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Modeling, Simulation and Quantification of Polymorphic Uncertainty in Real World Engineering Problems

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To approach the full complexity of real world engineering problems, three aspects are of major importance. First, the holistic characterization of quantities for geometrical, material and environmental parameters. Second, comprehensive simulation methods that capture the complexity of the multi-physical conduct and comply with the restricted availability of computational resources. The third aspect is the in-depth assessment of structural analysis results.

The assessment of structural safety and robustness is based on the consideration of uncertainties. Since this assessment results from the characterization of quantities as well as from the comprehensive simulation methods, uncertainty is required to be regarded in all previously mentioned aspects. The complexity of real world engineering problems involves two sources of uncertainty, namely natural variability and lack of knowledge. Both types are combined by polymorphic uncertainty models.

The main focus is the presentation of methods opening up new perspectives towards real world engineering problems, including advanced polymorphic uncertainty modeling and quantification methods, based on state of the art simulation methods. Advanced methods in computational mechanics, e.g. time-dependent analysis, multi-physical or multi-scale approaches, entail extensive numerical effort. If polymorphic uncertainty is involved, uncertainty quantification methods are required that multiply this effort of the basic solution. In order to achieve high accuracy at feasible computational cost, advanced uncertainty analysis techniques are covered, which incorporate model order reduction, surrogate modeling or multi-fidelity approaches.

The motto, “GACM meets sustainability”, is addressed from several perspectives. Reliable decision making in structural designing leads to optimal resource management, complying with requirements in safety and robustness. Additionally, the consideration of time-dependent uncertainties enables the treatment of life cycles and, therefore, paves the way for long-lasting structure design. Moreover, contributions are invited that face advanced material-efficient building technologies, such as additive manufacturing, which require time-dependent modeling and quantification of uncertainties for the simulation of reliable manufacturing processes.

Topics of interest include:

- polymorphic uncertainty in robust design optimization
- polymorphic uncertainty in multi-scale approaches
- model order reduction, surrogate models and multi-fidelity approaches in uncertainty quantification
- time-dependent polymorphic uncertainties

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