2005-2006 Learning Technologies Grants Proposal
(COVER PAGE)

Project Information

Incorporation of Computational Fluid Dynamics into Engineering Courses
Project Title

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Department of Biological and Agricultural Engineering

Project Director(s)

Department of Biological and Agricultural Engineering
Requesting Department

$4,700	$3,000
Amount Requested Year 1	Amount Requested Year 2

Project Director's Signature

Proposal Endorsement Signatures

Department Head

Dean

Proposal Abstract (100-word maximum)

Engineering students must be become familiar with an increasingly sophisticated level of technology and software packages that are used in the professional marketplace. This project will allows students in several courses to gain experience working with one software package that is used to analyze thermal and fluid systems using computational fluid dynamics. The specific software proposed (AirPak) is used in industry to model the airflow and heat gains within buildings for environmental control (temperature and ventilation) analysis, and is adaptable to other industrial and research applications.

INCORPORATION OF COMPUTATIONAL FLUID DYNAMICS INTO ENGINEERING COURSES

Section I. Project Description

Introduction

Engineers are being required to analyze systems and perform their work using increasingly sophisticated technology and software packages. One driving force for this is the continued trend toward higher power computers with lower cost which allows for the use of high level analysis techniques that up until recently were only available to well funded research centers. This project is designed to provide students with experience in using one such sophisticated software package such that they will be a more valuable asset at their future employers and thus be better prepared to enter the competitive job market.

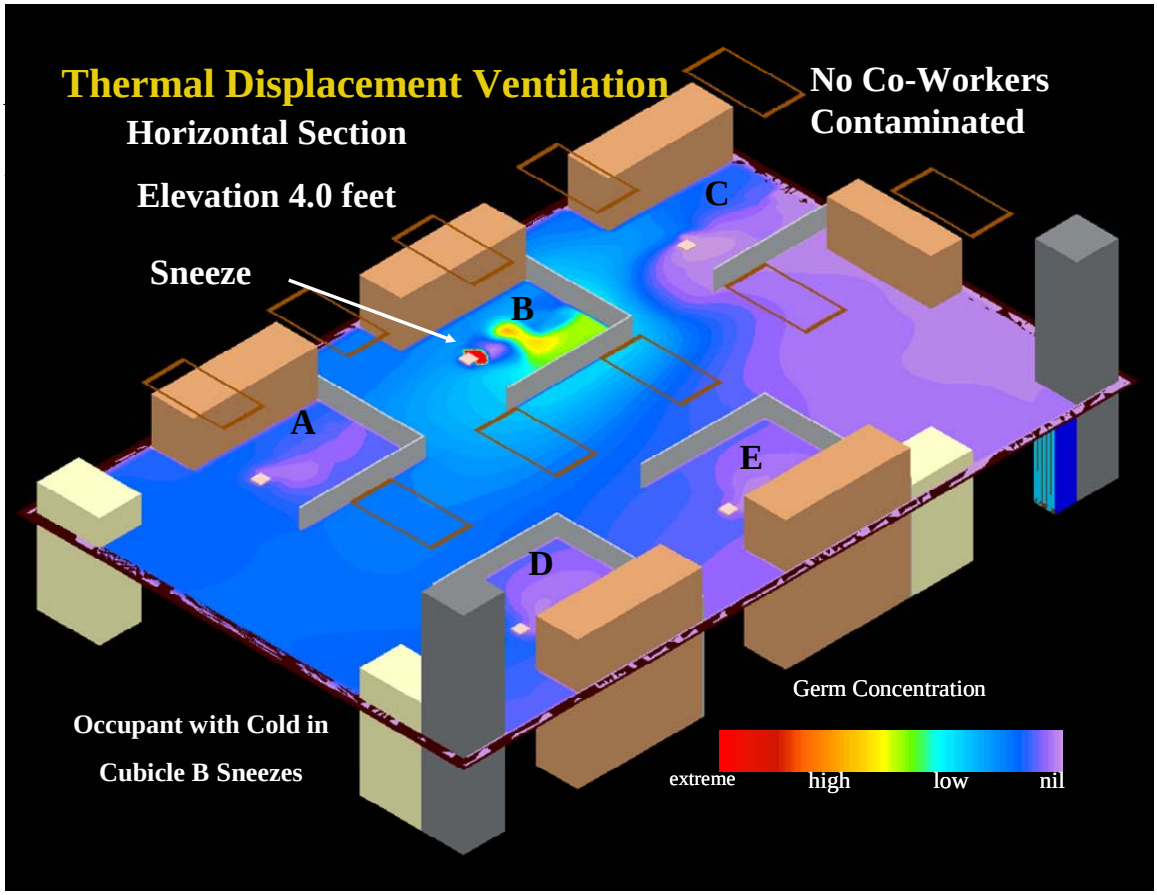
Nature of the Technology

Computational Fluid Dynamics (CFD) is an analytical tool that is used to predict complex fluid (such as air or water) flow patterns. These programs will divide the region under study into a number of finite volumes and will solve the Navier-Stokes fluid equations to predict the fluid flow between each adjacent volume element. When combined with other engineering analysis, such as heat and mass transfer, CFD programs can analyze the flow rates, temperatures and concentration levels of contaminants in a wide variety of situations, such as within the occupied spaces of buildings. CFD is now accepted as a valid approach to analyzing fluid and thermal systems in applications ranging from aircraft design to flow within automotive engine components.

Several CFD packages are available in the marketplace. The most sophisticated of the general purpose packages available is a product of Fluent, Inc. Their core analytical program is called Fluent, and they also have available several front-end packages that provide a user-friendly method of adapting Fluent to special purpose applications. One of these is a package called AirPak, which is designed to accurately model airflow, heat transfer, contaminant transport and thermal comfort in buildings associated with heating, ventilation and air conditioning (HVAC) systems.

Rationale

The AirPak software package is designed to provide the user with an easy to use tool to analyze air flow and thermal conditions within buildings. One outcome is the prediction of temperatures, air flow and distribution of contaminants, and relative humidity levels within rooms that can be used to verify if an HVAC system is properly designed. A recent and extremely important application is in the prediction of the distribution of potential harmful agents within large buildings, such as might be introduced by a terrorist act. The figure below shows example results presented by a colleague at a recent symposium using CFD as an engineering tool. The presentation focused both on the use of CFD to simulate a new concept in building conditioning air distribution (thermal displacement ventilation) as well as predicting the spread of contaminants from one occupant in a cubicle office environment, such as a sneeze or the release of anthrax spores when opening a letter. The use of CFD to analyze a situation like this is one important tool used in the engineering profession, and students that know how to use these tools will have a competitive advantage over others when seeking professional jobs after graduation.



Relevance of the Project to Unit and University Priorities

The engineering program at the University of Georgia provides students with a broad-based curriculum with emphasis on learning skills which employers in the state and region need. Engineering is an ever changing occupation which requires keeping up with the latest technology and analysis techniques. The inclusion of this high performance software package in the engineering courses taught at UGA will enhance the department's ability to achieve its goal of providing a solid fundamental education and the technical skills needed to be successful in today's global market.

Specific Courses and Number of Students that will Benefit from this Project

Two core curriculum courses and two courses focused on the building structures area of emphasis in the UGA undergraduate program will benefit from this project. UGA offers a two course sequence in building environmental control (HVAC), and the AirPak software package will be a valuable addition to the material learned. The building structures area of emphasis is one of the more popular choices in the UGA engineering program. The first course in this sequence (ENGR 4620) had an enrollment of 30 students in the spring of 2005, while the follow-on second course (ENGR 4660) has an enrollment of 12 students this fall (2005), and these represent approximately 15% of the total undergraduates in the engineering programs at UGA. These two courses are senior level and applications oriented typically taken by students at or near the end of their undergraduate degree program, and thus are a perfect opportunity to given students exposure to tools that they may soon use in their professional jobs.

The two core curriculum courses that could incorporate this software package into the course topics are fluids (ENGR 3160) and heat transfer (ENGR 3150). All students in the program take these courses, and Dr. Lawrence typically teaches ENGR 3150 during one of the semesters during the school year. Enrollment in these courses is approximately 40 to 50 students per school year for each course.

In addition, graduate research and focused courses might benefit from the use of this CFD software package. One current masters student in engineering is considering a doctorate studying the impact of different building rooftop systems on the urban 'heat

island' effect that occurs in larger metropolitan areas, and AirPak would be a tool that could assist in that research.

Section II. Project Budget

The total project budget requested from the Learning Technologies Grant is $7,700 for the two years of requested funding. The funding request is broken down according to the items listed in the table below.

Item	First Year Cost	Second Year Cost	Total Cost	Total Requested from LTG
AirPak Computational Fluid Dynamics 20 seat site license (allows for up to 20 users at one time), annual fee required	$2,900	$3,000	$5,900	$5,900
UGA personnel technical support for setting up AirPak on the engineering computer network and in the computer lab	$300	-	$300	$300
Faculty release time for development of applications and implementation	$3,000	$1,000	$4,000	$1,500
TOTALS	**$6,200**	**$4,000**	**$10,200**	**$7,700**

The AirPak site license selected allows for up to 20 users at one time and the pricing is based on the academic rate. A cost escalation factor of $100 is included for the second year as a contingency for potential cost increases from the supplier. Several hours of UGA computer technical support are required for setting up this software in the engineering computer network and assuring that the student computer lab computers in the Driftmier Engineering Center all can access the program, and for technical support through the year. An additional request is included for faculty release time to develop applications based on case studies in industrial and commercial buildings. One industrial plant in the Athens area is interested in having using the modeling software to analyze specific problems they have with ventilation systems within their facility. Other potential applications will be pursued upon confirmation of award, which may include application on existing UGA buildings or new buildings in the design process. These applications will be studied by the faculty involved and case studies for student projects developed from this experience. It is anticipated that external funding will help defer some of the cost for developing these applications, as reflected in the proposed budget.

The project will incorporate several major milestones, which are listed in the table below.

Date	Objective	Person Responsible
1/06	AirPak license and installation	Dr. Tom Lawrence / Paul Bowles (IT Professional Associate)
1/06	Identify potential applications for the Spring 2006 course	Dr. Tom Lawrence
5/06	Student and industry partner survey on effectiveness of these case studies in learning (spring)	Dr. Tom Lawrence Dr. Tim Foutz
8/06	Identify potential applications for the Fall 2006 course(s)	Dr. Tom Lawrence
12/06	Student and industry partner survey on effectiveness of these case studies in learning (fall)	Dr. Tom Lawrence Dr. Tim Foutz
4/07	Renewal of AirPak license	Paul Bowles

Section III. Learning Outcomes

The ultimate objective of this project is to enhance the student's academic course work with examples of technology and computer software packages that they may use in the professional careers. Two primary methods for assessing the effectiveness of this project and the AirPak software in this area will be used: (1) using feedback from the facilities (industrial, UGA engineering facilities group or other commercial buildings); and (2) from a formal survey of students at the completion of the course asking for their feedback and evaluation of this method in their academic program. The student survey will be done as a supplement to the typical course evaluations done at the end of a semester.

Other potential applications exist for this software package in graduate engineering course work within the UGA program. One likely candidate will be in studying the interaction of buildings, solar heat gains and wind patterns for their impact on the urban heat island conducted as part of applied meteorology or special topics courses. The urban heat island effect is becoming a significant concern and proposed solutions currently are based more on intuition judgment rather than scientific analysis.

Section IV. Support Plan

The project will be implemented by Dr. Tom Lawrence under the direction of Dr. Timothy Foutz, Undergraduate Coordinator for the Department of Biological and Agricultural Engineering. Before obtaining his Ph.D. and entering an academic career at

UGA in January of 2004, Dr. Lawrence spent nearly 20 years in industry and consulting engineering positions. Dr. Lawrence is working to enhance the academic program at UGA through the inclusion of "real-world" examples based on his experience and in support of the needs of industries and companies in Georgia. He has developed case study projects for UGA engineering courses to date in conjunction with the CertainTeed plant in Athens and Commissioning and Green Building Services, LLC in Buford, Georgia. Dr. Lawrence will build on this experience to develop additional case study applications using the AirPak software package, starting in the Spring 2006 semester with the Building Environmental Control I (HVAC) course. This will be continued on with additional applications for the Building Environmental Control II course in the Fall 2006 semester and made part of the regular syllabus for these courses in subsequent offerings in 2007.