X-ray computed tomography (CT) is a measuring technique which has become an important technology in the production environment over the last years. Due to a number of advantages of CT compared to, e.g., coordinate measuring machines (CMMs), CT has been recently spread in the field of manufacturing metrology and coordinate metrology and is currently becoming more and more important measuring technique for dimensional measurements. This is mainly due to the fact that with CT, a complete three-dimensional model of the scanned part is in a relatively short time visualized using a computer, and measurements of outer as well as inner geometries can be performed with a micrometer accuracy.

The result of every dimensional CT measurement, as of every other measuring instrument, has to be accompanied with a statement about measurement uncertainty. The knowledge about measurement uncertainty is an important factor for decision making about manufactured parts. However, due to many influences in CT, estimation of the uncertainty is a challenge, also because standardized procedures and guidelines are not available yet.

In this thesis, several methods for uncertainty estimation were applied in connection with a number of industrial components as well as calibrated workpieces. Measurement uncertainty was often used as a parameter for quantification of a selected influence quantity. Uncertainty estimation using the substitution method appeared to be well applicable to CT measurements in production environment. By performing repeated measurements of the calibrated workpiece, characterization of a CT system under study for a specific task part was achieved. The task-specific measurement uncertainty from repeated measurements was then transferred to other uncalibrated workpieces. It was documented in the thesis that CT is a well-established technique for tolerance verification of manufactured parts.

Two reference objects for performance characterization of industrial CT systems were developed within the scope of the Ph.D. thesis. Namely, CT ball plate and CT tree, which were further used for identification, characterization and correction of measurement errors in the CT volume. Their application appeared to be suitable for this task. Because the two objects consist of ruby spheres and carbon fibre, CT scans did not produce image artifacts, and evaluation of sphere-to-sphere distances was robust.

Several methods for scale error correction were implemented to correct original reconstructed volume data sets. This was done using the CT ball plate, the CT tree, the calibrated features measured by CMM and the "data base" approach considering a previous characterization of the CT system with a number of CT measurements using a calibrated ball bar. As, for example, methods using the two reference objects consisting of spheres, is a classical way for correction of the voxel size, when the distance between centres of spheres measured by CT is compared to calibrated measures, the application of calibrated features was documented on a metallic as well as on a plastic part and resulted in comparable observations. The last mentioned method using the "data base" approach seemed to work well, but its applicability shall be further validated.