

How an NSF-funded nanotechnology program help lead and nucleate the broader national nanotechnology infrastructure ecosystem



Mary Tang
SNF Managing Director
nano@stanford

Caveat:
This is a perspective
from someone in
“traditional”
fabrication at Stanford



National Nanofabrication Facility List

The “threats” are here today

The National Nanofabrication database is continuously being expanded upon. To have your facility added, please contact us at contact@nanotechnyc.com

- Aging equipment/infrastructure (SNF opened in 1986)
- Research shifts away from hardware
- Operating costs increase faster than R&D funding
- Increased competition (160 US university nanofacilities today)

The CHIPS Act will buy US nanofacilities time....

- To develop long-term sustainable business plans
- To evolve a new ecosystem while continuing to serve our researchers

Title	Facility	City	State
Air Force Institute of Technology	Electronic Devices and Materials Laboratory	WPAFB	Ohio
Alfred University	Center for Prototype Manufacturing of	Alfred	New York
Arizona State University	ASU NanoFab	Tempe	Arizona
Auburn University	Alabama Microelectronics Science and Technology Center	Auburn	Alabama
Boise State University	Idaho Microfabrication Laboratory	Boise	Idaho
Boston College	Integrated Sciences Cleanroom and Nanofabrication Facility	Chestnut Hill	Massachusetts
Boston University	Optoelectronic Processing Facility	Boston	Massachusetts
Brown University	Micro Nano Biosystems	Providence	Rhode Island
Brigham Young University	BYU Integrated Microfabrication Lab	Provo	Utah
Brown University	Microelectronics Core Facility	Providence	Rhode Island

Our peers

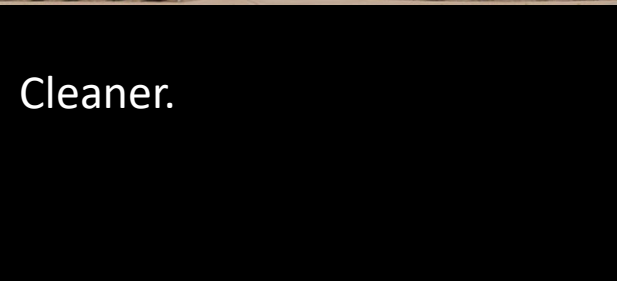


Scifres/Birck Nanofabrication Lab, Purdue University, 2007

Bigger.



Marvell Nanofabrication Laboratory, UC Berkeley, 2009



Singh Center for Nanotechnology
University of Pennsylvania, 2013



MIT.nano, MIT, 2018



Center for Nanoscale Systems Harvard University, 2007



SMBB University of Utah, 2014

Can we make an impact
without a new building?

Goal #1: Predictable operations

We don't want:

- To run out of process gases & chemicals
- To discover a machine is broken AFTER it has broken wafers

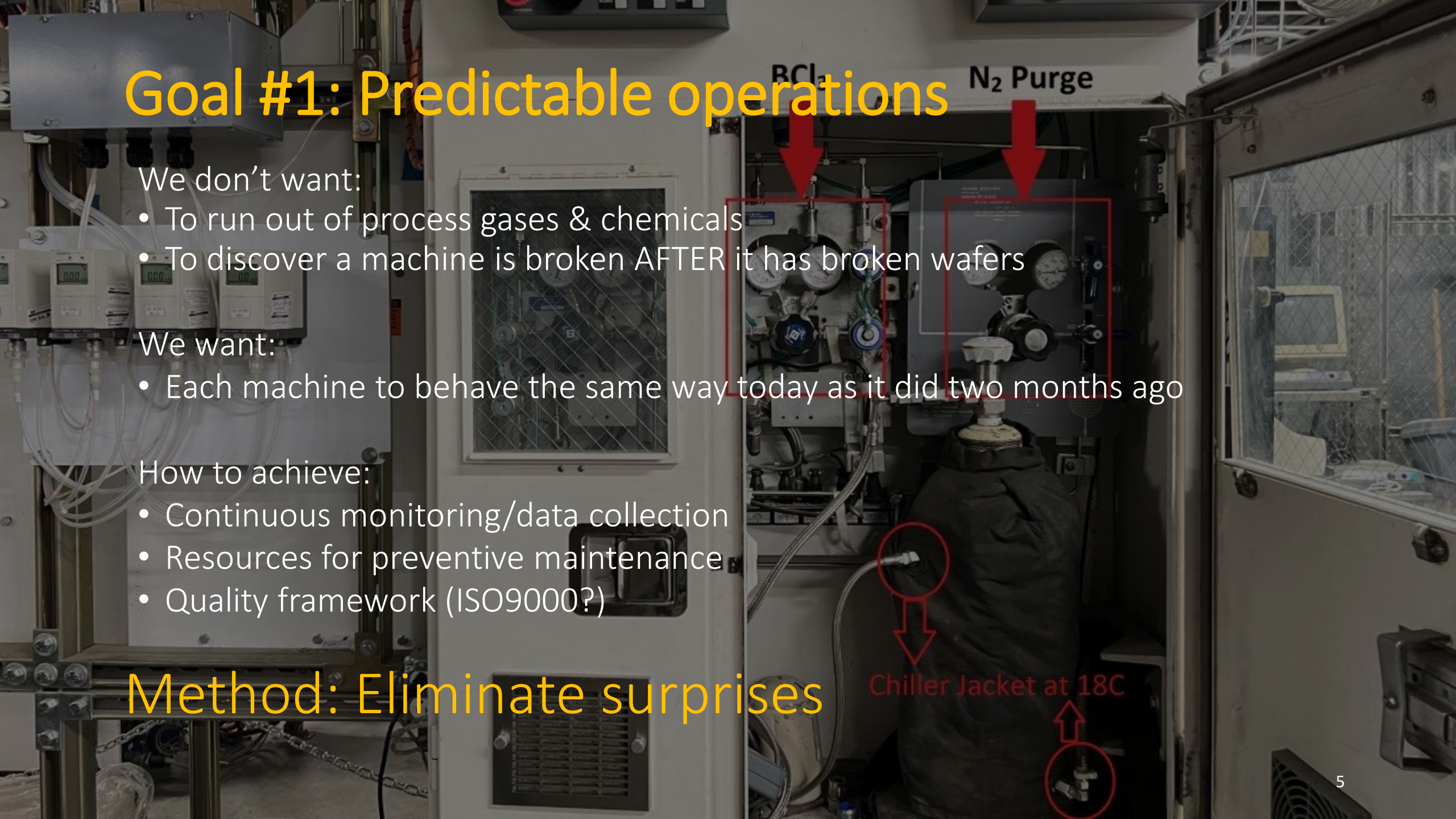
We want:

- Each machine to behave the same way today as it did two months ago

How to achieve:

- Continuous monitoring/data collection
- Resources for preventive maintenance
- Quality framework (ISO9000?)

Method: Eliminate surprises



Goal #2:

SNF pre-pandemic



Goal #2: Knowledge Capture

SNF In 2023
1/3 staff turnover since
the pandemic hit.



Capture ops & experimental info = FAIR library



Goal #3: Community

- Low barriers to entry
- Cultivate active engagement
- Provide social, as well a technical, value

Vision, Part 1: A Data/Hardware Ecosystem

Routes from “here” to “there,” with alternate routes, traffic alerts, ETA’s, suggested stops.

To build, we need:

- Predictable operations & knowledge capture
- Facilitated by data enabled lab operations

CNT transistor

An idea

Google Fab



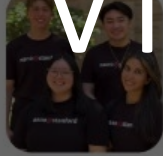
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PAID Community College Internships
Join the nano community!

Vision: Part 2

Convergence – Remove barriers to bridge

- Research and education
- Education and work
- Research and commercialization
- Software and hardware
- Researchers, disciplines, organizations



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A new nanofacilities ecosystem will:

Improve researchers' experience

- Lower the entry barrier
- Provide supportive community

Accelerate high quality research

- Sharing what didn't work
- Reduce experimental turnaround time
- Provide framework for data integrity/custody

Streamline nanofacilities operations

- Reduce operating costs
- Reduce our environmental footprint

Race to the bottom: How competition to publish first can hurt scientific quality

By Carolyn Stein and Ryan Hill

KEY TAKEAWAYS

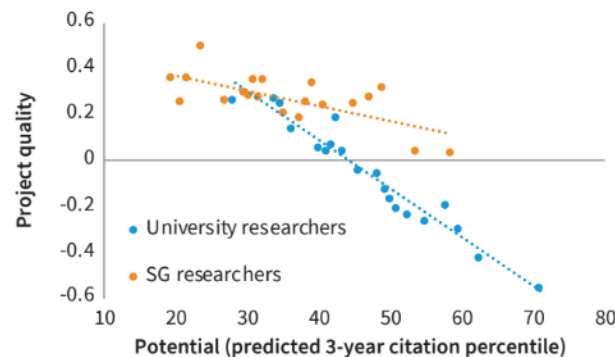
- Scientific research is a critical piece of R&D. Understanding what motivates scientists has important economic implications.
- A primary motivator in science is the credit associated with publishing first. But the race for a scoop leads to lower-quality work, which may threaten true scientific progress.
- **Government subsidies of collaborative research can improve research quality** by blunting the incentive to cut corners.
- Several scientific journals have recently instituted “scoop protection policies” aimed at curbing unhealthy competition.

Credit for new ideas is critical for research scientists. It is the currency of scientific careers that builds reputations and leads to funding, promotions, and prizes (Stephan, 1996). And where does the credit come from? It comes from the social and economic incentives that drive scientists to publish first, at least in some fields, and others.

Given the importance of credit, it is not surprising that scientists sometimes file papers before they are ready, or even before they know their own results. This is a known historical phenomenon, and Gottfried Leibniz and Gottfried Wilhelm Leibniz credit for inventing calculus. More recently, a manuscript by James Watson and Francis Crick led to Darwin's theory of evolution. More recently, the public conflict over the cloning of a human embryo was so acrimonious that governments in several countries have banned the practice.

While priority science is being done, scientific progress. As grants become increasingly selective, scientists must spend more time writing proposals, leading to “crippling demands” that subtract time from thinking, reading, and conducting research (Alberts et

Figure 4.
The Effect of Project Potential on Project Quality:
University Researchers versus Structural
Genomics Researchers



How can an NSF-funded nanotechnology program help lead and nucleate the broader national nanotechnology infrastructure ecosystem?

- Build a national nanotechnology infrastructure around information and people.
- Take data sharing and experiential education on a national level.
- Make it open-source.
- Make it community-based.
- Make it an ecosystem that is inclusive, welcoming all nanofacilities to participate.
- Engage experts to advise on infrastructure organization and management.