DWIGHT LOOK
COLLEGE OF ENGINEERING

Department of Mechanical Engineering

TEXAS A&M UNIVERSITY

Professor Zdeněk Němeček
Dean
Charles University,
Prague, Czech Republic

Dear Dean Němeček,

I am attaching my evaluation of Mgr. Martin Madlik's Ph.D dissertation. I believe the dissertation fulfils the partial requirement towards his doctoral degree. The report follows:

Report on the Mgr. Martin Madlik's Doctoral Thesis "Interactions of a Fluid Flow with an Elastic Body"

At the outset let me mention that the work carried out by Mgr. Madlik meets the requirements of a doctoral dissertation. There is substantial original contribution in the doctoral dissertation with regard to numerical aspects governing the interactions between a flowing fluid and a solid body. This thesis might be the first of its kind which is able to incorporate the large deformation of solids with the flow of a fluid in a meaningful manner.

Mgr. Madlik has considered the interactions between the solid and the flowing fluid in a variety of geometries and each of these is relevant to important technological problems. He has studied the flow of a fluid in an ellipsoidal Breathalyzer taking into account large deformations of the ellipsoidal breathalyzer. It is in the emptying of the Breathalyzer that one confronts very interesting deformations of the solid, where one sees the collapsing of the parts of the boundary of the domain. A similar collapse is observed in the flow in a compressible elastic tube. The flow in a curved tube which has a area of weakness has relevance to the problem of the development and bursting of an aneurysm and has important implications to problems in cardiovascular mechanics. The problem in a bifurcating tube also has relevance to problems in cardiovascular mechanics. Of course, for the problem to have real technical relevance, it is necessary to model the tube as an anisotropic inhomogeneous solid. The constitutive relations that are used, the Mooney-Rivlin or a Neo-Hookean solid models, are too simple to have relevance to realistic problems, but this is a reasonable start as anything realistic would be too complicated. It is imperative to test the codes against simple models before one launches off to study more complicated realistic models. This leads one to something that is lacking in the thesis, the corroboration of the method by checking against some known exact solutions. For instance, the numerous solutions obtained due to the compression of a one dimensional body, referred to as a

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chewing gum, seems to exhibit very interesting solutions, but in the absence of any qualitative analysis to suggest such solutions, one is left wondering if the solutions are indeed correct. This aspect could be viewed as the weakness of the thesis. There is no analytical study, a perturbation analysis, asymptotic analysis, etc., which will give more faith in the solutions that are presented. However, such analysis is far from simple and it is no accident that such analysis is unavailable. Also, there is no discussion concerning the stability of the numerical method being carried out. This is of course no mean task as the governing equations are so complicated. All that one can say is that the numerical results look very plausible and interesting. As I am not an expert on numerical analysis I cannot comment on the soundness of the numerical analysis. I will leave that judgment to an expert in the field.

This leads me to an area I am more conversant with, continuum mechanics. The chapters dedicated to continuum mechanics could have been written better. While there is no serious mistake, the way in which the material is written is unclear and confusing. For instance what Mgr. Madlik refers to as "stress energy" is really the "stored energy". Similarly, his comment that the derivative of the stored energy with respect to the Cauchy-Green strain being the linear momentum is incorrect. There are several other such errors. However, these do not affect the content of the work and definitely not the derivation of the governing equation and its numerical solution.

The main problem with the thesis is the innumerable errors in English. It needs someone that is quite conversant with the English language to proof read the thesis. This minor problem notwithstanding, as the original contributions in the thesis dwarf such minor problems, I believe Mgr. Madlik deserves to receive a Doctorate. The thesis, as a partial fulfillment of the degree is acceptable.

Sincerely yours,

K. R. Rajagopal

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