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## **Running an Academic Research Lab – Advice to Junior Faculty**

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I have completed the supervision of 176 PhDs and 31 postdocs at the University of Southern California (USC) in the last 35 years. There are still 20 PhD students in my laboratory right now. To run a large academic research lab for years is challenging but rewarding. I want to share my experiences in running the lab and supervising PhD students with junior faculty in this article.

### **Admitting New Students**

Admitting or recruiting good PhD students is critical to the success of a research laboratory. The PhD program is suitable for a small number of well-prepared and highly motivated students. It is designed to train those who desire to solve open problems innovatively and logically. It is common for PhD students to encounter problems without clear definitions, formulations, solution clues, etc. They need to face these unknowns and challenges under the supervision of their advisors.

In recruiting new PhD students, I pay attention to two factors: 1) academic background and 2) research potential. They are reflected in the transcript and the statement of purpose, respectively. Furthermore, one-on-one interviews are valuable. I demand a presentation on their previous research, followed by questions. I can observe their oral presentation skills and logical reasoning capabilities.

The size of a laboratory depends on funding and the director's management style. The quality of students is more important than quantity. Usually, an outstanding student is more productive than several poorer students. Thus, I advise not to have many students at the beginning of an academic career. Besides, it takes time to build the lab culture. Senior students can be good helpers once a good lab culture is in place.

### **Building Lab Culture**

Each lab has its culture, with core values established intentionally or unintentionally. Students learn values from their advisor as a role model. I build my lab culture with the following core values.

- *Integrity.* Integrity is the foundation of academic studies and research. The importance of integrity and its practices will always be emphasized. One related issue is plagiarism. As generative AI tools, such as ChatGPT, emerge recently, guiding students on adequately using these tools is critical. I encourage students to use

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Grammarly to correct grammatical errors but discourage them from using ChatGPT to compose an article.

- *Teamwork.* Teamwork is essential for engineers in companies or scholars in academia and technical societies. To build such a spirit, I encourage students to collaborate proactively. For example, I assign a senior member as a mentor to a new lab member.
- *Efficiency and Diligence.* Efficiency is much emphasized in industry. If students are unprepared, they need to adjust when joining a company. Efficient management is also a must for running a larger lab. Efficiency and diligence are two sides of a coin. I reply to emails quickly. If responding to a question that is involved is difficult, I will give a short reply and a more elaborate answer later. The same applies to paper revision. I also demand weekly reports and hold weekly meetings with each individual. Generally, efficiency and diligence build good momentum for the lab.
- *Transparency and Fairness.* A friendly and encouraging research environment will boost the lab's morale. Furthermore, mutual trust and respect will build a tight bond between lab alumni and the advisor in the long run. They come from transparent and fair advisor-advisee relationships. One example is a student's graduation schedule. Students want to know graduation requirements. Advisors should communicate with students about their expectations. Furthermore, social events such as the Thanksgiving Luncheon and pre-seminar pizza/drink time can shorten the distance between lab members.

### **Supervising Students**

Most people learn supervision skills from interactions with their advisors in an ad hoc manner. Instead, we may ask ourselves the criteria for a mature PhD who is about to graduate. Then, we will provide supervision and guidance for them to reach these objectives. Here are my mentorship goals.

- **Problem-solving capability**  
A mature PhD should be able to 1) identify critical aspects of an unsolved problem, 2) propose possible solutions, and 3) conduct experiments to verify the solution's effectiveness. Items #1 and #2 demand an extensive knowledge of the problem domain and some R&D experience from real-world projects. For the former, students will benefit from taking core courses and forming study groups. For the latter, students will learn how to apply acquired knowledge to a new context. The innovative application helps students appreciate the power of existing knowledge. Item #3 concerns implementation skills in the lab or software programming.

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- **Communication skills**  
Excellent oral and written communication skills are essential to career development. There are two main ingredients: 1) logical organization and 2) fluency. The former is fundamental to PhD training, while the latter is acquired through practice. I demand students submit weekly reports, give PowerPoint presentations in weekly meetings with me, and deliver seminars to the whole lab every 4-5 months. They also need to have three rehearsals for their qualifying and defense talks and attend rehearsals of other lab members to give critiques. Students will communicate their ideas and work better afterward.
- **Life-long learning capability**  
The PhD thesis topic should be jointly decided by the advisor and the advisee, considering factors such as funding and trending. Yet, the topic may be insignificant since technologies change rapidly nowadays. The topic primarily serves as a training tool. A PhD should be able to learn new material promptly and explore new opportunities continually through the training process. Thus, I give more emphasis to life-long learning. In this direction, research tastes play an essential role. A PhD can differentiate between good and mediocre work. For example, I ask students to form a study group. They select papers to discuss and exchange their views on them with rationales: strengths, weaknesses, and areas for further improvement. Senior lab members lead the study group.

### **Funding**

Writing good proposals takes time. Knowing the receivers' needs and telling them what you can offer beforehand is essential. It is, therefore, advised to plan visits to funding agencies and meetings with program managers. It will enhance the funding chances significantly. Even if your proposal is rejected, you can still get feedback from the program manager for feedback and referral. If your work is related to the industry, you can look for industrial grants, too. Industrial funding is usually of a shorter term (typically, one year and renewable) and quite demanding. On the other hand, students can benefit a lot from industrial collaboration since they solve real-world problems.

### **Conclusion**

Junior faculty members have various responsibilities in the university, such as teaching, mentoring graduate students, writing proposals, searching for new research directions, etc. How to prioritize them is the key to success. What was described above is a generic one. Please get advice from senior colleagues in the same department and school to better understand your environment. Best wishes for an exciting and memorable academic journey!