

# Introducing a Bachelor of Industrial Physics

In the fall of 2003, East Stroudsburg University (ESU) in Pennsylvania will enroll its first class in a new bachelor's degree program in industrial physics, one especially designed to equip students with the theoretical and practical skills needed to work in industry after completing their undergraduate education. And no, it is not your father's



Figure 1. Junior and senior students work in the East Stroudsburg University electronics laboratory under the supervision of Professor Robert Reed, who is in charge of the engineering transfer program.

applied physics degree draped with a new name. Graduates will be prepared to enter the workplace with the generalist training of a traditional physicist and the practical, hands-on skills of an engineer.

Degrees in physics, applied physics, and engineering physics are widely available. So why do we need a new type of undergraduate degree in physics? The answer is painfully simple. Only about one-third of physics students continue in physics or applied-physics graduate programs, according to the American Institute of Physics. The rest

switch fields in graduate school (one-fifth), find jobs in industry (one-third), or do something else. The industrial physics degree will better prepare those students who wish to pursue an industrial career path after earning their bachelor's degree and give them a competitive advantage in some industrial settings. ESU will continue its traditional undergraduate program in physics for those students who want to go on to graduate programs or who prefer a physics education less oriented toward industry.

Physicists may wonder whether ESU's industrial physics degree is just a renaming of an applied-physics or engineering-physics degree program. Clearly not. In academic environments, physics is increasingly split between "pure" physics (elementary particle physics and gravitation, for example) and "applied" physics (such as semiconductor physics, fusion, and nuclear power). Applied- and engineering-physics programs are often geared to producing graduate students (and ultimately Ph.D.'s) in the applied-physics disciplines.

Unfortunately, this approach fails to meet the needs of most ESU undergraduate physics students, who never enter physics or applied-physics graduate programs.

Meanwhile, industry's need for technically trained people remains strong. We believe that the ESU program can serve as a model for other colleges and universities.

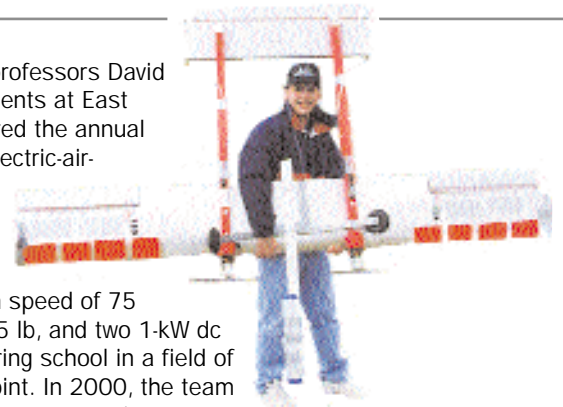
Some bachelor's degree physicists obtain jobs in industry that involve undergraduate physics. These people may work in quality control, instrumenting an assembly process, or designing new products for the marketplace. We decided to structure the new degree so that we could do a better job of training students for these types of jobs. We will not train research scientists in applied physics. We will train undergraduates to do physics-related work in industry. ESU's industrial physics program will equip students with the practical skills to get a job and an education that will enable them to quickly refine their skills and retrain when necessary.

Is there a need for such a program? "Graduates of the industrial-physics major would be ideally suited to a technologically oriented company such as ours," says Alex Marker, director of R&D at Schott Glass Technologies, Inc. (Duryea, PA).

ESU's physics faculty did not go unaided into the new program. Representatives from Eastern Engineering Associates, Instrument Specialties (now Laird Technologies), Schott

## Electric-Aircraft Team

Under the supervision of physics professors David A. Larrabee and John Elwood, students at East Stroudsburg University (ESU) entered the annual design/build/fly radio-controlled electric-aircraft competition, a student activity of the American Institute of Aeronautics and Astronautics. In 1999, the team entered *Javelin*, with a 108-in. wingspan, maximum speed of 75 mph, weight of 40 lb, payload of 15 lb, and two 1-kW dc motors. ESU, the only nonengineering school in a field of 37, came in 13th, beating West Point. In 2000, the team entered *Impulse*, with an 84-in. wingspan, maximum speed of 75 mph, weight of 20 lb, payload of 9 lb, and a 1-kW dc motor. ESU beat MIT as well as many other prestigious schools. In 2001, the team entered *ANSSR BAT*, with a 10-ft wingspan, maximum speed of 85 mph, weight of 17 lb, payload of 13 lb, and a 1-kW dc motor. ESU came in 18th, beating MIT, the University of California at Los Angeles, the U.S. Naval Academy, and the University of Texas at Austin.



Herbert W. Ziegler carries East Stroudsburg University's first electric aircraft, *Javelin*, which he worked on as an undergraduate.

**Physics Courses (minimum of 55 credits)**

Basic four-term physics sequence  
(mechanics, electricity and magnetism, relativity,  
elementary wave mechanics, thermodynamics)

Engineering Graphics

Advanced Laboratory

Statics and Dynamics (2 terms)

Electronics (with a laboratory)

Electromagnetic Theory I (with a laboratory)

Thermal Physics

Optics (with a laboratory)

Theoretical Physics

Computational Physics

Independent Study/Senior Project

**Plus two of the following electives**

Theoretical Mechanics

Strength of Materials

Special Problems in Physics

Electromagnetic Theory II (with a laboratory)

Statistical Physics

Advanced Electronics (with a laboratory)

Analytical Chemistry I (with a laboratory)

**Other required courses (42 credits)**

Calculus I and II

Multivariate Calculus

Differential Equations

General Chemistry I and II (with a laboratory)

Introductory Biology I (with a laboratory)

Principles of Macroeconomics

Principles of Microeconomics

Speech Communication

English Composition

Scientific Computing with Fortran

**Plus an additional 23 credits** (12 in arts and letters, 9 in social sciences, 2 in physical education)

Table 1. The curriculum requirements for the industrial physics degree at East Stroudsburg University.

Glass, and Weiler Corp., all industries located in northeastern Pennsylvania, helped to develop it. ESU is a four-year liberal arts college, a part of the Pennsylvania State System of Higher Education.

Some of the decisions about the new curriculum were difficult. For, example, how much quantum mechanics is needed? Certainly, quantum mechanics is important to modern physics of any kind. Yet, did we need a specific course in it, or could we structure a curriculum that provided an adequate background in the subject? Among the other questions we addressed: How much time should we spend on electric and magnetic fields as opposed to electronics? Is it better to have an upper-division mechanics class or a class that covers engineering statics and dynamics? In which courses could we add laboratory experience? The science content of the degree ended up as a cross between applied physics and engineering (Table 1 and Figure 1).

The curriculum has more of a hands-on

component than traditional undergraduate programs: electronics, electromagnetic theory, and optics all include a laboratory component. This exposure to laboratory work is in addition to Advanced Laboratory, an upper-division course. The senior project will also be laboratory-based. We have expanded our laboratory facilities to include a small machine shop so students can build some of their own equipment (Figure 2).

Absent in the junior and senior years are courses in quantum mechanics, theoretical mechanics, statistical mechanics, or anything to do with nuclear or elementary particles. We have replaced them with engineering graphics, electronics, engineering statistics, engineering dynamics, computational physics, and optics. We believed that undergraduates in industry would more likely use skills in electronics and optics than those taught in statistical mechanics and quantum mechanics, and the skills taught in statics and dynamics than Hamiltonian and Lagrangian mechanics.

The engineering graphics, statics, and dynamics courses are shared with ESU's engineering transfer program, in which preengineering students spend three years at ESU and then transfer to another university for two more years, most often Pennsylvania State University (University Park). Courses in computational physics and optics will cover skills important to physics-related industrial work. Many engineers and physics students do not have these skills after completing their bachelor's degree.

"This program looks particularly promising for colleges and universities with engineering transfer programs because the more-technical courses can be shared by the industrial physics and the preengineering programs, thus helping to ensure a critical mass of students," says Judy Franz, executive officer of the American Physical Society.

Generally, we will encourage practically oriented electives. Electromagnetic Theory II has been reformulated as a laboratory course centered on transmission lines, waveguides, antennas, and electromagnetic wave propa-

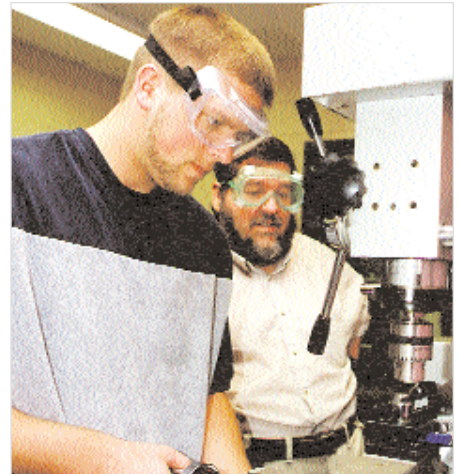


Figure 2. Garrick Alt, a junior physics major at the time, works in the machine shop at East Stroudsburg University, supervised by professor of physics David A. Larrabee.

gation. Advanced electronics will include the hands-on digital and analog design necessary for basic instrumentation. Strength of materials will cover basic elastic theory, the properties of commonly used materials, and an introduction to failure mechanisms.

We are actively recruiting our first class of students for fall 2003 and industrial partners who are interested in participating in the program or in hiring our students as summer employees. More information is available at <http://www.esu.edu/physics/larrabee/iphome.htm>.

All curricula are compromises. ESU's program leans toward the practical, serving the needs of the student who desires an industrial career. "The industrial physics program at ESU will provide a new source of talent that will help meet a growing need that we at Eastern Engineering Associates see in our part of the engineering-services industry," says president Allen R. Lewis. "The higher level of technology required in our business today demands the ability of companies to quickly provide practical solutions to complex problems with a workforce that can readily apply the basic related sciences to real-world industrial problems." ■

**B I O G R A P H Y**

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