The Remaining Useful Life (RUL) is a subjective estimate of the number of remaining years that an item, component, or system is estimated to be able to function in accordance with its intended purpose before warranting replacement. The remaining useful life is estimated based upon observations, or average estimates of similar items, components, or systems, or a combination thereof. For example, the remaining useful life of a roof with a PVC membrane that was installed approximately seven years ago and was poorly maintained might be approximately ten years. The Remaining Useful Life of building components and systems is noted in a Property Condition Assessment and is used to help calculate expected short- and long-term capital expenses required to maintain a property.

This thesis focuses on the prognosis of critical component failure and the estimation of the residual life before failure (RUL). We have developed methods based on experience. This orientation allows us to free ourselves from the definition of a failure threshold, a problematic point when estimating the RUL. We relied on the Case-Based Reasoning (CBR) paradigm to track a new critical component and predict its RUL. An instance-based approach (IBL) has been developed by proposing several formalizations of the experiment: a supervised one taking into account the state of the component in the form of a health indicator and an unsupervised one aggregating the sensor data into a series. mono-dimensional time forming a degradation trajectory. We then evolved this approach by integrating knowledge into these instances. Knowledge is extracted from sensor data and is of two types: temporal, which completes the modeling of instances, and frequency, which, associated with the similarity measure, makes it possible to refine the recall phase. The latter is based on two types of measurements: one weighted between parallel and fixed windows and one weighted with temporal projection. The windows are sliding which makes it possible to identify and locate the current state of degradation of new components. Another data-oriented approach was tested. This is based on characteristics extracted from experiences, which are mono-dimensional in the first case and multi-dimensional otherwise. These characteristics will be modeled by a support vector regression (SVR) algorithm. These approaches were evaluated on two types of components: turbojets and "LI-ION" batteries. The results obtained are interesting but depend on the type of data processed.