

# Inclusion of Sustainability Aspects in Technician and Undergraduate Education Programs

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# Outline

- Who we are
- What we do
- Where we are going

## **Nano-Link: Center for Nanotechnology Education (formed in 2006)**

Funded by:

National Science Foundation  
Advanced Technology Education Directorate

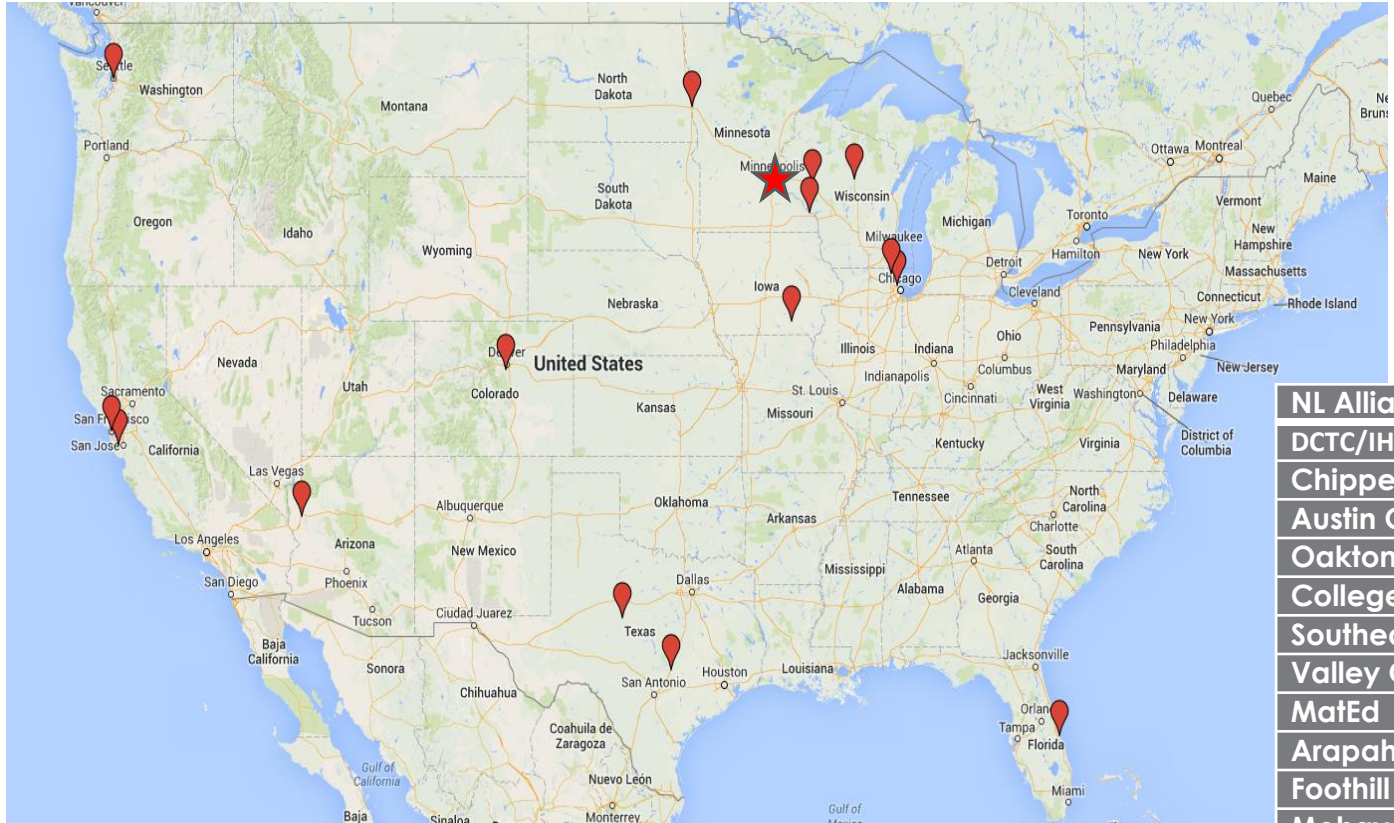
Home Institution:

Dakota County Technical College/Inver Hills Community College  
Minnesota US

Nano-Link is an Alliance of 15 Educational Institutions  
High Schools (1), Colleges (12) and Universities (2) through out the US  
Offering Certificates, 2 year degrees and 2+2 programs leading to a BS degree  
Multi-disciplinary Nanotechnology (Electronics, Biotech, Materials,)

D. Newberry: Director/PI





NL Alliance Member	Address
DCTC/IHCC	Minneapolis MN
Chippewa Valley Technical College	Eau Claire, WI
Austin Community College	Austin, TX
Oakton Community College	Skokie, IL
College of Lake County	GraysLake, IL
Southeast Tech	Winona, MN
Valley City State University	Valley City, ND
MatEd	Seattle, WA
Arapahoe Community College	Littleton, CO
Foothill College	Los Altos Hills, CA
Mohave Community Collge	Kingman, AZ
St. Petersburg College	St. Petersburg FL
Northcentral Technical College	Wausau, WI
Bio-Link	San Francisco, CA
OPTC	TX
Indian Hills Community College	Ottumwa, IA
University of MN	Minneapolis, MN
University of WI	Platsville, MN
Wheeling High School	Chicago IL



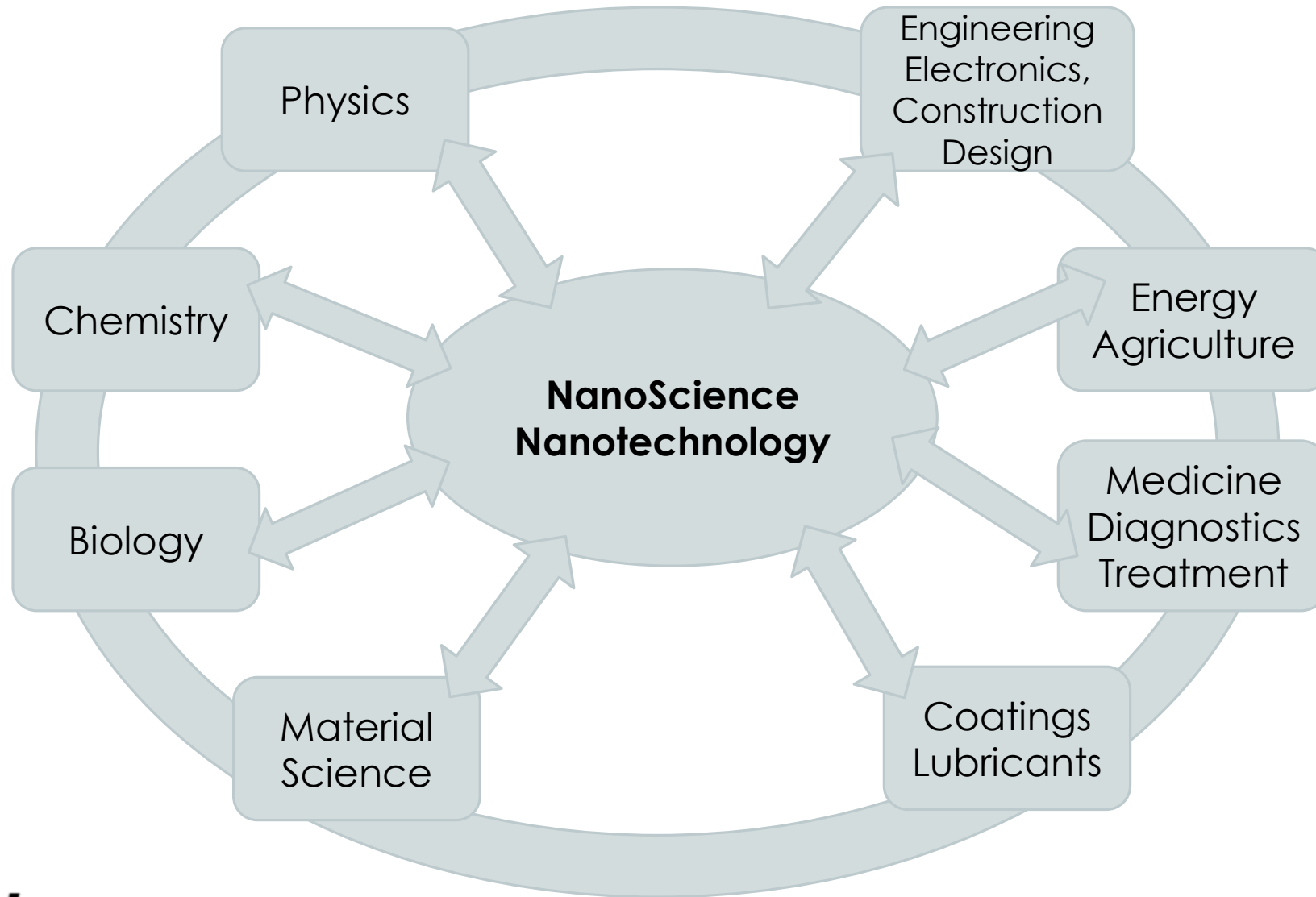
**Nano-Link is** an alliance of educational institutions (high school through graduate school)

**That provides nanoscience educational content, guidance and direction to anyone who wants, needs or desires that information**

**Nano-Link provides nanotechnology content in 3 forms:**

- Entire, 16 week courses (30 available)
- College level labs (45+ available)
- Modularized topic specific, 1 hour, activity based content
  - Used by over 300 educators in 4 countries, (38 US states) reaching over 32,000 students





**Dakota County Technical College**  
**Nanoscience Technology Program Course Outline and Credit Allocation**  
 rev. 2011

Semester 1 at DCTC			Semester 2 at DCTC			Semester 3 at DCTC			Semester 4 At Univ. of MN		
Course	Name	Credits	Course	Name	Credits	Course	Name	Credits	Course	Name	Credits
BIOL 1500	General Biology	4	CHEM 1500	Introduction to Chemistry	4	NANO 2101	Nano Electronics	3	MT 3111	Elem. of Micro Manufacturing	3
PHYS 1100	College Physics I	4	PHYS 1200	College Physics II	4	NANO 2111	Nanobiotechnology/ Agriculture	3	MT 3112	Elem. of Micro Mfg Lab	1
ENGL 1100	Writing & Research Skills	3	SPEE 1020	Interpersonal Communication	3	NANO 2121	Nanomaterials	3	MT 3121	Thin Films Deposition	3
MATS 1300	College Algebra	4	MATS 1250	Principles of Statistical Analysis	4	NANO 2131	Manufacturing, Quality Assurance	2	MT 3131	Intro to Materials Characterization	3
NANO 1100	Fund. of Nano I	3	NANO 1200	Fund of Nano II	3	NANO 2140	Interdisciplinary Lab	3	MT 3132	Materials Characterization Lab	1
			NANO 1210	Computer Simulation	1	NANO 2151	Career Planning and Industry	1	MT 3141	Principles and Applications of Bionanotechnology	3
			NANO 1222	Student Lab Experience and Research	3				MT 3142	Nanoparticles & Biotechnology Lab	1
									NANO 2970	Internship	2
Credits		18	Credits		19	Credits		15	Credits		17



## Economic and Societal Impacts -- Exposure





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# First Semester

In small groups

students are asked to come up with a nanotechnology based product

They describe the product, its attributes, purpose, audience etc.

Place these items on large poster boards in the classroom

As we progress through the semester –

and discuss societal, cost, feasibility, regulatory, environmental and economic aspects

students keep going back to their product – to determine how well their product

fits various (self determined) parameters

Also discuss how various aspects are tested and measured (use some SNO presentations)

Warning!!!! This can get ugly –

some students are willing to sacrifice environmental issues for the potential benefit of the technology

some students will think the cost is too high

some students now think “it will never sell”



## Societal Aspects

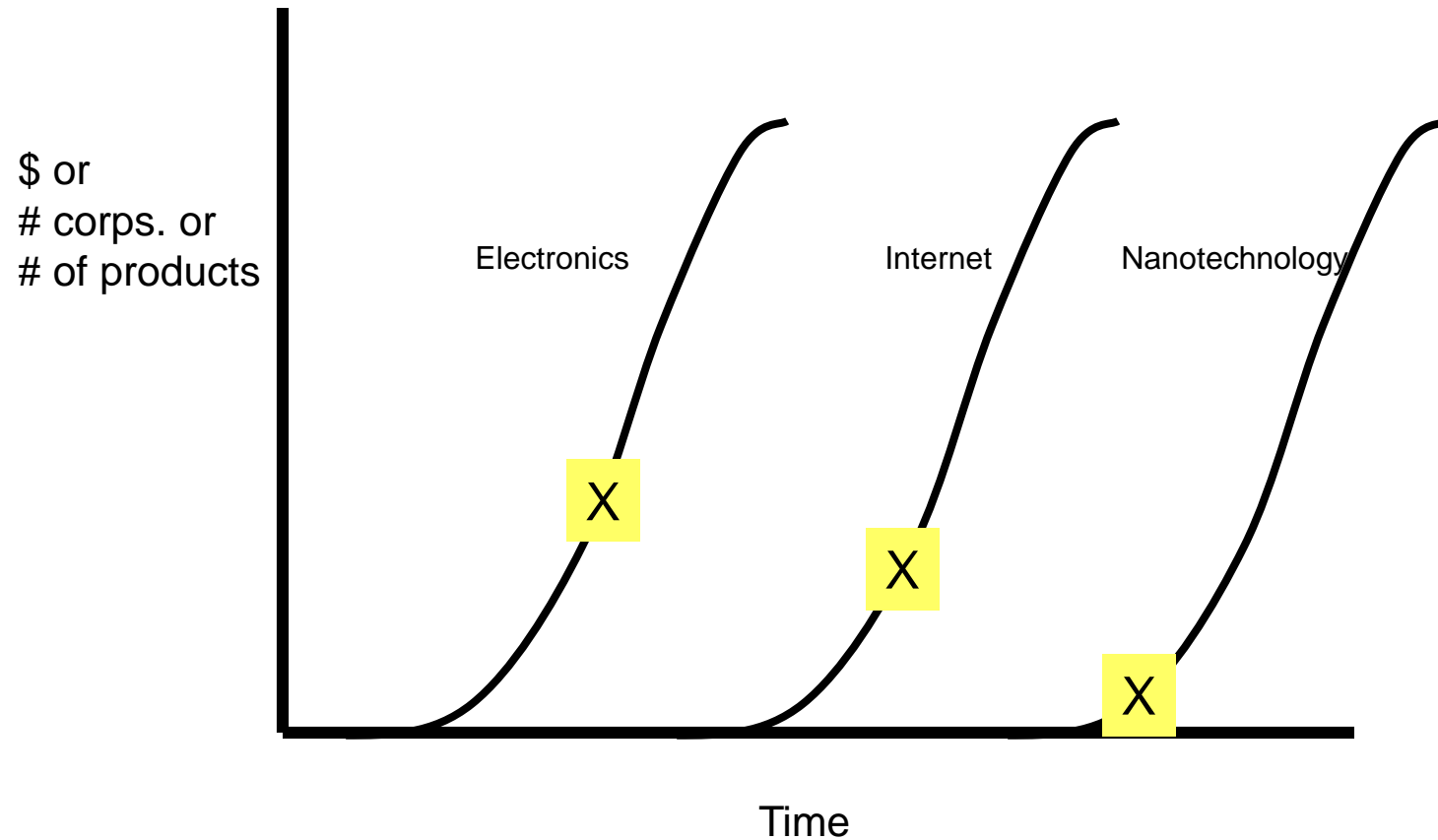
Not always technology based

How does the public view science/scientists/engineers

IP protection – global aspect

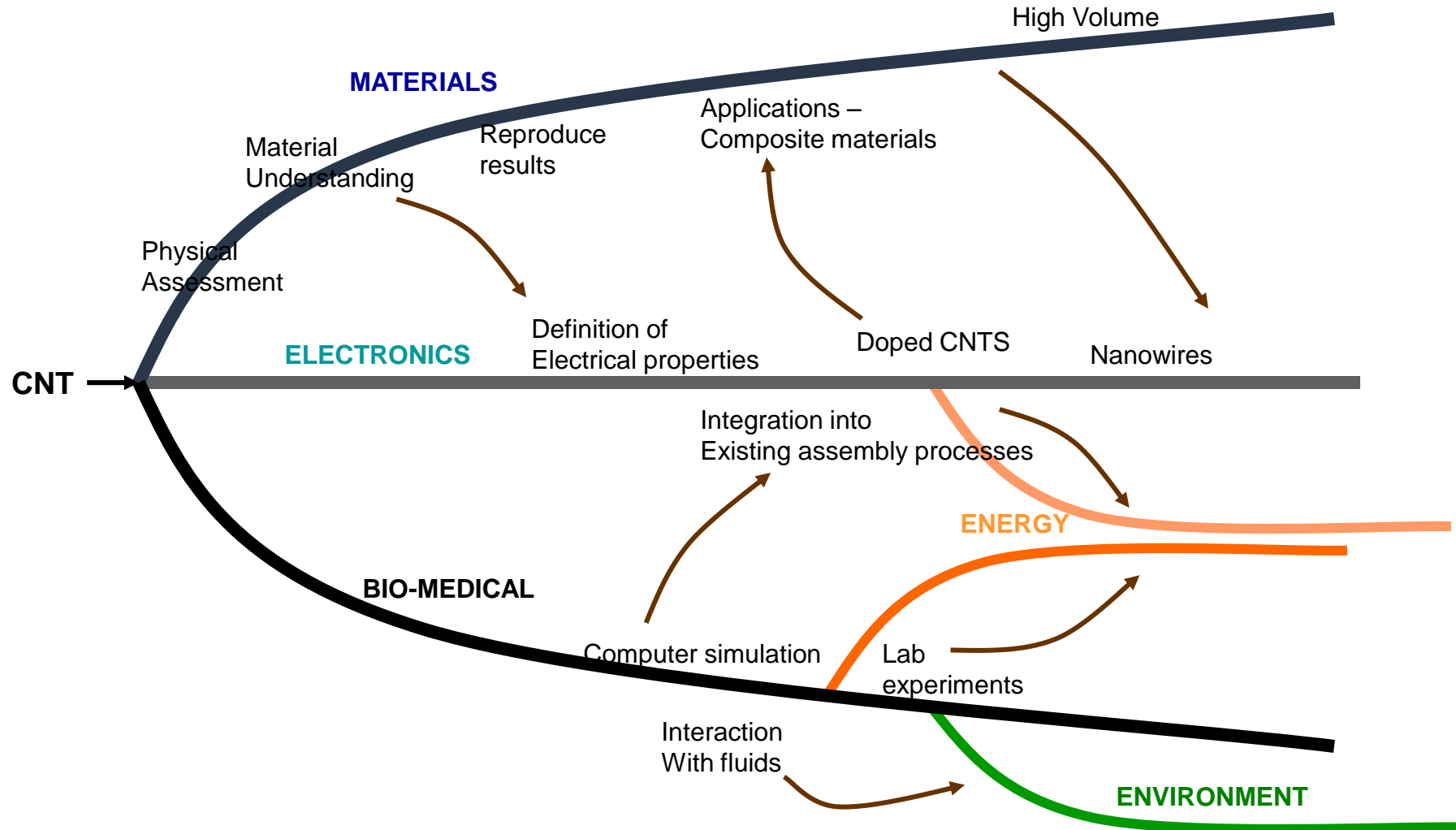
Hype versus reality

What is our obligation to them? (ref. dmn IEEE Editorial 2003)



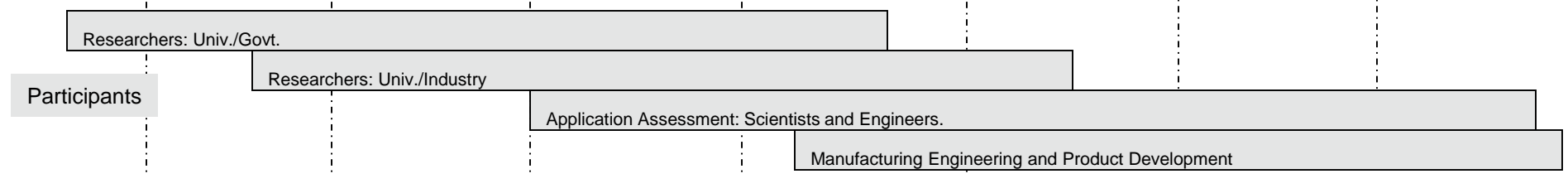
Where or when in the development of this technology did the general public become aware of the technology?

What is the impact of this early awareness?

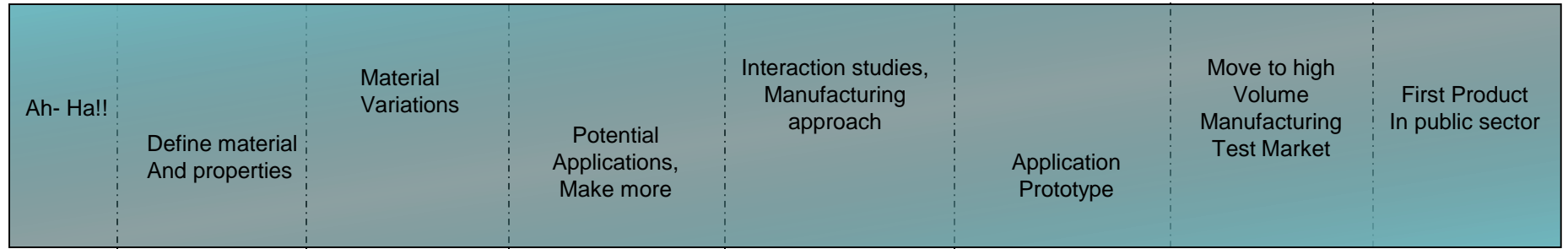


### Maturity Phase

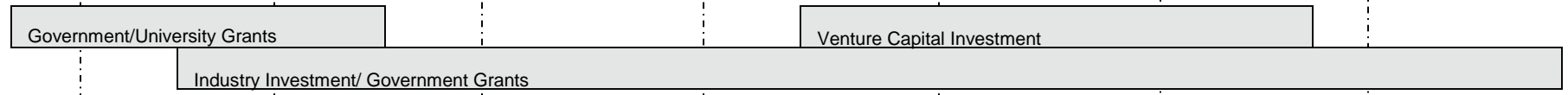
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### Technology Attributes



### Investment



## Discuss the Complex Matrix of Interactions

- Material
  - Size
  - Shape
  - Purity
  - Surface characteristics
  - Concentration
  - Entry method
  - Time – efficacy and storage
  - Temperature, pressure impacts
- 
- Classes include guest speakers from Mayo, Medtronic, U of MN et al.

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# Third Semester

- Manufacturing, QA and Reliability Class
  - FMEA and FMECA activities
  - Nanoscale assays for diagnostic purposes
  - Au nps for treatment purposes – significant of np diameter, interface coverage, time considerations, storage approach, end of np life consideration
  - Criticality of parameters, of failure mechanism, probability
- Lab Classes
  - Consider life cycle and end of life aspects
  - Disposal of ENMs and chemicals

Hardware Item	Failure Modes	Causes of Failure	Failure Effects	Severity	Probability of Occurrence	Criticality	Comments
CNT	Doesn't absorb Lamanin	CNT is the wrong shape or size	Stem cells don't attach to the CNT's and go to healthy part of brain	2	1	3	With proper sorting of CNT's this should be preventable
	Short wires the brain	CNT's in the brain cause parts of the brain to function in correctly	Serious change in patients brain function	4	2	6	Research how the presence of CNT's affect the function of neurons
	CNT's attacked by immune system	No or incorrect bio coating	Clots in the brain, possible hemmoraraging	4	3	8	Research the immune response to CNT's
Stem Cells	Don't attach to CNT's	Lack of lamanin in CNT	Stem cells regenerate in healthy part of brain	2	1	3	Learn to control the stem cells attachment to the CNT
	Don't differentiate into neurons	Cell wasn't in proper environment	Treatment was a waste, CNT's left in brain	3	2	6	Further research on stem cells to insure how they react and differentiate

## Larger Activities that Emphasize SN

- Industry Defined Topics
  - High temperature material for sensors – literature search, cost analysis
  - Biodegradable eating utensils– Regulatory, Manufacturing process, cost – definition of biodegradable
- Research topics – TiO<sub>2</sub> impact on bi-valve mollusks

# Nano-Link is Looking for....

- Grad students to talk about their work for 15 min videos – aimed at undergrads to explain, encourage and open horizons
- Research work that they (UG students) can support – not equipment intensive – but a way they can contribute to the needed body of knowledge
- Ideas for labs, experiments, activities, thought experiments that can emphasize sustainability aspects
- Work that can enhance your work
- If you are looking for ways to work with colleges (to perhaps enhance a proposal) Nano-Link is just the place!!!!



THANK YOU!!!!!!

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