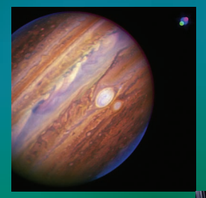

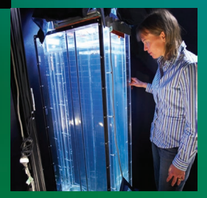

CENTERS

ABOUT PROFILES IN TEAM SCIENCE

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"Universities Have Departments; Society Has Problems"

INTRODUCTION
TO PROFILES IN TEAM SCIENCE

BY DEBORAH ILLMAN

Science is an essential literacy — "a civil right, in many ways," said the president of the Science Museum of Minnesota, Eric Jolly, to me in an interview for this project.

At the heart of science literacy is the understanding that science is not a static body of facts; it's a process of inquiry. And something very interesting has been happening to that process lately that has not appeared on the radar screens of journalists or the public—something I think people should know about.

It's the increasing trend toward team science: tackling problems that could not be solved by any one discipline alone.

The conventional wisdom most people learn in school is that to study a system, scientists isolate the variables. They study the effect of one variable at a time.

But in recent years, scientists and engineers have taken on really hard, messy problems that involve many dimensions. They are banding together in large interdisciplinary teams to go after federal funding for "big" projects, conducted over a longer time frame than conventional research projects. Though not quite on the scale of the space program or the Manhattan Project, these centers nevertheless employ a mission-oriented, team approach that is reminiscent of those historic efforts.

Over the past three decades, for example, the National Science Foundation has invested in interdisciplinary science and engineering through center programs of various "flavors." Examples are the Industry/University Cooperative Research Centers (I/UCRCs), Engineering Research Centers (ERCs), and Science and Technology Centers (STCs), among others.

In a way, the proliferation of centers is a response to the experience encountered by many academic researchers of "throwing results over the wall and getting frustrated that the world doesn't change," in the words of S. Shankar Sastry, director of one of the NSF STCs, called the Team for Research in Ubiquitous Secure Technology, and a professor at the University of California, Berkeley.

History may look back on these last couple of decades as a time when science grew up and took on real-world problems instead of sticking to the safe and tidy world of the tractable, in which studies are undertaken because they are do-able, even if not directly useful.

Today, curiosity-driven basic research in the university is being augmented with mission-oriented research and development. In these pages, we hear from the people involved and how they are managing both ends of the spectrum.

Profiles in Team Science is the result of a year spent exploring the NSF Science and Technology Centers. It was made possible by a Senior Fellowship from the NSF Discovery Corps Program in the NSF Chemistry Division. The booklet is focused on

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the group of currently funded STCs, and although these 17 centers are working on different topics, they all are organized following the same essential pattern: an integrated, 10-year program of research, education, diversity enhancement, knowledge transfer, and public outreach.

An STC typically involves several universities, dozens of faculty and postdoctoral researchers from many different departments, over a hundred graduate and undergraduate students, and dozens of industrial and community affiliates. A center has the staff, resources, and time to make a much larger and far-reaching impact than usually is possible with smaller grants.

Topics addressed by the STCs run the gamut from understanding what's happening to the Earth's ice sheets to learning what makes animals behave the way they do. One center is developing plastic electronics, while another develops water disinfection strategies that may help alleviate looming shortages of that resource around the nation and the world.

In the development of *Profiles in Team Science,* I set out to explore what taxpayers were getting for their investment in the STCs. What are these centers doing that otherwise couldn't be done—or done as quickly? What is team research like? How are the results being applied? How do directors manage these large operations? Why do they take on the task?

I knew going in that it would not be possible to cover everything happening in these centers. Accordingly, this booklet is intended to be a sampler. It is meant to be suggestive, not exhaustive. I chose to focus the scope primarily on research outcomes, results transferred to practice, and the personalities leading the charge.

I regret that I could not do justice to the complete array of activities going on in the STCs. For example, while selected examples of education and diversity enhancement are highlighted in these pages, it was not possible to include everything each center is doing in this regard. Diversity enhancement is one of the most significant legacies of the STC program, and an entire booklet could be written just on these efforts alone. After all, educating a diverse group of students provides the next generation of researchers to conduct team science, which is enhanced by peoples from all walks of life, and so this is a vitally important component of the STC mission. Furthermore, there were many more examples of K-12 and public outreach than could be included—and the same for startup companies and industrial partnerships, which are poised to move research results into practice for the benefit of society and our economy. What you'll see in these pages is just the tip of the iceberg. I hope readers will be enticed to visit the centers' Web sites and the NSF site for additional information.

I want to be clear about what this booklet is not. It is not an inventory of everything centers are doing. It does not officially represent the NSF STC program. It is not intended to be a critical evaluation of centers generally, or of the NSF STC program in particular.

I did not feel constrained to be "objective" in the journalistic sense—that is, I did not go out and find independent sources to quote, giving me the upside and the downside, the caveats and qualifiers.

Rather, what I sought to do was to lay some evidence on the table. To tell a few of the stories that seemed to be falling through the cracks because they didn't fit within the confines of the hard news format and traditional news beats in the media. To let readers hear, in the researcher's own words as much as possible, why they believe these outcomes are important, and how the experience has changed things for them and for their students, institutions, and disciplines.

I wanted to help shed light on a trend in science that has been increasing but largely invisible in the media, and therefore, to the public. Through the News Watch sections in this booklet, I have tried to point journalists toward emerging stories that are likely to break over the coming months.

Why should journalists and the public care about centers? Shouldn't journalists just report the results, never mind by what means obtained?

Most Americans keep up to date about developments in science and technology through the news media. So media coverage relating to centers is critically important to the nation if policymakers, the scientific community, educators, and taxpayers are to understand the role that these modes of science play in solving critical problems facing society.

If journalists fail to make the link between center-mode funding of research and the outcomes that centers achieve, government officials, scientists, and taxpayers will lack information they need to make informed decisions.

The appropriate level of federal funding for centers is an issue that continues to be debated nationally. It's a question of the balance between large, multi-investigator efforts versus smaller, single-investigator grants. For example, in 2005, responding to pressures, NSF modified the definition of a center, reducing the number of such entities from 300 to 200, according to

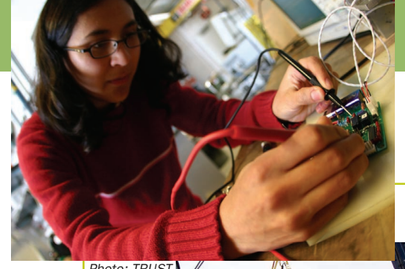

Photo: TRUST

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reports in the *Chronicle of Higher Education* and *Science.* NSF's annual investment in centers was estimated in those reports at $350 million, or 7 percent of the agency's budget.

Furthermore, managing team science remains an issue of public concern. Federal agencies are focusing not only on funding mechanisms and portfolio balance but also on ways of overcoming barriers to interdisciplinary collaboration and of improving communication between disciplines. The risks of faculty participation in team science can be significant, and rewards within the traditional academic culture can sometimes be uncertain or even negative. Meanwhile, campuses struggle to manage entities that not only straddle departments and colleges and share FTEs, but that dot the country with a constellation of partners.

Team science "doesn't fit in the traditional silo," notes Dennis Matthews, director of the Center for Biophotonics Science and Technology, an STC headquartered at the University of California, Davis, observing that "everyone loves to anoint a single hero."

Centers are a countermeasure against academic rigidity. They create a matrix structure, first of all within a university, crossing department and college lines, but even beyond that, across institutions. Centers apply a forcing function on the evolution of our universities to accelerate change and to expand horizons for students.

On the other hand, faculty and directors have so many affiliations these days, it can seem like a spaghetti bowl of centers, institutes, and programs. It's a wonder how they keep the acronyms straight, let alone manage divided loyalties.

And it's just as hard for public information officers and journalists to grapple with these relationships. Most media relations personnel are assigned to beats following college lines: engineering, arts and science, social sciences, medicine, and so on. Covering centers seems, once again, to fall through the cracks.

Center participants acknowledge the overhead of time and energy needed to manage team work. Centers have utilized videoconferencing, but alas, it never seems robust enough. Centers likely will be eager early adopters of new conferencing technologies.

Working in a six- or seven-ring circus can be tough. There is a certain amount of attrition of the players: teamwork is not everyone's cup of tea. Centers have played to their strengths in working these things out, but it has taken time and a few false starts. The question now is how these efforts will be institutionalized to leverage the effort so that even after NSF funding ends, the value will continue. Many of the current centers are planning now for "life after NSF" and taking stock of the legacies they will leave.

Doubtless one of the most important legacies is the new kind of student educated at an STC. I do believe that centers produce a different kind of graduate, one more able to work in teams, speak the language of other disciplines, with a broader suite of professional skills and an appreciation for the broad spectrum of research through development and application.

These individuals have spent their formative years in a diverse culture of tackling big problems and developing disciplinary strengths in the context of multidisciplinary breadth. That seems like a powerful combination.

Center participants point to the legacy of the STC program in building diversity and enhancing programs at four-year institutions and Historically Black Colleges and Universities (HBCUs). Another lasting outcome will be models for effective partnerships between universities and museums, zoos, and other community organizations. Centers are spinning off startup companies, a handful of which are described here, out of literally dozens to stem directly or indirectly from center research. Throughout these pages, you'll see examples of tangible results of mission-oriented research transferred to industry, government, and communities across the country.

The unintended outcomes are fascinating. Time and time again, we see a center set out in one direction and end up with an entirely different application. One center, for example, set out to develop solvent-free green manufacturing technology and ended up with a new way to deliver cancer therapies.

Writing about the STCs was an adventure. Much of my career has been spent trying to make science more accessible, not only through my own writing but also by coaching young people to become more effective communicators. Toward that end, I am grateful that several writing students had the opportunity to share in this experience. The project has contributed to the portfolios of up-and-coming writers, some of whom will continue in scientific research while others pursue writing or communication careers.

I would like to thank all of the members and center directors of the NSF STCs who gave of their time and energy, with particular thanks to Dennis Matthews, Mark Shannon, Joe DeSimone, Chris Paola, Walt Wilczynski, and Claire Max. I'd like also to acknowledge Alvin Kwiram, emeritus vice provost for research and former chair of chemistry at the University of Washington, for his input on this project. Finally, I would like to thank Kathy Covert, NSF Discovery Corps Program Director, and the NSF Chemistry Division for their support.

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