# Title

# T. Elguedj\*, R. Bouclier†, A. Duval\*, D. Eyheramendy◊ and S. Lejeunes◊

\* Univ Lyon, INSA-Lyon, CNRS, LaMCoS UMR5259
27 Avenue Jean Capelle, F69621 Villeurbanne Cedex, France

e-mail: [arnaud.duval;thomas.elguedj]@insa-lyon.fr

† Univ Toulouse, INSA-Toulouse, CNRS, IMT UMR5219

 135 Avenue de Rangueil, F31077 Toulouse Cedex 04, France

Email: bouclier@insa-toulouse.fr

◊ LMA, UMR7031, Aix-Marseille Univ, CNRS, Centrale Marseille, F1313453 Marseille Cedex, France

Email: lejeunes@lma.cnrs-mrs.fr; dominique.eyheramendy@centrale-marseille.fr

ABSTRACT

Geometry is the foundation of analysis yet modern methods of computational geometry have until recently had very little impact on analysis. As a consequence, the CAGD - FEA interface gives rise to many problems. Perhaps the most significant of all is the problem of translating CAGD files into analysis-suitable FEA geometry and meshing, reputed to take 80% of overall analysis time for complex engineering designs. The approximate, polynomial-based geometry of FEA also creates difficulties in modeling sliding contact, flows about 2 aerodynamic shapes, buckling of thin shells, etc. Further problems arising in the transition of design to analysis models due to ‘dirty geometry’, i.e. where a CAD model is mathematically inconsistent or has ‘small features’, which are not relevant for the design but obscure a numerical analysis. It would seem that it is time to look at more powerful descriptions of geometry to provide a new and more efficient basis for analysis.

An attempt to address these issues and improve on FEA has led to the introduction and development of Isogeometric Analysis [1], in which a single geometric representation is utilized for design and analysis. Following approaches have been proposed: Subdivision Surfaces, NURBS, Hierarchical splines, T-splines and LR B-splines. NURBS are the industry standard for CAGD systems used in engineering design. NURBS-based isogeometric analysis has already been applied to fuids, structures, fluid-structure interaction, phase-field modeling, electromagnetics, shape and topology optimization, material modeling (e.g., implicit gradient damage models), discrete and diffuse modeling of crack propagation, etc. Hierarchical splines, T-splines, and LR B-splines that allow efficient local refinement while maintaining higher-order continuity and exact geometry, have recently attracted increasing attention

**REFERENCES**

1. T. Hughes, J. Cottrell, and Y. Bazilevs. Isogeometric analysis: CAD, finite elements, NURBS, exact geometry and mesh refinement. *Computer Methods in Applied Mechanics and Engineering*, 194:4135– 4195, 2005.