2010

Carbon Footprint of Automobiles

Faculty Advisors: Don Tijunelis, Edita Baltrenaite

Lithuanian Counterpart

- Ruta Blagnyte
- Jolita Dudaite
- Vytautas Kalpokas
- Mindaugas Kargis
- Ruta Navickaite
- Remigijus Savickas

- Rajiv Bais
- James Burian
- Lien Choi
- Andrew Fournier
- Andres Mora
- Susan Rafalko
- Morayomola Shonekan
- Seantoia Swanston
- Teodora Vasilev
- Won-Jae Yi
- Mary Yu

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I. Team Information

IPRO 322 Roster, along with each individual's strengths, skills, and expectations, can be found in appendix A and B.

The logo of IPRO 322 is shown on the first page and the motto of this class is "Your waste, your responsibility. What is your carbon footprint?"

Team Purpose

The goal of the IPRO 322 team is to develop and present a "User friendly" way of identifying vehicles with respect to the emission of greenhouse gases throughout their life cycle.

Team Objectives

- To find the best fuel efficient cars by observing the following fuel types: electricity, gasoline, bio-diesel, and diesel.
- Research materials such as aluminum, plastic, steel, and glass in respect to the amount of green house gasses are emitted throughout the production process.
- Examine the Carbon foot print of the cars.
- To work collaboratively and effectively to achieve the outlined tasks that we have set for ourselves.
- To gain the proper knowledge needed in order create a way to attain our goal
- Meet deadlines for the project presentation
- Use time efficiently

II. Background

History

The project is intended to come up with a way for the average consumer to be able to relate to the carbon footprint of vehicles, and to make them more aware of the arising global issues. A carbon footprint is defined as the total amount of greenhouse gases produced to directly and indirectly support human activities; usually expressed in equivalent tons of carbon dioxide. Individual carbon footprint is the sum of all emissions of carbon dioxide, which are induced by individual activities in a given time frame. Usually a carbon footprint is calculated for the time period of a year. The best way to calculate carbon footprint is based on fuel consumption. The carbon footprint is a very powerful tool to understand the impact of personal behavior on global warming. In order to stop global warming, constant calculating and monitoring of personal carbon footprint is essential. The problem is, the little information that is out there is limited. although information about carbon footprint is available on the website of two government agencies; Environmental Protection Agency (EPA) "http://www.epa.gov/greenvehicles" and the U.S Department of Energy, the public finds it difficult to understand the data. However, if this information is displayed directly on cars, individuals would readily understand the relationship between the cars they drive and carbon footprint. Most of the information on carbon footprint is also based on the view of the reporting agency. In addition, there is not really a standard set to the actual total carbon footprint of vehicles, including manufacturing and disposal, not just the carbon emissions. It is essential that people know about global warming, carbon footprint, and how it affects each individual.

Global warming and climate change have become a very hot topic in recent years. However, climate change and global warming are not a new science. The very first record of the greenhouse effect was documented by Svante Arrhenius (Nobel Prize in Chemistry, 1903) in 1896. Arrhenius described the natural greenhouse effect which he observed was caused by the absorption of infrared by carbon dioxide (CO_2) and water (H_2O) vapor. It was proposed that this natural greenhouse effect was responsible for maintaining the earth's average temperature

(~33°C). He further proposed that a relationship between atmospheric CO2 and temperature suggesting that combusting fossil fuels which releases vast amounts of CO2 may result in a rise in average annual temperature or global warming. It was understood at this time that much of the solar radiation received by the sun was reflected back into space by our atmosphere. What radiation that passes through the atmosphere, primarily in the form of heat or infrared radiation was reflected off the surface of the earth. However, some of this heat remains trapped in our atmosphere due to greenhouse gasses which include nitrous oxide, methane, fluorocarbons and carbon dioxide. The basic principle remains that the more greenhouse gas that is present in our atmosphere, the more heat that is trapped, and the higher the average annual temperature will be. In the 1940's with the development of infrared spectroscopy, scientists were able to prove a correlation between increasing atmospheric CO2 and increasing temperature. It was also shown that water vapor absorbs different type of radiation than CO2 and did not contribute to global warming as much as was suspected. In 1955, Gilbert Plass after a series of experiments, summarized these results and concluded that emitting more CO2 would trap more infrared radiation which would result in warming of the earth. Up to this point it was thought that the oceans absorb most of the CO2, and so atmospheric CO2 was not that much of an issue. However, further research in the 1950's showed that the oceans could never be a complete sink for CO2. It was shown that CO2 has a lifespan of at least 10 year in the atmosphere. Furthermore, it was not known what happened to the CO2 after it dissolved in the oceans. There was a great possibility that it is just re-release back into the atmosphere. To date, it is thought that at most one third of all CO2 is absorbed by the oceans. In 1958, further evidence was found by Charles Keeling who measured atmospheric CO2 concentrations in Antarctica and in Hawaii. His atmospheric CO2 concentration curves have now become famous and shows definitive proof that atmospheric CO2 levels are on the rise at an exponential rate. His measurements continue to date, and a definitive record of atmospheric CO2 has been kept since 1958. Parallel measurements of temperature have also shown a total rise of almost 1°C or 1.8°F since the rise of the industrial age. This is significant because the boon of the industrial age essentially initiated a new period of history where fossil fuels were consumed in quantities never seen before in history. If the amount of CO2 is to double from the pre-industrial age, we

are to see a 4-5°C or 7.2-9°F increase in the annual average temperature. In 2000, we were at 37% increase from 1900 levels. This increase in temperature is very significant because the freezing point of water is very specific (0°C). A slight perturbation from the specific freezing point of water especially in the warmer direction will not allow water to for the crystals necessary for the formation of ice.

This brings us to our current issues. Of all the greenhouse gases, CO2 is the predominant form, contributing to over 75% of all the greenhouse gases present in our atmosphere. Skeptics point to methane as being a more dangerous greenhouse gas, but total contributions by methane is only around 13%. In the United States, the major sources of CO2 are power plants, heating systems and automobiles. When power plants and heating systems are combined, automobiles are the second leading source of CO2 emissions. The primary sources of CO2 are from the burning of fossil fuels and deforestation. In the United States there is an addiction to energy that is not seen anywhere else in the world. The United States consumes nearly as much coal as does China who has over four times the population of the United States. The average household in the U.S consumes around 9.5 tons of coal each year totaling over one billion tons of coal each year. India, the third greatest consumer of coal, also with nearly 4 times the population of the US consumes only roughly a third of that amount. If the goal of these developing nations is to achieve the American standard of living the world is truly at grave risk. In the US, the next primary source of CO2 emissions is from automobiles. There are more cars on the road in the US than all of the countries in the European Union combined. All told, the US emits more CO2 from automobiles than all of the countries in Europe, China, India and Japan combined. This is a significant problem with no easy solution.

This was all taken into consideration when deciding what to research for the project. It was decided to choose some fuels and then vehicles that run on those fuels to make an easy to use chart on the life cycle carbon footprint of these cars as our basis. The way we chose our fuels was by making a short survey asking about what 5 fuel types do they think would be the most used in 10 years. We asked people to take it and compiled the data to the top 5 most chosen fuels to research. They were petrol, biodiesel, hybrids (gas and electric) and hydrogen. The refining of each fuel will be taken into consideration to each vehicles total carbon footprint.

The vehicles we chose were the Ford Taurus, BMW 335d, Volkswagen Jetta TDI, Toyota Prius, and the Chevrolet Volt. Our Lithuanian counterparts will be researching cars sold in Europe and how they are manufactured. We will compile their data, along with ours in order to get a global idea of how the world is acting on this subject. Hopefully this IPRO will shed some light on this very important topic, and maybe even make a standard for dealerships to put on their window stickers.

III. Team Values Statement

Desired Behavior

- Show up on time to all class meetings (Monday and Wednesday from 10:00-11:25am)
- Communicate to class and professor a week in advance of known absences from class or meetings
- Address conflicts and complaints with team members directly, in class or in private
- Use IGROUPS efficiently to share all information
- Finish all assignments on time in order to not delay other's progress

Conflict Resolution

IPRO 322 will follow the "A-E-I-O-U" model of conflict resolution. We will attempt to communicate all concerns to the group and seek alternative resolutions. By separating the person from the problem, we hope to keep civility and focus solely on the problem at hand.

- A-ssume others mean well
- E-xpress one's feelings
- I-dentify your desired scenario
- O-utcomes expected to be made to the group
- U-nderstanding by the group is done on a mature level

IV. Work Breakdown Structure

Problem Solving Process

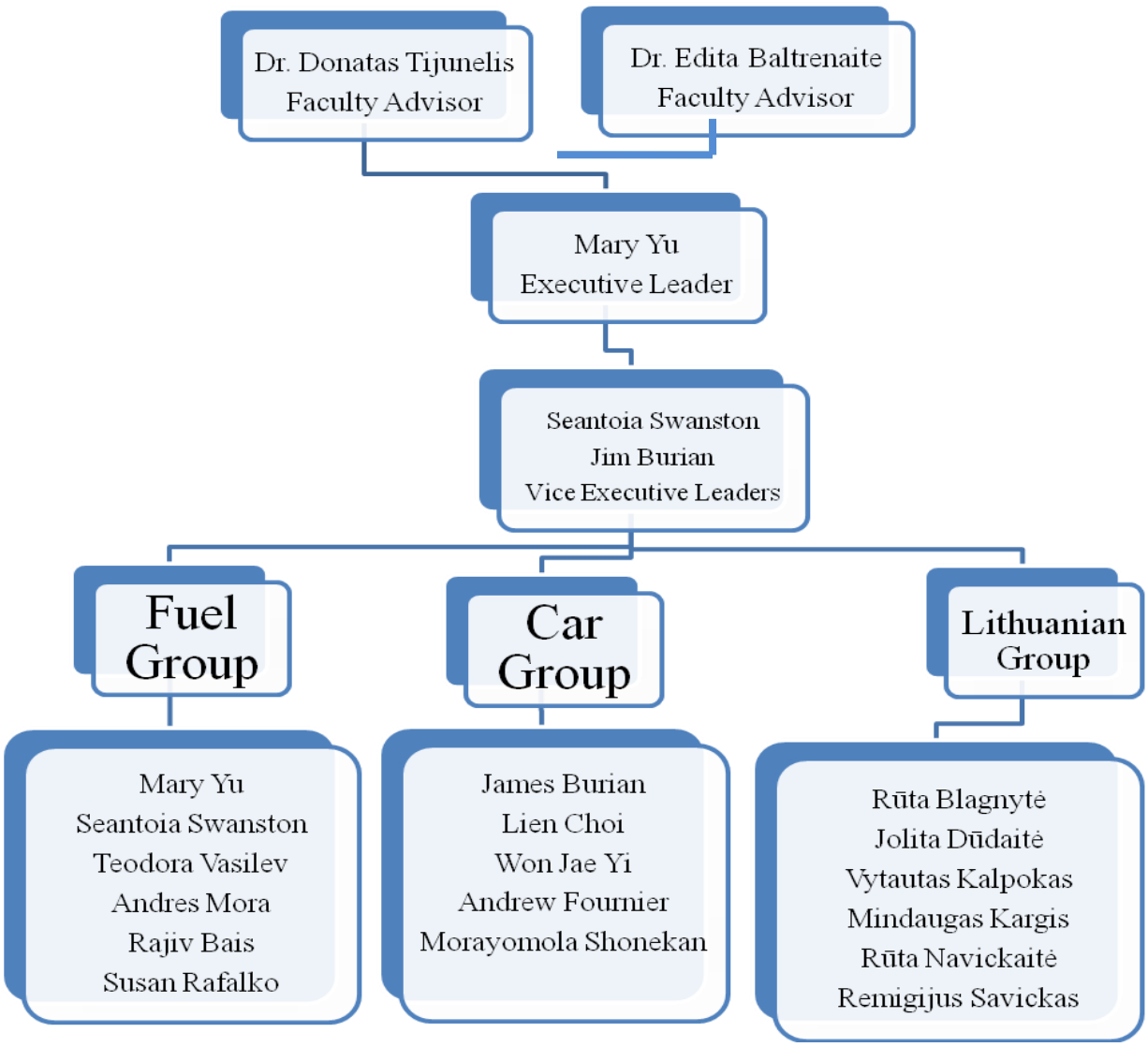
In order to determine a way to measure the carbon footprint that different vehicles emit during their lifetime, we have to undergo the following process:

1. Conduct research and surveys to determine:
    a. Which cars are the most popular
    b. Which cars are the most popular
    c. Which fuels are more likely to be used
2. Research the sources in which cars contribute in the release of greenhouse gases, such as:
    a. The greenhouse gases released during production of the cars
    b. The greenhouse gases released during the burning of fuels
    c. The greenhouse gases released during the production of the materials used in the cars
3. Determine how many of these factors can effectively be attributable to these vehicles
4. Develop/use a scale in which we can measure the total carbon footprint emitted by these vehicles
5. Find an efficient and simple way to present this to the end users, possibly by creating a sticker that can be appended to cars on display

Team Structure

The scope of this project has broken the group into three groups. The team led by Mary will be the Fuel Group, while the group led by James will be the Car Group. The Fuel Group will focus heavily on the fuel choices and their contribution. The Car group will focus on the emissions of the American cars that have been selected. Both groups will divide the work on materials and manufacturing. The Lithuanian Group will be led by Rūta Navickaitė. They will work on the European cars and finding their data as a whole. Mary will act as the overall executive leader of the entire group, while James and Seantoia will act as vice executive leaders

and take over if Mary is unable to attend, etc. Rūta Navickaitė will be the overall leader for the VGTU students.



Gantt Chart

Project Lead: Mary Yu & Rūta Navickaitė
Start Date: 1/11/2010 Monday
First Day of Week (Mon=2): ##

WBS	Tasks	Task Lead	Start	End	Duration (Days)	% Complete	Working Days	Days Complete	Days Remaining
1	**IPRO Deliverables**	Mary + Team	1/11/10	4/30/10	110	8%	80	8	102
1.1	Project Plan		1/11/10	2/17/10	37	30%	28	11	26
1.2	Midterm Review Presentation		2/05/10	2/25/10	21	0%	15	0	21
1.3	Ethics Reflective Paper		3/24/10	3/26/10	3	0%	3	0	3
1.4	Final Project Report (Draft)		2/25/10	4/09/10	38	0%	32	0	38
1.5	IPRO Day Abstract, Brochure & Poster		4/12/10	4/19/10	8	0%	6	0	8
1.6	IPRO Final Day Presentation		4/12/10	4/22/10	11	0%	9	0	11
1.7	IPRO Final Project Report		4/12/10	4/30/10	19	0%	15	0	19
2		Mary + Team	1/11/10	4/30/10	81	2%	80	1	80
2.1	Meet With Student from VGTU		2/01/10	2/08/10	1	100%	6	1	0
2.2	Talk with students from IPRO 347		2/01/10	4/01/10	59	0%	44	0	59
2.3	Disucuss plan with peers from Lithuania		2/08/10	2/08/10	1	0%	1	0	1
3	**Car Group**	Jim + Car Group	1/11/10	4/30/10	89	1%	80	1	88
3.1	Determine Car Categories and their cars		1/20/10	1/27/10	6	100%	6	6	0
3.1.1	Presentation		1/20/10	1/27/10	6	100%	6	6	0
3.2	Analyze Data		2/01/10	3/17/10	44	5%	33	2	42
3.3	Research		1/20/10	4/09/10	79	0%	58	0	79
3.3.1	Fuel Efficiency of Cars		1/20/10	4/09/10	65	0%	58	0	65
3.3.1.1	Electricity/Hybrid		1/20/10	4/09/10	65	0%	58	0	65
3.3.1.2	Gas		1/20/10	4/09/10	65	0%	58	0	65
3.3.1.3	Diesel		1/20/10	4/09/10	65	0%	58	0	65
3.3.1.4	Biodiesel		1/20/10	4/09/10	65	0%	58	0	65
3.3.1.5	Hydrogen		1/20/10	4/09/10	65	0%	58	0	65
3.3.2	Materials used in Cars		2/03/10	4/09/10	65	0%	48	0	65
3.3.2.1	Steel		2/03/10	4/09/10	65	0%	48	0	65
3.3.2.2	Aluminum		2/03/10	4/09/10	65	0%	48	0	65
3.3.2.3	Plastic		2/03/10	4/09/10	65	0%	48	0	65
3.3.2.4	Glass		2/03/10	4/09/10	65	0%	48	0	65
3.3.3	Plant Emissions		2/03/10	4/09/10	65	0%	48	0	65
3.4	Design User Friendly Approach		2/03/10	4/09/10	65	0%	48	0	65
1	**Fuel Group**	Mary + Fuel Group	1/11/10	4/30/10	89	2%	80	1	88
1.1	Determine Major Fuel Groups & Research		1/20/10	1/27/10	6	50%	6	3	3
1.1.1	Presentation		1/20/10	1/27/10	6	100%	6	6	0
1.2	Fuel Survey		1/31/10	2/06/10	7	50%	5	3	4
1.3	Analyze Data		2/01/10	3/17/10	44	5%	33	2	42
1.4	Research		1/20/10	4/09/10	79	0%	58	0	79
1.4.1	Fuel Efficiency of Cars		1/20/10	4/09/10	14	0%	58	0	14
1.4.1.1	Electricity/Hybrid		1/20/10	4/09/10	65	0%	58	0	65
1.4.1.2	Gas		1/20/10	4/09/10	65	0%	58	0	65
1.4.1.3	Diesel		1/20/10	4/09/10	65	0%	58	0	65
1.4.1.4	Biodiesel		1/20/10	4/09/10	65	0%	58	0	65
1.4.1.5	Hydrogen		1/20/10	4/09/10	65	0%	58	0	65
1.4.2	Materials used in Cars		2/03/10	4/09/10	65	0%	48	0	65
1.4.2.1	Steel		2/03/10	4/09/10	65	0%	48	0	65
1.4.2.2	Aluminum		2/03/10	4/09/10	65	0%	48	0	65
1.4.2.3	Plastic		2/03/10	4/09/10	65	0%	48	0	65
1.4.2.4	Glass		2/03/10	4/09/10	65	0%	48	0	65
1.4.3	Plant Emissions		2/03/10	4/09/10	65	0%	48	0	65
1.5	Design User Friendly Approach		2/03/10	4/09/10	65	0%	48	0	65
1	**Lithuanian Group**	Rūta Navickaitė + VGTU Group	1/11/10	4/30/10	66	0%	80	0	66
1.1	Meet With IIT peers		2/08/10	2/08/10	1	100%	1	1	0
1.2	Research		2/08/10	4/09/10	60	0%	45	0	60
1.2.1	Fuel Efficiency of Cars		2/08/10	4/09/10	60	0%	45	0	60
1.2.1.1	Electricity/Hybrid		2/08/10	4/09/10	60	0%	45	0	60
1.2.1.2	Gas		2/08/10	4/09/10	60	0%	45	0	60
1.2.1.3	Diesel		2/08/10	4/09/10	60	0%	45	0	60
1.2.1.4	Biodiesel		2/08/10	4/09/10	60	0%	45	0	60
1.2.1.5	Hydrogen		2/08/10	4/09/10	60	0%	45	0	60
1.2.2	Materials used in Cars		2/15/10	4/09/10	53	0%	40	0	53
1.2.2.1	Steel		2/15/10	4/09/10	53	0%	40	0	53
1.2.2.2	Aluminum		2/15/10	4/09/10	53	0%	40	0	53
1.2.2.3	Plastic		2/15/10	4/09/10	53	0%	40	0	53
1.2.2.4	Glass		2/15/10	4/09/10	53	0%	40	0	53
1.2.3	Plant Emissions		2/10/10	4/09/10	58	0%	43	0	58
1.2.4	Design User Friendly Approach		2/08/10	4/09/10	60	0%	45	0	60

V. Expected Results

The project's goal is to develop a “user friendly” way of identifying vehicles with respect to emissions of greenhouse gases (GHG) throughout their life cycle. In order to achieve our team goal, the following results will be pursued:

- Educate individuals about the effects of greenhouse gas emissions:- with growing concerns of global warming due to the high record levels of fuel burning , it is important for the public to understand what measures it needs to take to reduce such emissions.. This would promote proper maintenance of the earth as well as significantly reduce the rate of sicknesses and diseases.
- Gather and compare data on carbon footprint for vehicles:- research will be done on the gas emissions of specific cars in both Lithuania and the United States
- Compile research to develop a metric system: information from the research of fuels, the EPA requirements, and vehicles would help us develop an effective method to determine the amount of carbon footprint emitted per automobile. As a result, individuals would be more environmentally conscious.
- Analyze compiled information: the gathered information will be analyzed to investigate the cost of implementing the metric system and whether it should be used for all cars or only specific ones.

We at IIT cannot seclude our partners at VGTU (Lithuania). Both university teams hope to not only successfully develop a way to make a "user friendly" way to identify GHG emissions, but to show that two parties from separate countries can find solutions for people other than the native people they represent. Our groups come from different continents and we hope that we can through this project assist other countries in developing successful plans and helping those outside their own boundaries.

Obstacles

Some difficulties we might encounter during the course of this project include:

Inadequate technologies: availability of technology to develop a simple device for tracking GHG emission may be limited. People generally like technologies to be both "user friendly" and easy to use. Although entire public is not technologically inept, it is important that new technologies are easy to adapt to when purchased at first.

Communication difficulties: even though both VGTU and IIT students are working via IIT-TV and Internet, communication could prove difficult because we cannot speak with ourselves as often as we may like. Due to time differences, more time management and special arrangements will be needed to have successful working sessions.

VI. Budget

Activity	Cost	Description
Transportation	**$100**	**Trips to oil refineries (BP Gas and car dealerships**
Final Project/Presentation	**$150**	**Cost of binding, printing, posters, brochures, supplies, etc.**
Goal Parties	**$100**	**Food and drinks**
Miscellaneous	**$50**	**Anything else that might come up during the semester**
Total	**$400**	**Projected total**

VII. Designation of Roles

Minute Taker: Rajiv Bais and Teodora Vasilev. Raj and Teodora will be responsible for recording decisions made during meetings and class sessions, including task assignments or changes under consideration. They will upload the minutes onto iGroups immediately after every class session.

Agenda Maker: James Burian, Seantoia Swanston and Mary Yu. As the leaders of the class, James, Seantoia, and Mary will create an agenda for each class session. The agenda will provide structure to the meetings and offer a productive environment.

Time Keeper: Andrew Fournier. Andrew is responsible for making sure meetings go according to the agenda.

iGroups Moderator: Won-Jae Yi. Won-Jae will be responsible for ensuring that the IPRO deliverables are completed on time and properly uploaded to the iGroups website. He will also responsible for organizing iGroups account, updating the calendar, and organizing the files.

VIII. Appendix A

IPRO 322 - Roster		
Team Member	**Major**	**Contact Information**
Bais, Rajiv	Political Science	rbais@iit.edu
Burian, James	Mechanical Engineering	jburian@iit.edu
Choi, Lien	Molecular Biochemistry Biophysics	lchoi@iit.edu
Fournier, Andrew	Biochemistry	afournie@iit.edu
Mora Andres	Computer Engineering	amora2@iit.edu
Rafalko, Susan	Computer Engineering	srafalko@iit.edu
Shonekan, Morayomola	Electrical Engineering	mshoneka@iit.edu
Swanston, Seantoia	Political Science	sswansto@iit.edu
Vasilev, Teodora	Architecture	tvasilev@iit.edu
Yi, Won-Jae	Computer Engineering	wyi3@iit.edu
Yu, Mary	Biomedical Engineering	myu8@iit.edu

IX. Appendix B

Team Information - Skill Set and Expectation List			
Team Member	**Strength**	**Knowledge/Skills to Develop**	**Expectations for the Project**
Bais, Rajiv	Sociable, motivated, hard working, dedicated, skilled in Microsoft Word, Excel, Adobe Photoshop, and Matlab. Fluent in English, Spanish, and Hindi	Understanding of current cars' contribution to greenhouse gas effect. Learn about emissions standards in US as well as in Europe through communication with our counterpart in Lithuania.	Emphasizing team work amongst ourselves and developing strong communication skills with classmates here and at VGTU (Lithuania). Gain more knowledge about carbon footprint emitted from cars and ways to relate and create better understanding of this information to consumers.
Burian, James	Hard worker, organized, good leadership skills, works good in groups, great at hands on type of work	I would like to be more efficient in a group setting and grow my leadership skills, as well as learning more about the effects of carbon emissions caused by automobiles	To gain a better knowledge on carbon emissions and its effects on the environment. To work well in a group with our our Lithuanian counter parts and our team here.
Choi, Lien	Friendly, good in groups, a fair understanding of automobiles	collaboration skills, communication skills on a project	Would like to use this as a medium to work on some team skills and would like to get a better understanding of policy making in general; especially one that could have

			global impact.
Fournier, Andrew	Ability to find compromise, can use most basic computer programs, can follow directions.	Knowledge of current car types, insight to the pollution vehicles leave behind, ability to work with people who are in different parts of the world.	Learn about and educate others about carbon footprints from vehicles. Learning how to communicate and work on the same project together with our Lithuanian counterparts.
Mora Andres	Hard working and capable. Proficiency in Microsoft Word, Excel, PowerPoint, programming languages and more. Fluent in English and Spanish.	More about every stage in which a car produces any emission of greenhouse gases, and how to measure it effectively.	To be able to develop a way to measure the carbon footprint a car emits, while doing it in an efficient way, without adding more, or leaving out any data.
Rafalko, Susan	Hard worker, organized, work well in groups, dedication, proficient in Microsoft Word and Excel. Fluent in English and Polish.	Knowledge about current cars' effect on the world in terms of the greenhouse gas effect from every aspect. Develop leadership skills and ability to work with people from different parts of the world.	Show consumers the carbon footprint of the vehicles they drive in a way that they will understand and use wisely. Strengthen communication and team work skills.
Shonekan, Morayomola	Pspice Schematic,Microsoft word, Microsoft Excel,Research	gain better understanding of the green house gases emitted from automobiles and possible measures to reduce such emissions	Although there has been so much talk about Carbon footprint and Green House Gases, I hope that through this project, the public would be further enlightened and properly educated on these issues.

Swanston, Seantoia	I am well organized.I am a great Leader and have been trained in that area. I Work very well with other people.I carry a very heavy international background.	Would like to gain more knowledge about about cars and develop skills outside of my Political Science major.	I expect to learn a lot more about global warming and to have this project impact my life as well with regards to lessening my carbon emissions.
Vasilev, Teodora	Motivated, positive,work well with other people, professional, friendly, proficient in Adobe Photoshop, Illustrator, Autocad, Rhino, Revit, 3-d modeling,Photography. Fluent in English, Bulgarian and Spanish.	I would like to learn more about carbon foot print of vehicles, fuels and their production. I would also like to strengthen presentation and communication skills.	Take the research on the link between Co2 emission from cars/fuels and global warming to the next level. As well as alternative fuel use and specialty cars (like hybrids, fuel cell, natural gas etc..) if they contribute to cleaner air or decreasing the Co2 in the air/atmosphere and to what extent. Inform consumers of our research, raise awareness about carbon foot print.
Yi, Won-Jae	Microsoft Word, Excel, PowerPoint, Adobe Photoshop and confident in computer-related works, co-operative, tries to be a perfectionist.	Understanding of automobile emission effects and standards in the U.S. and Europe.	Gain confidence in intercommunicating with teammates, especially with partners overseas. Acknowledge carbon footprint effects on current global warming issue. Think broader and break from Computer Engineer's aspect.
Yu, Mary	Organized, motivated, proficiency in Microsoft Word, Excel,	Understanding of current cars' contribution to	Strengthen team work and communication skills

	Adobe Photoshop, Scion Imaging, and Matlab. Fluent in English and Mandarin.	greenhouse gas effect. Learn about emissions standards in US as well as in Europe through communication with our counterpart in Lithuania.	with classmates here and in Lithuania. Strengthen knowledge of carbon footprint emitted from cars and ways to relate this information to consumers.