

Drone Assessment of Potential Rooftop Failure from Snow Loads: A Business Model

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CEE 797 Team 6

04/24/2020

Team Members

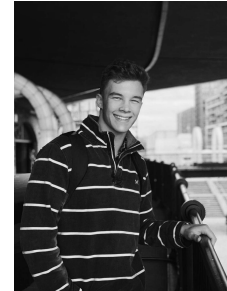
Brinton Dekreon



Jacob DeLashmutt (PM)



Daniel Marek



Faculty Advisor: Dr. Jennifer Jacobs Mentors: Adam Hunsaker, Aidan Short

Project Background

Continuation of a project that began September 2018

Objective:

To develop a business plan approach concerned with how snow load inspection/analysis services could be applied to business and institutional stakeholders.

Project Deliverables and Scope of Work

Research & License



Building Codes

FFA Part 107 License

Computer Modeling



Baseline vs. Snow

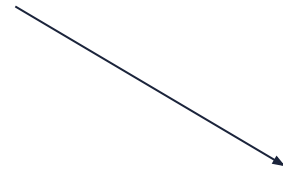
Load Analysis

Business Strategy



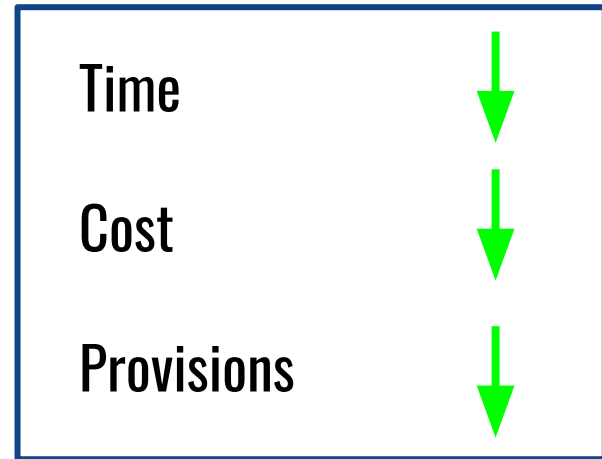
Service Pricing

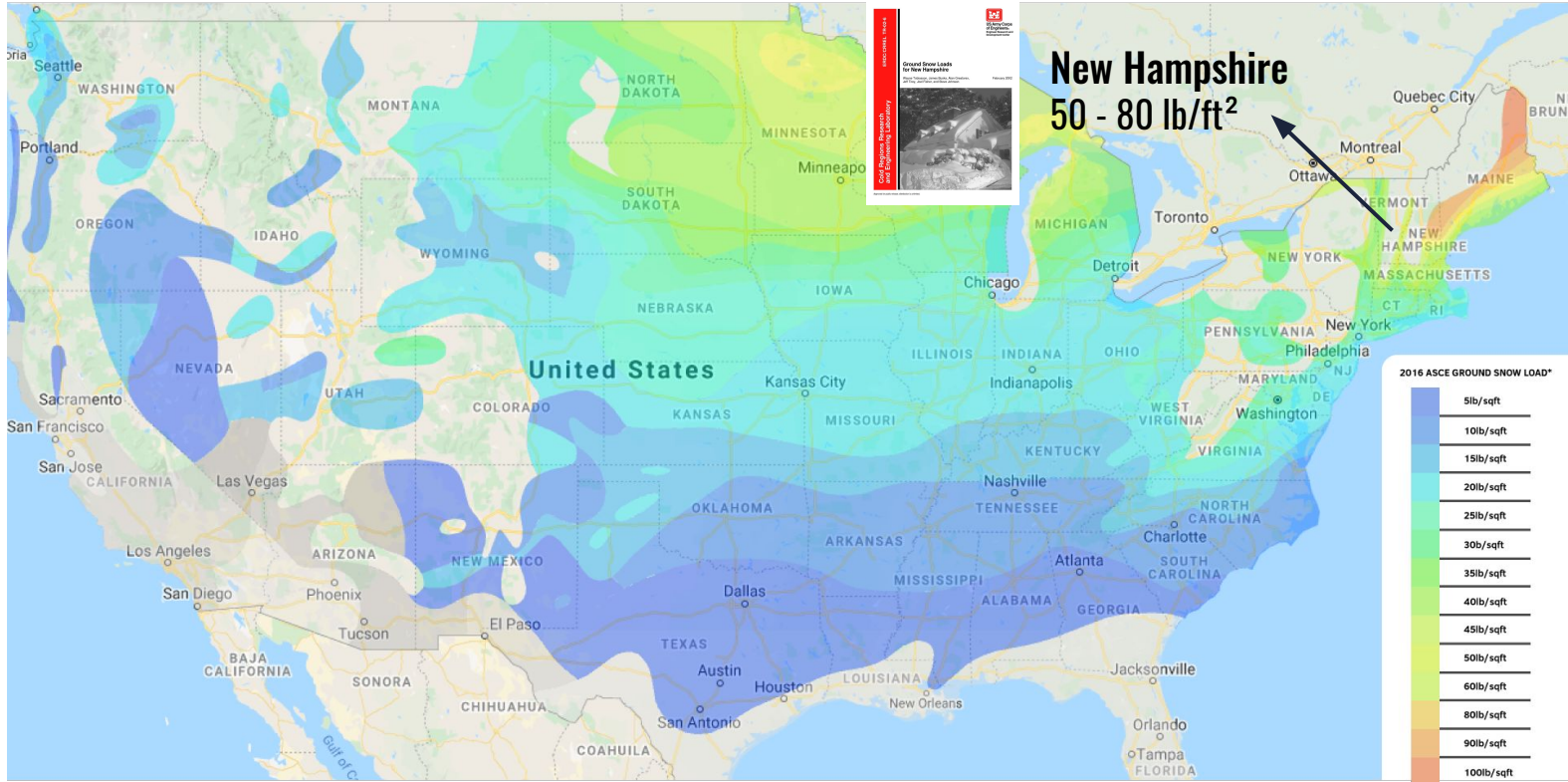
Financial Analysis



DJI Phantom 4

Use of Drones in Construction





Maps of ground snow loads in IBC and in ASCE 7 indicate a 2 percent probability of the indicated load being equaled or exceeded in any given year.

Flat Roof Snow Load

$$P_f = 0.7 \times C_e \times C_t \times I_s \times P_g$$



P_f = Flat Roof Snow Load

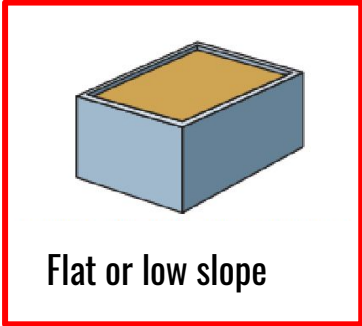
C_e = Exposure Factor

C_t = Thermal Factor

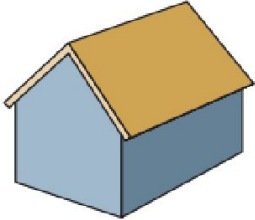
I_s = Importance Factor

P_g = Ground Snow Load

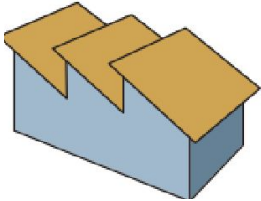
Roof Types



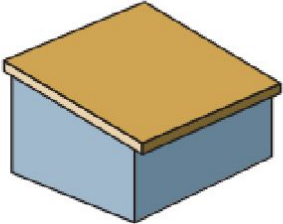
Flat or low slope



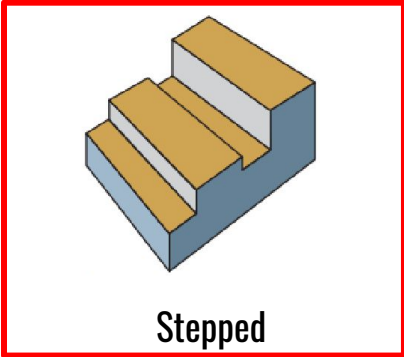
Gable or Multispan



Sawtooth



Monoslope



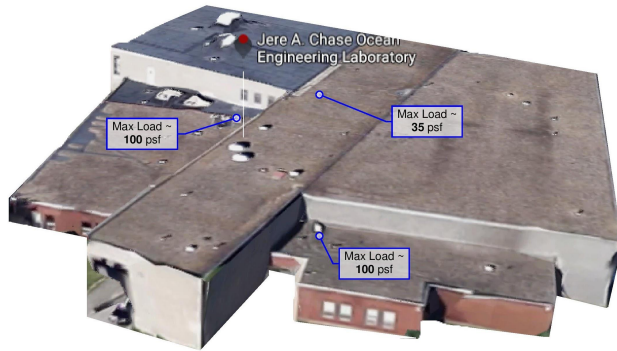
Stepped



Computer Modeling

Case Study

Theoretical Analysis of Chase Ocean Engineering Laboratory



Why Chase?

- Flat Roof with varying elevations
- Required to take into account snow drift

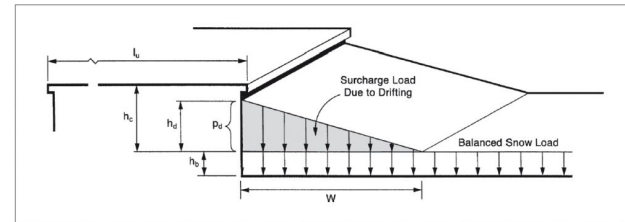
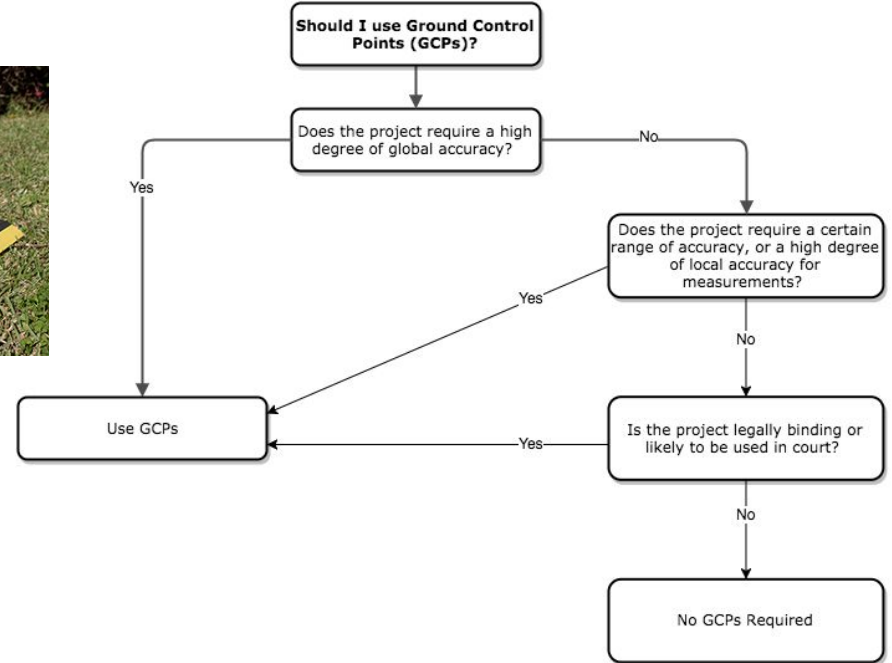
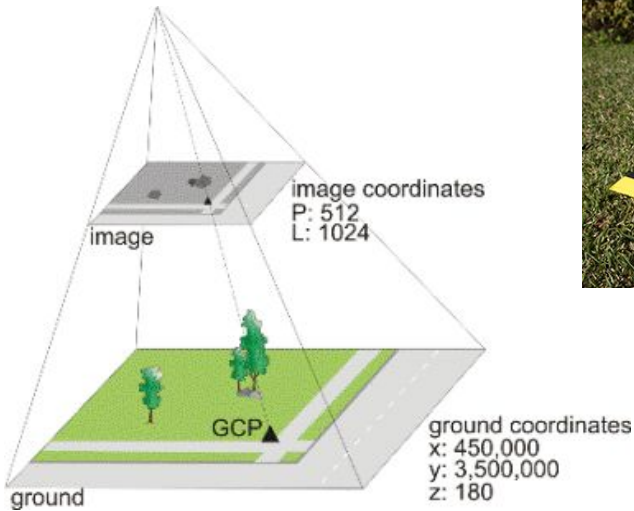


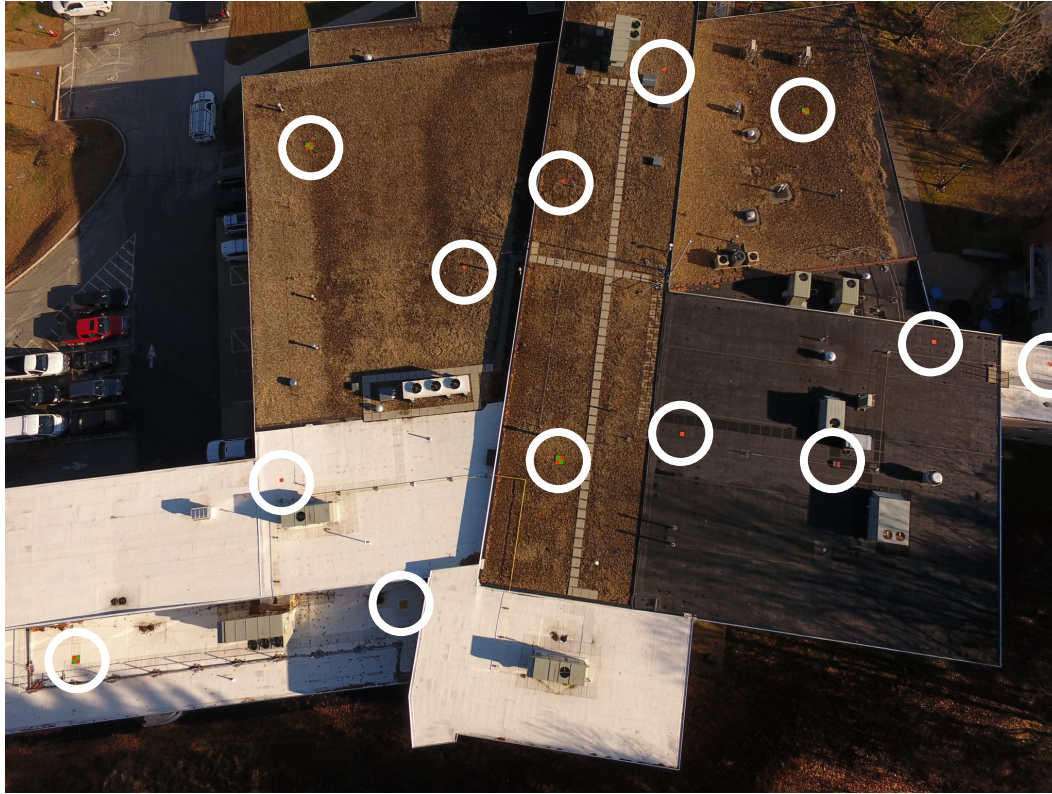
FIGURE 7-8 Configuration of Snow Drifts on Lower Roofs.

Use of Ground Control Points (GCPs)



GCPs on Chase





Modelling Workflow

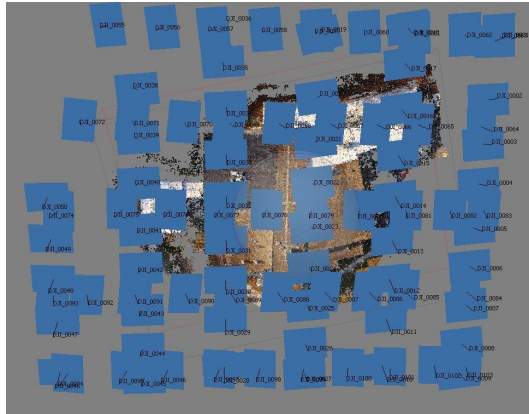
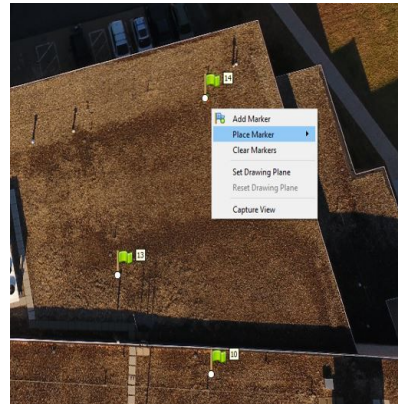
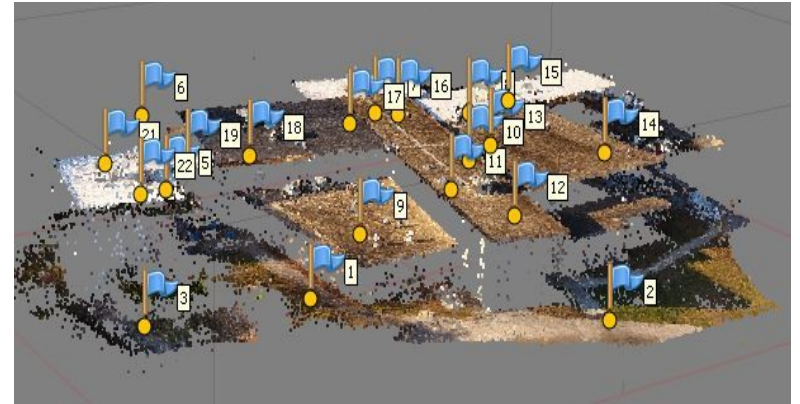


Photo Alignment



Placing Markers



Optimizing Alignment

Modelling Workflow



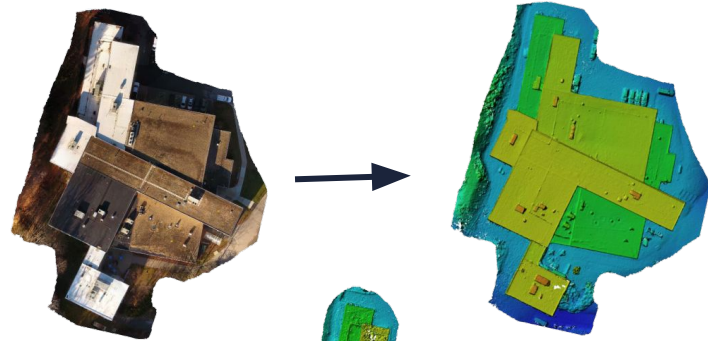
Dense Point Cloud



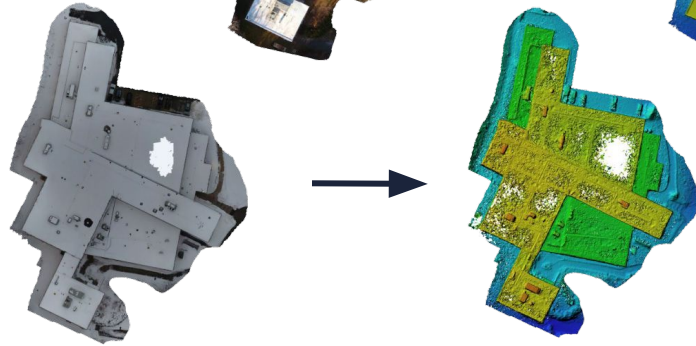
Adding Texture & Mesh

3D Modelling

Pre-Snow

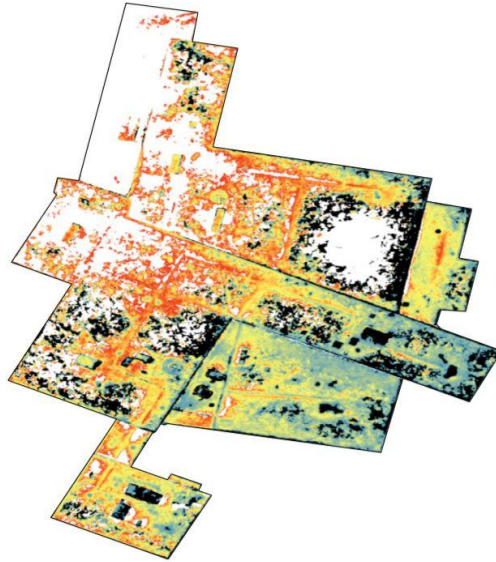
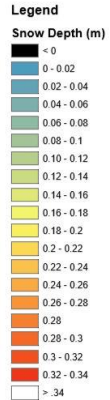


Post-Snow

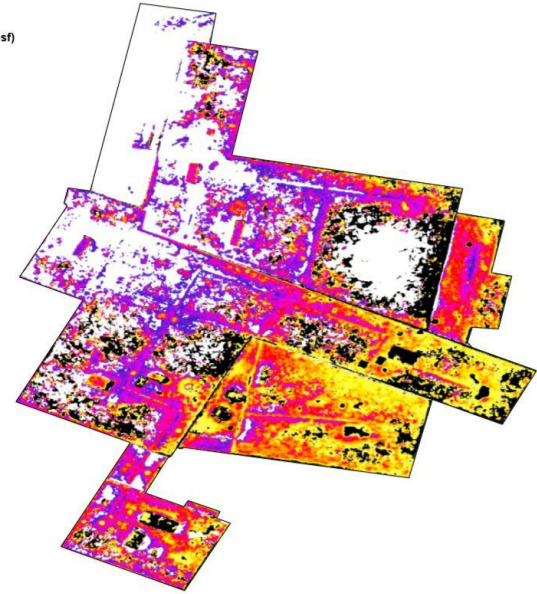
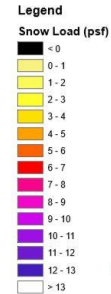


Model Results

Snow Depth (m)

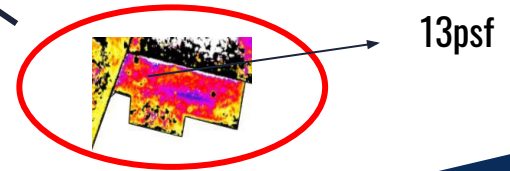
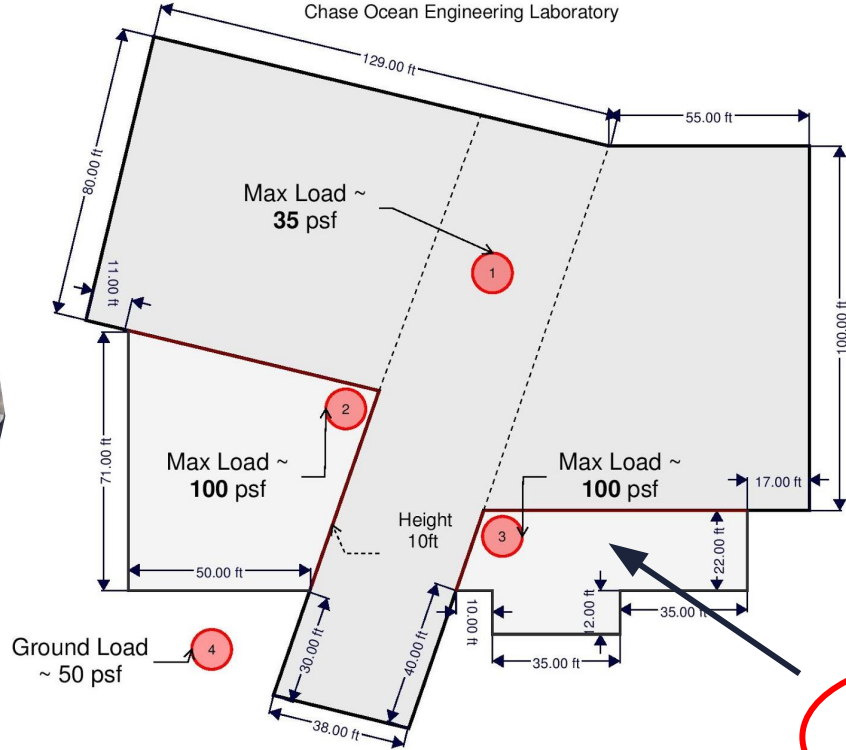
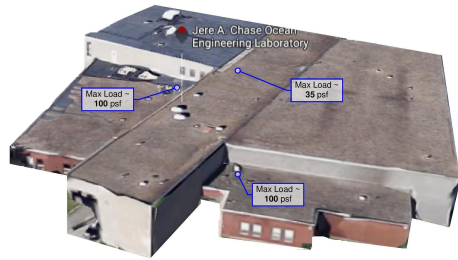


Snow Load (psf)



Calculated Snow Loads (ASCE 7-10)

Chase Ocean Engineering Laboratory

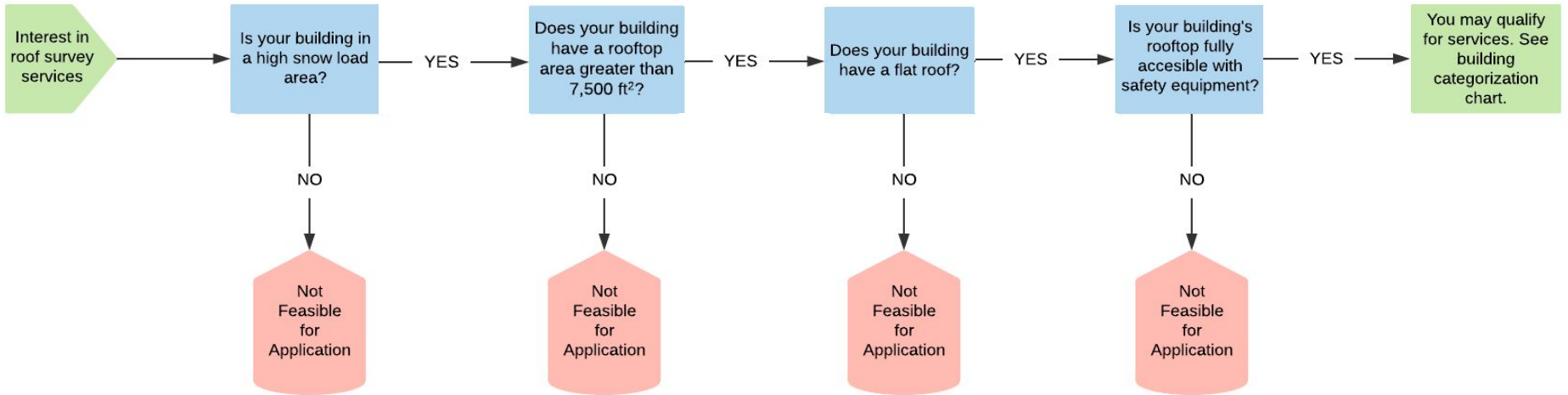


Business Strategy

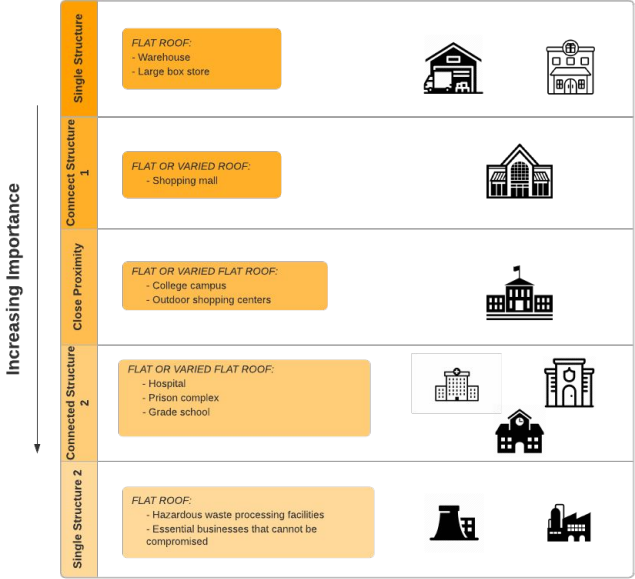
Building Categorization

- Building must meet standards for survey
- Based on building use, location, roof type, etc.
- Parameters outlined by following flowchart and categorization chart

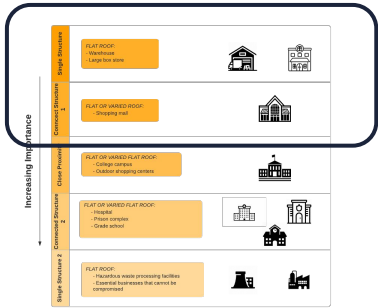
Protocol Flowchart



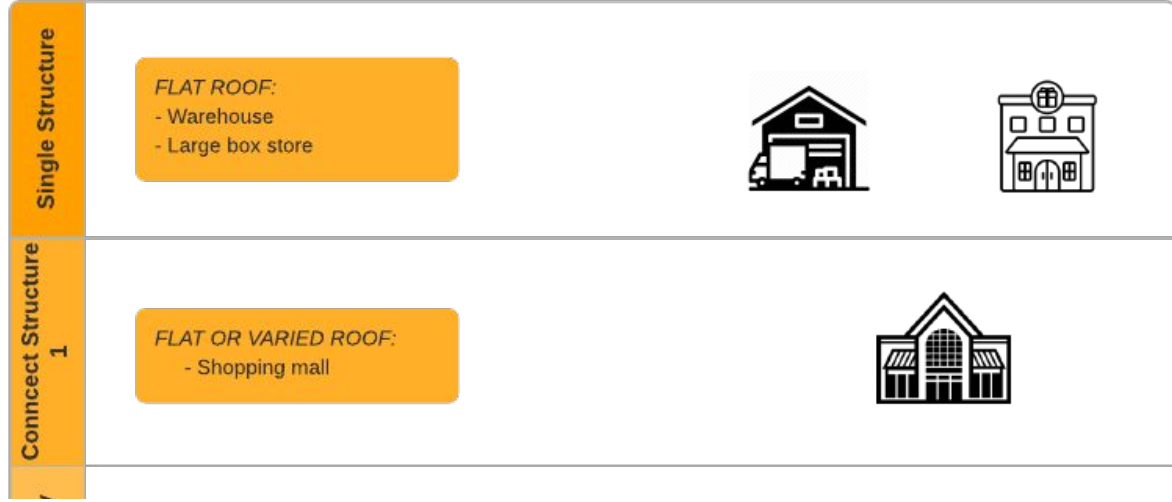
Building Categorization Chart



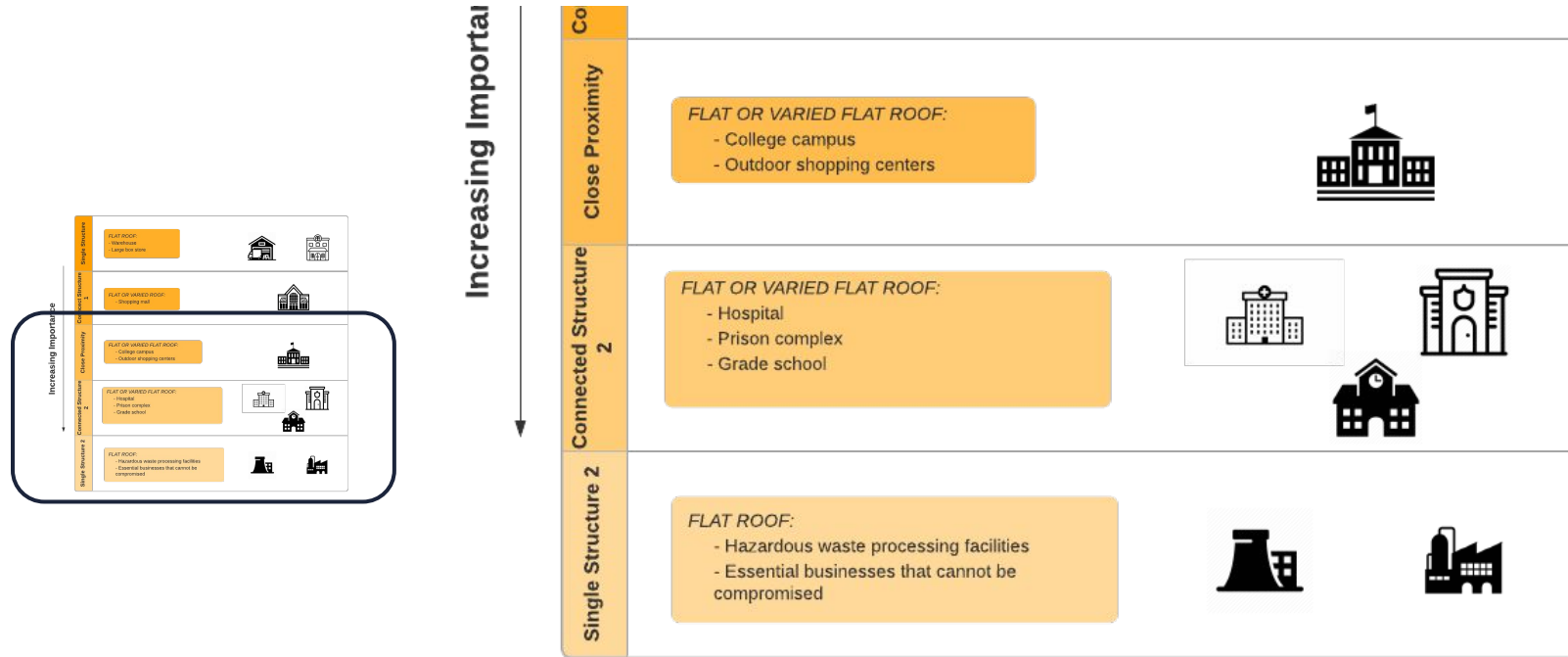
Building Categorization Chart



Importance



Building Categorization Chart



Interviews



Peter Kalaitzidis
Easy Aerial Inc.

“Drones are amazing, but what drones do is **replace** the human **eyes... not the skill of the human**”.



Sargeant Eric Bourn
UNH Patrol Sergeant & County Drone Unit

“People often **lack** the **technical knowhow** to protect their buildings against **subtle** issues associated with snow”.

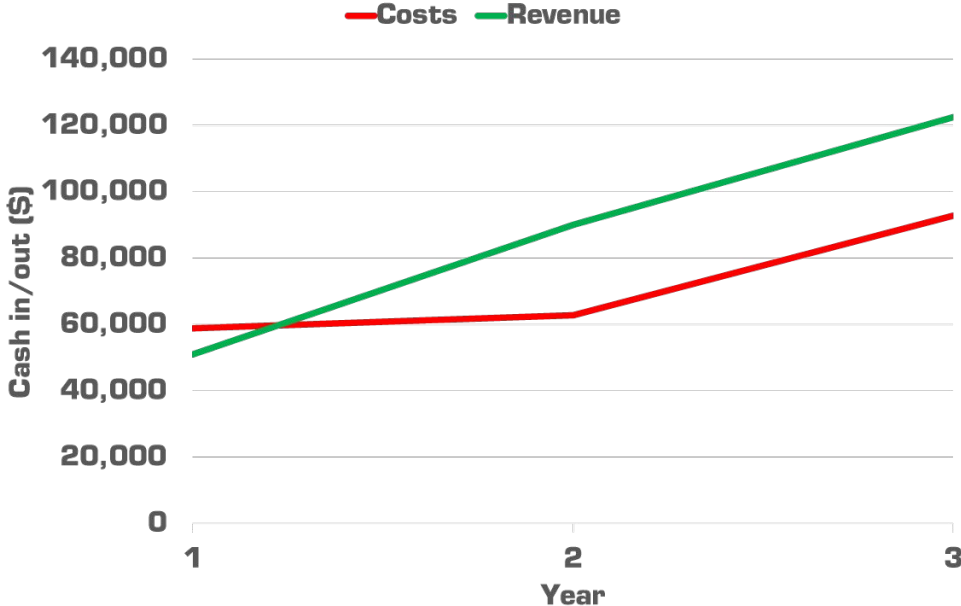
Services & Pricing



Financial Assessment

Year	Costs	Revenue	Overall	Profit
1	\$58,787	\$51,000	-\$7,787	-\$7,787
2	\$62,870	\$90,000	\$27,130	\$19,343
3	\$92,870	\$122,400	\$29,530	\$48,873

Break-even Analysis (3 yr)



Financial Takeaways

Operations



6 Months/yr

Breakeven



16 Months

Profit



\$50,000

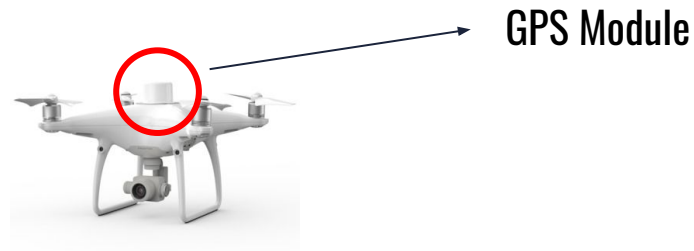
Obstacles Encountered

- Obtaining drone license
 - FAA Part 107 sUAS exam
- Gaining roof access
 - Building approval
 - UNH Health and Safety training
- Weather restrictions
- COVID-19



Alternatives Considered

- When calculating design capacity - Use architectural/structural drawings
- For flights - DJI RTK - eliminates need for as many GCPs



Conclusions

Is there a problem?



Is there a reasonable solution?



Achieve sustainable growth?



Recommendations

Existing Roofing Company:



Snow Load Drone Company:



Thank you for your time

Q&A

- **Could you provide me with more detail about how the costs of the business have been included?**
 - **What are some of the assumptions you have made about revenue and growth?**
 - **How many clients, what type of clients and what level of service?**

Year 1		<i>Average Roof Size</i>		10,000 sqft		
Type of package	Time Req (days)	Number of days allocated	Number of Jobs	Fee per ft2	Revenue per Month	Revenue Per Season
Basic	1	5	7	\$0.05	\$3,500.00	\$21,000.00
Premium	2	4	2	\$0.15	\$3,000.00	\$18,000.00
Premium +	3	3	1	\$0.20	\$2,000.00	\$12,000.00
	Total:	12			Total:	\$51,000.00
Year 2		<i>Average Roof Size</i>		15,000 sqft		
Type of package	Time Req (days)	Number of days allocated	Number of Jobs	Fee per ft2	Revenue per Month	Revenue Per Season
Basic	1	5	7	\$0.05	\$5,250.00	\$31,500.00
Premium	2	6	3	\$0.15	\$6,750.00	\$40,500.00
Premium +	3	3	1	\$0.20	\$3,000.00	\$18,000.00
	Total:	15			Total:	\$90,000.00
Year 3		<i>Average Roof Size</i>		17,000 sqft		
Type of package	Time Req (days)	Number of days allocated	Number of Jobs	Fee per ft2	Revenue per Month	Revenue Per Season
Basic	1	5	7	\$0.05	\$5,950.00	\$35,700.00
Premium	2	6	3	\$0.15	\$7,650.00	\$45,900.00
Premium +	3	6	2	\$0.20	\$6,800.00	\$40,800.00
	Total:	17			Total:	\$122,400.00

Q&A

- **Your pricing seems problematic, a 10,000 sq ft building would cost \$500 to fly, does that cover your own costs?**

Startup Budget				
Estimated Startup Expenses	\$51,197.00			
Estimated Losses	\$7,590.00			
Total Estimated Budget	£58,787.00			

Startup Expenses				
Expense	Category	Budget	Padding	Total
Domain name	Non-Essential	\$20.00	10%	\$22.00
Squarespace- annual	Essential	\$250.00	10%	\$275.00
Logo + Brand identity	Non-Essential	\$1,000.00	10%	\$1,100.00
DJI Inspire 2 (Used in good condition)	Essential	\$3,750.00	10%	\$4,125.00
DJI Zenmuse XT (Thermal Imaging Camera)	Non-Essential	\$3,500.00	10%	\$3,850.00
FAA Test Preperation Course	Essential	\$300.00	10%	\$330.00
FAA Remote Pilot Certification Testing Fee	Essential	\$150.00	10%	\$165.00
Liability Insurance	Essential	\$1,000.00	10%	\$1,100.00
Extended Warranty Drone Plan	Essential	\$300.00	10%	\$330.00
Agisoft MetaShape Professional Software	Essential	\$3,500.00	10%	\$3,850.00
ArcGis Drone2Map Software - annual	Essential	\$1,500.00	10%	\$1,650.00
ArcGis Creator Package - annual	Essential	\$500.00	10%	\$550.00
LLC filing fees	Essential	\$850.00	10%	\$935.00
Business Cards	Non-Essential	\$50.00	10%	\$55.00
QuickBooks Online	Non-Essential	\$0.00	10%	\$0.00
High Performance Computer (iMac)	Essential	\$2,000.00	10%	\$2,200.00
Backup Drive- 4 TB	Essential	\$100.00	10%	\$110.00
Other Technical Supplies	Essential	\$500.00	10%	\$550.00
One Person Wage	Essential	\$30,000.00		\$30,000.00
Total Estimated Startup Costs		\$49,270.00		\$51,197.00

First Season of Operations Costs Budget

Monthly Overhead Expenses		Category	Budget
Car/ Transport		Essential	\$1,000.00
Equipment Maintenance		Essential	\$100.00

Transport & Maintenance per month

10% Padding on all costs

Incl. Marketing, IT, Equipment, Insurance, Software and Other fees

First Season of Operations Revenue Snapshot

Year 1		Average Roof Size	10,000 sqft			
Type of package	Time Req (days)	Number of days allocated	Number of Jobs	Fee per ft2	Revenue per Month	Revenue Per Season
Basic	1	5	7	\$0.05	\$3,500.00	\$21,000.00
Premium	2	4	2	\$0.15	\$3,000.00	\$18,000.00
Premium +	3	3	1	\$0.20	\$2,000.00	\$12,000.00
	Total:	12			Total:	\$51,000.00

*Prices shown are an estimate only and based on a typical commercial building with roof area of 10,000ft2 and do not include any additional expenses incurred i.e. Travel

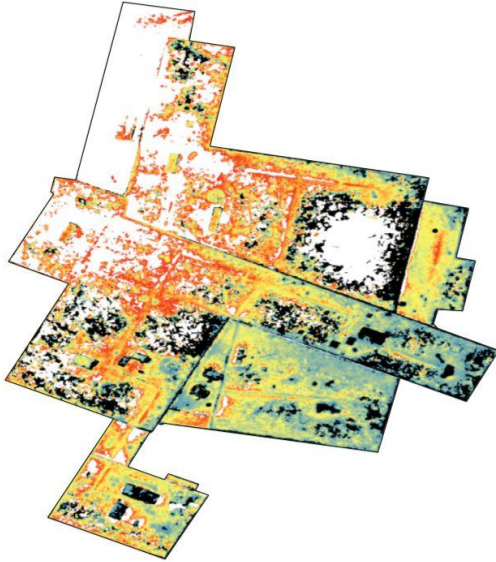
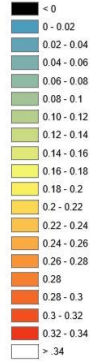
Q&A

- In the Case Study, your results seem to indicate that the snow depth and loads, even under these modest snow amounts vary across the roof. Can you explain those variations.
 - Do those areas that have much deeper snow match where you think the snow should be deeper?
 - Did you find there were any snow drifts?
 - Does the highest load appear to match the highest design loads, if not, why?

Model Results

Legend

Snow Depth (m)



Legend

Snow Load (psf)

