

TEMPLE UNIVERSITY  
Department of Mathematics

# Applied Mathematics and Scientific Computing Seminar

Room 617 Wachman Hall

Wednesday, 19 October 2011, 4:00 p.m.

## The Shape of the Optimal Javelin

by Yossi Farjoun

Universidad Carlos III de Madrid

### Abstract.

Optimal-shape problems can often be converted into eigenvalue maximization problems. However, in many cases the resulting ODE is singular at the ends of the domain and this can lead to difficulties in finding the solution numerically. I will present one such physical problem: Finding the taper of the javelin whose lowest mode of vibration has the largest frequency. The equations describing this taper are difficult to solve directly and a naive approach fails.

Using a “similarity solution” of the ODE, the problem is reduced to a non-linear dynamical-system with a critical point. This new dynamical system is not singular: by starting near the critical point, on the stable manifold and solving the system “backwards” the solution is found. The resulting shape has a frequency of vibration 5 times larger than that of the uniform-diameter rod.

This method of solution is applicable to other problems. For example, the shape of the tallest column (the problem that inspired this study) can also be found and the results of J. B. Keller and F. I. Niordson [1] are easily reproduced in this way.

[1] J. B. Keller and F. I. Niordson ; J. Math. Mech. 1966 (16)