REDEN

**Graduation project: Data-Driven Model Order Reduction**

This project is hosted by Reden. Reden is a small (±20 people) research and engineering consultancy company in Hengelo (Ov.). We are specialized in the modeling of physical processes and in the application and development of advanced simulation techniques and software (Figure 1). Our clientele involves both medium-sized and large enterprises, and we are active in various research consortia. If you would like to know more about us, visit our website: www.reden.nl.

At Reden, we often build reduced order models for our clients. Besides the reduction of the computational cost and computation time, a benefit of reduced order models is that these can be exported out of the simulation software. This enables our clients to run these models without installing specific software and, in case of commercial codes, without acquiring licenses.

It is often challenging to create reduced order models from simulations in commercial software. Commonly, only basic (if at all) model order reduction methods are provided as built-in functionalities. Furthermore, these software packages are generally closed source, and functionalities to export system matrices (for usage with e.g., open source model order reduction libraries) are typically not compatible with advanced modeling techniques. Since, additionally, we are working with several software packages, this challenge is persistent and recurring.

A universal solution lies in the application of data-driven approaches. Instead of applying a model order reduction technique to the model itself, we can generate ample simulation results, and apply data-driven modeling techniques to create a (compact or reduced) model. A myriad of such data-driven techniques exists, but the efficient application requires answering the following questions: 1) What technique is most suitable for what type of model (e.g., fluid mechanics, solid mechanics, magnetism, etc.)? 2) What and how much simulation data is needed to achieve the required accuracy? Furthermore, the application of data-driven approaches to simulated data (w.r.t measured data) offers several opportunities and challenges that we would like to explore: 1) With simulated data an abundance of results can easily be generated, load cases can be applied that rarely occur in physical products or that are difficult to perform in experiments, and outputs can be evaluated that are difficult or impossible to measure in practice. 2) Simulated data is (nearly) noise free. 3) When uncertainty is involved, simulations provide the opportunity to generate labeled data and to easily perform large variations in model parameters.

At Reden, we have a wide interest in model order reduction, particularly in relation to digital twins and (structural) health monitoring. If you are interested to work on this graduation project (or another graduation project related to these topics) contact Ronald Kampinga: r.kampinga@reden.nl.

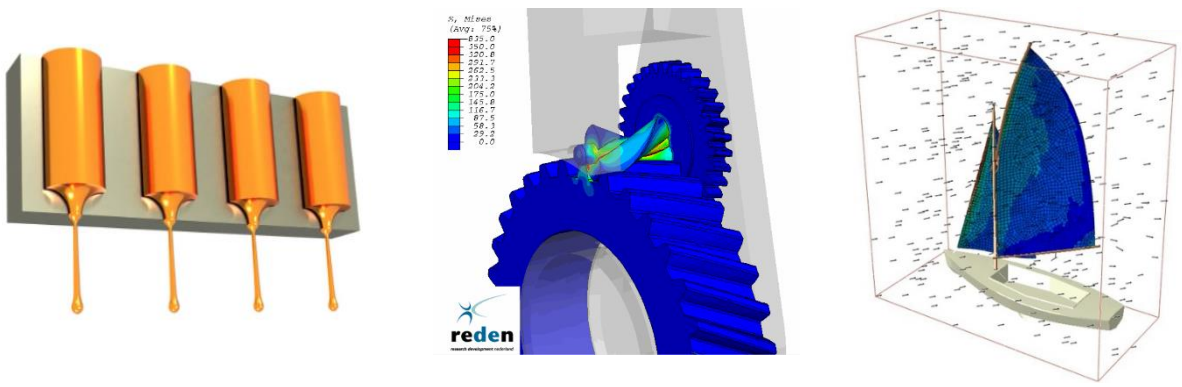


Figure 1: some examples of computations performed by Reden. 1) Flow simulation of inkjet printing. 2) mechanical simulation of gearwheels. 3) Fluid-structure interaction computation of a sail.

We understand innovation