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## **URBAN MOBILITY HUMAN POWERED TRANSPORTATION USER GROUP**

### **Phase1: Problem statement and sub-theme**

Urban mobility is just a too broad theme to be tackled on its own. So in order to be able to talk about it more in depth, and with more detail, we identified the following sub-themes: navigation, human powered transport, self-driving cars, rush hour, infrastructure, and public transport. Our group will focus on the sub-theme of human powered transport.

Human powered transport is a growing issue. In past the 50 years, the population in the cities has augmented drastically, there is an unparalleled number of cars driving around. Because of this, using motorized vehicles as a mean of transport is not always the best solution to move around in a big city, not even considering traffic jams, pollution etc.. Lots of people find it easier to move from point A to B using a bicycle for example. We are growing more conscious about the negative effects of mass motorization, so more and more people are looking for cheaper and cleaner ways of transport. Human powered transport gives way to a several number of challenges, like how do we accommodate the growing number of cyclists in the already overcrowded automobile lanes (even though this subject will be tackled within the subtheme: infrastructure, it's worth mentioning). The economical role that an increasing use of bicycles will have (manufacturing, repair shops etc.) and raises some questions like will the number of non-car related accidents increase? Is it worth to promote the use of human powered transport instead of alternatives like public transport for example?

Human powered transportation is deeply related with other sub-themes, meaning that it plays an important role. We will mention those subthemes when talking about our specific case. For example, rush hour doesn't only affect motorized vehicles, but also cyclists. In the case of self-driving cars, it could bring along a heap of safety issues. Therefore, we would have to see how an automated machine maneuvers when faced with the ,sometimes unpredictable, movements of cyclists. If the number of bicycle users increases exponentially, new infrastructures should be built: cycling lanes to ensure the user's safety, parking lots for bikes, public transportation systems and so on. Hence, within the sub-theme of human powered transport we have chosen our actor to be cyclists. We will also be using the city of New York as a real life example to implement our solutions as it is a city in which human powered transport plays an important role and seems to be a big issue.

### **Phase 2: Problem analysis**

#### **2.1. User, society, enterprise**

Regarding the human powered transportation sub-theme from a user perspective, one can think of various sub-actors, such as cyclists, pedestrians, skaters, 'hoverboarders', etc. One will notice a main actor being cyclists. Cyclists are considered to be one of the biggest groups in human powered transport in the western world and therefore we see them as our main actor in this situation. In this assignment we are going to focus on the subgroup of cyclists that use the bicycle as a mean of transportation to go to work.

The relationship between various actors raises a lot of unanswered questions: Do bike lanes make the streets of a city as New York safer?, How do cars react on cyclists when there are coming more and more of them?, How do more and more new upcoming transportation products interact and suit in the infrastructure that the city has at the moment and in the future?. Cyclists do have the most efficient maneuverability in a city as New York. This group of people can go from A to B in a matter of minutes without completely following the rules of the streets most of the time. This maneuverability in relationship with other users of the roads, such as cars, raises along a lot of safety issues. Therefore, the city of New York is building a lot of miles of protected bike lanes. However, is this really improving the city's transportation? In this report we will look for a solution that fits best with regard to the moral values of all actors by analysing several solutions from different perspectives.

## **2.2. Why history matters**

Present day urban mobility in New York is as it is today because of decisions of different actors and events that happened in the past. The most important actors that made these decisions are city planners and the government (society). Furthermore, there are more factors and actors who had a noticeable influence on these choices. The users itself had influence by lobbying for the Good Roads Movement, which was a political movement that successfully demanded for better roads. This was the beginning of an infrastructure for bicycles. Another factor that has had a major influence on today's urban mobility infrastructure, is the geographic location. The landscape of a place is determined by hills, rivers, rocks, etc. A bike lane can't go through, for example, a river. To solve this, a bridge or a tunnel can be built. So in fact the geographic location always affects the way in which an infrastructure is built. Considering our focus on New York city, we want to mention a last actor: the bicycle advocacy group Transport Alternatives. TA, founded in 1973, has as goal the promotion of bicycle use.

When we take a look at the history of the bicycle use in New York city, we notice several remarkable events. In 1894 the first bike lane of the United States was created in New York. Thereafter there were built more of them, and the more bike lanes they built, the more used they were. Around half the 20th century cars became continually more accessible for the public, and therefore many people switched from riding a bicycle to driving a car. Since then the flow on the roads increased significantly through those car drivers, while the cyclists (for a lesser extent) also still used the roads. This lead to hundreds of accidents each year. Therefore a discussion raised about who was responsible for these accidents, the car drivers or the bike riders. In 1987 the government first blamed the cyclists and the government announced that in some avenues no bicycles were allowed anymore, as an experiment for some months. The cyclists were offended about this ban, especially the packet delivering drivers since they had to cross these avenues to deliver their packages, and started to protest against the ban. TA played a significant role in these protests, they encouraged

people to go onto the streets and they lobbied in favor of the cyclists. After a few weeks, the government repealed the ban. Since a couple of years ago, New York city changed their vision and is actively working on the enlargement of the infrastructure of bike lanes. They try to do so by creating more bike lanes and lately started creating a bike sharing system.

Decisions that were made in the past, with regard to bike lanes, mostly limit today's problem solving. They do so, because of path dependency and lock-in effects. Nowadays the infrastructure of the bike lanes is hard to change, because it is so big and has been used for quite a long time. Therefore an alternative infrastructure for bikes is very expensive and has to deal with habits of the users. Hence, in most cases, it is more convenient to enlarge the infrastructure of bike lanes than to change it.

### ***2.3. Conflicting values in the societal debate***

Concerning human powered transportation, we have to take into account some relevant moral values for the general problem. In this section we will discuss those values and their relations with cyclists.

The first value that we will discuss is safety. Safety affects all types of cyclists, not just the people that use their bikes to go to work (which is the group on which we are going to focus our assignment). While commuting, it is important that cyclists feel safe from road obstacles, other cyclists and vehicles on the road. Sustainability is a moral value that also plays an important role. In the past decades, there has been a growing consciousness about the climate change and greenhouse gas emissions. Cars are big contributors to the earth's pollution. Bicycles offer a clean alternative for transportation in cities. Additionally, it is not only an environmentally friendly way of transport but a cheap one too. The price of a car, gas or even public transportation is way bigger than the cost of owning and maintaining a bicycle. Hence, we can deduce another moral value: affordability. Furthermore, a moral value that is also worth to mention, is enjoyability. Vehicle transportation can be frustrating when for example you are stuck in traffic. And vehicle transportation can be quite monotonous as well, if you take the same route every day. Cycling offers an enjoyable commute. With a city equipped with a proper infrastructure, cyclist wouldn't need to be worried about traffic and could choose between different routes to get to the same destination. The last relevant moral value that will be discussed is realism. The solutions that will be implemented to favorise human powered transportation in cities should be possible to accomplish. A city where bicycles only are allowed, so no cars and busses, is an example of a solution that is too unrealistic.

We have to bear in mind that the solutions implemented to improve human powered transportation might be in conflict with other sorts of transportation. For example, creating an extensive grid of bike lanes in a city might reduce the space where cars can circulate, aggravating traffic congestion. An increasing demand of bikes would result in an increased production of bikes. If we look at it from an economic point of view, the bike manufacturers and bike repair shops would benefit from that, but fuel companies and car dealerships might suffer from it.

The next point is related to sustainability. Even though bikes are pollution free when being used, there is some waste generated when they are produced. Although bikes can be bought second hand, it would be interesting to see the effects of mass production of bikes (and all its components) in the environment.

Another theme that can cause a debate is whether the local government should inject funds in improving human powered transportation in their cities, knowing that there are more important issues to be solved.

People who use their bikes to reach their workplace would prioritize their interest in the moral values that affect them directly, in this case that would be safety, affordability and enjoyability (this also includes trip time for example).

### **Phase 3: Possible solutions**

In a metropolis as New York city one comes across thousands of problems regarding urban mobility. When looking at the conflicting values in the societal debate we should move towards possible solutions to the massive problem of mass motorization. In this section we will look at different possibilities to solve these problems. From the user point of view, we will take into account the interests of all actors in the human powered transport mobility sector, but we will focus on cyclists, with a specification on people that use their bike to go to work.

The first solution we propose is the improvement of the infrastructure used by cyclists (e.g. bike paths). This can be done by building more bike lanes, making existing bike lanes bigger and creating more distance between the bike lane and the road. This would result in a safer and larger space for the growing amount of bike lane users. Furthermore, improving bike lane infrastructure would create jobs, since many people are needed for such a big project. Therefore it would also be beneficial from an enterprise perspective. When improving on the infrastructure, people will be able to move from A to B easier and faster, which could be of interest for enterprises in the city. Next to the increase of safety this improvement would also contribute to a more sustainable way of living, which again is an advantage from the society perspective. Opponents of the improvement of bike lane infrastructure argue that more bike lanes will reduce the space for motorized lanes, which will result in aggravating traffic congestion. However, we expect that this problem will not have a big scale, since most people who normally use the car to go to work, then would take the bicycle and hence there would be less cars on the road. Another issue which has to be taken into account is the concern that this change in road distribution between cars and bicycles could be an obstacle for instance for the emergency transport, since there is less space for cars. When looking in this direction one might come up with ways of human powered emergency transport, which would take place in bike lanes.

Next in order, instead of changing the infrastructure, we propose improving the means of transport itself. Therefore, what could be of any help in a city as New York is innovation in the human powered transportation sector. As engineers we saw a growing amount of electric and autonomous vehicles, which have to suit and thus adapt to their environment to avoid safety issues. When looking at the flip side of the coin one can notice that there could be innovation on the other side, which is human powered transport, and in this case bicycles. A human powered transport system could be designed in a way that it could adapt and fit in a surrounding containing autonomous vehicles, for example a bike which can brake and steer itself. In spite of this solution, it brings along a great amount of research and costs. Users are the one's to be protected in a system containing all kinds of different vehicles, so when these

vehicles can adapt to each other's environment the users will benefit from that. Additionally, the threshold for people that do not yet use a bicycle could decrease as a result of increasing safety and appeal of modern technology implemented in the form of human powered transport. More safety will be created, new markets could be established which will encourage the rise of new enterprises. And furthermore, the society could benefit from this solution if there are improvements found in the production of these new innovations increasing sustainability.

With our last solution, we will be tackling the safety problem that a growing amount of people in cities (hence more cyclists) can bring. People that have never driven a bicycle before might interrupt the cycling flow or even bring themselves and others in danger. Therefore, as a user, education might be a possible solution. Introducing beginner cyclists with the rules and values of traffic in form of tutorials for example may help them to better integrate in the flow of cyclists. One could even exploit this idea even further by obliging people to get a license to be authorized to use the bike lanes. Therefore bike license companies should be founded, which is beneficial from the enterprise perspective. From a societal point of view this would also be valuable, because the amount of accidents with bicycles will decrease and thus safety will increase. However, implementing this change could lead to a decrease in the use of bicycles, because people could not have enough time or money to get such a license. Therefore other transport options as the car or subway will be even more busy than they already are now.

## **Phase 4: Evaluations of the solutions**

### ***4.1. Ethical evaluation of the options***

#### **4.1.1. Intuition**

In this section we will rank the three solutions given in phase 3, according to our intuition. The arguments used in this section are based on the arguments that are already mentioned in phase 3.

The first solution, improving current bike lane infrastructure, is also ranked as the most preferable solution according to our intuition. To start, this solution is preferred because all actors (from an User, Society and Enterprise perspective) have benefits. Implementing this solution will lead to a safer ride for bike lane users, it will positively affect the sustainability in the city and it will create lots of jobs to build all improvements. Secondly, this solution is preferred, because it is easier to build further upon the current bike lane infrastructure than to change it completely. The city planners who built the infrastructure until now have followed a certain path dependency and it is hard to change this direction, since the current infrastructure has gained much momentum already and users are used to this kind of infrastructure. Finally, this is the preferred solution because this solution will attract most new bike users, compared with the other solutions. It will because the improvements are all mainly focused on making bicycle use more attractive.

The second solution, improving way of transport, is ranked as second best solution according to our intuition. For now we will focus on the improvement of a bicycle. Firstly, considering the use of the bicycle will be much more safe and easy, the threshold for using a bicycle will decrease and therefore people are encouraged to use a bicycle. Moreover, society would benefit from this increase in bicycle use then, because safety increases and there will be a decrease of carbon dioxide emissions. Apart from the fact that riding a bike is more sustainable than driving a car, in the research on the improvements for the bicycle, research could also be done in the field of sustainable bike production. However, research in the field of bicycle improvements in the innovating way we focus on would be expensive, since not many research is done in this field yet.

The third solution, cycling education, is ranked as the less preferable solution according to our intuition. To begin with, it would be beneficial for enterprises, since companies or organisations have to be founded which provide lessons and exams about biking. However, this could be a barrier for people who do not have much money and so cannot afford these lessons and a license. Moreover, this solution will not encourage people to use the bicycle to go to work. Instead, it will even discourage people to use the bicycle, since people have to take an exam and maybe lessons, which can be time consumingly. Especially in a city as New York, in which people are very busy already, this would be a barrier to get the license and hence would be a barrier to use the bike. Additionally, if this solution would be implemented it probably would have a major resistance, since many people have used the bicycle for a long time already, so are used to it and argue that they are able to ride a bicycle safely. This could possibly lead to protests, as already happened in rear 20th century.

Overall, we came to the conclusion that according to our intuition improving current bike lane infrastructure is the most convenient solution. This followed by improving the way of transport. Finally, the less preferred solution is user education. Evaluating the method of intuition, it is important to say that we as bicycle user ourselves look from a perspective which is influenced by our experiences and hence is not objective with regard to all concerns.

#### 4.1.2. Utilitarianism

In this section we are going to discuss from an utilitarian point of view the solutions mentioned above, concerning how to improve human powered transport in a big city like New York. Lets first recall the main base of utilitarianism, which is the principle of utility: One should choose the action, or the action is correct if it brings the greatest happiness and the least unhappiness overall. In other words, the solution is good if the good consequences are greater than the bad consequences, maximizing the utility. To apply this philosophical point of view to the solutions we propose, we will analyze each one of them, stating the effect that they have on the different actors.

The first solution proposes an improvement of the already existing infrastructure (in some parts of the city). This would mean improving the division between bike paths and car lanes (or directly making two separate paths) and enlarging the already existing infrastructure by making more bike paths. Lets first focus on the effect for our main actor: the users that take the bike to go to work. An improvement of the infrastructure will first result in better safety and less travel time. More people would feel attracted by this way of transport but since we

would have more lanes, they wouldn't be overcrowded. The second beneficiaries would be in principle the motorized vehicles. If the cyclists have their own lanes, the drivers don't have to pay attention to them, which will mean they can focus on other tasks in the road, increasing their state of alertness, therefore improving the safety. But, when making the infrastructure bigger, we might be taking roads that were used by cars before. More bike lanes could equal to less car roads, which could result in traffic jams. Here we have a conflict already. The Society and enterprise could also benefit from these solutions. The reforms needed could be performed by a private company or by the state, either way creating jobs and improving the economy. This solution brings happiness not just to the actor that we focus on but also other actors within the USE group. The amount of discontent this solution would bring would be hypothetical, and affect just a portion of all the people concerned.

The second solution proposes the creation of a new way of human powered transport that could fit in the city traffic. This would be in the benefit of the users, but now it is society that would be affected in a negative way. If we introduce a new actor in the car lanes, even if it would be designed accordingly to fit in the already existing infrastructure, cars would still have to get used to sharing the road with a new actor. If this new mean of transportation were to become very popular, the roads would become overcrowded and we would be back to square one: safety issues, traffic jams and solution one would be implemented, but with the extra cost of designing a new transportation mode. For this solution we can already see some conflict, since the overall happiness achieved with it could not be sufficient, translating into not enough people accepting this solution. This would mean discontent for the enterprise charged with the design of the bike.

The third solution focusses on giving the bicycle user a cycling education. This would resemble the system we already have for car users. Where one has to pass a theoretic and practic exam in order to be allowed to drive. Now this of course would reduce the amount of bicycle against bicycle accidents, but is yet to be seen the effect on bicycle-car accidents. Also, one of the main attractive features of the bike as a mean of transportation is that anyone can use it. By creating a licence and making people pay for it, we may decrease the accessibility to the people. From the three solutions, this one is the one that can be seen as less fit when looked upon from a utilitarian point of view. It's quite safe to predict that this solution will bring unhappiness to those affected by it.

Analyzing all three solutions and comparing the positive and negative consequences, we come to the conclusion that from an utilitarian point of view, the best alternative would be Solution 1: improving the already existing infrastructure, because after doing cost-benefit analysis it brings most overall pleasure. Evaluating the method of utilitarianism, we have to criticise that the utilitarianistic point of view does not take into account the distribution of happiness. In our case the analysis becomes difficult then, because we do not have a guideline for how to deal with the differences in happiness between User, Society and Enterprise.

#### 4.1.3. Kantian Theory

In this section we analyse the 3 solutions, mentioned in phase 3, from the perspective of the Kantian Theory. Kantian theory is a form of duty ethics, which stresses on the fact that

actions should be done with regard to moral norms. Core concerns in Kantian theory are the issues of autonomy, duty and good will. According to Kant, a person himself is able to determine what is morally right and what is not, and it is his duty to obey to these moral norms (van de Poel and Royakkers 2011). Only then a person is acting out of good will, which is the only thing in Kantian ethics which is unconditionally good. An action is morally right if it obeys to the two fundamental principles of Kantian ethics: each action could be implemented universally and each action should respect the rationality of each person.

The first solution proposes an improvement of the current bike lane infrastructure. This would increase the safety of the cyclists as well as the enjoyability for the car drivers. If, for example, the bike lanes are more separated from the road, cyclists will feel more safe because there is more distance between the cars and the bicycles and the car drivers will experience a higher level of relaxation because they do not have to be constantly focussed on the cyclists anymore, which increases the enjoyability of a ride. According to Kantian theory this is a right way to handle, since moral values of both actors are taken into account and improved, which means that all actors are handled equally. Furthermore, if this solution would be implemented, more people will use the bicycle and hence less people will drive a car each day. This improves overall sustainability of the city, which according to Kantian theory again is the right way to handle, since it is possible to make the moral rule "make urban mobility more sustainable" make an universal law. However, in this solution the reciprocity principle of Kantian theory could be violated. There could be people who rationally do not agree with the decision of the government to spend that much money on a project. If the government should decide to do it anyways, the rationality of these people is not respected.

The second solution, improving way of transport, would make human powered transport more safe. When we again focus on the example of the improved, self braking and steering bicycle, it provides more safety and enjoyability. The ride is more enjoyable because people have to pay less attention to the traffic and can just relax and enjoy the view along with the fact that the bike provides more safety through braking and steering before hitting a car or other bicycle. However, if the bicycle makes the decision to brake, while the rider does not want to brake, the action is in violation with the reciprocity principle of Kant's theory, because the rationality of the rider is not respected in that case. Moreover, the prices of the new vehicles would be high, since companies have to do much research first. Not all people can afford such a vehicle then and this is in violation with the universality principle of Kantian theory, which states that all people should be treated equal.

The third solution, implementing user education, would be a very immoral thing to do according to Kantian theory. In this solution the rationality of people who are not yet practiced in riding a bicycle would be rudely disrespected. These people would have to take over a way of thinking that the government would impose to them. This is in big contrast with the idea of moral autonomy, discussed in Kantian theory, which stresses on the fact that people themselves can decide what is morally right through reasoning (van de Poel 2011).

Evaluating all three solutions, we can conclude that the first solution, improving current infrastructure, is preferred from a Kantian theory perspective, because in comparison with the

other solutions it violates the reciprocity principle fewest and is universally applicable. Evaluating the method of Kantian theory, we have to mention that Kantian theory does not take into account the consequences of implementing the given solutions. It does, for example, not take into account the fact that improving way of transport could lead to a huge increase of human powered transport users and therefore could cause congestions on for instance bike lanes.

#### 4.1.4. Virtue ethics

In this area we are going to take a look into the life of an engineer and his or her virtues concerning the problem of mass motorization. Let us first repeat the main focus of this ethical theory. Virtue ethics focuses on the nature and definition of virtues. Furthermore, Virtue ethics discusses what could be changed to one's character to become a 'good person'. The last between brackets, as a 'good person' is conceived differently by every individual. In the upcoming section a discussion will follow for each solution provided with a specific focus on the actor's virtues, to get to the recommendation on behalf of virtue ethics.

The first solution is considering the change of infrastructure to improve the efficiency of bike lanes in a city. When looking at the virtues that take a role in the problem of mass motorization there are a few frequently recurring virtues, patience and courage are two of those. An engineer has a lot of decisions to make and some of the decisions are way out of reach, mainly because it are future decisions. One might think of changes in the infrastructure that could lead to future consequences. However the decisions have to be made and the actions have to take place. Therefore courage, for making the prominent decisions, and patience, for waiting for the consequences and actions to take place, are main virtues for an engineer. The first solution could therefore be of great interest, as the solution makes place for a lot of new coming cyclists that enjoy the freedom of safe bicycle lanes. Cycling, for example, enables people to communicate while cycling without barriers such as windows etc. and thus creates social relationships, which encourages people to engage virtues such as: Courage, responsibility, respect and so on. Additionally, making way for a big group of upcoming cyclists creates a community in which people can interact, go to work together or create a healthy lifestyle together, which is encouraged by virtue ethics as it makes the individual a better person.

For the second proposal, changing way of human powered transport, virtues such as trust and compassion might play a role. According to the ethical theory of virtues, the change should be a positive change, to become a moral standard. When new innovations arise on the market, a user will go for specific features. So when looking at for example a bicycle that can scan the environment for dangers and react upon that, the user has to trust the system. Also engineers will have to create the new innovations with close look upon the virtues that the users engage and how to improve them by means of this innovation. Therefore user virtues have to be taken into account. This solution is not of great interest as seen from the virtue ethics point of view, as it is not clear enough which concrete virtues will be increased by the final result.

The final solution will be of interest from the virtue ethics perspective. Mainly because education can enable people to engage virtues such as commitment, discipline and

excellence. It might also be a good solution when looking through the eyes of the engineer as education is increasing the efficiency of people using a bicycle. However, as this solution is only short term, it will hardly influence the character of the individual. Therefore it is not the most interesting solution concerning the virtue ethics point of view.

In conclusion, one can notice that the first solution is of most interest when looking from the perspective of virtue ethics. The main reason for this is that virtue ethics focuses on the change in one's character. According to this ethical theory, engaging virtues is what makes a person a 'better person'. Thus when looking at the change in infrastructure, people need to plan ahead and make big decisions, which encourages individuals to engage different virtues.

#### 4.1.5. Role of ethics in a real activity

A debate was held, between each of the USE groups, tasked to deal with the issue of human transportation inside urban mobility. Enterprise, User and Society all presented the solution they deemed the most suitable and beneficial. As User representatives, we proposed our first solution: improving the already existing infrastructure. Surprisingly, similar solutions were presented by the other two groups. Now this has its positive and negative consequences. As a positive aspect, we would have the fact that, working on the same solution from different USE perspectives, we have more room for improvement, but at the same time, this could backfire in the following way: If we all focus on the same solution, we might neglect other possibilities that in the end could have been more beneficial.

As mentioned above, since we were all defending the same solution, the debate focused more on defending the interest of our respective actors within the solution. We had the same goal, but different paths to achieve it. Inside our solutions one of the modifications proposed was to place safety poles in order to divide cyclist path and car roads improving safety for both, but it limits access for public services (e.g. ambulance, fireman) or the private sector (e.g. delivery trucks). When it comes to building the infrastructure, two actors can complete the task: either the state or a private enterprise. For this case, the chosen actor was enterprise.

The discussion was mostly based on utilitarian principles, meaning that we tried to make our solution work in order to bring the most happiness and less discontent.

Instead of coming to an unanimous answer, our debate was more a sort of self reflection. The fact that we had input from different points of views with different interests was favourable to all of us, since it can be hard to find flaws in an own's idea. Some of the problems we found in our proposed solution were: The discontent from Cabs drivers, the economical costs of such a construction, a storage problem due to the predicted increase in bike use as a mean of transportation (where are people going to park their bikes?), and the fact that we have to keep in mind that our solution could not be totally accepted, we would have a whole infrastructure, reducing car roads, that nobody would be using.

At the same time, we could agree on these positive aspects: it would make cycling more attractive, benefits in sustainability and safety, tourists could use these new infrastructures and the economic benefit that carrying out such a project would bring, such as creating jobs. In conclusion, the criteria and negotiation tactics used by each group were much the same. In our group, we had in mind that in order to convince the other groups that our solution was

the best, we offered a solution that wasn't just beneficial for the User, but also for the Society and Enterprise. Our colleagues seemed to follow a similar path of thought.

#### **4.2. Historical evaluation of the options**

Historical influences are key factors that can influence the engineering cycle and the innovation process. A past decision can increase or decrease the leeway to implement the solution to a social problem. Therefore path dependency can lead to unintended future consequences in the implementation of a proposal. Now we have come to three proposals, we are going to evaluate how and why the idea's are going to be implemented. In this section a close eye will be set on future consequences and the feasibility of each of the solutions. A feasible solution would be the one that satisfies all the nonlinear and linear constraints. This entails that the solution would solve problems encountered by multiple perspectives without ignoring others. Every solution brings along different views and opinions which can influence the future probability of the proposal. This we take into account when analyzing the different unintended consequences that the future might bring. Elaborated will be on how the realisation of the proposals will be organized to avoid unintended future consequences. We will discuss each proposal separately to create a clear overview of what the solution entails.

#### **SOLUTION 1**

For the first proposal, improving the already existing infrastructure, the goal is to increase safety and the flow of traffic in bike lanes. The implementation would entail increasing the amount of bike lanes and making the already existing bicycle infrastructure broader. To achieve the goal of more safety, the user should not be deterred by the decrease of safety that the engineers create. Therefore, during the process of changing the infrastructure, engineers should keep in mind that remaining the safety in traffic and thus not decrease it by any means is the main issue. When looking at the way to organise the realisation of the first solution, we need to take a close look at the innovation process in order to indicate whether or not a participatory or technocratic approach, or a combination is suitable.

For this proposal, a combination of the participatory approach and the technocratic approach would be most suitable. In the first stage of the innovation process ideas need to be generated and evaluated. To create more elaboration and depth in this phase, a participatory approach could be of good help. Stakeholders from different backgrounds within the USE trajectory and with different views on the problem might come up with different ideas for where to implement the improvements. With a close collaboration between the stakeholders a participatory approach is going to work for this first phase of the innovation process. In the second stage of the process, which entails planning and concepting, a technocratic approach would be of good help, because we assume that the planning would be better if one has the knowledge of planning. However, in the concepting stage the proposal might need tests and those are conducted by the users. Furthermore, the development and prototyping phase would be most efficient if it were approached in a combination of technocracy and participation, as prototypes indeed need to be tested and checked. Product and market testing leans more towards a participatory approach as it is down to the users who are the market if the solution will fit. At last, the market launch phase

of the innovation process will be conducted by the engineers, and therefore it would conclude a technocratic approach. The reason for this again is that engineers have most knowledge of the situation and the innovation being launched, and therefore it is best that this group will conduct the launch. Altogether, this solution is most efficiently implemented with a mixed approach. Both the technocratic and the participatory approach suit this implementation in our suggestion.

In the implementation of this proposal, one might notice that past decisions decrease the leeway that we have in the present. A city as New York, which is one of the most densely populated cities in the world, is made for the transportation of people. However, decisions that were made in the past are not the most efficient, with respect to the bike users, if we look at the present situation. Originally, when the automobile was invented, the big cities were using this as building blocks for their new infrastructure. Everything was centered around the automobile industry and therefore, the infrastructure would be based on that too. The city of New York was build around the automobile industry as well. This creates a path dependency for the present. Another example of past decisions that influence present situations is the amount of taxi's that New York City contains. The city has been known for it's 'yellow cabs' for years already. However, when implementing this solution, it creates a huge safety issue for the bike lane users. Cyclists often are obliged to make an emergency brake or to speed up because of the speed of the cars next to the unprotected bike lanes. The fact that parking spots are in between the sidewalk and the main road is a past decision that could be taken another look at nowadays. Mainly the fact that cars have to pass the bike lane when they have to park creates safety issues for the users of bikes and therefore reinforces, again, the threshold to start using a bike as means of transport. Additionally, the culture in America plays a big role in the path dependency of this problem too. American culture has been mayorly influenced by the car industry, and this resulted in a culture in which the love for motorized vehicles became a heritage. Therefore the stigma of using a bicycle is very low. However, more and more people living in a metropolis as New York City are using another form of transport instead of a car. Additionally, the number of car ownerships in the city has dropped a lot in the past years, nowadays, around 44 percent of the households in NYC does not have a car (Wikipedia 2014). This first proposal is a solution that offers a big chance and a big benefit, however, it remains a major change. Therefore, it is not possible to adapt the solution in any way, in order for it to increase the leeway to implement the solution. However, one might consider the leeway when it stays stationary as being an acceptable solution as well.

The solution entails a change in infrastructure. However, this can mean several ways of changing the infrastructure. One of them could be relocating the bike lanes and parking places to create a safer environment for the cyclists to cycle in. This might lead to unintended consequences. An example could be that the parking places are swapped with the bike lanes, meaning that the cars and bicycles are further away from each other, increasing the safety aspect of our solution. However, in a city as New York, people that come from the sidewalks need to reach to a taxi. This could cause problem when the people cross the bike lanes or the taxi's cannot see their clients. This is a clear example of a solution that brings along the same kind of problem it wants to tackle. Another example could be lowering the amount of car lanes and replacing them with bike lanes. This is off

course a huge offer that a metropolis has to make, however it might be a big solution when looking at the environmental aspect of our problem. On the other hand, this solution will bring along a big group of people that do not agree with this implementation. One could think of delivery companies, people that use the car because of capability issues, or taxi companies. The design could be implemented avoiding the unintended future consequences, however there needs to be a close collaboration between the different stakeholders in this case.

## SOLUTION 2

The second proposal we offer, comes a bit in response of the first one. Instead of changing or improving the infrastructure, improve the transport vehicle itself. This solution can be deemed feasible because big companies like Audi have started working on concept models (<http://www.electricbike.com/audi-ebike/>). Developing such a technology can appear to be costly (like the bike itself). The government should motivate the private enterprise sector to work on that field via subsidies and investments (We have seen that this is quite a successful method, like in the Age of Promise, when infrastructure needed to be built). The idea is to create a type of bike that has characteristics comparable to a car (e.g. adjustable suspension to make the ride more smooth, improvements in safety, gps, etc.), but stays a bike in the end and most important, human powered. Of course this doesn't mean that this new type of bike would lack an electric motor, but it would still offer the possibility to pedal if the user desires. Before the product would be put on the market, consumer and bike user associations should be consulted. This new type of bike would not be cheap to produce and therefore, expensive to buy. Even though the projected user would be people that use it to get to work everyday, meaning that they have a regular source of income, market studies should be made, in order to see how much more the consumer would be willing to pay, in exchange for the improvement. This would be a participatory approach, since the final product wouldn't just be designed by the engineers-scientists, but by a broad community of people. Car users should also be taken into account, since there is going to be a new type of vehicle occupying the road.

When trying to implement this solution, we encounter several issues related to decisions that have been taken in the past. First we come across a recurrent problem which is that, even though in the beginning roads were for pedestrians and cyclists, as cars were introduced and gained popularity, they ended up being the dominant vehicle in the road. It's important to keep in mind that, even though a new high-tech transportation device is being introduced, it's still a bike, and is yet to be seen, how much technology can improve the safety of such vehicle. A second problem we face is the bicycle culture itself. E-bikes or high-tech bikes are just recently being introduced. Bicycles have always been a relatively cheap and simple mode of transport and this new generation of bikes would threaten that. Would all this improvements and subsequent increase in cost pay off? Also we need to take into account that our new means of transport would be designed to go in the road along with the car. This could render bike paths obsolete (assuming that a large majority of cyclists adopt this new technology), so they should be removed. However, we need to remember something. We live in an age of technological innovation and advances. Resisting technology seems futile, we can see it in all domains such as health, automated cars and bikes are no exception. The

amount of applications an e-bike could have, combined with smartphones for example could be amazing.

Like any solution proposed, there will always be consequences that the designers behind the idea didn't have in mind when conceiving the product. The e-bike is not an exception. Let's consider an extreme case: Everybody embraces this technology, not just the actor we focus on, but people start using it for leisure. Of course, the companies behind the production of this kind of bikes would benefit financially from this, but an enormous increase in vehicles in the road would end up demanding a change in infrastructure, which is basically solution 1, but with the extra cost of the new bikes. New circulation rules and regulations should also be implemented, so we have administration tasks to be done. The opposite can also happen: no one uses the e-bikes. Users could deem this new e-bikes to be too much. Existing bikes get the job done already and there already exist a simple form of electrical bike. This is very unlikely, since it's explained above that the production of this new devices would be made closely with consumer associations and other groups involved. However, in the case it happened, the technological companies would suffer economically, and could even go bankrupt.

It's important to avoid the last case at all cost, since technological firms play quite an important role in our society. This can be achieved following the design process explained before, and introducing gradually this new technology.

### SOLUTION 3

Our third and last proposition concerns creating new regulations and implementing a licence system similar to the what we have for cars, motorcycles and other types of motorized vehicles. People would have to pass a test to obtain the license. We could say that our third solution intends to change the user itself. Since nowadays bikes are a means of transportation that is used from a very early age, it is not considered necessary to pass any type of test that certifies the user as capable of properly riding a bike safely, without being a threat to other users (other cars and bikes for example). Buying a bike would become a relatively more complex task, since anyone without a permit could not be able to acquire one. From the three solutions, this should specially be achieved through participation methods. The bike community should be consulted throughout the whole process, and the public opinion seriously taken into account, since it would represent a big, radical change.

We already have a history of licence-systems in our society, as mentioned before, for cars for example. When cars began to be introduced, there were no regulations, a license was not needed to drive around and there were no speed limits, but because of safety issues regulations and laws were created. If society managed to do it with cars, it could also be possible for riding a bicycle.

As in any solution, we find issues and problems that need to be faced in order to properly implement it. Historically, bikes have been a regulation-free cheap mode of transport, and that is one of the main reasons why people prefer them over other vehicles. The process of acquiring a bicycle is also very simple, almost anyone can buy one since nowadays no license is required and it costs only a fraction of what a car or motorbike would cost. A Lot of

people can afford the bike but are far from having an income that allows them to buy a car. If this license and regulation system were to be applied, the bike would become a more restricted vehicle, in economic terms, studies should be done to see what percentage of bike users could afford these licenses and bicycle conduct lessons. This could cause a big clash in society, which brings us to the next issue related to path dependency: acceptance. How accepted would this solution be within the bike community? This would not only be affecting our actor, but anyone that owns a bike. It's easy to predict that biking could lose attractiveness in the eyes of the users, which in the end, will end up recurring to other types of transport.

## **Phase 5: Reflection, recommendation and our redesigned USE proof solution**

### ***5.1. Reflection and recommendation based on ethical analysis***

In this section we will reflect on the relevance of the use of ethical theories to tackle the issues of bicycle users, who are part of the human powered transport sub-theme in urban mobility. Evaluating the use of ethical theories to analyse this concern, we can conclude that it is very relevant to use these theories, due to the fact that in our case all actors prioritise other moral values. Users concentrate on safety and affordability values, Society prioritises sustainability and safety, while Enterprise focuses more on profitability. Hence, ethical theories are a suitable way to analyse and compare the different values each actor takes into account. Each perspective ended up with the same result, namely the conclusion that the first solution, improving current infrastructure, is the preferred one. However, each perspective came up with other reasons wherefore improving infrastructure is the best solution. After this reflection, we will give a recommended solution based on the ethical analyses.

Reflecting on our intuition, we have to mention that we, as active bike users, can not give an objective opinion, because we use the bike each day and so have some prejudices. In our opinion bike users should always get priority, while people who drive by car to their work each day certainly have a different opinion about who gets priority. Furthermore, when we use our intuition, we do not take into account all moral values. Intuition is more based on feelings and experiences, so that is not the right point of view for an ethical evaluation. Hence, we came intuitively to the conclusion that improving bicycle infrastructure is the best solution, because this solution attracts most cyclists, is easy because you can follow the path dependency of infrastructure and provides more safety for all actors.

When we reflect on the utilitarian point of view, we see that improving infrastructure gives most overall happiness and less pain. A criticism about utilitarianism is the fact that it does not take into account the distribution of happiness. However, in our case, all actors benefit in an approximately equal amount. Users get more safety and enjoyability, safety and sustainability increases for Society and jobs are created for the Enterprise perspective, which benefits as well from happier employees. A final criticism for utilitarianism is the issue that happiness and pain are difficult to measure. This criticism holds for our case as well. It is

problematic to determine how much happiness is increased by for example the increase in sustainability.

Giving an evaluation on the Kantian theory perspective, we want to stress on the fact that Kantian theory does not take into account the consequences of actions. In our case we came to the conclusion that improving infrastructure is the best action from a Kantian perspective. However, improving bike lane infrastructure is defined by creating more bike lanes and enlarge current bike lanes, this would lead to a decrease in space available for cars to drive on, which could lead to more congestions. Another criticism of Kantian theory is that it is too rigid. In our proposed solution of licensing and education on bicycle riding, we notice that Kantian theory immediately sweeps away this solution due to the violation of the rationality principle. However, education gives the opportunity to people to become better in reasoning by giving people more knowledge. Kantian theory does not take this into account.

Reflecting on the virtue ethics perspective, we have to mention the point of criticism that virtue ethics does not tell how to act. Hence, it was quite difficult to decide which solution was the best one from a virtue ethics point of view. Eventually, we came to the conclusion that improving infrastructure also from this point of view was the preferred solution. However, we came to this conclusion due to the fact that in this solution we could think of most virtues that played a role, and not because one virtue is better than the other. Furthermore, virtues are not unconditionally good. When in our case, for example, the engineer would have the courage to make the decision to create a bike lane next to the road, while after executing, it turns out that there happen lots of car to bike accidents, this was not a good decision.

Evaluating the debate with the other actors, we got several new, interesting insights. All actors came up with the same solution, but each actor had its own reasons. First of all, this lead to much positive feedback, from which we could conclude that we were on a good path. Furthermore, while discussing this solution and its advantages and disadvantages, we came up with some new ideas to improve the solution of improving infrastructure even more. The most important insights we got were the issue that if more bikes are used, there are needed more bike storages as well. Moreover, we came up with the idea to separate the bike lanes from the roads by putting flexible planters in between. This would lead to an increased feeling of safety, without negatively affecting the manoeuvrability to stop at the side of the road of taxis and emergency transport. Overall, our debate went very well despite the fact all actors started with the same solution.

In conclusion, after reflecting in each one of the three solutions proposed using different ethical theories we all agreed that from an ethical point of view, solution one (improving current bike lane infrastructure) is the best solution. We recommend to establish several improvements in the following years such as first of all creating more bike lanes, secondly making current bike lanes bigger and furthermore separating current and future bike lanes from the road by using flexible planters.

## ***5.2. Reflection and recommendation based on historical analysis***

When reflecting on the historical analysis of the three proposals, one notices different pro's and con's regarding the user, society and enterprise. In this piece, reflected will be on the relevance of historical analysis on the three solutions and the feasibility of each solution regarding different perspectives from the USE groups. According to our reflection upon the different solutions, the history plays a big role in some of them. Mainly in the first solution, where change in the infrastructure is proposed. We see comparisons in the first two solutions, as culture plays a big part in the psychology behind the implementation of the proposals.

In the first proposal, a change in infrastructure must lead to a safer environment for the bike users. This might happen in different way, however it will always affect the car lane users. We took into account that there are future consequences that just cannot be avoided with decisions that we make in the present. This is one of the factors that decreases the feasibility of the first solution. Another factor that decreases the implementation feasibility is the fact that the infrastructure above ground of the city of New York is based upon motorized vehicles. This interrupts the freedom of human powered vehicles on which we will elaborate in the reflection of the second proposal. One cannot simply change the infrastructure because this takes a lot of time and might create interruptive situations as we look at the density of the traffic in the city. We learned that implementing the first solution in a big city will bring along big risks and it will cost a lot of money, but the progress will be great afterwards. Both the environment and the city itself will improve. The pollution will decrease as a result of the increase of bike use and the city will gain more positive attention as bike users bring along and create a community that is healthy and proactive. This might influence the character of the city and attract more tourists and so on. When focussing on other groups within USE we see that entrepreneurs will benefit from this solution as they will be asked to plan and arrange the implementation. Additionally, people will start using a bike which they have to buy, increasing the profit of entrepreneurs in this field. As already stated, the society will gain more interest as it will get a better reputation as the city becomes healthier.

Reflecting on our second proposal we see that history brought along the dominance of cars. This problem can be compared with the problem in the first solution, where the infrastructure is based upon cars. However, the feasibility of this solution, according to the historical evaluation is might be bigger compared to the first solution. This because in this proposal, engineers will come with a new innovation to bring on the market that fits in the car infrastructure. A new innovation might, however, bring along another path dependency and future consequences that we did not think of yet. In this proposal another factor might bring down the feasibility, which is the costs. Just as solution one, this solution might be very expensive. Although, one might state that the implementation will not be that expensive, as the product will be focussed on functioning alongside other motorized vehicles. When looking at future consequences, this proposal is not realistic for the problem we ought to tackle. What we mean is that if this solution will be implemented and socially accepted, bike lanes might be discarded as these new bikes will use the car lane instead. This will bring up numerous ethical and social issues and will not be good for the feasibility of this solution.

Our last proposal, as previously explained, consists on the implementation of a regulation and education system that teaches people how to safely drive on the streets as a bike user. This solution will give rise to a lot of social issues as cycling has always been a regulation-free, cheap way of transport. However, with this solution we do not intend to violate the freedom of using a bike, we are just trying to make it a safer by means of factor. Furthermore, the factor that plays a big part in this solution is acceptance. A big part of the negative response to the implementation of this solution could possibly come from the fact that, we would be forcing users that consider themselves to be experienced cyclists (imagining they started using a bike at a very early age) to take classes on how to ride a bike. If we step back and look at our society, one comes to realise that it is ruled by laws and restrictions. Bikes are one of the few things not subject to any of those restrictions. Anticipating a large negative response from any bike user in general, we deem this solution as the least feasible when reflecting through a historical analysis.

After reflecting on the three solutions proposed from a historical point of view, we come to the conclusion that the first solution, which concerns creating new bicycle infrastructure and improving the already existing one has the most chances of succeeding. Cities used to be dominated by bikes and pedestrians until the appearance of the car. Then they were modified accordingly to the latest. From history, we already know that a transition of that magnitude is possible. Hence, our recommendation is to implement solution 1.

### ***5.3. Reflection and recommendation based on combined ethical & historical analysis***

In this section, the reflections based on ethical and historical analysis will be combined, in order to come up with the best USE proof solution. This will serve as a conclusion. Looking at both reflections, we can see a similitude. The solution that seems to have the most chances for an optimal outcome from both an ethical and historical point of view is the one that revolves around creating new, safer bike lanes, and improving the already existing ones. It appears to be not just user friendly, but beneficial for the other actors as well. We notice from a historical perspective that such reform will be possible and when analyzed from different ethical perspectives, there does not appear to be a conflict.

Summarizing, the aspects that made this decision stand out from the other two are: the increase in safety and road space that directly benefits the users; the creation of jobs that such a project brings along (which benefits enterprise); the fact that this solution will attract most new bike users on a daily basis, which therefore lowers pollution and stimulates moving, hence it is an eco friendly and healthy proposition; taking into account path dependency and leeway, it is the most feasible one, due to fact that this solution is less radical with respect to leeway than the other solutions; it is the one that had the most positive aspects for bike users overall (it needs to be considered that this answer is not objective, since the authors of this assignment cycle on a daily basis); it is the solution that brings the most happiness and least unhappiness for everyone; this solution violated the least the reciprocity principle (compared to the others) and can be applied universally; and this solution involves most virtues for engineers.

Hence, the definitive, USE proof, recommended design is as follows: creating more bike lanes, making current bike lanes bigger and separating current and future bike lanes from

the road by using flexible planters. The latter is added to the design due to new insights from the debate. This addition leads to an increase in safety, without affecting other actors negatively though the flexibility of the planters. We did not have to do further additions or redesign, because this solution was the best option from each actor's perspective. A final recommendation we want to add is to introduce the implementation of the solution with a campaign, in order to promote the project and increase the chances of people using this new infrastructure.

#### **5.4. Final overall recommendation**

##### General recommendation of overall case

Looking at the overall case of current urban mobility, we think that it is a good idea to take a new look on it. Since, for many people, it is an essential aspect of daily life, it is important to take care to make it as efficient and comfortable as possible. Especially in a city as New York, where millions of people each day are traveling to their work, school or just for sightseeing, it is good to think about aspects on which to improve.

In our opinion, the bicycle is the transportation vehicle of the future. Therefore to make the appeal of riding a bicycle more attractive, infrastructure should be adapted. Riding a bicycle is much cheaper, more sustainable and better for health than driving a car or using the subway. First of all, due to the better affordability of the bike poor people have the possibility to travel in a cheap way as well. Consequently, more people will have access to urban mobility and this will lead to an increase in well-being of underprivileged citizens. Furthermore, pollution will decrease, bike shops will have higher profits and as earlier mentioned well-being will rise, which all contributes to a more sustainable city. In addition to that, health of the citizens will also increase, by the less pollution and through the fact that more people will ride a bike twice a day. Moreover, less accidents will happen and thus safety will go to a higher level. Next to all these benefits there are much more advantages of improving the infrastructure for bicycles, such as the less noise harassment and more enjoyable rides. When looking at all these advantages for User, Society and Enterprise and noticing that there are no significant disadvantages, we came to the conclusion that this solution stands far above the other ones.

However, there are some challenges that have to be tackled next to implementing the proposed solution, to optimize use of bikes in cities. While looking at the solutions from a historical point of view, we noticed a major issue in the United States: the fact that the desire for big cars is embedded in the American culture. In the U.S. there is a culture which is almost about 'the bigger, the better'. The latter also holds for vehicles. Many Americans want a big car and think that by riding a 'little' bicycle their status will go down. Hence, the image of the bike has to become better to increase bike use, from a different point of view than the change in infrastructure we already proposed.

In conclusion, to optimize the use of bicycles infrastructure has to be improved. Our recommendation, as already explained, consists of three actions: creating more bike lanes, making current bike lanes bigger and separating current and future bike lanes from the road by using flexible planters. Next to this we think that the image of the bike has to move up. These issues could be combined by introducing the improvement of infrastructure with a

campaign, which also concentrates on changing the imago of the bicycle. These factors together will lead to a more sustainable future, in which the bicycle will be an essential facet of urban mobility.

### Reflection on engineering cycle

The method we used in this assignment to analyze the issue of human powered transportation within urban mobility, is called the engineering cycle. It consists of five phases: 1. Problem statement and sub-theme, 2. Problem analysis, 3. Possible solutions, 4. Evaluations of the solutions and 5. Reflection, recommendation and our redesigned USE proof solution. Within these phases there are several steps one has to follow to come to the result of a USE proof solution.

Reflecting on the engineering cycle from our experience, we came across several positive as well as negative aspects of it. First of all, we want to mention that the engineering cycle is a very useful tool to analyze problems. It is really convenient and stepwise, therefore easy in use. When using the engineering cycle, you take a look at problems from many different perspectives. First, the problem is viewed from several ethical perspectives and second the problem is looked at from a historical perspective. Within the ethical perspective analysis, we also had a debate with the other actors (Society and Enterprise) that took a look at the problem from again another mindset. This debate was very useful in our case, despite the fact we all started with the same preferred solution. We brainstormed about additional improvements that could be made and this led to several new insights. The many viewpoints are a strong aspect of the engineering cycle, since all actors in the societal debate have different opinions and values, and in this way as much as possible are taken into account. Moreover, each ethical theory has its own advantages and disadvantages. By analyzing the problem from different ethical theories, one gets a better view of the total. However, in our case we got the same conclusion from each perspective. Hence for our case it was not really interesting while doing the research. Positive side of this, is that we were each time more sure about the solution we wanted to choose. Thus it increases the reliability of our study.

Furthermore, we noticed that there are many reflections. Even reflections on reflections on reflections. We think this is a useful approach, because you take a look back on what you did before, and there is the possibility to compare it with other perspectives. However in our case, due to the fact that we got the same conclusion each time, it was more repeating ourselves over and over, so that was quite annoying. We do think that it is useful, since after each reflection there is the possibility for redesign, which is another very good facet of the engineering cycle. Hence, you are not stuck with one design, but have the possibility to combine several designs.

However, a negative side of the engineering cycle and the many different values that are taken into account, is the fact that it is difficult to determine which value is more important than the other. Additionally, it is difficult to say which point of view is the better one. When deciding that one point of view is better than another, one actor in the societal debate is ignored while another is given preference. By considering alternatives from different perspectives this facet is a little bit nuanced, but in each theory it remains tough to make this

decision. In addition, these decisions always are influenced by personal issues and so are not completely objective.

Overall, it was really useful to do a project like this. We were introduced to the engineering cycle approach of problem solving and gained experience on how to take a look at problems from different perspectives. Moreover, we learned some ethical theories with background and are now more aware of the role different actors play in establishing solutions.

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