Embedding Computational Fluid Dynamics Industrial and Research-Scale Projects Using High-Performance Computing in an Upper-Level Engineering Physics Course

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Adam Dorety is currently a freshman at the University of Central Oklahoma (UCO). He is involved in UCO Robotics, and the UCO chapter of the American Society of Mechanical Engineers. He has continued his research on the Underwater Remote Operated Vehicle (ROV) and hopes to compete at the national tournament in June 2013. He hopes to graduate in 2015 and join the workforce. His experience with undergraduate research has undoubtedly strengthened his commitment to mechanical engineering.

Dr. Evan C. Lemley, University of Central Oklahoma

Professor Lemley teaches thermo-fluid engineering and works with undergraduates to perform fluid dynamics research that is mostly focused on small scale flow problems. He is currently an Assistant Dean of Mathematics and Science and a Professor of Engineering and Physics at the University of Central Oklahoma, his home institution for more than fifteen years. Previously, Professor Lemley worked as a mechanical engineer in the power industry. His bachelor's degree is in physics from Hendrix College and his M.S.M.E. and Ph.D. were earned at the University of Arkansas.

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Poster

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This poster focuses on the results of projects in a combined senior level-graduate level course (enrollment of 12) in fluid dynamics at the University of Central Oklahoma (UCO), a predominantly undergraduate institution (PUI) . A high performance computing (HPC) cluster, Buddy has been deployed recently at the UCO. The first author operates and administers the Buddy cluster and serves as instructor of the fluid dynamics course, providing an opportunity to advance the course outcomes to include a high impact project that takes advantage of distributed computing. The goal of the projects is to expose students to HPC “at scale.” The projects require the use of computational fluid dynamics (CFD) on a HPC system; intentionally exposing students to a new way of doing things. The poster will encapsulate the quantitative and visual results of the projects and examine the impact on students of the projects.

This study described in this paper was conducted, in part, during a 3-semester hour fluid dynamics course, ENGR 4533/5443, in Fall 2015 at UCO. This course is a follow-on course to a junior level engineering fluid mechanics course and was made up of six undergraduates and five graduates. This course covers continuum viscous fluid dynamics; the first portion of the course is focused on understanding and applying the Navier-Stokes equations (NSE), which are a set of partial differential equations describing fluid flow.. The latter part of the course is focused on using computational fluid dynamics (CFD) to solve the NSE. Individual CFD projects were completed by the students. In these projects, students were required to develop a problem that needed significant computational resources - such that it was not reasonable to run the simulations on a single computer workstation.

The goals for implementing the CFD project in this way was to make an impact on the student’s long term ability to use HPC when they graduate, which is becoming a necessary engineering technical skill.