Viewpoint: Polishing the Coins of the Academic Realm

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ABSTRACT

This essay boils down into three pages what I've learned in my 32 years of mentoring PhD students.

1. INTRODUCTION

One of my favorite activities is advising, so I was happy to accept the invitation to give advice about giving advice.

2. GETTING STUDENTS OFF ON THE RIGHT FOOT

Some faculty give new students a list of their expectations and student rights. One student did so well that I asked if he knew why. He said I gave him helpful guidance upon entering grad school, when he was eager to hear it. He then told me what I said, which I've been telling to new students ever since:

- *Show Initiative* – Don't wait for faculty to tell you what to do; if we were good at management, we probably wouldn't be professors. Read papers, attend lectures, ask questions, challenge assumptions, and explore on your own.
- *Sink or Swim* – We'll offer you what we think are great projects with plenty of potential, and we'll support you the best we can, but it's what you do with the opportunity that makes or breaks your graduate student career.
- *Educate Your Professor* – We're in a fast moving field, so for us to give you good advice we need to know what you're working on. Teach us!

3. IT TAKES A VILLAGE TO RAISE A CHILD

Advising is simpler if you foster an environment that helps students learn how to become successful researchers. The goals of the environment should be:

- Create a heterogeneous community that provides camaraderie, group learning, mentoring from senior students, and hands-on education in other fields.
- Offer opportunities for students to practice communication skills by presenting to outsiders, to improve their research via honest feedback, to inspire them with earned praise, and to set milestones for their research.
- Provide ways for students to acquire research taste, in particular how to identify problems that if solved are more likely to scale and have impact.

For many Berkeley systems students, the three paths to these goals are team-oriented, multidisciplinary projects; research retreats; and open, collaborative research labs.

3.1 Multidisciplinary Projects

I try to work with colleagues to create exciting, five-year projects that I would die to work on if I were a graduate student again. We self-assemble into teams of typically 2 to 4 faculty with the right areas of expertise to tackle a challenging and important problem, then recruit 10 to 20 graduate students to work towards building a prototype that demonstrates our proposed solution. Table 1 shows the ten Berkeley projects in which I have participated.

The multidisciplinary nature of the project means students gain hands-on knowledge about other areas by working closely with students and faculty in other fields. The experience they gain building the common prototype helps them develop taste in research topics, which in turn helps them pick interesting research topics for their dissertations and later in the rest of their careers.

Group projects create communities where students have others with whom to interact. In particular, the more senior students can mentor the junior ones. Being a Ph.D. student can be a very lonely experience, especially when it comes time to write a dissertation; being part of a group helps a lot.

We recently started celebrating the ten-year anniversary of the end of projects. The high participation level at these reunions indicates that these personal ties in such communities remain 10 years later. Figure 1 shows the SPUR, RAID, and NOW reunions.

3.2 Research Retreats

Key to the success of these projects, and to the development of systems graduate students, has been twice–a-year, three-day retreats where students on the project present their results to one- or two-dozen guests from industry or non-academic labs. These are intensive events, lasting from early breakfast to late night discussions, although we do take off part of one afternoon to have some fun. Retreats act as project milestones, with the specter of presenting to outside visitors motivating students. We close the retreats with an outsider feedback session that offers advice on any aspect of the research. It's surprisingly rare in academia to get frank feedback about research, but who can't benefit from constructive criticism?

Hence, retreats mean graduate students give two serious talks a year over their careers and receive advice from experienced researchers from other institutions with different experience and perspectives from the faculty on the project. Students are energized when external people care about their work and find it important. When we advisers say something is good, many students assume that we are just acting as cheerleaders or trying just to get more work out of them. I believe that interaction with thoughtful colleagues from industry and non-academic labs is vital to both acquiring research taste and in learning to identify critical problems and impactful solutions in computers systems.

Such projects and retreats might be hard at many places. Building collaborations with nearby institutions and local industry can get many of the same benefits. For example, there is an annual Boston Area Architecture workshop involving Brown, Harvard, UMass, Northeast, RPI, and local industry so that their students can cut their teeth in front of a friendly audience and get feedback from outsiders. The key is to get everyone to stay for the full event and have people outside your group giving frank feedback.

We have been doing retreats for 25 years. To my surprise, three years ago we discovered another technique that is becoming just as important to the success of projects and graduate students.

3.3 Open Collaborative Laboratory

We were increasingly seeing people optimize their schedules to avoid disruptions by working from home when they didn't have classes or meetings, since computers and networks were just as fast at home as in the office. The negative global impact of such a local optimization can be thought of as corollary of Metcalf's Law: if the value of a network is proportional to the square of the number of connected users, even a small group leaving a network can significantly decrease its value. This drop in value can in turn cause others to leave, with the negative feedback loop continuing until the network nearly collapses.

In 2006, we experimented by creating a physical office area with contiguous open space for everyone in the project, including the faculty. We hoped that easy access to faculty would draw students to campus and that the open space would inspire innovation by increasing the chances of spontaneous discussions. [1]

The open space makes it very convenient to quickly grab a group of interested people on a moment's notice for a discussion rather than trying to wander around the building or exchange a volley of emails to schedule a meeting. We have also been surprised to see new students in this space quickly act like senior graduate students. Apparently, easy access to faculty plus watching how senior graduate students operate helps new students move up the learning curve quickly.

The research retreats and open space also build esprit de corps, as we play together one afternoon at retreats —for example, skiing, paint ball, and river rafting—and in the lab we collectively watch presidential debates and big sports events.

The challenge of our open space is then to preserve concentration while enhancing communication [1], for otherwise people will still stay home. Distractions are reduced with large displays, headphones, and relying on cell phones instead of landline phones; the custom is to make and take calls outside the open space. We also included many small meeting rooms in which to hold vigorous conversations. The result is an open space about as quiet as a library or coffee shop, which is good enough for most to concentrate while encouraging spontaneous communication.

4. ACTUAL ADVISING

Clearly, the students who always do well are a joy to meet. I do wonder how much advising you are really doing for them. For those students who need more help, the only thing I can say with confidence after 32 years is that every student is different, and its unlikely there is a single path that works for all. Moreover, there are limits to how much you can change, since students have had at least 20 years of people shaping their personalities before they even meet you. You can tell new students that being a successful researcher is different from being a successful undergraduate student, as they generally have no opinions on the topic when they arrive. For example, it's often a surprise that grades are less important than research, and that they need to learn how to work on their own rather than just follow orders. They also need to find the right balance between learning the literature and starting to build. Clearly, advice changes over time. New students may need a "starter" project, and you give them larger tasks as students mature: reviewing, mentoring, and even helping write proposals.

I see four other topics for advisors: recognizing that part of advising is being a role model, helping with public speaking, bolstering confidence, and counseling them.

4.1 You're A Role Model; Act Like One

I am struck from parenting two now-grown sons that it's not what you say but what you do that has lasting impact. I bet this lesson applies as well to your academic progeny. Hence, I am conscious that students are always watching what I do, and try to act in ways that I'd like them to emulate later.

For example, my joy of being a professor is obvious to everyone I interact with, whereas I hear that some colleagues at competing universities often complain to their students about how hectic their lives are. Perhaps differing advisor behavior explains why many Berkeley systems students try academia? (See Figure 1.)

4.2 Practice Public Speaking

Giving good talks is a problem for many students. Our culture is that practice talks are good for everyone, so we all do them, including me. We practice answering difficult questions as well as delivering smooth talks to avoid a "deer-in-headlights" incident at the real talk.

4.3 Bolster Confidence

Self-confidence can be a problem for students, especially early in their careers and for some belonging to underrepresented groups, so look for chances for them to succeed. Perhaps it's suggesting a paper that they be lead author on, taking a summer internship at a company that is a good match for their talents, or even having success as a teaching assistant. I have seen even very senior students blossom late in their careers when they have some wins under their belts that everyone recognizes.

Make sure that you praise such students when they do have real success; all of us love praise for a job well done, but some of us need it more than others. Students learn from criticism as well as praise, just be careful it doesn't deflate potentially fragile egos. I try to remember to phrase critiques as questions—"What do you think about …?"—both orally and in my written comments on papers. I try to include something to praise in all the red ink that I put on a student's paper, but keep in mind that false praise for a mediocre job may hurt more than help. [2]

4.4 Be A Trusted Counselor

Students may ask for personal advice, perhaps even for serious personal problems. As they are often far from family and friends, you must be there for them.

5. TRICKS OF THE TRADE

Surely the most traumatic matter for the students is picking the thesis topic, as they believe it will have such a big impact on their careers. One of my advisors when I was a UCLA graduate student was Gerald Estrin, who had worked with John von Neumann. I still remember him telling me: "Every CS PhD student I have seen, including myself, had a least one period when they are convinced that their dissertation topic is utterly worthless." Just retelling this story can help students cope, but look for opportunities to get others to praise their work. The project and retreat model can help: it improves their taste in research, it increases their confidence in their ability to pick a topic and pursue it, there are other students to talk to, and they get regular feedback on their chosen topic from the outsiders, which can be a shot in the arm.

Here are four pieces of advice for advisors: help students if they stumble, aiding non-native speakers, co-advising, and post-graduate mentoring.

5.1 Help If They Stumble

When students stumble in the program and stop making progress, I have had luck with sending them to industry for a six-month leave, as three months may not be enough to do something significant. Twice students have come back fired up knowing what they want to do for their dissertation and, perhaps more importantly, *why* they want to do it. A third student decided to stay in industry. That was likely a good decision, as I didn't look forward to trying to drag him across the PhD finish line if he didn't return with a greater sense of purpose, and I'm not sure he would have graduated if he weren't reinvigorated. One colleague asks stuck students to send him a daily report about their research and progress. Some days it could just summarize a paper or talk, or even "I didn't do anything." He finds that 3-4 weeks of this often gets them back on track.

Berkeley faculty hold two meetings a year to review the progress and give feedback to all our PhD students. Having a forum to hear others both praise and criticize your students provides a valuable perspective, and collectively we come up ideas on how to help students in need. Reviews also ensure that no student falls through the cracks. Occasionally, after several warnings, we tell students that their progress is so slow that they should drop out. On more than one occasion, these letters lit a fire under lethargic students and they shortly filed their dissertations.

5.2 Aid Non-Native Speakers

Non-native English speakers can offer another set of challenges. As far as I can tell, they just need practice speaking and writing English. (I wish this need were limited to non-native English speakers!) Some colleagues have had luck hiring graduate students from other parts of campus to work with CS graduate students to improve their writing. One colleague suggests making sure that if they share an apartment that their roommates don't speak the same language so that they are forced to speak English. I am trying an experiment to improve the diction of an international student by having him take a course outside the university called "Learn to Speak like an American."

5.3 Try Co-Advising

As part of our new open labs, we are also trying joint advising. I find my co-advisor offering great advice that I wish I'd said, and I hope vice versa. Co-advising also has the benefit that when one advisor is traveling there is someone else to meet with the student. It also makes advising more fun for everyone involved. I believe it works well *if* the advisors meet with the student simultaneously, so that they give consistent advice. (In case you care, from my long years in academia, you get just as much credit whether you are the sole advisor or if you co-advise a student.)

5.4 Mentorship Doesn't End At Graduation

After investing 5 or 6 years to train an apprentice, it must be worthwhile to spend a little more time after graduation to help him or her succeed. I offer to give a talk at their new institution to give them one last shove in the right direction. Danny Cohen recently asked for advice from Ivan Sutherland—who supervised his 1968 thesis—adding that Danny views advisor is a lifetime job. I agree. I still offer advice to, and receive it from, my former students. (In fact, my former student Mark Hill suggested that I write this essay.)

6. ADVISING IN RETROSPECT

When I was finishing my PhD, to help decide what I would do next I read a book based on interviews of people talking about their jobs. [3] What I got from the book was that people were happy with their careers if they designed or built objects that lasted, such as the Empire State Building or the Golden Gate Bridge, or if they shaped people's lives, such as patients or parishioners. Thus, I went into the job of assistant professor with the hypothesis that my long-lasting impact was going to be the students I mentored rather than the papers I published.

Thirty-two years later, I can confirm that hypothesis: your main academic legacy is the dozens of students you mentor (see Figure 1), not the hundreds of papers you publish. My advice to advisors is to get your students off to a good start, create stimulating research environments, help them acquire research taste, be a good role model, bolster student confidence, teach them to speak well publicly, and help them up if they stumble, for students are the real coins of the academic realm.

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8. REFERENCES

[1] T. J. Allen and G. Henn, 2006. *The Organization and Architecture of Innovation: Managing the Flow of Technology*, Butterworth-Heinemann, , 152 pages.

[2] Dale Carnegie, 1998, *How to Win Friends and Influence People*, Pocket, 288 pages.

[3] Studs Terkel, 1974. *Working: People Talk About What They Do All Day and How They Feel About What They Do*, Pantheon Books, Random House, New York, 589 pages.

Table 1. Patterson's Research Projects

Years	Title	Profs	Students
1977-1981	X-Tree: A Tree-Structured Multiprocessor	3	12
1980-1984	RISC: Reduced Instruction Set Computer	3	17
1983-1986	SOAR: Smalltalk On A RISC	2	22
1985-1989	SPUR: Symbolic Processing Using RISCs	6	21
1988-1992	RAID: Redundant Array of Inexpensive Disks	3	16
1993-1998	NOW: Network of Workstations	4	25
1997-2002	IRAM: Intelligent RAM	3	12
2001-2005	ROC: Recovery Oriented Computing	2	11
2005-2010	RAD Lab: Reliable Adaptive Distributed Computing Lab	7	30
2007-2012	Par Lab: Parallel Computing Lab	8	40

SPUR reunion in 1999. Left-right, front row: David Patterson (Berkeley), Garth Gibson (CMU/Panasas founder), Richard Fateman (Berkeley), Shing Kong (Pathscale), Brent Welch (Panasas). 2nd row: John Ousterhout (Stanford), Mark Hill (Wisconsin), Susan Eggers (Washington), Paul Hansen, B. K. Bose, Mike Nelson (VMware), Mendel Rosenblum (Stanford/VMware founder), Ben Zorn (Microsoft). Last row: David Wood (Wisconsin), Jim Larus (Microsoft), Luigi Semanzato, Randy Katz (Berkeley), Scott Ritchie, George Taylor, Andrew Cherenson, Corinna Lee (AMD/ATI), Ken Lutz (Berkeley), David Lee (Silicon Magic Founder), David Hodges (Berkeley).

RAID Reunion in 2002. Left-right, front row: David Patterson (Berkeley), Randy Katz (Berkeley), John Ousterhout (Stanford). 2nd row: Pete Chen (Michigan), Garth Gibson (CMU/ Panasas founder), Ann Chevernak (USC ISI), Ed Lee (Data Domain), Mary Baker (HP Labs), Kim Keeton (HP Labs), Ken Shirriff (Sun Labs), Fred Douglis (IBM Research). Last row: Ken Lutz (Berkeley), Martin Schultz, ??, Ethan Miller (UC Santa Cruz), Mendel Rosenblum (Stanford/VMware founder), John Hartman (Arizona), ??.

<Missing NOW Reunion Photo>

<Missing NOW Reunion names>

Figure 1. Pictures from the SPUR, RAID, and NOW reunions