The Ne\(^3\)LS Network, Québec’s initiative to evaluate the impact and promote a responsible and sustainable development of nanotechnology

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Abstract. The spectacular progress made by nanosciences and nanotechnologies elicits as much hope and fear. Consequently, a great number of research and training initiatives on the ethical, environmental, economic, legal and social issues regarding nanotechnology development (Ne\(^3\)LS) are emerging worldwide. In Québec, Canada, a Task Force was mandated by NanoQuébec to conceive a Ne\(^3\)LS research and training strategy to assess those issues. This Task Force brought together experts from universities, governments or industry working in nanosciences and nanotechnologies or in Ne\(^3\)LS. Their resulting action plan, made public in November 2006, contained several recommendations, including the creation of a knowledge network (Ne\(^3\)LS Network). In the following years, after consulting with numerous key players concerned with the possible impacts of nanosciences and nanotechnologies in Québec, the Ne\(^3\)LS Network was launched in January 2010 in partnership with the Fonds québécois de la recherche sur la nature et les technologies, the Fonds québécois de la recherche sur la société et la culture and the Fonds de la recherche en santé du Québec, NanoQuébec, the Institut de recherche Robert-Sauvé en santé et en sécurité du travail as well as the University of
Montreal. Its objectives are to 1) Foster the development of Ne³LS research activities (grants and fellowships); 2) Spearhead the Canadian and international Ne³LS network; 3) Take part in the training of researchers and experts; 4) Encourage the creation of interactive tools for the general public; 5) Facilitate collaboration between decision-makers and experts; 6) Involve the scientific community through a host of activities (symposium, conferences, thematic events); 7) Build multidisciplinary research teams to evaluate the impact of nanotechnology.

Introduction
Nanoscience and nanotechnology raise many challenges for stakeholders involved in the innovation process. Challenges are even greater if we consider the tremendous potential of this enabling technology. As a matter of fact, “many experts, researchers, engineers, social scientists and policy makers believe that nanotechnology will lead to important changes in society and that these changes may be of the same magnitude as was the introduction of computers.” (Science Metrix, 2005) However, technological breakthroughs need more than a strong base of science and favorable economic context to create wealth. In fact, the 20th century has shown with the turmoil surrounding biotechnology, especially in the case of genetically modified organisms (GMO), that we also need new approaches for integrating technology into society. When it comes to nanotechnology, the specter of GMO is now omnipresent in the minds of policymakers, scientists and the general population. How can we avoid a crisis that could ruin the emergence of a technology and its collective efforts of achieving good for society? One of the solutions to avoiding the pitfalls of nanotech development is to target our interventions toward a more responsible framework. As stated by the Commission de l’éthique de la science et de la technologie (CEST) in Québec, “Nanotechnology is an emerging sector of activity, and one that draws on a host of disciplines. For these reasons, steps should be taken to build the foundation of systematic and responsible development.” (CEST 2006) Because nanotechnology has not reached its full potential and has not yet been fully integrated into our markets, stakeholders can still make choices and try to address concerns. Though, far from being ideal, the present nanotechnology situation can still be seen as advantageous in comparison with the one with GMO. It remains possible to better position ourselves toward value creation and responsible development.

In regards to this situation, many countries around the globe are investing in social and safety aspects of nanotechnology development. For example, the United States, through the NNI, will allocate US$ 116.9 M in 2011 on environmental, health and safety issues, as well as US$ 34.8 M for education and societal dimensions. (NNI 2010) This represents around 8.6% of the overall NNI budget of US$ 1761.6 M.

Despite interesting initiatives¹, the situation in Canada still lags behind many European countries, the U.S. and Japan. The Canadian research community is still waiting for a national strategy on nanotechnology and a clear commitment from the government to assess crucial questions about nanotechnology development. In Canada, the acronym NE³LS is used for these questions. As defined by Lorraine Sheremeta “NE³LS is an acronym that stands for the Ethical, Environmental, Economic, Legal and Social issues associated with Nanotechnology. This acronym is a simple adaptation of the GE³LS acronym that relates the same issues to Genetics and Genomics.” (Sheremeta 2005) However, in Québec our scope also includes health and safety issues regarding nanotechnology.

¹ For example, University of Alberta and University of Toronto joint initiative, Position statement by the Commission de l’éthique de la science, NanoQuébec’s task force on ethics environment and society.
Many years have passed since Mnyusiwalla, Daar and Singer (Mnyusiwalla & al. 2003) urged us to mind the gap between ethics and nanotechnologies, and since Sheremeta stated: “Though there is evidence of ad-hoc progress in the area of NE3LS research, there remains a need for a well-defined, highly coordinated and appropriately funded NE3LS research agenda in Canada. The Federal Government, in cooperation with the governments of all Canadian provinces and territories must joint with industry to support the development of a research agenda that will address the unique issues, both foreseen and unexpected, that nanoscience and nanotechnology will raise.”(Sheremeta 2005)

Presently, the Canadian government has not yet established a national initiative to coordinate research in this field and assess Ne3LS questions. The momentum lies mainly on a provincial level.

The province of Québec is the first province in Canada to launch various initiatives to assess NE3LS-related issues, supported by several agencies. One of the cornerstones of the work done in Quebec was the position statement Ethics and nanotechnology: a basis for action, released by the CEST. Among the CEST recommendations is a proposal to create a multidisciplinary research program to assess the impact and risks associated with nanotechnology. In the meantime, NanoQuébec, the provincial organization responsible for structuring nanotechnology, in partnership with the granting agencies of Québec (Fonds québécois de la recherche sur la nature et les technologies (FQRNT), Fonds québécois de la recherche sur la société et la culture (FQRSC), Fonds de recherche en santé du Québec, (FRSQ) and the Institut de Recherche Robert-Sauvé en santé et en sécurité du travail (IRSS) developed its own framework. (Groupe de réflexion 2006). The framework was conceived with a panel of experts and included a strategy for NE3LS research and training as well as recommended actions to build capacity of NE3LS expertise in Québec. This process resulted in the creation of a Task Force on society, environment and ethics. (Groupe de réflexion 2006). This Task Force, in accordance with the CEST’s recommendations, then proposed the creation of a NE3LS Knowledge Network. As a result of this initiative, the Québec Government, via its funding agencies (FQRNT, FQRSC, FRSQ), has dedicated funds for NE3LS research in Québec through special scholarships and research grants. The Ministère du Développement économique, de l’Innovation et de l’Exportation (MDEIE) and the IRSST are also providing financial support to the network. (Groupe de démarrage NE3LS, 2007).

The Ne3LS Network
In January 2010, after consulting with numerous key players concerned with the possible impact of nanosciences and nanotechnologies in Québec, the Ne3LS Network was launched in partnership with the FQRSC, the FQRNT, the FRSQ, NanoQuébec, the IRSST as well as the University of Montreal.

Its objectives are to:
1. Foster the development of Ne3LS research activities (grants and fellowships);
2. Spearhead the Canadian and international Ne3LS network;
3. Take part in the training of researchers and experts;
4. Encourage the creation of interactive tools for the general public;
5. Facilitate collaboration between decision-makers and experts;
6. Involve the scientific community through a host of activities (symposium, conferences, thematic events);
7. Build multidisciplinary research teams to evaluate the impact of nanotechnology.

Based at the CHU Sainte-Justine Hospital, which is affiliated with the University of Montreal, the Ne3LS Network aims at establishing a knowledge network. This knowledge network will connect with different actors of nanotech development (academia, industry, governments and public) and
become a sharing platform. Consequently, all parties in this field will exchange knowledge and will eventually help to better shape public policies in this field. However, as a foundation of this initiative, a research network will be created to stimulate the production of knowledge in fields covered by NE3LS. The main scope of this network is to monitor the nanotech development process and supply it with an appropriate knowledge in social sciences as well as risk assessment, thereby maximizing its benefits while answering its key issues. Consequently, we aim at developing a balanced approach geared toward responsible and sustainable development.

This network relies on three main research axes, which are defined as follows:

**Axis 1: Nanoscience and Nanotechnologies: How do we Define Them?**
This axis examines the importance of clearly defining nanosciences and nanotechnologies, taking into account their scientific, social, political, economic and philosophical dimensions. Labelling a practice or a product as nanotechnological is not without consequence depending on the socioeconomic, cultural or ideological context. Therefore, it becomes all the more important to identify the impact that terminology has on society and perception, as these choices provide reference points for a technological development that will either align or disconnect with societal values worldwide. Moreover, close examination of the dialogues between technology actors such as government, industry, science and society, can prove beneficial.

**Axis 2: Interdisciplinary Risk Analysis and Acceptability**
With every technological breakthrough comes doubts posing as potential risks. Whether financial, legal, technological, environmental or health-related, these risks must be assessed. Each discipline uses its own definitions and assessment strategies to measure risk limits. Nanotechnology is particularly invested with great possibilities, be it as a means of producing new medication, improving diagnostic tests or creating greener or better performing materials. Scientific and industrial literature is teeming with discoveries in the field of nanotechnology. However, this progress must always be made with due consideration to humans and their environment. There are over 1,000 “nanoproducts” on the market today, even though studies measuring their effects on humans and the environment are yet to be completed. Furthermore, national and international regulations need to be put in place. Risk assessment thus represents a massive undertaking, requiring a multidisciplinary approach aimed at analyzing our ideas and perceptions on risk and its acceptability. In this sense, risk and risk assessment criteria will need to be clearly defined.

**Axis 3: Governance of Nanotechnology**
This axis investigates the regulatory modes governing nanotechnology practices as defined by the various players involved in its economic and technological development, such as governments, markets, the general public and the scientific community. Advances in nanotechnology have not only prompted questions concerning legislation and personal accountability, but have also given rise to issues related to democracy and ethics. Hence, this axis proposes not only to analyze the rules of economic and technological development of nanotechnologies, but also to understand their implications. Knowledge translation and dialogues between science and society are also explored. Research capacity building in this field was the clear mandate given by the Government of Québec to the Ne3LS network. In order to meet this expectation and promote activities and expertise, the network relies on research grants and scholarships. As previously mentioned, the funding agencies of Québec have created 6 dedicated scholarships per year (3 at the Doctorate/Ph.D. level and 3 at the Master’s level). In addition, the network is financing pilot projects with seed money, hoping to leverage more important provincial and federal funding.
At present, the network’s start-up phase is focused on maximizing interdisciplinary research and supporting educational activities. The network then seeks to enhance knowledge transfer activities, thus enabling it to operate at full potential in the years to come. The network is seeking collaborators in all fields related to NE3LS and would like to establish links with Asia, USA and Europe.

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