Robotised laser welding is an innovative joining technique which is increasingly finding applications, especially in the automotive industry. In order to reduce the time needed to prepare and program the laser welding robot, off-line programming systems are used. The off-line programming systems currently available only allow kinematic simulations of the robot motion, which are insufficient for a proper a priori prediction of the ability to weld the seam as dynamic effects in the path tracking accuracy are not taken into account. Combining off-line programming systems and dynamic simulations of the robot motion makes it possible to predict the path tracking errors in advance.

Dynamic simulations require accurate robot models. Furthermore, it is desirable that the simulation is sufficiently time efficient to make the off-line programming process effective and fast. This thesis discusses the dynamic modelling, identification and simulation of a Stäubli RX90B industrial robot to be used for off-line programming for robotised laser welding.

In this thesis, a finite element formulation has been used for the modeling of the robot arm. The model is extended with models of the robot controller and the driving system, including joint friction caused by bearings and gears. At first, phenomenological friction models from the robotics literature were applied. These models included simple Coulomb and viscous friction descriptions. Measurements have pointed out, how-ever, that these models are insufficient to describe the friction behaviour of the robot at the required level of accuracy.

Therefore, a new friction model has been formulated that relies on insights from sophisticated tribological models. The friction model accurately describes the friction behaviour in the full velocity range with a minimal and physically sound parametrisation. The model has been extended in such a way that it is able to predict the joint friction behaviour in the pre-sliding regime during reversals of the joint velocity.

Accurate robot models require model parameters that are known with sufficient accuracy. The model parameters have been found either from information supplied by the manufacturer or by means of identification techniques. For the modelling and identification of the robot controller the information of the manufacturer has been used. The model parameters associated with the inertia properties of the robot arm, the parameters of the gravity compensating spring, the motor inertias and the friction parameters have been found by means of experimental parameter identification.

Using linear least squares estimation techniques the unknown model parameters have been acquired. The problem of parameter identifiability in the presence of unmodelled dynamics and disturbances has been solved using singular value decomposition. Furthermore, scaling techniques have been applied in a way so that all parameters are estimated with the same relative accuracy.
The robot model has been validated by means of closed-loop dynamic simulations. The simulated path tracking errors correspond well with the measured path tracking errors. Furthermore, the measured joint torques correspond with the simulated joint torques. In order to reduce the amount of time needed for the dynamic simulations, a perturbation method has been applied. In this perturbation method, deviations from the nominal motion due to joint friction and limitations of the control system are modelled as first-order perturbations of the nominal motion.

The application of dynamic simulations in off-line programming has been demonstrated by means of three typical welding trajectories. It has been shown that it is possible to a priori detect path tracking errors and to identify trajectory configurations that are too demanding for the robot.