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Steps Towards Productive Use of IGA in LS-DYNA for Full Vehicle Crash Simulations

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Isogeometric Analysis (IGA) is a rather new Finite Element Analysis (FEA) method that uses spline basis functions known from Computer Aided Design (CAD) models. IGA not only allows a closer connection of design and analysis, but may also offer additional benefits such as a more accurate geometry description, higher predictive accuracy, a larger explicit time step size and more efficient computations.
Exploiting the full potential of IGA requires a holistic IGA-based development process and rather fundamental changes of the status quo, which is difficult to realize all at once in industry. An approach that allows a smooth step-by-step introduction of IGA in industry, is the use of hybrid simulation models, i.e. of conventional FEA models in which certain components are replaced by IGA components. LS-DYNA with its comprehensive FEA and IGA capabilities supports the use of such hybrid models and considerable effort has recently been devoted to enabling a simple one-by-one exchange of FEA shell components with their IGA counterparts [1]. This not only required the crash-specific capabilities to be available for IGA in LS-DYNA, but to also support connection modeling techniques for spotwelds, bolts, and rigid bodies attached to isogeometric shells. So far, the focus was on the application of isogeometric (trimmed NURBS-based) shells and thin-walled components, which already allowed capturing the majority of vehicle components. A promising approach to extend the application of IGA to bulky vehicle components is the concept of trimmed B-Spline solids [2]. Another crucial requirement for reliable crash simulations with high predictive accuracy is a realistic representation of material nonlinearities like plasticity, damage and failure.
In this contribution we present the most recent steps towards productive use of IGA for crash in LS-DYNA with a focus on trimmed multi-patch NURBS shells, the new *IGA keyword family and explicit dynamic analysis. We particularly discuss material plasticity, damage, failure, and element erosion for IGA. Additionally, we present our first simulation attempts with trimmed B-Spline solid models in LS-DYNA. Finally, we show one of the first full vehicle crash simulations of a hybrid IGA/FEA model and compare the results with conventional FEA models.

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