<u>Curriculum vitae</u>

Name: ANDREA LANI

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Birth date:	19/2/1975
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University education and qualifications

- 1/2010 12/2010, **Postdoc**, NASA Ames / Stanford Center for Turbulence Research (CTR), CA, US.
- 10/2003 12/2008, **Ph.D. in Engineering Sciences**, Thesis: *An Object Oriented and High Performance Platform for Aerothermodynamics Simulation*, Université Libre de Bruxelles (ULB), Belgium.
- 10/2002 9/2003, **Diplome d'études approfondies in Applied Science** (Grade: 17/20), ULB, Belgium.
- 10/1994 12/2000, **M.Sc. in Aerospace Engineering** (Final grade: 110/110, highest possible w/o honors, overall GPA=3.67), Polytechnic of Turin, Italy.

Carrier summary

• 10/2008 – now, **Senior Research Engineer**, Aeronautics & Aerospace Dept., Von Karman Institute (VKI), Belgium.

Project leader and main developer of COOLFluiD (http://coolfluidsrv.vki.ac.be/trac/coolfluid), a worldclass C++ / MPI / CUDA platform for scientific HPC (1,000,000+ code lines, 50+ developers and/or users so far) featuring a **unique combination of advanced numerical solvers** (Finite Volume, Residual Distribution, FEM, Spectral Finite Difference & Volume) and multi-physical models. I have directly supervised and heavily contributed to develop: an all-speed Inductively Coupled Plasma (ICP) code for designing experiments in the VKI Plasmatron, jacobian free implicit methods, a Collisional Radiative (CR) model solver, an ALE solver for modeling expanding hypersonic flows into the VKI Longhshot tunnel, a coupled multi-fluid plasma / Maxwell solver for Solar physics, fluid-radiation coupling based on a Monte Carlo transport algorithm. I have ported an existing unsteady parallel implicit ideal MHD code to GPU's. I have directly supervised more than 10 developers (under-graduates, graduates, Ph.D. students, two engineers). I coordinate a development team including 15 international collaborators. COOLFluiD versions have been distributed to several partner institutions (ESA, ULB, VUB, KUL, Polytechnic of Milan, EPFL, Prague and Warsaw Universities, University of Illinois, École Central Paris, Argonne National Lab, NASA Ames), two companies (3E, ELSYCA). COOLFluiD has been involved in 15+ international research projects (EU FP7, NATO RTO, US AFOSR, many Belgian and ESA), contributing to raise 3,000,000+ euros so far. I have contributed to write successful research proposals and to procure funding for me and collaborators.

Coordinated CFD activity for the following ESA research projects:

- ESA BLAST: provided aerodynamic and aerothermodynamic database for the concept mission;

- ESA EXPERT Phase C/D: aerothermodynamic analysis of the spacecraft at peak heating conditions;

- **ESA AMOD**: integration of flow-radiation coupling and a Monte Carlo algorithm for radiative transport; Contribution to the following research projects is ongoing:

- ESA PRODEX-9 CCN: porting of Finite Volume (FV) MHD solver to GPU's.
- FWO G.0729.11N grant: development of multi-component models for Space Weather simulations;

- ESA IXV CATE: heat flux computation on TPS with partial wall catalycity model on ESA IXV vehicle.

- US AFOSR grant: integration of partial wall catalycity models for TPS testing in ICP conditions.

- ESA Plasmatron+: extension of ICP solver to all-speed and thermo-chemical nonequilibrium models.

- ESA VSWMC: design and development of the first European infrastructure for Space Weather modeling.

- Visiting researcher at NASA Ames / Stanford CTR in July 2011.

- Member of the steering committee for the NATO STO AVT 205 research group.
- Visiting scientist at University of Illinois at Urbana Champaign in February 2013.
- Visiting scientist at NASA Ames in July 2013.

• 1/2010 – 12/2010, **Postdoctoral research fellow**, NASA/Stanford CTR, US.

Contributed to further development of **ADPDIS3D**, a Lawrence Livermore National Lab (LLNL) / NASA solver for massive parallel calculations pioneering a variable high-order finite difference method for overset meshes with application to high-Reynolds 3D hypersonic flows in chemical nonequilibrium. This experience has led to the publication of **one journal article**, **one conference paper**, **three book contributions** to CTR annual briefs and has allowed me to establish valuable collaborations with senior NASA/LLNL scientists.

• 10/2002 – 9/2008, **Researcher**, Aeronautics & Aerospace Dept., VKI, Belgium.

Co-initiator, project leader and main developer of COOLFluiD. My specific tasks have included design / implementation of the kernel, parallel datastructure, parallel implicit FV and more advanced RD solvers (1D / 2D / 3D / axisymmetric) for compressible and incompressible Navier-Stokes, ideal MHD models, hypersonic gas mixtures in thermo-chemical equilibrium / nonequilibrium and the **management of about 20 other researchers** (under-graduates, post-graduates, fellow Ph.D. students, one postdoc). Functionalities coming from legacy codes have been integrated and generalized for handling more complex applications.

Fundamental contribution to the following research projects has been provided:

- GOA (Regional Government): implementation of MHD RD solver for Space Weather;

- ESA PRODEX-8: implementation of an unsteady parallel implicit FV solver for MHD applications;

- ESA AMOD: integration of advanced aerothermodynamic models into the carrier code (COOLFluiD);

- NATO RTO AVT 136 (and related AFOSR grant): numerical validation of high enthalpy flow experiments (from CUBRC, US and DLR, Germany) within an international working group, including US Air Force, University of Minnesota, Cranfield University, DLR, AOES.

The contribution to AVT 136 has been rewarded with a co-authorship in a joint **major publication in the prestigious J. Progress in Aerospace Sciences** and with the invitation to join the steering committee for the follow up AVT 205 activity as a NATO STO technical team member.

• 2/2002 – 9/2002, **Applied Research Orientation**, Aeronautics & Aerospace Dept., VKI, Belgium. Collected the final results and written the final dissemination and technical reports for EU Fp7 IDEMAS and ESA ARD projects. Started working on the preliminary design of the COOLFluiD platform.

• 5/2001 – 1/2002, **Development engineer**, NUMECA International, Belgium.

Developed algorithms for regularizing hierarchical mesh refinement / coarsening and adaptively controlling the first cell on the wall according to the local y+ inside boundary layers in FINE / Hexa, a large fully hexahedral commercial C++ FV solver for adaptive unstructured non-conformal grids.

Key skills and achievements

I'm a hard and ambitious worker, able to perform efficiently both in autonomy and in a team. I have **strong analytical skills and capability to think out-of-the-box**. I learn quickly and I have a positive attitude allowing me to seek and find the best possible solution to each problem. I'm particularly **passionate about scientific and high-performance computing**, involving complex numerical algorithms and physical models, object-oriented (OO) design and scientific programming (C/C++, MPI, CUDA). I have an eye for software solutions combining both efficiency and flexibility. **I truly enjoy programming with C++**. I have a **unique and highly diversified experience in the research field**, including demonstrated ability to manage R&D projects from start (proposals writing, funding procurement) to finish (reporting, results delivery), a proven expertise in advanced software engineering and scientific computing, computational methods, complex multi-physical modeling (e.g., plasma flows, aerothermodynamics for aerospace related problems), **experience collaborating with experimentalists on a daily base for model validation**, My main carrier objective is to give a fundamental contribution, as a **professor** and/or **project leader** and/or **research manager and scientifi**c problems. I'm particularly interested in lead R&D positions involving HPC, scientific software design and development, modeling of complex multi-physical phenomena.

- Co-initiator and project leader in the design and implementation of COOLFluiD, a large componentbased HPC platform, which has already involved contributions from 50+ researchers (~30 supervised by me) and from the collaboration of partner institutions in Belgium and abroad.
- 10+ yr experience in developing state-of-the-art numerical algorithms (e.g., parallel high-order implicit

FV and RD solvers on unstructured grids), datastructures for complex CFD applications.

- 10+ yr experience in multi-physics and aerothermodynamics modeling, simulation and analysis with different numerical algorithms on complex aerospace-related applications.
- 10+ yr experience in OO design for scientific computing, generic C++ programming (expression templates, STL, etc.).
- 6 yr experience in developing parallel SIMD algorithms using MPI (in Linux), including parallel I/O.
- Familiarity with Fortran (77, 90) and C languages, GPU programming with CUDA C/C++.
- Familiarity with Linux tools (e.g., latex, emacs, svn, kdevelop, kcachegrind, valgrind, cmake, gdb, gprof, scripting, doxygen, Eigen, boost, HDF5, PETSc), Open and MS Office (Word, Excel, PowerPoint).
- Familiarity with CFD software such as NUMECA's HEXPRESS and Fine/Hexa, Tecplot, Gambit, Ogen.
- 8 journal articles, 28 conference papers, 5 book contributions, 7 international invited seminars.

Teaching activities

- 10/2004, 10/2005, VKI Lecturer on C++ scientific programming and COOLFluiD (6 hours).
- 12/2009, VKI Lecturer on computational aerothermodynamics with COOLFluiD (4 hours).
- 7/2011, VKI Lecturer on CFD for aerothermodynamics for a Chinese delegation (3 hours).
- 7/2012, VKI Lecturer on CFD for aerothermodynamics for a Chinese delegation (2 hours).
- 2/2013, VKI Lecturer on CFD for aerothermodynamics for a Chinese delegation (2 hours).
- 2/2013, Invited lecturer on CFD for aerothermodynamics for a undergraduate class at UIUC (1 hour).

Membership of professional bodies

- Member of American Institute of Aeronautics and Aerospace (AIAA) since 4/2007.
- NATO RTO technical team member since 3/2011.

Service to scientific community

- Technical contributor to the NATO RTO AVT 136 international research group.
- Technical team member in the steering committee of NATO RTO AVT 205 research group.
- Scientific reviewer for AIAA Journal, EUCASS, SIAM J. Sci. Comp., J. Comp. Phys.
- Experienced supervisor or advisor for Master After Master in Fluid Dynamics (17 students), for the Short Training Program (13 students) and for Ph.D. candidates (3 students at the moment).
- Organizer of the Mini-symposium "*Computational methods for atmospheric, astrophysical and laboratory plasmas*" in 10th International Conference of Computational Methods in Sciences and Engineering (ICCMSE), April 2014.

International seminars as invited speaker

- *"Reusable OO design techniques for a high performance multi-physics and multi-method framework"*, 7th April 2009, MOX, Politecnico di Milano, Italy.
- *"An Object Oriented and High Performance Platform for Aerothermodynamics"*, CTR Tea seminar, Center for Turbulence Research, Stanford, CA, 2010.
- *"COOLFluiD: a modular platform for reactive flows and multi-physics"*, NASA Ames, CA, 2010.
- "An Object Oriented and High Performance Platform for Aerothermodynamics Simulation", PECOS, UT Austin, Texas, 2010.
- *"The COOLFluiD multi-physics platform"*, EPFL, Lausanne, Switzerland, 2012.
- "COOLFluiD: an open computational platform for multi-physics simulation & research", UIUC, IL, 2013.
- *"COOLFluiD: an open computational platform for multi-physics simulation & research"*, Aerospace Design Laboratory, Stanford, CA, 2013.
- *"COOLFluiD: a computational platform for plasma and multi-physics"*, Laboratory for Computational Physics and Fluid Dynamics, Naval Research Laboratory (NRL), Washington DC, 2014 (to be held in November).

Prices and Awards

- 01/2010 12/2010: Postdoctoral research fellowship from NASA Ames / Stanford CTR.
- 01/2003 09/2008: NATO RTO Ph.D. fellowship from the VKI.
- Co-author in *David Weaver best student paper* awarded at the 42nd AIAA Thermophysics Conference, Hawaii: "*Vibrational state to state kinetics in expanding and compressing nitrogen flows*", 2010.