# PhD Proposal 2017

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| **School: Ecole Centrale de Lyon** | |
| **Laboratory: LTDS** | **Web site: www.ltds.ec-lyon.fr** |
| **Team: DySCo** | **Head of the team: Pr. Jezequel** |
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| **Collaboration with other partner**<br><br>**In France:** | <br><br>**In China:** |

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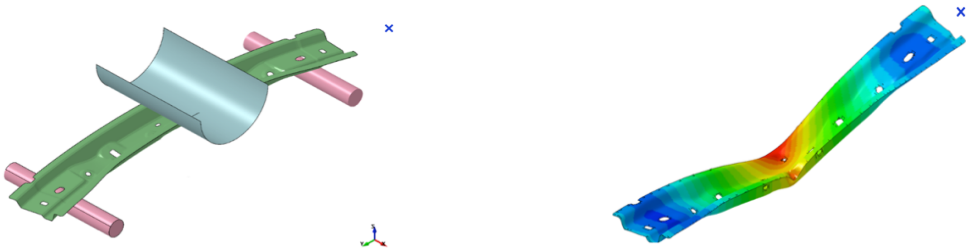
| **Title : Shape optimization based on isogeometric formulation for dynamical response of structures** |
| **Scientific field: Mechanical Engineering** |
| **Key words: Isogeometric, FEA, shape optimization, dynamic** |

## Details for the subject:

The concept of isogeometric analysis (IGA) was proposed in 2005 by T.J.R. Hughes et al.[1, 2]. The approach was based on NURBS (Non-Uniform Rational B-Splines), a standard technology employed in computer aided design (CAD) systems. They proposed to match the exact CAD geometry by NURBS surfaces, then constructed a coarse mesh of ‘‘NURBS elements’’. For purposes of finite element analysis (FEA), the basis was refined and/or its order elevated without changing the geometry or its parameterization. Analogues of finite element h- and p-refinement schemes were presented and a new, more efficient, higher-order concept, k-refinement, was introduced. The refinement does not require any further communication with the CAD system. The isogeometric analysis is so simple that it may facilitate more widespread adoption of this technology in industry. Therefore, it develops fast in recent years and is widely recognized around the world as an important trend in both solid mechanics and shape optimization [3, 4].



The main objective of this Ph.D. proposal is to develop innovative approaches for the shape optimization of structures described by an isogeometric model under dynamical constraints. The isogeometric point of view of the structure will be fully exploited within the optimization loop to enhance its efficiency and accuracy. Industrial cases will be used to show the relevancy the proposed approaches.

**Background, Context:**

The DySCo team is first specialized in dynamical behavior of structures. Recently, the shape optimization field has been opened successfully within the team and has lead to several Ph.D. defenses, mainly in parametric shape optimization under dynamical constraints. More recently the use of isogeometric approach has appeared to be of special interest and has lead to three Ph.D. defenses, two within an industrial context and one under a CSC grant [5-7]. It is clear now that this research field will be a major topic in a near futur, as classical shape optimization description has failed to provide yet efficient and versatil approaches for a daily use in the industry.

**Research subject, work plan:**

The main objective of this subject is to be able to provide approaches able to deal with the shape optimization of structures with an isogeometric description under dynamical constraints. Several key issues will have to be treated, such as :

- the description of the dynamical behavior of the structure provided by the isogeometric approach
- the sensitivity analysis of the optimization equations
- the use of gradient and/or meta-heuristic approaches for the optimization

**References:**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3. Seo, Y.-D., H.-J. Kim, and S.-K. Youn, *Shape optimization and its extension to topological design based on isogeometric analysis.* International Journal of Solids and Structures, 2010. **47**(11–12): p. 1618-1640.

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6. P. Froment, F. Gillot, Y. Tourbier, L. Jezequel, CAD-based large scale shape optimization method with intensive simulations, WCSMO-10, Orlando, FL, USA, May 19-24, 2013

7. L. Zhen, F. Gillot and L. Jezequel, An isogeometric Reissner-Mindlin shell with lagrange basis, 11th World Congress on Computational Mechanics (WCCM XI), Spain, Jully 20-25, 2014