Mathematics can be used to describe a wide variety of phenomena with great precision. An applied mathematician, through discussion, careful listening, and a willingness to ask simple questions, can take the verbal description of what an investigator or experimentalist thinks is happening in his or her observations and build a clean mathematical model that is subject to analysis. Such models sometimes lead to a quick rejection of the investigators theory. Sometimes they lead to questions that require more experimental work and the model’s refining. Often, interesting mathematical questions arise that require their own explorations. Sometimes deep and difficult mathematics is needed and sometimes only a deep understanding of simple mathematics. The point is, mathematics can be a subtle probe in a variety of areas. However, it is frequently the case that only someone coming out of deep engagement with mathematics can make full use of mathematics in a scientific setting.

In my career I have had the good fortune to work with excellent collaborators in both mathematics and in several areas of science and engineering. This has allowed me to work on a variety of cool applications as well as giving me the tools to find some interesting problems independent of disciplinary investigators. Often this work has involved the creation of novel mathematical models and their analysis. We will take a journey through nearly thirty years of fun applications that show the power of mathematics to illuminate problems in several areas and the realization via collaboration that the whole is often greater than the sum of the parts.

This talk will be descriptive and nontechnical, accessible to undergraduates who understand a derivative as a rate of change.