Doctoral studies:
Sensitivity methods for tolerance analysis

Context:

Manufacturing processes introduce geometrical imperfections. Hence, two parts collected on the same assembly line have slightly different shapes, and their dimensions are also different from the designer's request. Such imperfections have detrimental effects on the performance of mechanical components, and the designers need to take them into account, for instance by associating a tolerance interval with each dimension of a component.

The probabilistic approach provides a suitable framework to consider such imperfections, the dimensions of a part can be modeled using random variables and the uncertainties are subsequently propagated to the response of the system. The scatter associated with the system's performance is characterized, which allows designers to check whether the quality requirements are fulfilled.

These PhD studies are included in the AHTOLAnd project, coordinated by the company Phiméca and funded by the French *Fonds Unique Interministériel* (FUI).

Description of the project:

The objective of the PhD studies is the implementation of numerical methods for the identification of the so-called critical dimensions, i.e. the dimensions with a major impact on the performance of the system. This is an important matter as additional inspection efforts are deployed during the manufacturing for the critical dimensions.

The use of sensitivity analysis (e.g. Sobol', Morris or Borgonovo indices) looks promising in this context, and will be investigated in depth during the doctoral studies. A special emphasis will be laid on the over-constrained systems with gap variables. These extra variables introduce additional complexity in the problem. Previous research efforts allowed solving this problem when a reliability analysis is performed[1,2,3]. This issue is not addressed in the literature in the case of sensitivity analyses and it will be investigated during the PhD studies.

Background: A manufacturing-oriented engineering degree (e.g. mechanical design, structural engineering or industrial engineering) and/or experience with stochastic methods, with an interest for numerical analysis.

Language: French and/or English (knowledge of French is not mandatory, but would be helpful in daily life).

Funding: A three year contract starting in fall 2016 with preparation of the PhD dissertation.

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[1] A. J. Qureshi, J.-Y. Dantan, V. Sabri, P. Beaucaire, N. Gayton, A statistical tolerance analysis approach for over-constrained mechanism based on optimization and Monte Carlo simulation, *Computer-Aided Design*, 44(2):132-142 , 2012.

[2] P. Beaucaire, N. Gayton, E. Duc, J.-Y. Dantan, Statistical tolerance analysis of over-constrained mechanisms with gaps using system reliability methods, *Computer-Aided Design*, 45(12):1547-1555, 2013.

[3] A. Dumas, N. Gayton, J.-Y. Dantan, B. Sudret, A new system formulation for the tolerance analysis of overconstrained mechanisms, *Probabilistic Engineering Mechanics*, 40:66-74, 2015.