



National University Rail Center - NURail
US DOT OST-R Tier 1 University Transportation Center

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**NURail Research Experience for Undergraduates (REU) Summer Program in
Multimodal Freight Transportation Risk**

By

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DISCLAIMER

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TECHNICAL SUMMARY

Title

NURail Research Experience for Undergraduates (REU) Summer Program in Multimodal Freight Transportation Risk.

Introduction

NURail hosted an REU Summer Program in Multimodal Freight Transportation Risk at the Rail Transportation and Engineering Center (RailTEC) in the Department of Civil and Environmental Engineering at the University of Illinois at Urbana-Champaign (UIUC) from 31 May to 31 July 2013. Four selected undergraduate students were mentored by a faculty and a group of graduate research assistants to perform research in multimodal transportation safety and risk.

Description of Activities

Applications from undergraduate students in Civil Engineering or related major at NURail-affiliated universities were evaluated, and four students were selected to participate in this program in 2014.

The main objective of the program was to expose undergraduate students to academic research, and at the same time encourage the students to pursue graduate studies.

Selected undergraduate students had the opportunities to:

- Learn about transportation risk basic concepts and methodologies
- Interface with faculty and graduate researchers involved in transportation safety and risk
- Collaborate to work on a real-world transportation risk assessment project
- Present research results and write a daily blog to record their experiences

The focus of the program was on completing a comprehensive literature review to understand the key safety and risk issues for multimodal transportation modes. The deliverables of the program include individual blogs describing daily research activities.

Outcomes

Each undergraduate student was paired with a graduate research assistant to complete an actual route-specific risk analysis as a team. The undergraduate students also worked on individual route-specific multimodal transportation risk analysis to assess the risk of transporting petroleum crude oil on railway, roadway, pipelines, or/and waterway.

Of the four selected undergraduate students 1) Manuel Martin-Ramos pursued a graduate study in railway transportation engineering at the University of Illinois at Urbana-Champaign (UIUC), and have accepted a job with a transportation consultant in New York, 2) Eli Hyman is currently working at BNSF Railway, 3) Jeff LaHucik pursued a graduate study in transportation pavement, and 4) Hannah Morsch pursued a graduate study in hydro engineering at UIUC.

Conclusions/Recommendations

The undergraduate students recorded their daily experience in a blog that can be access by other undergraduate students in the future to learn more about participating in academic research. The same program can be duplicated annually with different themes e.g. based on NURail's key research areas.

Publications/Examples

The undergraduate students' individual blogs detailing their daily experience and links to their presentations are available on the following pages:

Eli Hyman Blog Archives	pages 5 - 32
Hannah Morsch Blog Archives	pages 33 - 54
Hannah Morsch Presentation	pages 55 - 63
Jeff LaHucik Blog Archives	pages 64 - 102
Manuel Martin Blog Archives	pages 103 - 138
Manuel Martin Final Report	pages 139-142

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UIUC NURail Research: Eli Hyman Blog Archives

June 2013 – July 2013

Monday, June 3, 2013

Day 1

Today was the kickoff meeting for our projects. We learned about the expectations of what the "risk" group would accomplish this summer and a couple of the grad students showed us a case study involving transportation risk, specifically by way of rail. It was interesting learning about the many uses of ArcGIS in solving these transportation issues. I quickly began to realize the real world applications that this field of study can be applied to.

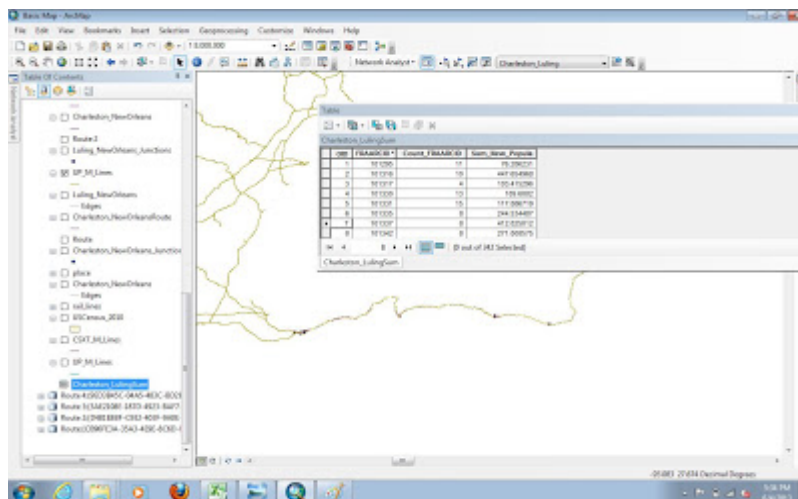
After the meeting we had a tutorial where a couple of the grad students showed us some of the basic features of ArcGIS, introducing the concept of layers, .shp files, and how to sort data by different attributes. I'm currently in the process of trying to install Windows and ArcGIS on my Mac, which has run into some complications. In the meantime, I've scanned through a couple different reference sources and the TRB website to learn more about this field of transportation risk. From the reference sources, it is pretty clear to me that the issue of transportation risk in aviation is relatively unexplored. I look forward to learning more about this topic in the next two months.

Tuesday, June 4, 2013

Day 2

At the beginning of the day I browsed through the tutorial book for ArcGIS to learn more about this software. I continued to try and install the program on my computer but ran into difficulty. Francesco and I decided that to simply switch to another computer in the office that had ArcGIS already installed on it. Jesus gave us a further tutorial in using ArcGIS, and we got our first assignment; calculating the expected population impact along 6 different train routes.

We had a lunch meeting where Xiang gave a very interesting presentation showing us different statistics on the dangers of broken rails. After the meeting, Manu and I worked on our ArcGIS assignment until the end of the day. I'm much more familiar with this program than I was at the start of the day, and I feel more comfortable using the program. For the rest of the week, we will work on finishing this assignment and I hope to become even more familiar with using ArcGIS.

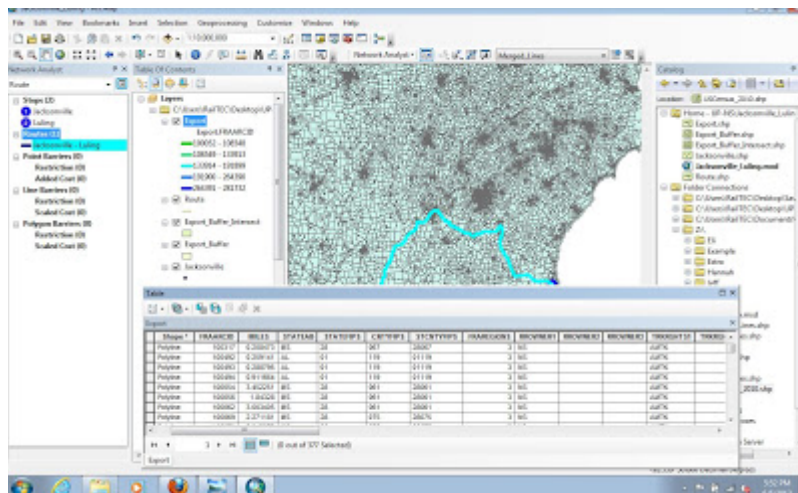


Wednesday, June 5, 2013

Day 3

Today I worked on our ArcGIS project the whole time. Manu and I worked on finishing the 6 routes that we were assigned. After I did the process a few more times I became very comfortable with it and it was just a matter of being systematic. Jesus gave us a 45 minute tutorial on the next step of our ArcGIS project, which focused on exporting our data to Excel for presentation to the company

Tomorrow Manu and I will continue working on the ArcGIS project and begin the process of exporting our data to Excel. We are discovering very small differences in our mean for the number of people affected, so we're going to look into the problem and try and discover the source of the error.



Thursday, June 6, 2013

Day 4

Today Manu and I worked on the closing steps of our ArcGIS project. We exported the data files into Excel and ran them through Matlab. By using Matlab, our data was neatly organized by its ID numbers and was nicely laid out in Excel. I began the process of comparing my results with Manu, which I will continue tomorrow.

I attended an interesting meeting today where Chen-Yu presented his research on the causes of passenger train derailments and freight train derailments. He created frequency and severity diagrams with his data and drew some conclusions about the similarities and differences in the frequency and severity of these two types of rail transport. It was particularly interesting how he incorporated the very recent findings from the passenger train derailment in Bridgeport, CT. I also learned a lot about the different classifications of derailments and collisions.

Tomorrow, I hope to attend Xiang's PhD defense, and I will finish the ArcGIS project up by comparing my results with Manu. If time permits, I will continue doing research to find a topic that interests me for my aviation risk project. I have already found several interesting articles on the ValuJet crash in the Everglades that was caused by expired chemical oxygen generators of the cargo hold of the plane.

FRANKID	FRANKID	TOFRANKID	Order	Density Buff	Track Class	Signal or Ear Length
234454	202890	231356	3	401.89173	4 S	3.3644113
234455	231356	180066	2	332.62768	4 S	3.2526690
203133	180066	231376	3	798.08266	4 S	4.8360738
178665	252376	240595	4	654.144028	4 D	8.49066477
178679	240595	184914	5	338.382982	4 D	8.79881234
178688	304914	184914	6	486.423948	3 D	8.13842147
178689	304914	184914	7	541.250594	#N/A	#N/A
178688	304914	184902	8	1243.338310	#N/A	#N/A
178685	304914	184903	9	1521.878007	#N/A	#N/A
231798	304914	184906	10	2221.864449	#N/A	#N/A
203270	304906	203228	11	4296.83172	#N/A	#N/A
178678	252328	252329	12	4558.33815	4 D	8.4687533
178679	252329	184908	13	4834.87380	3 S	2.1232738
241790	304904	240588	14	5237.28335	3 S	6.1375604
240558	238949	240574	15	2773.76559	3 S	8.0622578
241823	238918	238975	16	3043.82068	3 S	8.30988023
241953	238975	281342	17	3431.98327	3 S	3.3689336
241878	282342	253027	18	4185.93965	3 S	8.15899038
241884	237827	253028	19	5447.88018	3 S	6.2841729
253957	237830	253028	20	3043.48089	3 S	8.13481567
241888	237828	240568	21	3323.23902	4 S	6.5639308
241968	237848	253030	22	3533.75322	4 S	2.25208887
280182	237850	234628	23	2830.88661	4 S	5.12461575
280183	279838	279879	24	15.8229808	4 S	3.27796812
280184	279879	179389	25	6.1786369	4 S	4.91938189
279250	175589	279674	26	278.854119	4 S	1.85547496
279282	179684	179388	27	486.878728	4 S	2.88833182
153305	175590	179394	28	486.301444	4 S	3.85281132
253963	175594	175600	29	1343.23108	3 S	4.40531136

Friday, June 7, 2013

Day 5

This morning I listened to Xiang's P.h.D. defense. It was my first time ever attending a P.h.D. defense, so it was very interesting to see how the process worked. Xiang gave about a 2.5 hour presentation, intertwined with frequent questions from the committee. It looked very exhausting to do, but he definitely knew his subject well and had done his research.

After this I finished checking the ArcGIS project with Manu. All of our data was very close to each other, and we believe that the miniscule error arose from very minor changes that we made to the automatically created routes to make the route pass closer to the cities given to us in the Excel documents. Later, Xiang taught us the steps for our risk calculation as the next step in our ArcGIS project. These calculations will give us an effective method of interpreting all of the data that we've collected from ArcGIS this week. He taught us some more about what exactly risk means and the different terms involved in the calculation process. Next week, I'll complete these risk calculations. For the rest of today, I'm going to read about the ValuJet flight 592 accident.

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234454	202890	231356	3	401.89173	4 S	3.3644113
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153305	175590	179394	28	486.301444	4 S	3.85281132
253963	175594	175600	29	1343.23108	3 S	4.40531136

Monday, June 10, 2013

Day 6

Today I worked on the next part of the ArcGIS project. In Excel I analyzed the data from the different routes according to the categories that Xiang and Jesus gave us. For each route, we broke down the risk based on type of tank car (Isotainer or Tank-car 1) and based on different ranges of risk levels. All of these calculations allow the data to be more easily interpreted and presentable to a company. It's very satisfying to see the ultimate result of all of the work that we've done. Not surprisingly, for all 6 routes and both types of tank cars, approximately 75% of the risk fell between 1.0E-04 and 1.0E-06, the middle two levels of risk. This is to be expected; it basically is saying that for most of the route there is not a great deal of risk, but there is a non-negligible amount of risk involved.

After I compared and checked my Excel sheets with Manu, I continued to read more about the ValuJet accident, reading the NTSB accident report on it. After searching through many articles, it's apparent to me that this is the most high profile hazmat accident in aviation history thus far. One recent accident occurred in 2010, when UPS flight #6 crashed. There were a large number of lithium-ion batteries on board the plane, and there were other instances I've read about of lithium batteries catching on fire. This is potentially an area that I can look to further when I do my own project.

Total length		Segments		Pop. dens		Length		Risk		
Absolute	Relative	Absolute	Relative	Absolute	Relative	Absolute	Relative	Absolute	Relative	
111	100%	451								
Distribution										
Class 1	11	9.9%	> 3000	28,387,139	8.1%	1.0E-04	5,409,975	8.8%	0.0002121	11.4%
Class 2	11	9.9%	1000 - 3000	154,389,955	44.3%	1.0E-04 - 1.0E-06	211,790,811	28.3%	0.00039121	61.7%
Class 3	25	22.5%	100 - 1000	406,227,519	116.3%	1.0E-05 - 1.0E-08	483,825,425	65.7%	0.00057687	20.4%
Class 4	845	761.3%	20 - 100	242,769,667	68.0%	1.0E-06 - 1.0E-07	117,968,219	16.4%	5.2146E-05	1.4%
Class 5	9	8.1%	< 20	87,597,262	24.7%	1.0E-07	10,112,704	1.4%	1.9461E-06	0.2%
Unknown	17.58	15.8%								
Operation										
Signal	874.62	78.3%								
Non-Signal	239.09	21.7%								
Unknown	17.58	1.6%								
Pop Density										
Pop Density	978	8.8%								
Shapefiles										
Shapefiles	1	0.9%								
Total Car Mile	111	100%								

Tuesday, June 11, 2013

Day 7

For the first half of the day, I continued researching and reading about different cases of aviation accidents involving hazardous materials. The most rigorous and complete sources in many cases were the NTSB (or equivalent organizations in the incident countries) reports. Transportation risk as it relates to hazardous materials is a pretty undiscovered field. There are several complications that I've come upon in my research. The post-accident investigations inevitably involve much speculation and educated guessing. Due to the nature of these accidents, recovery of data, equipment, etc. is usually impossible or significantly hindered. Thus it is difficult to glean useful information from the investigations. Also, "near-misses" aren't really reported due to concerns about prosecution and punishment. As a result, I'm only reading about worse-case scenarios. This makes it more difficult to learn about effective methods of risk mitigation. Nevertheless, I will move forward with my research in this field, as I have a great deal of interest in aviation.

For the second half of the day after Francesco's lunch meeting, Xiang and Jesus gave us a template and demonstrated how to prepare the final presentations for our ArcGIS project. Manu and I collaborated in

splitting up the work. We got a fair amount of it done in the time we have and plan to finish up tomorrow or Thursday.

Basic Route Information						
	Charleston -Luling (UP/CSX)	Charleston -Luling (UP/NS)	Savannah -Luling (UP/CSX)	Savannah -Luling (UP/NS)	Jacksonville -Luling (UP/CSX)	Jacksonville -Luling (UP/NS)
Total Length (Miles)	866	913	763	788	612	853
Segments	348	453	301	359	249	377
Distribution of Track Class						
Class 1	0.0%	1.6%	0.0%	1.3%	0.0%	0.8%
Class 2	6.9%	1.1%	7.4%	2.0%	9.3%	2.3%
Class 3	11.1%	2.7%	11.6%	5.5%	14.5%	4.6%
Class 4	81.3%	92.7%	80.1%	88.9%	74.8%	89.3%
Class 5	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Method of Operation						
Non-Signaled	70.9%	73.9%	87.8%	85.6%	59.4%	88.3%
Signaled	28.2%	24.2%	31.3%	32.1%	39.0%	8.5%
Average Population Density per Squared Miles	337	596	341	374	405	374

Wednesday, June 12, 2013

Day 8

Today I worked on finishing the ArcGIS project with Manu. We worked on creating a Powerpoint presentations summarizing all of the information and creating the appropriate maps in ArcGIS. We ran into a little bit of difficulty fitting all 11 routes onto one slide, but by resizing some things and shifting others around, we were able to make everything fit. We have been working in tandem with Hannah and Jeff to sync our Powerpoint presentations.

In the spare time that I had today, I continued to do research on risk mitigation in aviation. Rather than focusing on specific accidents, I've started to look more for general techniques that mitigate the risk. I found out about a program called Aviation Safety Reporting System (ASRS), which is an anonymous system which allows pilots to confidentially report close calls in an effort to increase safety in the future. This is precisely the type of system that would allow you to introduce reforms that would help mitigate risk in the future. I will continue to read about the ASRS and do more research on this.

Tomorrow, I will continue my research on the ASRS and our group will put the finishing touches on our presentation.

Thursday, June 13, 2013

Day 9

For the first part of the day, we worked on putting the finishing touches on our ArcGIS presentation. In our meeting today, Chen-Yu, Xiang, and Laura looked over our presentation and made some suggestions on how to improve it before we ultimately present it to the company. They also talked to us about the project that we will be doing in the coming weeks. This involved them explaining the process of literature review as a research practice.

After the meeting, we worked on fixing the presentation, which consisted of updating the maps, font sizes, spacing, etc. I continued to look over the ASRS reports to glean some information from them, as well as doing searches through the U of I library to find journal articles about aviation risk. In the short time that I've spent searching through the library, I can already tell that this is going to be a far more valuable resource to learn more about my research interests than Google has been. Tomorrow I plan to continue reading the articles that I found today, as well as finding new pertinent ones.

Journal of Risk Research
Vol. 13, No. 4, June 2010, 479-499



An inductive reasoning approach for building system safety risk models of aviation accidents

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(Received August 2008; final version received May 2009)

An inductive reasoning approach is employed to develop a prototype hybrid decision support tool whose main objective is to build probabilistic causal models representing the safety risk involved in aviation accidents. In this context, 15 aircraft accidents representative of five major accident types are selected to build an initial seed for the case-base of the prototype tool. Consequently, within each individual accident model, main clusters of causal factors are identified for inclusion in the initial seed, thereby improving, both quantitatively and qualitatively, the case-base of the prototype tool. A new methodology developed specifically for indexing aviation accidents into databases is used for indexing the initial seed into the case-base of the tool. The resulting product is a highly

Friday, June 14, 2013

Day 10

Today I delved into researching different topics of interest for my aviation project. I began with some simple searches with the words "aviation" and "risk" in them, and started reading some articles. After a few common themes became apparent to me, I further refined my search to glean some information on these themes. A couple areas of interest include:

1. The effects of fatigue on pilots
2. The effects of fatigue on air traffic control
3. Outdated technology and poor infrastructure (runways, traffic management systems, etc.) that pilots and air traffic control rely on
4. The mitigation of risks from terrorist attacks on flights

Throughout next week, I will continue to read articles in these topics, as well as search for new interest topics.

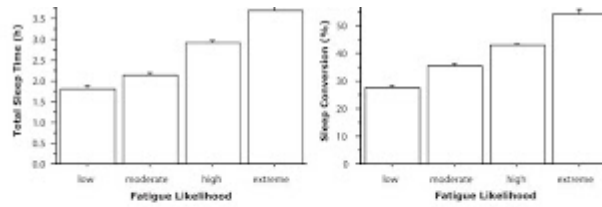


Fig. 4. The effect of estimated fatigue likelihood on the total amount of sleep obtained during a duty period (panel A), and the percentage of the rest opportunity that is converted to sleep during a duty period (panel B). Data are represented as mean \pm standard error. Asterisks indicate significant differences from other levels of fatigue likelihood, as determined by post-hoc analyses using Fisher's PLSD.

sleep. This result is consistent with previous studies that have shown that pilots have difficulty converting time in on-board rest facilities into an reasonable amount of sleep (e.g. Signal et al., 2009). When pilots have been surveyed previously about their sleep, they have tended to attribute this poor rate of conversion to a number of environmental factors associated with sleeping on-board an aircraft, e.g. comfort of the bed, light and noise levels, warmth and dryness of cabin air.

Furthermore, the data indicate that pilots obtain substantially more sleep during duty periods when fatigue is likely to be elevated than when fatigue is likely to be low. The results of this study demonstrate that long-haul pilots do use in-flight napping as a fatigue countermeasure, but more should be done to increase its efficacy.

Acknowledgements

Monday, June 17, 2013

Day 11

Today I continued reading articles about different sources of aviation accidents such as ice accumulation, runway incursions, bird strikes, and pilot/ air traffic control fatigue. This continues to give me a greater background on the different types of hazards that exist within the world of aviation.

In between reading the articles, I've been attending some of the lectures from the SNCF visit. Riley gave an introduction to the research that he does on concrete cross ties as well as the sleeper and fastening system. Later I will attend more of the lectures from the graduate students, as well as meeting with Rapik and Jesus to discuss the final results of our ArcGIS project.

Learning from aircraft fuel tank explosions

Frederic Gil

Process Safety & Fire Engineering Advisor, BP Refining Technology, Sarnbury, UK

Introduction

On 17 July 1966 a Boeing 707, operated by Trans World Airlines as flight 800, crashed into the Atlantic Ocean shortly after takeoff from John F. Kennedy Airport in New York. All 230 people on board were killed. After a detailed investigation, the National Transportation Safety Board (NTSB) determined that the fuel-air vapours in the fuselage centre fuel tank ignited, causing an explosion of the tank, and initiated the break-up of the plane.

The TWA 800 incident is not only well known due to the human tragedy, but also because during the investigation multiple reconstructions developed to argue that this incident was intentional, not accidental. Different versions developed conspiracy theories trying to support either that a secret US Navy missile had downed the plane or that the government was trying to cover up the story^{1,2}, that secretaries had launched a missile^{3,4} or that a bomb had been placed on board. All these theories, supported by some references to TWA 800 as 'wreck of fate'⁵, have often been more aimed by the media or published than more serious writings on this tragedy, the Milon's book⁶ on the 30th investigation.



Fire on Thai Airways Boeing 707-400 on 3rd March 2001, Bangkok, Thailand after centre fuel tank explosion. Picture source: NTSB memory.

currently delivers more airplanes worldwide than Boeing, their cumulative operational fleet hours are still relatively small (approximately 1% of total fleet hours). The FAA therefore statistically determined that their

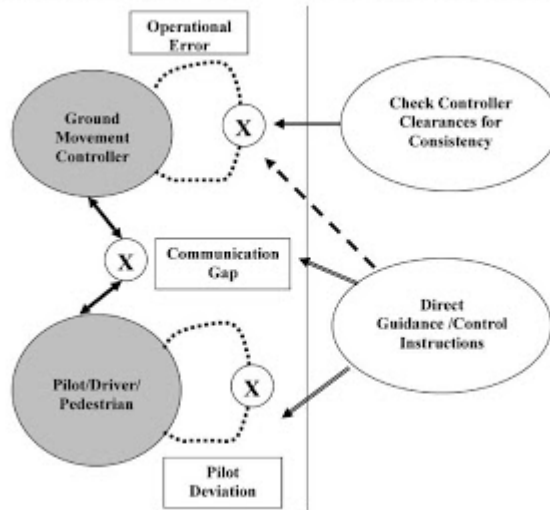
Tuesday, June 18, 2013

Day 12

For most of the day today I listened to presentations by Francesco and Gilles Saussine on balast flight. In the spare time Manu and I made the necessary changes to the ArcGIS presentation before we present

it to the company. I looked up articles for my aviation project as well, specifically on runway incursion avoidance systems.

Tomorrow I plan to attend more of the presentations from SNCF and continue reading articles for my aviation project.

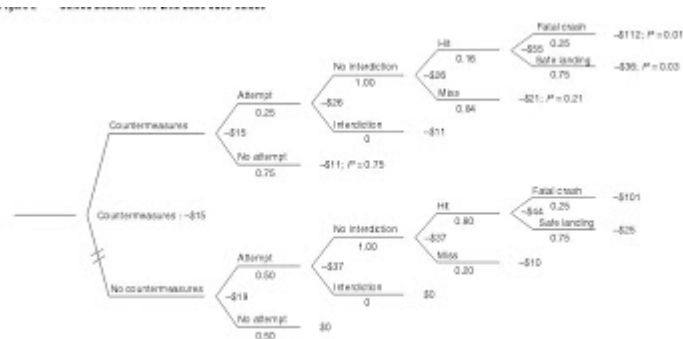


Wednesday, June 19, 2013

Day 13

For the first part of the day, I continued to read articles for my aviation risk project. My focus today was in flight cabin safety, terrorist threats, and runway incursions/safety. I read some very interesting articles on the MANPADS air defense system, the economic costs of terrorist attacks, and runway arrestor systems for planes that overrun their target. Another interesting article discussed the effects of noise cancelling headphones on passenger safety.

For the rest of the day today, I am going to attend the seminars from Professor Tutumeler's research group. Tomorrow I will continue to read articles for my aviation project and possibly begin outlining my Powerpoint presentation.

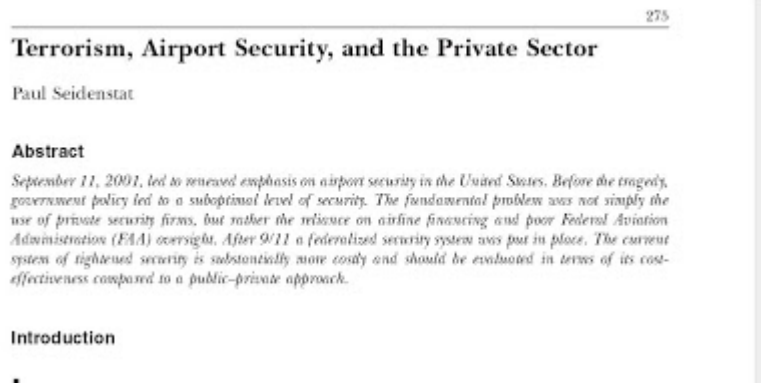


Thursday, June 20, 2013

Day 14

Today I spent most of the day reading articles for my aviation project. I focused on articles about mitigating the risks from terrorism, as well as articles that discussed the economic conditions of the post 9/11 flying world. These articles discussed the security efforts administered by the TSA and federal government to create safe flying conditions. I also found some interesting articles about other security measures to prevent terrorism, such as profiling. I attended a short lecture from Deb about the work that his research team has done investigating an Amtrak section of the Northeast Corridor.

Tomorrow, I plan to continue reading articles for my aviation project, as well as attending several of the lectures on the safety meeting organized by Francesco.



Friday, June 21, 2013

Day 15

For the beginning of a day I attended the lectures where Chen-Yu, Xiang, and Laura presented on their topics of transportation risk.

For the rest of the day, I continued to read articles for my aviation project, in the process compiling a document that summarizes all of the articles that I've read. The articles that I read today focused on bird strikes, methods to identify terrorists, and the effectiveness of post 9/11 security measures instituted by the government.

On Monday I will begin outlining the risk factors and slides for my Powerpoint presentation. The document that summarizes all of the articles that I've read will be particularly helpful in building my outline.



Intent to deceive?

Can the science of deception detection help to catch terrorists?
Sharon Weinberger takes a close look at the evidence for it.

In August 2000, Nicholas George, a 22-year-old student at Pomona College in Claremont, California, was going through a checkpoint at Philadelphia International Airport when he was pulled aside for questioning. As the Transportation Security Administration (TSA) employees searched his hand baggage, they chatted with him about innocuous subjects, such as whether he'd watched a recent game.

Inside George's bag, however, the screeners found flash cards with Arabic words — he was studying Arabic at Pomona — and a book they considered to be critical of US foreign policy. That led to more questioning, this time by a TSA supervisor, about George's views on the terrorist attacks on 11 September 2001. Eventually, and

pick out suspicious or anomalous behaviour in passengers. There are about 3,000 of these officers working at some 161 airports across the United States, all part of a four-year-old programme called Screening Passengers by Observation Technique (SPOOT), which is designed to identify people who could pose a threat to airline passengers.

It remains unclear what the officers found anomalous about George's behaviour, and why he was detained. The TSA's parent agency, the Department of Homeland Security (DHS), has declined to comment on his case because it is the subject of a federal lawsuit that was filed on George's behalf in February by the American Civil Liberties Union. But the incident has

government is deploying officers in a trial in And in the United States a programme that at nonverbal behaviour terrorists as they walk Department of Defence have expressed Yet a growing number — not just about but about the scene. "Simply put, people

Monday, June 24, 2013

Day 16

Today I spent the first half of the day continuing to read articles about mitigating terrorist threats, as well as an article about preventing runway incursions. Other articles that I read focused on securing cargo, and defending aircraft from missiles. After this, I browsed over the Udemy course again to get an idea of the type of PowerPoint that I am supposed to create.

With this in mind, I created an outline covering the material that I felt was appropriate for my PowerPoint. I am in a somewhat unique position given the nature of airplane accidents. I have identified the typical risk factors that affect daily flight. The outline is certainly subject to change.

Here is the link to the outline, I would appreciate your comments: [PowerPoint Outline](#)

Tomorrow I will continue working on my outline and reading articles on efforts to protect aircraft the Man-Portable Air Defense Systems (MANPADS) such as the Northrop Grumman Guardian.

Homeland Security: Protecting Airliners from Terrorist Missiles

Summary

Recent events have focused attention on the threat that terrorists with shoulder fired surface-to-air missiles (SAMs), referred to as Man-Portable Air Defense Systems (MANPADS), pose to commercial airliners. Most believe that no single solution exists to effectively mitigate this threat. Instead, a menu of options may be considered, including installing infrared (IR) countermeasures on aircraft; modifying flight operations and air traffic control procedures; improving airport and regional security; and strengthening missile non-proliferation efforts. Equipping aircraft with missile countermeasure systems can protect the aircraft even when operating in areas where ground-based security measures are unavailable or infeasible to implement. However, this option has a relatively high cost, between \$1 million and \$3 million per aircraft, and the time needed for implementation does not allow for immediate response to the existing terrorist threat. Procedural improvements such as specific flight crew training, altering air traffic procedures to minimize exposure to the threat, and improved security near airports may be less costly than countermeasures and

Tuesday, June 25, 2013

Day 17

Today I spent a large part of the day continuing to read articles about aircraft safety measures, such as defense mechanisms against MANPADS, autopilot, bad weather mitigation systems (primarily ice), and other articles discussing the role of human error in accidents.

For the rest of the day, I attended the lunch meeting where Kwan made a presentation on his role in the Thai railway system. The risk group had a short meeting with Kwan where he asked us some questions about our railroad risk calculation project.

Tomorrow I will continue to read articles on the role of human error in aircraft accidents, and possibly began working on the Powerpoint.

Perceived vs. measured effects of advanced cockpit systems on pilot workload and error: Are pilots' beliefs misaligned with reality?

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Received 3 March 2008
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Automation

ABSTRACT

Four types of advanced cockpit systems were tested in an in-flight experiment for their effect on pilot workload and error. Twelve experienced pilots flew conventional cockpit and advanced cockpit versions of the same make and model airplane. In both airplanes, the experimenter dictated selected combinations of cockpit systems for each pilot to use while soliciting subjective workload measures and recording any errors that pilots made. The results indicate that the use of a GPS navigation computer helped reduce workload and errors during some phases of flight but raised them in others. Autopilots helped reduce some aspects of workload in the advanced cockpit airplane but did not appear to reduce workload in the

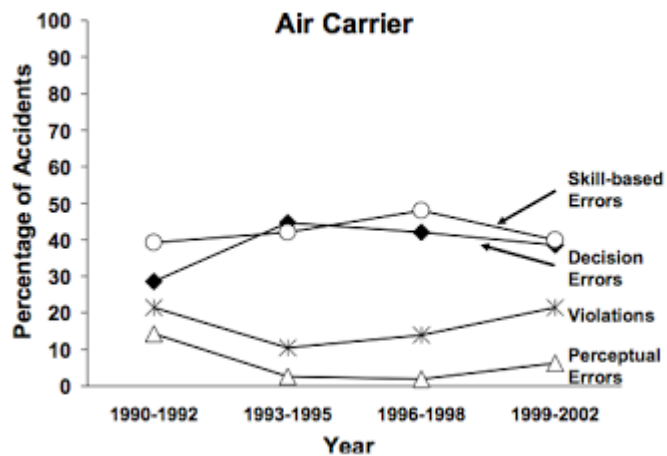
Wednesday, June 26, 2013

Day 18

Today I spent most of the day continuing to read articles, focusing on the human risk factors for aviation accidents such as pilot error, proper training methods from flight instructors, advanced flight control systems vs. conventional systems, and autopilot.

In the middle of the day, we had a meeting with Xiang where he checked up on the progress of everyone in our group and made suggestions on how to execute our final project. He made particularly helpful suggestions to me with regards to the risk analysis framework, as I can't easily do a qualitative analysis. His discussions with us about risk were particularly interesting because it became very apparent that risk is defined however you want to it to be. It's not something that's a stringent definition, it changes depending on the situation that you're investigating; that's a very interesting concept to me.

Tomorrow I will continue to read articles on these human factors and possibly get started on the Powerpoint presentation.



Thursday, June 27, 2013

Day 19

At the beginning of the day today, I attended the safety meeting where Jesus presented his research. It's interesting to me how precise you have to be with regards to the assumptions that you make when considering a release. Professor Barkan brought up issues such as wind direction and terrain that affect release severity, both things which I had never thought about taking into account, but definitely two pertinent factors.

For the rest of the day, I continued my literature review, focusing on human factors such as pilot age and simple human error. At the end of the day, I read an interesting article (Safety Practices, Training Practices and CRM: A Midpoint Perspective) that introduced the concept of crew resource management (CRM) to me. The author of the article, Daniel Maurino, made several interesting points about the flaws in how we evaluate aviation accidents. He made the analogy that accident investigation is the "postmortem of the system conducted after the point of no return...there is not much that can be done about it, other than organizing a funeral." It's similar to the thought that I have in the back of my head reading these accident reports, "Yes we will be able to identify the causes of this accident, but how much good are we really doing to prevent similar accidents in the future? Do the suggestions that the NTSB make actually help improve safety?"

I appreciate his acknowledgement that human error is unavoidable, and he goes on to detail how the accident investigation process is flawed, because it doesn't investigate the "systemic and organizational" issues that lead to these errors. This article will prove extremely useful for my risk mitigation module, as it really opened my eyes to the issues of accident investigations. Most importantly, he makes sincere attempts and suggestions of ways that the training and monitoring ("surveillance" as he calls it) process can be improved to make the aviation world a safer place.

Safety Prejudices, Training Practices, and CRM: A Midpoint Perspective

Daniel E. Maurino

*International Civil Aviation Organization
Montreal, Canada*

Problems in the application of data from accidents and incidents in the design of crew training are discussed. An alternative approach, monitoring normal operations, is proposed and described. Criticisms of the usefulness of crew resource management (CRM) training based on accidents are considered, and the importance of normal process monitoring for evaluation of CRM efficacy is discussed.

Error-prone people do, of course, exist, but they seldom remain at the hazardous sharp end for very long. Quite often, they get promoted to management. (Reason, 1997)

Tomorrow I will continue my literature review and possibly get started on the Powerpoint.

Friday, June 28, 2013

Day 20

Today I spent the whole day continuing/wrapping up my literature review before I begin my Powerpoint. I focused on human factors such as distractions in the cockpit, crew training, leading causes of accidents (both commercial and general aviation), and one particularly interesting article that focused on mitigating errors that occur while taxiing.

Now that I feel I have a solid background of the risk factors involved with flight, I'm going to continue editing the outline that I made that will aid me in writing my Powerpoint. Once I feel that my outline properly conveys my intentions, I will begin writing the Powerpoint.

Pilot Navigation Errors on the Airport Surface: Identifying Contributing Factors and Mitigating Solutions

Becky L. Hooey

*Monterey Technologies, Inc., at NASA Ames Research Center
Moffett Field, California*

David C. Foyle

*Human Factors Research and Technology Division
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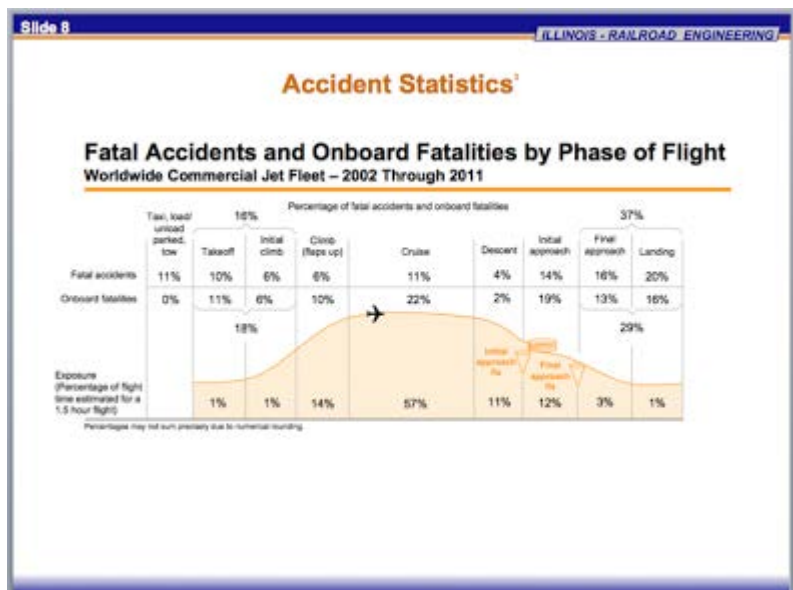
Monday, July 1, 2013

Day 21

Today I spent the majority of the day beginning to write my Powerpoint. It was a challenge to balance the expectations of the layout of the presentation with the topics that I wanted to address along with incorporating all of the research that I've done. I have to be able to simplify all of the research into easily readable and comprehensible slides, while at the same time making sure that my slides have substance to them.

Occasionally throughout the day, I would open up the articles that I've been reading in the past couple of weeks to jog my memory on the key points and "deliverables" of the articles. Tomorrow I will continue to work on my presentation and continue the practice of having articles open as I write the Powerpoint.

I'm doing some experimenting with the order of my slides to determine what is the most user friendly arrangement. I'll play this by ear and make a decision closer to when I have to finalize my presentation.



Tuesday, July 2, 2013

Day 22

Today I spent most of the day working on my Powerpoint. I continued to read the article on the TSA's attempts to reach 100% screening of cargo in the post 9/11 era. It was interesting to learn about the challenges that the TSA faces with trying to ensure the safety of cargo while at the same time making sure that they don't slow down the industry and cause disastrous economic effects.

I faced some challenges in the phrasing of my risk factors with regards to trying to make a risk matrix. Ranking the likelihood and consequence for the risk factors you see in the picture below required a significant amount of educated guessing. I looked back at the Udemy course to get a handle on the scale that you used to rank the likelihood of the consequence. I'm going to alter the criteria to make them fit my risk factors better, as I need a scale that has some numbers between unlikely (3) and likely (4). This will be useful for factors like fatigue and outdated technology which are a constant presence. I feel it is appropriate to change the criteria as long as I justify my new choices.

Tomorrow I will continue to work on the Powerpoint and read literature to fill in my knowledge gaps.



Wednesday, July 3, 2013

Day 23

Today I spent the majority of the day working on my Powerpoint. I continued the slides on the risk factors, as well as the risk matrix slides. As a reference, I looked at the "Guidelines for Chemical Transportation, Security, and Risk Management" to learn more about risk matrices. After consulting with this reference, I changed the consequence and likelihood scales to more closely match my risk factors. As a whole, my risk factors occur far more frequently than those involved in the reference source and your Udemy course, so I had to "tilt" the scale more towards categories with a higher likelihood.

I also read a few articles that helped me learn more about why maintenance errors occur and how often they occur. This helped greatly with that particular slide on my Powerpoint.

I plan to continue working on my Powerpoint, as well reading more literature where I find it necessary to fill in any knowledge gaps.

Risk Factor Rankings

- **Outdated Technology (4,2):** Everyday air traffic control deals with antiquated radar and radio technology; there have some cases of near misses and runway incursions partially attributable to this
- **Pilot and ATC fatigue (3,2):** Crewmembers and ATC employees are certainly fatigued for a fair share of their assignments; it has been attributed as a factor in some fatal accidents
- **Cargo Shifting (1,4):** This is an extremely rarely documented phenomenon; in it's one documented case, it caused the aircraft to stall and crash (National Airlines Flight 102)

Monday, July 8, 2013

Day 24

Today I spent the whole day working on my Powerpoint. Xiang reviewed my Powerpoint over the weekend and suggested some changes that I make, which I did. The largest change that I made was introducing my risk matrix methodology and discussing the advantages and disadvantages of it instead of simply jumping right into it without any explanation.

Our risk group spent a couple of hours presenting our modules to each other and making suggestions on how we can improve our presentations. I took the suggested changes into account. I appreciated the discussion that I had with my group members over the risk methodology framework that I employed, specifically with regards to how I ranked the risk factors.

Tomorrow I will continue to work on my Powerpoint, beginning my modules on risk mitigation and the case studies if I have time. I will also continue reading literature where I find it necessary to fill in any gaps in my knowledge and research. Within the next couple of days I hope to have my risk mitigation module finished.

Risk Matrix Disadvantages

- The disadvantage of this method is that you must estimate the values of the likelihood and consequence of these risk factors; it's very difficult to put an exact number on this
- A risk factor can have significantly varying levels of consequence depending on the conditions of the accident
- The boundaries for the different levels were adapted from that of a general risk matrix, so it is difficult to set boundaries that perfectly capture the appropriate likelihood and consequence levels
- The limited amount of incidents that involve the identified risk factors further exacerbates the aforementioned disadvantages

Tuesday, July 9, 2013

Day 25

Today I spent most of the day working on my Powerpoint. I focused on finishing my "Investigation of Risk Factors" module and beginning my "Risk Mitigation" module. I wrote a few of my slides on the Aviation Safety Reporting System (ASRS), continuing to read articles in the process to learn more about the ASRS and runway incursion prevention systems.

Brandon presented in the lunch meeting about RailTEC's research in Colorado on rail pads, which was pretty interesting. After the lunch meeting I continued working on the Powerpoint. Tomorrow I will continue working on my "Risk Mitigation" module and possibly begin my case studies.

Thursday, July 11, 2013

Day 27

At the beginning of the day today I went to the safety meeting where Laura presented her work on the conditional probability of release of tank cars. It was interesting seeing the methods that she used for her calculations.

For the rest of the day, I worked on the "Risk Mitigation" module, especially focusing on methods of mitigating security risk. I went back and looked at some of the articles on the economic effects of terrorist attacks and anti-MANPADS technology. Other than some minor changes possibly, I'm pretty close to being finished with the "Risk Mitigation" module. Tomorrow I will begin doing the case studies for each of the different risk factors.


Here is what I have for my Powerpoint so far. All of the modules are on one presentation: [Powerpoint](#)
PLEASE NOTE: The file is too big for Google Docs to generate a preview in your web browser, you will need to download it off of the link.

Slide 43 ALLIANCE - RAILROAD ENGINEERING

Terrorist Attack Prevention-Civilian (Continued)


- Airports can be outfitted with sensor grids that could detect a missile attack. They could then activate aircraft-based or ground-based countermeasures:
- Ground-based countermeasures currently in operation are the Marine Corps "HUMRAAM" system, a vehicle anchored SAM system, or the Army's tactical high-energy laser (THEL)
- Studies were completed on ground-based antennas that could emit microwave pulses to jam the missile
- Northrop Grumman and BAE have produced systems for civilian aircraft that use DIRCM to fend off incoming missiles

7. Congressional Research Service; <http://www.law.umaryland.edu>



"HUMRAAM"

<http://www.armytechnology.com/projects/surface-launcher-and-missile-defense-1.jpg>



The Northrop Grumman "Guardian", produced for civilian aircraft

<http://www.pacificmissiles.eu/uk/see-what-new-guardian-200705-guardian-001.html>

Friday, July 12, 2013

Day 28

For the first part of the day today, I read parts of the NTSB reports on accidents that had identified fatigue as a factor. This gave me a good background on what it was about fatigue that contributed to the accidents. Additionally, I had a better understanding of what the NTSB suggested to help mitigate the risk from fatigue.

After consulting with Manu, I have decided to add a few slides in my risk matrix framework to explain the percentages that I assigned to the risk factors. My hope is that this will help communicate my thought process and give more credence to the percentages that I chose.

Next week I will continue to work on my risk mitigation module, and work on revising my risk matrix framework (as described above). I also plan to begin writing my paper next week.

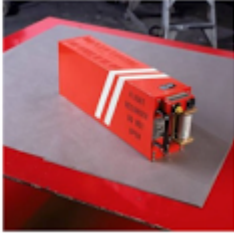
Here is the link to my current version of the Powerpoint (the file is too large to appear in your browser, please download it after clicking the link): [Powerpoint](#)

Slide 50

ILLINOIS RAILROAD ENGINEERING

Investigation Process


- The NTSB is required to investigate any incidents that departed from American airports or had American fatalities/injuries
- Their accident reports are extremely thorough; they consider the history of the airplane, the activity of the pilots in the days leading up to the crash, the experience of the pilots, weather conditions, the response from emergency personnel, and many other factors
- There are two pieces of equipment that are critical for the investigators to recover: the cockpit voice recorder (CVR) and flight data recorder (FDR)
- The CVR records conversations in the flight deck and over the radios, while the FDR records data such as time, altitude, air speed, headings, flaps, attitudes, and accelerations



<http://media.nts.gov/2013/07/15/201307150010-back-to-work-landing0843/>

1. National Transportation Safety Board; http://www.ntsb.gov/doclib/manuals/FDR_Handbook.pdf

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Monday, July 15, 2013

Day 29

Today I spent the whole day writing my Powerpoint. I spent the afternoon reviewing my Powerpoint with Jeff and Manu and discussing the framework of my risk matrix with Francesco. We had a very interesting discussion on the framework for how a risk matrix is designed and how the likelihood and consequence levels are defined. We especially had a disagreement on whether "outdated technology" is a constant factor or not. We eventually came to an agreement after clarification on how the likelihood category is defined.

Tomorrow I will continue to work on changing my risk matrix framework based on my discussions with Francesco, and I will also continue my "Case Studies" Powerpoint module.

Here is the link to my current version of the Powerpoint. Please download it after clicking the link, instead of trying to open it in the browser: [Powerpoint](#)

Likelihood Level	Description
1 (Very Unlikely)	Expected to occur on <1% of incident flights
2 (Unlikely)	Expected to occur on 1-10% of incident flights
3 (Likely)	Expected to occur on 10-50% of incident flights
4 (Very Likely)	Expected to occur on >50% of incident flights
5 (Certainty)	Constant factor on incident flights

Consequence Level	Description
1 (Minor)	No or limited minor injuries; limited hull damage
2 (Low)	Potential multiple minor injuries or limited serious injuries; notable hull damage
3 (High)	Potential multiple serious injuries or limited fatalities; significant hull damage
4 (Very High)	Potential multiple fatalities; complete hull loss

Tuesday, July 16, 2013

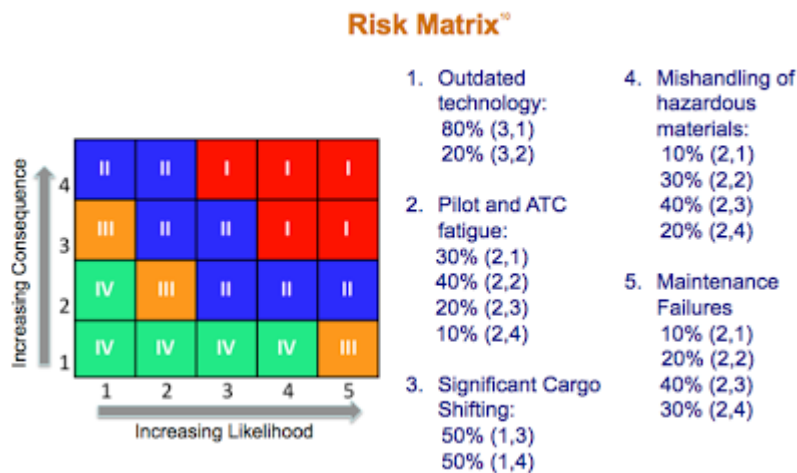
Day 30

Today I spent most of the day continuing to write my Powerpoint, focusing on the "Case Studies" module and adapting my risk matrix slides to fit the suggestions that Francesco made. I also implemented all of the edits that I had picked up yesterday from my presentation to Jesus, Jeff, and Manu.

I sat in on the lunch meeting where Matt presented on RailTEC's research on railpads at Pueblo. It was interesting seeing the technology that was used to collect data.

Tomorrow, I will continue working on the "Case Studies" module. I hope to begin writing my paper within the next couple of days.

Here is the updated version of my Powerpoint. Please download it instead of trying to view it in your browser. [Powerpoint](#)



Wednesday, July 17, 2013

Day 31

Today I spent the day finishing up the "Case Studies" module on my Powerpoint, specifically the "hazardous materials" and "maintenance error" case studies. I continued reading accident reports from the NTSB and articles to find good representative cases for each of my risk factors. I settled on ValuJet flight 592 for "hazardous materials" and Aeroperú Flight 603 for "maintenance errors."

Especially for the "maintenance errors" module it was very interesting to read about the different representative incidents. This one was particularly striking to me because something seemingly so minor can doom a flight. Right before the incident flight, the aircraft was being repaired and the maintenance workers appropriately put tape over the static ports while polishing the plane. When they finished working on the plane, they neglected to remove the tape and that completely compromised the accuracy of the plane's instruments, eventually leading it to crash in the Pacific Ocean. If the maintenance workers had spent 30 seconds removing the tape, this incident never would have happened.


Tomorrow I will finish up any last minute changes that I have to make on the Powerpoint and I will begin writing my paper.

Here's the link to my recent version of the Powerpoint. Please download it instead of trying to view it in your browser: [Powerpoint](#)

Slide 60 ILLINOIS - RAILROAD ENGINEERING

Maintenance Errors Case Study⁴

- Aeroperú Flight 603, operated on a Boeing 757, crashed into the Pacific Ocean in October 1996
- Shortly after takeoff, the pilots were receiving incorrect and conflicting readings on their instrument panels
 - The over-speed alarm was erroneously activated for the last 12 minutes of the flight
 - The altimeters and airspeed indicators were malfunctioning, so the pilots didn't know whether to heed the sink rate or "too low-terrain" alarm



The aircraft involved in the accident

http://upload.wikimedia.org/wikipedia/commons/thumb/3/38Aeroperu_Boeing_757-200_N52AW_MIA_1996-1-8.png/260px-Aeroperu_Boeing_757-200_N52AW_MIA_1996-1-8.png

4. <http://www.skybrary.aero/bookshelf/books/1719.pdf>

Thursday, July 18, 2013

Day 32

At the beginning of the day I attended the safety meeting where Jeff presented his research on pipeline risk. After that, I continued my discussion with Francesco about the appropriate way to use a risk matrix and I began to write my paper for the REU. Francesco gave me some helpful suggestions on

changes I can make to the risk matrix framework in accordance with Rapik's recommendations. I worked on cleaning up the citations in my presentation too.

Tomorrow I will continue working on the REU paper, as well as making minor edits to the PowerPoint (i.e. continuing to clean up the citations)

Here is the current link to my PowerPoint. Please download it instead of trying to view it in your browser: [Powerpoint](#)

Eli Hyman

CEE Aviation Risk REU

For the first two weeks of my REU I was introduced to the concepts of risk in the context of a risk analysis for a train route. We used ArcGIS to analyze the risk of 11 different train routes throughout the United States using two different types of train cars. I worked with the 3 other interns to prepare a PowerPoint that we presented to Professor Saat and Professor Barkan. This project gave me a good overview of the typical process involved in performing a risk assessment.

The next several weeks were spent doing a literature review to gain background knowledge on the different risk factors involved in a typical flight. My assignment was to produce a series of modules on the very broad topic of aviation risk. For the literature review, I read academic journals and articles on the causes of aviation incidents, as well their respective mitigation techniques.

Friday, July 19, 2013

Day 33

At the beginning of the day today, I presented my Powerpoint to Jeff and Hannah, where they made helpful suggestions as to some improvements that I can make. After implementing these changes, I continued writing my paper for the REU. I'm organizing my paper in a semi-chronological order. So far, a lot of my paper emphasizes the research process that I undertook from the beginning of my work here to the Powerpoint modules.

Next week, I will continue writing my REU paper. I plan to write a few paragraphs on the specific, more technical aspects of my research, as well as an evaluation of the effectiveness of the research process I undertook.

Here is the last version of my Powerpoint. Please download it instead of trying to view it in your browser: [Powerpoint](#)

Accident reports, published by the National Transportation Safety Board (NTSB) were very useful because I could read in depth details of any accident that occurred in the U.S., and better understand the massive investigative process that aims to understand the causes behind these accidents. As an aviation enthusiast, this was very interesting because I could inform myself on many well-known accidents such as ValuJet Flight 592 and American Airlines Flight 191. I was impressed with the variety of academic journals that published articles related to my research fields. There were human factors journals, sleep institutes, and aviation psychology journals that all had excellent journals on common aviation risk factors.

The most difficult part of the risk analysis was executing an effective method of expressing the risk. I decided to primarily do a qualitative risk analysis, including a semi-quantitative risk matrix. The challenge in doing a quantitative risk analysis is the highly unpredictable nature of aircraft accidents. Trying to model the number of people affected by a plane crash is a fruitless task, because the behavior of these accidents is difficult to model. Quantitative analysis makes sense when investigating hazardous material spills in pipelines and railroads, since one only needs to concern themselves with latitudes and longitudes, and not altitudes.

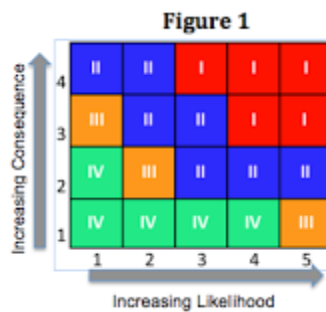
Excerpt of the draft of my REU paper

Monday, July 22, 2013

Day 34

Today I spent most of the day continuing to write my research paper for the REU. I focused particularly on the methodology and framework of the risk matrix. I talked extensively about why I chose to use a risk matrix to evaluate my risk factors, as well as acknowledging the drawbacks that came along with it. I make it clear that it was a fairly arduous process that required invaluable input from my colleagues and the graduate students. I also talk about case studies for the two risk factors that I identified as most severe, in order to demonstrate how I used them to establish "key takeaways" for each of the risk factors. Tomorrow I will continue to work in finishing my research paper, as well as compiling a PowerPoint for my presentation on Thursday.

Here is the link to my current version of the research paper: [Research Paper \(https://docs.google.com/file/d/0B2_Wyare8mDKUkICMedYRURtUTA/edit\)](https://docs.google.com/file/d/0B2_Wyare8mDKUkICMedYRURtUTA/edit)



From the literature review, I was able to come up with a list of 5 main safety risk factors that affect incident flights (outdated technology, pilot and air traffic control (ATC) fatigue, significant cargo shifting, mishandling of hazardous materials, and maintenance failures). The ultimate purpose of the risk matrix was to rank the factors by risk, using the standard definition that risk= (probability) * (consequence). The risk matrix would provide the likelihood (probability) and consequence levels necessary to do the calculations. The benefit of using a risk matrix is its customizability. The parameters of the likelihood and consequence

Tuesday, July 23, 2013

Day 35

Today I finished writing my REU research paper, and focused on editing it. I also created a PowerPoint based off of my modules to present at the safety meeting Thursday. It was a bit of a challenge to shorten the slides to an appropriate length and to delete enough slides to fit a 20 minute presentation, but I think I have a good amount of information in my presentation. At the lunch meeting today, I listened to Brent do a presentation on insulators.

Tomorrow I will continue to work on improving my PowerPoint presentation for Thursday, as well as looking for any improvements that I can make to my research paper.

Slide 12 ILLINOIS - RAILROAD ENGINEERING

Risk Analysis

**Introduction to Aviation
Transportation
Risk Analysis**

Eli Hyman
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Rail Transportation and Engineering
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Environmental Engineering
University of Illinois at Urbana-
Champaign, U.S.A.



United Airlines Logo[®]



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UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Wednesday, July 24, 2013


Day 36

Today I worked on polishing my PowerPoint presentation for tomorrow. I presented to Manu, Jeff, and Hannah and they made some useful suggestions for changes that I could make. After I made the changes that they suggested, I read about some interesting incidents, mostly terrorist hijackings. There were also some interesting articles I found on improvements in security since the 1970's. I also worked on familiarizing myself with the presentation so that it goes smoothly tomorrow.

Slide 16 ILLINOIS - RAILROAD ENGINEERING


Hazardous Materials Case Study

- The "signature" event in the mishandling of hazardous materials is ValuJet Flight 592
- SabreTech, the contracted maintenance operator for ValuJet, placed improperly sealed, expired oxygen generators in the cargo hold
- Employees failed to put safety pins on the generators, and they falsely identified the generators as empty canisters, which would have been safe to fly in the cargo hold



The ill-fated ValuJet aircraft, a DC-9

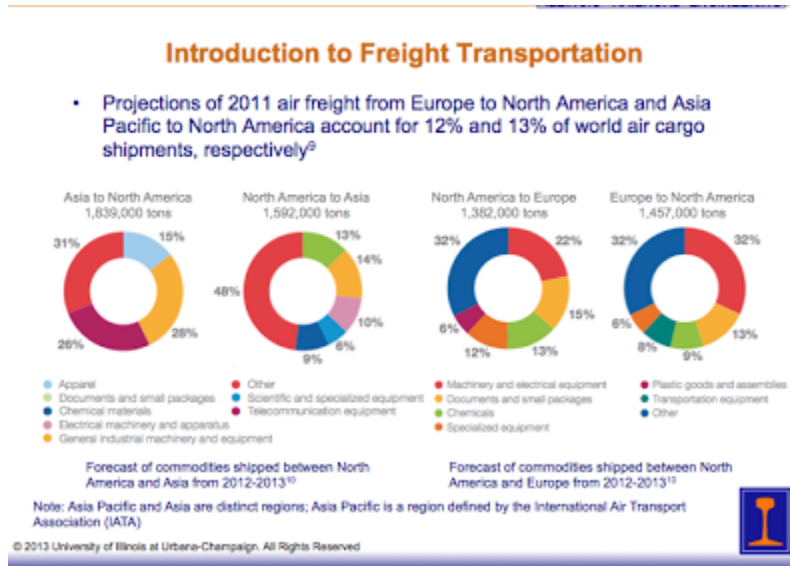
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Friday, July 26, 2013

Day 37

At the beginning of the day today, I made minor touch ups to my presentation for the safety meeting. My presentation went very well. Hannah and Manu also did their presentations on waterways and rail, which was very interesting to see. In the next couple days, there are some minor changes that I have to make to clarify and improve my presentation. Over the next couple days, I'm also planning to continue reading about aviation incidents to learn more about aviation incidents and risk factors.



Friday, July 26, 2013

Day 38

At the beginning of the day today, I focused on making changes to my PowerPoint that were suggested at the safety meeting yesterday. I added a table to my risk calculations slide to make my methodology more clear, and added more info breaking down types of commodities shipped for my cargo flight slides. I also filled out and submitted the student form evaluating my REU performance. I moved all of my modules, the REU paper, and my outline to the RaiITEC server.

After this, I read about articles/stories about various aviation incidents and runway incursions.

Risk Factor Weighted Rankings-Summarized²

- Risk = $f(\text{probability } P, \text{consequence } C)$

- Risk = $P \times C$

The risk factors ordered from highest to lowest risk:

Risk Factor	Likelihood	Consequence	Risk
Mishandling of hazardous materials	2	2.7	5.4
Maintenance failures	2	2.6	5.2
Pilot and ATC fatigue	2	2.1	4.2
Outdated technology	3	1.2	3.6
Significant cargo shifting	1	3.5	3.5

Note: This is a semi-quantitative ranking. Rankings are preliminary and subject to change.
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Tuesday, July 30, 2013

Day 39

Today I read some accident reports and articles about incidents. It's interesting to see how foreign countries handle their investigations compared to the United States. Tomorrow, Laura is giving me a project relating to the Lac-Megantic accident. In any spare time I have, I will continue to read accident reports.

Loss of Thrust in Both Engines After Encountering a Flock of
Birds and Subsequent Ditching on the Hudson River
US Airways Flight 1549
Airbus A320-214, N106US
Weehawken, New Jersey
January 15, 2009

Tuesday, July 30, 2013

Day 40

At the beginning of the day today Laura showed me the system that she wants me to use to document photos from the Lac-Megantic train accident. I started to sort through all of the photos. There was some difficulty identifying parts of the cars given their decimated nature.

At the lunch meeting today, Chen-Yu presented his work on passenger rail collisions and derailments, which was pretty interesting. In my spare time today I read the accident report on US Airways Flight 1549, which miraculously landed in the Hudson River without any fatalities. Tomorrow I will continue to work on documenting the photos from the Lac-Megantic accident if I have time. At the beginning of the day I will be working on the ArcGIS project that Xiang assigned us.

National Transportation Safety Board. 2010. *Loss of Thrust in Both Engines After Encountering a Flock of Birds and Subsequent Ditching on the Hudson River, US Airways Flight 1549, Airbus A320-214, N106US, Weehawken, New Jersey, January 15, 2009. Aircraft Accident Report NTSB/AAR-10/03. Washington, DC.*

Abstract: This report describes the January 15, 2009, accident involving the ditching of US Airways flight 1549 on the Hudson River about 8.5 miles from LaGuardia Airport, New York City, after an almost complete loss of thrust in both engines following an encounter with a flock of birds. The 150 passengers, including a lap-held child, and 5 crewmembers evacuated the airplane by the forward and overwing exits. One flight attendant and four passengers were seriously injured, and the airplane was substantially damaged.

Safety issues discussed in this report include in-flight engine diagnostics, engine bird-ingestion certification testing, emergency and abnormal checklist design, dual-engine failure and ditching training, training on the effects of flight envelope limitations on airplane response to pilot inputs, validation of operational procedures and requirements for airplane ditching certification, and wildlife hazard mitigation. The report also discusses survival-related issues, including passenger brace positions; slide/raft stowage; passenger immersion protection; life line usage; life vest stowage, retrieval, and donning; preflight safety briefings; and passenger education. Safety recommendations concerning these issues are addressed to the Federal Aviation Administration, the U.S. Department of Agriculture, and the European Aviation Safety Agency.

Wednesday, July 31, 2013

Day 41

Today I worked on finishing the ArcGIS project that Xiang requested. I had a great time doing this REU and learned a lot about transportation and aviation risk.

Total Length (Miles)	2,293
Average Population Density per Square Mile	304



National University Rail Center - NURail
US DOT OST-R Tier 1 University Transportation Center

UIUC NURail Research: Hannah Morsch Blog Archives

June 2013 – July 2013

Monday, June 3, 2013

Day 1

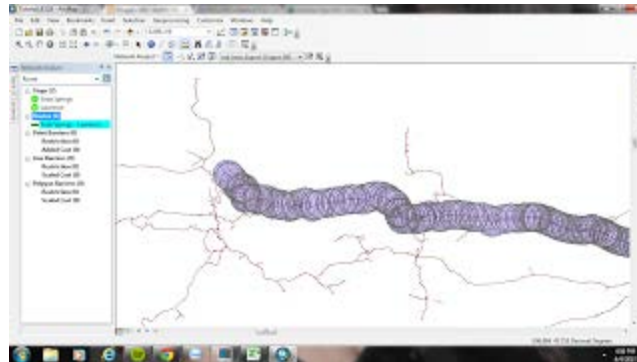
Today, the internship started off with a kick-off meeting at 8:00 AM. I met the fellow undergraduate interns, as well as the graduate mentors. I learned that I will be working on waterway transportation, and Xiang will be my mentor. Professor Saat gave us an overview of the different projects that we will be working on throughout the course of the research. He also emphasized that the work we will be doing will mirror the lifestyle of a graduate student.

Next, we went to the room in which we will spend most of our time doing research. Today was spent familiarizing myself with ArcGIS, and specifically following a tutorial that was provided. I struggled very much at first, but towards the end of the day, working with ArcGIS became much more natural. Tomorrow, I hope to better secure my understanding with this program.

Tuesday, June 4, 2013

Day 2

Today we started off with Jesus giving us an overview of what we will be doing for the next week. I started working more with ArcGIS and started a project that will be completed at the end of the week. Today, I struggled greatly with the project, but I can see great improvements in the knowledge of the workings of ArcGIS. At our lunch meeting today Xiang made a presentation regarding railroad risk, which I found very interesting. Tomorrow, I hope to continue my work with the week project and strengthening my abilities with using ArcGIS.



Wednesday, June 5, 2013

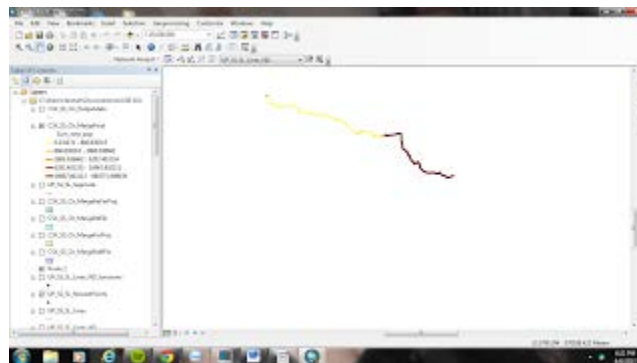
Day 3

Today, I spent the entire day progressing on the week project using ArcGIS. I have 3 of the 4 routes almost complete. I have found that a key component to excelling in this project is to stay organized. By making sure the files were distinctly named, and they are all in the same place, I was able to make a lot more progress today. I look forward to making even more progress tomorrow finishing up the routes, as well as working on the extracted data in the excel documents.

Thursday, June 6, 2013

Day 4

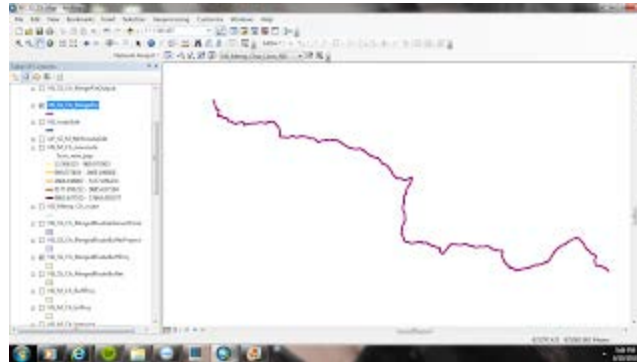
Today I was able to finish up all of the four routes that I have been working on all week. My knowledge of ArcGIS is greatly increasing, and I was able to work through the remaining two routes much more efficiently today. Tomorrow, I still need to export the data using Matlab into an excel file and calculate the remaining data. At the meeting today, Chen-yu presented on the causes of train collisions/derailments and discussed the causes of the train collision that occurred on May 17th. I really enjoy listening to the presentations by the graduate students. They are able to present difficult data and research in an interesting way that is fairly easy to follow. I am very much looking forward to listening to the other graduate students speak.



Monday, June 10, 2013

Day 5/6

Both Friday and today consisted of fixing up little glitches on the routes and the excel document. Today, however, I was informed that my route was very slightly off, so each were needed to be fixed, as well as recalculated. Although fixing these little mistakes can be difficult and frustrating, I feel that it is helping me improve my proficiency in ArcGIS. Tomorrow I intend to continue to fix up these minor mistakes.



Tuesday, June 11, 2013

Day 7

Today, I finished up the excel document, as well as the risk calculations for all of the routes in the project. However, there were small discrepancies between my partner and my data, which will be fixed tomorrow. Jesus showed us how to make the graphs on ArcGIS that we will use in our PowerPoint for the customer. This PowerPoint will be completed by Friday at noon, and it will be started tomorrow.

A screenshot of an Excel spreadsheet. The spreadsheet has columns labeled Y, Z, AA, AB, AC, AD, AE, AF, AG, AH, AI, AJ and rows numbered 28 to 44. The data is organized into two main sections. The first section, highlighted in orange, is located in rows 28-32 and columns AB-AC. The second section, highlighted in blue, is located in rows 39-44 and columns AB-AC. The values in the orange section are: Prob of release (4.71E-06), Frequency (212480), Annual risk (8.53E-04), and Frequency (1173). The values in the blue section are: Prob of release (7.20E-06), Frequency (138946), Annual risk (1.30E-03), and Frequency (767).

	AB	AC
28	Prob of release	4.71E-06
29	Frequency	212480
30		
31	Annual risk	8.53E-04
32	Frequency	1173
33		
34		
35		
36		
37		
38		
39	Prob of release	7.20E-06
40	Frequency	138946
41		
42	Annual risk	1.30E-03
43	Frequency	767
44		

Wednesday, June 12, 2013

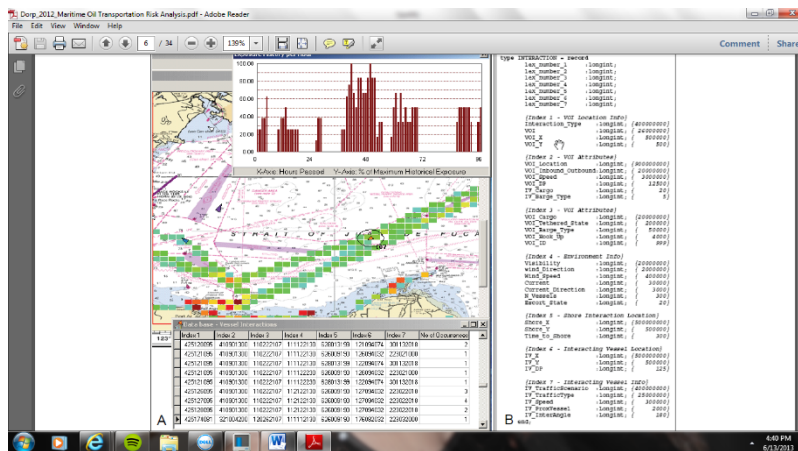
Day 8

Today consisted on working more on the PowerPoint presentation of all of the routes, as well as the risk analysis of these routes. This PowerPoint presentation will be a compilation of all four of the research assistant's data. I focused mostly today on presenting the risk analysis calculations in tables and graphs, so that the customer will be able to easily follow our results. Below is an example of one of the graphs that I created that compares the risks of isotainers vs. a tank car for the various routes. This presentation's deadline is this Friday, but I am confident we will finish it by tomorrow. Tomorrow will be focused on compiling everyone's separate PowerPoint slides, and then going through each one of them together to catch the little mistakes.

Thursday, June 13, 2013

Day 9

We started off the day completing the first draft of the PowerPoint presentation that will be presented to our customer early next week. At 11 AM we presented this PowerPoint to the graduate students at our weekly meeting. Also Chen-yu, Laura, and Xiang spoke about their personal projects they were working on this week. Excellent feedback was given regarding the PowerPoint and the rest of the day was spent fixing the presentation keeping the graduate's students constructive criticism in mind. I also began my research for maritime transportation of hazardous material risk. Xiang, my mentor, gave me three articles to begin reading as well as a maritime transportation book. I read a few chapters of the book and I read about half of one of the articles. This article referred to the risk of different types of oil spills, as well as collision and grounding risks. This article will be very beneficial in my final project in the fact that it contains very detailed definitions, formulas, and data. An example of this has been saved as a screenshot below. I look forward to continuing to learn about maritime transportation risks more tomorrow.



Tuesday, June 18, 2013

Day 10/11/12

The past three days at RailTEC have been spent finding various articles from journals that pertain to maritime transportation of oil and the risks associated with it. So far, I have found around twelve. Five of these have been read and analyzed; an example of one of these literature review can be seen below. Today I attended the lunch meeting, which today consisted of a seminar regarding ballast flight and projection. I very much enjoyed Francesco's presentation about this topic last week, and enjoyed an even deeper analysis of ballasts today. Today we also completed the PowerPoint, with Professor Barkan and Professor Saat's constructive criticism taken into account. Tomorrow will be spent continuing to research articles for my final project, as well as possibly meeting with Xiang in order to get help on the best places to search for more relevant articles.

1. Dorp, J. and J Merrick. 2011. On a Risk Management Analysis of Oil Spill Risk using Maritime Transportation System Simulation. *Annals of Operations Research*. 187(1): 249-277.

This article was very useful in the fact that it provided a plethora of data, graphs, and analysis. Risk is defined in this article as being the sum with respect to the incident or context of the situation of the product of the likelihood of an accident occurring and the volume of oil spilled. The article then begins to describe the use of automatic independent surveillance (AIS) to calculate vessel routes, which are simplified by removing midpoints and recording error. Environmental effects are also added to these routes, which include wind, visibility, and most importantly current. These effects of a strong effect on the likelihood of an event occurring. There are two main types of scenarios that can cause an accident, collisions and grounding. Various equations are introduced that allow the calculation of probability of an oil spill occurring. An important aspect to note is that the time-to-shore has an extreme dampening effect on grounding accident probability, especially as the time-to-shore value exceeds five hours. This article also takes into account the probabilities and tank capacities of bunker and diesel fuels. Crude oil and bunker fuel have a much higher oil outflow. Overall, this article was very helpful and an informative start to my research.

Day 13

Today I did more research on my final project on the risks associated with maritime transportation of hazardous materials. I found three more articles, two of the three being from the journal *Safety Science*. I read three more articles and wrote a literature review on each, which can be seen below. Now that I have thoroughly read eight articles, I feel like I have at least a basic knowledge of maritime transportation. I feel as though the quantitative analysis of this final project is going to be much more difficult than the qualitative analysis. Due to the shortage of data on minor oil spills, it may be difficult to acquire adequate data that will show appropriate and reasonable trends. Tomorrow, I hope to finish up all of the articles that I have currently found and have saved in my folder.

Today's Literature Review

5. Okogu, BE. 1994. Oil Spill Hazards at the Upstream Level. *Energy Policy*. 22(5): 393-402.

This article focuses on the prevention and care of oil spills. The negative effects of oil spills include but are not limited to pollution of the water, coast, and land and destruction of marine life. Okogu uses the country of Nigeria as an example, due to its developing nature and high occurrences of oil spills. Nigeria had over 750 oil spills within four years, and still faces destruction of land due to these spills. In order to avoid more spills and limit the severity of the spills that do occur, one needs an oil spill response plan (ORP). Many aspects including heavy communication and financial readiness are involved in an adequate ORP. The Nigerian government enforces prevention by taking action such as awarding scholarships to people in the oil-producing area and providing national spill funds. Both of these prevention strategies have the potential to be moral hazards. Awarding scholarships could allow the host community members who sabotage to sabotage more effectively with better education. Providing national spill funds could potentially become a moral hazard because it could cause oil companies to take fewer measures against oil spills. Preventing a moral hazard resulting in the latter example is prevented by giving rewards if an oil spill does not occur, and forcing the oil company to chip in a certain amount in the incident of an oil spill. Some other prevention and care strategies include: use of double-hull double-bottom tankers, microbes to rid oil from the water, equipment to transform contaminated soil and water into useful substances, and compensation for the host families. Although this article didn't have a clear focus on oil spills due to transportation, it provided a lot of interesting and new information about the effects of oil spills.

6. Ellis, J. 2011. Analysis of accidents and incidents occurring during transport of packaged dangerous goods by sea. *Safety Science*. 49: 1231-1237

This article provided a lot of new information that I had not seen in other articles. Ellis first introduced the different databases where the results come from, which include PHMSA, MAIB, HMIRS, LMIU, GISIS, Burgess, and Compton. All of the results had a common theme: almost all of the hazmat accidents occurred due to an error occurring before the goods were loaded on the ship. Accidents due to collisions, grounding, weather conditions, etc. only accounted for about two percent of the total. Very informative event trees and bar charts were used to illustrate the contrasts between the different types of accidents. This article also provided useful information to find specific data, which will be very helpful in my final project.

7. **Iakovou, E. 2001. An Interactive Multiobjective Model for the Strategic Maritime Transportation of Petroleum Products: Risk Analysis and Routing. *Safety Science*. 39: 19-29.**

I feel as though this article is going to be very beneficial and useful in my final project. It includes a plethora of ways to quantitatively analyze the risk of transporting petroleum products along waterways. The recommended model in this article is one that is made up of a series of linked sub models and data bases. Using two separate objective functions, one using transportation cost and the other using risk cost, you can optimize both and come up with a compromised solution. The author then proceeds to give a step-by-step procedure to follow if the solution that is obtained is not satisfactory. Next, a case study is shown that occurs in the Tampa Bay Area, and an analysis is performed. Some important computer software that will help in calculating the optimization are GIS, IOTS and MIS. This article will be an important one to re-look at as I begin my own quantitative analysis of a certain route.

Thursday, June 20, 2013

Day 14

Today consisted of more research on my final project on maritime transportation of hazardous materials. I started of the day searching for more articles that were relevant to my project. As my research is continuing, I am finding it more difficult to find new articles that will be useful to my project. I found four that I downloaded, but found two of these four to be not relevant enough. I read and completed a literature review on the two remaining articles I found, which can be seen below. I also have been brainstorming on a route that I should analyze for my final project and determining a

program that will best allow me to analyze it. I found a layer off of the ArcGIS website that shows all of the USACE navigable inland waterways, as well as port and waterway facilities. I discovered that it is going to not be possible to have the same origin and destination as all of the undergraduate research assistants. For example, Jeff only has one pipeline route, which does not correspond to any of the possible waterway o/d's. However, I could still correspond my origin and destination with Manu, due to the fact that the possible railway routes are very plentiful. I will clear this issue up with Xiang or Professor Saat as soon as I begin the analyzing step of my project. Xiang introduced me to a marine oil pollution website that goes into great detail on the specific effects of oil entering bodies of water. So far, this website has provided me so much knowledge on why oil spills have such significant effects. I will navigate around this website more tomorrow, as well as find new articles to read and review.

Today's Literature Review

5. **Slob, W. 1998. Determination of risks on inland waterways. *Journal of Hazardous Materials*. 61: 363-370.**

Although this article focuses on the evaluation of risks on inland waterways in the Netherlands, the overall theme should be beneficial in my final project. This study is composed of four phases. In the first phase, the effects and frequency of spills are evaluated. In phase two, the necessary combating of these spills with respect to the location is evaluated. In phase three, cost analyses are performed and the determination of the involvement of necessary government and/or private companies is made. In phase three a development of a contingency plan is made in regards to oil spills. The tables and graphs in this article will be very useful when trying to quantify the risks in an inland route in my personal research.

6. **Camp J., M Abkowitz, and E LeBoeuf. 2010. Inland waterway resource and spill management needs in Southeastern USA. *Disaster Prevention and Management*. 19: 483-497**

The main reason I chose to include this article as part of my research is because it analyses spills that occur in the USA, which is most applicable to my final project. The authors completed a study which involved a plethora of questionnaires given to local, regional, and federal personnel. Through these questionnaires, the authors were able to see an overlying trend within responses. Most people valued highly human safety and the protection of natural resources. Also, in order to better avoid spills, communication and increased involvement is absolute key. Specifically, providing visual information and direct communication is favored. The most critical threats that can cause oil spills are agricultural activities and sewer overflows. As far as concerns with the current response of oil spills, most people believed hazmat materials needed a better control, more preparation, increased timeliness of response, and meeting all demands associated with the spill. Similarly, most people believed increased training would be beneficial in the preparation of spill activity. Lastly, most people believed that having a visual model improves decisions that need to be made in the case of an oil spill. This article also will be very beneficial to me in the fact that it gave me a few types of software ideas that will allow me to map a waterway route and perform a mock oil spill analysis. This includes: RiverSpill, SMIS, ICWater, and

GNOME. RiverSpill and ICWater are GIS-related software, and since I already have ArcGIS installed on my computer, it will be much easier to run these add-ons, hopefully.

Friday, June 21, 2013

Day 15

Today consisted of more research, but today I focused more on searching through relevant and credible websites in order to find more specific information. I started off looking at the Global Marine Oil Pollution website. This website was very interesting in the fact that it focused a little on the chemical aspects of what occurs when oil enters the water. I don't need very specific chemical reactions, but I found that the reasons why some of the oil evaporates while other oils sink to the bottom was very helpful. I also enjoyed reading about the environmental effects on marine animals due to oil spills. I knew that oil spills were bad for marine animals, but I never knew the reasons behind it. Hypothermia, poisoning, and loss of flight are the main reasons as to why so many animals are killed in oil spill accidents. I also searched throughout other websites to learn which routes are most prevalent for crude oil transportation. So far, I have found a lot of information on inland waterway transportation, but it has been a struggle to find most traveled routes for crude oil transportation. I will meet Monday to create a schedule with Xiang on how to format and organize my final project. Also, he will help both me, as well as the other undergraduate research assistants on how to find corresponding origin/destination routes to analyze.

Monday, June 24, 2013

Day 16

Today, same as the past six or so days, I researched more about risks of maritime transportation of oil. I found four more articles through the university library, as well as a really good website that provided me with some useful information. I have found that as I have gotten a better broad view of maritime transportation, I am able to read the articles at a much quicker pace. Below are the literature reviews that I completed off of the articles/website I read today. I also researched the different maritime 'highways' that are possible, and narrowed those down to three that carry hazardous materials. I will meet with Xiang soon this week in order to discuss further which route will be the best to evaluate. I also have the concern about comparing risk costs with the fellow undergraduate researchers. The costs for maritime transportation is most environmental-related, while the other researchers have costs that involve people affected. This hopefully will be cleared up within the next couple days. Tomorrow I intend to try to find more information for the quantitative analysis aspect of the final project, as well as possibly meeting with Xiang.

Today's Literature Review

1. **Dobbins, J and L.C. Langsdon. 2012. *Generation of Inland Waterway Trip Information using Automatic Identification System (AIS) Data*. Intermodal Freight Transportation Institute (IFTI) at the University of Memphis**

This article found by Xiang is extremely relevant to my research. Although carrying out a similar procedure for my personal research will be difficult due to my limited knowledge of computer software, this paper gave a great example of using data and performing risk analysis. Using six months of archived AIS data, the vessel positions were grouped by day in GIS software. Then, a river layer on GIS was used to locate where each trip begins and ends, and AIS was used to locate lock and dam locations. Next, GIS software was used to create a color distribution graph of activity. AIS data, if I can get access to it, may end up being very useful in my personal research, as I see the wide range of applications in this analysis. Also, to obtain data, I could try to use information from U.S. Army Corps of Engineers Navigation Data Center or the U.S. Army Corps of Engineers Lock Performance Monitoring System

2. http://www.marad.dot.gov/documents/2012_Marine_Highway_Corridors-_PRINTER_FRIENDLY-_V_10.pdf

I found an interesting website that shows the different maritime routes throughout the United States and coastal areas. It also identified the congestion levels, most carried cargo, and environmental friendliness. One route that I found carries a large amount of hazardous material is Interstate 10. This route goes from Brownsville, TX to Jacksonville and Port Manatee, FL and includes Texas, Louisiana, Mississippi, Alabama, and Florida. Congestion is an issue around the Houston area. Another route that carries hazardous materials is Interstate-65. This route includes all channels, ports, and harbors in Alabama, Mississippi, and Tennessee. The large amount of chemical production in southern Alabama accounts for the hazmat transport necessity. Another route that carries hazmat materials is Interstate 75. This is the busiest route on the continent, handling more than 3 million ships annually. This route goes from Detroit, MI, to Toledo, OH.

3. **Wong, K.F.V and N.A. Ghait. 1996. *Spill Science and Technology Bulletin*. 3(3): 171-175**

I really liked this article because it is one of the very few I have found so far that give a monetary value to the damage attributed to oil pollution. Also, since one of the possible routes I will be doing spans the Gulf of Mexico, this article will be useful in the fact that it gives the costs associated with two types of oil pollution in the Gulf area. In addition, monetary values are given along points in the Atlantic coast and the Pacific Coast. The difficulty with this data is the different points along each of these coasts vary vastly. This is due to the differences between the environmental sensitivity along the coast. The data achieved by these authors is fairly accurate, with a sensitivity of about 10%. If I choose to use the highway along the route near the Gulf of Mexico, this data will be of much use.

4. **Fleming, S. 2007. Major Oil Spills Occur Infrequently, but Risks Remain. *Highlights*. GAO**

This report focused a lot on the Oil Spill Liability Trust Fund, and the changes over the years. Between 1990 and 2006, 51 major oil spills occurred. For every spill that occurs, there is a liability limit that is dependent on the type of ship that is being used. Also, the liability limit is much higher for single-hull tankers than for double-hull tankers. This is because the risk of a release is significantly higher for a single-hull tanker. Of the 51 major spills, only ten of these spills exceeded the liability limit, meaning that money was taken out of the national fund. The national fund obtains its money from a barrel tax, which is \$0.05 per barrel of oil. Some interesting graphs were shown that compared the oil spills and costs for each year between 1990 and 2006. There was no correlation between the years and the amount of oil spills. There was also no correlation between the number of oil spills and the total costs associated for oil spills for that given year. The costs of an oil spill depend on some key components: remoteness, proximity to shore, proximity to economic centers, effectiveness of spill response, and public interest. This article also gave basic information on the effects of different types of oil on the environment, with heavy oils being the most detrimental. Some issues with the Oil Spill Liability Trust Fund is that sometimes tanks will erupt months after the accident, or resources will be seen as effected much time after the accident. The decision on what can be covered isn't fully proclaimed. Overall, this article contained a lot of very important information that will be of much use in particularly the qualitative aspect of my report.

Tuesday, June 25, 2013

Day 17

I began my day searching for more articles to read on my final project regarding maritime transportation of oil. I found four, and read one and half. At 12:00, I went to the daily lunch meeting in which Dr. Kawprasert spoke regarding Thai railways. It was very interesting to hear the comparisons between U.S. railways and Thailand railways, as far as structure, sleepers, and signaling. I was also very impressed to hear that Dr. Kawprasert set up the design for calculating the Monsanto project, which had to be immensely challenging. After the presentation, all of those involved in safety and risk went to a conference room with Dr. Kawprasert and Professor Barkan. We discussed the comparisons and differences between how the graduate and undergraduate research assistants calculated the risks for this Monsanto project with how Dr. Kawprasert completed the risk assessment originally. It seemed as though very little has been changed in the risk analysis design of this project, which shows the great functionality of the procedure Dr. Kawprasert came up with. After the meeting, I started reading the next article for my project. Below is the literature review I completed.

Today's Literature Review

1. **Montewa, J, K Przemyslaw, F Goerlandt, and P Kujala. 2010. *A Model of Risk Analysis for Oil Tankers*. *The Archives of Transport*. 22(4): 423-445**

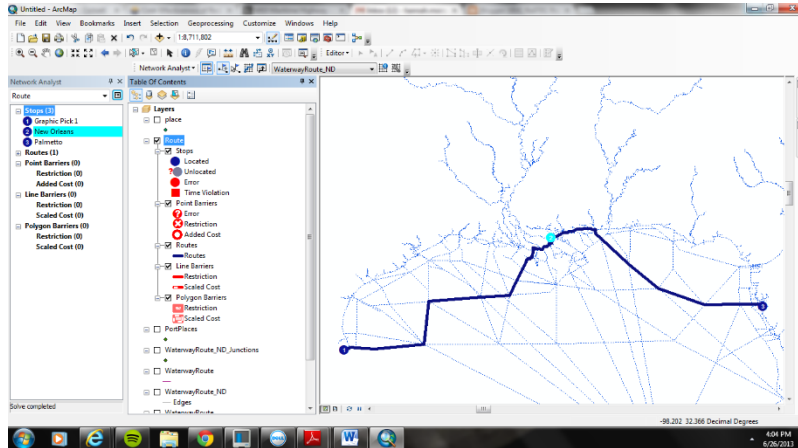
This article focused on evaluating the risks of routes in Finland during the summer months. It focused on modeling probability, using many different constants and variables. The article first discusses a numerical model for calculating the number of possible oil tanker collisions for overtaking and head-on

situations, which is dependent on the overtaking rate and the probability of coming in contact. Next, the article focuses on the number of possible oil tanker collisions for crossing situations. This is dependent on the intensity of the vessel, angle of intersection, and velocity. Then the article turns its focus on models for collisions and groundings. Various models are given for each. The issue was this article that may prevent me from using this information is the fact that these models are even stated to be highly subjective. Also, data was used in Finland only in the summer months. This paper may be of use for a reference and comparison for other models in my later research.

Wednesday, June 26, 2013

Day 18

Today I began the day doing further research for articles on the risks associated with maritime transportation. I found a few articles and completed one article review. The rest of my day was spent searching for possible routes for my case study. I chose to do the route that originates in Brownsville, TX and ends in Palmetto, Florida. I chose this route because it is the most traveled and one of the only routes in the United States that carries crude oil. I will be doing the risk analysis on accidents occurring rather than on people effected. Xiang had a meeting with all of us today and we discussed our planned routes with him. We found that it will be impossible for all four of us to coordinate the same origin and destination in our routes. Therefore, Manu and Jeff will only be able to do similar routes while Eli and I will have completely unique routes. I look forward to speaking to Professor Saat tomorrow about the project and completing further analysis.

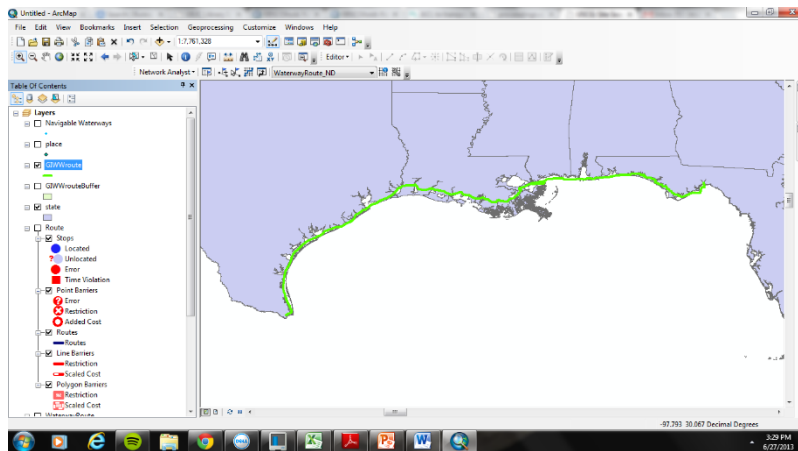


Thursday, June 27, 2013

Day 19

Today I started off the day with a meeting with Professor Saat, Professor Barkin, and the other safety crew. We spoke briefly about how our projects were coming, and then Jesus presented. After the meeting, I began doing more research on the highway route I was previously going to do. However, this route of transportation is very rarely used, only one vessel for every ten days. Instead I have decided to

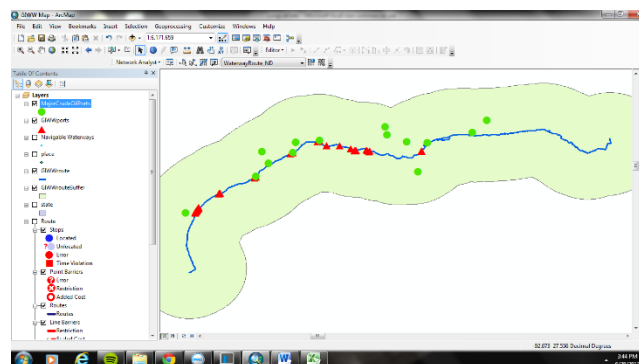
do the Gulf Intracoastal Waterway route. This goes from Brownsville, TX to St. Marks, FL. This is an essential route for distributing imports across various ports along the coast. Below is a picture of this new route. Tomorrow I hope to meet with Xiang to obtain help with the quantification aspect of the risk of my project.



Friday, June 28, 2013

Day 20

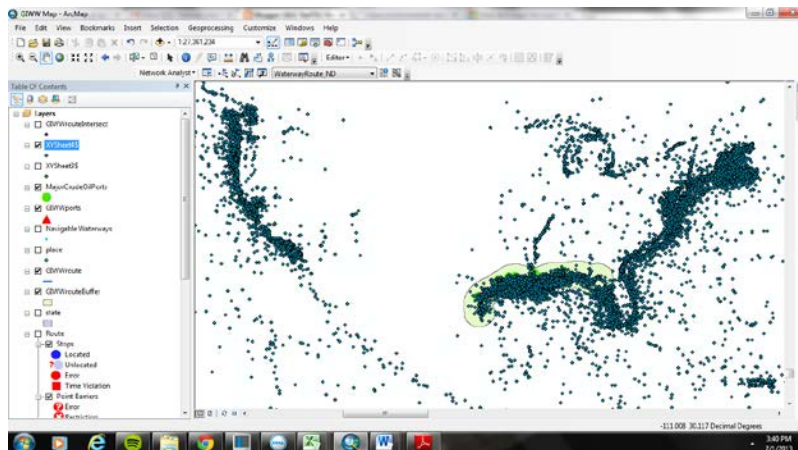
Today, I started off completing the buffering and editing of my route. Then, I labeled all of the ports on the route and labeled the ports that import/export crude oil. This was very time consuming, as I had to manually find them out of thousands of ports, and also the names of the ports weren't exactly labeled the same. Then, I began organizing my data. I had found a data base off of the US Coast Guard Website. I unzipped this document and loaded it onto an excel spreadsheet. This data will allow me to label all of the incidents on ArcGIS. However, before I can do that, I have to fix the longitude and latitude units, as well as delete those incidents that do not have longitude and latitude values. This is a very tedious process, but will be helpful in discovering the risk.



Monday, July 1, 2013

Day 21

Today I began working on finding numerical data for my project on waterway transportation of crude oil. Last Friday, I had found the database of all of the US Coast Guard's documentation of vessel accidents. In one of the documents, I found that latitude and longitude coordinates were included in the location of the vessel casualties, so I knew I would be able to incorporate it into GIS. This however, took much longer than planned as I had to change the units from degree minutes to degree minutes seconds to decimal degrees in order for ArcGIS to be able to read the coordinates. This took a good portion of the day to figure out. I also had to finish deleting all of the blank rows in the data. After I finished this, I added this data to GIS. I found that over 22% of the vessel casualties occurred along my buffered route. This confirmed that this route was a very reasonable route to choose. I still need to find information on average numerical costs due to a typical oil spill. Tomorrow I will start working on interpreting the data I found and presenting it in an easy-to-read format, using graphs, bar charts, and tables. Also, I hope to get a good start on my PowerPoint this week.



Tuesday, July 2, 2013

Day 22

Today I started off trying to make sense of the data obtained from the US Coast Guard. However, there is about twenty files that have a lot of data that doesn't apply to my research, as well as no headers on any of the documents. I went through the data and condensed the excel sheets to data that applied to me. With this condensed data, I found that the years that this data is obtained from ranges from 1986-1998, which may be too out-of-date for my research purposes. I went to various other websites to find more data, and my only luck was big incidents that occurred. I also found data that said that the US Coast Guard only accounts for about ten percent of total oil spills, due to the inability to obtain data from small spills. I will keep trying to find data in order to perform my case study risk analysis tomorrow.

ID	UNIT	ON SOURCE	DATE	CITY	STATE	BOAT LOG	WATERWAY	DATE	STATUS	VESSELS OF NON-VESSEL	DATE CASE	TIME OSC	RISK	MILE	LAT	DIR	SPILL	LAT	LONG	DIR	SPILL	LONG	
1	MPCOR001A1INS	USCG	01/01/2000	LAKA	CHIA LA		INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	0	000000	580	N	0000	W	0000	0	0000	0	0000	0	
2	MPCOR001B1INS	USCG	01/01/2000	FT WALDSTN	FL		INTERCOASTAL WTR	01/01/2000	DISPERSED	0	000000	1681	168	N	0000	W	0000	0	0000	0	0000	0	
3	MPCOR001C1INS	USCG	01/01/2000	DESTIN	FL		INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	2760	N	0000	W	0000	0	0000	0	0000	0	0000	0
4	MPCOR001D1INS	USCG	01/01/2000	DESTIN	FL		INTERCOASTAL WTR	01/01/2000	DISPERSED	0	000000	2000	N	0000	W	0000	0	0000	0	0000	0	0000	0
5	MPCOR001E1INS	USCG	01/01/2000	PORT ARTR	TX		INTERCOASTAL WTR	01/01/2000	DISPERSED	0	000000	208	N	0000	W	0000	0	0000	0	0000	0	0000	0
6	MPCOR001F1INS	USCG	01/01/2000	FREEDOMTS	TX		INTERCOASTAL WTR	01/01/2000	CLEAN UP	0	000000	1815	N	0000	W	0000	0	0000	0	0000	0	0000	0
7	MPCOR001G1INS	USCG	01/01/2000	WESTAPOLA	TX		INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	800	N	0000	W	0000	0	0000	0	0000	0	0000	0
8	MPCOR001H1INS	USCG	01/01/2000				INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	2030	N	0000	W	0000	0	0000	0	0000	0	0000	0
9	MPCOR001I1INS	USCG	01/01/2000				INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	130	N	0000	W	0000	0	0000	0	0000	0	0000	0
10	MPCOR001J1INS	USCG	01/01/2000				INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	1200	N	0000	W	0000	0	0000	0	0000	0	0000	0
11	MPCOR001K1INS	USCG	01/01/2000				INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	325	N	0000	W	0000	0	0000	0	0000	0	0000	0
12	MPCOR001L1INS	USCG	01/01/2000				INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	630	N	0000	W	0000	0	0000	0	0000	0	0000	0
13	MPCOR001M1INS	USCG	01/01/2000				INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	630	N	0000	W	0000	0	0000	0	0000	0	0000	0
14	MPCOR001N1INS	USCG	01/01/2000				INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	390	N	0000	W	0000	0	0000	0	0000	0	0000	0
15	MPCOR001O1INS	USCG	01/01/2000				INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	1900	N	0000	W	0000	0	0000	0	0000	0	0000	0
16	MPCOR001P1INS	USCG	01/01/2000				INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	800	N	0000	W	0000	0	0000	0	0000	0	0000	0
17	MPCOR001Q1INS	USCG	01/01/2000				INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	1200	N	0000	W	0000	0	0000	0	0000	0	0000	0
18	MPCOR001R1INS	USCG	01/01/2000	PORT ARTR	TX		INTERCOASTAL WTR	01/01/2000	CLEAN UP	0	000000	830	N	0000	W	0000	0	0000	0	0000	0	0000	0
19	MPCOR001S1INS	USCG	01/01/2000				INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	830	N	0000	W	0000	0	0000	0	0000	0	0000	0
20	MPCOR001T1INS	USCG	01/01/2000				INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	1200	N	0000	W	0000	0	0000	0	0000	0	0000	0
21	MPCOR001U1INS	USCG	01/01/2000				INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	1010	N	0000	W	0000	0	0000	0	0000	0	0000	0
22	MPCOR001V1INS	USCG	01/01/2000	PANAMA FL	FL		INTERCOASTAL WTR	01/01/2000	CLEAN UP	1	000000	1300	N	0000	W	0000	0	0000	0	0000	0	0000	0

Wednesday, July 3, 2013

Day 23

Today I began looking for a way to quantify the environmental risk associated with my case study. I found a layer on ArcGIS that will show the amount of different types of wildlife in a given state. I have to find a way to utilize this in order to best estimate the risk. I want to ask Xiang about this next week. The majority of the day was spent starting on my PowerPoint. I was able to complete the first module, which just gave an overall background on maritime transportation and compared it to other modes of transportation. Attached you will be able to find this module. I also began the second module, which is focusing on major oil spills, and the causes and effects of oil spills.

<https://docs.google.com/file/d/0B8PoDxCDFrvsOEphcXIYVIJSRk0/edit>

Monday, July 8, 2013

Day 24

Today consisted of first completing research to fill in the holes in my PowerPoint. For example, I discovered that I should discuss broadly all of the waterway systems in the United States in my introduction. I currently was only mentioning the intracoastal waterways, but I need to also mention the inner waterway systems that consist of the Mississippi River and its tributaries. Also, all of the four undergraduate researchers showed each other the modules we have completed so far on the projector and gave each other constructive criticism. I feel this was very helpful, and it gave us ideas to bounce off each other. Tomorrow I plan to complete the next module on the causes and effects of oil spills, giving two examples of major oil spills.

Tuesday, July 9, 2013

Day 25

Today consisted of a lot of research about different oil spills across the United States. I wanted to include two major crude oil spills in my PowerPoint that caused major damage. I, of course, included the Exxon Valdez Oil Spill. I had some trouble finding another major spill that had as significant effects. Instead of including two major spills from the United States, I chose to discuss the Prestige Oil Spill that occurred in Spain. This spill, I found out, was comparable in intensity to the Exxon Valdez. Although I found significantly less information about this spill, I was able to find enough to make an informative slide. I am almost done with my second module, and I will finish this module tomorrow. I also will start my literature review module tomorrow, as well.

Wednesday, July 10, 2013

Day 26

Today I spent the majority of my time working on the rest of my second module. I am so glad that Xiang advised me to make a literature review of all of my readings. It has made organizing my research much easier. My finished second module is the attached link below. Xiang went through the first half of my module so I was able to fix all of his constructive criticism. I will finish the second module regarding the literary review tomorrow.

[Module 1 Hannahppt.ppt](#)

Thursday, July 11, 2013

Day 27

Today began with a weekly safety meeting, where we discussed our projects and I listened to a great presentation by Laura. I spent the remainder of the day working on my next module. This module discusses the risk analysis. Unfortunately, the risk analysis won't be as quantitative as I wish it could be. The costs associated with the risk of maritime transportation of crude oil depends on so many different factors. I, however, will do the best I can to provide as much quantitative analysis as possible. I completed ten of the slides today. Tomorrow, I look forward to finishing this risk analysis module and starting on the comparisons and contrasts of the previous literature I have read. In this literature, there are many different strategies to perform risk analysis that I would like to discuss.

Friday, July 12, 2013

Day 28

Today I finished up the third risk module. I was having troubles determining the equation for the probability due to the fact there are so many different theories on what should be taken into account. I am now working on an analysis of the previous research to show the comparisons and contrasts of the different researchers' theories. On Monday, I will finish this module. Below is the link to my draft of my third module.

[Module_1_Hannahppt.ppt](#)

Tuesday, July 16, 2013

Day 29

Today I finished my draft of my fourth module, which consisted of a comparison and contrast of my past research. The literature review helped me immensely, and I am very grateful Xiang recommended me doing one. Hopefully, this module will make it clearer why I am having so much trouble with the quantitative aspect of this project. So many variables need to be taken into account, and I don't have the knowledge or means at this time to fully use these variables. Below is the first draft of my fourth module.

[Module_1_Hannahppt.ppt](#)

Wednesday, July 17, 2013

Day 30

Today I finished about half of my last module regarding my case study. I have been looking for layers to be able to have a more in-depth quantitative analysis of my route, but I have not yet found one. Tomorrow I will continue looking. For now, I looked up more information on the history behind the route, confirmed its benefits, why it was made, etc. I completed about nine slides regarding basic, background information. This can be found below. Tomorrow I hope to dive deeper into my quantitative analysis.

[Module_1_Hannahppt.ppt](#)

Thursday, July 18, 2013

Day 31

Today I finished my draft of my fifth module, the case study. I had trouble doing the risk assessment on my route due to lack of a solid model and data. I will meet with Xiang tomorrow to discuss my troubles with the quantitative aspect of this case study. Tomorrow, I will start the revising process of my PowerPoints as well as continue to develop my case study.

Friday, July 19, 2013

Day 32

Today I met with Xiang and discussed the case study module and the literature review module. He gave me a lot of helpful advice on how to be more accurate with my risk model, as well as how to best format my literature review module. I was able to find a probability that measure the probability of an oil spill occurring on the route, rather than a conditional probability. I also worked on my risk analysis module and decided to combine my shortened literature review with my risk analysis, due to the high similarity of the results. I look forward to completing all the modules early next week.

Monday, July 22, 2013

Day 33/34

All of my modules are completed and today was spent reviewing them for formatting errors and consistency. Xiang told me on Friday that he would like me to write an informal report on my literature review. I began this report today. Hopefully, this should be done by Friday. This week will be spent compiling slides that I would like to present. I also need to review some of the major articles, so I can explain my slides more in-depth.

Tuesday, July 23, 2013

Day 35

Today I began the day organizing my slides for the presentation on Thursday. I was able to finish that before the meeting at noon. After the lunch meeting, I worked a little more on my informal report and also read through the majority of an article that I had only skimmed through before named *History of the Gulf Intracoastal Waterway* by Lynn M. Alperin. I came across some new information during my report and realized that I needed to familiarize myself more about the background of the Gulf Intracoastal Waterway and why and how it came into play. I hope to receive feedback about my presentation by Xiang before Thursday. Tomorrow I will work more on my report and also adding more notes to my presentation.

Wednesday, July 24, 2013

Day 36

Today I first reviewed my presentation for tomorrow with the undergraduate group, and I was able to get a lot of helpful advice on revisions. After that, I looked over the revisions Xiang recommended

which were also immensely helpful. I feel very prepared to present tomorrow and look forward to hearing feedback.

Thursday, July 25, 2013

Day 37

Today we began the day finishing up final touches on our presentations. At 11:00 we had a safety meeting in which three of the undergraduate researchers presented their research. I presented and received a lot of great feedback. I was able to improve the accuracy of my risk cost, with the knowledge that I needed to pay closer attention to units. Also, Professor Saat advised me to perform a module that focuses on the transloading from ship to rail, specifically a literature review of it. Tomorrow and next week I will be completing this as well as doing the final touches on my other modules.

Monday, July 29, 2013

Day 38/39

Both Friday and today consisted of extended research on intermodal transportation. It was difficult to find articles only on rail-sea intermodal transportation so I had to do a lot of searching. I was able to find four quality articles so far that I believe I will be able to complete my last module with the information from. One of the four articles provides quantitative analysis on the risk associated with rail-sea intermodal transportation. Below is the literature review of these four articles. Also I completed six slides of my module, the final module will be attached hopefully tomorrow, as I hope to have it finished.

1. "Intermodal Transportation and Containerization." *Intermodal Transportation and Containerization*. N.p., n.d. Web. 29 July 2013

This article has very useful information on the background behind intermodal transportation in the United States. Although it does not have a central focus on rail-water intermodal transportation, this article contains very useful information that will provide a great background in my final module.

Particularly, there is a cost equation and flow chart that will definitely be cited in my module. Also, the use of containers and the advantages and disadvantages of their use was evaluated; this is a very important aspect of rail-waterway intermodal transportation. Overall, this is a very helpful and informative article.

2. Ashar, A. S Swigart. 2007. *A Comparative Analysis of Intermodal Ship-to-Rail Connections at Louisiana Deep Water Ports*. Louisiana Department of Transportation & Development.

This report describes ship-to-rail transport in immense detail; much of which will have great importance in my research. The first section regarding the background information about ship-to-rail intermodal transportation will be the most helpful. This describes the main configurations in which ship-to-rail transfer occurs. It also describes the various ports and rail lines on which it occurs. This report contains a great deal of information that will definitely be used in final module regarding intermodal transportation.

3. **Reis, V. JF Meier, G Pace, R Palacin. 2013. Rail and Multi-modal Transport. *Research in Transportation Economics*. 41(1): 17-30.**

This journal article provided a great deal of information on each type of intermodal transportation; these included: rail-air, rail-rail, rail-sea, rail-highway, etc. Although the rail-sea portion was rather short, it provided some crucial information for my research. For example, all of the different types of port terminals were identified. These included container, intermediate hub, and barge terminal. Then, each type of rail terminal was identified. These included on-dock, near-dock, and satellite. The “hinterland” concept is then explained and identified. The article then discusses the flow between terminals, as well as the four main functions of the intermodal transport chain: composition, connection, interchange, and decomposition. Overall, this article provides a good overview on the process of rail-water intermodal transportation.

4. **Nachtmann, H. M Rossetti. 2004. *WebShipCost – Quantifying Risk in Intermodal Transportation*. Department of Industrial Engineering, University of Arkansas.**

This report provides very interesting and beneficial information on how to quantify the risk associated with intermodal transportation. This report does focus solely on the risk associated with rail-sea intermodal transportation, which might limit its accuracy. However, this report will be of much use as I explain intermodal transportation risk in quantifying terms.

Tuesday, July 30, 2013

Day 40

Today I mainly worked on my last module regarding the intermodal transportation between rail and waterway. I was able to find a lot of qualitative information, but am lacking in the quantitative analysis. One of my slides discusses a procedure on how to determine the costs using WebShipCost. Tomorrow is my last day as an intern at RailTEC. I will meet with Rapik to discuss the program. I will

also revise my last module and look for more quantitative information and hopefully expand my module. If I have time, I will write a short summary of my research at RailTEC.

Wednesday, July 31, 2013

Day 41

Today was my last day at RailTEC as an intern. I worked the entire day with the rest of the interns helping Xiang out with the Monsanto project. We had a very nice lunch at Mas Amigos. I had a great time working at RailTEC and will miss it and the people very much.



National University Rail Center - NURail
US DOT OST-R Tier 1 University Transportation Center

UIUC NURail Research: Hannah Morsch PowerPoint Presentation

June 2013 – July 2013

MARITIME TRANSPORTATION RISK MANAGEMENT

Introduction to Transportation Risk Analysis

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Rail Transportation and Engineering
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Learning Outcomes

At the end of this lecture students will be able to:

1. Be comfortable with the basic vocabulary associated with maritime transportation.
2. Be knowledgeable of the basic infrastructure and routes.

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What is Maritime Transportation?

Maritime transportation is the transport of goods, cargo, and people across different waterways, such as seas, lakes, and rivers.

Key Words:

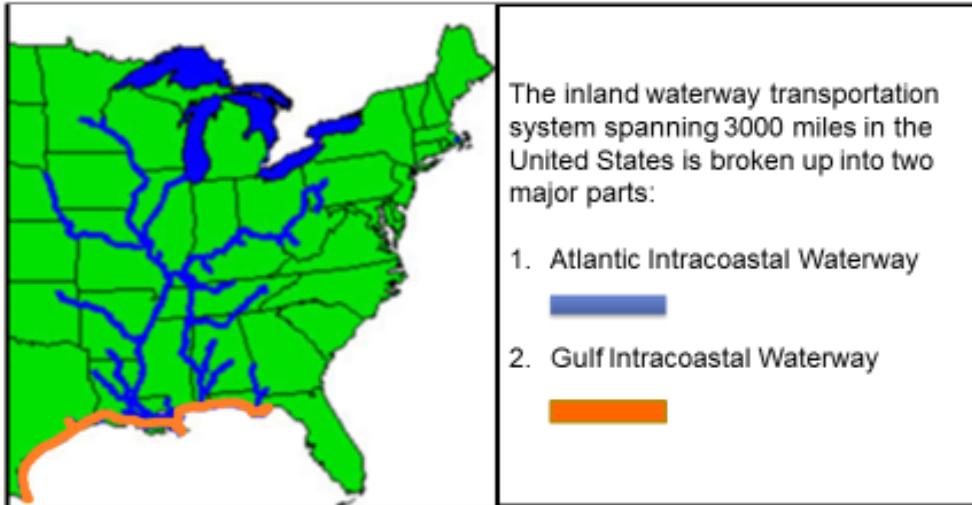
- Vessels: A ship or large boat used in maritime transportation
- Oil Tankers: A cargo ship used to transport crude oil in bulk
- Barge: A flat-bottomed boat that carries freight.
- Accident: possible events and conditions that will result in casualty or harm of people, the environment, and/or the economy.



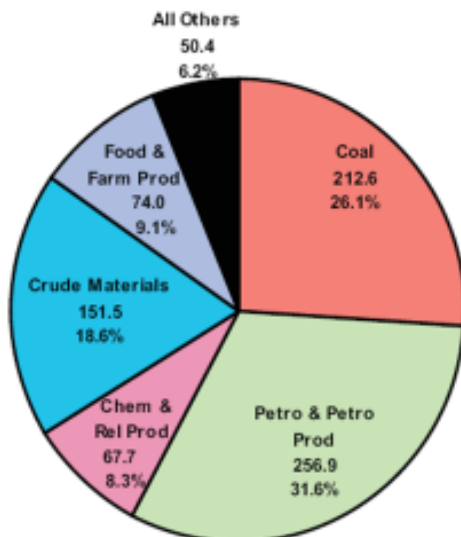
Maritime Transportation Importance

- Maritime Transportation is crucial and of high dependence as a use of transporting imports and exports across the seas. However, the importance of developing an efficient form of inner waterway transportation as a means of shipping in the United States has been looked into in recent years for
 - Economic prosperity
 - Decreasing Environmental Impact
 - Overall Convenience

Interwaterway Transportation Routes

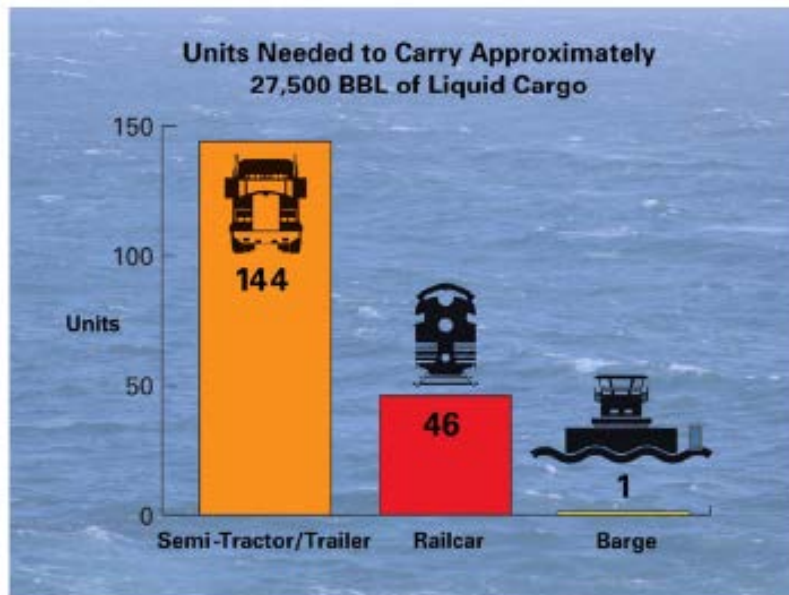


Inland Transportation Goods



As you can see, fossil fuels make up for over half of the inland transportation of goods. The ability to transport large amounts at once makes the shipment of these fossil fuels efficient.

Cargo Capacity Compared to Other Types of Means of Transportation



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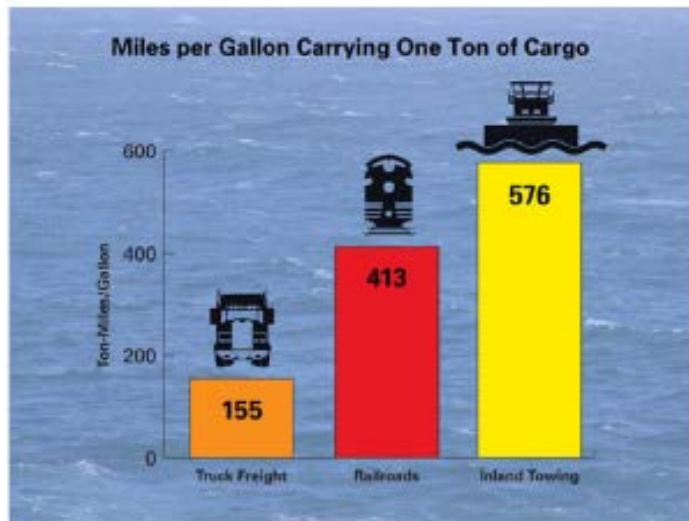
The Positive Aspects of Maritime Transportation

- Fuel Efficiency
- Relatively low fatalities/injuries
- Small amount of oil spills

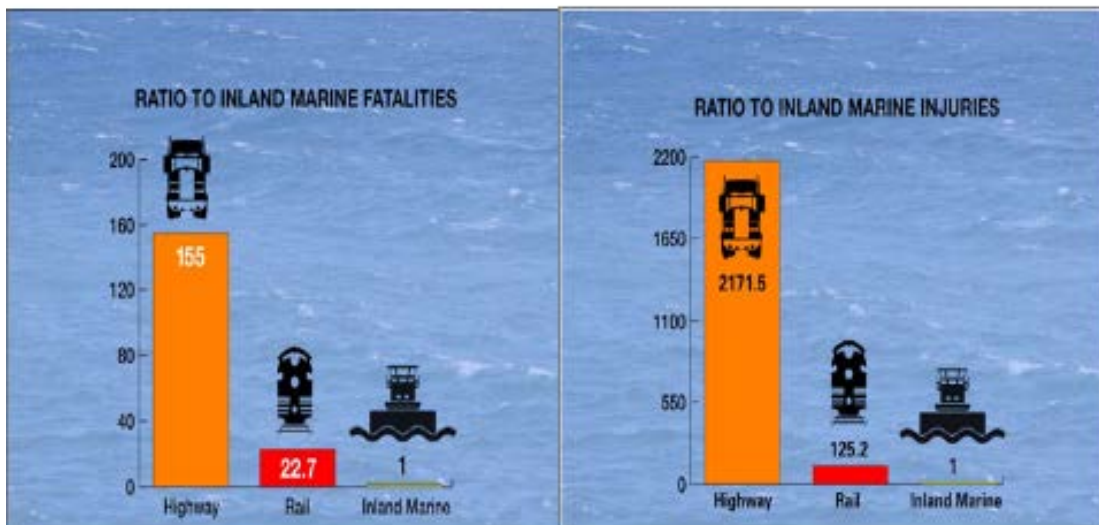


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Fuel Efficiency



Low Fatalities and Injuries



So why is maritime transportation not used more in the United States?



It may be as a more efficient 'highway' system is not fully developed or used. For example, the M-10 Highway on the given map has only one vessel travel this route every ten days. If this system was more consistently used it could relieve the congestion of many roadways and railways.

Key Takeaways

- The uses of maritime transportation in the United States.
- The benefits associated with waterway transportation compared with other modes of transportation.
- The basic framework of the Maritime Highway System.



Additional Resources

- Kruse C, A Protopapas, LE Olson, and DH Bierling. 2007. *A Modal Comparison of Domestic Freight Transportation Effects on the General Public*. U.S. Maritime Administration and National Waterways Foundation.
- "America's Marine Highway Program." *DOT Maritime Administration* -. N.p., n.d. Web. 03 July 2013



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TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

HM-16 Project: Model Post-Secondary Education Curricula for the Transportation of Hazardous Materials



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UIUC NURail Research: Jeff LaHucik Blog Archives

June 2013 – July 2013

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6.3.13

The day started off in a team meeting. The team meeting served to match the undergraduate research interns with their graduate student mentors (my mentor is Jesus). The general outline of the research program was given and expectations were clearly defined. A status report was given in order to provide the undergraduate research interns with the procedures and results completed thus far. We were shown to the office where we will be working for the next two months. Jesus and Xiang demonstrated some uses of ArcGIS via a projector. I met with Sheree Waltz to confirm my employment information. I started completing tutorials out of the GIS Tutorial Spatial Analysis Workbook 2. Tutorial 3-1 did not load properly and therefore was not completed. I do not have the spatial analyst package installed and therefore I could not complete tutorial 3-3. I completed tutorials 1-1 through 5-7 (minus the previously mentioned tutorials). Tomorrow, I plan on completing the GIS Tutorial Spatial Analysis Workbook 2.

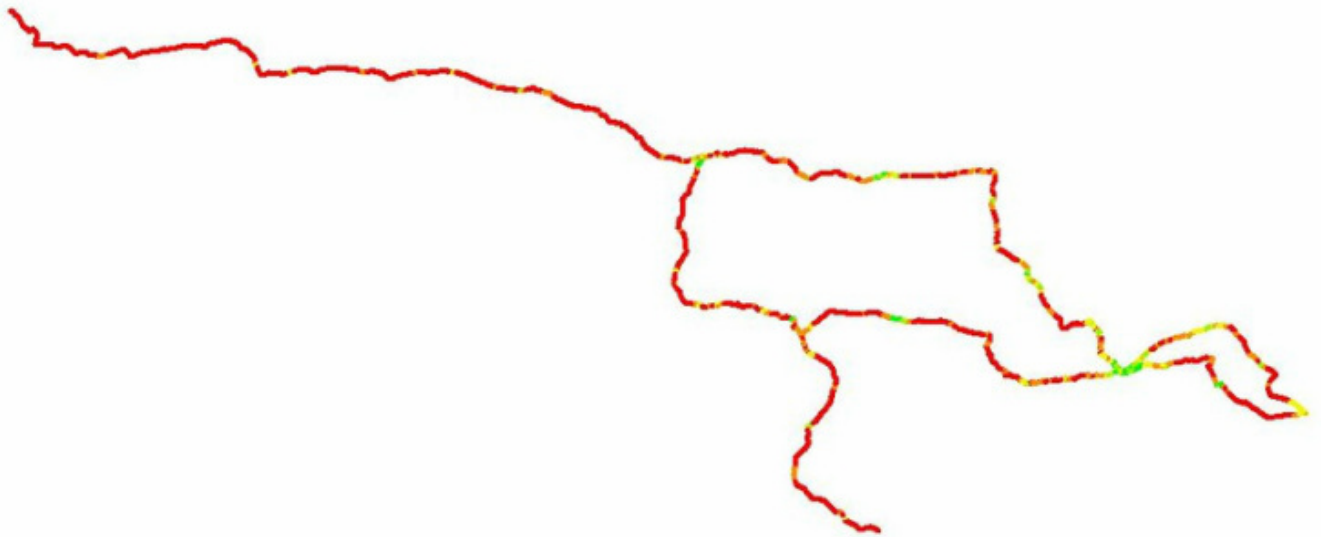
6.4.13

Jesus presented the step-by-step process of using ArcGIS to perform population calculations that will be required later on in the risk analysis. The final product is an image that shows the population at specific track segments (both numerically and visually). The numerical portion is located within the attribute table while the visual portion is displayed on the ArcGIS screen. I was given five routes to analyze. Of those five, I completed three routes today. During lunch we had a meeting with the faculty, graduate students, and research assistants of RailTEC. Xiang Liu presented his research during the lunch meeting, his research focused on the risk of hazardous material release due to train derailment. Tomorrow I will start working on the remaining two routes that I was assigned. The image below shows the population along one of the routes I analyzed today. This output will be used as a consequence input into the risk model.



6.5.13

I completed my remaining routes and obtained the population distribution (as well as population density) along each of the routes. I have yet to compare my final results with the results that my partner obtained. My partner is working on the same routes as I am in order to have two final products that (in theory) should be identical. If our final products turn out to be identical, then we are confident that our analysis of the data is correct. Jesus demonstrated the conversion of an attribute table in ArcGIS into Excel via the use of a Matlab program to order to FRAARCID's (thus putting the track segments in sequential order). I downloaded Matlab and began converting my attribute tables to Excel files. I plan on finishing these conversions tomorrow. The image below shows the population distribution along each of the five routes (all five routes are presented on the same screen) where the smallest population is represented by dark red and the largest population is represented by dark green, with a sliding color scale in between the extreme values.



6.6.13

Today consisted of exporting the attribute tables with the population density and segment length information to excel. Using a matlab code written by Jesus, I transformed the attribute tables from ArcGIS to Excel files. Once the Excel files were formed, a simple function (vlookup) was used to match the population density, track class, signaled/dark, and length to each segment along each route. I ran into a few problems running the matlab code due to 2 small errors in my ArcGIS shape files. I resolved these and proceeded to complete my assignment. This portion of the project is due on Friday (tomorrow) at noon and I am currently done with it. I believe we are going to start working on the risk model tomorrow, or at least be introduced to it. During our meeting of the transportation risk research group today all the undergraduate and graduate research assistants spoke about what they've been working on for the past week. Chen Yu gave a presentation of his research from the past semester, his research focused on a frequency/severity analysis of passenger/freight trains. He also presented a case [study](#) about the most recent passenger train incident (May 2013) on the northeast corridor. Tomorrow morning, Xiang Liu is defending his PhD and I plan on attending. I have never witnessed a PhD defense before and am very interested to see one, especially this one since I have much interest in the topic of Xiang's research. I did not think there was a suitable picture to summarize today's work.

6.7.13

This morning I attended Xiang Liu's PhD final defense. I was very curious to witness a PhD defense since I have never seen one before. Xiang's research focused on the risk associated with transporting hazardous materials via rail. I thought his presentation was thorough, in depth, and showed strong analytic skills. His committee asked numerous, pointed questions and he always had the answer to them; demonstrating supreme knowledge of his research and all the associated background knowledge. This has renewed the debate in my head about which route to take to obtain my M.S. (thesis or non-thesis). I started doing some preliminary research into the subject of my independent study; pipelines. I read about the general history of pipelines, some of the major incidents involving pipelines, and some common substances transported via pipelines. I have found a data set of all pipelines and pipeline facilities in North America in a GIS format however this would cost \$5,000. I plan on continuing to search for free data sets in order to incorporate them as consequence inputs into my risk model. I have begun thinking a lot about how I want to formulate my risk model, specifically how I want to quantify the consequences. Xiang presented the risk model that him and Jesus have applied to this same project in order for us to become familiar with it. My new assignment is to input the data that I exported from my ArcGIS files into the risk model and interpret the outputs. I also want to dig further into the structure of the model and understand the input parameters and intermediate calculations. I'm more concerned with understanding the model on a theoretical level than just the results. My goal for Monday is to finish producing the risk model for each route and to dive deeper into the structure of the risk model rather than simply running a protocol with the model. The picture below shows some intermediate calculations and values of the first route that I ran through the model.

CALCULATION

1	2	3	Route Distance	Dist Relative	Density x Length	Shipments	Car-miles	Der. Rate	P(A)	CPR ISOTAINER	CPR TANK-CAR	Prob. Release ISOTAINER	Prob. Release TANK-CAR	Area Exp.	Pop. Exp	Risk ISOTAINER	Risk TANK-CAR
4	0.37	0.02%	1.206	1	0.37	28	1.0351E-08	0.0887	0.1357	9.19E-10	1.40E-09	0.785	3	2.35E-09	3.60E-09		
5	1.07	0.05%	2.023	1	0.70	28	1.9691E-08	0.0887	0.1357	1.75E-09	2.67E-09	0.785	2	3.95E-09	6.04E-09		
6	1.78	0.08%	1.747	1	0.71	28	1.9816E-08	0.0887	0.1357	1.76E-09	2.69E-09	0.785	2	3.41E-09	5.21E-09		
7	8.30	0.36%	16.847	1	6.52	28	1.8242E-07	0.0887	0.1357	1.62E-08	2.48E-08	0.785	2	3.29E-08	5.03E-08		
8	9.22	0.40%	3.862	1	0.92	28	2.5888E-08	0.0887	0.1357	2.30E-09	3.51E-09	0.785	3	7.54E-09	1.15E-08		
9	10.98	0.48%	8.233	1	1.76	28	4.9206E-08	0.0887	0.1357	4.37E-09	6.88E-09	0.785	4	1.61E-08	2.46E-08		
10	18.75	0.82%	36.393	1	7.77	28	2.1751E-07	0.0887	0.1357	1.93E-08	2.85E-08	0.785	4	7.10E-08	1.09E-07		
11	19.01	0.83%	1.248	1	0.27	28	7.4574E-09	0.0887	0.1357	6.62E-10	1.01E-09	0.785	4	2.43E-09	3.72E-09		
12	25.43	1.11%	33.613	1	6.42	28	1.7965E-07	0.0887	0.1357	1.59E-08	2.44E-08	0.785	4	6.56E-08	1.00E-07		
13	29.77	1.30%	28.202	1	4.34	28	1.216E-07	0.0887	0.1357	1.08E-08	1.65E-08	0.785	5	5.50E-08	8.42E-08		
14	30.26	1.32%	3.349	1	0.49	28	1.3792E-08	0.0887	0.1357	1.22E-09	1.87E-09	0.785	5	6.54E-09	9.99E-09		
15	30.41	1.33%	0.988	1	0.15	28	4.0678E-09	0.0887	0.1357	3.61E-10	5.52E-10	0.785	5	1.93E-09	2.95E-09		
16	30.77	1.34%	2.446	1	0.36	28	1.0072E-08	0.0887	0.1357	8.94E-10	1.37E-09	0.785	5	4.77E-09	7.30E-09		
17	30.90	1.35%	0.868	1	0.13	28	3.5736E-09	0.0887	0.1357	3.17E-10	4.85E-10	0.785	5	1.69E-09	2.59E-09		
18	37.24	1.62%	43.112	1	6.34	28	1.7753E-07	0.0887	0.1357	1.58E-08	2.41E-08	0.785	5	8.41E-08	1.29E-07		
19	37.69	1.64%	3.099	1	0.46	28	1.2759E-08	0.0887	0.1357	1.13E-09	1.73E-09	0.785	5	6.05E-09	9.25E-09		
20	42.30	1.84%	31.364	1	4.61	28	1.2915E-07	0.0887	0.1357	1.15E-08	1.75E-08	0.785	5	6.12E-08	9.36E-08		
21	44.03	1.92%	11.723	1	1.72	28	4.8273E-08	0.0887	0.1357	4.28E-09	6.55E-09	0.785	5	2.29E-08	3.50E-08		
22	47.07	2.05%	20.675	1	3.04	28	8.5134E-08	0.0887	0.1357	7.55E-09	1.16E-08	0.785	5	4.03E-08	6.17E-08		
23	47.61	2.08%	3.668	1	0.54	28	1.5103E-08	0.0887	0.1357	1.34E-09	2.05E-09	0.785	5	7.16E-09	1.09E-08		
24	49.88	2.17%	15.427	1	2.27	28	6.3525E-08	0.0887	0.1357	5.64E-09	8.62E-09	0.785	5	3.01E-08	4.60E-08		
25	50.97	2.22%	7.414	1	1.09	28	3.0528E-08	0.0887	0.1357	2.71E-09	4.14E-09	0.785	5	1.45E-08	2.21E-08		
26	52.81	2.30%	10.946	1	1.84	28	5.1637E-08	0.0887	0.1357	4.58E-09	7.01E-09	0.785	5	2.14E-08	3.27E-08		
27	55.42	2.42%	3.895	1	2.61	28	7.3134E-08	0.0887	0.1357	6.49E-09	9.92E-09	0.785	1	7.60E-09	1.16E-08		
28	56.96	2.48%	1.260	1	1.53	28	4.2891E-08	0.0887	0.1357	3.81E-09	5.82E-09	0.785	1	2.46E-09	3.76E-09		

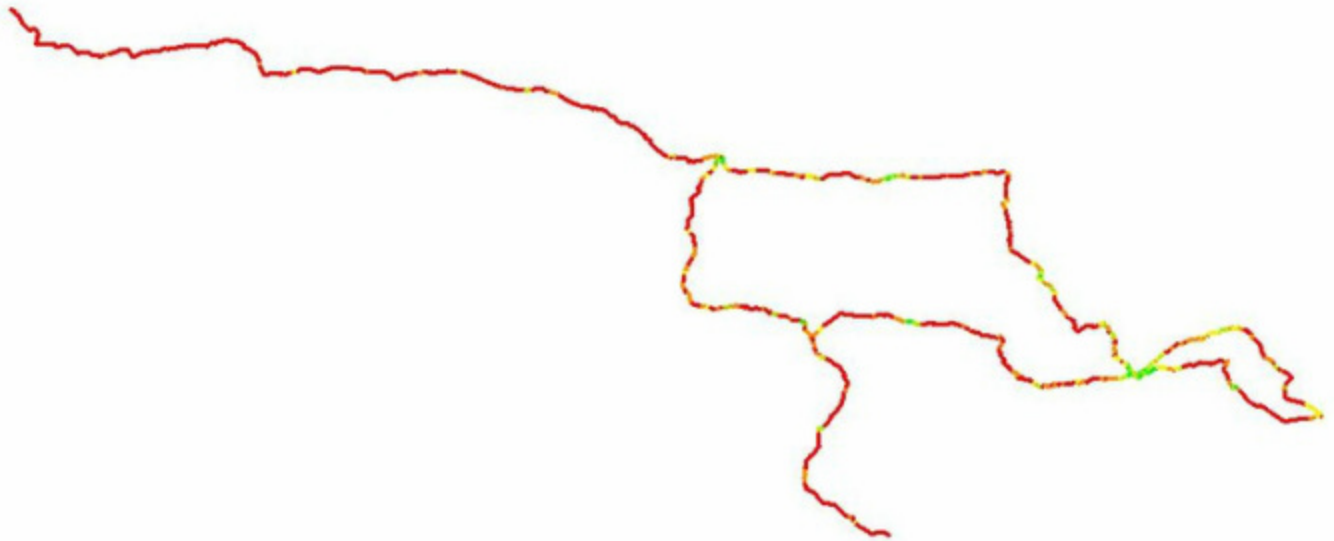
6.10.13 (part 1)

I spent the morning completing the risk calculation spreadsheets for all five routes. The output of which can be seen in Figure 1. This figure shows the percentage of: each track class, method of operation, population density quantiles, and risk at risk level quantiles. The figure also shows the total probability of release and the total annual risk. After this was completed, I did some file maintenance on my computer and organized all my files. Hannah noticed that some of our results were largely different so we started investigating this. It turns out that some of her area calculations were in meters squared instead of miles squared and that her population sums were drastically large. We worked to rectify this for a while. In the meantime, Jesus was analyzing my routes against his results from the program PC Miller. He noticed some very slight variations that were not visible with the given JPEG image and required us to make these changes. This affects every route we have and put us back tremendously. I spent the rest of the afternoon attempting to make the changes Jesus requested and I ran into error after error in the process. I was only able to completely re-finish one route for the rest of the afternoon. I am going to continue working on this at home tonight in the hopes of getting caught up for tomorrow. Figure 1 is therefore outdated and incorrect.

	Total Length		Segments												
	Absolute	Relative		Pop dens	Length	%Length	Risk Level	Length	% Length	Risk	%Risk				
	960	100%	511												
Distribution				Pop dens	Length	%Length	Risk Level	Length	% Length	Risk	%Risk				
Class 1	0	0.0%		> 3000	1.954699	0.2%	> 1.0E-04	5.919971	0.6%	0.000110991	10.9%				
Class 2	3	0.3%		1000 - 300	61.46068	6.4%	1.0E-04 - 1.0E-05	64.72554	6.7%	0.000475734	46.6%				
Class 3	18	1.9%		100 - 1000	243.9355	25.4%	1.0E-05 - 1.0E-06	349.7963	36.4%	0.00034201	33.5%				
Class 4	929	96.8%		20 - 100	433.0675	45.1%	1.0E-06 - 1.0E-07	459.8457	47.9%	8.66174E-05	8.5%				
Class 5	6	0.6%		< 20	219.3645	22.9%	< 1.0E-07	75.39975	7.9%	4.92045E-06	0.5%				
Unknown	4.10	0.4%													
Operation															
Signal	950.62	99.0%													
Non-Signal	5.76	0.6%													
Unknown	3.40	0.4%													
							Risk Level	Length	% Length	Risk	%Risk				
							> 1.0E-04	8.174	0.9%	0.000277379	17.8%				
Pop Density per mile	235						1.0E-04 - 1.0E-05	91.74035	9.6%	0.000721957	46.3%				
							1.0E-05 - 1.0E-06	427.5803	44.5%	0.000476987	30.6%				
Shipments	1						1.0E-06 - 1.0E-07	378.1518	39.4%	7.97535E-05	5.1%				
Total Car-Miles	960						< 1.0E-07	50.04089	5.2%	4.15139E-06	0.3%				
Annual Accident Prob	5.33E-05														
Annual Accident Freq	18749														
Prob of release	4.73E-06														
Frequency	211290														

6.10.13 (part 2)

After eating dinner, I continued to work from home. I completed the remaining four routes in ArcGIS, accounting for the minor changes Jesus requested and ensuring that each route was the exact same as the PC Miller solution. I then exported the attribute tables using the matlab code used previously in order to place each segment in geographic order from west to east. The attribute table for each route is now stored in excel and is in order. Tomorrow I will continue to work with these routes on excel and re-run the risk calculations for each route. I plan on completing this before tomorrow's RailTEC lunch meeting. The figure below shows all five routes, including the minor changes that were made.



6.11.13

I completed the risk calculations for each route. I uploaded my final ArcGIS files and risk calculations for each route to our project team's shared drive. Hannah and I compared some statistics (i.e. segments, miles, population, and area) from the attribute table of each route in order to ensure that we were each producing the same routes and corresponding information. I have spent some time going through the risk model conceptually and feel that I have a good grasp of the mechanisms behind calculating risk. Xiang answered a few questions that I had about the model and explained some of the concepts in depth. In terms of quantifying the consequences, the model only incorporates persons affected. I believe that we should be including more input parameters into the consequence term (i.e. depth to water table, permeability rate, and environmental effects of the hazardous material) in order to more accurately assess the risk associated with transporting a certain material over a specific route. This would require much more data than our current risk model framework and is something I am thinking about in regards to my independent research. Today at the RailTEC lunch meeting Francesco Bedini presented on high speed rail ballast flight. His presentation served as a sort of interim report of where he is in his research. Francesco presented the causes that he found relevant to the initiation of ballast flight and the resulting consequences. He outlined the methodologies he plans to use in the course of his research. I gained a lot of insight into this topic which I knew nothing about previous to our meeting today, other than a brief mentioning of this phenomenon in CEE 310. Xiang and Jesus went over the powerpoint template for creating a presentation and explained their expectations for our presentation slides. Jesus demonstrated more uses of ArcGIS to input our risk analysis into a map format in order to be more visually appealing and geographically referenced. Hannah and I are still having small discrepancies in our final values of risk for each route and we are working to rectify this. Once these issues are rectified, we will compile all of our results into the presentation format presented by Xiang and Jesus. The deadline for finishing the presentation is noon on Friday.

6.12.13

Today we accomplished a lot. This morning, Hannah and I continued comparing our final two routes and got the results to agree. Once that was completed, we split up our portion of the powerpoint. My responsibility was creating the maps: shipment routes, isotainer risk by segment, and tank car risk by segment. Hannah's responsibility was completing the tables and graph for our routes. Creating the maps proved to be a very tedious task and ended up taking me most of the afternoon. At the end of the day, we were all done with our portions of the presentation and we combined all of our slides into one powerpoint. Tomorrow will be spent reviewing the powerpoint as a whole group and discussing each slide individually in order to create the best powerpoint we possibly can. We have a safety group meeting tomorrow.

6.13.13

This morning, the group of undergraduate research assistants and I reviewed our presentation slide-by-slide in order to look for errors and for ways of improving the appearance of the results. We corrected a few things (i.e. formatting issues, font size, and graph display) and all agreed that we wanted to refine the maps more. Xiang gave us some advice on what literature (journal articles and books) to read for our independent research projects and what to look for while reading. Our weekly safety group meeting was especially light today; Francesco, Dr. Saat, Tyler, and Jesus were not in attendance. Laura and Chen-Yu gave additional advice on reading articles. We are approaching the end of the project we have been working on since the beginning of this [internship](#). I presented the portion of the presentation that Hannah and I created as well as the introduction material during the meeting. We received some very insightful comments and ideas from Xiang, Chen-Yu, and Laura. It was apparent that we need to refine our maps a little and make them more clear and consistent from one to the other. Many changes/additions were proposed however most were turned down since we want to keep the layout of the presentation, figures, and results the same as previous, interim presentations to make it easier for the client to comprehend the presentation. Manu and I worked together to get our maps to be more visually appealing and ready to present. This was tedious and took quite a while to tweak each map to get it just right. The four of us looked over the presentation one last time to ensure that our changes were effective and we all agree that the presentation is ready to be shown to Dr. Saat and Prof. Barkan. After this I started researching journal articles to read for my independent research project. I will list the articles and authors below. I am excited to start this project since it is largely self guided and is open to my own interpretation and formulation.

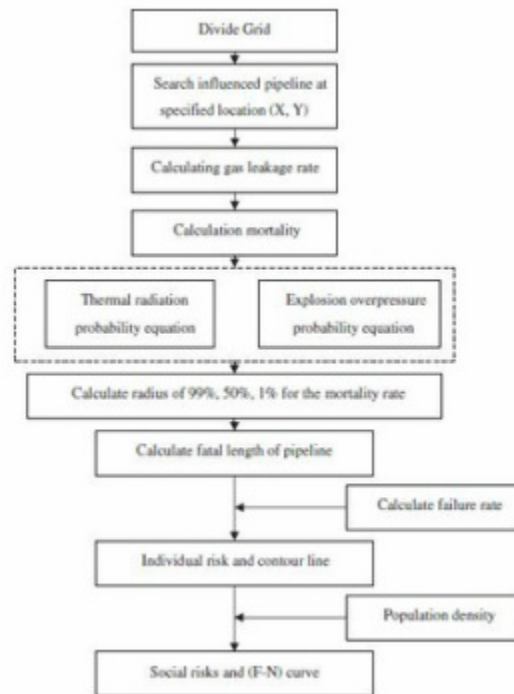
- Metropolo P., 2004, Natural Gas Pipeline Accident Consequence Analysis
- Ma L., 2013, A Novel Method of Quantitative Risk Assessment Based on Grid Difference of Pipeline Sections
- Jo Y., 2008, Individual Risk Analysis of High-Pressure Natural Gas Pipelines
- Han Z., 2011, Comparison Study on Qualitative and Quantitative Risk Assessment Methods for Urban Natural Gas Pipeline Network
- Han Z., 2009, An Integrated Quantitative Risk Analysis Method for Natural Gas Pipeline Network
- Cooke R., 1998, A Probabilistic Method for the Failure Frequency of Underground Gas Pipelines

I plan on starting to read these articles tomorrow morning as well as searching for literature review articles to gain a more in-depth knowledge of pipelines, initiating mechanisms for failure of pipelines, and consequences of pipeline failures.

6.14.13

I spent a good portion of my day reading a textbook titled *Guidelines for Chemical Transportation Safety*,

Security, and Risk Management. I started and finished this textbook today. It provided a nice, high-level description of risk assessment specific to transportation of hazardous materials. It lacked specific examples and mathematical formulations of risk, likelihood, or consequence parameters. I realize it would be difficult to provide a mathematical formulation of those parameters while still remaining broad, however some specific examples implementing the knowledge presented in the textbook would have been very helpful. The theoretical contributions from this textbook combined with the practical experience of the project I have been working on for the past two weeks has given me a very nice introduction to transportation risk and has given me a direction that I want to follow for my independent research project. I created a file where I will keep the citation for each article/textbook/incident report that I read along with my notes and key takeaways. I believe this will help me stay organized and once I begin writing my paper it will be very easy to cite literature and compile my references. Unfortunately I was only able to read one of my articles that I listed on yesterday's blog entry since I decided to read a textbook today and it took up much of my time. I read the article titled *A Novel Method of Quantitative Risk Assessment Based on Grid Difference of Pipeline Sections.* This was an interesting article to read and was mathematically rigorous but it diverged from what I thought it would be about. It wasn't time wasted since I found a great data set from the European Gas Pipeline Incident Data Group, I am very excited to explore this document on Monday. This article also proposed a nice, logical framework (shown below) for calculating individual and societal risk that I believe I might use for the formulation of my own risk model. I will try to post each article that I read to this blog for ease of reference.



Ma_l_2013_a_novel_method_of_quantitative_risk_assessment_based_on_grid_difference_of_pipeline_sections.pdf

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6.17.13

This morning Jesus requested that we change the grouping of our routes in the powerpoint as well as add a few more routes. Instead of having two groups of five and six routes each, we changed the powerpoint

to three groups of three, six, and six routes each. Manu and I worked on these changes all morning and into the early afternoon. I read through the data set that I found on Friday and found two tables that I believe will prove to be crucial to my risk model. The data set also contains many tables relating various factors to failure rates and other parameters. I have shown below the two most important tables from this data set and I also posted the document below as well. I attended a presentation by Philippe Pouligny for SNCF, he talked about concrete tie research currently being done in France as well as various other track components. I enjoyed the lecture and look forward to attending many more throughout the remainder of this week. After this presentation, we went back to the office and split up our project presentation in order to present it to Professor Barkan and Dr. Saat. I presented the introduction slides and the risk model, the other undergraduates presented the routes and our results. We received some constructive advice on how to better present the results; Professor Barkan and Dr. Saat agreed with our results, they just wanted us to make some changes to our presentation of the results. I plan on attending lectures from 8:30 - 3:30 tomorrow but afterwards I will work on improving our powerpoint. I will most likely do some more reading of journal articles at home tomorrow after work since I will be out of the office on Friday.

Period	Interval	Number of incidents [-]	Total system exposure [km-yr]	Primary failure frequency per 1000 km-yr
1970 - 2007	7 th report 38 years	1173	$3.15 \cdot 10^6$	0.372
1970 - 2010	8 th report 41 years	1249	$3.55 \cdot 10^6$	0.351
1971 - 2010	40 years	1222	$3.52 \cdot 10^6$	0.347
1981 - 2010	30 years	860	$3.01 \cdot 10^6$	0.286
1991 - 2010	20 years	460	$2.25 \cdot 10^6$	0.204
2001 - 2010	10 years	207	$1.24 \cdot 10^6$	0.167
2006 - 2010	5 years	106	$0.654 \cdot 10^6$	0.162

Table 1: Primary failure frequencies

Cause	Distribution [%]
External interference	48.4
Construction defect / Material failure	16.7
Corrosion	16.1
Ground movement	7.4
Hot-tap made by error	4.8
Other and unknown	6.6

Table 2: Distribution of incident per cause.



8th_report_of_the_european_gas_pipeline_incident_data_group.pdf

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6.18.13

Today I spent the vast majority of the day in presentations. The first presentation of the day was given by Francesco Bedini on an introduction to ballast flight risk. His presentation brought about a lot of detailed conversation from our colleagues from SNCF and it also provided an opportunity for them to share some of their research and conclusions about this phenomenon. This phenomenon is sporadic and therefore hard to model. Ballast flight risk was the topic of Gilles Saussine's presentation in the afternoon. The next presentation was from Alain Robinet of SNCF, he presented on the platform issues in France and specifically about their bituminous layer research. I found this especially interesting since my academic ambitions are on the infrastructure side of transportation. Next, Gilles Saussine presented SNCF's research into ballast flight and ballast modeling. The scientific accuracy and mathematic rigor employed in their models is quite impressive, and yet those models are "simplified" and make use of some assumptions; this speaks to the difficulty of modeling the phenomenon of ballast flight. I attended another meeting after this about possible research affiliations between U of I and SNCF. This concluded the presentations/meetings for the day, after which I went back to the office and met with the other undergrads for a little bit. They made the changes to the powerpoint that were suggested yesterday at our meeting. I will continue reading journal articles tonight and tomorrow morning before the first SNCF presentation at 10 am. I really look forward to the rest of these presentations for the remainder of the week, I am intrigued by their content and they are thought provoking. Below is a slide containing a proof of the risk assessment formulation from Gilles's presentation.

BALLAST FLYING
BALLAST FLYING RISK ASSESSMENT : A METHOD

Figure 10: Generic graphic of the SSIA

R and C are independent and gaussian random variables, representing respectively the strength and stress.

$$R \in N(\mu_R, \sigma_R) \quad C \in N(\mu_C, \sigma_C)$$

These functions are defined by the following formula:

$$f_x(x, \mu, \sigma) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\left(\frac{x-\mu}{\sigma}\right)^2\right]$$

We define the failure probability :

$$P_f = P(R < C) = P(R - C < 0) \quad P_f = \int_0^{\infty} f_r(x) F_c(x) dx$$

If we define : $Z = R - C$. Then $Z \in N(\mu_z, \sigma_z)$ and $Z = \mu_z + U \sigma_z$ with $U \in N(0,1)$
 and $\mu_z = \mu_R - \mu_C$ $\sigma_z = \sqrt{\sigma_R^2 + \sigma_C^2}$

Consequently:

$$P_f = P(Z < 0) = P(\mu_z + U \sigma_z < 0) = P\left(U < \frac{\mu_C - \mu_R}{\sqrt{\sigma_R^2 + \sigma_C^2}}\right)$$

The analytic solution of these equations is:

$$P_f = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\frac{\mu_C - \mu_R}{\sqrt{\sigma_R^2 + \sigma_C^2}}} \exp\left(-\frac{u^2}{2}\right) du$$

The result is the occurrence probability of the stress strength scenario we have defined.

William W. Hay Railroad Engineering Seminar - 18 June 2013

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6.19.13

Today I attended some more presentations, the first being from Gilles Saussine on the topic of ballast research being conducted at SNCF. The presentation had two main components: DEM/FEM modeling of ballast and the implementation of these models to solving various problems as well as maintenance procedures and ways of quantifying these procedures. The global effect of tamping and stabilizing are well known however the small-scale mechanisms are still unknown. The use of DEM and FEM are crucial numerical methods used to model laboratory and in situ tests, but the main drawback to them is the computing power and run time needed to run a single simulation. Before this presentation and during my lunch I read an article entitled *Historical Analysis of Accidents in the Transportation of Natural Gas*. This article contained some statistics on the causes of pipeline failures as well as the resulting events (i.e. loss of containment, fire, explosion etc.) however the article is rather outdated so I chose not to use these statistics in my project. The article did present the issue of data collection and the incompleteness of databases, making me aware of shortcomings to be aware of. The next presentation was given by Debakanta Mishra. His presentation was about triaxial testing of ballast, a Union Pacific ballast box test study, and geogrid testing along with depth placement analysis. Maziar Moaveni presented on aggregate imaging and a new methodology developed at U of I. The final presentation of the day was given by professor Erol Tutumluer. After today's presentations, I spent some time looking for maps of the Keystone XL pipeline. I found portions of the entire route as a KMZ file.



Montiel_h._1996_historical_analysis_of_accidents_in_the_transportation_of_natural_gas.pdf

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6.20.13

I spent the whole morning in presentations. Huseyin Boler presented on the topic of shear strength behavior of glued railroad ballast and a new approach to optimize ballast gradation. His work was interesting in the sense that it was very current; some of the DEM models presented were ongoing projects and the observations that Gilles Saussine were very instructive. I look forward to seeing this project progress and continue to utilize state-of-the-art computing technologies to numerically model such difficult phenomena. The next presentation was from Ted Sussman from the VOLPE Center. He talked about the current research being conducted at VOLPE as well as government/industry applications of their research. After lunch I continued to work on my project. I spent some time thinking about how I want to utilize the Keystone Pipeline map that I found (seen below in Google Earth). The second image shows the official route of the pipeline, including extensions. It is my plan to use the route of the second image, in my case study, by first importing the kml file from Google Earth into ArcGIS then adding the Cushing extension so the pipeline extends continuously from the Canadian border to the Gulf Coast. I first have to research how to import a kml file into ArcGIS, then I have to edit the map to make it equivalent to the official route as shown in the second image. Next, I found a database of pipeline incidents on the PHMSA website. In order to use the most recent data, I downloaded the database from 2010 to present (I realize that this is a relatively narrow time frame and if I have time remaining after I finish this case study, I will expand this database to 10+ years before present); the database file is attached below. I went through the database and applied many filters to the data; I am only interested in those incidents involving crude oil, occurring in the pipeline, and occurring onshore. All of these parameters were chosen in order to replicate the Keystone Pipeline. I spent the rest of the afternoon pouring through the database as there were over 500 incidents and 600 information categories. I narrowed down the database to the filters I listed previously as well as discarding all irrelevant categories of incident information. My plans for this data are as follows:

1. Create a severity-frequency plot to define high-frequency/high-severity causes.
2. Create a release size distribution function and fit a statistical model to it.
3. Explore any possible correlation between release size and estimated damages.

4. Create a map in ArcGIS of all the incidents in the database displaying release amount and estimated damages to see if there are geographic "hot-spots."
5. Explore other parameter statistics that might be relevant to my case study.
6. Begin creating a powerpoint on introduction to pipeline risk as well as one for the case study of the Keystone Pipeline.

I plan on spending a good amount of time analyzing this database and fine-tuning the route map of the Keystone Pipeline. I will not be in the office tomorrow.



Keystone Mapping Project
 Zoom [+/-] to view. Eye alt approximate.

- Keystone XL Route. Subject to change.
- MP Milepost Marker. Frequency of 10 miles. Eye alt: 35 km.
- Waterbody Crossing. Eye alt: 800 km.
- Access Road. Eye alt: 800 km.
- NA Not Available. Data withheld.
- Water Well. Within 1320 feet or 1 mile. Eye alt: 1500 km.
- Gas Well. Within 1 mile. Eye alt: 1500 km.
- 500 Foot Construction Corridor. Eye alt: 30 km.

keystone.steamingmules.com

Search
 ex: 37 25.818' N, 122 05.36' W
 Get Directions History

Places

- My Places
- Sightseeing Tour
Make sure 3D Buildings layer is checked
- Temporary Places
- Keystone XL: MT-TX

Layers Earth Gallery >>

- Primary Database
- Borders and Labels
- Places
- Photos
- Roads
- 3D Buildings
- Ocean
- Weather
- Gallery
- Global Awareness
- More



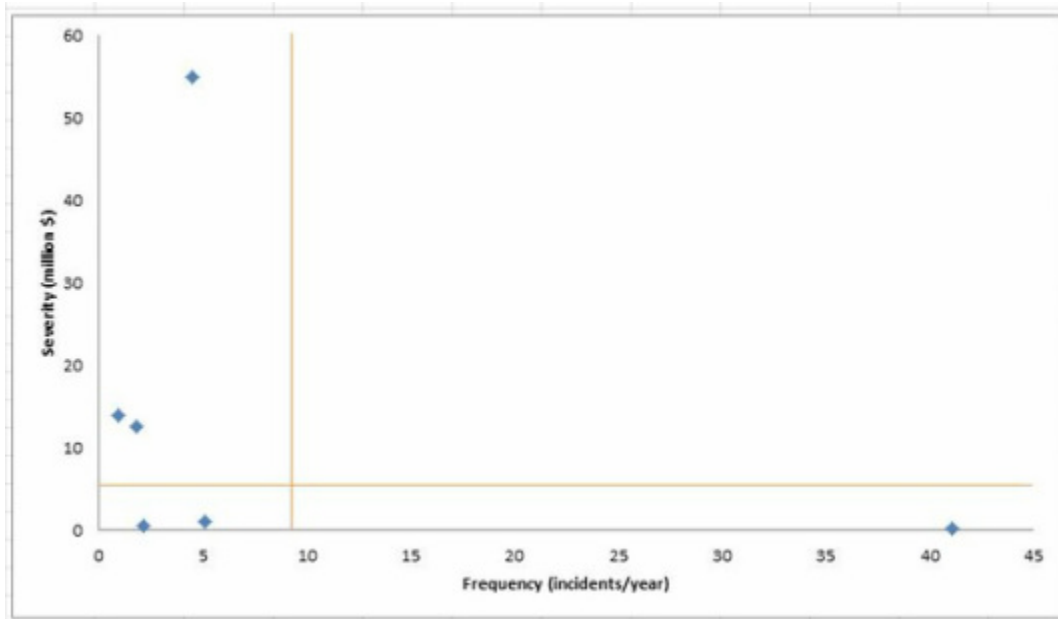
2010-to_present_significant_hazmat_pipeline_incidents.xlsx

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6.21.13

Last night I created a severity-frequency chart of the data from 2010 to present. The chart didn't turn out the way I thought it would; corrosion was high-frequency but very low severity yet pipe/weld material failure was low frequency yet very high severity. The standard deviation of cost per incident for each category is quite large and therefore I plan on incorporating incident data from the period of 2002-2009 in order to decrease the variability and reduce the influence of outliers. I don't want to eliminate outliers all together since they have significant contributions to the consequences and then my analysis wouldn't be complete. Next week I will work on adding the additional data into my database I'm using as well as work on the list of tasks I provided yesterday.

failure cause	number of incidents	frequency (year ⁻¹)	total cost	st. dev. cost	severity (M\$)	barrels lost	average barrels lost
corrosion	137	41.1	38407403	1434863.147	0.280346007	9726.2	70.99416058
excavation damage	17	5.1	19454002	3371326.491	1.144353059	7697	452.7647059
pipe/weld material failure	15	4.5	8.25E+08	208882906.7	54.97204633	27478.26	1831.884
incorrect operation	7	2.1	4244480	1497741.657	0.606354286	20.32	2.902857143
other	6	1.8	75172440	18662484.72	12.52874	14316	2386
external impact	3	0.9	41954370	16517472.68	13.98479	2560.01	853.3366667



6.24.13

This morning I read a Wikipedia page about crude oil (petroleum), hoping to get a better understanding of the material that is being transported via the Keystone pipeline. One of the main things I was looking for was the manner in which oil disperses so I could determine an area affected in terms of the release amount. I believe that this will be a very hard calculation to find literature on, and I will most likely end up using the recommendations from the [Emergency Response Guidebook 2012](#). The rest of the morning was spent searching for articles related to oil pipelines and damage modeling as well as learning how to import .kml files from Google Earth into ArcGIS. This was necessary since the only map I found of the Keystone Pipeline was in Google Earth; it took me a few hours to learn the data interoperability tool which allows one to import .kml files into ArcGIS. Using this tool, I was able to reproduce the Keystone Pipeline route (see image below); I only included the portion of the pipeline within the United States. The Keystone Pipeline only extends south until Steele City, NE but I included the pipeline that it is going to be connected to; from Steele City, NE to Nederland, TX. This route will be the basis of my risk analysis and will allow me to spatially reference all risk values and data. I spent some time creating a list of statistics that I need in order to build my risk model (not yet complete):

- Probability Mass Function (PMF) of release cause
- Probability Density Function (PDF) of release size given a release cause
- cleanup/environmental/socioeconomic costs per release size
- correlation between release size and affected area

I have found some more articles that deal specifically with crude oil pipelines. I plan on reading these articles over the coming days in addition to continuing work on my case study of the Keystone Pipeline. I spent the rest of the day sifting through the 2002-2009 pipeline incidents database. So far I have only been filtering out the non-crude oil incidents and then I will continue to filter the database so that it matches the 2010-present data that I have already formatted. One inconsistency I have noted so far is that the metric for the size of the spill in the 2002-2009 database is either barrels or gallons, while the more recent database is strictly barrels. I will have to pay attention to my units when combining the two databases.



2002_to_2009_significant_crude_oil_pipeline_incidents.xlsx

[Download File](#)

6.25.13

I spent all morning editing the database from 2002 to 2009 so it was similar in nature to the database I edited from 2010 to present. The most time consuming part of this task was that the release quantities had varying units between gallons and barrels, which were randomly distributed throughout the incident database. I used a conversion factor of 1 gallon = 0.0238095238 barrels of oil. During our weekly RailTEC lunch meeting, Athaphon Kawprasert from the Thailand Railway's presented on the status quo of railroads in Thailand and on their 7 year plan. The 7 year plan involves 68 billion US \$ and is meant to vastly improve the rail infrastructure of the nation. After the meeting, the risk and safety group met with Athaphon and discussed certain aspects of the project we worked on for the first few weeks of this internship. I spent the rest of the afternoon and some of the evening working on the database I am compiling from 2002 to present. One of the major difficulties with this is inconsistent latitude and longitude readings provided in the 2002-2009 data. The format switches randomly between decimal degrees and degrees, minutes, seconds. ArcGIS requires decimal degrees in order to plot the points as x,y data; therefore, I will have to individually convert every value that is not of the decimal degrees format. I plan on spending all day tomorrow working on this database.

6.26.13

The morning was spent importing the various cost categories from the two databases into my consolidated 2002-present database as well as assigning each incident a number from 1-7 according to

its cause; this will help greatly when I go to break the database up by cause. The cause categories are as follows:

1. other
2. equipment failure
3. corrosion
4. incorrect operation
5. material failure
6. excavation damage
7. external impact

In the afternoon, we had a meeting between Xiang and the four undergrad interns. We each gave a short status update about our individual projects. Xiang suggested that I prepare a tutorial on how to import Google Earth data into ArcGIS since nobody in the RailTEC safety/risk group has done this procedure before. I explained to Xiang the general outline of my risk model and he made some suggestions, such as using other software instead of excel to perform statistical curve fitting to a known distribution. I have to ask him for the name of that software once I get to that point in my data analysis. After this meeting, Manu and I talked briefly about how we want to compare our risk results once we have completed our individual projects. As of now, we have come to the conclusion that we will definitely compare population affected per mile per barrel. Hopefully, our routes will be very similar as well as our origin/destination; we will be able to confirm this after Manu runs his network through PC Miller. We also discussed possibly writing a joint paper (in addition to our individual papers), time permitting, about the risk comparison between our two modes and the impact the Keystone Pipeline will have on the shipment of crude oil. I think this would be a very interesting paper and would be highly applicable to the industry. I spent the rest of the afternoon converting the latitude and longitude coordinates that were given in the original databases to decimal degrees (in order to be compatible with ArcGIS); this is proving to be a very tedious and time consuming task.

6.27.13

We had our weekly safety/risk group meeting this morning with Dr. Saat and Prof. Barkan on a conference call since they were both out of town. All of the research assistants gave a short synopsis of their work from last week and their visions for the coming week. Jesus presented his research on multiple tank car release events and their consequences. I spent the rest of the morning and all afternoon finishing converting all latitude and longitude coordinates to decimal degrees. I plan on using the precise location for each incident to obtain the population density at each incident location and hopefully this will correlate well with the costs for each incident. I have a lot of papers that I have been compiling and putting aside, so tomorrow I will probably read a few papers and continue to work on this database.

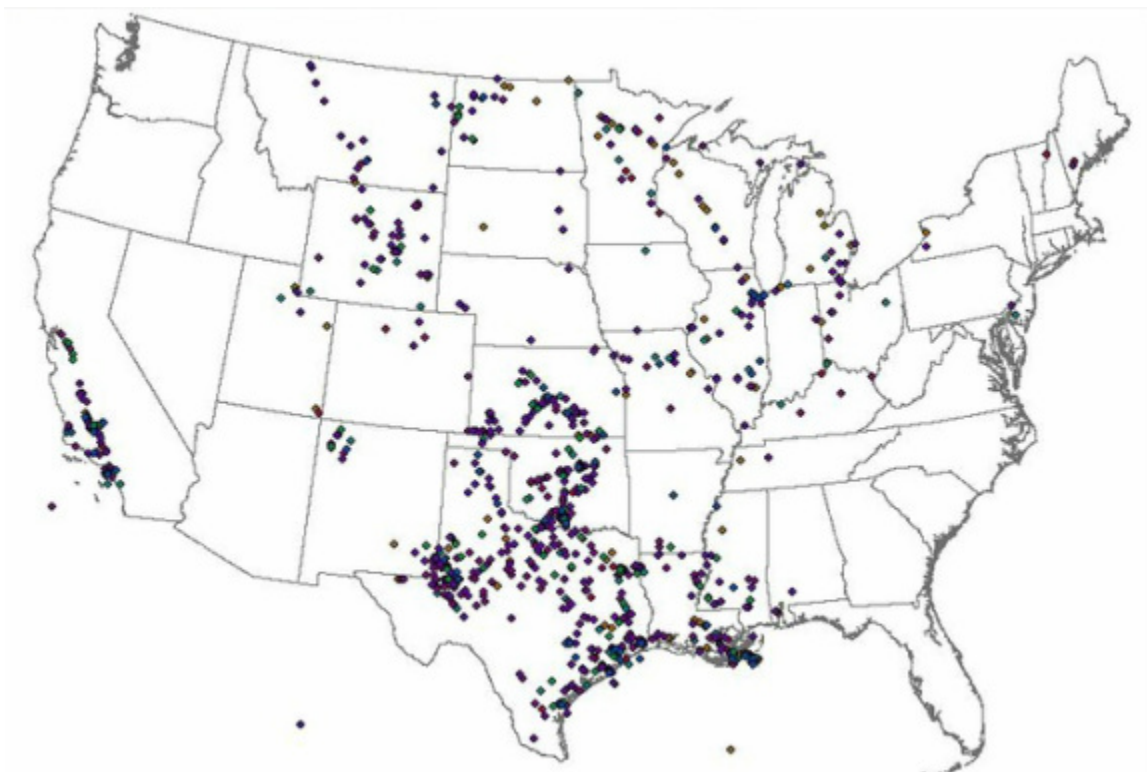
6.28.13

I spent all morning dividing my compiled database into separate excel files for each causal category. I also helped Hannah convert about 30 text files to excel files since her computer wouldn't convert them for

some reason. Once I created the excel files for each category, I imported this data into ArcGIS via the "add XY data" tool. By using the latitude and longitude of each incident, I was able to spatially plot each incident and display it in the map below; the map shows all 7 categories of incident causes. I attached the excel file with all the data separated by causal category below. Next, I spatially joined each cause data layer with 2010 US census data in order to obtain the population density at each incident location. Next, I exported each data table to excel from the spatially joined layers in ArcGIS and deleted all unnecessary columns that were added by the census layer. The categories I decided to keep from the census data layer were: FID, GEOID, area (square miles), and population density (persons/square mile).

List of tasks to complete:

- Create tutorial on how to use XY data import.
- Create tutorial on how to import Google Earth data into ArcGIS.
- Segment the Keystone Pipeline route into 0.1 mile segments.
- For each causal category, develop a model that will output cost (given population density and release size as input variables).
- Generate statistics on incidents/year.
- Create a PMF of the incident causes.
- Create a probability distribution (either PMF or PDF, TBD) for the release size of each incident cause.
- Produce a severity vs. frequency chart for my database (using only cost as the measure of severity, for the time being).
- Find an article describing the costs associated with evacuating people from their homes.
- Catch up on the articles that have been piling up in my "to read" folder.
- Start outlining my powerpoint modules (introduction to crude oil pipeline risk management and the case study of the Keystone Pipeline).
- Create a detailed document explaining every step I've taken so far in my data analysis and case study.





Incident_data_by_cause.xlsx

[Download File](#)

7.1.13

This morning I went back to my pipeline incidents ArcGIS file that I created on 6.28.13. I went through each cause category layer and deleted any incidents that were not on the mainland US (due to errors in latitude and longitude data entries). The map below shows all pipeline incidents that occurred in the US between 2002 and present day on crude oil pipelines. I also created a map of each cause by itself. I then exported the data tables to excel files and deleted the unnecessary census columns; I kept the same columns as on 6.28.13. After configuring each excel file to be the same as each other, I began thinking of how I wanted to analyze the data. At first, my thought was to create a function for each cause that would take release size and population density of the incident as inputs and output the total cost of the incident. I quickly realized that this was a much more difficult approach than I thought it would be. Therefore, I created a PMF of release size for each cause. The PMF consisted of 10 release size (barrels) ranges as seen in the data table below. For each release size (and incident cause) I calculated the average cost of cleanup, railroad, environmental, socioeconomic, and oil. The railroad cost category is the amount the railroad owed in fees as well as damages to their infrastructure. Socioeconomic costs included effects on the public, private businesses, and personal property. I now had a total average cost for each release size per incident cause. I then calculated the probability of each release size per incident cause as well as the average barrels released. With this information I was able to calculate the average barrels released per incident, average cost per incident, and frequency of incidents by cause per year (all calculated using the total probability rule). I created an excel workbook that would do this process automatically for all 7 cause categories (attached below is the excel workbook for incorrect operation incidents). I now have all the background statistics needed to start with the risk analysis case study. I spent some time in ArcGIS learning how to split my route into smaller segments using the "densify" and "split line at vertices" commands. I am still working to perfect this process. The whole reason behind doing this step is that the Keystone Pipeline will have sensors every 0.1 miles, therefore I would like to calculate the risk associated with each segment between sensors. So far, I have been unable to produce segments that are all 0.1 miles in length; I will continue to refine this process tomorrow. As of right now, the only way I plan on implementing area/population affected is by assigning a cost to evacuation (which I found an article on today) and adding that to the other costs that I obtained from historical data. I will calculate the area affected in terms of the release size (I found an article today that measured the average thickness of Venezuelan crude oil which is very close in viscosity and composition to canadian sands crude oil) and from there determine a radius to use as my buffer in ArcGIS. My current intent is to have the final result of my risk analysis case study be risk in terms of dollars per mile per year. When showing this information in ArcGIS, I will only show the evacuation costs per segment since each segment has the same base cost plus their individual evacuation costs.



Incident Category

- other
- material failure
- incorrect operation
- external impact
- excavation damage
- equipment failure
- corrosion failure

PMF release size (barrels)	average cost (\$)						statistics		
	cleanup	railroad	environmental	socioeconomic	oil	total	average barrels released	number of releases	% of total releases
barrels<=1	\$ 3,615.53	\$ 5,065.72	\$ 3,337.13	\$ 67,392.65	\$ 48.09	\$ 79,459.12	0.49	69	0.371
1<barrels<=5	\$ 3,636.87	\$ 4,138.19	\$ 3,526.24	\$ 3,003.17	\$ 303.91	\$ 14,608.39	3.10	50	0.269
5<barrels<=10	\$ 3,449.04	\$ 14,725.75	\$ 9,093.00	\$ 2,986.37	\$ 792.17	\$ 31,046.32	8.08	12	0.065
10<barrels<=50	\$ 11,252.88	\$ 33,104.94	\$ 14,711.79	\$ 24,745.97	\$ 2,553.23	\$ 86,368.80	26.05	30	0.161
50<barrels<=100	\$ 4,496.08	\$ 7,556.76	\$ 212.56	\$ 14,915.03	\$ 8,349.60	\$ 35,530.03	85.20	5	0.027
100<barrels<=500	\$722,560.23	\$788,597.54	\$ 509,318.56	\$ 620,562.09	\$ 27,520.18	\$ 2,668,558.61	280.82	11	0.059
500<barrels<=1000	\$ -	\$ 25,827.70	\$ -	\$ 867.72	\$ 62,066.67	\$ 88,762.09	633.33	3	0.016
1000<barrels<=2000	\$103,605.82	\$ -	\$ 24,990.35	\$ -	\$ 117,600.00	\$ 246,196.16	1200.00	1	0.005
2000<barrels<=5000	\$708,059.85	\$335,061.21	\$ 780,948.36	\$ 13,015.81	\$ 412,384.00	\$ 2,249,469.22	4208.00	2	0.011
barrels>5000	\$ 60,253.08	\$ 97,317.68	\$ 35,804.77	\$ -	\$ 756,135.33	\$ 949,510.86	7715.67	3	0.016
average barrels released per incorrect operation release:						210.997			
average cost per incorrect operation release:						\$ 250,368.10			
total incorrect operation caused releases:						186			
incorrect operation caused releases/year:						15.081			



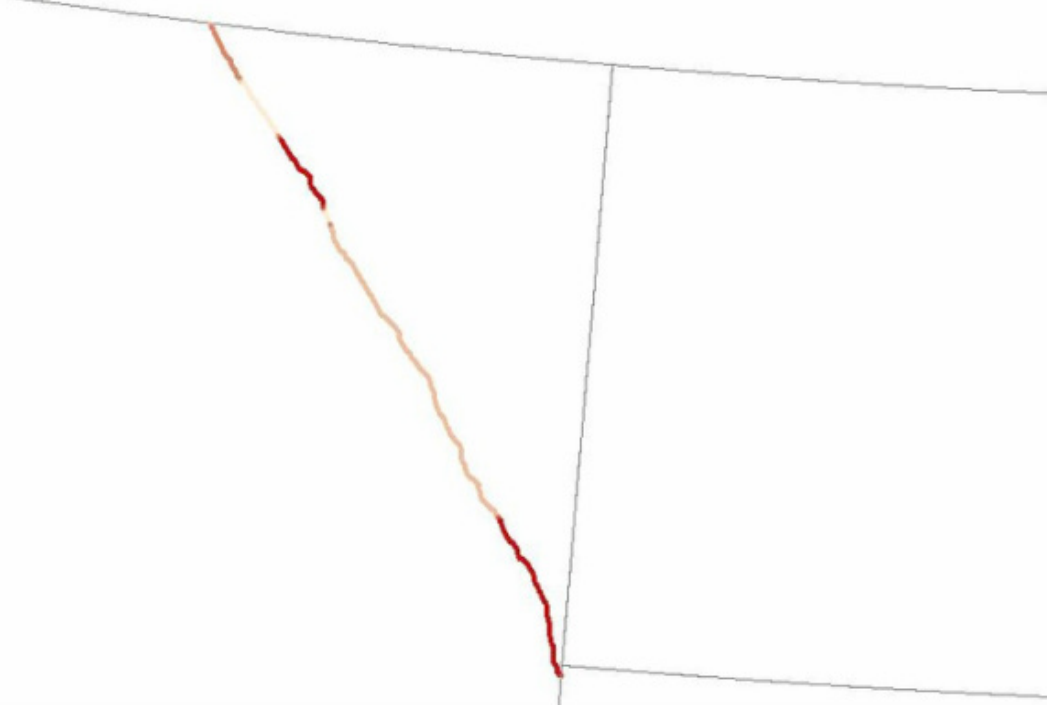
Incorrect_operation_final_data.xlsx

[Download File](#)

7.2.13

I spent the morning continuing to work on my pipeline risk analysis spreadsheet and I have come up with a preliminary template to the point where I can input route information and have the risk output calculated automatically. I am not sure whether or not this will be my final template, I might need to make some changes and I might also make it more sophisticated, it is a work in progress. Jesus presented at the weekly RailTEC lunch meeting; his presentation was very much similar to his presentation at the safety meeting last week. After the lunch meeting, we spent some time discussing the intricacies and assumptions we used in the risk model for the two week project at the beginning of the internship in order to gain better insight for our own projects. I then started working in ArcGIS to get the route information (segment length and population density for each segment) that I need for my risk template. I ran into problems while trying to intersect my buffered route with the 2010 census data, I believe it's due to the fact that my route consisted of approximately 26,000 segments and I am working to correct this issue; this is where I finished off my day at the office. I decided to continue working at home for a few hours tonight while some thoughts were fresh in my head. First, I calculated the population density along the keystone pipeline route in Montana; the smaller route allowed the intersect to work properly rather than crashing. I used a buffer of 0.857 miles since that was the average exposure radius I received after utilizing the total

probability rule on all the data I gathered. I then created a detailed, step-by-step process of how I went about calculating these values (the first document attached below). The map of the population density along the pipeline route in Montana is shown below. I then exported this data to excel where I imported it into my risk analysis template. By doing this, I realized a few small calculation errors that were easy to fix. As a result of our discussion with Xiang after the lunch meeting today, I implemented a more rigorous calculation of the route risk. I used De Morgan's rule to make the computation much easier to repeat segment-to-segment. I implemented these changes to the pipeline risk analysis spreadsheet (second document attached below). I used the length and population density data from the Montana pipeline segment to compare risk values between the two methods. My previous risk analysis gave a societal route risk of \$789,000.00/year and my new risk analysis gave a societal route risk of \$517,000.00/year. I also have more mathematical and structural confidence in the accuracy of the second analysis.



Gis_route_information.docx

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Pipeline_risk_analysis_spreadsheet.xlsx

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Pipeline_risk_analysis_spreadsheet_segment_1.xlsx

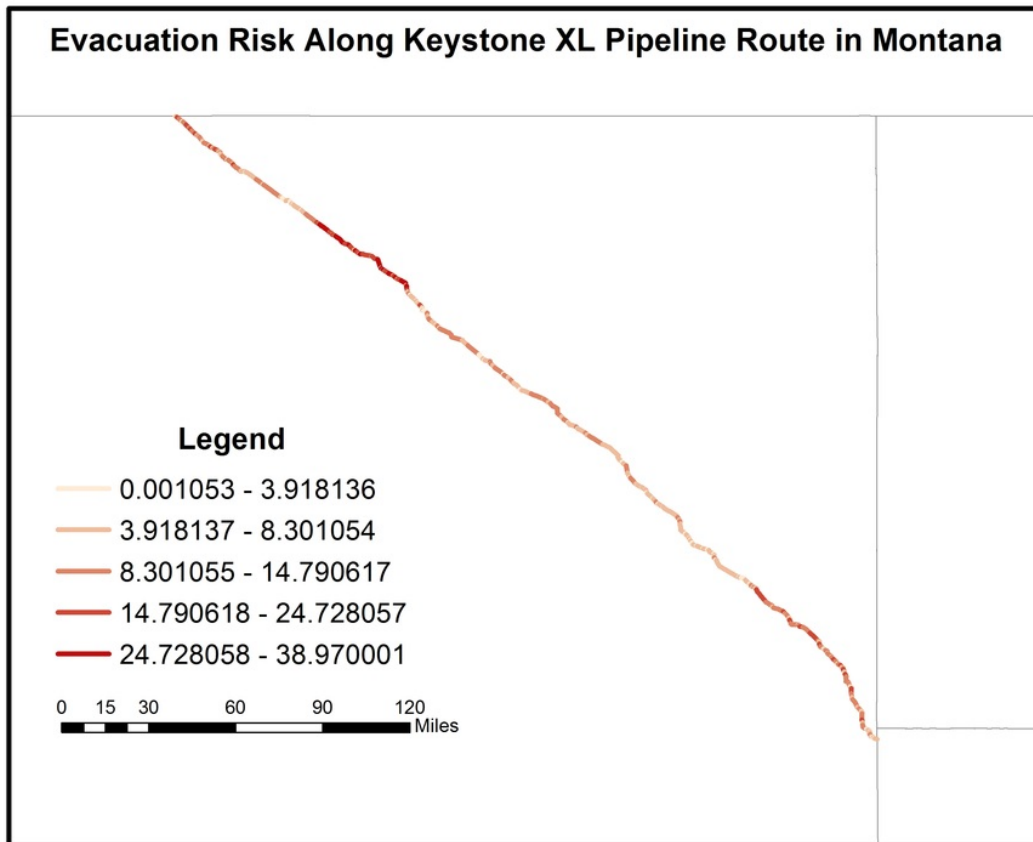
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7.3.13

A quick note on last night's work: the new risk analysis template that I have adopted assumes statistical

independence of the segments, otherwise the calculations would become too cumbersome and I would also have to derive a correlation coefficient which is no small task. I believe that this assumption is valid since it essentially means that the failure frequency of one segment does not depend on others around it and in all the incident reports I have seen, only one failure occurs per incident since this failure reduces stress and pressure along the rest of the pipeline.

I started the day by splitting the entire route from Montana to Texas into 12 segments. It was necessary for me to do this so that ArcGIS won't crash on me when I intersect the route with the census data; this process took a lot longer than I expected. I then spent the rest of the morning and a good amount of the afternoon working on my first powerpoint; an introduction to pipeline risk analysis. This powerpoint presents the current pipeline infrastructure in the U.S., some statistics on volume transported and pipeline length, the main maintenance strategy (called a smart pig), and pipelines that are under development/construction. I attached the powerpoint below, this is my rough draft of it and I will continue to edit and revise it upon receiving feedback. Next I re-ran the route information from the first segment of the Keystone XL Pipeline through my risk analysis template (I made a few formatting changes today) and then joined the risk results with the route layer in ArcGIS. I display the resulting map below (this is not a finalized map, it is simply to get an idea of the spatial variation of risk) which shows the evacuation risk, in dollars, per segment. The evacuation risk is directly proportional to average population density along each segment and the segment length.



Introduction_to_pipeline_risk_analysis

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7.5.13

I spent the day working in GIS finishing the 10 segments of the Keystone XL pipeline route that I had left. I then merged all the segments to have the whole route as one layer with the population density of each segment. A picture of the population density distribution of the whole route is shown below. I then exported this data to excel in order to perform my risk calculations. I found a few additional formatting errors that I quickly fixed and I changed the layout of my risk template, adding a column that normalized the total risk by the length of the segment since all segments were not the same length. I am satisfied with this template for now, however I would like to make it more sophisticated in order to account for population density as a contributor to cost in the PHMSA data that my model is built upon; I have been thinking about this for quite a while however I have not come up with a way to carry this out. Other than possibly adapting my risk template, my next task will be to work on my powerpoints and read some journal articles that have been piling up. I attached a copy of my current risk template below.

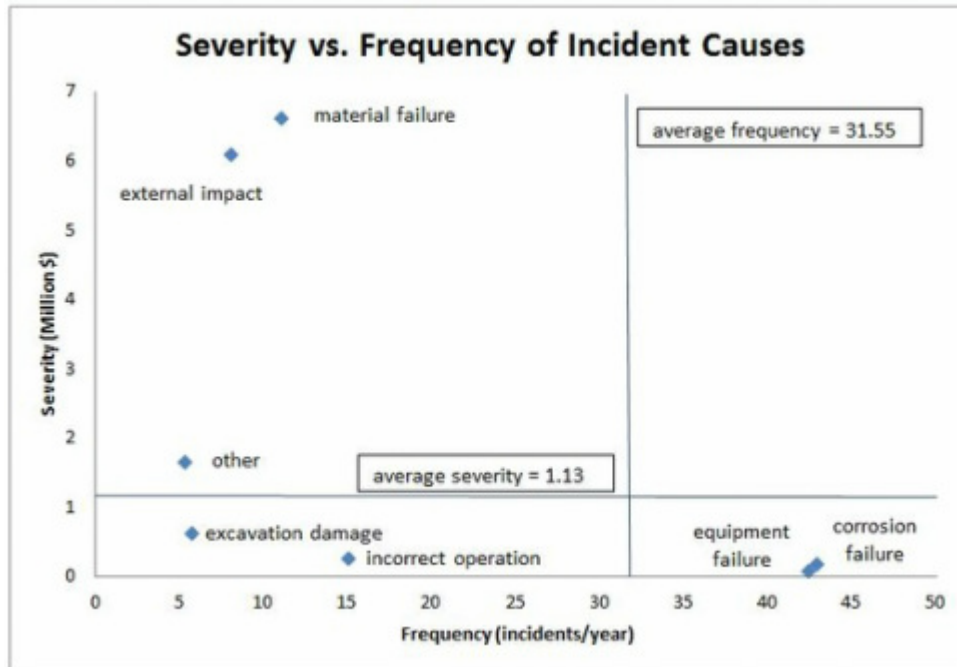


Pipeline_risk_analysis_spreadsheet.xlsx

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7.8.13

I spent the morning working on my data analysis powerpoint (attached below). First, I created a historical graph of incidents per year as well as a severity vs. frequency graph (shown below) of the various incident causes. Unfortunately, there wasn't a cause that fell in the high-severity/high-frequency sector so I plan on researching risk mitigation strategies for the two most severe causes (material failure and external impact) and the two most frequent causes (equipment failure and corrosion failure). I included both of these figures in my powerpoint along with my map of pipeline incidents by cause. The powerpoint included the process/methodology of my data analysis and why each step was relevant to my research. In the afternoon, all of the undergraduates went through their presentations and we critiqued each other's work. I received some valuable suggestions that I plan on incorporating into my powerpoints (I presented my introduction and data analysis powerpoints). I spent the rest of the afternoon researching multivariate regression and putting thought into improving my risk model.



Pipeline_data_analysis.ppt

[Download File](#)

7.9.13

I started the morning by using multivariate regression to analyze the impacts of population density and release size on the costs of a particular incident cause. The r-squared values that resulted were very low, thus showing a very weak correlation. It is my belief that this is resulting from me using barrels released instead of net barrels lost. Therefore, I went back into my original database (that only includes crude oil incidents with lat/long coordinates that have been converted to decimal degrees) and computed the net barrels lost. It took me a few hours to break the database up by incident cause. Brandon Van Dyk presented at today's weekly RailTEC lunch meeting. He presented on the testing instrumentation that was installed at TTC as part of the concrete tie project. After the meeting, I imported the "other incident" data into ArcGIS in order to obtain the population density for each incident. I then exported this back to excel and removed all unnecessary columns; I kept GEOID10, NAMELSAD10, and POP10_SQMI. I ran multivariate regression on the four cost categories: cleanup, pipeline, environmental, and socioeconomic. Cleanup and pipeline costs had an adjusted r-squared value of greater than 0.83 which I am quite satisfied with. The other two cost categories had r-squared values less than 0.1, which is not

good. I then performed a regression of environmental cost with the regressor variable being net barrels lost since the P-value for that variable in the multivariate regression was approximately 4 times less than population density. The resulting r-squared value was still too low however the significance of F (i.e. the probability that the outcome was purely random) was below 20% so I will most likely accept these coefficients. The socioeconomic cost is a different story, I performed simple linear regression using each regressor variable independently and the results were worse than the results in the multivariate regression. I will have to think about how I plan on accounting for the socioeconomic cost, of the other cause at least. I will most likely compute the average socioeconomic cost per incident and use this value (perhaps I can compute the sum of squared errors for this case and compare to the residuals of the regression results and use this as a decision criterion). The sum of squared errors (SSE) for the multivariate regression is the smallest compared to the two univariate regressions SSE's and the average SSE. The results of the regression analysis' for the "other incidents" cause are presented in the figure below. Whether or not I use the regression coefficients for environmental/socioeconomic costs has yet to be determined since the r-squared values are so low. Other than not including these costs at all, I really have no choice other than to use these coefficients since the SSE of the difference from the mean is greater than the SSE of the multivariate regression residuals (i.e. using these coefficients would be more accurate than using an average value). I spent the rest of the afternoon working with ArcGIS and running multivariate regression in Excel. I plan on finishing this process for all incident causes tomorrow. Attached below is the Excel file of the "other incident" cause data along with the regression results. Below is a list of items on my to do list:

- finish multivariate regression analysis for each incident cause.
- create equations for each incident cause.
- compile data/equations in risk model.
- do sensitivity analysis on buffer radius (if time permits).
- incorporate changes into introduction powerpoint (add slides on economic/job impacts of pipelines).
- change data analysis powerpoint to incorporate multivariate regression.
- create outline of remaining powerpoints (previous research/significant incidents, risk model, case study).
- create xy data import tutorial.
- create google earth to ArcGIS tutorial.
- read articles and complete literature review.
- prepare presentation for next week's safety group meeting.

cost	intercept	net barrels lost coef.	population density coef.	adjusted R ²	significance F
cleanup	-71542.88188	3899.53705	4.82435	0.83187	1.51E-25
pipeline	-111385.692	3906.85715	19.79299	0.8597	5.06E-28
environmental	143278.8263	524.390174	0	0.0108521	0.195260782
socioeconomic	810721.6601	175.3358447	-4.239600628	-0.031599	0.995521957
oil released	0	98	0	n/a	n/a

note: these coefficients for socioeconomic cost were a result of the multivariate regression and had the lowest SSE when compared to the SSE's of univariate regression of both variables and the SSE of the difference from the mean value.



Other_incidents_final_data.xlsx

[Download File](#)

7.10.13

I spent the morning joining the remaining pipeline incident information in Excel with population density information in ArcGIS and performing multivariate regression on the resulting data. I then compiled the regression coefficients for each cost category within each incident cause and eventually, using the total probability rule, joined all the coefficients for each incident cause to come up with one overall regression equation. This equation has population density and release size as inputs and outputs the predicted total cost of an incident. The average adjusted R-squared values for these coefficients are quite low however the significance of F is less than 20% on average, meaning that there is approximately a 20% probability that the regression output was obtained by chance. I am not too happy with this but the results are better than using average values for the risk model (in terms of minimizing SSE, the underlying principle in linear regression). I have identified some other key factors that perhaps account for the low R-squared values: time of day, residential or business area, response time of pipeline operators and emergency services, fire or explosion or simply a leak, and depth to groundwater. Some of these variables are unrealistic to account for due to incomplete entries in the PHMSA database, unavailability of data, and the sheer amount of time that it would take to analyze these variables. Perhaps if this was the topic of my masters research I could attempt to incorporate these variables in my regression equations but I just don't have the time. Next, I incorporated this data into my risk model and made the appropriate changes. I made the risk model interactive, so the user can choose to use an average release size or they could input different release sizes corresponding to whichever scenario they would like. I attached the updated risk model. Next, I ran the risk model on the Keystone XL pipeline route information from ArcGIS. The overall route risk was about 33% less than the overall route risk obtained from the model using average values. It should be noted that the coefficient for net barrels lost far outweighs the coefficient for population density and as a result, population density plays a very small role in the cost term. For some reason, I can't upload any pictures today so I will post below the maps of population density along the Keystone XL pipeline, risk along the pipeline, and a map of the pipeline incidents by release size. Xiang made some suggestions to my first two powerpoints I created and tomorrow I plan on incorporating these suggestions along with updating my data analysis powerpoint to include multivariate regression. I will also start working on my risk model powerpoint tomorrow. I got a lot done today, however I still have quite a bit to complete before my presentation at next week's safety group meeting.



Pipeline_risk_analysis_spreadsheet_multivariate_model.xlsx

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Pipeline_incidents_map_release_size.jpg

[Download File](#)



Keystone_xl_population_density_map_newest.jpg

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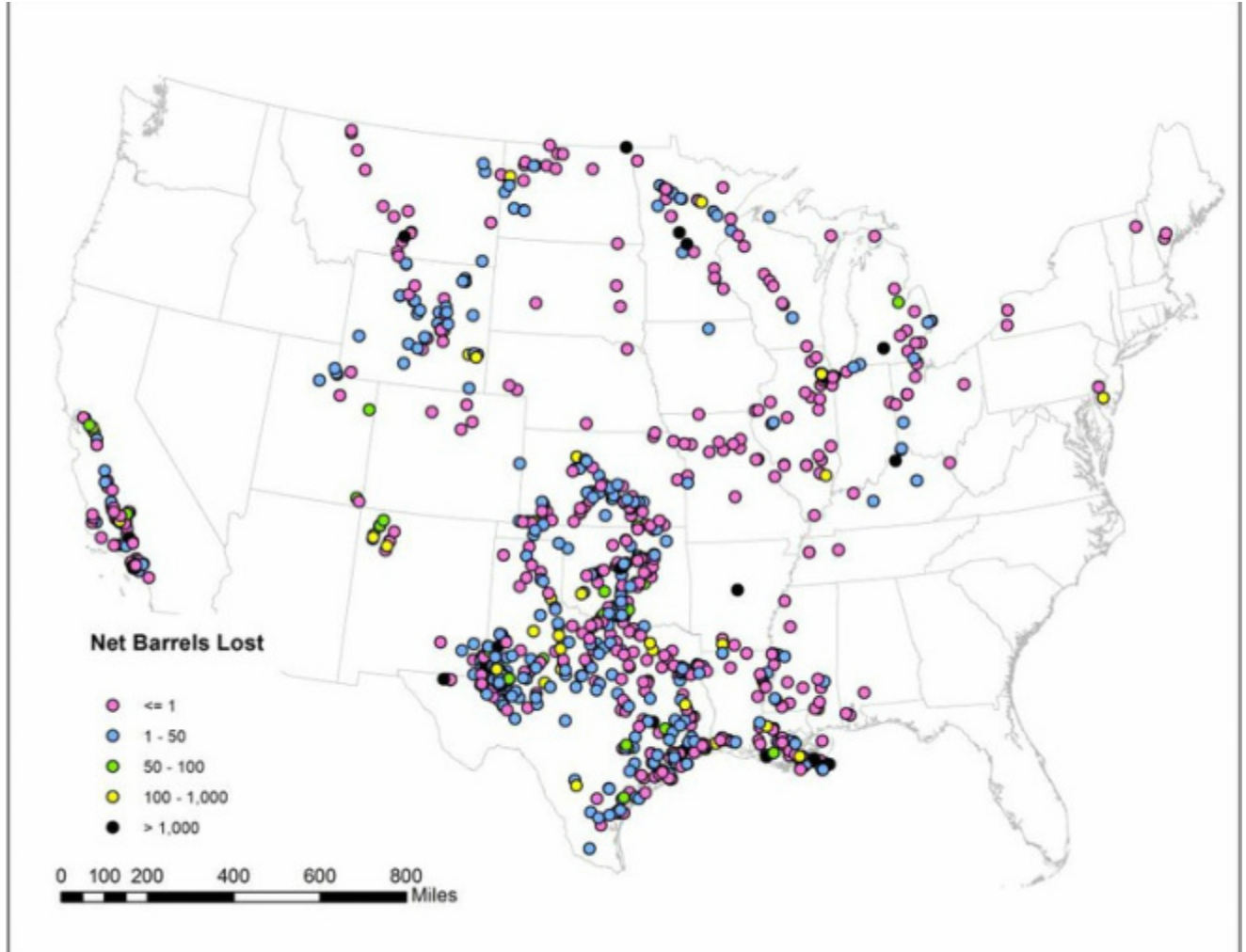


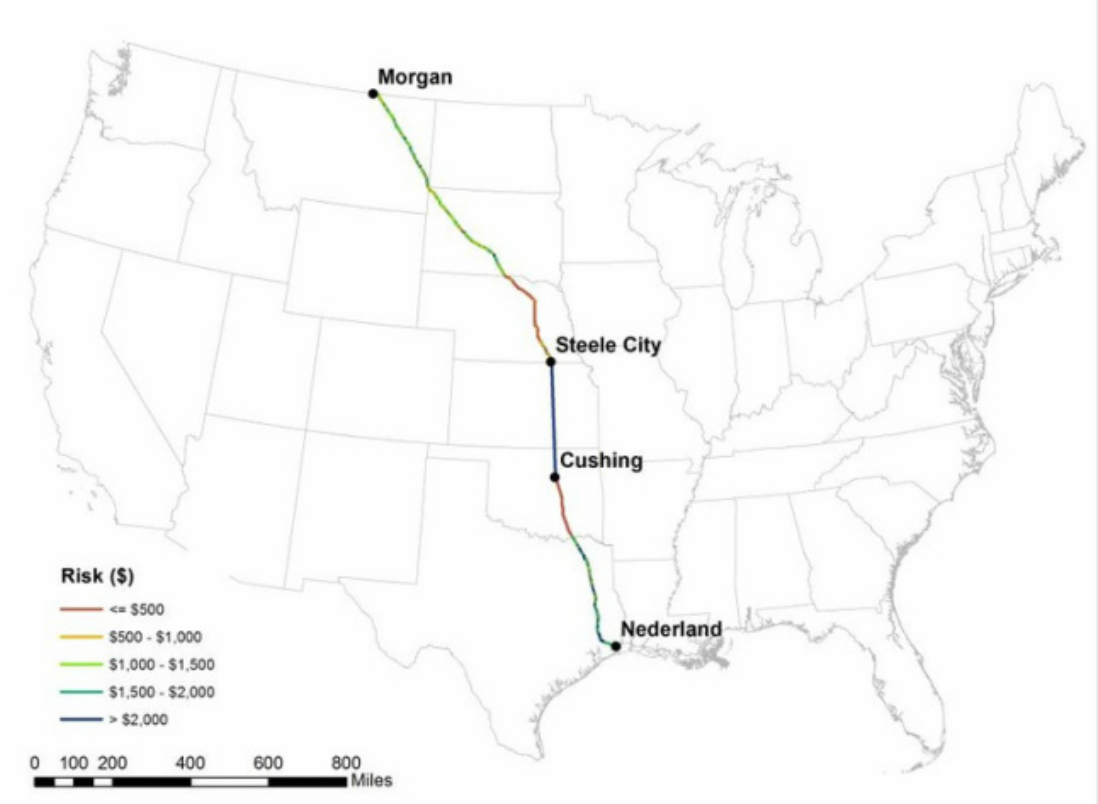
Keystone_xl_risk_map.jpg

[Download File](#)

7.10.13 continued

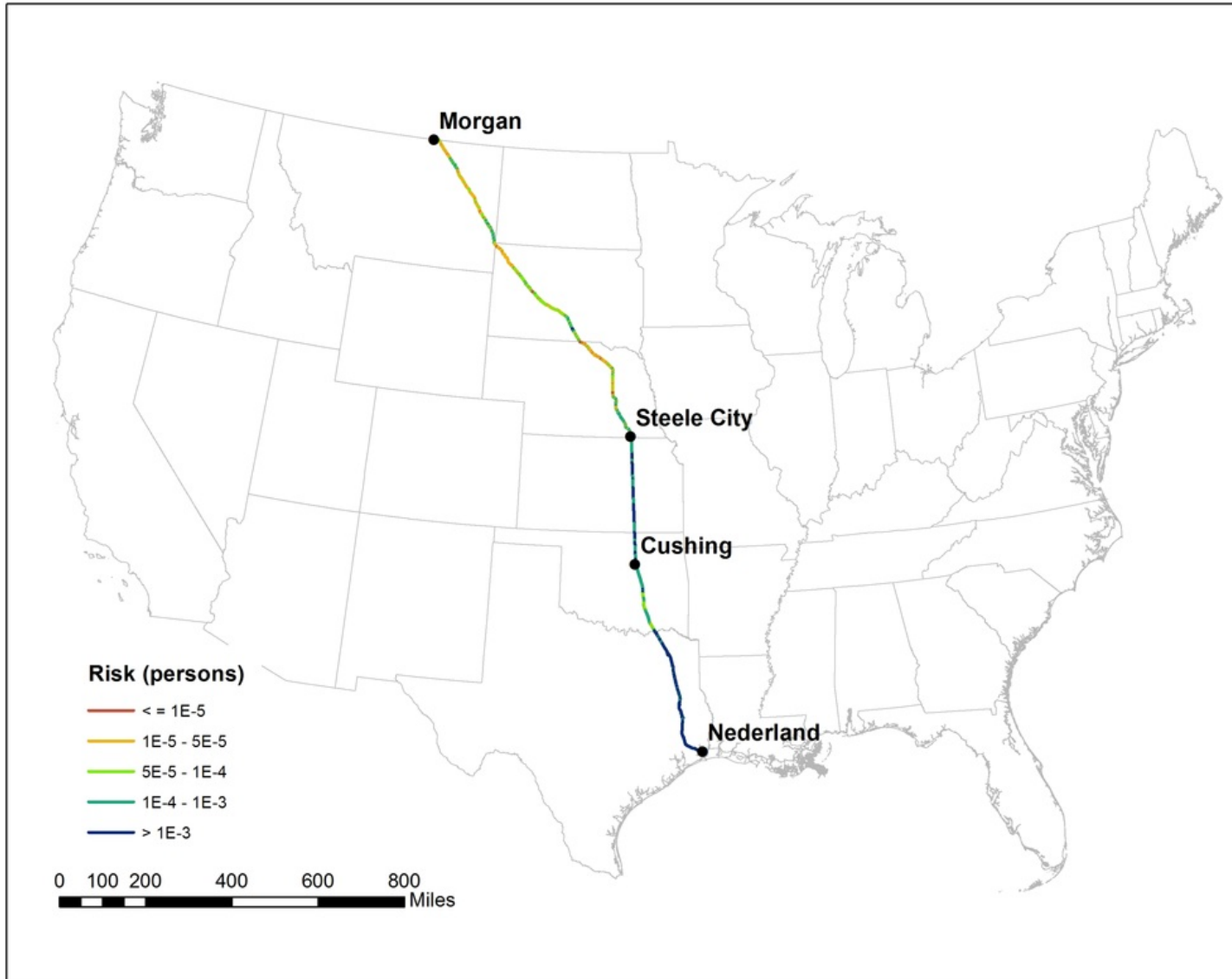
Below are the images I was trying to upload. The first is an image of the crude oil pipeline incidents I analyzed from the PHMSA database, the color of the dot represents the net barrels lost in the incident. The second image is the population density along the Keystone XL pipeline route. The third image is the results of my risk analysis case study on this route.





7.11.13

Laura presented her research on the conditional probability of release of tank cars this morning at the weekly safety group meeting. I spent some time this morning creating a rough outline of my five powerpoints I plan on creating (introduction to pipeline transportation, pipeline data analysis, pipeline risk model, case study: Keystone XL Pipeline, and previous research/significant accidents). I attached the outline below. Next, I created a brief document describing the role of each column in my risk model and its mathematical formulation. I attached this document below. I went back into my risk model and added a column for risk in terms of people affected since this is an easily comparable quantity to other modes of transportation; I attached the resulting map of risk in terms of persons affected per year. I also tweaked some other values, so I had to redo the Keystone XL Pipeline risk analysis. In order to compare the results from my risk analysis and manu's risk analysis I added a "persons affected per barrel" column into my model and created a map of this quantity in ArcGIS. Attached below is the newest and, hopefully, final risk model. I spent quite a bit of time revising my data analysis powerpoint (using Xiang's suggestions) and updating it with the regression analyses; this is attached below. At home, I did some more work. I updated my introduction to pipeline transportation powerpoint with new images, new statistics, and incorporating Xiang's suggestions. I have almost finalized this powerpoint, I still need to determine where in the powerpoint I want to place my slide on smart pigs or if I am going to get rid of the slide all together. I also started doing some further research into the Keystone XL Pipeline Project in preparation for preparing my case study slide. I found some great papers on the U.S. State Department's website about the project; one of the papers being an 80 page environmental risk assessment of the project. I started reading this paper and plan on continuing to read it tomorrow; so far it is validating a lot of steps/assumptions I have made so far, however it is also a much more in-depth analysis.



Powerpoint_module_outline.docx

[Download File](#)



Multivariate_regression_pipeline_risk_model_defense.docx

[Download File](#)



Pipeline_risk_analysis_spreadsheet_multivariate_model.xlsx

[Download File](#)



Pipeline_data_analysis_revised.ppt

[Download File](#)



Introduction_to_pipeline_risk_analysis_revised.ppt

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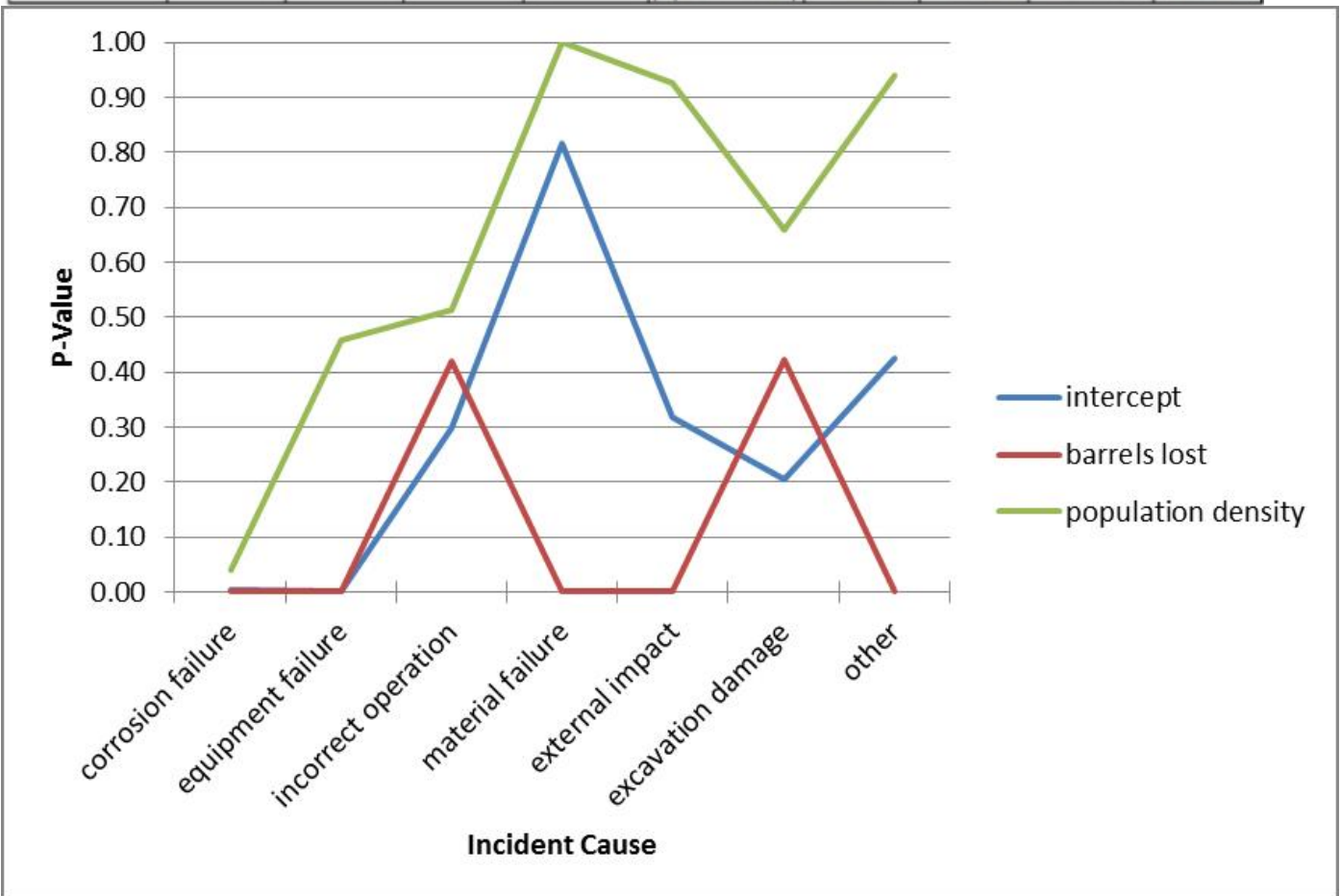
7.12.13

This morning, I worked on my risk model powerpoint. It is kind of difficult trying to describe my entire thought process and mathematics behind the model in short sentences and pictures. I spent all morning and early afternoon working on this powerpoint. In the afternoon, Xiang went through my data analysis powerpoint and gave me a bunch of formatting suggestions. I realized that I have to describe my regression analysis much better and I am going to take a much deeper look at my approach to this analysis method. Xiang and Jesus gave all of us some pointers and guidelines in terms of presenting charts, tables, and text. I started working on re-analyzing my regression techniques and trying to come up with the best methodology. This will extend past my time at the office and into tonight and this weekend. I spent many hours tonight working on completing the regression analyses, compiling the resulting statistics and coefficients, and working on some graphs to display the relevant values. The regression results have improved significantly; however, they still don't have much predicting power. I believe I am now finally done with data analysis (for the most part). I have attached below the spreadsheet with all the graphs, coefficients, and statistics. My goal for tomorrow is to incorporate these new regression results into my risk model and rerun the risk analysis of the Keystone XL Pipeline. If time permits, I will also continue to update/edit my data analysis powerpoint. The first image shown below is the table of results from the regression analyses. The second image below is a graph of the coefficient p-values for each incident cause (the lower the p-value, the smaller chance that the coefficient was obtained randomly).

To-Do List

- integrate new regression results into my risk model.
- make the suggested changes to my data analysis powerpoint.
- incorporate new regression techniques in data analysis powerpoint.
- review introduction powerpoint with the pointers from Xiang and Jesus in mind.
- continue working on risk model powerpoint.
- start working on case study powerpoint.
- continue with literature review, especially Keystone XL Pipeline Project documents.
- create tutorials on "xy data import" and "transforming Google Earth data to GIS data." (not as high priority)
- start compiling slides from introduction, data analysis, risk model, and case study powerpoints into one presentation for the safety meeting on Thursday.
- research the pipeline incident that occurred in Marshall, MI in 2010; to be used as one of my significant accident slides.

incident cause	P	R ²	significance F	sample size (n)	regressor variable	coefficient	p-value	lower 95%	upper 95%
corrosion failure	0.3472	0.0656	6.22E-09	561	intercept	86670.62	0.0048	26490.97	146850.27
					barrels lost	421.64	4.57E-09	282.60	560.69
					population density	47.24	0.0408	1.98	92.50
equipment failure	0.3243	0.1936	4.51E-25	524	intercept	39479.81	0.0002	19165.03	59794.58
					barrels lost	133.75	3.65E-26	110.25	157.25
					population density	-10.97	0.4585	-40.02	18.08
incorrect operation	0.0965	0.0068	0.5946	156	intercept	200526.05	0.2993	-179845.82	580897.92
					barrels lost	121.94	0.4182	-174.82	418.70
					population density	110.18	0.5139	-222.46	442.83
material failure	0.0848	0.2524	3.44E-09	137	intercept	-1280730.87	0.8157	-12128793.46	9567331.71
					barrels lost	10308.19	4.74E-10	7274.61	13341.77
					population density	5.34	0.9995	-16297.00	16307.69
external impact	0.0619	0.2365	2.07E-06	100	intercept	2803258.19	0.3176	-2734925.68	8341442.07
					barrels lost	4008.17	3.56E-07	2552.90	5463.44
					population density	-231.64	0.9258	-5154.62	4691.34
excavation damage	0.0446	0.0110	0.6822	72	intercept	491888.79	0.2037	-272781.15	1256558.73
					barrels lost	376.45	0.4212	-551.64	1304.54
					population density	-184.04	0.6594	-1013.46	645.37
other	0.0408	0.2381	0.0002	66	intercept	664002.63	0.4262	-992718.68	2320723.94
					barrels lost	1583.40	3.82E-05	869.31	2297.49
					population density	-53.06	0.9406	-1469.92	1363.79



Final_compiled_statistics.xlsx

[Download File](#)

7.13.13

This morning, I fixed my risk model to incorporate the new regression results. I also created two graphs; one showing cost risk vs. cumulative length and the other showing persons affected risk vs. cumulative length. Then, I used the Keystone XL Pipeline route information to run the risk model. I merged this data with ArcGIS as produced three maps: cost risk, persons affected risk, and persons affected per barrel risk. The route risk using this new model is less than the route risk of the previous model I had. Attached below is the new model spreadsheet.



Pipeline_risk_analysis_spreadsheet_multivariate_model_most_recent.xlsx

[Download File](#)

7.14.13

I spent a few hours today working on revisions to my introduction and data analysis powerpoints as well as completing my risk model powerpoint. My risk model presentation is a rather high level summary of the model that I spent almost a month developing. To truly go into it in depth and detailed like it deserves would be too long of a presentation as well as too much of math/probability theory; this I am saving for my paper. Therefore, I am not entirely happy with the justice I have done to my model but the case study powerpoint will highlight the results that the model produces. I spent a lot of time redoing graphs for my data analysis powerpoint as well as refining the multivariate linear regression slides. I am pretty happy with the new slides I added on regression, and I think the figures as well as what I have to say about them is an accurate representation of the contribution that regression had on my risk model. None of these powerpoints are final or error-proof but they are getting there. Tomorrow I plan on completing my case study presentation after doing a little more background research on the Keystone XL Pipeline. I also plan on compiling the four powerpoints into one presentation for the safety group meeting as well as adding a few slides to make this presentation self-sufficient. Hopefully completing this by tomorrow night will give Xiang some time to review my powerpoint and make some suggestions. Attached below are the most recent copies of the three powerpoints I have completed thus far.



Introduction_to_pipeline_risk_analysis_revised.ppt

[Download File](#)



Pipeline_data_analysis_revised.ppt

[Download File](#)



Pipeline_risk_model.ppt

[Download File](#)

7.15.13

I spent most of the day working on my case study powerpoint and then compiling my four powerpoints into one, for my presentation on Thursday. Manu, Eli, and I each went through our powerpoints and gave each other some suggestions. I have attached my case study and presentation powerpoints below, these are not final copies and they are pending review.



case_study_keystone_xl_pipeline.ppt

[Download File](#)



Safety_group_meeting_7.18.13.ppt

[Download File](#)

7.16.13

Today I shortened my presentation for Thursday since the amount of slides I previously had would most likely be too long of a presentation. I also wrote some speaking points in the notes of each slide. I formatted the references for all of my powerpoints and made them more formal than simply putting the url at the bottom of the slide. Matt Greve presented at the weekly RailTEC lunch meeting; his presentation was on rail seat pressure distributions and his field instrumentation and data from in situ testing. For the rest of the day, I read some articles that I have been piling up. My goal by the end of Friday is to have read most of, if not all, the papers I have waiting in my folder. The plan for next week will be to incorporate any suggestions/comments/criticism from my presentation this Thursday into my research and then to start writing a paper detailing my entire research project. I will also be working on my literature review/significant crude oil pipeline incidents powerpoint. This will most likely be my last powerpoint that I need to create (perhaps a risk mitigation one if I have time).

7.17.13

I spent the whole day reading articles and summarizing them in my document with summaries from all the articles I have read so far. I also spent a good amount of time going through Athaphon Kawprasert's PhD dissertation. Two chapters of his dissertation discuss risk modeling and I have found these extremely helpful and thought provoking. This has provided me with thoughts on how to possibly improve my risk model and data analysis techniques. I made a good amount of progress today on reading articles I had found (including more that I found this morning). I have about 9 more articles to read through and summarize before I can start writing my literature review. I should be able to finish this by end of day Friday and start writing my paper this weekend. I will spend some time tonight preparing and practicing for my presentation tomorrow morning.

7.18.13

This morning I presented my research on crude oil pipeline transportation risk analysis at the weekly safety meeting. I received a lot of helpful feedback and we had some thought provoking discussion, particularly in the area of how I defined segment and route risk. This is going to require a lot of thought as to how I formulate these equations and will also require me to explore all the implications and assumptions associated with each formula. Between comments from my peers and Dr. Saat, as well as techniques I have read about in journal articles, I have come across a few different methods of data structuring and analysis that I feel would be worthy to look into. My plan is to continue this pipeline research next semester as well, during Dr. Saat's transportation safety and risk class. After the meeting, I spent some time talking with Xiang about these two formulations of risk and we gained some valuable insight from thinking hard about the assumptions behind both; we are still unsure as to which one is the "correct" approach. Jesus found a tool in ArcGIS that will allow me to split up my route into segments of almost equal length. This was a problem I was having previously, it was drastically increasing the time it took to complete this portion of the analysis as well as possibly introducing error into my risk model. I spent the afternoon working in ArcGIS to re-analyze the route as well as searching for and reading more articles online. At night, I started creating an outline for my paper that I plan on writing to present my research methodology and results. My plan for tomorrow is to continue working with ArcGIS, update my risk model, re-perform the route analysis of the Keystone XL pipeline, and continue reading more articles (particularly ones involving probabilistic formulations of route/segment risk).

7.19.13

I spent the day reading articles as well as starting to write my paper. I wrote the data analysis chapter today, it is attached below. This is not a final version.

7.22.13

I spent the morning and early afternoon working on the risk model chapter of my paper. I have attached this below, it is not a final version. For the remainder of the afternoon I worked on the case study chapter of my paper. I have been doing a good job of keeping track of my references and chose to reference by name and year, this will make it much easier once I combine all the chapters into one final paper.

7.23.13

I spent a good portion of the morning finishing the rough draft of my case study paper; I have attached it below. As I have been writing my paper, I have been thinking of tidbits of information or clarifications that I have forgotten to include in my paper so far. I have been writing these down as I think of them and once I finish all chapters in my paper, I will return and incorporate these changes. Today at the weekly RailTEC lunch meeting, Brent presented his research on the measurement of lateral forces on the concrete crosstie fastener system. His research was quite interesting, especially the field instrumentation that was custom made. For the remainder of the day, I read journal articles. My plan for tomorrow is to create an outline of my literature review chapter and start writing that chapter as well as the introduction chapter. By the end of Friday, I would like to have those two chapters written as well as the CEE REU paper. I will most likely base my executive summary off of the CEE REU paper since that will be a summary of my research.

7.24.13

Today I wrote the introduction and literature review chapters. This took all day since I went back and reread some of the key points of each article that I read previously in order to make sure I did a thorough literature review. I have attached these chapters below, note that they are rough drafts. My plan for tomorrow is to write the executive summary, create a title page, create a table of contents, and put all the references in alphabetical order. I would also like to start on my REU paper, which shouldn't be too hard or take too long since it will essentially be a summary of the paper I am currently writing. Friday will probably be spent finishing the REU paper and proofreading both papers.



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7.25.13

Today I finished the paper I have been working on for the past few days, however I have not had a chance to proofread it yet. I also started writing my paper for the CEE department and will finish this by tomorrow afternoon. Today's weekly safety group meeting was quite lengthy since Eli, Manu, and Hannah each presented their research. It was nice to see the results of their summer's research work. By the end of day tomorrow, I hope to have finished my second paper and proofread both papers.

7.26.13

Today I completed my REU paper and proofread it. Dr. Saat review it and we now have a final version of the paper (attached below).



cee-reu-research-summary_jeff_lahucik.pdf

[Download File](#)

7.29.13

I spent the morning finalizing my research paper and then proofreading it. This will continue to be a work in progress as this research progresses into next semester for Dr. Saat's transportation risk class. In the afternoon, I worked on organizing my files and uploading them to the shared folder so they can be accessed by graduate students in RailTEC in the future. I started editing my powerpoint presentations to accommodate the changes I have made over the previous week or two. I will continue to edit these presentations tomorrow.

7.30.13

This morning I finished editing my powerpoint modules and uploaded them to the RailTEC server. Today, at the weekly RailTEC lunch meeting, Chen Yu presented his work on passenger train accidents and shared rail corridor. For the remainder of the day, I worked on a joint paper between Manu and myself comparing the risk of transporting crude oil via pipeline and rail. So far, I have written the risk formulation chapter which presents the risk models and elaborates on the individual variables in the models for both modes of transportation. I also wrote a few paragraphs on "an introduction to crude oil transportation by

pipeline" as well as "an introduction to the Keystone pipeline route." It is our hope to finish this paper tomorrow in order to provide a quick comparison between the two modes of transportation.

7.31.13

Today was the last day of the research program, so to celebrate the entire RailTEC team went out for lunch. We spent the day working on a last minute project.



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UIUC NURail Research: Manuel Martin Blog Archives

June 2013 – July 2013

Manuel Martin's Internship Daily Blog

Daily blog of my internship at the REU Summer Program in Multimodal Freight Transportation Risk

Bienvenido a este Blog!
Welcome to this Blog!

As a participant of the REU Summer Program in Multimodal Freight Transportation Risk under Dr. Rapik Saat I will use this blog to record and analyze my daily learning journey throughout the mentioned program. Therefore, every day I will post a brief overview of that day undertaken tasks and a list of objectives for the following day.

Please feel free to share your comments, constructive critiques will be very well received and appreciated, and/or email me if you have any questions or just want to talk about any of the topics here mentioned.

Saludos and have a great day :)

Manuel Martin

Day 1: June 3, 2013

Today, the internship finally started. We had a kick-off meeting at 8:00 AM. After meeting the rest of the undergraduate interns and the graduate mentors, professor Rapik explained us clearly what are the expectations, objectives and methodologies of the program. I am going to be working with Chen-Yu (grad student) and, among other things, I will perform a railroad transportation risk study. Later we were told that during the next two weeks we are going to undertake a quantitative risk analysis for a company in order to assess for each given route the risk associated with the transportation of a hazardous material by railroad. This is very exciting as the company will decide which route is most suitable based partly on the results of this study. After a short presentation about a similar analysis performed in other routes by some of the grad students, we were shown to what will be our office for the next two months.

Jesus and Xiang gave us a two-hour GIS basic tutorial. After that I started to work on my own, first going over everything they explained us one more time, and then doing online GIS tutorials mainly focusing on the Network Analyst tool. One of the exercise that I carried out was the calculation of the route that would minimize the time necessary to go through points 1 to 14 (not necessarily in order) as it is shown in Fig1. This task was accomplished using the roadway system of a city including length and allowed velocity for each street. These different examples have allowed me to remember some concepts and GIS tools that I had forgotten.

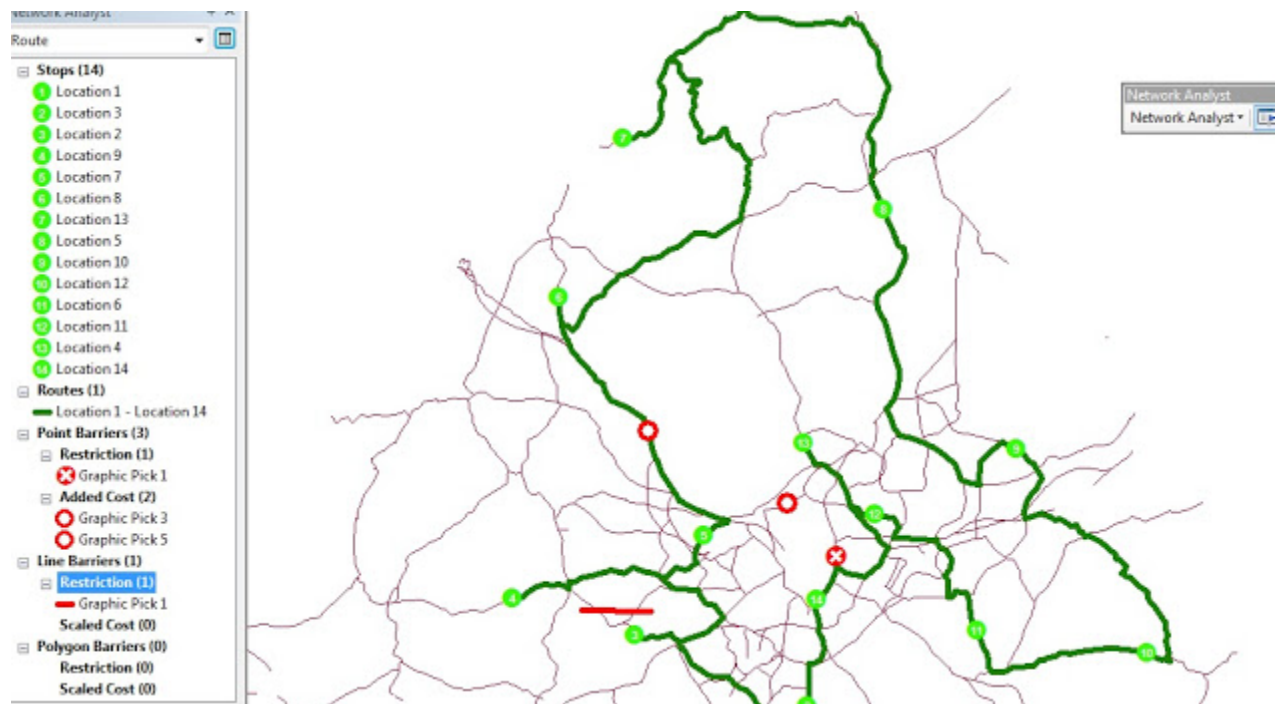


Fig1: Route optimization using ArcMAP's tool Network Analyst.

Tomorrow:

- Jesus and Xiang GIS tutorial II
- Go over the tutorial II
- Remind some other useful GIS tools: Merge, Buffer, Intersect
- Understand all the steps of their qualitative risk analysis

Day 2: June 4, 2013

We started the morning working with Jesus. He continued with the GIS tutorial and today he managed to share his input files so that we could easily follow the same ArcMap steps in our own laptops. Then he gave each of us several routes to work on. At the beginning the work was going pretty slow as I was still getting used to most of the commands and GIS tools. At 12:00 we had a meeting with the rest of students and professors from RailTEC. Xiang, who is defending his thesis this coming Friday, presented a ppt about the relation between the frequency of rail inspection and the risk of derailment (risk of hazardous material leakage). Among other very good points, it was commented that a cost effective analysis must be undertaken as even if the rail line is inspected daily there will always be a risk (best case it would be very small) associated with transportation. Also it is important to consider the effect of weather (cold/warm) in all of this analysis.

For the rest of the day I worked in the quantitative risk analysis of the first route that I was assigned. Using ArcMap I determined for each segment of the route the population that would be affected in case of a leakage event assuming a 0.5 mile radius of impact. The following figure (FIG2) shows the final result where the route is colored according to the amount of people affected (green being the lowest and red the highest).

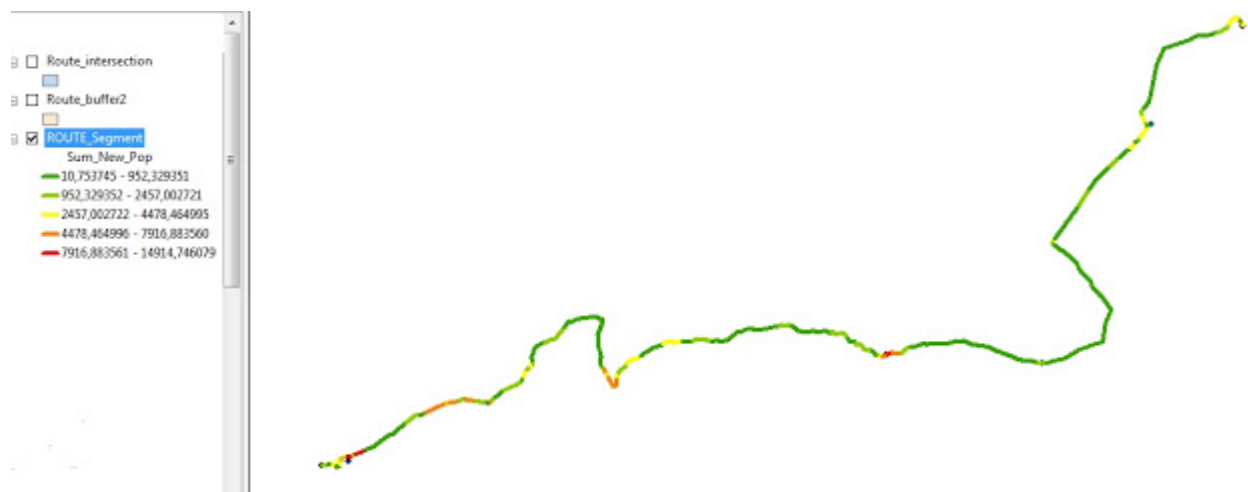


FIG2: Amount of people living within a 0.5 mile radius from the rail line.

Today:

- Jesus and Xiang GIS tutorial II (Done)
- Go over the tutorial II (Done)
- Remind some other useful GIS tools: Merge, Buffer, Intersect (Done)
- Understand all the steps of their qualitative risk analysis (Done)
- *-Weekly RailTEC meeting (Done)

Tomorrow:

- Work on the other 5 routes
- Keep working to improve skills with ArcMap

Day 3: June 5, 2013

Today we kept working on the rest of the routes (2, 3, 4, 5 and 6). Basically we followed the same procedure that was undertaken yesterday for route number 1. We continue working with ArcMap and I should state that I worked much faster today, as I was already very comfortable with the software. In the afternoon, Jesus showed us very clearly how to do the following steps of the quantitative analysis, mostly using Excel and Matlab.

In addition, Eli and I start to compare the results that we obtained in the past days and to our surprise we found out that although they were pretty similar (that was somehow relieving), they were not the same (differences of 0.001%). So tomorrow we will try to find the source of the error.

On the overall, it was a very productive day!!

Saludos

Today:

- Work on the other 5 routes (To be finished)
- Keep working to improve skills with ArcMap (Done)
- *-Excel and Matlab tutorial de Jesus (Done)

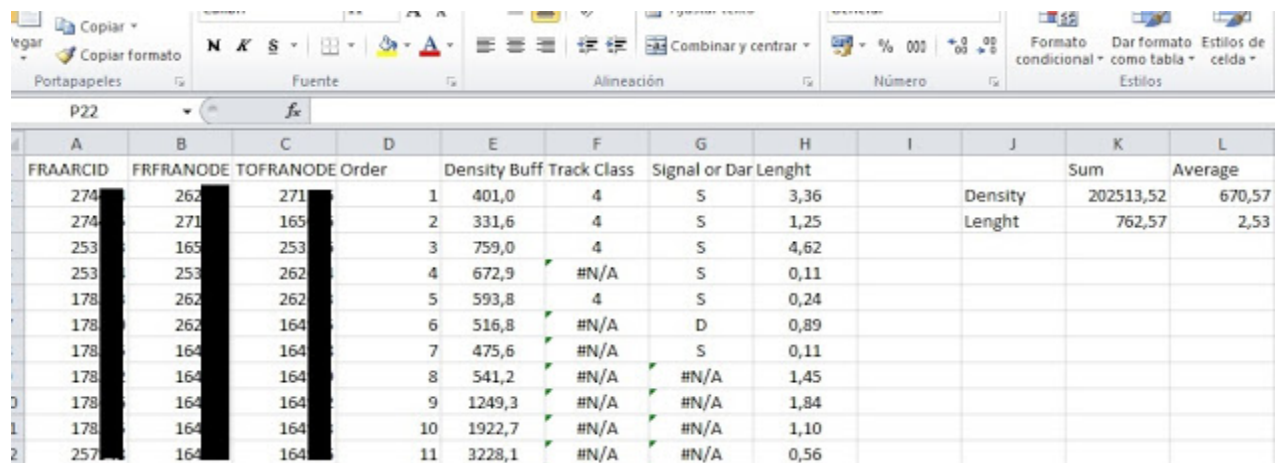
Tomorrow:

- Work on the other 5 routes
- Try to understand why Eli and I are getting different results
- Finish the ArcMap part of the routes
- Work on the Excel and matlab part of the routes
 - o run the matlab code
 - o calculation of the different parameters

Day 4: June 6, 2013

I spent the most of the time in the morning finishing up and double-checking the ArcMap files. In the afternoon, I started to work on the calculation files. For every route I ran the matlab code (that Jesus provided us) changing the initial parameters when it was required. After that, I modified and updated the excel files and collected all the resulting data. FIG3 partially shows the Excel spreadsheet that contains the data from one of the routes.

I really like the environment in the office. We are continually working side by side, helping each other's to solve any issues that may arise.



FRAARCID	FRFRANODE	TOFRANODE	Order	Density	Buff	Track	Class	Signal or Dar	Lenght	Sum	Average	
274	262	271	1	401,0		4		S	3,36	Density	202513,52	670,57
274	271	165	2	331,6		4		S	1,25	Lenght	762,57	2,53
253	165	253	3	759,0		4		S	4,62			
253	253	262	4	672,9		#N/A		S	0,11			
178	262	262	5	593,8		4		S	0,24			
178	262	164	6	516,8		#N/A		D	0,89			
178	164	164	7	475,6		#N/A		S	0,11			
178	164	164	8	541,2		#N/A		#N/A	1,45			
178	164	164	9	1249,3		#N/A		#N/A	1,84			
178	164	164	10	1922,7		#N/A		#N/A	1,10			
257	164	164	11	3228,1		#N/A		#N/A	0,56			

FIG3: Excel spreadsheet with the data from one of the routes.

Today:

- Work on the other 5 routes (done)
- Try to understand why Eli and I are getting different results (to be finished)
- Finish the ArcMap part of the routes (done)
- Work on the Excel and matlab part of the routes
 - o run the matlab code (done)
 - o calculation of the different parameters (done)
- *Safety group meeting (Chen-Yu presentation) (done)

Next day:

- Try to understand why Eli and I are getting different results
 - o assess if the errors are significant
- Get all the files to the server and ready for Jesus
- Xiang tutorial about risk model
- Xiang's thesis defense

Day 5: June 7, 2013

The day started with Xiang's thesis defense. I am very glad I got the opportunity to attend such an event. He did a great presentation. After that, we went back to the office and continued working on the routes. I prepared all the files for Jesus and then I finished the Excel calculations. Later, Eli and I went over the entire ArcMap process trying to find the source of the differences in the results. We found out that in one of the route this difference was caused by the fact that in some parts our lines were not exactly the same. So we fixed that and recalculated the data.

For the rest of the routes, the obtained results were pretty much the same, errors of 0.001%, which are probably rounding errors. In the afternoon, Xiang gave us a brief tutorial of the justification, background and methodology of the risk model used for this project. I will calculate the necessary data to apply this model on Monday. For today I think this is enough. Now is time to celebrate Xiang's work.

Today:

- Try to understand why Eli and I are getting different results (done)
 - assess if the errors are significant (done)
- Get all the files to the server and ready for Jesus (done)
- Xiang tutorial about risk model (done)
- Xiang's thesis defense (done)

Next day:

- Understand the risk model developed by Xiang and Jesus
- Perform the calculations necessary for the model

Day 6: June 10, 2013

Today is Monday, a brand new week starts! I spent most of the morning working on the quantitative risk model of the project. After calculating all the necessary parameters and values for the 6 routes, Jesus and I talked about the minor differences that Eli and I were still getting on the results of 3 of the routes. We found out that all calculations were fine but those 3 routes were not identical. My route had some "extra" segments so that the train would run through one of the indicated city. However, we both agreed that, on reality, the optimized train route would not pass through that city. Hence those extra segments were eliminated.

Taken into account this modification, I updated all the calculations. In addition all the necessary values of the quantitative risk model were determined. Tomorrow, after Xiang's tutorial, I will start preparing the final project presentation. In the afternoon I had some time to read some very interesting articles (they are listed below).

Today:

- Understand the risk model developed by Xiang and Jesus (done)

- Perform the calculations necessary for the model (done)
- *-Read some articles regarding railroad history and improvements (done)
 - Rail innovation down the track
 - Track classification
 - California high speed project Overview

Next day:

- Tutorial by Xiang on professional ppt and how to present the results
- Prepare the final risk analysis presentation
- RailTEC weekly meeting

Day 7: June 11, 2013

I spent most of the day working on the final project presentation. At 12:00 pm we had the RailTEC weekly meeting, where Francesco gave a presentation on the flying ballast risk assessment. He explained some of the most important causes of this phenomenon. Later, he explained some of the research that it is currently being done around the world in this area and listed some possible mitigation measures. I thought it was a very interesting topic. I really enjoy these meetings as they are a GREAT way to learn more about a wide variety of topics.

On the afternoon, Xiang and Jesus briefly talked about the important factors to consider when preparing a professional presentation. I have to say that they both are really helpful, as they are always willing to answer any of our questions. After this "mini" tutorial Eli and I worked on the final presentation. We will probably have it finished by Thursday.

Today:

- Tutorial by Xiang on professional ppt and how to present the results (done)
- Prepare the final risk analysis presentation (To be finished)
- RailTEC weekly meeting, Francesco's presentation (done)

Next day:

- Work on the final risk analysis presentation
 - o Prepare the final GIS maps
 - o Prepare the final graphs and tables

Day 8: June 12, 2013

Eli and I spent the morning working on the final GIS maps. As expected the first map took us a significant amount of time as there were some options and settings of ArcMap that needed to be determined. However, once that we had finished this one, we quickly prepared the rest of them. In the afternoon, we worked on the excel tables and graphs. I should mention that we based the presentation design in the template that Xiang provided us.

By the end of the day, we managed to put all the slides together and merge them with Jeff and Hanna's ones. Fig4 shows a comparison of the risk per car-shipment in the eleven analyzed routes.

We all agreed that tomorrow we will set up the projector and closely review the entire presentation to have the final file ready by Friday morning.

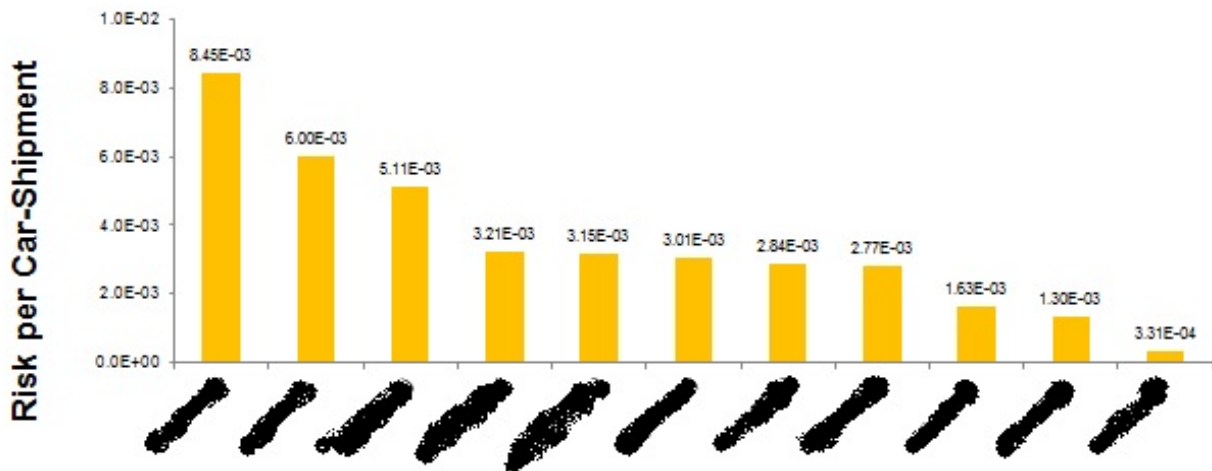


Fig4: Risk per car-shipment for each route.

Today:

- Work on the final risk analysis presentation
 - o Prepare the final GIS maps (done)
 - o Prepare the final graphs and tables (done)

Next day:

- Look at the final presentation
- Read some articles to start deciding about my research topic
- Safety group meeting (Project presentation)

Day 9: June 13, 2013

Today it was a very productive day. The group started the morning looking at the presentation. We corrected some typos and some small design mistakes. Later Xiang explained us in detail the plan for the coming weeks. I will review literature focusing on Railroad Hamzat Transportation. He also provided us with many advises on how to look for paper and articles. In addition, he mentioned some important journals for us to take a look at.

After that, we had the safety group meeting, where we presented the project. It was very constructive, as we received plenty of important feedback, and ideas. I spent the rest of the day editing the presentation in order to include those comments and also to improve its consistency and final design.

Today:

- Look at the final presentation (done)
- Read some articles to start deciding about my research topic (no time)
- Safety group meeting (Project presentation) (done)
- *Work on the consistency and design of the final presentation (done)

Next day:

- Read some articles to start deciding about my specific research topic
- Literature review on Railroad Hazmat Transportation

Day 10: June 14, 2013

Following Xiang's advice, the first document that I started looking at this morning was Athaphon Kawprasert's dissertation (2011-01-14): "Quantitative analysis of options to reduce risk of hazardous materials transportation by railroad". I read about 1/3 of the thesis and it is very remarkable and explanatory. After the presentation, Kawprasert does a review of the literature regarding railroad hazardous materials analyses. This provided me with a good amount of articles to read in the future. Then he introduces the concept of route rationalization and how risk could be reduced by rationalization of hazardous materials transportation route structure. FIG5 shows the rationalized route given a set of cities and quantities that need to be transported between them. Although this example is very explanatory, as he states, the practical application of this method may not be feasible, given the size and complexity of the railroad system.

Later he describes the effects of train speed on hazardous materials transportation risk analysis. I did not get to the conclusion and discussion of this topic yet, so I'm looking forward to continue reading on Monday.

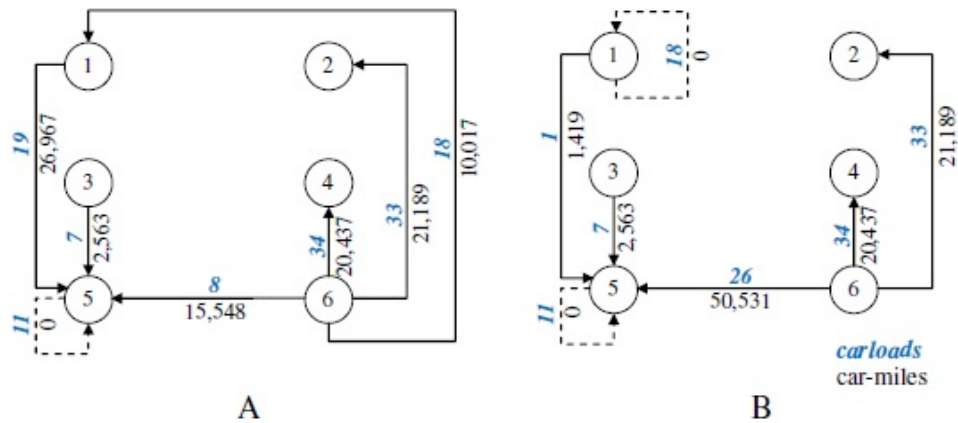


Figure 3.10: Schematic Diagram of Traffic Flow When (A) Release Rate is Minimized and (B) Risk is Minimized



Minimizing the release rate reduced car-miles by 32.0% and risk by 16.3%, whereas the minimization of risk reduced car-miles by 17.8% and risk by 17.8%. In this study, a single car design was assumed, so that the flow with the derailment rate minimized is the same as the flow with the release rate minimized. The chosen route used on different routes, then these two flows will depend on the conditions and characteristics of the different alternatives. However, the values of the metric associated with each of the optimal flows did not differ by much.

FIG5: Example of the application of the rationalization method.

Today:

- Read Athaphon Kawprasert's dissertation (To be finished)
- Read some articles to start deciding about my specific research topic (To be finished)
- Literature review on Railroad Hazmat Transportation (To be finished)

Next day:

- Continue reading Athaphon Kawprasert's dissertation
- Read some articles to start deciding about my specific research topic
- Literature review on Railroad Hazmat Transportation

Day 11: June 17, 2013

Although my plan for the day was to keep reading Kawprasert's dissertation, when I got to the office in the morning, Jesus told me that the presentation needed to be rearranged. Instead of dividing the ppt in 2 parts it was decided to do it in 3 parts, so that the final results were clearer to the customer. It was necessary to do some new maps, so Jeff and I worked on that. Later we both organized to change the rest of the presentation (graphs and tables).

At 2:00 pm we all decided to attend the SNCF Concrete Tie Research presentation by Philippe Pouligny (Head of Track Engineering Division). It was very interesting to learn what the challenges are that SNCF is facing especially on the HSR, where trains go as fast as 350 Km/h. Moreover, Philippe also discussed the main topics that are currently being researched and why they are focusing on them. (Different types of fastening systems, hollow concrete ties...)

At the end of the day we presented the final risk analysis ppt, which summarizes our work for the past two weeks, to professors Saat and Barkan. There was a good discussion regarding the more surprising presented values and we received some very much appreciated comments. Tomorrow I will work on incorporating those suggested changes.

Today:

- Continue reading Athaphon Kawprasert's dissertation (no time)
- Read some articles to start deciding about my specific research topic (to be finished)
- Literature review on Railroad Hazmat Transportation (to be finished)
- *-Work on the final presentation (change format and add 3 parts)
- *-Presentation of the the risk analysis project to professor Saat and Barkan
- *-Attend the SNCF Concrete Tie Research presentation by Philippe Pouligny (Head of Track Engineering Division)

Next day:

- Work on the changes of the risk analysis presentation
- Continue reading Athaphon Kawprasert's dissertation
- Read some articles to start deciding about my specific research topic
- Literature review on Railroad Hazmat Transportation
- Attend the weekly RailTEC meeting (Hay Seminar Presentation)

Day 12: June 18, 2013

I started the day editing the presentation and incorporating the changes that were discussed yesterday (new maps, change colors, a reorganize graphs). After that I went to the Hay Seminar presentation. Gilles Saussine (Group Head of Soil Mechanics and Infrastructure at SNCF) gave a presentation on "Ballast Flying and Projection Phenomena: Issues and Challenges". I really enjoyed it, especially when he talked about how they faced the different challenges. Moreover, I found very interesting that they are already planning on change the operation speed of some segments of the high speed lines, based on their modelling results.

After the presentation, Jesus explained us how to look for certain information in the timetables and how to use them to double check the RCRMS data.

Today:

- Work on the changes of the risk analysis presentation (done)
- Continue reading Athaphon Kawprasert's dissertation (no time)
- Read some articles to start deciding about my specific research topic (to be finished)
- Literature review on Railroad Hazmat Transportation (to be finished)
- Attend the weekly RailTEC meeting (Hay Seminar Presentation) (done)

Next day:

- Continue reading Athaphon Kawprasert's dissertation
- Read some articles to start deciding about my specific research topic
- Literature review on Railroad Hazmat Transportation

Day 13: June 19, 2013

Today, I spent most of the day reading Kawprasert's dissertation. First, I finished chapter 4 where he talks about the effect of train speed on hazmat transportation route risk analysis. I found it very thought-provoking as in the project we didn't consider the effects that the speed of the derailment could cause. It is stated that "The higher the speed of a derailment, the more cars are likely to derail, and of these the higher the probability that one or more will suffer a release (Barkan et al., 2003)." In addition, in this chapter the author discussed the use of speed-dependent CPR (conditional probability of release) and finally, applies all of these concepts in a case study.

Later I read chapter 5, where he discusses different options for route infrastructure improvement in order to reduce the risk associate with the transportation of hazmat in that infrastructure. I really like this chapter because as much as companies are willing to undertake risk mitigation measures, they still need to optimize their benefits. Therefore, providing cost-efficient risk mitigation measures is crucial.

Today:

- Continue reading Athaphon Kawprasert's dissertation (to be finished)
- Read some articles to start deciding about my specific research topic (to be finished)
- Literature review on Railroad Hazmat Transportation (to be finished)

Next day:

- Finish reading Athaphon Kawprasert's dissertation
- Start reading Xiang's dissertation

Day 14: June 20, 2013

I spent most of the morning reading Kawprasert's dissertation. The following couple of paragraphs briefly summarize the content of two chapters of Kawprasert's document.

In chapter 8, the author discusses about the issues that need to be addressed when using route risk as a parameter to compare different routes. He also describes several potential techniques that can be useful in this regard. In addition, he introduces some statistical methods that can allow risk managers to quantitatively distinguish among risk alternatives when, for some reason, the risk analysis could not be completed for the entire route or network.

In chapter 9, Kawprasert develops and shows several new techniques to present and communicate risk results more effectively. Based on the result from a quantitative risk analysis, he discusses how to illustrate the major factors affecting risk depending on the context and the questions of interest of the users

On the afternoon, Xiang asked me to help him with his current research. He needs me to gather and present some information he requires for his broken rail frequency analysis. I think this is a good opportunity to learn how to work with different railroad databases as well as to understand some factors that affect the behavior of this phenomenon. After Xiang described me precisely his concerns and interests on the topic, Chen-Yu explained me in detail how to work with the FRA database. His "tutorial" was very helpful. Tomorrow, I plan on working in this as well as continue with the literature review.

Today:

- Finish reading Athaphon Kawprasert's dissertation (done)
- Literature review on Railroad Hazmat Transportation (to be finished)
- *-Gather and edit information Xiang requires for his research (to be finished)

Next day:

- Literature review on Railroad Hazmat Transportation
- Gather and edit information Xiang requires for his research

Day 15: June 21, 2013

This morning, I continued with the literature review. I wanted to get a better understanding on how the speed of the train affects the overall risk so I started the day off by reading Barkan, C. P. L., Dick, C. T. & Anderson, R., 2003. Railroad Derailment Factors Affecting Hazardous Materials Transportation Risk, Washington, D.C.: Transportation Research Record: 1825. Paper No. 03-4429. In this article, the FRA accident data for the period 1992-2001 is analyzed to determine and understand first what are the most frequent and severe accidents and second what are the factors affecting hazardous materials transportation risk. One of the most significant conclusions is that the speed and number of cars derailed significantly relate to hazardous materials release probability.

Later, I read Saat, M. R. & Barkan, C. P., 2005. Release Risk and Optimization of Railroad Tank Car Safety Design, Washington, D.C.: Transportation Research Record: Journal of the Transportation Research Board, No. 1916: 78-87. In this study a new metric for quantifying hazardous materials releases is developed and applied to evaluate tank car thickness and safety. It is determined that the rate of release and thus the quantity of release depend on the size of the puncture, the tank's internal pressure, and the viscosity of the commodity. At the end of the document, the trade-off between reduced release probability and increased accident exposure with increased tank thickness is discussed and an optimization of this trade-off is presented.

After lunch I talked to Xiang as I have some questions regarding the procedure and methodology he wanted me to follow to do the analysis he assigned me. I worked on it for the rest of the day and I plan to finish it by Monday.

Today:

- Literature review on Railroad Hazmat Transportation (to be finished)
- Gather and edit information Xiang requires for his research (to be finished)

Next day:

- Understand the reasons for the rise of crude oil transportation by rail
- Find key origins and destinations of this transportation.
- Gather and edit information Xiang requires for his research
- Literature review on Railroad Hazmat Transportation

Day 16: June 24, 2013

Today, I worked on the task that Xiang assigned me. After finishing the excel file with all the data and calculations that he required, I prepared some graphs to facilitate the understanding of the results. Then we both discussed them and we agreed that they were reasonable. He may perform a further analysis but for now he doesn't need my help any more.

On the afternoon, I started to research about transportation of crude oil by rail. This topic is of special interest as crude oil has just become the most transported hazardous material by rail (measure in ton mile). I'm still trying to understand the reasons behind this growth. However, I found that one of them it is the enormous increase in crude oil production in North Dakota. This increasing amount of crude oil cannot be transported exclusively by pipelines, which are at their maximum capacity, so it is being transported by rail. FIG6 shows the estimated crude oil exported from North Dakota by rail. As it can be observed its growth has been incredible. Tomorrow, I will continue analyzing this phenomenon and I will try to determine the most important pairs of origin-destination of crude oil transportation.

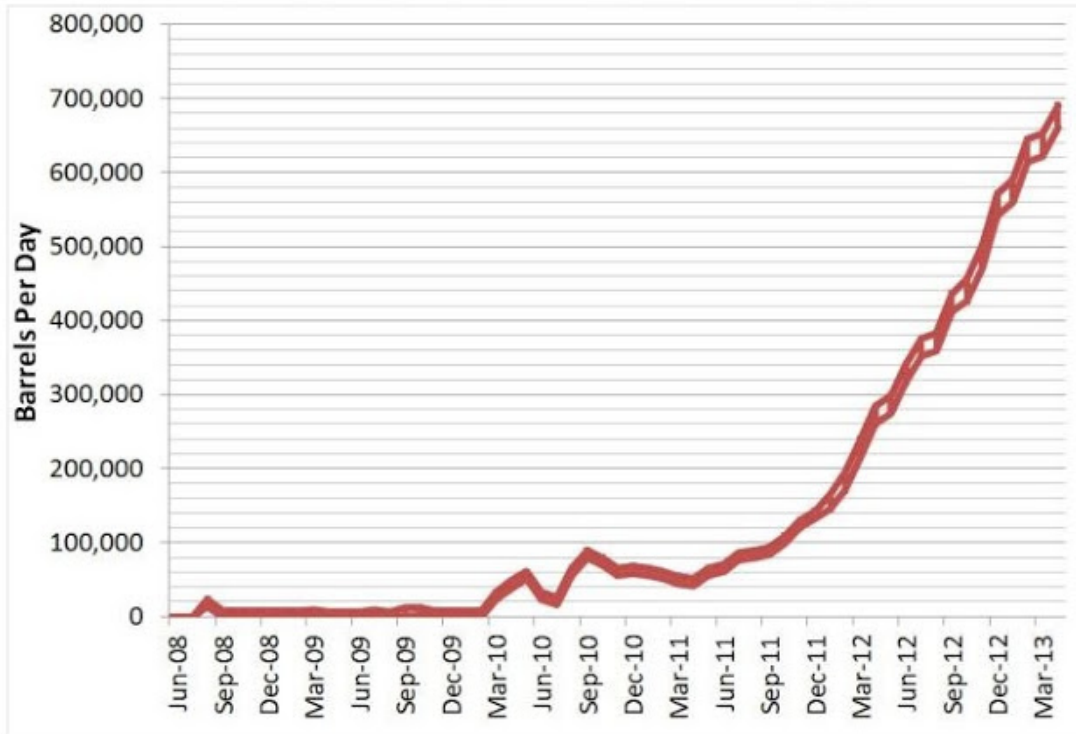


FIG6: Estimated North Dakota Rail Export Volumes.

Today:

- Understand the reasons for the rise of crude oil transportation by rail (to be finished)
- Find key origins and destinations of this transportation (to be finished)
- Gather and edit information Xiang requires for his research (done)
- Literature review on Railroad Hazmat Transportation (to be finished)

Next day:

- Understand the reasons for the rise of crude oil transportation by rail
- Find key origins and destinations of this transportation
- Literature review on Railroad Hazmat Transportation
- Attend the weekly RailTEC meeting

Day 17: June 25, 2013

Today I spent most of the day searching online for the reasons behind the rise of crude oil transportation by rail and the key origins and destinations of this transportation. I found very helpful data in both AAR ([Association of American Railroads](#)) and EIA ([U.S. Energy Information Administration](#)) websites. I first analyzed the trend of the past years and then, after some research, I located the main areas of crude oil production and the location of the most important refineries in the U.S. Tomorrow, I will try to analysis this data to determine the frequent routes that are followed by the crude oil unit trains. In addition, I will prepare a couple of slides summarizing all of this information so that Xiang and Jesus can take a look at it.

At 12:00 we had the RailTEC weekly meeting where Athaphon (UIUC alumnus) gave a short presentation on the Thai Railways Development Plan. He first briefly summarized the railway

situation in Thailand to then talk about the important investments that are taking place in order to improve the infrastructure and also to develop the high speed train system. Among other things, it was very surprising to see how they use different materials for certain infrastructure elements due to different cost (example: majority use of concrete ties)

Today:

- Understand the reasons for the rise of crude oil transportation by rail (done)
- Find key origins and destinations of this transportation (to be finished)
- Literature review on Railroad Hazmat Transportation (to be finished)
- Attend the RailTEC weekly meeting (done)
- *-Safety group meeting with Athaphon Kawprasert's (Kwan) (done)

Next day:

- Find key origins and destinations of crude oil transportation
- Work on presentation of oil transportation by rail
- Literature review on Railroad Hazmat Transportation

Day 18: June 26, 2013

This morning, I kept reading articles from AAR and EIA. I located the most important crude oil rail loading facilities in North Dakota as it can be observed in FIG7. I had a especial interest in the Rangeland Energy's Crude Oil Loading Terminal, often called COLT (in the map is label as Inergy) because it can process up to 160,000 bbl/d. This is a considerable value as it is about one fifth of the total crude oil produced in North Dakota. Due to the importance of this facility I will take this point as the origin of my route.

After doing an analysis of most common crude oil destinations, (they vary significantly in response to market needs and price opportunities) originated in North Dakota, I found that the Gulf Coast is one of the top destinations as it is the area with more refineries. Hence, I decided that my route would go from the COLT loading facility in ND to the GT Omniport unloading facility in TX, which can up to 100,000 bbl/d. Both of this facilities are connected directly to BNSF.

On the afternoon all the interns had a small discussion with Xiang to talk about what we have been doing for the past days and to explain and justify to the rest of the group the route that each of us chose to do our case study.

Moreover, today I have been thinking that in my risk quantitative analysis I want to take into account the effect of the speed of the rail. I think I can do this by using a speed-dependent CPR. Tomorrow, among other things, I will read a couple articles that Xiang has recommended me to have a better understanding of how I can include this parameter on the risk equation.

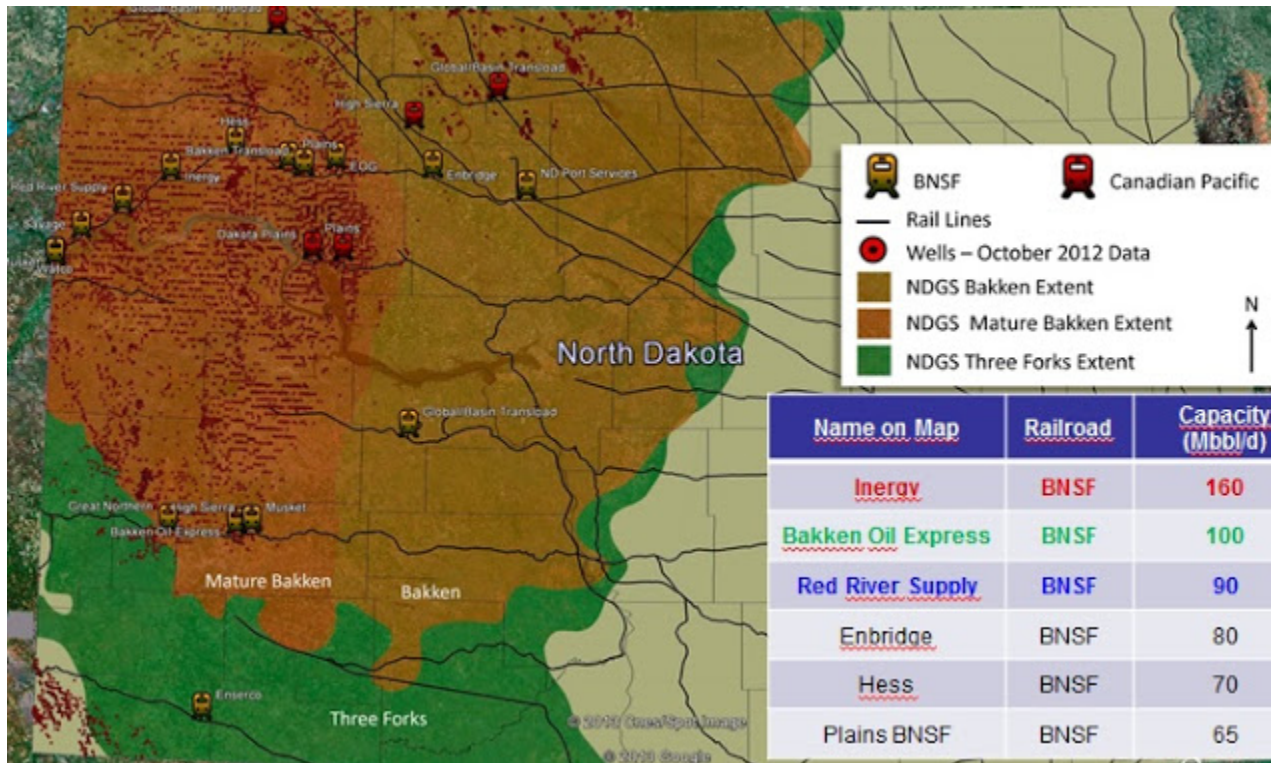


FIG7: Rail loading facilities of Crude oil in North Dakota.
Source: North Dakota Pipeline Authority 2013

Today:

- Find key origins and destinations of crude oil transportation (done)
- Work on presentation of oil transportation by rail (done)
- Literature review on Railroad Hazmat Transportation (to be finished)
- *-Decide the route of my case study (done)

Next day:

- Create an outline of the different "udemy" modules
- Start to work on the "udemy" ppt (module 1 introduction)
- Read Xiang's article regarding Safety Effectiveness strategies for the Transportation of Hazardous Materials by rail
- Determine the risk model to be used in the case study
- Literature review on Railroad Hazmat Transportation
- Safety group meeting (Jesus presentation)

Day 19: June 27, 2013

We began the morning with the weekly safety group meeting. Both Professor Saat and Professor Barkan joined us in a conference call. We all described briefly what we have been doing for the past days and then Jesus gave a great presentation focusing in the analysis of multiple consequences of tank car release. It was very interesting, not only the presentation but also all the comments that he received.

Then I read Xiang's article: Liu, X., M.R. Saat, C.P.L. Barkan, 2013. Safety Effectiveness of Integrated Risk Reduction Strategies for the Transportation of Hazardous Materials by Rail. Transportation Research Record - Journal of the Transportation Research Board. In the article a new methodology is developed to estimate the reduction of hazardous materials release risk by implementing integrated risk reduction strategies. The strategies that are considered are tank car safety design enhancement, reduction of train speed, accident prevention. One of the tables in this article shows the speed dependent CPR for different types of tank cars. I plan on using the speed dependent CPR on the model to evaluate risk more precisely.

For the rest of the day I work on a preliminary outline for the ppt modules of the final project (Railroad Risk Analysis Case Study). I plan on finishing it by tomorrow and then I will start to work on the power point presentation.

Today:

- Create an outline of the different "udemy" modules (to be finished)
- Start to work on the "udemy" ppt (module 1 introduction) (no time)
- Read Xiang's article regarding Safety Effectiveness strategies for the Transportation of Hazardous Materials by rail (done)
- Determine the risk model to be used in the case study (to be finished)
- Literature review on Railroad Hazmat Transportation (to be finished)
- Safety group meeting (Jesus presentation) (done)

Next day:

- Create an outline of the different "udemy" modules
- Start to work on the "udemy" ppt (module 1 introduction)
- Determine the risk model to be used in the case study
- Literature review on Railroad Hazmat Transportation

Day 20: June 28, 2013

Today, I spent most of the day working on the outline of the PowerPoint modules of the final project. I think having a clear written description of the topic and objective of each module is going to make the process of developing the presentation faster. In addition, having a well-thought outline will prevent me from missing any important point and it will help me to structure the different modules properly.

After finishing the outline, I started to work on the first module: Introduction to Rail Transportation. Finally at the end of the day, I got the required files to work in ArcMap ready so that on Monday I can start working on the calculation of the population density along the route.

Today:

- Create an outline of the different "udemy" modules (done)
- Start to work on the "udemy" ppt (module 1 introduction) (to be finished)
- Determine the risk model to be used in the case study (to be finished)
- Literature review on Railroad Hazmat Transportation (to be finished)

Next day:

- Work on the "udemy" ppt (module 1 introduction)
- Obtain the "practical" route using PC*Miler software
- Draw the route in ArcMap
- Determine the risk model to be used in the case study
- Literature review on Railroad Hazmat Transportation

Day 21: July 1, 2013

I started the day working on the first module of the presentation. I read some information of FRA website and several articles to have a better understanding of the importance of the railroad industry. Some of this articles are: AAR; June 2012; **The Economic Impact of America's Freight Railroads**, AAR; April 2013; **Overview US Freight Railroads**, AAR; April 2013; **A short history of US Freight Railroads**. In addition, I read some other relevant information in FAR and other railroad related websites.

On the afternoon, Jesus showed me quickly how to use the software PC*Miler. After that, he calculated using this mentioned software the practical route between my origin (the COLT loading facility in Epping ND) and my destination (the unloading facility in Port Arthur TX). After that, I drew the route in ArcMap and started to work with this software to calculate the population density along the route.

Finally, today I had a very constructive conversation with Xiang. We both agreed that in my case study I will use the same risk model that we used in the first couple of weeks. The only parameter that I am going to modify is the CPR. (I will consider speed-dependent CPR). He also mentioned that I should try to find articles that specifically talk about the analysis of the risk associated with the transportation of crude oil by rail. I also mentioned him the possibility to create a GIS tool to optimize the risk evaluation process and he advised me to work on this once that the learning modules are finished.

Today:

- Work on the "udemy" ppt (module 1 introduction) (to be finished)
- Obtain the "practical" route using PC*Miler software (done)
- Draw the route in ArcMap (done)
- Determine the risk model to be used in the case study (done)
- Literature review on Railroad Hazmat Transportation (finished)

Next day:

- Work on the "udemy" ppt (module 1 introduction)
- Work with ArcMap to obtain the population density along the route
- Literature review on the evaluation and analysis of crude oil transportation risk
- Attend the RailTEC weekly meeting

Day 22: July 2, 2013

I started the morning doing some traffic data analysis for Xiang. The aim of this short analysis was to make sure that the results obtained in the previous study were correct. After that, I kept working on the first module of the educational presentation. I finished the first part of the first powerpoint that gives an introduction to Rail Transportation. I started the second part which describes the basics of the transportation of hazardous material by rail.

Then I attended the RailTEC weekly meeting where Jesus presented an extended and improved version of his presentation on Thursday. After that we had a discussion with Xiang addressing some comments that were brought up on the meeting: We discussed the precision of the risk model that we are using and if with the utilization of the buffer we were miscounting people.

I worked on GIS for the rest of the day. The ArcMap process is taking me longer because along the way I'm creating a tool that will automate the entire analysis. This tool will be very useful in the future if other risk analysis based on population affected were to be undertaken.

Today:

- Work on the "udemy" ppt (module 1 introduction) (to be finished)
- Work with ArcMap to obtain the population density along the route (to be finished)
- Literature review on the evaluation and analysis of crude oil transportation risk (to be finished)
- Attend the RailTEC weekly meeting (Jesus' Presentation) (done)

Next day:

- Work on the "udemy" ppt (module 1 introduction)
- Work with ArcMap to obtain the population density along the route
- Literature review on the evaluation and analysis of crude oil transportation risk

Day 23: July 3, 2013

Today I spent most of the day working on ArcMap. First I started working on the analysis of the selected route, which is almost finished. Then I spent the rest of the day working on the automatization tool. I'm developing this tool using the application model builder which comes with ArcMap. My idea is that this tool will take as an input the .shp file that contains the route that wants to be analyzed and a buffer distance to take into account that different buffer distances maybe required depending on the hazardous material analyzed. The tool will automatically go through all the necessary steps (join tables, intersect layers, buffers...) and it will give the user a table with the population density for each segment of the route. A preliminary scheme of this tool is shown in FIG8.

Tomorrow I plan on working in finishing the tool and also the GIS analysis of my route.

- Develop a tool to automatize the GIS process (done)
- Literature review on the evaluation and analysis of crude oil transportation risk (to be finished)

Next day:

- Work on presentation 2: Rail Hazardous Material Transportation
- Literature review on the evaluation and analysis of crude oil transportation risk

Day 25: July 8, 2013

I started the morning working on the second presentation that gives an overview of Rail Hazardous Materials Transportation. The presentation is almost finished. In addition, I spent some time helping Jesus analyze an accident consequence database that he requires to obtain more precise results for his report.

At the end of the day, we all (the interns) presented our introduction powerpoints and provide each other with some helpful comments. Tomorrow I plan on finishing the second presentation.

Today:

- Work on presentation 2: Rail Hazardous Materials Transportation (to be finished)
- Literature review on the evaluation and analysis of crude oil transportation risk (to be finished)
- *-Partial analysis of an accident consequence database to help Jesus (done)

Next day:

- Finish presentation 2: Rail Hazardous Materials Transportation
- Start presentation 4: Case study introduction,

Day 26: July 9, 2013

Today I kept working on the second presentation. Following a previous recommendation of Xiang, I decided to add a couple of slides to provide the reader with a basic understanding of the consequences of crude oil rail transportation accidents. To do so I will list the most important accidents and I will very briefly review two of them. I have been reading about the recent Canadian accident in order to include this as one of the examples. I am aware of the fact that this accident has not occur in U.S, however, as it is one of the worst disasters regarding crude oil rail transportation its review will be worth it.

In addition, I downloaded the PHMSA crude oil rail accident database. I spent the entire afternoon working on it. I have about 300 incidents, some of them are duplicates as each tank car is reported individually. I am working on erasing these duplicates and also on locating those accidents in GIS. I plan on finishing this analysis tomorrow. I think it would be very

interesting to see where these accidents have occurred and if this location has any relationship with the associated cost of the accident.

Today:

- Finish presentation 2: Rail Hazardous Materials Transportation (to be finished)
- Start presentation 4: Case study introduction, justification (no time)
- Literature review on the evaluation and analysis of crude oil transportation risk (to be finished)
- Attend the RailTEC weekly lunch meeting (Brandon's Presentation) (done)
- *-Work with the PHMSA Hazardous Materials incident database (to be finished)

Next day:

- Finish presentation 2: Rail Hazardous Materials Transportation
- Start presentation 4: Case study introduction, justification
- Literature review on the evaluation and analysis of crude oil transportation risk
- Work with the PHMSA Hazardous Materials incident database

Day 27: July 10, 2013

I spent most of the morning working on the analysis of the PHMSA Hazardous Materials release incident database. The location of some of the accidents as well as a couple other values were not recorded properly so I had to fix them. This was a very tedious process. However, once I was done, I managed to locate geographically each accident in ArcMap. FIG9 shows the location of every U.S. crude oil transported by rail release incident from 1971 to May 2013. This figure will be included in my second ppt.

On the afternoon I worked on the second presentation. I added some new slides that give a brief overview about the different crude oil release incidents that have occurred in the past 40 years. Tomorrow I will start working in the new module.



FIG9: Location of the U.S. crude oil transported by rail release incidents 1971-2013

Today:

- Finish presentation 2: Rail Hazardous Materials Transportation (done)
- Start presentation 4: Case study introduction, justification (No time)
- Literature review on the evaluation and analysis of crude oil transportation risk (to be finished)
- Work with the PHMSA Hazardous Materials incident database (done)

Next day:

- Start presentation 4: Case study introduction, justification
- Literature review on the evaluation and analysis of crude oil transportation risk
- Attend the Safety group meeting (Laura's presentation)

Day 28: July 11, 2013

I began my working day attending the Safety Group presentation. As usual, each of us briefly talked about the work that we have been doing for the past week and then Laura gave a presentation regarding his research. That is the analysis of the conditional probability of release in a derailment. I think his presentation was very interesting especially because, among other factors, it takes into account derailment speed and the possible interaction between tank cars when a derailment occurs. According to her results although the velocity of the first car is the highest, it cannot interact with any other car (this is one of the assumptions). Therefore, the highest CPR is found in the 8th car since its velocity is still

significant and it also has the possibility to collide (and therefore release its material) with one of the first 7 cars.

After the meeting I continued to work on my excel spread sheet. I used the spread sheet that we developed the first couple of weeks as a starting point but I had to make some changes. I want to quantify the risk associated with the transportation of crude oil in two different routes. The practical route (the one that the software PC*miller provides) and the shortest route. I think it will be interesting to see the results as the practical route goes through several important cities such as Kansas and Houston. FIG10 shows the alignment of these two routes. In addition, I will compare the risk using a 111A100W1 tank car (the most frequently used) and a 112J340W tank car (very rarely used but it has a lower CPR).

Between tomorrow and Monday I plan on finishing this calculations and as soon as I do I will go back to work on the third presentation.



FIG10: Alignment of the practical and the shortest route

Today:

- Start presentation 4: "Case study introduction, justification" (to be finished)
- Attend the Safety group meeting (Laura's presentation) (done)

Next day:

- Work on presentation 4: "Case study introduction, justification"
- Work on the excel calculations of the risk analysis
- Meeting with Xiang to go over the basic structure and formatting of the ppt

This link contains the folder with the modules that I have developed so far.

Day 29: July 12, 2013

I spent most of the day working on the excel spread sheet. I finished all the necessary calculations for the practical route. After talking with Jeff, we both decided that we were going to quantify the risk in terms of people affected per barrel transported. This unit of measure clearly describes the risk associated with the transportation of crude oil. In addition, it allows us to compare the two different modes of transportation and it can be very helpful for a company when deciding which transportation mode is more adequate.

On the afternoon we met with Xiang and we went over one of Jeff's presentation. Aside from explaining us the basic formatting of the powerpoint, Xiang and Jesus gave us many useful comments that we could all apply to our ppt.

On Monday I plan on finishing the spread sheet with the calculations for the shortest route and I will work on the presentation 3: "Risk scenario and quantitative risk model."

Today:

- Work on presentation 4: "Case study introduction, justification" (no time)
- Work on the excel calculations of the risk analysis (to be finished)
- Meeting with Xiang to go over the basic structure and formatting of the ppt (done)

Next day:

- Work on the presentation 3: "Risk scenario and quantitative risk model."
- Work on presentation 4: "Case study introduction, justification"
- Finish Work on the excel calculations of the risk analysis

Day 30: July 15, 2013

I spent most of the day working on the excel spread sheet. I finished the calculations for the shortest route between the origin (Epping) and destination (Port Arthur). I will include the analysis of this route in the last module: "Risk Mitigation Measures".

On the afternoon, Xiang and I had a small talk. He recommended me to make a complete database of the reported crude oil release incidents. He suggested adding the information that I obtained from PHMSA with the one provide in the FRA database. He also pointed out that as crude oil transportation by train has boomed, the development of this database will be very helpful in the near future.

This database will be very helpful for my case study as well. Right now I am assuming the worst case scenario, that is the accident occurs at night and the released crude oil sets on fire. According to DOT Emergency Response Guidebook, this situation requires the evacuation of people within 0.5 miles from the location of the accident. However, in general this approach overestimates the risk as many cases don't fall in this category. Once that I develop

the crude oil release incidents database, I plan on obtaining some basic statistics that would allow me to know for example how many accidents have occurred during the day and how many at night.

Today:

- Work on the presentation 3: "Risk scenario and quantitative risk model." (done)
- Work on presentation 4: "Case study introduction, justification" (to be finished)
- Finish Work on the excel calculations of the risk analysis (done)

Next day:

- Work on presentation 4: "Case study introduction, justification"
- Work with ArcMap to obtain the necessary maps for the presentation
- Work on the Crude Oil FRA-PHMSA database
- Attend the RailTEC weekly lunch meeting

Day 31: July 16, 2013

Today I started the day working on the 4th presentation: "Case study introduction, justification". After doing the first couple of slides, I had to go back to ArcMap to obtain the maps that I wanted to show in the presentation. FIG11 shows one of this maps, where the FRA Track Class distribution is shown for the studied route.

On the afternoon I began to work on the FRA-PHMSA crude oil release incident database. I downloaded the FRA accident database for the period 2003-2012. I obtained that in total, there have been 290 accidents involving cars that contained any kind of hazardous material. Tomorrow I plan on keep working on this database eliminating all the data that is not related to the transportation of crude oil.

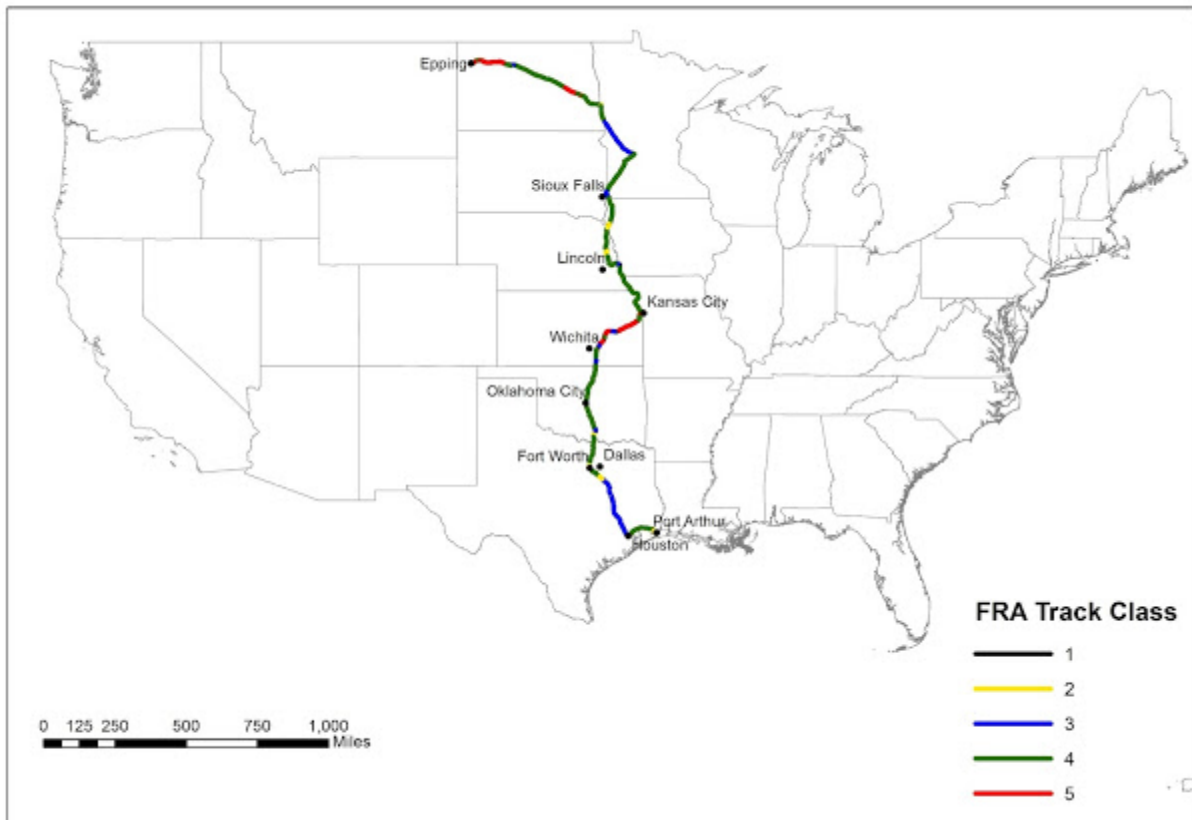


FIG11: FRA Track Class distribution

Today:

- Work on presentation 4: "Case study introduction, justification" (to be finished)
- Work with ArcMap to obtain the necessary maps for the presentation (to be finished)
- Work on the Crude Oil FRA-PHMSA database (to be finished)
- Attend the RailTEC weekly lunch meeting (Matt's presentation) (done)

Next day:

- Work on presentation 4: "Case study introduction, justification"
- Work with ArcMap to obtain the necessary maps for the presentation
- Work on the Crude Oil FRA-PHMSA database

Day 32: July 17, 2013

I spent the entire morning working on the crude oil FRA-PHMSA database. I found that in total there have been 9 accidents (crash or derailment) of train that were transporting crude oil since 1990. This number is much larger (269) if we consider all the incident releases (not only accidents). I made some graphs and charts that show some basic characteristics of this incidents. FIG12, one of the most interesting figures that I obtained, shows the number of crude oil release incidents reported to PHMSA per year (2003-2013).

On the afternoon I met with Chen-Yu and we reviewed my first three modules. He made some very significant suggestions and formatting comments. I spent the rest of the day working on these. Between tomorrow and Friday I plan on finishing the preliminary database (if I have time I plan to supplement it with the NTSB reports) and the 4th presentation.

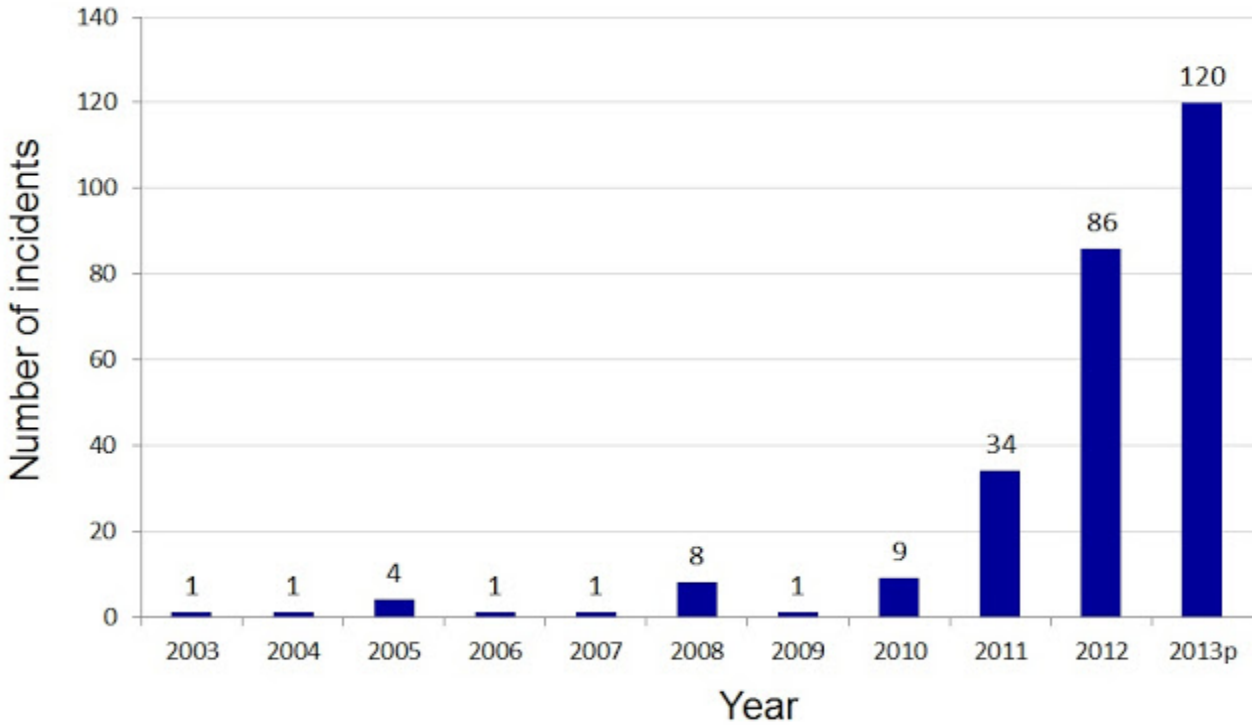


FIG12: Number of crude oil release incidents per year.
 *the value for 2013 is an estimation

Today:

- Work on presentation 4: "Case study introduction, justification" (no time)
- Work with ArcMap to obtain the necessary maps for the presentation (to be finished)
- Work on the Crude Oil FRA-PHMSA database (to be finished)

Next day:

- Work on presentation 4: "Case study introduction, justification"
- Work with ArcMap to obtain the necessary maps for the presentation
- Work on the Crude Oil FRA-PHMSA database
- Attend the Safety group meeting

Day 33: July 18, 2013

I started the morning attending (via conference call) the Safety group meeting. Although I had seen Jeff's presentation before, I thought the discussion that his risk model generated was very interesting.

I worked on the crude oil FRA-PHMSA database for most of the day. I managed to find the FRA reports for each of the crude oil release accidents (7 accidents -crash or derailment- from 2003-2013) recorded in PHMSA database. Since there are only 7 events I don't think behavior trends can be extrapolated from this database. However, as there is currently a boom in the transportation of crude oil by rail, I think this database will be very helpful in the future. It can be the starting point to keep track of all the crude oil-related incidents. Once that I

finished this, I worked on ArcMap for the rest of the night. Tomorrow I plan on finishing both the work with ArcMap and presentation 4.

Today:

- Work on presentation 4: "Case study introduction, justification" (to be finished)
- Work with ArcMap to obtain the necessary maps for the presentation (to be finished)
- Work on the Crude Oil FRA-PHMSA database (done)
- Attend the Safety group meeting (Jeff's presentation) (done)

Next day:

- Work on presentation 4: "Case study introduction, justification"
- Work with ArcMap to obtain the necessary maps for the presentation
- Work on the Canadian accident module

Day 34: July 19, 2013

Today I spent the entire day working on the case study. I had to reedit some of the maps so that the formatting was consistent. I also reviewed the part that I had completed so far to take into account the recommendations that were given to Jeff in yesterday's meeting. This has taken me longer than I expected but I think I will finish this module on Monday.

Today:

- Work on presentation 4: "Case study introduction, justification" (to be finished)
- Work with ArcMap to obtain the necessary maps for the presentation (to be finished)
- Work on the Canadian accident module (no time)

Next day:

- Work on presentation 4: "Case study introduction, justification"
- Work with ArcMap to obtain the necessary maps for the presentation
- Work on the Canadian accident module

Day 35: July 22, 2013

I worked on the case study for most of the day. I started the morning by finishing some of the route maps that I wanted to include in the presentation. Moreover, I went back to the project powerpoint that we worked at the beginning of June to find some graphs that would allow me to better communicate the results obtained in my case study. I spent most part of the afternoon developing these graphs. FIG13 which is one of the mentioned graphs, represents the distribution of risk by segment along the Epping to Port Arthur BNSF route. At the end of the day I finished the case study presentation. This file along all the other presentations

that I have developed so far can be found in [this link](#). Tomorrow I will work on the Canadian accident module and I hope I can have some slides ready for the final presentation on Thursday.

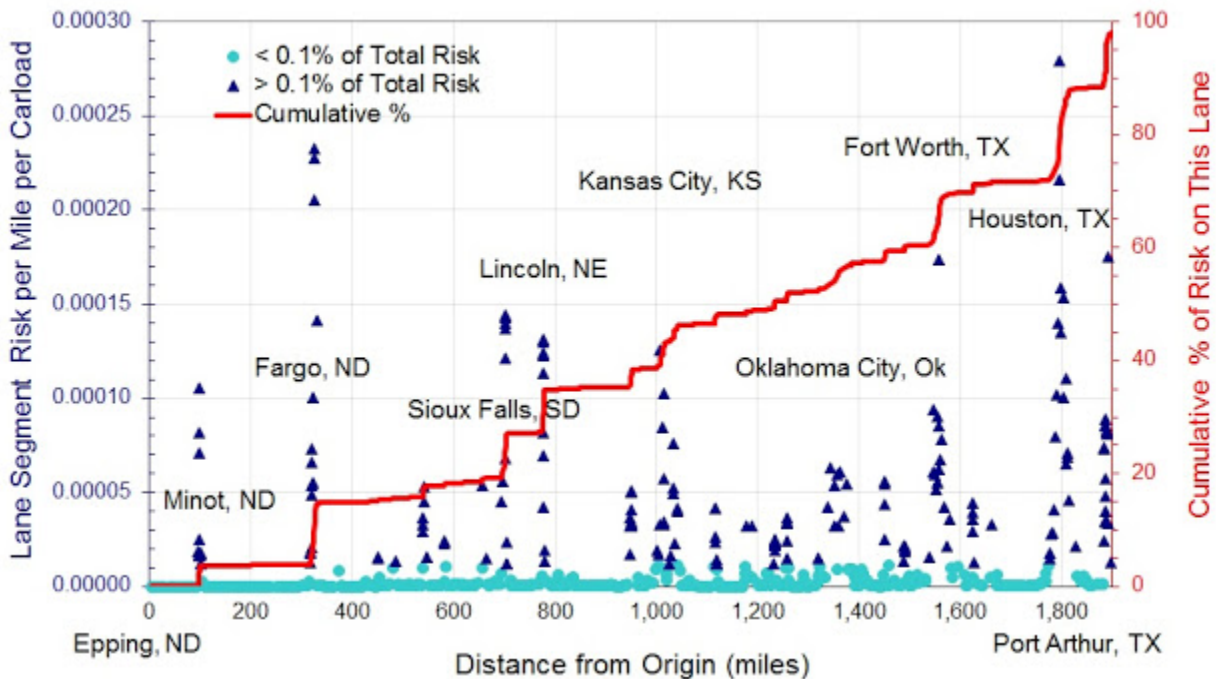


FIG13: Epping to Port Arthur: Distribution of risk by segment.

Today:

- Work on presentation 4: "Case study introduction, justification" (done)
- Work with ArcMap to obtain the necessary maps for the presentation (done)
- Work on the Canadian accident module (no time)

Next day:

- Start the Canadian accident module
- Attend the RailTEC weekly lunch meeting

[This link](#) contains the folder with the modules that I have developed so far.

Day 36: July 23, 2013

Today I spent most of the day reading news articles from different sources about the Lac-Mégantic accident. I found that a good source of information is [wikipedia](#). It is hard to find detailed information because most of the search results are always articles with repeated, old or inaccurate information. I found a good source of pictures [here](#). FIG14 shows an aerial view of Lac-Mégantic's downtown area after the derailment.

I think that it is essential to learn from this event as much as possible to guarantee that such accidents don't happen again. I plan on finishing this module tomorrow.



FIG14: Aerial view of Lac-Mégantic's downtown area after the accident.

Today:

- Start the Canadian accident module (to be finished)
- Attend the RailTEC weekly lunch meeting (Brent Williams' presentation) (done)

Next day:

- Work on the Canadian accident module
- Prepare the presentation for the safety group meeting
- Review the presentation with the other interns

Day 37: July 24, 2013

I spent the day preparing the presentation for the safety group meeting. Although I wanted to include some slides to justify and explain all the assumptions and hypothesis of my analysis I could not do so, in order to keep the presentation under 25 slides. Later I met with Chen-Yu that had reviewed my 4th module: "Case study" and that had some very helpful comments. I have to say that he has been a great help!

On the afternoon the rest of the interns and I reviewed our presentations for tomorrow. It was helpful because we all provide suggestions to each other's presentations.

Today:

- Work on the Canadian accident module (to be finished)
- Prepare the presentation for the safety group meeting (done)
- Review the presentation with the other interns (to be finished)

Next day:

- Work on the Canadian accident module
- Review the presentation with the other interns
- Attend the Safety Group meeting

Day 38: July 25, 2013

I began the morning working with the rest of the interns on the review of the safety meeting presentations. At 11:00 am we had the meeting. It was a very interesting meeting as we began discussing the Spanish high speed accident that had just happened. After that, Hannah, Eli and I gave our presentations. We obtained plenty of helpful and constructive feedback and comments to improve our work. On the overall I was happy with the presentation.

On the afternoon I started to organize all the files. I want to make sure that every file has a proper name and that my work is accessible to anyone in the future. I will work with the other interns to have the "Summer Team" folder well organized.

I stopped this work to help Xiaonan with the M project as it needed to be delivered by Friday. I spent most of the night working on the ArcMap part of the project, developing the necessary maps.

Today:

- Work on the Canadian accident module (no time)
- Review the presentation with the other interns (done)
- Attend the Safety Group meeting (done)
- Present my analysis on the Safety Group meeting (done)
- Work on the M project (done)

Next day:

- Work on the Canadian accident module
- Review my presentation considering the different comments
- Organize the files and the "Summer team" folder

Day 39: July 26, 2013

I spent most of the day reviewing my ppt modules. Among other improvements, I included all the comments that I received in the presentation on Thursday.

On the afternoon I organized all my files on the server, making sure that everything can be easily find and accessed. On Monday I will continue with this task as especially the ArcMap files are requiring more time that I had expected.

Today:

- Work on the Canadian accident module (to be finished)
- Review my presentation considering the different comments (done)
- Organize the files and the "Summer team" folder (to be finished)

Next day:

- Work on the Canadian accident module
- Organize the files and the "Summer team" folder

Day 40: July 29, 2013

Today I started the day working on the Canadian accident module. I spent most of the morning reading articles about it and working on the ppt. The module is almost done. I only have to include a couple of slides to give an overview about the repercussions of the accident and the new regulations/recommendations that the different Canadian administrations have approved. I plan on finishing this module tomorrow.

On the afternoon I finished organizing all the M project ArcMap files and I started to read about Autolt script, a programming tool that I may be able to use to automatize the calculations in excel of the M project. Tomorrow, I will further look into the feasibility of using this tool.

Today:

- Work on the Canadian accident module (to be finished)
- Organize the files and the "Summer team" folder (to be finished)
- *-Start to work on the M project automatization tool (to be finished)

Next day:

- Work on the Canadian accident module
- Organize the files and the "Summer team" folder
- Start to work on the M project automatization tool

Day 41: July 30, 2013

Today I spent most of the day working on the Canadian accident module. By the end of the day I had finished it and I started to work on the M project as Xiang asked me to help them. I think tomorrow I will continue with this task as there is still a lot to do.

Today:

- Work on the Canadian accident module (finished)
- Organize the files and the "Summer team" folder (to be finished)
- Work on the M project automatization tool (to be finished)
- *-Work on the M project (to be finished)

Next day:

- Organize the files and the "Summer team" folder
- Start to work on the M project automatization tool
- Work on the M project

Day 42: July 31, 2013

Today was the last day working in B118. I spent the entire day organizing files and working on the M Project. I stayed until 9 pm working on it because there was still a lot to do.

I must say that I have had an amazing experience here as part of RailTEC. I have really enjoyed working and learning from all the graduates students. I hope I can soon be a part of all of this, maybe as a graduate student myself.

Thank you so much to everyone that helped me. Especially to Xiang, Jesus, Chen-yu and Rapik and to the rest of undergrads: Jeff, Hanna and Eli. It has been a pleasure working with all of you.

Keep up the hard work! And have a great summer.

Hasta pronto amigos!

P.S. I will continue working from Spain for the next couple of days until the M project is done.



National University Rail Center - NURail
US DOT OST-R Tier 1 University Transportation Center

UIUC NURail Research: Manuel Martin report

The Economic Impact of America's Freight Railroads

June 2013 – July 2013

The Economic Impact of America's Freight Railroads

ASSOCIATION OF AMERICAN RAILROADS

JUNE 2016

Summary

Freight railroads in the United States are **the best in the world**. Every year, they save consumers billions of dollars while reducing energy consumption and pollution, lowering greenhouse gas emissions, cutting highway gridlock, and reducing the high costs to taxpayers of highway construction and maintenance. They also have a tremendous broader economic impact: **in 2014 alone, America's major freight railroads supported 1.5 million jobs, nearly \$274 billion in output, and \$88 billion in wages across the U.S. economy**. In addition, millions of Americans work in industries that are more competitive thanks to the affordability and productivity of America's freight railroads.

Freight Railroads Mean More Jobs and a Stronger Economy

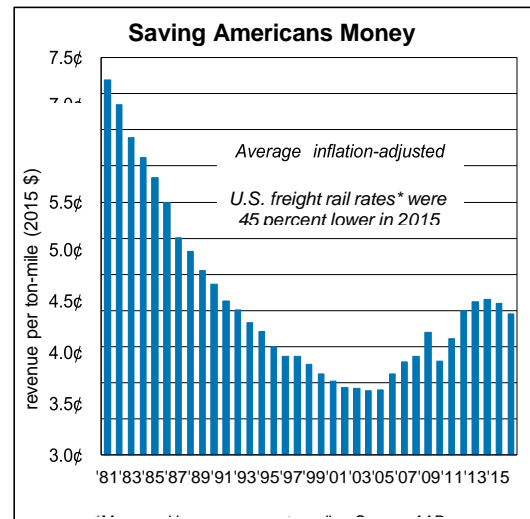
By linking businesses to each other here and abroad, freight railroads have played a crucial role in America's economic development for 185 years. They remain critical today, serving nearly every industrial, wholesale, retail, and resource-based sector of our economy:

- The approximately **170,000 freight railroad employees** are among America's most highly compensated workers. In 2014, the average U.S. Class I freight railroad employee earned wages of \$86,200 and fringe benefits of \$33,400, for total average compensation of \$119,600. By contrast, the average wage per full-time U.S. employee in 2014 was \$57,100 (66 percent of the comparable rail figure) and average total compensation was \$70,700 (just 59 percent of the rail figure).
- A June 2016 study from Towson University's Regional Economic Studies Institute examined freight railroads' broader economic impact. The study found that, in 2014 alone, **the operations and capital investments of America's major freight railroads supported approximately 1.5 million jobs** (1.1 percent of all U.S. workers — nearly nine jobs for every railroad job), nearly **\$274 billion in economic output** (1.6 percent of total U.S. output), and **\$88 billion in wages** (1.3 percent of total U.S. wages). Railroads also generated nearly **\$33 billion in tax revenues**. These impacts include direct, indirect, and induced effects across the U.S. economy. In addition, millions of Americans work in industries that are more competitive thanks to the affordability and productivity of America's freight railroads.
- Rail industry employees are covered by the Railroad Retirement System, which is funded by railroads and their employees. In fiscal year 2015, **557,000 beneficiaries** received retirement and survivor benefits totaling **\$12.2 billion** from the system.
- Railroads account for approximately **one third of all U.S. exports** by volume, providing a vital link to international markets for American firms, farmers, and resource producers.

Freight Railroads Save America Money

Railroads help their customers control their prices, saving them (and, ultimately, U.S. consumers) **billions of dollars each year, enhancing the global competitiveness of U.S. goods, and improving our standard of living.**

- Average **U.S. freight rail rates** (measured by inflation-adjusted revenue per ton-mile) **were 45 percent lower in 2015 than in 1981.** This means the average rail shipper can move close to twice as much freight for about the same price it paid more than 35 years ago.
- Several years ago, the American Association of State Highway and Transportation Officials (AASHTO) estimated that if all freight rail traffic were shifted to trucks, rail shippers would have to pay an additional \$69 billion per year. Adjusted for increased freight volume and inflation, that figure is probably close to \$100 billion today.



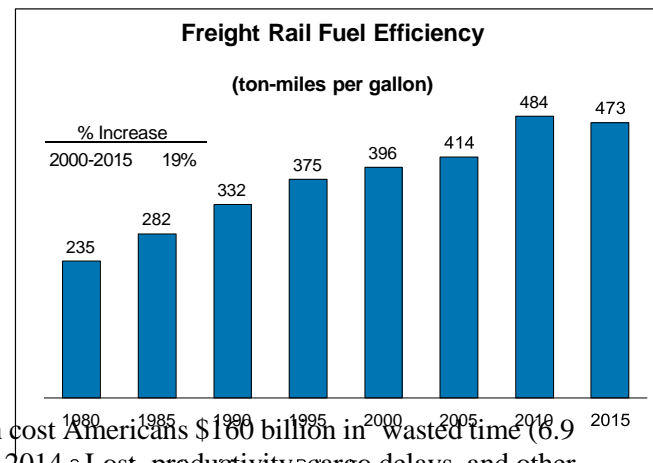
Freight Railroads Provide Huge Public Benefits

In addition to their role as an economic engine, railroads offer substantial public benefits:

- **Fuel efficiency** – On average, railroads are **four times more fuel efficient than trucks.** In 2015, railroads moved a ton of freight an average of **473 miles** per gallon of fuel.
- **Greenhouse gases** – Because greenhouse gas emissions are directly related to fuel consumption, moving freight by rail instead of truck **reduces greenhouse gas emissions by 75 percent**, on average.
- **Highway congestion** – According to the Texas Transportation Institute's

2015 Urban Mobility Scorecard, highway congestion cost Americans \$160 billion in wasted time (6.9 billion hours) and wasted fuel (3.1 billion gallons) in 2014. ~~Lost productivity, cargo delays, and other costs add tens of billions of dollars to this tab. But a train can carry the freight of several hundred trucks.~~ That means railroads reduce highway gridlock, the costs of maintaining existing highways, and the pressure to build costly new highways. That's especially important now when government funding for highway spending and other purposes is under such severe pressure.

- **Pollution** – Moving freight by rail rather than truck significantly reduces emissions, and that means cleaner air for all of us. In March 2008, the EPA issued stringent new locomotive emissions standards that will cut rail emissions by up to 90 percent.



Transporting the Things We Use Every Day

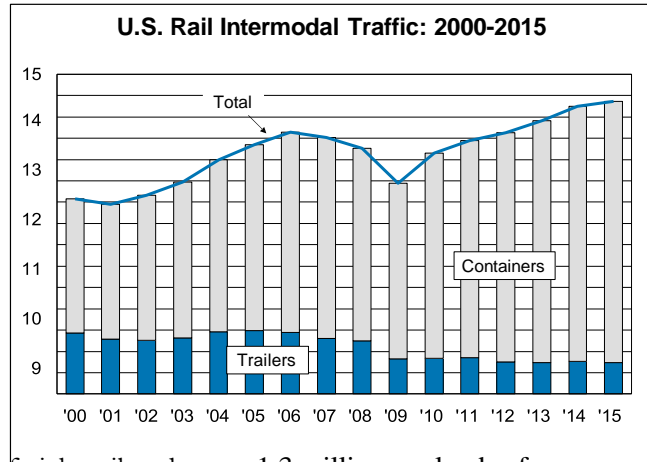
From one end of the country to the other, America’s freight railroads transport a huge variety of goods, including the following:

- **Agricultural and food products** – In a typical year, railroads haul around 1.6 million carloads of wheat, corn, soybeans, and other agricultural products, plus another 1.6 million carloads of animal feed, beer, birdseed, canned produce, corn syrup, flour, french fries, frozen chickens, sugar, wine, and countless other food products. If it’s on your table or in your pantry, there’s a good chance railroads helped get it there.
- **Chemicals** – The approximately 2.2 million carloads of chemicals that America’s railroads carry in a typical year help clean our water, fertilize our farms, package our food, build our cars and homes, protect our health, and enhance our well-being in thousands of other ways.
- **Coal** – Historically, more electricity has been generated from coal than from any other fuel source, and railroads account for around 70 percent of U.S. coal deliveries. By helping to keep coal-based electricity affordable, railroads enhance our standard of living.



- **Intermodal** – Rail intermodal service (moving shipping containers and truck trailers on rail cars) transports a huge variety of consumer goods, from electronics and greeting cards to clothing and furniture, as well as large amounts of industrial and agricultural products. U.S. railroads transported

13.7 million intermodal containers and trailers in 2015. Around half of rail intermodal volume consists of imports or exports, reflecting the vital role intermodal plays in international trade.



- **Paper and lumber** – In a typical year, America’s freight railroads carry 1.3 million carloads of lumber and paper products — including wood to build our homes, newsprint and magazine paper, and cardboard for packaging. Railroads also haul tens of thousands of carloads of recycled paper and cardboard each year.
- **Motor vehicles** – Railroads haul approximately 70 percent of new motor vehicles sold in the United States, as well as many of the parts and accessories used to build them.
- Railroads also carry millions of carloads of raw materials and industrial products that are critical to our way of life, including **metallic ores** (such as iron ore and bauxite), **steel** and other metal products, **crude oil**, **crushed stone and cement** used in construction, **scrap metal** for recycling, and much more.