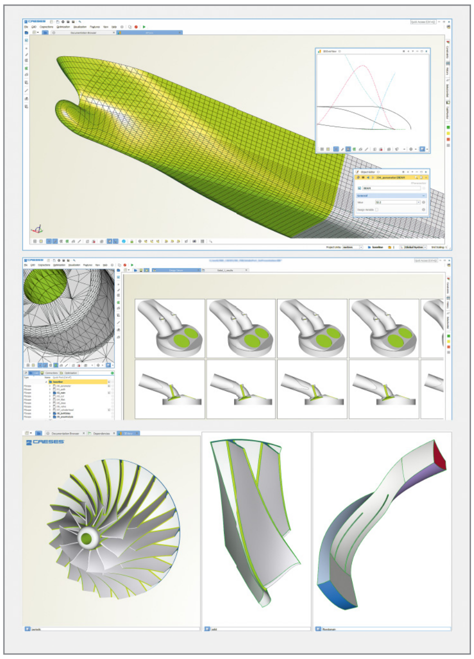
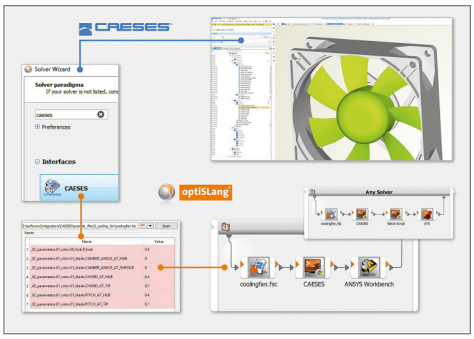
Geometry Optimization

# APPLICATION OF CAESES® AND OPTISLANG® FOR SHAPE OPTIMIZATION



CAESES: CAD for simulation engineers



Direct CAESES interface available in optiSLang

## CAESES

CAESES is the CAD engine for simulation engineers that want to conduct automated shape optimizations. It is used in many industries and focuses on the efficient and robust variation of complex free-form surfaces. Typical applications are turbochargers, pumps, volutes, turbines, ducts, wings, intake/exhaust manifolds, piston bowls, ship hull forms and many more. CAESES helps you to avoid busted or invalid geometries to drastically speed up your process. No pre-processing is needed – the geometry is directly ready for fully-automated meshing and analysis. CAESES comes with easy-to-use automation capabilities which allow you to also run it in batch mode. It is fully integrated with optiSLang and ANSYS Workbench which makes it a joy to plug it into existing simulation-based workflows.

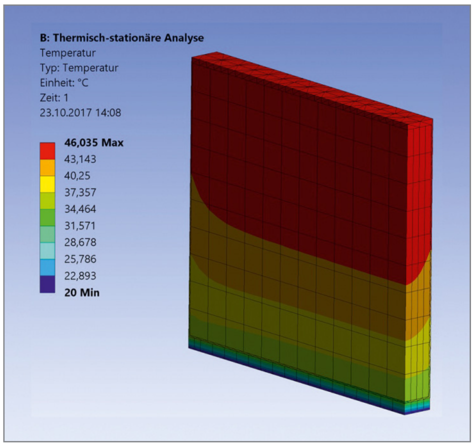
## Full Integration with optiSLang

optiSLang users get immediate and intuitive access to the powerful CAESES CAD models through the graphical user interface (GUI) of optiSLang and the ANSYS Workbench. The design variables of the parametric CAESES geometry are automatically provided to the optiSLang user by simply loading the model. The geometry generation is controlled within optiSLang to create large sets of geometry variants with a single click. There is no CAESES expertise required to make use of this connection. This enables you to find your optimal design candidate, and it brings together the latest optimization technologies from optiSLang and the robust and efficient CAD models from CAESES. No scripting is needed – the interaction between the two software packages has been streamlined to conduct comprehensive design studies and RDO with highest ease.

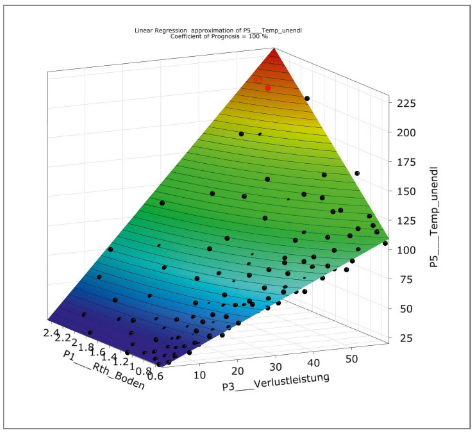
**Contact**
FRIENDSHIP SYSTEMS AG | Benzstrasse 2 | 14482 Potsdam | info@friendship-systems.com | Phone +49 331 967660 | www.CAESES.com

## Elektrotechnik

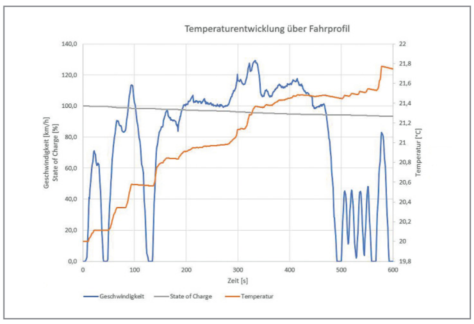
# METAMODELLE ZUR ANALYSE DES TEMPERATURVERHALTENS VON LITHIUM-IONEN ZELLEN




Thermische Analyse in ANSYS




Designpoints zur Abdeckung des Parameterraums




Temperaturverlauf aus Lastprofil

## Ziel

Im Bereich der neuen Geschäftsfelder werden bei ElringKlinger zukunftsträchtige Technologien erforscht und entwickelt. Im Fokus stehen dabei Lösungen mit elektrischen Antrieben. Nicht nur die Reichweite, sondern auch Punkte wie Lebensdauer und Zuverlässigkeit spielen dabei eine wichtige Rolle. Zu hohe Temperaturen schädigen den Energieträger und verkürzen somit die Lebensdauer. Bei der Verwendung von Lithium-Ionen Zellen ist aus diesem Grund das Temperaturverhalten von besonderer Bedeutung. In diesem Projekt wurde ein Modell erstellt, welches Aussagen zur Temperaturentwicklung erlaubt.

## Umsetzung

Das Temperaturverhalten einer Zelle wurde in stationären und transienten thermischen Analysen in ANSYS untersucht. Dabei wurde optiSLang an erster Stelle zur Durchführung einer Sensitivitätsanalyse verwendet. Durch das Latin Hypercube Sampling konnten die gewünschten Design-Points erstellt werden, um im Anschluss die entsprechenden Simulationen durchzuführen. Als Parameter kamen die Wärmeentwicklung der Zelle, Wärmeleitfähigkeit innerhalb der Zelle und der thermische Widerstand zur Kühlplatte zum Einsatz. Die so gewonnenen Ergebnisse wurden zur Erstellung eines MOP in optiSLang ausgewertet.

## Ergebnis

Das generierte MOP wurde im letzten Schritt in Excel übernommen, sodass eine unkomplizierte Anpassung der Parameter ermöglicht werden konnte. Diese Berechnungsumgebung verspricht schnelle Aussagen über die Temperatur einer Zelle, ohne eine FEM Simulation durchführen zu müssen. Es müssen lediglich die vorliegenden Randbedingungen hinterlegt werden und das MOP berechnet den entsprechenden Temperaturwert. Zusätzlich ist es möglich, den Temperaturverlauf über ein ganzes Lastprofil zu berechnen.

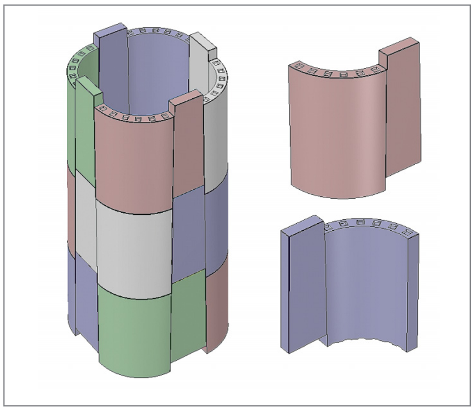
**Kontakt**
ElringKlinger AG | Max-Eyth-Straße 2 | Ulrich Werz | Abt. CU-2NF

HOCHSCHULE MAINZ
UNIVERSITY OF
APPLIED SCIENCES

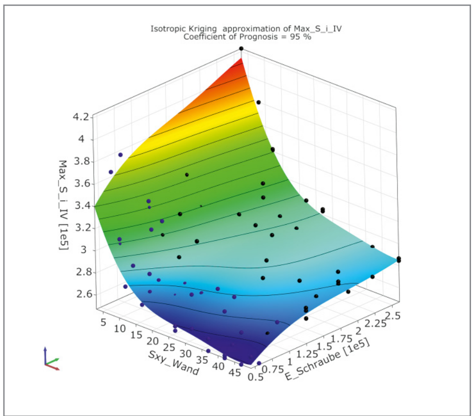
TUBULARIS

**Bauwesen**

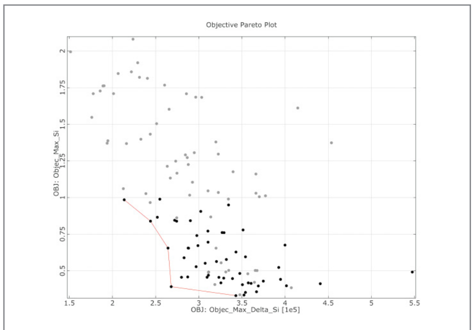
# OPTIMIERUNG DER STEIFIGKEITEN VON KRAFTÜBERTRAGENDEN FUGENBEREICHEN



Turm- und Fertigteilgeometrie




Antwortfläche zur maximalen Schraubenlast

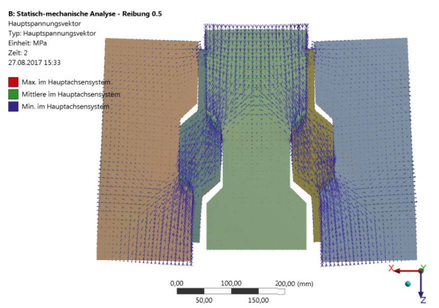



Pareto Front der Optimierungsziele

Das übergeordnete Ziel des Vorhabens war die Entwicklung des PCC-Towers, ein Fertigteilkonzept der Fa. TUBULARIS GmbH für den Bau von Hybridtürmen der nächsten Generation. Das Fertigteilkonzept der TUBULARIS GmbH beruht auf einem innovativen Produktionsprozess von kleinformatigen Betonfertigteilen, welche dezentral in gewöhnlichen Betonfertigteilwerken hergestellt werden können. Die Fugen zwischen den Betonfertigteilen bestimmen dabei maßgeblich den Lastfluss im Turmbauwerk. Die ausschlaggebenden Punkte sind dabei die kraftübertragenden Fugenbereiche und deren Steifigkeiten.

Zur Auswertung und parametrischen Optimierung wurde die Software optiSLang von Dynardo gewählt. Die Fugen mit ihren Steifigkeiten dienten dabei als Inputparameter:

- Schubsteifigkeit der Wandfuge
- Dehnsteifigkeit der Schraubenverbindung




Nachrechnung der Schubversuchsreihe

optiSlang stellt nach der Berechnung die Abhängigkeiten der Inputparameter zu den Optimierungszielen in verschiedensten Formen dar. Die in diesem Projekt gestellten Optimierungsziele stehen dabei untereinander im Konflikt und bilden eine Pareto Front. Eine Versuchsreihe an Schubfugen zeigte jedoch, dass diese Front in der Praxis nicht erreicht wird.

**Kontakt**
Hochschule Mainz | Bauingenieurwesen
Holzstraße 36 | 55116 Mainz

ZIM Zentrales Innovationsprogramm Mittelstand
Bundesministerium für Wirtschaft und Technologie
Betonwerk Hachmeister 56626 Andernach
Institute of Innovative Structures
TECHNOLOGY HOCHSCHULE MAINZ UNIVERSITY OF APPLIED SCIENCES

MECURIS

Medical Science

# SHAPE OPTIMIZATION APPROACH OF A NEW PROSTHETIC FOOT

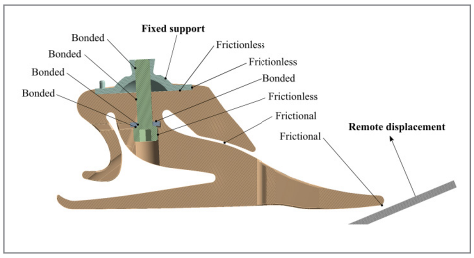



Fig. 1: Finite Element Simulation setup (toe-off phase)

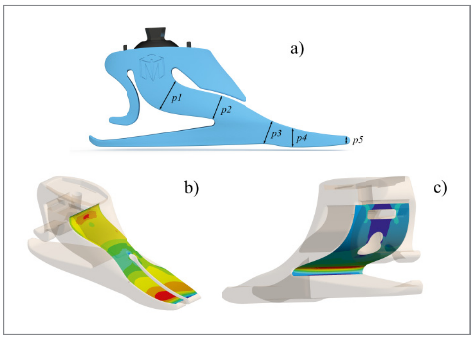



Fig.: Geometric parameters as input variables, and stress parameters as output variables

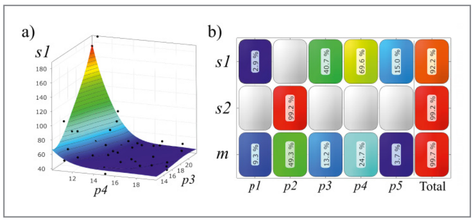



Fig 3: Metamodel of Optimal Prognosis, and Sensitivity Matrix from the CoP values

The goal of this study is to present an optimization approach of the shape of a new prosthetic foot. Prosthetic feet have to withstand different loading conditions over time, and should provide comfortable walking for the wearer. To ensure the sufficient load-bearing capabilities, static Finite Element Simulations were performed, see Fig. 1. However, mechanical testing of the subject foot pointed out that the mass and the forefoot stiffness should be reduced.

As input variables, five geometric parameters were implemented in the CAD model that controlled the thickness of the forefoot, see Fig. 2 a). Three output parameters were defined, of which the first two, s1 and s2, were maximum equivalent Von-Mises stress values, see Fig. 2 b) and c). The third output was the mass (m) of the foot body.

First 50, consequently 100 samples were collected using Advanced Latin Hypercube Sampling, because the parameter sensitivities can be represented accurately with this method. The outputs were approximated with the Metamodel of Optimal Prognosis. For the optimization, parameters s1 and s2 were constrained not to be greater than a necessary safety limit, and the objective was to minimize parameter m.

The Coefficient of Prognosis (CoP) value for parameter s1 was 92.2% and resulted in a 3.7% inaccuracy in the validation of the optimum (see Fig. 3). With 100 samples, this CoP value increased to 97.6%, with a 0.8% validation error, and the CoP for the other two parameters was in each case at least 98%.

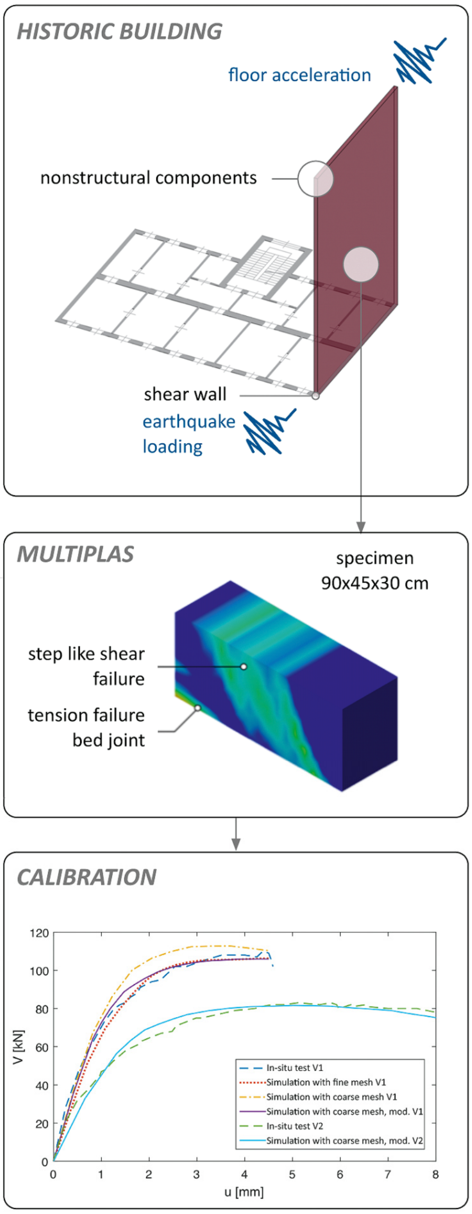
Due to the optimization, the mass of the model was reduced by 8%, and the maximum displacement of the toes increased by 54% for the same reaction force value, corresponding to a 35% reduction of the forefoot stiffness. Therefore, the desired improvements of the prosthetic were reached.

**Contact**
Mecuris GmbH | Lindwurmstraße 11 | 80337 Munich | Germany | +49 89 552623-86 | servus@mecuris.com | www.mecuris.com

TECHNISCHE
UNIVERSITÄT
WIEN

**Civil Engineering**

# DETERMINING SEISMIC DEMANDS ON HISTORIC FAÇADE COMPONENTS USING MULTIPLAS




## Introduction

Major earthquake events in the past demonstrated that damage to historic façade components poses a significant danger to persons and property. Especially freestanding nonstructural components, such as statues, balustrades and ornamental vases are highly at risk, even when the primary structure performs well. When assessing the vulnerability of these nonstructural components to seismic excitations, peak horizontal floor acceleration is commonly investigated. Previous research focused mainly on nonstructural components of nuclear power plants and industrial plants. In our present study, FE analysis was used to estimate horizontal floor accelerations for typical masonry shear walls.

## Method

Our extensive case study was conducted to investigate the influence of induced nonlinearities on the horizantal floor accelerations for old masonry buildings. Nonlinear FE time-history analyses considering three different hazard levels were performed with ANSYS. A set of synthetically generated ground motions was used as input to the structure models. In order to take specific failure mechanisms into account, multiPlas was calibrated using small scale tests as well as experimental tests at wall level. The comparison of the static loading curves between the simulation and the test results shows very good correlation. Also the observed crack behavior was reproduced correctly by the plastic strain activities.

## Results

Our present study shows that multiPlas can be used to predict seismic demands on historic façade components for proper hazard assessment and retrofitting. The results indicate that there is significant scatter in the absolute distribution of the horizontal floor accelerations between the applied ground excitations. It can be well observed that the extent of nonlinear behavior varies for different hazard levels.

**Source |** A. Rudisch, V. Dunjic, A. Kolbitsch: "Investigation of horizontal floor acceleration in historic masonry buildings"; Mauerwerk, 21 (2017), 6; S. 348 - 356.
**Contact |** andreas.rudisch@tuwien.ac.at

Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

**Automotive Engineering**

# COST-BENEFIT OPTIMIZATION OF THERMOELECTRIC GENERATORS

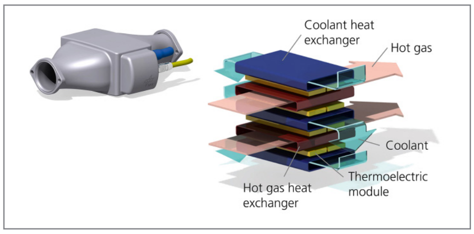



Fig.1: Highly integrated TEG design with crossflow heat exchangers

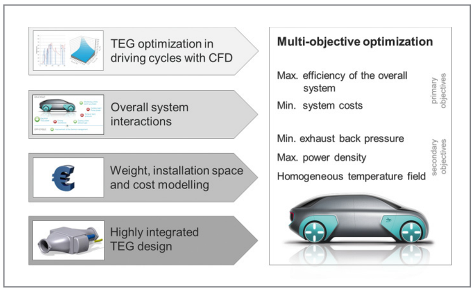



Fig.2: Method with the dependences and objectives

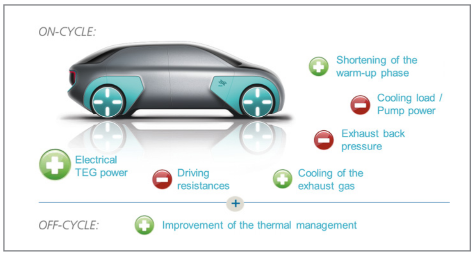



Fig.3: Positive and negative effects of a TEG

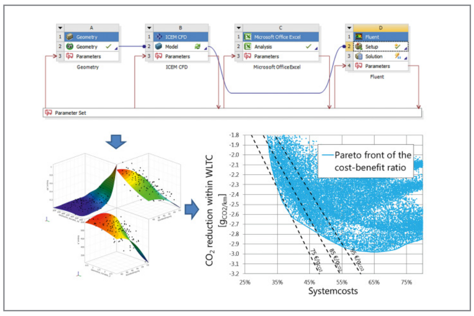



Fig.4: Optimization of the cost-benefit ratio with ANSYS, optiSlang and proprietary tools

## Motivation

Regardless whether a conventional or a hybrid vehicle concept is used, approximately 2/3 of the fuels chemical energy is lost as waste heat. Especially the waste heat of the exhaust gas provides through its high temperature level the highest potential for waste heat recovery.

## Technology

Thermoelectric is based on the Seebeck effect and allows to convert a heat flow into electrical energy. Thermoelectric Generators (TEG) convert exhaust waste heat into electrical energy (Fig.1). TEGs have the following characteristics: no moving parts, maintenance-free for a long period, noiseless and vibration-free.

## Method

The simulation environment is based on ANSYS, optiSlang and proprietary calculation tools (Fig.2). This environment calculates all positive and negative effects of a TEG on the overall vehicle system (Fig.3). There are 13 input parameters which describe the TEG, especially the hot gas heat exchanger. The result of each design point includes the weight, the cost, the effective net power on the overall system and the cost-benefit ratio. It is possible to optimize any of these results.

## Conclusion

As an example, measurement data of the reference vehicle, Volkswagen Golf VII (1,2 L; 77 kW) is used. The method made it possible to reach a best gravimetric and volumetric power density in the WLTP-cycle compared to other known research projects:

- gravimetric power density: **130 W/kg**
- volumetric power density: **230 W/dm³**

Potential fuel reduction of **~2–3%** and a cost-benefit ratio of **75 €/$g_{CO_2}$/km** within WLTP-cycle shown in a simulative study.


**Contact |**
Timo Knobelspies | timo.knobelspies@dlr.de | +49 711 6862-421
Martin Kober | martin.kober@dlr.de | +49 711 6862-457
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR) | Institut für Fahrzeugkonzepte | Pfaffenwaldring 38-40 | 70569 Stuttgart | www.DLR.de