

# SEI

# Societal and Ethical Implications

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National Nanotechnology Coordinated Infrastructure Coordinating Office



National Nanotechnology  
Coordinated Infrastructure



# What the heck is SEI? (and where did it come from?)



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# 21<sup>st</sup> Century Nanotechnology R&D Act (2003)

Section. 2. (a) NATIONAL NANOTECHNOLOGY PROGRAM- The President shall implement a National Nanotechnology Program that shall—...

(b) (10) ensuring that ethical, legal, environmental, and other appropriate societal concerns, including the potential use of nanotechnology in enhancing human intelligence and in developing artificial intelligence which exceeds human capacity, are considered during the development of nanotechnology by--

(A) establishing a research program to identify ethical, legal, environmental, and other appropriate societal concerns related to nanotechnology, and ensuring that the results of such research are widely disseminated;

(B) requiring that interdisciplinary nanotechnology research centers established under paragraph (4) include activities that address societal, ethical, and environmental concerns;

(C) insofar as possible, integrating research on societal, ethical, and environmental concerns with nanotechnology research and development, and ensuring that advances in nanotechnology bring about improvements in quality of life for all Americans; and

(D) providing, through the National Nanotechnology Coordination Office established in section 3, for public input and outreach to be integrated into the Program by the convening of regular and ongoing public discussions, through mechanisms such as citizens' panels, consensus conferences, and educational events, as appropriate



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U N I V E R S I T Y O F C A L I F O R N I A

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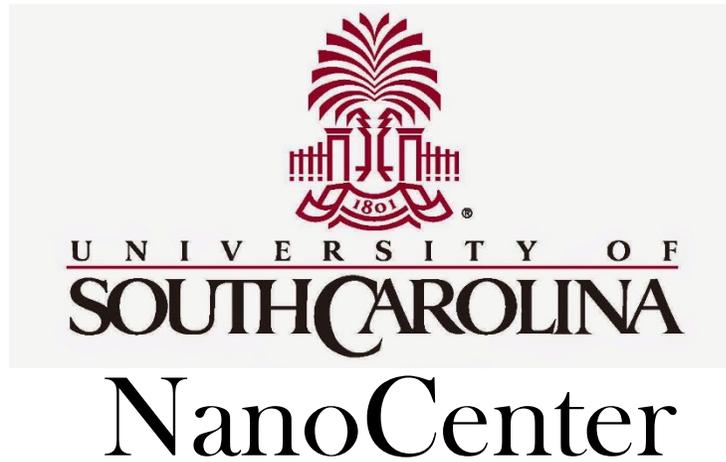


CEIN

Center for Environmental  
Implications of Nanotechnology

CE  NT

Center for the Environmental  
Implications of NanoTechnology



# So what is SEI in the NNCI?

- It is four main sites that do work researching, training, and communicating some of the social and ethical issues raised by and inherent to nanoscale science and engineering.
- It is a support system for the rest of the NNCI sites that want to work SEI programs into their sites.

# So what is SEI in the NNCI?

- It is four main sites that do work researching, training, and communicating some of the social and ethical issues raised by and inherent to nanoscale science and engineering.
- It is a support system for the rest of the NNCI sites that want to work SEI programs into their sites.
- It does not singlehandedly fulfill all the “societal, ethical, and environmental” directives under the 2003 Nano R&D Act. (not with less than .03% of the federal nano budget)

# NNCI SEI “Umbrella”

- We do work in both micro and macro-ethics (with an emphasis on the latter since few science or engineering programs address those important issues).
- We look at both the social impacts of nanotechnology, but also the social aspects of nanotechnology.
- We address the variety of societal implications associated with nanotechnology, including social change, equity issues, economics, and policy.
- We include “environmental issues” in this list, but others have tens of millions of dollars to study those, so they are not our primary focus.

# NNCI SEI “Umbrella”

- We envision numerous audiences for our work – including NNCI users, NNCI practitioners, policymakers, journalists, and the general public.
- Ideally we envision those groups not simply as consumers of our work, but as partners in developing that work. I.e., we want two-way discussions, not one-way communication. Hoping to work toward the daunting goal of:

“integrating research on societal, ethical, and environmental concerns with nanotechnology research and development, and ensuring that advances in nanotechnology bring about improvements in quality of life for all Americans”

# Texas Nanofabrication Facility



**Led by LeeAnn Kahlor, Associate Professor, PhD in Mass Communication**

## **Development Activities:**

- SEI video training model (V.1) developed from prior NNIN research.
- Module V.1 shared with TNF team to gain feedback. Module V.2 was created to reflect the changes.
- Module V, part of TNF REU training; focus group data collected from interns to guide Module V.3.
- A TNF-funded MA student (minority) produced her thesis from the SEI team's data.
- PhD student added to team with expertise in science communication.
- Module 3 was reviewed by Dr. David Gottfried, Georgia Tech, and Jameson Wetmore, Arizona State.
- A revised module V.3 is now online as part of the required TNF user training program.
- Data is collected from users pre- and post viewing of the module.

## **Presentations**

- **NNCI**
  - Kahlor presented V.2 in a SEI session at the annual meeting in 2017.
- **NSF Nanoscale Science and Engineering Grantees Conference**
  - Kahlor co-chaired a panel on Nanotechnology and Converging Technologies in 2017.

## **Papers**

- Kahlor, L., Li, X., & Jones, J. "Development and pilot testing of an evidence-based training module for integrating social and ethical implications into the lab." **Under review** at *NanoEthics*.

## **Future Direction**

- Ongoing data collection is being analyzed for preparation of a second publication.
- Discussions of scalability to other sites are underway.



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# Southeastern Nanotechnology Infrastructure Corridor

**Led by Jan Youtie, Principle Research Associate, PhD in Political Science**

**Focus:** nanotechnology commercialization, while still attending to social and ethical implications

## **“I-Corps Plus SEI”**

- Tool development—presentation, interactive exercise based on I-Corps and Business Model Canvas
- Dissemination:
  - NNCI Winter School, AZ, January 2018
  - Georgia State University Faculty Entrepreneurship & Innovation Workshop (with a national I-Corps trainer), May 2018

## **Nanoinformatics**

- Text mining of nanotechnology publication and patent title and abstract records
- Uses:
  - Identify emergent nanotechnology topics
  - Broadening SENIC outreach

**Plans** → Training video: “8 things you need to know about social implications of nanotechnology research in the cleanroom”

Prototype at: <https://smartech.gatech.edu/handle/1853/60412>



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# Research Triangle Nanotechnology Network

**Led by David Berube, Professor, PhD in Communication**

## Assessment Programs

- IRB for 3 universities.
- User data – survey generated user and satisfaction data.
- Nanotechnology: A Maker's Course (MOOG) – user and satisfaction data.
- Kickstarter – semi-structured interviews and content analysis.
- Workshops and programs – survey generated user and satisfaction data.
- K-12 tours and experiences – survey generated user and satisfaction data.
- NEW – IRES and REU – methods under development

## Communication

- Facebook – Alerts on articles, conferences, events, and developments at RTNN and across the overall nanosphere.
- LinkedIn - Alerts on articles, conferences, events, and developments at RTNN and across the nanosphere with an emphasis on business and industry
- Twitter – as a pointer to Facebook and LinkedIn and reporting from conferences and meetings.

## Team Science

- Determining the mission and goals of team science: teams working well together or teams moving the science and technology forward.
- Integrating information on disciplinarity (inter-, trans, etc.) to determine if we can borrow the literature to develop answers to wicked and sticky problems.\*
- Investigating new methods to gather information on teams working together beyond interviews and surveys. Developing an observational and ethnographic tool set (see Cooke et al. (2015). Enhancing the Effectiveness of Team Science. NAS.



# Nanotechnology Collaborative Infrastructure - SouthWest



**Led by Jameson Wetmore, Associate Professor, PhD in Science & Technology Studies**

## **SEI User Facility**

- Experts in studying the social aspects of emerging technologies work with visitors to integrate new techniques and approaches into their research and programs. Highlights this year include:
- Working with Christopher Scott, Associate Director of the Center for Medical Ethics and Health Policy at Baylor College of Medicine, develop foresight exercises to better involve stakeholders in discussions of the future of genome editing technologies.
- Partnering with Gillian Bartlett and Vaso Rahimzadeh at the McGill University Faculty of Medicine to revise a game developed at ASU to promote discussions about nanotechnology so that it can be used to foster communications between parents and their terminally ill children.

## **Engaging the Public**

- SEI scholars at ASU continue to work with local, national, and international science centers to find ways to engage the public in discussions about the future of nanotechnology and other emerging technologies. Recently this effort has expanded to include botanical gardens.

## **Science Outside the Lab**

- Every summer the NCI-SW sponsors a week long immersion in Washington, DC to train graduate student scientists and engineers across the NNCI in the social, political, and professional aspects of S&T.

## **NNCI SEI Coordinating Office**

- NCI-SW also coordinates SEI across the NNCI, including hosting the annual Winter School



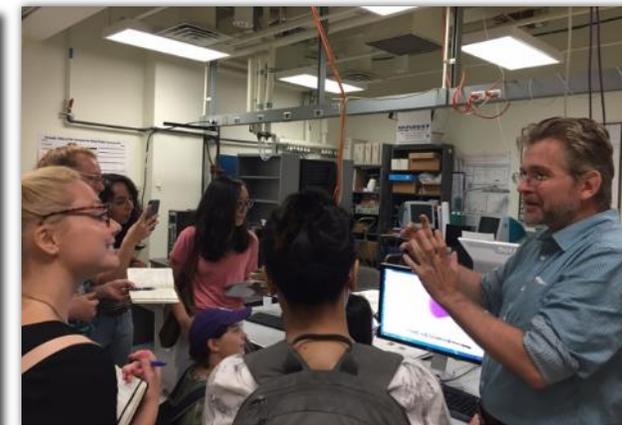
# SEI - SHyNE Nano-Journalism

- Experiential learning for journalism students
  - Interact with nanoscience researchers
  - Visit and embed with facility staff
- Communications training for scientists
  - Science Writing Workshops
- Nano-Journalism Interns
  - Fraser Stoddart: The Man Behind the Celebrity
  - Highlight research in SHyNE Facilities



Abigail Foerstner

Northwestern | MEDILL



## Education Outreach



Virginia Tech Science Festival



Energy & Materials Discovery Camp

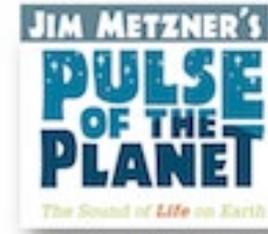


High School students from Japan

## Economic Empowerment



## Public Engagement



- 19 NanoEarth radio shows
- 1.1M listeners/week
- Up to 1M downloads/month



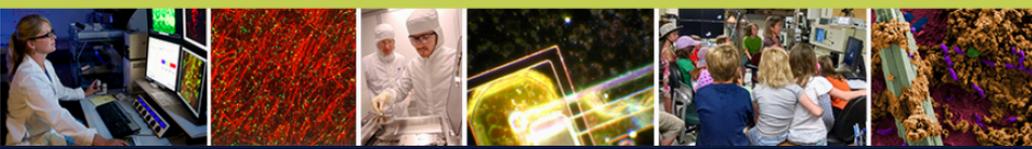
## Underrepresented Groups



- **MUNI** – **M**ulti-cultural and **U**nder-represented **N**ano-science **I**nitiative



- 64 MUNI visitors from 13 colleges, universities
- Participate in research, workshops, HBCU Summit



Nanotechnology in STEM
What is Nanotechnology
Why Teach Nanotechnology
How to Teach Nanotechnology
<b>Ethics</b>
Nanoscience in the Earth and Environmental Sciences
Methods
Nanoscience Topics in Earth Science
Instructional Resources
Goldschmidt Workshop 2017
NanoEarth Workshop 2018
Goldschmidt Workshop 2018
MONT Activities
Contribute Materials

## Teaching Ethics and Nanotechnology

Ethics Education is an increasingly important component of the pre-professional training of scientists. Funding agencies (NSF, NIH) require training of graduate students in the responsible conduct of research, employers are increasingly expecting their workers to have basic training in ethics, and the public demands the highest standards of ethical conduct by scientists. Yet, few faculty have the requisite training to effectively teach about ethics in their classes, or even informally in mentoring students working in their labs.

This module has been developed to meet the need of introducing ethics education into the STEM curriculum:

- **For faculty**, resources, case studies, and teaching activities are provided to facilitate instruction in ethics within established geo "core" courses or in a dedicated course on "Ethics and Nanoscience";
- **For students**, resources are provided to help expand their understanding of ethical situations that may arise in their careers, and to give them the tools they need to appropriately address these issues.
- **To start**: Take a look at this video on [The Ethics of Nanotechnology](#)--developed by the Microelectronics Research Center, University of Texas--Austin.

## Responsible Conduct of Science

Much of the ethics training in the STEM disciplines is focused on the Responsible Conduct of Research (RCR) fellows supported by research grants from the National Science Foundation. The following is a collection of focuses on the ethical "doing of science" and encompasses topics such as: plagiarism, falsification of data, authorship, peer review, publication, collaboration, intellectual property, conflicts of interest, reproducibility. This collection of resources on these topics is available at

[Responsible Conduct of Research](#)--initially created for the [Teaching Geoethics Across the Geoscience Curriculum](#) return to this Nanoscience module.

## Professionalism: Responsible Conduct of Scientists

**Beyond Responsible Conduct of Research**, attention to the **Responsible Conduct of Scientists** is every bit as important as attention to a safe, inclusive welcoming, and productive work environment. Professionalism in the STEM disciplines involves how scientists interact with colleagues in the work environment and with the public in serving a wide variety of societal needs. Professionalism impact the ability of scientists to do their work and for Science to progress. Please use this module as a guide to help address issues that you should be aware of? The goal is to help identify instances of unprofessional conduct, to prevent such conduct, and to encourage scientists to act to mitigate and resolve these issues.

## Journal Articles and Books of Interest to Ethics and Nanotechnology/science

(This is not an exhaustive compilation-- but a place to start for explorations of ethics and nanotechnology with students in your research lab and classrooms).

### Books:

- Allhoff, B. R., Lin, P., Moor, J., and Weckert, J., 2007, *Nanoethics: The Ethical and Social Implications of Nanotechnology*, Wiley, 416 pp.
- Arnaldi, S., Ferrari, A., Magaudda, P., and Marin, F., 2014, *Responsibility in nanotechnology development*, Springer.
- Berne, R. W., 2005, *Nanotalk: Conversations with scientists and engineers about ethics, meaning, and belief in the development of nanotechnology*, CRC Press.
- *Nanoethics ethics for technologies that converge at the nanoscale*. 2007. Dordrecht: Springer Netherlands.
- O'Mathuna, D. P., 2009, *Nanoethics: Big Ethical Issues with Small Technology*, Bloomsbury:New York, 248 pp.

### Journal Articles:

- Bürgli, B. R., and Pradeep, T., 2006, Societal implications of nanoscience and nanotechnology in developing countries: CURRENT SCIENCE-BANGALORE-, v. 90, no. 5, p. 645.
- Chen, H., Roco, M. C., Son, J., Jiang, S., Larson, C. A., and Gao, Q., 2013, Global nanotechnology development from 1991 to 2012: patents, scientific publications, and effect of NSF funding: Journal of nanoparticle research, v. 15, no. 9, p. 1951.
- Crow, M. M., and Sarewitz, D., 2001, Nanotechnology and societal transformation: Societal implications of nanoscience and nanotechnology, p. 45.
- David, K., and Thompson, P. B., 2011, What can nanotechnology learn from biotechnology?: social and ethical lessons for nanoscience from the debate over agrifood biotechnology and GMOs, Academic Press.
- Dunphy Guzman, K. A., Taylor, M. R., and Banfield, J. F., 2006, Environmental risks of nanotechnology: National nanotechnology initiative funding, 2000– 2004, ACS Publications.
- Fisher, E., 2007, The convergence of nanotechnology, policy, and ethics: Advances in Computers, v. 71, p. 273–296.
- Godwin, H. A., Chopra, K., Bradley, K. A., Cohen, Y., Harthorn, B. H., Hoek, E. M. V., Holden, P., Keller, A. A., Lenihan, H. S., Nisbet, R. M., and Nel, A. E., 2009, The University of California Center for the Environmental Implications of Nanotechnology: Environmental Science & Technology, v. 43, no. 17, p. 6453–6457.
- Hogle, Linda F., 2009, Science, Ethics, and the "Problems" of Governing Nanotechnologies: The Journal of Law, Medicine & Ethics, v. 37, no. 4, p. 749–758.
- Hoover, E., Brown, P., Averick, M., Kane, A., and Hurt, R., 2009, Teaching small and thinking large: Effects of including social and ethical implications in an interdisciplinary nanotechnology course: Journal of Nano Education, v. 1, no. 1, p. 86–95.
- Lead, J. R., Aruguete, D. M., and Hochella Jr, M. F., 2010, Manufactured nanoparticles in the environment: Environmental Chemistry, v. 7, no. 1, p. 1–2.
- Mnyusiwalla, A., Daar, A. S., and Singer, P. A., 2003, 'Mind the gap': science and ethics in nanotechnology: Nanotechnology, v. 14, no. 3, p. R9.
- National Science and Technology Council, C. o. T., Subcommittee on Nanoscale Science, and Engineering, a. T., 2014, National Nanotechnology Initiative Strategic Plan p. 88.

- Ethical decision-making
- Sexual harassment/bullying, workplace "climate"
- Personal and professional ethics/values
- Ethics and Impacts of Nanotechnology on Society
- Collection of online resources and references

[https://serc.carleton.edu/msu\\_nanotech/ethics.html](https://serc.carleton.edu/msu_nanotech/ethics.html)

# NNCI Network Activities

## Winter School on Responsible Innovation and Emerging Technologies



January 3-10, 2019  
at Saguaro Lake Ranch

Training the next generation of social scientists in how to study emerging technologies



# NNCI Network Activities

## Winter School on Responsible Innovation and Emerging Technologies



Training the next generation of social scientists to know how to study emerging technologies



January 3-10, 2019  
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# NCI-SW Science Outside the Lab 2018



Included participants from  
over half of  
the NNCI sites:

Stanford  
UNC Greensboro  
Northwestern  
NC State University  
Duke  
University of Washington  
Harvard  
University of Nebraska

ASU's Alyssa Sherry  
(Chemistry) will serve as TA

June 3-9, 2018



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Please join us in Breakout Session 2  
tomorrow from 11:15-12:15  
to learn more and discuss SEI collaborations