A photograph of a traditional wooden boat with a pointed bow, resting on a river. The water reflects the warm, golden light of a setting sun. In the background, a range of tall, dark, and rugged karst mountains rises against a sky with soft orange and yellow hues.

# BECOMING A PHILOSOPHY DOCTOR: A PERSPECTIVE

ANDREY CHERNIKOV

# OUTLINE

1. My Background
2. My Current Research
3. Elements of Success
  - Breadth of Learning
  - Depth of Inquiry
  - Attitude

## Disclaimers:

- Your mileage may vary
- A somewhat subjective account

# THE EARLY YEARS

- 10 years of School
- 4 years of college at KBSU
  - B.S. in Applied Math and CS
- 2 years of grad school at KBSU
  - M.S. in Applied Math and CS
  - M.S. Thesis in Molecular Dynamics modeling
- (simultaneously) 4 years at IIPRM KBSC RAN
  - Developed Geographic Information Systems



# WILLIAM & MARY AND ODU

- 6 years in the CS Ph.D. program at William and Mary
  - Dissertation titled “Parallel Generalized Delaunay Mesh Refinement” (2007)
  - Distinguished Dissertation Award
- 4 years of post-doctoral activities at W&M and ODU
- 6 years as Assistant Professor at ODU
- Since 2017 Tenured Associate Professor



# MY INTERESTS AND HOBBIES

- Reading
- Watching Films & Documentaries
- Running, swimming, lifting weights



- 3<sup>rd</sup> Dan (black belt) in Shotokan Karate

# CURRENT RESEARCH

- Member of Center for Real-Time Computing (CRTC)  
<https://crtc.cs.odu.edu/>  
<https://www.cs.odu.edu/~achernik/>
- Projects funded by NSF, NASA/NIA/VSGC, DoD, and other agencies
- Now accepting PhD students



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## Main Page

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- 3 Extreme-Scale Adaptive/Anisotropic Parallel Mesh Generation
  - 3.1 Overview
- 4 Real-time Adaptive Mesh Generation in Medical Image Computing
  - 4.1 Overview

## Announcements

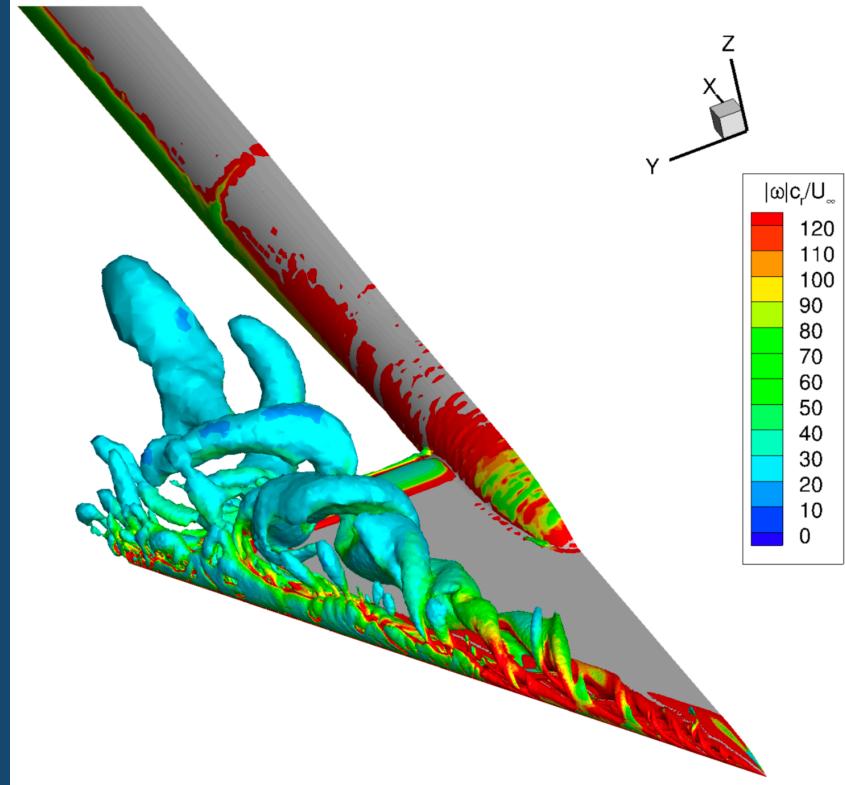


# SIMULATION AS ONE OF THREE PILLARS OF SCIENCE

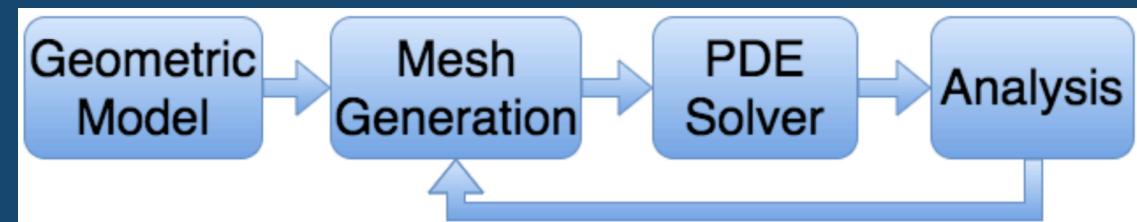
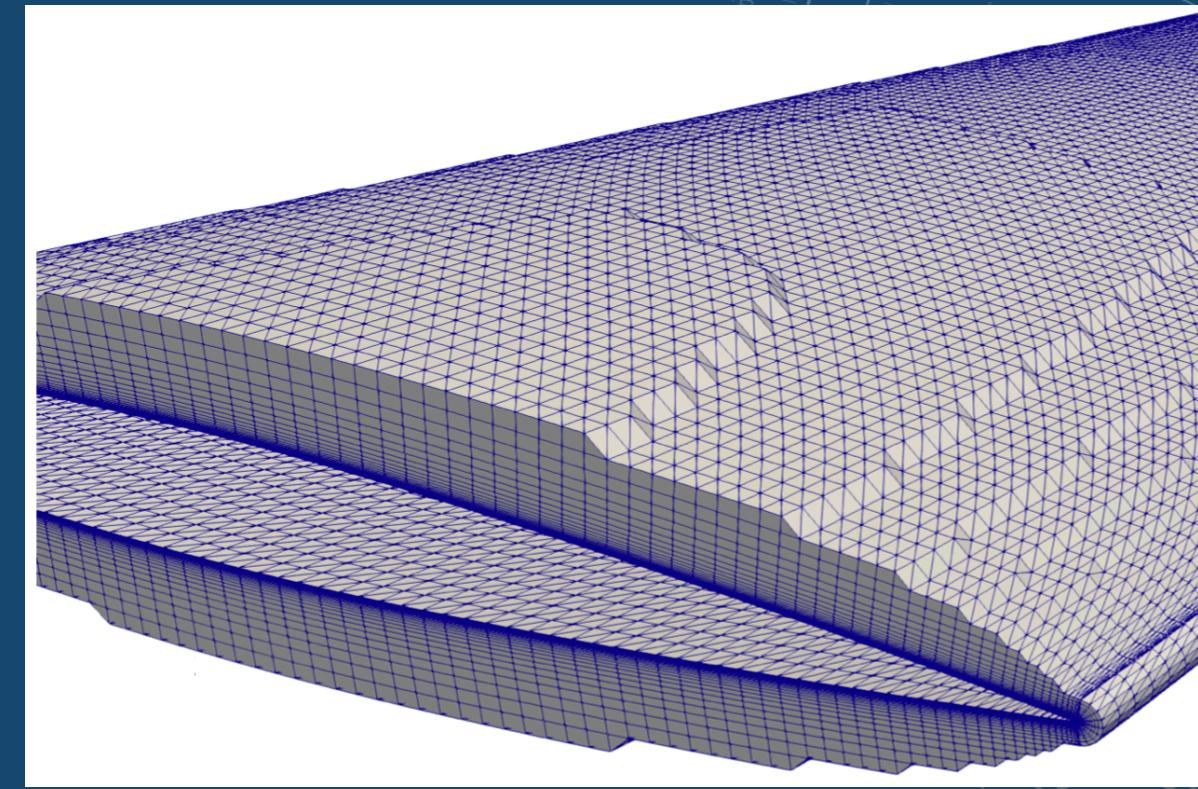
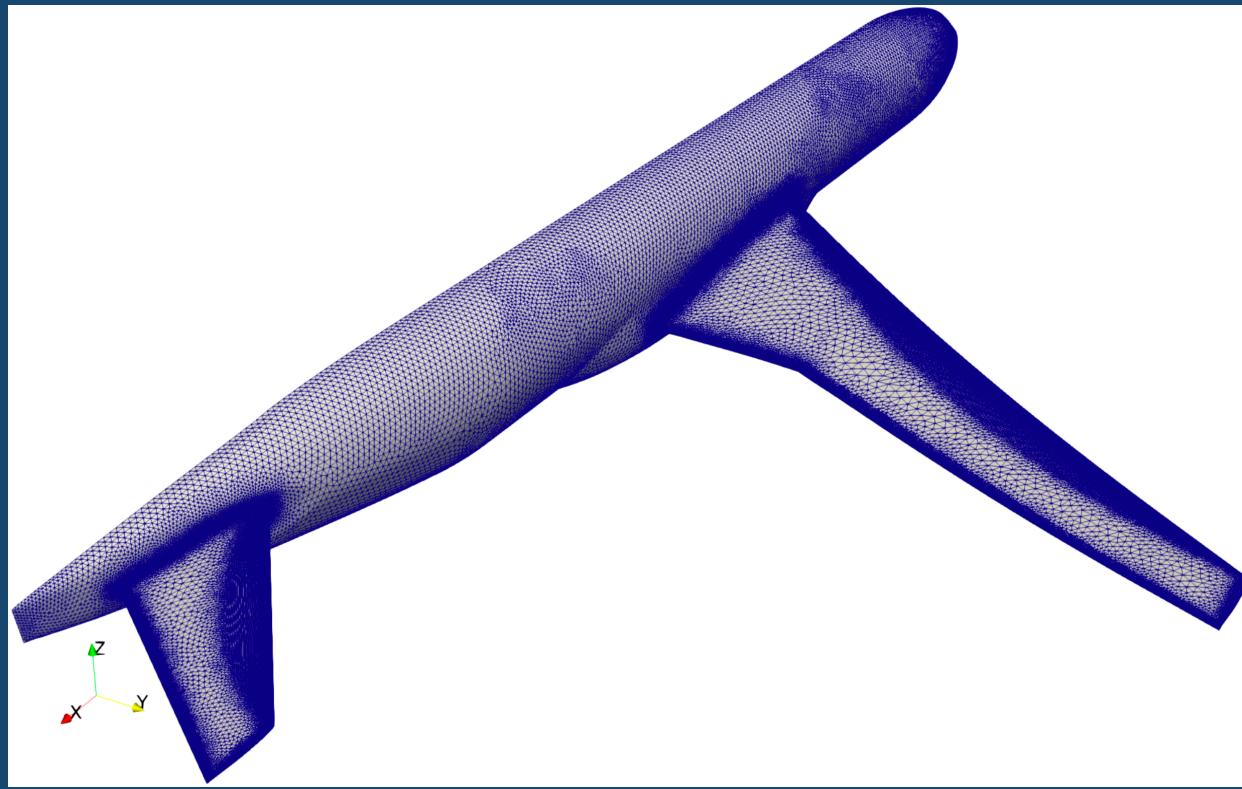
1. Experiment
2. Theory
3. Simulation (new)

➤ Physics-based, such as:

- aircraft, land, and marine vehicles
- medical, e.g., surgery and haptics
- virtual reality, e.g., games
- geological and atmospheric
- chip and other devices

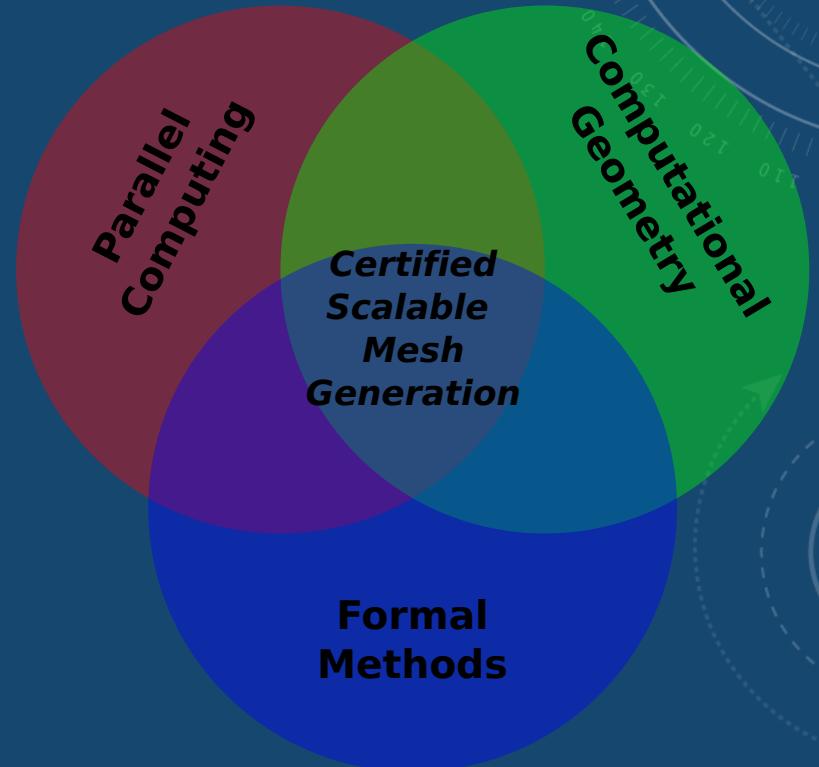


Iso-Surfaces of Vorticity Magnitude.  
Hybrid RANS/LES simulation of vortex breakdown over a delta wing. Beckett Yx Zhou, Boris Diskin, Nicolas Gauger, Juliette Pardue, Andrey Chernikov, Christos Tsolakis, Fotis Drakopoulos, and Nikos Chrisochoides. AIAA Aviation and Aeronautics Forum and Exposition. (AIAA 2019-3524).



# RESEARCH METHODOLOGIES

1. Parallel Computing: scalability on various architectures, correctness (no race conditions), stability, etc.
2. Computational Geometry: geometric algorithms, proofs of their correctness and complexity
3. Formal Methods: computer-assisted proofs, certified software



The F-35, variants of which are used by the Air Force, Navy, and Marine Corps, has had its critics since its inception. Lawmakers have scrutinized it over multiple delays in production and its price tag, which at \$406.5 billion, makes it the costliest weapons program in US history.



An F-35A Lightning II. US Air Force Photo

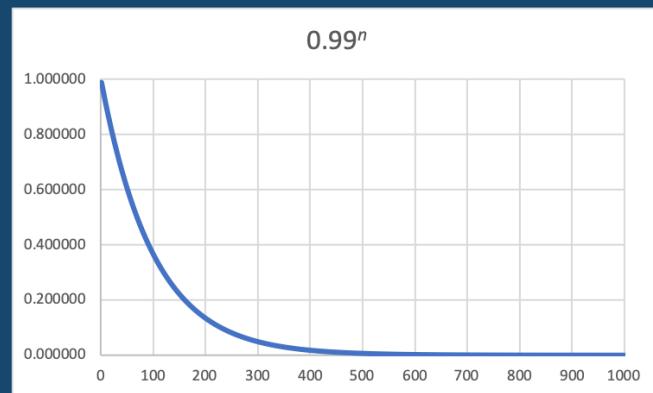
**Elon Musk says the US's F-35 stealth jet 'would have no chance' against a 'drone fighter plane'**

<https://www.businessinsider.com/elon-musk-f-35-drone-fighter-2020-2> (accessed 02/28/2020)

Problems with the F-35 surfaced soon after it joined the fleet. Over 800 flaws riddled the software, according to a recent report by the Defense Department's director of operational test and evaluation, which also said the 25 mm cannon on the Air Force's F-35A, the most common variant, displayed an "unacceptable" level of accuracy.

# THE NEED FOR FORMAL METHODS

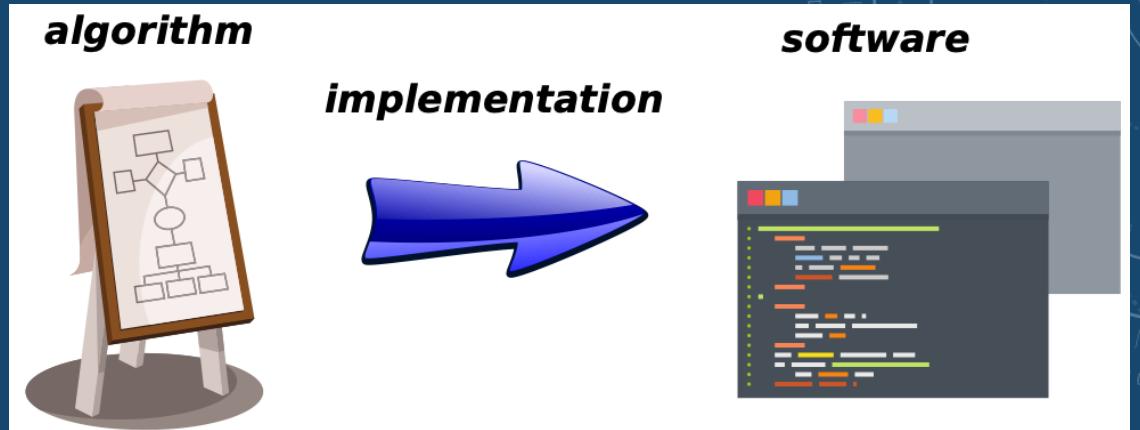
- $n$  is # of sub-problems (sub-domains)
- $p$  is the probability of successfully solving any one sub-problem
- $p^n$  is the probability of successfully solving all sub-problems



- E.g.,  $0.99^{100} = 0.366032$ ,  $0.99^{1000} = 0.000043$ ,  
 $0.999999^{1,000,000} = 0.367879$

# SOFTWARE TESTING VS CORRECT-BY-DESIGN

- Testing not sufficient
  - limited number of cases
  - fixing some bugs may lead to other bugs
- Correct-by-design approach using a proof assistant software
  - proving correctness of algorithm *via* its implementation
  - automatic extraction of executable code
  - reduction of ancillary bugs due to purely functional programming and large proven standard library



executable function  $F : X \rightarrow Y$   
proposition  $P :=$   
for all  $x$  from  $X$ ,  
 $F(x)$  has certain properties  
Theorem :  $P$  holds.  
Proof. tactic ... tactic. Qed.

# BREADTH: UNDERSTANDING THE LANDSCAPE



Develop breadth from

- courses
- journals, magazines, e.g.,  
<https://dl.acm.org/magazine/cacm>
- books
- films, documentaries
- diverse locations and people
- hobbies

# DEPTH: DEVELOPING THE SKILLS AND TOOLS

## Reading:

- Read “between the lines”
- What was NOT done?
- Was the chosen methodology appropriate?
- Are the conclusions supported by evidence?
- Is the analysis tight or loose?



## Writing & Presenting (in addition):

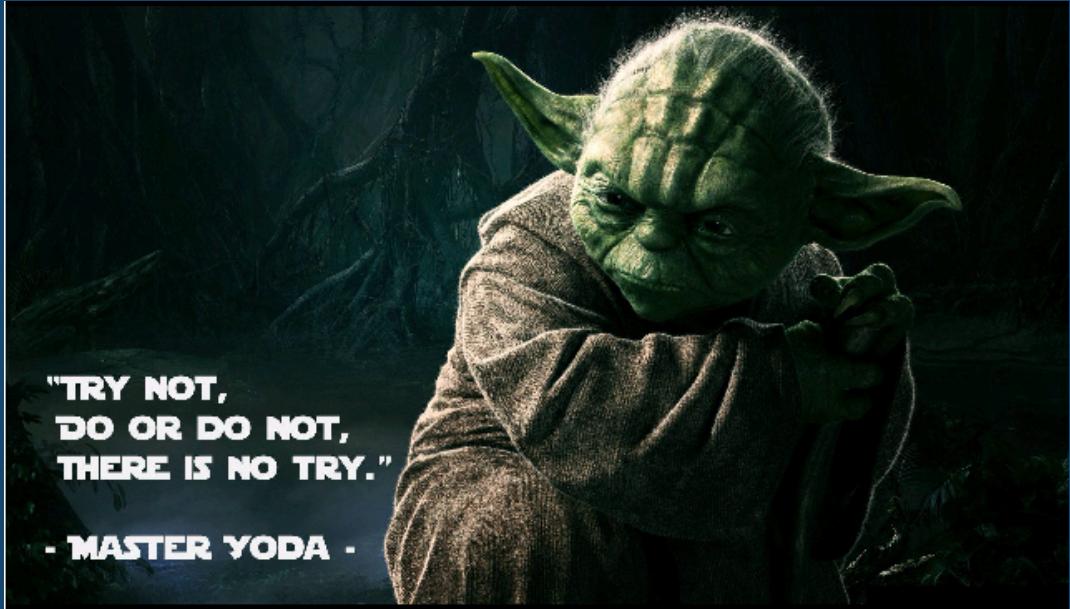
- Adopt the approaches used by the best in your discipline
- Iterate the drafts
- Do NOT introduce more math and jargon than needed
- Explain the intuition behind the findings

# ATTITUDE FOR SUCCESS



- Your health is the top priority
- Take ownership of your work
- Pipeline the publications
- Work in the lab
- Follow a regular work schedule
- Take time to rest and reflect
- Meet with the advisor at least once a week

# FINAL WISDOM



**"TRY NOT,  
DO OR DO NOT,  
THERE IS NO TRY."**

- **MASTER YODA .**

- “The first principle is that you must not fool yourself, and you are the easiest person to fool.” -- Richard Feynman
- “One of the great challenges in life is knowing enough to **think** you're right but not enough to **know** you're wrong.” -- Neil deGrasse Tyson
- “Practice... every day. All day” -- Film Desperado
- “Not everything that counts can be counted, and not everything that can be counted counts.” -- Sign hanging in Einstein's office at Princeton
- “I skate to where the puck is going to be, not where it has been.” -- Wayne Gretzky
- “No one can be told what the Matrix is. You have to see it for yourself.” -- Film The Matrix