Irena Lasiecka
Department of Mathematical Sciences
University of Memphis
lasiecka@memphis.edu
http://www.memphis.edu/msci/people/lasiecka.php

TITLE: How to eliminate/control flutter arising in flow structure interactions

Abstract

An appearance of flutter in oscillating structures is an endemic phenomenon. Most common causes are vibrations induced by the moving flow of a gas (air, liquid) which is interacting with the structure. Typical examples include: turbulent jets, vibrating bridges, oscillating facial palate in the onset of apnea. In the case of an aircraft it may compromise its safety. The intensity of the flutter depends heavily on the speed of the flow (subsonic, transonic or supersonic regimes). Thus, reduction or attenuation of flutter is one of the key problems in aeroelasticity with application to a variety of fields including aerospace engineering, structural engineering, medicine and life sciences.

Mathematical models describing this phenomenon involve strongly coupled systems of partial differential equations (Euler Equation and nonlinear plate equation) with interaction at the interface - which is the boundary surface of the structure. The analysis of the model leads to consideration of nonlocal PDE's. The aim of this talk is to present a mathematical theory describing: (1) qualitative properties of the resulting dynamical systems (existence, uniqueness and robustness of weak solutions), (2) asymptotic stability and associated long time behavior that includes the study of global attractors, (3) feedback control strategies aiming at the elimination or attenuation of the flutter.

Since the properties of the flutter depend heavily on the speed of the flow (subsonic, transonic or supersonic), it is natural that the resulting mathematical theories will be very different in the subsonic and supersonic regimes. In fact, supersonic flows are known for depleting ellipticity from the corresponding static model. Thus, both wellposedness of finite energy solutions and long time behavior of the model have been open questions in the literature. The results presented include:

- Existence, uniqueness and robustness of finite energy solutions;
- Existence of global and finite dimensional attracting sets for the elastic structure in the *absence of any mechanical dissipation*;
- Strong convergence to multiple equilibria for the subsonic model.

As a consequence, one concludes that the supersonic flow alone (without any dissipation added to the elastic structure) provides some stabilizing effect on the plate by reducing asymptotically its dynamics to a finite dimensional structure. However, the resulting "dynamical system" may be exhibiting a chaotic behavior which can be controlled by finite dimensional controls.