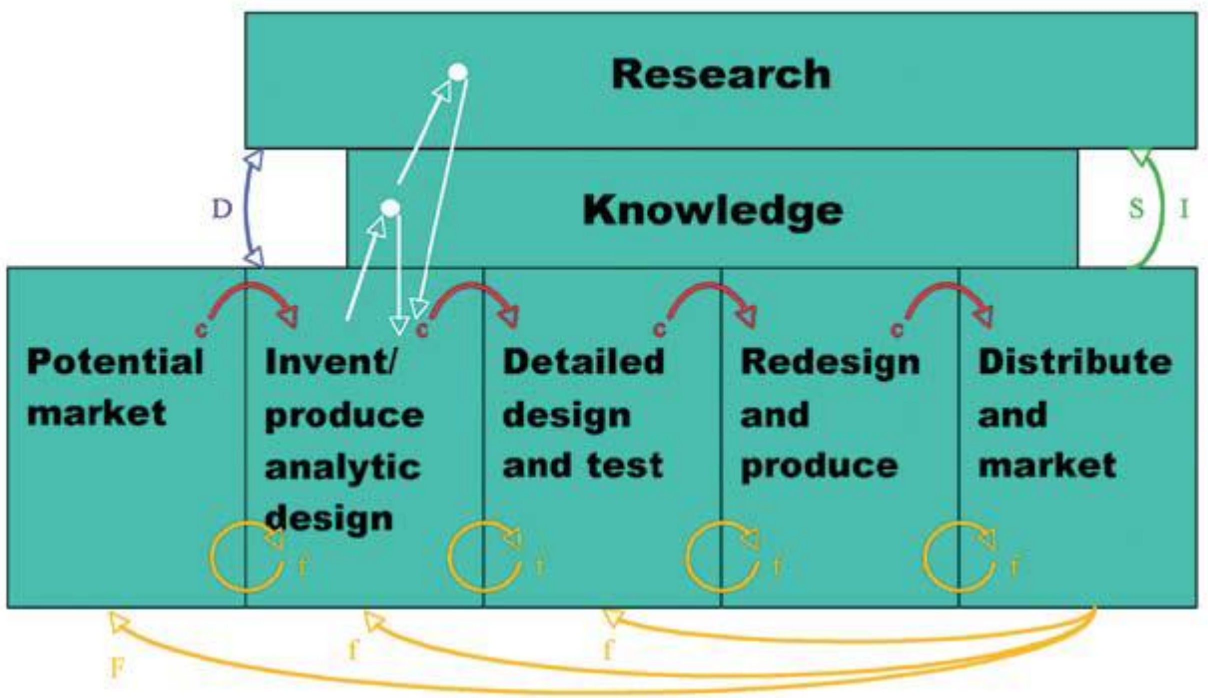

Figure 1: Chain-linked model of technological innovation (CLM) (Kline & Rosenberg 1986)

This model takes into account that the innovation process can be sequential. Nevertheless, this process is more complex as there are numerous feedback loops.[5] When a problem arises, solutions are firstly looked for on the basis of the existing scientific and technical knowledge.[6] However, if scientific and technical knowledge are found to be insufficient, new research is conducted.[7] Figure 1 shows the interconnectedness of particular steps of the process and feedback loops. This means that although we, in SATORI, differentiate stages of innovation and technology development plans (stage 1, 2, and 3), we emphasize a non-linear character of the innovation process. In this regard, the chain-linked approach "surpassed the linear model [of innovation] by emphasising that science is part of the process, but not necessarily the initiating step."[8] For instance, basic research contributes to the stock of existing knowledge and therefore has an indirect influence on innovation.[9] However, it "may also give rise to new designs and be influenced by innovations, particularly related to scientific instruments."[10]

Let us now further discuss the three main stages of innovation and technology development plans and the additional class of programs and (urban) plans. Each stage is first defined and then

[5] Gulbrandsen, Magnus, and Oslo NIFU STEP, "The Role of Basic Research in Innovation", Confluence: 55., p. 57.
[6] Ibid.
[7] Ibid.
[8] Caraça, João, Bengt-Åke Lundvall, and Sandro Mendonça, "The changing role of science in the innovation process: From Queen to Cinderella?" in *Technological Forecasting and Social Change*, 76.6 (2009): 861-867, p. 864.
[9] Gulbrandsen, Magnus, and Oslo NIFU STEP. "The Role of Basic Research in Innovation." Confluence: 55., p. 57.
[10] Ibid.

analysed in terms of the application of ethics assessment, in particular the ethical impact assessment (EIA) approach described in SATORI Deliverable D4.1.

Stage 1: Basic Research

Basic or fundamental research develops scientific knowledge and predictions, principally in natural sciences but also in other empirical sciences, which are used as the scientific foundation for applied research. Traditionally, research is classified as basic (fundamental) or applied depending on the objective.[11] Basic research is conducted to gain knowledge or understanding of phenomena without specific applications in mind.[12]

Basic research can be understood as "pure science", therefore science for science's sake. Basic research may be performed without any thought of social improvements, such as health or economic prosperity.[13] Basic research raises a problem of missing knowledge about potential applications and impacts of fundamental research. In general, ethical impact assessment for basic research (as described in SATORI Deliverable D4.1) can be done either at the *level of research programs for new scientific fields* or the *level of individual projects*. The ethical impact assessment for basic research should include a significantly expanded foresight stage. Furthermore, we recommend that more financial and time resources should be allocated relatively to the EIA scales for technological research and innovation. Nonetheless, the EIA for basic research has its limits. In some cases, regardless how much time and effort are put into foresight, speculating on potential future applications and impacts of fundamental research has an increased likelihood that the predictions are wildly off the mark.

Stage 2: Applied Research

Applied research is conducted to gain knowledge or understanding necessary for meeting a specific need.[14] Applied research focuses on the development of technology and techniques.

Ethical impact assessment for applied research is conducted in the same manner as EIA is conducted for innovation − development (stage 3). Therefore, EIA of applied research uses the same threshold analysis, scales of EIA, foresight stage, identification stage and evaluation stage. Despite the fact that applied research brings more knowledge about the potential impacts, there often are still many uncertainties. Therefore, in EIA for applied research there should be more emphasis on foresight stage, since it is more difficult to see what applied research might lead to.

Basic Research vs. Applied Research

Recently, the clear line between basic and applied research has become blurry. Contemporary basic research is more and more connected to the social, political, technological, and economic context. Despite the argument about the feedback loops between the technical innovation stages, we suggest other factors contributing to this situation. These factors relate to both research

[11] Ibid.
[12] Ibid.
[13] Briggle, Adam, and Carl Mitcham. *Ethics and science: an introduction*. Cambridge University Press, 2012.
[14] AAAS, "Definitions of Key Terms", http://www.aaas.org/page/definitions-key-terms

programs for new scientific fields and the level of individual projects of fundamental research. One of these factors refers to the research programs for new scientific fields and it is about the financial support for basic research, hence the distribution of investments in research and the resulting benefits. Researchers depend on research funding and policies of science budgets. Because the potential applications of the results and the impacts of basic research are unknown to a great extent, researchers are to an increasing extent "motivated to produce knowledge that is valid and important in the eyes of their peers; they are seldom motivated to consider the relevance or implications of their work for society at large."[15] In this way, basic research losses its "pure" character and becomes more related to potential applications. The second factor, is related to the assumption that basic research scientists have only one responsibility – to produce good science (peer reviewed and free from misconduct)[16] and that they do not need to consider how that research relates to society.[17] In SATORI, we support the claim that good science should go beyond this definition. And therefore, scientists should not only avoid scientific misconduct, but also consider their social accountability. Consequently, they should consider what the value of the research is, which knowledge should be pursued, which scientific pursuits should be regulated or illegal, what "good science" is and who should define it.[18]

All things considered, we believe that the distinction between basic science and applied science is still valid, even if there is no clear line. We acknowledge that it is sometimes difficult to determine whether a particular project falls into the former or the latter category. In terms of the ethics assessment approaches proposed by us, this might not present much of a problem, since the approaches for both are quite similar.

Stage 3: Innovation – development

Basic and applied scientific research lays the foundation for the development of technological goods at the *development stage*. The end-products of this stage may be categorized into three main groups:

1) structures and spaces,
2) products, and
3) applied systems and processes.

Structures can be defined as large to very large stationary or slow-moving man-made bodies or systems of connected parts, which are often designed for human occupancy. Examples of this category are public outdoor spaces such as squares and parks, industrial buildings such as factories and oil drilling rigs, and earthworks such as levees and artificial islands. *Products* can be defined as machines, tools, components, materials and services, which may be physical or intangible (the latter includes virtual products and services). Physical products are often mass-produced in factories and tend to be smaller and more transportable than structures. Finally,

[15] Ibid., p. 218.
[16] Ibid., pp. 2016-2017.
[17] Ibid., pp. 2016-2017.
[18] Ibid., p. 219.

applied systems and *processes* are taken as one category since they are related. Systems can be defined as a set of interacting or interdependent component parts (which can be structures, machines, tools, people, etc.) forming a complex whole, while processes can be defined as a set of interrelated activities that interact to achieve a result. Many of the largest system development projects are about the development of *socio-technical systems*, in which the role of humans is explicitly designed. For example, the conception, development and integration of a new supersonic air transportation system may involve airport facilities, air traffic control systems, airplanes, passengers, air traffic controllers, et cetera.

At the development stage, we may also discern between the following substages:[19]

1) Conception
   (Research is conducted on a new future product.)
2) Definition
   (Feasibility of the new product is determined. A prototype may be produced.)
3) Development
   (The new product is designed and engineered in detail.)
4) Implementation
   (The new product is constructed, manufactured or installed.)

The three kinds of technological products and the four substages at the development stage may require ethics assessment approaches that differ from one another as well as from the ethics assessment approaches for basic research and applied research. In general, our ethical ethical impact assessment approach (as described in SATORI Deliverable D4.1) at the development stage should be less focused on foresight than it is at the basic research and applied research stages. Fewer resources need to be spent on foresight since at the development stage we have a clearer view of the products that are likely to emerge and of their potential impacts on society and the environment.

As regards the differences in terms of ethical impact assessment *within* the development stage, let us first make recommendations concerning the three main categories of technological goods:

- First, the development of new structures and spaces benefits from increased stakeholder consultation or participation, since these goods often have a direct and unavoidable impact on communities. Stakeholder-driven ethical analysis gives stakeholders a chance to express their interests, values and opinions on large development projects such as a new public recreation area or a coastal wind farm.
- Second, for (smaller) product development projects, principle-driven ethical analysis might often be preferred, since it is more cost-efficient and time-efficient. Because product uptake by consumers is usually voluntary, direct consultation or participation of

[19] Jouker, R. "The Difference between Different Types of Projects. Project Perspectives" 2013, Vol. XXXV, 2013, 12–15. http://www.ipma.world/assets/re-perspectives_2013.pdf

these and other stakeholders during ethical analysis may not be necessary, although their inclusion may certainly still be helpful.

- Thirdly, since an overwhelming majority of product-type goods (machines, tools, components, materials and services) are being developed by commercial businesses, ethical impact assessment for products development projects should be integrated into established corporate responsibility (CR)[20] tools, including policies, strategies and programs, wherever this is possible.

As regards the four substages at the development stage, we recommend the use of slightly different ethical impact assessment approaches if these substages are not subsumed into a single development project.[21] We recommend that going from the "conception" substage to the "implementation" substage, the relative amount of resources needed for the foresight stage decrease in comparison to the resources allotted to the ethical analysis stage. This is because an ever clearer picture of the nature of the end-product and its potential ethical impacts emerges during the development process (which slowly obviates the need for an extensive foresight stage).

Programs and (urban) plans

Next to the three main classes of research and development project, there is a more distinct class of projects whose aim is to develop and implement plans and programs in relation to engineering and innovation. A program is a purposely developed and managed collection of related projects. An urban plan is a plan for the development and management of urban, suburban and nature areas, which considers a wide array of issues such as sustainability, air pollution, and traffic congestion.

The category of programs and plans may contain the following subcategories:

- environmental, land use, regional, urban and spatial plans;
- technology development programs; and
- product development programs.

Due to their often large scale, these programs and plans have a potential for big impacts on people, animals and the environment. This means that the projects to develop and implement these programs and plans require an ethical impact assessment process that puts significant emphasis on participation (or consultation) by relevant stakeholders in the ethical analysis. It is not recommended that the ethical impact assessment is conducted on the basis of principle-driven ethical analysis.

[20] In SATORI we use a broad concept of *corporate responsibility* (in contrast to *corporate social responsibility*, CSR) in order to foster a wide array of companies' responsibilities taking account of social as well as economic and environmental responsibilities.
[21] Engineering projects do not always focus on all of the phases of the project life cycle. For example, a project is sometimes intended to end at the "definition stage" with the creation of a prototype or proof of concept.