Virtual Design of Tribological Systems using Data-based Models

For the design of tribological systems it is necessary to accurately estimate essential characteristics, e.g. the coefficient of friction or wear, already before production. These estimates make it possible to optimally dimension the system with respect to functionality and costs. As a result, the risk to dimension the system too small is reduced and over-engineering is prevented. Mathematical models based purely on physical principles are not sufficient for these purposes. Therefore, we developed data-based models which allow more accurate estimations of essential characteristics and are used within a computer-aided-engineering system for virtual design.

Within the K-Project for heuristic optimization in production and logistics (HOPL) we conduct research on so-called optimization networks. Optimization networks are used for describing and solving optimization problems that can be represented as a network of multiple interrelated sub-problems.

In a cooperative project between Miba Frictec, the Upper Austria University of Applied Sciences, and the Department of Knowledge-Based Mathematical Systems of the Johannes Kepler University Linz data-based models for tribological systems have been developed to improve the design process and dimensioning of these systems. For this purpose we used novel and improved methods for data-based modelling. These methods can be used as components in combination with other optimization elements within a network, for instance for optimal dimensioning of tribological systems.

One central challenge of dimensioning tribological systems is the fact that the accuracy of mathematical models which are purely based on physical principles is not sufficient for predicting system properties. Major influence factors such as the properties of the oil or the surface characteristics cannot be easily captured in a mathematical model and are also changing over time. There are no simulation models which can be used for accurate estimation of these properties.
systems correctly, which means that on the one hand customer requirements have to be fulfilled but the system should not be unnecessarily overengineered. Often the exact properties of a tribological system can only be determined by producing prototypes which can be tested in special test benches.

![Fig. 2: Test bench for friction plates (© Miba frictec)](image)

**Developed solution by HOPL: Data-based Models**

Miba Frictec owns a large database with results of previous tests which have not yet been used systematically and over multiple projects for the development of new designs. Within the K-Project HOPL we have developed data-based models which - for the first time – subsume the information from previous tests of test profiles contained in the database and can be used for the estimation of properties of new designs. For modelling we mainly used heuristic optimization algorithms as well as novel techniques for the identification of fuzzy inference systems. The resulting models are more accurate than estimations by experts, are more compact than models produced by standard techniques for data-based modelling, and can be integrated directly into digital tools for tribological systems design.

**Impact and effects**

The newly developed data-based models will be integrated into a CAE-system to support engineers when dimensioning tribological systems together with customers. This simplifies the dimensioning process because the expected characteristics of the system can be easily calculated and different dimensioning variants can be easily analysed and compared. This has previously been very difficult even for experts and therefore only possible with restrictions. Because of the more accurate estimations the number of produced and tested prototype profiles can be reduced and a system design can which fulfills customer requirements can be identified faster than before.

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**Contact and information**

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