Doing Interdisciplinary Research

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"I'm on the verge of a major breakthrough, but I'm also at that point where chemistry leaves off and physics begins, so I'll have to drop the whole thing."
We are not students of some subject matter, but students of problems. And problems may cut right across the borders of any subject matter or discipline.

-- Karl Popper
Philosopher and Professor
London School of Economics
• What is Interdisciplinary Research?
  – What does it mean to you?
  – What can it help with?
  – What are the potential problems?
Definitions

Interdisciplinary research is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice.
Interdisciplinary research by definition requires the researchers to learn the other discipline. I like to stress vocabulary, but also methodology; I feel very strongly about it.

-- Ruzena Bajcsy

Director of the Center for Information Technology Research in the Interest of Society, University of California, Berkeley
Interdisciplinary vs. Multidisciplinary

Multidisciplinary research is taken to mean research that involves more than a single discipline in which each discipline makes a separate contribution. Investigators may share facilities and research approaches while working separately on distinct aspects of a problem.

Research is truly interdisciplinary when it is not just pasting two disciplines together to create one product but rather is an integration and synthesis of ideas and methods.
Multidisciplinary:
Join together to work on common problem, split apart unchanged when work is done.

Interdisciplinary:
Join together to work on common question or problem. Interaction may forge a new research field or discipline.
If you think of disciplines as organs, true interdisciplinarity is something like blood. It flows. It is a liquid. It is not contained. There is no inside and outside.

-- Alice Gottlieb
Professor of Medicine and Director
Clinical Research Center
Robert Wood Johnson Medical School
IDR is becoming more important as we try to understand how systems work. While many fundamental, single-discipline questions remain to be addressed, science and engineering are ready to address much bigger questions, such as ecologic and planetary systems. No single discipline has the capability to even start addressing whole systems.

-- Edward Stone
Jet Propulsion Laboratory
IDR In Practice

• Conversations and connections that lead to new knowledge
• Personal communication or “culture” barriers
• Tradition in academic institutions of organizing research and teaching activities by discipline-based departments—a tradition that is commonly mirrored in funding organizations, professional societies, and journals
What is 2+2?

- Engineer 3.998
- Computer Scientist $O(1)$
- Meteorologist 40% chance of a non-zero answer

- Economist
  - Step 1: cost/benefit of various approaches to determining 2+2
  - Step 2. Value of knowing the answer to 2+2

- Mathematician
  - Part 1. The answer exists.
  - Part 2. Ans. $\in \{\text{Re}\}$

Adapted from a presentation by Prof. Woody Flowers, MIT
Challenges for individual researchers

- Difficult to develop a career based on continuous interdisciplinary research
- Shifting peer group
- Finding high status outlets for publications
- Managing publication overload
- Lack of institutional support
Skills needs for individual researchers

• Understanding the languages, research methods and cultures of different disciplines
• High tolerance of ambiguity – personality more important than discipline base
• Willingness to learn from other disciplines
• Good communicator
• Open minded
• Able to absorb information and its implications rapidly
NRC Recommendations

- Students should **seek out** interdisciplinary experiences, such as **courses** at the interfaces of traditional disciplines that address basic research problems, interdisciplinary courses that address **societal problems**, and research experiences that span more than one traditional discipline.
• For example, students can
  – Begin preparation for IDR through an IDR project or summer IDR experience.
  – Approach interdisciplinarity by first gaining a solid foundation in one discipline and then adding disciplines as needed. Additional courses provide opportunities to understand the culture of other disciplines, gain new skills and techniques, and network with other researchers.
Some Keys to Success

Pay your dues: Traditional disciplines give you a strong base from which to launch yourself. “If you're not well educated in a basic discipline you can't do interdisciplinary research.

Listen and explain: Traditional disciplines have very different cultures, languages, criteria for judging what's good, and even senses of what science is.

Be humble: Meetings of minds don't work if one party does all the talking. Having alpha-male scientists at interdisciplinary institutes is a risk.

Be patient: “It's only just now that I feel I'm trained enough across three or four fields that can get something done.”

Be brave: Exploring new ground is risky “This isn't a place for every scientist. You need a large amount of self-confidence and the willingness to take risks.”
The most interesting observation is that the students are the integrating glue. Graduate students, undergraduates, and postdocs are the ones that go between the laboratories that make things happen.

-- Harvey Cohen
Professor of Pediatrics
Stanford School of Medicine and Chair
Interdisciplinary Initiatives Program
Sources

• **Nature Magazine:**
  
  **Correspondence**
  [http://www.nature.com/nature/journal/v447/n7145/full/447638a.html](http://www.nature.com/nature/journal/v447/n7145/full/447638a.html)

  *An indifference to boundaries*
  [http://www.nature.com/nature/journal/v447/n7145/full/447638a.html](http://www.nature.com/nature/journal/v447/n7145/full/447638a.html)

• **National Research Council**
  
  **Facilitating Interdisciplinary Research**
  [http://www.nature.com/nature/journal/v447/n7145/full/447638a.html](http://www.nature.com/nature/journal/v447/n7145/full/447638a.html)
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<th>Aspect</th>
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| Initial Stages: Building Bridges | • Common problem(s) to solve  
• Leadership  
• Environment that encourages faculty/researcher collaboration  
• Establishing a team philosophy  
• Seed/glue money  
• Seminars to foster bridges between students, postdoctoral scholars, and PIs at the same institution  
• Workshops to foster bridges between investigators at different institutions  
• Frequent meetings among team members  
• Think of the end at the beginning |
| Supporting the Project       | • Science and engineering PhDs trained in research administration  
• Support project initiation and team building  
• Seamless and flexible funding  
• Willingness to take risks  
• Recognize potential for high impact  
• Involvement of funding organization |
| Facilities                  | • Physical co-location of researchers  
• Shared instrumentation  
• Enhance chance meetings between researchers, such as on-site cafeterias |
| Organization/Administration | • Matrix organization  
• Rewards for academic leaders who foster IDR  
• Tenure/promotion policies for interdisciplinary work  
• Utilize experts with breadth and IDR experience for assessment  
• Professional recognition of successful practitioners of IDR |