Taking Risks in Research

Some thoughts on going outside your traditional and comfortable areas of expertise and making it work

Margot Gerritsen
margot.gerritsen@stanford.edu

NSF Career Preparation 2010

Dear all,

The motivation for talking to you about taking tack in research comes directly from my own experience. So, allow me to first write a bit about my own research path.

I started my university education with the equivalent of a BSc and MS degree in applied and engineering mathematics. This particular major at Delft University of Technology included a strong fundamental physics and thermodynamics component. I chose this major with the idea that it would give me a sufficiently thorough maths and physics background to work in many different application areas. One way to read this is that, at the age of 18, I simply did not know what engineering or earth sciences area I wanted to work in and wanted to keep doors open till a later time.

After the MS degree, I completed a Ph.D. in computational mathematics, with a minor in mechanical engineering (fluid mechanics mostly), at Stanford. After my Ph.D. I took a faculty position at the University of Auckland, New Zealand, and came back to Stanford in the Department of Petroleum Engineering (now Energy Resources Engineering) in 2001. I am now a tenured professor here with courtesy appointments in Mechanical Engineering and Civil and Environmental Engineering , and a strong affiliation with the Institute for Computational and Mathematical Engineering.

I have worked on a list of seemingly disconnected, or only slightly related research topics. Not sequentially, but often two or three areas at the same time. They include

- Compressible gas dynamics
- Coastal ocean modeling

- Sail shape optimization
- Pterosaur flight dynamics
- Enhanced oil recovery
- Wind turbine placement optimization
- Search engine design for digital archives
- Large scale solar systems
- Numerical analysis of hyperbolic systems of equations

You may conclude from this that I was right in that my more fundamental education in maths and physics opened many doors, or you may think that I still do not know what I really want to do when I grow up!

I am truly excited about the diversity of my research interests. I have learned so much from stepping out, from exploring other fields. The experience has given me great exposure and breadth that now allows me to, quite quickly, understand new research areas and make suggestions for or deeper contributions to ongoing research projects. It also now allows me to relatively quickly start up new research programs at Stanford.

It was not always easy. The thoughts expressed on these pages will illustrate some of the challenges I encountered, and the approach that I developed to deal with them and succeed.

As always, any approach, or path to success/survival, is very personal. What worked for me, may not work for you, or may not appeal to you. But, I hope that these thoughts my give you some of your own, and at least show you that it is possible to do things in academia in ways that are less traditional and perhaps a bit riskier.

The documents is really a braindump. One of these days, I will write it up nicely. Despite of its chaotic nature and first-draft status, I hope it will still have some useful information.

1. Why work in many different areas in science and engineering?

Satisfying a thirst for knowledge/following your passions. There are many outstanding questions in science and engineering that are intriguing and exciting. An academic setting is an ideal place to discover these because of the many seminars and local meetings you can attend.

Cross-fertilization. Many disciplines in engineering and earth sciences face similar challenges, and have developed unique solutions that may very well be applicable to other research areas. Finding out about such alternative, and often refreshing, approaches is not always easy. Research communities are still relatively closed, with own journals and own conferences. But, if you enter a new discipline and explore it, you will find many pearls.

Synthesis. Bringing ideas together from different disciplines to create new solution approaches is often an effective way to jump a field. When ideas click, it is a wonderful feeling.

X0,000 ft views. The more you broaden your mind, the easier it is to develop a 10, 20, 30 or 100,000 ft view. Having a good perspective on research and understanding common challenges allows you to relatively quickly make useful suggestions to colleagues or students, find interesting and useful problems to work on, and help develop larger scale research programs (at school, university or national level).

Helping others. Your specific knowledge can be very helpful to others (cross-fertilization/synthesis), and finding people you can be useful to is extremely satisfying. In other words, interdisciplinary or multi-disciplinary work creates many teaching moments

Local, national and international connections. Communities open for you, friendships develop. You expose yourself to different cultures. Personal enrichment

Enriched teaching. The more you learn, the more effective you are as an instructor. Teaching mathematics courses, for example, has become more fun and effective for both myself and my students because I can use many examples from different disciplines to illustrate mathematical concepts.

Agency dollars. You can go where the funding emphases are. If you look at NSF, DoE, NHI or other large funding agencies, you find that every so many years the emphases in the funding programs change. For example, DoE has strong support for carbon sequestration programs right now. If you are versatile, you can jump on such opportunities.

Private/non-agency funding. With an extended network of connections, and broader knowledge, alternative funding sources can open themselves to you. Two examples from my own background: Funding from National Geographic (in return for appearance in a NG documentary on pterosaur flight) to build a flying replica of a pterosaur, and funding from the Library of Congress to develop search tools. Both funds were not advertised to the wider community but were given to me because of my own connections.

2. What are some of the challenges you may encounter?

2.1 Being seen as too wide-spread, a Jack of all trades but master of none

Most responses I got when I first showed the desire to work in different disciplines at the same time were in this direction. This is quite understandable. The "traditional" academic position is very deep but rather narrow. Many and for some of you most, people you will encounter will have built academic careers as expert in one specific application area. They are part of a (small) community. Because of their extensive experience receive "world expert" status in the first 10 years or so. And they feel very comfortable and safe doing so.
Maybe they have never been excited about other areas. They are very happy where they are, and good on them too. Or perhaps some have felt the desire, but were a little too nervous to do so.
Because entering a new field, re-establishing yourself and going through yet another steep learning curve are often daunting.
Most people who discourage you, and certainly most that have discouraged me, simply did this out of concern for me. They were afraid I would spread myself too thin, would be seen to be too unorganized, would be seen to be too shallow, would not be able to get good support letters for tenure.

Coping strategies/ideas

Define yourself clearly by finding the commonalities between the disciplines. Although your work may seem disjointed, naturally there is always a common thread (because that is you!). You choose these topics and areas because of your talents, the tools that you developed and the interests that you have. And it is generally possible to define that. For example, I introduce myself as a computational engineer interested in modeling of natural and engineering fluid flow processes.

Most areas I work on (with the exception perhaps of search engines and large scale solar) fit in this general, overarching, definition.
Having this definition of self as researcher, this elevator pitch if you like, allows you to explain better to others how things fit together.

Explicitly point out cross-fertilization and synthesis in communicating research. When you write papers, give talks or write proposals talk about the origin of your ideas, point out commonalities. In other words, use these opportunities to make colleagues better understand that you are not an unorganized do-it-all, who cannot set priorities.

Set strict quality measures. You can dispel the idea that you are a master of none if you set very high quality goals for yourself in everything you do. For example, if I enter a new discipline, I demand of myself that I publish a few papers in that area in the best journals. That shows I am not a master of none, but instead a little mistress of several.

Give it some depth and time and size. Don't change topics haphazardly or work in an area for a very short period of time only. Give it a few years. Get a reasonable number of publication in the area. Get a critical mass of students. Give it all you got.

2.2. Encountering problems during continuation or tenure evaluation

Even if you have been hired explicitly because of your interdisciplinary interests or expertise, you may still find that ultimately tenure decisions are based on work in one discipline. This is often the case if you are hired in a traditional department as an interdisciplinary person. You must be aware of this, and talk about the tenure decision process in light of your activities often and deeply with your chair and dean. This is often rather difficult to do at the start of your career, but gets easier as people start understanding your contributions and the unique opportunities that your approach brings to the department or school.

Coping strategies

Define yourself well. See above

Give colleagues and university leaders a clear picture of your research and your contributions. Give them a good understanding of the communities you live in so that they know better who to approach for letters. Tell them about the journals you publish in, the invited talks you have been asked to give.

Reach out through courses, seminars and service. Offer new courses that enrich your school or department. Crosslist these courses if they, by their nature, are also interesting to other schools. Give many talks in different schools/departments to

make colleagues aware of what you bring. Serve in Ph.D. committees in other departments or as chair of Ph.D. committees, so that people start to see that you are versatile and have good ideas.

2.3. Dealing with steep learning curves

If you get excited about a new area you typically face a steep learning curve before you can contribute. There are many ways to learn about a new application area, but here are a few ideas that worked for me.

Start by consulting existing groups, or joining research proposals as consultant or co-pi

Teach a course in the area. Volunteer to teach a course in the new area, even when you are brand new. There is nothing like facing lecture deadlines to learn new material. Also, the act of teaching the material makes you understand it so much faster and better. Just jump in. You'll generally be ok. Uncomfortable, yes, and sometimes downright scary, to teach a subject that you are not that familiar with. But don't forget that you are not teaching experts, but students who probably will know less than you do if you prepare well for a lecture. And, be honest to the students. If you do not know an answer, just say so, but promise to follow-up.
One thing I often do is teach a continuing studies course (open university) first. These courses can be arranged quickly, and the general audience that attends them requires you to really think about the area in simpler terms: the best way to get through to first principles.

Organize seminars in the area, or give seminars.

Visit research groups for an extended period.

Find a small, reasonably do-able, project to work on first. This may not lead to a major contribution, and you won't come in the field with a big splash, but you can perhaps wet the appetite of some colleagues in the field and use the small project as a springboard to something bigger and better.

2.4 Encountering the "market barrier"

To publish in a new field requires that you are accepted by the people in this field as a valuable contributor. You must be quickly seen as a knowledgeable person who can add to the research community. This may not be so simple at the start. Here are a few suggestions.

Seek collaborations with established figures in the field

Do not attack widely accepted methodologies, thoughts or approaches. People are sensitive to criticism. If you see you can suggest alternative approaches that may be better than existing approaches, be very political about the way you present them. Offer it as a gentle alternative. Give credit to authorities in the field. Do not present yourself as an arrogant new rookie.

Attend meetings in the new discipline and be very active. Go to a conference, not necessarily to present, but to listen, learn and talk to people. Ask good questions. Be open, passionate, friendly. Follow-up with new contacts.

3. How do you find exciting new areas?

Naturally, there are many ways to discover new research passions. Here are some of the ways I have used and still use

Regularly and frequently attend seminars outside your own department.

Read "Annual Review of .....". These annals contain wonderful articles that introduce important topics in a given research area. They contain excellent references, give a good introduction to the field, and generally explicitly discuss outstanding and outstanding problems.

From time to time, attend conferences such as APS-DFD or AGU that attract a very large number of participant and offer a wealth of (short) intro talks and posters. Spend a lot of time at poster sessions. They are often more instructive than talks and allow you to talk directly to researchers

Offer consulting services to your university community. I have run a computational consulting service at Stanford for quite a few years. See http://icme.stanford.edu/consulting/csquared/index.php
This exposes me and my students to many interesting and open mathematical problems in engineering and science. It also led to a few consulting jobs with industry, which then continued onto sponsored projects.

4. How do you cope with the work and manage your projects?

Working in multiple disciplines may increase your workload and definitely requires careful time management.

Involve others and delegate. Starting new projects and/or running several programs at the same time is not possible without strong collaboration with others (colleagues, postdocs, grad students) and a willingness to delegate.

Early on, set (realistic) milestones. Plan conference attendance, set deadlines for publications.

Regularly evaluate your progress and adapt your approach accordingly. Be honest to yourself. It may be that you find that ideas you had for new contributions were not very good, or do not lead to anything anytime fast. Cut your loss then, change tacks if necessary.

Set more realistic expectations. Most of us are perfectionists. It is good to let go of that a bit. I apply the 80/20 rule. I used to, on average, spend around 20% of my time doing 80% of the work, and 80% of the time completing the final 20. This is not a very effective use of time, obviously. I now try not to demand perfection and stop at the 80% mark. This is not easy to do at first, but gets easier after a while.

Use hours productively. Don't allow yourself to get distracted all the time by email or your PDA. Bounce ideas of others, ask suggestions from others, if you feel stuck. Don't continue working too many hours if you are not productive. It is much better to take some hours off when you are tired, or just not thinking well, then to keep on working and putting in unproductive hours just because you feel you have to, or others do it.

Smell the roses. Good ideas often do not come to you while you are concentrating alone in the office. In my own case, most of the ideas I generated that made an impact came to me during time-off. Hikes, bikerides, roadtrips, sailing, yoga, are all activities that help me digest information and formulate ideas.

A healthy mind in a healthy body. Eat your veggies, exercise and spend loving time with friends and family. It will make you feel better, it will make you happier, and therefore also more productive.

Accept and embrace the levels of discomfort that come with starting new projects. You are pushing yourself, you are learning, and that's good. Trust yourself and others. Something will come out of any struggle. Stay positive and open. OK, easier said then done sometimes. Just keep telling yourself.

Follow your passion

Grasp opportunities when they present themselves

Be open, interested and eager to learn from other