Proposal for Purchase of In-house Drone for Cal Poly’s Construction Management Department

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Over the years, the construction industry has been steadily seeing an influx of new technology and innovation that has potential to improve the industry in many ways. One form of technology that has been introduced into the construction industry is Unmanned Aerial Systems (UAS). UAS technology includes drones, photogrammetry capabilities, and the software that links field data to analytic tools. In the past decade, drones in construction have seen a considerable amount of growth and the uses for drones in construction, therefore new job opportunities in construction have been created that require knowledge of UAS technology. As the construction industry is incorporating more technological advances, so too should universities be adapting to prepare future construction professionals. Therefore, this project creates a detailed budget for implementing this technology into Cal Poly’s Construction (CM) Department, shows the potential benefits of the technology into specific courses, and justifies the need to implement the technology from the viewpoint of industry professionals through survey data. The data collected in this project is to encourage the department to purchase an in-house UAS technology and implement drones into the curriculum to better inform and prepare students, as well as to provide a curriculum that reflects industry trends.

Key Words: drone, UAS, photogrammetry, construction education, technology

Introduction

This project was developed from a personal interest in drone technology. I began research on drones for personal and recreational uses and what different drones were capable of, depending on different price ranges and what specific activities I wished to achieve with the drone. After some time, I realized that modern day drones are very sophisticated and could do be utilized for a number of applications. Then I began to do more research on drones and how drones are implemented in the construction industry. I found out that drone usage in the construction industry has actually been growing at a fast rate in the last decade and this growth has opened new opportunities for construction professionals within the construction industry that had not been seen before. This then brought me to researching drone requirements and I became aware that in order to fly drones for any other purposes than recreational uses, a commercial drone license is required. This spurred my interest into what the
actual costs of obtaining proper drone training, commercial drone license, and cost of the actual drone may be for a construction management student like myself. When I began to think about the various costs that can be associated with being properly trained, licensed, and equipped with a drone, I wondered what the benefits for a student might be once they are actually out in the work force and whether or not the benefits would outweigh the costs of being properly prepared for a construction career in drones. That made me think I had found my senior topic idea of “Analyzing the Costs and Benefits of Obtaining a Commercial Drone License for CM Students”.

I discussed my senior project proposal with my Subject Matter Expert and Senior Project Director, and we found my senior project idea could take a different course, a course that may be beneficial to not only construction management students, but also the Construction Management Department at Cal Poly. We discussed the fact that Cal Poly did not currently have an in-house drone of their own for the Construction Management Department, and this senior project may be the perfect opportunity to come up with a proposal as to why the department should invest into obtaining a drone of their own. I felt this was a senior project that would satisfy my interest in drones in construction, while also being able to provide usefulness to the Construction Management Department at Cal Poly. Not only will students and the department benefit from the project, but as more students become better prepared and aware of the opportunities that drones offer, this helps the construction industry be more effective and fully utilize the potential of drones in an innovative way.

Methodology

In order to complete this senior project, I came up with a survey as an industry tool to gauge what industry professionals felt in regard to UAS technology in the construction industry. Particularly, the survey was focused on the growing use of UAS in the construction industry and how the large growth has created opportunities in a niche market that is yet to be fully utilized to its full capacity. The survey gauged if industry professionals felt that implementing UAS technology into the CM curriculum would be a worthwhile investment. Next, I came up with the costs that the CM Department would incur if they were to acquire an inhouse UAS technology. This included cost of drone, the cost of software or programs that would be needed for information processing of field data, as well as licenses and training to operate the drone on campus.

After receiving input from the surveys, it was concluded that the majority of industry professionals were in agreement that UAS technology has become an essential tool in the construction industry. The results justified the importance of purchasing a drone for use in the CM Department curriculum. After this milestone was achieved, an outline of the costs and requirements were needed, so the next step in the process was to come up with a shortlist of courses within the CM department that could adopt a module on UAS. This process allowed me to demonstrate that industry professionals agreed that an investment in this technology may be beneficial. This also allowed me to outline the costs to determine if purchasing the UAS technology would be feasible for the department. With the quantitative costs outlined, and support from industry professionals, coming up with courses that could adopt a drone module to implement the technology into the classroom and in the curriculum was the final step of the process.
## Deliverables

**Industry Survey Tool**

### Unmanned Aerial System (UAS) Industry Survey

Please select one option for each statement provided.

1. Select the primary industry you work in.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Closest Match</th>
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<tr>
<td>Residential</td>
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<td>Virtual Design and</td>
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<td>Construction</td>
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<td>Other</td>
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2. Learning about Unmanned Aerial Systems (UAS) and their many construction applications would provide value for Construction Management students.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
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3. Incorporating UAS technology into the Construction Management curriculum would reflect current industry trends.

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<tr>
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<th>Disagree</th>
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4. Investing in UAS technology may help the Cal Poly CM Department better prepare CM students for the opportunities presented by UAS in the construction industry.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
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5. Over the last decade, new/more job opportunities have become available in the construction industry that have to do with UAS technology.

<table>
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<th>Strongly Agree</th>
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6. The use of UAS in the construction industry has been increasing over the past decade.

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<thead>
<tr>
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*Figure 1: Industry Survey*
Survey Responses

1. Select the primary industry you work in.

   ![Industry Selection Diagram]

2. Learning about Unmanned Aerial Systems (UAS) and their many construction applications would provide value for Construction Management students.

   ![Agreement Levels Diagram]

3. Incorporating UAS technology into the Construction Management curriculum would reflect current industry trends.

   ![Agreement Levels Diagram]
4. Investing in UAS technology may help the Cal Poly CM Department better prepare CM students for the opportunities presented by UAS in the construction industry.

5. Over the last decade, new/more job opportunities have become available in the construction industry that have to do with UAS technology.

6. The use of UAS in the construction industry has been increasing over the past decade.
Results

Industry Survey

The industry survey was completed by over forty industry professionals within various construction sectors ranging from residential, commercial, heavy civil, architect/engineer, and virtual design/construction. Most industry professionals worked in commercial, followed by heavy civil, then virtual design/construction, with residential and architect/engineer being tied for last. Over fifty percent of the respondents strongly agreed that Learning about Unmanned Aerial Systems (UAS) and their many construction applications would provide value for Construction Management students, with the other thirty-nine percent agreeing and only 2 individuals feeling neutral about the statement. Regarding the statement, “Incorporating UAS technology into the Construction Management curriculum would reflect current industry trends”, almost eighty-nine percent agreed or strongly agreed with the statement, while only four people responded with neutral and one disagreed. All the remaining statements received over eighty percent of responses having agreed or strongly agreed by the respondents, with only a few outliers that felt neutral or disagreed. With all the statements receiving the majority of support in the form of industry respondents agreeing or strongly agreeing, it is apparent that investing in UAS technology is something that would provide value for CM students. With UAS increasing over the past decade in various construction disciplines, as well as job opportunities unique to UAS technology being available, the survey results demonstrate that this is an investment that would prove beneficial and is backed by industry professionals from various sectors.

Cost of Drone

The cost to purchase a DJI Phantom 4 Pro drone would be $1,599 MSRP for the drone itself. This drone is capable of carrying out the necessary functions that would be required for a complete UAS system.

Source: https://www.dji.com/phantom-4-pro
Cost of Software

Unmanned Aerial Systems (UAS) would not be complete without capable software that would be responsible of linking field data to analytic tools. Skyward is a widely used software within the construction industry that allows users many features to be an end-to-end solution on a jobsite. Skyward provides a drone software platform, training, consulting, as well as connectivity. Skyward serves as a data analytics solution that enables businesses to manage and track worksite operations through drone mapping, surveys, and inspections. The entire drone workflow from planning flight missions, accessing controlled airspace, streaming data, and creating maps & models can be achieved with the help of Skyward. Skyward offers different software plans but the plan the department should opt for is the mid-tier “Business+” Plan. Which would be 998$ per year (Skyward, 2021). This plan has the necessary functions that the department would need to carry out the necessary activities that would be needed.

![Skyward Software Plans Table]

*Figure 3: Skyward Pricing*

Source: [https://skyward.io/pricing/](https://skyward.io/pricing/)
**Licenses and Training**

The required licenses and training to operate a drone on campus would be:

- 1 air vehicle Operator and 1 visual observer
- Part 107 certification: Part 107 (14 CFR part 107) is the primary law for flying small drones (less than 55 pounds) in the United States. You can fly under part 107 rules for many reasons, including work or business, recreation, education, or for public safety missions. The Part 107 exam must be taken at an FAA-authorized testing center. The testing fee is a flat $173.
- Drone Pilot Training Courses and Test Prep for FAA Part 107 exam costs about 299$. It is highly recommended to take this test prep training courses as such programs boast a 99% passing rate for students who sign up for the course.
- There is also a statutory provision ([P.L. 115-254, Section 350](https://www.faa.gov/regulations_policies/laws_public_laws/index.cfm?doc_id=373)) (PDF), as amended by P.L. 116-283, Section 10002) that clarifies that education and research uses of drones for educational purposes can be operated under the rules for recreational flyers. This includes programs for institutes of higher education, programs run by JROTC, and educational programs chartered by a recognized Community Based Organization. (Educational Users, 2021)
- 20+ hours active flight time maneuvering sUAS

![Figure 4: Cost Breakdown](image)
Courses That Can Adopt Drone Module

Current CM courses that could adopt a drone module could include:

- CM 239 Construction Surveying
  - Topography and contour line generation
  - Watershed and drainage analyses
  - Earthwork calculations including cut/fill
  - Stockpile quantity takeoffs
  - Site logistics such as distance measurement and boundaries

- CM 314 Heavy Civil Construction Management
  - Earthwork calculations including cut/fill
  - Site logistics such as equipment selection, placement, operation, and hauling routes
  - Crane positioning and working ranges
  - Drilling, blasting, and pile location

- CM 421 Emerging Trends: Unmanned Aerial Systems (UAS)

- Future possible course development in Advanced Construction Surveying Technologies

Conclusion

During the course of this project, it was determined that drone technology has become more and more prevalent in the construction industry and does not show any sign of being phased out by technological innovation. On the contrary, it is something that will be continued to be used for more innovative ways to solve various construction issues in all sectors. Whether it be residential, commercial, heavy civil, architect/engineer, or Virtual Design Construction all these sectors can implement drones for various purposes which ultimately result in a better project delivery. Drones are just one main component of Unmanned Aerial Systems (UAS) and the UAS technology has come a long way in recent years, allowing companies to do things such as measure 3D site surveys, assess visual site timelines, access survey data with ease, create and analyze 2D orthomosaic site maps, 3D photogrammetric models, and much more. Companies that have been early adopters to this technology are able to use these benefits to their advantage and create an environment that challenges their employees to solve increasingly challenging projects with innovative solutions. It should come to no surprise that the large majority of industry professionals that were surveyed overwhelmingly supported the idea of implementing UAS technology in the Cal Poly CM department. With the total cost of implementing UAS technology being just over $3,000 for the mentioned capable drone, Skyward Software, and necessary training/licenses this seems like a cost that the department could be able to invest for the improvement of the department and benefit of all those involved. The largest cost would be the one-time purchase of the drone, which should last for many years to come with proper care and maintenance. And with several courses that are able to adopt a learning module on the topic, this is something that would be valuable in training CM graduates to be superb in the field, as incorporating the topic into the curriculum would not require a complete overhaul of any material or course already being offered.
References

“Commercial Drone Software & Services.” Skyward, 24 May 2021, skyward.io/.


