

# Leveraging Northeast Cyberteam Successes to Build the CAREERS Cyberteam Program: Initial Lessons Learned

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## ABSTRACT

Given the pivotal role of data and cyberinfrastructure (CI) in teaching and scientific discovery, it is essential that researchers at small and mid-sized institutions be empowered to fully exploit them. While access to physical infrastructure is essential, it is equally important to have access to people known as Research Computing Facilitators (RCFs) who possess a mix of technical knowledge and interpersonal skills that enables faculty to make the best use of available computing resources. Meeting this need is a

significant challenge for small and mid-sized institutions that do not have the critical mass to build teams of RCFs on site.

Launched in 2017, the National Science Foundation (NSF) funded Northeast Cyberteam (NECT) built a program to address these challenges for researchers/educators at small and mid-sized institutions in four states — Maine, Massachusetts, New Hampshire, and Vermont — while simultaneously developing self-service tools that support management and execution of RCF engagements. These tools are housed in a Portal called Connect.cyberinfrastructure and have enabled adoption of program methods by the broader research computing community. Initiated in 2020, the NSF-funded Cyberteam to Advance Research and Education in Eastern Regional Schools (CAREERS) has leveraged the NECT methods and tools to jumpstart a program that supports researchers at small and mid-sized institutions in six states and lays the groundwork for an additional level of support via a distributed network of experts directly accessible by the researchers in the

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region. This paper discusses findings from the first four years of NECT and the first year of CAREERS.

## Keywords

Workforce development, Research computing facilitator, Project portal, Ask.CI, CNCT.CI, Connect.Cyberinfrastructure, Ask.Cyberinfrastructure, Northeast Cyberteam, CAREERS Cyberteam

## 1. INTRODUCTION

Given the pivotal role of data and cyberinfrastructure (CI) in teaching and scientific discovery, it is essential that researchers at small and mid-sized institutions be empowered to fully exploit them. Access to physical infrastructure is essential, and equally important is access to people known as Research Computing Facilitators (RCFs), who possess a mix of technical knowledge and interpersonal skills that enables them to help researchers and educators use CI resources efficiently [1].

Providing access to RCFs can be challenging for small and mid-sized institutions for several reasons: (1) RCFs are in short supply and are difficult to recruit and retain, especially for institutions where budgeting for even one position is challenging to motivate; (2) it is impossible for a single RCF to have sufficiently broad expertise to cover all disciplines needing support; (3) if a lone RCF on campus changes jobs, research and education projects dependent on that RCF may slow or grind to a halt.

Launched in July 2020, the Cyberteam to Advance Research and Education in Eastern Regional Schools (CAREERS) aims to develop, implement, test, and refine a distributed approach to making research computing more accessible to researchers at small and mid-sized institutions via a regional collaboration. The CAREERS program region covers six eastern states: Connecticut, Delaware, New Jersey, New York, Pennsylvania, and Rhode Island. To do so, CAREERS builds on ideas developed by prior Cyberteam initiatives — the NSF-sponsored Northeast Cyberteam. Initiated in 2017, the Northeast Cyberteam Program (NECT) [2, 4, 5] is a collaborative effort across Maine, New Hampshire, Vermont, and Massachusetts that helps researchers at small and mid-sized institutions who are using advanced computing resources, while simultaneously training a new generation of RCFs. The program combines direct assistance to computationally intensive research projects; experiential learning opportunities that pair experienced mentors with students interested in research computing facilitation; sharing of resources and knowledge across large and smaller institutions; and development of tools that enable efficient oversight and facilitate replication of these ideas.

One of the most fundamental skills of successful facilitators is their ability to quickly learn enough about new domains and applications to draw parallels with their existing knowledge and to help solve the problem at hand. Recognizing this, a key concept in training facilitators through experiential learning is providing tools to enable self-service learning. The Connect.cyberinfrastructure (Cnct.CI) Portal is used to access the self-service learning resources that provide just-in-time information delivery to participants as they embark on projects in unfamiliar domains [6]. It also serves as a repository for best practices, tools, and techniques developed during a project. The NECT program places intentional emphasis on capturing and disseminating best practices to leverage and build on existing solutions whenever practical.

CAREERS leveraged the NECT tools and methods to jumpstart a similar program in six additional states. Simultaneously, CAREERS will lay the groundwork to provide a new layer of

support through which professional RCF domain expertise can be shared with researchers across the region. Significant learning has taken place during the adaptation of the NECT methods and tools and is reported here.

## 2. NORTHEAST CYBERTEAM — METHODS AND TOOLS

The collaborators in the Northeast Cyberteam [3, 4] recognized a diversity of specialized knowledge at various institutions in its four-state region, as well as an abundance of researchers at small and mid-sized institutions who could benefit from increased use of large-scale cyberinfrastructure. However, to do so, these researchers would need to overcome barriers such as not knowing how to start, whom to talk to, or how to address problems when they arise. A typical engagement, which we call a “project,” is proposed by a researcher whose computational or data needs have surpassed the processing power of their laptop, or who desires to apply a new technique (e.g., machine learning) in their work.

Each project involves a researcher seeking to better utilize cyberinfrastructure, a student facilitator, and a mentor with relevant domain expertise. This team works together over a period of three to six months to help the researcher move beyond the daunting inflection point where their needs exceed current computation and/or storage resources to a solution that makes effective use of new cyberinfrastructure. Student facilitators are recruited from institutions in the region and are paid for their participation at a rate that is based on experience level and project duration. The projects have involved students at a range of skill levels and usually represent their first experience with research computing facilitation. The exposure of this student cohort to facilitation work, and ensuring a positive and empowering interaction, is crucial to our goal of expanding the workforce pipeline. Mentors are volunteers and are usually professional RCFs from research computing groups at larger institutions in the region who have subject matter expertise relevant to the project. Mentors are paired with student facilitators assigned to a project and work with them to develop a strategy to provide direct assistance to the researcher in making use of appropriate cyberinfrastructure resources. Through this model, students receive training in and exposure to facilitation that otherwise would not be available, research projects move forward to use advanced cyberinfrastructure, and the effectiveness of the mentor is multiplied. The individuals involved may all be at the same institution, but in many cases, they are at different institutions throughout the region.

Program direction is set by a Steering Committee that meets weekly and is composed of leaders from each of the larger institutions that serve as anchors for the program, a Program Manager who coordinates day-to-day activity, and key advisors from a few other institutions. The Steering Committee approves all projects undertaken. For a selection of projects, the Steering Committee relies less on soliciting competitive applications from researchers (though intellectual merit does naturally play a role in the selections) and more on outreach to faculty at smaller institutions who can benefit from access to cyberinfrastructure but are either unaware of available resources or have given up after a poor experience. Care has been taken in sourcing and monitoring projects to ensure that they (1) lead to results that might not otherwise have been achieved and (2) establish a model for engagement that others at the participating institution can follow [4].

While most costs go to student support, the NECT also invested in active management, including a Program Manager, who keeps the flow of projects running smoothly, and steering committee members who recruit, qualify, and oversee projects in their home states. While the value of program management is often overlooked, this investment has been critical to success. It has enabled several important outcomes including (1) efficient recruiting of projects, students, and mentors; (2) development of process, tools, and strategy; (3) effective communication across the anchor institutions; and (4) ability to explain the purpose and benefits of the program to grant administrators who have sometimes expressed initial skepticism about supporting this kind of collaboration across institutions. The Program Manager also coordinates across the geographically dispersed team of participants, who have varying amounts of time to invest in the program, and provides leadership to ensure forward progress.

## 2.1 Monthly Meetings

To create a convivial team environment despite the geographic distribution of participants, the NECT hosts a monthly Zoom meeting in which student facilitators are expected to share their experiences with each other and learn about other projects currently underway. Since the program is often their first exposure to research computing, this gives student facilitators a window into the diversity of domains, techniques, and subject matter that research computing encompasses, and it provides mentoring and networking opportunities with professional RCFs in different regions and at differently resourced institutions. It also gives them an opportunity to learn how other student facilitators are approaching their projects, and it provides support, especially during the initial stages of projects, where the learning curves can be quite steep.

At the beginning of a project, after the student facilitator has had an opportunity to meet with their mentor and researcher and has a solid understanding of the task at hand, they prepare and present a simple “launch presentation” that includes brief descriptions of the project, goals, timeline, and what they hope to learn. An important consideration in the launch presentation is the use of a scaffolded template that builds confidence and lowers barriers and anxiety around presenting about a topic to which the student facilitator might have just been introduced.

At subsequent meetings, student facilitators give brief verbal status updates until, at the end of the project, they present a “wrap presentation” summarizing what was accomplished, what was learned, and what contributions were made to the self-service learning tools and Git repository housed on the Portal. The monthly meetings, presentations, and project status updates are intended to build camaraderie while giving students additional exposure to the world of research computing and facilitation. The results have been very positive, with students and mentors offering insights and advice to each other both at the meeting and out of band.

## 2.2 The Portal

With so many simultaneous moving parts, NECT needed to develop a new tool to manage and organize the Cyberteam projects and participants as well as collect and disseminate the expertise and knowledge resources required to efficiently complete the projects. To serve this need, NECT developed the Cnct.CI Portal [2, 4, 6].

The Steering Committee relies heavily on the Portal for management of project workflows and capturing project outcomes. The Portal advertises projects and assists in recruiting mentors and student facilitators. The Portal is also used to access and aggregate

self-service learning resources that provide just-in-time information delivery to participants as they embark on projects in unfamiliar domains [6]. There is usually not enough time to enroll in a traditional training course or attend a seminar when a new domain or application is encountered. Therefore, the goal of these learning resources is to reduce the need for direct assistance; reduce duplication of effort by adapting and building awareness of available documentation, training, application software and software utilities; and supplement these resources where there are high-impact opportunities.

A uniform underlying infrastructure is provided by a common tagging infrastructure and voting capabilities modeled after crowd-sourced repositories such as Stack Exchange [3]. This infrastructure allows a user to click on a tag from any part of the Portal and obtain a listing of all related Portal content, including mentor profiles, project descriptions, frequently asked questions, and training resources. With a continuously growing and evolving list of tags, this creates the opportunity to search for content in a granular yet curated manner. This underlying tagging mechanism also facilitates mentor matching and identification of targeted learning resources. For example, a Cyberteam member seeking advice on a particular topic can search by individual tags to obtain a listing of all Portal users that have identified that topic as a skill in their profile. The voting capabilities are a crowd-sourced mechanism to ensure that content stays up to date in the rapidly evolving world of research computing where new tools and methods are constantly emerging. Participants in the portal can vote on certain content to confirm its relevance. Curation by moderators ensures removal of obsolete information, often with guidance from the voting.

Many Portal functions have utility beyond the NECT, and the tag-based skills-matching functions in the Portal benefit from broad participation because deep knowledge is widely dispersed throughout the research computing community. Therefore, the Portal was developed with an eye toward making it possible for other communities to adopt it while maintaining their own branding and project workflows. This has already happened, with several pending proposals planning to use the portal for management of their own projects.

## 2.3 Expansion

The NECT enables researchers at small and mid-sized institutions in the region to take advantage of cyberinfrastructure as their work requires it. Simultaneously, NECT exposes a new generation of potential facilitators to the exciting and dynamic field of research computing earlier in their careers than most professional research computing facilitators came into the practice. As of March 2021, the NECT has launched 48 projects at 23 institutions, pairing a diverse population of student RCFs with knowledgeable mentors to assist researchers and educators in the region.

As noted previously, the strength of Portal features such as mentor matching and aggregation of learning resources grows with the size of the population participating. As a result, an active effort to find collaborators willing to bring their communities to the Portal has been underway for several years [4, 6]. Explorations to expand the Portal have yielded opportunities to collaborate with other programs focused on workforce development for the research computing community, including six Cyberteams and the XSEDE Campus Champions program. Representatives from each program meet monthly to exchange experiences, prioritize feature requests, and curate the tag taxonomy. Opportunities to partner with other communities of practice are constantly sought after and welcome.

### 3. LAUNCHING CAREERS

As noted in the introduction, the CAREERS program was initiated in July 2020. It leverages the NECT tools and methods to expand the RCF workforce pipeline, train student facilitators, and make advanced computing resources more readily available to researchers at small and mid-sized institutions in six additional states. The CAREERS program is led by one “anchor” institution from each state: Yale University (CT), University of Delaware (DE), Rutgers University (NJ), Rensselaer Polytechnic Institute (NY), Penn State (PA) and University of Rhode Island (RI). Yale serves as the PI institute for the grant. The goal for the student facilitator program is to complete 72 projects over the three-year duration of the grant (on average, four projects per state per year). Simultaneously, CAREERS is laying the groundwork for a new layer of support which shares domain and professional RCF expertise throughout the region.

The CAREERS Cyberteam adopted the NECT experiential learning model and engaged the NECT Program Manager to serve as Co-Program Manager, ensuring efficient transfer of knowledge. This has been an effective strategy for building a process that brings value to researchers at small and mid-sized institutions in a new region. It has also provided valuable insights that have led to adjustments that will improve the scalability of the NECT tools and methods beyond the 10 states (4 in NECT and 6 in CAREERS) where they are currently deployed. Some of these adjustments were made during the initial design of the CAREERS program, and others have been motivated by lessons learned during deployment.

#### 3.1 Initial Adjustments to the Northeast Model

##### 3.1.1 Program Management

As noted above, the CAREERS program engaged the NECT Program Manager to serve as Co-Program Manager on the CAREERS team, partnered with a Co-Program Manager new to the process. This approach has yielded several positive outcomes, outlined below in the Lessons Learned section.

##### 3.1.2 Flexible Financial Setup

The NECT program distributed funding for students equally across three states — Maine, New Hampshire, and Vermont, with a slightly heavier burden placed on Massachusetts, where there is an abundance of small and mid-sized institutions as well as major research-oriented institutions. However, with the diversity of geography, institution, and population density as well as characteristics of institutions in the six states covered by the CAREERS program, it is necessary to have a more flexible arrangement so that each state can proceed at a rate that is natural for the conditions in that state (# of researchers/projects) and anchors (capacity to host projects).

A key decision was to have Yale serve as a “central banker” for the payments to student facilitators. We pre-allocated funds for just one project per year to each of the other anchor institutions and included the corresponding participant support costs in their subaward budgets. We then assigned the remaining project participant support funding to Yale's budget, where it can be disbursed flexibly and appropriately as projects are selected and funded.

As expected, this has allowed us to put money into the projects that need it, wherever they happen to be anchored and whenever they happen to start. We have also been able to adjust the funding for individual projects to reflect the level of the students and the duration of the projects without getting mired in whether a particular subaward budget has the right amount of remaining

funds. Finally, it has allowed us to adapt to a significant amount of administrative and policy diversity among the various institutional offices (e.g., finance, sponsored projects, and international student offices) that we partner with at the institutions involved in the program. To cite one example encountered so far, some of our anchor institutions may not be able to pay participant support costs to their own students — even for training projects on their own campuses. However, they can pay the costs for students from other schools who participate in those projects, and, it turns out, their own students are also permitted to participate, so long as a different institution (Yale, in our case) officially oversees the relationships with those students and pays them.

### 4. LESSONS LEARNED

Porting an idea from one realm to another always presents challenges and requires adjustments. In this section, we highlight a few of the lessons that we have learned from the first year of the CAREERS program.

#### 4.1 Portability of the Northeast Cyberteam Methods and Tools

One important takeaway has been how well the Cyberteam program developed by the NECT has worked for CAREERS “out of the box.” When porting the Cyberteam procedures to CAREERS, it was unknown how the differences (e.g., new institutions, new steering committee members, new and larger region) between NECT and CAREERS would affect the efficiency of the process. However, we have been reassured to find that the NECT program design adapted quite smoothly. Our new institutions have different business processes, internal cultures, and resources; and our steering committee is composed of new faces who bring fresh perspectives to the idea of a Cyberteam. Yet, far more aspects of the Cyberteam process have worked seamlessly in CAREERS than have needed adjustment, and we have launched 19 projects in the first eight months of the program.

#### 4.2 Active Program Management Facilitates Rapid Adoption of Process

One of the major takeaways from the NECT was the value of the Program Manager (PM). Program management by steering committee members at the institutions anchoring the program in each state was instrumental in recruiting projects, students, and mentors and in advocating for the program within the anchor institution and the surrounding schools. The NECT Program Manager organized the development of process, tools, and strategy as well as communications among program participants and in the research computing community.

CAREERS incorporated this knowledge into its program in two ways. First, since the Cyberteam concept and infrastructure had already been established by the NECT, CAREERS was able to function efficiently with 25% of the program management time spent in the first year of the NECT. Secondly, we elected to divide the program management time over two Program Managers instead of one. With a larger region and a goal of almost twice as many projects, it was necessary to have more than one set of eyes overseeing the program management. For example, early in CAREERS, through our marketing efforts, we had an unexpectedly robust but very welcome influx of student facilitators and found ourselves in the enviable position of needing to quickly match them, based on interests and skills, with nearly two dozen projects. Considering this, dividing the work between a team of Program Managers ensured CAREERS got off the ground quickly and operated smoothly. Onboarding the second co-PM also efficiently

exposed areas on the Portal where clarification/documentation was necessary. Having co-PMs also created a sense of camaraderie, and the Co-PMs were able to thoughtfully consider situations and adjust the process and tools as necessary. On the flip side, the other steering committee members were less involved with overall program management than their counterparts on NECT because there was more delineation between the anchor institution lead role and program manager role on the steering committee.

### 4.3 Shift in Steering Committee Role

When adapting the NECT methods to the new CAREERS program, we experienced a natural shift in the relationship between the steering committee and the NECT methodology. The NECT steering committee, having invented the methods, knows the procedures intimately and possesses an inherent sense of ownership over the process of running it. On the other hand, the CAREERS steering committee was tasked with learning the NECT process and how it works. As the NECT procedures and concept were ported into the new program, this led to a teacher-learner paradigm between the Program Managers and the steering committee that was not present for the NECT program. One way this difference was apparent was in the process of onboarding the new CAREERS steering committee. Having not had a direct hand in designing the Cyberteam project procedures, the new steering committee members identified several opportunities to improve the documentation of the procedures as well as areas where the methodology itself could be made more explicit and, therefore, easier to learn and follow.

### 4.4 Systematic Outreach Yields Robust Results

With established marketing materials, process, methodology, and proven results (i.e., NECT's successful experience) at the outset, CAREERS was able to tap into large numbers of students at two of its anchor schools: Rutgers University and the Rensselaer Polytechnic Institute. At Rensselaer, the co-PI introduced CAREERS to the Rensselaer Center for Open Source (RCOS), a community of open-source student developers at RPI that cultivates an inclusive, creative, and entrepreneurial community that seeks to empower students to develop open-source solutions to real-world problems. The ability to approach so many students early on allowed CAREERS to rapidly build a deep pipeline of students that could then be matched with projects as they were identified.

### 4.5 Portal Facilitates Adoption of Process, Creates Opportunities for Enhancement

A major resource that NECT made available to CAREERS was the Connect.cyberinfrastructure Portal. The Portal is a valuable tool for advertising the Cyberteam, maintaining active projects, and connecting the students and mentors with new projects. In addition to the public-facing portion of the Portal, the backend of the Portal has detailed forms for project descriptions, progress tracking, and outcomes. This backend has been instrumental in standardizing and reinforcing the process for launching and managing a successful Cyberteam project. When seeking projects, the steering committee members are empowered with a predetermined set of questions to present to a potential project leader. At project creation, it guides the project leaders on requirements for the project, such as an appropriate description, milestones, and deliverables that are consistent with a research facilitation engagement. As the project progresses, we use it to track progress towards the predetermined timeline and milestones. And at the end of the project, the project outcomes are captured for future reference. Across all these steps,

the structure provided by the Portal ensures adherence to a standard process, leading to decreased friction from the very first CAREERS project.

When using the Portal, the CAREERS Cyberteam identified several improvements to be made to accommodate the expansion to both a new region and new users. We added a User Guide to enable more self-directed onboarding. The new User Guide details the different participant roles in a Cyberteam project and how each member can interact with the Portal to submit or apply for a project, respectively. In response to the enthusiastic influx of potential student facilitators, we added an "I'm Interested" button to every project page that students could use to indicate that they would like to be considered for that project. Student interest is collected in a report that the Program Managers use to assess potential student-project matches to present as candidates to the appropriate steering committee member. Lastly, a few small features were added to the Portal to enable the Program Managers to handle the expansion of both the user base and the projects. These include a sorted project view to find projects easily in various states and a report for tracking which students are engaged on which projects and which students are still seeking a position.

### 4.6 Working with Varying OSP and HR Policies Requires Precision and Adaptability

The Office of Sponsored Projects (OSP) at each anchor institution is a valuable partner for the program as they handle the disbursement of payments to our student facilitators for participating in their projects. We knew embarking on the CAREERS program that working with six different OSPs (one for each anchor institution) would present some logistical hurdles as we oriented everyone onto the same page. We found certain terminology was more effective in describing the student role in the program, which resulted in a smoother interaction. For example, the NSF grant that supports the CAREERS project is funding student facilitators via participant support costs. We found that it was important to use terms that reflected this category of expense (which is oriented toward educational experiences) and avoid terms such as "number of work hours," which connote student employment. Our efforts to "speak the language" of our OSP and HR partners have improved interactions. We found that the same approach was helpful when engaging with International Student Offices for F-1 visa student facilitators, as their situations have strict guidelines around how they can work or earn money.

## 5. FUTURE DIRECTIONS

The CAREERS program has been operating for approximately one year out of the three-year grant period. Therefore, we still have several objectives to tackle as well as an eye on goals for the future after the end of the grant in 2023. Some key areas of focus for the upcoming year are outlined below.

### 5.1 Develop a Distributed Expertise Network

In addition to expanding the NECT process to a new, larger region, CAREERS has a second novel objective to establish a distributed expertise network of professional RCFs directly accessible by researchers and educators in the region. As noted earlier, many small and mid-sized institutions cannot financially justify a full-time RCF, and providing domain expertise across all parts of the research computing community is challenging, even for institutions with multiple RCFs [5]. The CAREERS program plans to pilot a lightweight and cost-effective system to share RCF expertise across institutions of all sizes across the CAREERS region, leveraging the mentor network that we are building in the Portal. Engagement with

this expertise network will provide and create opportunities to multiply available expertise throughout the region while providing direct support to researchers at small/mid-sized institutions for shorter “help desk-like” engagements.

## 5.2 Provide Organized Access to Local, Regional and National Compute Resources

In addition to a lack of access to RCFs, researchers at small and mid-sized institutions may not have reliable channels for access to high-performance computing resources. The formation of the CAREERS Cyberteam has provided a route for researchers at these target institutions to acquire the cycles and storage necessary to effectively conduct their proposed projects from regional resources. The CAREERS and Northeast Cyberteams have offered access to supercomputers and clusters from several of their participating anchor institutions. For example, on one of its earliest projects, CAREERS provided computing resources allocated from Rensselaer Polytechnic Institute's AiMOS supercomputer, ranked 29th in the November 2020 TOP500 list of the world's most powerful computing systems. Building pipelines of access to a spectrum of local, regional, and national computing resources, as appropriate, plays a pivotal role in establishing an effective CI strategy for the region. We seek to build on this as CAREERS develops.

## 5.3 Enhance Portal and Further Engage with Research Cyberinfrastructure Community

Throughout the CAREERS program, we will continue to add enhancements and improvements to the Cnct.CI Portal as the needs arise. Along with the expansion of the Portal to CAREERS, several other Cyberteams and organizations have adopted the Portal to facilitate their programs, and any improvements made are accessible to every program. We have already seen benefits from the CAREERS enhancements in Northeast Cyberteam operations. Likewise, the expansion of the Portal to the additional Cyberteams creates opportunities to attract CAREERS participants, especially mentors and distributed RCFs. We will continue to engage with the community to identify opportunities to promote collaboration across the research cyberinfrastructure community through the methods and tools encapsulated within the Portal.

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