Report on the 48th Meeting of
the Society for Natural Philosophy

The 48th Meeting of the Society for Natural Philosophy was held at Foz do Iguaçu, Brazil, on January 4-8, 2010. The topic of the meeting was "Advances in Fundamental and Applied Mechanics: A Bridge between the Physical Behavior and the Mathematical Modeling of Materials". The meeting was organized by Roger Fosdick and Paolo Podio-Guidugli. Adair Roberto Aguiar acted as the local organizer.

The meeting consisted of seven invited lectures and one round-table lecture:

Invited Lectures.

- Antonio di Carlo: Muscle models or work on elastomers.
- Sahraoui Chaieb: Large deformation of lipid membranes: From the Golgi Apparatus to the Malaria.
- Yi-chao Chen: A continuum theory for materials with microstructures.
- Richard Lehoucq: A statistical mechanical foundation for peridynamics.
- Mitch Luskin: Numerical analysis of quasicontinuum methods.
- Roberto Paroni: Dimension reduction techniques: Ideas and applications.
- Lev Truskinnovsky: Modeling microstructure effects.

Round-Table-Lecture.

- Fernando P. Duda: On a theory for species migration in a finitely strained solid.

In addition, the two organizers each gave a one-hour invited lecture at the concurrent 11th Pan American Congress of Applied Mechanics:

- Roger Fosdick: Coexistent phases and critical point behavior in thermoelastic solids.

- Paolo Podio-Guidugli: A continuum mechanist's revisit of molecular dynamics.

The meeting was coincident with and embedded in the 11th Pan American Congress of Applied Mechanics (PACAM XI). Since the aims of the PACAM series mesh well with those of the Society, it was recognized from both PACAM XI organizers and SNP that PACAM XI would be an excellent and unique opportunity for the Society for Natural Philosophy to bring engineers, physicists, and applied mathematicians together and to provide a modern focus to the aims and goals of research in the bridge between the physical and the mathematical sides of the mechanics of materials. Primarily, the bridge that the title of this SNP meeting alluded to was the engagement of ideas and discussion concerning various length and time scales from atomistic to continuum. It was thought that the welding of Applied Mechanics together with the edges of advancement in the physical and

mathematical science of materials at the fundamental and computational level was a novel idea and much needed aim as material research confronts the challenge to bridge between small space and time scales, and the continuum limit.

The SNP Arrangements Committee approved the meeting on this basis and strongly recognized that it presented an opportunity for the Society to promote its presence and aims in South America, and to engage participants from a larger scientific community associated with the PACAM XI. The traditional format of the SNP meetings to have 50-minute invited lectures and round-table talks was retained. At the opening ceremony of PACAM XI, Roger Fosdick gave a speech on the mission and history of the Society, which was well-received by the general audience.

An open discussion on future directions of research was held at the end of the meeting. The discussion was moderated by Roger Fosdick, and the SNP members and general PACAM conference attendees participated. A highlight of the comments that were made by various attendees follows.

- Mechanics (Hamiltonian Mechanics, non-Hamiltonian, dissipative, continuum Mechanics) should be better recognized and practiced as a part of Physics.

- Chemomechanics has been underplayed in the past years. It is a field full of opportunities and difficulties, e.g., environment assisted degradation that involves both chemistry and mechanics. Storing energy by changing the chemical composition of solid alloys could be an interesting subject, leading to novel applications.

- Boundary Element Methods are powerful in solving moving boundary problems. If fast volume integration can be done in the same way as fast surface integration, we have the possibility of extending the application of boundary elements to nonlinear and inhomogeneous problems.

- Numerical analysis of computational methods and schemes needs more consideration. There is an emphasis in the fundamental mechanics community to develop models based on serious mathematical analysis, but a casual attitude towards the development of faithful and accurate computational methods. The theory of computing in mechanics needs to be appreciated and better addressed. It offers many challenging opportunities for mechanics researchers who are interested in numerical analysis. The nonlinearities and nonconvexities that arise in mechanics are a source of great interest in the modeling and understanding of novel physical behavior. The numerical analysis of computational schemes that are supposed to capture these complexities is essential. The development and promotion of algorithms that do not have a numerical analysis backing and the use of canned programs in applications for which they are not justified is a dangerous threat to serious mechanics research.

- There are researchers in computational mechanics, in engineering environments, who could connect more with mechanics and with numerical analysis. Often algorithms are developed within computational environments by those with little knowledge of

continuum mechanics, kinetic theory, stochastic and probability theories. Computations using ABACUS and ANSYS by those with little understanding in physical theories can be disastrous.

- The peridynamic theory provides a novel computational method in mechanics. The basic building blocks of mechanics are at the root of this non-local theory. It involves operators in a non-local sense, and notions of weak differentiability. It shows great promise in handling highly irregular and nominally singular and small scale behavior.

- Dimension reduction is a mathematical framework which allows one to deduce lower dimensional theories. It serves to justify most of the classical lower dimensional theories, and it may be used to produce new models. It is important to establish the rate of convergence of the solutions to the solutions of the limit problems. Researchers are joining dimension reduction with evolution equations to describe the propagation of fracture or the evolution of damage in plates or beams. An important area for its application may be biomembranes or self-assembling materials. Dimensional reduction is also used in computational mechanics for drastically reducing the degrees of freedom of a system while maintaining the extraction of essential information.

- The relation between theory and experiment is of great importance. Experiments without theory can establish observational information about phenomenological behavior. However, it is good to keep in mind that there are examples where theory drove the experiment in mechanics. Also, modern instruments are of incredible sophistication, that the difference between theoretical speculation and practical manipulation is diminishing.

In summary, the 48th SNP meeting was a great success, which resulted from the enormous efforts made by Fosdick, Podio-Guidugli and Aguiar. They spent a large amount of time on various organizing tasks, especially Aguiar and Fosdick on soliciting and securing funds to support all expenses, including travel and hotel, for all of the invited speakers. Their contributions to the Society are commended. A proposal to the National Science Foundation was developed by Fosdick. Although not funded by NSF, it was used by Aguiar, with much hard work, to generate funds from various Brazilian agencies so that the Society could fully support the invited speakers and provided the roundtable speaker with partial support.