Juhani Pitkäranta: *Mathematical and historical reflections on the lowest-order finite element models for thin structures*; Helsinki University of Technology Institute of Mathematics Research Reports A449 (2003).

Abstract: *We discuss the mathematical theory and history of the lowest-order linear and bilinear finite element models for beams, arches, plates and shells. The finite element formulations considered are based on the non-asymptotic Timoshenko beam and Reissner-Mindlin plate models and the analogies of these models for arches and shells. We follow some of the historical roots of the successful linear and bilinear elements, to find various physical justifications for formulations that now may be understood as purely numerical modifications within the usual energy principle. The simplified mathematical theory of such formulations is outlined, first in cases of the beam, arch and plate. We finally focus on the still challenging and largely open problems arising in the modelling of shell deformations. We consider here a simplified shallow shell model and an interpretation of the MITC4 shell element within that model, called MITC4-S. We sum up the results of the recent finite element theory for MITC4-S, concerning the approximation of bending- and membrane-dominated deformations of a shallow shell.*

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