Annual Review of Biomedical Engineering, 2009. Martin L. Yarmush, James S. Duncan and Martha L. Gray (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, USA. Vol. 11. ix + 329 pp. Price not mentioned.

Annual Reviews are good gauges to assess the research trends in different fields. A cursory examination of titles of the chapters itself gives one an understanding of how a field is evolving and who the main players are in that field. Out of the topics considered in volumes 2–11 of the *Annual Review of Biomedical Engineering*, 58 are on biomechanical engineering, 44 on biochemical engineering, 28 on bioelectrical engineering and 33 on imaging.

The first impression the topics discussed in the 11th volume of *Annual Review of Biomedical Engineering* makes on a reader is the increasing emphasis of this subject on studies at the micro and nano sizes, and more so on the mechanical response. While biomechanics at the small sizes had occupied one-fifth of the book in 2008, it is almost two-thirds in 2009. This trend might simply be the choice of the editors but certainly it does indicate the unmistakable trend in the evolution of the field. Out of the 12 chapters of the book, only two are on imaging – a topic that usually used to take the lion's share in biology and medicine. Two others are on neural interface and mass spectrometry. The rest are concerned with mechanics and that too at the micro and smaller sizes. It is not surprising because the efforts to implicate mechanical responses in diagnosis and therapeutics are being pursued around the world with a lot of vigour and hope. This book, in particular, focuses on the importance of mechanical response and behaviour on muscles, heart and brain tissues, and cancer cells. There is also a substantive discussion on how rapidly growing micro and nano engineering techniques are useful in setting up platforms for studying single cells and arrays. Although there is a slant towards the biomechanics, less than half of the chapters have authors with a mechanical engineering affiliation. This means that more than the mechanical engineers pursuing biological and medical research, researchers in the allied disciplines are pursuing mechanical studies. It is surely an indication of the disappearance of disciplinary boundaries.

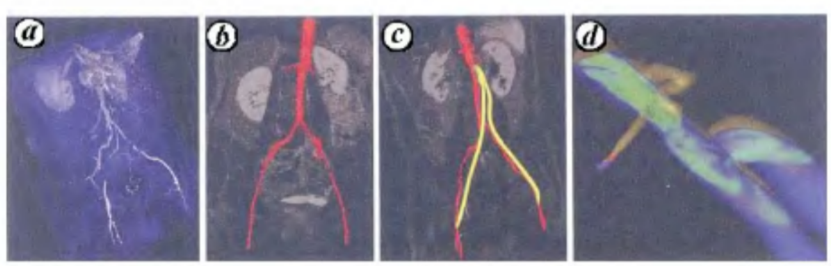
A slightly offbeat chapter on muscle physiology in sports performance attracts the attention of the reader. We remember the numerous gold medals garnered by Michael Phelps in 2008 Olympic Games. Perhaps some would have read about the special swimsuits successful Olympic swimmers wore. The ones made by Speedo, as we learn in this chapter, used special fabric, method of stitching, and customized shape to reduce water resistance and to help the swimmer maintain an optimal posture. The impact of this swimsuit was so much that (more than 89% of the winners wore this!) the Federation Internationale de Natation has stipulated new rules on the swimsuits to ensure fair competition. The technological impact on other athletic equipment is delightfully discussed in this chapter.

The significance of biomechanical modelling comes to the fore in a chapter on 'patient-specific modelling of cardiovascular mechanics'. The authors of this chapter convincingly write why actual geometry of a particular patient is important in predictive therapy. They discuss how advanced imaging techniques help determine the vascular structure and also arrive at judicial boundary conditions for the purpose of simulation. Modelling the flow of blood and the time-varying deformations of the blood-vessels are shown to be of great importance. The ensuing fluid-structure problem is not easy. One also needs to know the material properties in a particular patient; they certainly vary spatially and also temporally. If one had such data, the chapter says, it would be possible to predict long-term efficacy of an intervention or treatment. The patient-specific quantification of biology is certainly a welcome addition to the already advanced cardiovascular field.

A subsequent chapter also states the importance of mechanics but in another disease – cancer metastasis, albeit not quantitatively. It discusses how cancer cells from the primary tumour interact with other cells and molecules as they travel through the circulatory system before lodging on a host organ. Detachment of the cancer cells from the primary tumour and adhesion to other cells in transit, and eventual attachment onto a target is definitely a mechanical process. Carcinoembryonic antigen and podocalyxin-like protein, both incidentally chapter authors' findings, are noted to be of great use in fundamental understanding of this problem and eventual benefit in diagnostics and therapy.

With the trend set by the two chapters discussed in the preceding paragraphs, subsequent four chapters too focus on biomechanics of cells and tissues. These chapters, of necessity, have an engineering flavour. All these, in particular, emphasize the experimental approaches from mechanical manipulation techniques for cells and tissues; building sophisticated cell-arrays on microfabricated chips and probing cells to measure their mechanical responses. For example, in the chapter on heart-valves, there are numerous references and discussions on the role played by individual cells. All of these require precise measurements and subsequent interpretations. The interpretations require the aid of modelling and theory.

An important observation that we can make after reading this volume of Annual Review is that the quantitative and analytical approaches are not emphasized as they should be. Biomedical engineering research ought to be different from biological and medical research. One



Overview of a simulation-based medical planning approach as applied to designing bypass surgery for patient with occlusive cardiovascular disease in the aorta and the iliac arteries. Shown from left are (***a***) magnetic resonance angiography data; (***b***) preoperative geometric solid model (red); (***c***) operative plan (proposed aortofemoral bypass graft shown in yellow) and (***d***) computed blood-flow velocity in the aorta and the proximal end of bypass.

significant way they can be different is by using mathematical modelling that engineering disciplines enjoy by virtue of the laws of physics and chemistry. But, unlike the previous volume, in the present volume we do not see much mathematical modelling. It is not indicative of the trend in the field but is only the sampling of the topics and authors chosen.

All the chapters in this book live up to the standards set by the Annual Reviews and successfully give a bird's eye-view of the topic while identifying areas for further research. There is a copious set of references in most chapters except in one where the authors apologize for the apparently hurriedly put-together chapter. It is also surprising that many a chapter does not fully utilize the useful features set by the Annual Reviews. For example, although it is customary to use the wide margins to define the jargon of the field or to explain important terms succinctly, only two or three chapters use this. In the rest, the margins are left blank leaving enough space for readers to write their comments, perhaps. Likewise, Annual Reviews chapters have a unique feature of highlighting a reference in the list using bold font and briefly mention that reference's main contribution in the wide margin space in the reference section. It is a useful feature in today's information-rich world. However, most authors have not paid attention to this. It shows that the authors, distinguished and accomplished as they are, must also be very busy and could not do the needful by putting in that little extra effort. Nevertheless, the volume under review is a pleasure to read and understand how the field is evolving.

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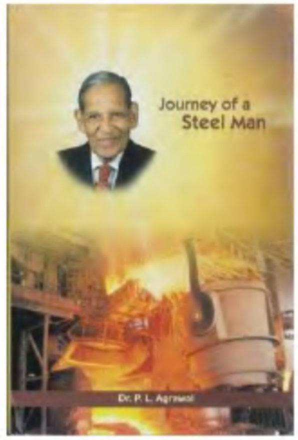

Journey of a Steel Man. P. L. Agrawal. 56-A, New Fatehpura, Sukhadia Circle, Udaipur 313 004. 2009. Price: Rs 450.

Engineers as a rule are a reticent lot. They do not tell their stories. Scientists are different. They cannot wait to write and, often in the process, create literary masterpieces. Freeman Dyson, Peter Medawar, James Watson and Richard Feynman, to name a few, have transformed the often dry and frustrating years of research into joyous and eureka moments. With their stories they readily share the excitement of their profession and make it all look so obvious. Even if the scientists do not write, others do that for them. G. Venkataraman's masterful narration of the lives and works of Indian scientists that came in a series of diminutive volumes, and Robert Kanigel's story on Srinivasa Ramanujan – *The Man Who Knew Infinity* – are histories of our own countrymen. But, sadly we have no such stories of our engineer heroes. We would like to read how the great Diwan Mokshagundam Visveswarayya managed to persuade the Maharaja to loosen his purse strings for building a modern industrial and irrigational infrastructure in the erstwhile Mysore State or how the legendary American dam builder Harvey Slocum along with the great Indian civil engineer A. N. Khosla, worked to raise that huge Bhakra Nangal dam. It was said that Slocum had a direct access to Prime Minister Jawaharlal Nehru and he used that relationship masterfully to fight off major and minor pinpricks that officialdom inflicted on him. On one of his visits to the dam site, Pandit Nehru was so overwhelmed by the edifice rising before him that he rushed to a worker nearby and asked him whether he realized what he was building. The worker merely said that he is working to earn for his family meals and left the 'vision thing' to the Prime Minister. But the designers and builders of the modern Indian industrial infrastructure should have been conscious of the grand vision that Pandit Nehru eulogized and did not allow that to be diminished by the demanding chores of managing thousands of workers and hundreds of engineers, and keeping the projects on schedule.

We now have a volume of reminiscences from one such visionary metallurgical engineer and a former Chairman of Steel Authority of India (SAIL) P. L. Agrawal in an engaging volume, *Journey of a Steel Man*. Agrawal comes from a modest middle class Jain family in Udaipur. His parents knew the importance of education and encouraged their children to go for university learning. Agrawal did not disappoint them. He was a bright student and was eager to learn and seek advice from other learned men whom he met in Udaipur. Advised by a senior member of his extended clan that he should opt for metallurgy as the country was planning to build many new steel plants, he chose to study metallurgy at our country's one of the premier institutions, Banaras Hindu University. Those were the heady days of newly independent India with their share of turmoil at universities. He never allowed those to distract him from his studies. After his graduation with outstanding academic credentials, he chose academia as his career and was persuaded to go for doctoral studies in the United Kingdom. He did his Ph D in a record time at Sheffield University and returned home to teach at his alma mater. But the university was to lose him shortly to steel industry. Indian planners had chosen to build three massive steel plants – the plants that Prime Minister Nehru would come to call as the temples of modern India – but had no trained engineers to build and operate them. The country was in a hurry and so chose to seek help from the Western countries. One such country that came forward to help was Germany. It came not only with loans and grants to build a steel plant for million tonnes in Rourkela, a rural backward region in Orissa but also with some state-of-the-art technologies. LD process, the so-called oxygen steel making process was included for the plant, perhaps for the first time in Asia. But where are the engineers to build? Hindu-