SECAM Panel discussion

The Southeast Conference on Applied Mathematics (SECAM) was held at North Carolina State University (NCSU) on November 9-11, 2001. The conference was generously supported by grants from the Army Research Office, the National Science Foundation and the National Institute of Environmental Health Sciences and locally by the Center for Research in Scientific Computation, the Department of Mathematics and the College of Physical and Mathematical Sciences at NCSU.

This document summarizes the panel discussion that took place on November 10, 2001. The two main themes of the discussion were to identify the major recent advances in Applied Mathematics and to discuss promising avenues of investigation and outstanding challenges. The panelists were Professors S. Antman (University of Maryland), H.T. Banks (North Carolina State University), P. Cook (University of Delaware) and M. Mackey (McGill University).

1 Recent advances

One of the main driving forces behind recent changes in applied mathematics was described as the continuous increase in computational power. However, there was an agreement among the panelists that in spite of some spectacular successes, numerical computing may have outpaced both the state of the art in numerical analysis and modeling capabilities for complex systems.

Major progress in the study of *nonlinear* phenomena was discussed. Recent success in integrating both *microscopic* and *macroscopic* aspects of complex systems into mathematical models was discussed. Advances in control theory, including feedback control and real time calculations were also mentioned.

In spite of its relatively recent prominence in applied mathematics per se, the area of biomathematics was described as having an extended and successful history dating back to the 1930s and 1940s. For example, many concepts in the field of neurobiology were shaped by mathematically gifted people such as Alan Hodgkin and Andrew Huxley.

2 Present challenges

Looking ahead in terms of present and future challenges and opportunities, many of the above issues were further analyzed. A need for high quality numerical analysis as proper "hygiene" for scientific computing was identified. The careful analysis of numerical errors and the development and refinement of numerical methods for time dependent problems were cited as specific examples. Several panelists expressed concern about the slow disappearance among young mathematicians of traditional skills such as asymptotics, scaling analysis and the construction and analysis of similarity solutions.

At the same time, a strong need for mathematicians to look beyond their own field was cited. One specific example discussed was materials science with the use of inverse problem techniques to establish proper constitutive equations to describe the behavior of specific types of materials. In biomathematics, several areas were cited as being especially promising. For instance, control theory is important in clinical processes; as one panelist put it "if one can't cure diseases, control them". Examples abound: smart cardiac pacemakers, deep brain stimulations to control Parkinson tremors or chemotherapy to mention but a few. In that general field, molecular biology appears to be the next big step as no fully satisfactory mathematical models exist at the cell level. It was remarked that *uncertainty* and *nondeterministic* models play an ever increasing role not only in biological applications, but in countless other areas as well.

3 Education

The panelists also discussed various issues related to the training of applied mathematicians. There was an agreement concerning the need for *broad* training. For instance, one cannot do biomathematics without a solid understanding of the underlying biological issues. Similarly, controlling a system requires a high level understanding of its dynamics. Most of the panelists agreed about the need for Mathematics departments to offer joint majors or minors with other fields. It was suggested by some of the panelists that Mathematics departments should *require* a strong background in the Sciences, while at the same time science departments should require a strong background in Mathematics.

4 Funding

Finally, the issue of funding was discussed. It was noted that the various funding agencies play an extremely important and leading role. Several initiatives from NSF aimed at facilitating multidisciplinary research and team work were commented upon positively. Efforts from NIH geared toward the initiation of collaborations between mathematicians and researchers in Biology and the life sciences were also noticed. The difficulties linked to team work were mentioned. Among those, the need for a mathematician to keep his/her own identity instead for instance of turning into a second rate engineer or biologist was singled out. Even though it was recognized that multidisciplinary research and team work are necessary in many cases, it was emphasized that individual researchers have an important role to play. Some on the panel also expressed concern about certain high level funding decisions and vision being partially public relations driven.