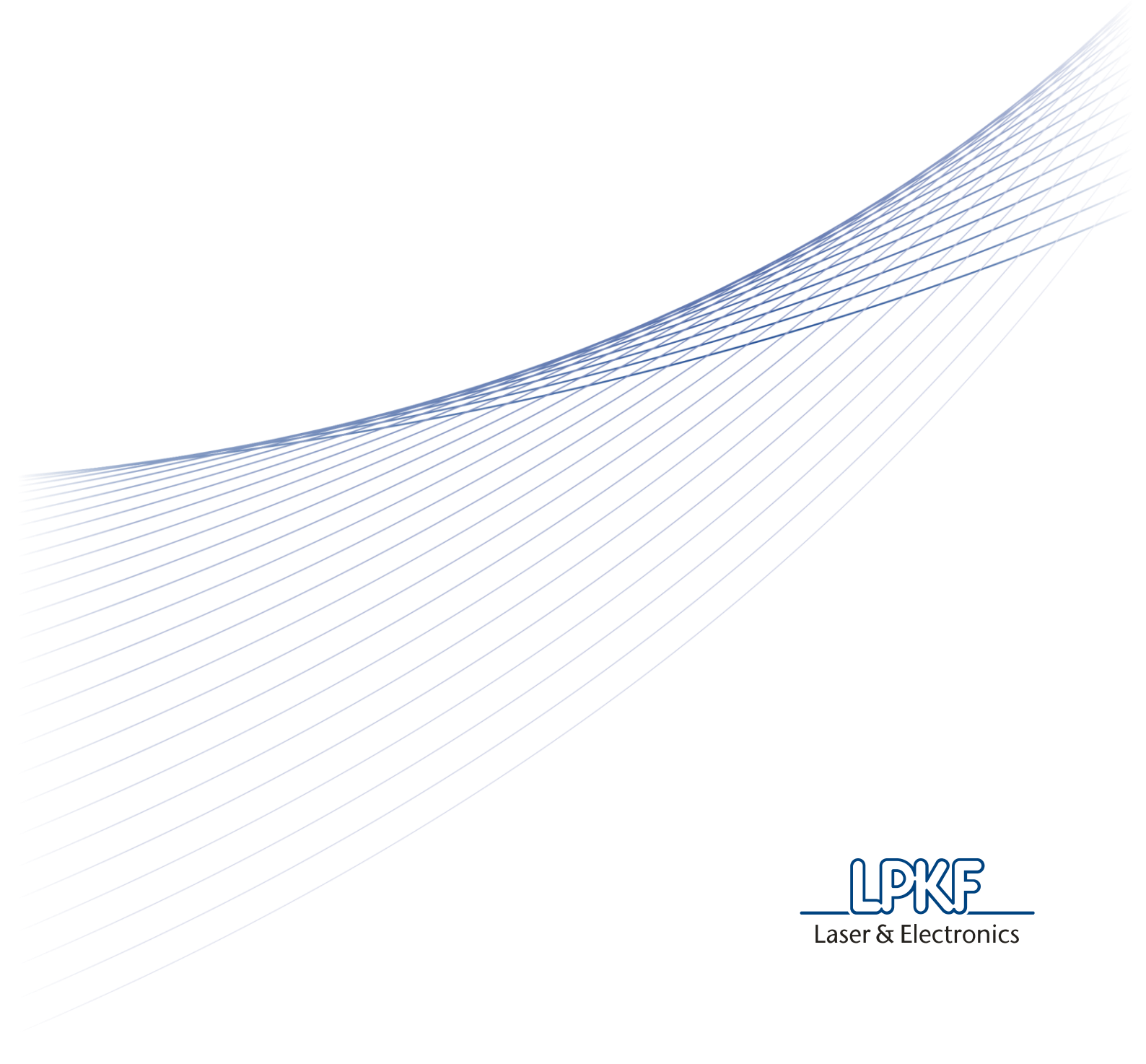
Developing Projects and Enhance Students´ Experience

Inhouse-PBC Prototyping at Shippensburg University



LPKF
Laser & Electronics

Effective in-house prototyping

Shippensburg University has been using LPKF laboratory equipment since 2012. The machines for the complete in-house production of printed circuit boards enable both students and scientists to carry out teaching, research and development assignments. Read the user report from the university.

Introduction

Shippensburg University is a public, comprehensive liberal-arts university with about 7,000 students. We launched our Bachelor of Science in Computer Engineering in 2011, and a Bachelor of Science in Electrical Engineering in 2014. In response to the feedback from our industrial partners, all our engineering programs feature a balance of traditional engineering lectures and real-word experiences that inspires students to learn and build confidence for becoming professional engineers.

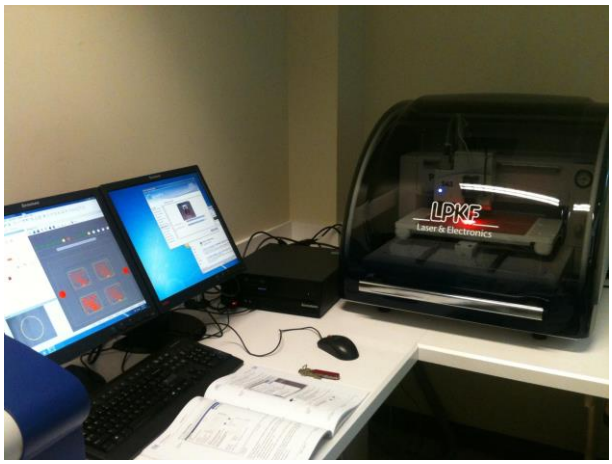


Figure 1 - ProtoMat S63 at Shippensburg University

The Engineering Department created the fabrication lab in 2012 focusing programs on electronic design and fabrication. “We selected the LPKF prototyping equipment for reliability, cost, and environmental safety” said Dr. Tom Briggs, professor in the School of Engineering at Shippensburg University. Using a mechanical milling machine reduced students’ exposure to chemicals. The department uses the ProtoMat S63, MiniContac RS, ProtoFlow S, ProtoPrint S, and ProtoPlace S.

The equipment transformed the educational experience of juniors taking the CMPE322 Microcontrollers course. Students learn typical programming and interfacing tasks using reference boards. By the end of the semester, students are partnered and tasked with identifying a problem. They must then list the requirements necessary and develop a custom microcontroller system to interface with at least one external IC, communicate with another computer, and solve a definable problem. Using OrCAD & Allegro Shippensburg University students do schematic capture and PCB layout and submit a bill-of-materials for purchasing. They use the LPKF equipment to manufacture their circuit boards, electrically test, program, and demonstrate a working embedded system.

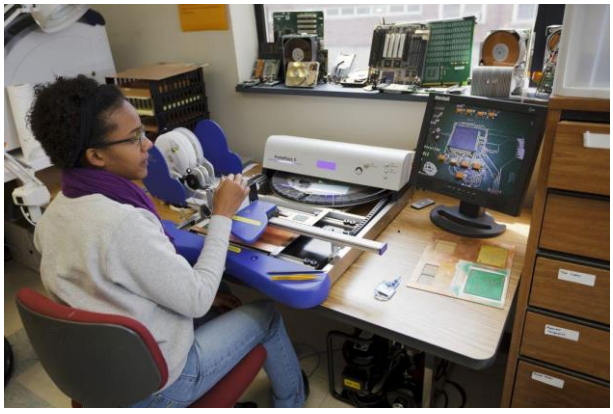


Figure 2 - A Shippensburg University student using ProtoPlace

The value of inhouse prototyping for the university

Since 2012, Shippensburg University students have processed more than 250 custom designs. “Outsourcing the board fabrication would have cost us an estimated $30,000 over the past six years, and in-house production exposes students to the entirety of the process,” said Dr. Tom Briggs, Engineering Department chair. Students are better designers when they understand the process. “It is hard to place a value on the improved educational outcomes we are able to provide to our students.”

The equipment

The LPKF equipment in Shippensburg’s Engineering Department has been reliable and durable. The machine has over 3,200 hours of running time, performing over 6,000 tool exchanges with the machine’s head traveling over 12 kilometers.

While the LPKF equipment and software are relatively easy to learn and use, students need training to use the equipment safely. Engineering Department faculty created a series of instructional videos to demonstrate each phase of the process so students can work independently, which frees up valuable faculty resources.

Project Examples

Fully trained, students have launched into innovative projects. Shippensburg University’s Women in Computer Science and Engineering (WiCSE) group built the “WonderFall,” a programmable waterfall with 32 solenoid valves that can create custom patterns in the streams.

The group demonstrates the waterfall every other year at the National Science & Engineering Festival. Students built a custom UAV controller, integrating the sensors, PID controller, and motor controllers into a single integrated, open-hardware board. The capability to design custom boards in house has connected the students’ imaginations to what is possible and has given expression to their design ideas.

Research

Having the LPKF equipment in house ensures rapid design iteration. Coupled with rapid 3D printing, the department has created devices for academic and industrial partners engaging more than thirty undergraduates in sponsored research since the lab’s creation.

The Engineering Department collaborated with the Geography/Earth Science Department on a large-scale project at NASA’s facility on Wallops Island in Virginia. The agency used commercial water sensors that cost more than $2,500 each and collected only local data to the device. Because they were cost prohibitive, the agency only deployed a few of the commercial sensors in a large watershed. So, Shippensburg University students and faculty created a sensor that costs less than $200, included an additional range of sensors, and the sensors communicate wirelessly. At completion, the project will create one of the largest sensor arrays, with more than 100 sensors connected over a mesh wireless network supporting real-time data monitoring of a watershed.

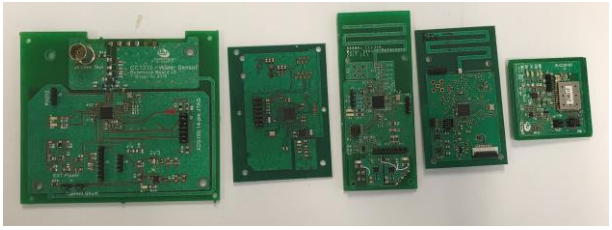


Figure 3 - Shippensburg University engineering student/faculty iterations of sensor boards

Over the past few years, each iteration improved some aspect of the design, a process significantly enhanced by the ability to fabricate in house. Figure 3 shows a left-to-right progression of sensor board iterations. The latest prototype is a multi-layer compact PCB and represents the ready-for-production design.

By using the in-house equipment, students who usually complete their work in the course of a semester can iterate every few days. The rapid iteration ensures they can see at least a prototype to completion. The production-ready prototypes will be deployed into the field by the end of 2018. The fabrication lab with the LPKF production line makes it possible to complete a project of this scope.

Coupling the prototyping lab with 3D printing capabilities, students can iterate through both circuit board and housing design. Students experience with “fit to envelope” design and integrating the physical and electronic systems.

As the project shifts from research and development to production, the department’s production fabricator will be able to manufacture fully functional and tested boards, avoiding multiple iterations of tooling and testing charges. It saves the department time and money, both scarce resources in higher education.

Conclusion

The LPKF prototyping equipment added to the Engineering Department six years ago has become the centerpiece of the fabrication lab. The readily available production line has transformed how students learn and make them better prepared engineers upon graduation. In-house design iteration has enabled students and faculty to tackle more sophisticated research projects than is typical of institutions of similar size, and the reliability and quality of customer support ensures the department can continue to benefit from the equipment investment for years to come.

The Author

Tom Briggs is a Professor in the Department of Computer Science at Shippensburg University. He is working on projects in Machine Learning, Semantic Web, and Embedded Systems. He is involved in the AI and Embedded Systems research groups at Ship. He also mentors students through the Upsilon Pi Epsilon honor's society, Cutter project.

Tom has over twenty years of experience in computer science and engineering and is actively engaged in supporting advanced research and development with area industries. His work includes systems architecture, UNIX and Linux administration and systems design and development; research, and project management.

Tom holds degrees in computer science from the University of Maryland, Baltimore County (PhD) and Shippensburg University (MS, BS).

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