A GIS Laboratory, Indeed

Above: RDO Integrated Controls drove its mobile mapping truck across campus several times to collect data, showing students who had collected GIS data with handheld devices that alternative methods exist.

A good place to get a sense of where the geographic information system (GIS) field is headed is Lattie F. Coor Hall at Arizona State University in Tempe, Ariz. That's the home of the 30-credit-hour Masters of Advanced Study in GIS (MAS-GIS) Program within ASU's School of Geographical Sciences and Urban Planning. Here, students are exposed to not only the latest GIS concepts but also ever-evolving technologies.

ASU's School of Geographical Sciences and Urban Planning offers additional options for GIS studies, including an undergraduate certificate and an undergraduate degree program that is in development. Like all master's programs, though, the MAS-GIS is designed to convey the most advanced concepts in its field.

The program was developed from 2002–2003 and launched in 2004 by Dr. Robert C. Balling, Jr., who had overseen ASU's Office of Climatology for 18 years.

>> By Don Talend

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It was really a terrific thing, at age 50, to take a right turn and do something completely different. I recommend it for everybody," said Balling, who had overseen ASU's Office of Climatology for 18 years before developing the MAS-GIS program.

Balling–the associate program director–and several faculty associates–including Nik Smilovsky, MS, GISP, product specialist for Topcon Positioning Systems dealer RDO Integrated Controls in Phoenix–part of RDO Equipment Co.–teach a total of 10 courses in the program, which also includes an internship and capstone GIS project in the final semester. Typically, students start in the fall semester and complete their studies in 12 months.

Shortly after he turned 50, the phone rang and Balling was told about the opportunity to develop a new program. "I was involved in the climate debate and wrote a bunch of books and had a pretty successful operation," he recalled. "It was really a terrific thing, at age 50, to take a right turn and do something completely different. I recommend it for everybody," he said with a laugh.

Balling developed the MAS-GIS program to fill a niche, like some other master's GIS programs. Several programs are online, a format that works for some students but not others, Balling contended. "We've had success with the on-campus program," he said, noting that ASU's program is accelerated compared with several two-year programs. "It's to our benefit. People love to come to Arizona State and spend a year. Our niche is that you can come here and work all day if you like; we go to school at night."

Since 2004, more than 250 students have received their master's degrees through the program. Roughly one-third of students enroll in the program immediately after receiving an undergraduate degree and another one-third have worked in another field for years and are seeking a change. "Students have a median age of 28, typically are working or have worked, and see this program as an opportunity to move their careers along rapidly," Balling reported. "They believe a master's degree will not just improve their job situation but also open up opportunities for a variety of jobs they currently can't compete for. A lot of employers don't say you have to have a master's degree, but it's to your advantage to have it."

As an advanced GIS studies program, the MAS-GIS is equipped with the latest geospatial data collection technologies. The most advanced of these technologies is Topcon's IP-S2 HD mobile mapping system operated by Smilovsky and Survey Account Manager Yon Egusquiza, the use of which RDO Integrated Controls donates to ASU.

Hands-on mobile mapping

The IP-S2 system mounts on the back of a vehicle and consists of a dual-frequency, dual-constellation Global Navigation Satellite System (GNSS) receiver that establishes the geospatial position of the vehicle; an inertial measurement unit (IMU) that tracks vehicle attitude (pose); a long-range Light Detection and Ranging (LiDAR) sensor head equipped with 64 laser that captures high-resolution, high-density point clouds at up to 100 meters away that are time-stamped using special software; and external wheel encoders that capture odometry data from the vehicle. In addition, a high-resolution digital camera captures 360-degree images.

Every second, the scanners collect 1.3 million x, y and z points that are used to obtain accurate geospatial positions for assets. Traditionally, LiDAR data have been collected from the air; because this system collects the data from ground level, it provides critical data that cannot be obtained from aerial surveys. Integration of these technologies creates a three-dimensional position for the vehicle and provides accurate tracking in challenging or denied GNSS environments. A laptop computer inside the truck uses a Web browser to communicate with the bed-mounted equipment via an Ethernet cable; data collection does not require an Internet connection.

In GIS Data Management, which Smilovsky teaches in the spring semester, students are tasked with hands-on collection of the data that they process later. For the 2012-13 school year, Smilovsky subdivided the entire campus into equilateral grids and had each student collect a minimum of 50 features.

The goal of the data collection was to have students manually collect data, said Smilovsky, adding that use of mobile

One common location in which students gather data using mobile mapping is the university's Palm Walk pedestrian wall.

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mapping is part of RDO Integrated Controls' ongoing community involvement initiative. Later, he showed them how much more efficient collection was with the truck-mounted mobile-mapping system. One common campus feature with a large volume of potential point cloud data that lends itself to the use of mobile mapping is the Palm Walk pedestrian mall. Another instructor, Don Thorstenson, is developing a project for his GIS for the Public Sector course in which students would collect data on trees on campus and develop a GIS database for ongoing maintenance. It's another application for mobile mapping.

"Our students love being out there, they love seeing mobile mapping," Balling said. "So much of what we do is in the lab and some of the people are just itching to grab that GPS antenna pole, go outside and do things and see stuff outside of this building."

During the fall semester, RDO Integrated Controls forged even deeper ties with ASU and the GIS field. Smilovsky and RDO developed a paid internship for ASU MAS-GIS students to collect data with mobile mapping.

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Nik Smilovsky and Yon Egusquiza of Topcon dealer RDO Integrated Controls can view point cloud data as they collect them while they drive across campus for ASU MAS-GIS courses.

Master's degree opens doors

International students are well-represented in the program. Program graduate Mridul Mittal of New Delhi, India enrolled in the program in fall 2011, having completed undergraduate degrees in Computer Science and Engineering at Amity University in India. He had heard about the GIS field only about a year earlier.

"I was really interested in it and actually my purpose was to study GIS so that I could get into natural resource management, landscape management or even wildlife conservation," Mittal said. "But I couldn't see doing it with my bachelor's degree. I was looking for a program that would give me the technical skills–I have a computer science background–to get into fields like this. GIS proved to be a perfect match as a technical background to get into natural resource planning."

RDO Integrated Controls

The IP-S2 HD mobile mapping system uses five redundant technologies, including GNSS, LiDAR and high-speed digital photography, to collect high volumes of three-dimensional data efficiently.

While completing his studies, Mittal worked as a GIS intern with the Arizona Game and Fish Department and continued to do so as of fall 2012. At first, his work was limited to cartography, but he has begun developing applications for the agency and public, updating metadata records, and developing a metadata geoportal and started working on data download sites. A small portion of his work has also included creating maps to resolve disputes between private landholders and the state government. Other projects assist department scientists in studying wildlife species.

Mittal recalled processing data collected by mobile mapping during his MAS-GIS studies. The GIS database that was built using the point cloud, GPS location data and video was amazing, he said. "I work at Game and Fish and I work with a huge amount of data, especially shape files of the whole state. Suppose we used LiDAR–we would have highly populated data, very accurate and precise points. When we collect GPS data, we get only one point. Imagine taking 10,000 points in one location–you have accurate data, bigger data and you can do precise calculations and have the exact thing you want."

One project that Mittal managed during his master's studies that no doubt will prove to be valuable in years to come was building a mobile Android application for hiking trails in Arizona. He mapped out about 1,000 trails throughout Arizona, building them from data collected from cities, the Arizona State Parks Trails System and even his own hikes.

"It was a challenge to bring those different data in various forms together and make a single database to build my app," he said. He used Google Maps as a base map and ESRI shapefiles to illustrate trail lines. As of fall 2012, Arizona State Parks Trails System developers were working on a mobile device-friendly iOS version of the app and Mittal expected it to be ready by spring 2013.

"The main reason why they wanted me to create the app was that they have many applications now for hiking, but all of them require GPS," Mittal said. "This application does not require GPS–although it has an option for it–because all of the trails are already mapped in. If you needed GPS, you would drain the battery in a couple, maybe three or four hours. With this application, you preload the map before you go on the hike and I designed algorithms for elevation and time predictions for the hike. "You know where to go, even though you don't have a data or GPS connection."

Another MAS-GIS graduate, who came to Arizona State from China, is not quite as settled into his career as Mittal is but looks forward to taking advantage of the opportunities that the master's degree will provide. Zhe Yang received an undergraduate degree from the China University of Geosciences in Wuhan, central China in August 2011. A year later, he had completed his MAS-GIS studies at ASU.

During the final year of his undergraduate studies, Yang served an internship in water conservation, learning the basics of database programming. "I learned a lot about the basic concepts of GIS, but I thought I needed more real-world practice and knowledge," Yang said. "When I started to look at American universities, my professor recommended ASU. I found that the MAS-GIS program is focused on real-world GIS knowledge, not only the research work. This really attracted me. I think that the MAS-GIS program has given me a better understanding of the GIS field and more practical opportunities."

Yang and a fellow MAS-GIS student, Danielle Williamson, managed data, performed analysis and created maps to visualize results for a study for the Center for Equal Progress for the MAS-GIS Faculty Associate Consortium during their first semester. They determined that many low-income areas in the Phoenix metropolitan area were exposed to high pollution, and that race is tied to exposure levels, based on data collected from toxic release inventory sites in the year 2000. Further, styrene–a derivative of benzene, a constituent found in gasoline, and a carcinogen–was the most common and concentrated pollutant. Relying on data from the U.S. Census Bureau and Maricopa County, the study also indicated that pollution had been reduced significantly across the county by 2010.

While serving an internship for the City of Phoenix Aviation Department's Technology Division, Yang used a handheld laser rangefinder to locate a newly installed chair charging station at Phoenix Sky Harbor International Airport.

In fall 2012, Yang was serving another internship, for Westland Properties Group, a real estate management company, in Scottsdale. He created a database using residential sale data in Maricopa and Pinal counties to provide insight into home sale trends among Westland's properties.

Yang said that, now that he has his master's degree, he wants to focus on one area of the GIS field for full-time employment. "My opinion is to try as much as I can to experience more industries related to GIS and after that, I can find a way that I would go in the future," he said.

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Students also gather data on foot for their classwork, using equipment such as this GNSS receiver.

What the future holds

If anything, Balling expects equipment to become increasingly sophisticated as GIS becomes increasingly sophisticated. That means that ASU's School of Geographical Sciences and Urban Planning will continue to continually replace its equipment, giving individual instruments a service life of a year or two. It helps that the school is an Esri development center; the school's instruments and software must "keep up" with Esri product development.

While equipment will change in coming years, fundamental GIS concepts will not, Balling said. "I teach spatial analysis–fact is, that doesn't really change at all," he said. "Software has changed but not the basic concepts they have to learn–spatial interpolation, multivariate statistical analysis–those are a hundred years old. It's like teaching calculus."

Smilovsky thinks that GIS will continue to be a growth field. "I think it's the general acceptance that more and more companies are realizing that they need to have a few people in GIS," said Smilovsky, noting that companies such as UPS and FedEx rely heavily on GIS for their logistics.

"I know this–whatever we're doing today, we're not going to be doing 10 years from now," Balling said. "The instruments will be smaller and faster and collect more data. There will also be less desktop. We're going to the cloud and we won't rely on software as much."

Mittal agreed with the notion that mobile devices will become more powerful in GIS. "Field work will go out of the desktop and to mobile devices and mobile devices will take on the whole enterprise," he said.

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