Welcome & Year in Review

Prof. Juan J. Alonso, Dr. Thomas D. Economon, and Dr. Francisco Palacios

2nd Annual SU2 Developers Meeting
Stanford University
December 18, 2017
Welcome Developers!

1st Annual SU2 Developers Meeting, September 2016, TU Delft
Welcome to the Meeting - Demographics

Years of CFD Experience

- < 1 Year: 9 (7.6%)
- 1-2 Years: 20 (16.9%)
- 2-5 Years: 33 (28%)
- 5+ Years: 56 (47.5%)

Affiliation

- Academia: 50 (42.4%)
- Industry: 33 (28%)
- Government: 5 (4.2%)
- Student: 29 (24.6%)
- Other: 1 (0.8%)

How familiar are you with SU2?

- Developer: 47 (39.8%)
- User: 43 (36.4%)
- Have not used SU2: 28 (23.7%)
What is SU2?

- SU2 is an open-source software package for multiphysics analysis and design. Gradient availability through adjoints.

- Research platform for CFD, multiphysics, adjoint methods, HPC, and more. Reusability, readability, portability…

- Software released as open source under the LGPL 2.1 license. Available freely on GitHub.

- C++/MPI core with a Python layer for automation (~250k lines of code, HPC-ready).


https://github.com/su2code/SU2
https://su2code.github.io
SU2 and the NASA CFD Vision 2030 Study

- Emphasis on physics-based, predictive modeling
  Transition, turbulence, separation, unsteady/time-accurate, chemically-reacting flows, radiation, heat transfer, acoustics and constitutive models

- Management of errors and uncertainties
  Quantification of errors and uncertainties arising from physical models, mesh and discretization, and natural variability

- Automation in all steps of the analysis process
  Geometry creation, meshing, large databases of simulation results, extraction and understanding of the vast amounts of information

- Harness exascale HPC architectures
  Multiple memory hierarchies, latencies, bandwidths, programming paradigms and runtime environments, etc.

- Seamless integration with multi-disciplinary analyses and optimizations
  High fidelity CFD tools, interfaces, coupling approaches, the science of integration, etc.

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A Global Development Team...
Unsteady CFD to inform lower-fidelity unsteady aero models for flutter prediction

Unsteady pitching/plunging simulation in SU2

Unsteady aero parameters Cl, Cd, Cm over time

Unsteady aero data fit to ROM equations to get model parameters

ROM Model parameters fit to SU2 CFD data

Aeroelastic/flutter predictions in ASWING\(^1\) using CFD based aerodynamic ROM model

The objective of the work is:
- to improve the accuracy of transonic flutter prediction,
- while maintaining low online computational cost
- for wing/aircraft configurations in conceptual design
- permitting inclusion in a conceptual design/optimization loop

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The SU2 Timeline

SUmb solver developed @ ADL

June 2008
Francisco Palacios completes PhD with Juan Alonso on committee

Summer/Fall 2009
Francisco spends 3 months at Stanford

2010
Work on CADES (predecessor to SU2) begins

Summer/Fall
Preparations for releasing SU2 as open source

Jan 2011
Francisco joins ADL @ Stanford

2003-2008 2009 2010 2011
“We must think big... on Jan 20th everybody in the aeronautical community must know that there is a new player in the CFD open-source community.”

- Dr. Francisco Palacios, January 9 2012
STANFORD UNIVERSITY UNSTRUCTURED CODE (SU²) RELEASED TODAY, THURSDAY JANUARY 19, 2012

The First Release of The SU² Open-Source Computational Fluid Dynamics (CFD) Analysis and Optimization Suite is Out Today

Stanford University's Aerospace Design Laboratory (ADL) is releasing its Stanford University Unstructured (SU²) open-source code today, Thursday January 19, 2012. This suite is a collection of C++ based software tools for performing Partial Differential Equation (PDE) analysis and solving PDE constrained optimization problems. The toolset is designed with computational fluid dynamics and aerodynamic shape optimization in mind, but is extensible to treat arbitrary sets of governing equations such as potential flow, electrodynamics, chemically reacting flows, and many others.

A key feature of SU² is that it incorporates everything needed to perform a complete design loop; from the ability to compute flow and adjoint solutions, to obtaining objective function sensitivities relative to specified design variables, and, using this information, drive gradient-based shape optimization through built-in mesh deformation algorithms.

The software structure has been designed for maximum flexibility, leveraging the class-inheritance features native to the C++ programming language. This makes SU² an ideal vehicle for performing multi-physics simulations. Additionally, the decomposition of the flow solver allows for the rapid implementation of new spatial discretization methods and time-integration schemes.

SU² is under active development in the Aerospace Design Lab (ADL) in the Department of Aeronautics and Astronautics at Stanford University and is be released under an open-source license.

If you would like more information on SU², please check out http://su2.stanford.edu or email us at susquared-dev@lists.stanford.edu
Stanford University Unstructured (SU²): An open-source integrated computational environment for multi-physics simulation and design.


*Stanford University, Stanford, CA 94305, U.S.A.

Jan 7
AIAA SciTech Presentation

Jan 8
SU2 v2.0, CFD Online Forum Open

Jan 15
SU2 v2.0 Workshop

May 17 & 25
SU2’s first two PhDs

Aug 10
SU2 on GitHub

Sep 30
OpenMDAO / SU2 Joint Workshop

Winter
Spring
Summer
Fall

2013
Mar 14
Francisco’s farewell from Stanford

Wednesday, March 18
MS302
PDE-constrained Optimization using the Open-source Code SU2
2:00 PM - 3:30 PM
Room: 151 AB

Most established codes for PDE-constrained optimization are proprietary, unavailable, or prohibitively expensive for many users. The SU2 code is freely available as open-source and features a complete computational framework for multidisciplinary design in applications such as, but not limited to, aerospace engineering. This minisymposium will cover up-to-date topics within the SU2 framework related to its continuous and discrete adjoint capabilities, the application to large-scale aeroelastic design, and the utilization of many-core architectures. Each of the topics covered involve the combination of multiple research areas of interest to the CS&E community.

Mar 15
SIAM CSE Mini

Mar 14, Mar 15, and Mar 18
March
TU Kaiserslautern Visits Stanford

Jun 23
SU2 v4.0@ AIAA AVIATION Travis CI

2015
2017

Winter
- Jan 19: SU2 v5.0

Spring
- Feb 3: SU2 Winter Workshop @ Stanford

Summer
- Aug 21: SU2 Summer School @ Kaiserslautern

Fall
- Sep 11: Webpage Moves to GitHub
- Dec 18: 2nd Annual SU2 Dev Meeting

SU2 Article Becomes Most Read Paper in AIAA Journal
- Nov 8 (2016)

Technical Meeting
- Dec 1: Open Technical Call (YouTube)

SU2 Technical Meeting
- 137 views • 2 weeks ago

https://su2code.github.io
Where are we today? Everywhere.

- ~11,000 email addresses on user list
- ~1,000 repository visits every 2 weeks
- ~300 repository clones every 2 weeks
- ~300 active forks on GitHub

Web hits at https://su2code.github.io by city.

**Git clones**

- Clones: 274
- Unique cloners: 254

**Visitors**

- Views: 10,180
- Unique visitors: 1,484
Lines of Code in SU2 by Release (w/out comments or blanks)

- **C/C++**
- **C/C++ Header**
- **Python**
- **Total**

*includes code in externals/*
Anyone can be an SU2 Developer.
74 Pull Requests in 2017
1,385 Commits Staged for Release
18,193 Code Lines Staged for Release
179 Continuous Regression Tests
109 Active Branches in Repository
320 Active Forks on GitHub

As of 12.14.2017
Some Topics for Today

- Delayed Detached Eddy Simulation (DDES)
- Coupled-Adjoints for FSI
- High-Order DG-FEM Solver for iLES/LES/DNS

- Parallel Performance Upgrades
- Adjoint-based Turbomachinery Design
- High-Speed Schemes. High-Order Schemes

- Non-Ideal Compressible-Fluid Dynamics
- Discrete Adjoint-Based Optimization
- Uncertainty Quantification for RANS
Open source is everywhere. Join us.

“In the tech community, there is a lot of momentum behind open source and this notion that, if everyone shares information, we'll all grow more quickly and all know more eventually. So, there's no reason to keep secrets. We really live that theory, and it feels like it's working for us as well …”

“… if you put information out there, somebody else is going to pick up the book, think ‘Hey, this looks kind of interesting,' start making chocolate, discover something you don't know, and get in touch with you.”

Greg D’Alesandre.  
Co-owner, vice-president of research and development, Dandelion Chocolate.  
On tech roots playing a role in releasing a book on chocolate creation from scratch.  
2nd Annual SU2 Developers Meeting
December 18th, 2017
Stanford University, Durand Building, Room 450
Stanford, California, 94305, USA

Meeting Agenda

0800 – 0825: Welcome & Year in Review, J. Alonso, Stanford, T. Economom, Bosch, F. Palacios, Boeing

0825 – 0850: Upgrades for Parallel Performance and Low Speed Flows with Heat Transfer
T. Economom, Bosch

0850 – 0915: Implementation and Assessment of High-Order Methods in the Framework of SU2
K. Singh, D. Drikakis, I. Kokkinakis, M. Frank, University of Strathclyde
A BGK-Kinetic Formulation Including Vibrational and Electronic Energy Modes
A. Mogavero, J. Herrera-Montoya, M. Fossati, University of Strathclyde

0915 – 0940: Current Developments and Applications Related to the Discrete Adjoint Solver in SU2
T. Albring, N. Gauger, et al., TU Kaiserslautern

0940 – 1005: Coffee Break

1005 – 1030: An Overview of DDES in SU2: Implementation and Recent Results
E. Molina, R. G. A. da Silva, Aeronautical Institute of Technology (ITA-Brazil)

1030 – 1055: Recent Advances in Flow Analysis Capability and Adjoint-based Design for Turbomachinery with SU2
M. Pini, S. Vitale, A. Rubino, L. Azzini, N. Anand, P. Colonna, TU Delft

1055 – 1120: Uncertainty Estimation of Turbulence Model Predictions in SU2
J. Mukhopadhaya, A. Mishra, G. Iaccarino, J. Alonso, Stanford

1120 – 1145: Coffee Break

1145 – 1210: SU2: A Reliable Computational Framework for Non-Ideal Compressible-Fluid Dynamics Applications
G. Gori, Politecnico di Milano, P. M. Congedo, Inria - Bordeaux Sud-Ouest, A. Guardone, Politecnico di Milano

1210 – 1235: Coupled Adjoint-based Sensitivities Using the SU2 Native FSI Solver
R. Sánchez, C. Venkatesan-Crome, R. Palacios, Imperial College

1235 – 1300: Development of a Nodal DG Solver within the SU2 Framework
E. van der Weide, University of Twente, J. Choi, Stanford, D. Mudigere, Intel Labs, P. Urbanczyk, J. Alonso, Stanford

In order to participate (in-person or virtually), please register for the meeting by following the link on the SU2 home page (https://su2code.github.io).
Thanks for your interest and note that all stated times are Pacific Standard Time (PST).
Institutions that have downloaded SU2. Sized by frequency.