including aspects related to analytical test methods and environmental fate and transport. The goal is to create a public repository of information and to shape a toxicity research agenda by pooling the expertise of industry and academic laboratories, under the supervision and direction of government authorities.

Finally, in 2006 the City of Berkeley adopted a nanotechnology disclosure ordinance, embedded within the hazardous materials business plan and subject to the same definitions and conditions as other chemical substances. Any facility that produces or handles manufactured nanoscale materials—defined as "manufactured nanomaterials that are engineered and which have a dimension less than 100 nanometers"—must submit a yearly report. Though there have been conversations between the various state agencies and the City of Berkeley, there does not appear to be any direct link between local- and state-level policy initiatives.

See Also: Berkeley, California, Local Regulatory Efforts; Carbon Nanotubes; Center for Environmental Implications of Nanotechnology; Center for Nanotechnology and Society (Kent School of Law); Environmental Protection Agency (U.S.).

Further Readings

Blue Ribbon Task Force. *Thinking Big About Thinking Small: An Action Agenda for California* (2005).

Council on Science and Technology. *Nanoscience and Nanotechnology: Opportunities and Challenges in California* (2004).

Center for Nanotechnology and Society-UC Santa Barbara. "Data Visualization: Lux Maps." www.cns.ucsb.edu/lux-maps/ (cited July 2009).

Woodrow Wilson Center Project for Emerging Nanotechnologies. "U.S. NanoMetro Map." www.nanotechproject.org/inventories/map (cited July 2009).

Saxenian, Annalee. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press, 1996.

Starr, Kevin. *California: A History*. New York: Modern Library, 2007.

Whiteley, Carol and John McLaughlin. *Technology, Entrepreneurs, and Silicon Valley*. Morgantown, WV: Institute for the History of Technology, 2002.

Javiera Barandiaran
University of California, Berkeley

Cambridge, Massachusetts, Local Regulatory Efforts

The City of Cambridge, Massachusetts, has a celebrated history of engaging in local governance of new and emerging technologies. One of the city's most notable technology policies is its recombinant DNA ordinance. The city has an industrial history that is based in fabricating items such as automobiles and textiles; however, current industries are generally engaged in the high-tech sector, such as nanotechnology, biotechnology, and information technologies.

The approximately 105,000 people that call Cambridge home take pride in their city's dedication to academic and scientific innovation, as well as in its commitment to good public policy. When Cambridge Public Health Department (CPHD) officials in the city's Environmental Health Unit were presented with the challenge and opportunity of considering a possible nanotechnology regulation, they made efforts to assess possible policy approaches from a number of different angles. In summer 2008, the Cambridge nanotechnology policy was approved by the city council.

The CPHD, in collaboration with the Cambridge Nanomaterials Advisory Committee, decided not to pursue a nanotechnology regulation at the current time, due to the lack of assessment mechanisms and criteria for determining and evaluating risks associated with nanotechnology. The CPHD and the Nanomaterials Advisory Committee decided that it would be appropriate to recommend six steps that would enable the city to take a proactive, anticipatory approach in governing nanotechnology. The CPHD notes that the Nanomaterials Advisory Committee meetings and discussions dealt specifically with health and safety issues related to nanomaterial handling, exposure, and storage, as opposed to larger regulatory questions related to consumer products and environmental issues, which are traditionally addressed by state and national agencies.

Cambridge officially considered regulating nanotechnology in a city council meeting on January 8, 2007, encouraged to explore the issue after Berkeley, California, approved a measure in December 2006 to amend its hazardous materials ordinance to include a health and safety disclosure for nanoparticles. Sam Lipson, the director of the Environmental Health Unit (EHU), undertook the task of examining the Berkeley regulation and

determining appropriate measures for Cambridge. In order to bring multiple perspectives, transparency, and "experts in the field" into the EHU's examination of the issue, Lipson assembled the Cambridge Nanomaterials Advisory Committee (CNAC) in summer 2007. Eighteen individuals selected for their professional expertise in various fields comprised the committee. Members included university researchers, industry scientists, lawyers, policy scholars, and local government officials. Four committee members were also Cambridge residents. The Cambridge Nanomaterials Advisory Committee met for the first time in the summer of 2007 and met on a monthly basis through January 2008. Meetings were facilitated by Lipson and the CPHD. The committee was given the task of developing a series of policy recommendations for the city to pursue. In committee meetings, members engaged in dialogue regarding issues related to existing oversight mechanisms for nanotechnology, possible risk frameworks applicable to nanotechnology, and the state of nanotechnology regulation and oversight on the federal, state, and local levels.

The Cambridge Nanomaterials Advisory Committee, in collaboration with the Cambridge Public Health Department, determined six policy recommendations for the city to pursue for the following two years. The recommendations were compiled into a report, "Recommendations for a Municipal Health & Safety Policy for Nanomaterials," authored by Lipson and edited by Susan Feinberg. The report engages in an overview of nanotoxicology, a field that has focused primarily on naturally occurring nanoparticles, such as those found in diesel exhaust, and then identifies gaps in the current nanoparticle health and safety literature. The report raises questions that have not yet been answered regarding risks related to engineered nanomaterial uptake into the body, safe nanomaterial exposure thresholds, and whether there exist "meaningful differences" between human exposure to naturally occurring nanomaterials and engineered nanomaterials. The report's recommendations were approved as official policy mandate by the Cambridge city council at its July 28, 2008 meeting.

Recommendations

The first recommendation suggests that the CPHD collaborate with the Cambridge Emergency Planning Committee and the Cambridge Fire Department in order to create an inventory of locations in the city that work with engineered nanoparticles. These efforts would be integrated as a survey into the Fire Department's ongoing data collection program for hazardous chemicals and materials. The survey would collect information from firms regarding nanomaterials that are processed, handled, manufactured, or stored in Cambridge facilities. These efforts would contribute to a more robust understanding of the activities of nanotechnology firms in Cambridge.

The committee's second recommendation to the city entails assessing firms' practices for mitigating nanomaterial exposure risks. Pursuant to this recommendation, the CPHD will assist local businesses and laboratories that engage in the handling, production, or storing of engineered nanomaterials in a voluntary or "elective review of" health and safety procedures in an effort to review and share best health and safely practices, while protecting proprietary information and intellectual property. Sharing of safety techniques and best practices would ultimately contribute to improving the "safety culture" in Cambridge laboratories and research centers that handle engineered nanomaterials.

The third recommendation discusses public outreach and education efforts, via public education programs and Website materials. The CPHD seeks to publish information related to consumer products containing engineered nanomaterials on its Website, and include links to other resources, such as the nanotechnology-based consumer products inventory provided by the Project on Emerging Nanotechnologies. Additionally, the report recommends that the CPHD continue engaging in citizen's forums on nanotechnology, in collaboration with the Museum of Science Boston and NISE Net (Nanoscale Informal Science Education Network). The Museum of Science has hosted two such forums—on May 22, 2008 and January 22, 2009—with the intention of educating Cambridge citizens on nanotechnology and the city's policy efforts, as well as eliciting views and opinions from citizens. Museum organizers and CPHD officials envision these forums serving as a "new public comment period," where citizens can share their thoughts on the city's nanotechnology policy with city officials.

The final recommendations encompass tracking health and safety research on engineered nanomaterials and new developments in state and national nanomaterial policy. This information will be compiled into a report and presented to the city council every two years. The report emphasizes that the CPHD should continue to track

scientific developments related to nanomaterial health and safety issues, and report back to the city council every two years. Also included in this report would be an overview of new developments related to nanotechnology policy, regulation, and oversight, and would additionally detail information on new standards and practices. This iterative revisitation of the city's nanotechnology policy will account for potential scientific and policy changes, including advances in nanotechnology risk assessment and new policies on the state and national level. CPHD officials also see the policy revisitation process as an ideal time for updating and engaging with the public.

Nanotechnology policy efforts in Cambridge, Massachusetts, serve as an example of local governance of new and emerging technologies. Following Berkeley, California, Cambridge was the second local government in the United States to implement a nanotechnology policy. However, it is likely that other local and state governments will follow suit. Officials in cities such as Madison, Wisconsin, and Ann Arbor, Michigan, are considering developing their own policies and have contacted local Cambridge officials in order to learn more about the city's model.

See Also: Anticipatory Governance; Berkeley, California, Local Regulatory Efforts; Nanoscale Informal Science Education Network.

Further Readings

Conley, Shannon N. and Dana Bersch. "Nanotechnology Policy in Cambridge, Massachusetts: Local Reflexive Governance." *Yearbook of Nanotechnology in Society Vol. 2.* New York: Springer, Forthcoming.

Lipson, Sam. "The Cambridge Model: How Public Oversight of Biotech Is Good for Everyone—Even Business." *GeneWatch*, v.16 (2003).

Lipson, Sam. "Recommendations for a Municipal Health & Safety Policy for Nanomaterials: A Report to the Cambridge City Manager." Cambridge Public Health Department, Cambridge Health Alliance (2008).

Project on Emerging Nanotechnologies. "Consumer Products: An Inventory of Nanotechnology-Based Consumer Products Currently on the Market." http://www.nanotechproject.org/inventories/consumer (cited April 2009).

Shannon N. Conley
Center for Nanotechnology in Society
Arizona State University

Canada

In worldwide government funding of nanotechnology research and development, Canada currently ranks eighth, and contributes significantly to scientific knowledge and innovation across a variety of areas of interests, including fundamental phenomena and processes, nanomaterials, nanoscale devices and systems, and nanobiosystems. The National Research Council (NRC), Canada's central institution for science and technology research, characterizes nanotechnology in terms of the research, development and commercialization of materials and devices at the scale of one billionth of a meter.

Canada's Nanotechnology Position

This definition reveals Canada's position on nanoscale research, whereby commercial viability is essential to prioritization and execution of research. It is also indicative of Canada's overall approach to investing in nanotechnology, which differs significantly from other Western countries in that it has no centralized policy statement or strategy for nanotechnology research and development. In fact, the provinces of Quebec and Alberta have released position papers detailing the strategic role of the provincial government in nanotechnology for which there is no federal counterpart.

The decentralized nature of funding and research, coupled with a strong focus on commercial and industrial applications, poses significant challenges for nanotechnology development in the Canadian context. In 2005, the Prime Minister's Advisory Council on Science and Technology (now closed) commissioned a series of four reports on nanotechnology, asking if Canada was in need of a national nanotechnology strategy.

The results of these studies revealed a degree of ambivalence, concluding that other nations and regions have implemented national strategies that have been productive in the development and commercialization of nanotechnology; while acknowledging that Canada has the tools, assets, and potential to contribute to this kind of development, the studies fell short of recommending that Canada draft and implement its own national policy. Despite a lack of central direction, there is a rich body of work emerging from Canada, and Canadian research has received significant international interest. For example, in 2008 the *International Journal of Nanotechnology* published a quadruple volume on Canadian-based research and development.