
# UMRIDA Final Report

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## 4.1 Final publishable summary report

This section must be of suitable quality to enable direct publication by the Commission and should preferably not exceed 40 pages. This report should address a wide audience, including the general public.

The publishable summary has to include **5 distinct parts** described below:

- An executive summary (not exceeding 1 page).
- A summary description of project context and objectives (not exceeding 4 pages).
- A description of the main S&T results/foregrounds (not exceeding 25 pages),
- The potential impact (including the socio-economic impact and the wider societal implications of the project so far) and the main dissemination activities and exploitation of results (not exceeding 10 pages).
- The address of the project public website, if applicable as well as relevant contact details.

Furthermore, project logo, diagrams or photographs illustrating and promoting the work of the project (including videos, etc…), as well as the list of all beneficiaries with the corresponding contact names can be submitted without any restriction.

**Executive Summary**

Virtual prototyping (VP) is a key technology for environmental friendly and cost effective design in the aircraft industry. However, the underlying analysis and simulation tools, are currently applied with a unique set of input data and model variables, although realistic operating conditions are a superposition of numerous uncertainties under which the industrial products operate (uncertainties on operational conditions, on geometries resulting from manufacturing tolerances, numerical error sources and uncertain physical model parameters). Major new developments in this new scientific area of Uncertainty Management and Quantification (UM and UQ) and Robust Design Methods (RDM) are needed to bridge the gap towards industrial readiness. The UMRIDA project, which stands for Uncertainty Management for Robust Industrial Design in Aeronautics, addresses these objectives by performing major research in both UQ and RDM and developing methods to handle a large number of simultaneous uncertainties including generalized geometrical uncertainties within a quantifiable objective of a turn-around time acceptable for industrial readiness. To assess the quantifiable objective, the developed methods are applied to a unique database with prescribed uncertainties build from industrial challenges provided by the project partners.

Research was performed in both UQ and RDM and developing methods to handle a large number of simultaneous uncertainties including generalized geometrical uncertainties within a quantifiable objective of a turn-around time acceptable for industrial readiness. A series of different methodologies was investigated and successfully assessed on the unique database with prescribed uncertainties, which was built from industrial challenges provided by the project partners. The UMRIDA project allowed to raise the Technology Readiness Level for various methodologies for UQ and RDO from a basic level 2-3 to an industrial applied level of 5-6, demonstrated by the application of the developed methods to industrial challenges form the UMRIDA database while respecting the quantifiable object defined. The turn-around times of these methods are at the end of the project appropriate for use in daily engineering practice. This was achieved by reaching speed-ups of 5 to 10 for all methods investigated by the consortium partners.

The UMRIDA project reached nearly all objectives and in its whole clearly responds to all main challenges and goals that were set out to reach at the start of the project. The UMRIDA database with prescribed uncertainties formed the backbone of the project, and it was used for assessment of the developed uncertainty quantification and robust design optimization methodologies. The developed UQ and RDO methods are now in use by the industrial project partners, and software vendors integrated the findings of the project into their commercial software offer. First functionalities have been available to their clients since mid-term of the project on and the availability of methods is constantly enlarged. Some industrial and academic partners contribute to in-house or open source libraries, which equally have been extended throughout the project.

## Summary description of project context and objectives

The ultimate objective of aircraft design methodologies, within a fully computerized design environment based on the concept of Virtual Prototyping (VP), is to rely essentially on analysis: Computer Aided Design (CAD) definitions for the geometry, Computational Fluid Dynamics (CFD) for the aerodynamic loads and noise sources; Computational Structural Mechanics (CSM) for stresses and lifetime evaluations, including combined Fluid-Structure Interactions (FSI); Conjugate heat Transfer (CHT) for heat fluxes and heat transfer; Combustion modelling for emissions; Computational Aero-acoustics (CAA) for noise estimations. This objective should lead to a shorter design cycle, with fewer costly tests and as importantly, fewer redesigns due to unanticipated test results. An important limitation of the extensive application of analytical tools, at the basis of virtual prototyping, is connected to the **level of uncertainty** they introduce **in the analysis and design process.**

For example, when performing 3-D viscous flow analysis of engine components, there is uncertainty in the definition of the boundary conditions representing the operational environment; in the discrepancy between the CAD geometry and the real geometry resulting from the manufacturing tolerances and assembly process; in the true deformed geometry of the parts being analysed at engine operating conditions. In addition, modelling uncertainties are present, resulting from imperfect models for turbulence, multi-species reaction rates, or combustion; as well as numerical errors from the set-up of the simulations (such as grid dependencies, or convergence levels).

This leads to a **global uncertainty on the results of the analysis**, on which design decisions have to be taken. The ability to **quantify the impact of these uncertainties on the predicted behaviour** of aeronautical components and to **account for these uncertainties in the design process** is crucial for a **reliable risk management** and better estimates of safety margins. Managing the design process in light of these uncertainties is therefore the key to robust design.

Introducing the probabilistic nature of uncertainties in simulation software systems, is a highly challenging undertaking, as the whole process transforms the resolution of deterministic physical conservation laws, to **non-deterministic methods**, governed by stochastic partial differential equations (SPDE). As a consequence, predicted quantities, such as loads, lift, drag, efficiencies, emissions, noise, …., are not represented anymore by single numbers, but by a *Probability Density Function* (PDF), providing a domain of confidence, associated to the considered uncertainties, introducing hereby a **fundamental shift in paradigm** for the whole of the VP methodology.

The main concept is summarized in Figure 1. The current deterministic approach is to set single valued computational conditions, leading to a single value for the output quantity □ (in red). When the uncertainty is introduced by a PDF, the output quantity is also transformed into a probabilistic quantity. Figure 1 illustrates this fundamental change, which can be strongly dependent on how the input uncertainty parameter is defined. From the output PDF, one can derive the C*umulative Distribution Function* (CDF), leading to the definition of a domain of variation for a given level of confidence, say 95%. This is shown on the right side of Figure 1, which shows the predicted PDF and CDF for the drag on an airfoil with geometrical uncertainties. The vertical bar represents the deterministic prediction.

**A very important property**, shown intentionally on this Figure I.1.1, **is that the deterministic output, corresponding to the mean value of the input uncertain variables, is <u>not equal</u> to the mean value of the output PDF.**

The importance of assessing and quantifying the various uncertainties affecting the virtual prototyping process, in particular in aeronautics, has been growing significantly in the last few years in Europe and in the US, and in particular as an outcome of the FP6 project NODESIM-CFD (Non-Deterministic Simulations for CFD-based Design Methodologies), precursor of this UMRIDA project.

The incorporation, up to an advanced industrial level of uncertainties in the VP methodology, has become a major necessity, in order to reduce the risks associated to the design decisions based on numerical simulations and virtual prototyping.

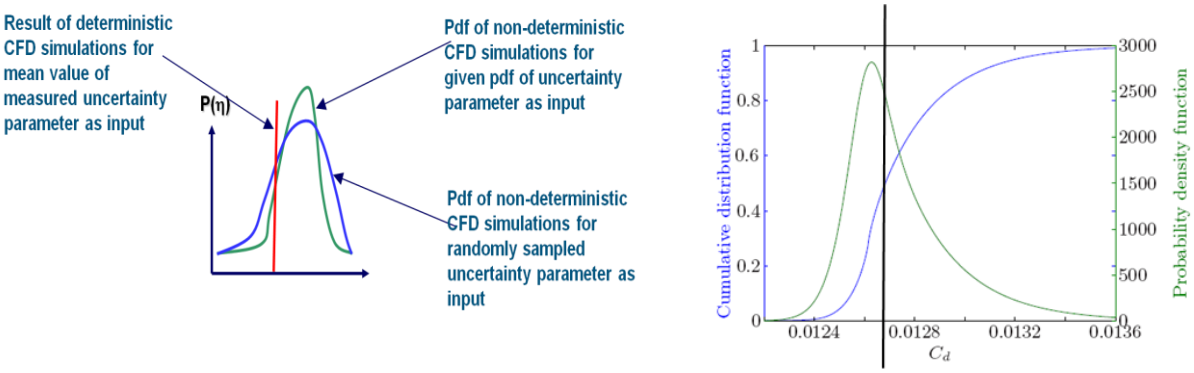


**Figure 1: The main concept of non-deterministic simulations**

**Scientific and technical objectives**

The UMRIDA project focuses on uncertainty management at all levels of the analysis and design process and it is believed to offer a significant potential for innovative and safer designs. The technical objectives of UMRIDA can be summarized as follows:

**Objective 1**: Develop innovative methods for UQ and RDM to respond to the main challenges mentioned above

**Objective 2**: Develop new methods for the large-scale introduction of the UQ methodologies in robust design methods, in order to produce designs incorporating the major uncertainties.

**Objective 3**: Apply the developed UQ and RDM methods to complex systems of particular interest for the aeronautical industry. To achieve this objective, industry has pre-defined Industrial application Challenges (IC's) ***with prescribed uncertainties***, including multi-physics applications, demonstrating the industries strong needs for UQ and RDM methods in their day-to-day work. This leads to a ***new generation of database***, including whenever possible, new experimental data with controlled uncertainties, on which the methods will be tested and *validated*, as well as **best practices** in the application of UQ and RDM to industrial cases.

**Objective 4**: Advance UQ and RDM to the Technology Readiness Level 5-6 from a presently estimated TRL of 2-3. Figure 2 illustrates this in relation to the pre-cursor project NODESIM-CFD. A quantifiable objective is set by the industrial partners as: **handling at least 10 simultaneous uncertainties, in a turn-over time of no more than 10 hours on a 100 core parallel processor.**

**Objective 5**: Facilitate co-operation and dissemination of UQ and RDM awareness towards European industries, research establishments and universities and foster co-operation between different industries as airframe, turbo-engines, helicopters, and sea and ground transportation, including the European CleanSky project.

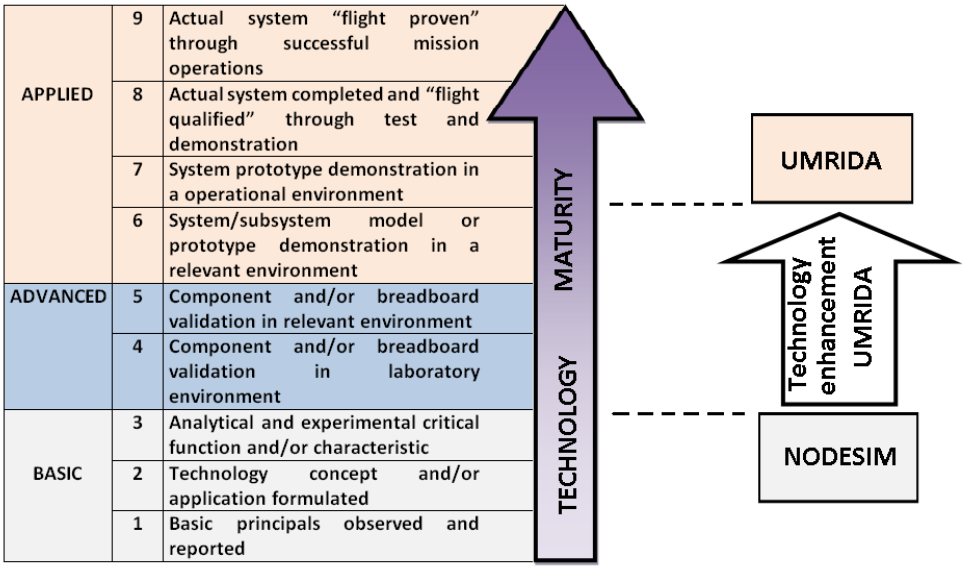


**Figure 2**: Progress in Technology Readiness Level (TRL) during the UMRIDA project.

Reaching these objectives will enable industry and all partners involved:

To strengthen the competitiveness of the European Aeronautical Industry, since UQ and RDM are not yet systematically used in industry (apart from some very few attempts on research level). It is expected that, at the outcome of the project, the innovative UQ and RDM methodologies, to be developed in UMRIDA, will be ready to being applied at a wider scale in the aeronautical industry.

To secure global leadership by promoting the novel UQ and RDM methods in day-to-day industrial practice, beyond Aeronautics, towards other Transport areas, such as Land and Sea. The downstream objective of the UMRIDA project is to contribute to the integration of generalized risk analysis into all design practices whereby safety margins and the associated risks are identified at each level of the product development.

**Progress beyond the state of art**

In order to reach these objectives, a significant progress beyond the state of the art is needed. The activities of UMRIDA project partners can be grouped into three main fields of activity:

**I. Advance methods for uncertainty quantification**

Three different approaches for uncertainty propagation are investigated. First, **Method of moments (perturbation method) and adjoint based methods;** the principle of these methods is the use of a Taylor series to expand an output quantity around its mean. The key element here is the evaluation of first and second order sensitivity derivatives in this Taylor series. Second, **Monte-Carlo Methods (Multi-Level Monte-Carlo)** are studied by several partners. The basic idea is to perform a high number of deterministic simulations with sampled parameters and evaluate output quantities on different levels in order to reduce significantly the computation time in comparison with standard Monte-Carlo methods. Third, non-intrusive **polynomial chaos or collocation methods** are investigated. In these methods the principle resides in the expansion of the solution into a polynomial chaos or an interpolating polynomial, which forms an approximation of the solution around the uncertainties.

**II. Characterization of most influential uncertainties and dimension reduction**

A second approach to tackle many simultaneous uncertainties is to determine the most influential uncertainties in the problem and solve only for these, in order to reduce the dimensionality of the

problem. This implies that the input uncertainties are well known, which represents a challenge in itself for many industrial problems.
Thus, a first line of action is the accurate **quantification of input uncertainties.** Output PDFs are dependent on the shape of input PDFs and it is necessary to develop a methodology that allows to derive correct information for input PDFs from generally scarce experimental data or knowledge. A second line of action is the **identification of the most important uncertainties** in the problem description. A third line of action focuses on **Surrogate models or Reduced order models** for the description of aerodynamic or turbomachinery test cases.

III. **Advances in robust design and optimization methodologies**
The last year of the UMRIDA project will focus on Robust Design Optimization techniques. The objective of robust design is to produce **designs which are less sensitive to variations of conditions/parameters** due to uncertainties. In general it must be noted that **design under uncertainties is a new field of research** and it is unclear so far how to enforce robustness, robust objective/constraint formulations and dependence on used optimizers within an industrial design environment. These issues are addressed within UMRIDA.

## Main S&T results/foregrounds

**Novel and unique database with prescribed uncertainties**
A unique database with prescribed uncertainties for UQ and RDM was built within the UMRIDA project. The purpose of the generic methodology description is to be (partly) independent from the specific use case, thus allowing for a common view by all partners on the different test cases. A common language of all partner's use case descriptions enables for easier collaboration and better means of comparability of different methods within the project. For this purpose a test case description template has been used for the description of all test cases differentiating between the test case description and the definition of uncertainties. Finally, the database comprises of four basic test cases and nine industrial test cases spanning a range of applications as diverse as 2D cases to full 3D cases for exterior aerodynamics, turbo machinery design, and multi-disciplinary applications such as aero- and thermo-acoustics, and fluid-structure interaction.
The database test cases with prescribed uncertainties were used throughout the project by the project partners as benchmarks for the development of various UQ and RDO methodologies and in particular for the workshops on UQ held in Delft on the 15th till 16th of April 2015 and on RDO held in Brussels from 21st till 23rd of September 2016. The database formed thus the backbone of the activities within UMRIDA and fulfills one part of objective 3 defined above.

**Progress in methods for Uncertainty Quantification (UQ)**
The work with respect to uncertainty propagation performed within UMRIDA is based on three classes of uncertainty propagation techniques: Method of moments (perturbation method) and adjoint based methods; Sampling, Monte-Carlo and Multi-Level Monte-Carlo Methods; polynomial chaos and collocation methods. These are applied to operational and geometrical uncertainties, uncertainties resulting from the manufacturing and assembly process, and modeling (epistemic) uncertainties, and by some partners combined with techniques that rely on surrogate modeling.

The general speed-up reached by the developed methods is in the order of 5-10, when compared to standard approaches. In some cases the speed-up compared with the situation at the start of the project can be significantly larger, if for example sparse grid techniques are compared with full tensor grids. Tables 1 to 3 provide an overview of speed-ups reached for the various UQ methods.

Table 1. Speed-up achieved by the consortium for Polynomial Chaos and Collocation methods if applied to database test cases.

| Polynomial Chaos and Collocation methods | | | | | |
|---|---|---|---|---|---|
| Partner | Method | Test case | Number of uncertainties | Speed-up | Reference for speed-up |
| Airbus Group Innovation | Sparse PC OpenTurns 1.4 (OT1.4) | IC-02 | 8 geometrical 2 operational | 18 | OT1.2 |
| ESTECO | Adaptive sparse PC | BC-02 | 11 geometrical 2 operational | 7 | Classical PC |
| ONERA | Compressive sampling | BC-02 | 1 geometrical 2 operational | 12.5 | Tensorized sampling |
| NUMECA | Sparse Probabilistic Collocation | BC-02 | 10 geometrical | 8.3 | Classical PC with regression |
| | | BC-01 | 6 geometrical 3 operational | 7.2 | Classical PC with regression |
| VUB | Reduced basis method with regression based PC | BC-02 | 10 geometrical | 6.7 | Classical PC with regression |
| | | BC-01 | 19 geometrical 2 operational | 4.6 | Classical PC with regression |

Table 2. Speed-up achieved by the consortium for Monte-Carlo and sampling techniques if applied to database test cases.

| Monte-Carlo and sampling techniques | | | | | |
|---|---|---|---|---|---|
| Partner | Method | Test case | Number of uncertainties | Speed-up | Reference for speed-up |
| CIMNE | Multilevel MC | BC-02 | 13 | 5 | Class MC |
| DLR | Quasi MC + gradient enhanced surrogates (Kriging, RBF, PC) | BC-02 | 26 geometrical 2 operational. | 5-6 | Class. Quasi MC |
| TU Dresden | (Extendible) LHS | IC-09 | 15 geometrical | 10 | Class MC (random sampling) |

Table 3. Speed-up achieved by the consortium for perturbation techniques if applied to database test cases.

| Perturbation techniques | | | | | |
|---|---|---|---|---|---|
| Partner | Method | Test case | Number of uncertainties | Speed-up | Reference for speed-up |
| Finmeccanica + INRIA | Automatic differentiation | BC-02 | 12 geometrical 2 operational | 2.5 | Finite Diff |

The above methodologies were applied to test cases from the UMRIDA database, showing that the UMRIDA quantifiable objective is successfully reached by several partners by applying a variety of methods (Reduced basis method, Method of moments, Level 2 sparse grid, Multi-Level Monte Carlo, Gradient-Enhanced Kriging) to deal with test cases from the UMRIDA database (BC-01, BC-02, BC-03). Industrially relevant and representative test cases (IC-03, IC-04, IC-05, IC-06 and IC-09) were also successfully handled. Finally, UQ strategies were applied to non-aerodynamic cases, including thermo-acoustics, acoustics and aero-elasticity with up to 10 operational and geometrical uncertainties. INRIA developed a set of numerical methods for the reduction and estimation off numerical errors and applied it reaching the UMRIDA quantifiable objective to the test case IC-03. This work contributes to reaching the objectives 1, 2, 3, and 4, which are listed above.

**Progress in characterization of most influential uncertainties and dimension reduction**

A first very important step in the quantificaiton and propagation of uncertainties is the correct quantification of input uncertainties. TU Dresden and Airbus Group Innovation focused on measurement of production scatters. There are several problems to address in quantification of geometry variability due to production. These include the analysis of point cloud data, data reduction (as the avaliable data is in many cases substantial) and statistical analysis. MAN Diesel & Turbo Schweiz worked on methods for identification and quantification of input experimental uncertainties. The lifecycle of turbo machinery was outlined and the major documents that deliver data for the input uncertainty quantification were identified. These documents are instructions, drawings, guidelines, and protocols. The identified uncertainties were used to analyse and improve internal manufacturing instructions for rotating parts.

Several partners worked on dimension reduction techniques in order to reduce the cost of uncertainty propagation techniques. VUB worked on reduced basis methods coupled with regression based polynomial chaos, where coarse mesh solutions were used to sample a covariance matrix, which in return was used to reduce the dimensionality of the problem. Techniques based on Karhunen-Loeve Decomposition or Principal Component Analysis were applied by several partners to random fields representing production variability or to the handling of correlated engineering parameters. On such reduced bases CIMNE and NUMECA used non-intrusive uncertainty quantification methods: MLMC and Probabilistic Collocation respectively. Two partners (WUT and FNM) developed 1$^{st}$ and 2$^{nd}$ order sensitivity methods for their in-house solvers, with the help of INRIA on the usage of their automatic differentiation software.

Surrogate modelling techniques for airfoils were used by ONERA and DLR. ONERA worked on Kriging-based surrogate models for the lift-to-drag ratio, while DLR worked on adaptive gradient-enhanced surrogate models, using the adjoint TAU code, and compared the efficiency and accuracy with Kriging, direct integration (Quasi MC) and full MC reference statistics.

This work contributes to reaching the objectives 1, 2, 3, and 4, which are listed above.

**Progress in robust design and optimization methodologies**

The challenge for Robust Design Optimization lies in coupling optimization methods with the UQ approaches developed in the project. Most of the partners used the UMRIDA database test cases including industrial challenges (IC) for the assessment of their developed methods. The geometries to be optimized were described using both deterministic (nominal) design parameters and stochastic variables. In some of the applications the number of stochastic variables exceeded 10, which was set as a threshold to be achieved to ensure the success of UMRIDA. The stochastic objective functions were optimized by using gradient-free algorithms, which are easy to implement for various types of stochastic quantities, whereas VUB formulated a gradient-based

method using an adjoint solver. All uncertainty propagation techniques developed within UMRIDA were used, i.e. polynomial chaos or collocation methods, sampling based methods and Multi-Level Monte-Carlo, and perturbation methods. Different objectives functions were formulated to obtain robust or even reliability based approaches. Finally, the developed robust design frameworks were demonstrated mainly by using high-fidelity methods such as RANS solvers for CFD simulations. The different partners demonstrated that methods for uncertainty quantification can successfully be integrated into design optimization frameworks to achieve a robust and reliability-based design capability based on high-fidelity CFD. The successful application of RDO to industrial challenges from the UMRIDA database was demonstrated during the final UMRIDA workshop, where RDO techniques were applied to the basic challenges BC-01 and BC-02, and to industrial challenges IC-02, IC-03, IC-04, IC-05, IC-06, and IC-07. The computational resources needed for RDO were judged acceptable in an industrial context. This work contributes to the objectives 1, 2, 3, and 4 listed above.

## Potential impact – dissemination/exploitation

Research innovation is a driving force for economic growth, the creation of new job opportunities and the enhancement of the standard of living. Communicating research results can effectively accelerate research and technical development (RTD) towards increasing the technology readiness level (TLR), overpassing boundaries beyond the current state of the art, and even creating new research horizon lines on future and emerging trends.
Communication, dissemination and exploitation activities are a crucial part of all FP7 projects in order to ensure the wide use and dissemination of the knowledge generated, thereby promoting further scientific developments and maximizing the impact of the project.
All UMRIDA partners have actively participated in the realization of dissemination and outreach activities throughout the entire project duration. A significant number of scientific publications in highly-ranked journals have been recorded, while UMRIDA was also presented in various major scientific fora across Europe, as well as on an international level.
Furthermore, since the beginning of the project, all partners have contributed to the development of exploitation scenarios for the project outputs, thus maximizing the project's impact even after its end.
In what follows, a brief summary of the main activities realized for the dissemination and exploitation of the UMRIDA results is presented.

**Methodology and Planning**
In order to ensure the effective dissemination and exploitation of the project's results, a Dissemination and Exploitation Plan (DEP) was developed during the first months of the project. The UMRIDA DEP has been continuously updated throughout the entire project lifetime based on contributions from all the partners. The aim of this plan was to introduce a strategy for identifying opportunities, coordinating activities and ensuring the maximization of the project's impact, by diffusing its progress and achievements to the industry, scientific community and the general public.
Indeed, the various target groups had been identified and different communication tools and channels were considered as the most appropriate per case. More specifically, the scientific community was highly reached through publications and scientific presentations, industrial representatives were approached through exhibitions, forums and newsletters, while the general public was targeted through publications in popularized media.
Furthermore, a timeline of activities was developed, where the dissemination and exploitation objectives had been introduced across the project's lifetime, following its progress and needs. According to each running period, the dissemination and exploitation objectives would vary and thus, the target activities were changing and evolving accordingly.
More specifically, during the first months of the project the focus was based on the development of communication material for raising awareness for the project. Shortly after the first semester, the first set of results was delivered and UMRIDA was presented in various conferences and referenced in multiple scientific papers. Following the project's development, a significant number of activities was realized towards and after the first half of the project. That was a key point in the project's timeline, where the first significant outputs on UQ had been generated and the 1$^{st}$ UMRIDA Workshop on UQ was organized. The final semester was also

significantly productive in terms of dissemination and outreach activities. By the end of the project, partners had completed their experiments and their final results on Robust Design Optimization were available. Again, at this time, the 2nd and final UMRIDA Workshop was realized.
We are now in the post-UMRIDA period, where the project has been successfully completed, however its legacy still lives on. A number of publications and conference presentations are planned to take place during 2016 and 2017, while exploitation activities have been defined for putting in use the project results in both short and long-term applications.

**Communication Material**
In order to effectively support the dissemination activities of the project, it was important to allow UMRIDA to have an "image" which would be communicated to the world. To this end, it was necessary to create an UMRIDA visual identity, which would mark the project recognizable across events, dissemination and communication actions.
First of all, a unique project logo was developed during the first month of the project, and afterwards a project leaflet and poster were created. These included generic information discussing the project's objectives, methodology and expected outcomes. Hard copies were distributed to all consortium partners, in order to facilitate them to their dissemination and networking activities.
Furthermore during the first semester, a dedicated website was developed and became available at www.umrida.eu. The public website acts as a 24/7 online reference point for the project and it includes information on the general scope of UMRIDA's motivation and challenges. The website had been continuously updated with the project news and progress updates, while further updates are being realized even after the end of the project with regards to dissemination activities (i.e. list of publications, etc.) and other news.
The project's visual identity was also followed during the UMRIDA 1st Workshop on UQ and 2nd Workshop and Symposium on UQ and RDO. Announcements were developed and distributed via e-mail, in order to communicate the events' scope, and to attract participants by offering information on keynote speakers and key dates.

**Dissemination Activities**
An extremely imperative precondition so as to ensure augmented exploitation, high impact and increased likelihood of uptake of the project's results, is to prudently and effectually disseminate and communicate the appropriate information to the relevant and interested audiences in a concise and well-articulated manner. Dissemination activities mainly include publications in highly-ranked journals and participations in high-impact scientific events, and aim to spread the project research and results to the scientific community, towards enhancing its scientific impact.
Dissemination and communication activities promote the project research but also the scientists and partner institutions driving this research, thus leading to enhanced recognition, networking and new collaborations. They enhance knowledge sharing and the acceleration of innovation, while they contribute to the European excellence by enhancing the scientific and industrial profile of the European research and development.
Being at the forefront of the current research in the field, UMRIDA introduces a fundamental shift in engineering design under a large number of uncertainties, accounting for cost- and time-efficiency, as well as safety. The UMRIDA partners recognize the importance of spreading awareness on the novelty results of the project and the entire consortium has actively contributed to the diffusion of the project outcomes.
A complete list of the project's dissemination activities is provided in Section 4.2. This includes a long list of publications in highly-ranked journals, as well as proceedings publications, presentations in various conferences, seminars, workshops and other fora.
In overall, the UMRIDA dissemination outcomes can be summarized in numbers as follows:

- More than 60 scientific papers were published; 20 in peer-reviewed journals and 41 in conference proceedings
- More than 40 presentations were realized in international conferences
- Approximately 70 presentations were realized in workshops; including the two UMRIDA workshops, specialized in UQ and RDO
- Approximately 20 presentations were realized in technical seminars, summer schools and other events
- 8 academic thesis were developed within the activities of UMRIDA

- 10 UMRIDA-related entries were published at newsletters of mass outreach; including the EASN Association Newsletter and the ENGINSOFT Newsletter
- 12 press releases, announcements and presentations were published at various EC-supported and other media; these include popularized articles through CORDIS, as well as information shared across the European Commission's social media channels
- Two UMRIDA events open to external participants were realized
- 1 book summarizing the most significant outcomes and gained-know will be published by Springer

If we were to select a few of the major UMRIDA dissemination activities, we could discuss the following:

**The 1st UMRIDA Workshop on UQ**
The workshop took place in April 2015, shortly after the completion of the project's mid-term. It was open to external participants who were invited to take part and study at the selected tests cases:

- BC-01: NASA rotor 37
- BC-02: RAE 2822 airfoil
- BC-03: DLR F6 wing-body
- BC-04: F11 (KH3Y) TO2 configuration
- IC-08: Supersonic/Transonic flow design of business aircraft

The overall objective was the assessment and application of UQ methods capable of fulfilling the following quantitative objective, which was also regarded as a challenge to all workshop participants:
"Development and application of UQ methods for a large number of uncertainties (~10) within an acceptable CPU return time of 10 hours on no more than 100 cores parallel processors."
The UMRIDA UQ-Workshop counted 54 registered participants, with 3 invited speakers and 11 participants external to the UMRIDA consortium. A total of 29 presentations were given:

- 3 invited lectures
- 6 external contributions
- 20 UMRIDA contributions

**UMRIDA participation at the AERODAYS 2015 Conference**
UMRIDA took part at the periodic AERODAYS Conference which took place in October 2015. A project booth was setup where industrial representatives, academics and researchers would visit, learn and acquire more information on the project. This participation was definitely an opportunity for enhancing dissemination outreach and networking activities.

**UMRIDA Mini-symposium at the SIAM UQ 2016**
An UMRIDA mini-symposium was organized as part of the SIAM 2016 Conference, which took place in April 2016. This was a great opportunity for the UMRIDA outcomes to be disseminated through a major platform.

**The 2nd UMRIDA Workshop and Symposium on UQ and RDO**
The second and last UMRIDA event took place in September 2016, right before the completion of the project. It was open to external participants who were invited to take part and study at the selected tests cases:

- BC-01: NASA rotor 37
- BC-02: RAE 2822 airfoil
- BC-03: DLR F6 wing-body
- BC-04: F11 (KH3Y) TO2 configuration
- IC-08: Supersonic/Transonic flow design of business aircraft

The workshop included:

- 2 invited speaker (from Rolls-Royce and Airbus) representing both turbomachinery and external aerodynamics
- 2 invited sessions from the EUFORIA project (3 presentations) and the ERCOFTAC SIG-45 (2 presentations)
- 2 further external contributions from Italy and South Korea

- 5 technical sessions on RDO in turbomachinery, Innovative methods and modelling uncertainties, RDO in external aerodynamics, UQ for manufacturing variability and RDO for Multiphysics applications
- Round table discussion on Industrial maturity of UQ and RDO
- 60 participants to the workshop over the 2,5 days followed a total of 33 presentations
- 22 participants from outside the consortium

**The UMRIDA Book on UQ and RDO, and Best Practice Guide**

One of the most significant outcomes is the development of a book summarizing the developed techniques as well as discussing tips and best practices. The development of this book is a complex process as it involves the integration of various techniques, experiments and approaches, and it discusses both the academic as well as industrial point of view. The book will be published by Springer and it will be particularly oriented at the industrial design teams.

## Exploitation Activities

While dissemination activities aim to raise awareness upon the project's scope, methods and results, exploitation is equally important in order to fabricate ways for introducing the project's developed foreground into the commercial market, as a final end-user product/service. The potential for exploitation of the processes developed within UMRIDA was being continually evaluated by the partners throughout the entire project lifetime.

From large industrial partners to SMEs and from research organizations to academic institutions, it is worth noting that all partners have defined exploitation scenarios for the use of the produced results and the developed know-how. This justifies the industrial needs which UMRIDA addresses, as well as the positive results which the project generated.

A brief presentation of the exploitation scenarios defined is presented in Section 4.2 (some of this information is confidential and non-disclosed). These were introduced in multiple forms, including:

- Proprietary software, distributed under license for commercial purposes
- Software methods delivered as open-source packages for research activities
- Optimization of internal processes and existing methods, including training of employees
- Introduction of new lecture notes and academic materials, for forming the education base of the next generation engineers and scientists
- Setting the grounds for further research in UQ and RDO, related to aeronautics as well as examining possible spill-overs (e.g. other means of transport, medical applications, etc.)
- Establishment of new collaborations, identification of new opportunities and creation of new job positions

In total, 27 exploitation scenarios were defined by the UMRIDA partners.

## Summary and Project Legacy

The UMRIDA dissemination and exploitation activities followed the project development across its entire lifetime. All partners have actively contributed to the diffusion of the generated results, as well as on the identification of exploitable scenarios for the use of the UMRIDA outcomes.

In overall, the project's scientific impact is clearly marked across the scientific community, as a significant number of publications and scientific presentations were realized. A number of academic theses were developed within the UMRIDA activities and a series of lectures were given, where UMRIDA techniques and results were presented.

Further academic material and even new courses has been introduced, following the partners' interest on the positive outcomes of the project. This incorporates the UMRIDA "way of thinking" at a didactic level and in dedicated courses and workshops. This may be a longer-term action, but it is considered as essential, as this might be the more powerful way to contribute to the evolution of mentalities and spread the new approaches developed by UMRIDA.

The UMRIDA Book on UQ and RDO, and Best Practise Guide will cover the basic developments, the applications to the industrial test cases of the database with uncertainties and the RDM developments and applications developed. This will definitely be the living legacy summarizing all outcomes of the UMRIDA research, towards a paradigm-shifting reliable design under a large number of simultaneous uncertainties.

Accordingly, a new set of communication material (leaflets and posters) are being developed. These will discuss the project's final outputs and will aim to further spread awareness and diffuse the successful completion of UMRIDA and its achievements.
Developed techniques and methods are already being available to the clients of the UMRIDA partners, as they benefit from their supplier's novel and optimized designs. Indeed many of the developed software packages being valorized address specific industrial requirements for reliable designs under uncertainties. Accordingly, research and academic institutions discuss future research programs and opportunities following the successful results of UMRIDA.

## Project Website

www.umrida.eu

## 4.2 Use and dissemination of foreground

**Section A (public)**

This section includes two templates

- Template A1: List of all scientific (peer reviewed) publications relating to the foreground of the project.
- Template A2: List of all dissemination activities (publications, conferences, workshops, web sites/applications, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters).

These tables are cumulative, which means that they should always show all publications and activities from the beginning until after the end of the project. Updates are possible at any time.

| TEMPLATE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES |
|---|

| NO. | Title | Main author | Title of the periodical or the series | Number, date or frequency | Publisher | Place of publication | Year of publication | Relevant pages | Permanent identifiers[2] (if available) | Is/Will open access[3] provided to this publication? |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *Quantification Of Combined Operational And Geometrical Uncertainties In Turbo-Machinery Design* | D. Wunsch, R. Nigro, G. Coussement, C. Hirsch **(NUMECA)** | Proceedings ASME TurboExpo | GT2015-43399 | ASME | Montreal, Canada | 2015 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 2 | *Uncertainty quantification of simultaneous operational and geometrical uncertainties in turbomachinery design practice* | Dirk Wunsch, Rémy Nigro, Gregory Coussement, Charles Hirsch, Yoshihisa Takekoshi **(NUMECA)** | Proceedings of the International Gas-Turbine Congress | Sumbission 244 | International Gas-Turbine Congress | Tokyo, Japan | 2015 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 3 | *Manufacturing Tolerances in Industrial Turbo-Machinery Design* | Rémy Nigro, Dirk Wunsch, Grégory Coussement, Charles Hirsch **(NUMECA)** | Proceedings of the SIAM UQ16 | 2016 | SIAM | Lausanne, Switzerland | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 4 | *Bringing Uncertainty Management and Robust Design Methodologies to Industrial Level* | Dirk WUNSCH, Charles HIRSCH **(NUMECA)** | Aviation in Europe – Innovation for Growth. Proceedings from the Seventh European Aeronautics Days | 2015 | European Commission | Brussels, Belgium | 2015 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 5 | *Chapter 14 – UNCERTAINTY QUANTIFICATION IN* | Remy Nigro , Dirk Wunsch, Gregory Coussement, Charles | STO-TR-AVT-191 | Information not available at the time of the report | NATO | Information not available at the time of the report preparation | 2016 | Information not available at the time of the report | Information not available at the time of the report | NO |

[2] A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).

[3] Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

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| | *INTERNAL FLOWS* | Hirsch (**Numeca**) | | preparation | | | | preparation | preparation | |
| 6 | *Vision, Objectives and Research Activities* | Dirk Wunsch, Charles Hirsch (**Numeca**) | UMRIDA Book and BPG | Information not available at the time of the report preparation | Springer | Information not available at the time of the report preparation | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 7 | *Non-Intrusive Probabilistic Collocation Method for operational, geometrical and manufacturing uncertainties in engineering practice* | Remy Nigro , Dirk Wunsch, Gregory Coussement, Charles Hirsch (**Numeca**) | UMRIDA Book and BPG | Information not available at the time of the report preparation | Springer | Information not available at the time of the report preparation | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 8 | *Manufacturing uncertainties in high pressure compressor* | Remy Nigro , Dirk Wunsch, Gregory Coussement, Charles Hirsch (**Numeca**) | UMRIDA Book and BPG | Information not available at the time of the report preparation | Springer | Information not available at the time of the report preparation | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 9 | *Robust Design in turbomachinery applicaitons* | Remy Nigro , Dirk Wunsch, Gregory Coussement, Charles Hirsch (**Numeca**) | UMRIDA Book and BPG | Information not available at the time of the report preparation | Springer | Information not available at the time of the report preparation | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 10 | *Conclusions and project summary* | Charles Hirsch (**Numeca**) | UMRIDA Book and BPG | Information not available at the time of the report preparation | Springer | Information not available at the time of the report preparation | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 11 | *Introduction - The need for Uncertainty Quantification (UQ) and Robust Design Optimization (RDO)* | Dirk Wunsch, Charles Hirsch (**Numeca**) | UMRIDA Book and BPG | Information not available at the time of the report preparation | Springer | Information not available at the time of the report preparation | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 12 | *Use of sofware for UQ at the example of* | Remy Nigro , Dirk Wunsch, Gregory Coussement, Charles | UMRIDA Book and BPG | Information not available at the time of the report | Springer | Information not available at the time | 2016 | Information not available at the time | Information not available at the time of the report | NO |

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| | *FINE TM* | Hirsch (**Numeca**) | | preparation | | of the report preparation | | of the report preparation | preparation | |
| 13 | *STO-TR-AVT-191: Uncertainty Quantification in internal flows* | Remy Nigro , Dirk Wunsch, Gregory Coussement, Charles Hirsch (**Numeca**) | 55th AIAA Aerospace Sciences Meeting, SciTech2017 | 2017 | AIAA | Gaylodrd, Texas | January 2017 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 14 | *Robust optimization of the conjugate heat transfer of the HPT cooled blade* | K. Vinogradov **(NPO-SATURN)** | Proceedings of the ASME Turbo Expo 2015 | 2015 | ASME | Montreal, Canada | 2015 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 15 | *Efficient methodologies for Robust Design Optimization with large number of uncertainties* | Alberto Clarich **(ESTECO)** | Proceedings of the ECCOMAS 2016 Conference | 2016 | ECCOMAS | Crete Island, Greece | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 16 | *Innovative methodologies for Robust Design Optimization with large number of uncertainties* | Alberto Clarich, Rosario Russo **(ESTECO)** | Proceedings of the SIAM UQ16 | 2016 | SIAM | Lausanne, Switzerland | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 17 | *NON-ADAPTIVE CONSTRUCTION OF SPARSE POLYNOMIAL SURROGATES IN COMPUTATIONAL AERODYNAMICS* | Eric Savin **(ONERA)** | Proceedings of the SIAM UQ16 | 2016 | SIAM | Lausanne, Switzerland | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 18 | *Computation of higher-order moments of generalized polynomial chaos expansions* | Eric Savin (ONERA), Béatrice Faverjon (INSA-Lyon) | International Journal for Numerical Methods in Engineering | Information not available at the time of the report preparation | WILEY | Information not available at the time of the report preparation | 2016 | Information not available at the time of the report preparation | https://arxiv.org/abs/1607.01914 | NO |

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| 19 | *AN EFFICIENT AERODYNAMIC SHAPE OPTIMIZATION FRAMEWORK FOR ROBUST DESIGN OF AIRFOILS USING SURROGATE MODELS* | D. Maruyama, D. Liu, S. Görtz **(DLR)** | Proceedings of the ECCOMAS Congress 2016 VII European Congress on Computational Methods in Applied Sciences and Engineering | 2016 | ECCOMAS | Crete Island, Greece | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 20 | *"Mesh adaptation for viscous simulations"* | V. Menier, A. Loseille, F. Alauzet **(INRIA)** | Proceedings of the 6th. European Conferece con Computational Fluid Dynamics (ECFD VI) | Information not available at the time of the report preparation | ECFD | Barcelona, Spain | 2014 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 21 | ``*Main issues in anisotropic mesh adaptive FMG",* | V. Menier, A. Loseille, F. Alauzet **(INRIA)** | Proceedings of the 6th. European Conferece con Computational Fluid Dynamics (ECFD VI) | Information not available at the time of the report preparation | ECFD | Barcelona, Spain | 2014 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 22 | *Anisotropic mesh adaptive FMG* | G. Brethes, O. Allain, A. Dervieux **(INRIA)** | International Journal for Numerical Methods in Engineering (IJNME) | Information not available at the time of the report preparation | WILEY | Information not available at the time of the report preparation | 2015 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | YES |
| 22 | *Mesh adaptation for CFD* | A. Dervieux, F. Alauzet, A. Loseille, B.Koobus **(INRIA)** | Book in preparation (To be completed) | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | 2016-2017 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | *NO* |
| 23 | *CFD Validation and Adaptivity for Viscous Flow Simulations* | V. Menier, A. Loseille, F. Alauzet **(INRIA)** | Proceedings of the 44th AIAA Fluid Dynamics Conference | 2014 | AIAA | Atlanta, Georgia | 2014 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 24 | *Multigrid Strategies Coupled with Anisotropic Mesh* | V. Menier, A. Loseille, F. Alauzet **(INRIA)** | Proceedings of the AIAA Scitech 2015 | 2015 | AIAA | Kissimmee, Florida | 2015 | Information not available at the time of the report | Information not available at the time of the report | NO |

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|---|---|---|---|---|---|---|---|---|---|---|
| | *Adaptation* | | | | | | | preparation | preparation | |
| 25 | *Towards a certified model of numerical uncertainty in CFD* | V. Menier, A. Loseille, F. Alauzet **(INRIA)** | Proceedings of the 2015 Conference on Modelling Fluid Flow (CMFF'15) | 2015 | CMFF | Budapest, Hungary | 2015 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 26 | *A decade of progress on anisotropic mesh adaptation for computational fluid dynamics* | F. Alauzet, A. Loseille (INRIA) | Computer-Aided Design 72 | Volume 72, March 2016 | Elsevier | Information not available at the time of the report preparation | 42278 | *Pages 13–39* | *http://www.sciencedirect.com/science/article/pii/S0010448515001517* | *NO* |
| 27 | *Accurate Computation of Grain Burning Coupled with Flow Simulation in Rocket Chamber* | D. Gueyffier, F.-X. Roux, Y. Fabignon, F. Alauzet(INRIA) | Journal of Propulsion and Power (AIAA) | Vol. 31, No. 6 (2015) | AIAA | Information not available at the time of the report preparation | November 2015 | pp. 1761-1776 | http://arc.aiaa.org/doi/abs/10.2514/1.B35736?journalCode=jpp | NO |
| 28 | *A parallel matrix-free conservative solution interpolation on unstructured tetrahedral meshes* | F. Alauzet (INRIA) | Computer Methods in Applied Mechanics and Engineering 299 | Volume 299 | Elsevier | Information not available at the time of the report preparation | February 2016 | *Pages 116-142* | *https://hal.inria.fr/hal-01211749/file/RR-8785.pdf* | *YES* |
| 29 | *Anisotropic Norm-Oriented Mesh* | A. Loseille, A,. Dervieux, F. Alauzet(INRIA) | 53rd AIAA Aerospace Sciences Meeting, AIAA SciTech | (AIAA 2015-2037) | AIAA | Kissimmee, Florida | 2015 | To be completed | http://arc.aiaa.org/doi/abs/10.2514/6.2015-2037 | NO |
| 30 | *A mesh-adaptative metric-based full multigrid for the Poisson problem* | G. Brethes, O. Allain, A. Dervieux(INRIA) | International Journal for Numerical Methods in Fluids | 79-1, 3053 | WILEY | Information not available at the time of the report preparation | 2015 | *To be completed* | *http://www-sop.inria.fr/members/Gautier.Brethes/article-ADA-MG.pdf* | *YES* |
| 31 | *Anisotropic Norm-Oriented Mesh Adaptation for a Poisson problem* | G. Brethes, A. Dervieux(INRIA) | Journal of Computational Physics | 322 (2016) 804826. | Elsevier | Information not available at the time of the report preparation | 2016 | To be completed | http://www-sop.inria.fr/members/Gautier.Brethes/Norm-Oriented-Poisson.pdf | YES |
| 32 | *MULTILEVEL MONTE-CARLO* | Gabriel Bugeda, Jordi | Journal of Aeronautics | Information not available at the | Elsevier | Information not available | 2016 | Information not available | Information not available at the | NO |

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| | *METHODS APPLIED TO THE STOCHASTIC ANALYSIS OF AERODYNAMIC PROBLEMS* | Pons-Prats | | time of the report preparation | | at the time of the report preparation | | at the time of the report preparation | time of the report preparation | |
| 33 | *Robust Design Optimization using multi level stochastic methods* | Gabriel Bugeda, Jordi Pons-Prats | Information not available at the time of the report preparation | Information not available at the time of the report preparation | Information not available at the time of the report preparation | Information not available at the time of the report preparation | 2017 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 34 | *Reliability-Based Design Optimization with the Generalized Inverse Distribution Function* | Domenico Quagliarella, Giovanni Petrone, Gianluca Iaccarino **(CIRA)** | Computational Methods in Applied Sciences Series: Advances in Evolutionary and Deterministic Methods for Design, Optimization and Control in Engineering and Sciences | Information not available at the time of the report preparation | Springer | Information not available at the time of the report preparation | 2015 | *77-92* | *http://www.springer.com/us/book/9783319115405#* | *No* |
| 35 | *Optimization Under Uncertainty Using the Generalized Inverse Distribution Function* | Domenico Quagliarella, Giovanni Petrone, Gianluca Iaccarino **(CIRA)** | Computational Methods in Applied Sciences Series: Modeling, Simulation and Optimization for Science and Technology | Volume 34 | Springer | Information not available at the time of the report preparation | 19 June 2014 | 171-190 | http://rd.springer.com/chapter/10.1007/978-94-017-9054-3_10 | No |
| 36 | *Robust Design Optimization of a Supersonic Natural Laminar Flow Wing-Body* | Domenico Quagliarella, Emiliano Iuliano (CIRA) | Proceedings of the SIAM UQ16 | 2016 | SIAM | Lausanne, Switzerlnad | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 37 | *Uncertainty Quantification of Thermoacoustic Instabilities in a Swirled Stabilized Combustor* | A. Ndiaye, M. Bauerheim, S. Moreau, F. Nicoud (CERFACS) | Proceedings of the ASME Turbo Expo 2015: Turbine Technical Conference and Exposition | GT2015-44133 | ASME | Montreal, Canada | 2015 | N/A | http://www.math.univ-montp2.fr/~nicoud/PDF/ASME_Ndiaye.pdf | YES |
| 38 | *Uncertainty quantification of thermo-acoustic instabilities in annular* | M. Bauerheim, A. Ndiaye, P. Constantine, G. Iaccarino, S. Moreau, | Proceedings of the Stanford Center for Turbulence Research | N/A | Stanford | Stanford | 2014 | *209-218* | *http://www.math.univ-montp2.fr/~nicoud/PDF/CTR_Bauerh* | *YES* |

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| | *combustors* | F. Nicoud (CERFACS) | Summer Program | | | | | | *eim.pdf* | |
| 39 | *Symmetry breaking of azimuthal thermoacoustic modes: the UQ perspectives* | M. Bauerheim, A. Ndiaye, P.Constantine, S. Moreau, F. Nicoud **(CERFACS)** | Journal of Fluid Mechanics | 789 | Cambridge University Press | Cambridge | 2016 | 534-566 | https://hal.archives-ouvertes.fr/hal-01279395 | YES |
| 40 | *Stability analysis of thermo-acoustic nonlinear eigenproblems in annular combustors. Part II. Uncertainty quantification* | L. Magri , Bauerheim M., Nicoud F. (CERFACS) and Juniper M. | Journal of Computational Physics | In press | Elsevier | Information not available at the time of the report preparation | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 41 | *Sensitivity analysis of thermo-acoustic eigenproblems with adjoint methods* | Juniper M., Magri L., Bauerheim M. and Nicoud F. (CERFACS) | Proceedings of the Stanford Center for Turbulence Research Summer Program | N/A | Stanford | Standford | 2014 | 189-198 | http://www.math.univ-montp2.fr/~nicoud/PDF/CTR_Juniper.pdf | YES |
| 42 | *Sparse polynomial surrogates for aerodynamic computations with random inputs* | E. Savin, A. Resmini, J. Peter **(ONERA)** | Proceedings of the 18th AIAA Non-Deterministic Approaches Conference, AIAA SciTech 2016 | AIAA paper 2016-0433 | AIAA | Gaylord, Texas | 2016 | *19 pages* | *http://dx.doi.org/10.2514/6.2016-0433* | *No* |
| 43 | *Stochastic Model reduction for Polynomial Chaos Expansion Using Proper Orthogonal Decomposition* | M. Raisee, D. Kumar, C. Lacor **(VUB)** | Proceedings of the 6th Chaotic Modeling and Simulation International Conf. | 2013 | CHAOS | Istanbul, Turkey | 11-14 June 2013 | 461-468 | Information not available at the time of the report preparation | NO |
| 44 | *Development of a Non-Intrusive Model Reduction Approach for Polynomial Chaos Representation* | M. Raisee, D. Kumar, C. Lacor **(VUB)** | Int. Workshop on UQ in Fluids Simulation (BOQUSE) | Proc. BOQUSE | BOQUSE | Bordeaux, France | 16-18 December 2013 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 45 | *Stochastic Model Reduction for Polynomial Chaos* | M. Raisee, D. Kumar, C. Lacor | Chaotic Modeling and Simulation | 4 | CMSIM | Information not available at the time of the report | October 2013 | 615-623 | Information not available at the time of the report | NO |

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|---|---|---|---|---|---|---|---|---|---|---|
| | *Expansion Using Proper Orthogonal Decomposition* | **(VUB)** | | | | preparation | | | preparation | |
| 46 | *A Nonintrusive Model Reduction Approach for Polynomial Chaos Expansion Using Proper Orthogonal Decomposition* | M. Raisee, D. Kumar, C. Lacor **(VUB)** | International Journal for Numerical Methods in Engineering (IJNME) | 103/4 | WILEY | Information not available at the time of the report preparation | 27/7/2015 | *293-312* | *http://onlinelibrary.wiley.com/journal/10.1002/%28ISSN%291097-0207/earlyview?start=1&resultsPerPage=20* | NO |
| 47 | *Towards an efficient non-intrusive Polynomial chaos approach for high-dimensional stochastic problems using a reduced basis approach* | D. Kumar,M. Raisee, C. Lacor **(VUB)** | Proceedings of the 6th. European Conference on Computational Fluid Dynamics (ECFD VI) | 2014 | ECFD | Barcelona, Spain | July 2014 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 48 | *Adjoint based multi-objective shape optimization of a transonic airfoil under uncertainties* | Dinesh Kumar, Joao Miranda, Mehrdad Raisee, Chris Lacor **(VUB)** | Proceedings of the 5th International Conference on Engineering Optimization (EngOpt 2016) | 19-23/06/2016 | EngOpt | Brazil | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 49 | *An Efficient Non-intrusive Reduced Basis Model for High Dimensional Stochastic Problems in CFD* | D. Kumar,M. Raisee, C. Lacor **(VUB)** | Computers & Fluids | 138 | Elsevier | Information not available at the time of the report preparation | 2016 | 67-82 | http://www.sciencedirect.com/science/article/pii/S0045793016302614 | NO |
| 50 | *An efficient non-intrusive reduced basis approach for uncertainty quantification in CFD* | Dinesh Kumar, Mehrdad raisee, Chris Lacor **(VUB)** | Proceedings of the 1st ECCOMAS Thematic Conference on Uncertainty Quantification in Computational Sciences and Engineering (UNCECOMP 2015) | 25-27/05/2015 | ECCOMAS | Crete Island, Greece | 417-431 | *http://2015.uncecomp.org/* | Information not available at the time of the report preparation | NO |
| 51 | *Efficient use of 2nd order sensitivity* | Marcin Wyrozębski, Łukasz Łaniewski-Wołłk, | Journal of Computational | Information not available at the | Elsevier | Information not available | 2016—2017 | Information not available | Information not available at the | NO |

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| | *information for Uncertainty Quantification* | Jacek Rokicki **(WUT)** | Physics | time of the report preparation | | at the time of the report preparation | | at the time of the report preparation | time of the report preparation | |
| 52 | *Usage of Relative Expected Improvement for Robust Optimization* | Krzysztof Marchlewski, Łukasz Łaniewski-Wołłk, Jacek Rokicki **(WUT)** | Archives of Mechanics | Information not available at the time of the report preparation | Springer | Information not available at the time of the report preparation | 2016—2017 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 53 | *Continuation Multi Level Monte Carlo for Uncertainty Quantification in Compressible Aerodynamics* | Michele Pisaroni, Fabio Nobile, Penelope Leyland **(EPFL)** | Proceedings of the SIAM UQ16 | 2016 | SIAM | Lausanne, Switzerland | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 54 | *A Continuation Multi Level Monte Carlo (C-MLMC) for Uncertainty Quantification in Compressible Aerodynamics* | M. Pisaroni et al. **(EPFL)** | CMAME Journal (Computer Methods in Applied Mechanics and Engineering) | Information not available at the time of the report preparation | Elsevier | Information not available at the time of the report preparation | Information not available at the time of the report preparation | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 55 | *Variance reduction through robust design of boundary conditions for hyperbolic systems of equations* | J. Nordström, M. Wahlsten **(LIU)** | Journal of Computational Physics | 282 | Elsevier | Information not available at the time of the report preparation | 2014 | 1-22 | http://www.sciencedirect.com/science/article/pii/S0021999114007499 | No |
| 56 | *An Investigation of Uncertainty due to Stochastically Varying Geometry* | M. Wahlsten, J. Nordström (LIU) | Proceedings of the 1st ECCOMAS Thematic Conference on International Conference on Uncertainty Quantification in Computational Sciences and Engineering (UNCECOMP 2015) | 2015 | ECCOMAS | Crete Island, Greece | 2015 | *898-907* | *http://www.eccomas.org/spacehome/1/10* | *Yes* |
| 57 | *AN INVESTIGATION OF UNCERTAINTY EFFECTS IN MIXED HYPERBOLIC-* | Jan Nordström, Markus K. Wahlsten **(LIU)** | Proceedings of the SIAM UQ16 | 2016 | SIAM | Lausanne, Switzerland | 2016 | Information not available at the time of the report | Information not available at the time of the report | NO |

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| | *PARABOLIC PROBLEMS DUE TO STOCHASTICALLY VARYING GEOMETRY* | | | | | | | preparation | preparation | |
| 58 | *Robust Boundary Conditions for Stochastic Incompletely Parabolic and Hyperbolic Systems of Equations* | M. Wahlsten, J. Nordström (LIU) | Proceedings of the SIAM UQ16 | 2016 | SIAM | Lausanne, Switzerland | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 59 | *Engineering approach for the extension of Latin Hypercube samples while maintaining the correlation structure* | R. Schmidt, M. Voigt, K. Vogeler **(TUD)** | Proceedings of the 12th International Probabilistic Workshop | 2014 | EPSC | Weimar, Germany | 2014 | 1-18 | None | Yes |
| 60 | *COMPARISON OF TWO METHODS FOR SENSITIVITY ANALYSIS OF COMPRESSOR BLADES* | Robin Schmidt, Matthias Voigt, Konrad Vogeler **(TUD)**, Marcus Meyer **(RR)** | Proceedings of ASME Turbo Expo 2016 | 2016 | ASME | Charlotte, USA | 2016 | Information not available at the time of the report preparation | Information not available at the time of the report preparation | NO |
| 61 | *Sensitivity analysis of a two-stage high pressure compressor using an extended Latin hypercube sampling* | R. Schmidt, M. Voigt, K. Vogeler (**TUD**) | Proceedings of the 7th Dresdner-Probabilistik-Workshop | None | TUD | TUD | 2014 | *1-18* | *http://probabilistik.de/vortrag/v2014_schmidt.pdf* | *Yes* |
| 62 | *COMPARISON OF TWO METHODS FOR SENSITIVITY ANALYSIS OF COMPRESSOR BLADES* | R. Schmidt, M. Voigt, K. Vogeler **(TUD)**, M. Meyer **(RR)** | Proceedings of ASME Turbo Expo 2016 | None | ASME | Charlotte, USA | 2016 | 1-11 | https://asme.pinetec.com/gt2016/index.html | No |
| *63* | *UMRIDA Book and Best Practise Guide* | *All UMRIDA Partners* | *UMRIDA Book and Best Practise Guide* | *Information not available at the time of the report* | *Springer* | *Information not available at the time* | *Information not available at the time of the* | *Information not available at the time* | *Information not available at the time of the report* | *No* |

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| | | | | *preparation* | | *of the report preparation* | *report preparation* | *of the report preparation* | *preparation* | |

**TEMPLATE A2: LIST OF DISSEMINATION ACTIVITIES**

| NO. | Type of activities[4] | Main leader | Title | Date/Period | Place | Type of audience[5] | Size of audience | Countries addressed |
|---|---|---|---|---|---|---|---|---|
| 1 | Workshop presentation | Dirk Wunsch **(*Numeca*)**, Charles Hirsch **(*Numeca*),** Remy Nigro **(*UMons*)**, Gregory Coussement *(UMons)* | *Propagation of combined operational and geometrical uncertainties in an integrated CFD design environment by means of a sparse collocation method* | 25-26/05/2014 | ERCOFTAC Workshop on Uncertainty Quantification in Computational Fluid Dynamics, Pisa, Italy | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 2 | Workshop presentation | Dirk Wunsch **(*Numeca*)**, Charles Hirsch **(*Numeca*)** | *Overview and progress of UMRIDA project and potentially several presentations on UQ methods* | 23-26/09/2014 | ANADE workshop on Receptivity and Sensitivity Analyses; Uncertainties and Mesh Adaptation Algorithms, Cambridge, UK | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 3 | Workshop presentation | Dirk Wunsch **(*Numeca*),** Charles Hirsch **(*Numeca*)**, Remy Nigro **(*UMons*)**, Gregory Coussement **(*UMons*)** | *Propagation of uncertain geometrical fields by means of a sparse collocation method* | 08-09/10/2014 | 7. Dresdner-Probabilistik-Workshop, Dresden, Germany | Scientific Community, Industry | 80 | International |
| 4 | Workshop presentation | Remy Nigro, Dirk Wunsch, Gregory Coussement, Charles Hirsch | *Robust Design Optimization of the BC-01 (Rotor 37) test case and Best Practices for RDO in engineering practice* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |

[4] A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.

[5] A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias, Other ('multiple choices' is possible).

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| 5 | Workshop presentation | Remy Nigro, Dirk Wunsch, Gregory Coussement, Charles Hirsch | *Uncertainty Quantification of manufacturing variability applied to the IC-09 (Aerodynamic High Pressure Compressor Rotor Blade Design)* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 6 | Workshop presentation | Dirk Wunsch **(*Numeca*)**, Charles Hirsch (*Numeca*) | *Uncertainty Management for Robust Industrial Design in Aeronautics - Overall Presentation* | 27-29/10/2014 | 4th EASN Workshop on Flight Physics and Aircraft Design, Aachen, Germany | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 7 | Workshop presentation | Dirk Wunsch **(Numeca International)** | *Sparse probabilistic collocation method applied within the integrated industrial CFD environment FINE* | 15-16/04/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 8 | Web-based information | NUMECA | *UMRIDA Project public website* | 04/2015 | http://www.umrida.eu | Industry, Scientific Community, General public | Information not available at the time of the report preparation | European/International |
| 9 | Conference presentation | Dirk Wunsch **(*Numeca*)**, Charles Hirsch **(*Numeca*)**, Remy Nigro **(*UMons*)**, Gregory Coussement **(*UMons*)** | *Quantification of combined operational and geometrical uncertainties in turbo-machinery design* | 15-19/06/2015 | ASME Turbo Expo, Montreal, Canada | Scientific Community, Industry | 150 | International |
| 10 | Conference presentation | Charles Hirsch **(NUMECA)** | *Project Overview* | 20-23/10/2015 | AERODAYS 2015 | Scientific Community, Industry, Policy Makers, Academia | <10,000 | Europe, International |
| 11 | Presentation | Dirk Wunsch **(NUMECA)** | *Uncertainty Quantification in FINE* | 26-28/10/2015 | NUMECA International User meeting | Scientific Community, Industry | ~120 | Brussels, Belgium |
| 12 | Presentation | Dirk Wunsch **(NUMECA)** | *Training: Uncertainty Quantification in FINE* | 26-28/10/2015 | NUMECA International User meeting | Scientific Community, Industry | ~40 | Brussels, Belgium |
| 13 | Presentation | Rémy Nigro, Dirk Wunsch, Grégory Coussement, Charles | *Manufacturing Tolerances in Industrial Turbo-Machinery Design* | 5-8/04/2015 | SIAM UQ16 | Scientific Community, Industry | >300 | Lausanne, Switzerland |

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| | | Hirsch (NUMECA) | | | | | | |
| 14 | UQ course | Dirk Wunsch, Charles Hirsch | *General Introduction to Uncertainty Management and Risk Analysis* | 30.11.2015-01.12.2015 | ERCOFTAC UQ Course, EDF, Paris, France | Scientific Community, Industry | 20 | EU |
| 15 | UQ course | Dirk Wunsch, Charles Hirsch | *Overview of propagation techniques – Application of non-intrusive polynomial chaos/collocation methods* | 30.11.2015-01.12.2015 | ERCOFTAC UQ Course, EDF, Paris, France | Scientific Community, Industry | 20 | EU |
| 16 | Poster | NUMECA | *FINE/Design3D - Integrated multidisciplinary environment for design optimization, uncertainty quantification and robust design* | 13.06.2016-17.06.2016 | ASME Turbomachinery Technical Conference and Exposition, Seoul, South Korea | Industry | 4000 | International |
| 17 | Presentation | Rémy Nigro, Dirk Wunsch, Grégory Coussement, Charles Hirsch (NUMECA) | *Robust Design Optimization of the BC-01 (Rotor 37) test case and Best Practices for RDO in engineering practice* | 20.09.2016-23.09.2016 | UMRIDA Symposium/Workshop on UQ and RDO, September 20th - 23rd 2016, Brussels | Scientific Community, Industry | 50 | International |
| 18 | Presentation | Charles Hirsch (NUMECA) | *UQ in Numeca software* | May 2016 | NUMECA User Meeting China, Bejing, China | Scientific Community, Industry | 50-100 | International |
| 19 | Presentation | Charles Hirsch (NUMECA) | *UQ in Numeca software* | June 2016 | NUMECA User Meeting Japan, Tokio, Japan | Scientific Community, Industry | 50-100 | International |
| 20 | Presentation | Rémy Nigro, Dirk Wunsch, Grégory Coussement, Charles Hirsch (NUMECA) | *Uncertainty Quantification of manufacturing variability applied to the IC-09 (Aerodynamic High Pressure Compressor Rotor Blade Design)* | 20.09.2016-23.09.2016 | UMRIDA Symposium/Workshop on UQ and RDO, September 20th - 23rd 2016, Brussels | Scientific Community, Industry | 50 | International |
| 21 | Presentation | Dirk Wunsch (Numeca) | *Uncertainty Quantification and Robust Design Optimization for turbomachinery applications* | 04.10.2016 | NUMECA Seminar, taking your turbomachinery design to the next level, Zurich, Switzerland | Industry | 20-40 | Europe |
| 22 | UQ course | Charles Hirsch (NUMECA) | *General Introduction to Uncertainty Management and Risk Analysis* | 27.10.2016 | ERCOFTAC UQ Course, Ghent University, Belgium | Scientific Community, Industry | 20 | EU |
| 23 | UQ course | Dirk Wunsch, Charles | *Overview of propagation techniques with large number of* | 27.10.2016 | ERCOFTAC UQ Course, | Scientific Community, | 20 | EU |

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| | | Hirsch (Numeca) | *uncertainties* | | Ghent University, Belgium | Industry | | |
| 24 | UQ course | Dirk Wunsch, Charles Hirsch (Numeca) | *Manufacturing Tolerances and Robust Optimization* | 28.10.2016 | ERCOFTAC UQ Course, Ghent University, Belgium | Scientific Community, Industry | 20 | EU |
| 25 | Presentation | Rémy Nigro, Dirk Wunsch, Grégory Coussement, Charles Hirsch (NUMECA) | *Uncertainty Quantification of manufacturing variability and Robust Design optimization in turbomachinery* | 15.11.2016-16.11.2016 | VKI, Rhodes-Saint-Genese, Belgium | Scientific Community, Industry | 20-40 | EU |
| 26 | Workshop presentation | Ximun Loyatho **(DASSAV)** | *Application of UQ to a Falcon Jet Configuration* | 15-16/04/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 27 | Workshop presentation | Gilbert Rogé (**DASSAV)** | *Falcon Jet Industrial Challenge 3 (IC-03) Test case description and Application* | 15-16/04/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 28 | Workshop Presentation | Gilbert Rogé, Ximun Loyatho (DASSAV) | *Application of RDO to aerodynamic Falcon Shape Design* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~60 | Europe, International |
| 29 | UQ course | Gilbert Rogé (DASSAV) | *Foundations and applications of Method of Moments for Uncertainty Quantification. UMQ for the Aircraft Industry.* | 30.11.2015-01.12.2015 | ERCOFTAC UQ Course, Chatou, France | Scientific Community, Industry | 20 | EU |
| 30 | UQ course | Gilbert Rogé (DASSAV) | *Foundations and applications of Method of Moments for Uncertainty Quantification. UMQ for the Aircraft Industry.* | 27.10.2016-28.10.2016 | ERCOFTAC UQ Course, Ghent, Belgium | Scientific Community, Industry | 20 | EU |
| 31 | Workshop presentation | Ximun Loyatho **(Dassault Aviation)** | *Application of UQ to a Falcon Jet Configuration* | 15-16/04/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 32 | Workshop presentation | G. Rogé, X. Loyatho **(DASSAULT)** | *Falcon Jet Industrial Challenge 3 (IC-03) Test case description and Application* | 15-16/04/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 33 | Workshop presentation | Ximun LOYATHO *and Gilbert ROGE (Dassault Aviation)* | *Application of RDO to aerodynamic Falcon shape design* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |

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| 34 | Workshop presentation | N. Ceresola - N. Magnino **(Alenia Aermacchi)** | *Application of second order Method of Moments to BC-02* | 15-16/04/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 35 | Web-based information | EASN | *The UMRIDA project* | 10/2013 | http://www.easn.net/research-projects/ | Industry, Scientific Community, Policy makers, General public | 98 (65 news/33 returning visitors) average daily pageviews according to www.googleanalytics.com | Europe, International |
| 36 | Web-based information | EASN | *The UMRIDA project* | 10/2013 | http://www.easn-tis.com/umrida/ | Industry, Scientific Community, Policy makers, General public | 20 (15 news/5 returning visitors) average daily pageviews according to www.googleanalytics.com | Europe, International |
| 37 | Newsletter | EASN | *UMRIDA progress update* | 11/2013 | http://www.easn.net/newsletters/EASN_Newsletter_November_2013.html | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 38 | Newsletter | EASN | *UMRIDA progress update* | 04/2014 | http://www.easn.net/newsletters/EASN_Newsletter_April_2014.html | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 39 | Newsletter | EASN | *UMRIDA progress update* | 12/2014 | http://www.easn.net/newsletters/EASN_Newsletter_December_2014.html | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 40 | Leaflets distribution | EASN | - | 27-29/10/2014 | 4th EASN Workshop on Flight Physics and Aircraft Design, Aachen, Germany | Industry, Scientific Community, Policy makers, General public | 150 | Europe, International |
| 41 | Article in the popular press | EASN | *Robust design in aeronautics: Steps towards more time- and cost-efficient product development* | | http://cordis.europa.eu/news/rcn/123155_en.html | Industry, Scientific Community, Policy makers, General public | >10,000 | Europe, International |

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| 42 | Newsletter | EASN | *UMRIDA progress update* | 04/2015 | http://www.easn.net/newsletters/EASN_Newsletter_April_2015.html | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 43 | Newsletter | EASN | *UMRIDA progress update* | 07/2015 | http://www.easn.net/newsletters/EASN_Newsletter_July_2015.html | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 44 | Newsletter | EASN | *UMRIDA progress update* | 12/2015 | To be completed | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 45 | Exhibitions | EASN/NUMECA | *Project Overview* | 20-23/10/2015 | AERODAYS 2015 | Scientific Community, Industry, Policy Makers, Academia | <10,000 | Europe, International |
| 46 | Leaflets distribution | EASN | - | 2-4/09/2015 | 5th EASN Workshop on Aerostructures, Manchester, UK | Industry, Scientific Community, Policy makers, General public | 150 | Europe, International |
| 47 | Newsletter | EASN | *UMRIDA progress update* | 12/2015 | http://www.easn.net/newsletters/EASN_Newsletter_December_2015.html | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 48 | Newsletter | EASN | *UMRIDA progress update* | 03/2016 | http://www.easn.net/newsletters/EASN_Newsletter_March_2016.html | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 49 | Newsletter | EASN | *UMRIDA progress update* | 06/2016 | http://www.easn.net/newsletters/EASN_Newsletter_June_2016.html | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 50 | Newsletter | EASN | *UMRIDA progress update* | 09/2016 | http://www.easn.net/newsletters/issues/easn-newsletter-september-2016 | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 51 | Article in the popular press | EASN | *2nd UMRIDA workshop on Robust Design Optimization (RDO)* | 30/03/2015 | http://cordis.europa.eu/event/rcn/145815_en.html | Industry, Scientific Community, Policy makers, General public | >10,000 | Europe, International |
| 52 | Article in the popular press | EASN | *1st UMRIDA Workshop on Uncertainty Quantification* | 12/01/2015 | http://cordis.europa.eu/event/rcn/141457_en.html | Industry, Scientific Community, Policy makers, General public | >10,000 | Europe, International |

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| 53 | News release | EASN | *Announcement on the 1st UMRIDA Worskhop* | 11/2014 | http://www.easn.net/news/12/228/ | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 54 | News release | EASN | *Announcement on the 1st UMRIDA Worskhop* | 12/2014 | http://www.easn.net/news/12/228/ | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 55 | News release | EASN | *Announcement on the 1st UMRIDA Worskhop* | 12/2014 | http://www.easn.net/news/12/228/ | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 56 | News release | EASN | *Announcement on the 1st UMRIDA Worskhop* | 12/2014 | http://www.easn.net/news/12/228/ | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 57 | News release | EASN | *Announcement on the 1st UMRIDA Worskhop* | 12/2014 | http://www.easn.net/news/12/228/ | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 58 | News release | EASN | *Announcement on the 1st UMRIDA Worskhop* | 11/2014 | http://www.conference-service.com/conferences/applied-mathematics.html | Industry, Scientific Community, Policy makers, General public | >10,000 | Europe, International |
| 59 | News release | EASN | *Announcement on the 1st UMRIDA Worskhop* | 11/2014 | http://www.conference-service.com/conferences/simulation.html | Industry, Scientific Community, Policy makers, General public | >10,000 | Europe, International |
| 60 | News release | EASN | *Announcement on the 1st UMRIDA Worskhop* | 11/2014 | http://www.conference-service.com/conferences/applied-mathematics.html | Industry, Scientific Community, Policy makers, General public | >10,000 | Europe, International |
| 61 | News release | EASN | *Announcement on the 1st UMRIDA Worskhop* | 11/2014 | http://www.transport-research.info/event/umrida-workshop-uncertainty-quantification | Industry, Scientific Community, Policy makers, General public | >10,000 | Europe, International |
| 62 | News release | EASN | *Announcement on the 2nd UMRIDA Worskhop* | 03/2016 | http://www.transport-research.info/event/2nd-umrida-workshop-robust-design-optimization-rdo | Industry, Scientific Community, Policy makers, General public | >10,000 | Europe, International |
| 63 | News release | EASN | *Announcement on the* | 03/2016 | https://easn.net/news/14/272/ | Industry, Scientific Community, Policy makers, | ~10,000 | Europe, |

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| | | | *2ndUMRIDA Worskhop* | | | General public | | International |
| 64 | News release | EASN | *Announcement on the 2nd UMRIDA Worskhop* | 03/2016 | http://www.conferencealerts.com/show-event?id=169570 | Industry, Scientific Community, Policy makers, General public | ~10,000 | Europe, International |
| 65 | Workshop presentation | Dirk Büche **(MAN Diesel & Turbo Schweiz)** | *Design of Experiments for Uncertainty Analysis of Radial Compressor Components* | 15-16/04/2015 | UMRIDA UQ Workshop, Delft, The Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 66 | Workshop presentation | **Dirk Büche (MAN Diesel & Turbo Schweiz)** | *Robust Compressor Optimization by Means of Evolutionary Algorithms* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 67 | Workshop presentation | S.Richard, O. Paulien (SAFRAN Turbomeca) | *Turbomeca Industrial Test Case IC01* | 15-16/4/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 68 | Workshop presentation | S.Richard, J. Lamouroux (SAFRAN Turbomeca), A. Ndiaye, F. Nicoud (CERFACS) | *Validation and Evaluation of UQ methods for Industrial Challenges* | 20-22/9/2016 | UMRIDA Workshop on Uncertainty Quantification, Brussels, Belgium | Scientific Community, Industry | ~60 | Brussels, Belgium |
| 69 | Conference presentation | Kirill A. Vinogradov, Gennady V. Kretinin, Kseniya V. Otryahina, Roman A. Didenko, Dmitry V. Karelin, Yury N. Shmotin **(SATURN)** | *ROBUST OPTIMIZATION OF THE HPT BLADE COOLING AND AERODYNAMIC EFFICIENCY* | 13-17/06/2016 | ASME Turbo Expo 2016, Seoul, South Korea | Scientific Community, Industry, Policy Makers, Academia | >600 | International |
| 70 | Conference presentation | Kirill A. Vinogradov, Gennady V. Kretinin, Kseniya V. Otryahina, Igor A. leshenko **(SATURN)** | *ROBUST MULTIPHYSICS OPTIMIZATION FOR COOLED TURBINE BLADE AND FAN BLADE BY MEANS IOSO* | 10-14/07/2016 | Inernational IOSO Optimization Technology User Conference IOSO 2016 | Scientific Community, Industry | 90 | International |
| 71 | Conference presentation | K. Vinogradov **(NPO-SATURN)** | *Robust optimization of the conjugate heat transfer of the HPT cooled blade* | 15-19/06/2015 | ASME Turbo Expo 2015, Montreal, Canada | Scientific Community, Industry | 200 | International |
| 72 | Workshop | R.A. Didenko, K.A. Vinogradov **(NPO-** | *Overview and progress of UMRIDA project and NPO* | 23-25/03/2015 | 2nd International Forum "Innovation.Technology.Produ | Industry, Scientific | 65 | Europe, |

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| | presentation | **SATURN)** | *Saturn activities in Unceratiinty Quantification and Robust optimization of the industrial tasks* | | cing.", Rybinsk, NPO Saturn, Russia | Community | | International |
| 73 | Workshop presentation | *K. A. Vinogradov, G.V. Kretinin, I.N. Leshenko, K.S. Fedechkin, K.V. Otryahina, K.R. Pyatunin, D.V. Karelin,(NPO-Saturn)* | *Robust multiphysics optimization for fan blade by means surrogate models and IOSO technology* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 74 | Workshop presentation | K. A. Vinogradov*, G.V. Kretinin, I.N. Leshenko, K.S. Fedechkin, K.V. Otryahina, K.R. Pyatunin, D.V. Karelin,(NPO-Saturn)* | *Robust multiphysics optimization for cooled turbine blade by means surrogate models and IOSO technology* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 75 | Workshop presentation | Kirill Vinogradov **(NPO-Saturn)** | *Robust optimization of the HPT cooling blade in conjugate heat transfer computations* | | UMRIDA UQ Workshop, Delft, The Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 76 | Conference presentation | A. Clarich, R. Russo **(ESTECO)** | *Reliability-based optimization applying Polynomial Chaos expansion* | 20-25/07/2014 | 6th. European Conferece con Computational Fluid Dynamics (ECFD VI), Barcelona, Spain | Scientific Community, Industry | 3000 | International |
| 77 | Conference presentation | A. Clarich, R. Russo **(ESTECO)** | *Innovative methodologies for Robust Design Optimization with large number of uncertainties using modeFRONTIER* | 14-16/09/2015 | EUROGEN2015, Glasgow, UK | Scientific Community, Industry | 200 | International |
| 78 | Workshop presentation | Alberto Clarich, Rosario Russo **(ESTECO)** | *Efficient UQ of large number of Uncertainties: Adaptive Sparse Polynomial Chaos expansion with modeFRONTIER* | 15-16/04/2015 | UMRIDA UQ Workshop, Delft, The Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 79 | Newsletter entry | Alberto Clarich, Rosario Russo **(ESTECO)** | *Innovative methodologies for Robust Design Optimization with large number of uncertainties using modeFRONTIER* | 15/12/2015 | ENGINSOFT Newsletter - Simulation Based Engineering & Science | Industry, Scientific Community, Policy makers | >1,000 | Europe, International |

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| 80 | Presentation | Alberto Clarich, Rosario Russo **(ESTECO)** | *Innovative methodologies for Robust Design Optimization with large number of uncertainties* | 5-8/04/2015 | SIAM UQ16 | Scientific Community, Industry | >300 | Lausanne, Switzerland |
| 81 | Workshop presentation | Alberto Clarich, Rosario Russo **(ESTECO),** Nicola Magnino **(Leonardo)** | *Reliability-based Robust Design Optimization using Polynomial Chaos expansion of acoustic liners for aero-engine inlet applications* | 20-22/09/2016 | UMRIDA RDO Workshop, Bruxelles, Belgium | Scientific Community, Industry | ~60 | Bruxelles, Belgium |
| 82 | Presentation | E. Savin , A. Resmini, J. Peter **(ONERA)** | *Efficient methodologies for Robust Design Optimization with large number of uncertainties* | 5-10/06/2016 | ECCOMAS 2016 Conference, Crete Island, Greece | Industry, Scientific Community, Policy makers | >300 | Europe, International |
| 83 | Presentation | Eric Savin **(ONERA)** | *NON-ADAPTIVE CONSTRUCTION OF SPARSE POLYNOMIAL SURROGATES IN COMPUTATIONAL AERODYNAMICS* | 5-8/04/2016 | SIAM UQ16 | Scientific Community, Industry | >300 | Lausanne, Switzerland |
| 84 | Conference presentation | E. Savin, A. Resmini, J. Peter **(ONERA)** | *Sparse generalized polynomial chaos for non-intrusive uncertainty quantification in aerodynamic computations* | 25-27/05/2015 | 1st ECCOMAS Thematic Conference on International Conference on Uncertainty Quantification in Computational Sciences and Engineering (UNCECOMP 2015), Crete Island, Greece | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 85 | Conference presentation | E. Savin , A. Resmini, J. Peter **(ONERA)** | *Sparse polynomial surrogates for aerodynamic computations with random inputs* | 4-8/01/2016 | AIAA SciTech 2016 Conference, San Diego, California | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 86 | Workshop presentation | Eric Savin **(ONERA)** | *Non-adapted sparse polynomial surrogates for aerondynamic computations with random inputs* | 15-16/04/2015 | UMRIDA UQ Workshop, Delft, The Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 87 | Workshop presentation | Jean-Luc Hantrais-Gervois & *Eric Savin (Onera, France)* | *Sparse polynomial surrogates for non-intrusive, high-dimensional uncertainty quantification of aerodynamic* | September 12-15 2016 | 14th Int. Conf. Zaragoza-Pau on Mathematics and its Applications, Jaca (Spain) | Scientific Community, Industry | Information not available at the time of the report | Europe, International |

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| | | | *and aeroelastic computations* | | | | preparation | |
| 88 | Conference presentation | Eric Savin, Jean-Luc Hantrais-Gervois, Jacques Peter (ONERA) | *Sparse polynomial surrogates for uncertainty quantification in computational fluid dynamics* | 12-15/09/2016 | 14th Int. Conf. Zaragoza-Pau on Mathematics and its Applications (Jaca, Spain) | Scientific community | ~60 | Europe |
| 89 | Workshop presentation | Eric Savin, Jean-Luc Hantrais-Gervois (ONERA) | *Sparse polynomial surrogates for non-intrusive, high-dimensional uncertainty quantification of aerodynamic and aeroelastic computations* | 20-22/09/2016 | UMRIDA Symposium & Workshop on Uncertainty Quantification (UQ) & Robust Design Optimization (RDO) (Brussels, Belgium) | Scientific community, industry | ~60 | Brussels, Europe |
| 90 | Conference presentation | Eric Savin (ONERA) | *Computation of higher-order moments of generalized polynomial chaos expansions* | 9-13/01/2017 | AIAA Science and Technology Forum and Exposition 2017 (Grapevine TX, USA) | Scientific community, industry | >300 | International |
| 91 | Seminar | D. Liu, S. Görtz (DLR) | *On approximating large matrices* | 18/02/2014 | DLR $C^2A^2S^2E$ brown bag seminar, Germany | Scientific Community, Industry | 35 | Germany |
| 92 | Workshop presentation | S. Görtz (DLR) | *Influence of reduced-order modelling of geometrical uncertainties on statistics* | 08-09/10/2014 | 7. Dresdner-Probabilistik-Workshop, Dresden, Germany | Scientific Community, Industry | 80 | International |
| 93 | workshop presentation | D. Liu, S. Görtz (DLR) | *Efficient quantification of geometric uncertainties using gradient-assisted surrogate models and Karhunen-Loève expansion* | 15-16/04/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | Information not available at the time of the report preparation | Europe |
| 94 | Presentation | S. Görtz, D. Maruyama (DLR) | *Robust design: first results* | 42083 | Airbus-DLR workshop on MDO and optimization, DLR, Braunschweig, Germany | Industry | 10 | France |
| 95 | Workshop presentation | Daigo Maruyama, *Stefan Görtz, and Dishi Liu (DLR)* | *A Framework for Robust and Reliability-Based Design Optimization of Airfoils Considering Geometrical Uncertainties* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 96 | workshop presentation | Dishi Liu, Daigo Maruyama, Stefan | *Surrogate-Based Robust Aerodynamic Shape Optimization of Airfoils* | | 17. STAB-Workshop, Germany | Scientific Community, Industry | ~60 | Germany |

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| | | Görtz (DLR) | *Considering Geometric Uncertainties* | | | | | |
| 97 | Presentation | Dishi Liu, Daigo Maruyama, Stefan Görtz (DLR) | *SURROGATE-BASED ROBUST AIRFOIL OPTIMIZATION CONSIDERING GEOMETRICAL UNCERTAINTIES* | 5-8/04/2015 | SIAM UQ16 | Scientific Community, Industry | >300 | Lausanne, Switzerland |
| 98 | Confernece Presentation | D. Maruyama, D. Liu, S. Görtz (DLR) | *AN EFFICIENT AERODYNAMIC SHAPE OPTIMIZATION FRAMEWORK FOR ROBUST DESIGN OF AIRFOILS USING SURROGATE MODELS* | 5–10 June 2016 | ECCOMAS Congress 2016 VII European Congress on Computational Methods in Applied Sciences and Engineering, Crete Island, Greece | Scientific Community, Industry | >300 | EU, International |
| 99 | Seminar | D. Maruyama (DLR) | *Robust and Reliability-Based Design Optimization of Airfoils* | 42605 | DLR C²A²S²E brown bag seminar, Germany | Scientific Community | 35 | Germany |
| 100 | workshop | D. Liu, D. Maruyama, S. Görtz | *Methods for quantifying aerodynamic uncertainties and for robust and reliable shape design* | 42328 | 2nd DLR Stochastic Workshop | Scientific Community | 15 | Germany |
| 101 | workshop | S. Görtz | *DLR Vision for Uncertainty Quantification and Management* | 42348 | Airbus-DLR workshop on UQ&M | industry | 10 | Germany, UK |
| 102 | Seminar | D. Liu | *Efficient solution of large linear system by low rank Cholesky decomposition* | 42479 | DLR C²A²S²E brown bag seminar, Germany | Scientific Community | 35 | Germany |
| 103 | Workshop | S. Görtz, T. Franz, N. Karcher, M. Ripepi, M. Abu-Zurayk, D. Maruyama, D. Liu | *Surrogate and Reduced-Order Models for Use in Optimization, MDO and Robust Design* | 42510 | 3rd NPU-DLR workshop on aerodynamics | Scientific Community | 100 | China, Netherlands, Germany |
| 104 | Conference | R. Zimmermann, D. Liu | *Speeding up Kriging by Using Pivoted Cholesky Decomposition and Low-Rank Structures* | 42562 | 2016 SIAM Annual Meeting | Scientific Community | Information not available at the time of the report preparation | USA |
| 105 | Conference | V. Menier, A. Loseille, | *"Mesh adaptation for viscous* | 20-25/07/2014 | 6th. European Conferece con Computational Fluid Dynamics | Scientific community, | 3000 | International |

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| | presentation | F. Alauzet **(INRIA)** | *simulations"* | | (ECFD VI), Barcelona, Spain | Industry | | |
| 106 | Conference presentation | V. Menier, A. Loseille, F. Alauzet **(INRIA)** | ``*Main issues in anisotropic mesh adaptive FMG",* | 20-25/07/2014 | 6th European Conference on Computational Fluid Dynamics (ECFD VI, Barcelona, Spain | Scientific community, Industry | 3000 | International |
| 107 | Conference presentation | V. Menier, A. Loseille, F. Alauzet **(INRIA)** | *CFD Validation and Adaptivity for Viscous Flow Simulations* | 16-20/06/2014 | 44th AIAA Fluid Dynamics Conference, AIAA-2014-2925, Atlanta, GA, USA | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 108 | Conference presentation | V. Menier, A. Loseille, F. Alauzet **(INRIA)** | *Multigrid Strategies Coupled with Anisotropic Mesh Adaptation* | 05-09/01/2015 | AIAA Scitech 2015, Jan 2015, Kissimmee, United States | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 109 | Conference presentation | V. Menier, A. Loseille, F. Alauzet **(INRIA)** | *Towards a certified model of numerical uncertainty in CFD* | 01-04/09/2015 | Proceedings of the 2015 Conference on Modelling Fluid Flow (CMFF'15), Budapest, Hundary | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 110 | Workshop presentation | Adrien Loseille **(INRIA)** | *Mesh adaptive computation of the flow around a Falcon jet* | 15-16/04/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 111 | Conference presentation | G. Brethes, A. Loseille, F. Alauzet, A. Dervieux(INRIA) | *Adaptation for A Compressible Inviscid Flow Convergent error-controlled mesh adaptation* | 7-10/06/2015 | International Conference on Adaptive Modeling and Simulation (ADMOS 2015), Nantes, France | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 112 | Conference presentation | INRIA | *To be completed* | 12-14/10/2015 | 24th International Meshing Roundtable, Austin, Texas | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 113 | Conference presentation | G. Brethes, A. Loseille, F. Alauzet, A. Dervieux(INRIA) | *Main issues in anisotropic mesh adaptive FMG* | 27-29/04/2015 | 1st Pan-American Congress on Computational Mechanics, Buenos Aires | Scientific Community, Industry | Information not available at the time of the report | International |

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| 114 | Conference presentation | G. Brethes, A. Loseille, F. Alauzet, A. Dervieux(INRIA) | *Towards a certified model of numerical uncertainty* | September 1-4, 2015 | CFD Conference on Modelling Fluid Flow (CMFF 15), The 16th International Conference on Fluid Flow Technologies, Budapest, Hungary | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 115 | Workshop presentation | Frédéric Alauzet, Alain Dervieux, Loïc Frazza and Adrien Loseille, (INRIA) | *Reduction of numerical uncertainties in CFD : Application to the simulation of transonic flows around the generic Falcon geometry* | | | | | |
| 116 | Conference presentation | Domenico Quagliarella **(CIRA)** | *Uncertainty Sources in the Baseline Configuration for Robust Design of a Supersonic Natural Laminar Flow Wing-Body* | 14-16/09/2015 | 11th edition of the International Conference on Evolutionary and Deterministic Methods for Design, Optimization and Control with Applications to Industrial and Societal Problems (EUROGEN-2015) | Scientific Community, Industry | Information not available at the time of the report preparation | Europe, International |
| 117 | Workshop presentation | Domenico Quagliarella **(CIRA)** | *Parametric Study and Characterization of the Sources of Uncertainty in Test Case IC-08 baseline* | 15-16/04/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 118 | Workshop presentation | Domenico Quagliarella*, Emiliano Iuliano (CIRA)* | *Robust Design of a Supersonic Natural Laminar Flow Wing-Body using CVaR risk function* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 119 | Conference presentation | Domenico Quagliarella, Emiliano Iuliano (CIRA) | *Robust Design Optimization of a Supersonic Natural Laminar Flow Wing-Body* | 5-8/04/2015 | SIAM UQ16 | Scientific Community, Industry | >300 | Lausanne, Switzerland |
| 120 | Conference presentation | Jordi Pons-Prats **(CIMNE)** | *MULTILEVEL MONTE-CARLO METHODS APPLIED TO THE STOCHASTIC ANALYSIS OF AERODYNAMIC PROBLEMS* | 29/06-02/07/2015 | Congress on Numerical Methods in Engineering (CMN 2015), Lisbon, Portugal | Scientific Community, Industry | Information not available at the time of the report preparation | Europe, International |

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| 121 | Workshop presentation | Jordi Pons-Prats, Gabriel Bugeda (CIMNE) | *The Multi-Level Monte Carlo method and Robust design optimization: an assessment of a coupled us* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 122 | Workshop presentation | Jordi Pons Prats **(CIMNE)** | *Multilevel Monte-Carlo Methods applied to the stochastic analysis of aerodynamic problems* | 15-16/04/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 123 | Conference presentation | A. Ndiaye, M. Bauerheim, S. Moreau, F. Nicoud **(CERFACS)** | *Uncertainty quantification of thermoacoustic instabilities in a swirled stabilized combustor* | 15-19/06/2015 | ASME Turbo Expo 2015, Montreal, Canada | Scientific Community, Industry | 200 | International |
| 124 | Summer School | M. Bauerheim, A. Ndiaye, P. Constantine, G. Iaccarino, S. Moreau, F. Nicoud **(CERFACS)** | *Uncertainty quantification of thermo-acoustic instabilities in annular combustors* | 06/07-01/08/2014 | Stanford Center for Turbulence Research Summer Program, Stanford, CA, USA | Academia, Scientific ccommunity | 80 | International |
| 125 | Workshop presentation | A. Ndiaye (CERFACS) | *Introducing UQ to better handle thermoacoustics instabilities in aeroengines* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 126 | Workshop presentation | S. Richard, J. Lamouroux (Turbomeca) , A. Ndiaye (CERFACS) | *Application of a UQ method to evaluate the risk of occurrence of combustion instabilities in a helicopter combustor* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 127 | Summer School | Juniper M., Magri L., Bauerheim M. and Nicoud F. (CERFACS) | *Sensitivity analysis of thermo-acoustic eigenproblems with adjoint methods* | 06/07-01/08/2014 | Stanford Center for Turbulence Research Summer Program, Stanford, CA, USA | Academia, Scientific ccommunity | 80 | International |
| 128 | Workshop presentation | Aissatou Ndiaye **(CERFACS)** | *Uncertainty quantification study of combustion instabilities in high dimensional and complex systems* | 15-16/04/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 129 | Workshop presentation | Martin Schmelzer **(TU Delft)** | *Bayesian estimates of RANS model error based on uncertain closure coefficients* | 15-16/04/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |

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| 130 | Conference presentation | M. Schmelzer et al. **(TU Delft)** | *Preliminary results for local uncertainty quantification for RANS turbulence modeling* | 05-08/04/2016 | SIAM Conference on Uncertainty Quantification, Lausanne, Switzerland | Scientific Community, Industry | >300 | Europe, International |
| 131 | Thesis | Daquan He (TU Delft) | *Robust aerodynamic optimization with Taguchi's theory* | 2015 | TUDELFT, The Netherlands | Scientific Community | Information not available at the time of the report preparation | Europe, International |
| 132 | Thesis | Huiqing Wang (TU Delft) | *Stochastic Collocation with CFD robustness concepts for multi-dimensional probability spaces* | 2015 | TUDELFT, The Netherlands | Scientific Community | Information not available at the time of the report preparation | Europe, International |
| 133 | Thesis | Laurent van den Bos (TU Delft) | *Fast Non-Intrusive Uncertainty Quantification, with Applications to Fluid Flows* | 2015 | TUDELFT, The Netherlands | Scientific Community | Information not available at the time of the report preparation | Europe, International |
| 134 | Thesis | Iliass Azijli (TU Delft) | *Physics-Based Enrichment of Volumetric Velocity Measurements for Incompressible Flows* | 2015 | TUDELFT, The Netherlands | Scientific Community | Information not available at the time of the report preparation | Europe, International |
| 135 | Thesis | Wouter Edeling (TU Delft) | *Quantification of Uncertainties in Turbulent Flow Simulations* | 2015 | TUDELFT, The Netherlands | Scientific Community | Information not available at the time of the report preparation | Europe, International |
| 136 | Thesis | Martin Schmelzer (TU Delft) | *TBD* | 2016 | TUDELFT, The Netherlands | Scientific Community | Information not available at the time of the report preparation | Europe, International |
| 137 | Workshop presentation | M. Schmelzer (TU Delft) | *Quantification of epistemic uncertainties for RANS turbulence modeling of* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |

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| | | | *industrial-relevant flow cases* | | | | | |
| 138 | Thesis | Dinesh Kumar (VUB) | *Development of efficient uncertainty quantification and robust optimization methods for advanced applications in computational fluid dynamics* | 2016 | VUB, Belgium | Scientific Community | Information not available at the time of the report preparation | Europe, International |
| 139 | Thesis | Marco Serafini (VUB) | *Robust optimization of 2D NACA airfoil under uncertainties using Neural Networks* | 2015 | VUB, Belgium | Scientific Community | N/A | Europe, International |
| 140 | Conference presentation | M. Raisee(VUB) | *Stochastic Model reduction for Polynomial Chaos Expansion Using Proper Orthogonal Decomposition* | 11-14/6/2013 | 6th Chaotic Modeling and Simulation International Conf., Istanbul | Scientific Community, Industry | ~100 | International |
| 141 | Workshop presentation | M. Raisee(VUB) | *Development of a Non-Intrusive Model Reduction Approach for Polynomial Chaos Representation* | 16-18/12/2013 | International Workshop on Uncertainty Quantification in Fluids Simulation (BOQUSE 2013), Bordeaux, France | Scientific Community | 150 | International |
| 142 | Workshop presentation | M. Raisee, D. Kumar & C. Lacor (Vrije Universiteit Brussel) | *Efficient uncertainty quantification of the falcon Jet using Reduced Basis Method* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 143 | Conference presentation | D. Kumar **(VUB)** | *Towards an efficient non-intrusive Polynomial chaos approach for high-dimensional stochastic problems using a reduced basis approach* | 20-25/07/2014 | Barcelona, Spain | Scientific Community, Industry | 3000 | International |
| 144 | Workshop presentation | D. Kumar **(VUB)** | *A Reduced Basis Approach for Efficient Nonintrusive Polynomial Chaos in CFD* | 08-09/10/2014 | 7. Dresdner-Probabilistik-Workshop, Dresden, Germany | Scientific Community, Industry | 80 | International |
| 145 | Workshop presentation | M. Raisee(VUB) | *Efficient Uncertainty Quantification Schemes for Handling Large Number of Uncertainties Recent Development and Applications* | 15/12/2014 | Francis99- workshop 1, Norwegian University of Science and Technology, Trondheim, Norway | Scientific Community, Industry | 100 | International |

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| 146 | Conference presentation | Dinesh Kumar **(VUB)** | *An efficient non-intrusive reduced basis approach for uncertainty quantification in CFD* | 25-27/05/2015 | 1st ECCOMAS Thematic Conference on International Conference on Uncertainty Quantification in Computational Sciences and Engineering (UNCECOMP 2015), Crete Island, Greece | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 147 | Workshop presentation | Dinesh Kumar **(VUB)** | *An efficient non-intrusive PC-based reduced order scheme for uncertainty quantification of high dimensional stochastic problems* | 15-16/4/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 148 | Workshop presentation | D. Kumar, M. Raisee & C. Lacor (VUB, Belgium) | *Aerodynamic shape optimization of the RAE2822 airfoil under uncertainties using adjoint based multi-objective approach* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 149 | Conference presentation | Dinesh Kumar **(VUB)** | *Adjoint based multi-objective shape optimization of a transonic airfoil under uncertainties* | 19-23/06/2016 | 5th International Conference on Engineering Optimization (EngOpt 2016), Brazil | Scientific Community, Industry | <600 | International |
| 150 | Workshop presentation | Krzysztof Marchlewski **(Warsaw University of Technology)** | *Analytical Uncertainty Quantification on Kriging meta-model* | 15-16/4/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 151 | Workshop presentation | Marcin Wyrozębski **(Warsaw University of Technology)** | *Efficient use of 2nd order information in Uncertainty Quantification* | 15-16/4/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 152 | Workshop presentation | Ł. Łaniewski-Wołłk **(Warsaw University of Technology)** | *Introduction to Uncertainty Quantification and Robust Design* | 24-26/06/2015 | Workshop on Mesh Movement and Adaptation in Adjoint-based Design | Scientific Community | 40 | International |
| 153 | Conference presentation | Lukas Laniewski-Wollk, Marcin Wyrozebski **(Warsaw University of Technology)** | *Efficient Usage of 2nd Order Sensitivity for Uncertainty Quantification* | 5-8/04/2015 | SIAM UQ16 | Scientific Community, Industry | >300 | Lausanne, Switzerland |
| 154 | Conference presentation | Krzysztof Marchlewski, Łukasz Łaniewski-Wołłk | *Robust optimisation of air delivery duct shape* | 18.10.2016 | 6 EASN International Conference, Porto, Portugal | Scientific Community, Industry | >200 | International |

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| | | (WUT) | | | | | | |
| 155 | Workshop presentation | Krzysztof Marchlewski, Łukasz Łaniewski – Wołłk (WUT) | *Robust optimization of the air delivery duct shape* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 156 | Workshop presentation | Marcin Wyrozębski, Łukasz Łaniewski-Wołłk, Jacek Szumbarski (WUT) | *Efficient Usage of 2nd Order Sensitivity for Uncertainty Quantification* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 157 | Conference | Michele Pisaroni **(EPFL)** | *Continuation Multi Level Monte Carlo (C-MLMC) for Uncertainty Quantification in Compressible Aerodynamics* | 10-14/08/2015 | International Congress on Industrial and Applied Mathematics (ICIAM) 2015 | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 158 | Conference presentation | Michele Pisaroni **(EPFL)** | *Multi Level Monte Carlo for Uncertainty Quantification in Compressible* | 18-20/05/2015 | ERCOFTAC International workshop on Uncertainty Quantifiction in CFD , Paris, France | Scientific Community, Industry | Information not available at the time of the report preparation | Europe, International |
| 159 | Workshop presentation | Michele Pisaroni **(EPFL)** | *Multi-Level Monte Carlo for Uncertainty Quantification in Compressible Aerodynamics* | 15-16/4/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 160 | Conference presentation | Michele Pisaroni, Fabio Nobile, Penelope Leyland **(EPFL)** | *Multi Level Monte Carlo for Uncertainty Quantification in Compressible Aerodynamics* | 5-8/04/2015 | SIAM UQ16 | Scientific Community, Industry | >300 | Lausanne, Switzerland |
| 161 | Workshop presentation | Michele Pisaroni, *Fabio Nobile, Penelope Leyland (École polytechnique fédérale de Lausanne)* | *A Continuation Multi Level Monte Carlo algorithm for the treatment of geometrical and operational uncertainties in aerodynamics* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 162 | Conference presentation | J. Nordström **(LIU)** | *Variance reduction by robust design of boundary conditions for stochastic hyperbolic systems of equations* | 31/03-03/04/2014 | SIAM Conference on Uncertainty Quantification, Savannah, USA | Scientific Community, Industry | 20 | International |

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| 163 | Conference presentation | J. Nordström **(LIU)** | *Robust Design of Boundary Conditions for Stochastic Incompletely Parabolic Systems of Equations* | 07-11/07/2014 | SIAM Annual Meeting (AN14), Chicago, USA | Scientific Community, Industry | 20 | International |
| 164 | Conference presentation | Jan Nordström **(LIU)** | *An Investigation of Uncertainty due to Stochastically Varying Geometry* | 25-27/05/2015 | 1st ECCOMAS Thematic Conference on International Conference on Uncertainty Quantification in Computational Sciences and Engineering (UNCECOMP 2015), Crete Island, Greece | Scientific Community, Industry | Information not available at the time of the report preparation | International |
| 165 | Workshop presentation | M. Wahlsten (LIU) | *Robust Boundary Conditions for Stochastic Incompletely Parabolic Systems of Equations* | 15-16/4/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 166 | Conference presentation | Jan Nordström, Markus K. Wahlsten **(LIU)** | *AN INVESTIGATION OF UNCERTAINTY EFFECTS IN MIXED HYPERBOLIC-PARABOLIC PROBLEMS DUE TO STOCHASTICALLY VARYING GEOMETRY* | 5-8/04/2016 | SIAM UQ16 | Scientific Community, Industry | >300 | Lausanne, Switzerland |
| 167 | Conference presentation | M. Wahlsten, J. Nordström (LIU) | *Robust Boundary Conditions for Stochastic Incompletely Parabolic and Hyperbolic Systems of Equations* | 5-8/04/2016 | SIAM UQ16 | Scientific Community, Industry | 60 | International |
| 168 | Workshop presentation | Markus Wahlsten, Jan Nordström (Linköping University) | *Robust Boundary Conditions for Stochastic Incompletely Parabolic Systems of Equations* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 169 | Workshop presentation | Sönke Klostermann **(Airbus Group Innovations)** | *Surrogate Modelling on airfoil level for 3D DLLM wing* | 15-16/4/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 170 | Workshop presentation | Sönke Klostermann, *Régis Lebrun (Airbus Group Innovations)* | *Robust Design Optimisation of 3D Wing Based on Differentiated Lifting Line Method* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |
| 171 | Workshop presentation | R. Schmidt, M. Voigt, K. Vogeler **(TUD)** | *Sensitivity analysis of a two-stage high pressure compressor using an extended Latin* | 08-09/10/2014 | 7th Dresdner-Probabilistik-Workshop, Dresden, Germany | Scientific Community, Industry | 80 | International |

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| | | | *hypercube sampling* | | | | | |
| 172 | Workshop presentation | R. Schmidt, M. Voigt, K. Vogeler **(TUD)** | *Engineering approach for the extension of Latin Hypercube samples while maintaining the correlation structure* | 04-05/11/2014 | 12th International Probabilistic Workshop, Weimar, Germany | Scientific Community, Industry | 150 | International |
| 173 | Leaflets distribution | TUD | - | 08-09/10/2014 | 7. Dresdner-Probabilistik-Workshop, Dresden, Germany | Industry, Scientific Community | 80 | Europe, International |
| 174 | Workshop presentation | Robin Schmidt **(TU Dresden)** | *Extension of Latin Hypercube samples while maintaining the correlation structure* | 15-16/4/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 175 | Conference presentation | Robin Schmidt, Matthias Voigt, Konrad Vogeler **(TUD)**, Marcus Meyer **(RR)** | *COMPARISON OF TWO METHODS FOR SENSITIVITY ANALYSIS OF COMPRESSOR BLADES* | 13-17/06/2016 | ASME Turbo Expo 2016, Seoul, South Korea | Scientific Community, Industry, Policy Makers, Academia | >600 | International |
| 176 | Workshop presentation | R. Schmidt, M. Voigt, K. Vogeler (**TUD**) | *Sensitivity analysis of a two-stage high pressure compressor using an extended Latin hypercube sampling* | 08-09/10/2014 | 7th Dresdner-Probabilistik-Workshop, Dresden, Germany | Scientific Community, Industry | ~75 | International |
| 177 | Conference presentation | R. Schmidt, M. Voigt, K. Vogeler (**TUD**) | *Engineering approach for the extension of Latin Hypercube samples while maintaining the correlation structure* | 04-05/11/2014 | 12th International Probabilistic Workshop, Weimar, Germany | Scientific Community, Industry | ~150 | International |
| 178 | Workshop presentation | Robin Schmidt **(TU Dresden)** | *Extension of Latin Hypercube samples while maintaining the correlation structure* | 15-16/4/2015 | UMRIDA Workshop on Uncertainty Quantification, TU Delft, Netherlands | Scientific Community, Industry | ~60 | Delft, Europe |
| 179 | Conference presentation | Robin Schmidt, Matthias Voigt, Konrad Vogeler **(TUD)**, Marcus Meyer **(RR)** | *COMPARISON OF TWO METHODS FOR SENSITIVITY ANALYSIS OF COMPRESSOR BLADES* | 13-17/06/2016 | ASME Turbo Expo 2016, Seoul, South Korea | Scientific Community, Industry, Policy Makers, Academia | >600 | International |
| 180 | Workshop presentation | Robin Schmidt, Matthias Voigt and Ronald Mailach (TU Dresden) | *Exploitation of an Extendable LHS Sampling Approach in Sensitivity Analysis* | 20-22/09/2016 | 2nd UMRIDA UQ and RDO Symposium & Workshop | Scientific Community, Industry | ~90 | Brussels, Belgium |

**Part B2**

Please complete the table hereafter:

| # | Type of Exploitable Foreground[6] | Description of exploitable foreground | Confidential Click on YES/NO | Foreseen embargo date | Exploitable product(s) or measure(s) | Sector(s) of application[7] | Timetable, commercial or any other use | Patents or other IPR exploitation (licences) | Owner & Other Beneficiary(s) involved |
|---|---|---|---|---|---|---|---|---|---|
| *1* | Commercial exploitation of R&D results | Efficient methodologies have been developed for the computation of the sensitivity of aerodynamic performances with respect to geometrical parameters. | **YES** | 30/9/2016 | A differentiated CFD code, derived from company proprietary solver UNS3D available for UQ. | Aerodynamic design of aircraft wings | 2018 | N/A | **FNM** |
| **2** | Commercial exploitation of R&D results | A robust design methology have been develpped for robust optimization of acoustic liners to be installed inside engine nacelles . | **YES** | 30/9/2016 | A tool for acoustic optimization of liners is available.<br>Both tools are installed and running on company's HPC and can be launched from personal workstations. | Design of acoustic panels in engine nacelles. | 2018 | *N/A* | **FNM** |
| **3** | Commercial exploitation of R&D results | Low-rank approximation of large covariance matrices occuring in the context of geometrical uncertainties. | **YES** | 1/4/2014 | Software | Aircraft design | 2014 | N/A | **DLR** |
| **4** | Commercial exploitation of R&D results | Truncated Karhunen-Loève expansion for parameterization of geometrical uncertainties of 3D geometries with geometrical constraints. | **YES** | 1/4/2014 | Software | Aircraft design | 2014 | *N/A* | **DLR** |
| **5** | Commercial exploitation of R&D results | Methods for the evaluation of mesh-based errors | **YES** | 31/09/2016 | Software Algorithm | Activity in engineering | 2016 | Part of protected software | **INRIA** |
| **6** | General advancement of knowledge | Development of efficient methodologies for reliability based design of aerodynamic configurations. | NO | 31/09/2016 | Methodology and software | Aircraft design | 2016 | *N/A* | **CIRA** |
| **7** | Commercial exploitation of R&D results | Methods for UQ quantification (Adaptive Sparse PCE) and RDO optimization (Reliability-based RDO) implemented in modeFRONTIER software | **YES** | 30/9/2016 | Software parts | Engineering applications (aerospace, automotive, manufacturing, etc..) | 2015-2016 | Part of protected software | **ESTECO** |

[19] A drop down list allows choosing the type of foreground: General advancement of knowledge, Commercial exploitation of R&D results, Exploitation of R&D results via standards, exploitation of results through EU policies, exploitation of results through (social) innovation.

[7] A drop down list allows choosing the type sector (NACE nomenclature) : http://ec.europa.eu/competition/mergers/cases/index/nace_all.html

| # | Type of Exploitable Foreground[6] | Description of exploitable foreground | Confidential Click on YES/NO | Foreseen embargo date | Exploitable product(s) or measure(s) | Sector(s) of application[7] | Timetable, commercial or any other use | Patents or other IPR exploitation (licences) | Owner & Other Beneficiary(s) involved |
|---|---|---|---|---|---|---|---|---|---|
| **8** | Commercial exploitation of R&D results | Creation of a new Software product capable of handling simultaneous operational and geoemtical and manufacturing uncertainties in an industrial design environment. Including sparse grids, Pearson reconstruction, scaled sensitivities and Karhunen-Loeve expansion | **YES** | N/A | New software package | All fields of application of FINE software, aeronautics, turbomachinery, industrial configurations, boats, … | 2015 | Part of protected software | **NUMECA** |
| **9** | Commercial exploitation of R&D results | Creation of a new Software product capable of for optimization under uncertainties (Robust Design Optimization) | **YES** | N/A | New software package | All fields of application of FINE software, aeronautics, turbomachinery, industrial configurations, boats, … | 2016 | Part of protected software | **NUMECA** |
| **10** | Commercial exploitation of R&D results | Evaluation of UQ and RD methodologies in industrial context | **YES** | N/A | Methodology made available in DASSAV aerodynamic shape optimization framework | Aircraft Company. Aerodynamic Shape Design. | 2017 | | **DASSAV** |
| **11** | Commercial exploitation of R&D results | Integration of UQ and RDO methodologies in the design process for new compressor and turbine stages.<br>Integration of the results into manufacturing drawings and quality control. | **YES** | N/A | Software packages Instructions for design and manufacturing control. | Development, Design, Supply Chain | 2015 | No | **MAN Diesel & Turbo** |
| **12** | Exploitation of results through innovation | Methodology for exploiting UQ in the combustor design process for adressing the risk of combustion instabilities | **YES** | N/A | Methodology and tools from CERFACS | Combustor design | 2018 | *N/A* | **CERFACS** |
| **13** | Commercial exploitation of R&D results | Modification of Software product "APPROX" for surrogate model construction. Addition new and modified algorithms as to modified full-square regression, "wiegthed" approximation, and neural networks. | **YES** | N/A | Software | Turbomachinery industry and other fields of application of the optimization software | 2017 | Part of protected software | **NPO-SATURN** |
| **14** | Commercial exploitation of R&D results | Webinar, newsletter and training courses for modeFRONTIER users, illustrating best-practice of UQ and RDO | NO | 30/11/2016 | Webinar, trainings | Engineering applications (aerospace, automotive, manufacturing, etc..) | 2016 | N/A | **ESTECO** |
| **15** | General advancement | Matlab codes for computing higher-order moments of gPC expansions | NO | N/A | Software package available at | All fields of UQ using gPC | | N/A | **ONERA** |

| # | Type of Exploitable Foreground[6] | Description of exploitable foreground | Confidential Click on YES/NO | Foreseen embargo date | Exploitable product(s) or measure(s) | Sector(s) of application[7] | Timetable, commercial or any other use | Patents or other IPR exploitation (licences) | Owner & Other Beneficiary(s) involved |
|---|---|---|---|---|---|---|---|---|---|
| | of knowledge | | | | https://github.com/ericsavin/LinCoef/ | expansions | | | |
| **16** | General advancement of knowledge | Further development of methods, while applying to other engineering fields (bio-medics, automotive). | **YES** | 31/9/2016 | Development of research software | Research | 2016-2017 | *NA* | **CIMNE** |
| **17** | General advancement of knowledge | Development of a research UQ and RDO software platform, combining UMRIDA developments with other developments available within CIMNE | **YES** | 31/9/2016 | Development of research software | Research | 2016-2022 | NA | **CIMNE** |
| **18** | General advancement of knowledge | Novel sampling methods and general developed probabilistic methods | NO | None | Methodology | Academia | 2016 | N/A | **TUD** |
| **19** | General enhancement of knowledge | Development of new and efficient methodologies for RDO and UQ methods with C- MLMC methods | NO | 31/12/2018 | Methodology and software | ANY | 2018 | To be defined with UMRIDA MGT | **EPFL** |
| **20** | General enhancement of knowledge | Application of UQ and RDO techniques for stochastic optimisation in Aero and Marine full scale applications within the collaboration with the NATO AVT-252 group | **YES** | dec 2018 | New data sets with UQ and RDO analysis on full scale vehicle level applications | Aero and marine vvehicles | 2018 | *Restricted to AVT-252 members and associated UMRIDA partners* | **EPFL** |
| **21** | General advancement of knowledge | Delivery of various courses | NO | - | Academic material and courses | Mechanical engineering, mathematics and Computational Science | - | - | **EPFL** |
| **22** | General advancement of knowledge | UMRIDA results used in teaching and supporting varuous MSc projects | NO | - | Academic material and courses | Mechanical engineering, mathematics and Computational Science | - | - | **EPFL** |
| **23** | General advancement of knowledge | Introduction of the project outcomes to internal forums | **YES** | N/A | Training of employess | Multiple domains (structural, fluid, thermal, etc.) | N/A | No | **AIRBUS** |
| **24** | General advancement of knowledge | New academic material | **YES** | Mid-2017 | New courses and lecture notes | Uncertainty Quantification, and Applied Numerical Analysis | 2017 | NO | **TUDELFT** |

| # | Type of Exploitable Foreground[6] | Description of exploitable foreground | Confidential Click on YES/NO | Foreseen embargo date | Exploitable product(s) or measure(s) | Sector(s) of application[7] | Timetable, commercial or any other use | Patents or other IPR exploitation (licences) | Owner & Other Beneficiary(s) involved |
|---|---|---|---|---|---|---|---|---|---|
| **25** | General advancement of knowledge | Know-how used in pararell projects | **YES** | - | - | CFD and Uncertainty Quantification | - | - | **VUB** |
| **26** | General advancement of knowledge | Coursed taught based on the UMRIDA material | NO | - | Academic material and courses | Uncertainty Quantification | 2014, 2016 | - | **VUB** |
| **27** | General advancement of knowledge | Delivery of a graduate course in UQ which partly stems from the UMRIDA outcomes and know-how | NO | - | Academic material and courses | Uncertainty Quantification | 2017 | - | **LIU** |

## 4.3 Report on societal implications

Replies to the following questions will assist the Commission to obtain statistics and indicators on societal and socio-economic issues addressed by projects. The questions are arranged in a number of key themes. As well as producing certain statistics, the replies will also help identify those projects that have shown a real engagement with wider societal issues, and thereby identify interesting approaches to these issues and best practices. The replies for individual projects will not be made public.

| **A General Information** *(completed automatically when **Grant Agreement number** is entered.* | |
|---|---|
| **Grant Agreement Number:** | **605036** |
| **Title of Project:** | **Uncertainty Management for Robust Industrial Design in Aeronautics** |
| **Name and Title of Coordinator:** | **Prof. Charles Hirsch, President Numeca International** |

| **B Ethics** | |
|---|---|
| **1. Did your project undergo an Ethics Review (and/or Screening)?**<br>• If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final project reports?<br>Special Reminder: the progress of compliance with the Ethics Review/Screening Requirements should be described in the Period/Final Project Reports under the Section 3.2.2 *'Work Progress and Achievements'* | ***NO*** |
| **2. Please indicate whether your project involved any of the following issues (tick box) :** | ***YES*** |
| **RESEARCH ON HUMANS** | |
| • Did the project involve children? | |
| • Did the project involve patients? | |
| • Did the project involve persons not able to give consent? | |
| • Did the project involve adult healthy volunteers? | |
| • Did the project involve Human genetic material? | |
| • Did the project involve Human biological samples? | |
| • Did the project involve Human data collection? | |
| **RESEARCH ON HUMAN EMBRYO/FOETUS** | |
| • Did the project involve Human Embryos? | |
| • Did the project involve Human Foetal Tissue / Cells? | |
| • Did the project involve Human Embryonic Stem Cells (hESCs)? | |
| • Did the project on human Embryonic Stem Cells involve cells in culture? | |
| • Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos? | |
| **PRIVACY** | |
| • Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)? | |
| • Did the project involve tracking the location or observation of people? | |
| **RESEARCH ON ANIMALS** | |
| • Did the project involve research on animals? | |
| • Were those animals transgenic small laboratory animals? | |

| | |
|---|---|
| • Were those animals transgenic farm animals? | |
| • Were those animals cloned farm animals? | |
| • Were those animals non-human primates? | |
| **RESEARCH INVOLVING DEVELOPING COUNTRIES** | |
| • Did the project involve the use of local resources (genetic, animal, plant etc)? | |
| • Was the project of benefit to local community (capacity building, access to healthcare, education etc)? | |
| **DUAL USE** | |
| • Research having direct military use | |
| • Research having the potential for terrorist abuse | |

# C Workforce Statistics

**3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).**

| Type of Position | Number of Women | Number of Men |
|---|---|---|
| Scientific Coordinator | 0 | 14 |
| Work package leaders | 4 | 19 |
| Experienced researchers (i.e. PhD holders) | 4 | 32 |
| PhD Students | 1 | 16 |
| Other | 6 | 6 |

| | |
|---|---|
| **4. How many additional researchers (in companies and universities) were recruited specifically for this project?** | **2** |
| Of which, indicate the number of men: | 1 |

## D Gender Aspects

| | | |
|---|---|---|
| **5. Did you carry out specific Gender Equality Actions under the project**? | ○<br>**X** | Yes<br>No |

**6. Which of the following actions did you carry out and how effective were they?**

| | | Not at all effective | | | | Very effective |
|---|---|---|---|---|---|---|
| ❑ | Design and implement an equal opportunity policy | ○ | ○ | ○ | ○ | ○ |
| ❑ | Set targets to achieve a gender balance in the workforce | ○ | ○ | ○ | ○ | ○ |
| ❑ | Organise conferences and workshops on gender | ○ | ○ | ○ | ○ | ○ |
| ❑ | Actions to improve work-life balance | ○ | ○ | ○ | ○ | ○ |
| ○ | Other: | | | | | |

**7. Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?**

○ Yes- please specify

**X** No

## E Synergies with Science Education

**8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?**

○ Yes- please specify

**X** No

**9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?**

○ Yes- please specify

**X** No

## F Interdisciplinarity

**10. Which disciplines (see list below) are involved in your project?**

**X** Main discipline[8]: **1.1**

**X** Associated discipline[8]: **2.3** ○ Associated discipline[8]:

## G Engaging with Civil society and policy makers

| | | |
|---|---|---|
| **11a Did your project engage with societal actors beyond the research community?** *(if 'No', go to Question 14)* | ○<br>**X** | Yes<br>No |

**11b If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?**

○ No

○ Yes- in determining what research should be performed

[8] Insert number from list below (Frascati Manual).

- ○ Yes - in implementing the research
- ○ Yes, in communicating /disseminating / using the results of the project

| | | |
|---|---|---|
| **11c In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?** | ○<br>○ | Yes<br>No |

**12. Did you engage with government / public bodies or policy makers (including international organisations)**

- ○ No
- ○ Yes- in framing the research agenda
- ○ Yes - in implementing the research agenda
- ○ Yes, in communicating /disseminating / using the results of the project

**13a Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?**

- ○ Yes – as a **primary** objective (please indicate areas below- multiple answers possible)
- ○ Yes – as a **secondary** objective (please indicate areas below - multiple answer possible)
- X No

**13b If Yes, in which fields?**

| | | | | | |
|---|---|---|---|---|---|
| Agriculture | | Energy | | Human rights | |
| Audiovisual and Media | | Enlargement | | Information Society | |
| Budget | | Enterprise | | Institutional affairs | |
| Competition | | Environment | | Internal Market | |
| Consumers | | External Relations | | Justice, freedom and security | |
| Culture | | External Trade | | Public Health | |
| Customs | | Fisheries and Maritime Affairs | | Regional Policy | |
| Development Economic and Monetary Affairs | | Food Safety | | Research and Innovation | |
| | | Foreign and Security Policy | | Space | |
| Education, Training, Youth | | Fraud | | Taxation | |
| Employment and Social Affairs | | Humanitarian aid | | Transport | |

**13c If Yes, at which level?**

- ○ Local / regional levels
- ○ National level
- ○ European level
- ○ International level

## H Use and dissemination

| | |
|---|---|
| **14. How many Articles were published/accepted for publication in peer-reviewed journals?** | **20** |
| **To how many of these is open access[9] provided?** | |
| **How many of these are published in open access journals?** | |
| **How many of these are published in open repositories?** | **1** |
| **To how many of these is open access not provided?** | **19** |
| **Please check all applicable reasons for not providing open access:** | |
| **X** publisher's licensing agreement would not permit publishing in a repository<br>❑ no suitable repository available<br>**X** no suitable open access journal available<br>❑ no funds available to publish in an open access journal<br>❑ lack of time and resources<br>❑ lack of information on open access<br>❑ other[10]: …… | |

| | | |
|---|---|---|
| **15. How many new patent applications ('priority filings') have been made?** *("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).* | | --- |
| **16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).** | Trademark | --- |
| | Registered design | --- |
| | Other | --- |
| **17. How many spin-off companies were created / are planned as a direct result of the project?** | | --- |
| ***Indicate the approximate number of additional jobs in these companies:*** | | |

**18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:**

| | | | |
|---|---|---|---|
| **X** | Increase in employment, or | **X** | In small & medium-sized enterprises |
| **X** | Safeguard employment, or | **X** | In large companies |
| ❑ | Decrease in employment, | ❑ | None of the above / not relevant to the project |
| ❑ | Difficult to estimate / not possible to quantify | | |

| | |
|---|---|
| **19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (*FTE = one person working fulltime for a year*) jobs:** | *Indicate figure:*<br>*48.63* |

[9] Open Access is defined as free of charge access for anyone via Internet.
[10] For instance: classification for security project.

| | |
|---|---|
| Difficult to estimate / not possible to quantify | ❑ |

# I Media and Communication to the general public

**20. As part of the project, were any of the beneficiaries professionals in communication or media relations?**

X Yes ○ No

**21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?**

○ Yes X No

**22 Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?**

| | | | |
|---|---|---|---|
| X | Press Release | ❑ | Coverage in specialist press |
| ❑ | Media briefing | ❑ | Coverage in general (non-specialist) press |
| ❑ | TV coverage / report | ❑ | Coverage in national press |
| ❑ | Radio coverage / report | ❑ | Coverage in international press |
| X | Brochures /posters / flyers | X | Website for the general public / internet |
| ❑ | DVD /Film /Multimedia | ❑ | Event targeting general public (festival, conference, exhibition, science café) |

**23 In which languages are the information products for the general public produced?**

| | | | |
|---|---|---|---|
| ❑ | Language of the coordinator | X | English |
| ❑ | Other language(s) | | |

***Question F-10*:** Classification of Scientific Disciplines according to the Frascati Manual 2002 (Proposed Standard Practice for Surveys on Research and Experimental Development, OECD 2002):

**FIELDS OF SCIENCE AND TECHNOLOGY**

1. NATURAL SCIENCES

1.1 Mathematics and computer sciences [mathematics and other allied fields: computer sciences and other allied subjects (software development only; hardware development should be classified in the engineering fields)]

1.2 Physical sciences (astronomy and space sciences, physics and other allied subjects)

1.3 Chemical sciences (chemistry, other allied subjects)

1.4 Earth and related environmental sciences (geology, geophysics, mineralogy, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, oceanography, vulcanology, palaeoecology, other allied sciences)

1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences)

2 ENGINEERING AND TECHNOLOGY

2.1 Civil engineering (architecture engineering, building science and engineering, construction engineering, municipal and structural engineering and other allied subjects)

2.2 Electrical engineering, electronics [electrical engineering, electronics, communication engineering and systems, computer engineering (hardware only) and other allied subjects]

2.3. Other engineering sciences (such as chemical, aeronautical and space, mechanical, metallurgical and materials engineering, and their specialised subdivisions; forest products; applied sciences such as

geodesy, industrial chemistry, etc.; the science and technology of food production; specialised technologies of interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile technology and other applied subjects)

3. MEDICAL SCIENCES

3.1 Basic medicine (anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immunohaematology, clinical chemistry, clinical microbiology, pathology)

3.2 Clinical medicine (anaesthesiology, paediatrics, obstetrics and gynaecology, internal medicine, surgery, dentistry, neurology, psychiatry, radiology, therapeutics, otorhinolaryngology, ophthalmology)

3.3 Health sciences (public health services, social medicine, hygiene, nursing, epidemiology)

4. AGRICULTURAL SCIENCES

4.1 Agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)

4.2 Veterinary medicine

5. SOCIAL SCIENCES

5.1 Psychology

5.2 Economics

5.3 Educational sciences (education and training and other allied subjects)

5.4 Other social sciences [anthropology (social and cultural) and ethnology, demography, geography (human, economic and social), town and country planning, management, law, linguistics, political sciences, sociology, organisation and methods, miscellaneous social sciences and interdisciplinary , methodological and historical S1T activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences].

6. HUMANITIES

6.1 History (history, prehistory and history, together with auxiliary historical disciplines such as archaeology, numismatics, palaeography, genealogy, etc.)

6.2 Languages and literature (ancient and modern)

6.3 Other humanities [philosophy (including the history of science and technology) arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic "research" of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other S1T activities relating to the subjects in this group]

# 2. FINAL REPORT ON THE DISTRIBUTION OF THE EUROPEAN UNION FINANCIAL CONTRIBUTION

This report shall be submitted to the Commission within 30 days after receipt of the final payment of the European Union financial contribution.

## Report on the distribution of the European Union financial contribution between beneficiaries

| Name of beneficiary | Final amount of EU contribution per beneficiary in Euros |
|---|---|
| 1. | |
| 2. | |
| | |
| n | |
| | |
| Total | |