

Challenging times

The National Nanotechnology Initiative and the challenges of modern society.

In January 2000, US President Bill Clinton gave a speech at Caltech, during which he launched the National Nanotechnology Initiative (NNI). He spoke about the development of lightweight materials, about the miniaturization of information storage devices and about powerful methods for cancer diagnosis, and pledged an initial investment of US\$500 million of the federal budget (<http://go.nature.com/IyW47n>). The origin of the NNI can be traced back to March 1999, when Mihail C. Roco presented the idea to the White House. After the Clinton administration, the NNI was endorsed by both the Bush and Obama administrations, and has received more than US\$20 billion of federal budget over the years.

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In a Q&A published on page 401, Michael A. Meador, current director of the National Nanotechnology Coordination Office — which serves as a contact point between the NNI, the US government and the public — discusses the way in which the NNI has evolved and how it operates today. The overall aim of all of the government agencies forming the NNI, as it was 16 years ago, is the development of the science and technology of nanoscale materials for the public good. Despite several examples of technological achievements that have led to practical implementation of nanotechnology, in its first decade, the majority of the research efforts were on understanding the fundamental properties of materials at the nanoscale. In the last few years, however, the focus has gradually shifted to the development of nanotechnology to provide solutions to societal challenges such as information, security, health and resources management.

In 2010, the NNI launched the Nanotechnology Signature Initiatives (NSIs), which aim at concentrating the efforts of several government agencies towards areas considered of high priority for society.

Three NSIs were initially launched: on the development of solar cells; on the development of modern electronic systems and architectures; and on the development of large-scale and cost-effective production of nanomaterials. Two more NSIs followed in 2012, one that focuses on the creation of a community-based knowledge infrastructure for the development of nanomaterials, and another on the development of sensors with high sensitivity and high portability.

The clearest sign that the NNI, like other major bodies involved with nanotechnology globally, is focusing attention on solving societal problems, was the launch, on 22 March 2015, of the sixth NSI on water sustainability (<http://go.nature.com/CGZLv4>). The initiative, which involves six US government agencies, establishes some specific and ambitious goals, including doubling the throughput of water filtered by membranes within 5 years, the development and commercialization, within 10 years, of processes for desalination that are an alternative to those based on reverse osmosis, and, also within 10 years, the development of catalysts for water purification that are an alternative to those based on precious metals, which have been developed for some time.

A different way in which the NNI intends to operate in the future is through the nanotechnology-inspired grand challenges. Since 2013, the Obama administration has used the concept of grand challenges as a tool for science and innovation. The general concept of the challenges is to identify ambitious but achievable goals that can solve societal problems with contributions from both industry and academia, and that can engage the public imagination. The identification of a challenge does not translate directly into a well-defined programme and allocated government funding. Rather, it's a declaration of what the US government, in consultation with academia, industry and the public, considers areas of importance for society, followed by an invitation to all these parties to work on these areas. The concept of the grand challenges was adopted by the NNI in summer 2015. A public request for information, which included a number of examples of potential grand challenges, was published in June 2015, and proposals were accepted for a month.

The first grand challenge, announced in October 2015, was about the creation of a new type of computer capable of handling large amounts of data and able to operate with the energy efficiency of a human brain (<http://go.nature.com/uAQTPC>). Perhaps surprisingly, it was not about directly solving a societal problem, such as curing high-mortality diseases or the management of resources such as energy, food and water. But a new type of computer could be a powerful tool to tackle these problems indirectly. As explained by Paul Weiss and Ali Javey (*ACS Nano* **9**, 10533–10536; 2015), in the next few years, wearable sensors will provide large quantities of data that could be essential in solving problems related to health or natural resources, but this data will be useless without a new type of machine able to deal with all this information in an efficient way.

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This concept of nanotechnology contributing to solving societal challenges indirectly is also highlighted in this issue. In a Commentary on page 398, Koen Beumer emphasizes that the traditional attitude is to consider nanotechnology as a tool to solve problems related to poverty by primarily developing technologies that address those problems directly. He argues, however, that this approach may in fact limit the potential benefits offered by a nanotechnology and could even be counterproductive.

It is still too early to tell whether the nanotechnology-inspired grand challenges will prove effective. But the idea of focusing attention on issues that the public can relate to should be appreciated. Furthermore, the interest expressed by a number of industries and foundations (<http://go.nature.com/G14cRu>) in the development of a powerful computer is certainly a positive sign. Further grand challenges covering different topics will be necessary to assess their usefulness. Hopefully, the next US President, who will take office at the beginning of 2017, will endorse the concept. □