Some possible presentation topics

Students registered for Mechanics in Spring 2019 are required to give a 25-minute presentation on a topic related to this course's material. Since the first 7 lectures have focused on elasticity, it would be natural to choose something in this area. Here are some possibilities:

MORE APPLICATION-ORIENTED

(1) Hair can be modelled as an inextensible one-dimensional elastic body. This is developed in Chapter 4 of *Elasticity and Geometry: from hair curls to the nonlinear response of shells*, by B. Audoly and Y. Pomeau.

(2) Stress plays a role in many biological systems, for example in modeling the mechanisms and consequences of growth. Alain Goriely's book *The Mathematics and Mechanics of Biological Growth* provides self-contained discussions of many interesting examples. Those discussed in Chapters 4 and 6 involve 1D models (strings and rods, so to speak).

(3) A basic "adhesion" problem involves peeling a sticky tape from a surface by lifting one end. The tape can be modeled as an elastica, but now there is a free boundary (where it meets the surface). Recently some papers have explored what happens if the strength of the adhesive is nonuniform. *Adhesion of heterogeneous thin films I: Elastic heterogeneity* by S.M. Xia, L. Ponson, G. Ravichandran, and K. Bhattacharya (J Mech Phys Solids 61, 2013, 838–851) provides a good summary of the topic's history, and studies the consequences of heterogeneity in a simple (but already interesting) setting where a 1D model is possible.

MORE PDE-ORIENTED

(4) As I mentioned in Lecture 7, for nonlinear elastostatics with a Dirichlet boundary condition, we don't expect solutions to be unique in general. However Fritz John showed in a classic paper that in the class of deformations with uniformly small strain the solution is indeed unique. The arguments are elegant and elementary, except for the use of a fundamental result about deformations with uniformly small strain (which could, for the purposes of a presentation, be simply taken as fact). The paper is *Uniqueness of non-linear elastic equilibrium for prescribed boundary displacements and sufficiently small strains*, CPAM 25 (1972) 617–634.

(5) In linear elasticity, Korn's inequality says that if the linear elastic energy of a deformation is small, then the deformation is close (in H^1) to a rigid motion. A nonlinear version of Korn's inequality lies at the heart of work by Friesecke, James, and Müller concerning the relation between 3D elasticity and Kirchhoff plate theory. Their proof of the nonlinear Korn inequality is elegant and self-contained, making it suitable for a presentation. The Friesecke-James-Muller paper is *A theorem on geometric rigidity and the derivation of nonlinear plate theory from three-dimensional elasticity* (CPAM 55, 2002, 1461–1506) and the nonlinear Korn inequality is presented in Section 3 (pp 1468–1474).

(6) The mechanics of elastic ribbons (including, for example, a Mobius band) can be reduced to the study of a one-dimensional variational problem for the configuration of the ribbon's midline (viewed as a parametrized curve in 3-space). The paper *A corrected Sadowsky functional for inextensible elastic ribbons* by L Freddi, P. Hornung, M.G. Mora, and R. Parroni, J Elasticity 123 (2016) 125-136 identifies the variational problem. (It also gives references to earlier work; you may find it more convenient to present one of the earlier papers.)

You are not required to choose from this list of suggestions! The books listed on my syllabus include many examples and/or topics that would be suitable for a presentation. Something close to your prior work or research interests will be fine, provided you can present it in a way that's accessible to the class.

Please let me know your tentative choice of topic by the end of March, by email or in person. (It is not always easy to define a topic that's limited enough to be presentable in 25 minutes yet ambitious enough to be interesting. I am of course available for consultation.)