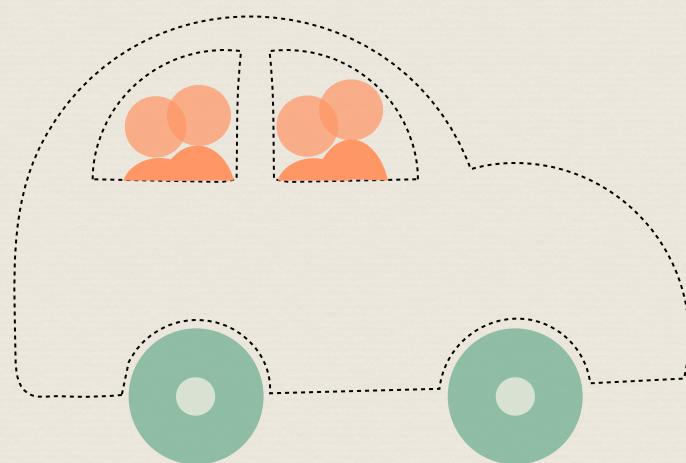




CARPOOLING FOR A BETTER WORLD



INDUSTRIAL ANALYSIS REPORT

Global Manufacturing Strategy

Tsinghua University

2015

“ BY SHARING WE
STAND
PREPARED TO
BUILD
RELATIONSHIPS AND
GIVE WINGS TO
HUMANITY. ”

A GROWING MARKET

The market of carpooling is much diversified. It include the individual user who shares his car with his colleagues, the student who user carpooling to have cheap travels and the one who use it to reduce his impact on environment.

We can group these different actors in the following categories:

- **Usage for daily travels**
- **Usage for long travels**
- **Carpooling organization inside a company**
- **Business companies proposing carpooling**
- **Institutional carpooling systems**



REAL IMPACTS OF THE ENVIRONMENT



Even if this is not the first motivation of carpoolers, reducing the number cars on the road will reduce the pollution.

By taking the decision to use carpooling, the users can contribute to the protection of the planet.

This awareness regarding the environment is also a motivation for the companies to propose carpooling services for its employees and encourage them to reduce the CO₂ emissions at their scale.

NEW TECHNOLOGIES

Dynamic carpooling consists on managing a continuous access to the carpooling available offers. A real time access is provided through a continuous updating of the offers and the demands

The popularization of smartphones, tablets, connected devices, free access to the Wifi, GPS, 3G, 4G, the ‘in real time’ became totally possible and accessible for all people.

Then the implementation of decentralized systems like Multi-Agent Systems (MAS) or Blockchain will help the market to grow. The objective of these Agents is to successfully associate the different users through an optimization process subjected to several, complex and variable constraints.



PUBLIC POLICY AND SOCIAL ASPECTS

The market is highly dependent on the public policy and the social awareness. If these two aspects could be an opportunity, some public policies are obstacles for the development of this kind of markets.

Due to the high competition in the transportation industry, some countries prefer to protect the classic market from this kind of activities.



This IAR will study the differences of Law and Culture in different countries to try to highlight the points that are going to help this market.

About Autors



Massine AKILAL

« After a preparatory class in France, I entered an engineering school specialized in Mechanics and Energy. After two years in this school and an Internship in automotive industry, I decided to take a double degree program in Tsinghua University.

For me it was an opportunity to study abroad first and then to study Industrial Engineering completing my initial background in mechanics. »



Morgane BARILLET-GENESTIER

« I am French and I have a professional bachelor in Quality Management.

After my graduation, I worked for Airbus SAS in Toulouse (France) for 1 year. I was in charge of several suppliers as Supplier Operation Manager in the Procurement team.

I finally had the opportunity to integrate the Industrial Engineering Department in Tsinghua University to do a Master degree in Management of Science and Engineering. It is a real chance for me to finalize my academic cursus and improve myself in a lot of domains. »



Santiago COELLO

« I am from Guayaquil, Ecuador. I received my Bachelor Degree in Mechanical Engineering in ESPOL university, Ecuador.

I am a candidate master student in Management Science and Engineering, Chinese Program, at Industrial Engineering Department in Tsinghua University, focused in logistic and supply chain area."

MyCHE_车 is a group consisting of 3 graduate international students at Tsinghua University. They come from two different countries : France and Ecuador.

This report was written as a part of « Global Manufacturing Strategy' course by the Industrial Engineering Department during the Spring Semester 2015.

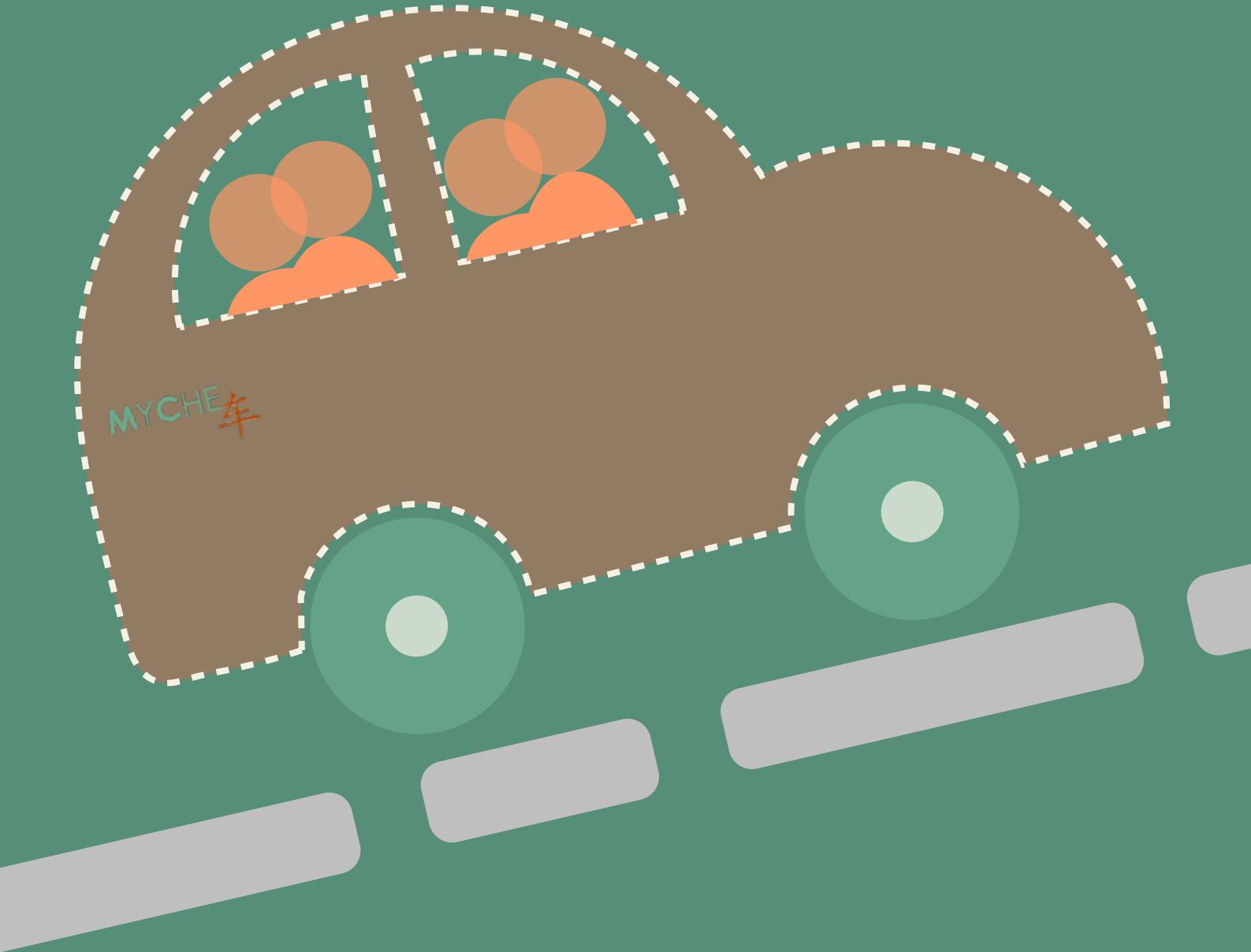
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The contents of this report deals with different elements : history of carpooling, market and technology analysis, law and public policy and social awareness.

Based on this, this report propose a discussion about the future of carpooling.

Introduction

Objective



EXECUTIVE SUMMARY

INTRODUCTION

Concept of Carpooling

Carpooling over the years

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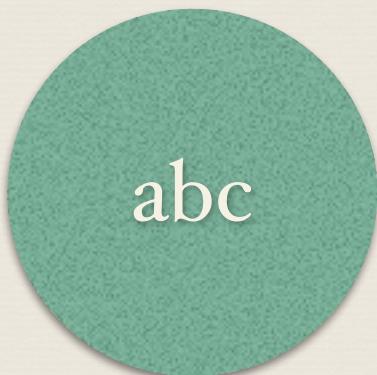
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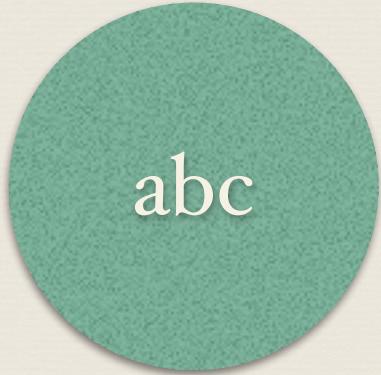
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Introduction

Concept of Carpooling

Carpooling is an option whether or not own or drive a car. If someone know that travel the same route as a neighbor or co-worker, consider arranging to carpool or ride-share. Carpooling is seen as a more environmentally friendly and sustainable way to travel as sharing journeys reduces carbon emissions, traffic congestion on the roads, and the need for parking spaces. Authorities often encourage carpooling, especially during high pollution periods.

Carpool commuting is more popular for people who

work in places with more jobs nearby, and who live in places with higher residential densities. Is significantly correlated with transport operating costs, including gas prices and commute length, and with measures of social capital, such as time spent with others, time spent eating and drinking, and being unmarried. Is significantly less likely among people who spend more time at work, older workers, and homeowners.



Carpooling - Wikipedia

Carpooling over the years

1

World War II car sharing clubs
(1942-1945)

2

Energy crises (1970-1980)

3

Early organized ride sharing schemes
(1980-1997)

4

Reliable ride sharing systems
(1999-2004)

5

Technology-enabled ride matching
(2004-today)

1942-1945

World War II car-sharing clubs

Focus on conserving resources for the war. Car sharing clubs exchange and self-dispatching system. Matched riders and drivers via bulletin at work.

Propaganda for Carpooling during the Second World War. Sources: Oregon State Archives, US Archives and Records Administration

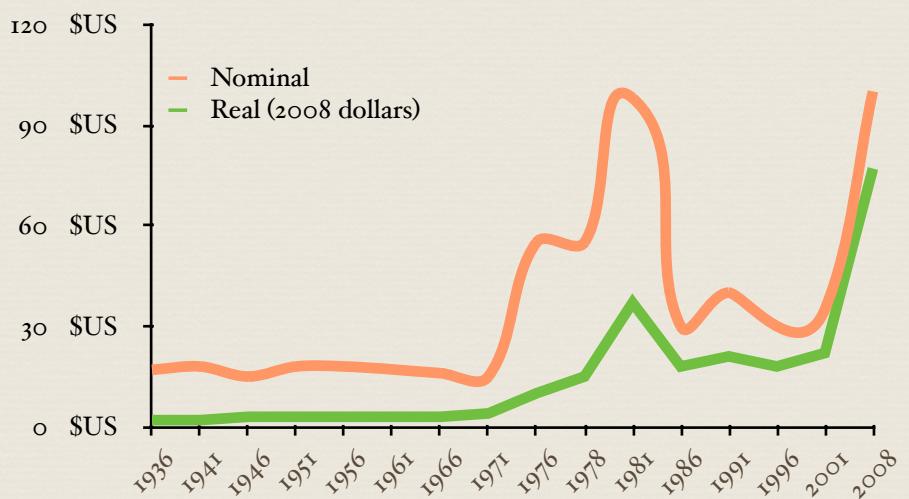


1970-1980

Major responses to the energy

Grew significantly in the 1970s in response to the energy crisis and the Arab oil embargo of 1973 to 1974. Focus on conserving fuel. Employer and government sponsored ridesharing projects.

Oil Prices



Early organized ride sharing schemes

1980-1997

Focus on mitigating traffic congestion and air quality issues.
Telephone based ride matching.

Reliable ride sharing systems

1999-2004

Focus on mitigate traffic congestion. Online ride matching services.
Traveler information services.

Technology-enabled ride matching

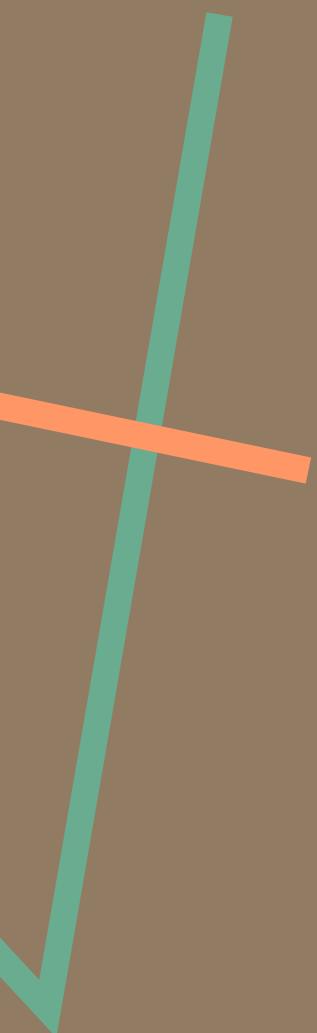
2004-today

Focus on reducing climate change. Financial incentives for “green trips” through sponsors. Growing dependence on foreign oil and traffic congestion. Partnerships between ride matching software companies and regions and large employers. Internet, mobile phones, and social networking platforms. Real time ride sharing services.

Part I



Market Analysis



Part I: Market Analysis

In 2010, 1 000 millions cars passed

In 2004, 87 millions cars were produced

This period encompasses the fifth ride sharing phase, called: “technology-enabled ride matching”. In this period is most notable for the widespread integration of the Internet, mobile phones, and social networking (i.e. an online community where individuals connect and interact) into ride sharing services. At present, the majority of North American ride matching services use online websites as their chief technology medium. Many of them are based on a ridesharing software

platform purchased from a private company. As of July 2011, there were approximately 12 such companies in North America that offer this software. (E.g. Ecology and Environment, Inc. offers Green Ridew, and Pathway Intelligence Inc. provides Jack Bell Ride-Share). While the abundance of online ridesharing systems is promising, it has resulted in disparate, non-standardized databases that leave many programs with a lack of critical mass.

There are approximately 638 ride matching programs in North America.

As of July 2011, the authors estimated that there were 638 ride matching services in North America, based on an extensive Internet search. This tally includes both online (most have an Internet-based component) and offline carpooling and vanpooling programs. Those located in sparsely populated

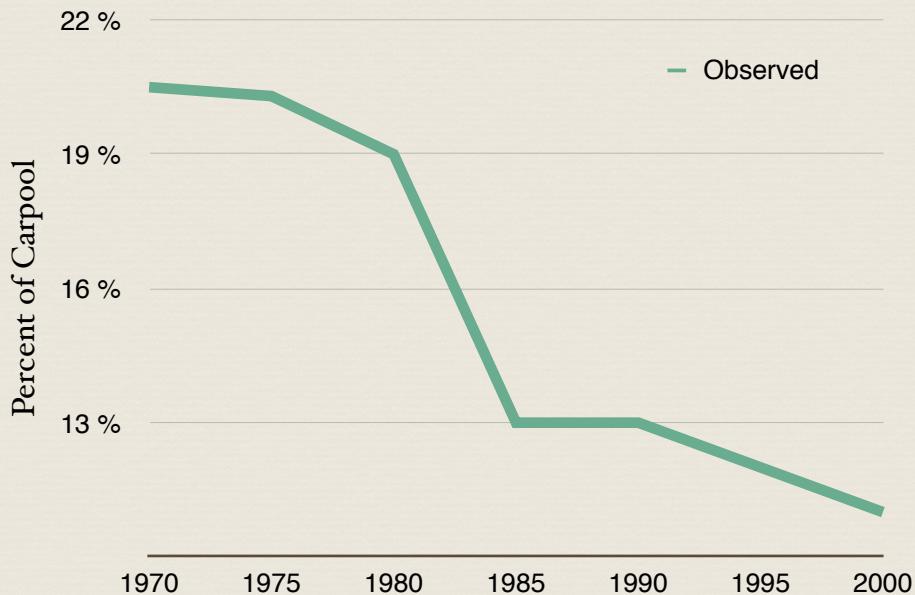
rural areas, which appeared to have very low use, were excluded. Institutions that have their own ride matching website but employ a common platform were each counted separately. Of the total, 401 are located in the USA, and 261 are in Canada (24 programs span both countries). Carpooling attracts the largest focus, with 612 programs offering ride matching, and 153 providing vanpool ride matching; 127 offer both.

The future is the share economy

3 000 million people have access to internet

Market size and growth

Observed carpool trend in the United States 1970-2000



Source: The rise and fall of the American carpool: 1970–1990, Erik T. Ferguson & Associates, P.O. Box 888729, Dunwoody,

International comparison of work trip modes shares.

Nation	International Comparison of Work Trip Mode Share						
	Personal Vehicle, Driver	Personal Vehicle, Passenger	Public Transit	Walked	Cycled	Other	Carpool & Public Transit
United States	78.2%	12.6%	4.7%	3.0%	0.4%	1.0%	17.3%
Canada	73.8%	6.9%	10.5%	6.6%	1.2%	1.0%	17.4%
UK	62.0%	8.0%	14.0%	11.0%	4.0%	1.0%	22.0%
Australia*	71.0%	7.6%	8.5%	4.7%	1.2%	7.1%	16.0%

Sources: US Census, 2000 Journey to Work, StastCan, 2001 Commuting Patterns of Canadians, UK DfT, 1999 National Travel Survey, ABS, 2001 Census of Population & Housing

North American Ride matching Services (July 2011).

612 Carpooling

143 Vanpooling

Sources: ITS Berkeley, Transportation Sustainability Research Center

Ride matching platform partnerships

From 2004 to the present, a new generation of ride matching platforms has been developed for regions and employers to use. Moreover, there has been significant growth and overall success with this strategy. Partnerships between ride matching software companies and its large-scale clients take advantage of existing common destinations and large numbers of potential members. These firms sell their ride matching software “platforms” to public agencies and employers, which are sometimes used as standalone websites for each group. While this partnership strategy has gained more users than previous ridesharing phases, it is most suited for commuters with regular schedules.

« Green trip » sponsored incentives

Many public agencies and companies promote ridesharing by providing its members with incentives. One example is NuRide—an online ridesharing club with over 63 000 members in seven US metropolitan areas (NuRide, 2011). NuRide rewards points when members carpool, vanpool, take public transit, bike, walk, or telecommute for both work and personal trips. These points can be used for restaurant coupons, shopping discounts, and attraction tickets. NuRide partners with public agencies, employers, and businesses to sponsor the incentives. Similarly, RideSpring works with employer commute programmes and participating employees can enter monthly drawings for prizes from over 100 retailers (RideSpring, 2010).

Social networking platforms

The rise of social networking platforms, such as Facebook, has enabled ridesharing companies to use this interface to match potential rides between friends or acquaintances more easily. These companies hope that social networking will build trust among participants, addressing safety considerations.

One example is Zimride, which has partnered with 86 US and Canadian colleges, universities, and companies that each has their own “network” of

members (Zimride, 2011). In addition to each network’s website, Zimride also uses the Facebook platform to attract public users.

Another service is PickupPal (2011), with over 156 000 members in 120 countries. It allows members to create their own groups based on common area, company, school, and shared interests. However, social networking may limit itself by relying on more isolated groups and excluding less tech-savvy users.

In North America, two companies are beginning to offer real-time ridesharing services: AvegoTM and Carticipate.

Real-time ridesharing uses Internet-enabled “smartphones” and automated ridematching software to organize rides in real time. This enables participants to be organized either minutes before the trip takes place or while the trip is occurring, with passengers picked up and dropped off along the way.

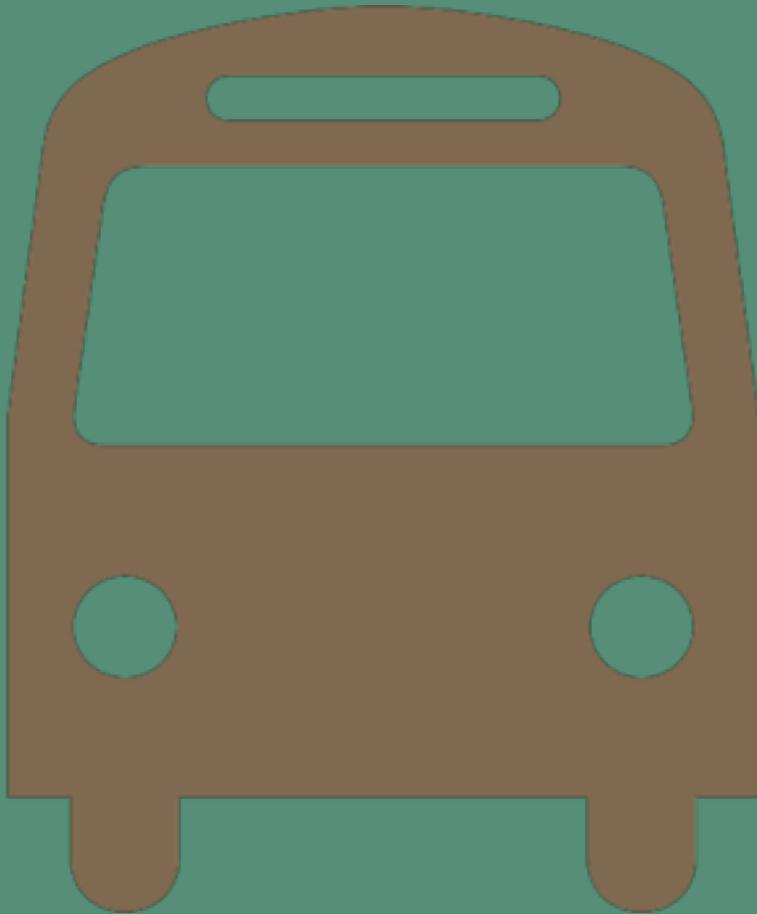
These programmes attempt to address the inconvenience of traditional carpooling and vanpooling. As in most ridesharing services, a high subscriber base is required. These key developments and their target journey purposes are summarized in Table 3.

Real-time ridesharing services

Part II



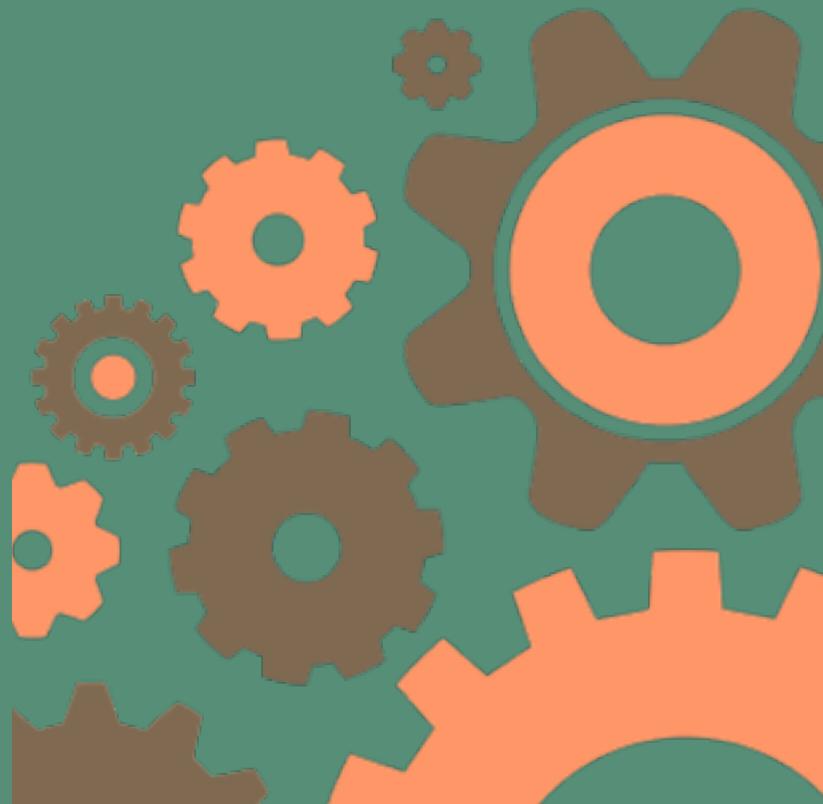
Transportation Analysis







Part III



Technologies Analysis



Static carpooling

Most of carpooling systems could be described as static carpooling systems. The implementation of the concept is usually made through a simple website which can only save and display the available offers. The only advantage of this solution is the simplicity of implementation. A registration is required from potential users to have access to the full functionalities of the website. But unfortunately, the provided functionalities consists only in adding or consulting the offers with different options like the type of the car that don't change anything to the transportation problematics. For those websites, a data base is necessary to save the uploaded offers and answer the consultation requests. The only technological aspect that is important to deal with is the storage capacity which is absolutely not a problem nowadays. Indeed the management of those databases is very simple.

The websites like Blablacar is included in this category. The consultation of the offers is public but all other functionalities are accessible after a registration. After accessing the result of research on the database, the user can exchange some messages with the driver for the details. All the communications are made publicly and on the website. The carpoolers can have access the personal contact of each other only after buying and finalizing the transaction. Other website, with nonprofit objective, can give access to the personal contacts directly on the offer to reduce the number of operations made on the website.

The success of those systems doesn't guarantee a stability for those companies. Indeed, regarding the development of new technologies and the evolution of people's habits, the existing websites are becoming obsolete and a modification of the technologies seems to be a must.

Dynamic and flexible system

This is a new concept in the area of carpooling and transportation in general. It consists on managing a continuous access to the carpooling available offers. A real time access is provided through a continuous updating of the offers and the demands. The development simultaneous development of this new “Smart” concept and the new technologies is not a coincidence. Indeed with the popularization of smartphones, tablets, connected devices (particularly for the cars), free access to the Wifi, GPS, 3G, 4G... the ‘in real time’ became totally possible and accessible for all people. This evolution is directly relevant to the carpooling industry in the way that it is going to transform and change this industry by giving more solutions to solve the problem of flexibility.

But even if the access to these technologies is a big opportunity for all the companies in the transportation industry, the all potential of this situation is not exploited. The major part of the startup projects have been failed due to security problems, automation of the procedure and optimization in the process of offers association. But all the concepts developed are based on one unique technology which is the recuperation of GPS position in real time and sharing it with

Technologies to boost the market

A distributed system for more flexibility

Solving the problem of flexibility of carpooling is a major challenge for all the companies in this industry. Regarding the dynamic aspect of carpooling environment, a good carpooling system has to be adapted to this evolving environment. Indeed the variation speed of the inputs are a major obstacle for the development of reliable system. The collection of data is made through a large area and large number of users. The prediction of evolution of those data (like the position of cars, the time that people need to carpool...) through statistical methods become impossible. The only solution is making a dynamic model of the network with decentralized decision making. It means that the decision of association a user to a car must be done autonomously.

This aspect could be implemented by decentralized systems like Multi-Agent Systems (MAS) or Blockchain. The objective of these Agents is to successfully associate the different users through an optimization process subjected to several, complex and variable constraints. The choice of using MAS is directly related to the variation, the increase and the distribution of information sources. Indeed, in the classic systems, when the size of the network increases the complexity of the medialization became high and the limits of the systems are revealed. But with the MAS, the size of network increases the relevance of the solution. Indeed, managing a high number of data sources is not a constraint anymore. Then, the system become interesting because it offers more possible solutions.

Optimization in the association of vehicles

Technologies to boost the market

The optimization is a key point for our analysis. Since the development of IT, people started studying optimization applied to different areas. We can easily use the large number of studies about optimization in transportation and specifically in transportation by taxi as a start point for our carpooling problem. Indeed, we can easily identify similarities between a taxi network and a carpool network especially for travels home – work.

In the carpooling industry, some optimization algorithms have been developed but not in order to make the system more flexible. Those algorithms focus more about associate rides after collecting static data. Indeed, two limitations can be listed.

- The first one is the limitation of geographic area. Indeed, if we look to carpooling websites that use optimization concept, we can notice that the geographic area is limited to one company, one university or one small organization.
- The second one is the problem of flexibility. The results that have been applied don't take in consideration the dynamic aspect of problem. After making the combinations and association of drivers and passengers, the system will not be able to adapt to other situation like an introduction on a new user (driver or passenger), modification of location of one of them....

If we assume that the taxi optimization problem is a good starting point, we have to emphasize an important point which is specific to the carpooling system. Indeed, for the taxi problem, we need to associate clients to drivers. For this we consider the current positions of the taxi, the initial and the final positions of the clients. In the carpooling system, the driver and the client have two different objectives. It means that the driver has his own itinerary and we should consider whether a deviation from the initial itinerary is acceptable or not. It means in the carpooling system, we should introduce a concept of tolerance that is going to quantify to what extent the deviation is important. Users and the arcs are the itinerary that can be taken. These two kind information are automatically updated using GPS localization module. For this part of technology, there is nothing innovative and a lot of applications like Uber are already using this.

The second graph is built by collecting the information, the constraints and the preferences of users. It is built with the initial position, the final position, the number of people and the total duration of the trip. This last variable is calculated using an adapted function and including other parameters like the late time admitted, the tolerance about distance and all constraints that are considered as relevant.

With a similar way, we can build the last graph about the offers. We will build it using the initial position of cars, the destination of cars, the number of available sits, the duration of the trip and also one more parameter which consist in a vector of intermediate destinations. Indeed, to simplify the resolution of the problem, it is better to create a vector that groups all the information about the points that are possible to serve. Doing this, we can easily check if a user's destination can be served by comparing this final destination of the user to the intermediate points of cars.

When this basic concept if developed, we need to develop a strategy of treating the data. For this we are going to use 5 major steps.

- 1** **Acquisition of information**
- 2** **Acquisition of the offers**
- 3** **Building the graphs**
- 4** **Decomposition of the process**
- 5** **Optimization**

Step I:

Acquisition of the

For this step we need to receive all the demands for carpooling and treat them in parallel. For this, the time is one of most important parameters. Each interval of time t , we refresh the entering data and build the new matrix containing the information for the graph of demands.

In this part we need to use 3 major technologies. The first one is the internal clock of the system with a precision of a few seconds or less. Then we need to use GPS inside user's device. If the device doesn't contain any GPS technology, other solutions are possible like using Wi-Fi signal or 3G/4G localization system. Then the last one is the communication protocol. Indeed, to send all these data from a device to another, we need build first a communication protocol which is going to guarantee in one hand, the transmission without any loss of information and in the other hand, the security of users by the cryptography algorithms.

Step II:

Acquisition of the offers

During this step, we are going to perform the same tasks than last part. Also in this part we need to update the data in "continuous" flow. For this we are going to setup a time t before each new acquisition. The technology that we are going to use is the same. But, as we are talking about cars moving, we need to use better quality technology to have accurate data processing. Indeed, if for the users, a simple GPS in the smartphone is adapted, for the car we need to use the integrated GPS with more precision and high frequency of updates.

Step III:

Building the graphs

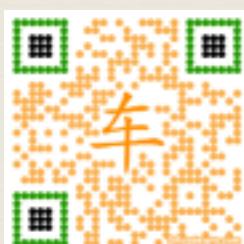
This step is totally virtual and doesn't use any real hardware technology. But even if only algorithms are involved for this step, it is a critical step. Indeed, for the 2 previous steps we defines the way to collect and to store data in Matrix. Then using theories coming from "Graph theory", we are able to build a Graph. Here graph refers to mathematical concept of graphs.

Acquisition of the offers

: Step iv

This step is also a virtual one. It consists on grouping the users and the cars in small geographic areas. In order to simplify the calculations and then reduce the complexity, different studies agreed to group the data within circular areas.

The method that is used is called “hierarchical clustering”



Hierarchical clustering - Wikipedia

Optimization

: Step v

Considering the definition of the problem, the multiple objective optimization seems to be a must. Indeed, more and more problems can't be solved by optimizing one function. Our problem is one of them. The distributed modeling that we choose imposed to use this kind of optimization.

Many possible algorithms and methods can be used to solve this kind of problems. In the literature, and for the multiple objective optimization problems, we can find the following algorithms.

Simulated Annealing using Metropolis algorithm which is based on the research on an equilibria inside the system, Tabu Search for the problems where we need to record the different tries, Evolutionary algorithms and Ant colony which are the most flexible, robust, and decentralized algorithms that we have developed. The only obstacle is the evolution of the research in this area. Indeed, even if the concept is developed, the application on real cases are difficult. Maybe this algorithm will be the future of this industry, but for the moment, the specialists agree to say that the most adapted algorithm for carpooling is the “Dijkstra's algorithm”

Dijkstra's algorithm - Wikipedia



Executive Summary

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Introduction

Concept of Carpooling

Carpooling is an option whether or not own or drive a car. If someone know that travel the same route as a neighbor or co-worker, consider arranging to carpool or ride-share. Carpooling is seen as a more environmentally friendly and sustainable way to travel as sharing journeys reduces [carbon emissions](#), [traffic congestion](#) on the roads, and the need for [parking](#) spaces. Authorities often encourage carpooling, especially during high pollution periods.

Carpool commuting is more popular for people who work in places with more jobs nearby, and who live in places with higher residential densities. Is significantly correlated with transport operating costs, including gas prices and commute length, and with measures of [social capital](#), such as time spent with others, time spent eating and drinking, and being unmarried. Is significantly less likely among people who spend more time at work, older workers, and homeowners.

Carpooling over the years



World War II car-sharing clubs (1942-1945)

Focus on conserving resources for the war. Car sharing clubs exchange and self-dispatching system. Matched riders and drivers via bulletin at work.



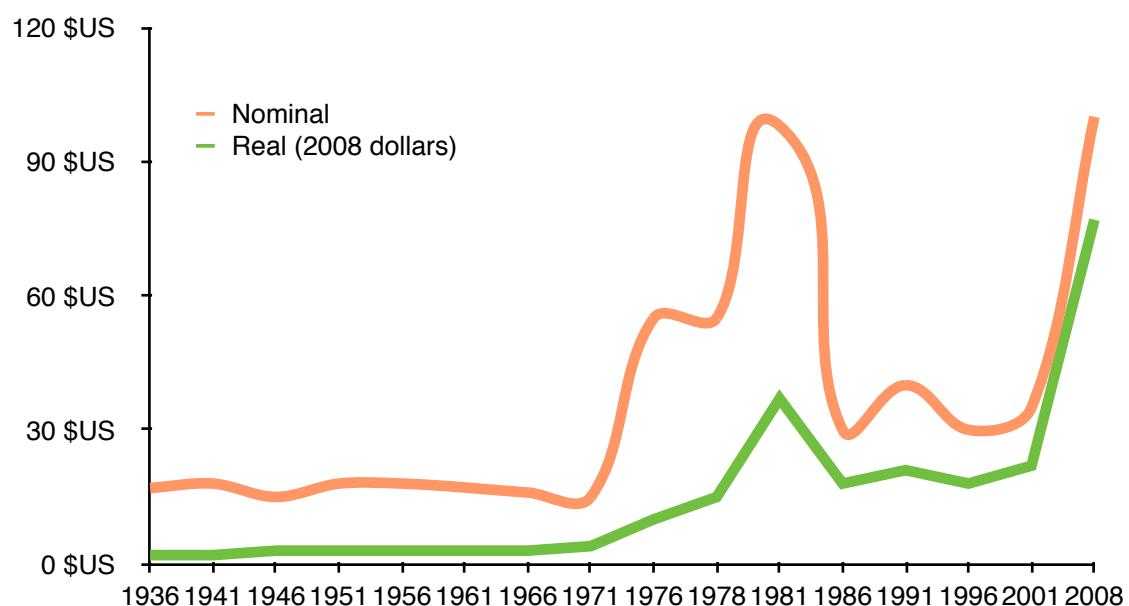
Fig. 1 Propaganda for Carpooling during the Second World War.

Sources: Oregon State Archives, US Archives and Records Administration

Major responses to the energy crises (1970-1980)

Grew significantly in the 1970s in response to the energy crisis and the Arab oil embargo of 1973 to 1974. Focus on conserving fuel. Employer and government sponsored ridesharing projects.

Oil Prices



Oil Prices

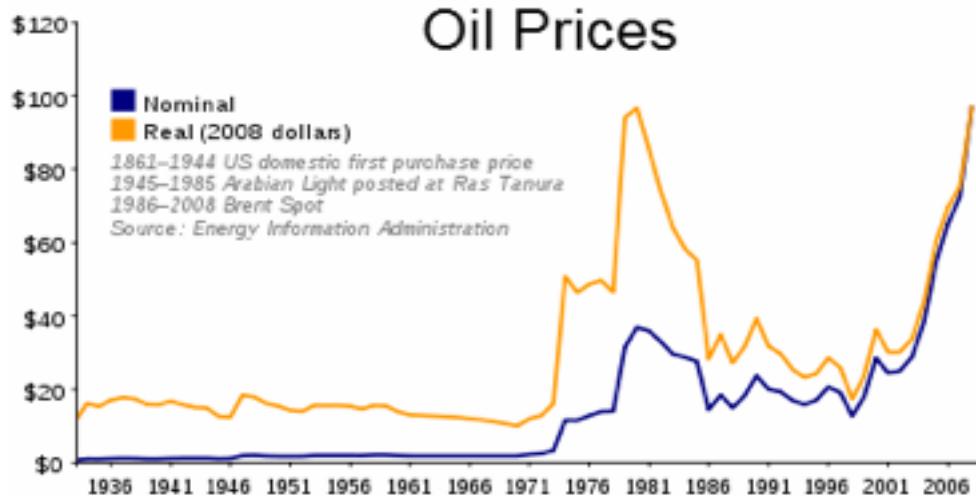




Fig. 3 Cars wait in long lines during the gas shortage in 70's

Early organized ride sharing schemes (1980 - 1997)

Focus on mitigating traffic congestion and air quality issues. Telephone based ride matching.

Reliable ride sharing systems (1999 - 2004)

Focus on mitigate traffic congestion. Online ride matching services. Traveler information services.

Technology-enabled ride matching (2004 - to present)

Focus on reducing climate change. Financial incentives for "green trips" through sponsors. Growing dependence on foreign oil and traffic congestion. Partnerships between ride matching software companies and regions and large employers. Internet, mobile phones, and social networking platforms. Real time ride sharing services.

Part 1: Market Analysis



This period encompasses the fifth ride sharing phase, called: "technology-enabled ride matching". In this period is most notable for the widespread integration of the Internet, mobile phones, and social networking (i.e. an online community where individuals connect and interact) into ride sharing services. There are approximately 638 ride matching programs in North America.

At present, the majority of North American ride matching services use online websites as their chief technology medium. Many of them are based on a ridesharing software platform purchased from a private company. As of July 2011, there were approximately 12 such companies in North America that offer this

software. (E.g. Ecology and Environment, Inc. offers Green Ridew, and Pathway Intelligence Inc. provides Jack Bell Ride-Share). While the abundance of online ridesharing systems is promising, it has resulted in disparate, non-standardized databases that leave many programs with a lack of critical mass.

As of July 2011, the authors estimated that there were 638 ride matching services in North America, based on an extensive Internet search. This tally includes both online (most have an Internet-based component) and offline carpooling and vanpooling programs. Those located in sparsely populated rural areas, which appeared to have very low use, were excluded. Institutions that have their own ride matching website but employ a common platform were each counted separately. Of the total, 401 are located in the USA, and 261 are in Canada (24 programs span both countries). Carpooling attracts the largest focus, with 612 programs offering ride matching, and 153 providing vanpool ride matching; 127 offer both.

Market size and Growth

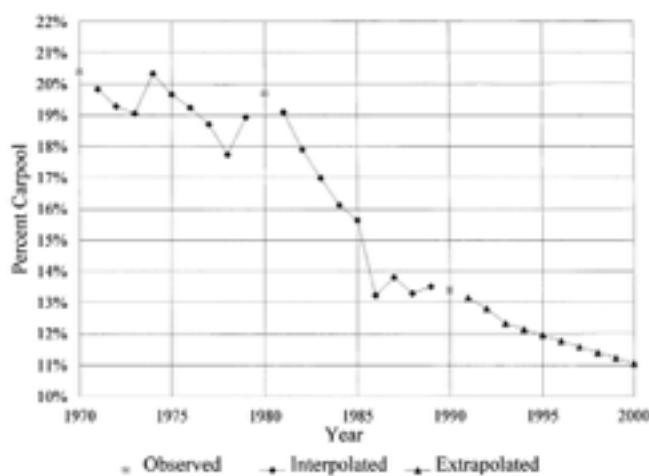


Fig. 4 Interpolated and extrapolated carpool trends in the United States 1970-2000. Source: *The rise and fall of the American carpool: 1970–1990*, Erik T. Ferguson & Associates, P.O. Box 888729, Dunwoody, Georgia 30356, USA

International Comparison of Work Trip Mode Share							
Nation	Personal Vehicle, Driver	Personal Vehicle, Passenger	Public Transit	Walked	Cycled	Other	Carpool & Public Transit
United States	78.2%	12.6%	4.7%	3.0%	0.4%	1.0%	17.3%
Canada	73.8%	6.9%	10.5%	6.6%	1.2%	1.0%	17.4%
UK	62.0%	8.0%	14.0%	11.0%	4.0%	1.0%	22.0%
Australia*	71.0%	7.6%	8.5%	4.7%	1.2%	7.1%	16.0%

Fig. 5 International comparison of work trip modes shares. Sources: US Census, 2000 Journey to Work, StastCan, 2001 Commuting Patterns of Canadians, UK DfT, 1999 National Travel Survey, ABS, 2001 Census of Population & Housing



Fig. 6 North American Ride matching Services (July 2011). Sources: ITS Berkeley, Transportation Sustainability Research Center

Ride matching platform partnerships

From 2004 to the present, a new generation of ride matching platforms has been developed for regions and employers to use. Moreover, there has been significant growth and overall success with this strategy. Partnerships between ride matching software companies and its large-scale clients take advantage of existing common destinations and large numbers of potential members. These firms sell their ride matching software “platforms” to public agencies and employers, which are sometimes used as standalone websites for each group. While this partnership strategy has gained more users than previous ridesharing phases, it is most suited for commuters with regular schedules.

“Green trip”-sponsored incentives

Many public agencies and companies promote ridesharing by providing its members with incentives. One example is NuRide—an online ridesharing club with over 63 000 members in seven US metropolitan areas (NuRide, 2011). NuRide rewards points when members carpool, vanpool, take public transit, bike, walk, or telecommute for both work and personal trips. These points can be used for restaurant coupons, shopping discounts, and attraction tickets. NuRide partners with public agencies, employers, and businesses to sponsor the incentives. Similarly, RideSpring works with employer commute programmes and participating employees can enter monthly drawings for prizes from over 100 retailers (RideSpring, 2010).

Social networking platforms

The rise of social networking platforms, such as Facebook, has enabled ridesharing companies to use this interface to match potential rides between friends or acquaintances more easily. These companies hope that social networking will build trust among participants, addressing safety considerations. One example is Zimride, which has partnered with 86 US and Canadian colleges, universities, and companies that each has their own "network" of members (Zimride, 2011). In addition to each network's website, Zimride also uses the Facebook platform to attract public users. Another service is PickupPal (2011), with over 156 000 members in 120 countries. It allows members to create their own groups based on common area, company, school, and shared interests. However, social networking may limit itself by relying on more isolated groups and excluding less tech-savvy users. At present, there are four major North American ridesharing programmes focused on social networking: GoLocoTM, Gtrot, PickupPal, and Zimride.

Real-time ridesharing services

In North America, two companies are beginning to offer real-time ridesharing services: AvegoTM and Carticipate. Real-time ridesharing uses Internet-enabled "smartphones" and automated ridematching software to organize rides in real time. This enables participants to be organized either minutes before the trip takes place or while the trip is occurring, with passengers picked up and dropped off along the way. These programmes attempt to address the inconvenience of traditional carpooling and vanpooling. As in most ridesharing services, a high subscriber base is required. These key developments and their target journey purposes are summarized in Table 3.

Some companies

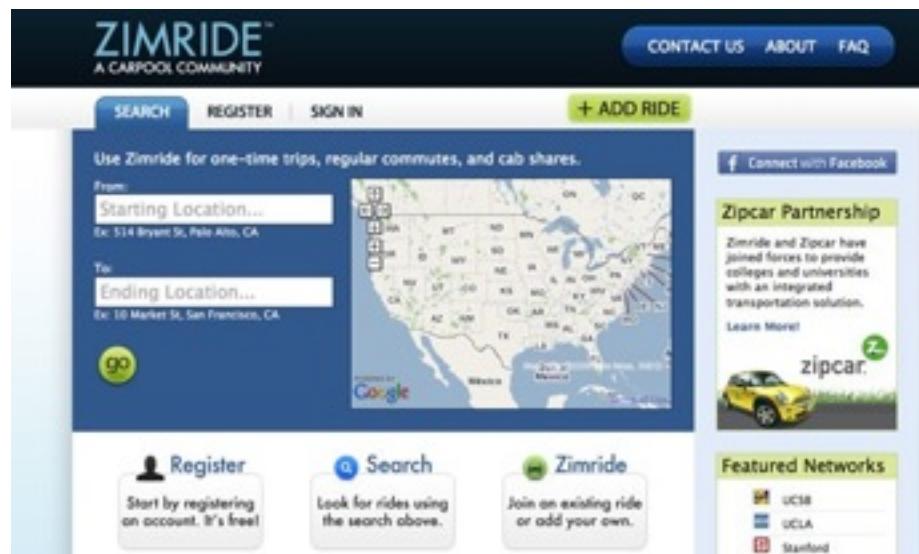


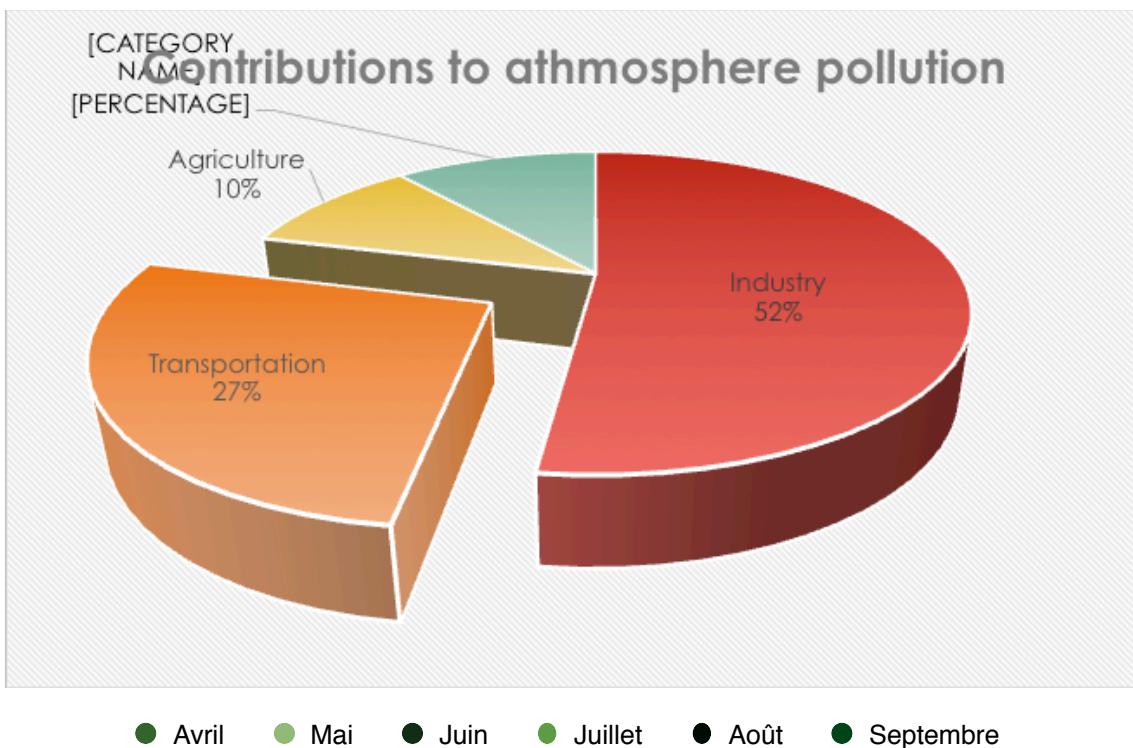
Fig. 7 Zimride.com: Ridesharing with Facebook (USA)



Fig. 8 Nuride.com

Part 2: Transportation Analysis

Environment Impacts



● Avril ● Mai ● Juin ● Juillet ● Août ● Septembre

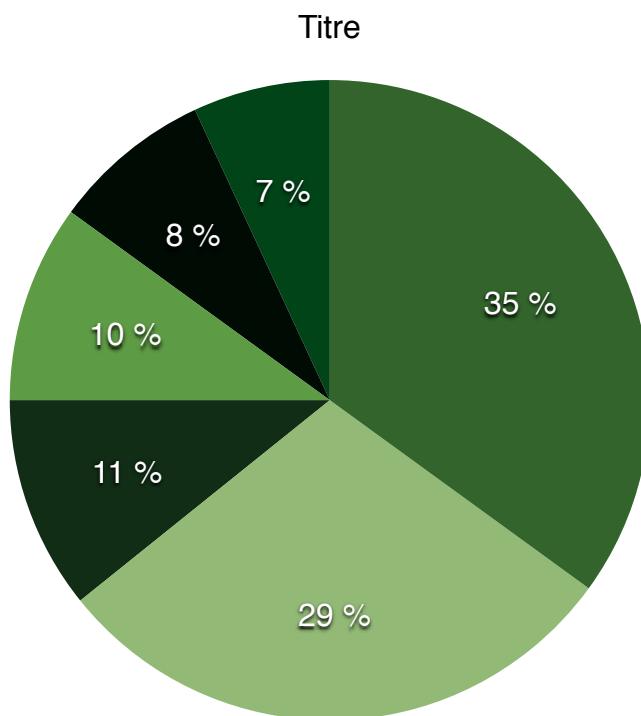


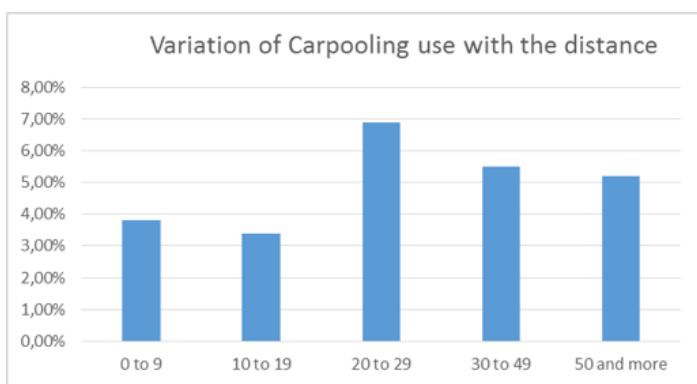
Fig. 9 Contribution on transportation to the atmosphere pollution. Source <http://www.ec.gc.ca>

The part of atmosphere pollution due to the transportation is very high in the big cities. For these areas, we consider that the transportation by road is the first responsible of emission of NOx and PM10 particles. The process of emission of those particles is:



- The VOC (Volatile organic compounds): those particles are emitted directly from the exhaust of cars.
- NOx: some of those particles are emitted by the engine and some others are produced by chemical reactions in the atmosphere due to the NOx emitted.
- PM10 and PM2.5 are emitted or created by the VOCs. Their volatility is due to the traffic.

In this part we are going to calculate the ecological impact of using carpooling. We are limiting our study of ecological impact to the CO₂ emission during the travels. Our statistics are collected from the last ENTD (a French study which is made each 10 years to know how French people are traveling). The study was made with a sample of 20200 representative households of the national (France) tendency.



Those figures are showing that the most important use of carpooling is related to travels between 20 and 30 km.

Fig. 10 Variation of Carpooling use with the distance. Source ENTD 2010

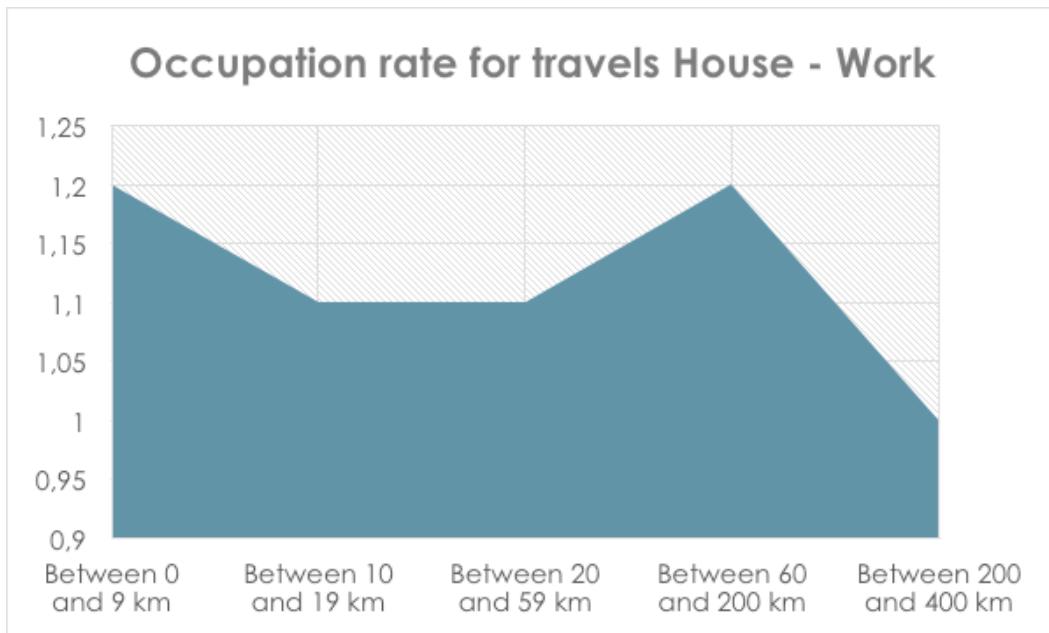


Fig.11

Variation of occupation rate for a type of travels. Source ADEME 2013

Short Distance Trips

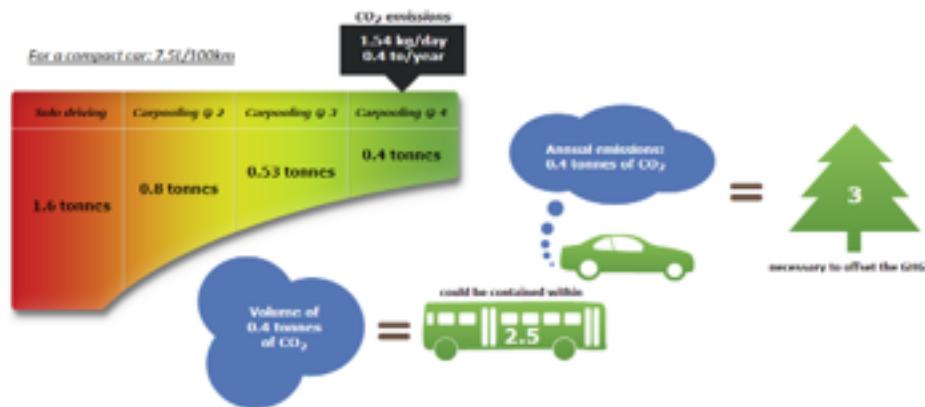


Fig. 12 CO₂ Emissions for different scenarios with small car. Source Canadian ministry of transportation



Fig. 13 CO₂ Emissions for different scenarios with medium car. Source Canadian ministry of transportation



Fig. 14 CO₂ Emissions for different scenarios with SUV. Source Canadian ministry of transportation

We learn from ENTD's figures that, the mean distance between house and work place is 14.7km.

This simulation is made for:

- round trip
- 5 working days per week and
- 52 working weeks in the year.

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- round trip
- 5 working days per week and
- 52 working weeks in the year.

Increasing the occupation rate

From 1.2

To 2



Will reduce the CO2 emissions by

0.71 Tonnes

Per Year, per Car



With



=

- 12%

Of the total emitted in France by transports

Long Distance Trips

From the previous part, we estimated the emission due to short travels and the potential to reduce this value.

Regarding the percentage of long distance trips, and by ponderation operation, we estimate the total reduction of CO2 emissions in France

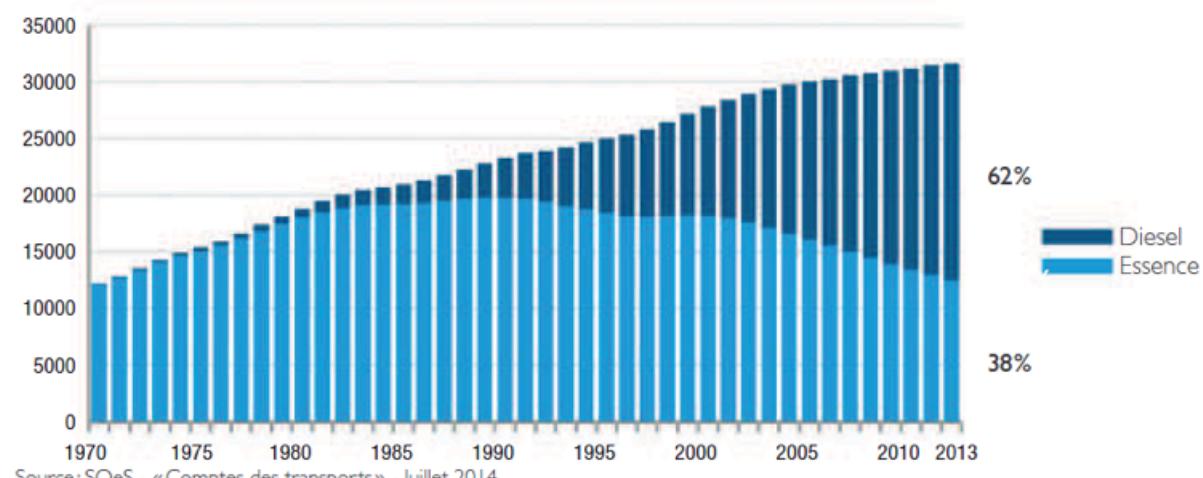


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Transportation Cost



Traffic Flow

Part 3: Technology Analysis

Used Technologies

Limited Possibilities

Technologies to boost the market

Part 4: Law and Public policy

Countries Examples

China



The Directorate General for Competition, Consumer Affairs and Fraud Control (DGCCRF) points out in a press release of February 7, 2014 , that carpooling is permissible under the condition that it is free or that the money paid by people transported corresponds to a cost sharing generated by the use of the vehicle.



USA

The Directorate General for Competition, Consumer Affairs and Fraud Control (DGCCRF) points out in a press release of February 7, 2014 , that carpooling is permissible under the condition that it is free or that the money paid by people transported corresponds to a cost sharing



Government Actions

HOV Lanes

High Occupancy Vehicle Lanes



Restricted traffic lane reserved at peak travel time or longer for the exclusive use of vehicles with a driver and one or more passengers.

HOV Lanes

All over the world



Part 5: Social awareness

Motivations

Oil Prices and Carpooling

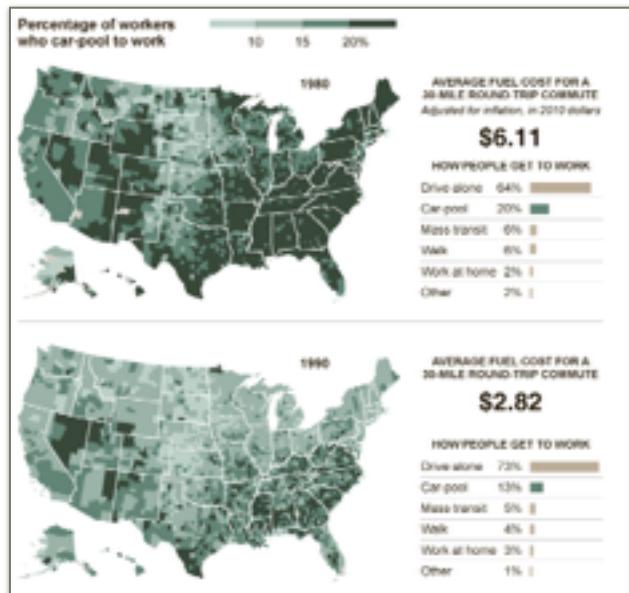
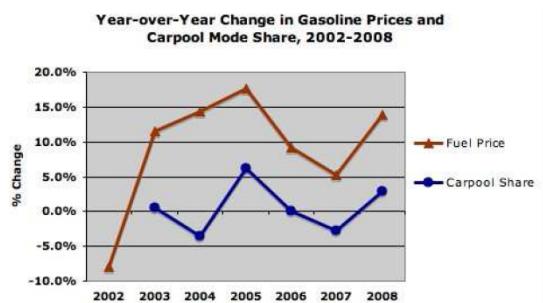
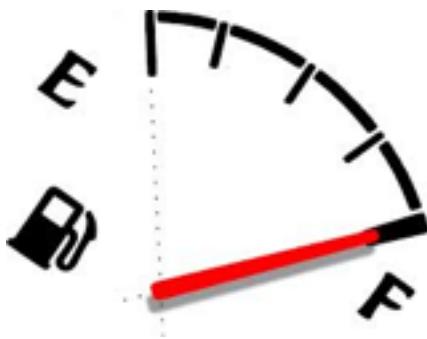


Fig. 13 Relation between oil prices and carpooling, Park, Haeyoun; Gebeloff, Robert (28 January 2011). "Car-Pooling Declines as Driving Becomes Cheaper". The New York Times

Motivations for Carpooling

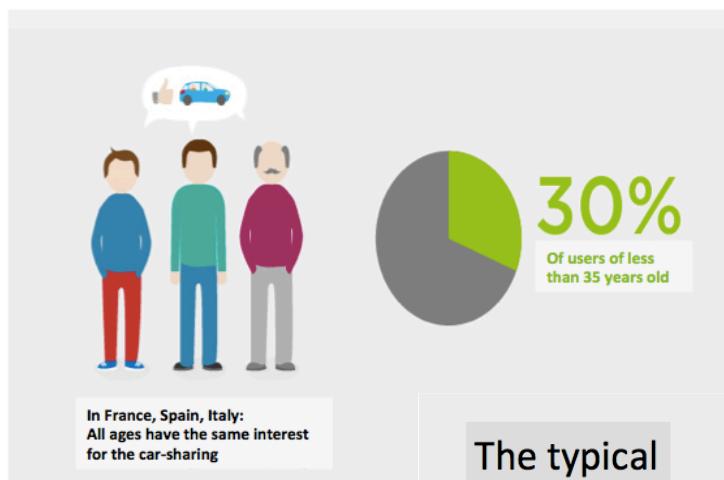
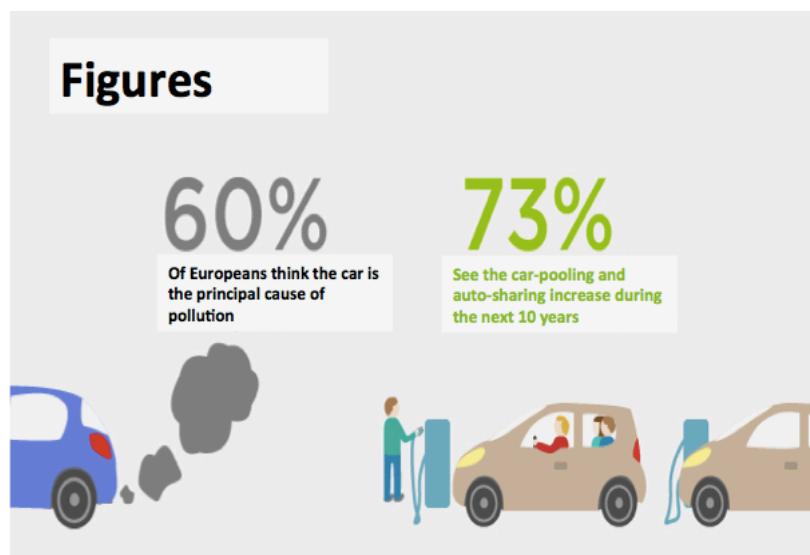
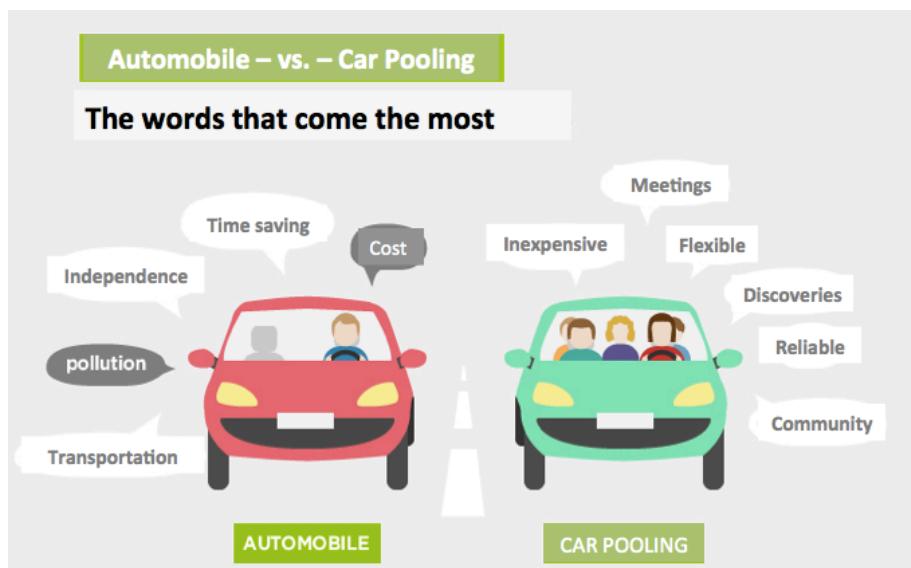
Factor	Frequency Selected	% of Total (N=789)
Sharing vehicle expenses	703	89
Access to HOV lanes	699	89
Enjoy travel with others	691	88
Travel time saving	690	87
Preferred parking at work	687	87
Help environment and society	684	87
Carpool partner matching program	680	86
Encouraged by program at work	677	86
Drop off kids at school/day care	674	85
Reliabilityy of arrival time	666	84
Slitting tolls on toll roads	159	20
Other	109	14
Get work done while traveling	79	10
Relaxation while traveling	77	10

Reasons for not Carpooling

Main Reason	Frequency Selected	% of Total (N=789)
Location and schedule limitation	1682	55
Travel flexibility	1394	45
Need a vehicle during the day	1190	39
Need to make other stops during trip	862	28
Appreciate alone time	567	19
No program to encourage me	417	14
Other	248	8
Like to listen to radio that others do not	175	6
Potential partners have disagreeable traits	125	4

With who you carpool

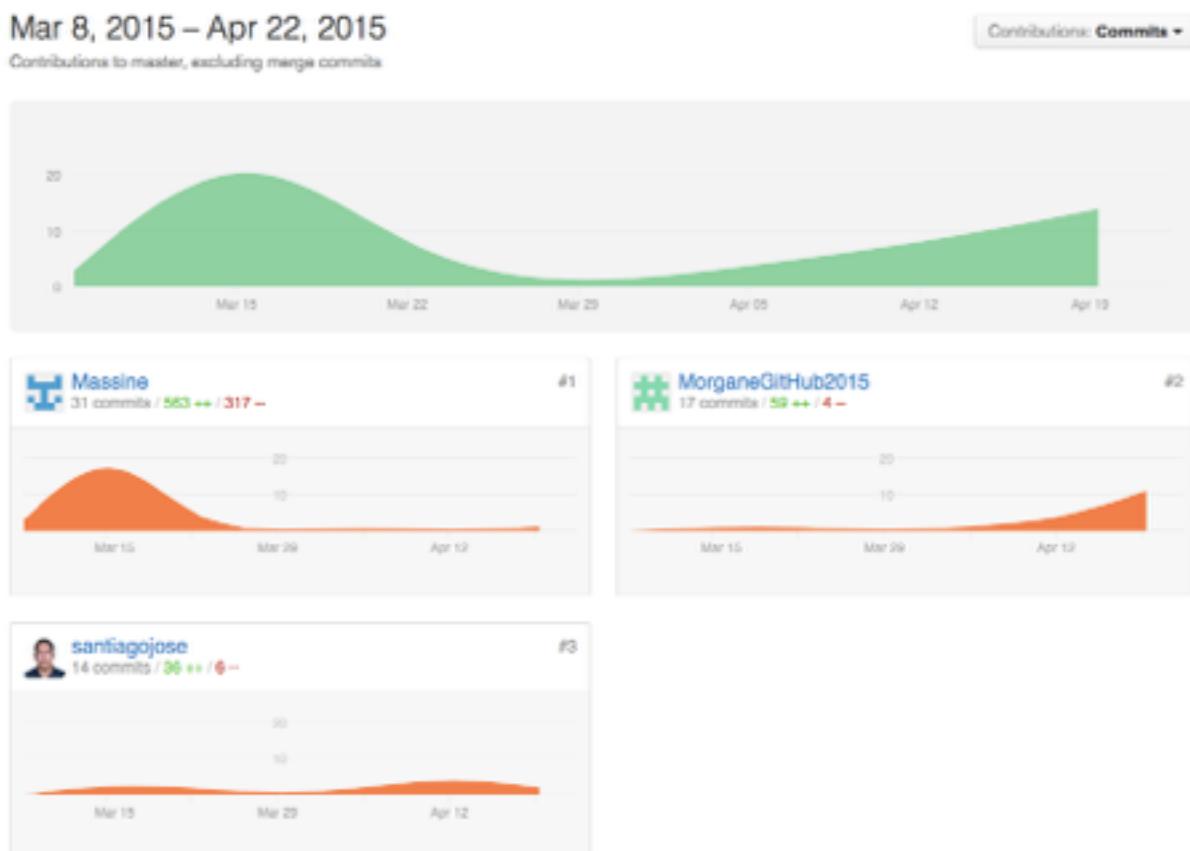
Type of Carpooler	HOV2	HOV3+
	Frequency	Frequency
Adult family member	335	94
Coworker, nearby office building	141	51
Child	91	95
Casual carpooler	22	14
Neighbor	17	10
Other	33	7



Part 6: Challenges

Appendix

GitHub



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