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From GIS to UAVs: Emerging Opportunities for Drone Support Services in Academic Libraries

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Abstract

In 2015, The Claremont Colleges Library purchased a drone for its Emerging Technology Loan program. At the time, Federal Aviation Administration regulations were still in their infancy in regards to drone use in public and for teaching and research –lending wasn’t even a consideration. After three years of waiting for the regulations to catch up with the demand, The Claremont Colleges Library GIS Specialist was able to pilot a drone lending program that circulates both the drone and the GIS Specialist for course integration. This paper outlines the history of GIS at The Claremont Colleges Library, its evolution toward drone services, and the successes, challenges, and lessons learned along the way.

Keywords: drones, UAVs, academic libraries, GIS, Geographic Information Systems

From GIS to UAVs: Emerging Opportunities for Drone Support Services in Academic Libraries

A Geographic Information System (GIS) is a geographic framework for gathering, managing, and analyzing spatial location data into layers of information that are then visualized using maps and 3D scenes (“What is GIS?,” n.d.). As GIS and its related technologies have developed over the past three decades, academic libraries have come to view it as another information resource. In the early 1990s, librarians began to acquire skills for providing access and support for GIS through the Association of Research Libraries (ARL) GIS Literacy Project, a partnership with Environmental Systems Research Institute (ESRI) (March & Scarletto, 2017). Five years after the project launch, an ARL survey found that, out of 72 ARL library respondents, 74% offered some level of GIS service (Holstein, 2015). Academic libraries have implemented a range of GIS services, including GIS software, instruction, workshops, helping users locate or format geospatial data, and curating and preserving geospatial data and GIS outputs. In a more recent ARL survey, all 54 respondents indicated that they offer GIS software or mapping technologies at their library. In a 2005 survey of two consortia, 31 of 106 institutions indicated that they already provide GIS services, while 15 institutions said they were considering it. As indicated by these surveys, GIS support in academic libraries continues to rise (Holstein, 2015; March & Scarletto, 2017).

As computers increase in power and cloud-based storage becomes ubiquitous, GIS and related technologies have become more user-friendly and less discipline-specific, allowing researchers to develop new methodologies. This has led to a surge of interest in GIS outside of environmental studies and Earth sciences. Digital humanities and social sciences have begun experimenting with GIS-related data collection tools, such as Global Positioning System (GPS) units, remote sensing devices, and drones. This cross-pollination of tool adoption has led to a

demand for academic libraries to offer technology lending for experimentation and utilization in research and learning.

Technology lending services in academic libraries provide access to emerging technologies and digital tools that would otherwise be difficult to acquire. Public service initiatives of this nature have been documented in libraries for more than a decade. Holden and Deng (2005) documented the Monmouth University library's initiative to survey their campus community for potential users of a laptop lending program before the availability of wireless access. The objective of technology lending programs is usually two-fold: make technology more accessible and help students meet the increasing expectation from faculty for multimodal projects that incorporate a mix of digital media into the methods and presentation (Hahn, Mestre, Ward, & Avery, 2011). The use of GIS technologies in student projects can be viewed as the epitome of multimodal research in college work today.

To meet the research, teaching, and learning needs of their community, The Claremont Colleges Library has offered library GIS support services for more than twelve years and technology lending for more than four years. The program offers technology such as virtual and augmented reality devices, an Unmanned Aerial Vehicle (UAV) or drone, GPS units, and more. Of all the technology available for lending, drones and GIS have become popular services in their own right.

This paper describes the evolution of UAV support services at The Claremont Colleges Library to support the growing utilization of drones in the curricula. It highlights the successes, challenges, and lessons learned by The Claremont Colleges Library staff during three years of a drone lending program. Staff continues to use these lessons to improve its UAV lending service.

Literature Review

Vocabulary

The terms *UAV* and *drone* are used interchangeably and are commonly referred to as “flying robots.” Although the terms are used synonymously, they should be distinguished from some of the other technologies in the drone/UAV family.

Unmanned Aerial Vehicle (UAV). A “pilotless aircraft” that flies without human passengers or a pilot on board; a device which can be flown remotely or autonomously (Dalamagkidis, 2015; “Marketline Case Study,” 2014).

Unmanned Aircraft System (UAS). The Federal Aviation Administration (FAA) defines a UAS as “an unmanned aircraft and the equipment necessary for the safe and efficient operation of that aircraft” (“Unmanned aircraft systems,” n.d.). In other words, it includes the UAV, its remote pilot, and any other technology required to make the system work. Dalamagkidis (2015) indicates that UAS and UAV are typically used interchangeably except when legal or regulatory circumstances require an emphasis on the system, in which UAS is the preferred term.

Unmanned Combat Aerial Vehicles (UCAVs). The military variant used for combat in the form of drone air strikes and reconnaissance missions (“Marketline Case Study,” 2014).

Commercial Use of Drones

Improved technical capabilities have led to a growth in popularity of UAVs. The commercial sector usually centers discussion of UAVs on innovation, either for their potential to improve efficiency or to reach new customers. Examples of this can be seen in commercial endeavors such as Amazon’s Prime Air drone, Google X’s Project Wing unmanned delivery program, and Facebook’s solar-powered stratospheric unmanned aircraft, Aquila (“Amazon,” n.d.; “Marketline Case Study,” 2014; Warwick, 2015). Non-commercial sectors, such as

education and research, are also seeing opportunity for new methods which can lead to new discoveries.

Drones in Research and Education

There are a range of uses for UAVs in research. As early as 2011, formal programs in drone journalism had begun to surface (Birtchnell & Gibson, 2015). By 2012, UAVs were being used in geology, environmental science, and archaeological geophysics for aerial data capture in topographical, geological, architectural, and infrastructural surveys. By 2015, social researchers were grappling with the impact of drones on their own research.

In 2011, the University of Nebraska and the University of Missouri began designing journalism courses that incorporated drones. They wanted to develop students' drone skills for reporting on natural disasters and other events that would otherwise be difficult to photograph and document (Morris, 2015). As UAS technology advances and journalism pushes to remove legal barriers for civilian use, they may open the door for greater use in the arts and humanities. For now, science and engineering continue to lead as early adopters of UAVs in research and education, largely influenced by the longer history of use in the science and technology industries ("Marketline Case Study," 2014).

In 2015, geologists began to explore the potential of micro UAVs for research and teaching (Jordan, 2015). Micro UAVs could be used for surveys, field mapping, and monitoring, including access to hard-to-reach and dangerous areas, such as overhanging rock or gas-rich volcanic areas (Jordan, 2015). They could also be used to collect ambient weather data, gas measurements, and long-term aerial monitoring, along with the possibility of generating 3-D models from that data (Jordan, 2015).

In the arts, humanities, and social sciences, drones have the potential for field work and data collection by extending the range of data captured and providing new vantage points. However, instructors in these disciplines have struggled with the challenges of teaching human geography and spatial social sciences. They have grappled with the ethics of drone use and the privacy of human subjects while also envisioning the possibilities for social and cultural inquiry through aerial data (Birtchnell & Gibson, 2015).

In the field of analytical and environmental chemistry, instructors have used drones to create a video learning object to help students apply good soil sampling sites (Fun Man Fung & Watts, 2017). The drone enabled the instructors to provide their view of the sampling site in order to improve student understanding of the terrain so they could apply what they learned in the classroom.

Evolution of Drone Services at The Claremont Colleges Library

The Claremont Colleges Library is one of many services offered to The Claremont Colleges Consortium, a group of five liberal arts undergraduate colleges and two graduate universities. The consortium includes Pomona College, Claremont McKenna College, Scripps College, Harvey Mudd College, Claremont Graduate University, and Keck Graduate Institute. The library serves as a central service to all of the seven colleges, as envisioned by the first president of Pomona College, the first college established in the consortium. Because of its unique structure, the library has been well positioned to partner with faculty on innovative approaches to research, teaching, and, learning. Over the years, this partnership has evolved through GIS, technology lending, and, more recently, UAVs.

GIS Services

The Claremont Colleges Library has supported GIS for more than 13 years. Initially, GIS services were offered in the Maps and Government Documents division on a part-time basis. In 2009, the undergraduate colleges received a Mellon grant to further develop a five-college major in Environmental Analysis. The grant included funding for full-time GIS support in the library, so the library created a GIS lab. As the grant expired, faculty members of the undergraduate colleges were awarded a Mellon grant to develop digital humanities pedagogical practices across the undergraduate colleges. To support the new grant, the library transformed the GIS lab into a Digital Tool Shed to accommodate the shift to a broader support of digital scholarship. GIS support services were later folded into consultation services of the Research, Teaching, and Learning Services (RTLS) division. GIS devices such as GPS units circulated through the Tech Lending Program.

As GIS technology improved, became more user-friendly, and appealed more to digital humanities practitioners, the demand for GIS support in the library increased. In response to this demand, the RTLS division increased its capacity for GIS support. The STEM Team Leader developed skills in ArcGIS applications and began to offer beginner-level consultations. This freed up the GIS Specialist to focus on course-integrated GIS instruction and explore new opportunities for GIS-related technology support, such as working with GPS units, mobile devices, and UAVs for field work.

Tech Lending Program

The library's Tech Lending Program began as the Emerging Technology Loan Program in 2014. It was funded through an internal technology innovation proposal to demonstrate the library's responsiveness and commitment to emerging user needs through access to scarce and expensive technologies. At the time, the program featured a pair of Google Glass, a GoPro Hero, and a Leap Motion Controller, among other technologies. Items were circulated and tracked

using a Google Form. In 2015, the program was revised to streamline the circulation of the technologies by cataloging and circulating the items through the services desk.

In the summer of 2015, a Phantom 1 drone was purchased for the collection. However, due to outdated FAA regulations, the library could not circulate it. The drone sat on a shelf, collecting dust for over a year until FAA regulations were modified to allow recreational use of drones. This meant that students, faculty, and staff could operate the drone as long as it was not for research, teaching, or commercial use.

By the time the library was able to make the drone available to library users in Fall 2016, its technology was nearly obsolete. The Emerging Technology Loan Program was renamed as the Tech Lending Program, the Digital Tool Shed was opened, and digital humanities activities were in full swing. To accommodate digital humanities research and learning, the Tech Lending Program acquired DSLR cameras, lenses, mounts, tripods, audio recorders, and other items. In Fall 2017, GPS units were donated to the collection from one of the undergraduate colleges for circulation and use.

The Evolution: From GIS to UAVs

With the influence of the Digital Humanities program, digital projects were on the rise, and the GIS Specialist noticed an increase in drone-related questions. Drone use on the campuses and the legality and ethics of their use became a topic of conversation among faculty. In Spring 2017, members of a cross-college group applied for a grant that involved the use of drones. A stipulation in the grant required a drone policy to be in place or in development.

A drone policy committee was formed with faculty representation from each of the seven Claremont colleges and the library GIS Specialist. It took a little less than a year for the policy to be drafted and approved by each of the seven presidents. During that time, the GIS Specialist

completed a six-month course for the FAA107 drone license, meeting new regulations that require an FAA drone pilot's license in order to fly drones in the United States for teaching and research purposes.

In Fall 2017, the newly-licensed GIS Specialist initiated an experimental drone support service with a borrowed Phantom 3 drone. He spread the word that he was licensed and could facilitate the use of a drone in course fieldwork. Several faculty responded, and experimentation began. Word spread that he had access to a drone and was able to facilitate use of it. At some point, there was confusion about the library's drone lending program, and users began asking for the older Phantom 1 drone. That drone had become obsolete, so the library staff removed it from the program.

By Spring 2018, a semester-long course on drones was being offered by a biology professor in the Environmental Analysis program in collaboration with the GIS Specialist. This upper-division biology course incorporated a practical approach to the use of UAVs in organismal biology and environmental science. The GIS Specialist's role in the course was to teach the use of the drone, related imagery software, GIS, and ESRI's StoryMaps, an ArcGIS application. The students' final output was a StoryMap that documented their research with a UAV. One can be viewed at <http://bit.ly/droneStorymap>.

Successes, Challenges, and Pro Tips

After a failed first attempt at a drone lending program and a year-long pilot to offer drone support to The Claremont Colleges community, the authors gained valuable insights through the challenges and successes of supporting drone use.

Successes

Despite its technology becoming quickly obsolete, the addition of a drone to the Emerging Technology Program lead to some unexpected successes:

- Purchasing a drone prior to the hype forced the library staff to learn more about FAA regulations and stay abreast of the changes, which primed them for a redesigned drone lending and support services program.
- An unmet need and interest in drone support was discovered. Federal requirements for a drone license create a barrier for faculty who want to experiment with drones and determine if one is right for their course. Having a licensed drone operator on staff allows the library to overcome this barrier.

Challenges

During the GIS Specialist's experimental drone program, some ongoing challenges were identified:

- Drones are still expensive. Despite the dramatic price decrease for UAVs, the cost of accessories to make the system usable is still cost prohibitive. This was learned through trial-and-error with the borrowed drone as the GIS Specialist had to scramble for necessary accessories, such as a backpack, extra batteries, and propellers. The library funded those accessories.
- Technology is still unreliable. The borrowed drone used in the pilot malfunctioned during a demonstration and came crashing down. No one was hurt, but the drone was out of commission for a few weeks while the manufacturer looked into the issue and sent a replacement.

Pro Tips

Before an institution dives into a drone lending program, a few things should be considered:

- Get licensed. Although FAA drone licensing can be time-consuming and costly, follow the restrictions and get licensed before attempting to use a drone for any research or teaching. UAVs have many cool applications and may look like toys, but they need to be used with caution and consideration for other people.
- Stay current with FAA drone regulations. Currently, drone operators can fly under a special rule for model aircraft or the FAA's small UAS rule, but the drone must be registered. There are some size exceptions to registering, which can be found in the fine print.
- Perform outreach to campus departments and do a needs assessment for drone use and support from the library. Drone support can be costly and time consuming. Consider the staffing in the library and the ability to build capacity.
- Develop a UAV consultation service that includes discussion on responsible use of a UAV, ethics, and privacy.
- Work with your campus to develop a drone policy if one does not already exist.
- Purchase an extended warranty or insurance to cover damage and loss. Consider investing in more than one drone if it will be embedded in a course. This will ensure that the course schedule is not disrupted if it malfunctions or is damaged.
- Invest in a parachute, extra batteries for extended use, extra propellers, and a backpack to protect the drone during transport.

Next Steps for The Claremont Colleges Library

The lessons learned from the lending program has led to a new vision for drone support. In the next iteration, the authors will propose that the library invest in several micro UAVs that will circulate for experimentation and recreational purposes and one small UAV that will

circulate for research and teaching purposes. The micro UAVs have a lower price point, making them a lower-risk investment. The small UAV's size will require registration with the FAA, so the library policy will require facilitated use of it in research and teaching. The GIS Specialist, licensed to fly drones, will "circulate" or be embedded in the course or research project unless another licensed operator is on the teaching or research staff. The goal of the next pilot is to promote use of UAVs in the arts, humanities, and social sciences, while also making smaller models available for student experimentation.

At the time of writing this article, a proposal is being drafted for one Phantom 3 Advanced drone and related accessories for use in teaching and field research. Included in the proposal are three small UAVs that do not require registering with the FAA. The Phantom 3 accessories include an iPad mini for operating the drone, manufacturers insurance, a drone parachute, extra propellers, propeller guards, two extra batteries (important for field work), and a backpack designed for transporting the drone and all the accessories. The estimated proposed budget for all is \$2,000. If the proposal is approved and funding is granted, the authors look forward to sharing new adventures with drones in research and teaching.

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