Practical Solutions: Basic and Applied Research, Science, Engineering, and Design

Vinton G. Cerf • Google

My good friend, Ben Schneiderman, has penned a book worthy of your attention. It takes readers through a new synthesis of collaborative research, reinforcing the idea that research isn’t so much a solitary affair but, rather, a synthesis of theory, application, engineering, and design. He offers 14 concrete case studies throughout the book, with two of my favorites listed early: Rita Colwell and Google.

I’ve long believed that the progress of science is characterized by the creative interaction of theory, observation, and engineering. Theories suggest observation and measurement, the better to judge the theory by its predictions. But to make observations, you need instruments. Sometimes the instruments are incapable of making the necessary observations (for example, inadequate resolving power, insufficient sensitivity, or inadequate power intensity), leading to engineering challenges. Then sometimes the engineering fails because the theory is inadequate to guide the detailed design or leads to designs that simply don’t work the way the theory says they should. It’s not uncommon for a measurement to lead to false results, owing to errors in calibration or set up. I’m reminded of a brief kerfuffle associated with a measurement involving the time of flight of neutrinos in the 2011 experiment, Oscillation Project with Emulsion-tRacking Apparatus (OPERA; https://en.wikipedia.org/wiki/Faster-than-light_neutrino_anomaly). The neutrinos appeared to arrive at their destination faster than light. Ultimately, an improperly connected optical fiber proved a primary culprit contributing to this erroneous result.

Schneiderman teaches us the interconnectedness of science, engineering, and design. In chapter 3, his thought-provoking illustration shows the relationships among scientific “disciplines” based on 7.2 million scientific papers. If ever you were convinced of the multidisciplinary nature of science, this diagram reinforces the notion. Schneiderman makes a strong case for motivating science by working on solving practical problems drawn from civic, business, and global challenges. An example of this would be in the case of global warming, desertification, and declining reserves of fresh water. While not all science needs to be focused on problem solving, it seems fair to say that hard problems may defy solutions until a fundamental understanding of the problems’ basics are adequately understood.

Schneiderman has a charming way of disarming critics by including in each chapter a “Skeptics’ Corner,” in which he tries to anticipate objections to his theses and defend them. I found this a particularly refreshing way of promoting dialog and reflection. At the start of each chapter is a wordle made up of all the words in the chapter—a fast way of giving readers a glimpse of what’s to come.

He devotes a chapter to new ways of promoting adoption of research results and measuring the impact of research. In a pithy preface to this chapter, Schneiderman makes the point that clear writing is fundamental to achieving impact. Anyone who has picked up a typical scientific paper will appreciate how quickly you can get lost in specialist argot and acronyms, no matter what the subject...
matter. The fastest way to appear irrelevant is to obfuscate results behind a thicket of impenetrable prose.

I was particularly taken with his chapter on prototyping, iteration, and data visualization. If insight is a key objective of scientific research, visualization is often a path to enlightenment. Transfer of insight into practical application is one of the best ways to demonstrate the value of research, and Schneiderman makes a good case here.

Taken as a whole, this book is a kind of recipe for thinking through a successful career in science or research. The chapters lead up to a strong chapter on recommendations for action. Schneiderman provides advice to students, junior researchers, and senior practitioners in his penultimate chapter, and closes with a strong argument that concrete problems of the 21st century are perfect foils for the advancement of scientific knowledge that can be used to find practical solutions.

Reference

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