ChE book review

Success and Creativity in Scientific Research: Amaze Your Friends and Surprise Yourself

By David Sholl
CRC Press, 130 pages
ISBN: 978-0367619183

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While "Introduction to Engineering" courses for first-year undergrads abound, similar formal offerings providing an initiation to graduate research are rare. While colleges of engineering routinely provide first-year service courses across the engineering disciplines, an introduction to graduate training in such areas as writing proposals and research papers, as well as discussions of collaborative research and lab responsibilities, is nearly non-existent. At NC State I have taught such a "good citizen" graduate offering for almost 30 years,[1,2] though this course format has only been adopted in a few other campuses to the best of my knowledge. David Sholl's book, and the associated departmental seminar format utilized for its graduate delivery, on the other hand, offer an "Introduction to Research" approach that could be more easily adapted to local engineering departmental interests.

The general absence of teaching for such graduate service offerings arises, in my view, for two reasons. If we consider faculty as either new or seasoned (tenured), each group has reasons to avoid teaching a graduate service course. First, many new faculty are under considerable time demands to excel in research, and as a result are routinely assigned an introduction to the departmental course (e.g., mass and energy balances for chemical engineering). Their service to the department appears in the early, typically sophomore, then junior, courses. Seasoned (tenured) faculty who are successful are routinely overbooked with required upper level undergraduate courses, research paper writing, graduate advising, society presentations, and proposal writing. The general notion of teaching a graduate service course devoted to professional development is thus seen by most faculty, new or seasoned, as not the best use of their time. Most have research careers dedicated narrowly to the concise advice: "Propose, execute, publish." As a consequence, few faculty have a motive to provide new graduate students with a formal "Introduction to Research" instruction, and most new graduates students learn by osmosis, i.e., observing and imitating behavior of more senior graduate students over time.

The seven chapters in this delightfully brief (130-page) book address development of a research reputation (overnight [rare] or incremental), deep thinking versus trivial consideration of worthwhile thesis topics, poor versus productive professional habits, approaches to ideation, barriers to and benefits from good writing habits, oral presentations, and the selection of research problems that will have an impact. These formal topics deserve careful consideration and reading because they provide a constructive alternate to the informal "learning by osmosis," an approach that is too typical of graduate training. Sholl adopts a wise style to create a brief, yet broad and credible text: he chooses a different book (or two) to concisely provide a focus for each chapter topic and utilizes the key themes from each. Following the dictum of Pablo Picasso, he doesn't stealthily borrow but boldly takes key themes from each author.

Each chapter is engagingly presented by offering a focused approach to its title and, in parallel, with (usually) successful biographical examples. This style maintains a storytelling freshness woven into the clearly classical dimensions of developing a research career. The example researchers presented as illustrations are generally positive, but sometimes tragic, to illustrate the uncertainty of attempting research topics as well as research writing. The use of strong language in chapters and sections will likely keep the reader well engaged; for example, the chapter title "How to Have Outrageously Good Ideas" is more appealing than "Finding a Thesis Problem", etc. While the writing style in the book is on the light side, the messages are utterly serious, as the author focuses to make each topic broadly accessible. The concise writing is greatly welcomed as strong statements are supported mostly by living examples, rather than being drained of strength by endless subsequent qualification.

The research topics covered are important and effectively presented. The seven themes chosen provide a broad introduction to key elements of a successful career in research. As an experimentalist, a major omission in my eyes is a discussion of the research laboratory and the research group as a community, with personnel and citizenship responsibilities as well as ethical considerations. This omission may arise from the author's research that centers on computation, an area that generally does not involve lab safety, laboratory equipment maintenance, training in experimental techniques and, at times, multiple authoring of papers and presentations. Nonetheless, these aspects are normally presented by the research advisor, and thus have less importance here than the topics

chosen. The recent decades of undergraduate incorporation of group work and undergraduate research experience may have sensitized most new graduate students to these latter dimensions.

A second opportunity for improvement would incorporate presentation of research and development within industry and government, as the majority of graduate students will be employed outside of academia. In government and industry, the operative cultures differ from those in academia, and thus training for a research career should also include reference to professional life in the most likely domains of employment.

The gender balance within the book could be improved with the inclusion of more female examples, which would better speak to the 24-29% of female MS and PhD graduate students in engineering.[2] Only two women examples are cited by Sholl: Fiona Wood, creator of artificial "spray-on" skin (positive) and Elizabeth Holmes, the central character in the Theranos fraud example (negative). I was surprised that Frances Arnold (Caltech), the first female ChE to win the Nobel Prize (2018), does not appear in Chapter 1 or Chapter 7, the latter titled "How to win the Nobel Prize and Change the World."

A final curious example presented was of an Olympic speed skater, whose rise to athletic glory occurred because his faster rivals suffered collisions that disqualified them in both the trials and finals, leaving him literally the "last man standing." Rather than highlight an individual athlete who succeeded because others failed, a better athletic example of an innovative leader would be Dick Fosbury. The creator of the distinctive "Fosbury flop" style of high jumping, Fosbury used his new approach to clear a seven foot four inch bar by creating a truly revolutionary style, now widely practiced. Like Frances Arnold's "directed evolution technique," Fosbury's achievement has been widely adopted by others. In a similar vein, Sholl does nicely present Kuen Charles Kao, a Hong Kong-born immigrant who became a US and UK citizen and electrical engineer, and who received the Nobel Prize and was knighted for his invention of optical fiber communications.

Readers of this review who wonder about prior related articles on graduate instruction might visit the *Chemical Engineering Education* journal archives to learn about other single course graduate offerings involving professional development and/or research writing that have appeared with diverse titles and emphases. These include courses describing research methods,[3] theory and methods of research,[4,5] research proposals in biochemical engineering,[6,7] as well as more sharply focused graduate topics including the critiquing of journal articles[8,9] and developing oral communication skills.[10,11]

The phrase "Find a need, and fill it" has been attributed to many, including Ruth Staffford Peale. Sholl's new text, *Success and Creativity in Scientific Research*, and its progeny, should help fill the need for launching new MS and PhD graduate careers.

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