Abstract. This thesis addresses the challenges and complexities of End-of-Line testing for highly variant custom-built geared motor production. Performing automated End-of-Line testing for the highly variant geared motors is a complex process as every variant differs from the other. Not enough training data is available to train one model for each variant type. And all motor variants cannot be guaranteed to be tested with the same model. So, there is a lack of knowledge on which variants can be tested with the same model. Considering this, a framework that automatically derives the variants into clusters with similar acoustic behavior is needed. This research contributes to the problem of grouping similar geared motor variants using various traditional Machine Learning and Artificial Neural Network (ANN) algorithms to reduce the challenges in End-of-Line (EOL) testing leading to improvement in performance. The detection of faults in the motor is performed using fault diagnosis methods. The sound produced by the motor variant with and without fault is distinguishable to human hearing. So, with the help of acoustic signals and a given hand-crafted feature vector, fault diagnosis can be performed on the geared motor variants. However, recording the acoustic behavior of all variants in a batch-size-one production and segregating by hearing is not practical. This thesis provides a solution based on ANN algorithms and helps in the fault diagnosis of the custom-built geared motor variants.

First, a framework is developed to find clusters of variants, where an anomaly detection approach is trained for each cluster. When a motor is custom manufactured and has its acoustic data recorded, the model helps in clustering the variant into a group of variants with similar acoustic behavior. The thesis deals with implementing various Machine Learning models to reduce the dimensions of acoustic data using Principal Component Analysis (PCA), t-Distributed Stochastic Neighbor Embedding (t-SNE), and Self-Organizing Maps (SOM) techniques. Once the dimensionality of acoustic data is reduced, a clustering algorithm is applied using the K-Means and Competitive Neural Network (CPN) algorithms. The thesis also uses an anomaly detection method using One-Class Classifier (OCC) with Gaussian Mixture Model (GMM) to provide a benchmark for the investigated approaches. The thesis's final phase unfolds the model's evaluation. The clustering algorithms take center stage in the final Machine Learning model developed in the thesis. Clustering, an unsupervised learning technique, is challenging to evaluate without the actual data labels. However, this thesis uses state-of-the-art approaches like the Area Under the Receiver Operating Characteristic Curve (AUC-ROC) to evaluate the model successfully. The results from analyzing and evaluating the final model with the hand-crafted feature vector dataset are well documented and discussed in the thesis. By evaluating the various pipelines with different techniques, the baseline approach K-Means clustering combined with the t-SNE dimensionality reduction technique obtained a performance of '0.7642' weighted average AUC score, and the CPN ANN clustering technique, combined with the SOM ANN dimensionality reduction technique, performs the best with a '0.8021' weighted average AUC score.

Keywords: End-of-Line testing, Custom-Built Geared Motors, Machine Learning, Dimensionality Reduction, Unsupervised Learning, Clustering, Anomaly Detection, Artificial Neural Networks, Quality Inspection.