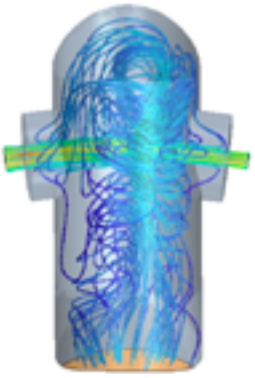
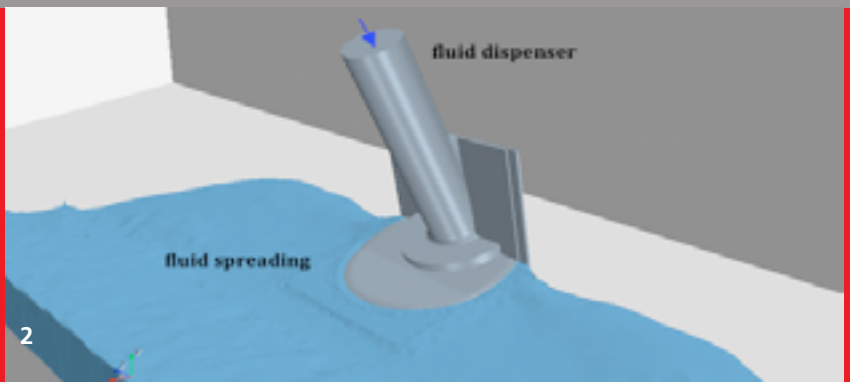
Fraunhofer
SCAI

FRAUNHOFER INSTITUTE FOR ALGORITHMS AND SCIENTIFIC COMPUTING SCAI



1



2

1 *Simulation of a mixing chamber*
2 *CFD for highly viscous fluids in plant engineering*

OPTIMIZATION USING CFD SIMULATION SERVICES

Optimization of Fluid Flow
When developing technical devices and components one is strongly interested in an efficient functionality of its design, meeting the requirements in a best manner. As numerical simulations have been well established in virtual design and computation times were further reduced, the application of sophisticated optimization algorithms gained lately in importance.

Technical Approach
In the majority of cases the fluid problem exhibits the necessity of multiple objective functions. Furthermore the number of design parameters and boundary conditions might be large, so that an engineer quickly looses track of complex correlations concerning the flow conditions. Applying a combination of advanced methods for sensitivity analysis, design of experiment (DoE), non-linear meta modeling and robust design will reduce the design space and clarify the physical dependencies. These optimization methods are merged with numerical simulation and flow evaluation into a nearly automatic process chain. Fraunhofer SCAI successfully applies these approaches integrating commercial and in-house simulation and optimization tools.

Application Areas
There are practically no limitations for applying optimization methods to fluid problems as long as a necessary amount of simulations can be achieved in acceptable computation times. Optimizations methods are widely used in turbomachinery, aerodynamics, biomedical engineering and many more. On the following page an example from the polyurethane industry, where optimization methods were applied for fluid flows is depicted and explained.

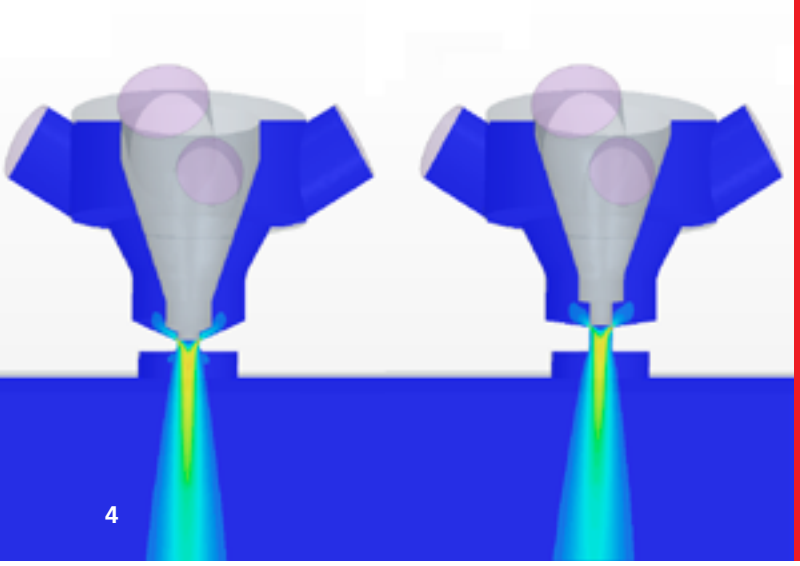
Our Offer
Fraunhofer SCAI offers the application of sophisticated in-house and/or commercial optimization and robust design methods in combination with numerical simulations for your complex flow problems. This approach is supported by Fraunhofer SCAI`s long-time experience with advanced simulation tools for various fields of applications like fluid flow, structural mechanics, electromagnetics and more.

Fraunhofer Institute for Algorithms and Scientific Computing SCAI

Schloss Birlinghoven 1
53757 Sankt Augustin
Germany

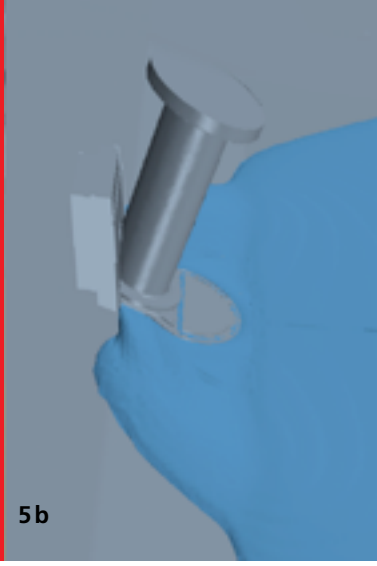
Contact
Dr.-Ing. Carsten Brodbeck
Phone: +49 2241 14-4063
carsten.brodbeck@scai.fraunhofer.de

www.scai.fraunhofer.de



4

5a



5b

EXAMPLE: OPTIMIZATION OF PLANTS AND COMPONENTS FOR THE POLYURETHANE PRODUCTION

Project Description

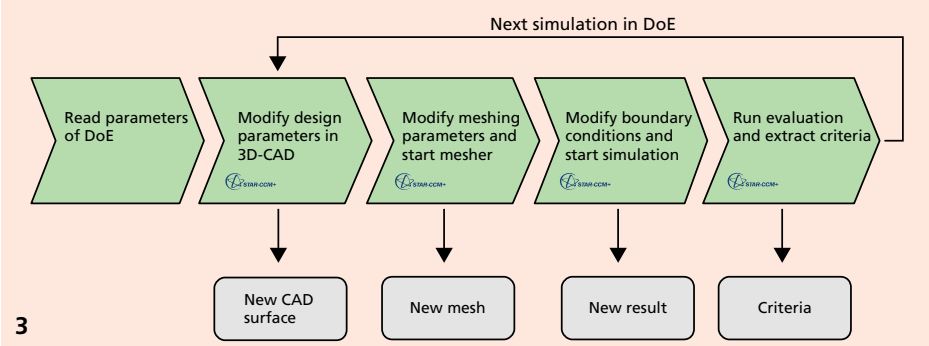
The project was funded by German Federal Ministry for Economy and Technology and was a cooperation between research facility **Fraunhofer SCAI** and the industrial company **Hennecke Polyurethane Technology**. The work comprised two different subdomains of polyurethane processing, namely the optimization of mixing devices (mixing injector, mixing chamber) and slab stock foam plants. In both tasks the fluid solver STAR-CCM+ from cd-adapco, the optimization software DesParO from Fraunhofer SCAI and an self-developed process chain environment was applied (Fig. 3).

Mixing Devices

In order to achieve a good mixing quality of polyurethane components Polyol and Isocyanate, the injectors should efficiently generate jets with large momentum. Therefore several geometric parameters were varied for a sensitivity analysis. Based on this analysis the design space was reduced and the optimization process was launched, yielding a set of optimal parameters for a required range of operating mass flow (Fig. 4). Separately the mixing chamber was treated in a similar way, investing more effort in establishing adequate objective functions for mixing quality (Fig. 1).

Slab Stock Foam

These plants which are used for the production of foam blocks have a large geometric extent but the polyurethane fluid with high viscosity is moved rather slowly on conveyor belts. In order to achieve a foam of high quality it is essential, that the fluid is spread over the complete width of the plant and passes the orifice before the foam expansion is started. Due to the small orifice gap height (millimeter) and the large gap width (meter) extended meshes were necessary and due to the small velocities, the high viscosities and the multiphase approach convergence was reached rather slowly. These circumstances made it inevitable to reduce the procedure to a pure sensitivity analysis. However the simulations (Fig. 5) showed definite tendencies, which were incorporated into the design of a simplified prototype.



3

3 *Phases of process chain environment*

4 *Mixing injectors*

5a *Slab stock foam*

5b *Simulated process*