

# **Pursuing a Personalized Program to Prepare for an Academic Career at an Engineering Department without a Formal Teaching Curriculum**

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## **Abstract**

Typically, when applying to graduate school for doctoral programs, students are not 100% certain of the route their careers will take: industry, academia or both. Most times though, they lean more towards one of these options. In such a case the potential graduate student tailors their applications /interests to schools with the kind of curriculum that fits their particular needs. Once in graduate school, their original preference may become stronger. On the other hand the preference may shift. In such cases the student hopes that their current situation affords them enough flexibility to still meet their career goals. For some students, until the end of the doctoral program they do not have a preference and they are open to either career path or a customized career path that is a mix of both industry and academia. This is usually challenging as proper planning and preparation are essential to succeeding in either career path.

This paper discusses how a chemical engineering graduate student who started out interested in a career path in industry with the possibility of guest lecturing evolved. Halfway through her doctoral degree program her interest in sharing knowledge (academia) grew. Her various research and teaching experiences as a graduate student informed her decision to pursue a more academic career path with the possibility of industry involvement in the capacity of a consultant. Her department, like majority of the other chemical engineering doctoral programs, did not offer any structured program for PhD students interested in academia. So, she proceeded to design a personalized program to prepare herself for a successful teaching career with the guidance of a mentor. This program included a variety of targeted experiences that would culminate in a competitive teaching portfolio and a more confident prospective professor.

## **Introduction**

Acquiring a PhD does not confer upon an individual the highest possible knowledge in their field. On the contrary, it only gives a person the keys to the vault of knowledge: to question all, to “think out of the box” and to learn continually. In the course of obtaining a doctorate degree, an individual does not necessarily acquire all the skills to be an effective teacher, active researcher and good academic citizen<sup>1</sup>: expectations of any new faculty member. The road to becoming an efficient and effective professor is a deliberate one that requires planning. However, some essential skills can be picked up during graduate studies such as research skills

through RA assignments and a few teaching skills through teaching assistantships. When preparing to become a professor, it is important to look at the big picture and the final goal. This will largely shape the preparation process. The type of institution (community college, small 4-year college, or research based PhD granting university) and the type of position (tenure track or non-tenure track) sought are some of the important factors. After extensive literature search about the various options available for an academic career, the primary author of this paper determined that she would prefer to pursue a tenure track position at a research university. In order to prepare for such a position she formulated a plan with the assistance of her mentors.

### **Preparing for a Career in Academia: A Personal Plan**

Tutoring as an undergraduate, supervising a chemical engineering laboratory as a masters student and grading assignments for an undergraduate chemical engineering course were teaching experiences that were a standard part of my education. Although these were minor teaching responsibilities, these experiences exposed me to the opportunity to share knowledge and fueled my subsequent interest in becoming a college professor. At the time when my interest in teaching became clear, it almost seemed too late as I was already halfway through my doctoral degree program. Despite that, I started doing some reading about what it would take to become a professor. The wealth of information served only to confuse me further. I did two things at that point:

1. I mapped out a plan: Based on my findings, I identified the key things I needed to focus on to prepare for teaching in a research university.
2. I identified a mentor: I picked a professor whose teaching style I admired and started asking questions. I enrolled for an independent study titled “Teaching Chemical Engineering” with this professor.

**The Plan:** The three most important areas to pay attention to when preparing for the academic career path I had decided on were teaching, research and service<sup>1</sup>. Figure 1 shows a flowchart of the details of each of these three areas that needed to be addressed. I discuss below how I completed some of these details and my plan for attaining the rest. However, as Richard M. Reis pointed out, “substance alone is not enough”. I took a particular interest in his “Three-way stretch” preparation strategy<sup>2</sup> because it applied to all the stages of an academic career from being an undergraduate student to a retired professional. It includes 3 steps to a successful strategy.

1. Breadth-on-top-of depth<sup>2</sup>: This step focuses on broadening the scope of one’s expertise to include and/or discover parallels with other fields of study. In order words, think out of the box of your immediate specific work to find how your contributions may be applicable elsewhere. A practical example is choosing an interdisciplinary dissertation committee with a mix of both academic and industrial professionals.

2. Next-Step<sup>2</sup>: This step involves thinking and acting ahead of your current stage. This shows your enthusiasm and preparation for the position to which you aspire. A good example is teaching undergraduates while still in graduate school.
3. Multiple options<sup>2</sup>: This step allows simultaneous preparation for careers in academia and industry (government & private).

Boyer also proposed a model of scholarship which comprised four functions<sup>5</sup>:

- (i) Discovery: Building new knowledge from original research
- (ii) Integration: Utilizing knowledge across disciplines/specialties
- (iii) Application: Draw on knowledge from research findings to solve societal problems
- (iv) Teaching: Use teaching tools to achieve optimal learning

Although Boyer emphasizes the importance of discovery scholarship, he draws attention to the scholarship of teaching which he considers the central element of scholarship. “Without teaching, the continuity of knowledge will be broken” he rightfully said.

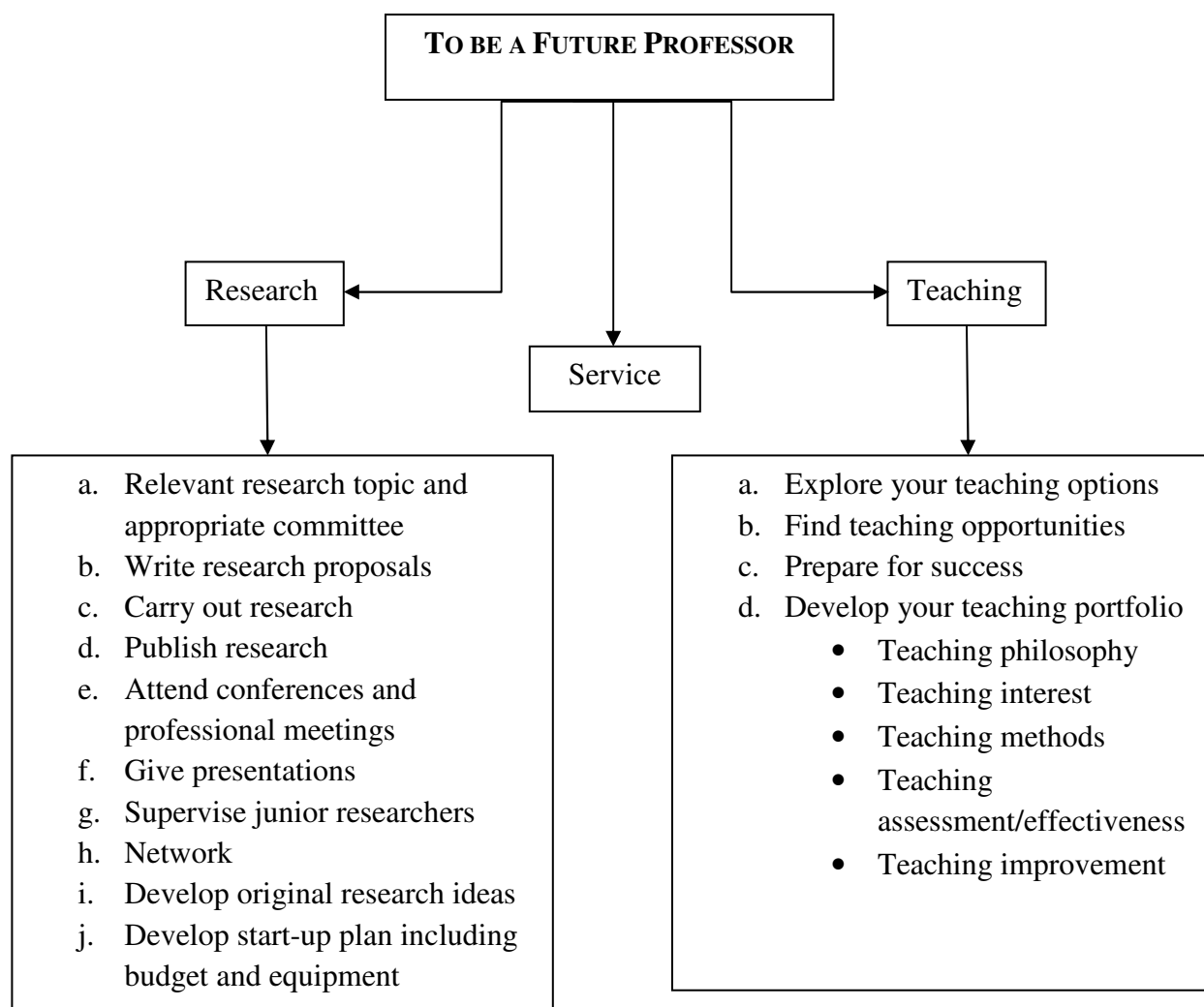


Figure 1: Flowchart to Prepare for an Academic Career in a Research University

**Research:** In my particular case, at the start of my degree program, I picked a research area I was interested in and stayed with it throughout my graduate program. My research was a Joint Industry Project (JIP) with a 5 year privacy clause on the finish date of my dissertation. This meant I would not be able to publish my work in any public journals until 5 years after I finished my dissertation. At that time since I was not interested in full-time faculty positions, this did not pose a problem. In retrospect, I should have negotiated.

- a. Relevant research topic and appropriate committee: I am a chemical engineer with a keen interest in reaction kinetics. At the same time I was trying to be relevant in oil refining. My project offered me the perfect synergy of the two as I was able to work on kinetics of reactions in a specific heavy oil refining process (Delayed Coking). The world's interest in unconventional oil and their refining processes keeps rising as the sources for conventional oil dwindle. Lack of worthwhile information about the kinetics of delayed coking defined the relevance of my project. The project and advisor were a package deal, as usual. I selected committee members who would give me a balanced dissertation committee. While most of my advisors are from my department, they have varying research interests, hence different contributions to make to my research. I have also included a recently retired industry professional in my committee.
- b. Write research proposals: At the start of my doctorate degree, I conducted a thorough literature search on my topic of interest, then identified a need and subsequently wrote a research proposal and presented the paper at the annual board meeting (ABM) of the JIP members. After the meeting the members voted 97% to fund my project. While the process of deciding may be different for private versus public funds, the experience of writing a proposal is the same.
- c. Carry out research: From design to shakedown to full operation, I have and still am carrying out my research. After identifying a goal, I designed and built a unit that would help me achieve my goal. As with any new non-steady state bench scale unit, high temperature and pressure controls pose a challenge but learning from every run has been the key to improved controls.
- d. Publish your work: Unfortunately, due to privacy agreements with the JIP members I am not allowed to publish my research. I write bi-annual reports and present papers at the ABMs which are accessible only to JIP members. However, I plan to find other opportunities to publish things I happened upon by chance during the course of my research that are not directly related to my research findings but could be applicable in various fields. I also intend to talk with professors with whom I can conduct short term projects that will end up in published papers.

- e. Attend conferences and other professional meetings: I have in the past attended only a few conferences since I typically do not present at these conferences. Now, I intend to attend more conferences and professional meetings for the purpose of networking and hopefully presenting some papers.
- f. Give presentations: I have given numerous presentations to JIP members of my research project. However, I will plan to focus more on a broader audience, a diverse public. This means more presentations at conferences or professional meetings such as this one.
- g. Supervise junior researchers: I had the rare opportunity as a current doctoral student to supervise a masters student on my project. He is working on a topic for which I had laid the foundation during my masters research. He also assists me with cleaning up after my experiments. It is a different dynamic managing people. I also have technicians who help me as needed. The possibility of mentoring an undergraduate student is an opportunity I can take advantage of as a member of Omega Chi Epsilon.
- h. Network: This is an area for which I have had no preparation. With the help of my mentors, I intend to network at upcoming conferences and professional meetings.
- i. Develop original research ideas: For my doctoral dissertation, we identified a need and I had to develop a process to enable me to conduct original research in order to meet this need. I intend to work more on this skill possibly in a post-doc position where I can come up with original research ideas.
- j. Develop start-up plan including budget and equipment: For my research, I had to design my experimental facility from scratch. As a result I had to do a detailed design of the proposed unit. This included P&IDs, equipment descriptions and sizing, a budget for the equipment cost, operational cost (excluding electricity) and analytical cost. My plant design course which I took as an undergraduate was useful for this purpose. I will use knowledge from this experience to develop similar plans for the research ideas I develop.

**Teaching:** The teaching part for me was more challenging since my university did not have a formal plan to assist me with my career goals. This part involved some creativity and that is where my mentor came in.

- a. Explore teaching options: For teaching, a few options exist such as teaching lecture-style classes, computer-style classes, lab classes etc. My favorite type of class to teach is the lecture-style class. I can keep my hands busy and work practical examples that would bring the material home for the students. In some cases, depending on the course

material, one option may be more appropriate. It is therefore necessary to be conversant with all options.

- b. Finding teaching opportunities: A graduate student may be assigned teaching assistant duties that would allow them to experience some portions of teaching such as making up homework questions, grading homework and tests, supervising labs or tests, and conducting discussion hour. As a masters student, I was a TA for the unit operations laboratory for 3 semesters. This allowed me to supervise a group of undergraduate students in hands-on laboratory activities. I had the experience of grading thermodynamics homework from a different TA assignment. At this point I still did not feel like I could teach so I volunteered to guest lecture for professors in their absence. I got two opportunities to do so in lecture style classes. For my independent study, I also had the opportunity of teaching one week's worth of lectures for mass transfer course.
- c. Prepare for success: Like any first time teacher, my greatest fear was being unable to answer a question that a student had. That was enough to make me prepare adequately for all the opportunities I listed above. I prepared by referencing various books on the subject matter and looking for interesting examples. As I continue to read about teaching I see that in order to be efficient and effective at the same time, I have to take into account the differences in the learning styles and background of my students<sup>3</sup>. Teaching, in my opinion, is not an exact science. It is a process of continual learning. Choosing lecture objectives in line with the overall course objectives is another way to prepare for success<sup>4</sup>.
- d. Develop my teaching portfolio: This was the focus of my independent study. It was a mix of real live teaching experiences and reading assignments about teaching from selected references. For the teaching experience, I planned and delivered real lectures with specific objectives. I also designed homework and exams that tested the specified objectives. Referring to feedback from students after these lectures, I did a self evaluation and in a one page document discussed things I could do differently. I graded process simulation computer exams. This was a more complex and different experience than grading regular paper exams. I had to award partial credit based on the learning objectives and I had to try to figure out why some simulations did not run. I also created a syllabus for a course which I designed. In creating the syllabus, I picked texts and reference materials that would be most relevant to the objectives of the course. A statement of teaching philosophy was a natural corollary to this experience as I was able to evaluate the ideas and objectives that shape my teaching. From this experience, I was also able to identify my preferred method of teaching and my weak areas that need more work. At the end of the independent study, I felt more confident about the possibility of pursuing a career in academia.

**Service:** I have tried to serve my college in various ways by volunteering on community service days and volunteering to be a student judge at the university's research colloquium. Attending the department's annual industrial advisory board meeting is another way I have tried to serve. In the future I will like to serve as the graduate student council representative for my department. I need to take a more active role to find professional service opportunities such as volunteering to chair sessions for division meetings.

Although I still have quite a bit of work to do before entering the job market for faculty positions, I have a solid preparation strategy which I developed with the assistance of my faculty mentor.

It is challenging for a recent PhD graduate to fit into faculty positions because of the gap that exists in the expectations from each stage. Most graduate programs prepare doctoral students for research positions with less emphasis on teaching and service. In cases where no formal preparation exists in the department for individuals interested in academia, such individuals either forgo the idea or decide to design individualized programs. In such a case, the role of a faculty mentor is imperative. It is important for current faculty to recall the trials of their early years in faculty positions and come up with a few things they wish they knew about life as a faculty member before they started at their positions. Pass these words of wisdom on to your mentee.

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