

NNIN Economic Impact Survey Report

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“The NNIN is an excellent use of federal funding, Funding cooperative access to critical tools that support early stage R&D is mandatory for small company private sector growth in anything except software and websites. Providing access this necessary toolset for physical sciences innovation helps balance technology innovation in the country and without it, there's a large category of capability that would go untouched in the US and end up overseas, like the semiconductor sector.” – *NNIN User, The Microelectronics Research Center at UT Austin*

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Executive Summary

This report will summarize and outline the economic impact of the National Nanotechnology Infrastructure Network (NNIN) in its users and the nation. Survey data were used to address key evaluation questions. The report answers these questions and addresses additional tasks outlined in the Project Plan.

Evaluation Questions

- *What economic value does the NNIN create for the Nation? What economic value does the NNIN create for its users?*
- *How many jobs has the NNIN helped to contribute to the economy? How much money has NNIN contributed to the economy (salaries and taxes)?*
- *What kinds of new technologies have been brought to the market from development activity that took place inside NNIN facilities?*

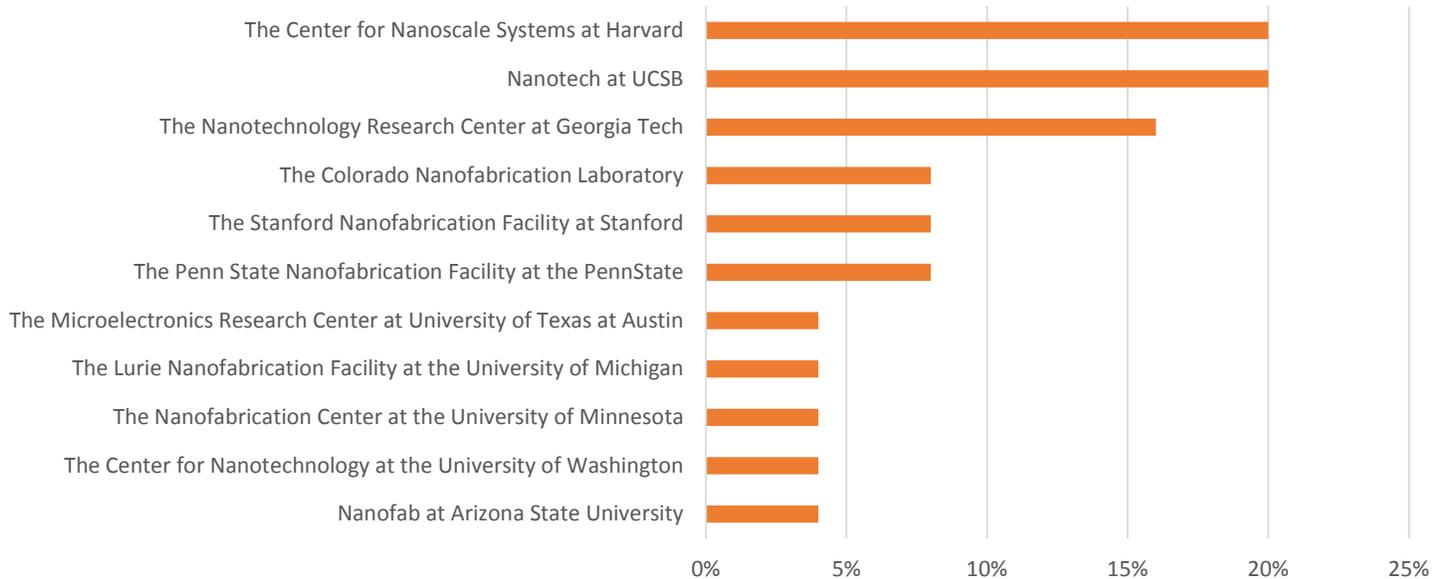
Companies which use NNIN facilities do so because of the affordable, accessible and overall supportive services and tools that they provide. NNIN facilities are indispensable to users and their absence would quite possibly stunt the growth of an entire generation of innovative scientists, engineers and business people from creating the jobs and producing the new products that keep the US economy moving. NNIN facilities appeal to established and early stage companies alike, however, start-up companies seem to benefit the most from NNINs cost effective and high quality facilities. NNIN user companies are innovators, job creators, tax payers and revenue generators. They are stimulating the US economy through product development, job creation. The products that NNIN user companies have developed have brought value to the market place, the social sector and natural environment. The report below outlines the ways in which NNIN user companies have expressed the extent to which they rely on NNIN facilities for their continued productivity and survival.

“My company was founded with technology developed or proven at NNIN and would not exist without it. We are presently the market and technology leader in our area and have been listed by Deloitte LLP as the fastest growing semiconductor company in North America. The critical thing to understand is that NNIN provides the facilities, staff, and technology to support key early-stage development. These are leveraged many-fold to produce commercially and nationally important results.” – NNIN User, The Stanford Nanofabrication Facility

Data collection

The NNIN Economic Impact Assessment Survey (EIA) was distributed to 111 unique e-mail addresses representing as many companies based on company contact information gathered by NNIN user facilities.¹ The EIA survey was launched in March 2013 and remained open for 5 weeks. Reminders were sent out weekly with an additional reminder sent out in the last week of data collection for a total of 6 email reminders. In addition to email reminders, phone calls were made to all non-respondents in the last week to boost response rates (one company contact replied and conducted the survey by phone). The project champion also contacted particular companies to encourage their participation. In all, the useable response rate for the EIA survey is 77%, with a total of 86 partially completed or complete usable responses. Of the 25 non-respondents (i.e., those that never started the survey) most were either from the Harvard, UCSB or Georgia Tech user facilities.

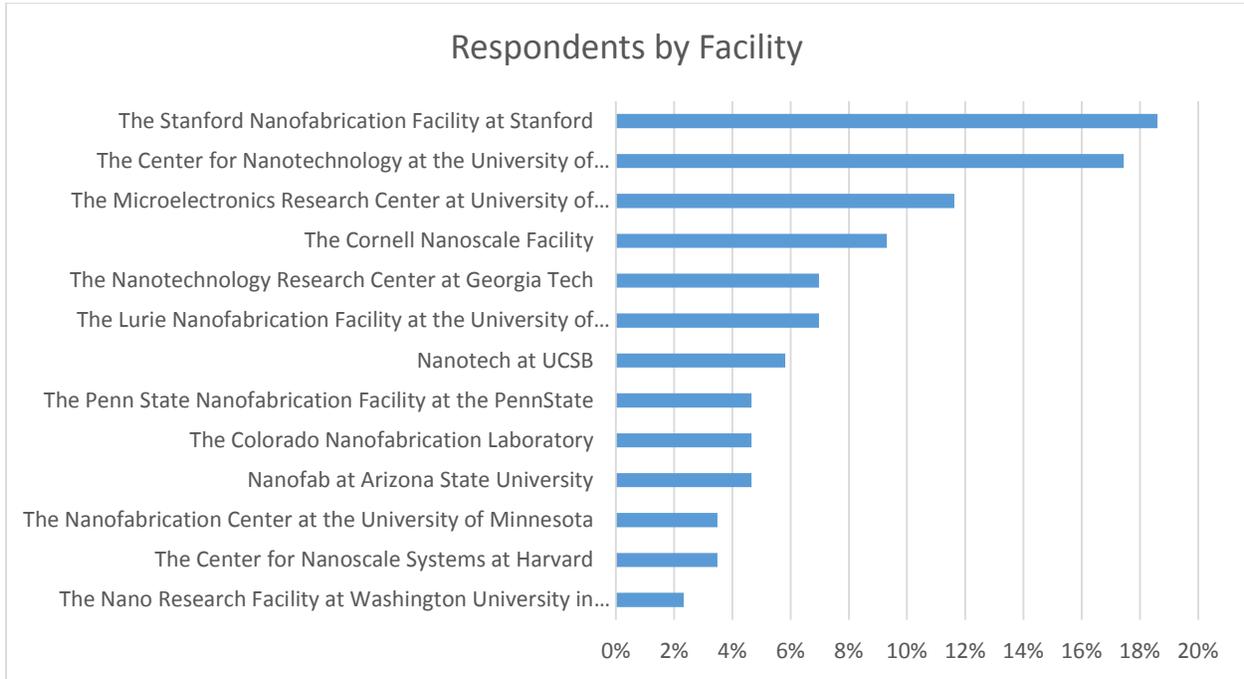
Figure 2: Non-Respondents by Facility



¹ No companies were listed for the Howard University facility

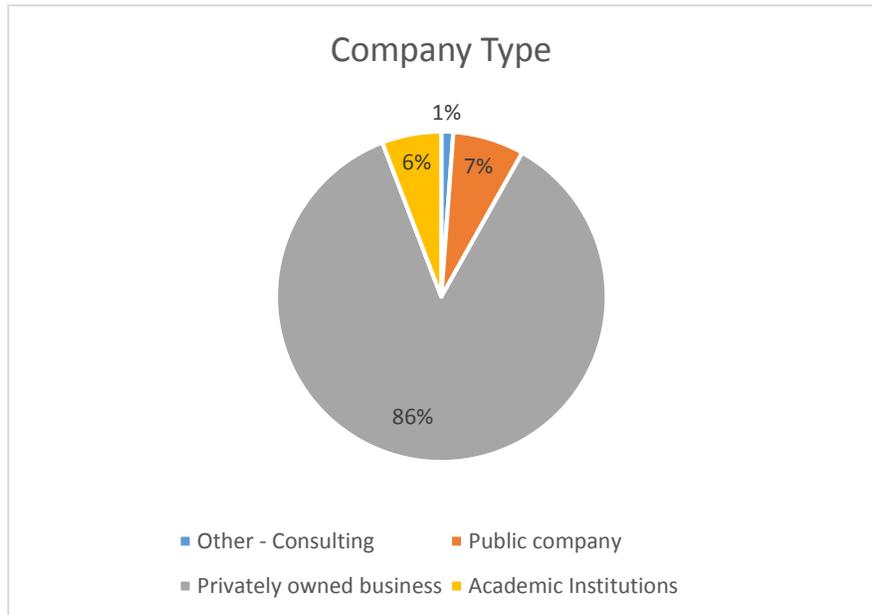
Company Demographics

Of the companies that responded to the online survey instrument, the most used the facilities located at the Stanford and University of Washington facilities.

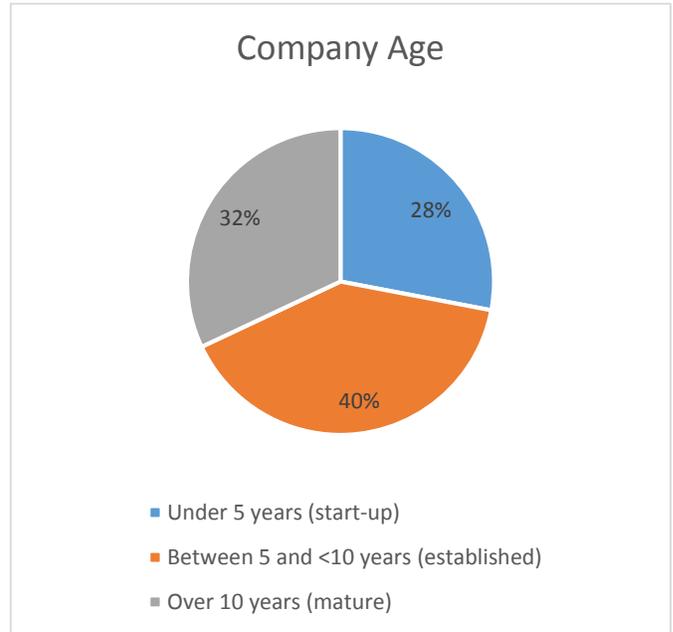


Most of our respondents are privately-owned, as opposed to public companies or academic institutions.

The age of companies using NNIN facilities are fairly evenly distributed between start-up, early and more mature organizations.



Respondents use NNIN facilities for business related product development and/or research 74% of the time, as opposed to academic research or other purposes. Most companies began using NNIN facilities between 5 and 10 years ago (43%), followed by early-stage and start-up companies (31%) and more mature companies (15.1%). A vast majority of respondents are long term users, having used NNIN facilities for between 1 and 5 (50%) or between 6 and 10 years (31%). A few companies reported 2013 as their first year using NNIN facilities (8%). An average these companies also use NNIN facilities very frequently either multiple times a week if not daily (58%).



The companies in our sample represent a number of different sectors, from the automotive industry to water analysis. Most companies reported their sector as being in the semiconductor, photonics, sensors and optics fields. Other sectors represented included biotechnology, manufacturing and electronics and aerospace, medical devices, life sciences, health care and clean energy.

“Having a semiconductor fabrication facility such as the UM LNF available... has allowed us to offer our customer's an expanded range of MEMS and thin Film product solutions beyond our current in-house capabilities. This has added to our customer growth and opened opportunities for new business.” – NNIN User, *The Lurie Nanofabrication Facility at UMich*

Findings

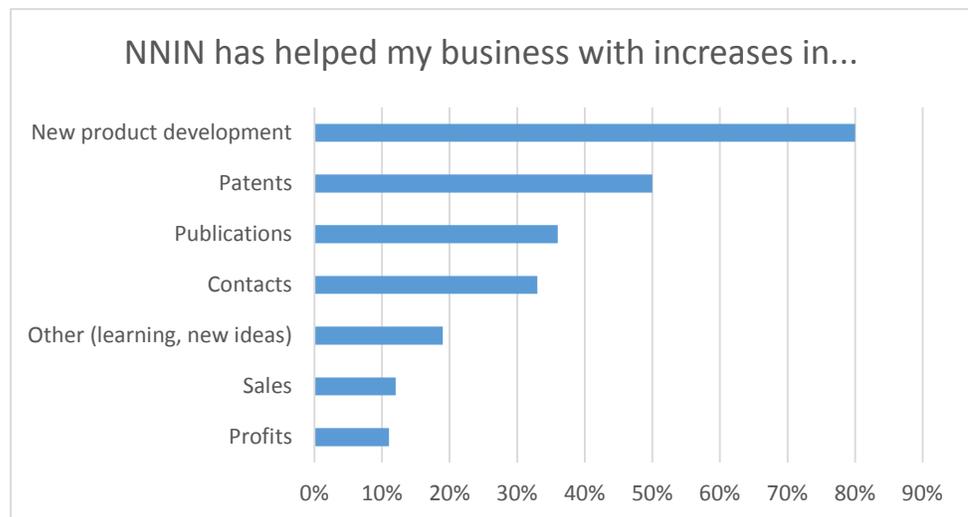
What economic value does the NNIN create for the Nation? What economic value does the NNIN create for its users?

A vast majority of respondents indicated that they would be severely (51%) or significantly (27%) affected if they were to no longer have access to NNIN facilities. NNIN facilities are central to the continued productivity and survival of the companies that use them. Alternatives are cost prohibitive and it is clear that NNIN facilities have become central to R&D processes for these firms. The one company that indicated that it would be not at all affected by the lack of access to NNIN facilities, reported having its own in-house facilities to fall back on. A few quotes from users will help to illustrate the value that NNIN brings to its users:

“This is the reason our company is based in Ithaca NY - access to the CNF - if we lose that access then we would lose our ability to prototype our product. It would effectively shut us down.”

“We are small business and could not afford expensive equipment we need to do our R&D i.e. without ASU we would have not existed today!!”

All respondents indicated that NNIN has helped their business. The ways that NNIN has helped can be summarized into the following take home message: Nearly all respondents (94%) indicated that NNIN facilities led to either increased profits, product sales, product development, patents, funding / investment, cost and time saved and/or increased flexibility in process development for their respective companies.

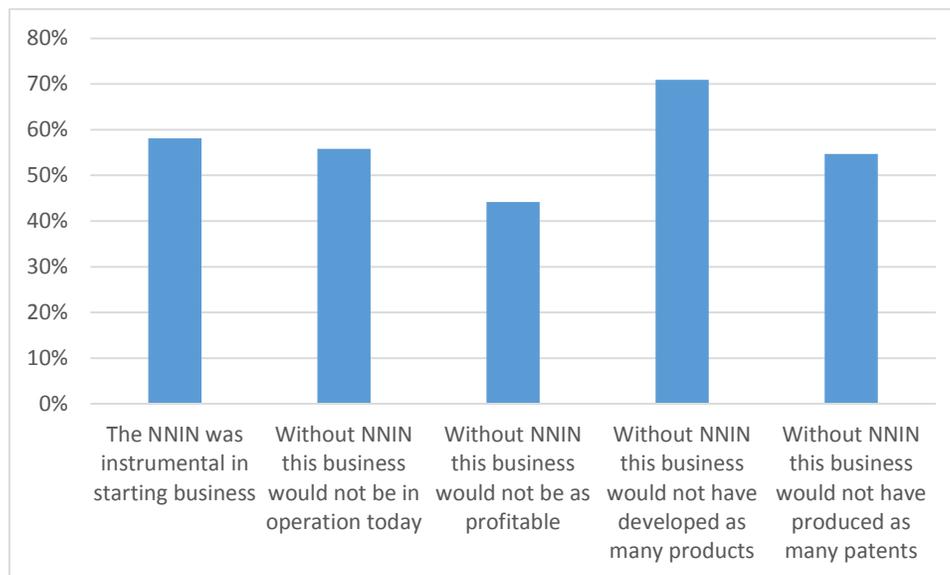


In addition, 59% indicated that the NNIN has led to their company conducting more research, publishing more, obtaining more useful contacts, and learning more and/or

generating more ideas. Users reported that NNIN facilities are more useful than other competing facilities because of location (67%), cost (66%), specialized equipment and tools (65%) familiarity (50%) staff and consulting services (41%). Other reasons why NNIN facilities were more useful to companies than competitors included the quality of facilities, transparent cost structure, flexibility and control of data. In addition one respondent left this lengthy and informative note:

“A close connection with a highly skilled academic research community was critical. A large part of our initial investments funded public PhD research. This supported the facilities and students while leveraging our investments across the technology community. Net result for us was a valuable public technology base from which we built our proprietary development. In addition, we have since hired many of the students that our funding helped educate.”

The majority of respondents, agreed or strongly agreed that the NNIN was instrumental in starting their business (58%) and/or that without NNIN facilities, their business would not be in operation today (56%). In addition to company formation, several users indicated that without NNIN facilities, this business would not be as profitable as it is today (44.8%).

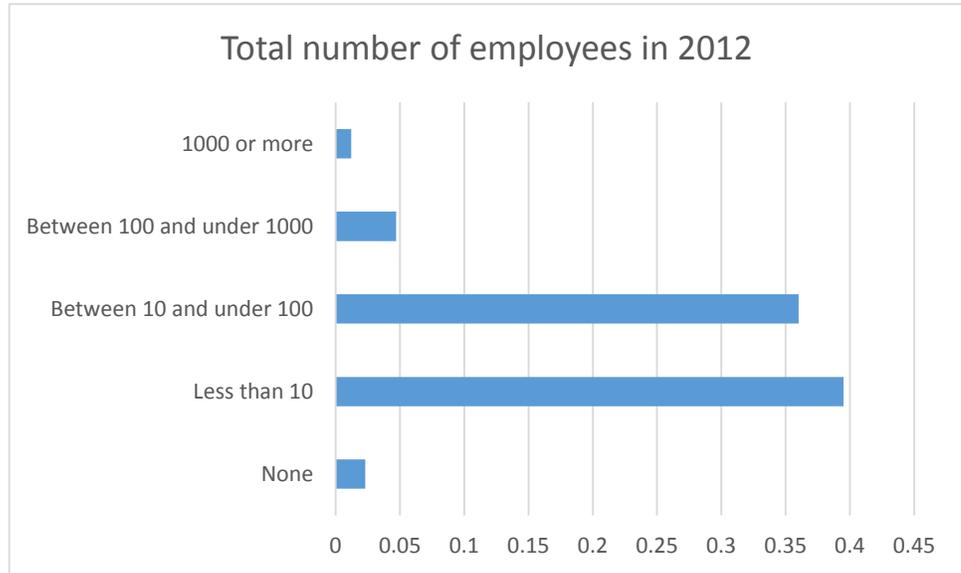


The Cornell Nanoscale Facility, which is an NNIN facility funded by the NSF, is the heart and soul of innovation at Cornell. It enables start up companies...to have access to top notch researchers and equipment to prototype a variety of products. Access to this facility has made all the difference... And even if our company were to grow and leave the area we would keep personnel at this facility to do prototyping and testing.” – NNIN User, The Cornell Nanoscale Facility

How many jobs has the NNIN helped to contribute to the economy? How much money has NNIN contributed to the economy (salaries and taxes)?

A vast majority of companies (81%) reporting having employees in 2012, while most employed between 1 and 9 employees (40%), a large number also reported having between 10 and 99 employees (36%) with a few hiring over 100 (5%) and one company employing over 1000 people last year alone. These NNIN companies reported providing a combined 2692 jobs

in 2012, spending just under 100 million dollars on payroll (\$95,535,000), with most companies spending between 100 thousand and just under 1 million USD on payroll in 2012 (36%).



Most respondents also either agree or strongly agree that they would not have been able to hire as many people (67%) without having access to NNIN facilities. The majority of companies (61%) also reported hiring new employees in 2012, most hired between 1 and 9 employees (58%), three companies hired between 10 and 99 employees and two hired over 100 new employees in 2012. These NNIN companies reported hiring 422 people in 2012.

NNIN respondents earned just under 400 million dollars of combined revenue (\$386,985,000) in 2012. Likewise NNIN companies reported raising just under 350 million dollars (\$340,335,000) in financing as a result of the work done at NNIN facilities.

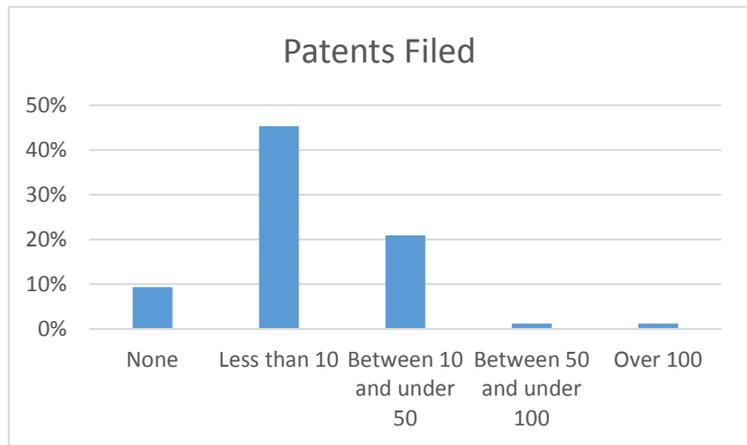
“Without the state of the art facilities we have access to through the NNIN, rapid advancement in product development on 3 products would not be possible. Additionally there is NO WAY a start-up company like us can develop such infrastructure with expensive tools.” – NNIN User, The Nanotechnology Research Center at Georgia Tech

What kinds of new technologies have been brought to the market from development activity that took place inside NNIN facilities?

The majority of companies reported that they would not have produced as many patents (55%) nor would they have developed as many products without NNIN facilities. Without NNIN facilities, this business would not have developed as many products. At the same time, of the 86 respondents, 15% were no longer using NNIN facilities. When asked if they were successful in developing products that went into production as a result of work done at the NNIN facility most said no (54%). However, when explaining this result respondents reported that they “...used NNIN to create prototypes. The prototypes were made successfully. The product was not completed” or that they “...did not intend to use NNIN for production. It was only used for some R&D.”

An impressive 40% of companies reported using NNIN facilities for most or all of their product development needs. A large majority of companies (74%) in our sample created at least 1 new or improved product in 2012, one company created over 1000 new products in 2012 alone. The companies that had not yet created any new or improved products, indicated that they either do not use NNIN for

product development, or that they were still in the pre- and early product development phase. Since they first began using NNIN facilities, these companies have filed 825 patents. Most filed at least 1 patent since they began working with NNIN facilities (69%). While



most companies filed less than 10 patents (45%), others filed between 10 and 50 patents (21%) since they first began using NNIN facilities. One company filed over 50 patents and another over 100 since first starting work at the NNIN. Of the 825 patents filed, most filings took place within the last 5 years (85% or 697 patents).

The table below outlines a few of the many products that NNIN companies have created or are currently in the process of developing for market.

3D ICs	Infrared cameras	Molecular diagnostic assay	Solar Passivation, Process Integration, Processing on wafer coupons.	Water analysis cartridge
Accelerometer	Ka-band power FETs in the AlGaIn/GaN material system.	Silicon nanoparticle phosphors	Special high sensitivity silicon avalanche photo diodes.	FET based biosensors for enzyme activity detection
Cathode battery material	Memory technology	new memory devices	Thermoelectric coolers	Environmental TEM specimen holders.
Chemical Detection Sensor, Cartridge and Instrumentation.	Memristor based NVM	NextInput developed a novel MEMS force sensor for use in multiple product lines.	A micromachined piezoelectric composite for high frequency medical imaging applications.	Carbon based energy storage materials for use in batteries and capacitors
Chemical sensor	MEMS accelerometers of various types	A micromachined piezoelectric composite for high frequency medical imaging applications.	A dual axis integrated X-Y gyro	Optical resonators to trap nanoparticles
Chemical Vapor Detector	MEMS device	A dual axis integrated X-Y gyro	High performance piezoelectric microphones	High efficiency solar cells for concentrated PV systems, and for space satellites.
Diesel particulate control technology using enhanced ESP.	MEMS-based piezoelectric vibration energy harvester and electrical conversion module.	A biosensor with structures for microfluidic management and electrochemical assay of fluid.	Microelectrode Arrays (MEAs) -- High-Throughput, "On the Body" and implantable MEAs for a variety of electrophysiological applications.	A sputtered dielectric for high temperature tolerant capacitors, and multiplex gas sensors
Fluorinated photoresist for the display industry.	MEMS-tunable VCSEL for medical imaging.	Prognostics machine health monitoring sensor system.	Highly textured silicon carbide betavoltaics	Blue laser diodes
Heads up display based on scanned beam laser projection.	Microbolometer, ultraviolet sensor	Semiconductor bio-sensors.		

In all, NNIN facilities create value for their users and the nation in a variety of ways. In the words of one user the value that NNIN creates is “immeasurable.”

Appendix (Attached in Separate Files)

1. *Copy of Online Survey (.pdf)*
2. *Raw Data (.xls)*