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Advancing Engineering Ethics in Multi-Institutional Research Networks: Developing & Piloting Educational Case Studies

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Introduction

Engineering research is increasingly conducted by large, multi-institutional and multidisciplinary teams or networks [1]. The engagement of engineers in these complex research networks poses new challenges to ethics and the responsible conduct of research (RCR). While there is extensive literature on engineering research ethics at the individual laboratory level (micro level) [2,3] and the societal implications of engineering advances (macro level) [4-6], little research has explored ethics at the meso level where engineers work together in a collaborative research network or multi-team system [7]. Our project was funded by the National Science Foundation (NSF) to address this gap in the understanding of ethics and RCR within large engineering research networks and to develop educational materials. Our work has extended the literature on engineering research ethics to specifically address the network level [7,8]. This paper reports on a set of educational case studies we developed and piloted to advance understanding of ethical issues at the meso level within large and dispersed research networks.

At the network level ethics issues can take three basic forms: (1) divergence across individuals, laboratories, or institutions within the network that create barriers to collaboration; (2) issues facing the network itself; and (3) ensuring the network capacity to identify and address societal challenges of the proposed new technologies [7]. Divergent expectations and norms across laboratories within a network (Type 1 issues) can cause challenges for cross-network collaboration (meso-level), requiring intervention and resolution from network leadership. Second, at the network or meso-level, network leaders face challenges to develop a shared mission supported by network norms and best practices (Type 2 issues). For example, determining what stakeholders the network should engage and which technologies to push forward for translation are all meso-level issues that can raise ethical issues. Finally, network leaders need to ensure network capacity to address societal implications at the macro level including the personnel, resources, and structures to enable early identification of and successful attention to problems raised by the research and technology in development (Type 3 issues).

To address these three types of meso-level issues, our project used design-based research to produce and pilot a unique set of ethical case studies focusing on challenges in complex research networks. These case studies can complement others that may focus on the challenges facing individual researchers or laboratories at the micro level and those that may focus on the societal implications of research and emerging technologies at the macro level. With the rise of big team science and specifically of large, multi-institutional research networks, our ethics case studies fill a need for ethics education focusing on issues arising within these networks.

Background Literature

The proliferation of big team science has generated a significant body of research and the science of team science (SciTS) explores collaboration and effectiveness [1, 9-13]. While big team science can be housed within a single research institution, the SciTS field has recognized that dispersed teams crossing multiple institutions but pursuing a unified overarching scientific goal –

what we call research networks – can face particularly acute challenges. For example, seven features of large scientific teams or networks have been reported to impact their effectiveness: (1) member diversity, (2) multidisciplinarity, (3) team size, (4) goal misalignment across labs, (5) changing membership, (6) being dispersed geographically, and (7) conflict arising from task interdependence [1]. The development of common approaches and effective network leadership are necessary to develop trust amongst collaborators and avoid miscommunication and disputes [14-16]. However, attention to the ethical challenges facing these networks has been sparse. Even in the seminal National Research Council (2015) report [1], *Enhancing the Effectiveness of Team Science*, the word ethics appears only twice. The subsequent 2025 report similarly gave little attention to ethics [17]. The literature that does explore ethical issues at the network level has called for more attention to the challenges of authorship attribution, data sharing, and reconciling ethical norms across institutions [18-22].

In addition to working towards conceptualizing and identifying network-level ethics issues [7], our work aimed to study how network ethics is perceived by participants in complex engineering networks and ultimately to develop tools to advance ethics and RCR at the network level. In our prior work, we used semi-structured interviews to investigate how the members of a large Engineering Research Center (ERC) perceived ethical issues [8]. That study revealed five themes related to network ethics: (1) data sharing, (2) authorship or inventorship credit, (3) collaboration, (4) attention to ethics and regulation, and (5) network leadership. These themes are briefly described as they provided the grounding for the development of the network ethics educational cases.

Data Sharing

Research shows that most researchers severely limit data sharing outside of their immediate research lab prior to publication [23,24], only sharing with "known and trusted individuals" [23]. The literature reveals a variety of concerns related to data sharing including data quality, potential misuse, losing a competitive advantage, protecting future publications, and data ownership [25-27]. In our study, ERC participants were clear on disclosure guidelines for sharing data, protocols, or technologies outside the network. However, data sharing norms and expectations were more diverse within the network. Whether researchers were willing to share data before publication beyond their immediate collaborators depended on laboratory norms and whether trust was already established with a wider circle. This divergence in norms and practice is an invitation to conflict, raising ethical issues that warrant discussion.

Authorship

Given that authorship determines career advancement in science and engineering fields, ethics related to authorship is widely discussed in the literature [21, 28]. These concerns can be acute for large collaborative teams [21, 29], with difficulties increasing with team size [30]. Larger, multidisciplinary teams are likely to hold a range of authorship norms [8, 29, 31] and less likely to adhere to authorship guidelines [32]. Indeed, in large, multidisciplinary teams it can be difficult to determine the contributions of individual researchers [29], leading to errors in both directions – exclusion or overly generous decisions about authorship inclusion [33].

Multidisciplinary research teams may develop strategies to try to avoid conflict [34], for example, developing multiple publications with different disciplinary foci, allowing for different authors to serve as first author depending on the disciplinary focus of the journal [8, 34]. The significant potential for conflict related to authorship in large research teams and the ethical issues raised by failure to properly negotiate and attribute authorship credit make this an important topic for ethical discussion within the network.

Collaboration

The literature on big team science provides analysis of the competencies necessary for success across the trajectory of collaboration from team formation through consolidation [1, 9, 11]. Trust was of particular concern for our ERC participants in newly formed collaborations, including concerns about how other labs would use their data and potentially beat them to publication [8]. Once trust was established in a collaboration across research groups, data sharing and authorship were reported as being less problematic. Collaboration raises multiple ethical issues warranting discussion, including how to ensure integrity in collaborative research, how to prevent misappropriation of research tools, how to avoid misattribution of credit, and how to resolve conflicts that may arise. In a new engineering network, the development of trust and setting the stage for a successful collaboration represents another important topic for discussion.

Ethics and Regulation

Research suggests that leaders of large scientific networks need to develop practices that prioritize and promote ethical awareness and communication [15, 35, 36]. Research suggests training for all researchers to routinize discussion of ethical issues and the regular inclusion of ethics within research meetings [36]. However, findings from our ERC participants revealed that discussion of ethics in individual labs and collaborative research settings vary widely, and not all network participants saw ethics as pertinent to their specific scientific contributions. In addition, some participants viewed their work as a technical contribution to the overall goals of the network, consequently they viewed ethics as belonging solely in the domain of their clinical partners, who may be more familiar with the federal regulations governing research with human participants. Exploring different perspectives on ethics and regulation within the network can be crucial to establishing the importance of ethics, normalizing ethics discussion, and building a common vocabulary.

Network Leadership

Network leadership is needed to establish norms and practices that bridge the differences across multiple research labs within a network [37, 38]. Without the establishment of network-wide standards and guidance on these ethical issues, a large, multidisciplinary network will struggle to conform consistently with established ethical norms and realize the true potential of research collaboration across teams [7, 8]. A network that fails to address these issues risks unnecessary conflict and failures of ethics and integrity in research.

Central to the success of large research networks is trust [38]. Network leadership needs to promote an environment of trust and collaboration to alleviate concerns such as data sharing [8,

23, 24, 27]. Other critical factors connected to the success of large research networks are "developing a shared vision, strategically identifying team members and purposefully building the team, promoting disagreement while containing conflict, and setting clear expectations for sharing credit and authorship" [38].

Sponsoring discussion of ethical issues can be an important way for network leaders to explore the range of perspectives within the network, uncover emerging issues, and promote explicit attention to the ethics and integrity of network research. These discussions can also surface domains in which network participants see a need for leaders to take action, whether through investigation, conflict resolution, or proactively setting network-wide norms and policy. It is clear that leadership needs to purposefully promote ethical conduct of research within a network through the establishment of shared policies and mechanisms such as collaborative agreements to avert conflict and resolve disputes that cross laboratories, institutions, and disciplines [8, 37].

However, ensuring the ethical and responsible conduct of research across a large network is the responsibility of all network members. Our prior work described above revealed a range of knowledge about relevant ethics issues, as well as divergent views on some issues. Indeed, several of our ERC participants expressed a need for education on network ethics. Thus, this study describes the development of four educational case studies based on network ethics issues identified as important by the network participants themselves.

Methods

Research Design

Design-based research (DBR) is a framework for constructing and testing theoretically- and contextually-grounded educational interventions using a series of approaches intended to advance design, research, and practice [39]. DBR provides educational researchers with a pragmatic framework to develop "educational theories that work" within the unique constraints of a specific educational setting [40]. As such, DBR studies (1) are situated in an authentic educational context; (2) focus on a specific intervention; (3) use mixed methods; (4) occur iteratively; and (5) involve collaboration between researchers and practitioners [41].

DBR studies are composed of design cycles that include the analysis, design, evaluation, and revision of an educational intervention. Design cycles repeat through progressively larger participant groups, widening the context to approach systemic integration. This study shares the first iterative cycle of the development and implementation of four educational case studies designed to elicit discussion on ethical issues relevant to large engineering research networks.

Context

The four educational cases presented in this study were developed for use in an NSF-funded Engineering Research Center (ERC). The ERC is a multi-institutional team of teams that is focused on the development of transformative technologies designed to preserve biological systems and extend the ability to bank and transport living materials including cells, tissues, organs, microphysiological systems, and whole organisms. The ERC includes six institutions

(five universities and one large research hospital) spread across the continental U.S. and consists of clinicians, scientists, and engineers, in addition to staff and faculty working on issues including engineering workforce development and ethics and public policy. While the educational cases were piloted in a single ERC, the cases are not specific to this ERC and are designed to be relevant to other engineering research networks.

All six institutions offer training in research ethics and responsible conduct of research (RCR). In addition, participation in federally funded research and in research at these institutions requires compliance with certain baseline requirements on the ethics of research, including human subjects research and research with animal subjects. The goal of our educational case studies was not to replace existing ethics and RCR training, but rather to provide learning opportunities about ethics issues relevant to the engineering network.

Development of Educational Case Studies

Educational cases studies have a long history in the engineering field [42]. An education case study provides an illustration of issues faced by engineers in the workplace [43, 44]. The case is shared for analysis and discussion of possible actions that should be taken to address the issue [43, 44]. Engineering case studies have been demonstrated to improve student learning across topics including ethics, failure, and design in various engineering disciplines [45-47]. Indeed, case studies play a particularly important role in engineering ethics education [48]. While various repositories of engineering case studies exist [49, 50], this study addresses the contemporary issues of network ethics and as such adds to the existing engineering case study literature.

The four educational cases were developed based on the literature and findings from our exploration of the ERC participants' views of network ethics [8] to specifically address ethical issues at the network level. The four educational cases focus on (i) Sharing Data, Protocols & Technologies, (ii) Credit & Authorship, (iii) Ethics & Regulations, and (iv) Collaboration. Each case was discussed and refined through collaborative conversations with the research team, consultation with the ERC leadership, and a review of one case study by two ERC members for wording, format, and length. A summary of the four educational cases is provided in Table 1 and the full educational cases are provided in the Appendix and posted in the Online Ethics Center for Engineering and Science (OEC) [51]. Note that the Appendix and OEC post include a bibliography of additional optional readings for each case; this was added after piloting to further enhance the value of the case studies as an educational tool.

To develop case studies that can easily be used by busy ERC researchers and trainees, we limited the description of each case to one or two pages. Each case presented a hypothetical situation posing ethical challenges intended to elicit discussion about different views and approaches to the issue. Each case progressed through several stages with discussion questions posed at each step. The cases explicitly note that they are hypothetical, and that any resemblance to actual individuals is unintended.

Table 1. Overview of the four educational case studies.

Case Study Topic	Case Study Summary
Sharing Data, Protocols & Technologies	This case explores issues arising from different views on sharing raw data between collaborating labs prior to publication. In addition, the case explores the role of network leadership in developing guidelines for data sharing.
Credit & Authorship	This case explores authorship conflicts and issues arising from different publication strategies across collaborating laboratories (e.g., moving rapidly to publish the early results vs. collecting more data and publishing a more comprehensive article in a high-impact journal). The role of network leadership in resolving authorship disputes is also explored.
Ethics & Regulations	This case explores how to navigate differences in understanding of and attention to ethics between collaborators from different disciplines. The case also explores how to navigate personal values and work expectations. Finally, the case explores how ethics, regulations, and policy issues (e.g., equitable access to new technologies) should impact research decisions.
Collaboration	This case explores the norms and expectations that should apply in visits and collaboration across laboratories. Further, the case explores how to handle violations of trust when these norms and expectations are not followed. Finally, the case explores the role of network leadership in resolving disputes between collaborating laboratories.

Taken together, these cases raised all three types of ethical issues that arise at the network level. For example, Case I on data sharing starts by raising issues rooted in divergence across network laboratories in approaches to data sharing (Type 1 issues) but progresses to issues of what policies and practices the network as a whole should adopt (Type 2 issues). Case III on ethics and regulation begins by addressing differences between laboratories (Type 1 issues) but quickly engages questions about the capacity of the network to address the societal and ethical implications of its work (Type 3 issues).

Implementation of Educational Case Studies

We piloted a subset of these case studies within the ERC in an IRB-approved protocol (STUDY00022261) that invited researchers, trainees, and staff across the network (excluding undergraduates, whose contact with the network was more transient) to volunteer. Table 2 shares a timeline for implementation and the range of participant roles for each of the three pilot sessions. Two pilots included participants from different institutions, and one pilot included participants from a single institution within the ERC research network.

Table 2. Overview of implementation and participants.

Case Study	Date Piloted	Range of Participant Roles
Credit and authorship	February 5, 2025	Graduate students and PI (across multiple institutions)
Sharing Data, Protocols & Technologies	February 26, 2025	Postdocs and PI (across multiple institutions)
Collaboration	July 17, 2025	Graduate students and Postdoc (from a single institution)

Each group received one case study by email prior to the scheduled Zoom session. Each Zoom session was scheduled for 90 minutes and led by the first and second authors. At the start of each session, we confirmed consent and reviewed what participants should expect. We took multiple steps to establish the discussion session as a safe place to share candid perspectives. First, we refrained from recording the session. Second, although participants knew that others in the discussion group were from the same research network, we imposed Chatham House Rules, allowing participants to talk about the experience later with others but prohibiting them from revealing the identity of other participants and from attributing any particular comment or position to a participant. Over the next hour, we took the group step-by-step through the case study and questions posed for discussion (see Appendix for details). For the final 30 minutes, we asked each participant to complete a confidential online survey (described in the data collection section) to give us feedback on their experience. Once all participants completed their survey, we then invited them to share any feedback or suggestions verbally.

Data Collection and Analysis

Feedback on the educational case studies was collected in two forms. The primary data source was a survey administered at the end of the case discussion. The survey included basic demographics information and a mix of Likert-scale and open-ended questions to provide feedback on the case materials and case discussion, and suggestions for improvement (see Figure 1). The secondary data source was discussion with participants at the end of the case discussion. Survey items were collated and analyzed to iteratively improve the educational case materials.

Figure 1. Survey questions.

Feedback on Case Materials
The length of the pre-reading was (too long, a little too long, just right, a little too short, too short)
Describe what additional information you would have liked to have or what information was unnecessary.
The context of the case study was (very unclear, unclear, clear, very clear)
What extra information would you have liked to have about the case study?
Feedback on Case Discussion
The topic of the case study was relevant to my work within [name of ERC] (strongly agree, agree, neutral, disagree, strongly disagree)
My voice and opinions were heard and valued in the discussion (strongly agree, agree, neutral, disagree, strongly disagree)
The discussion was (too long, a little too long, just right, a little too short, too short)
Participating in the case study discussion improved my understanding of ethical issues within a large research network (strongly agree, agree, neutral, disagree, strongly disagree)
What were some of the big ideas that you took away from the session?
Feedback on Results and Next Steps
Overall, participating in this case study module was valuable (strongly agree, agree, neutral, disagree, strongly disagree)
What other case topics would you like to see discussed?
How could we improve the case study module?
Any other feedback that you would like to provide?

Findings

Feedback on Case Materials

Across the three case implementations, the participants' response to the case materials was overwhelmingly positive. Of the 10 participants, nine responded that the length of the pre-reading was just right and one participant responded that it was a little too short. Five participants responded that the context of the case was very clear and the other five participants said that the context of the case was clear. Overall, there was agreement that the "context needed to be a bit open-ended to get everyone's varied perspectives" (Participant 2). Indeed, the case studies were framed to allow participants to relate the case to specific situations in their professional experiences and to argue for different solutions depending on the specifics of the situation. For example, related to Case IV (Collaboration), Participant 10 noted different interpretations of how novel or important Dr. Avis's contributions were and how much effort Dr. Avis put into the procedures would lead to different suggestions for resolving the issue.

Participant 7 suggested that "to get a grasp on who is who, a schematic could be included to easily see who is who". In response to this suggestion, we developed a visual representation of each case to help participants track the laboratories and researchers in the case and make clear how they fit into the bigger network; see the figure accompanying each case in the Appendix. To further assist tracking, all individuals in these cases who are based at the same university have

names that start with the same letter as the name of that university (e.g., Drs. Fernandez and Ferris, as well as students Fredrik and Felice are all at Fairmont University). Finally, trainees who do not yet have their terminal degree are identified by their first name, as our discussants piloting these cases frequently distinguish between trainees and more senior laboratory members.

Feedback on Case Discussion

Feedback on the case discussion was also positive, with the majority of participants agreeing that the topics were relevant to their work in the ERC and the discussion improved their understanding of ethics at the network level (see Table 3). It is important to note that these are self-reports of learning and that we did not formally assess participants' knowledge about network ethics. It is also important to note that the 10 participants were volunteers and are not necessarily representative of the full ERC membership; for example, it is possible that the volunteers had a particular interest in engineering ethics. The length of the discussion was considered appropriate by the participants. Without the added time for data collection related to the DBR study, each case discussion was one hour long. The data suggests that much can be accomplished within a one-hour discussion.

Table 3. Survey responses related to the case discussions. (Most frequent response is **bolded**)

	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
The topic of the case study was relevant to my work within [name of ERC].	**7**	2	1	0	0
My voice and opinions were heard and valued in the discussion.	**10**	0	0	0	0
Participating in the case study discussion improved my understanding of ethical issues within a large research network.	2	**5**	3	0	0
	Too long	**A little too long**	**Just right**	**A little too short**	**Too short**
The discussion was…	0	0	**7**	3	0

One of our concerns in setting up the discussion groups was the hierarchical relationships among PIs, Postdocs, and graduate students. With only three pilots, it was not possible to compare groups composed entirely of trainees with mixed groups that also included faculty PIs. All of our pilots were mixed, but all participants strongly agreed that their voice and opinions were heard and valued (see Table 3). In fact, Participant 3, a faculty PI, responded that they "would love to have more 'mixed' sessions where I hear the perspectives of trainees."

Feedback on Results and Next Steps

We asked participants what other case topics they would like to see discussed within the center. Of the six participants who did not participate in session on Case Study II: Credit and authorship, five named authorship as a critical topic for discussion. In terms of improvements, some participants provided feedback on group constitution. For example, Participant 7 wrote "Including participants from different centers might [expand on different viewpoints], although I appreciate the logistics may be challenging." Additionally Participant 9 wrote, "In the future it may be better to mix trainees from institutional sites. We were all from one site and that likely biased discussion towards our shared experiences with similar lab groups/PIs."

Discussion and Next Steps

In keeping with the literature on educational cases in engineering [42-48], feedback on the three pilots suggests that educational cases are an appropriate mechanism for creating learning opportunities related to network ethics. With the integration of suggestions from participants, the four cases are ready for implementation by others in different settings. The next steps of the DBR cycle would be to implement with different ERCs or similar engineering research networks to determine transferability beyond the context of our ERC. Future DBR cycles would also need to investigate group constitution in terms of position in the network (e.g., PI, postdoctoral student, graduate student), different disciplinary backgrounds (e.g., science, engineering, medicine), and different institutions.

Another consideration is the role of facilitation of the case study discussions. These pilots were facilitated by experts in STEM education and ethics, respectively. Facilitation by PIs in their research groups or engineers in network settings might produce different results. While each case has supporting facilitation materials consisting of the case with questions, an illustrative figure, and a bibliography of resources, someone without expertise in ethics might be less able to guide the conversation.

Conclusion

Multi-institutional engineering research networks face ethical issues at the network level that are distinct from those at the individual level (micro) and from those at the broad societal level (macro). Attention to these meso-level network issues is crucial to the ability of a large, complex research network to accomplish its research goals ethically and responsibly. This study responds to the need for educational materials to support case-based learning on ethical issues within an engineering research network. Using DBR we were able to develop and pilot a set of educational case studies that can be used easily to advance understanding of ethical issues and support the ethical conduct of research within engineering research networks.

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Appendix. Four educational case studies. (See also S.M. Wolf, G. Roehrig, T.L. Pruett, K. Uygun. "NetEthics: Educational Case Studies on Research Ethics & Responsible Conduct of Research in Multi-Institutional Research Networks." Online Ethics Center for Engineering and Science (OEC), 2025. https://onlineethics.org/cases/stem-ethics-projects-2017-present/netethics-educational-case-studies-research-ethics.)

Case Study I: Sharing Data, Protocols & Technologies

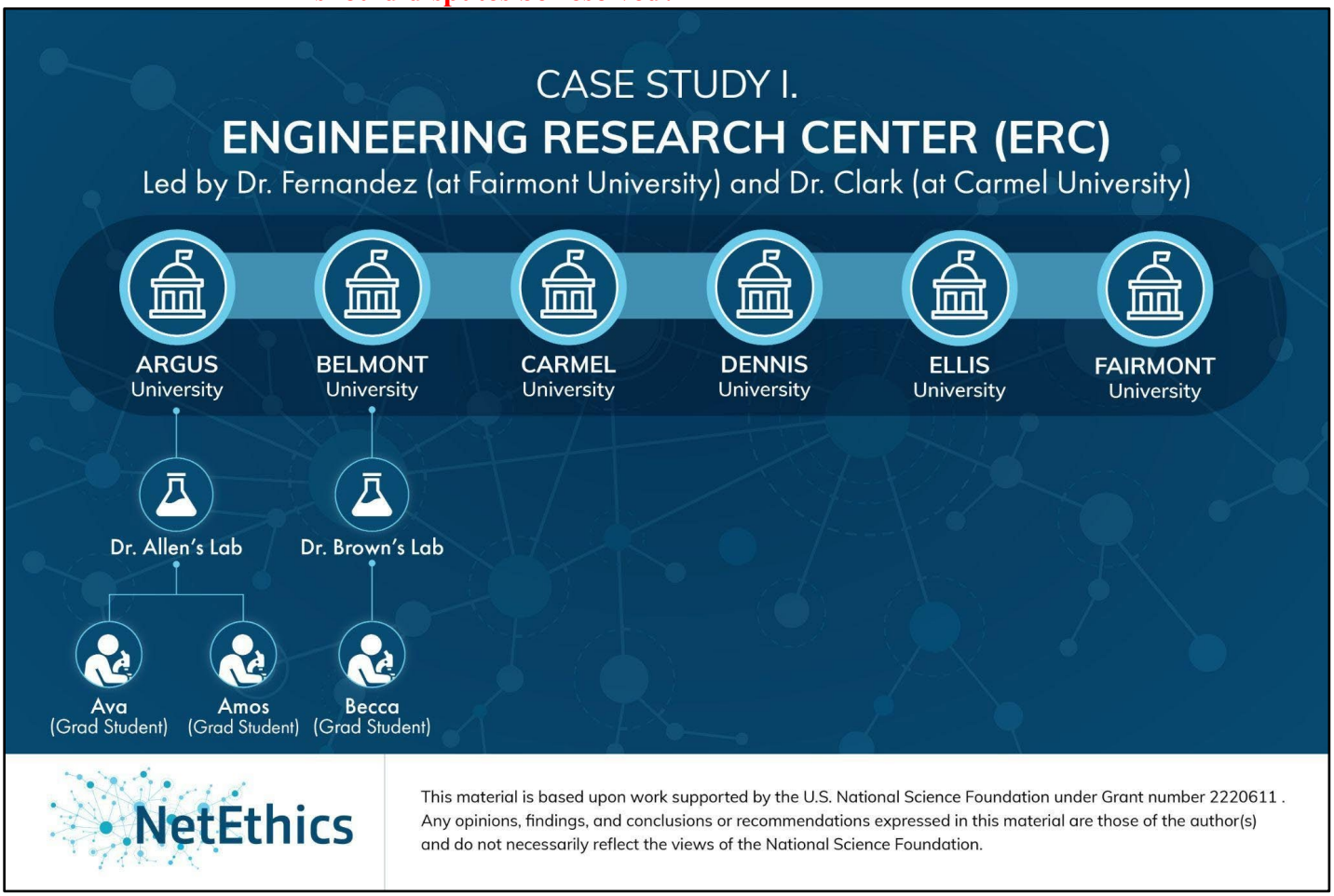
- **Ava** is a graduate student in **Dr. Allen**'s lab at Argus University. **Amos** is another graduate student in the same lab.
- Ava is collaborating with **Dr. Brown**'s lab at Belmont University. **Becca** is a graduate student in Dr. Brown's lab.
- All are part of a research network -- an Engineering Research Center (ERC) crossing 6 institutions. **Drs. Fernandez** (at Fairmont University) and **Clark** (at Carmel University) are the leaders of the ERC.

Dr. Allen's lab at Argus University is working on advanced biopreservation technologies. The lab is part of a network of labs at 5 other institutions that are all part of an Engineering Research Center (ERC). Dr. Allen's lab meets weekly and researchers working on different projects update the group on their progress, sharing raw data freely including prior to publication. Ava is a graduate student in the lab working on a particular project that involves colleagues in Dr. Allen's lab as well as colleagues at another lab in the ERC – Dr. Brown's lab at Belmont University.

1. **Amos is another graduate student in Dr. Allen's lab who is working on a different project. Amos asks to see the raw data** from Ava's project. Ava knows that Dr. Allen supports data sharing, but also checks with Dr. Brown, who instructs Ava **not** to share the data before publication. Ava tells Amos, who complains to Dr. Allen. Dr. Allen is concerned because of the commitment in the Allen lab to openness and data sharing.
   a. **Did Ava do the right thing? What should Ava do now? Why?**
   b. **What should Dr. Allen and Dr. Brown do (if anything) and why?**
2. **Ava and Becca (a graduate student in Dr. Brown's lab working on the cross-lab project) are preparing a presentation** on their progress for the ERC's annual meeting.
   a. **Should they present results that have not yet been published?** They are eager to report their excellent progress but don't want to raise issues or get in trouble.
   b. After their presentation, others in the ERC who are not on their project ask them questions about their protocol and data. **Can they answer those questions? Are there limits to what they can share? Why or why not?**
   c. **Should the ERC have guidelines on this? Should the ERC have a process for providing guidance to presenters? What kind of process would be appropriate?**
3. **Dr. Allen suggests to Drs. Fernandez and Clark that ERC progress would be aided by creating an ERC-wide mechanism for sharing data** within the ERC. Dr. Allen suggests building a password-protected platform providing access to

data, with clear indication of which scientists generated those data and the status of their publication in progress.

a. **Should the ERC create such a platform? Why or why not?**
b. **Is there a better way to enable data sharing within the ERC?**
c. **How should the ERC leaders handle differences in data-sharing practices from lab to lab? What about projects that cross multiple labs? How should disputes be resolved?**



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Case Study II. Credit & Authorship

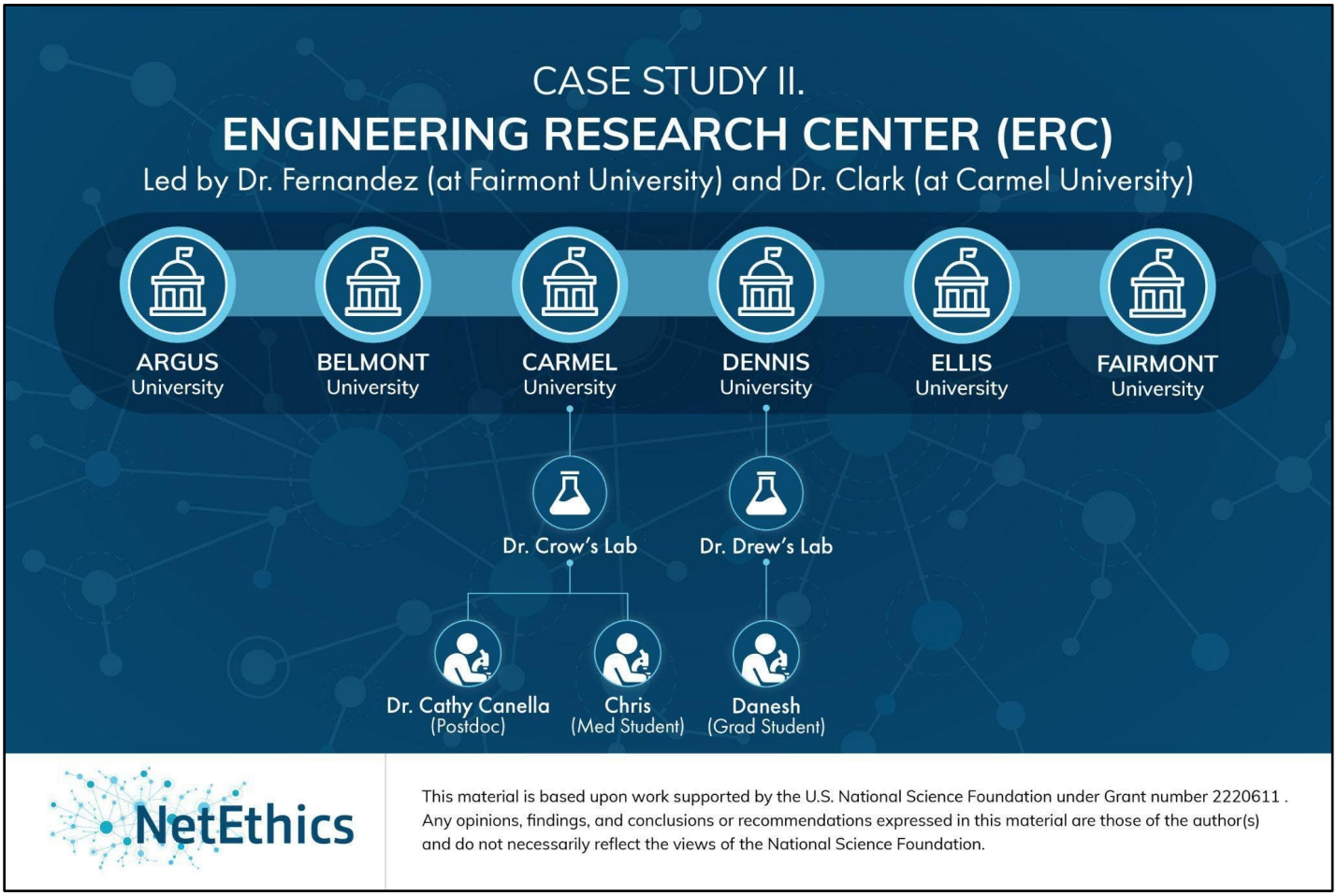
- **Cathy Canella**, MD, is a postdoc in **Dr. Crow**'s lab at Carmel University. **Chris** is a medical student in the lab.
- Dr. Canella is leading a cross-lab project involving students and colleagues from **Dr. Drew**'s lab at Dennis University. **Danesh** is an engineering grad student in Dr. Drew's lab.
- All are part of a research network – an Engineering Research Center (ERC) crossing 6 institutions. **Dr. Fernandez** (at Fairmont University) and **Dr. Clark** (at Carmel University) lead the ERC.

Cathy Canella, MD, is a postdoc in Dr. Crow's lab at Carmel University leading a project in the ERC on advanced biopreservation. The project involves students and colleagues in Dr. Crow's lab and in Dr. Drew's lab at Denis University. Dr. Crow's lab is heavily comprised of MDs and medical students, while Dr. Drew's lab is dominantly comprised of engineering PhDs and graduate students. The project is yielding exciting results!

1. **A disagreement emerges over publication strategy.** Dr. Drew advocates moving rapidly to publish the early results in an engineering journal. Dr. Canella would like to collect more data and publish a more comprehensive article in a high-impact medical or scientific journal. Dr. Crow sees both arguments and suggests they publish 2 separate articles – an early one in an engineering journal and then a later one in a medical or scientific journal. Dr. Canella is concerned that the early article will in effect "scoop" the later article, creating problems for the later article's placement. Dr. Canella is also concerned about potential violation of journal rules on duplicative publication.
   a. **What should Dr. Canella do and why?**
   b. **What should Dr. Crow and Dr. Drew do?**
2. A decision is made to move forward with the engineering article. While Dr. Canella is seen as the first author, several **authorship issues emerge**. **How should these issues be addressed and resolved?**
   a. Chris is a graduate student in Dr. Crow's lab who helped Dr. Canella fix problems with a piece of equipment used for measurement. Chris claims **they "had a deal" that promised co-authorship**. Dr. Crow discourages such "deals," feels that Dr. Crow as PI together with the lead author should determine others' co-authorship based on authorial contributions, and that all lab members should help each other without such promises. However, Dr. Canella is reluctant to alienate Chris, whose help and cooperation Dr. Canella may need in the future. **What should Dr. Canella do? How should Dr. Crow approach the reality of these "deals"?**
   b. Dr. Drew instructs Dr. Canella to **add to the co-author list a grad student in Dr. Drew's lab (Danesh) who did not make an authorial contribution**. Dr. Canella expresses concern to Dr. Crow, who disagrees with this practice. Dr. Crow urges Dr. Canella to omit Danesh. **What should Dr. Canella do?**
   c. Dr. Crow and Dr. Drew **both feel they deserve to be listed last as senior author**. Dr. Canella feels that Dr. Crow was substantively involved in the research but that Dr. Drew had very little involvement. However, the research crosses both labs

and they are the PIs of the two labs. Both also would like to be listed as corresponding author. **How should this dispute be resolved?**

3. After discussion, Dr. Crow and Dr. Drew still cannot agree on senior authorship. Dr. Drew and Danesh are also dismayed that Danesh has been excluded from authorship. They **ask the ERC leadership to resolve these disputes**. The ERC leaders – Drs. Fernandez and Clark -- know that authorship practices vary by lab and PI within the ERC. They are also aware of disciplinary differences in authorship norms (e.g., medicine vs. engineering) within the ERC. Finally, they recognize that journals have rules on authorship.
   a. **How should they resolve the disputes over Dr. Canella's paper?**
   b. **What guidance should they create for the ERC, if any? How can they prevent such disputes?**
4. Dispute resolution has consumed time and Dr. Canella becomes concerned about a research group outside the ERC "scooping" the article. Dr. Canella shares this concern with Dr. Crow, who encourages rapid submission of the article. Although the **journal instructions require sign-off by all authors** on the submitted manuscript and there have been a number of recent edits, Dr. Crow encourages Dr. Canella to "go ahead and submit" as "everyone saw the article a week ago when you shared it and the subsequent edits didn't change the basic conclusions."
   a. **What should Dr. Canella do? Why?**



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Case Study III. Ethics & Regulations

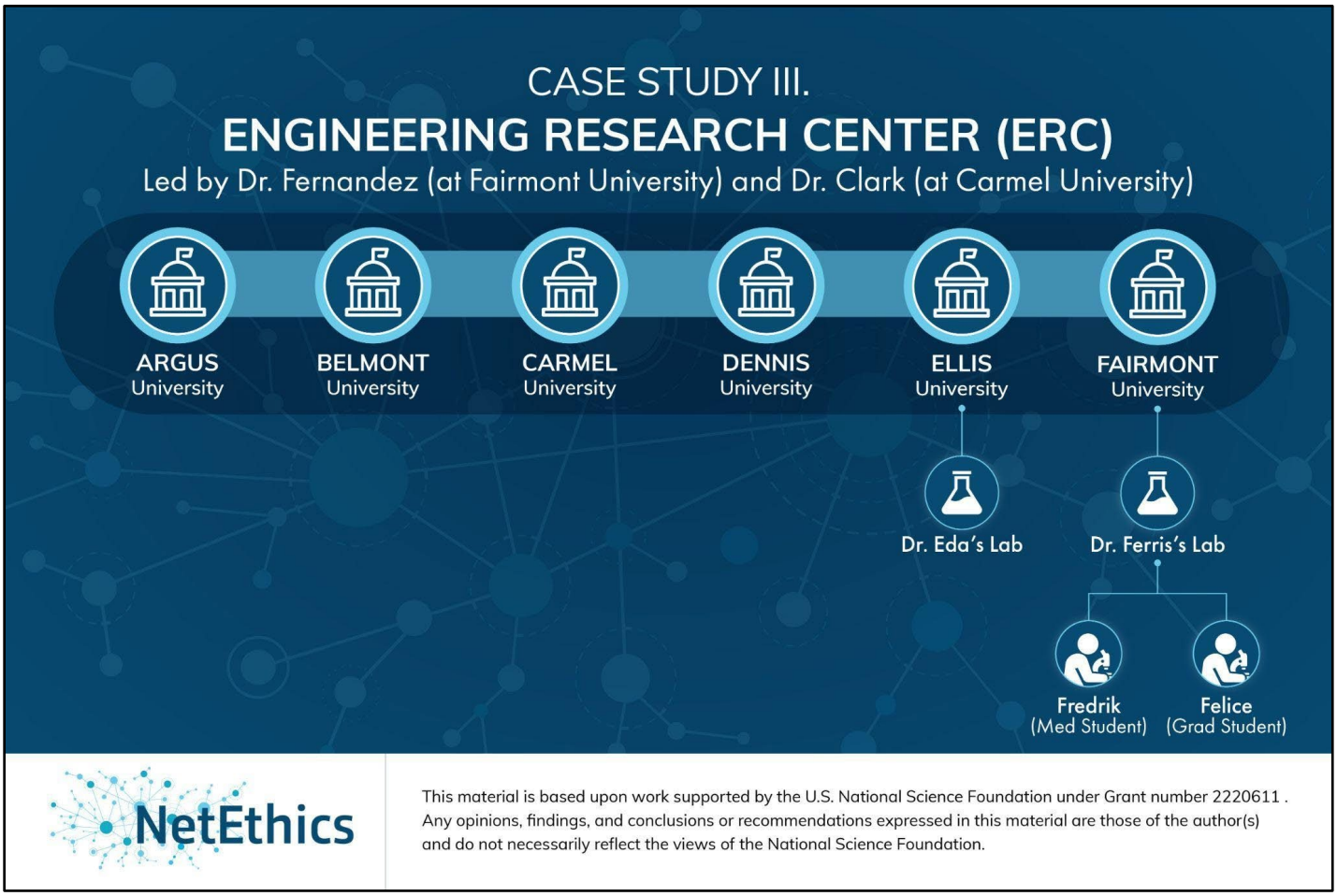
Dr. Eda is an engineer and PI of a lab at Ellis University.
Dr. Ferris is a surgeon and PI of a lab at Fairmont University. **Fredrik** is a medical student in that lab. **Felice** is a graduate student who joins that lab. Both Fredrik and Felice participate in the ERC's summer reading club for trainees.
All are part of a research network – an Engineering Research Center (ERC) crossing 6 institutions. **Dr. Fernandez** (at Fairmont University) and **Dr. Clark** (at Carmel University) lead the ERC. The ERC includes **ethics faculty** based at Fairmont.

Dr. Eda and Dr. Ferris are PIs at two different universities (Ellis and Fairmont), who are leading ERC work on biopreservation of solid organs for transplantation. Dr. Eda is an engineer whose lab is developing cooling protocols with infusion of cryoprotective agents as well as rewarming methods. Dr. Ferris is a surgeon whose lab is currently working with rodent livers, applying the Eda protocols to biopreserve, store, rewarm, and then transplant those livers into rats. They hope to progress to larger animals and ultimately clinical trials in human beings. The Ferris lab is reporting exciting success in rat models.

1. Graduate students in the Eda lab are aware that the ERC includes researchers working on ethical issues, but the **students are not sure those ethical issues really apply to their work**. After all, the Eda lab is not conducting research on animals or human beings. The lab holds weekly meetings, but those are devoted to research progress. They ask Dr. Eda if they should be spending time learning about the ethical implications of biopreservation. Dr. Eda reassures them that the lab's work "is quite early in the translational process. We really need to focus on getting the science to work. There's plenty of time to think about any ethical issues later." Besides, says Dr. Eda, "we are good people and our ultimate goal is to save lives with organ transplantation."
    a. **What should the students do?**
2. Fredrik is a medical student in the Ferris lab. Fredrik has trained to perform surgery on the rats to retrieve and later transplant livers. Fredrik also works with the *ex vivo* organs, applying the Eda protocol. The lab is racing to complete a high volume of transplants in order to publish in a prominent journal. Given the volume of work, Fredrik is relieved to welcome a new graduate student, Felice. Felice is willing to work with the *ex vivo* organs, but **declines to be trained to perform the surgery, based on discomfort subjecting animals to these procedures and euthanizing them**. Fredrik wants to respect Felice's decision, but finds the volume of work too great for one person. Fredrik asks Felice to reconsider.
    a. **What should they each do and why?**
    b. **What is the role (if any) for the lab leader?**
    c. **Should the ERC address these issues more broadly? If so, how?**
3. Felice and Fredrik both participate in the ERC's summer reading club for trainees. The group reads about illegal organ trafficking outside the U.S. The group also reads a report from the National Academies about unfairness in the U.S. transplantation system that disadvantages rural, poor, and historically marginalized patient populations. They ask Dr. Ferris how these issues should affect the work in the lab and ERC. Dr. Ferris thanks them but says **those are ethics questions for later, when**

the technology is proven and is being applied. Dr. Ferris says that for now, their ethics job is to follow IACUC rules in working with animals and eventually IRB rules when they get to research with human participants. When Felice and Fredrik talk with trainees in other ERC labs, they hear that those labs are taking the same general approach. Felice and Fredrik are confused – the **ethics scholars** in the ERC suggest that paying attention to ethics and social issues early in developing a new technology is important, but their PIs seem to disagree.

a. **What should the students do?**
b. **What should the ERC leaders do, if anything?**
c. **What should the ethics faculty do?**



Additional readings on these issues (optional):

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Case Study IV. Collaboration

Dr. Arlo Avis is a member of an engineering lab led by **Dr. Aaron** at Argus University..
Dr. Frances Flores is a member of a lab led by **Dr. Fortier** at Fairmont University. These two labs have recently begun to collaborate.
All are part of a research network – an Engineering Research Center (ERC) crossing 6 institutions.
Dr. Fernandez (at Fairmont University) and **Dr. Clark** (at Carmel University) lead the ERC.

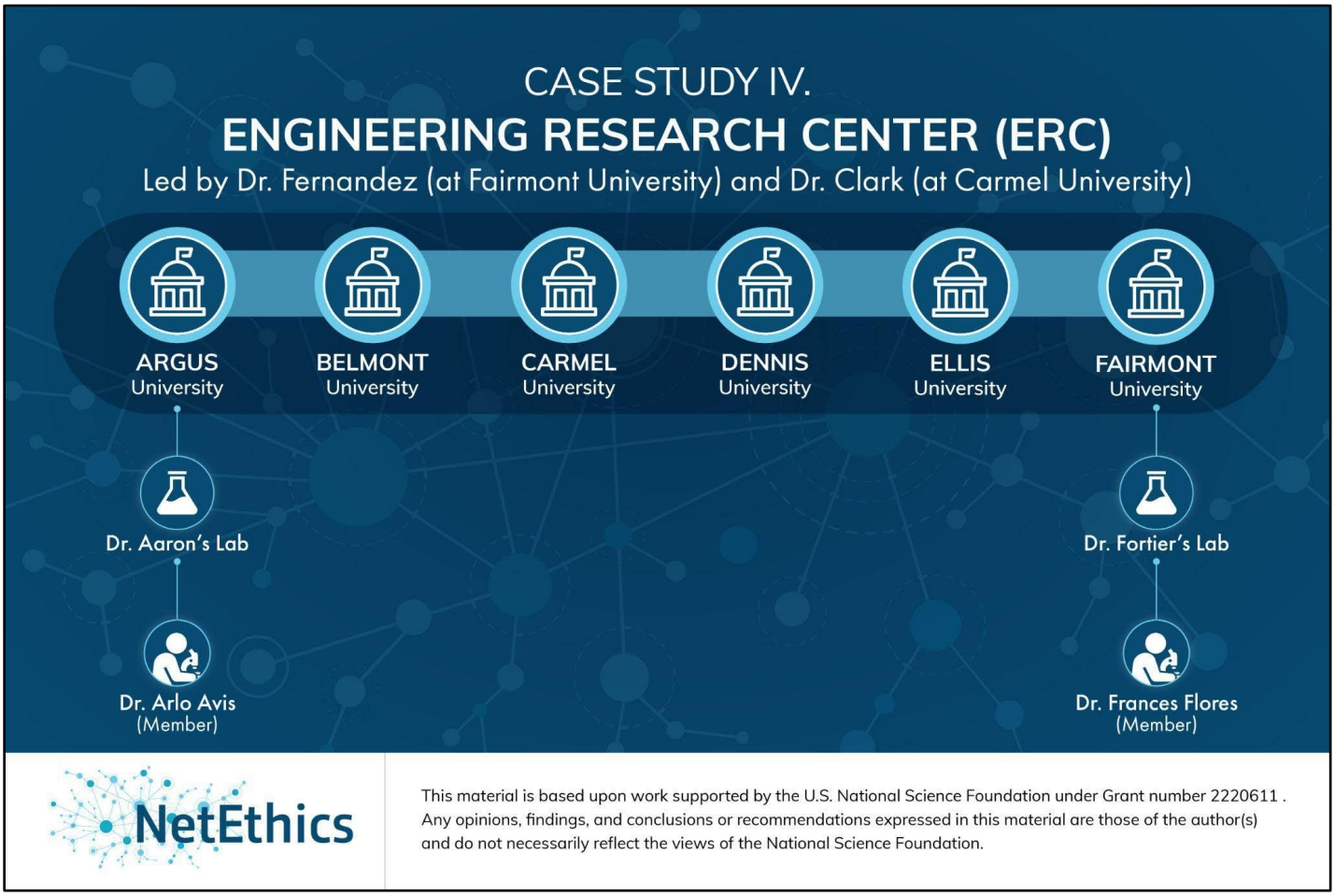
Dr. Arlo Avis is a member of an engineering lab led by Dr. Aaron at Argus University. Long before the ERC was funded and started work, the Aaron lab was known for its research excellence. Dr. Aaron describes **the lab as "a family" where everyone "is friends."** With the start of the ERC, some members of the Aaron lab (including Dr. Avis) **began a new collaboration with a lab** led by Dr. Fortier at Fairmont University. As Dr. Aaron says, "We are just getting to know the Fortier lab. So far, it's been just email and Zooming. So we'll have to see how the relationship develops. Right now, the jury is out…."

1. **Dr. Frances Flores, a member of the Fortier lab, asks to come visit Dr. Avis for a week to observe and participate in research**. Dr. Avis is not sure how to handle this request.
   a. **What should Dr. Avis do? Are there procedures or data that should not be shared with Dr. Flores? How far should Dr. Avis trust the visiting scientist?**
   b. **Are there steps that Dr. Aaron and Dr. Fortier should take as PIs to get the relationship between their labs off on the right foot?**
   c. **Should the ERC have rules or guidance to help build good collaborations across labs?**
2. Dr. Flores **visits the Aaron lab and spends a week working with Dr. Avis. Dr. Flores then returns to the Fortier lab, executes experiments based on procedures learned in the Aaron lab, writes up the results, and submits the paper to a journal**. No one in the Aaron lab is offered co-authorship or credited. When Dr. Avis finds out, Dr. Avis lodges a complaint with ERC leadership and at Fairmont University's Office of the Vice President for Research. Other members of the Aaron lab are divided on this – some think Dr. Avis is totally justified and has been ripped off. Others think Dr. Avis has been badly treated by Dr. Flores, but that Dr. Avis's complaints are endangering the cross-lab collaboration and the new ERC. The "family spirit" in the Aaron lab starts to break down, as some pressure Dr. Avis to withdraw the complaints, while others support Dr. Avis.
   a. **What should Dr. Avis do?**
   b. **Dr. Aaron? Dr. Fortier?**
   c. **The ERC leaders?**
   d. **Is there some way this could have been avoided?**
3. Other labs in the ERC have now heard about this dispute. Reactions vary, but **a number of labs are now more cautious about collaborating across labs within the ERC. Several PIs finally ask to meet with the ERC leadership** to find a positive way forward. They are concerned that the ERC needs ground rules for collaboration,

a way to minimize disputes and misunderstandings, and a dispute resolution mechanism that will not "blow up" relationships within the ERC.

a. **What should the ERC leaders do?**

4. The ERC holds its first center-wide annual meeting – an in-person meeting at one of the universities in the ERC combining professional meetings and social events. The **unresolved dispute between Drs. Avis and Flores hangs over the whole meeting. When asked, various members of the Aaron lab say, "We just don't trust the Fortier lab. If you want us to work with someone, we have to like them and trust them."** The two labs sit separately at the dinners.
   a. **What should members of the labs do?**
   b. **What should the PIs do?**
   c. **What should others in the ERC, including the ERC leaders, do?**



Additional readings on these issues (optional):

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