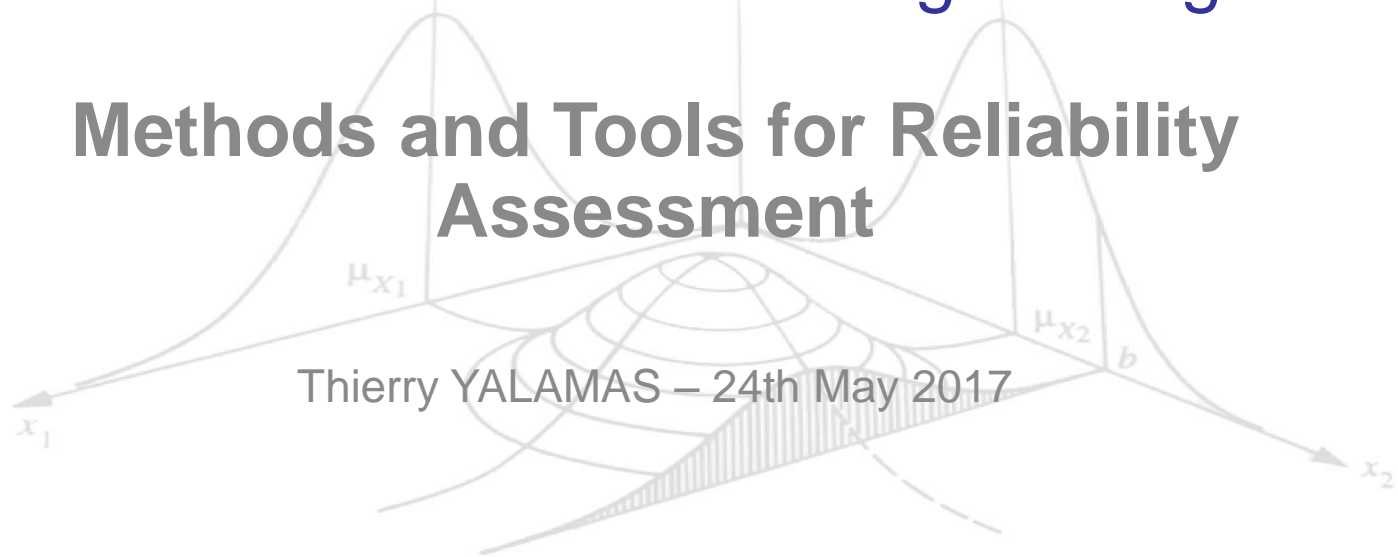


PHIMECA

Solutions for Robust Engineering

Methods and Tools for Reliability Assessment



Thierry YALAMAS – 24th May 2017

Robust engineering ?

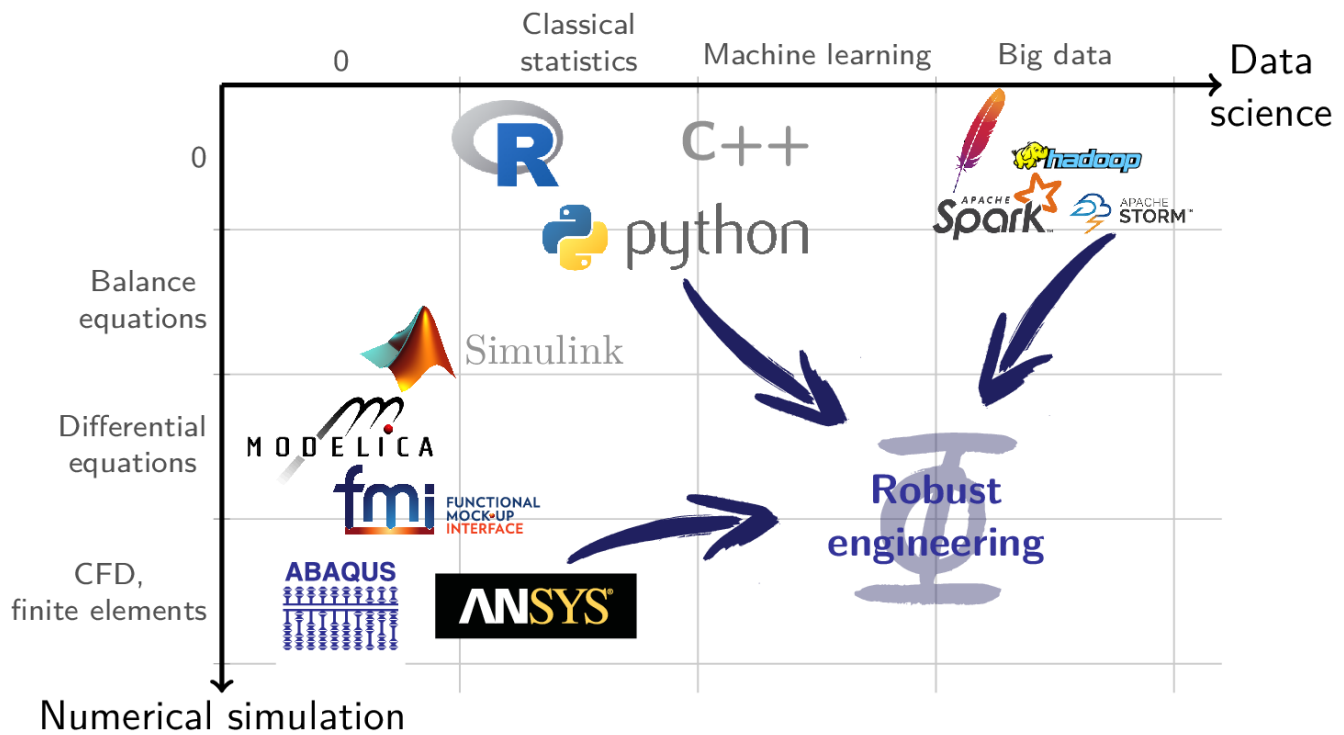
Why?

- Uncertainty / uncertainties are part of the life of any system / infrastructure: uses, environment, choice of architecture
- Yet an engineer seeks to design and maintain systems
 - Robust: insensitive to variations of environment or use in particular
 - **Reliable: with guaranteed performances over a fixed lifetime – Probabilistic assessment of performances**
 - And economic (to produce and / or to maintain)!

How? For 15 years, Phimeca's approach has been based on combination

- From the modeling of physics: 3D modeling (finite elements) or 0D / 1D modeling
- From data modeling: data mining or expert models
- In compliance with regulatory / regulatory frameworks

Robust engineering ?



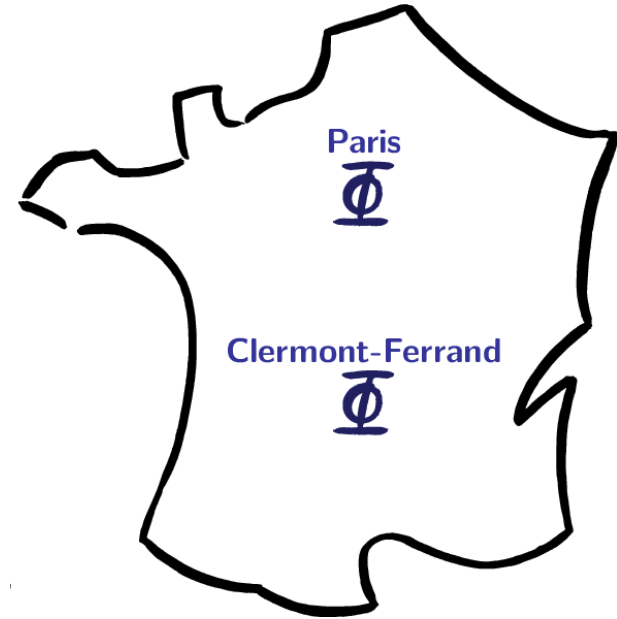
Phimeca in figures

Identity card

- SME founded in 2001
- Based in Clermont-Ferrand and Paris

Main figures

- Turnover : 1,5 M€
- R&D : ~ 15% of the turnover
- 21 employees (19 engineers or doctors)



Some references

Automobile



Aéronautique



Défense



Energie



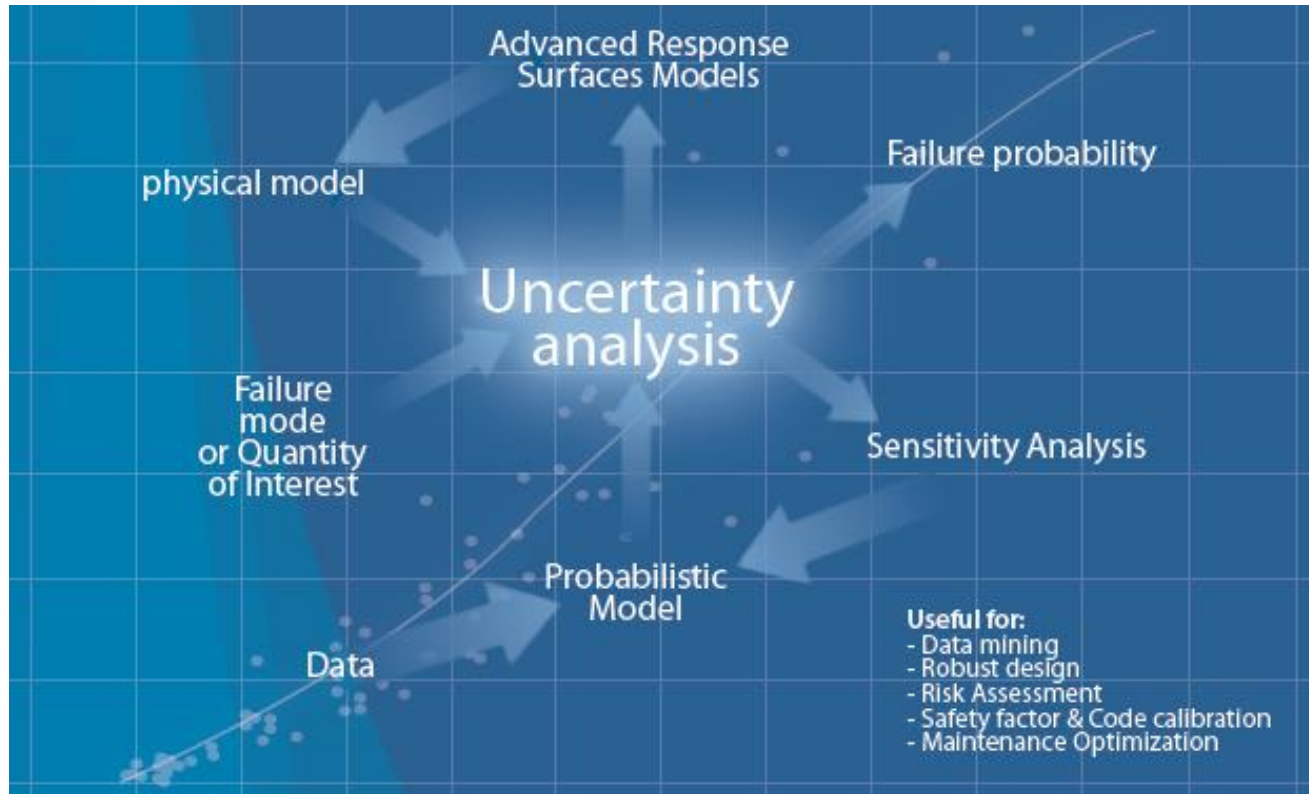
Construction



Autres secteurs



Uncertainty analysis



Main probabilistic methods

☐ For sensitivity analysis

- Monte Carlo : distribution and correlation analysis, sensitivity
- Quadratic cumul (Taylor)

☐ For reliability analysis

- Simulations : Monte Carlo, Directional Simulations, Conditional Simulations, Subset Simulations
- FORM/SORM (approximation methods), Importance Sampling
- Advanced Methods : 2SMART, Méta-IS, AK-IS... combination of surrogate models and more classical methods

Several types of tools

- ④ **Scientific library** : with a scientific (mathematical) point of view several general scientific library cover uncertainty/reliability aspects
- ④ **Objectives Driven Engineering Platform (Optimisation)** : initially dedicated to describe simulation workflows for optimisation purposes, they include more and more « robust » design modulus
- ④ **Reliability Softwares**: softwares specifically designed for numerical reliability assessment

Scientific library

Matlab World

- FERUM (Berkeley & Sigma – Clermont): <http://www.ifma.fr/FERUM>
- UQLab (ETH Zurich) : <http://www.uqlab.com/>
- OpenCOSSAN (University of Liverpool) :
<http://www.cossan.co.uk/software/open-cossan-engine.php>

Python World

- OpenTURNS (Airbus, EDF, Phimeca): <http://www.openturns.org>
Open Source software !

 R World: numerous packages on statistics, reliability, etc...

Optimisation (workflow) platforms

☐ Optimus - www.noesissolutions.com/Noesis

☐ optiSLang – www.dynardo.de

☐ modeFrontier - <http://france.enginsoft.com/modefrontier/index.html>

☐ All these platforms contain MonteCarlo, approximation methods (FORM/SORM) but not too many other methods

Reliability Software content - PhimecaSoft

- ☐ **Design domain exploration** : plan of experiment & deterministic sensitivity analysis
- ☐ **Probabilistic model** : statistical data analysis or user defined probability distribution
- ☐ **Sensitivity/distribution analysis**: Monte Carlo, Taylor, Sobol Index
- ☐ **Surrogate modelling**: Polynomial chaos expansion, SVM, Gaussian Process
- ☐ **Reliability analysis**:
 - Simulations: MonteCarlo, Directional sampling, Conditionnal sampling, Subset simulations
 - Approximation methods: Form/Sorm, Importance sampling
 - Advanced methods: 2SMART (Subset + SVM)

Reliability Software - PhimecaSoft

- ☐ Aim: make easy the use of complex methods
- ☐ Based on OpenTURNS scientific library with a convivial Graphical User Interface
- ☐ Non intrusive methods: PhimecaSoft may be used linked with any (Finite Element) Software
- ☐ Next step (2017-2018): easy link and/or integration in Ansys, Optimus or other software

<http://www.phimeca.com/PhimecaSoft-107>

Reliability Softwares

- ☐ Cossan-X: software based on OpenCOSSAN
- ☐ Nessus: initially developed for NASA purpose <http://www.nessus.swri.org>
- ☐ Proban: distributed by DNV <http://www.dnv.com.cn>
- ☐ STRUREL: initiated at Munich University <http://www.strurel.de>

I thank you for your attention !

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