Enhancing the Response Time of the Nantucket Fire Department

An Interactive Qualifying Project
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By:
Alex Pappas
Aidan Lippert
Dongsheng Sun
Jasmine Loukola

Report Submitted to:

Professor Jiusto
Professor Looft
Worcester Polytechnic Institute

Paul Rhude
Nantucket Fire Chief

Peter Morrison
Nantucket Demographics Expert

Project Webpage: https://wp.wpi.edu/nantucket/projects/projects-2016/fire-dept/

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Introduction

> "People pay a lot of money to live here on the island, they deserve to have the best quality of emergency services possible" (Rhude, 2016)

The island of Nantucket has one active fire station servicing over 10,000 year-round residents. Fire Chief Paul Rhude is new to the island of Nantucket, having only spent one year here. However, he has made strides toward hiring more staff, creating policy change concerning public safety, and enforcing national standards on a department which had previously tended toward outdated standards. One important policy change that Chief Rhude implemented was that sirens and lights no longer need to be employed when responding to automatic alarms, hoping to reduce car accidents caused by people trying to get out of the way of emergency vehicles.

Fire organizations work hard to keep communities safe every day. Fire stations not only provide fire suppression services, they also handle medical calls and other emergencies. Response time is one key metric which measures the effectiveness of a fire department. The response time of a fire department is defined as the length of time from when a call is dispatched to when fire personnel and equipment arrive at the scene. The national standard for fire response time is five minutes. It was found that the Nantucket Fire Department (NFD) is only meeting the 5-minute national standard 39% of the time. In 2014, a WPI IQP team investigated the causes of Nantucket's extended response time. According to their research, one of the causes is that direct paths to a scene from the fire station are often unavailable due to traffic, congestion, and limited staffing at the station (Brecher et al., 2014). Limited staffing can make it nearly impossible to respond to emergencies, because there are often concurrent calls with only enough staff to respond to one call at a time. Additionally, the 2014 team noted that traffic is a more significant problem in the summer, when there is a significant swell in population due to tourists.

> "The national standard for response time is 5 minutes for 90% of calls with an additional 1 minute for gathering equipment" (NFPA 1710, 2015).

The purpose of this project was to assist the Nantucket Fire Department in reducing its call response time by exploring staffing and housing issues, station locations, and their dispatch information system. Currently, the NFD is understaffed, overworked, and hence out of compliance with the national response time standard (Table 1). In Nantucket, each firefighter handles nearly double the calls per person than the commonwealth average.

	National Standard	Commonwealth Average	Current NFD	Proposed Changes
90% of calls	5 mins	--	12 mins	< 9 mins
Annual Calls/Person	--	123	258	< 200

Table 1: Comparison of NFD to Standards

Our team offered the NFD four recommendations that each address a specific problem. In combination, these recommendations provide mutual aid, increased staffing, and better response decision making, which all culminates in a lowered response time. The goal for these recommendations is to reduce response time and improve overall emergency performance, leading to a safer, more secure community. The four recommendations are as follow:

1. **Refine the dispatch information system:** In order to perform useful analysis on call data, it first must be cleaned of anything that is not time sensitive or an emergency call. By refining the system used to record calls, no data cleaning would be necessary. If this process is streamlined, automatically cleaning calls when they are placed, then analysis can be performed immediately, and no resources would be wasted on manually cleaning the data.

2. **Implement a dynamic deployment system:** Adding a dynamic deployment vehicle in the downtown area would help decrease response time in the downtown area. Additionally, it could tailor responses more towards the medical aspect of calls. Calls from downtown scenes constitute 60% of calls, and 45% of those calls are medical. By adding dynamic deployment vehicles downtown, the quality and speed of those calls would increase.

3. **Pursue the Siasconset station renovation:** The renovation of the Siasconset station not only helps improve response times in the Siasconset area, but also helps to lower the insurance ratings of the 2,328 buildings outside of the service radius of the proposed new fire station at 4 Fairground Road. Insurance rates are based off of a buildings' proximity to a fire station, which is explained further in the recommendations section. By utilizing the station in Siasconset, vehicles would not have to drive through the congested downtown area before they respond to emergencies on the eastern end of the island.

Develop the response time simulation into a program: Our team developed a response time simulation, taking into consideration many factors of an emergency call. This program considers that all of our previous recommendations have been implemented. It uses dynamic deployment and the Siasconset station as two additional stations. Not only will the program tell the operator which station to deploy personnel from, but it will also determine the fastest route to a scene.

Methodology

The purpose of this project was to assist the Nantucket Fire Chief in reducing and improving the response time and the quality of performance of the Nantucket Fire Department by exploring all avenues for improving response efficiency such as providing housing for hiring additional fire personnel, enhancing firefighter training, adding or staffing additional fire station locations, and exploring other options for non-full time fire personnel.

Objectives and Methods:

1. **Dispatch Call Information Data Analysis and Quality Control:** Accessed and prepared the NFD's call data to analyze key trends in emergency response performance.
2. **Assess current response time and readiness of the Nantucket Fire Department**.
3. **Identify and interview different stakeholders to gain insight on opinions of the response time and potential ways to reduce the response time for the Nantucket Fire Department**: Interviewed key personnel for specific insights in their perspective fields.
4. **Study and assess potential solutions to reduce the NFD response time**: Researched other similar islands to figure out how they operate their various stations.
5. **Perform cost analysis on combinations of options to improve response time**: Insurance quotes were received from various companies and we calculated how much money can be saved by implementing our recommendations.
6. **Provide detailed recommendations to the Fire Chief of the Nantucket Fire Department**: Created recommendations based on our research and results.

Response Time and Staffing Standards

Response time is defined as the length of time from when a call is dispatched to when the fire department staff is on the scene. Fire department standards are set by an annual colloquium of fire chiefs and fire prevention analysts that are then summarized in multiple texts, including the National Fire Protection Agency's (NFPA) guidelines (NFRIS, 2010). These standards were the basis of this project analysis. For response time, the relevant NFPA standards are numbers 1710 and 1720, which are not legally binding, but are tracked by the state and other review bodies. These standards call for:

- 5-minute response time for 90% of calls
- 4-person minimum on 90% of calls for fires
- 3-person minimum for Basic Life Support (BLS): BLS is a level of medical care which is used for victims of life-threatening illnesses or injuries until they can be given full medical care at a hospital. It can be provided by trained medical personnel, including emergency medical technicians, paramedics, and by qualified bystanders (NFPA, 2015).

- 4-person minimum for Advanced Life Support (ALS): ALS, also known as the Paramedic level of medical emergency services, is a set of life-saving protocols and skills that extend Basic Life Support to further support blood circulation and provide an open airway and adequate ventilation (NFPA, 2015):
    - The department must deploy sufficient resources to arrive within an 8-minute response time to 90 percent of all ALS incidents.
    - Minimum of two members trained at ALS level and two trained at the BLS level for all ALS calls.
    - ALS personnel need to complete over 3000 hours of rigorous life support training.

Dispatch Information System Data Analysis and Quality Control

Fire departments alert emergency personnel to respond to calls and record the detailed statistics of each call using a dispatch information system. The system used by the NFD is based out of the joint-dispatch at the police station, and is a program licensed to the department. The program currently in use on Nantucket is in active development, and updates are frequent. It is unknown if there are cloud-storage capabilities, but this topic was discussed as potentially advantageous because data would not be deleted in the case of a power outage.

Over the years, fire stations have evolved, broadening the types of calls handled. Fire departments now respond to much more than just fires. National organizations, such as the Federal Emergency Management Agency, have created a comprehensive code system to keep track of fire departments' responsibilities (NFRIS, 2010). All calls are designated a code from 100 to 900 depending on the broad nature of the call (Table 2). Calls are then further broken up into more specific subcategories.

SERIES	HEADING
100	Fire
200	Overpressure Rupture, Explosion, Overheat (No Fire)
300	Rescue and Emergency Medical Service (EMS) Incidents
400	Hazardous Condition (No Fire)
500	Service Call
600	Good Intent Call
700	False Alarm and False Call
800	Severe Weather and Natural Disaster
900	Special Incident Type

Table 2: Dispatch Incident Codes

At end of 2013, the NFD dispatch moved from the fire station to a joint-dispatch at the police station. Additionally, in 2014, the measurement of response time was redefined as the time from dispatch to arrival on scene. The previous definition of response time was between the time of

alarm to arrival on scene to match the national standards. Figure 1 shows the difference between response times when using the two different metrics.

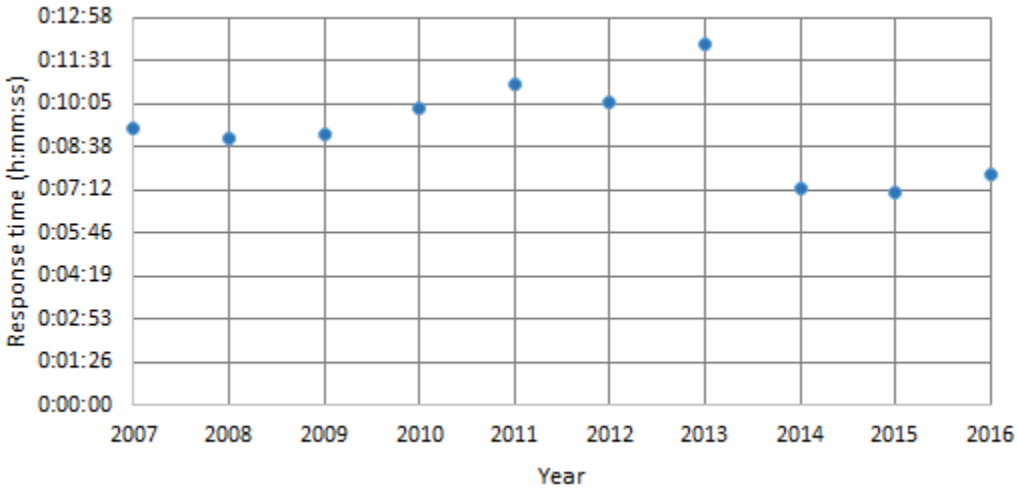

Figure 1: Average Response Time 2007 to 2015

Data Preparation and Cleaning

After understanding how incident codes operate, the call logs were cleaned, meaning that the call data was refined to only include certain calls. The system for recording call times is not automated, meaning that the data is prone to human error. Whether operators start calls too early, or end calls too late, there are errors and outliers in the data which may affect analysis of the response time. The following information outlines the steps in deleting unnecessary data:

1. **Delete any bad data points:** Due to either human or system error, the dispatch system was filled with incorrect data points, such as 0-minute call responses, and 30-minute call responses, as well as some two-hour call responses. According to various fire personnel, many calls above 30 minutes or calls recorded as 0 minutes are inaccurate. While some calls do last above 30 minutes, the frequency of those calls is very rare. These data points skew not only average response time, but also the standard deviation. Thus, we determined that they should be deleted to maintain accuracy.

2. **Delete data that is not time sensitive or considered an emergency to respond to**: Certain call types are not time sensitive cases or emergencies. For example, 900 type calls are citizens' complaints, and a 462 call is an aircraft standby. Neither of these call types are affected by the speed of response. For our analysis, they were removed from the data pool.

Data Preparation Outcome: By correcting the data and deleting roughly 500 calls, the quality of the data improved. As previously mentioned, by taking out inaccurate data points and non-time sensitive calls, the standard deviation of the data decreased (Table 3). When the standard deviation decreases, the data values get closer together, which suggests that the data is more accurate and reliable.

		Response Time		
	Total Calls	Average	Median	Deviation
Original	3122	7:06	6:09	5:56
Clean	2734	7:12	6:21	4:06

Table 3: Summary of Cleaned Data for 2015

Findings

In this section, an analysis of emergency response was developed, first by sharing basic insights into the volume and types of calls, then by describing what was found in terms of staffing, facilities, dynamic deployments, and response time simulation script.

Call Volume and Type Findings:

1. Response time is currently defined in the NFPA standards as the time from dispatch to arrival on scene of an emergency.
2. The annual total of emergency calls to the NFD is increasing.
3. Medical and false alarms make up about 80% of the calls.

The first factor impeding emergency response is simply that the number of calls has increased by 32% from 2007 to 2015 (Figure 2).

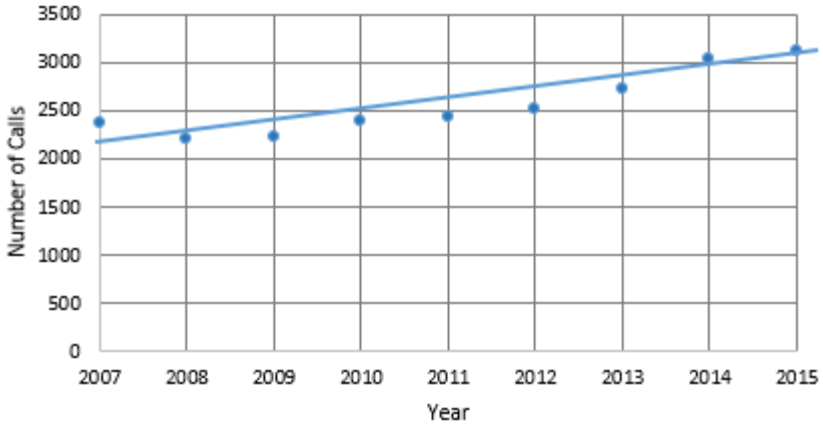

Figure 2: History of Call Volume with Trendline from 2007 to 2015

Next, we examined the trend over time in each incident type (Figure 3), which shows that the number of medical calls and false alarm calls have risen steadily since 2007, reaching 45% and 37% of calls respectively. This upward trend in calls is largely responsible for the overall rise in calls since 2007 and indicates these two incident types have increased by about 400 calls within nine years. Other incident types make up a smaller percentage of all emergency calls, which makes them have a smaller impact on total response time.

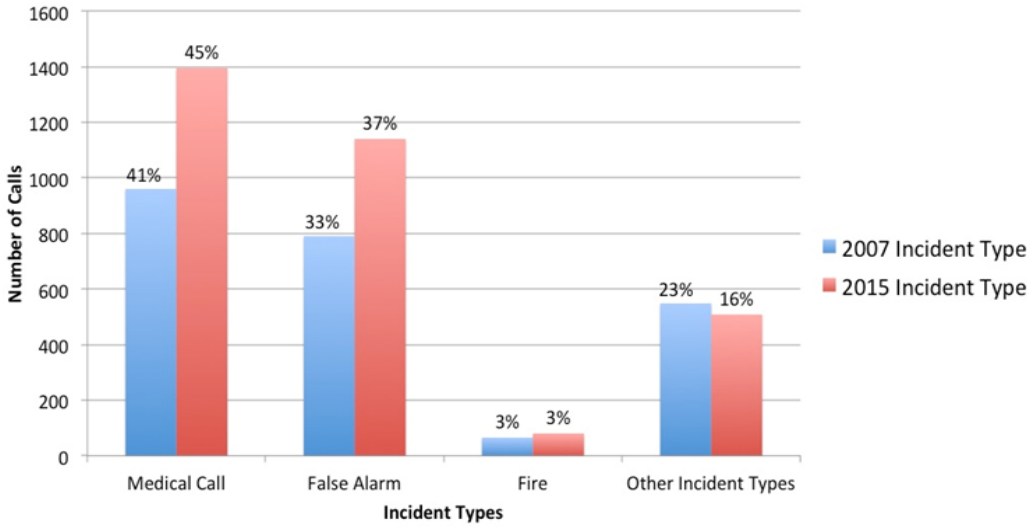

Figure 3: Incident Types in 2007 versus 2015

The data collected is from calls all over the island (Figure 4). The densest call area is downtown, including 60% of the emergency calls. The second densest area is Siasconset. If there is an emergency call in the Siasconset area, it typically takes over ten minutes to respond due to the location of the centralized station. There are 60 calls per month in the Siasconset area in the

summer and 30 calls per month in the winter. The current staffing situation in Nantucket is inadequate, which makes getting to the outer parts of the island difficult, especially when concurrent calls occur and there are not enough personnel on duty.

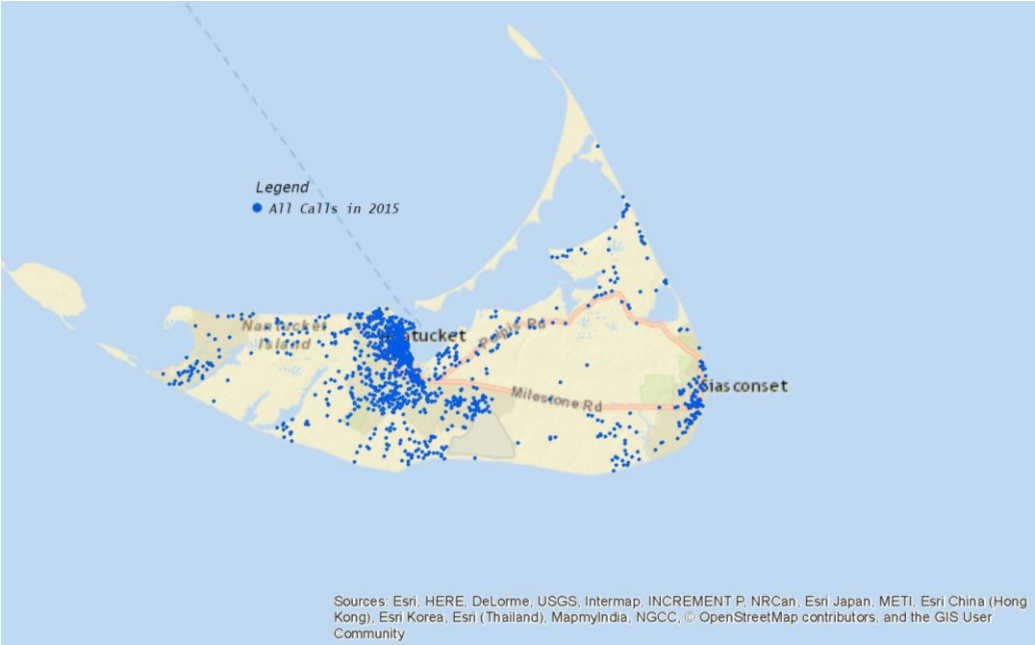

Figure 4: Location of all calls in 2015

NFD Staffing: 2016 & Beyond:

The single most important cause of the NFD being out of compliance with national emergency response standards is inadequate staffing. Not only is the department short on staff, but they also respond to nearly double the calls per person compared to the rest of the commonwealth (Table 4). This is partially due to their total lack of staffing, but also because of their small personnel shifts (Table 5).

	Commonwealth Average	Current NFD	Proposed Changes
Annual Calls/Person	123	258	<200

Table 4: Average Calls per Person

As previously mentioned, the standard response for fire is four people, and the response for medical is three people. In the winter, the NFD cannot respond to a fire call because they only have three people on duty at a time (Table 5). This problem does not touch upon concurrent

calls. The department barely has enough people to respond to one call, let alone respond to many calls at once. The following list outlines our team's findings concerning staffing in the NFD:

1. **Understaffing is due largely to lack of housing:** Housing on the island is both expensive and hard to find. The average firefighter on Nantucket makes around $64,045 a year (Salary Genius, 2015). Even with this amount of money, finding housing is still a challenge due to various reasons.[1]

2. **The NFD is currently working to increase their staff:** Four paramedics and four firefighters are proposed to be hired by the NFD in 2017. Some fire departments are reducing the number of career firefighters and adding volunteers, because the cost of two volunteers is about the same as one career firefighter (Beutner, 2012). Other communities and fire departments recruit college students to be volunteer firefighters (Beutner, 2012). The NFD has been actively exploring such creative, less expensive staffing options.

3. **The Town is negotiating the creation of an ALS level job under the NFD union contract:** The NFD's current union/town contract expires in 2017. With their previous contract expiring, this leaves the opportunity to add in new ALS jobs in their contract.

4. **On-call personnel are now alerted and asked to report to the station when the on-duty emergency personnel are out of the building:** Before this policy was enacted, the fire department only contacted on-call personnel when a concurrent call was logged. This new policy alerts on-call staff as soon as the on-duty personnel leave the station. The policy seems to contribute to the change in the response time trends for concurrent calls because it cuts out the time required for the on-call staff to get to the station before they deploy.

[1] There is another IQP team working on affordable housing. To find out more in depth information on the Nantucket Housing Crisis, visit http://wp.wpi.edu/nantucket/projects/projects-2016/town-managers-office/

		2016	Proposed
Amount of Personnel	Full-Time Personnel	24	32
	Call Personnel	17	17
	Total Personnel	41	49
	Seasonal Personnel	0	16
Shift Size	On Duty Summer	4	9
	On Duty Winter	3	5

Table 5: Current vs Proposed Personnel Analysis

Facilities and Resources

The NFD has all of their resources (Table 6) located together in the downtown area. They used to have their facilities spread out across the island, but now they deploy out of a central station where all of the most essential equipment is stored. The following list outlines our team's findings concerning facilities and resources.

1. **The NFD is operating out of one centralized location:** The fire station currently deploys out of a central station in the downtown area (Figure 5) and will be moving to the new station at 4 Fairgrounds, combined with the police station, once plans are approved.

	Amount
Engines	5
Tankers	2
Ladder Trucks	1
Ambulances	4
Specialty Units	3
Boats	0
Helicopters	0

Table 6: Current NFD Resources

2. **The NFD has two inactive satellite stations:** The NFD used to have three active stations, but now they only have one (Figure 5). The satellite stations on either end of the island are different sizes and serve different purposes. The Madaket station is a shed that acts as a garage bay for an old fire truck. The Siasconset station is larger, housing two garage bays, a basement, and land with room for additions on the back and sides of the building. Additionally, there is a NFD owned vehicle on Tuckernuck for any emergencies that occur in that area. However, due to the lack of department personnel, the keys are simply left in the truck for use by the residents of Tuckernuck during an emergency.

3. **Siasconset Station Reopening:** The Siasconset station is large and in a convenient location to help decrease response time. Since there is space for potential additions, we recommend that the new station include 24/7 bunk rooms for on-duty members. Not only is there space for on-duty members, but this renovation would also include a bunk room for off-duty and seasonal members. There are a few challenges to renovating this historic station, but the renovation plans and benefits will be discussed in more detail in our recommendations section.

⇨ 5 feet of setback is needed on the sides and rear of the property to comply with Nantucket zoning laws ⇨ Only 50% of the land can be built on

Table 7: Current NFD Resources

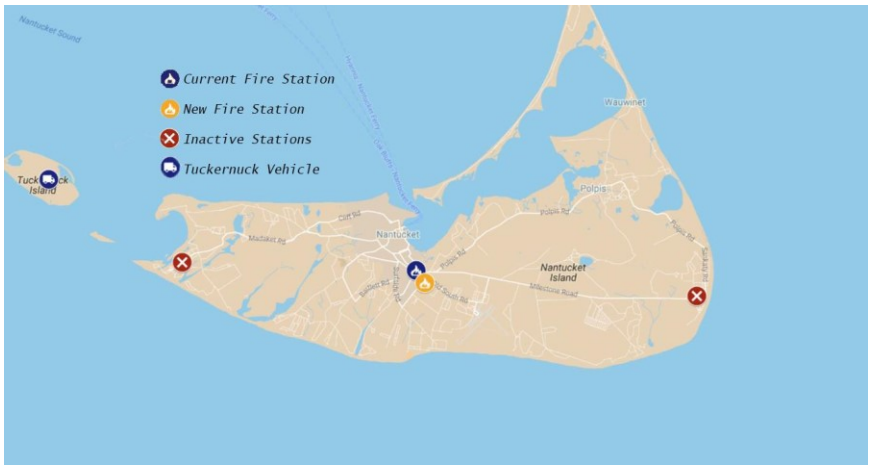

Figure 5: Geographic Locations of Fire Stations on Nantucket

Dynamic Deployment:

Dynamic deployment references a new idea for emergency response units to pre-allocate specialized vehicles in many locations to act as a basic station on wheels. This practice is becoming common in Europe, especially in cities with small streets (Ambulansforum, 2015). Vehicles range from Utility Task Vehicle (UTV) style to larger Sport Utility Vehicles (SUV) (Figure ES.6). The following findings relate to the need for dynamic deployment on Nantucket:

1. **The downtown area is dense with calls:** Most calls are in the downtown area (60% in 2015) with 45% of those calls being medical (1,395 medical calls). All of these calls are the NFD's responsibility because there is no private ambulance service on Nantucket.

2. **The downtown area is a problem area:** The downtown area has a lot of congestion, especially during the summer, which makes it difficult for an emergency response vehicle to mobilize.

3. **Change in medical treatment policies:** The standard for medical response in Massachusetts has changed to treat people on scene instead of moving them to a hospital (NFD 2016). These vehicles are designed to bring equipment to a scene, instead of people to equipment.

Figure 6: Two Potential Designs for Dynamic Deployment Vehicles (Left: UTV & Right: SUV)

Response Time Simulation:

Using the locations of the new fire station, the Siasconset station, and the standby location for the proposed dynamic deployment vehicle, we created a Google maps API[2] based simulation script to estimate response times. Our findings about the response time simulation are as follows:

1. **Simulation tools are useful for predicting results:** Simulation tools can generate insight into spatial aspects of response time, and if used properly can predict how much time can be saved if the operator implements certain recommendations.

2. **The response time simulation results are promising (Figure 7):** Implementing the recommendation to renovate the Siasconset station and employ the dynamic deployment vehicle caused 90% of calls to have a response time of less than 8 minutes.
    a. With implementing two recommendations, the 90% point of all calls decreases by 4 minutes.
    b. Adding concurrent calls and traffic conditions will make the estimation more precise for time analysis, but will require a dedicated team to complete.

3. **Plenty of room to develop the simulation into a program:** There is potential for this simulation to be developed into a system for reducing response time by implementing more functions. With more functions added, the program could be able to[3]:

[2] An API is a set of methods and tools that can be used for building software applications.
[3] More details are provided in recommendation 4.

a. Provide the best route for emergency vehicles
b. Advise the most accessible station for each specific emergency call

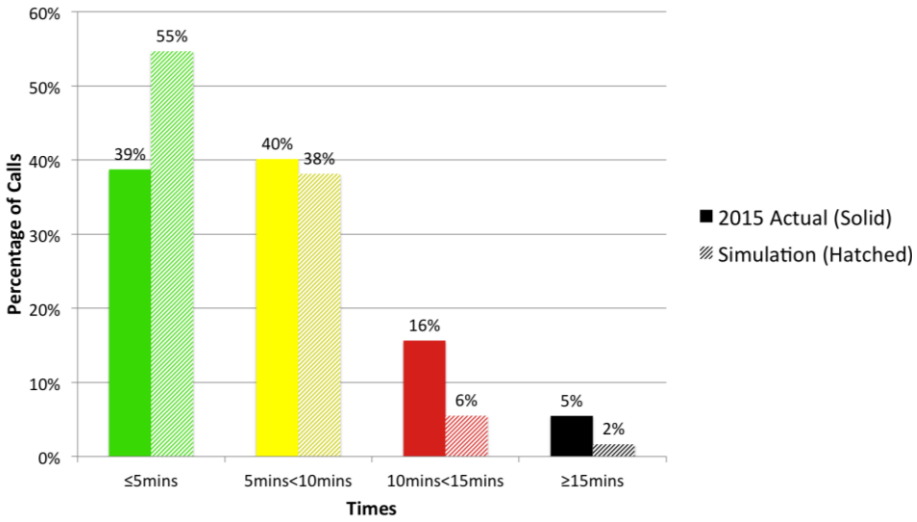

Figure 7: Response Improvement 2015 Actual versus 2017 Simulation (2,723 Calls Total)

Recommendations

The Nantucket Fire Department currently has a response time above the national standard due to under-staffing, facility centralization, and heavy seasonal traffic. These problems have multiple components that all connect to lead to an increased response time. Understaffing is the largest issue faced by the NFD (NFD Staffing Finding). The easiest way to remedy this would be to hire new people. However, there is nowhere to house new staff since the housing prices are so high on Nantucket.[4] Normally, staff would be located at other fire stations, but since the island does not have fully staffed satellite stations, this does not offer a solution. Solving just one of these challenges would be both expensive and difficult, so finding a solution that incorporates each would be the most effective way to improve the time and quality of emergency responses. The following writing outlines our team's recommendations to the NFD, with explanation of how each could improve NFD emergency response performance.

Recommendation 1: Refine the dispatch information system to improve data quality and availability for analysis. The fire station records every call, even if the call does not have any bearing on response time. To analyze response time, it is necessary to clean the data of irrelevant points. A potential future project would be to help the NFD find a way to automatically clean calls. If the fire department were to have two sets of data, cleaned and uncleaned, they could

[4] Another 2016 IQP team worked on affordable housing. To find out more in depth information on the Nantucket Housing Crisis, visit http://wp.wpi.edu/nantucket/projects/projects-2016/town-managers-office/

send the full data to the state as required, but still have cleaned data for statistical analysis. Developing the data information system would require programming and design skills consistent with that of WPI students, and could likely be completed within the seven week period of an IQP. In this potential project, the team would need to complete the following tasks in order to complete the system:

- Compile a standard for clean data
- Split data into two sets, clean and unclean
- Develop a program that automatically cleans the data
- Share information with the fire department

Recommendation 2: Purchase and implement a dynamic deployment vehicle and deploy it as the Nantucket Fire Department's first-responder downtown. A dynamic deployment vehicle would need to include all necessary ALS gear and be small and stable enough to handle Nantucket's narrow cobblestone streets. The downtown area is prone to having many medical calls, especially during the summer (See Dynamic Deployment Finding). This is partially because of the cobblestone and rough sidewalks functioning as challenging walking surfaces for many visitors. One potential location for this vehicle for standby is in front of the sheriff's station because not only is it downtown, but it is also close to the Madaket side of the island. Having a vehicle that can access both the downtown area as well as parts of Madaket would be extremely valuable for decreasing response time. Multiple companies were contacted for comparable vehicles. Their estimates revealed that the cost of a dynamic deployment vehicle is extremely varied, ranging anywhere from $20,000-$300,000 based on vehicle type and the amount of customization required. One potential, less expensive solution is to provide one of the companies with a vehicle, such as an SUV, to be fitted with pre-fabricated equipment racks. Further analysis could be addressed by a future student project, and should be addressed as quickly as possible, as the simulation project shows a large potential improvement for response time and quality. To complete this recommendation, the fire department and future project teams should:

- Determine necessary specifications to implement in the dynamic deployment vehicle
- Contact multiple dynamic deployment vehicle customization companies for cost estimates including:
    - Odyssey Specialty Vehicles (http://www.odysseysv.com)
    - FastLane Emergency Vehicles (http://flev.com)
    - PL Custom Emergency Vehicles (http://www.plcustom.com)
- Designate funding within the budget for the vehicle or vehicles chosen
- Train fire department personnel to ALS levels to fully utilize the vehicle with 2-3 persons.

Recommendation 3: Renovate and reopen the Siasconset fire station as a fully staffed station. This station is currently used as a garage to house older engines, and does not have any space for housing, offices, or bunk rooms. There are about 30 calls per month in the winter and about 60 calls per month in the summer in this area (NFD, 2016). An additional incentive for reopening the Siasconset fire station is that if the Siasconset station was renovated and expanded, the insurance rates in the Siasconset area would decrease substantially, as would the response times. We recommend that the data be shown to the town to support this statement, along with the simulation (Figure 10). The potential savings in response time and potential to save lives could have a significant impact on Nantucket residents. In order to implement this change, the NFD would need town support and funding. To enact this recommendation as soon as reasonably possible, the town and fire department should:

- Run a feasibility study
- Establish funding
- Build the addition
- Increase staffing

The recommended renovation is displayed in Figures 8 and 9.

Figure 8: Top view of addition

This total addition of 3,486 square feet over two floors would allow housing for seasonal employees as well as providing capabilities for 24/7 staffing. There are two bunk rooms for seasonal employees, which would provide housing for four additional summer staff. The town owns the building, so they would not need to buy new property. This design would preserve the historic character of the building.

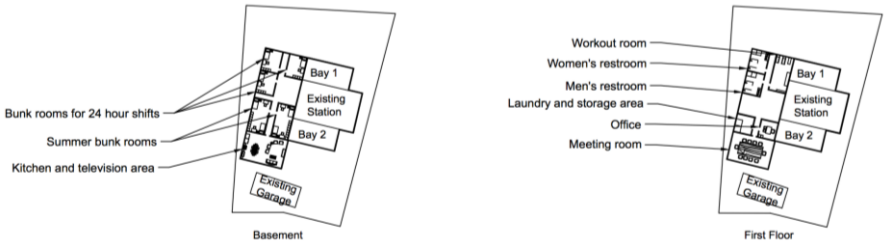

Figure 9: Floor plan of addition with labeled rooms

Our team found, through contacting multiple local insurance companies, that insurance rates are based on where a building is in comparison to a fire station. The least expensive insurance rates are on buildings located within a 5-mile radius of a staffed fire station. This radius has a dramatic effect on a building's ISO[5] rating, causing a large effect on annual insurance premiums. The current rating in the Siasconset area is an ISO 9 rating, while within the 5-mile radius of the centralized station there is an ISO 4 rating. If the Siasconset station were to be reopened and fully functional, 2,328 buildings would now qualify for lower ISO ratings (Figure 10). Additionally, the reopening would result in savings for all properties that experience an ISO rating decrease.

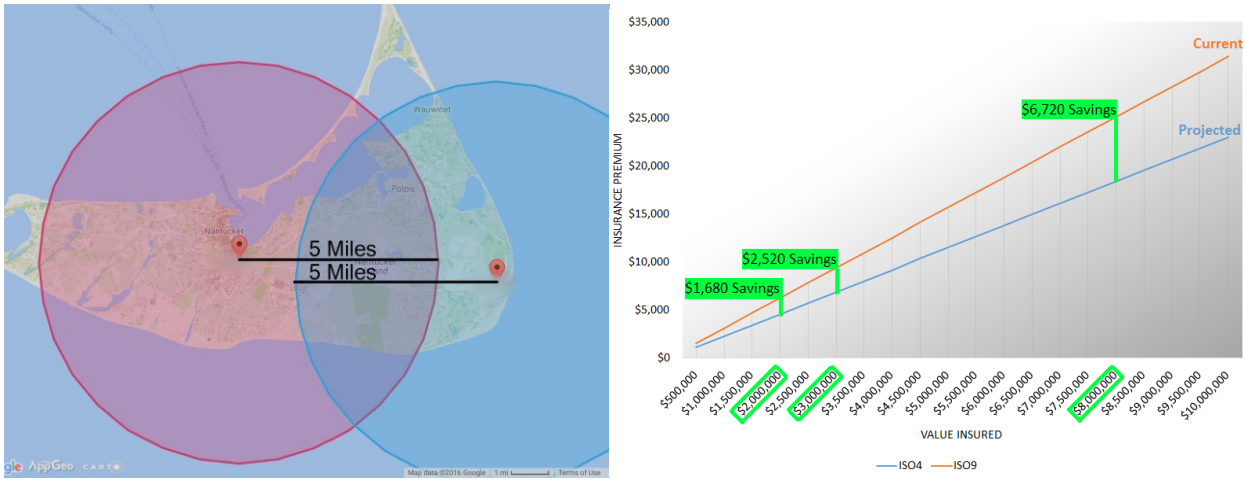

Figure 10: 5-mile insurance circles and savings based on ratings

The renovation costs of the Siasconset station were roughly estimated to cost $1,743,000 based on construction costs of $500 per square foot (Table 7). The upkeep and staffing is estimated to be $1,200,000 per year (Rhude, 2016). The total estimated annual insurance savings of $4,444,789 is based off the ISO rating changes, the number of buildings affected, and the

[5] ISO is the International Organization for Standardization. They develop and publish International Standards for a variety of fields from fire protection insurance to medical devices.

median value of the houses affected. It is important to note that the savings do not go directly to the town, they go to the property owners affected. The town could potentially explore the designation of fire protection districts into the town, which would allow for specialized taxes that could go directly to the fire department.

Siasconset Renovation		
	Renovation	Future Years
Cost	$1,743,000	$1,200,000
Annual Savings	--	$4,444,789

Table 8: Estimated Annual Costs and Insurance Savings of Siasconset Reopening

Recommendation 4: Use and further develop the simulation software. To estimate future response times, a basic simulation script was developed that implements Google Maps API. The simulation script can be optimized to conduct cost analysis precisely based on the NFD call data by predicting how much response time will be reduced when the solution has been proposed. For the NFD to determine the most cost effective solution, they first should:

- Decide new station locations
- Hire more staff
- Implement dynamic deployment

This script could be further developed to reduce response time through optimizing routes and choosing the best stations to deploy from. Therefore, it would be advantageous to have this program further developed after the previous two recommendations are implemented. To develop the simulation further, the following steps should be taken:

1. The script should be able to determine which station is the most accessible location for a specific emergency call. Based on the existing simulation script, this step is easily developed and could be done first in two months. In the case that this step is undertaken by a WPI IQP, the group should include all time influential factors such as concurrent calls, extreme weather, and extreme traffic as variables, and add them to the script. Once those variables are added, the team should create a user-friendly interface to let people in the fire department access the program easily.

2. After a user interface is made, the system can be further optimized. The program can be improved to find the best route to the emergency site. In the summer, there is a lot of congestion in the downtown area, which makes it difficult for emergency vehicles to reach their destinations. Through machine learning and algorithm optimization, this system can give advice as to what the fastest route for emergency vehicles is, and eventually it should be able to show detours to avoid congested areas. Finding the fastest route when there is traffic will be difficult to implement. The group that develops this

simulation should devise the algorithms by themselves instead of implementing Google API, which takes time. The time it takes to develop the system will be based on the technical ability of the group in charge of designing this system.

We recommend that this potential project be considered by the Nantucket Project Center in conjunction with WPI Fire Protection Engineering or WPI Computer Science majors and the NFD. This project could be organized as an Interactive Qualifying Project (IQP) or Major Qualifying Project (MQP). To determine the most appropriate methods to work on this project, the following necessary knowledge should be taken into consideration. The team must fully understand the following topics:

- Traffic circumstances in Nantucket
- Call codes used by the fire department
- How to code the necessary recommendations for the simulation
- How to share this simulation with the fire department and educate them on its use

Table ES.8 summarizes the initial costs of Siasconset renovations and the dynamic deployment vehicle.

	Capital
Siasconset Reopening	$1,743,000
Dynamic Deployment Vehicle	$300,000
Total	$2,043,000

Table 9: Cost of Proposed Fire Department Additions

The GIS maps below estimate how much the response time would be reduced after all three recommendations, including the new fire station, the Siasconset fire station, and the dynamic deployment standby location, have been implemented (Figure 11). Compared to the 2015 data, the downtown area in the simulation data is covered by green dots, which designates less than 5 minutes of response time. In the Siasconset area in 2015, the map is dominated by larger than 10 minute response times. After simulation implementation, the response times improve considerably.

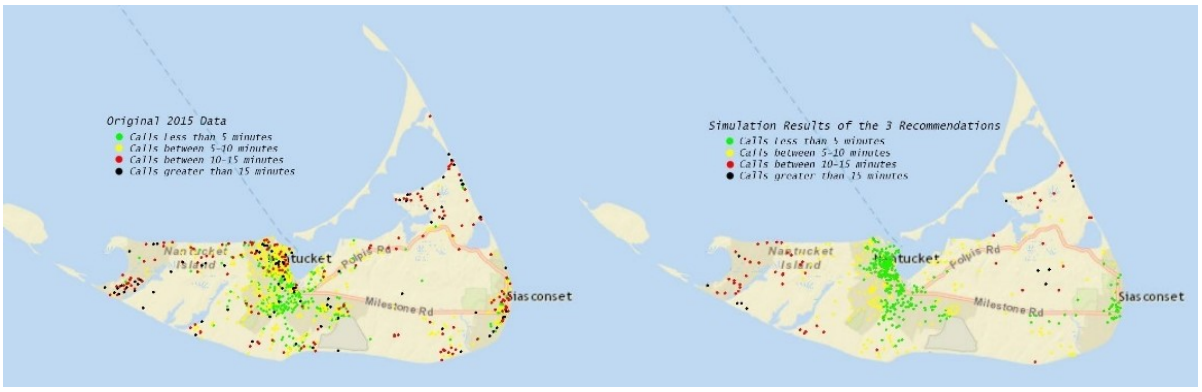

Figure 11: 2015 Call Data Compared to Simulation Results of Recommendation Locations

Conclusion

This project has been a great learning experience for the whole team. Not only have we gained individual skills such as coding, GIS mapping, and Excel graphing, but we have also learned how to cooperate and coordinate with other people in a team. We have learned how to work together on an in-depth project, conduct interviews, and write a report. On top of working with other students, we also learned how to conduct ourselves in a professional setting. The fire department has been an integral part of our project, and working with them has showed us not only how a fire department runs, but what it means to truly devote yourself to bettering the community for others. The fire station runs on mutual respect, discipline, and order, all things that will help us later in our personal and professional lives. Nothing would get done without the firefighters respecting each other and the engines and ambulances wouldn't work without proper maintenance done every day.

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