

Mentoring Practice of P. Givi

"A mentor is someone who sees more talent and ability within you, than you see in yourself, and helps bring it out of you..." Bob Proctor (born 1934).

I have had the honor of serving on the faculty of Engineering at the University of Pittsburgh for almost 20 years. Prior to that I had the opportunity and experience of working in industry (Flow Research Company), government laboratories (NASA Langley and Glenn research centers), and at another university (State University of New York at Buffalo). At Pitt I have been blessed to be surrounded by an outstanding group of colleagues and students. As a result, I have been fortunate to make some contributions in several aspects of my academic duties. In this report, I provide a summary of my activities and philosophy pertaining to graduate student training, supervision and mentoring.

The difference of working in academia (compared to industry and/or government labs), is to also train your collaborators along the way. This training is markedly different from that in a traditional classroom. In graduate research, by the time the student is finished with the thesis, his/her mastery of the subject matter should be comparable to, if not exceeding, that of the advisor. Moreover, for their marketability, today's graduate students must acquire skills well beyond those in course work and research. These are the competencies in a wide variety of subjects, including communication, collaboration, management, ethics, administration, cultural awareness, emotional endurance & intelligence, volunteering, resourcefulness, activity in professional societies, initiation, persistence, citizenship, ... and more. The importance of expertise in these attributes have been discussed in many sources; for example, Ref. [1]. It is also to be recognize that many of these skills are not inherent to most individuals and can only be *acquired*. Moreover, retention of students in science and engineering is not a trivial issue, and numerous studies show that effective mentoring techniques are needed to keep students in graduate school, especially those from underrepresented minority groups [2]. I firmly believe that the primary reason for the success of my students is, at least partially, due to their informal (and very subtle) training in such skills through our day-to-day interactions. As a result, most of my former PhDs have been very successful with stellar records as professors in academia, scientists & engineers in government laboratories, private industry, and software & data companies. Having had the experience of working with PhD students for over 33 years, it is somewhat of a difficult task to express all aspects of my mentoring philosophy in three pages. So, I just dive into a listing of some of the basic elements of my mentoring practice. (*This listing is by no means complete!*):

Focus on Fundamentals: In my tenure at Pitt, I have taught 14 different courses (not including supervised readings, special topics, *etc.*). These courses are all in Mechanical Engineering and are distinctly different from 15 other courses I had previously taught at other universities (in Aerospace, System, Mechanical and Civil Engineering). Most of my colleagues feel that teaching 29 different subjects¹ in almost that many years is inefficient, if not insane. I disagree! I try to make a point (mostly to my graduate students, and also to my colleagues). We are in the business of education, and in doing so we emphasize the *fundamentals*. Mathematics, Physics, Chemistry, and Computing constitute the basis for engineering. So, if these basics are understood well, all of the rest follow! This is not just in the context of classroom teaching but also in conducting research. A good researcher understands the fundamentals and articulates them effectively.

¹ Actually 30. I have just developed a new course which will be taught in Fall 2022.

Communication: The results of formal studies, e.g., Refs. [3, 4] indicate that competency in forms of scientific communication (both written and oral) is essential for success after graduation. Therefore, I put a heavy emphasis on this aspect of my mentoring. My students are encouraged to publish in leading journals and to present their work at national and international conferences. I include them in writing survey and tutorial articles, where a clear writing-style is essential. Also, I implement the well-known concept of *“the mentee becoming the mentor,”* with the flow of training goes from the postdocs to PhD candidates to masters students, to our undergrad research aides, and occasionally to K-12 students. The mentees will understand their mentors much better with the experience of mentoring themselves.

Teamwork: Direct correlation between leadership/teamwork self-efficacy with interpersonal competence beliefs in science and engineering has been well recognized [5]. Due to intrinsic transdisciplinary nature of my research, teaming of experts from various domains is essential. An example is Ref. [6], in which the PhD candidate collaborated with experts in HPC (high performance computing, fluids engineers, quantum algorithm developers, computer scientists and applied mathematicians. To develop this element of their training, my students are involved in collaborations, and writing multi co-authored articles, including reviews & surveys. An example of the latter is Ref. [7].

Professional Services: As the founding Faculty Advisor for the local chapter of AIAA, I appreciate interactions with students in extracurricular activities. I have had a very pleasant experience in guiding students to get involved in professional issues. Examples: raising funds and organizing local seminars for chapter societies. Serving on the editorial boards of journals is very time consuming. But it does bring significant visibility. The same goes for peer reviewing of journal papers and proposals. To encourage their participations in such activities, I continually nominate them to serve as referees for journals. After their graduation, I nominate them for editorship of respected journals. I have also had the opportunity to serve as the primary organizer or the member of organizing committee of several technical conferences, symposiums, workshops, and other scientific meetings within US and abroad. My graduate students have been involved in organizations of all of these conferences and, at times, they have served as key administrators. The task of such organization is daunting and exhaustive. However, the rewards are obvious and very well worth it for graduate students’ professional growth and marketability.

Internship & Partnerships: Almost all of my graduate students are involved in internship & partnerships. These are either through our research collaborations with a diverse group of scholars worldwide, through visits at government laboratories (e.g., NASA Centers or DoD & DOE labs), or various industries. Some of our students have attended summer schools or short courses around the globe depending on the nature of their research. Such interactions are necessary both in terms of exposing them to new ideas, and in helping them in placements. Transfer of knowledge to industry and government laboratories is another impact of this training. We are pleased to see our mathematical & computational models being utilized in leading industries and prestigious national and international laboratories.

Diversity and Cultural Awareness: While this issue is of significant current interest, it has always been a non-issue with my group. Our team has always been very diverse in ethnicity, race and gender. We have been very active in recruiting qualified women and minorities to our lab and nominating them for fellowships and awards. Our student coming from a wide variety of very different backgrounds bring so much pleasing flavors to the melting-pot of our laboratory.

Marketability & Placement: We can all philosophize endlessly about mentoring, but ultimately our success as PhD advisors is measured by placement, and subsequent visibility, progress and accomplishments of our graduates. In addition to success in research & education, and all of the additional training, our students still need to be assisted in identifying the right career direction(s). I do spend a lot of time with my graduating students to help them identify their career paths. I can state that all of my former PhDs are very satisfied with their current positions....At least that is what they tell me!



Our *PhD-Tree*: This poster is a tree of my PhD graduates (academic children), their offspring PhD students (my academic grandchildren), great grandchildren, and so on. I am indebted to my former dear student, Dr. Shervin Sammak, who generated this poster a few years ago.

References

- [1] Fedynich, L. and Bain, S. F., Mentoring the successful graduate student of tomorrow, *Research in Higher Education Journal*, 12:1 (2011).
- [2] Packard, B. W.-L., Mentoring and retention in college science: Reflections on the sophomore year, *Journal of College Student Retention: Research, Theory & Practice*, 6(3):289–300 (2004).
- [3] Anderson, C. B., Lee, H. Y., Byars-Winston, A., Baldwin, C. D., Cameron, C., and Chang, S., Assessment of Scientific Communication Self-Efficacy, Interest, and Outcome Expectations for Career Development in Academic Medicine, *Journal of Career Assessment*, 24(1):182–196 (2016).
- [4] Mitchell, K. M., McMillan, D. E., Lobchuk, M. M., Nickel, N. C., Rabbani, R., and Li, J., Development and Validation of the Situated Academic Writing Self-Efficacy Scale (SAWSSES), *Assessing Writing*, 48:100524 (2021).
- [5] Deemer, E. D., Sharma, P., and Xu, C., Leadership/Teamwork Self-Efficacy Scale: Longitudinal Confirmatory Factor Analysis in the Context of an Energy Science Intervention, *Journal of Career Development*, p. 0894845320953899 (2020).
- [6] Gourianov, N., Lubasch, M., Dolgov, S., Berg, Q. Y., Babaee, H., Givi, P., Kiffner, M., and Jaksch, D., A Quantum Inspired Approach to Exploit Turbulence Structures, *arXiv:2106.05782*, (2021), accepted for publication in *Nature Computational Science*.
- [7] Yilmaz, S. L., Ansari, N., Pisciuoneri, P. H., Nik, M. B., Otis, C. C., and Givi, P., Applied Filtered Density Function, *J. Appl. Fluid Mech.*, 6(3):311–320 (2013).