



VENICE PROJECT CENTER

Cruise Ships: Influencing the City of Venice

An Interdisciplinary Qualifying Project
Submitted to the faculty of
Worcester Polytechnic Institute
in partial fulfillment of the requirements for the
Degree of Bachelor of Science

Student Authors:

Nicholas Hunnewell

James Reese

Ryan Vautrin

Damian Skweirczynski

Project Advisors:

Professor Fabio Carrera
Professor Daniel Gibson

January 13, 2010
www.ships-veince-09.blogspot.com
ve09-ships@wpi.edu

Table of Contents

1. Introduction	10
2. General Background	12
2.1 Beginnings of Luxury Cruising.....	12
2.2 Competitive Roots.....	13
2.3 Tragic Sinkings	14
2.3.1 R.M.S. Titanic	14
2.3.2 R.M.S. Britannic	14
2.3.3 R.M.S. Lusitania.....	15
2.3.4 R.M.S. Empress	15
2.3.5 S.S. Andrea Doria.....	16
2.4 Cruise Shipping in Venice.....	16
2.5 Inner Workings of Cruise Liners.....	17
3. Environmental Impact.....	19
3.1 Measuring the cruise ships' effects on hydrodynamics in canals	19
3.1.1 Methodology.....	20
3.1.2 Results and Conclusion.....	21
3.1.3 Future Recommendations.....	22
3.2 Measure the amount of particulate matter that is present during and after the presence of cruise ships.....	23
3.2.1 Future Recommendations.....	24
3.3 Measure the vibrations caused by the passing of ships	25
3.3.1 Future Recommendations.....	25
4. Economic Impact.....	26
4.1 Determining where passengers spend their money and how much.....	26
4.1.1 Methodology.....	30
4.1.2 Results and Conclusion.....	31
4.1.4 Future Recommendations.....	32
5. Social Impact.....	33
5.1 Provide a qualitative analysis and visual representation of the impact of cruise ships on Venetian life.....	33
5.2 Methodology	36
5.3 Visual Deliveries	37

5.4 Future Recommendations	37
6. Works Cited.....	38
7. Appendix	44

Table of Figures

Figure 1: The S.S. Prinzessin Victoria Luise	12
Figure 2: The R.M.S Titanic	14
Figure 3: The R.M.S Britannic	14
Figure 4: The R.M.S. Lusitania	15
Figure 5: The R.M.S. Empress	15
Figure 6: The S.S. Andrea Doria	16
Figure 7: Overview of Boat Passenger Traffic.....	17
Figure 8: Inner Workings of a Ship.....	18
Figure 9: Before Ships passes canal	21
Figure 10: During Ship passing.....	21
Figure 11: Directly after the ship passes.....	21
Figure 12: A few minutes after the ship passed.....	21
Figure 13: Hydrodynamic Results	22
Figure 14: Pollution from the Smoke Stacks	23
Figure 15: WTTC Demand Forecast 2007	27
Figure 16: WTTC Demand Forecast 2008	27
Figure 17: WTTC Predictions until 2019	29
Figure 18: Surveying area located in Piazzale Roma	30
Figure 19: Info graphic of surveying results.....	31
Figure 20: Canadian Cruise Lines ship waiting to dock in Bar Harbor.....	33
Figure 21: Pedestrian Traffic in St. Mark’s Square during Acqua Alta.	35
Figure 22: A Cruise Liner along Alaska’s Icy Coastline	36

Executive Summary

Italian tourism is divided amongst attractions that are known the world around. Rome, Florence, Milan and Sicily all see their fair share of tourists, but none of these cities are as unique as Venice. Historical Venice occupies 6.3 square kilometers, 1279 square kilometers less than Rome (1,285 square kilometers), yet both cities welcome 20 million visitors every year. This works out to 3,174,603 visitors per square kilometer per year in Venice, versus 15,637 in Rome. These tourists bring an estimated 1 billion euro into the city annually. Not surprisingly, cruise ships hold a vital role in bringing visitors to this archipelago. In 2007, Venice saw over 500 cruise ships dock in its harbor. These cruise ships brought over 1,000,000 tourists to the city that same year. For a city with a population of about 62,000, this is an astronomical amount of people to accommodate. On paper, it appears that the cruise ship industry is doing Venice an incalculable favor, providing a steady stream of tourists with deep pockets and little inhibition to spend. But doesn't it sound too good to be true? Might there be a side to the cruise shipping industry that is not helping, but hurting the city of Venice?

It is well established that passing motorboats create moto ondosso, or wake, that has a detrimental effect on the canal structure. The cruise ships that dock in Venice almost daily have displacements between 20,000 and 60,000 tons, exponentially larger than the average motorboats around Venice. If the small boats in Venice can exact a toll on the canal walls, how much damage to these gargantuan vessels cause? Do the emissions of their massive diesel engines pollute the water and atmosphere? The massive population spike that is associated with the arrival of these ships must put a strain on the pedestrian and waterway traffic throughout the city. These visitors may also contribute to pollution of the city. It has been established that tourists spend a great deal of money in Venice, however it is not specified in what manner they spend it. How much comes from cruise passengers? In total, what are the positive and negative impacts that the cruise ship industry has on Venice?

These questions have been touched upon, although very lightly, in recent publications such as *The Venice Report* and *Migropolis*, both of which will be discussed in the following chapters. They present conflicting opinions about the ships affect on the environment, and offer little in terms of sources. However, this project, will function to uncover the unknown and the disrupted; to investigate environmental, economic and social benefits and detriments that cruise ships bring to Venice.

This project is intended to fill the gap in information that surrounds cruise ships in Venice. The ultimate goal of this project is to develop a publicly accessible profile of the positive and negative economic, social and environmental impacts of cruise ships and their passengers on the city. By studying cruise ship passenger spending throughout the city, a profile of the economic contribution of cruise ships will be produced. In addition, the team will be measuring and analyzing the environmental and social effects of the vessels to more completely map the impact of the cruise ships.

This project was and still is a crucial step towards the preservation of Venice. Venice has been a cruise destination since the beginnings of the cruise ship industry. By

investigating the extreme impacts of the industry, we would obtain a better perception on how Venice is affected. The ultimate goal of our project was to develop a publicly accessible profile of the positive and negative economic, social, and environmental impacts of cruise ships and their passengers on the city. Our main objectives consisted of; determining the passenger expenditure throughout the city, analyzing the cruise ships' affect on canal flow by means of hydrodynamics, and provide a qualitative analysis and visual representation of the impact of cruise ships on Venetian life. The methods we used to analyze and conclude these objectives consisted of surveying the passengers, testing the hydrodynamics of these canals before, during, and after the passing of these ships, and to time lapse and visually record the flood of tourists into and in Venice.



Piazzale Roma Surveying Area



Hydrodynamic Testing Canals

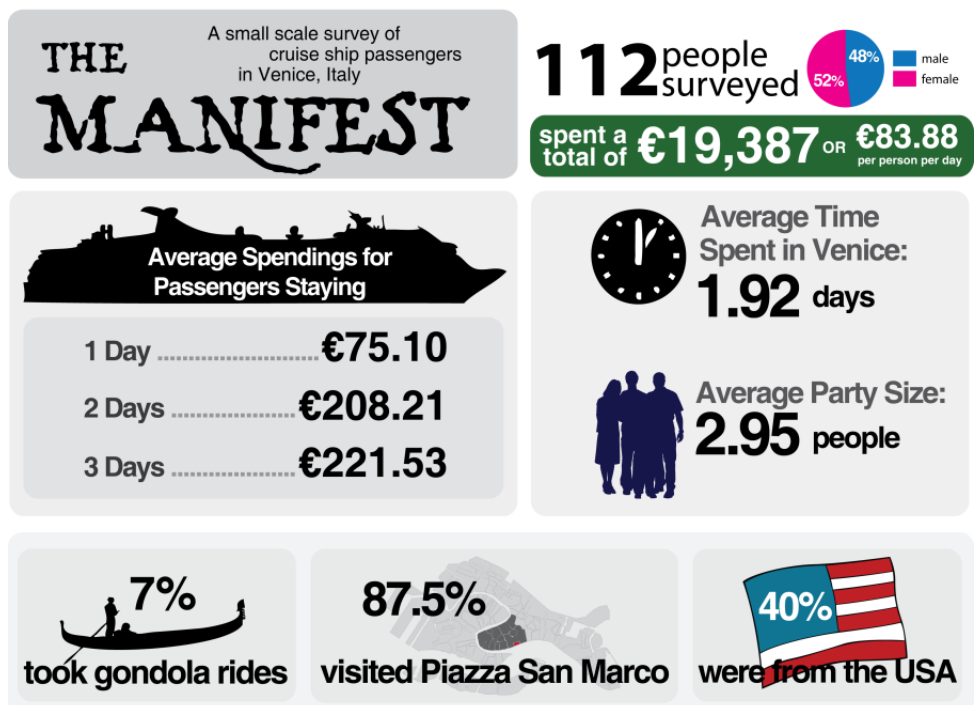
Hydrodynamic Testing Results and Analysis

The cruise ships all had a major impact on the flow of the canal. We performed a total of 7 tests, although we attempted many more. Boat traffic, weather implications, and the unpredictable cruise ship arrival times prevented us from obtaining an adequate amount of tests. The fully carried out hydrodynamic testing produced remarkable results. On average, the natural volumetric flow of the canal is $.91 \text{ m}^3/\text{s}$, during a passing; it is increased to an average of $1.51 \text{ m}^3/\text{s}$. The average velocity of the canal increased by an astounding 62.8%. Immediately after the passing of the cruise ship, all the water that was sucked under the hull was pushed back out, briefly reversing the natural flow of the canals. At times, the reverse flow actually surpassed the velocity of the natural flow (although in the opposite direction).

In theory, the constant changes to the canals natural flow may increase the amount of deterioration endured by the canal walls, and the surrounding fondamente. *Migropolis*, a publication on various aspects of Venice in general, makes a connection between cruise ships, and how their vibration causes the fondamente to erode as the pass by it. There is no doubt that the aggressive changes in flow may also impact the canals in a similar fashion.

Economic Results and Analysis

The completion of our survey resulted in the data from 112 individuals. These individuals were part of 32 parties, with a 50-50 male to female ratio. The average age of these passengers was roughly 46 years old. The data collection came from 5 different cruise ships over 8 cruise calls. The main country of origin was the United States aboard all these ships. These cruise ship passengers dispersed all throughout Venice, although Piazzale San Marco was most visited, along with its neighboring churches and museums. The sum spent by the 112 individuals as a group totaled 19,875 Euro, with each individual spending an average of 83.38 Euro per day. The



average expenditure for passengers who only spent one night in Venice was 75.10 Euro, for two nights 208.21 Euro on the second night, and for anything greater than 3 nights was 198.27 Euro on the third night. Hence the total expenditure was roughly 481.58 for a 3 night stay. After an interview with Marco Nogara, Captain of the Carnival Liberty, we learned that some of the crew is also let off the ship on days leave to do as they please until curfew. We could not collect enough survey data to address this, so further research is needed. Although we can estimate the crew members part in the Venetian economy. They do not pay any expenses while aboard the ship itself, though many of them do disembark with the passengers and spend money in the city. The crew members obviously do not all disembark due to safety regulations, and their job responsibilities, though many do get off. The crew makes up more or less 33% of the population aboard any ship. The cruise ships that came to Venice had an average of 1775 paying passengers aboard, hence an average crew of 586. Whether it's to get a souvenir, a snack, or something for loved ones back home, they will spend some money. If we low-ball estimate a total of 10 Euro per crew member that disembarks, and assume 35% of the crew members disembark, then we could possibly have a grand total of roughly 2,051 Euro going towards the Venetian economy per visit. This total is strictly per cruise ship, and in 2009 alone there were 560 cruise calls, hence producing an estimate of 1,148,560 Euro this year alone.

Social Results and Analysis

With the footage collected during the length of the project, two videos were produced and posted online to show the size and impact of the cruise ships on Venice. The first video, comprised solely of time-lapse footage taken, shows the progression of the ships and passengers in a typical day in Venice. The video starts with footage of an empty Piazza San Marco and shows multiple clips of cruise ships entering the city, traveling down the Giudecca Canal, and docking in the port. The passengers are then showed exiting the ship, loading on shuttle buses, and dispersing throughout the city. The video ends with the ships exiting and night falling. This video is set to "Hurricane 2000" performed by the Scorpions and the Berlin Philharmonic Orchestra.

The second video had a much more serious theme and was intended to more accurately depict the impact of the cruise ships as they came into the city using real time, time lapse, and slow motion footage. The video starts with shots of the Giudecca in the early morning and shows the sun rising as ships begin to pour into the city. The passengers then disembark the ship and spread out through the city, focusing on popular attractions like Piazza San Marco and Rialto Bridge. After crowding into the city's more famous areas, the passengers return to their ships and the ships exit the city as night falls. The video then takes a different turn, starting with clips of Piazza San Marco flooded and transitions into the funeral of Venice. Slow motion shots combined with Mozart's Requiem in D Minor, K 626 - 8. *Sequentia: Lacrimosa Dies Ire* provides a somber end to

the video. The rest of the score includes three pieces from native Venetian Antonio Vivaldi

Recommendations

In the very limited amount of data that we gathered, it is suggested that these cruise ships are producing significant alterations of the natural flow and direction of the canals adjacent to the Giudecca. This prompts the need for the continuation of the testing and a more in-depth and standardized testing procedure. The location used throughout our series of tests is an ideal location and could be reused with the continuation of the testing. To accurately measure the speed of the canal, the testing distance should be at least double the length of the original distance (6.87 meters) used throughout the duration of our project. The continuation of the testing would also require a higher number of tests to gather accurate and conclusive results. Multiple control tests before and after each ship are required to gain enough data to compare the important results with.

Another key area of the testing that needs to be addressed is “kickback” of the canal after the ship has passed. When the canal changes direction after the cruise ship has passed, the float needs to be timed from the moment it starts to move until when it stops. The distance should then be recorded for later use and the float should continue forward flow and be timed over the set distance as in normal tests. If any trends or significant results do arise, the project can again evolve to incorporate the possible implications of the increased flow. This would mean a correlation between the increase flow of the canal and its effects on the degradation of canal walls.

Unfortunately, due to time constraints and conflicting schedules, the project group was not able to secure an aethalometer for use. However, if an aethalometer is secured for use at the project center, the students should take full advantage of its abilities. Measurements should be taken all along the path cruise ships take: the Lido inlet, Giardini, San Giorgio Maggiore, Piazza San Marco, Punta della Dogana and along both sides of the Giudecca. These measurements should be taken while the cruise ships are passing these locations. Most importantly, measurements should be taken where the cruise ships are moored: at the Stazione Marittima. Measurements should be taken here at regular time intervals to monitor the black carbon output (if any) over the duration of the ships stay. These readings should be compared to ones taken at the same locations, however with no cruise ships passing.

When all the data has been compiled, compare the observed black carbon levels with any port or government regulations, as well as industry standards and health regulations. Also, if possible, attempt to correlate emissions with fuel grade and engine size and number. These characteristics of cruise ships are available to the public through many sources.

Future project groups exploring this element of cruise shipping are advised to contact Jeff Blair, CEO of Magee Scientific and former VPC student, and Dr. Grisa Mocnik, Director of Aerosol d.o.o. It is extremely important to make contact as early as possible. Reach out to Jeff, and talk to him about fuel emissions, black carbon, and possible collaboration with Magee Scientific. Jeff has a plethora of knowledge in the area and is more than willing to assist you. If possible, secure an aethalometer early in A-term so testing may begin immediately upon arrival in Venice. Dr. Mocnik is the director of the production plant of aethalometers based in Ljubljana, Slovenia. She will be more than willing to organize a meeting and facilitate a tour of the Aerosol plant in Ljubljana.

With a survey yielding only 112 total subjects, this data can only make suggestions as to the spending habits of passengers. A project team devoted to surveying passengers would yield a far greater number, giving further validity to the results of the experiment. If surveying in this way, it is imperative to be at the bus stops at least 2 ½ hours before the ships departure to catch passengers. Having the survey translated into common languages, such as Italian, Spanish, French and German will allow the group to reach out to more and more passengers.

Future groups should also consider the economic impact of the crew. The same survey could be used; however reaching the target will be more difficult. Since the release of crewmembers is staggered, survey teams will need to be constantly available to administer the questionnaire. After this data is collected, the group could begin to determine which cruise ships prove the most lucrative to Venice.

The impact that cruise ships hold on Venetian society is difficult to quantitatively measure. Any annoyance or displeasure that Venetians may feel cannot be measured in units. However, it is possible to identify the source of annoyance, and from there, to attempt to quantify that source.

This procedure would need to begin with a survey of Venetians seeking to identify the annoyance. There are myriad possible answers to such a survey; however there are some that are easy to anticipate. It is likely that many will answer with, “the passengers get in my way.” This answer may serve as a stepping-stone to an experiment that could reveal the severity of said annoyance.

During a weekend with cruise ships docked in port, closely record the routes that several Venetians take through the city on their daily errands. Compare the time, distance, and route taken to a day without cruise passengers. Any differences between the two trips can be attributed to the presence of the passengers. This would reveal numbers, in travel time and distance, that would correlate to (and essentially quantify) any social disapproval of cruise ships.

1. Introduction

In 1844, a British cargo ship making a transatlantic journey made a point to bring a live cow along. Why? This cow provided fresh milk to the crew for the 14 days at sea. What sets this voyage apart from every one before it is the commodity, and luxury, that went with it? It became, by default, the first luxury cruise the world had seen.¹ Cruises progressed to become more refined, yielding ocean liners such as the Olympic and the world-famous Titanic, and serving as a major means of tourist transportation. The invention of the airplane and progression of transatlantic flights led to a decline in luxury cruise shipping, but the appeal of a voyage at sea kept the industry alive. Cruise ships remain to this day an integral part of tourism the world around, and are growing at an astonishing rate. Between 1998 and 2008, international cruise ship passengers almost doubled from about 17,000,000 to about 33,000,000.² These ships and their passengers are a key element in the travel and tourism industry, which has also seen rapid growth in recent years. In 2007, the travel and tourism accounted for 10.4% of the world GDP, or about \$5.39 trillion.³ In just one year, this increased to \$5.89 trillion.⁴ Both directly and indirectly, travel and tourism employed an estimated 231.2 million people worldwide in 2007, a number that increased to 238 million in 2008.^{5,6} This global expansion of tourism, and especially tourism due to shipping, is even expected to continue despite global economic downturn. Experts at World Travel and Tourism Council (WTTC) predict that the industry as well as its indirect impact will expand to \$10.48 trillion by 2019.⁷ Although these statistics are on a global scale, small countries, especially Italy, have seen similar surges in cruise shipping and tourism.

In 2008, the WTTC ranked the Italian travel and tourism economy number 7 in worldwide absolute size.⁸ Italy commands an immense tourist presence year in and year out. Between 1998 and 2008, the total number of international tourists in Italy increased over 23% from 58,499,000 to 72,102,400.⁹ The Italian Ministry of Foreign Affairs estimates that each year, these tourists spend over 30 billion euro while in Italy. This, when combined with the revenue the tourism industry directly produces, accounts for over one-third of the Italian GDP, an estimated 530 billion euro in 2008.¹⁰ These numbers show that Italy as a whole brings in a substantial amount of money via tourism cruises. However, this reveals nothing about *where* in Italy tourists go. Do some cities attract more tourists than others? And if they do, do they experience problems and difficulties in accommodating such masses of people?

¹ "Report for Selected Countries and Subjects." IMF -- International Monetary Fund Home Page. <http://www.imf.org/external/pubs/ft/weo/2009/01/weodata/weorept.aspx?sy=2008&ey=2008&scsm=1&ssd=1&sort=country&ds=.&br=1&c=512%2C941%2C914%2C446%2C612%2C666%2C614%2C668%2C311%2C672%2C213%2C946%2C911%2C137%2C193%2C962%2C122%2C674%2C912%2C676%2C313%2C548%2C> (accessed October 2, 2009).

² Using "World", "Other, including Intl Visitor Numbers" from 1998 to 2008. "Tourism Impact Data Forecasting Tool." WTTC. www.wttc.org/eng/Tourism_Research/Tourism_Impact_Data_and_Forecast_Tool/ (accessed September 30, 2009).

³ *Progress and Priorities 2007/08* (2007): 5-6, http://www.wttc.org/bin/pdf/temp/finpp_2007.html (accessed September 12, 2009).

⁴ *Progress and Priorities 2008/09* (2008): 5-7, http://www.wttc.org/bin/pdf/temp/progress_and_priorities_2008.html (accessed September 12, 2009).

⁵ *Progress 2007* *ibid*.

⁶ *Progress 2008* *ibid*.

⁷ "World-Key Facts at a Glance." World Travel & Tourism Council. www.wttc.org/eng/Tourism_Research/Tourism_Economic_Research/ (accessed October 4, 2009).

⁸ *PROGRESS* *ibid*.

⁹ Using "Italy", "Other, including Intl Visitor Numbers" from 1998 to 2008. "Tourism Impact Data Forecasting Tool." WTTC. www.wttc.org/eng/Tourism_Research/Tourism_Impact_Data_and_Forecast_Tool/ (accessed September 30, 2009).

¹⁰ "The Italian Economy." The Italian Ministry of Foreign Affairs. www.esteri.it/MAE/EN/Benvenuti_in_Italia/Conoscere_Italia/Economia.htm (accessed September 13, 2009).

Italian tourism is divided amongst attractions that are known the world around. Rome, Florence, Milan and Sicily all see their fair share of tourists, but none of these cities are as unique as Venice. Historical Venice occupies 6.3 square kilometers, 1279 square kilometers less than Rome (1,285 square kilometers), yet both cities welcome 20 million visitors every year.^{11,12} This works out to 3,174,603 visitors per square kilometer per year in Venice, versus 15,637 in Rome. These tourists bring an estimated 1 billion euro into the city annually.¹³ Not surprisingly, cruise ships hold a vital role in bringing visitors to this archipelago. In 2007, Venice saw over 500 cruise ships dock in its harbor. These cruise ships brought over 1,000,000 tourists to the city that same year.¹⁴ For a city with a population of about 62,000, this is an astronomical amount of people to accommodate. On paper, it appears that the cruise ship industry is doing Venice an incalculable favor, providing a steady stream of tourists with deep pockets and little inhibition to spend. But doesn't it sound too good to be true? Might there be a side to the cruise shipping industry that is not helping, but hurting the city of Venice?

It is well established that passing motorboats create moto ondosso, or wake, that has a detrimental effect on the canal structure. The cruise ships that dock in Venice almost daily have displacements between 20,000 and 60,000 tons, exponentially larger than the average motorboats around Venice. If the small boats in Venice can exact a toll on the canal walls, how much damage to these gargantuan vessels cause? Do the emissions of their massive diesel engines pollute the water and atmosphere? The massive population spike that is associated with the arrival of these ships must put a strain on the pedestrian and waterway traffic throughout the city. These visitors may also contribute to pollution of the city. It has been established that tourists spend a great deal of money in Venice, however it is not specified in what manner they spend it. How much comes from cruise passengers? In total, what are the positive and negative impacts that the cruise ship industry has on Venice?

These questions have been touched upon, although very lightly, in recent publications such as *The Venice Report* and *Migropolis*, both of which will be discussed in the following chapters. They present conflicting opinions about the ships affect on the environment, and offer little in terms of sources. However, this project, will function to uncover the unknown and the disrupted; to investigate environmental, economic and social benefits and detriments that cruise ships bring to Venice.

This project is intended to fill the gap in information that surrounds cruise ships in Venice. The ultimate goal of this project is to develop a publicly accessible profile of the positive and negative economic, social and environmental impacts of cruise ships and their passengers on the city. By studying cruise ship passenger spending throughout the city, a profile of the economic contribution of cruise ships will be produced. In addition, the team will be measuring and analyzing the environmental and social effects of the vessels to more completely map the impact of the cruise ships.

¹¹ "Rome Tourist Information." Undercover Tourist. <http://www.undercoveurtourist.com/italy/rome.html#facts> (accessed October 1, 2009).

¹² "Canal maintenance." Venipedia. http://venipedia.org/index.php/Canal_maintenance (accessed October 3, 2009).

¹³ "Canal maintenance." Venipedia. http://venipedia.org/index.php/Canal_maintenance (accessed October 3, 2009).

¹⁴ "VTP Statistics." Venezia Terminal Passeggeri S.p.A.. <http://www.vtp.it/pages/statistiche.jsp?language=1> (accessed September 10, 2009).

2. General Background

As discussed in chapter one, cruise shipping is not a new industry. There were many years of development that preceded the floating giants we see today. The history of shipping moves from practical transportation to a traveling amusement park, and covers everything in between.

2.1 Beginnings of Luxury Cruising

June 29, 1900 was the birth of a new era of luxury. The S.S. Prinzessin Victoria Luise, (*Figure 1*)¹⁵ the first ship ever built for the act of cruising, set sail on her maiden voyage. This historical day was the start of a rapidly growing industry known as cruising. The S.S. Prinzessin Victoria Luise was built purely as a luxury to its passengers by the Hamburg America Line Corporation. The 407 foot ship housed over 400 first-class passengers in its 120 cabins. Its quadruple steam engines propelled it across the oceans at an astounding speed of 15 knots.¹⁶ The S.S. Prinzessin Victoria Luise accompanied its passengers with a gym, a dining hall, an art gallery, a library, as well as an onboard casino to provide entertainment and opulence.¹⁷ Over a century later, there are over 230 cruise ships in the world, yet, in these past 109 years, cruising hasn't made many significant changes. Yes, technology advances have been made, but the concept of cruise ships has been identical. Shortly after the S.S. Prinzessin Victoria Luise, the cruise shipping industry exploded. Since 1980 alone, the industry has boomed roughly 232 percent, that's more or less 8 percent a year for the past 29 years!¹⁸

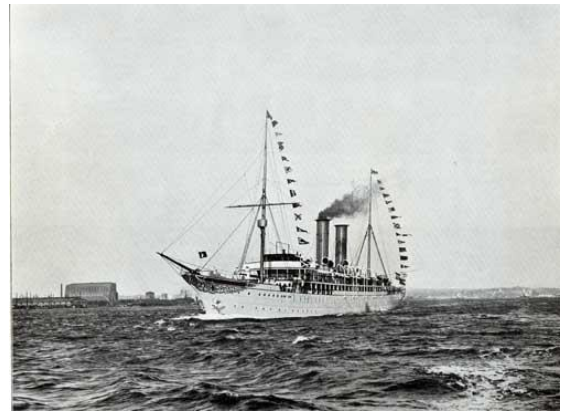


Figure 1: The S.S. Prinzessin Victoria Luise

White Star Lines, a competitor to Hamburg America Lines, constructed blueprints for their first fleet of ocean liners in 1849, known as the "Big Four." These ships set records in sheer size and luxury; among them the largest ships were given the title of Olympic Class Liners. However, even though construction for these ships began early, they didn't set sail until after The S.S. Prinzessin Victoria Luise, starting in 1901. The "Big Four" consisted of The Celtic, The Cedric, The Baltic, and The Adriatic. These vessels "broke the mold" for traditional liners and they made other ships look obsolete with their interior luxuries and their speed.¹⁹

¹⁵ "S.S. Prinzessin Victoria Luise (1900) - Photographs - 1908 - Hamburg American Line." [Archives of Passenger Lists, Vintage Brochures, Steamships, WW1, WW2, WPA](http://www.gjenvick.com/HamburgAmerikaLinie/1908-NordlandFahrten-PrinzessinVictoriaLuise.html). 2 Oct. 2009 <<http://www.gjenvick.com/HamburgAmerikaLinie/1908-NordlandFahrten-PrinzessinVictoriaLuise.html>>.

¹⁶ "PRINZESSIN VICTORIA LUISE Articles Prinzessin Victoria Luise was a pas." [Free Articles at Amazines.Com - Author Publishing and Free Article Database](http://www.amazines.com/Prinzessin_Victoria_Luise_related.html). 11 Sep. 2009 <http://www.amazines.com/Prinzessin_Victoria_Luise_related.html>.

¹⁷ "S.S. Prinzessin Victoria Luise (1900) - Photographs - 1908 - Hamburg American Line." [Archives of Passenger Lists, Vintage Brochures, Steamships, WW1, WW2, WPA](http://www.gjenvick.com/HamburgAmerikaLinie/1908-NordlandFahrten-PrinzessinVictoriaLuise.html). 2 Oct. 2009 <<http://www.gjenvick.com/HamburgAmerikaLinie/1908-NordlandFahrten-PrinzessinVictoriaLuise.html>>.

¹⁸ "Cruise Ships." [GlobalSecurity.org - Reliable Security Information](http://www.globalsecurity.org/military/systems/ship/passenger-cruise.htm). 6 Sep. 2009 <<http://www.globalsecurity.org/military/systems/ship/passenger-cruise.htm>>.

¹⁹ "TGOL - Celtic." [The Great Ocean Liners](http://www.thegreatoceanliners.com/celtic2.html). 14 Oct. 2009 <<http://www.thegreatoceanliners.com/celtic2.html>>.

2.2 Competitive Roots

Thousands upon thousands of wealthy people worldwide were attracted by the luxuries introduced by cruise ships. The demand for cruising instigated the need for much larger ships to be built. The White Star lines, designed three sister ships to fulfill the consumer needs. These 3 ships were by far the largest of the “Olympic” class liners with an average weight of about 47,500 tons per ship. Construction on the first of the three sisters, the R.M.S Olympic, began in late 1908. Work on her sister, the R.M.S Titanic, began a year later in March of 1909. Finally, construction on the last and biggest of the three sisters, the R.M.S. Britannic, began in 1911.²⁰

Competition for the best cruise liner was fierce throughout the early growth of the industry. Yet, with ticket prices ranging from about \$40, for third class, to nearly \$4,500, for first class, the price for luxury were not cheap. Today these prices would be equivalent to about \$200 to nearly \$50,000, respectively.²¹ Mostly rich were targeted by initial cruise ship companies. Some major cruise ship lines included:

- Cunard Lines was of the three largest passenger lines during the early 1900’s. It was a British-American owned company which, at one point merged with White Star Lines to rebuild their competitive edge. The funds that resulted in this merging, funded the construction of two “super liners” known as the R.M.S. Mauritania, and the R.M.S. Lusitania. Cunard Lines sustained its competitive edge ever since, and in 1998 sold its rights to Carnival Cruise lines, one of the major cruise lines today, for \$500 million.²²
- White Star Lines was the largest passenger line during the early 1900’s. Most commonly known for its “Olympic” cruise liner the Titanic, this prominent British shipping company had to merge with Cunard Lines after the sinking of their two sister ships, the Titanic and the Britannic, which dealt a great blow to their industry. They became known as Cunard White Star Limited.²³
- Hamburg America gave birth to the first cruise liner. During World War I and World War II they company suffered immense losses. They eventually merged with Hapag-Lloyd lines, a German company that is still around today.²⁴
- Inman Lines was also one of the three largest passenger lines during the early 1900’s. During their growth, they were absorbed by another company known as American Lines in 1902, and again by United States Lines in 1932.²⁵

²⁰ "HMHS Britannic." Titanic-Titanic. 14 Oct. 2009 <<http://www.titanic-titanic.com/britannic.shtml>>.

²¹ "WebTitanic | Titanic Story | Titanic's Maiden Voyage ." WebTitanic | Boarding Page. 14 Oct. 2009 <<http://www.webtitanic.net/framemaids.html>>.

²² Matthews, Jackie , and Maria Andriano. "Cunard History at a Glance." Cunard. 10 Oct. 2009 <www.cunard.com/images/Content/History.pdf>.

²³ "Cunard Line History." RMS Titanic - Ship of Dreams - Award Winning Educational Site. 14 Oct. 2009 <<http://www.titanicandco.com/cunard.html>>.

²⁴ "HAPAG-LLOYD AG -- Company History." Connecting Angel Investors and Entrepreneurs. 2 Oct. 2009 <<http://www.fundinguniverse.com/company-histories/HAPAGLLOYD-AG-Company-History.html>>.

²⁵ "The Inman Line - Passenger lists and Emigrant ships from Norway-Heritage." Passenger lists and Emigrant ships from Norway Heritage. 14 Oct. 2009 <http://www.norwayheritage.com/p_shiplist.asp?co=inman>.

2.3 Tragic Sinkings

The fear of every Cruise Line Company, to this day, is the tragic possibility of one of their vessels sinking. Whether its rogue waves, collisions, or even enemy fire, a ship can only endure so much damage before meeting its watery grave. Throughout the history of cruising, hundreds of ships have suffered catastrophic final voyages; in many situations, causing thousands of lives to be claimed by the sea. The fear imposed onto future passengers dealt great blows to the financial aspect of many cruise ship companies; in some cases completely destroying the company altogether, the White Star Lines being a great example, as stated previously.

2.3.1 R.M.S. Titanic

The Cruise Ship most commonly associated with sinking is the R.M.S Titanic (*Figure 2*)²⁶. The release of the film *Titanic* in 1997 portrayed the ships first and final voyage. White Star Lines suffered a great loss on April 15th, 1912 when the R.M.S Titanic collided with an Iceberg, killing 1,517 of her 2,223 passengers.²⁷ This catastrophe opened the eyes of ship builders when it came to the safety aspect of cruising. Life preservation boats were enlarged to over compensate for the number of cruise ship passengers, and boat hulls were enforced more thoroughly. White Star lines, especially, obsessed over cruise ship safety. They wanted to regain trust and recover from the sinking of the R.M.S. Titanic by redesigning their next ship, the R.M.S. Britannic. They made enough changes to their initial design to add roughly 4,000 tons of extra weight²⁸. These modifications included; a double skin to minimize flooding in case of rupture extended watertight bulkheads, four rows of rivets on plating where stress would be greatest and giant sized lifeboat davits to overcompensate for the ships passengers.²⁹



Figure 2: The R.M.S Titanic

2.3.2 R.M.S. Britannic

The R.M.S Britannic (*Figure 3*)³⁰ is not as widely known as her sisters. She was initially designed as a cruise ship, but the British commissioned her for use as a hospital ship during World War 1 on December 21, 1915, just months after her completion. The R.M.S. Britannic was short lived. She never carried a paying passenger, only wounded soldiers, on her voyages from Italy to England. Not even a year



Figure 3: The R.M.S Britannic

²⁶ Ballard, Robert. "PBS Online - Lost Liners - Titanic." *PBS*. 22 Sep. 2009 <<http://www.pbs.org/lostliners/titanic.html>>.

²⁷ Ballard, Robert. *Ibid*

²⁸ "Diving the HMHS Britannic." *Technical diving, GUE training courses, charters, forum*. 13 Sep. 2009 <<http://www.ocean-discovery.org/britannic.htm>>.

²⁹ "Britanic." *Tripod | Error*. 22 Sep. 2009 <<http://captaindraconian.tripod.com/Britanic.html>>.

³⁰ Ballard, Robert. "PBS Online - Lost Liners - Britannic." *PBS*. 22 Sep. 2009 <<http://www.pbs.org/lostliners/britannic.html>>.

later, on November 21, 1916, in the waters off of the Greek island of Kea, the R.M.S Britannic struck an enemy mine and sank shortly afterward. Though, with all its safety precautions, there were only minimal casualties. Out of more than 1,000 passengers, only 30 were killed, most from initial impact.³¹

2.3.3 R.M.S. Lusitania

The second most well known ship to have sunk was the R.M.S. Lusitania. (Figure 4)³² She was designed by Cunard Lines well before the White Star's "Olympic" class ships were built. After nearly 9 years of service, during World War I, a German U-boat torpedoed the R.M.S. Lusitania, sinking the ship in only 18 minutes. On May 7th, 1915, 30 miles off the coast of Cape Clear Island, the ocean claimed 1,198 lives.³³ Her sinking was, at the time, controversial, since the cruise ship possessed no threat to the Germans. Yet, Germans tried to justify their actions saying that the ship was carrying war materials, and that it was mounted with guns. They claimed that since it was marked as an auxiliary ship and since it passed through a German "war zone" they were not responsible for the lives of any American citizen on board. Many people today believe that the sinking of the R.M.S. Lusitania was a catalyst for American participation in WWI.³⁴



Figure 4: The R.M.S. Lusitania

2.3.4 R.M.S. Empress

The Empress of Ireland, or commonly known as the R.M.S. Empress, (Figure 5)³⁵ was designed and owned by Canadian Pacific's steamships. On her maiden voyage on January 27th, 1906 she proved very reliable, fast, and cautious. Unfortunately she was a little too cautious for her own good. In the early morning of May 29th, 1914 the Empress was outbound from Quebec, while the



Figure 5: The R.M.S. Empress

Storstad, a coal freighter, was inbound to Montreal. Their paths were intersecting so both captains corrected their courses, making it so the ships would pass each other's starboard sides with ease. After they had corrected their course though, a fog bank came in and enveloped both ships. Fearing that the fog would cause the two ships to collide, the captain of the Empress slowed her to a crawl, but in vain. The Storstad collided with the Empress, dealing her a capsizing wound. After a short 14 minutes, the Empress sank

³¹ Ballard, Robert. *Ibid*

³² Ballard, Robert. "PBS Online - Lost Liners - Lusitania." *PBS*. 22 Sep. 2009 <<http://www.pbs.org/lostliners/lusitania.html>>.

³³ Ballard, Robert. *Ibid*

³⁴ Jessup, Pete. "The Sinking Of The Lusitania." *History Times*. 22 Sep. 2009 <www.historytimes.com/fresh-perspectives-in-history/military-history/world-war-1/416-the-sinking-of-the-lusitania>.

³⁵ Ballard, Robert. "PBS Online - Lost Liners - Empress of Ireland." *PBS*. 22 Sep. 2009 <<http://www.pbs.org/lostliners/empress.html>>.

under the water, killing 1,012 of her 1,477 passengers. The Storstad endured minimal damage and made it to shore.³⁶

2.3.5 S.S. Andrea Doria

The S.S. Andrea Doria (*Figure 6*)³⁷ was built as an icon for Italian national pride. She was built to instigate the growth of the Italian economy after World War II. She was constructed by Italian Lines and was launched on her maiden voyage on 14 January 1953. Unfortunately, she was another ship that sank, but in her case, all her passengers and crew had time to evacuate before she sank and disappeared into the ocean. On July 17th 1956, she departed from Genoa for the 51st crossing from Italy to New York. On July 25th, the day before she was to arrive in Boston, the Andrea Doria collided with the S.S. Stockholm, a Swedish Ocean Liner, which dealt her a catastrophic blow. The Andrea Doria took nearly 11 hours to fully submerge into the water, which is why there were no casualties from the sinking. Unfortunately there were 46 casualties due to the initial impact of the two ships.³⁸ The S.S. Andrea Doria was the last major transatlantic passenger vessel to sink before aircraft became the preferred method of travel.³⁹



Figure 6: The S.S. Andrea Doria

2.4 Cruise Shipping in Venice

The city of Venice is unique in the sense that it is entirely maritime based. That being said, the monitoring of cruise ships in the Venetian lagoon is critical to a smooth running harbor. In 1997, the Venetian Port Authority created the Venezia Terminal Passeggeri S.p.A. (VTP) to oversee private ships in the harbor. VTP monitors ferries, private and public yachts, hydrofoils and the largest of all, cruise ships. Since 1997, they have kept detailed statistics of the passenger vessels in the port, down to the very last person on board.⁴⁰ These figures illustrate a steady but rapid increase in the presence of cruise ships in the harbor. The years between 1998 and 2008 saw the number of cruise ship calls (dockings) rise from 227 per year to 535 per year. While cruise calls doubled, cruise passengers almost tripled 335,483 to 1,225,088 (*Figure 10*)⁴¹. Referring back to the WTTC statistics, this means that in the same time it took worldwide cruise ship passengers to increase 95%, passengers in Venice increased 250%. VTP doesn't expect

³⁶ Ballard, Robert. *Ibid*

³⁷ Ballard, Robert. "PBS Online - Lost Liners - Andrea." *PBS*. 22 Sep. 2009 <<http://www.pbs.org/lostliners/andrea.html>>.

³⁸ Ballard, Robert. *Ibid*

³⁹ Grace, Michael L.. "Cruise Line History - Cruising The Past - Cruise History." *Cruise Line History - Cruising The Past - Cruise History*. 2 Oct. 2009 <<http://cruiselinehistory.com/?p=958>>.

⁴⁰ "VTP Company." Venezia Terminal Passeggeri S.p.A. <http://www.vtp.it/pages/azienda.jsp?idm=QV9U4KV1T7NUJU79NCV910SK3R3G36W2&m=0> (accessed September 10, 2009).

⁴¹ "VTP Statistics." Venezia Terminal Passeggeri S.p.A.. <http://www.vtp.it/pages/statistiche.jsp?language=1> (accessed September 10, 2009).

this growth to slow any time soon; they have predicted that 2009 will yield 560 cruise calls and 1,397,981 passengers.⁴²

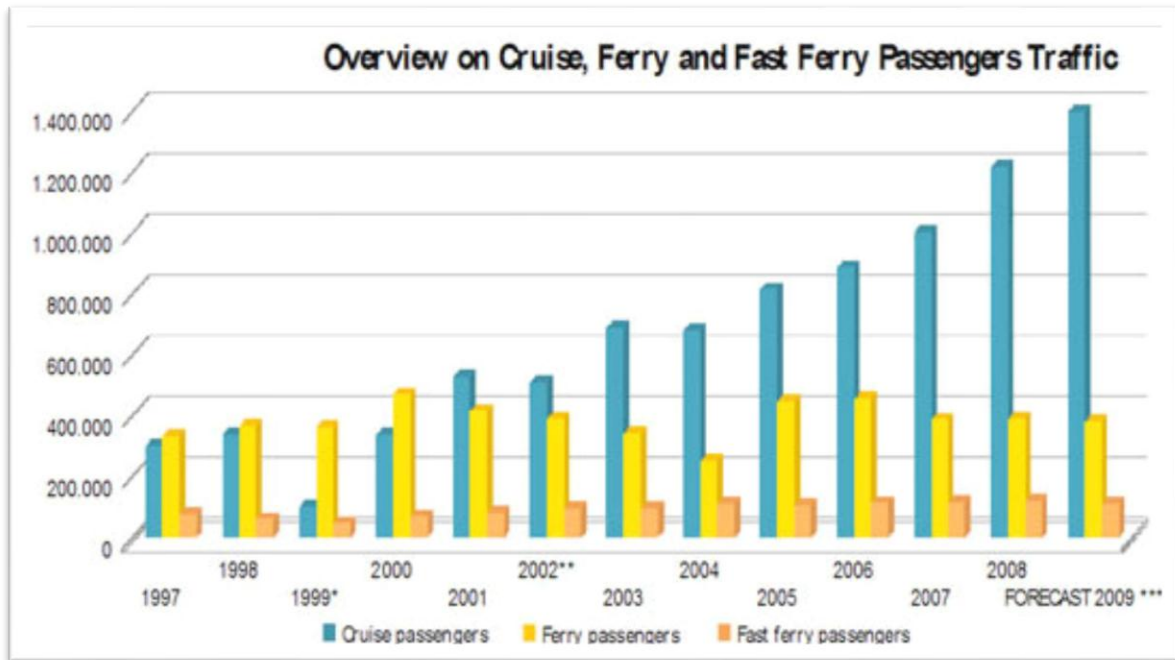


Figure 7: Overview of Boat Passenger Traffic

2.5 Inner Workings of Cruise Liners

Cruise ships are extremely large boats that house thousands of people at a time and carry tons of food, drinks, and luggage. Their purpose as boats in these circumstances is quizzical, because they transport people all over but in the end, they bring them back to where they departed. These behemoths average a weight of 100,000 gross tons alone;⁴³ the question is how do they float, how do they keep themselves from sinking if they hit something, and how do they make themselves move. The hulls of these giant ships are usually made from a lightweight and sturdy metal, and are spread out to disperse the weight so it becomes buoyant. The hulls are rounded to reduce drag and make them travel more efficiently. Having a rounded bottom, they sit in the water, travel at a slow pace, and are extremely stable. There is usually no rocking sensation with a rounded bottom as opposed to a V shaped bottom, which that sensation is common on; with a V shaped bottom, the boat can cut through the water and raise itself up out of the water. With the

⁴² VTP Statistics *ibid*

⁴³ Briggs, Josh. "HowStuffWorks "How Cruise Ships Float"." Howstuffworks "Adventure". <http://adventure.howstuffworks.com/cruise-ship2.htm> (accessed October 1, 2009).

possibility of colliding with things in mind, the designers of these ships gave an inner tube like shield; a double hull. If the ship were to collide or ram something, it would only sustain damage to its outer hull most likely, limiting the amount of water it would take on. If the damage was so severe that it was to penetrate both hulls, a third line of defense to stop the water would be there; the bulkheads. These vertical dividers are watertight compartments that were installed behind the inner hull, to stop the whole ship from being flooded so it would stay afloat.⁴⁴

Older ships used diesel engines to power the propellers that pushed the water. The transmission of the ship was similar to the transmission to a car; it determined the RPM of the propellers. Some of the larger ships used an “Aero derivative gas turbine” system, which ignited compressed air in a combustion chamber. The exhaust gases from that reaction would be forced over a turbine to provide the ship with mechanical energy, which could then be used to spin the electrical generators. These older ships would require roughly 380 tons of fuel per day if it were to travel full speed. The ships would usually carry enough fuel for 12 days of travel.⁴⁵

The newer ships of modern times are equipped with Azimuth Thrusters, which are propellers that are housed inside a pod that can rotate a full 360 degrees for extreme maneuverability. This type of propulsion replaced having rudders; for with the extreme maneuverability, the rudders were not needed. They also have better benefits over the traditional propellers, such as decreased stopping distance, greater fuel efficiency, and better maneuverability. As shown in *Figure 11*⁴⁶, these engine rooms for these goliaths are located in the stern, or the back end of the ship. The control room where the captain and his crew navigate the ship is in the front or bow of the ship, so they can see everything that’s coming at them.⁴⁷

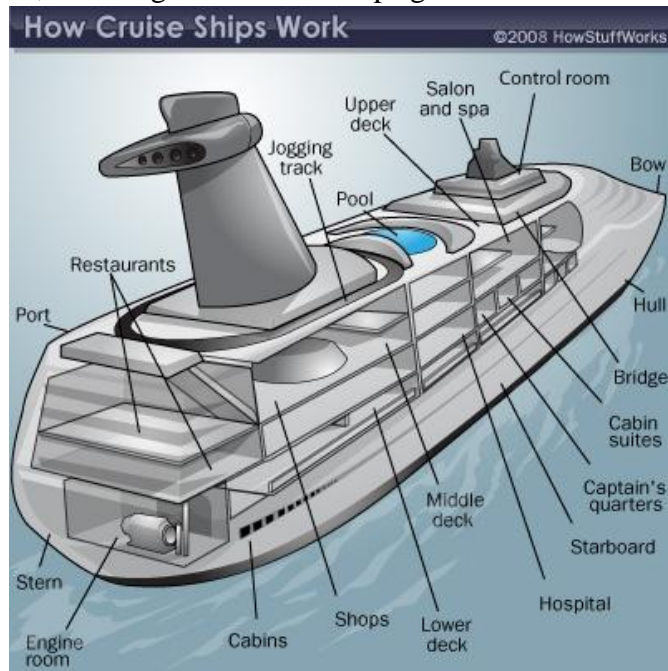


Figure 8: Inner Workings of a Ship

⁴⁴ Briggs, Josh *Ibid*.

⁴⁵ Briggs, Josh. "HowStuffWorks "How Cruise Ships Move"." Howstuffworks "Adventure". <http://adventure.howstuffworks.com/cruise-ship3.htm> (accessed October 1, 2009).

⁴⁶ Briggs, Josh. "HowStuffWorks "Inside a Cruise Ship: Amenities and Jobs"." Howstuffworks "Adventure". <http://adventure.howstuffworks.com/cruise-ship4.htm> (accessed October 1, 2009).

⁴⁷ Briggs, Josh. "HowStuffWorks "How Cruise Ships Move"." Howstuffworks "Adventure". <http://adventure.howstuffworks.com/cruise-ship3.htm> (accessed October 1, 2009).

3. Environmental Impact

Chapter One pondered numerous ways in which cruise ships can leave their mark on the environment. Sadly, a majority of these ways are detrimental. The small harbor of Venice is highly susceptible to the adverse effects of cruise ships. However, as will soon be addressed, there have been numerous studies offering conflicting results on the environmental impact of these ships. Determining the true extent to which these vessels harm the city would provide key information regarding future ship policy. Controls on emissions and other sources of detriment could be regulated by the city to ensure the preservation of the surrounding environment.

This objective was split up into three sub-objectives:

1. Measure the cruise ships' affect on the hydrodynamics in canals
2. Measure the amount of particulate matter that is present during and after the presence of cruise ships
3. Measure the vibrations cause by the passing of the ships.

3.1 Measuring the cruise ships' effects on hydrodynamics in canals

In 2009, *The Venice Report*, an in depth publication highlighting the inner workings on the city of Venice, was released by the Venice in Peril Foundation. This foundation published the report in collaboration with Oxford University and the British Committee for the Preservation of Venice. The report covered many aspects pertaining to the effects of cruise ships in Venice, including their hydrodynamic properties and how they affect natural flow of the canals. The report highlights the effects of the passing cruise ships on the adjacent canals that feed into the Giudecca Canal.

However, the two studies cited by the report gave conflicting views. The first, a petition presented by neighborhood communities, claimed that the cruise ships sped up the speed of the smaller canals bordering the Giudecca and increased the decay of the canal walls. It has long been suspected that the passing cruise ships increase the natural flow of the canals to a point where the degradation is subsequently increased, but no study has yet confirmed such claims. The second study, a response to the petition by the Venezia Termini Passeggeri in 2007, claimed that the cruise ships produce fewer wakes than the vaporetti due to the shape of their hulls and their slow speed through the canal. The VTP also quoted an earlier study in 2003, where Mr. Adami concluded that the “increase” in speed of the canals was no more than that of the normal tides.⁴⁸

⁴⁸ Da Mosto, Jane , Thierry Morel, Tom Spencer, Enrico Tantucci, Renato Gibin, Stefania Tonin, Fabrizio Fracchia, Roberto Agnoletto, Francesca Mattassoglio, Lidia Panzeri, and Anna Somers Cocks. *The Venice Report* (2009): Print.

3.1.1 Methodology

The massive displacement of cruise ships does not create a noticeable wake as small crafts do, but rather a slow, steady suction as it forces the water underneath its stern. This suction is negligible in the open ocean; however a cruise ship in the Giudecca Canal is a different story. The small canals on either side of the Giudecca Canal are susceptible to changes in normal flow under the influence of this suction.

A float device consisting of a sinker, fins, and a float tied together with fishing line was used to measure the velocity of the canal flow. (See Figure A 21) The fins, designed to act as underwater sails, were suspended from the float at the approximate mid-depth of the canal. This device was placed in the middle of the canal, and a set distance of 6.87 meters was marked along the fondamenta. When the flow of the canal carried the device across the first boundary, a stopwatch began timing. Timing was stopped when the device crossed the end of the 6.87 meter distance. The velocity of the water flow was calculated using these values. Using canal dimensions, the flow rate was also determined.

This procedure was carried out in canals that line the Giudecca Canal. Specifically, the Rio del Fornasa proved to be a prime testing area. It is one of the 4 canals that flow solely in one direction: towards the Giudecca. It is also the easiest to access and has the least amount of boat traffic (See Figure A 20). Measurements were initially taken before any ships had passed to obtain a control time. (See Figure 9). Next measurements were taken during the pass to determine the immediate effects on canal flow. (See Figure 10). Comparing these two types of measurements revealed the effect that passing cruise ships had on canal hydrodynamics. To further investigate the effects of hydrodynamics, tests were done directly after the passing, and a few minutes after the passing of the cruise ship. (See Figures 11 and 12). To determine the possible effects on canal walls during the cruise ship passing, no physical data was obtained. Although the visual produced during the pass called for further research.

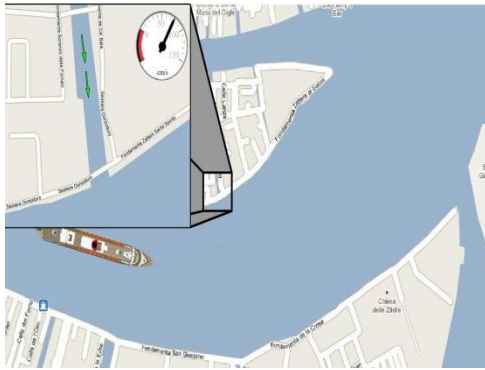


Figure 9: Before Ships passes canal

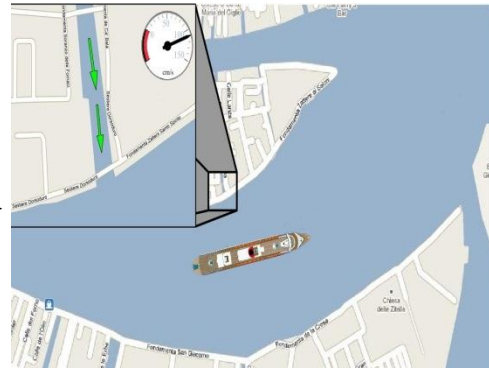


Figure 10: During Ship passing

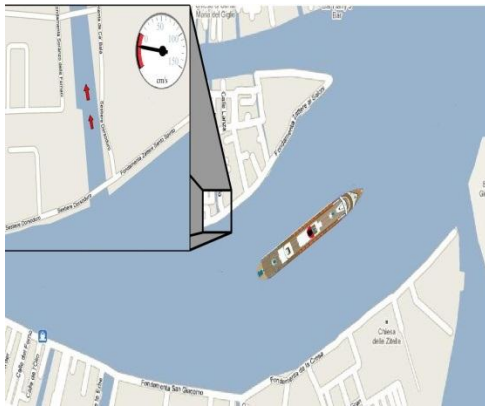


Figure 11: Directly after the ship passes

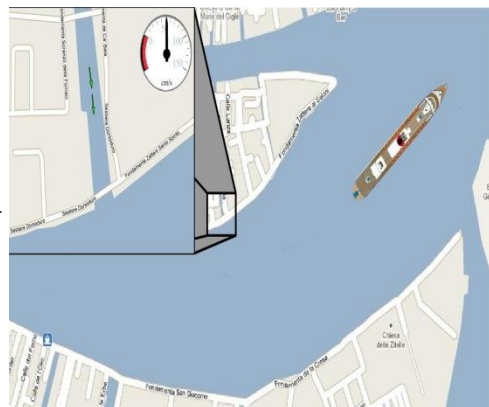


Figure 12: A few minutes after the ship passed

3.1.2 Results and Conclusion

The hydrodynamic testing produced remarkable results. The cruise ships all had a major impact on the flow of the canal. We performed a total of 7 tests, although we attempted many more. Boat traffic, weather implications, and the unpredictable cruise ship arrival times prevented us from obtaining an adequate amount of tests. On average, the natural volumetric flow of the canal is $.91 \text{ m}^3/\text{s}$, during a passing, it is increased to an average of $1.51 \text{ m}^3/\text{s}$. The average speed of the canal increased by an astounding 62.8%. Immediately after the passing of the cruise ship, all the water that was sucked under the hull was pushed back out, briefly reversing the natural flow of the canals. In theory, the

constant changes to the canals natural flow increases the amount of deterioration endured by the canal walls and the surrounding fondamente (*Figures 9-12*).

As for the hydrodynamic impacts, the increase in flow of the canal as the cruise ship passes causes the natural state of the canal to be altered. The canal velocity was not the only thing affected by the passing of the ships, the direction of the canal was also altered. This is a true testament to the sheer force of the water displaced by these commercial liners as the canal the tests were performed on was specifically chosen because of the single direction characteristics of its flow. Although this project provided no specific correlation between the increase in flow and the deterioration of the canal wall, the concept is well founded.

Test #1	3/11/2009	Distance - 6.27 Meters						Test #4	9/11/2009	VERY SMALL SHIP							
Costa Fortuna	Control	During Passing	After Passed		Moved back .37 meters and then moved forward	Control AVG	Flow Increase	Saga Rose	Control	During P	After Passed	Fast Ferry Passed	Control AVG	Flow Increase	AVG Increase		
	1.09.59	0.27.55	1.09.59						1.10.00	1.37.02	1.13.04						
	0.49.57								1.06.04								
	0.56.69				Vaporetto passing				1.09.07					%			
	0.57.70								1.10.02				65.122	62.2895	62.7769		
	1.07.70					58.7755556	53.1268		0.31.07								
	0.52.86								1.21.01								
	0.52.57								0.46.30								
	1.00.05								1.02.30								
	1.02.25								0.46.20								
									1.04.00								
									1.12.08								
Test #2	4/11/2009							Test #5	9/11/2009								
Grand Princess	Control	During Passing	After Passed		Moved back 3.84 meters and then took 18.03 seconds to go 6.27 meters	142.7575	77.3742	Costa Fortuna	Control	During P	After Passed						
	2.21.07	0.32.30	0.18.03						1.37.80	0.34.10	0.53.30						
	2.12.84								1.14.90		0.22.10				%		
	2.43.24								1.22.40		0.32.30				78.0444444	66.3069	
	2.12.88								1.20.00								
									1.14.00								
									1.26.80								
Test #3	7/11/2009							Test #6	15/11/2009								
Costa Victoria	Control	During Passing	After Passed					Costa Serena	Control	During P	After Passed						
	1.37.00	0.38.09						1.10.20	0.16.20	0.49.90	Moved back 6.5 feet in 5.2 seconds then moved forward entire distance in 0.49.90		75.34	78.4975		
	1.36.09								1.23.60								
	1.38.01					93.053	59.0663		1.09.70								
	1.27.08								1.15.30								
	1.24.07								1.17.90								
	1.31.07																
	1.19.01																
	1.26.08																
	1.35.04																
	1.57.08																

Figure 13: Hydrodynamic Results

3.1.3 Future Recommendations

In the very limited amount of data that we gathered, it is suggested that these cruise ships are producing significant alterations of the natural flow and direction of the canals adjacent to the Giudecca. This prompts the need for the continuation of the testing and a more in-depth and standardized testing procedure. The location used throughout our series of tests is an ideal location and could be reused with the continuation of the testing. To accurately measure the speed of the canal, the testing distance should be at least

double the length of the original distance (6.87 meters) used throughout the duration of our project. The continuation of the testing would also require a higher number of tests to gather accurate and conclusive results. Multiple control tests before and after each ship are required to gain enough data to compare the important results with.

Another key area of the testing that needs to be addressed is “kickback” of the canal after the ship has passed. When the canal changes direction after the cruise ship has passed, the float needs to be timed from the moment it starts to move until when it stops. The distance should then be recorded for later use and the float should continue forward flow and be timed over the set distance as in normal tests. If any trends or significant results do arise, the project can again evolve to incorporate the possible implications of the increased flow. This would mean a correlation between the increase flow of the canal and its effects on the degradation of canal walls.

3.2 Measure the amount of particulate matter that is present during and after the presence of cruise ships

Cruise ships are known for their luxury and comfort. Their sole existence is to produce capital by providing passengers with these luxuries. Nevertheless, these amenities come at a price, which the environment has to pay for. In today’s world, cruise ships hold anywhere from 256,872 gallons of fuel, up to 1,195,446 gallons of fuel.⁴⁹ Of these cruise ships, most are fueled by diesel fuel and fuel-oil. One ton of diesel fuel is composed of approximately 264.2 gallons; Meaning that these ships can carry up to 4,550 tons of diesel fuel. The burning of diesel fuel produces many harmful emissions, which include carbon dioxide, and black carbon (*Figure 14*)⁵⁰.



Figure 14: Pollution from the Smoke Stacks

An annual report from Carnival, which is comprised of 11 cruise lines, stated that their ships emit approximately 401 grams of Carbon Dioxide per passenger.⁵¹ The Telegraph reports that this is more than three times the amount of Carbon Dioxide put out per passenger for a Boeing 747. Ocean water is greatly affected by the production of carbon dioxide. Ocean’s absorb nearly twice as much carbon dioxide as our atmosphere. After long term exposure to carbon dioxide produced by the burning of fossil fuels, ocean’s become overwhelmed with and become more acidic. A marine chemist by the name of Andrew Dickson states that, “oceans are getting more acidic. Lab experiments have shown that organisms find living more difficult as the CO₂ increases.”⁵² Black carbon, another emission, is produced through the incomplete combustion of fossil fuels. Magee scientific, a major producer of air-particulate readers, states that “black carbon is a

⁴⁹ "Vessel Traffic." *Nuka Research and Planning*. 20 Sep. 2006. 29 Sep. 2009
<www.dec.state.ak.us/spar/perp/docs/060920vesselreport_s.pdf>.

⁵⁰ Krystallon. www.krystallon.com/blog/?p=296 (accessed October 10, 2009).

⁵¹ "Cruise Ships Worse For Environment Than Planes." *Environmental Leader*. www.environmentalleader.com/2008/01/22/cruise-ships-worse-for-environment-than-planes/ (accessed September 5, 2009).

⁵² Diego, UC San. "Carbonated Oceans." *YubaNet.com | We Deliver News to the Sierra*. <http://yubanet.com/scitech/Carbonated-Oceans.php> (accessed October 4, 2009).

primary aerosol component of diesel fuel.”⁵³ They summarize their data in the following table:

1. **Black Carbon** is a known toxin and regulated pollutant by several regulatory agencies, including the California Air Resources Board (CARB).
2. **Diesel Particulate Matter** is known to cause adverse health effects in people who are exposed, including premature hospitalization, asthma attacks, bronchitis, other respiratory and cardiovascular symptoms, and premature death.
3. **Black Carbon** is the second leading cause of Global Warming.
4. **Black Carbon** is emitted as a primary pollutant to the atmosphere through a variety of incomplete combustion of sources and fuels; BC concentration cannot be modeled or predicted, it must be measured.
5. **Black Carbon** is not adequately characterized through PM-2.5 mass only measurements, chemical speciation is necessary.⁵⁴

Magee Scientific produces a device called an aethalometer that is designed to measure the amount of particulate matter pollution in the air, specifically black carbon. The basic layout of the aethalometer consists of a white paper, a light, and a digital reader. The air is pulled through the paper and the black carbon is filtered out and adheres to the paper. The paper is then illuminated from the back by the light and read by the digital reader, much like a spectrophotometer. Particulate black carbon is measured by the amount of “blackness” that has been collected on the paper. Although originally a cumbersome device, newer models have become handheld and can be used anywhere in the field⁵⁵.

3.2.1 Future Recommendations

Unfortunately, due to time constraints and conflicting schedules, the project group was not able to secure an aethalometer for use. However, if an aethalometer is secured for use at the project center, the students should take full advantage of its abilities. Measurements should be taken all along the path cruise ships take: the Lido inlet, Giardini, San Giorgio Maggiore, Piazza San Marco, Punta della Dogana and along both sides of the Giudecca. These measurements should be taken while the cruise ships are passing these locations. Most importantly, measurements should be taken where the cruise ships are moored: at the Stazione Marittima. Measurements should be taken here at regular time intervals to monitor the black carbon output (if any) over the duration of the ships stay. These readings should be compared to ones taken at the same locations, however with no cruise ships passing.

⁵³ "as quoted in Magee Scientific Company - Real-time scientific measurements." Magee Scientific Company - Real-time scientific measurements. <http://mageesci.com/index.htm> (accessed September 29, 2009).

⁵⁴ As quoted in MaGee *Ibid*

⁵⁵ Magee *ibid*.

When all the data has been compiled, compare the observed black carbon levels with any port or government regulations, as well as industry standards and health regulations. Also, if possible, attempt to correlate emissions with fuel grade and engine size and number. These characteristics of cruise ships are available to the public through many sources.

Future project groups exploring this element of cruise shipping are advised to contact Jeff Blair, CEO of Magee Scientific and former VPC student, and Dr. Grisa Mocnik, Director of Aerosol d.o.o. It is extremely important to make contact as early as possible. Reach out to Jeff, and talk to him about fuel emissions, black carbon, and possible collaboration with Magee Scientific. Jeff has a plethora of knowledge in the area and is more than willing to assist you. If possible, secure an aethalometer early in A-term so testing may begin immediately upon arrival in Venice. Dr. Mocnik is the director of the production plant of aethalometers based in Ljubljana, Slovenia. She will be more than willing to organize a meeting and facilitate a tour of the Aerosol plant in Ljubljana.

3.3 Measure the vibrations caused by the passing of ships

One of the often-overlooked aspects of the cruise ships in Venice is the vibration they produce. There has been suspicion regarding the effect of vibrations on the city structure. A study by the Istituto Idrografico concluded that in 2003, the sensitive gauge placed on Saint Mark's bell tower to measure the oscillations of the sea recorded "exceptional vibrations"⁵⁶ with every passing of a cruise ship was published in the 2009 Venice Report. Reports of vibrations were also published in Migropolis, a 2009 report on the city of Venice. Migropolis, however, also linked the vibrations to the deterioration of foundations and structural content of the city itself. By shaking loose the small particles holding the foundations together, these alleged vibrations were causing decay in canal walls and the collapse of sections of fondamente.

3.3.1 Future Recommendations

If the vibrations caused by the passing cruise ships are going to be investigated by a future project, serious consideration must be given to the testing procedure. One method of testing the vibrations would be to use the gauge on the side of San Marco's bell tower in Piazza San Marco. This gauge is quoted in The Venice Report as being the main instrument for the measurement of the vibrations. This gauge was not available to us due to the construction taking place around the base of the bell tower. An alternative method would be to use accelerometers and an arduino unit to measure the vibrations. These units can be placed at key locations across the city, specifically San Marco and point along the Giudecca canal. Both of these methods would require multiple baseline tests with no passing ships as a control to guarantee accurate results.

⁵⁶ Venice Report *ibid.* p44

4. Economic Impact

As touched upon in chapter one, travel and tourism, and therefore cruise ships, are economic forces to be reckoned with. The massive growth of cruise shipping in Venice over recent years has opened the city up to unimaginable profit. This project will seek to determine where passengers spend their money, and how much of it they spend.

4.1 Determining where passengers spend their money and how much

The early cruise ships served to bring passengers from point A to point B in luxury. Unbeknownst to anyone at the time, vessels such as the Titanic and Andrea Doria were part of a movement that would escalate far beyond what it began as. Though initially developed as a mode of transportation, cruise ships have evolved to become an inherent tourist attraction. The focus of these cruises is no longer the destination, but the ride itself, highlighted by on-board casinos, restaurants, pools and amusement. Regardless of all of the changes made, present day cruise ships remain under this economic umbrella. Cruise ships have made themselves comfortable in one of the most resilient and secure industries on the planet: travel and tourism

The state of travel and tourism in the world has been monitored by the World Tourism and Travel Council (WTTC) since 1990. Currently, WTTC is headed by President and CEO Jean-Claude Baumgarten, a French businessman who spent almost 30 years in management with air France, eventually climbing to become the Advisor to the Chairman. He, along with an executive team of similar backgrounds and over 100 members, seek to profile the status of travel and tourism, as well as its impact on the world's economy.⁵⁷ Publications profiling 176 countries are released annually, and plans to study and report on individual cities are underway. The largest publication, however, is *Progress and Priorities*, the yearly report on achievements and progress toward their ultimate goal of publicizing the economic power of travel and tourism. It also contains the financial information regarding travel and tourism in the world economy, revealing just how much the industry has been growing, and the numbers are astonishing.

Progress and Priorities 2007/08 states that in 2007, the direct and indirect elements of travel and tourism were expected to account for 10.4% of the world GDP, roughly \$5.39 trillion. Over 231 million jobs were expected to be a result of travel and tourism, representing over 8% of the world's total employment.⁵⁸ These numbers increased in the next year, when WTTC released *Progress and Priorities 2008/09*. It estimated that in 2008, the direct and indirect impact of travel and tourism would total to \$5.89 trillion, and would contribute 238 million jobs to the world's employment.⁵⁹ To put this in perspective, \$5.89, and even \$5.39 trillion, is larger than the national GDP of every country in the world except for the United States. These numbers are expected to only go up. WTTC predicts that by 2019, the contribution to the world GDP will be \$10.48 trillion, more than double Japan's current GDP.⁶⁰

⁵⁷ "A History of the World Travel & Tourism Council." World Travel & Tourism Council . <http://www.wttc.org/bin/pdf/temp/wttchistory.html> (accessed October 7, 2009).

⁵⁸ *Progress and Priorities 2007/08* *ibid*.

⁵⁹ *Progress and Priorities 2008/09* *ibid*.

⁶⁰ "Report for Selected Countries and Subjects." IMF -- International Monetary Fund Home Page.

<http://www.imf.org/external/pubs/ft/weo/2009/01/weodata/weorept.aspx?sy=2008&ey=2008&scsm=1&ssd=1&sort=country&ds=.&b>

These same trends can be seen in Italy, where tourism and travel account for one third of the country's \$2.3 trillion (€1.6 trillion) GDP, €30 million of which is direct spending of tourists.⁶¹ In both 2007 and 2008, WTTC ranked Italy eighth out of 176 in countries expected to generate the most travel and tourism demand (Figure 7).^{62,63} This is no surprise, as Italy will annually see over 72,000,000 international tourists.⁶⁴ The capital city of Rome attracts on average 20,000,000 yearly visitors⁶⁵, and so does the historical city of Venice. It is estimated that the tourists in Venice bring about €1 billion to the city annually.⁶⁶ As these figures show, the economy due to travel and tourism the world around in on a booming rise, and as an element of the industry, cruise shipping is rising as well.

ON AN ABSOLUTE SCALE		
Countries expected to generate the largest volume of Travel & Tourism Demand in 2008:		
T&T Demand, 2008 (US\$ bn)		
1	USA	1,747.5
2	China	592.0
3	Japan	514.3
4	Germany	505.7
5	France	418.8
6	UK	403.7
7	Spain	338.2
8	Italy	302.9
9	Canada	231.4
10	Mexico	157.6

Figure 16: WTTC Demand Forecast 2008

The same recession that dropped American, European and Asian markets to record lows also struck the world of travel and tourism. The WTTC's predictions made in *Progress and Priorities 2008/09* were far undercut by what truly came to be. 2008 saw the weakest

ON AN ABSOLUTE SCALE:	
Countries expected to generate the largest volume of Travel & Tourism Demand in 2017:	
Travel & Tourism Demand 2007 - 2017 (US\$ mn)	
1	United States 3,067,977.0
2	China 1,571,015.0
3	Japan 981,437.6
4	Germany 744,910.7
5	United Kingdom 605,124.6
6	France 542,658.2
7	Spain 503,957.5
8	Italy 395,970.7
9	Russian Federation 324,352.7
10	Canada 311,412.6

Figure 15: WTTC Demand Forecast 2007

As it stands, travel and tourism

appear to be a rock solid economic power. However, there are some discrepancies. As seen in Figures 15 and 16^{67,68} though Italy remained ranked 8th, the total demand *decreased* from 2007 to 2008. In an industry that has seen such immense gains over the past 10 years, what could possibly cause a reduction in demand? Yet notice when this decrease occurred: at the beginning of a global recessionary period.

r=1&c=512%2C941%2C914%2C446%2C612%2C666%2C614%2C668%2C311%2C672%2C213%2C946%2C911%2C137%2C193%2C962%2C122%2C674%2C912%2C676%2C313%2C548%2C (accessed October 2, 2009)

⁶¹ "The Italian Economy." The Italian Ministry of Foreign Affairs.

www.esteri.it/MAE/EN/Benvenuti_in_Italia/Conoscere_Italia/Economia.htm (accessed September 13, 2009).

⁶² *Progress and Priorities 2007/08* *ibid*.

⁶³ *Progress and Priorities 2008/09* *ibid*.

⁶⁴ Using "Italy", "Other, including Intl Visitor Numbers" from 1998 to 2008. Tourism Impact Data Forecasting Tool *ibid*.

⁶⁵ Rome Tourist Information *ibid*.

⁶⁶ Canal maintenance *ibid*.

⁶⁷ *Progress and Priorities 2007/08* *ibid*.

⁶⁸ *Progress and Priorities 2008/09* *ibid*.

percentage increase in travel and tourism economy, 1.0%, since the years immediately following September 11th, 2001 – the four years before 2008 each saw annual increases of 3.6%. What is even worse is that the WTTC predicts that 2009 GDP growth will be -3.5%, down \$400 billion to \$5.474 trillion, and will only expand by .25 % in 2010. The total direct and indirect employment is taking a hit, and is expected to decrease 2.8% for 2009. All of these numbers seem to abolish the idea that travel and tourism is a successful element of the world economy. But it is what the WTTC predicts to happen *after* 2010 that confirms the true economic power of the industry.⁶⁹

The times of economic despair will be short according to the WTTC. In the *Travel & Tourism Economic Impact Executive Summary 2009*, WTTC stated that “looking beyond the current crisis, [travel and tourism] is expected to resume its leading, dynamic role in global growth.”⁷⁰ They predict that the next ten years will see an average per-annum increase of 4.0% in the travel and tourism total contribution to the world GDP. Employment is also expected to rise 2.4% annually (*Figure 17*)⁷¹. These predictions are not baseless; the industry numbers returned to normalcy shortly after a similar decrease in September of 2001. What these numbers reveal is not a weakness that travel and tourism has, but rather an incredible resilience and a resistance to failure. The trends displayed by this element of the economy ensure its security for years to come, and cement it as a financial powerhouse in the modern global economy.⁷²

⁶⁹ *Travel & Tourism Economic Impact Executive Summary 2009* (2009): 3-8, http://www.wttc.org/bin/pdf/temp/exec_summary_2009.html.

⁷⁰ as quoted in *Travel & Tourism ibid.* pg 3

⁷¹ *Economic Impact ibid.*

⁷² *Travel & Tourism ibid.*

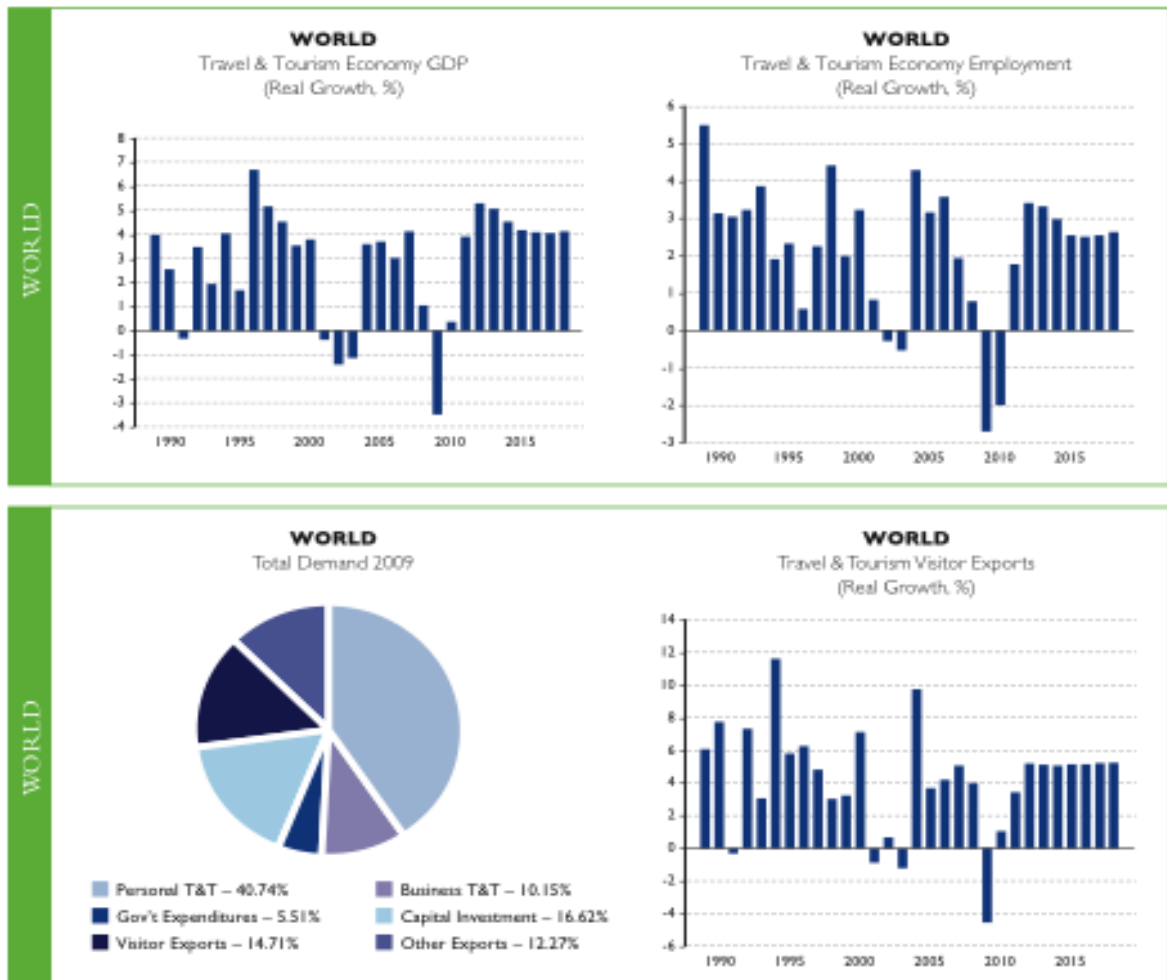


Figure 17: WTTC Predictions until 2019

The WTTC not only monitors the economics of travel and tourism, but also the tourist numbers and modes of transportation. According to their statistics, cruise shipping has seen an increase akin to that of the entire industry. Between 1998 and 2008, international tourist numbers climbed 36% from 1,291,120,000 to 1,756,310,000, and international cruise ship passengers rose from 17,069,100 to 33,358,300, an increase of over 95%.⁷³ This means that in the same ten-year period, world tourists increased by one third, but cruise tourists almost doubled. This lopsided growth illustrates the resurgence that cruise shipping has experienced in recent years. This massive worldwide expansion has fostered the success of smaller areas involved in cruise shipping, especially the quaint, unique city of Venice.

Crewmembers also play a great part in the Venetian economy. Although they do not pay any expenses while aboard the ship itself, many of them do disembark with the passengers. The crew makes up more or less 33% of the population aboard any ship, an average of 1,200 personnel, and because they have no expenses, most of their money will go towards the countries and cities they visit. The crewmembers cannot all disembark at

⁷³ Using “World”, “Other, including Intl Visitor Numbers” from 1998 to 2008. Tourism Impact Data Forecasting Tool *ibid*.

the same time due to safety regulations and their job responsibilities, however they often do have time to leave the ship. Whether it's to shop for food or souvenirs, if they leave the ship they will most likely spend some money. If we low-ball estimate a total of 10 euro per crewmember that disembarks, and assume 35% of the crewmembers disembark, then we could possibly have a grand total of roughly 4,200 Euro going towards the Venetian economy. This total is strictly per cruise ship, and in 2009 alone there were 560 cruise calls. All told, crewmembers spending this amount of money would produce 2,352,000 Euro this year alone.

4.1.1 Methodology

The most practical way of obtaining data regarding the spending habits of passengers is to ask them directly. This project incorporated the use of a survey to collect quantitative and qualitative elements of passengers' impacts on the economy. A questionnaire asking how much money was spent, where it was spent, what their nationality was, their party size, which ship they belong to and how many days they expect to spend in Venice was administered to passengers returning from a day, or more, on the city (See Figure A 8). We also noted the male to female ratio and age of the passengers. These questionnaires were composed in Italian, French, Spanish and English to accommodate likely language barriers. Surveying was administered at the cruise ship passenger drop off/pick up areas in Piazzale Roma while these passengers waited for their bus (*Figure 18*). Passengers were approached by groups of two students; one administering the questions, and the other recording the data.

Taking a closer look at our survey in a statistical point of view, shows a randomized block design, meaning that; all the experimental units, passengers in this case, will be broken up into X amount of blocks, parties or groups of people, all having size X, the size of their party (in this case not all the same numerical size). These passengers also shared the same point of interest: they came off of cruise ships into Venice. This setup sped up the process, had negligible to no cost, and produced the most precise data, which in turn



Figure 18: Surveying area located in Piazzale Roma

will produced more results, as well as produced ease for the passengers. By analyzing the data, we established the average per day per person spending, as well as identified the main passenger attractions.

4.1.2 Results and Conclusion

The completion of our survey resulted in the data from 112 individuals. These individuals were part of 32 parties, with roughly a 50-50 male to female ratio. The average age of these passengers was roughly 46 years old. The data collection came from 5 different cruise ships over 7 cruise calls. The main country of origin was the United States aboard all these ships. These cruise ship passengers dispersed all throughout Venice, although Piazza de San Marco was most visited, along with its neighboring churches and museums. The sum spent by the 112 individuals as a group totaled 19,875 Euro, with each individual spending an average of 83.38 Euro per day. The average cumulative expenditure for passengers who only spent one night in Venice was 75.10 Euro, for two nights 208.21 Euro on the second night, and for 221.53 Euro for three days.

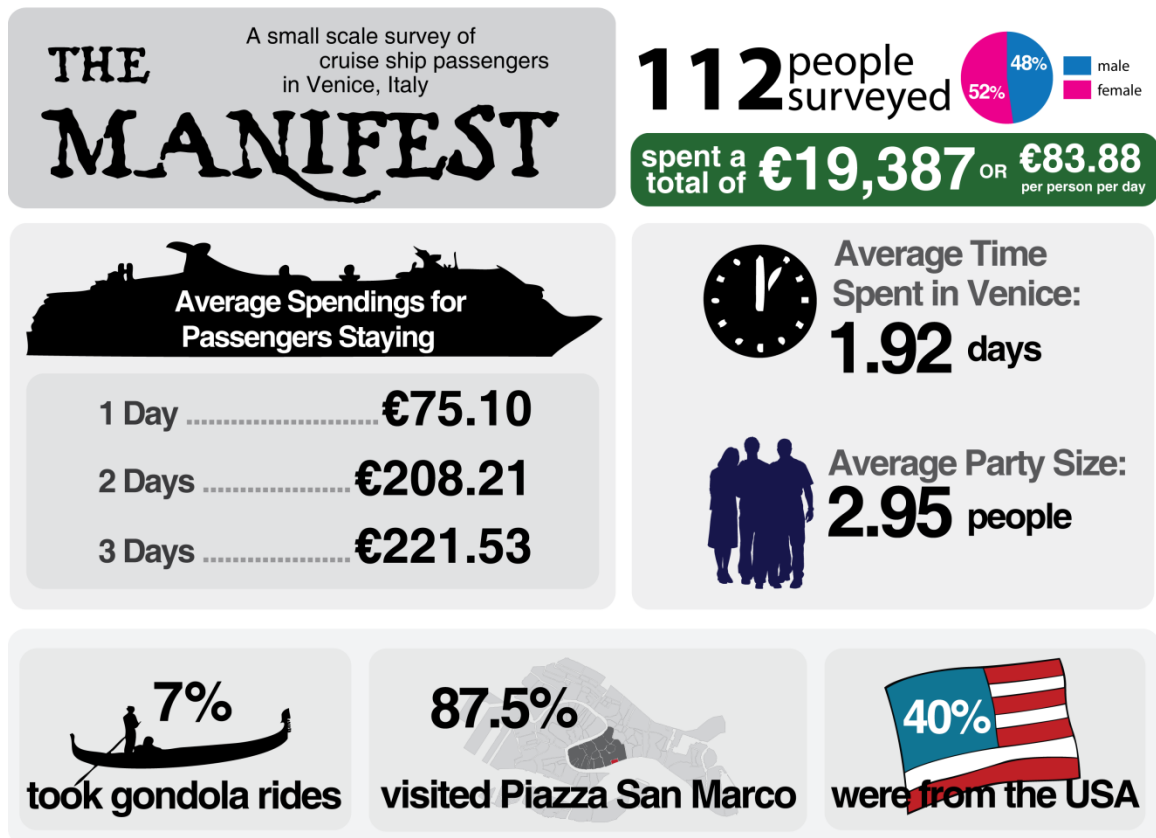


Figure 19: Info graphic of surveying results

The above graphic depicts all of the information obtained from the surveying of the cruise ship passengers. Everything from average spending to percentages of passengers visiting San Marco is covered and clearly stated.

4.1.4 Future Recommendations

With a survey yielding only 112 total subjects, this data can only make suggestions as to the spending habits of passengers. A project team devoted to surveying passengers would yield a far greater number, giving further validity to the results of the experiment. If surveying in this way, it is imperative to be at the bus stops at least 2 ½ hours before the ships departure to catch passengers. Having the survey translated into common languages, such as Italian, Spanish, French and German will allow the group to reach out to more and more passengers.

Future groups should also consider the economic impact of the crew. The same survey could be used; however reaching the target will be more difficult. Since the release of crewmembers is staggered, survey teams will need to be constantly available to administer the questionnaire. After this data is collected, the group could begin to determine which cruise ships prove the most lucrative to Venice.

5. Social Impact

Cruise ships are an every-day sight in Venice. Through the years, they have become integrated into the workings of both the harbor and the city. However, the potential to disrupt the lifestyles of Venetians is incredibly high. Chapter two touches upon the ways in which this could occur. Cruise ship disturbances, such as those in Bar Harbor, ME are likely to occur in Venice as well. Quantifying and compiling manners in which this could occur may lead to recognition of the topic, and in the future, a better quality of life in Venice. The main objective of this aspect of study is to provide a qualitative analysis and visual representation of the impact of cruise ships on Venetian life.

5.1 Provide a qualitative analysis and visual representation of the impact of cruise ships on Venetian life

With the ever expanding cruise ship industry growing at an astonishing rate all across the world, it is not surprising that Venice is not the only community being affected by these floating cities. In fact, Bar Harbor, Maine, (*Figure 20*)⁷⁴ a rustic town in "Downeast" Maine, is a very comparable example. Located roughly halfway up the Maine coast, this small town of 4,800 has seen the number of cruise visits rise over three hundred and fifty percent since 2002. With 96 cruise ships bound for its docks (six of which are bringing up to 2200 passengers or more), Bar Harbor is certainly no stranger to big ships. However, the same as with Venice, the question still burning is whether or not these ships help or hurt the places they anchor.⁷⁵



Figure 20: Canadian Cruise Lines ship waiting to dock in Bar Harbor

With thousands of tourists eager to stretch their legs and open their wallets, the economic force of these large ships cannot be ignored. A study done by University of Maine students in 2005 showed that the average passenger off of a cruise ship spent \$105.82 USD in Bar Harbor. By taking the number of passengers that also visited that year (nearly 130,000), this works out to 10 million USD. Tourist spending, however, is not the only source of income that these ships bring into the area. Charging fees at docking also bring in another estimated 2.5 million. These fees included \$1,750 for anchorage, \$4 per passenger, \$150 per tour bus, and \$40 per hour for a police detail.

⁷⁴ Gabe, Todd, Colleen Lynch, James McConnon, and Thomas Allen. "ECONOMIC IMPACT OF CRUISE SHIP PASSENGERS IN BAR HARBOR, MAINE." [umaine.edu. http://www.extension.umaine.edu/smallbiz/reports/cruise.pdf](http://www.extension.umaine.edu/smallbiz/reports/cruise.pdf) (accessed October 9, 2009).

⁷⁵ Gabe *Ibid*

With all of these sources combined, cruise ships and their passengers net Bar Harbor ten percent of its yearly income.⁷⁶

Success, however, rarely ever comes without a price. The massive influx of passengers arriving by sea has also produced more than its fair share of problems. In 2005, Bar Harbor police reported 376 arrests involving cruise ship passengers, 91 of which were alcohol related. These numbers began to throw up red flags in the small 4,800 person community. Ensuing studies discovered just how much the spike in tourism was affecting crime. Cruise ship passengers testified to cruise-dedicated pimps and prostitutes ready to service male passengers fresh off the ship, a crime almost unheard of in the entire state, let alone in the rustic coastal town.⁷⁷

Crime, however, is not the only recognized problem faced by locals. Congestion in the city streets cause by surges of passengers has also been a key problem. As you might imagine, a town of 4,800 people is not entirely equipped to support foot traffic that can double the town's population in a matter of hours. Foot traffic, however, is not the only traffic issue that faces Bar Harbor. Unlike Venice, Bar Harbor is also a big attraction for tourists driving their own cars. With only about five percent of the drivers on the road at any given time actually being from Bar Harbor, it is clear to see that Bar Harbor is a very active tourist location.⁷⁸ Noise pollution has also become a problem for the town's residents, especially those with waterfront properties. Multiple noise complaints have been formally filed against the ships for constantly running their engines and blasting loud music on their decks.

Trying to compensate for the problems, authorities in Bar Harbor have made changes that they feel would be more beneficial to the town. Firstly, a passenger limit has been placed on the cruise liner companies to try and control the number of people hitting the streets all at once. Replacing the previous two ship limit (thrown off by the introduction of "mega-ships" carrying 3000 or more passengers) the new restriction would be set at 5500 passengers at a time during peak tourist season and 3500 otherwise. An increase in the fees paid by the ships to dock has also been proposed. This fee would not only affect the anchorage fee of the ship itself, but would show a rise in the per-person fees and service costs.⁷⁹

Putting things in prospective, Bar Harbor is a great analogue to Venice when studying the effects of cruise ships. Firstly, it is a small controlled example with nearly one

⁷⁶ Gabe, Todd *Ibid.*

⁷⁷ Raynor, John. "Bar Harbor Maine ." Cruise Ship Woes Reduce Quality Of Life March 29, 2007. http://www.cruisebruse.com/Bar_Harbor_Maine_Cruise_Ship_Woes_March_29_2007.html (accessed October 9, 2009).

⁷⁸ Noble, Sally. "New rules in place to help Bar Harbor cope with ships." Maine Cruise Ship Information, Destinations, Maine Tourism. <http://www.cruisemaineusa.com/news-84.asp> (accessed October 9, 2009).

⁷⁹ Noble, Sally. "While Bar Harbor solves its mega ship problem, "mega berth" becomes embroiled in Portland's waterfront debate." Working Waterfront. <http://www.workingwaterfront.com/articles/While-Bar-Harbor-solves-its-mega-ship-problem-mega-berth-becomes-embroiled-in-Portlands-waterfront-debate/11886/> (accessed October 11, 2009).

twelfth of the population of Venice. However, for being smaller, it has the same ratio of cruise ship passengers to local population as that of Venice (roughly 25:1). The problems and benefits faced in Bar Harbor can easily be echoed and mirrored in Venice. Likewise, proposed and implemented changes to how cruise ships dock and how much they pay could also be scaled to fit the larger city of Venice.

Venice, being a mainly pedestrian city, also faces problems with congestion due to the passengers. Venice has approximately 62,000 residents that live within its 6.3 square kilometers of land. In those 6.3 square kilometers, there are no cars at all, making Venice mainly a pedestrian city. The main ways to travel in Venice are either by foot, or by boat. Venice is a historic city, so it has no need for wide



Figure 21: Pedestrian Traffic in St. Mark's Square during Acqua Alta.

streets that would accommodate automobiles. Venice has very narrow walkways which make for congestion on a daily basis, and they definitely are a headache when there is a massive influx of tourists; like what you would get when 3-5 cruise ships dock at once in Venice's harbor (Figure 21).

When people are stopping to take a picture of someone in the middle of the path, stopping every 10 feet, or are walking hand in hand with someone when the walkway is only around 4 people wide and has to accommodate both directions of travel it backs people up behind them for a while. This is a hassle for people who are in a rush or have places to be.⁸⁰ An even bigger hassle for pedestrian traffic comes between the changing of the seasons in the fall and the spring. These are the times of year when the tides rise and the streets and plazas flood; this is the time of *Acqua Alta*.⁸¹

In times of *Acqua Alta*, the local authorities put up elevated wooden walkways so that the residents and visitors can get around without being in a 3 foot puddle of water that covers most of the city. It is not uncommon for a police officer to be dispatched to direct the pedestrian traffic, so everyone gets to where they need to go in a timely and organized fashion⁸². Venice is not the only place in the world that feels overwhelmed when their city is flooded with pedestrians.

⁸⁰ Miller, Kyle . "Travel In Venice?." Navigamus. www.navigamus.net/2009/07/traffic-in-venice (accessed September 28, 2009).

⁸¹ "The Acqua Alta in Venice." Italy Travel. www.justitaly.org/italy/venice/venice-acqua.asp (accessed October 2, 2009).

⁸² "Acqua Alta Venice Italy flood planes in Venice Visit-Venice-Italy.com." Venice by two Venetians Culture history Guide Best Hotels restaurants Arts Music Visit-Venice-Italy.com. <http://www.visit-venice-italy.com/acqua-alta-venice-italy.htm> (accessed October 2, 2009).

In relation to Venice is Bar Harbor, Maine. It was quoted in 2000 with a population of 4820 residents. When the cruise ships dock though, the population can more than double, all in an hour. As the same in the case of Venice, the streets of Bar Harbor are strewn with heavy congestion of pedestrian traffic, and of tour groups and tour busses. This increase of people in the town boosts economic standings, but it also boosts the crime rate in local stores.⁸³

Alaska is also in the same boat with Venice. Although not even close in sheer size or coastline, with Alaska being one of the top cruise destinations in the world it gets its fair share of tourists. The cruise ships (*Figure 22*)⁸⁴ only sail about 20% of its coasts, and really only dock at about half of that 20% previously mentioned. Also, the cruise season for Alaska is incredibly short; it goes for about 4 months, from late May until Mid September. All of these tourists cause backlash to the towns of call, congesting their streets with excessive pedestrian traffic and heavy bus traffic on outlying roads.⁸⁵



Figure 22: A Cruise Liner along Alaska's Icy Coastline

5.2 Methodology

To provide this visual depiction of life in Venice, the students used two cameras to capture events around the city. A time-lapse camera was used to film processes that normally flow too slowly to be properly recognized by the human eye. Events such as Piazza San Marco filling up with pedestrians, lines forming, fondamente flooding, when captured with time-lapse, play back five times faster, allowing the overall motion to be perceived. This proved especially useful when filming cruise ships. They are restricted to a speed of five knots through the Giudecca, and the time-lapse footage sped up the process to better visualize it.

A handheld hi-definition camcorder was also used to capture events in real time. Footage of people window shopping, opening stores, eating lunch and moving about Venice was filmed with this camera. This footage was also translated into slow motion using Adobe Premier Pro editing software. The time-lapse, real-time and slow motion clips were cut and edited to deliver a set of final movies to illustrate how cruise ships intertwine with Venetian life.

⁸³ "Bar Harbor Maine - Cruise Ship Woes Reduce Quality Of Life." Cruise Bruise.

www.cruisebruse.com/Bar_Harbor_Maine_Cruise_Ship_Woes_March_29_2007.html (accessed September 29, 2009).

⁸⁴ "Alaska Cruise." *Destination 360*. 10 Oct. 2009 <www.destination360.com/north-america/us/alaska/images/s/cheap-alaska-cruise.jpg>

⁸⁵ Anicama, Joqtan "Alaska Cruise Ships - Angel Or Devil?." *Alaska Cruise Ships - Angel Or Devil? EzineArticles.com*. <http://ezinearticles.com/?Alaska-Cruise-Ships---Angel-Or-Devil?&id=563171>

5.3 Visual Deliveries

With the footage collected during the length of the project, two videos were produced and posted online to show the size and impact of the cruise ships on Venice. The first video, comprised solely of time-lapse footage taken, shows the progression of the ships and passengers in a typical day in Venice. The video starts with footage of an empty Piazza San Marco and shows multiple clips of cruise ships entering the city, traveling down the Giudecca Canal, and docking in the port. The passengers are then showed exiting the ship, loading on shuttle buses, and dispersing throughout the city. The video ends with the ships exiting and night falling. This video is set to “Hurricane 2000” performed by the Scorpions and the Berlin Philharmonic Orchestra.

The second video had a much more serious theme and was intended to more accurately depict the impact of the cruise ships as they came into the city using real time, time lapse, and slow motion footage. The video starts with shots of the Giudecca in the early morning and shows the sun rising as ships begin to pour into the city. The passengers then disembark the ship and spread out through the city, focusing on popular attractions like Piazza San Marco and Rialto Bridge. After crowding into the city’s more famous areas, the passengers return to their ships and the ships exit the city as night falls. The video then takes a different turn, starting with clips of Piazza San Marco flooded and transitions into the funeral of Venice. Slow motion shots combined with Mozart’s Requiem in D Minor, K 626 - 8. Sequentia: Lacrimosa Dies Ire provides a somber end to the video. The rest of the score includes three pieces from native Venetian Antonio Vivaldi

Both videos and all of the raw footage can be found on the Venice 2.0 Vimeo group page:

<http://www.vimeo.com/groups/29962>

5.4 Future Recommendations

The impact that cruise ships hold on Venetian society is difficult to quantitatively measure. Any annoyance or displeasure that Venetians may feel cannot be measured in units. However, it is possible to identify the source of annoyance, and from there, to attempt to quantify that source.

This procedure would need to begin with a survey of Venetians seeking to identify the annoyance. There are myriad possible answers to such a survey, however there are some that are easy to anticipate. It is likely that many will answer with, “the passengers get in my way.” This answer may serve as a stepping-stone to an experiment that could reveal the severity of said annoyance.

During a weekend with cruise ships docked in port, closely record the routes that several Venetians take through the city on their daily errands. Compare the time, distance, and route taken to a day without cruise passengers. Any differences between the two trips can be attributed to the presence of the passengers. This would reveal numbers, in travel time and distance, that would correlate to (and essentially quantify) any social disapproval of cruise ships.

6. Works Cited

"A History of the World Travel & Tourism Council." World Travel & Tourism Council . <http://www.wttc.org/bin/pdf/temp/wttchistory.html> (accessed October 7, 2009).

"Acqua Alta Venice Italy flood planes in Venice Visit-Venice-Italy.com." Venice by two Venetians Culture history Guide Best Hotels restaurants Arts Music Visit-Venice-Italy.com. <http://www.visit-venice-italy.com/acqua-alta-venice-italy.htm> (accessed October 2, 2009).

"Alaska Cruise." Destination 360. 10 Oct. 2009 <www.destination360.com/north-america/us/alaska/images/s/cheap-alaska-cruise.jpg>

Anicama, Joqtan "Alaska Cruise Ships - Angel Or Devil?." *Alaska Cruise Ships - Angel Or Devil? EzineArticles.com*. <http://ezinearticles.com/?Alaska-Cruise-Ships---Angel-Or-Devil?&id=563171>

Ballard, Robert. "PBS Online - Lost Liners - Andrea." PBS. 22 Sep. 2009 <<http://www.pbs.org/lostliners/andrea.html>>.

Ballard, Robert. "PBS Online - Lost Liners - Britannic." PBS. 22 Sep. 2009 <<http://www.pbs.org/lostliners/britannic.html>>.

Ballard, Robert. "PBS Online - Lost Liners - Empress of Ireland." PBS. 22 Sep. 2009 <<http://www.pbs.org/lostliners/empress.html>>.

Ballard, Robert. "PBS Online - Lost Liners - Lusitania." PBS. 22 Sep. 2009 <<http://www.pbs.org/lostliners/lusitania.html>>.

Ballard, Robert. "PBS Online - Lost Liners - Titanic." PBS. 22 Sep. 2009 <<http://www.pbs.org/lostliners/titanic.html>>.

"Bar Harbor Maine - Cruise Ship Woes Reduce Quality Of Life." Cruise Bruise. www.cruisebruisse.com/Bar_Harbor_Maine_Cruise_Ship_Woes_March_29_2007.html (accessed September 29, 2009).

Briggs, Josh. "HowStuffWorks "How Cruise Ships Float"." Howstuffworks "Adventure". <http://adventure.howstuffworks.com/cruise-ship2.htm> (accessed October 1, 2009).

Briggs, Josh. "HowStuffWorks "How Cruise Ships Move"." Howstuffworks "Adventure". <http://adventure.howstuffworks.com/cruise-ship3.htm> (accessed October 1, 2009).

Briggs, Josh. "HowStuffWorks "Inside a Cruise Ship: Amenities and Jobs".
Howstuffworks "Adventure". <http://adventure.howstuffworks.com/cruise-ship4.htm>
(accessed October 1, 2009).

"Britanic." Tripod | Error. 22 Sep. 2009
<<http://captaindraconian.tripod.com/Britanic.html>>.

"Canal maintenance." Venipedia. http://venipedia.org/index.php/Canal_maintenance
(accessed October 3, 2009).

Common Decibel Ranges." Osha. 10 Oct. 2009
<www.osha.gov/dts/osta/otm/noise/images/common_sounds.gif >

"Contamination By Cruise Ships." Oceana.
www.oceana.org/fileadmin/oceana/uploads/europe/reports/cruise_ships_eng.pdf
(accessed September 17, 2009).

Cotana, Franco, Andrea Nicolini, and Francesca Marranghello. "Italian Environmental
Performance: Noise Pollution Activities Report." CIRIAF.
www.crbnet.it/File/Pubblicazioni/pdf/979.pdf (accessed October 9, 2009).

"Cruise Ships." GlobalSecurity.org - Reliable Security Information. 6 Sep. 2009
<<http://www.globalsecurity.org/military/systems/ship/passenger-cruise.htm>>.

"Cruise Ships Worse For Environment Than Planes." Environmental Leader.
www.environmentalleader.com/2008/01/22/cruise-ships-worse-for-environment-than-planes/
(accessed September 5, 2009).

"Cunard Line History." RMS Titanic - Ship of Dreams - Award Winning Educational
Site. 14 Oct. 2009 <<http://www.titanicandco.com/cunard.html>>.

Diego, UC San. "Carbonated Oceans." YubaNet.com | We Deliver News to the Sierra.
<http://yubanet.com/scitech/Carbonated-Oceans.php> (accessed October 4, 2009).

"Diving the HMHS Britannic." Technical diving, GUE training courses, charters, forum.
13 Sep. 2009 <<http://www.ocean-discovery.org/britannic.htm>>.

Gabe, Todd, Colleen Lynch, James McConnon, and Thomas Allen. "ECONOMIC
IMPACT OF CRUISE SHIP PASSENGERS IN BAR HARBOR, MAINE." umaine.edu.
<http://www.extension.umaine.edu/smallbiz/reports/cruise.pdf> (accessed October 9, 2009).

Grace, Michael L.. "Cruise Line History - Cruising The Past - Cruise History." Cruise
Line History - Cruising The Past - Cruise History. 2 Oct. 2009
<<http://cruiselinehistory.com/?p=958>>.

"HAPAG-LLOYD AG -- Company History." Connecting Angel Investors and
Entrepreneurs. 2 Oct. 2009 <<http://www.fundinguniverse.com/company->

histories/HAPAGLLOYD-AG-Company-History.html>.

"HMHS Britannic." Titanic-Titanic. 14 Oct. 2009 <<http://www.titanic-titanic.com/britannic.shtml>>.

"Human Ear and Hearing." The Human Ear and Hearing.
www.kemt.fei.tuke.sk/Predmety/KEMT320_EA/_web/Online_Course_on_Acoustics/hearing.html (accessed October 11, 2009).

Jessup, Pete. "The Sinking Of The Lusitania." History Times. 22 Sep. 2009
<www.historytimes.com/fresh-perspectives-in-history/military-history/world-war-1/416-the-sinking-of-the-lusitania>.

Krystallon. www.krystallon.com/blog/?p=296 (accessed October 10, 2009).

"Magee Scientific Company - Real-time scientific measurements." Magee Scientific Company - Real-time scientific measurements. <http://mageesci.com/index.htm> (accessed September 29, 2009).

Matthews, Jackie , and Maria Andriano. "Cunard History at a Glance." Cunard. 10 Oct. 2009 <www.cunard.com/images/Content/History.pdf>.

Scheppe, Wolfgang. *Migropolis: Venice /Atlas of a Global Situation*. Hatje Cantz, 2009. Print.

Miller, Kyle . "Travel In Venice?." Navigamus. www.navigamus.net/2009/07/traffic-in-venice (accessed September 28, 2009).

Noble, Sally. "New rules in place to help Bar Harbor cope with ships." Maine Cruise Ship Information, Destinations, Maine Tourism. <http://www.cruisemaineusa.com/news-84.asp> (accessed October 9, 2009).

Noble, Sally. "While Bar Harbor solves its mega ship problem, "mega berth" becomes embroiled in Portland's waterfront debate." Working Waterfront. <http://www.workingwaterfront.com/articles/While-Bar-Harbor-solves-its-mega-ship-problem-mega-berth-becomes-embroiled-in-Portlands-waterfront-debate/11886/> (accessed October 11, 2009).

Pearson, Chris. " Cruise ships." Magnolia Voice.
<http://www.magnoliavoice.com/tag/cruise-ships/> (accessed October 8, 2009).

" PRINZESSIN VICTORIA LUISE Articles Prinzessin Victoria Luise was a pas." Free Articles at Amazines.Com - Author Publishing and Free Article Database. 11 Sep. 2009 <http://www.amazines.com/Prinzessin_Victoria_Luise_related.html>.

Progress and Priorities 2007/08 (2007): 5-6,
http://www.wttc.org/bin/pdf/temp/finpp_2007.html (accessed September 12, 2009).

Progress and Priorities 2008/09 (2008): 5-7,
http://www.wttc.org/bin/pdf/temp/progress_and_priorities_2008.html (accessed September 12, 2009).

Raynor, John. "Bar Harbor Maine ." Cruise Ship Woes Reduce Quality Of Life March 29, 2007.
http://www.cruisebruisse.com/Bar_Harbor_Maine_Cruise_Ship_Woes_March_29_2007.html (accessed October 9, 2009).

"Recycling Facts." University of Colorado at Boulder.
recycling.colorado.edu/education_and_outreach/recycling_facts.html (accessed October 11, 2009).

"Report for Selected Countries and Subjects." IMF -- International Monetary Fund Home Page.
<http://www.imf.org/external/pubs/ft/weo/2009/01/weodata/weorept.aspx?sy=2008&ey=2008&scsm=1&ssd=1&sort=country&ds=.&br=1&c=512%2C941%2C914%2C446%2C612%2C666%2C614%2C668%2C311%2C672%2C213%2C946%2C911%2C137%2C193%2C962%2C122%2C674%2C912%2C676%2C313%2C548%2C> (accessed October 2, 2009)

"Rome Tourist Information." Undercover Tourist.
<http://www.undercvertourist.com/italy/rome.html#facts> (accessed October 1, 2009).

"Sensitivity of Human Ear." Test Page for Apache Installation. <http://hyperphysics.phy-astr.gsu.edu/Hbase/sound/earsens.html> (accessed October 11, 2009).

"S.S. Prinzessin Victoria Luise (1900) - Photographs - 1908 - Hamburg American Line." Archives of Passenger Lists, Vintage Brochures, Steamships, WW1, WW2, WPA. 2 Oct. 2009 <<http://www.gjenvick.com/HamburgAmerikaLinie/1908-NordlandFahrten-PrinzessinVictoriaLuise.html>>.

"TGOL - Celtic." The Great Ocean Liners. 14 Oct. 2009
<<http://www.thegreatoceanliners.com/celtic2.html>>.

"The Acqua Alta in Venice." Italy Travel. www.justitaly.org/italy/venice/venice-acqua.asp (accessed October 2, 2009).

"The Inman Line - Passenger lists and Emigrant ships from Norway-Heritage." Passenger lists and Emigrant ships from Norway Heritage. 14 Oct. 2009
<http://www.norwayheritage.com/p_shiplist.asp?co=inman>.

"The Italian Economy." The Italian Ministry of Foreign Affairs.
www.esteri.it/MAE/EN/Benvenuti_in_Italia/Conoscere_Italia/Economia.htm (accessed September 13, 2009).

"Tourism Impact Data Forecasting Tool." WTTC.
www.wttc.org/eng/Tourism_Research/Tourism_Impact_Data_and_Forecast_Tool/
(accessed September 30, 2009).

Travel & Tourism Economic Impact Executive Summary 2009 (2009): 3-8,
http://www.wttc.org/bin/pdf/temp/exec_summary_2009.html.

"Venice Bags the Bottle." Tiny Choices. tinychoices.com/2009/07/13/venice-bags-the-bottle/ (accessed October 1, 2009).

Da Mosto, Jane , Thierry Morel, Tom Spencer, Enrico Tantucci, Renato Gibin, Stefania Tonin, Fabrizio Fracchia, Roberto Agnoletto, Francesca Mattassoglio, Lidia Panzeri, and Anna Somers Cocks. *The Venice Report* (2009): Print.

Vessel Traffic." Nuka Research and Planning. 20 Sep. 2006. 29 Sep. 2009
<www.dec.state.ak.us/spar/perp/docs/060920vesselreport_s.pdf>.

"VTP Company." Venezia Terminal Passeggeri S.p.A.
<http://www.vtp.it/pages/azienda.jsp?idm=QV9U4KV1T7NUJU79NCV910SK3R3G36W2&m=0> (accessed September 10, 2009).

"VTP Ship Schedule." Venezia Terminal Passeggeri S.p.A.
www.vtp.it/pages/calendario/ricerca.jsp (accessed September 3, 2009).

"VTP Statistics." Venezia Terminal Passeggeri S.p.A..
<http://www.vtp.it/pages/statistiche.jsp?language=1> (accessed September 10, 2009).

"WebTitanic | Titanic Story | Titanic's Maiden Voyage ." WebTitanic | Boarding Page. 14 Oct. 2009 <<http://www.webtitanic.net/framemaids.html>>.

"World-Key Facts at a Glance." World Travel & Tourism Council.
www.wttc.org/eng/Tourism_Research/Tourism_Economic_Research/ (accessed October 4, 2009).

7. Appendix

Figure A 1

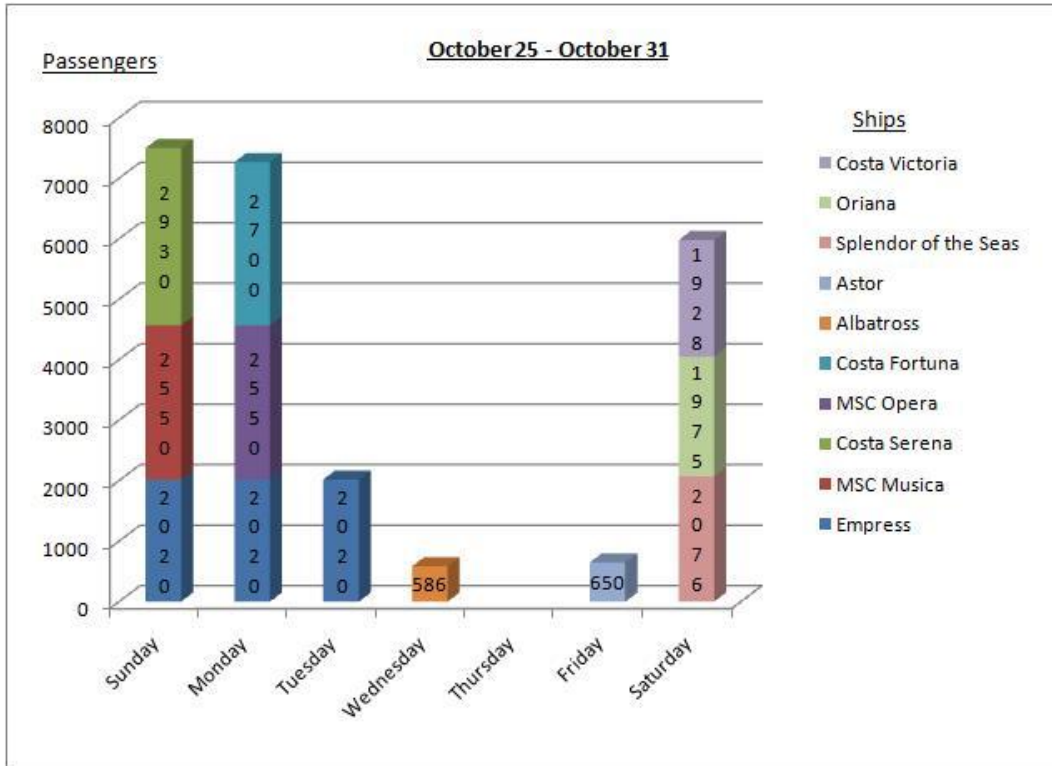


Figure A 2

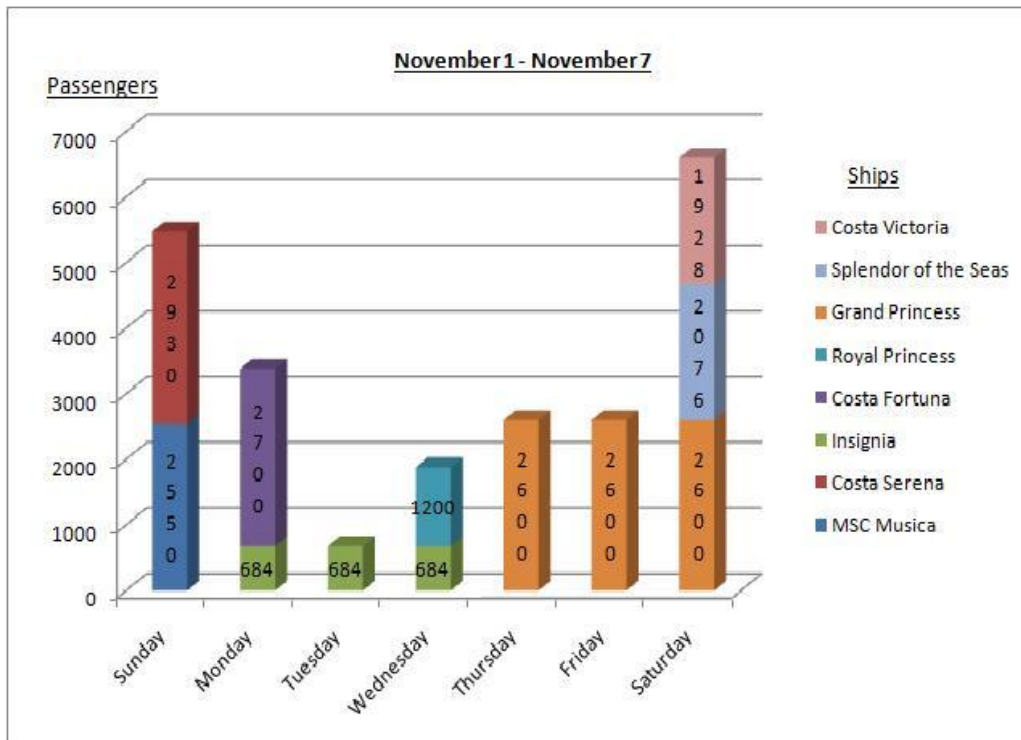


Figure A 3

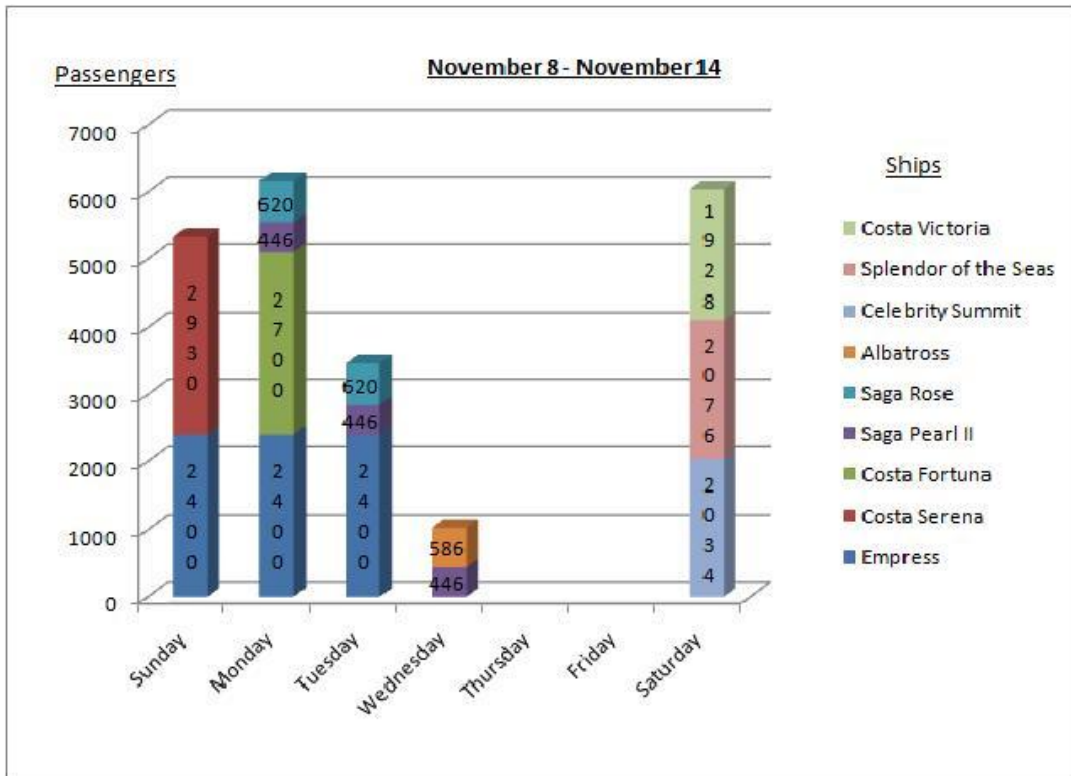


Figure A 4

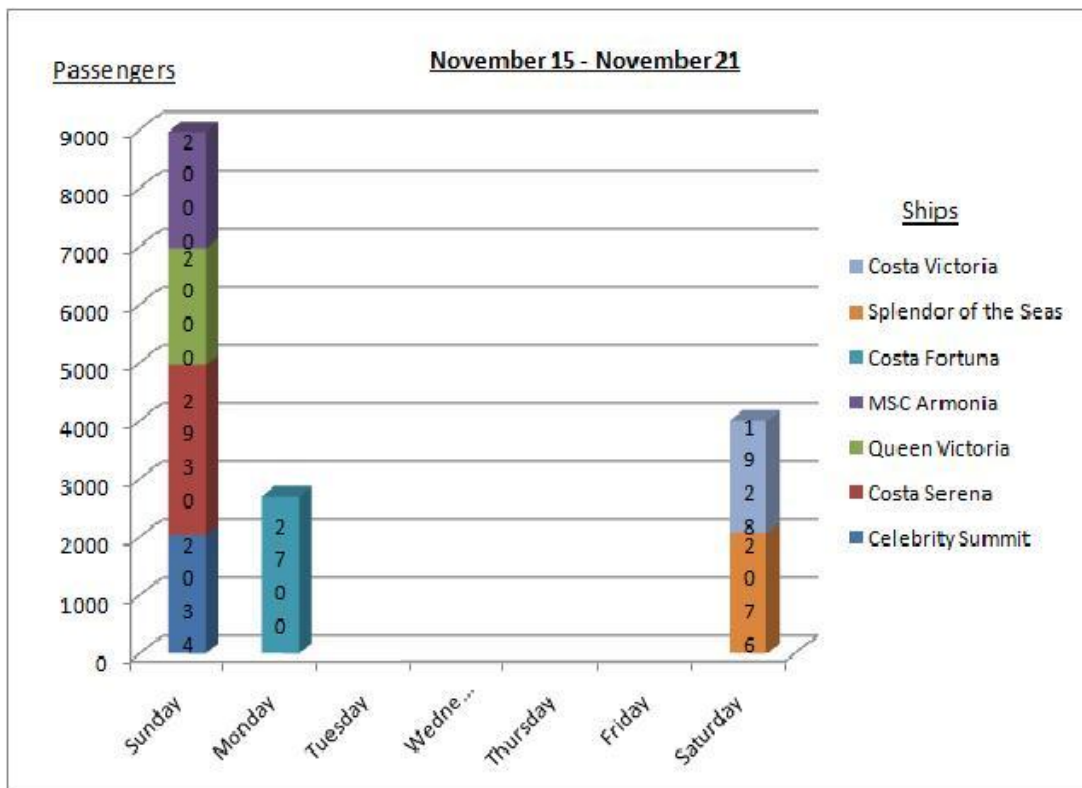


Figure A 5

Number of Passengers Getting Off a Cruise Ship in Venice

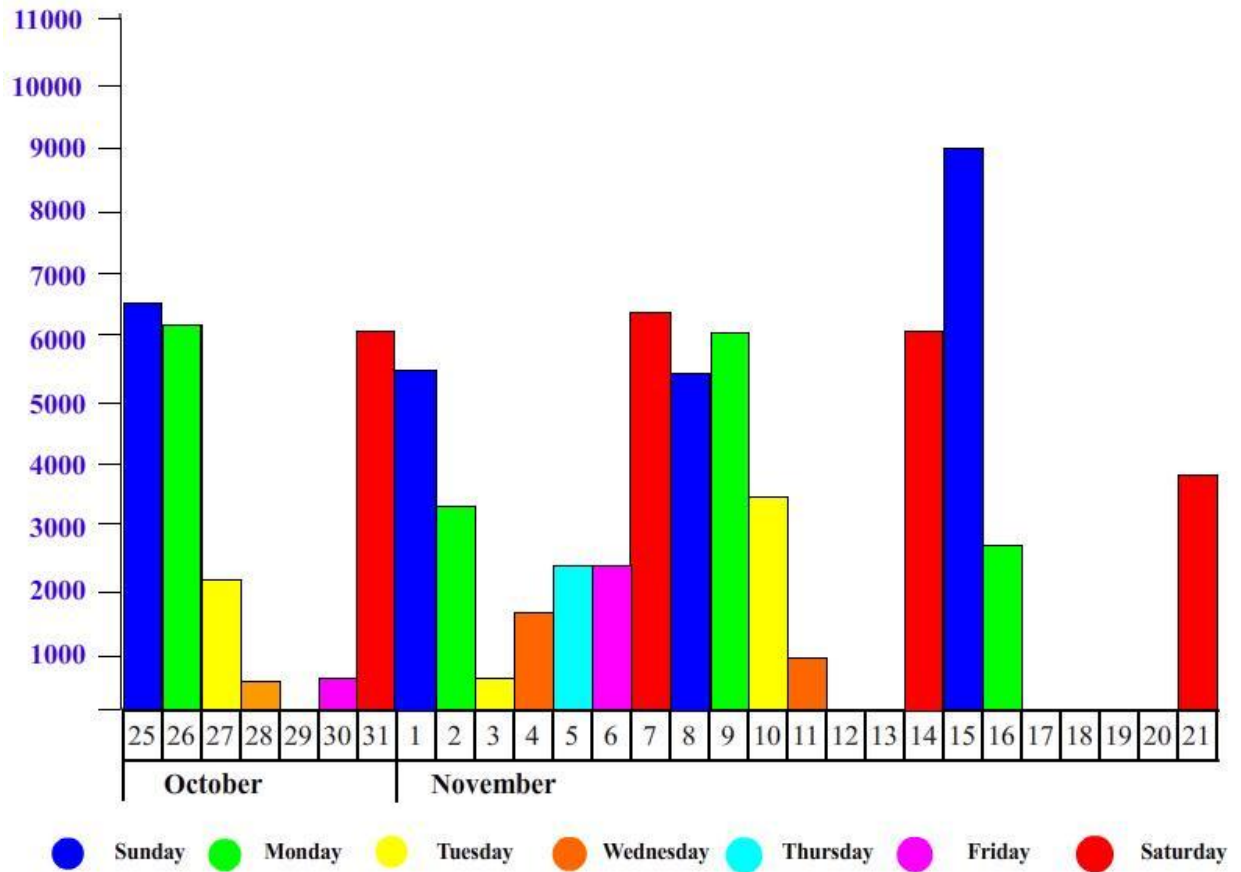






Figure A 6





 Which ship are you from?

 Where are you from?

 How many people are in your party?

 Did you visit a museum or church or any other attraction? Do you remember where it was?

 Did you take a gondola ride?

 Where did you eat?

 How many hours did you spend in Venice?


 How much money did you spend on your party?

Figure A 7



Nicholas Hunnewell
James Reese
Damian Skwirczynski
Ryan Vautrin
Interdisciplinary and Global
Studies Department
100 Institute Road
Worcester, MA 01609
ve09-ships@wpi.edu

Mr. Jeff Blair
Magee Scientific
Jeff.Blair@mageescientific.com

October 2, 2009

Mr. Jeff Blair

We are a group of Worcester Polytechnic Institute engineering students conducting a study abroad in Venice from October 25th 2009 through December 18th 2009. Our project will investigate the impact of commercial cruise liners on the city of Venice. The ultimate goal of this project is to provide Venice with a complete profile of the positive and negative economic, social and environmental effects of cruise ships on the city. In preparation for our time in Venice, we are currently compiling background information and developing a strategy to collect the data needed to complete our project's goal. We believe that your aethalometer could prove extremely useful to our project completion, so we politely request your permission to contact you with questions pertaining to our project.

We look forward to our time in Venice and the opportunity we have been given to contribute to such an influential and historic city. The group firmly believes that our collaboration will lead to the completion of our goals and yield results that will prove fruitful to the future of cruise ships and tourism in Venice. If you would like more information on our mission or progress, feel free to visit www.ships-venice-09.blogspot.com.

Sincerely,

Handwritten signature of Nicholas Hunnewell in black ink.

Nicholas Hunnewell, Mechanical Engineering

Handwritten signature of Damian Skwirczynski in black ink.

Damian Skwirczynski, Mathematical Sciences

Handwritten signature of James Reese in black ink.

James Reese, Biology

Handwritten signature of Ryan Vautrin in black ink.

Ryan Vautrin, Chemical Engineering

Figure A 8



Nicholas Hunnewell
James Reese
Damian Skwierczynski
Ryan Vautrin
Interdisciplinary and Global
Studies Department
100 Institute Road
Worcester, MA 01609
ve09-ships@wpi.edu

Alberto Gallo
albixg@gmail.com

October 9, 2009

Alberto Gallo,

We are a group of Worcester Polytechnic Institute engineering students conducting a study abroad in Venice from October 25th 2009 through December 18th 2009. Our project will investigate the impact of commercial cruise liners on the city of Venice. The ultimate goal of this project is to provide Venice with a complete profile of the positive and negative economic, social and environmental effects of cruise ships on the city. In preparation for our time in Venice, we are currently compiling background information and developing a strategy to collect the data needed to complete our project's goal. We believe that your expertise in the Venetian shipping industry would be crucial to the completion of our project, so we politely request your permission to contact you with questions pertaining to our project.

We look forward to our time in Venice and the opportunity we have been given to contribute to such an influential and historic city. The group firmly believes that our collaboration will lead to the completion of our goals and yield results that will prove fruitful to the future of cruise ships and tourism in Venice. If you would like more information on our mission or progress, feel free to visit www.ships-venice-09.blogspot.com.

Sincerely,

Handwritten signature of Nicholas Hunnewell in black ink.

Nicholas Hunnewell, Mechanical Engineering

Handwritten signature of Damian Skwierczynski in black ink.

Damian Skwierczynski, Mathematical Sciences

Handwritten signature of James Reese in black ink.

James Reese, Biology

Handwritten signature of Ryan Vautrin in black ink.

Ryan Vautrin, Chemical Engineering

Figure A 9

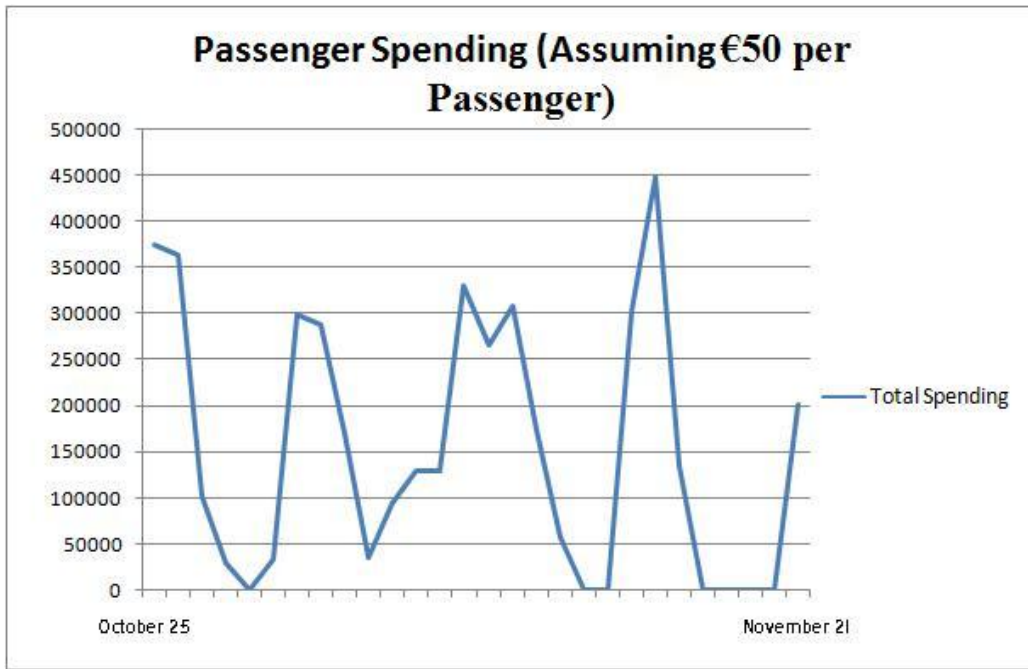


Figure A 236

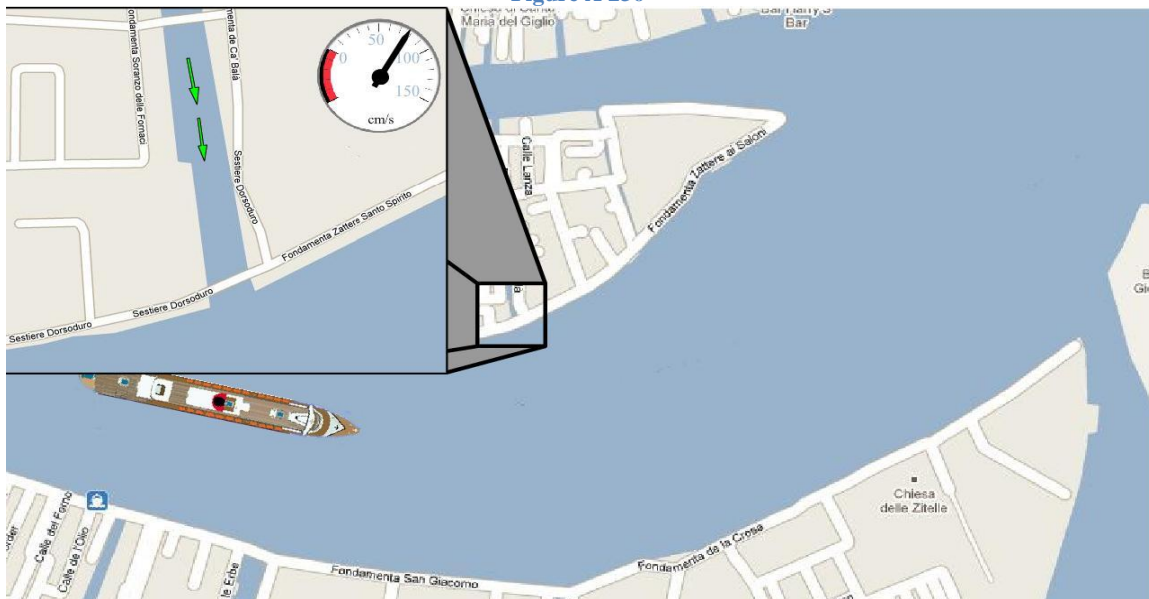


Figure A 247

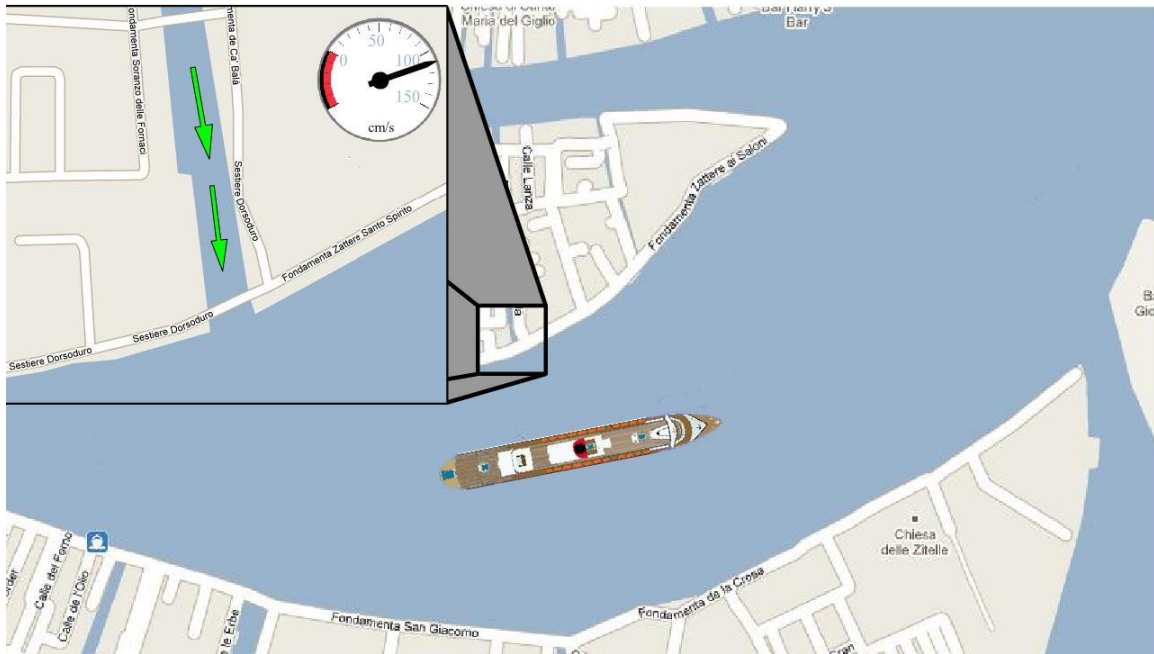


Figure A 258

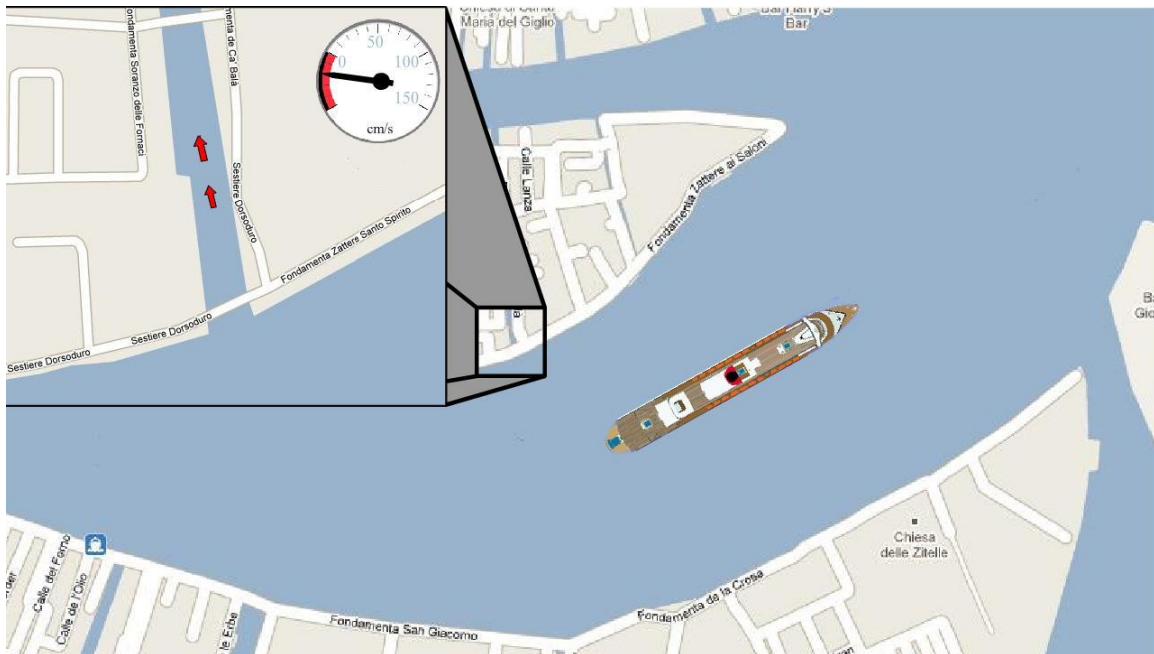


Figure A 269

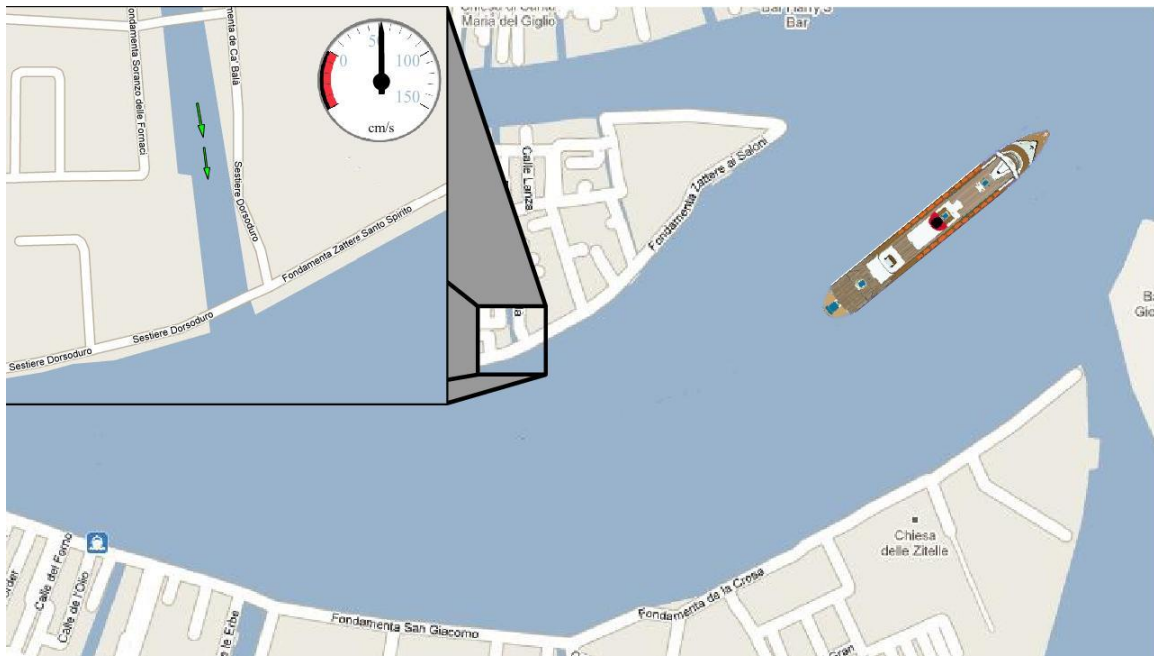


Figure A 20



Figure A 21



Table A 1

October 25 - October 31							
Sunday	Monday	Tuesday	Wenesday	Thursday	Friday	Saturday	
Empress: 2020					Astor: 650	Splendor of the Seas: 2076	
MSC Musica: 2550	MSC Opera: 2550		Albatross: 586			Oriana: 1975	
Costa Serena: 2930	Costa Fortuna: 2700					Costa Victoria: 1928	
November 1 - November 7							
Sunday	Monday	Tuesday	Wenesday	Thursday	Friday	Saturday	
MSC Musica: 2550	Insignia: 684			Grand Princess: 2600			
Costa Serena: 2930	Costa Fortuna: 2700		Royal Princess: 1200			Splendor of the Seas: 2076	
						Costa Victoria: 1928	
November 8 - November 14							
Sunday	Monday	Tuesday	Wenesday	Thursday	Friday	Saturday	
Norwegian Jade: 2400						Celebrity Summit: 2034	
Costa Serena: 2930	Costa Fortuna: 2700					Splendor of the Seas: 2076	
	Saga Pearl II: 446					Costa Victoria: 1928	
	Saga Rose: 628		Albatross: 586				
November 15 - November 21							
Sunday	Monday	Tuesday	Wenesday	Thursday	Friday	Saturday	
Celebrity Summit: 2034	Costa Fortuna: 2700					Splendor of the Seas: 2076	
Costa Serena: 2930						Costa Victoria: 1928	
Queen Victoria: 2000							
MSC Armonia:							
November 22 - November 28							
Sunday	Monday	Tuesday	Wenesday	Thursday	Friday	Saturday	
Costa Serena: 2930	Costa Fortuna: 2700					Costa Victoria: 1928	

Information taken from "VTP Ship Schedule." Venezia Terminal Passeggeri S.p.A.
www.vtp.it/pages/calendario/ricerca.jsp (accessed September 3, 2009).

Table A 2

TECHNIQUE	ADVANTAGES	DISADVANTAGES	SCALE LEVEL
GPS tracking	<ul style="list-style-type: none"> • High resolution • Mature technology • Easy to use • Continuous measurement • Unintrusive 	<ul style="list-style-type: none"> • Low sample size-limited by equipment • GPS signals blockage from buildings and foliage • High risk of loss of GPS equipment • Expensive 	MICRO LEVEL
Timing systems	<ul style="list-style-type: none"> • Non-intrusive • High resolution • High sample size 	<ul style="list-style-type: none"> • Expensive • Limited by battery life and data logger memory capacity 	MICRO LEVEL
Camera-based systems	<ul style="list-style-type: none"> • High resolution • Can work as surveillance, counting, and tracking tool • Can identify unique individual 	<ul style="list-style-type: none"> • Vibrations and changes in light, height, and temperature could degrade performance • Expensive • Intrusive/ ethical issues 	MICRO LEVEL
Mobile phone tracking	<ul style="list-style-type: none"> • Non-intrusive • Low-cost 	<ul style="list-style-type: none"> • Privacy security issue • Signals blockage from buildings and foliage • Immature technique • Low resolution • Ethic issue 	MICRO LEVEL
PDA Tracking	<ul style="list-style-type: none"> • High resolution • Can communicate with tourists in real-time • Can track their decision making process 	<ul style="list-style-type: none"> • Intrusive • Low sample size • Signals blockage from buildings and foliage • High risk of loss of PDA equipment • Expensive 	MICRO LEVEL
Manual observation and interview	<ul style="list-style-type: none"> • Can communicate with tourists • Can classify vehicles more accurately • Can count or track tourists more flexibly • Can acquire non-spatial information of tourist • Can track tourists' decision making process 	<ul style="list-style-type: none"> • Intrusive • Time-consuming • Low resolution • Low sample size 	MACRO or MICRO LEVEL
Self-administered questionnaire	<ul style="list-style-type: none"> • Can acquire non-spatial and approximate spatio-temporal information of tourist • Can count or track tourists more flexibly • High sample size 	<ul style="list-style-type: none"> • Intrusive • Time-consuming • Low resolution • Low sample size 	MACRO LEVEL

