

## **Workshop Result: Feedback from the 2021 Engineering Research Center Planning Grant Workshop**

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# Workshop Result: Feedback from the 2021 Engineering Research Center Planning Grant Workshop

## Abstract

ASEE has partnered with the National Science Foundation (NSF) to host the Engineering Research Center (ERC) Planning Grant Workshops (PGW) since their inception in 2018. The workshop purposes are to explain ERC goals, provide strategies for ERC design, and promote strategies for integrating Convergent and Transdisciplinary Research and Team Science into ERC proposals. Participation in the Planning Grant program is not required to submit an ERC proposal. In 2021, 23 teams joined the PGW, with a total of 114 participants from 54 institutions across the U.S. The 2021 program consisted of three, half-day sessions spanning three weeks. The workshop agenda was created collaboratively by leaders at NSF and ASEE, with particular attention to recommendations from prior cohorts.

In this this paper, we share:

- 1) information presented at the workshop about the key foundational components of an ERC
- 2) results of the workshop evaluation
- 3) access to recordings and workshop materials ([available here](#))

## Introduction

The goals of the NSF Engineering Research Center (ERC) Planning Grant Workshop are to explain ERC goals, provide strategies for ERC design, and promote strategies for integrating Convergent and Transdisciplinary Research and Team Science into ERC proposals. NSF Program Officers provided in-depth coverage of ERC goals, core pillars, and proposal preparation strategies. In addition to Program Officer presentations, speakers included university presidents, ERC directors, and subject area experts. In breakout sessions, Principal Investigators and team leaders learned about and shared ideas with Program Officers and other participants about promoting convergent research, team formation, and capacity building.

The workshop agenda, PIs' questions and concerns about the ERC proposal, and evaluation results are summarized. The workshop was delivered online, and sessions were recorded. The authors, NSF, and ASEE encourage dissemination of this link to the agenda and recordings to those interested in preparing an ERC grant proposal: <https://erc-assoc.org/content/planning-grant-workshops>.

## Background

Since its inception in 1984, the Engineering Research Center program at the NSF has funded 75 interdisciplinary centers located at universities across the United States [1]. The ERC program supports convergent research that leads to strong societal impact, and each Center includes additional foundation components of workforce development, culture of inclusion, and innovation ecosystem [2]. The integration of research, education, diversity, outreach, and

industrial collaboration positions ERCs to outlast the 10-year funding lifetime, making them change agents in academic engineering programs, engineering practice, and industry. NSF currently supports 14 active ERCs in advanced manufacturing; energy and environment; health; and infrastructure [1].

NSF continues to refine the goals and purpose of the ERC program to meet societal and industry needs. The ERC program’s current goal is to create a culture of technological innovation through partnerships with relevant stakeholders through team-based convergent research on critical and complex societal problems [3]. Following a 2017 National Academics of Sciences, Engineering, and Medicine (NASEM) study recommendation [4], the ERC program is placing greater emphasis on high-risk, high-payoff research, larger societal impact, convergent research approaches, engagement of stakeholder communities, and adoption of team science in team formation. The solicitation following the 2017 report marks the beginning of the “Gen-4” ERCs [2].

### Workshop Agenda

The 2021 PGW agenda was outlined by the NSF ERC team and incorporated feedback provided to Program Officers from prior Planning Grant evaluations, which contained participants’ ratings and comments. The 2021 PGW agenda, recordings, and materials can be accessed on the ERC website ([link](#)).

The agenda included plenaries, speakers, and breakout room activities, with speakers, including university presidents, current ERC Directors, experts in key ERC areas, and NSF Program Officers.

#### Day 1 – September 21, 2021

<b>Time</b>	<b>Title</b>	<b>Speaker</b>
11:00 – 11:05 AM	Welcome	Norman Fortenberry, <i>Executive Director, American Society for Engineering Education</i>
11:05 – 12:00 PM	University President’s Perspective (A University President’s Perspective on What it Takes to be a Successful Gen-4 ERC)	Noelle Cockett, <i>President, Utah State University</i> Regan Zane, <i>Director, Center for Advancing Sustainability through Powered Infrastructure for Roadway Electrification (ASPIRE)</i>
12:00 – 12:45 PM	NSF ERC Program Director Panel	Sarit Bhaduri, Sandra Cruz-Pol, Dana Denick, Randy Duran, Nadia A El-Masry, Mehdi Ferdowsi, Deborah Jackson, <i>Program Director, Engineering Research Center Program, NSF</i> Ram Gupta, <i>Expert, Engineering Research Center Program, NSF</i>
2:00 – 2:30 PM	Convergent Research Case Study: NSF Nanosystems Engineering Research Center	Veena Misra, <i>Director, Nanosystems Engineering Research Center on Advanced Self-Powered of Integrated Sensors and Technologies</i>

	for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST)	
2:30 – 3:15 PM	ERC Directors Panel Q&A	John Bischof, <i>Director, Advanced Technologies for Preservation of Biological Systems (ATP-Bio)</i> Saikat Guha, <i>Director, Center for Quantum Networks (CQN)</i> Cherie Kagan, <i>Director, Internet of Things for Precision Agriculture</i> Regan Zane, <i>Director, Center for Advancing Sustainability through Powered Infrastructure for Roadway Electrification (ASPIRE)</i>

Day 2 – September 27, 2021

<b>Time</b>	<b>Title</b>	<b>Speaker</b>
11:00 – 11:15 AM	Goals for the Day	Sandra Cruz-Pol, <i>Program Director, Engineering Research Center Program, NSF</i>
11:15 – 12:00 PM	University President’s Perspective (A University President’s Perspective on Promoting Diversity, Equity, and Inclusion in Engineering)	Gilda Barabino, <i>President, Olin College of Engineering</i>
12:00 – 12:45 PM	Setting the Stage for Successful Convergence Research	L. Michelle Bennett, <i>Chief Innovation Officer (Acting) National Institute of Environmental Health Sciences, Director, Center for Research Strategy National Cancer Institute</i>
1:15 – 2:30 PM	Breakout Session One: 4 Foundational Components of an ERC	Sarit Bhaduri, Sandra Cruz-Pol, Dana Denick, Randy Duran, Nadia A El-Masry, <i>Program Director, Engineering Research Center Program, NSF</i>
2:30 – 3:00 PM	Breakout Session Reports	Sandra Cruz-Pol, <i>Program Director, Engineering Research Center Program, NSF</i>

Day 3 – October 5, 2021

<b>Time</b>	<b>Title</b>	<b>Speaker</b>
11:00 – 11:15 AM	Goals for the Day	Deborah Jackson, <i>Program Director, Engineering Research Center Program, NSF</i>
11:15 – 12:00 PM	University President’s Perspective (Grand Challenges Require Innovative Solutions)	Darryll Pines, <i>President, University of Maryland</i>

12:00 – 12:45 PM	Organizational Systems, Leadership, and Teamwork	Steve W. J. Kozlowski, <i>Professor, University of South Florida</i>
1:05 – 1:50 PM	On Measuring Value and Impacts	Nick Berente, <i>Associate Professor, University of Notre Dame</i>
1:50 – 2:20 PM	Diversity and Culture of Inclusion (DCI) Video and Breakout Sessions	Sandra Cruz-Pol, Dana Denick, Nadia A El-Masry, Mehdi Ferdowsi, <i>Program Director, Engineering Research Center Program, NSF</i>
2:20 – 3:05 PM	Critical Elements of an ERC Innovation Ecosystem	Erik Sander, <i>Executive Director, Florida Engineering Experiment Station</i>
3:15 – 3:30 PM	Closing Remarks	Don Millard, <i>Deputy Division Director, NSF</i>

### PIs' ERC Proposal Questions & Concerns

Prior to the 2021 PGW workshop, prospective PGW Principal Investigators (PIs) were asked to submit questions and concerns they had about ERC proposals. Questions were solicited one month prior to the PGW. A total of 79 questions were submitted by 21 PIs. ASEE research staff coded the 79 questions into the following 7 categories.

#### Counts of Pre-Workshop Questions Submitted by Participating Planning Grant PIs

Category	Number of Questions
Center Design and Vision	18
Proposal Solicitation, Review Criteria, and Process	15
Innovation Ecosystem	14
Research	14
Team Science	7
Workforce Development	6
Diversity and Culture of Inclusion	5
<b>Total</b>	<b>79</b>

#### Sample Questions Submitted by Participating Planning Grant PIs

Category	Sample Question
Center Design and Vision	Does NSF prefer to fund ERCs that serve the needs of existing industries, or those that can serve as a platform to develop science and engineering for future technologies (or to push existing industry in new directions that they do not have the scientific knowledge base to move into at this point)?
Research	How do you best determine whether a given ERC thrust is timely or competitive?

Workforce Development	Do we need to think about doing research in education and workforce development in order to gain new scientific insights into EWD [Engineering Workforce Development] practice?
Diversity and Culture of Inclusion	To what extent does diversity and inclusion have to be integrated into the research activities themselves?
Innovation Ecosystem	How to build regional strength without diluting focus?
Team Science	How do you determine the best balance of team members?
Proposal Solicitation, Review Criteria, and Process	What is the best way for us to get feedback from NSF on research directions we might pursue in a full ERC proposal?

Questions were addressed by NSF Program Officers throughout the workshop. During the PGW, moderators for talks and panels selected questions to pose to speakers and panels from live submissions and pre-submitted questions. Additionally, questions in the “Proposal Solicitation, Review Criteria, and Process” category were reviewed by the NSF ERC Program Directors—some questions were added to the Frequently Asked Questions (FAQ) page appended to the ERC Gen-4 solicitation [5].

### Workshop Key Takeaways

The following section summarizes key quotes and takeaways from the three “University President’s Perspective” plenaries given during the PGW.

#### University President’s Perspective on What it Takes to be a Successful Gen-4 ERC – Noelle Cockett, *President, Utah State University*

“It’s not just a commitment of you, it’s not just a commitment of your dean, it’s not just a commitment of the vice president of research. Going after one of these grants is a commitment from the university, the state, and the communities where the impact might occur. And there’s no better way to show there’s a commitment of the university than by engaging the president of your university in the grant... it’s more than a letter of commitment from the president. It’s actual involvement.” [6]

Key Takeaways:

- 1) Successful ERC proposals require university support at the presidential level
- 2) State and local community support makes a difference, and they will become advocates when goals align
- 3) An ERC is a win-win for all stakeholders – what opportunities and benefits will stakeholders realize when partnering for an ERC?
- 4) A successful ERC pitch will capture the imagination of potential partners

#### University’s President Perspective on Promoting Diversity, Equity, and Inclusion in Engineering – Gilda Barabino, *President, Olin College of Engineering*

“Inclusive engineering starts and ends with people.” [7]

### Key Takeaways:

- 1) Diversity is part of a complex system and should not be viewed in isolation – diversity, equity, and inclusion must be viewed from a systems perspective
- 2) Impact will take time to measure
- 3) Communication must take place at all levels to create lasting relationships that build commitment, intentionality, and accountability

### University President’s Perspective: Grand Challenges Require Innovation Solutions – Darryll J. Pines, *President, University of Maryland*

“As a result of the [COVID] virus, as a result of the congruence of social injustice, as well as uncertainty in democracy... [the ERC grant] demands big ideas from all of you to engineer better solutions, not just for technology’s sake but for people and society.” [8]

### Key Takeaways:

- 1) ERCs should tackle grand challenges resulting in potentially broad societal impact
- 2) Convergent engineering approaches are required for grand challenges
- 3) Inclusive partnerships will broaden participation to lead to the best solution

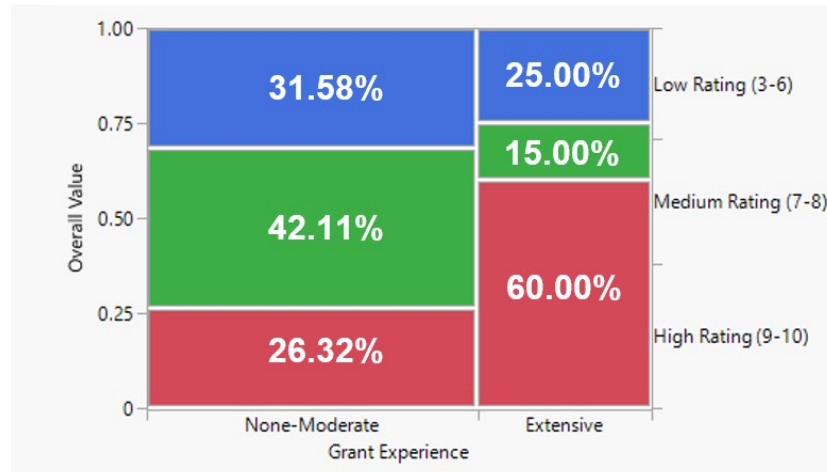
### **PGW Value to Participants**

Quality Evaluation Designs (QED) conducted the external evaluation of the ERC PGW. QED attended the three Zoom virtual workshop days to observe sessions and interact with workshop attendees, interviewed two workshop attendees, and deployed an exit survey. Survey responses were collected via Survey Monkey during the final session on the last day of the workshop, receiving a 94% response rate from 50 attendees. Follow-up requests resulted in a total of 85 participants completing the survey of approximately 100 who attended at least one day of the workshop (85% response rate).

Overall, the workshop was rated highly, with participants especially valuing the opportunity to interact with previous ERC Grant awardees and NSF program officers. Participants were asked to rate the *Overall Value* of the three-day workshop from 1 (*Not Valuable*) to 10 (*Extremely Valuable*). The average rating was 7.7, indicating that overall participants found the workshop valuable.

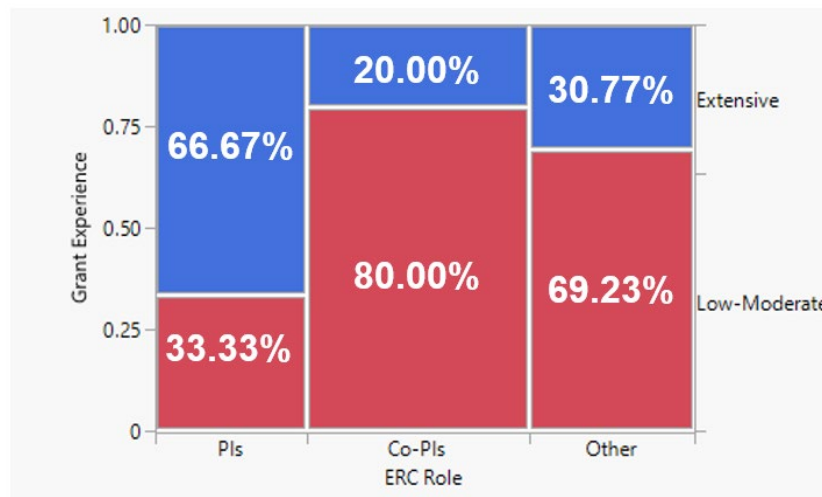
The factor that most impacted participants’ *Overall Value* rating was their self-reported *Prior Grant Experience*. Those who self-reported as having *extensive* grant experience were more likely to rate the workshop highly than those who had *none*, *minimal*, or *moderate* experience ( $G(\text{df}, 2) = 7.238, p = 0.026$ , Figure 1). On average those with *extensive* grant experience rated the workshop overall value as 8.2 and those with *none-moderate* grant experience rated the value as 7.5. Only 26.32% of participants with *none-moderate* grant experience gave the workshop high (7-10) ratings. Participants with *extensive* grant experience rated *Overall Value* as high 60% of the time, indicating that this workshop could be considered a “master class” in NSF grant writing.

**Figure 1: Overall Value x Grant Experience**



Participants' *ERC Role* correlated with *Grant Experience*. The majority of PIs (66.67%) had *extensive* grant experience, whereas only 20% and 31% of Co-PIs and those with other ERC roles reported extensive grant experience, respectively ( $G^2(df, 2) = 13.856, p = 0.001$ , Figure 2).

**Figure 2: ERC Role x Grant Experience**



Representative comments from participants include:

- “I have worked for three decades with the science side of NSF and NEVER before have I experienced such a comprehensive and thoughtful preparation program offered for large proposal writing teams. The value-add to NSF in terms of higher quality proposals that will have much higher societal impact outcomes that support NSF's mission is huge.”*

– Workshop Attendee with Extensive Grant Experience



- “I think you guys did a brilliant job! I actually learnt from each and session/event/speaker, even though I have been part of an NSF-ERC for 10 years!!”  
– Workshop Attendee with Extensive Grant Experience
- “There was a lot of sit-n-git and it would have been useful to have more interaction and exchange.”  
– Workshop Attendee with Moderate Grant Experience

Ensuring participants’ understanding of *ERC Foundational Components* was an important workshop goal. Using retrospective pre/post items, attendees rated their Pre- and Post- understanding of *ERC Foundational Components* (Figure 3). All post-ratings were 3.9/5.0 or higher, falling into the range of *Good Understanding*.

**Figure 3:** Pre vs. Post understanding of *ERC Foundational Components* (1= No Understanding, 2= Minimal Understanding, 3= Confused Understanding, 4= Good Understanding, 5= Excellent Understanding).

		Average
<b>Convergent and Transdisciplinary Research</b>		
Transdisciplinary research as an engineering approach	Pre	3.01
	Post	4.10
Strategies for conducting transdisciplinary research for high societal impact	Pre	2.86
	Post	3.94
<b>Team Science</b>		
The value and challenges of team science	Pre	3.13
	Post	4.19
Strategies for implementing team science	Pre	3.05
	Post	3.91
<b>Center Design</b>		
Communicating the value of ERC research	Pre	2.87
	Post	4.07
Strategies for effective center design	Pre	2.53
	Post	3.88
<b>Diversity and Culture of Inclusion</b>		
The multiple dimensions of diversity needed for innovative, relevant research	Pre	3.47
	Post	4.27
Strategies for fostering diversity and inclusion in research	Pre	3.56
	Post	4.17
<b>Innovation Ecosystem and Stakeholder Engagement</b>		
How to form trusted partners that work together to create and enhance the capacity for innovation	Pre	3.12
	Post	3.90
<b>Engineering Workforce Development</b>		
Evidence-based approaches for developing both curriculum and professional skills training	Pre	3.10
	Post	3.96

QED found notable differences on pre-ratings of understanding between those with *none-moderate* grant experience compared to *extensive* grant experience. However, those differences diminished substantially, and even disappeared in some cases, on post-ratings (see Figure 4). Even though *Overall Value* ratings were significantly different between the two groups, pre-/post-ratings show comparable increases in understanding. This shows that even though attendees with *none-moderate* grant experience rated the workshop lower, they still had comparable gains to those in learning about the ERC foundational components to those with *extensive* grant experience.

**Figure 4:** Pre-Post Understanding of *ERC Foundational Components* x *Grant Experience*

	<b>None-Moderate Grant Experience</b>	<b>Extensive Grant Experience</b>	<b>Difference between groups</b>
<b>Mean of Pre-ratings</b>	2.4/5.0	3.6/5.0	1.2
<b>Mean of Post-ratings</b>	3.5/5.0	3.7/5.0	0.2

When asked the most valuable aspect of the workshop, most participants cited being able to directly hear from current ERC directors, university presidents, and NSF program officers. They specifically liked hearing about the technical aspects and Foundational Components of an ERC. These were all core workshop objectives. Both attendees we interviewed specifically liked the advice to reach out to their university’s president, as this was something they had not thought to do before. Comments include:

Representative comments from participants include:

- “[Most valued:] *Networking with Program Managers and colleagues from other universities, and understanding ERC requirements better.*”
- “*It was a good immersive experience in the ERC culture and opportunity for clarification of terminology. The perspective of ERC directors and administrators was extremely valuable for me.*”
- “[Most valued:] *Listening to the university presidents discuss how the ERC proposal leadership should solicit their support.*”

Overall, most attendees were satisfied with the ERC PGW. They appreciated the quality of the presentations and being able to interact with current ERC directors, university presidents, and NSF program officers. Those attendees with *extensive* grant experience, such as the majority of PIs, gained the most value from the workshop. Participants urged the NSF to have materials posted online:

- “*I would love to have this available to teams who are CONSIDERING submitting a large center grant - ERCs, STCs, Expeditions....even those who might be considering it as part of their career trajectory in the next 5 years.*”

## **Conclusion**

The 2021 PGW accomplished the core workshop objectives of increasing participants’ understanding of ERC foundational components and providing strategies for ERC design, as well as integrating convergent and transdisciplinary research and team science into ERC proposals. Participants’ increased understanding of ERCs may increase the potential societal impact of ERC

grants and result in better-written ERC proposals. Materials and recordings of the workshop have been archived online as a resource for those interested in the ERC program and grant-writing process.

Participants with extensive prior grant experience, including the majority of Planning Grant PIs, received the most value from the workshop. This result might have been influenced by the fact that pre-workshop questions were solicited from Planning Grant PIs only; others were invited by the PI. The next annual PGW will incorporate recommendations and feedback provided by evaluation results and will continue to provide and disseminate information on the ERC program and strategies for putting together successful ERC proposals. Materials and recordings from the 2021 PGW can be found here ([link](#)).

### Acknowledgments

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