

# Session 11: Code Development within the FUN3D Framework

Mike Park

Computational AeroSciences Branch



# Is There a Better Way to Develop Software?

- Development of Langley CFD solvers has traditionally been a 1- or 2-person operation
- Lacked a rigorous testing environment
- Standardization and portability often overlooked
- Version control became a nightmare
- Low-level collaboration within LaRC very difficult; off-site collaborations virtually impossible
- Amount of source code and expertise needed for today's advanced algorithms quickly becomes unwieldy



# Modern Software Development Practices

- Formal version control using Subversion; repository sits outside LaRC firewall
- Enables anyone anywhere to work directly on our source code in real-time
  - Frequent commits encouraged (~1 hour or less; real-time view on website)
  - Integrates all capabilities in one centralized suite
  - User support vastly easier
- Documented coding standard ensures uniformity, portability
  - Pre-commit script checks for adherence, rejects sloppy code
  - Enables automated scripting of templates, other extensive source code manipulations
- Hundreds of tests performed continuously around-the-clock on wide range of compilers/hardware: x86/Sun/SGI/DEC/Mac/Opteron/HP/etc
  - Failures reported to team members immediately via email, SMS
  - Bugs confined to a few lines of code and identified within an hour, rather than thousands of lines developed over months
  - Compiler bugs identified routinely



# Modern Software Development Practices

- Weekly scrums foster collaboration and communication
  - Management/observers encouraged to attend, but only workers allowed to talk
  - One at a time, each member reports “did – doing – will do – in the way”
  - Scrum master notes impediments to progress, strives to remove them
  - Goal is to be done in 15 minutes
  - No “Death by PowerPoint”
- Additional discussion via mailing list, wiki
- Website also kept under Subversion, maintained collectively by entire team
  - Automatically generated and placed on server whenever text files in repository are updated
  - Team members need not know fancy HTML to contribute
- Unit testing slowly becoming more prevalent
  - Tough to retrofit legacy code
  - Released “FUnit”, framework for unit testing Fortran code at <http://nasarb.rubyforge.org/>
- Pair-programming practiced regularly



# Compiler Gauntlet and Build Dashboard

- Hierarchy of cascading continuous builds keeps close tabs on code status
- Failures reported to team members via E-mail/SMS
- Bugs typically found/corrected in minutes
- Interactive GUI allows access to current and archived build information
- If a revision passes the entire hierarchy, it is tarred up, ready for external release
- Website also built continuously

FUN3D: Clean Code Initiative - Mozilla Firefox

Compilers: PathScale-3.1, NAG-5.1.365, g95-0.91, Absoft-10.1.2, PGI-7.1-5, Sun-8.3-20070731, gfortran-20070123, Intel-10.1.015, Intel-11.0.025, LaheyX-6.20d, LaheyX-8.00a

**INCOMPLETE REPORT: a machine is down, or a compilation failed.**

As of Mon Sep 08 14:04:03 -0400 2008

69 Warning lines from 4 routines

- 40 PHYSICS\_DEPS/flux\_gengas.f90
- 20 PHYSICS\_DEPS/bc\_gen.f90
- 5 PHYSICS\_DEPS/jacobian\_gen.f90
- 4 PHYSICS\_DEPS/io\_gen.f90

Required 16 minutes

- Continuous integration for warnings across ~10 major compilers
- Interface allows team members to see any complaints/warnings

CruiseControl.rb - Mozilla Firefox

Getting Started Latest Headlines

LaRC Technical Publication Ap... CruiseControl.rb

**FUN3D-website-pubs** Build Now nelsen committed the checkin  
 build 33367 (29 Aug) took 43 seconds  
 33309 (25 Aug)  
 33104 (14 Aug)  
 30583 (8 May)  
 30473.5 (30 Apr)

**FUN3D\_01-unit\_tests** Build Now hnishika committed the checkin  
 build 33539 (13:34) took 1 minute  
 33538 (13:29)  
 33515 (5 Sep)  
 33514 (5 Sep)  
 33512 (5 Sep)

**FUN3D\_02-lightning** Build Now  
 build 33539 (14:22) took 26 minutes  
 33538 (13:56)  
 33515 (5 Sep)  
 33512 (5 Sep)  
 33509 (5 Sep)

**FUN3D\_03-alpha** Build Now  
 build 33539 (14:49) took 26 minutes  
 33538 (14:22)  
 33515 (5 Sep)  
 33512 (5 Sep)  
 33509 (5 Sep)

**FUN3D\_04-mpi\_testcases** Build Now Now building: 33538 for 56 minutes  
 build 33538 (15:19) incomplete building  
 33515 (5 Sep) incomplete  
 33506 (5 Sep) FAILED  
 33506 (5 Sep) FAILED  
 33504 (5 Sep) FAILED

**FUN3D\_05-seq\_testcases** Build Now thomasj, hnishika committed the checkin  
 build 33489 (4 Sep) took 1 hour 7 minutes  
 33481 (4 Sep) FAILED  
 33464 (3 Sep) FAILED  
 33430 (2 Sep) FAILED  
 33426 (2 Sep) FAILED

**FUN3D\_06-Complex\_mpi\_testcases** Build Now  
 build 33489 (4 Sep) took 49 minutes  
 33415 (1 Sep)  
 33411 (1 Sep)  
 33410 (1 Sep)  
 33406 (1 Sep)

**FUN3D\_07-Complex\_seq\_testcases** Build Now  
 build 33489 (4 Sep) took 3 hours 37 minutes  
 33415 (2 Sep)  
 33410 (1 Sep)  
 33406 (1 Sep)  
 33404 (1 Sep)

**FUN3D\_08-release** Build Now  
 build 33489 (4 Sep) took 9 minutes  
 33415 (2 Sep)  
 33410 (1 Sep)  
 33406 (1 Sep)  
 33404 (1 Sep)



# FUN3D Development Widespread

## Developers work on central source code in real-time

### Advanced Engineering Environments Branch

- Dana Hammond - HPC, computer science
- Bill Jones - geometry, gridding, adaptation

### Aerothermodynamics Branch

- Karen Bibb – high-energy applications
- Peter Gnoffo - high-energy algorithms
- Bil Kleb - software practices, applications

### Computational AeroSciences Branch

- Bob Biedron - dynamic simulations
- Jan-Renee Carlson – turbulence, jet flows, bc's
- Mark Carpenter - solvers
- Beth Lee-Rausch - applications
- Eric Nielsen - solvers, adjoints, design
- Mike Park - cut-cells, adaptation
- Chris Rumsey - turbulence
- Jim Thomas - solvers, discretizations
- Veer Vatsa - applications
- Jeff White - hypersonics

### Flow Physics and Control Branch

- P. Balakumar - turbulence

### NASA Glenn

### National Institute of Aerospace

### Academia

- Georgia Tech
- MIT
- NC A&T
- Penn State
- U. of Tennessee-Chattanooga
- U. of Wyoming

### OGA

- US Army/AMRDEC-Huntsville
- Argonne, Oak Ridge National Labs

### Industry

### Visitors/Students

Very broad mix of theoretical,  
development, and applied personnel:

- *Fundamental research*
- *Real-world applications*

