Project proposal template
Graduate School studentships
March 2015

Project title	Design, analysis and optimization of advanced cage armour solutions
First Supervisor	Dr — Demetrios T. Venetsanos
Second Supervisor	Dr Yahya Zweiri
School	Mechanical and Automotive Engineering
Other member of supervisory team (no more than three KU supervisors in total)	Dr Redha Benhadj-Djilali
Specific requirements beyond 2:1 degree	Good knowledge of a CAD package; good knowledge of an FEA package, preferably LS-Dyna; good knowledge of Matlab, preferably Optimization Toolbox;

Project summary

(max 4,000 characters)

Citizens at various locations worldwide are forced to live, even for a short period of time, in hostile environments due to armed confrontation between opposing sides. Both during these periods and especially after the end of such confrontations, it is imperative that supplies in food and water, as well as transportation of people in need, are secured. Furthermore, it is also imperative that debris and other obstacles that block the pathways of transportation are removed. For the aforementioned tasks, vehicles, such as trucks and bulldozers, are widely used. One of the major threats that such missions must be protected against, is the anti-tank rocket-propelled grenade (RPG) attacks. To this end, the so-called cage armor, or bar armor or slat armor, has been developed. A cage armor comprises of a rigid slatted metal grid fitted around key sections of the vehicle. The purpose of this armor is to disrupt the shaped charge of the warhead, meaning that it aims at preventing the optimal detonation from occurring. This type of protection is quite effective mostly against single warhead attacks. However, protection in contexts of tandem head anti-tank rockets and/or multi-hit events is compromised, thus a solution is a cost-effective solution is yet to be found.

The contribution of the proposed PhD is to explore a cost-effective solution of a cage armour able to offer increased protection against a wider range of anti-tank attacks. The proposed solution will be based on a design concept that implements sharp elements positioned within a current armour cage, able of shredding and deactivating incoming warheads. The sharp elements in subject would not protrude beyond the plane of the armour and would thus not pose a threat to surrounding personnel and civilians. The objective of the proposed to-be-explored solution is to drastically increase current cage effectiveness by protecting armoured vehicles against High Explosion Anti-tank (HEAT) tandem head and/or multi-hit attacks.

For the needs of the proposed PhD, a multi-objective optimization problem is to be setup and solved using advanced computational mechanics. More specifically, the design variables of the optimization problem will be the material for the sharp elements, the size and topology of the sharp elements, as well as the layout configuration of the sharp elements (number and orientation of sharp elements per structural cage armour unit). The objective function of the optimization problem will be the maximization of the protection efficiency and durability provided through a wide range of simulated attack scenarios.

For the needs of the proposed PhD, commercial CAD software will be used for the development of full 3D parametric models, such as for the cage armour. Furthermore, commercial FEA package, suitable for the analysis of shock-and-impact / blast problems, will be used for the structural analysis of the aforementioned models. For the later, knowledge of LS-Dyna is highly preferable. For the optimization of the explored design, a combination of stochastic and deterministic procedures will be used, mainly by utilizing functions from the MatLab Optimization Toolbox. For the needs of the proposed PhD, it will be required to write code in MatLab and develop scripts for LS-Dyna.

Finally, within the framework of the proposed PhD, it is anticipated that collaboration with Morgan company that specializes in cage armours will be developed and the proposed study results would inform downstream prototype building and solution validation under real fire conditions.