# PhD Proposal 2016

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<td><strong>Collaboration with other partner during this PhD:</strong></td>
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**Title:** Data-driven approaches for Prognosis and Health Monitoring (PHM) – From theory to application.

**Scientific field:** Automatic control, signal processing

**Key words:** Prognosis, Health monitoring, Data bases, Data-driven approach
Details for the subject:

Background, Context:
Optimizing the process availability cannot be reached by reducing the global cost of the process life cycle when maintenance is not predictive. On the one hand, corrective maintenance is commonly used even if it has many limitations due to production stops and downtime, when a failure occurs; on the other hand, preventive maintenance is used to avoid any production stops and to prevent the safety.

Neither corrective nor preventive maintenance gives good results in industrial processes. Indeed, the costs of the downtime and the equipment replacement can be substantial as well as unnecessary planned maintenances. In order to increase to maintenance performances, the operating conditions have to be taken into account.

In last decade, a new field in automatic control, called prognostics, has been developed. It is not just an extension of fault detection and isolation (diagnosis), it is a complete new field. In the diagnosis point of view, the goal is to detect, to isolate and to identify faults when they occur on a process. In the prognostics point of view, the goal is different and consists in the prediction of the process breakdown by taking into account the operating conditions. A first step consists in the health assessment, which leads to a second step, the health monitoring, and to a third step, the prediction of the Remaining Useful Life (RUL).

This new tool in automatic control has a large impact on industrial plants; it prevents large damages and enables to adapt the process maintenance.

In this context, many works have been done to propose different tools of prognostics and to achieve a better process control. The PHM society (www.phmsociety.org) has been created to promote collaborations with a free access to PHM knowledge. The LSIS is one of the pioneers in this new field in France.

Different approaches exist in the literature. For specific processes like aircrafts, pipelines, dampers, concretes, etc, material specifications and micro structural considerations are known and a damage function is defined. In this context, the health monitoring is essentially based on the definition of the damage function [1] [2] [3]. When the damage model is unknown, an approach consists in the estimation and the identification of the function of the damage model. This approach is presented in [4] [10] for instance.

In the literature [5] [6], some generic approaches are proposed, they consist in the application of damage abacuses, each abacus is associated to a specific operating conditions. The method consists to decompose a mission into several submissions (subtasks) [8]. In each submission, the environmental, operating conditions are similar and the damage trend is the same. The global trend is the result of trend concatenation of submissions.

Another approach is proposed in [7] [9] [10] [11] and uses a database to learn and "drive" the process prognosis. This method does not use any a priori knowledge from the process characteristics.

Research subject, work plan:
After a deep bibliographic research on prognostics approaches, the PhD student will work on fundamental approaches of data driven prognostics methodologies with an application on experimental tests.

The first step in data driven prognostic is to develop degradation indicators associated to the process health. Indeed, the indicator evolution assesses and trends the system health according to deterministic or statistical methods [9] [11].

The second step is to trend measurement and indicator deviations from their normal operating conditions. Several methods can be used like regressions, least square estimations, other
approaches use the principle components analysis, canonical variant analysis, model-based estimation [4] [10], for instance. The aim is to provide different tools and to compare them. The last step is to determine the RUL according to the trend estimation and future operating conditions. The aim of this work will consist in building a complete generic approach based on the above cited steps. This approach will be validated using experimental tests.

Good knowledge in automatic control is required as well as a good English speaking. The PhD student will be welcome in LSIS (Marseille, France) in ESCODI team.

References: