


Biology and Paris as a Smart City
Harvard Summer School 2015



PETITE CEINTURE 2.0

A photograph of a railway track in Paris, France, with trees and buildings in the background. The tracks run straight into the distance, flanked by dense foliage and trees. In the background, a multi-story building is visible through the trees. The sky is a pale, hazy blue, suggesting a clear day. The overall mood is serene and quiet.

**“An intimate place where past and
present make their appearance.
At last, la Petite Ceinture is likely to be
reclaimed by modern society.”**

-Pierre Folk, photographer

Team

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Harvard Summer School 2015

Biology and Paris as a Smart City

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Abstract

Petite Ceinture 2.0 is a proposal for repurposing the 32-kilometre abandoned railroad that encircles the city into a green bikeway with community gardens and social programming. We hope to turn this beautiful space into a part of daily life in Paris.

This project was inspired by and modelled on the process of angiogenesis – how the body builds new blood vessels to target wounds or low-oxygen areas. Similarly, Petite Ceinture 2.0 would bring “oxygen” into the city, easing the daily commute, increasing Parisians’ interaction with nature, and offering a platform for those seeking more social connection. The bikeway’s design and activities will be tailored to interests and needs of every arrondissement through which it passes, acknowledging diversity in the city and building a dynamic system of places.



Contents

Background and vision

Context

History of the Petite Ceinture

City as a living organism

Previous approaches

Angiogenesis: biological inspiration

Execution plan

Step 1: Analyse landscape

Step 2: Pave bikeway

Step 3: Enhance with gardens and games

Step 4: Monitor and respond

Step 5: Expand the network

Assessment plan



Part 1:

Background

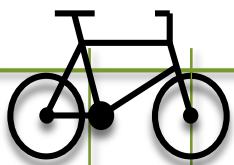




Paris Today

Paris is one of the most celebrated cities in the world. A dense and active city that maintains its elegance, Paris is at once bustling and beautiful. Home to 11 million people, this metropolis is constantly seeking to improve and provide its citizens and visitors a high quality of life. In recent years, Paris has begun to reinvent its image from a museum city to an innovative urban hub. Some of the city's current goals are to offer better (1) opportunities for engagement across people of different backgrounds and socioeconomic strata; (2) bikeability of the city; and (3) implementation of sustainable practices such as urban gardening. These improvements will make the city an even more engaging, pleasant, and inspiring place to live.

Whether Parisians begin their day with a pain au chocolat from a local boulangerie or a homemade breakfast, 43% of them soon find themselves in the depths of Paris's expansive Métro system. With 24 lines and a daily ridership of 14 million, the Paris Métro is one of the busiest subway networks in Europe. Despite the high density, people rarely engage with each other. Riding the Métro to work or any other destination typically requires a series of changes between lines, which can involve a lot of walking underground and waiting time. A survey found that 97% of Métro commuters have encountered law-breaking or impolite behavior on the Métro in the past month. Why does this constitute one or more hours of most Parisians' day?



“[Paris’ bike system] needs better intermodality, parking facilities, and links with the suburbs”

– Copenhagenize Index 2015 Ranking of the Most Bicycle-Friendly Cities



Meanwhile, aboveground Paris is in perpetual gridlock. Cars, trucks, scooters, and bikes struggle to navigate the city’s ceaseless traffic. Recognising that commuting within the city is often stressful, and motivated to clean up air pollution, Mayor Hidalgo is designating one-way streets as two-way bike lanes and even proposing car-free banks of the Seine.

The Copenhagenize Index 2015 ranks Paris the 17th most bicycle-friendly city in the world, highlighting the Vélib bike share which encompasses 20,000 bicycles and 1,230 stations. However, only 2% of Parisians commute to work by bike, and the Index recommends Paris improve the system with “better intermodality, parking facilities, and links with the suburbs.” What more can be done to make the city safe and pleasant for bikers?

Paris has 169 community gardens. While the city is beginning to actively engage with different forms of urban gardening, much of the city's produce is sourced from a 30-kilometre radius beyond the Périphérique. By ensuring that the city can supply more food from within city limits, citizens can build a more sustainable future. The city can improve its resilience in the face of climate change through the effective installation of community gardens.

Just like many global cities, Paris is home to people from very diverse backgrounds. The city belongs to born-and-bred Parisians, French citizens from other regions or former colonies, and immigrants seeking opportunity here. From Chinatown in the 13th arrondissement to the “bobo”-ised (bourgeois-bohemian) 20th, many neighbourhoods have sharp identities. The city needs to make a concerted effort to bring people together and create opportunities for social interaction between groups.



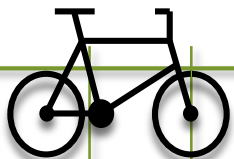


Our Vision

Imagine that you are a young Parisian living in Porte de Bagnolet in the 20th arrondissement, and working at Cite Universitaire in the 14th arrondissement. The year is 2020. A recent initiative in the city to repurpose an abandoned railway track has completely transformed your morning commute. Instead of riding line 3 and 4 of the Métro, cutting through the city's underbelly, you now commute the whole way by bicycle. It is a long but pleasant ride free of cars, pedestrians, and traffic lights. Exiting your house, you bike down the street and descend a ramp to the submerged railway. Once on the track, you are surrounded by greenery - part of it wild overgrowth from 73 years of disuse, but also some colourful community gardens.

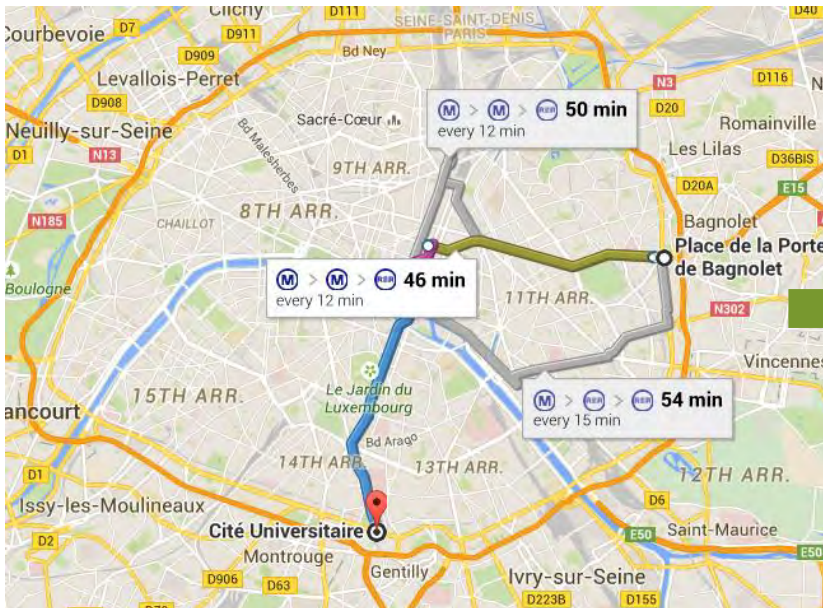


This case study is about our team member.
Gaspard Baudrin pictured by his home in Porte de Bagnolet.



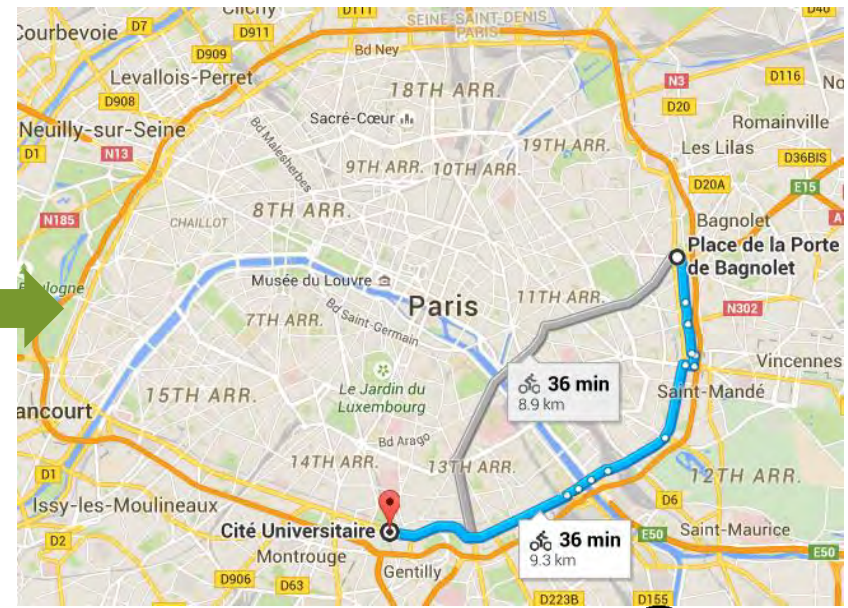
Gaspard posing with a tomato in Vert-ige garden

You ride along the counter-clockwise lane with many other bicyclists, hearing car horns from a distance and feeling grateful for the safety and relative quiet this track offers. You arrive at work 15 minutes earlier and more calmly than the Métro commute would have allowed. You have signed up to be one of the contributors and benefactors of the Vert-ige community garden by Rue Coulmiers near Cite U, and pick some vegetables for your lunch that day. You munch on some cherry tomatoes as you lock your bike and arrive at work.



 46 min

Circumventing Paris's traditional hub-and-spoke model for commuting
n.b. the bicycle path highlighted is an approximate



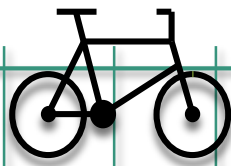
 36 min



Comparison of a commuter's experience in a bike-unfriendly vs. bike-friendly Paris

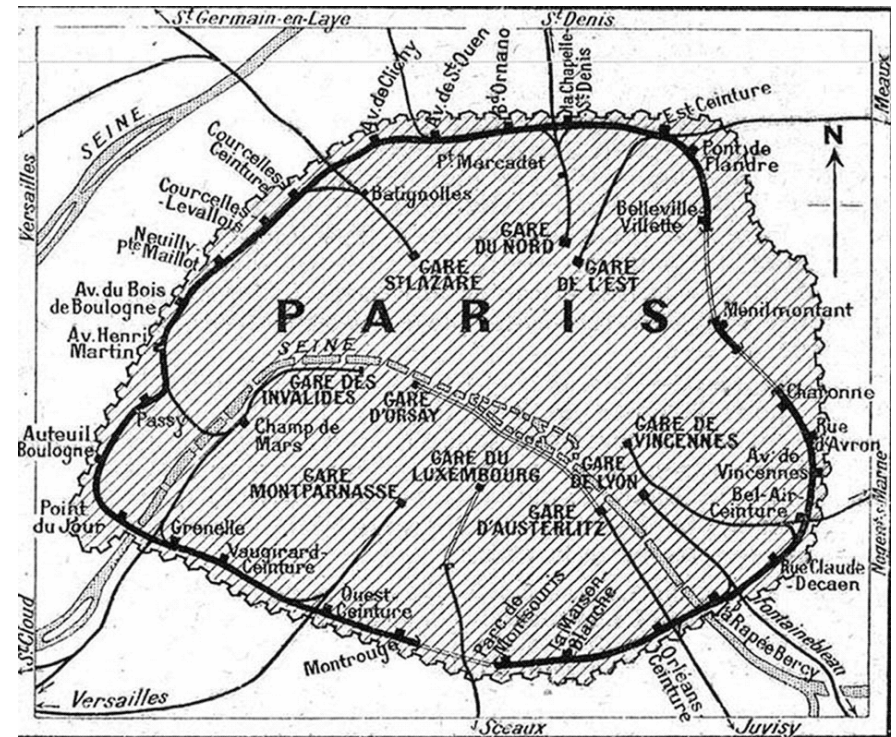
Part 2:
Context





History

The Petite Ceinture was built during the reign of Napoleon III, between 1852 and 1869. Prior to that, in the early 1800s, Paris' major rail companies each owned one of the main train stations: Nord, l'Est, Saint-Lazare, Montparnasse, Austerlitz, and Lyon. These companies and railway stations each serviced one radial connection reaching out of Paris to another city – a hub-and-spoke system – but had never considered building connections between the train stations. The Petite Ceinture was intended to connect these radial spokes more efficiently. This was especially important at the time because Paris did not have large boulevards, and relied on horse-drawn carriages for movement within the city.

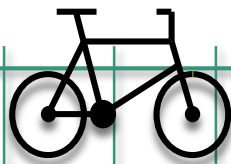


Map of the Petite Ceinture in 1920, highlighting the connections to Paris's main train stations.

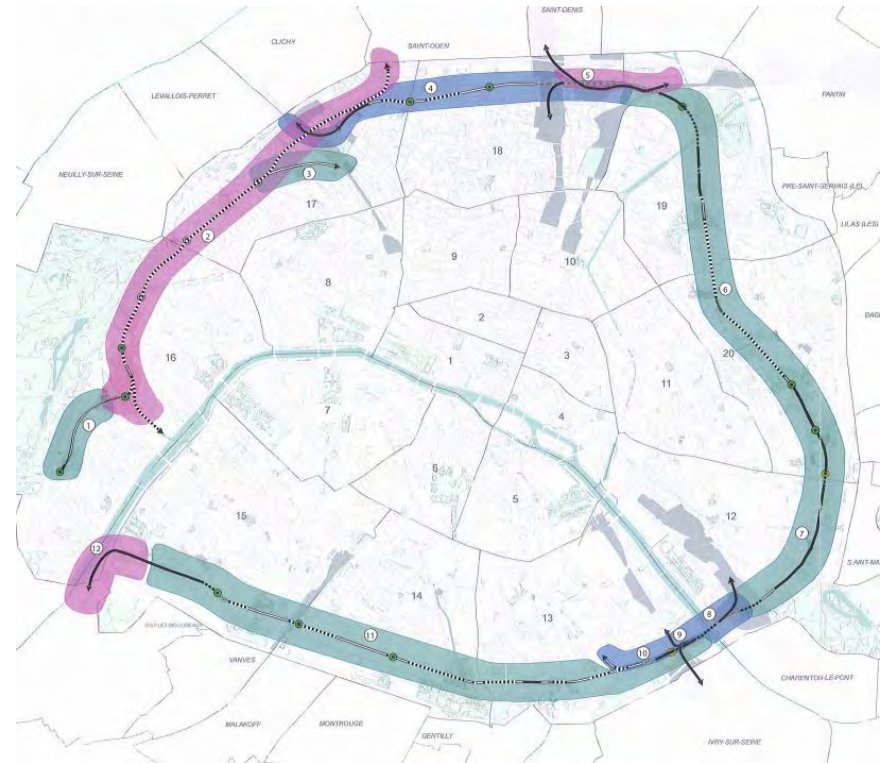
This railway line was mainly built for transporting cargo, and made a tremendous impact on the development of Paris's industry. Eventually, it was also used as a public transportation service for over 70 years. At its peak, this service transported an average of 90,000 passengers a day during the 1890 World Exposition.

[Background image: Montparnasse Station in 1900](#)

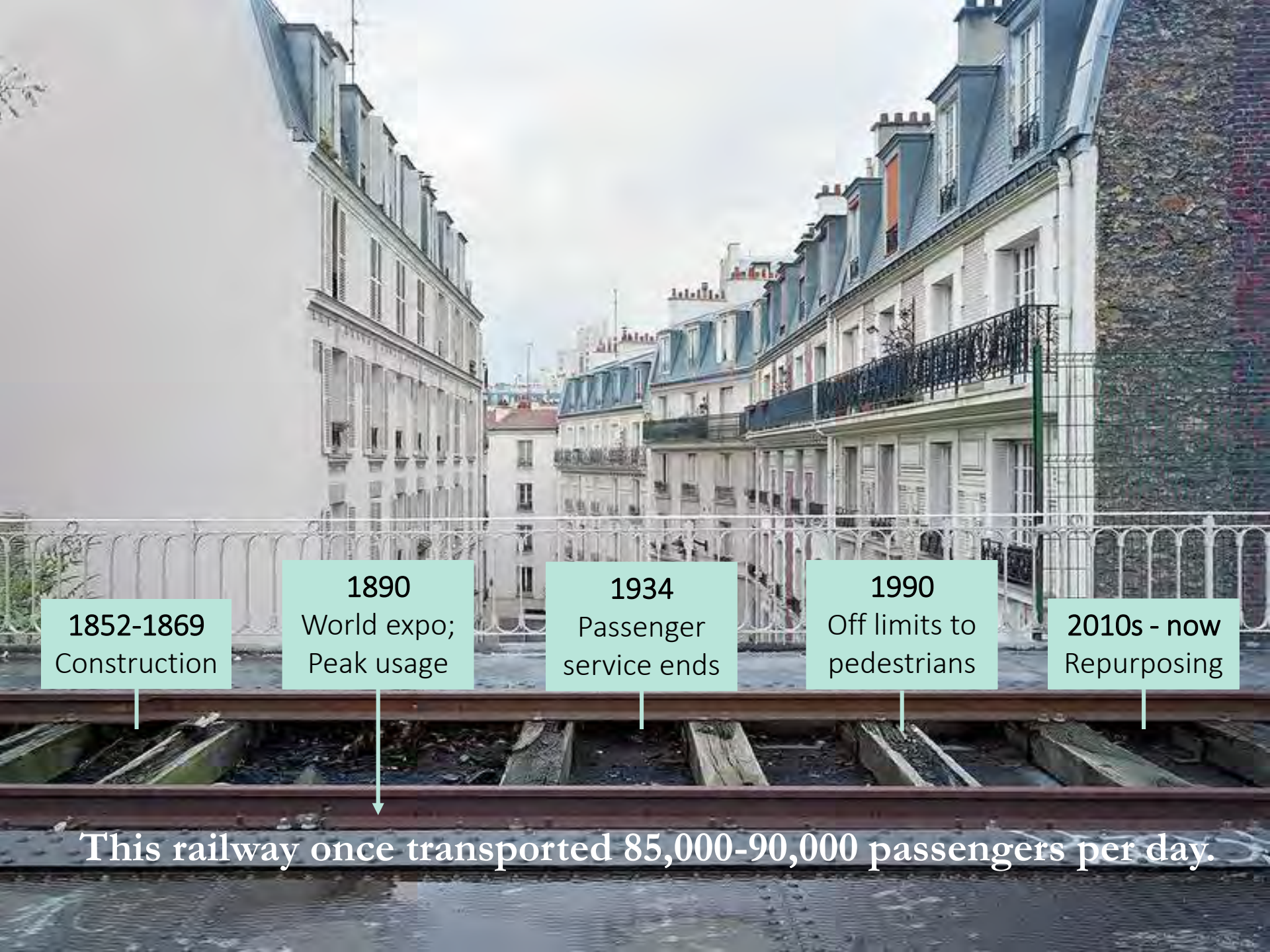




Over time, demand for the Petite Ceinture was replaced by other options for mobility. In 1900, the first line of the Métro started running, and was preferred as a more central and efficient option. The automobile revolution drew many away from public transportation altogether. Ultimately, the Petite Ceinture stopped being used for passenger transportation in 1934, and was abandoned altogether in 1990. Since then, it has been illegal for anyone to access the railway. Most of the line persists, with the exception of a segment in the south-west that was opened up for the RER C's route. Weeds sprout from the rails, and this overgrown vestige has become a natural sanctuary in the city.



Map of the Petite Ceinture in 2015,
by Atelier Parisien d'Urbanisme



1852-1869
Construction

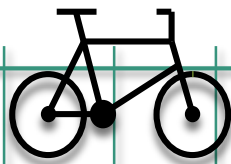
1890
World expo;
Peak usage

1934
Passenger
service ends

1990
Off limits to
pedestrians

2010s - now
Repurposing

This railway once transported 85,000-90,000 passengers per day.



Paris as a Smart City

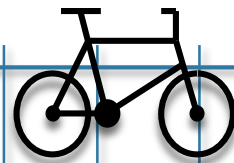
Since Mayor Hidalgo entered office in 2014, her mandate has marked a step in Paris's evolution into a more collaborative city. She set up a participatory budget for urban planning worth 20 million euros. This budget is open to the whole of Paris, not just certain districts, and encompasses all possible themes. Public space – the way we use and design it – has emerged as one of the most popular topics. The Mayor's Office has collected 2,800 new and innovative ideas, and successfully implemented 9 projects. This has been the largest and most ambitious citywide participatory budget in history.

The city can be studied as a living organism. Similar processes make up our bodies and our cities: intake of essential nutrients, circulation of oxygen can be parallel to importing essential resources, and transporting people around the city, and other smaller or more subtle analogies can also be drawn. Just as our bodies have evolved over time to operate efficiently, adaptively, and resiliently, our cities can innovate towards smarter operations. Our project is inspired by and modelled on angiogenesis, a process that takes place in our bodies' blood vessels.

Part 3:

Previous Approaches





Previous Approaches

Most of the railway has been abandoned since the 1934 but some old stations and segments parallel to the railway have already been repurposed for other uses. Several of the stations have been rented out to private businesses, and new projects such as nature trails for urban hiking and community gardens have been established at various points along the trail. In this section, we explore three types of previous approaches: projects concerning one station or segment of the railway, a proposal for a cohesive project along the whole railway, and various modes of low-carbon transportation which already exist in Paris.

Localised initiatives

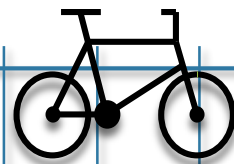
- 14e: Vert-tige
- 18e: La REcyclerie
- 20e: La Fleche d'Or

Initiatives concerning the entire railway

- Association sauvegarde de la Petite Ceinture
- Nathalie Kosciusko-Morizet ligne de vie

Transportation infrastructure

- Vélo-rail
- Vélib
- Bicycle expressway
- RATP tramway



14e: Vert-tige

Vert-tige is an association created in 2007 by six residents of 14th arrondissement. Their objective is to increase biodiversity of Paris and engage the neighbourhood in working on a garden together. The gardeners set aside a plot of land on the street of Rue Coulmiers, directly parallel to la Petite Ceinture. There are a variety of flowers, rose bushes, fruit trees, etc. and a shed full of shared gardening tools. The garden runs parallel to the train tracks on the street directly above.

Strengths:

- Valuable example of a successful urban garden.
- Open to the public every weekend afternoon.
- Adds greenery and colour to this street.



Vert-tige flowerbed, taken by Olivia Chen

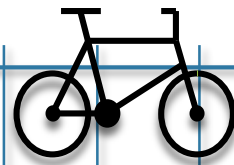


18e: La REcyclerie

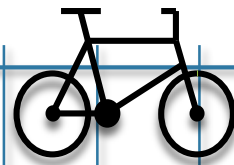
La REcyclerie is another example of repurposing of an old railway station, Gare Ornano. It is the neighbourhood's living room, with a bar, restaurant, study, urban farm, and "makerspace." La REcyclerie organises around 15 DIY and educational workshops a week. They have a backyard with 17 chickens, a herb garden, fruit trees, an aquaponics system, and more on the way.

Strengths:

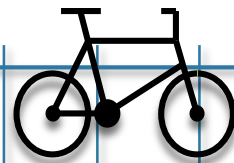
- Welcoming to everyone: you can work and rest here regardless if you purchase anything.
- Intentionally reaching out to the immediate neighbourhood as the target demographic.
- Educates schoolchildren about urban farming.
- Makerspace gives people an opportunity to fix things themselves with communal tools.
- Encourages behaviour change towards more sustainable practices such as recycling.
- Building materials are mostly recycled wood.



La REcyclerie urban farm, outdoor seating, and aquaponics, taken by Olivia Chen



Danse sur la Rails party at la REcyclerie, taken by Adam Tanaka



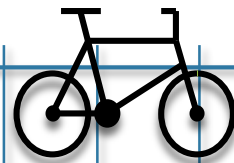
20e: La Fleche d'Or

The old railway station Charonne was converted into a café-concert-hall-restaurant in the early 1990s. The place was named “Golden Arrow” in memory of a train that ran from Paris to London between 1926 and 1972. The place is welcoming and popular, an open space where a versatile range of musicians coexist.

Strengths: encourages social interaction and brings together different types of musicians; the building's design acknowledges heritage; a social space with a distinct function and character.



La Fleche d'Or concert hall and exterior

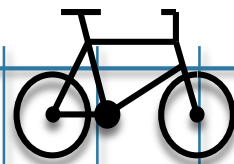


How our project hopes to expand on the three aforementioned social spaces:

- Replicate similar social spaces and community gardens all along the Petite Ceinture, now that the work has proven feasible and a positive addition to the neighbourhood.
- Repurpose old train stations all along the line to create a system of places.
- Tailor the character and function of each new social space to the audiences of each neighbourhood.

Association Sauvegarde de la Petite Ceinture

Association Sauvegarde de la Petite Ceinture (ASPCRF) promotes the preservation, knowledge and reuse by transit of the Petite Ceinture. The association believes that the Petite Ceinture has great potential to serve as a unique and helpful transport infrastructure, as well as provide the biodiversity that the city lacks. The association has not implemented any changes to the railway but has collected a lot of information about the history of the Petite Ceinture. Their website provides the timeline and story of this railway's development.



Projet de ligne de vie

Nathalie Kosciusko-Morizet, Deputy of Essone, and a candidate in the latest mayoral election of Paris, presented a proposal titled "Projet de ligne de vie" in September 2013. Her project aims to create a coherent green bicycle highway along the Petite Ceinture between all the arrondissements. The network would be quite extensive thanks to bike lanes connecting to the banks of the Seine. A hiking trail would also be developed by connecting the Petite Ceinture with the Vincennes woods.

The Petite Ceinture has become an extraordinary place of high biodiversity in the city, so the second axis of NKM's project is to plan community and pedagogical gardens at wider sections of the Petite Ceinture.

Strengths:

- Brings together many elements that different stakeholders hope to see in the Petite Ceinture's redevelopment.
- Involves a comprehensive study of the railroad's width and elevation at different points.

How our project hopes to expand on NKM's ideas:

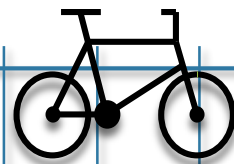
- Personalise the social programming and design to each neighbourhood through which the Petite Ceinture passes.
- Complement this project with adaptive growth in order to best serve the needs of Parisian residents. For example, instead of pre-setting bike lane connections towards the Seine, later expand the network according to the places with highest bicycle traffic.

Vélo-rail

Vélo-rails are four-seat vehicles with two seats attached to the pedals of the bicycle. It is a vehicle designed to circulate on railroads, and allows for up to six passengers.

We want to create a network for bicycles because this offers more flexibility. Vélo-rails are heavy and cannot be turned around easily, and more suitable for short leisurely trips instead of the daily commute. This can be incorporated as a fun activity in one part of the Petite Ceinture, in a neighbourhood with many families.





Vélib

Vélib is Paris's bike share system, with 20,000 bikes at 1,230 locations throughout the city. It is the world's sixth-largest bike share programme in circulation, and the largest in Europe. The system has been running smoothly since July, 2007.

Strengths:

- Already has a widespread network.
- Welcomes people who do not own bicycles.
- Method for collecting data on network usage.

Possibility for co-operation:

We hope Vélib's system can be expanded to increase access to the Petite Ceinture. Perhaps there could be bicycles available both on the Petite Ceinture and outside, near to access points.

Boulevards des Maréchaux

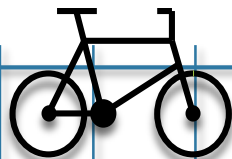
The City of Paris currently has 314 kilometres of bike lanes. In particular, a bike lane runs all the way around the city on Boulevards des Maréchaux, parallel to the Périphérique.

Strengths:

- Low-carbon transportation.
- Efficient, saving time by looping around the city.

How our project will complement the expressway:

- Improve bikers' experience by giving them a less polluted, less noisy, and more aesthetically enjoyable commute.
- Create an alternative for less capable bicyclists, because once on the rails, the surface is flat.
- Create safer bicycling experience, removed from pedestrian and vehicular traffic.



RATP Tram 3

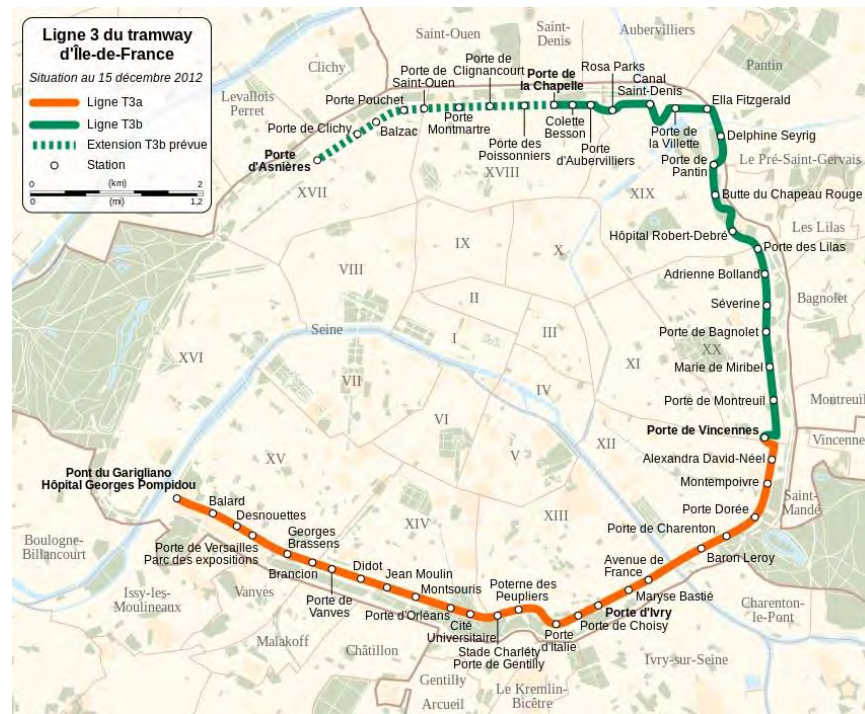
RATP operates tramway lines 3a and 3b, which hug the Périphérique on the south, east, and north-east sides of the city. This has been a 10-year long initiative by RATP and will be expanded further west.

Strengths:

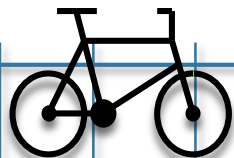
- Low-carbon transportation.
- Allows people to travel around the city rather than through the centre.

How our project will complement tram 3:

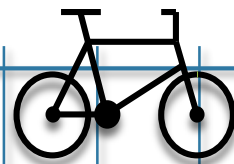
- While the tram runs close to the Périphérique, through wide boulevards that were previously under-utilised, we hope to build a more central ring road that connects neighbourhoods.
- Bicycles offers more autonomy than public transportation, and can be used door-to-door.



Map of current and planned stations of RATP tram 3



<u>Initiative</u>	<u>Implemented</u>	<u>Mobility</u>	<u>Sustainability</u>	<u>Society</u>	<u>History</u>
Localised initiatives					
Fleche d'Or	✓			✓	✓
RÉcyclerie	✓		✓	✓	✓
Vert-tige	✓		✓	✓	
Initiatives concerning entire railway					
ASPCRF	✓				✓
Ligne de vie		✓	✓	✓	
Transportation infrastructure					
Vélo-rail			✓		
Vélib	✓	✓	✓		
Maréchaux bikeway	✓	✓	✓		
RATP trams	✓	✓	✓		
Petite Ceinture 2.0		✓	✓	✓	✓



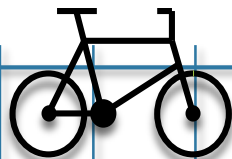
What Distinguishes Petite Ceinture 2.0

Having learned about many of these impressive initiatives, and felt very impressed by the ones we managed to visit, it has become clear to us what distinguishes our project and makes it a worthy contribution in the discussion of what to do with the Petite Ceinture.

We have tactics to maintain the railway's unique ambience
We believe that the Petite Ceinture has the capacity to host many activities and social spaces without immediately losing its natural beauty and unique ambience. We are exploring how to incorporate a meaningful variety of activities while protecting the “poetry of disuse” the Petite Ceinture has earned over decades of abandonment. We have proposed three tactics: (1) leaving at least 50% of the railroad itself untouched; (2) committing to preserve every species currently present on the railway; (3) closely monitoring network usage to see if the railroad will become too crowded.

**“Innovate while preserving
the poetry of disuse.”**

-Antoine Picon’s advice for this project



“The City of Paris doesn’t consider the Petite Ceinture a route for commuting. We consider it a space that can be opened to new uses.”
-Bruno Gouyette, City Hall of Paris

We are building a network of places

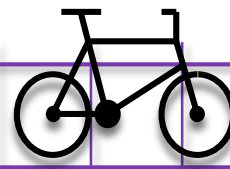
In conversation with Bruno Gouyette, Director of the Petite Ceinture at Paris City Hall, we learned that many stakeholders have taken interest in the Petite Ceinture, from rail operator SNCF to businesses interested in commercial opportunities to environmentalists. The abundance of interest in this railroad is certainly overwhelming, but it reflects the diverse potential of this railway.

While this railway historically was predominantly used for transportation and commuting, this is not what Paris needs today. The tramway and bicycle expressway have allowed for efficient commuting around the city's circumference: we need to focus on offering an experiential journey. Our bikeway may help you commute from place to place, but it must always be an engaging and pleasant option. This project is equal parts concerned with the social spaces and the bicycle route to connect them.

Part 4:

Biological Inspiration

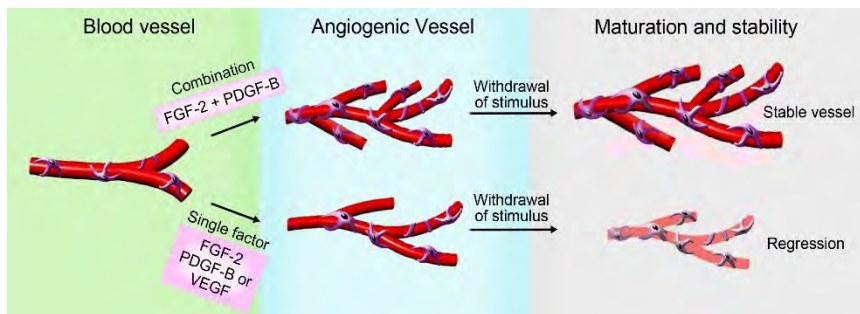


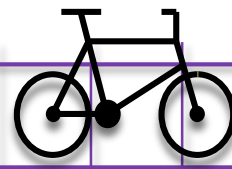


Angiogenesis

Angiogenesis is the growth of new capillary blood vessels from pre-existing blood vessels in our bodies. A crucial process for reproduction and wound healing through the development of new tissue, angiogenesis is routinely studied because of its direct roots to tumour growth in cancer patients. As all tissues in the body depend on a blood supply, successful angiogenesis is crucial to growth and maintenance of the body. Angiogenesis is carried out by endothelial cells, which line the walls of our blood vessels.

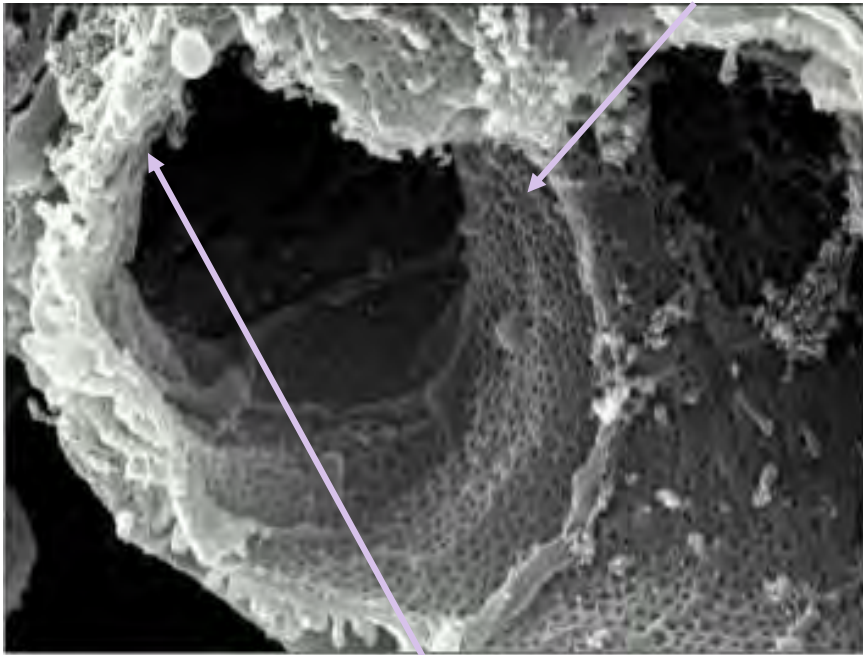
Endothelial cells have mechanoreceptors that allow them to analyse the blood flow over the vessel and correspondingly inform the blood vessel how to adapt. They are able to execute their function with tremendous flexibility by adjusting their number and positions easily to suit local requirements. They are responsible for repair the lining of established blood vessels and build new blood vessels. Endothelial cells trigger the process of angiogenesis with capillary growth. These smaller vessels sprout off of existing larger blood vessels before growing large themselves. Nearly every cell in the body is located within 50-100 μm of a capillary, demonstrating the full proliferation of capillaries in the body.





The Petite Ceinture as a Blood Vessel

Endothelial cell lining --- Continuous bicycle route along railway



Connective tissue where needed --- Gardens and activities where there is space and interest

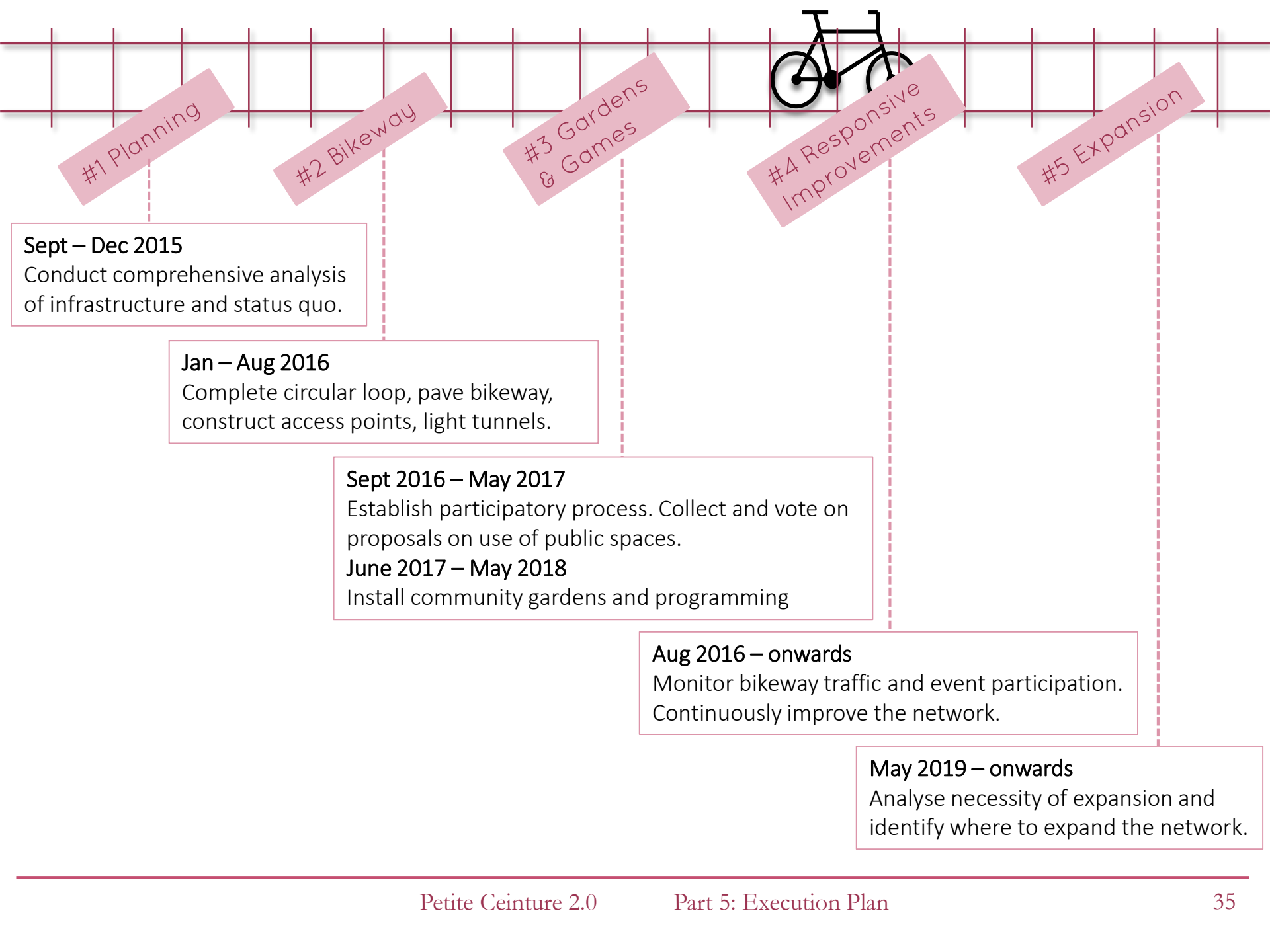
*New capillaries –
Expansion of network*

*HIF signals ---
Data on network usage*

Part 5:

Execution Plan





#1 Planning

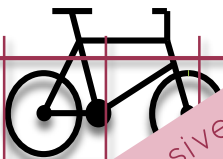
Sept – Dec 2015
 Conduct comprehensive analysis of infrastructure and status quo.

#2 Bikeway

Jan – Aug 2016
 Complete circular loop, pave bikeway, construct access points, light tunnels.

#3 Gardens & Games

Sept 2016 – May 2017
 Establish participatory process. Collect and vote on proposals on use of public spaces.
June 2017 – May 2018
 Install community gardens and programming



#4 Responsive Improvements

Aug 2016 – onwards
 Monitor bikeway traffic and event participation. Continuously improve the network.

#5 Expansion

May 2019 – onwards
 Analyse necessity of expansion and identify where to expand the network.

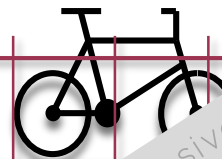
#1 Planning

#2 Bikeway

#3 Gardens & Games

#4 Responsive Improvements

#5 Expansion



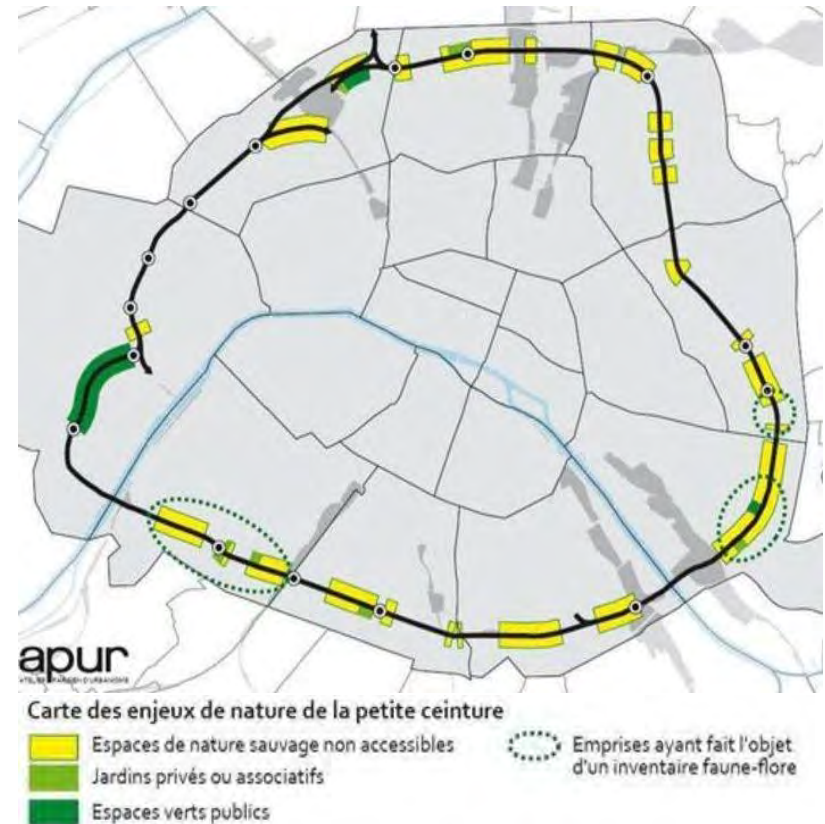
Step 1: Planning

The 32 kilometres of the Petite Ceinture involve a diverse range of infrastructure. Atelier Parisien d'Urbanisme (APUR) has conducted an extensive analysis of existing infrastructure.

Understanding where the bikeway is elevated, at grade, or submerged will help us to design appropriate access points. For example, there must be ramps or elevators to allow bicyclists to access segments not at grade. The relevant map is on the next slide.

Another important question in our planning is how the land has been used and what land is still available. Three segments have become public parks, and very small segments are private or community gardens. The rest is still untouched. This highlights the significance of opening up green space to the public.

Designation of the Petite Ceinture's Green Space





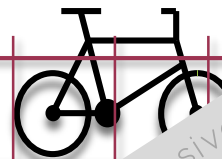
#1 Planning

#2 Bikeway

#3 Gardens & Games

#4 Responsive Improvements

#5 Expansion



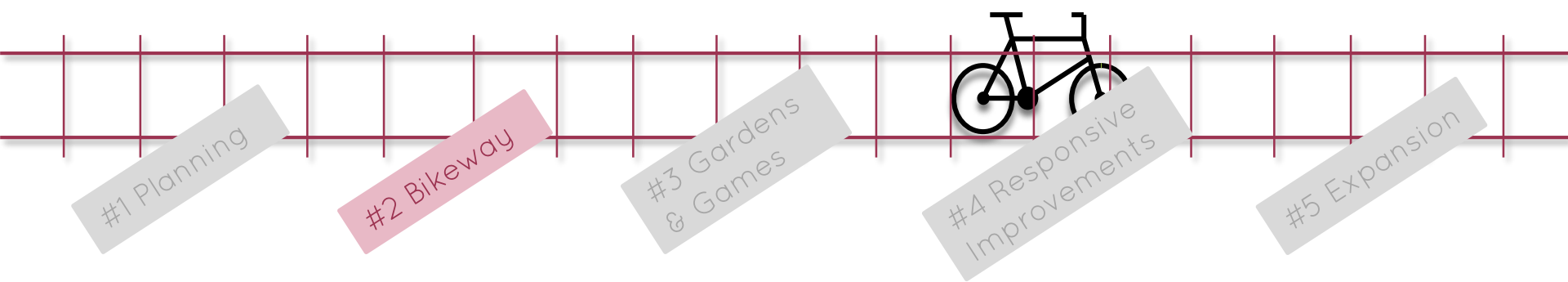
Case Study: 13th Arrondissement

Points of interest according to APUR maps:

- Gare du Boulevard Masséna. This old train station can welcome associations to encourage social bonding between the different groups of the 13th. It can become a quiet place to meditate, play chess, and practice calligraphy.
- A section directly to the east of the station can be dedicated to people who want to practice taichi, for example, as there is a distant view of the François-Mitterrand Library from there.
- This section is mostly elevated with side views, so bike access points will require ramps.
- There are several public spaces nearby, so it has the potential to become a dynamic place.

Detailed map of features on the Petite Ceinture along the 13th arrondissement





#1 Planning

#2 Bikeway

#3 Gardens & Games

#4 Responsive Improvements

#5 Expansion

Step 2: Prepare the Bikeway

The bikeway in our project is analogous to the thin layer of endothelial cells which line every blood vessel: a two-way highway will be the common element throughout the Petite Ceinture, connecting every social space along the network. To prepare for the bikeway, we need to (1) connect the missing part, (2) pave the bike route, (3) open access points, and (4) collaborate with Vélib. We aim to achieve this with a minimal impact on the environment.

“Paris will be the best bicycle city in the world by 2020.”

-Mayor Anne Hidalgo

Complete the loop

The most pressing work in preparing the bikeway at first is completing the circular network. There is a gap of approximately one and a half kilometres in the south-west section of the loop. The two endpoints must be connected to facilitate convenient commuting, and as much interaction between people of the south-west arrondissements as the rest of the network. This does not require new infrastructure, only that some roads are designated as a bike route that does not deviate far from the existing system.

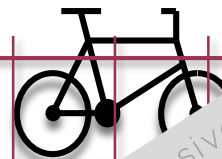
#1 Planning

#2 Bikeway

#3 Gardens & Games

#4 Responsive Improvements

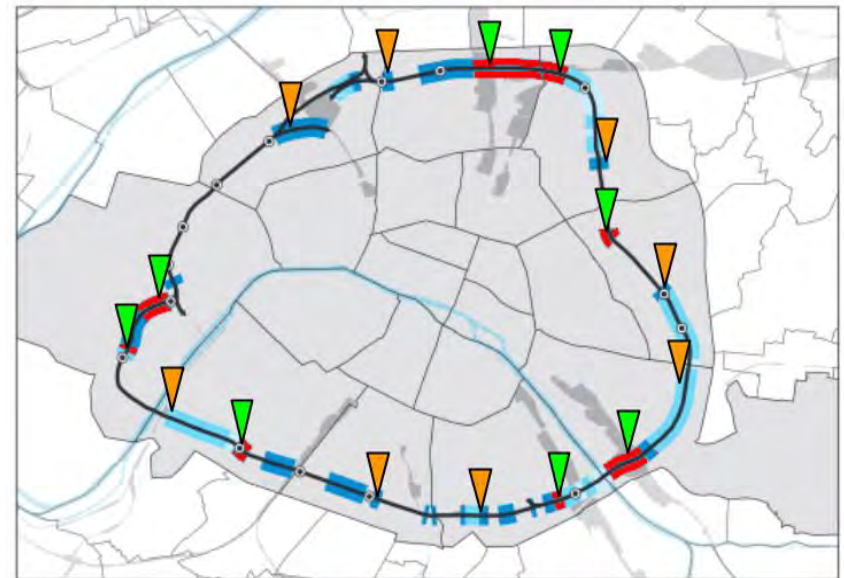
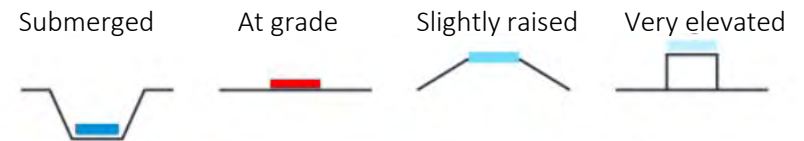
#5 Expansion



Access points

The access points will be spaced two kilometres apart. On average, it takes 8 minutes to ride two kilometres by bicycle, so the maximum length that a cyclist would need to ride to reach an access point is one kilometer over four minutes. Across the 32-kilometer network, there will be 16 access points.

There are 11 locations along the Petite Ceinture where access points can be opened at grade (marked in green). Only eight will be used because access points should be evenly distributed across the network. For arrondissements without access points at grade, we will build ramps (eight locations marked in orange). The ramps will need to be at a gentle enough gradient that it is possible for the bicyclists to enter safely. There will be street signs pointing to access points to help bikers find their way.

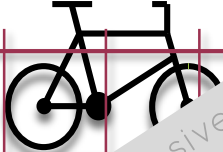


Map of proposed access points, by Cécile Crapart

#1 Planning

#2 Bikeway

#3 Gardens & Games



#4 Responsive Improvements

#5 Expansion

Paving

At the moment, the Petite Ceinture is lined by large rocks and weeds, and comprises rusted metal rails and wood or stone trestles. Thus it is critical for us to pave the bikeway of the Petite Ceinture with a material that people can bike on safely and efficiently. It is also important to us that the paving leaves a minimal environmental impact. We hope to use recycled plastic that has been compressed to pave bike lanes, gathering the plastic from the recycling processing facilities in Paris. To pave pedestrians lanes, we will use recycled wood chips, which can be obtained at a very low cost. Recognising the railway as an icon of the Petite Ceinture's rich history, we will leave at least 50% (one direction) of the railway untouched, by paving the two bike lanes between and to one side of the railways.



Rendering of roads paved by recycled plastic, by VolkerWessels in Rotterdam



For pedestrian paths: reused wood chips. Photo taken at La REcyclerie

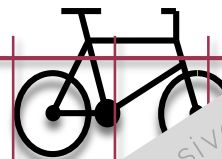
#1 Planning

#2 Bikeway

#3 Gardens & Games

#4 Responsive Improvements

#5 Expansion



Tunnels

The Petite Ceinture comprises several long tunnels. In order for bikers to safely navigate the tunnels, the tunnels must be sufficiently well lit. The three objectives of tunnel lighting are firstly to allow bikers to enter, pass through, and exit the tunnel safely, to provide this lighting without blocking or impeding the flow of bike traffic, and to minimise the cost of the lighting installation. We propose employing two strings of LED lights running along the ceilings of the tunnels. LED lights are typically low-cost and highly energy-efficient. This lighting can be enhanced with mirrors mounted and angled on the ceiling. Mirrors will produce more light without increasing electricity consumption, and their placement on the ceiling will not distract bikers as they traverse the tunnel.

Collaboration with Vélib

Vélib is a great success in Paris, seamlessly providing bikes at thousands of convenient locations, and encouraging people to travel in a more sustainable and healthy way. Such a strong bike share belongs in the Petite Ceinture. By installing Vélib stations at access points along the route, the Petite Ceinture can become a contained system where anyone can pick up a bike to travel along the route.



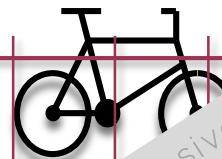
#1 Planning

#2 Bikeway

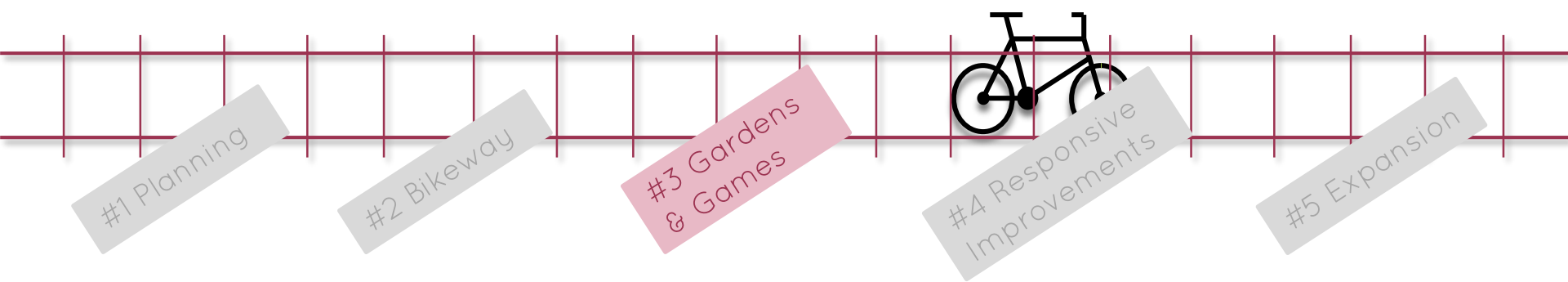
#3 Gardens & Games

#4 Responsive Improvements

#5 Expansion



Sketch of proposed bikeway
by Gaspard Baudrin
Emphasis on stairs, ramps,
and elevators for pedestrian
and bicyclist access



#1 Planning

#2 Bikeway

#3 Gardens & Games

#4 Responsive Improvements

#5 Expansion

Step 3: Enhance with Community Gardens and Activities

Beyond enhancing transportation connectivity, our project aims to improve social connection between people of different backgrounds. Activities all along the bikeway make this commute an experience. Wherever blood vessels are narrower, they only comprise endothelial cells and a protective layer called basal lamina. Wider blood vessels have room for connective tissue and muscle. The amount of tissue and muscle varies according to the diameter of the blood vessel. Similarly, at some points, the Petite Ceinture is as wide as 70 metres and there is space for more than the bikeway: community gardens, sports, and small events. There can be activities particular to the landscape of the Petite Ceinture: pétanque parallel to the railway, and rock-climbing on the walls.

**“It is a soft sort of moving,
to go from one place to
another in a calm, quiet,
and pleasant way.”**

-Fabienne Giboudeaux,
director of Paris’s smart city initiative

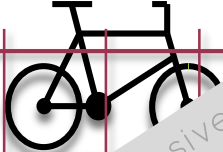
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#2 Bikeway

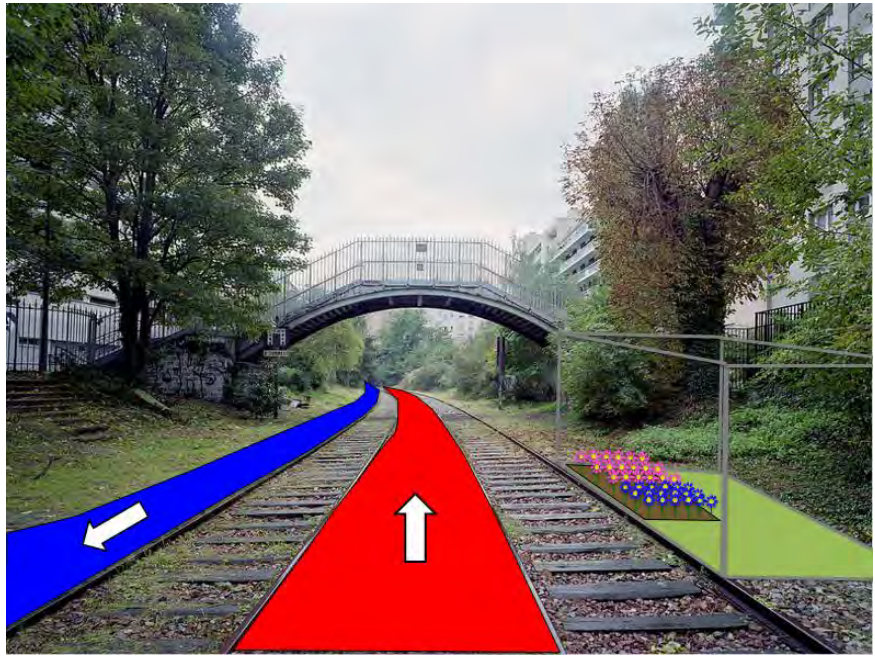
#3 Gardens & Games

#4 Responsive Improvements

#5 Expansion



Rendering of rock-climbing wall



Rendering of community gardens

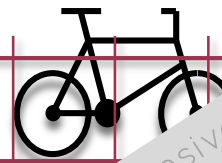
#1 Planning

#2 Bikeway

#3 Gardens
& Games

#4 Responsive
Improvements

#5 Expansion

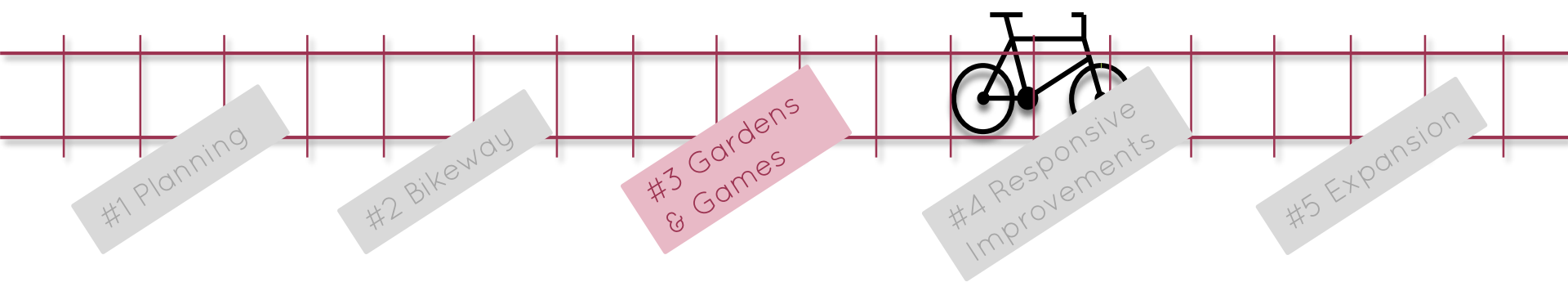


Example of public space synthesising bikes, urban gardens, and sports

Les Berges de Seine is an example of successful and creative social programming accessible to many. It is located on the south bank of the Seine. This space comprises hammocks, capsules for urban camping, small courts for badminton and totem tennis, mobile cabins that house urban gardens, and chalk art on the pavements. These innovative activities attract people of a diverse range of ages and races. Many bicyclists travelling along the river stop off to take advantage of these activities. This pop-up, lightweight programming is thoughtfully implemented but flexible and inexpensive.

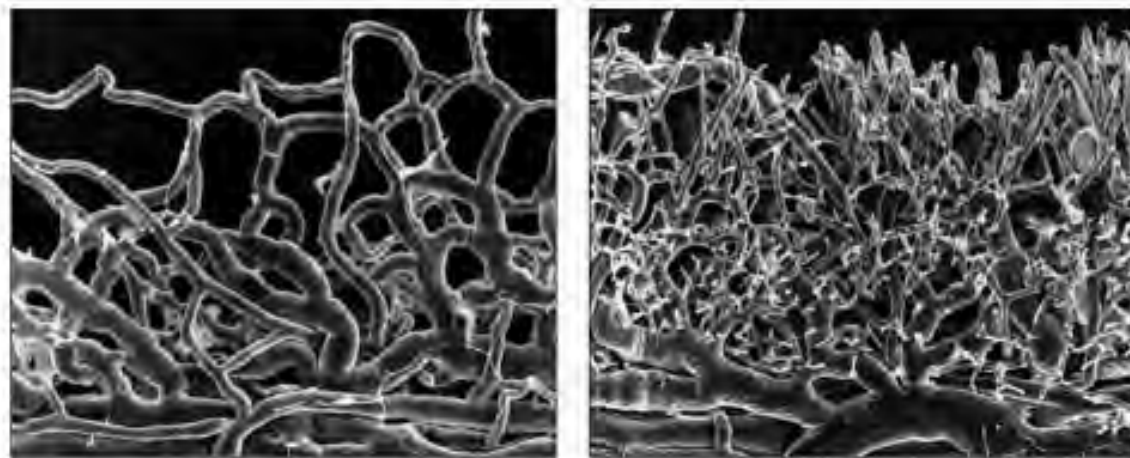


Photos of les Berges de Seine boardwalk, urban garden capsules, and chalk art, taken by Olivia Chen.



Personalised to neighbourhood needs

The choice of enhancements for each part of the railway can be informed by more than the width of the tracks. When the body is wounded or irritated, endothelial cells build capillaries that branch out around the damaged area. As seen in the diagram below, capillaries form incredibly efficiently. Our programs will be personalized to the needs of each neighbourhood and selected through a participatory process. Citizens will be welcome to make proposals and businesses to bid for public spaces. When the body heals, the capillaries break down. Similarly, our programming can be modified as neighbourhoods evolve.



X-rays of blood vessels before and after the body incurs a wound

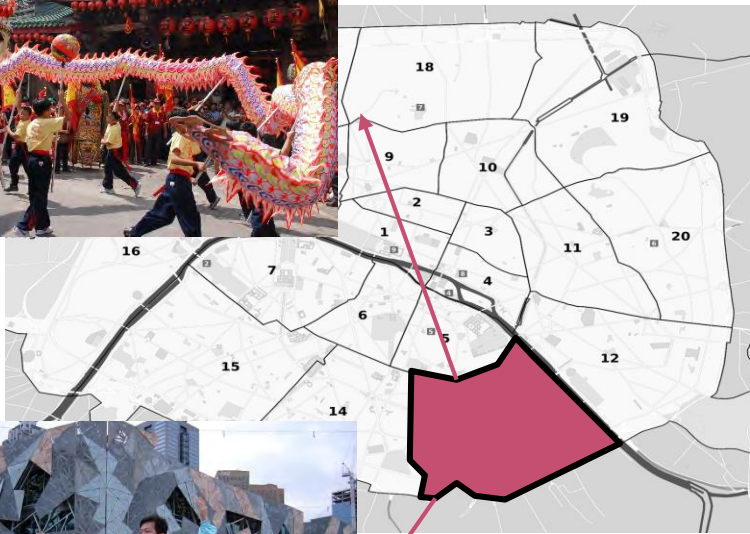
#1 Planning

#2 Bikeway

#3 Gardens & Games

#4 Responsive Improvements

#5 Expansion



Examples of traditional Chinese sports: dragon dancing and tai-chi

Case Study: 13th Arrondissement

The 13th arrondissement is facing different issues. Similarly to other less well-off neighbourhoods, there is significant socio-ethnic diversity and the challenge is to create links between different groups. Innovative initiatives in these areas are often located in “bobo” venues which fail to become open to all. We have noticed Chinese elderly practising taichi in Stade Georges Carpentier. This stadium is located between les Boulevards Exterieurs and le Périphérique, in one of the most polluted parts of the city. What if the elderly Chinese of the 13th arrondissement could practise their sports in a safer place with healthier air? We hope to integrate some spaces dedicated to calm activities such as chess or meditation into the Petite Ceinture in this neighbourhood.

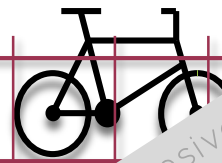
#1 Planning

#2 Bikeway

#3 Gardens & Games

#4 Responsive Improvements

#5 Expansion



Case Study: 16th Arrondissement

The 16th is known as an arrondissement with many families: 48% of people living here are married, compared to the city-wide average of 37%. Moreover, similar to other western arrondissements of the city, inhabitants have high standards of living. However, the 16th arrondissement is not a particularly dynamic neighborhood in terms of social and cultural initiatives. For example, there are very few communal gardens in this part of the city.

In response, our main goal is to provide interesting social programming suitable for families. For example, parents can cultivate a community garden while their children play nearby or attend a class about certain plants, or there could be sports facilities like a rock wall, where parents can show children a new sport.



Examples of family activities: gardening and playgrounds

#1 Planning

#2 Bikeway

#3 Gardens & Games

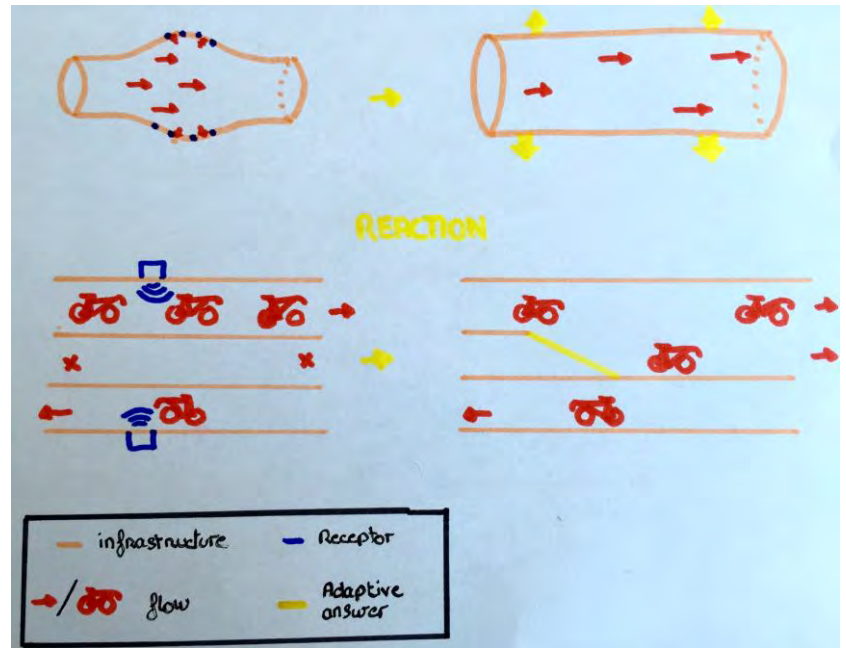


#4 Responsive Improvements

#5 Expansion

Step 4: Monitor and Respond

Endothelial cells not only form the lining of established blood vessels, but also signal the need for any improvements or changes in the blood vessels. Equipped with mechano-receptors that can sense the shear blood flow across the surface of the blood vessel, endothelial cells collect information that enables the blood vessel to adapt its diameter and wall thickness to the blood flow. Similarly, the bike lanes must adapt to user traffic, and this requires a mechanism to count the number of bicyclists that pass each day. While bike lanes cannot expand the way blood vessels do, we could perhaps designate lane directions according to commuter flow.



Adaptive response of blood vessels and bike lanes to blood flow and traffic flow respectively, by Gaspard Baudrin

#1 Planning

#2 Bikeway

#3 Gardens & Games

#4 Responsive Improvements

#5 Expansion

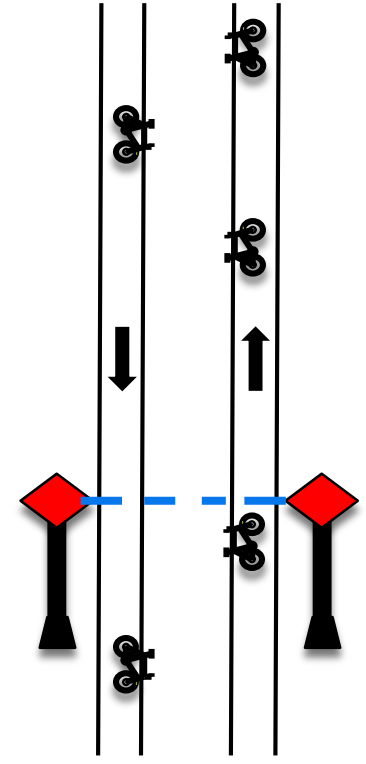


A helpful example is the Green Path, a nine-kilometre bicycle highway connecting Copenhagen to its closest city, Frederiksberg. Poles with sensors to count how many cyclists pass stand at each end of the path. Similar counters can stand at regular intervals along la Petite Ceinture, not only providing the Parisian government with data about the usage, but also showing all the bicyclists who pass by that they are part of a larger community initiative. The government and citizens should use the user data to understand which parts of the bike highway will require better maintenance.

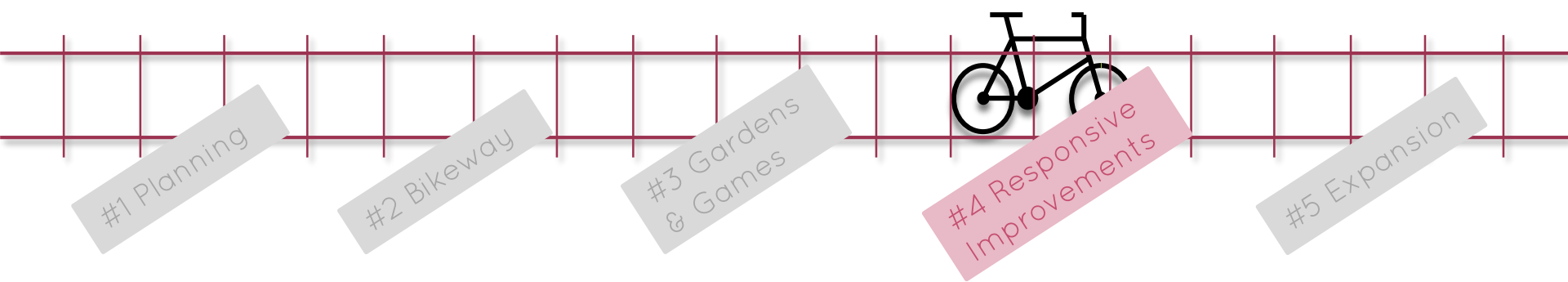
The efficacy of social programming in facilitating social interaction and community engagement can be measured through random surveys and data from event organisers.



Green Path counter in Copenhagen, taken by Olivia Chen



Rendering of sensors



Examples for using data to continuously improve Petite Ceinture 2.0

<u>Topic</u>	<u>Finding</u>	<u>Check Causation</u>	<u>Subsequent Action</u>
Bicycle usage	Low	Does the railway need to be made more accessible?	Add or change access points. Add or move Vélib stations. Increase signage on nearby roads.
Bicycle usage	High	Is the railway over-crowded and losing its unique ambience?	Set speed limits and rules about noise. Make sure the highly-used segments are well-maintained. Make sure the bikeway is still safe when crowded.
Participation in activities and event	Low	Are the activities not appropriate for the target audience?	Learn about the neighbourhood more: what do they need and what do they like? Modify events or even the locations or events continuously according to feedback of local citizens.
Demographic of bicyclists and event participants	Particularly homogeneous	Does the Petite Ceinture fail to offer something for everybody?	Look for ways to reach out to people of other backgrounds. For example, if very few older people come to Petite Ceinture, hold events more at their speed such as book club meetings and knitting workshops.

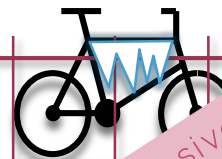
#1 Planning

#2 Bikeway

#3 Gardens
& Games

#4 Responsive
Improvements

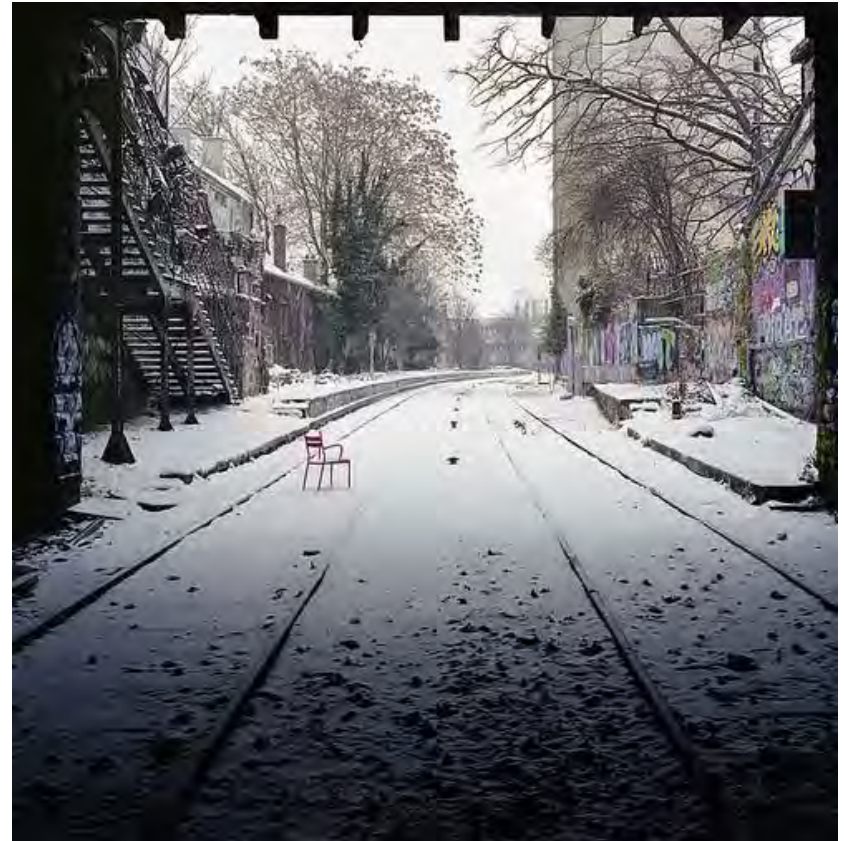
#5 Expansion



Seasonal Adaptation

While it is easy to imagine how lovely the Petite Ceinture will be during summertime, it may not be quite as useable during the winter. Data from bike share systems in Paris shows a strong seasonal effect on the percentage of people who commute by bike. Thus it would be most appropriate for our bikeway to close during the coldest months of the year: December, January, and February, when the average temperature is only five degrees Celsius, and monthly precipitation is relatively high for Paris.

However, social programming can continue during winter, especially at the most accessible social spaces: the old stations. These stations can serve hot drinks, and host seasonal events such as Christmas markets.



#1 Planning

#2 Bikeway

#3 Gardens & Games

#4 Responsive Improvements

#5 Expansion



Step 5: Expand the network

Endothelial cells consist of a gene regulatory protein, hypoxia-inducible factor 1 (HIF). When the endothelial cells detect a shortage of oxygen, they secrete HIF. The HIF in turn stimulates the transcription of proteins needed to build new blood vessels. Then, the proteins build new capillaries to service the parts of the body lacking oxygen.

Similarly, considering the bikeway of Petite Ceinture 2.0 as analogous to endothelial cells lining a blood vessel, this bikeway can support smart growth. Should the Petite Ceinture's bicycle highway prove to be a valuable addition to the city, it can form the spine of a growing network of bikeways, expanded based on traffic data. This falls in line with Mayor Hidalgo's vision of a car-free Paris.

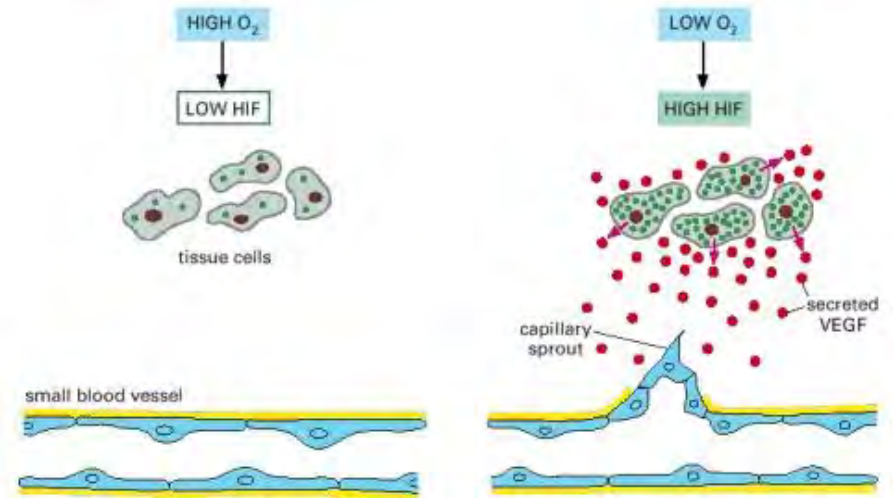
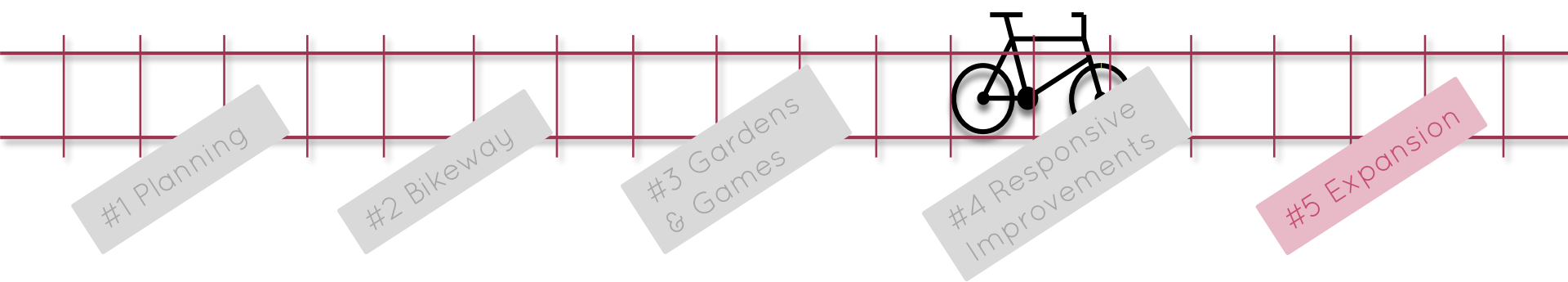


Diagram of how endothelial cells support responsive growth of new blood vessels.



The expansion of the bikeway can be a smart process targeting “low oxygen” areas in Paris. The expanded network should build new connections between neighbourhoods lacking green space and the Petite Ceinture, making gardens and greenery more accessible. The network can also reach out to areas with relatively high rates of cycling accidents.

This does not require new infrastructure: merely that the government designate certain car-free streets. To reduce the restrictive impact for cars, the city can begin by converting narrow one-way streets. These bicycle lanes will help bicyclists get closer to their destinations safely and pleasantly. Most importantly, bike lanes will be designated based on data and target neighbourhoods in greatest need of improved connectivity, furthering our objective of establishing a dynamic network.

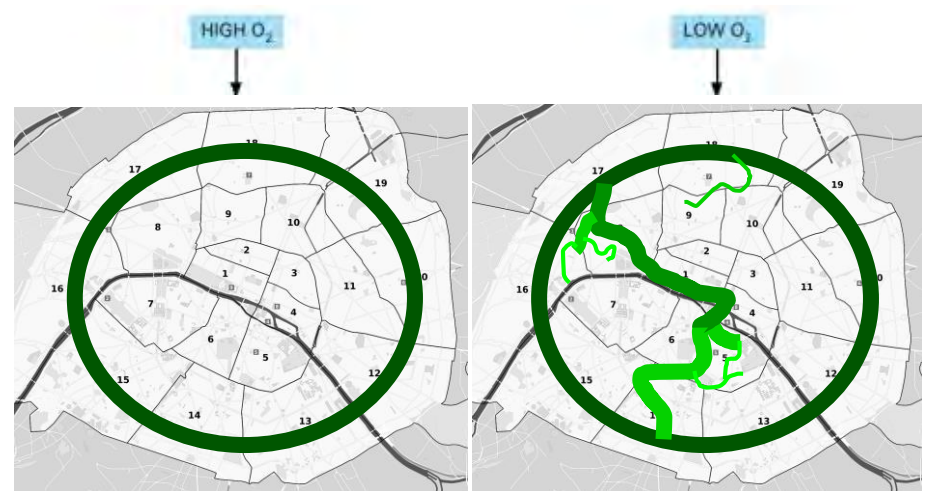
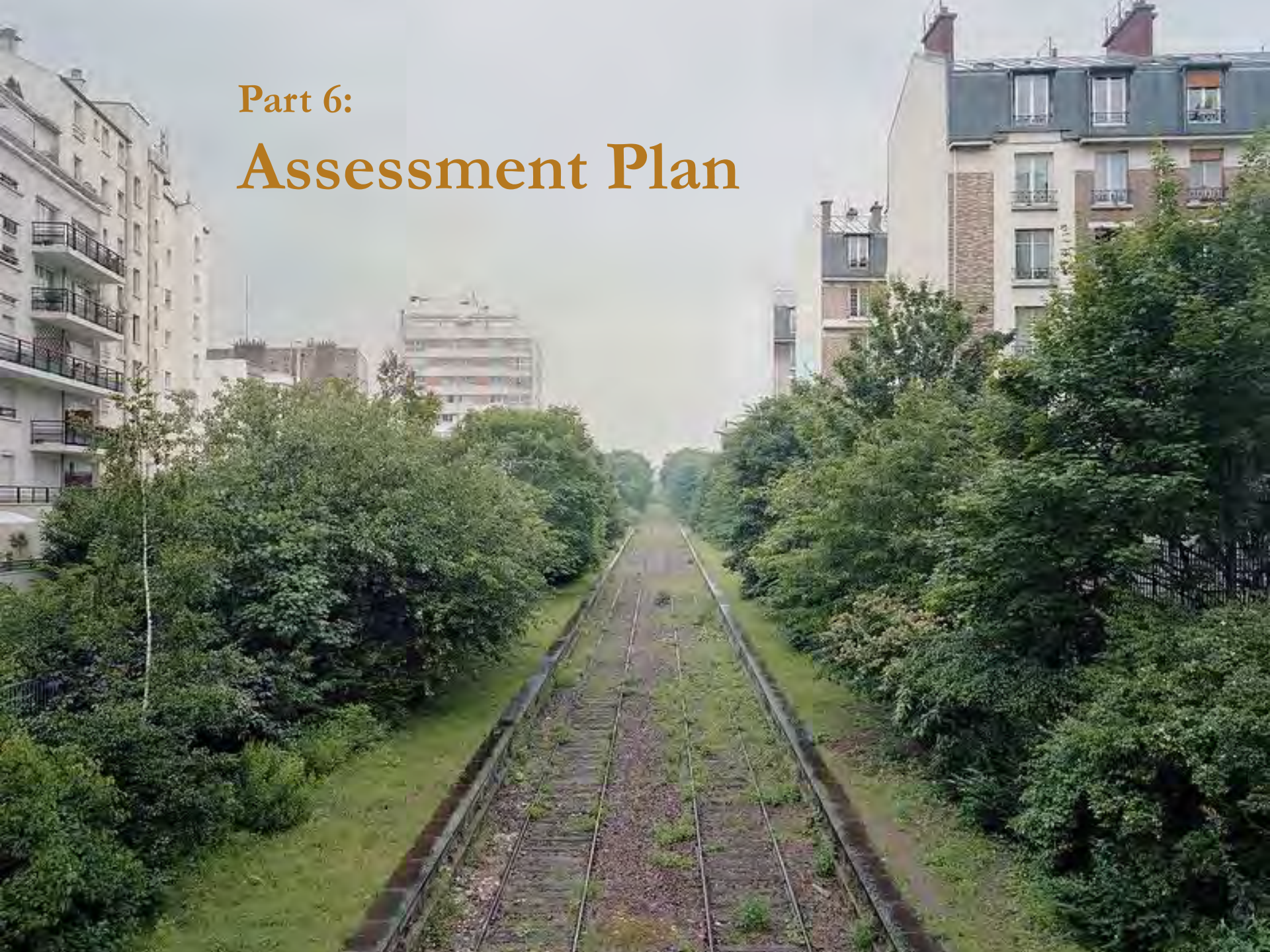
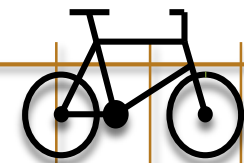


Diagram to illustrate that bike network expansion can target neighbourhoods lacking connectivity or greenery

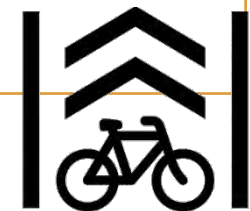
Part 6:
Assessment Plan

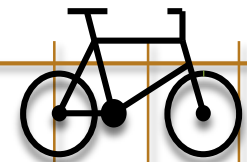




Mobility

<u>Motivation</u>	<u>Variable Measured</u>	<u>Method of Measurement</u>
CONNECTIVITY: offer a new option for Parisians to circumvent the city's traffic and travel safely.	Number of people of bicyclists per day. Average distance travelled.	Tally the number of people with aforementioned polls or sensors embedded in bikeway. Approximate distance travelled based on Vélib validations.
EXPERIENCE: create a commute that is experiential and explorative, not just efficient	Minutes that people linger at the gardens and social spaces along the track.	Measure the time it takes for people to pass between two tally poles. Those who take far more than the average riding time are most likely lingering to enjoy the place.
SAFETY: give bicyclists a safer way to commute	Difference in rate of traffic accidents for bicyclists on roads in the city vs. bicyclists along the Petite Ceinture.	Gather data from the police.





Sustainability

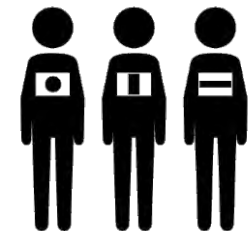
<u>Motivation</u>	<u>Variable Measured</u>	<u>Method of Measurement</u>
BIODIVERSITY: maintain the biodiversity that has grown over the last 73 years.	Number of species found in the Petite Ceinture's uncultivated areas.	Hire a team of ecologists to count what species they can find at set points along the railroad.
NATURE: encourage people to interact with nature in the city.	Land area of thriving community gardens. Number of people participating in the community gardens.	Tally surface area of productive community gardens with information from associations in charge of the gardens. Count number of people registered to participate in the gardening.
TEMPERATURE: make a cooler public space accessible, especially in summer heat.	Temperature difference between city-centre commuter hubs and various points along the Petite Ceinture.	Take the temperature of set locations in the city and on the Petite Ceinture with a thermometer throughout the year.

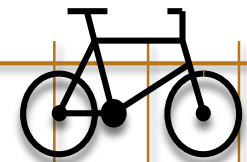




Society

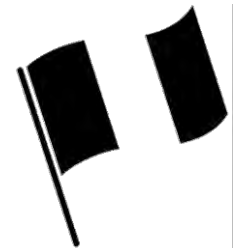
<u>Motivation</u>	<u>Variable Measured</u>	<u>Method of Measurement</u>
DIVERSITY: build a platform for people from diverse backgrounds to showcase their unique customs and stories.	Number of neighbourhoods and suburbs represented at events on the Petite Ceinture.	Ask for people's home address at registration.
INTERACTION: encourage people to interact and help them to meet each other.	Number of people who attend events at the Petite Ceinture. Success of the events in helping people to build new friendships.	Ask event organisers for estimates of number of participants. Check if previously unconnected event participants become friends on Facebook after the event.

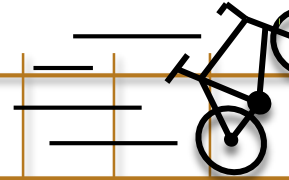




History

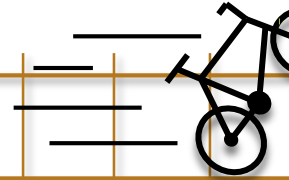
<u>Motivation</u>	<u>Variable Measured</u>	<u>Method of Measurement</u>
ICON: preserve the railroads as an icon of Paris's cultural heritage.	Percentage of the railroads that are still visible and untouched after our intervention.	Closely track the surface area that has been covered altered by our work with satellite shots.
PEACE: maintain the Petite Ceinture's unique ambience as to offer a uniquely peaceful public space.	Decibels at public spaces in the city centre vs at the Petite Ceinture.	Measure noise levels at the same time of day in set locations with noise-measurement phone apps..





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