SAND2010-4505P

Understanding the Evolution of Applied Mathematics in Industry

Panel Discussion, 2010 SIAM Annual meeting

Pavel Bochev
Applied Mathematics and Applications
Sandia National Laboratories
July 12, 2010

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

National Nuclear Security Administration

Sandia National Laboratories

Is the shift in emphasis visible?

- Inclusion of advanced applied mathematics in interdisciplinary curricula is driven by the adoption of increasingly sophisticated mathematical tools by science and engineering.

- This trend is not new or unusual: similar curricula expansions have occurred in the past when science and engineering disciplines co-opted new (for them) mathematical approaches. As a result, teaching

  — finite elements to engineers,

  — numerical methods to biology majors,

  — statistics to sociology majors

  is nowadays common practice, but this wasn't always the case

- The shift is a consequence of a natural lag in science and engineering curricula:

  — To become a part of a curriculum in a discipline, an applied math approach must establish its usefulness and become part of the "mainstream" for that discipline

  — On the other hand, until that moment, an applied math program benefits from fostering connections to an application field

- Consequently, my opinion is that what we observe is not a seismic shift accompanied by assimilation of applied math into science and engineering, but rather an adjustment and calibration process where curricula for each discipline find their proper equilibrium points.

Is there a shift from tool builders to tool users?

- Applied mathematics occurs at the intersection of several disciplines: mathematics, computational science, engineering. Consequently, drawing strict boundaries between tool users and tool builders is not always possible.

- Nonetheless, the mission of applied math is to provide innovative approaches and solutions that advance our modeling and simulation capabilities. Therefore, “tool building” should remain a core part of the training in applied math.

- Based on experiences with our summer students I do not see a significant departure from this model – their training shows strong emphasis on the “tool building” aspects of the discipline with focus on general principles rather than on application-specific details.

- However, there’s a noticeable shift in the application drivers used in their training from “academic” to “realistic”.

- This is a positive development which reflects the increasingly collaborative nature of science and engineering driven by the complexity of the problems being solved.

- As a result, I see applied math students that are better trained to work in teams and to communicate with the application scientists.

Is the trend good or bad for applied math?

- I consider the current trend to be a positive development for the applied math. Why?
- Applied mathematics is a very dynamic discipline that constantly evolves and renews itself in response to its customers needs.
- I view the current trend as a typical “technology transfer” cycle in which mature applied math tools and technologies are being adopted by the science and engineering disciplines that drove their development.
- Instead of leading to assimilation of the applied math into application sciences, this process frees the discipline to pursue new directions of research and respond to new challenges.
- Such “refocusing” of the applied math has occurred periodically and is driven by the application domains (and our funding agencies ☺)
- Inclusion of V&V and UQ into many applied & computational math curricula is one recent example – very few applied math programs offered this 10-15 years ago.
- It helps to maintain the role of applied math programs as incubators of new ideas and approaches that focus on discovery of fundamental principles rather than on application specific issues.