AGH University of Science and Technology

Students Today, Cutting-Edge Researchers Tomorrow

Background

Located in the most historical city in Poland, the AGH University of Science and Technology (UST) in Krakow is one of the most prestigious universities in its field. Founded in 1913, it employs more than 1,800 teaching and research staff members and provides higher education to more than 35,000 students each year.

The Department of Measurement and Electronics was formed in 1957, and, since 2006, it has been a leader in application-specific integrated circuit (ASIC) design research. Though the department's research team produced several validated chips in 2013 and collaborated with research institutes and industry to commercialize the technology, the rate of chip design and validation was not always that high. Similar to industry, the research team depended on the next generation of innovators from the undergraduate program to help graduate students with innovation-ready skills. Because of this, the department's faculty and staff members decided to modify the curriculum to help students develop their chip design and validation techniques and skills.

Industry Project During Master's Thesis

Dr. Piotr Maj, a member of the department's Microelectronics Team, can trace his success as a researcher back to an assignment early in his academic years. While he was completing his master's degree in 2005, Maj and a colleague were offered an industry project to develop a production test

Overview

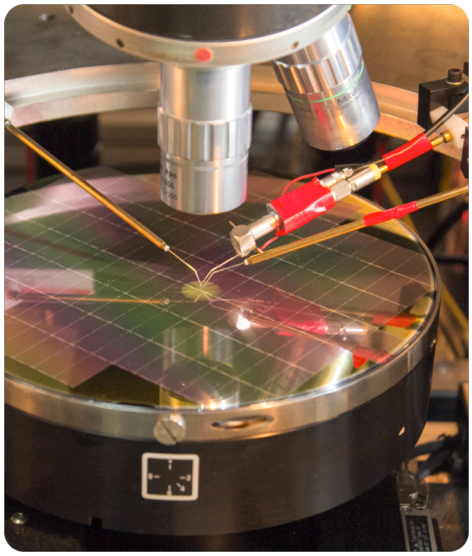
Customer Profile
Respected university produces cutting-edge and commercialized research.

Challenge
Preparing undergrad students to innovate at an advanced research level.

Solution
Teaching classes on an integrated hardware and software platform that scales to industry and research.

Implementation
Introduced three courses focused on programming in LabVIEW at various skill levels.

Results
Students became certified developers and joined both research teams and industrial companies.



system for an international tire company. The local National Instruments field engineer, who offered to assist, gave the project to Maj and his colleague and set a deadline of two weeks to deliver a working solution.

Having rarely used NI LabVIEW system design software or virtual instrumentation, the two men spent the next two weeks learning everything they could from LabVIEW manuals and documentation during the day and programming at night. On day 14, they presented the tire company with a system that used a noninvasive laser sensor and encoder to map the tire surface to the angle of rotation. This system tested a tire in less than a minute. The previous system covered only 10 percent of the tires during production, but the new solution helped the company test and validate 50 percent of the tires from the production line.

Maj learned two valuable lessons from this project: (1) If his colleague and he had formed a company prior to the negotiations, they would have profited from the commercialization of their solution, and (2) LabVIEW and commercial off-the-shelf NI modular hardware provided a powerful, rapid-prototyping platform that could be used to solve any challenge. Both of these lessons have shaped major decisions in Maj's life since.

Research in ASIC Design and Commercialization

After experiencing the power of LabVIEW system design software in the industry project, Maj decided to apply the same rapid-prototyping approach to his master's thesis project. He was tasked with accelerating the measurements on a diffractometer by more than 100X using a custom system featuring a silicon strip detector with a prototype multichannel ASIC. Using LabVIEW and an NI high-speed digital I/O device, Maj deciphered the communication protocol from the host PC to the instrument by observing the digital lines; he then proceeded to write an instrument driver to fully automate the system with LabVIEW. In just a few weeks, he realized the measurement results at a rate of more than 100X faster than with a traditional single-slit detector. Again, Maj found that using LabVIEW and modular hardware helped him generate results in a fraction of the time.

During the defense of Maj's thesis, one of the professors, Dr. Paweł Gryboś, questioned him about his testing approach and ability to rapidly develop a test system. Maj later discovered that Gryboś designed the ASIC under test in his thesis. Regarded as one of the premier analog designers in Poland and published in top electronics journals, Gryboś at the time was designing state-of-the-art ASICs and searching for someone to validate the design and functionality of the chips after fabrication. Thoroughly impressed by Maj's thesis work, Gryboś offered Maj a PhD position on his new research team in the Department of Measurement and Electronics. The team's goal was to bring together different fields of expertise to enhance ASIC development.

"With the increasing complexity of components we produce and accelerated development times, we need engineers who can quickly build and reconfigure control and measurement systems. Students from the Department of Measurement and Electronics organically gain those skills during their studies, and they can prove that with certificates."

—**Robert Salach-Bielecki**,
Senior Test System Project Leader,
Delphi Automotive

In February 2007, research team members collaborated with Rigaku Corporation in Tokyo, Japan, to develop a new ASIC for extremely fast detectors used in X-ray diffractometry. Within several months, they had their first working prototype ASIC that could run continuously rather than function as a finite shutter mode. This significantly enhanced the accuracy and functionality of the device. In November 2007, the chip was incorporated into products for sale. With a time to market of only nine months, this was one of the fastest commercializations of research technology at that time, which was another goal for the research team.

Education Enhancements

Similar to his achievements in research, Maj can trace his success as an educator back to his exposure to the power of LabVIEW. When he joined AGH UST as a researcher, he was given the opportunity to teach an undergraduate course. Since his X-ray detector specialty was too focused for undergraduate education, he decided to lecture on the engineering tool that enabled the success of his research—LabVIEW.

Basics in Graphical System Design was an elective course for the first semester. Maj initially worried that few people would sign up for the course, but more than 70 percent of first-year engineering students enrolled in it. They found the course valuable for a variety of reasons, but they most appreciated Maj's status as an NI Certified Professional Instructor for LabVIEW and his use of industry-standard NI course materials. All students in the class received a copy of the LabVIEW Student Edition to solve homework exercises on their own computers.

Though the students had already taken a few programming classes, this was the first course to incorporate real-world relevance. They learned how to create graphical user interfaces, automate decision making, and interact with real inputs and outputs. At the end of the course, they completed projects to apply their new skills. Engagement was high, and students gave positive feedback in surveys at the end of the semester.

After Maj demonstrated that he could sustain student interest in graphical system design, the experimental course was incorporated into the core curriculum. Propelled by the success of the first course, Maj designed two follow-up courses for advanced topics. He based the first course, Programming of Control-Measuring Applications, on using LabVIEW for controlling real-time and FPGA hardware for reliable, deterministic operations. The second course, Advanced Programming in LabVIEW, dived deeper into code architectures and programming paradigms. Though these were initially elective courses also, the department soon integrated them in the core curriculum based on the enrollment numbers and student feedback on Maj's enthusiasm and competence in the subject matter. He had recently been named a Certified LabVIEW Architect and received the title of LabVIEW Champion, which NI gives users to thank them for their outstanding evangelism of LabVIEW.

> *"It is the responsibility of educators to equip their students with the skills and knowledge to enter the workforce. The impact that LabVIEW has had on my career made the decision to teach it to my students an obvious choice."*
>
> —**Dr. Piotr Maj**, AGH University of Science and Technology

Average ASIC Output

2.25

per year before 2010

5.50

per year in 2010 and after

“I started my business based on LabVIEW. Right after graduating, I opened a system integration company and hired six CLD and one CLA engineers—all studying at Dr. Maj's LabVIEW Academy, just as I did when I was a student.”

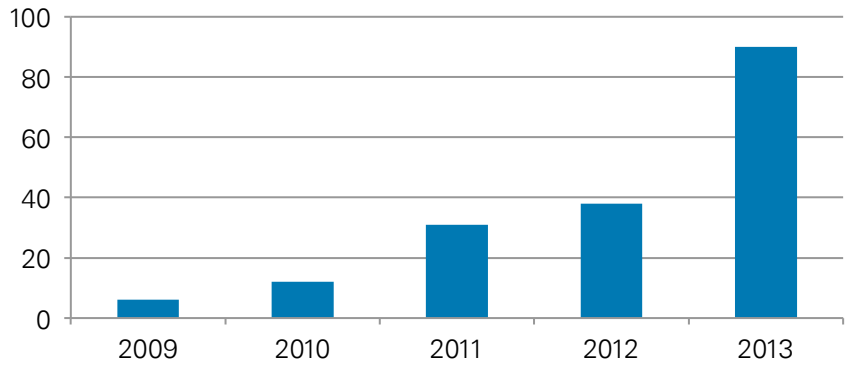
—**Szymon Pękala**, CEO, Extensa

Results

To help support the research team, Maj and his team recognized proficiency in using LabVIEW with NI hardware as a key driver of innovation. In 2010, he worked with NI field engineers to open Poland’s first LabVIEW Academy, a program that prepares students to become professionally certified in LabVIEW. Since the academy’s inception, more than 200 students have earned their Certified LabVIEW Associate Developer (CLAD) status, which sets them apart from classmates at job interviews. Graduates are now highly sought after by industry giants such as Delphi, Motorola, and Woodward as well as smaller companies in Poland.

To supplement the courses taught in the undergraduate curriculum, Maj and his team members worked to grow LabVIEW adoption in other research departments by evangelizing their success with the software. When he has time, Maj trains fellow researchers and PhD students on LabVIEW to improve their skills, which has led to more than 10 Certified LabVIEW Developers at the university and one Certified LabVIEW Architect, the highest level of certification.

Students Certified (CLAD) Per Year



As a result of this effort, Maj has recruited two former undergraduate students as colleagues and a third who is completing his PhD studies and plans to join the research team. The growing team of 10 staff and doctoral students has pioneered designs in the 3D CMOS and deep sub-micron technologies, and increased its design output from one ASIC per year in 2005 to more than 10 ASICs between 2013 and 2014. In April 2014, Rigaku released the next generation of 2D single photon counting X-ray cameras, called HyPix-3000, using the latest chip from the team. In the process, Rigaku again revolutionized in-house X-ray diffractometry applications.

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