Do Good Research and Run a Great Lab.

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Repeat after me: NO

You need to say no to many work requests

When in doubt, ask your mentor (or me)

When in doubt, say no



Ask yourself not if you can do it at that date, but if you could do it now.

Yes, even when a department head asks, you can say no

When not to say no: when Fredo asks.

Bonus advice: you don't need to explain why not

Saying no is awkward and unpleasant short term but will make your life better long term

Vacations

Highly recommended.

While I was on tenure track:

- 2 weeks in Galapagos & Ecuador (no internet!)
- 2 weeks in Tanzania (no internet)
- 2 weeks in Botswana (no internet)
- 2 weeks in Alaska (no internet half of it)
- 2 weeks in Italy
- Two 1-week trips to the Everglades
- + 2 trips to France every year



Today's session

Research in general

Running a research group and doing research with students

As usual, ask question, interrupt. Lots of upcoming related sessions: *funding, mentoring, etc.*

Quality above all

Should be your second guiding star (with quality)

Not always possible 100% of the time, but majority of the time.

Disclaimer: Variability between fields

- Time constant of research (plan, execute, etc.)
- Experimental vs theoretical projects
- Horizon of predictability/planning
- Time to publication, average # of publication
- Number of students per faculty
- Preparation and track record of students before grad school

Nail vs. hammer driven (problem vs. tool) Narrow vs. broad Interdisciplinary Applied vs theoretical Individual vs. collaborative Trailblazer vs. closer Know your strengths, cultivate them breadth, implementation, creativity, polyglot, theory, application

- Just the right size
- Friendly enough
- Good if you create an outgrowth of an existing community

Answers are easy, questions are hard

Half of the work is to figure out a good question or area of research

Be curious. challenge the status quo. What is important? What is a problem? What are blind spots?

Hamming: What is important in your field? Are you working on it?

If it's not working, maybe change the question

Yair Weiss as reported by Bill Freeman:

"The strong student starts doing what the advisor has asked, sees that it doesn't work, looks around within some epsilon ball of the original proposal to find what does work, and reports that solution."

Aim high

What is a good question? (See Hamming)

- Important (solving it has important consequences)
- Important to others
- Solvable, you have an angle of attack
- Assessable (can measure success, ideally quantitatively)
- Still relevant in 5-10 years
- Exciting to you
- Nice pluses:
 - not too crowded
 - has nice paper-sized sub-problems

Less good reasons to do research

Funding (although useful)

Fashion, groupthink

Finding & exploring good questions

- Keep a list of questions & half baked questions
- Talk to other people
- Keep some free time to just think broadly
- Once in a while, wonder if you're asking the right question (e.g. error control)
- Constantly reflect on the scope of projects. Sometimes needs to be narrowed down, sometimes broadened up
 - e.g. deep demosaicking

Novelty vs. results

See also Pasteur quadrants Hardest case: novel answer to old questions



Dealing with uncertainty

"Great scientists tolerate ambiguity very well. They believe the theory enough to go ahead; they doubt it enough to notice the errors and faults so they can step forward and create the new replacement theory." Hamming

In research, you often don't even know the question!

Be able to build on unknown territory. Assume some subproblems will be solved and build on hypothetical solutions. At the same time anticipate problems.

Good quality: sloppy math, story telling, hand waving

Focus on the big picture story, ignore unsolved details

Try to fail quickly. Avoid sunk cost fallacy.

Make mistakes. We all do.

Research is multiscale, leverage abstraction

Your work will never be perfect

Don't let the better be the enemy of the good.

- Make hard decisions. get things done. Narrow the scope. Simplify the problem.
- Assess costs/benefits.

Deadlines can help, just don't let them dictate everything

- Internal
- External
- In other fields:
 - rewarding but has a high setup cost
- Among students
- For tenure: avoid excessive collaboration with PhD/ postdoc advisor
- Don't be threatened by researchers/students who are smarter than you

Communication is half the job

- Communication is critical (oral, written, informal) big picture.
- contextualize. what does you audience/readers know? hold their hand.
- Explaining the question is half the job
- Focus on why, not how
- How much time you spend solving something doesn't necessarily translate in communication time

Communicate early and often (get feedback, collaborate.)



Manage your time

- Don't procrastinate
- Keep time for thinking
- Keep time for reading
- make hard decisions
- let deadlines motivate you/structure your time but don't be a slave to them
- important vs urgent. Focus on important & not urgent.
- To do lists, cards for the day
- http://www.dgp.toronto.edu/~hertzman/courses/ gradSkills/2010/TimeManagement.pdf

Research Group Composition

Decide what the right size is for you

https://elifesciences.org/articles/82831

Narrow vs broad

UG, grad, postdocs, research scientists

Sometimes even joint with another faculty member (careful about tenure though)

Managing composition over time is not always easy (people come and go)

Running a Research Group

Provide research vision and context (high-level)

Listen to people

Enforce respect (and lead by example)

Public praise, private criticism

Robust technical arguments should remain respectful

Group meeting, sub-group, reading groups

Have social events

e.g. tea break, dinner, hike, board games, retreat Peer collaboration/mentoring/hierarchical Interact with other groups (avoid isolation) Invite external researchers to come give talks

Dan Hastings on running a group

There are a number of key points to running an effective group

1. Make sure that all members of the group understand that they must treat each other with respect and with appropriate behavior. You should have no tolerance for an "isms" (racism or sexism or any other)

2. You must ensure that they all understand your values and the values of the Department and MIT. Integrity is key. Research, Academic and Financial Integrity.

3. You should provide the overall vision and direction for the group.

4. You should plan on meeting each one of them individually for an hour a week and have weekly group meetings. Now you see how the size of the group matters in terms of time.

5. You should over time have a clear plan for each degree student to do a thesis and for each postdoc to get the training they need.

6. The group should be set up in a way that they are supportive of each other. Sometimes this can be done by having students work collaboratively on projects.

7. Students/postdocs should be allowed and encouraged to give presentations

8. Students/postdocs should be encouraged to be part of a larger lab group in the Department so they can learn what others are doing

9. An effective group also spends some social time together. Plan on some social activities and you should actively celebrate all the finished theses and graduations.

10. An important rule to remember is public praise and private criticism. Support your students/postdocs in public and give them critiques of their work/performance in private. There is no point in belittling them. You do know more than they do but why demonstrate it in public.

Going to conferences

And sending students

Track record (varies a lot by field)

GPA

Letters (careful with bias)

Essay

Interviews?

Are they good team members? Ask. DEI?

From Dan Hastings:

Different faculty look for different things (for grad students)

- 1. Performance on UG subjects especially technical subjects
- 2. What the references say especially if they say something about research creativity

3. What the essay says in terms of interest in the areas that the faculty member has some interest. However, many UGs are pretty naïve as to their interests since they do not understand the field and often make choices on the basis of what UG classes they enjoyed.

- 4. Research experiences and other internship experiences that the student has had.
- 5. The quality and difficulty of the school that the UG attended
- 6. Where the student wants to go- what are their career goals?

7. Issues of diversity; some faculty want to have gender balanced groups, others don't care. Some faculty are very interested in attracting minority students since they see themselves as role models.

8. Whether they can deduce how closely the student needs to be directed. This may be related to how they are funded. Research Assistants are funded to help with the research and may need specific focused direction to ensure the work gets done. Fellowship students have more freedom but that is only valuable if they use that freedom responsibly and do not undertake a random walk.

Sometimes it is valuable to interview students but there is not a lot that you can tell from a short interview.

Doing research with students

See mentoring session

Goal :

1/ Have them do good research 2/ Become independent

Big tension: Direction vs feedback

Give Feedback, expectations

All students are different and may call for different mentoring Different role at different times:

Onboarding

Steady state

Career/long horizon chats once in a while

Crunches/deadline once in a while

Eventually, they should be independent

Starting/onboarding with a student

Set expectations

Ideally have them written down on web

Get to know them.

What do they like? What are their strengths? What do they want long term?

Make them read, quick experiments

Find a first research project together

Different levels of student autonomy

Regular research meeting

Frequency?

- I personally recommend weekly, 30-60 minutes
- Tension: How much of the work comes from you vs. the student?
- They should be in charge as much as possible
- They should have stuff to report, questions, to ask, they should critique their current status.
- Make room for them to bring stuff up, talk about longer term stuff if they want to. Ask them how they are doing.

Student collaborations

Other training (see mentoring)

- Writing
- Giving talks
- Reviewing
- Teaching
- Mentoring

Less regular meetings

At least once a year, talk about

- **Overall progress & performance**
- Goals, timeline
- Personal issues
- Anything the

Promote your students (see mentoring)

- Let them give talk
- When presenting their work, give their name/ photo
- Talk about them in informal meetings
- Write letters of recoemmendation (of course)
- But don't exaggerate. Get a reputation as someone whose evaluations are to be trusted.

Tough times (see other sessions)

Idea doesn't work

Is it because of the idea or the execution?

Student is underperforming

Student quits before work is completed

- Admitted student turns us down
- Tension between your interest and that of the student

Research topic

Graduation time (the students you want to keep the longest are the ones who could graduate the fastest)

Interpersonal challenges in lab:

authorship, collaborators don't interact well,

dating/breaking up on the job

Toxic ambiance/comments

Note: you don't have to deal with tough times alone. Talk to colleagues, mentors

In short

Quality

- Fun
- Respect

Some pointers

https://docs.google.com/presentation/d/ 1JeVaHpnz3ky2hM5YljIEPuSeGEgDE6z6Rg2aEFJ4BuQ/ edit#slide=id.g10efc2f3eae_0_34

http://people.csail.mit.edu/billf/www/papers/doresearch.pdf

http://www.cs.virginia.edu/~robins/YouAndYourResearch.html

http://people.csail.mit.edu/fredo/student.html

http://people.csail.mit.edu/billf/talks/10minFreeman2013.pdf

http://www.csee.umbc.edu/~mariedj/papers/advice.pdf

http://www.dgp.toronto.edu/~hertzman/courses/gradSkills/ 2010/