Minutes of the Regular Meeting of the Arts & Sciences Council

Thursday, November 8, 2018

Call to Order

José María Rodríguez García (Chair) welcomed everyone to the November meeting and introduced the first order of business: approval of the October minutes. There being no corrections, the minutes were approved.

Rodríguez García then announced that there will be a brief update from the Committee on Classroom Space and Infrastructure (CSI), followed by today’s main discussion on collaborative learning and vertical integration, which will be kicked off by a panel of three presenters. After the speaker presentations, he will open the floor for discussion.

Update from CSI

Carol Apollonio (Slavic and Eurasian Studies) said Council members received an email with 16 single space pages of complaints organized by administrative silo. She reiterated that four different offices deal with problems: the Registrar, Trinity Technology Services, Trinity Facilities, and Duke’s Facilities Management Department (FMD). She reminded everyone of Director of Facilities Jerry Conrad’s vivid image: if one turned a classroom upside down, everything that falls out belongs to Trinity Facilities. Everything else belongs to FMD.

Apollonio said the committee really wants to involve faculty in the early stages of decision-making about classrooms. She’s still waiting on several departments to turn in their information. Council members should review the document and send in further feedback if necessary. The committee also wants to listen to student voices, so Apollonio contacted the Duke Student Government President and DSG is conducting a survey. The next step will be a short survey for all faculty, which should come out next week.

She envisions a compelling set of things to communicate to the administration. The short-term goal is identifying immediate issues for up-fitting this summer, but the long-term goal is to identify how faculty can continue to drive the process regarding the spaces in which they teach.

Ruth Day (Psychology and Neuroscience) said there’s a problem with coordination among the various offices involved. The building where she works has been under renovation for a long time, and she has seen first-hand that such things as lighting, fall through the cracks because the various areas with oversight responsibilities don’talways work together.
Apollonio agreed it’s a challenge. It’s also a problem when you move one thing and then another thing changes. Tiered classrooms are hard for team-based learning, but flat classrooms create sightline issues. But there’re also some easily fixable things. For example, we need more writing surfaces that are not under screens.

Jeff Forbes (Computer Science) said some folks want white boards, some want chalkboards, so there’s a conflict in the desired pieces. How do you resolve those? Plus there’s accessibility issues regarding a board versus a screen.

Apollonio said her committee is collecting data, not resolving issues. However, they welcome suggestions on possible solutions to such conflicts. Regarding preferences for a certain board type, they’re thinking about recommending mobile boards that are cheap and easy to move. The Registrar-related issues are the most complicated to deal with, though maybe it could be proposed that each department or unit may control two classrooms for their faculty’s specific needs and requests.

Day said another step is to ensure functionality for all groups using the classroom. It’s frustrating to come into a classroom and have to move furniture. However, there’s also a problem with the selection of the furniture and with purchasing chairs that don’t fit the room.

Apollonio said the committee has received much input on this. She added that even though the committee has received numerous comments, they haven’t heard that people want a lecture room with stationery furniture. So we don’t teach the way people think we teach.

Rodríguez García said the CSI will present a draft of its report at the December meeting and Council will have the opportunity to respond and discuss. He’s also hoping for a December update from Dean Ashby on the first- and second-year experience.

Collaborative Learning (CL) and Vertical Integration (VI)

Rodríguez García then addressed the main agenda item for today’s meeting: collaborative learning (CL) and vertical integration (VI). While these are two different features of the way we choose to conduct instruction and research, and therefore may be treated as discrete questions or issues, Council is discussing them jointly because they regularly come up together in statements by senior administrators when they publicize Duke’s commitment to innovative pedagogies. Duke has engaged with collaborative learning, exploration, and research for a long time, one example being the humanities labs run by the Franklin Humanities Institute (FHI). They pioneered at Duke the connection between CL and VI in the form of free-ranging teams with participants in the humanities and interpretive social sciences, and at times with support from various natural science units. But these labs were anchored by department- originated courses and do not claim to create their own courses and haven’t asked for permission to do so. What’s new now is that CL and VI are becoming part of the strategic plan of the University as well as part of the priorities that the Board of Trustees would like to see addressed as Duke publicizes its capacity to turn first- and second-year students into researchers working on “real-world problem solving.” So there’re multiple stakeholders in the administration who would like to see more of the CL and VI features formalized in the curriculum and perhaps see them institutionalized as an element of Duke’s mission.

From interviews and numerous other interactions he’s had with faculty in preparation for today’s meeting, Rodriguez García has learned that there’s much to be gained from giving greater structure and monitoring to new and emerging CL projects. Nonetheless, the process of formalizing them may take away from the creativity of the project’s synergies since projects purporting to solve real-world problems often paradoxically neglect pedagogical depth, and this shortcoming may only be corrected by creating strong
support structures either in parallel to the project or before the project gets under way. A complementary perspective held by numerous faculty who have participated in the FHI labs is that CL and VI happen best after students have already taken courses in their disciplines. The Humanities Labs don’t generate their own courses, instead relying on courses already on the books. But at the same time, they rely on the experience that graduate and undergraduate students acquire in department-originated courses to tackle more focused and contemporary issues.

So there’s a fundamental issue that may come up in addition to whether CL and VI should be formalized to make those pedagogical features more easily identifiable and perhaps in the future also credentialize them in some way. The question is, should these initiatives be driven by donors, by senior administrators or by departments and their faculty?

In the medium term, Council may conceivably be asked to consider enacting a course component to institute formally key modes of instruction and/or research that encourage CL and VI. Currently, when faculty create a course by filling out an online form, they have to check boxes identifying the course components of the new offering, such as seminar, special topics, independent study, lecture, etc. These components don’t show on the transcripts; they’re descriptive tags that help students better understand the work involved in the class and how it will be delivered to them. In preparation for a possible future discussion about adding new course components to the existing ones, Rodríguez García wanted Council to host a faculty-driven conversation first so that we may all learn how different disciplines implement different forms of CL and/or VI. Nothing is on the table right now, though; he emphasized that today’s main concern should be with better acquainting one another with the terms on which pedagogical experiences are conducted across departments and divisions by individual faculty.

After the three speakers featured in today’s panel have given brief presentations, Rodríguez García will open the floor for questions.

[NOTE: the transcript of the ensuing panel presentation and open-mike discussion is followed by the slides shown by all three speakers.]

**Tom Nechyba (Economics)** said he was in the group that originally conceived Duke Ideas, which is now called Bass Connections. He led a theme for numerous years, but let that go last year. As the first teams were launched in 2012-13, faculty commented that the program involved a lot more teaching than they had anticipated. There would be teams working on projects, but the students needed more structure to actually profit from the opportunity. This was particularly important because Bass was conceived for undergraduates, including freshmen who often did not have the background and competencies necessary to work on the projects. Faculty wanted to know how we may deliver skills and competences so people can understand each other within the teams. Faculty wanted those conversations to happen without every foundation and method having to be re-taught. What were the possibilities for something more nimble? The VI idea was to catch students early enough and inspire them so that they would go take the courses needed to work on the project, such as statistics or econometrics. If we can begin to channel our undergraduates early in their careers, then we can change their Duke experience. Part of the discussion should be about what a support infrastructure could look like, and there’s likely not one answer. For example, he said, there could be a virtual infrastructure with real-time workshops on themes. Students could gain experience in Social Sciences labs in different areas but come together once a week to learn about methods across the board.

**Toril Moi (Literature)** said she was invited to speak because she’s a humanist who is interested in figuring out how her work and the work of her colleagues can fit into CL and VI at Duke. She’s not against teamwork or collaboration per se, but she has difficulty with fitting her workform within the
definition of teamwork as it’s defined at Duke and specifically by Bass Connections. There’s also a
tension between the University’s demand for ever increasing excellence in faculty scholarship and the
new types of CL used to train students in practical research. Moi said that creating a video in or for a
Bass-type setting is cool and counts as a deliverable or tangible product coming out of a lab, but it won’t
help the assistant professors in that group get tenure. While the humanities are wide-ranging, she focuses
today on the classical humanities, where the work at every level is to read, perform conceptual analysis,
interpret and then write. The objective for a doctoral student or a faculty member is to create output for a
single-authored work, whose completion could take five to six years. It’s hard for a humanist to drop
every long-term effort driving their scholarship in order to apply for a team project unless that’s what
their research was on anyway. It’s especially hard for junior faculty to participate in Bass Connections
because their participation is not rewarded by Duke. Another issue with Bass Connections is the
program’s focus on “real-world problem solving” since humanists produce insight and knowledge rather
than solve problems.

Moi said that humanities scholarship is hugely collaborative and can be vertically integrated in many
ways, such as a discussion group, a writing group, or a seminar. There’s a group talking together about a
problem, reading a book, and discussing it, but Duke does not define that as teamwork. She also said that
humanities scholars spend their undergraduate years building a vast array of knowledge, so first- and
second-year students can’t really do humanities research because they don’t know enough yet. She agrees
that faculty should awaken in students an enjoyment of research questions, but humanists already do that
by reading exciting books, and yet this is recognized less and less.

She emphasized that the workforms in the humanities can’t fit into the current structure of teamwork at
Duke. Top-level scholarship in humanities has to do with learning and judgment, and the problem with
judgment-based scholarship is that you can’t outsource it. Students can’t make their professor’s judgment
for her on Plato, for example. She – the professor – has to read the entire work and come to her own
conclusions, as does each student.

Moi said that humanists invented collaboration back in the time of the ancient Greeks, when Plato and
Aristotle came up with the idea for an academy of philosophers. Humanists also collaborate with others,
so Duke needs to expand the definition of collaboration to include how our humanities faculty constantly
collaborate. The University needs to recognize our workforms and ways of coming together as
collaborative teams; to acknowledge that reading, writing, and discussion groups are teamwork efforts
and that single authorship is the norm for the University to assess and promote the humanities cohort of
the faculty. Unless we make it easier to integrate a book project within a new CL and VI project, or fund
the two endeavors separately and equally, we’ll be discriminating against the humanities. Also, Duke
should count articles and books as desirable results of any research project on a par with Bass
Connections’ deliverables.

Moi concluded by saying that humanists don’t apply for Bass teams because the categories are set up to
marginalize them. Humanists work in stages, with one stage being teamwork and another being to work
alone to write and produce scholarship that resists the test of time.

Sara Haravifard (Physics) said she would talk about how she incorporates her collaboration with
national laboratories into her work with graduate and undergraduate students at Duke. She created a flow
chart of how she handles CL and VI (see appendix). Since joining the Duke faculty in July 2015, she’s
had close to 15 undergraduates in working in her lab, along with five international interns, three graduate
students, and three postdocs. So there’re layers of educational experience in her lab. She found it
interesting that of the undergraduates working in her lab, only three were Physics majors. Others were
either pre-meds or students who didn’t know what they wanted to study but were attracted to the idea of trying to discover something or to solve a problem.

Because of the complexity of her lab work, she breaks a problem down into many pieces and divides work up among students. The first step is pointing out new discoveries. Students then begin to review literature to discover additional concepts and relate them to one another. This is a two-way street with a dynamic question that may be adjusted depending on what students learn during the review process.

After the students know what they’re going to do, the next step is to make the sample. Again, she breaks that work into pieces.

Haravifard said an attractive aspect of her lab is the fact that all students have to do safety training, and that training teaches them how, in general, a lab works. Based on that, students then choose which areas they’re more comfortable working with. Also, she said, undergraduates can come into her lab, start in level one and continue through all the stages. They can stay in the lab or they can leave. Many people in the natural sciences want an undergraduate to stay with the lab for as long as possible, but she thinks differently. Students can choose how many steps they want to participate in because they’re already doing a task and she doesn’t need them to train other students.

Going back to the second step, Haravifard said that at some point in her lab there will be collaboration between undergraduates, graduate students and herself when they try to modify a recipe and figure out the best way to move forward. She said every step has quality control and it’s important for the student to be able to check their work. This could be tricky for undergraduates, especially those without a physics background because if something doesn’t work out, they often see it as a failure. She tells the students that there’s nothing wrong, but she needs the student to tell her what’s preventing the sample from working or what can improve it.

The next step is to travel to participate in experiments at national user facilities. Most facilities have resources for first-time users so she always tries to have the students travel to facilities and collaborate with others. This helps with training students on how a national facility works, but also gives them the opportunity to collaborate with analyzing and collecting data.

The next step, data interpretation, is a bit tricky as well, so she breaks this up into pieces giving the easier parts to undergraduate and graduate students. They then feed information back to senior lab members.

The last step is presenting the results. She tells students that not all who participate in an experiment will be a co-author and/or present at a conference. However, students still benefit from visiting a national lab and learning software, for example.

Haravifard said that if a course component should exist in the future, it should have clear terminology and reflect accurately the research involvement of the students. Undergraduates in the physical sciences increasingly need to be able to show they’ve done research when applying to graduate school or when interviewing for industry jobs. This research is now given credit through Independent Studies, but it might be helpful to have a course with a title like “Research Project” that could be flexible enough to show the students’ involvement in a project and the duration of that involvement, from one semester to several years. For one of her former undergraduates, currently at MIT, Haravifard had to write a detailed explanation in her recommendation letter since there’s no current way for the student’s transcript to reflect the work she did.

She summed up by saying that some students just want to work in a lab for experience, like pre-meds who are interested in how x-ray machines work. It’s important to target the student’s interest, then try to work
with that, while also giving them room to stay in the lab or leave. Adding a course would take away some of the pressure certain students feel to stay in a lab only to show that they’re doing research.

Rodríguez García thanked the speakers and highlighted several items for further discussion. He enjoyed Nechyba’s comments to the effect that, the more you open up the range of students available for a project, the more you also need a structure and a plan for the youngest and least experienced students to continue in the project meaningfully and not drop out. Is perhaps the course the right format that could provide one such structure, and how may we ensure that a new course component does not dilute the rigor inherent in all existing course varieties – the independent study, the lecture, the seminar, etc.? He found very useful Moi’s explanation that workforms in the humanities are diverse and polymorphous and that collaboration has been around since the ancient Greeks. Humanists work on a slower time scheme because of their need to build depth in subject, to acquire a foundation in any given discipline. This is why first- and second-year students really can’t normally produce original research in the humanities. While humanists need time together reading and discussing to inform each other’s thinking, it’s also important for them to have time alone to write. He also appreciated Haravifard’s enlightening description of integration in the physical science laboratory and wondered if her robust structures to ensure that members work organically through a sequence of fluid stages indicates that Bass projects aren’t structured enough. He surmised that Haravifard is preoccupied primarily with how to credentialize her students’ research for industries and graduate schools, and that turning physical science labs (already CL hubs) into CL courses is just a possible quick fix.

He opened up the floor for questions or feedback.

David Malone (Education) asked if the slides could be part of the minutes.

Rodríguez García said yes, if the panelists agreed. [All did.]

Malone said it seems that within each of the three divisions, there’re already different ways of approaching teaching and learning. What problem are we trying to solve? And will establishing a course format help solve this problem?

Nechyba said that when Bass originated, its courses were listed using Independent Study numbers. However, there had been discussion lately that certain logistical problems would be solved if those Independent Study courses were turned into standing courses. If they were, then the courses would be assigned a space to meet and a time, which isn’t happening in many projects that meet only sporadically or very informally.

Malone said he heard that Duke is overusing the Independent Study category in new ways and that makes it difficult to represent what the student has done; the amount of individual work a student has accomplished; and how the faculty monitor it.

Haravifard said it’s been difficult that her students sometimes had to take more than one Independent Study to stay connected to her lab. She hopes a way will be found to give existing course categories more flexibility, so that a student may continue to be associated with her lab by simply changing the title and time of one such course.

Moi said she is concerned about formalizing a new category for teamwork. Will there be a hoop she has to pretend she’s jumping through because a seminar isn’t enough? Seminars in the humanities feature intensive discussion and she fears that won’t be viewed as teamwork. She would like to see teamwork defined so it encompasses small discussions, writing groups, etc., because otherwise it devalues the work of humanists. People look at texts together and find out meaning together; what is that if not teamwork?
She doesn’t have a problem with the structure now, but is afraid that another structure may be created which sends the wrong message to our students, encouraging them to devalue humanistic work to the benefit of “real-life problem solving.”

Rodríguez García said that ECASC talked about the overuse of Independent Studies and he’s aware of the challenge this poses in the University’s accreditation process. We don’t use this course component for the purpose it was originally created, which was individual study with one faculty member that involved lots of reading and writing. Bass projects and other projects similarly driven by problem-solving concerns may minimize the reading and writing elements. ECASC also talked about whether the Independent Study component could be modified by individual departments, with faculty giving value to each student’s individual work based on their demonstrable and effective involvement in the program. This could answer in part Haravifard’s concern with how to credentialize the research her students do in the physical science lab.

Based on various discussions in ECASC, his interviews with multiple individual faculty, and today’s Council conversation, Rodríguez García doesn’t yet see a consensus on the need for a course component for CL but we’re having today’s conversation to see what elements need to be investigated.

Jeff Forbes (Computer Science) said he can identify about 13 different course components that currently exist. He wouldn’t worry that the existence of these would hurt a faculty member’s ability to teach seminars. He asked Val Konczal to clarify how course components are used.

Val Konczal (Trinity) said they’re used for statistics on what students are studying and how instruction is conducted, and to help determine limitations on what can be counted for graduation.

Moi wondered if a proposed course component could have a different name other than “collaborative learning” so it won’t imply that a seminar isn’t collaborative? Otherwise, why not add a new component for, say, working groups?

Cary Moskovitz (TWP) said it might be useful to separate out CL from VI since they’re two different things and aren’t always entwined. With VI, the Bass model is an extreme model but there’re other models out there, including undergraduates working with graduate students, undergrads with younger undergrads, etc. There’re different ways to do this besides Bass.

Rodríguez García thanked Moskovitz for his thoughtful comment, but said he explained the rationale for this conversation at the outset of today’s meeting. The issue is that CL and VI appear jointly in the addresses and vision statements authored or supervised by the University President and the Provost. Our senior leadership wants them to happen and continue growing together, and Bass Connections is the model they want to promote because it’s bringing lots of money to the University. Also, ECASC has identified Bass Connections as the main instigator of a new course component that would link CL to VI, turning existing projects into for-credit courses. Finally, he heard directly from faculty and leadership at the FHI the following concern: it’s not easy to see VI as a thing good in itself unless you commit first to a CL model where inexperienced undergrads will be mentored by graduate students. A common complaint refers specifically to graduate students being used as conventional TAs to relieve faculty of their labor in the weaker forms of VI implemented in some of the new team-based projects outside FHI.

Nechyba said there should be a bucket for something where people can work together but not be called Independent Study. Faculty can figure it out on their own, and Bass and others should be able to fit in.

Moi said she’s concerned about the University-wide conversation shifting to a higher level of pedagogical and curricular repercussions with the addition of CL and VI to Duke’s mission. She runs a center and has
already been told she’s not contributing to VI. It’s of the essence that we educate the University about workforms across divisions and disciplines, especially in the humanities and the arts. It’s not too much to ask to find ways to include humanities workforms in any new initiatives thoughtfully. She thinks it can be done, but we need to have a strong faculty voice in this process.

Haravifard suggested a course called “project” and then the instructor/PI can define the project, the team members, and the length. If it’s defined by the PI, it might be attractive to undergraduates because it will go on the transcript. A team member will be associated, so there will be collaboration.

Reeve Huston (History) said he sees two problems, one being recognizing the current workforms of students and faculty in the humanities and interpretive social sciences, and making room for that in fast-growing initiatives such as Bass. The other problem is, if what’s new here isn’t collaboration and teamwork, then where do we find language to describe it? “Project” sounds great. This designation might work for something that is ad hoc and won’t last forever, that is based on a particular problem that people will collaborate on and have a particular set of outputs. You can massage the language so you can include parallel research. He thinks we need to define what it is we’re talking about if we don’t want to accept the language of CL because it would be like letting Bass define and take control of what today was called the workforms of instruction, teamwork, and research in the humanities currently happening on campus.

Nechyba recommended that any action take into account flexibility and creativity.

Malone added that he’s heard several times that the humanities feel marginalized by the University and he wondered if there’s a need to talk more about this as a group.

Rodríguez García said ECASC will take up this issue and thanked Malone for bringing it up. There being no further business, the meeting was adjourned.

APPENDIX: SLIDES
Thomas Nechyba (Professor of Economics and Public Policy Studies)

Main Involvement Roles with Collaborative Learning & Vertical Integration:

(Founding) Director, Masters in Interdisciplinary Data Science (2018 – )
Director, Social Science Research Institute (SSRI) (2012 – )
(Founding) Education and Human Development Team Leader, Bass Connections (2013 – 2018)
Chair, Department of Economics (2003 – 2009)
(Founding) Director, EcoTeach Center (2000 – 2003, 2011 – 2016)

- Duke Students are Extraordinary, but ...
  - That does not mean they are equipped with the skills necessary to work effectively in social science “labs”

- Faculty and Students need Infrastructure to Support Collaborative Learning and Vertical Integration
“Teamwork,” “Vertical Integration,” and “Output” at Duke

- “Vertical integration”, “labs”: modeled on workforms in the sciences
- “Output” or “results” must be the direct product of teamwork
- Teamwork defined as not “a collection of individuals working in parallel”
- Faculty research (“research excellence”) is assumed to benefit from having (graduate) students
The Humanities: Varied Workforms

*Humanities* — a varied collection of disciplines, comprising different kinds of work. No one definition can subsume them all.

Certain humanities disciplines have practical, concrete dimensions:

- Exhibitions, concerts, performances, events
- Learning and communicating in foreign languages
- Interviews, film and video production
- Digital humanities, “big data”
- Certain kinds of lab-oriented philosophy

- It is easier to integrate undergraduates in such projects.
- But in some disciplines such projects don’t count as “research” for the purposes of tenure and promotion. Scholars can’t achieve “excellence” by doing them.

The Work of Humanist Scholarship

- Reading
- Conceptual analysis
- Interpretation (of objects, texts and artworks)
- Writing

Scholars need time together, but they also need much time alone.

- Studies of literature and the arts
- Aesthetics, theory, philosophy
- Historical investigations
- Theology, religion, etc.

Characteristics of top-level scholarship (“excellence”):

- Wide learning, trained judgment (texts, art, arguments)
- *Single-authored books*, essays [scholars work more like writers]
- A book project on average takes 5-6 years (so not “nimble”)
- Results: insight, knowledge, ideas (not “real-world” problem-solving)
The Work of Humanist Scholarship

Collaboration *before* and *during* the (individual) writing:
- Discussion of texts, ideas, artworks, etc. often in connection with visiting speakers, mini-symposia, one-day workshops
- Writing groups: encourage good writing, feedback on drafts. Can be crucial for good work.

Vertical integration:
- Judgment can’t be outsourced to assistants (they can read Plato with me, but not for me)
- Graduate students naturally participate in discussions, reading: this is training in scholarship, preparation for dissertations etc.
- Undergraduates may not have time for such informal groups
- Undergraduates: honors theses? -- Faculty advising load increases.
- Benefit for faculty: lively groups foster an intellectual environment. But nurturing them takes time. Can feel like an increased teaching load.
- Hard for junior scholars to take on such work if it doesn’t directly advance their own book projects, for the book is the gold standard for tenure and promotion.

Problem:
- Insistence on certain kinds of teamwork and certain kinds of problem-solving marginalizes key parts of the humanities.
- There is a conflict between the workforms and “output” required for “excellence” in scholarship and the workforms and “output” required by “vertically integrated teamwork.”

Solution:
- Understand and respect the workforms of scholarship.
- Acknowledge reading groups, discussion groups, writing groups as teamwork.
- Make it easier for scholars to integrate their book projects into Duke’s various collaborative projects. (Or fund work on books separately.)
- Set up projects in which new arguments, new insights about literature, art, history, theory, philosophy count as desirable results.
- Make sure scholars get time for individual research and writing.
Sara Haravifard
William M. Fairbank Assistant Professor of Physics
Assistant Professor of Mechanical Engineering & Materials Science

**Main Involvement Roles with Collaborative Learning & Vertical Integration:**
Director/PI of the Haravifard Lab on Materials Science
Associate of the Duke Initiative for Science & Society

**External Roles:**
Member-at-Large of the Executive Committee of the American Physical Society Topical Group on Magnetism (APS GMAG)
Vice Chair of the Executive User Committee & Chair of the General Field Facilities at the National High Magnetic Field Laboratory
Executive Member of the Spallation Neutron Source & High Flux Isotope Reactor User Group at the Oak Ridge National Laboratory

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**Collaborative Learning & Vertical Integration Chart @ the Haravifard Lab**

**Material Design**
- **Clarify Goal**
- **PI**
- **Literature Review**
- **Graduate & Undergraduate Students**

**Sample Synthesis**
- **Apply/Develop Technique**
- **Graduate & Undergraduate & High School Students**
- **Develop Recipe/Confirm Technique**
- **P/ Postdocs**

**In-house Characterization**
- **Utilize Tools**
- **Postdocs/Graduate & Undergraduate Students**
- **Quality Control**
- **P/ Postdocs Graduate & Undergraduate Students**

**Presenting Results**
- **Summarize Results**
- **Postdocs/ Graduate & Undergraduate Students**
- **Talks/Posters/Papers**
- **P/ Postdocs/ Graduate & Undergraduate Students**

**Data Interpretation**
- **Analyze Data**
- **P/ Postdocs/ Graduate & Undergraduate Students**
- **Theory Simulation/Collaboration**
- **P/ Postdocs**

**Experiments at National User Facilities**
- **Submit Proposals/Collaboration**
- **P/ Postdocs**
- **Sample Preparation/Experiment**
- **Postdocs/ Graduate & Undergraduate Students**