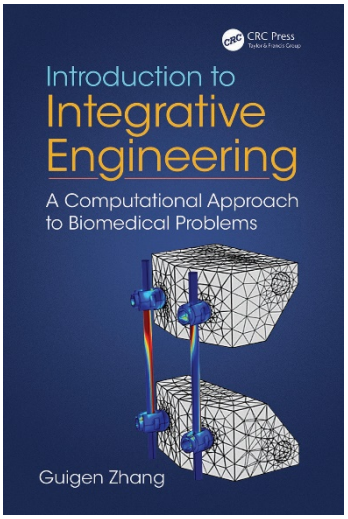
Guigen Zhang, President of the Institute of Biological Engineering and Professor of Bioengineering at Clemson, talks to Jenny Bourne of Clemson University about his new textbook, *Integrative Engineering*, and his vision for re-Engineering for our time:

Dr. Zhang, how would you describe what led you to write to this audience?



Over the years, I have been asked by many bioengineering and biomedical engineering students how they could market themselves when facing companies who show biases favoring students trained in a traditional engineering discipline. My motives for writing this textbook are, of course, not just to answer this question, but to reflect on thoughts I have developed over the years in my journey searching for a practical strategy to update engineering curricula and make them relevant to our time.

I wrote this book to inculcate the spirit of integrative thinking by linking commonalities based on the underlying mathematics across compartmentalized disciplines to generate novel solutions. This approach cultivates new ways to learn, question, hypothesize, invent, design, prototype, test, and generally think of problem-solutions and develop a sense of limitless possibility in engineering research and innovation.

What do you mean by "sense of limitless possibility"?

It is my hope that students will challenge themselves to embark on such an integrative journey of transdisciplinary exploration and reasoning and see themselves as the ones who can tackle complex problems that do not lend themselves to the disintegrated pieces conceptualized in traditional approaches.

Can you elaborate on your vision toward re-engineering?

In most universities, an engineering curriculum is a four-year program. When we talk about encouraging students to embark on transdisciplinary learning, we often encounter arguments of producing "Jacks of all trades and Master of none" and worries of not imparting to them sufficient specialty knowledge. In my journey searching for an effective solution to address this dilemma, I managed to ponder the writings that I have read over the years of Mencius, Daisetz Suzuki, Gilbert Ryle, Peter Drucker, James March, Roger Martin, Samuel Florman and Steve Jobs, among others, and especially Ryle's arguments on the difference between *learning how* and *learning that*, and so developed my solution or vision. This intellectual excise even prompted me to recollect the valuable wisdom I learned from my parents as a child—the wisdom of not stopping at *learning that,* but going a bit beyond and *learning how*.

In my mind, this wisdom holds the key to re-engineering for our times through linking commonalities underlying different subjects and disciplines and teaching the importance of *learning how* beyond *learn that* to make curricular room for the incorporation of the relevant content of humanities in engineering curricula. Doing so will help make engineers not only technically competent, but also conscious of social needs, so that they will be able to innovate not just for the technological pursuit, but also for an endeavor to create technology for humanity.

Learning how beyond learning that! How do you put them to work in your book?
With sights set on encouraging *learning how*, this book introduces a systematic look into the black box of how engineering knowledge is expressed mathematically and how, for example, differential equations are solved by computer-based approximate methods through domain discretization, field quantity interpolations, weighted integral of residue evaluations, linearization of differential equations into matrix algebraic equations, Gauss quadrature and numerical integrations, and minimization of approximation errors, among others.

Through hands-on experiences gained by problem-solving assignments in the process of *learning that*, students will see not only feasibility, but also practicality of solutions in a holistic way by taking advantage of computational tools. With this approach, a real-world problem in the domains of mechanical, electrical, thermal, electrochemical, mass-transport, biological and biochemical phenomena, among others, either individually or combined, will be dealt with in a transdisciplinary way.

Who could expect to benefit from this text? How is the information presented?
This book is written for junior- and senior-level undergraduate students in engineering and applied sciences, and it includes example problems primarily from the biomedical field. For graduate students and practicing engineers in industry and R&D labs, the book will be a valuable resource for finding and formulating solution ideas from complementary fields of engineering. The book will be useful for not only novice modelers, but also experienced ones.

This book is structured in four parts. Part I presents the rationale for converting from a compartmentalized disciplinary to a transdisciplinary approach in education and argues for promoting integrative, rather than reductive, learning. Part II provides a systemic discussion of hands-on details of computational modeling procedures. Part III discusses modeling environments of some common software [for example, COMSOL, ABAQUS and ANSYS] and explains the connections between software settings and the engineering fundamentals. Furthermore, methods to develop hands-on practical skills in performing computational modeling and practical issues concerning image-based modeling as well as the standardization and regulatory processes are discussed. Part IV provides useful knowledge in mechanics of materials and mathematics for "just-in-time" learning and referencing materials.

You also have a unique dedication for this book. Can you tell us more about that?
I dedicated this book to my parents, from whom I learned at a very young age the importance of *learning how* beyond *learning that*, and to my wife, for keeping me in check all these years whenever I wandered into foolishness. This is to reflect that the ideas and suggestions I advocate in this book are not just words, but actions I have been practicing all my life, and that integrative engineering practices have been the source of inspiration for my own innovative endeavors.

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