Deep-hole drilling methods are used for producing holes with a high length-to-diameter ratio, good surface finish and straightness. For drilling holes with a diameter of 20 mm and above, the BTA (Boring and Trepanning Association) deep-hole machining principle is usually employed. The process is used during the last production phases of expensive workpieces. For example, axial bores in turbines or compressor shafts are made with this process. In practice, it is necessary that a process monitoring system is devised to detect the dynamic disturbances during the process operation. These disturbances are ususally classified as either chatter vibration or spiralling. The aim of this PhD thesis is to develop such real-time monitoring strategies for the early and reliable detection of chatter vibration and changes in the process by using statistical process control techniques. Such strategies are needed in order to allow engineers to know when and how to adjust the process. In this work, we will focus on the on-line detection of chatter vibration.

This thesis is divided into two main parts. First, it is known that more than one single frequency dominate the process when chatter vibration is observed. Therefore, a new multivariate control chart is developed in order to monitor the amplitudes of these frequencies online. The first part is devoted to the development of the new rank based multivariate exponentially weighted moving average control chart. Simulations are conducted in order the study of its properties and comparisons of its performance against alternative procedures. The second part of this thesis is devoted to the introduction and modelling of the drilling process. Nonlinear time series modelling is used to describe the time varying dynamics of the process. It provides the basis of nonlinear time series based control charts. Finally, the performance of the proposed monitoring strategies is studied using several data sets. The results show that the transition from stable drilling to chatter vibration is quickly detected and that some alarm signals are related to known changes in the dynamics of the process.