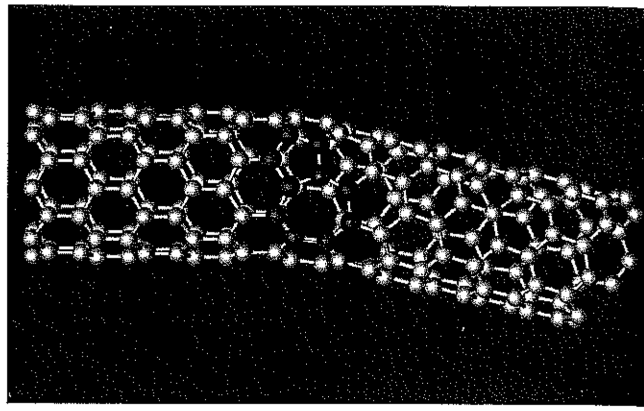
Interdisciplinary Research Centers

The idea that scientists and engineers need special institutions to foster cooperation across disciplinary boundaries is almost as old as the disciplines themselves. To the extent that nanotechnology has an institutional presence in a scientist's life, it is often mediated through such an interdisciplinary center. Through their architecture, equipment, and activities, interdisciplinary centers promote the idea that the nanoscale can only be effectively understood and exploited through cooperation among the disciplines.



Supported by a National Science Foundation grant, a team simulated the smallest and strongest carbon nanotubes.

Philanthropy, Industry, Military

Worries that the academic disciplines would present artificial barriers to research date back to at least the turn of the 20th century. In the United States, three organizational models emerged as solutions to this problem, all of which continue to inflect policy for nanotechnology.

The first was the corporate research laboratory, a model borrowed from the German chemical and electrical industries. Corporate labs at firms like General Electric and Westinghouse grew out of older workshops staffed by skilled artisans. However, by the early 20th century, high-tech firms began recruiting Ph.D.s in chemistry, physics, and other academic disciplines to conduct both basic and applied research. During the Cold War, some corporate research organizations (e.g., Bell Laboratories or IBM Research) grew very large and very focused on basic research. After the Cold War, this style of corporate research largely collapsed; policy makers at the National Nanotechnology Initiative have remarked that they see the current crop of interdisciplinary academic research centers as a way to fill the gap left when Bell Labs disappeared and IBM Research downsized.

The second model was the academic institute funded by a philanthropic foundation. The Rockefeller Foundation, in particular, specialized in building campus institutes in the interwar period, especially in basic research areas tied to biomedicine. Indeed, Rockefeller was so successful that some of the interdisciplinary fields it sponsored grew into their own disciplines, such as molecular biology. The ability of foundations to directly fund institutes waned during the Depression, and their role was largely taken over by the government during and after World War II. However, foundations remained extraordinarily influential in setting American and European science policy during the Cold War, not least because many foundation grant officers moved into government posts. Foundation influence declined during the 1960s, but may be making a comeback. In nanotechnology, nonprofits such as the Kavli Foundation currently operate on a model not much different from the prewar Rockefeller Foundation.

The third model is the military crash program of World War II, such as the efforts to develop radar, the proximity fuse, penicillin, and most famously, the atomic bomb. In these projects, scientists and engineers from many disciplines came together in what Peter Galison has called "trading zones," where they learned just enough of each other's conceptual and practical "languages" to accomplish concrete tasks. After the war, the Manhattan Project, in particular, was seen both as having been crucial to victory and as having been largely the work of physicists (because the nonphysics parts of the project were still classified). Thus, policy makers began to see physicist-directed, mission-oriented, interdisciplinary programs as an integral part of national security.

Facilitating Facilities

Government funding in the United States for interdisciplinary centers, therefore, exploded after World War II, leveled off following the Korean conflict, and then expanded again in the aftermath of Sputnik. Many of these were intended to foster what was sometimes ambiguously called "mission-oriented basic research," often with a focus on leading nonphysics disciplines to adopt perceived elements of physics methodology (use of computers, reductionism, quantitative and theoretical analysis). Elements of this model appeared at this time in many countries through, for instance, the French National Center for Scientific Research (CNRS) or the Max Planck Society centers in Germany.

In the United States, an additional factor was the desire to create a reserve force of Ph.D. scientists and engineers who could be mobilized (perhaps even drafted) in a national emergency. This tied government sponsorship of interdisciplinary centers somewhat closer to the university system than in other countries, since universities were seen as the source of the Ph.D.s populating this reserve force. A good example is the Materials Research Laboratories (MRLs) program started by the Advanced Research Projects Agency (ARPA) following Sputnik.

From the late 1960s to the mid-1980s, though, U.S. government funding for interdisciplinary centers waned, especially from military agencies. The Mansfield Amendment, requiring civilian control over basic research, for instance, forced ARPA to transfer the MRLs to the National Science Foundation (NSF) in the 1970s. These eventually evolved into the Materials Research Science and Engineering Centers, many of which are involved in nanotechnology research.

One effect of this shift was that the NSF became more interested in (and experienced at) funding and overseeing academic centers. Thus, the number of NSF centers grew, slowly in the 1970s and then very quickly from the mid-1980s onward. For instance, in 1977 the NSF funded the National Research and Resource Facility for Submicron Structures (NRRFSS) at Cornell University to provide microfabrication services to users from around the country. "Submicron" was the 1970s equivalent of "nano," and indeed the NRRFSS was one of the first institutions to adopt the nano prefix, changing its name to the National Nanofabrication Facility in 1986. Many of its peer institutions did so at the same time, so that by the 1990s, the NNF became the core facility of a National Nanofabrication Users Network—the predecessor of today's National Nanotechnology Infrastructure Network.

The Backbone of Nanotechnology

Another result of the dearth of U.S. government center funding in the 1970s was that the physical plant and equipment of academic science depreciated quickly. By the early 1980s, policy makers were talking about a "facilities crisis." This led NSF director Erich Bloch to create the Engineering Research Centers (ERC) program, modeled on the MRLs and the NRRFSS, in 1985. Bloch, a former IBM executive, made university–industry cooperation an imperative of these centers.

The perceived success of the ERC program led to the creation of a Science and Technology Centers program at the NSF in 1987, again with commercialization of academic research as a priority. By the late 1990s, the NSF was overseeing more than two dozen each of the ERCs, STCs, and Materials Research Science & Engineering Centers (MRSECs), and almost a dozen facilities of the National Nanofabrication Users Network (NNUN). Thus, when an NSF program officer, Mihail Roco, took charge of the National Nanotechnology Initiative (NNI), it was hardly surprising that NSF's leading role would be achieved through a new centers program modeled on the previous ones—the Nanoscale Science and Engineering Centers (NSECs).

Today, there are more than a dozen NSECs, all of which are encouraged to have some ethical, legal, and social issues component. Some have specialized in societal dimensions more than others: the Center for Biological and Environment Nanotechnology at Rice University, the Center for Environmental Implications of Nanotechnology (split between Duke University and a University of California (UC) Los Angeles/UC Santa Barbara consortium), and the Center for High-Rate Nanomanufacturing at Northeastern University. In 2005, the NSF funded the creation of two Centers for Nanotechnology in Society to study the social implications of nanotechnology. The centers were founded in 2005: one at Arizona State University, which is the world's largest center for the study of nanotechnology and society, and the Center for Nanotechnology in Society at UC Santa Barbara.

In the United States, the NNI has encouraged other federal agencies to follow the NSF's lead in building up interdisciplinary nanoscale research centers. Typical products of such programs are the Institute for Soldier Nanotechnologies at the Massachusetts Institute of Technology (funded by the Department of Defense), the Institute for Nanoelectronics and Computing at Purdue University (funded by NASA), and the Carolina Center for Cancer Nanotechnology Excellence at the University of North Carolina (funded by the National Institutes of Health).

Around the world, many countries have seen interdisciplinary research centers as the most effective way to leverage national expertise in nanotechnology. Typical examples include the National Center of Competence in

Research in Nanoscale Science at the University of Basel; the Joint Research Center for Atom Technology in Japan; and the Nanoelectronics Research Center at the University of Glasgow.

Interdisciplinary research centers are, in many ways, the institutional backbone of nanotechnology. With no single recognized nano journal or professional society, the local interdisciplinary nanoscale research center represents many scientists' most extended contact with the nanotechnology enterprise. This is partly because nanotechnology organized in an historical moment when interdisciplinary academic centers were the preferred mechanism for implementing many nations' science policy frameworks. However, the standard interpretation of what nanotechnology is also lends itself to the interdisciplinary research center concept. Nano is usually seen as a convergence of many disciplines; of university, industry, and government; and of scientists and the public. All these forms of convergence fit easily within the rubric of the interdisciplinary research center.

See Also: Interdisciplinarity; National Nanotechnology Infrastructure Network (U.S.); National Science Foundation (U.S.); Trading Zones.

Further Readings

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Cyrus C.M. Mody
Rice University

International Center for Technology Assessment

The International Center for Technology Assessment (ICTA) is a nonprofit, nongovernmental organization (NGO) dedicated to analyze the impact of technology on society in terms of economic, ethical, social, environmental, and political perspectives. ICTA's main focuses concern the environment, global warming, patent watch, nanotechnology, human biotechnology, corporate accountability, and economics. ICTA mainly focuses its efforts in the United States.

ICTA has repeatedly challenged the Environmental Protection Agency (EPA) on environmental issues. In 1999, it petitioned that carbon dioxide should be declared a pollutant that threatens public health and welfare. In 2009, EPA finally complied with the 2007 Supreme Court decision. Furthermore, in coalition with other environmental, consumer, and health groups, they filed a complaint concerning unregulated nanotech pesticide pollution against EPA. Pollution is by far not the only environmental threat ICTA is addressing and warning about. Invasive species pose a non-negligible danger to ecosystems all over the world. Genetically engineered plants may pose a threat to original plants. Genetically engineered plants that were not intended for humans may find their way into human food through contamination of other species.

Biopollution from genetically engineered organisms is particularly dangerous because it exists on the genetic scale, making it nearly impossible to control or clean up. ICTA and its sister organization, The Center for Food Safety, seek to educate policy makers and the public on the dangers of biopollution and invasive species, and to encourage stronger policies to prevent their spread. Another controversial topic that ICTA tackles is the profit-driven acquisition of patents of genetic material of plants, animals and even humans by pharmaceutical companies called "bioprospectors" in this context. This biopiracy potentially poses a great threat to countries in the third world, whose knowledge on traditional organic remedies could be bought by international companies, resulting in the poor rural population in these regions of the world losing access to their ancient cures.

ICTA's Patent Watch Program seeks to identify pernicious patents granted by the U.S. Trademark and Patent Office. Such patents include human cloning techniques as well as invasive surveillance methods or biological weapon delivery systems. In the United States, no patent can be refused due to ethical or public interest concerns. ICTA encourages grassroots activities against such patents, initiates and supports legal challenges against existing and future pernicious patents, and helps to raise awareness. In their view, the U.S. patent system poses a dual threat to society. First,