Feell your mobility: the design of an immersive and collective experience to nudge an active mobility behavior.

Feell → fill and feel

Jacopo William de Denaro

INDEX

Feell your mobility: the design of an immersive and collective experience to nudge an active mobility behavior.
A software to generate audiovisual experiences, in a system of interactive interfaces customized to evoke individual and collective immersion through the themes of health and the environment.

Jacopo William de Denaro
941803

2021/2022

Fig.1 Interconnection of all the themes

IMAGES INDEX

ABSTRACT

English

This research project came about at a time of enormous change. During and after the CoVID-19 pandemic that affected the whole world, our lives were overwhelmed, as well as everyone's lifestyle and personal habits. In the period just before, I bought myself a bicycle to do my daily home-college commute to reduce time and cost. Within a few months, despite the restrictions, the bicycle became an irreplaceable tool for commuting. Perceiving benefits from it in several respects, I became interested in it. I made it my thesis subject, at least the starting point, to enable as many people as possible to reap the same benefits. Thus began research in the field of urban mobility, trying to understand its interrelationships and be able to circumscribe my research.

Even when analyzing European cities, the average situation in urban mobility is critical; it represents a set of interlaced problems between the vast space devoted to parking lots and roads or the heavy traffic of the busiest hours. The fact that about 8 percent of CO_2 emissions in Europe come from motor travel over short distances (less than 5 km) is the real impact that traffic and related noise pollution have on people's mental health. In addition, the trend toward urbanization has fostered the already rapid spread of sedentarism, and physical inactivity, which in the problems it creates in the individual in the long term, represent one of the most significant risks to Western societies. Both obesity and traffic accidents claim more victims individually than there are in wars. A solution, starting from the individual's point of view, exists and has existed since before the problem arose, namely active mobility, which involves using physical force to move. The bicycle is the most efficient energy consumed, and distance traveled has already played a cultural role in empowerment and growth in poorer or marginalized communities. In the contemporary world, the bicycle can be a personal tool to make a movement to combat unnecessary emissions and a means of exercising without investing extra money or time, as well as cutting individual costs on transportation and, in the long run, public on public health expenditures. One design goal in urban planning on this wave is the 15-minute or proximity city. These kinds of solutions require significant public investments and infrastructure efforts that cannot happen before a cultural effort on the part

of the population. For people to adopt bicycling as a means of travel, several factors are mixed, including a perception of risk rather than a predisposition to experience life-changing events, which is more common among young people who are in the process of building their adult lives (defining the target group in this bracket). In personal and practical terms, mobility is a habit that depends on identity. Broadening the spectrum of observation to the community, we observe how if slowly more people influenced each other to take advantage of active mobility, there would be a marginal gain, which in the long run could have cumulative effects. As a planner in this research, we apply behavioral economics concepts in gently nudging people toward sustainable habits without restricting freedoms or choices but encouraging more personally and collectively beneficial behaviors. To encourage active mobility, the analysis of policies already tested offers insights into the importance of awareness and emotional perception for their success and investments in the area. To undertake the conception of the form of the project, which deals with stimulating the adoption of active modes for utilitarian transportation, the social nature of it was taken as the starting point. A rigidly human-centered approach that sees individuals as consumers was rejected, but society-centered thinking was adopted in which every individual can be an architect of social innovation. Social transformations and environmental transformations are not independent but influence each other. Sustainable design requires a holistic approach that has manifested to consider the social and ecological aspects of movement habits. Among the most enduring intellectual and cultural tools that have played a significant role socially are the arts, while the most impressive contemporary tool is the use of data. In a sense, data represents complexity that needs support rather than interpretation to be read. Through the visual and pleasurable stimulus of DataViz, critical thinking can be stimulated through a particular entanglement of the senses. Likewise, also sounds can foster a greater level of immersion: an aesthetic perception of sublime involvement.

Thus, the research project takes the form of a collective aesthetic experience during which generative audio-video content is enjoyed in which it depicts all the travel habits of participating individuals, seeking a sense of identification between users and the interconnected system of mobility. In the form of an installation, the study is named *"Feell your mobility,"* an intentional misnomer derived from the crasis of the terms *Fill*, to fill with one's data, and *Feel*, to feel the impact of mobility. In fact for it to be drawn procedurally, data on habits are needed, which will be entered directly through an interface. In the same way, the user can delve into the personal impact of travel habits and learn how these would vary upon adopting active means of transportation. By playing with the graphic elements, the user constructs meaning from experience. From conception, this project was subsequently prototyped and analyzed through a workshop in which emotional perception was tested. The project started with a target audience analysis with several quantitative questionnaires and ten qualitative interviews to formulate personas. The interface was designed with a straightforward and youthful energy language, while the software was programmed to generate an animation that would simultaneously represent the movement habits of different people.

A simulation of the experience was conducted with thirty people who perceived more emotions of pleasure and interest. In addition to providing insights into possible improvements to make the installation more engaging, the testing created interest in further study of these forms of interaction: although to verify possible effectiveness, the experience would need to be replicated, and the study would need to be extended over time.

Italiano

Questo progetto di ricerca è nato in un momento storico di grande cambiamento. Durante e dopo la pandemia di CoVID-19, che ha vista coinvolta l'intera popolazione mondiale, è inutile nascondere che le nostre esistenze sono state stravolte, così come lo stile di vita e le abitudini personali di ogni individuo si sono dovute modificare ed adattare repentinamente di fronte ad un nuovo scenario. Nel periodo appena antecedente la pandemia, ho acquistato una bicicletta sia per fare il mio percorso quotidiano casa-università sia per ridurre i tempi di spostamento che i costi relativi ai mezzi di trasporto.

Nel giro di pochi mesi, nonostante le restrizioni, la bicicletta è diventata uno strumento insostituibile per il mio spostamento. Percependone dei benefici sotto diversi punti di vista me ne sono interessato e ne ho fatto il punto di partenza per il mio oggetto di tesi, con il fine di poter permettere a più persone possibile di trarre gli stessi benefici. Ho iniziato così a circoscrivere la ricerca nell'ambito della mobilità urbana cercando di capirne le interrelazioni. La situazione, nelle città europee e non solo, è un insieme di problematiche interconnesse:

→ l'enorme quantità di spazio dedicato alla mobilità con autoveicoli, come la rete stradale e i parcheggi, il traffico intenso in alcune fasce orarie.
→ il fatto che circa l'8 percento delle emissioni di CO_2 in Europa derivi dagli spostamenti a motore su tratti brevi (meno di 5 Km).
→ il reale impatto che il traffico ed il relativo inquinamento acustico hanno sulla salute mentale delle persone.

La tendenza all'urbanizzazione ha favorito rapidamente la diffusione del dell'inattività fisica, creando nell'individuo sedentario una serie di problematiche che a lungo termine rappresentano uno dei rischi più grandi per le società occidentali. Partendo da un punto di vista individuale, la soluzione è sempre esistita, si può ridurre al minimo gli spostamenti motorizzati facendo i percorsi brevi a piedi o in bicicletta. Quest'ultima essendo il mezzo più efficiente in termini di energia consumata e distanza percorsa ha avuto in passato un ruolo culturale di emancipazione e di crescita nelle comunità più povere o emarginate. Può nel mondo contemporaneo emanciparci dalle emissioni superflue e aiutarci a ridisegnare l'ambiente urbano per un maggiore benessere collettivo?

La mobilità attiva è l'insieme dei mezzi di trasporto che richiedono l'energia fisica per muoversi. Questa modalità di spostamento minimizza le emissioni massimizzando l'attività fisica, attività utile per il benessere fisico e mentale. Pure i costi relativi vengono drasticamente tagliati: da quelli di natura economica come la benzina o l'abbonamento dei mezzi, a quelli di natura temporale come il tempo da trovare per fare del movimento.

Un ambiente urbano ideato su questo flusso collettivo è la Città dei 15 minuti o delle prossimità. Questo tipo di soluzioni però necessitano di grossi investimenti pubblici e impegni infrastrutturali che non possono avvenire prima di un reale cambio di paradigma e di uno sforzo culturale da parte della popolazione. È chiaro che approcciarsi ad un cambiamento comporta una serie di fattori da prendere in considerazione, come per esempio la percezione d'impatto del rischio piuttosto che una valutazione positiva e propositiva di vivere il cambiamento. Quest'ultimo è più naturale in una popolazione giovane rispetto a quella anziana, per il fatto che i giovani (definendo in questa fascia il target) sono maggiormente sensibili all'impronta che desiderano lasciare per il loro futuro da adulti.

In termini personali e pratici la mobilità è un'abitudine che, come tale, dipende dall'identità. Ampliando lo spettro di osservazione alla collettività si può notare che se un campione sempre più ampio di persone si influenzassero l'un l'altro nell'usufruire della mobilità attiva si avrebbe un guadagno marginale e portare a dei benefici incrementali sulla società. Dall'aria più pulita all'inquinamento acustico fino al risparmio sulle spese pubbliche sanitarie (HEAT, UE). In questa ricerca sono applicati i concetti dell'economia comportamentale per accompagnare le persone verso abitudini sostenibili, senza limitarne la libertà o le scelte individuali ma favorendo i comportamenti più vantaggiosi a livello personale e collettivo. Alcune politiche per favorire la mobilità attiva sono già state testate, offrendo spunti sul ruolo della consapevolizzazione e della percezione emotiva per la buona riuscita delle politiche. Per intraprendere il concepimento della forma del progetto per stimolare l'adozione di modalità attive per il trasporto utilitaristico, si è partiti dalla natura sociale di essa. È stato scartato un approccio rigidamente human centered che vede negli individui i consumatori, ma si è adottato un pensiero society centered in cui ogni individuo può essere artefice dell'innovazione sociale. Trasformazioni sociali e trasformazioni ambientali non sono indipendenti, ma si influenzano a vicenda. La progettazione sostenibile richiede un approcio olistico che si è manifestato nel considerare gli aspetti sociali ed ecologici delle abitudini individuali di movimento. Tra gli strumenti intellettuali e culturali più longevi che hanno avuto un ruolo importante a livello sociale troviamo le arti, mentre lo strumento contemporaneo più imponente è l'utilizzo dei dati. I dati sono spesso, soprattutto se in grande quantità, complessi e un supporto piuttosto che un'interpretazione può semplificarne la lettura. La visualizzazione dati sfrutta lo stimolo visivo può stimolare il pensiero critico attraverso attraverso una piacevole interconnessione dei sensi. Allo stesso modo anche i suoni possono favorire un livello di immersione maggiore: una percezione estetica di sublime coinvolgimento.

Il progetto di ricerca prende quindi la forma di un'esperienza estetica collettiva durante la quale si fruisce di un contenuto audio-video generativo in cui sono rappresentate tutte le abitudini di spostamento di chi è coinvolto. Sotto forma di installazione lo studio prende il nome di *"Feell your mobility"*, un errore voluto che deriva dalla crasi dei termini *Fill*, riempire con i propri dati, e *Feel*, per percepire l'impato della mobilità. Attraverso l'esperienza il participante viene immerso in un'immedesimazione collettiva con l'interconnesso sistema della mobilità urbana. L'esperienza parte appunto dall'inserimento in un interfaccia delle informazioni basiche sulle proprie abitudini di spostamento. I dati raccolti, non sensibili permettono di disegnare attraverso un processo generativo il contenuto principale dell'esperienza. Un contenuto audio-visvo proiettato in uno spazio adatto dove un gruppo di persone esperisce una sintesi delle proprie abitudini. Infine in una web-app personalizzata l'utente ha la possibilità di approfondire l'impatto individuale delle abitudini di spostamento, e di realizzare come queste muterebbero con l'adozione di mezzi di trasporto attivo. Infine giocando con gli elementi grafici l'utente costruisce il proprio significato a partire dall'esperienza. Attraverso la prototipazione le diverse parti dell'esperienza il concept del progetto si è consolidato. Il progetto è stato avviato a partire da un'analisi del target con diversi questionari quantitativi e dieci interviste qualitative al fine di formulare delle personas. È stata disegnata l'interfaccia con un linguaggio energetico diretto e giovanile mentre è stato programmato il software per la generazione di un'animazione che rappresentasse contemporaneamente le abitudini di movimento di diverse persone. Le conclusioni su questo percorso sono state generate attraverso un workshop in cui è stata testata la percezione emotiva.

È stata effettuata una simulazione dell'esperienza con un campione di trenta persone che ha percepito maggiormente emozioni di piacere ed interesse. Oltre ad aver fornito spunti su possibili miglioramenti per rendere l'installazione più coinvolgente, il testing ha creato partecipazione nell'approfondire gli studi su queste forme di interazione anche se, per verificarne una possibile efficacia, l'esperienza dovrebbe essere replicata e lo studio sarebbe da estendere nel tempo.

CHAPTER 1

URBAN MOBILITY AND HEALTH

1.1 →
Limits of current Urban Mobility

"The motor vehicle has been responsible for much that adversely affects our physical surroundings…

(Buchanann, 1967)

1.1.1 — Introduction

Mobility and transportation are essential to all of us. Mobility is an enabler of our economic and social life, from daily commuting to work, visiting family and friends, and tourism, to the proper functioning of global supply chains for the goods in our shops and industrial production (Mobility Strategy and Action Plan, 2021). While urban transportation has had a tremendous liberating effect, it has also posed a significant problem to the urban impact in which it operates. Cities are areas with a high concentration and accumulation of economic activity. They are complex spatial structures supported by infrastructures such as transportation systems. The greater the complexity and potential for disruptions in a city, the greater its complexity, mainly when it needs to be managed effectively. The efficiency of a city's transportation system in moving labor, consumers, and freight between multiple origins and destinations is critical to its productivity. Private automobiles are an essential mode of urban transportation in cities, where 70 percent of Europe's population resides. In addition to reducing the opportunity to be physically active, private diesel and gasoline vehicles have several effects. Their use contributes significantly to air pollution (e.g., particulate

matter, such as PM2.5), greenhouse gas emissions (e.g., carbon dioxide (CO_2) and black carbon), noise pollution, elevated urban temperatures, and motor vehicle crashes. All these factors can contribute to an increased risk of premature mortality and disease.

The theme of urban mobility has importance on a global level. Agenda 2030 identifies "*Sustainable Cities and Communities*" as one of the 17 Sustainable Development Goals (SDGs) to be achieved by 2030 by providing "access to safe, affordable, accessible and sustainable transport systems for all, improving road safety" (*Transforming our World: The 2030 Agenda for Sustainable Development*, 2015).

Traffic congestion occurs when urban transportation networks become too congested to handle the traffic volume. Traffic overloading levels vary over time, with a clear peak during the daily commute to work. Although most congestion can be attributed to overloading, other aspects of this fundamental problem must be addressed.

Increasing volumes of the private car, public transportation, and commercial vehicle traffic in developed countries have exposed the shortcomings of urban roads, particularly in the old city center of Milano, where street patterns have largely remained unchanged since the nineteenth century and earlier. This intricate nature makes motorized movements difficult and long-term car parking almost impossible. Congestion and parking are also linked because street parking consumes transportation capacity, removing one or two lanes from urban roads. Furthermore, looking for a parking spot causes additional delays and impedes local circulation: many delivery vehicles will double-park to unload their cargo. Instead for what concerns public transportation: a large proportion of the day's journeys are done during peak hours, when there will be long lines at stops, crowding at terminals, stairways, and ticket offices, and excessively long periods of hot and claustrophobic travel jammed in overcrowded vehicles. At such peak times, 'person congestion' inside public vehicles adds insult to injury, sometimes literally. Most traffic accident victims are pedestrians, and attempts to improve their safety have typically focused on restricting movement on foot rather than addressing the source of the problem (i.e., traffic speed and volume). Those conditions deteriorate the pedestrian environment by making large areas' off-limits' and forcing walkers to use unclean footbridges and underpasses. There is also obstruction from parked cars and increasing pollution of the urban environment, with traffic noise and exhaust fumes affecting those on foot directly.

A more significant proportion of the globe's population now resides in cities, and this level is forecast to reach 70% by 2050 (Fishman, 2016). The new urban age, combined with a growing awareness of liveability, has led to an emerging recalibration of city life. By deepening the topic of urban mobility, we encounter many themes: like long-time commuting, loss of public space, energy consump-

tion, accident and safety, infrastructure costs, traffic congestion, environmental impact, and difficulties for non-motorized transport systems; acknowledging the complexity of all the intricate problems that are inherited.

1.1.2 — The public space

The urban environment and the quality of urban spaces are greatly influenced by various modes of mobility, ranging from the highly impactful mass use of private vehicles to soft pedestrian walkways and cycle paths, as well as various modes of public transportation. Since ancient times, streets have played an important role in cities, connecting spaces, people, and goods and facilitating commerce, social interaction, and mobility.

Streets, along with plazas and squares, were an integrated system of movement space that contributed to defining cities' cultural, social, economic, and political life until the mid-twentieth century. They had a natural vibrancy and were dynamic and multifunctional places, especially for young people and teenagers, who were (and still are) the main actors in the process of public space appropriation.

The car society has undeniably destroyed the collective meaning of public spaces. Managing the increase in vehicular traffic has necessitated a change in the form of the city in order to meet the needs of a motorized population (Newman and Kenworthy, 1999). Streets have been reduced to "car spaces" and urban spaces to "parking spaces," ignoring their importance as places of interaction, diversity, and exchange. In virtually all cities, transport infrastructure is, to a considerable extent, devoted to the car.

This condition is problematic because private cars are the most space-intense transport modes. A parked car requires at least three times more space than public transport and ten times more than a bicycle. The current allocation of urban road space is unfair and inefficient from social, health, environmental, and economic viewpoints. Allocating more space to non-car transportation should be an obvious goal for urban planners. Despite increasing pressure on urban space, many cities continue to accommodate car growth by expanding roads and parking capacity based on the predicted and provided principles. According to estimates, there are more than one billion passenger cars worldwide, many of which are employed in cities. Recent developments point to two significant issues for urban transportation planners. The first is that the automobile competes for space with other modes of transportation. Second, commuters

using private cars commonly inhibit transportation system change within cities (Gössling, 2020). Walking, cycling, personal light electric vehicles, and public transportation – mainly electric-powered – are examples of sustainable transportation modes in urban mobility. Increased participation of these modes in urban mobility will help to promote high-quality accessibility and contribute to a high-quality urban environment. As the most distinguishing characteristic of cities, urban quality may be associated with urban design concepts such as urbanity and vitality (Grindlay, 2021).

Sustainable modes of transportation promote and increase urbanity and vitality, resulting in an improvement in urban quality. Walking is the most fundamental mode of commuting and is linked to urban quality: pedestrian access has been used to measure it. Although cars are still a part of the cityscape and must be considered when planning, we can no longer rely on cars to keep our cities running. Instead, we must strive to create a balanced city environment where people in cars, bicycles, and feet can coexist.

Streets are being redesigned based on this concept to reclaim their "past" social and multifunctional character. Re-balancing the relationship between public spaces and urban mobility entails socially and formally re-qualifying streets and public space networks by re-establishing an integrated use of spaces and multiple modes of movement.

Concretely, this means making streets more appealing to all users, improving their ability to function as both urban living and mobility spaces, and meeting new societal functional requirements (Ravazzoli and Torricelli, 2017b).

1.1.3 — Environmental pollution

Climate change is a threat to long-term development. After years of intensive research, scientists have concluded that man-made greenhouse gas (GHG) emissions are the primary cause of the Earth's average temperature increase over the last 250 years (IPCC, 2014). Man-made GHG emissions are primarily a byproduct of fuel combustion in power plants, automobiles, and homes. GHG emissions are also produced by farming and waste decaying in landfills (*Greenhouse gas emissions from transport in Europe*, 2019). In Italy, the transport system is the second most significant source of GHG emissions, around 27%. In Europe, it

shares the first spot with Energy Industries and fuel combustion by energy users (transport excluded): 25.4% of each total. Road transport constitutes the highest proportion of overall transport emissions (in 2019, it emitted 72% of all domestic and international transport GHG). Of these emissions, 44 % were contributed by passenger cars, while 19 % came from heavy-duty vehicles.

In terms of daily distance covered on an average day (working or non-working day), individuals cover only 11.4 km in Italy. Over 30% of European car journeys cover distances of less than 3 km; 50% cover less than 5 km. Commuting is the main reason for the daily distance covered. In most cases, this is the distance between home and the place of work and back (*Passenger mobility statistics*, 2019). Combining these statistics (fig.1) shows us how almost 8% of Europe's total greenhouse gas emissions come from short car trips and the role of cars in urban mobility. This last percentage on the emissions scale is considerable since it is more directly related to the habits of individual citizens when it comes to moving around the city. In this sense, behavioral change is a tool that people have in their hands to directly affect the health of the environment and mitigate climate change.

The issue of urban mobility, as we will also see in later chapters, is one that also directly touches on personal health. In analyzing emissions from urban transportation, we realize the impact that the same substances emitted have on human health. Road transport is responsible, in Europe, for more than 40% of nitrogen oxide emissions and 40% of fine particulate matter (PM2.5) emissions. According to the International Agency for Research on Cancer, air pollution, specifically PM2.5, is a leading cause of cancer. Chronic exposure can affect every organ in the body, complicating and exacerbating existing health conditions. Fine particulate matter is the air pollutant causing the most severe health problems and premature death (PM2.5). The World Health Organisation (WHO) has found evidence linking air pollution to type 2 diabetes, obesity, systemic inflammation, Alzheimer's disease, and dementia (*Air pollutions sources and Health impacts of air pollution*, 2021).

In addition, during the recent pandemic, it emerged that high levels of PM10 pollution were the second most crucial variable in explaining severe COVID-19 cases (after age) and the fourth most important in explaining mortality (after age, heart failure, and high blood pressure). Researchers estimate that a 1 g/m3 increase in PM10 levels will result in 3.% more patients experiencing severe symptoms and 2.7% more deaths.

Italy had the highest number of deaths worldwide in early April 2020. According to research, local weather circumstances and air pollution may have played a (secondary) role in this rapid transmission. Researchers collected meteorological and air pollution data from monitoring sites at airports in Florence, Trento, and Milan and used publicly available daily data from persons with COVID-19 in hospital ICUs. The statistical study revealed that viral transmission decreased when temperatures and humidity increased but increased as PM 2.5 levels went up (Lolli et al., 2020).

Environmental pollution is the most serious consequence due to the current state of urban mobility, significantly when scaled over the long term. Air pollution has severe consequences for public health, and the advancement of the greenhouse effect is the main threat of this era for the global community.

22% of EU GHG Emissions from transport sector

71.7% of transport emissions from car transport

50% of car trips are no longer than 5km

Short car trips emit **8%** of total EU GHG
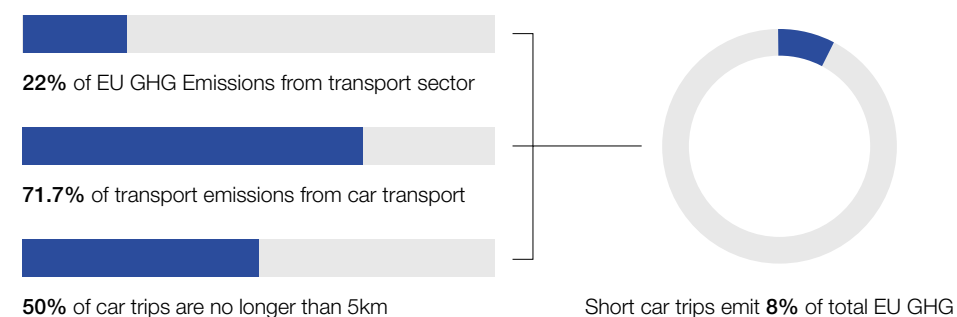
Fig.2 - Graphs of the share of green-house gasses made up by cars trips associated with commuting.

1.1.4 — Noise pollution

Noise fills everyday life.
Noise pollution is any change in the physical qualities of the environment induced by the conjugation of sounds, whether favorable or not (the latter refers to noise), that is hazardous to the health, safety, and well-being of living organisms, particularly human populations.
It is necessary to distinguish "sound" from "noise" to comprehend this issue.
Sound is a disturbance that travels through an elastic medium (air, water, Etc.) at a rate that is specific to that medium.
Noise, on the other hand, might be defined as an unpleasant sound, that is, a sound that disturbs people, even though its physical properties are identical to those of sound.
Excessive noise harms people's health and interferes with everyday activities at school, work, home, and in their spare time.
It can produce sleep disturbances, cardiovascular and psychophysiological consequences, decreased performance, irritation responses, and social behavior abnor-

malities. Almost every third of individuals in the WHO European Region suffer from traffic noise alone (*Traffic noise: exposure and annoyance*, 2001). Nighttime sound levels that are harmful to their health regularly impact European cities. Noise pollution has a substantial social and economic impact in addition to its solely medical impacts on individuals. Noise pollution causes sleep disruption, which affects an individual's work performance throughout the day, causes hypertension and cardiovascular illness, costs the health system more time and money, and has a detrimental impact on children's school performance.

The rise in social noise exposure is concerning, as there is evidence that noise exposure as a child can lead to hearing loss later in life.

Hearing loss due to noise exposure is a severe public health issue; scientists believe that 1.3 billion people worldwide suffer from it, and the World Health Organisation (WHO) believes that 10% of the global population is currently exposed to noise levels that may cause hearing loss.

Estimated percentage of inhabitants within urban areas exposed to unhealthy road traffic noise levels, based on Environmental Noise Directive thresholds, in 2017

Percentage of people above (L_den 55 dB)
• ≤ 15% • 15-30% • 30-65% • 50-65% • 65-75% • > 75%
No data   Outside coverage

Percentage of people per noise band (L_den)
55-59 dB 60-64 dB 65-69 dB 70-74 dB ≥ 75 dB
* Totally or partially modelled

Reference data: ©ESRI

Fig.3 - Map of the noise pollution level in different urban areas in Europe, Italy have generally high levels.

Noise exposure's non-auditory health effects, such as annoyance, sleep disturbance, heart disease, and cognitive damage, are all creating growing concerns. Annoyance, which may seem insignificant, can produce rage, tension, and tiredness and is believed to be the second most common source of health effects from ambient noise due to the enormous number of people impacted (Basner et al.,

2014). Sleep disruption is regarded to have the most negative influence on health since it can affect alertness, work performance, and overall quality of life. Indeed, research suggests that noise levels at night may have a more significant long-term impact on health than noise exposure during the day. Long-term exposure to environmental noise has been associated with cardiovascular disease, which includes high blood pressure, heart disease, and stroke.

For example, a review of the results of numerous research indicated that an increase of 10 dB in transport noise (traffic and airplanes) can result in a 7 to 17% increase in the risk of high blood pressure or heart disease (Murphy and King, 2014). Because noise has been linked to cardiovascular disorders like arterial hypertension, coronary artery disease, heart failure, and arrhythmia, it should be considered a cardiovascular risk factor.

In mice, noise-induced stress raises blood pressure, stress hormone levels, endothelial dysfunction, oxidative stress, NOX2 activity, nitric oxide synthase uncoupling, and vascular inflammation, all of which are avoided by NOX2 deficiency. Short-term simulated aircraft and railway noise decreases sleep quality and raises stress hormone levels, blood pressure, endothelial dysfunction, and oxidative stress, according to translational field investigations in healthy people and patients with heart disease.

Since the WHO evaluation in 2018, the quality of evidence on the detrimental cardiovascular effects of noise exposure has improved for key cardiometabolic risk factors, including obesity and diabetes mellitus.

Noise-induced stress raises cerebral oxidative stress and downregulates and uncouples neuronal nitric oxide synthase, which could explain why children exposed to airplane noise have delayed cognitive function development (memory and learning). Over 20 research studies have found that environmental noise can impair children's learning and cognitive development (Münzel, Sørensen and Daiber, 2021). Long-term traffic, rail, and aircraft noise exposure can impair memory, reading skills, and test performance.

After controlling for factors including socioeconomic level, the findings revealed a clear relationship between noise exposure and poor reading comprehension and memory. Although when discussing urban mobility, the topic of noise pollution is often left for last, its effects on citizens' health and its close correlation with air pollution make it a practical and instantaneous yardstick for recognizing the level of sustainability in urban transportation. In building an effective system that makes people aware of the impact of their transportation habits, the acoustic dimension could be crucial in telling the urban scenario in an immersive context.

1.2 →
Physical Inactivity

1.2.1 — The dimension of physical inactivity

Substantial evidence is that regular physical activity has significant and far-reaching health advantages. These benefits range from reduced risk of chronic diseases like heart disease, type 2 diabetes, and some malignancies to improved function and longevity. There is growing evidence that physical activity slows cognitive decline and benefits the brain and the rest of the body (Khan, 2009). Every year the World Health Organization, in collaboration with the European Commission, fabricates the "Physical Activity Factsheet" using data coming from Eurostat. As its name explains, it is a document containing information regarding national levels of physical activity in every country, with some insights regarding the policies and plans in action to promote active lifestyles. The Italian Factsheet (*Italy Physical Activity Factsheet*, 2021) underlines that more than half of the adult population (18 - 69 years) do not reach a sufficient level of physical activity, while among the youngest (11-15 years), only one child out of ten does sufficient exercise (Fig.4).
Zooming out a bit from the Italian context: data suggest that 31 percent of the world's population does not satisfy the minimal physical exercise guidelines. In contrast, physical inactivity contributes to 6–10% of all non-communicable disease deaths worldwide. Of course, there is a relationship between physical inactivity and the risks of being overweight or obese. The spread of obesity and the resulting increase in rates of chronic disease and other severe conditions threatens health systems, economies, and individual lives.
Obesity is caused by an energy imbalance: too many calories consumed vs. too few calories expended. Age, physical size, and DNA are just a few factors impacting how many calories (or "energy") people expend daily. The quantity of daily activity is the most changeable factor—and the easiest to change.
Researchers ("*Sedentary Behaviors, and Obesity*," 2008) believe that physical acti-

vity prevents obesity in multiple ways:
→ It boosts people's total energy expenditure, which can help them maintain an energy balance.
→ Physical exercise reduces waist fat and total body fat, which slows the progression of abdominal obesity.
→ Muscle-strengthening exercises increase muscle mass, increasing the energy used throughout the day—even when the body is at rest—and making it simpler to maintain a healthy weight.
→ It alleviates depression and anxiety, and this boost in mood may encourage people to keep to their exercise routines in the long run.
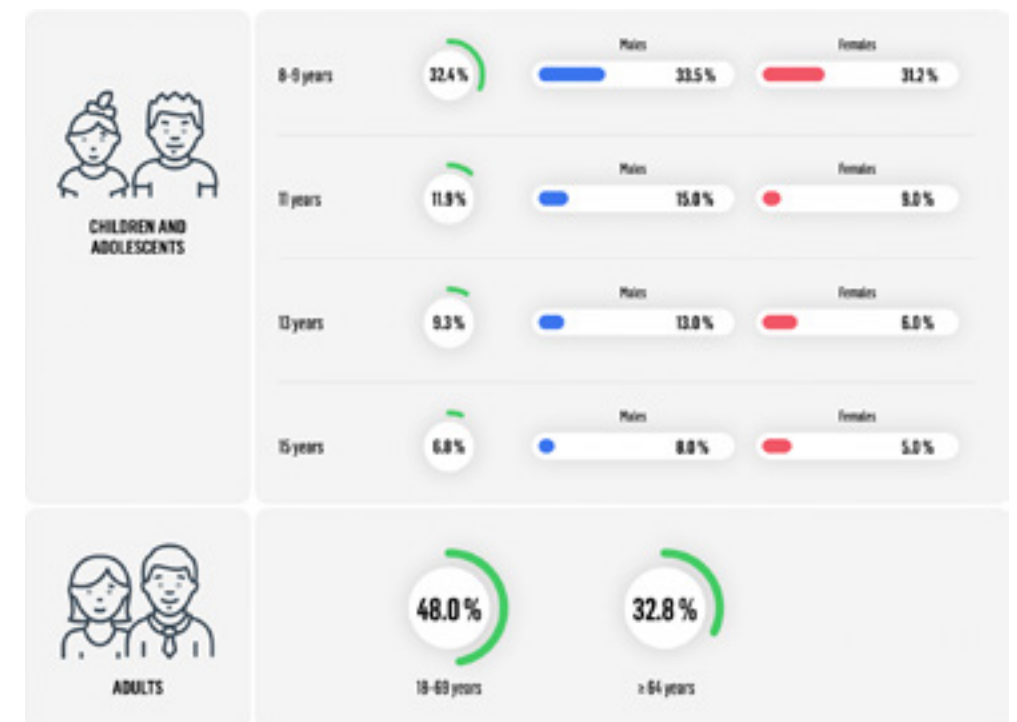
Fig.4 - Estimated prevalence of sufficient physical activity levels in Italy.

Research published by the American College of Sports Medicine in 2007 found a relationship between the increasing level of one's physical inactivity and the frequency of depression symptoms. In addition, the combination of depressive symptoms and physical inactivity may increase the risk of cardiovascular mortality, implying that the presence of depression and physical inactivity is responsible for a percentage of cardiovascular mortality cases (KAMPHUIS et al., 2007). The incidence and trends of a health issue, the severity of the risk associated with

exposure to that disorder, and evidence for effective prevention and control are all elements that should be considered when prioritizing public health action. A practice or behavior linked to a health issue and is either stable or increasing in prevalence should be a key target for disease prevention and health promotion in public health policy. While significant progress has been made in the organization and mobilization of efforts for tobacco and alcohol control and the promotion of a healthy diet, physical inactivity is now being recognized as the fourth form of exposure that must be addressed for non-communicable diseases. Physical inactivity is a global pandemic, a primary cause of death, and one of the top four pillars of a non-communicable disease approach. Despite evidence of its preventive effects, extensive studies on how to combat it, and the worldwide cost burden created by current levels of physical inactivity, the function of physical activity continues to be neglected.

As the Lancet Physical Activity Observatory states, there is an urge for the development of solutions in which the theme of physical activity plays a central role, as well as awareness campaigns to empower the citizens towards healthier lifestyles (Kohl et al., 2012).

1.2.2 — Relationship with mobility

As it was written in the previous chapter, there are severe health consequences from insufficient physical activity as well as from a sedentary lifestyle, bringing down people in a negative loop in which sedentarism, overweightness, and depression play their best (or worst) role to both individuals and social well-being. However, what is the meaning of this theme inside an urban mobility framework?

The built environment can be defined as a physical form of community and its anthropogenic surroundings that provide the backdrop for human activities, ranging in scale from individual structures to entire neighborhoods and cities. Urbanism is an integral part of human ecology, and city structures now influence the physical activity patterns of people who live in cities. Physical activity has decreased due to widespread rapid urbanization, simultaneous industrialization, automation, and motorized transportation (Ulijaszek, 2018).

We saw in chapter 1.1.3 that around half of all European car trips cover short distances (less than 5km). These distances are usually covered inside urban areas and are related to urban commuting. In a document from the Italian Institute of Statistics (Gli spostamenti sul territorio prima del Covid-19, 2020), it is reported that the private car is generally the preferred option for commuting: 2 out of 3 people use the car daily.

A study published by the BMJ from Anderson, Lu and Yang (2019) has shown a relationship between car ownership and physical activity and weight gain: for people over 50, there is an average gain of 10 kilograms. According to the data gathered, owning a car in a quickly growing global city resulted in long-term decreases in physical activity and weight gain.

Continued growth in car ownership and use in low- and middle-income nations may harm physical health and obesity rates.

The modes of transportation we choose as individuals and as a society, particularly in our cities, can directly impact our health and the environment.

Among car users, significantly higher physical activity is associated with higher income, flexible work schedules, shorter work hours, and mixed land use. Physical activity promotion is significant not just for the prevention of non-communicable diseases. However, it could also help combat global warming by promoting active transportation, improving social relationships, reducing social inequity, and encouraging public places. Global policy and planning efforts must urgently prioritize health promotion, in this example through physical exercise, as more than a risk factor for non-communicable illnesses, but rather as a fundamental human right (Kohl et al., 2012b).

🕐 20min → 😴 ~40Cal   🕐 20min → 🥵 ~170Cal
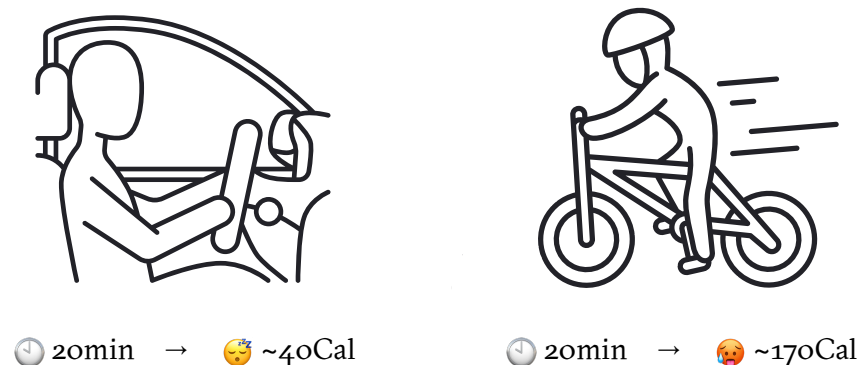
Fig.5 - Comparison of average physical activity by mean of transport (AINSWORTH et al., 1993).

Fig.6 - A perilous ride. Cabinet card photograph by Platt Brothers, [1884].
Library of Congress Prints & Photographs Division

1.3 →
Active Mobility

1.3.1 — What is active mobility?

Having observed in the previous chapters the critical issues of mobility as it is currently experienced in cities, it becomes evident that the mobility paradigm needs to be changed. First and foremost, urban mobility is fundamental to the functioning of our society. It is the portal for our daily lives, enabling us to access home, work, and all city services. Let us look at commuting patterns in different countries. As the country advances in its industrialization and development, its inhabitants gradually use more and more private motorized vehicles to get around, as opposed to less developed societies where people traditionally move around on foot or by bicycle. As some advanced countries already demonstrate, this trend is set to reverse, and older modes of travel are being revived. In this sense, we introduce the theme of active mobility. Active mobility, soft mobility, or active transport is the transportation of people or goods, through non-motorized means, based on human physical activity. The best-known forms of active mobility are walking and bicycling, although other modes include running, rowing, skateboarding, scooters, and rollerblades. Because of its prevalence, cycling is sometimes considered separate from other forms of active mobility. Utility or "transportation" bicycling generally involves short to medium distances (several kilometers, not infrequently 3 to 15 kilometers each way, or somewhat longer), often in urban environments. It includes commuting (i.e., going to work, school or college), shopping and errands, and visiting friends and family or for other social activities. This transportation mode can be seen as human-powered transportation, transporting people and goods using human muscle power. Unlike animal transportation, human-propelled transportation has existed since time immemorial in the form of walking, running, and swimming. Modern technology has enabled machines to enhance human strength. The bicycle is the most efficient means of human-propelled transportation in terms of the energy a

person has to expend to travel a given distance (Wilson, 1973). From a mechanical point of view, up to 99% of the energy supplied by the cyclist to the pedals is transmitted to the wheels, although the use of shifting mechanisms can reduce this percentage by 10-15%. In terms of the ratio of the weight of the load a bicycle can carry to its total weight, it is also an efficient means of transporting goods. A human being riding a bicycle at low to medium speeds, around 16-24 km/h, (10-15 mph), uses only as much power as necessary to walk.

Moreover, the carbon dioxide generated by the production and transportation of food required by the cyclist per kilometer traveled is less than 1/10th of that generated by energy-efficient automobiles. Around the turn of the 20th century, bicycles reduced the crowding of residential neighborhoods by enabling workers to move from more spacious homes into the suburbs. They also reduced dependence on horses. Bicycles enabled people to travel for recreation in the countryside because they were three times more energy efficient than walking and three to four times faster. Access to bicycles and the transportation infrastructure that supports them can dramatically reduce poverty. If roads can facilitate transportation at the macro level, bicycle access supports it at the micro level. In this sense, bicycling can be one of the most effective means of eradicating poverty in developing countries (Singhal, 2013).

Fig.7 - A group of women cycling in the beginning of the 20th century, from The Montifraulo Collection

In addition, bicycles have given women unprecedented mobility, contributing to their empowerment in Western nations. As bicycles became safer and cheaper more women had access to the personal freedom that they represented: because they expanded women's mobility, challenged Victorian notions of femininity,

and were quickly adopted by many suffragette activists. So the bicycle became the symbol of the New Woman of the late 19th century, especially in Britain and the United States. Bikes fueled campaigns for dress reform, which intended to loosen Victorian clothing and undergarment prohibitions so that women may dress in a way that allowed them to participate in physical activity: helped free women from corsets, ankle-length skirts, and other restrictive clothing (Herlihy, 2006). 19th-century feminists recognized the bicycle as a "freedom machine" for women.

> "I think it has done more to emancipate women than any one thing in the world. I rejoice every time I see a woman ride by on a wheel. It gives her a feeling of self-reliance and independence the moment she takes her seat, and away she goes, the picture of untrammeled womanhood"
> (Harper and Husted, 2010).

Now that we have done this brief analysis of active mobility and bicycling, and its role in changing history and bringing benefit and growth to contemporary societies, we can look in detail at the impact this mobility could have on health and the environment.

1.3.2 — Impact on Health

As stated in the previous chapters, physical inactivity and a sedentary lifestyle are significant challenges developed. Developing countries must contend with increasing urbanization and expanding motorized transportation. These issues can hurt people's health by leading to overweight and obesity. In addition to its many health advantages, physical activity is essential for avoiding or lowering

non-communicable diseases. Active mobility has been identified as a viable alternative for reducing sedentary lives, lowering risks of ensuing chronic diseases like obesity and diabetes, and raising physical activity levels to improve health standards (Arbab et al., 2022). For substantial health benefits, adults should do at least 150 minutes (2 hours and 30 minutes) a week of moderate-intensity, or 75 minutes (1 hour and 15 minutes) a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate and vigorous-intensity aerobic activity. Cycling is physiologically equivalent to other physical activities of comparable intensity, duration, and frequency, such as manual labor, sports, exercise, or walking. Biking for transportation can count toward the minimum 150 minutes/week of moderate-intensity aerobic activity recommended for physical health other than being listed as the safest way to get physical activity. Physical activity and leisure time have been linked to lower mortality risk and several diseases. Some intermediate health indicators, including obesity,
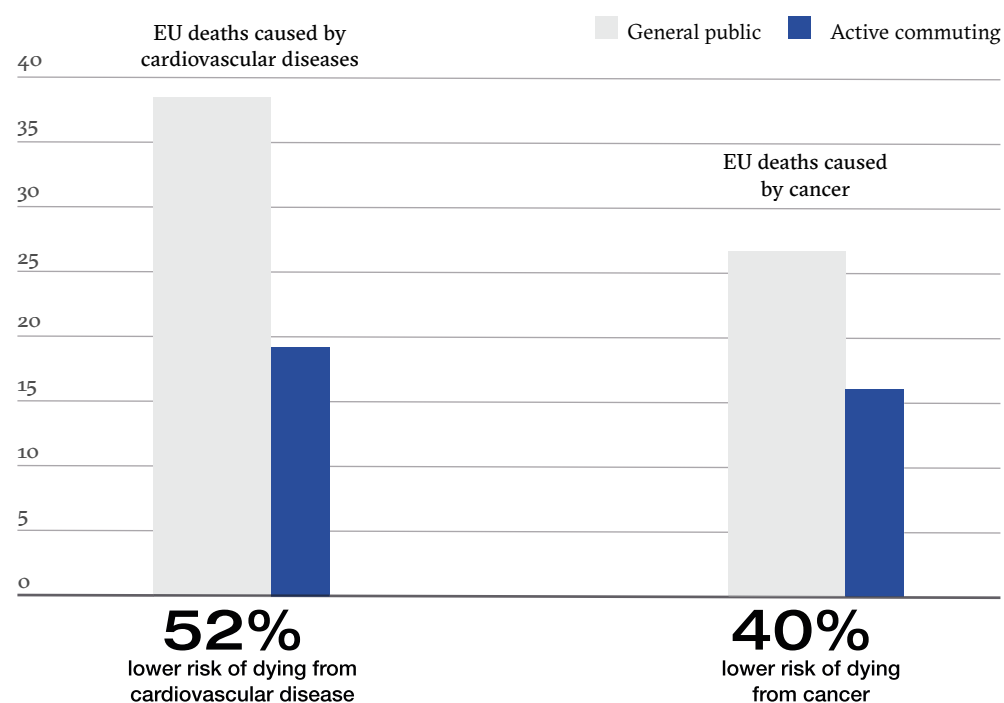
Fig.8 - Association between active commuting and incident cardiovascular disease, cancer, and mortality (Celis-Morales et al., 2017).

cardiorespiratory fitness, and biomarkers, also show positive correlations with physical activity. Benefits have been seen in the general population, as well as in young people, the elderly, people of different racial and ethnic backgrounds,

and overweight and obese individuals. Adults who walk or cycle for transport accumulate more physical activity than those who travel using only motorized modes. Not surprisingly, those who use only active modes of transport have the greatest amount of total physical activity. However, those who combine active travel with either public transport or car use are significantly more physically active than those who use only motorized modes of transport; physical activity is increased when active travel forms part of a multi-modal journey. Substantial physical activity can be accrued through active travel, which may contribute to more significant total physical activity (Sahlqvist, Song and Ogilvie, 2012). An article published in the International Journal of Behavioral Nutrition and Physical Activity (Kelly et al., 2014), studied how cycling and walking reduce the risk of all-cause mortality by 10%. Another study of nearly 2400 adults found that those who biked to work were fitter, leaner, less likely to be obese, and had better triglyceride levels, blood pressure, and insulin levels than those who did not actively commute to work (Gordon-Larsen et al., 2009).

In addition to physical disorders, a sedentary lifestyle may also impact mental health. Even more, nowadays, where the hustle culture brings stress in all forms and in many workplaces, episodes of burnout are always more frequent. Travel mode may also be associated with psychosocial health. Driving is directly linked with adverse health effects and has noted a dose-response relationship, so more driving was associated with worse outcomes. Active travel to work is perceived to be less stressful than car commuting relative to the stress of a work day. Recent transport research has demonstrated the beneficial impacts of walking and cycling on mental health (Rissel, 2015). While these impacts can be partly attributed to the benefits of physical exercise, they have also been linked to the 'transport environment.' Findings suggest that a transport environment designed for active travelers can directly and positively improve mental health and well-being. Drivers, metro passengers, and bus users are substantially less satisfied than pedestrians, rail passengers, and cyclists. Some studies have demonstrated that the adoption of active modes of transport brings a decrease in depression symptoms. In contrast, others have demonstrated an overall increase in emotional well-being and happiness. The form of transportation one chooses can have an impact on one's level of happiness.

1.3.3 — Impact on the environment

According to the World Health Organization, climate change is the most significant health risk of the twenty-first century. Increased heat-related sickness, worsened lung and heart disease from more significant air pollution, direct harm and displacement from floods, droughts, and other extreme weather events, and increased food insecurity are just a few of the physical and mental health implications of climate change. Because of the associated health benefits of mitigation, combating climate change has also been dubbed "the greatest global health opportunity of the 21st century." In cities, where 70% of people live in Europe, private automobiles play a significant role in urban transportation. Private diesel and gasoline vehicle use significantly reduces the opportunity for physical activity while also causing air pollution (such as particulate matter, or PM2.5), noise pollution, elevated urban temperatures, and greenhouse gas emissions (such as carbon dioxide (CO_2) and black carbon). Passenger cars are the largest producers of many health-damaging pollutants such as carbon monoxide, oxides of nitrogen, sulfur dioxides, ozone-forming substances, hydrocarbons, and fine particles. These factors can all increase the risk of early death and a rise in disease incidence, negatively affecting the environment. Traveling by bicycle produces no pollution, which is better for the environment and health than motorized modes. On climate, we must stress how active mobility contributes to CO_2 mitigation. A study from Brand et al. (2021) focuses on CO_2 emissions: they computed 'life cycle CO_2 emissions' across different modes, obtaining a value of 3.2 kgCO2 for daily mobility-related activities. Roughly 70% of this 3.2 kgCO2 comes from car trips and only 1% from cycling. These values show clearly how active mobility can contribute to fighting climate change: that life cycle CO_2 emissions could be reduced by 14% per additional cycling trip and by 62% for each avoided car trip. More recently, the COVID-19 lockdown demonstrated how drastically altering mobility patterns would affect air quality. An application on Northern Italy (Pautad et al., 2021), one of the most polluted regions in Europe, revealed that NO2 levels decreased by about 40% after a 70% reduction in mobility (primarily in car mobility).
In another recent study (Pisoni, Christidis and Navajas Cawood, 2022), the theme of active mobility was issued in terms of how to increase it and how that increase may impact the external costs of mobility. Adopting an active mode of transport distance is the most critical factor. This means that cities are the areas in which the highest potential for active mobility increase lies. It is also noted how current bicycle users are not particularly sensitive to the time/speed/di-

stance of their trip, as their modal preference is probably a matter of life choice, stressing the importance of a culture of walking and biking.
There is scope to increase active mobility since a high share of trips is related to short-distance trips(1.1.3), and car trips can be replaced by walking and cycling.

1.3.4 — Personal and collective dimensions

The issue of active mobility is multifaceted; although its adoption is a matter of individual concern, its repercussions affect all strata of society. As we have seen in the preceding paragraphs, the implications on individual health of adopting active modes for daily transportation are incredible. However, the implications of these individual improvements also reverberate in a collective dimension. Indeed, an overall elevation in physical well-being would also mean reduced public spending on health: the classic saying better safe than sorry. Beginning in 2007, the World Health Organization engaged a multidisciplinary team of experts across several states of the European Union to develop the HEAT: Health Economic Assessment Tool (Sonja Kahlmeier et al, 2017). It evaluates walking and cycling by quantifying physical activity benefits, carbon emission impact, air pollution exposure, and crash risks. The tool also monetizes these impacts, using the Value of Statistical Life and Social Costs of carbon. The HEAT was created to make it possible for users without prior experience in impact assessments to do economic analyses of the effects of walking and cycling on health. The HEAT calculates the value of mortality reduction due to specific amounts of walking or cycling, so addressing the following query:
If x people regularly walk or cycle an amount of y, what are the health impacts on premature mortality and their economic value?
Along with the health advantages of exercise, HEAT enables accounting for the mortality risks associated with exposure to air pollution and car accidents while commuting by foot or bicycle. HEAT can analyze the effects of switching from motorized modes of transportation to walking or cycling.
A tool like the one developed by WHO can help gain insight into the multi-level effects that a transition to active mobility can bring to a city. In addition to the health and economic implications, such a transition would radically alter the urban environment on several levels. For example, noise pollution represents the

acoustic side of the city experience, one of the primary senses of human beings is affected by vehicle traffic on the streets, all the more so in more urbanized cities. In most urban areas, traffic is the most important source of noise nuisance, which can contribute to insomnia, stress, and hearing damage. There is also emerging evidence of an association between high noise levels and heart disease. Motor vehicle noise also contributes to reduced community livability. A decrease in motorized traffic would also reduce noise pollution since noise from active modes of transportation produces virtually zero noise, improving the quality of the urban experience.

Fig.9 - Visual and photographic rapresentation of the amount of public space needed for each form of commuting for the same amount of people, Cycling promotion fund.

Another issue is the use of urban space for mobility: a high percentage of space is devoted to roads, which are used exclusively for transporting vehicles and would hardly have other uses. A large part of the space around is used for parking cars, thus employing most of the public land for transit and storage of cars. Thus a street is rarely used for public activities or serves dual functions such as that of a park. Cars generally take up a considerable amount of space when contrasted with the space taken up by public transportation or active modes. Again, a change in transportation modes in cities could lead in the medium term to a substantial change in the shape of cities, creating a new dignity for urban space, which would change shape to a more fervent and distributed space.
Extensive and safe cycling infrastructure can enable inexpensive travel around cities. Walkable and bikeable neighborhoods foster social interaction and community cohesion. Findings from a systematic review of the built environment and health indicate that more walkable neighborhoods are associated with increased physical activity, increased social capital, lower rates of obesity, lower reports of depression, and less reported alcohol use. Walking and cycling are integral aspects of 'Slow Cities,' allowing individuals to experience meaningful

connections to local places while living more ecologically responsible ways. In this sense, we realize how mobility and the adoption of active mobility is an issue that embraces every individual's life and the social fabric on different levels to have local and global implications in climate change consciousness.
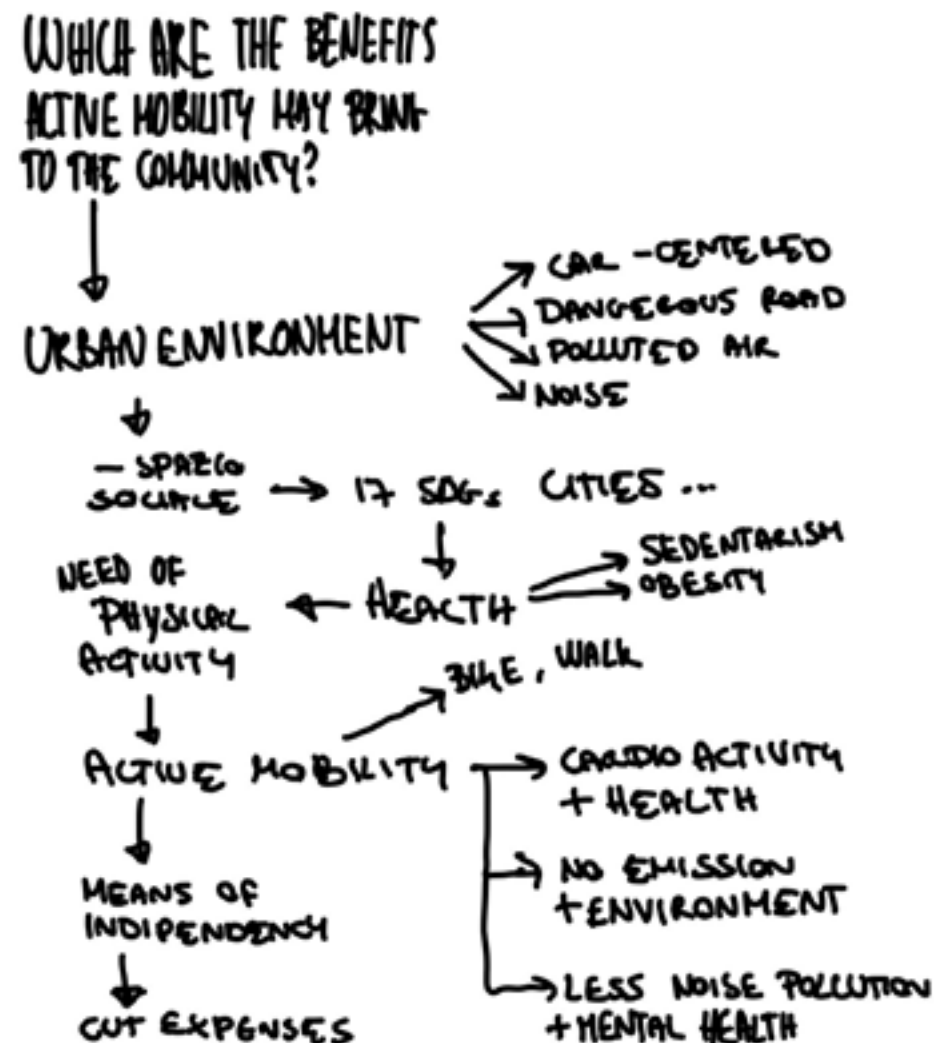
Fig. 10 - Chapther synthesis based on the first research question

CHAPTER 2

BEHAVIOUR, MOTIVATION, AND COLLECTIVE GOOD

2.1 →
From top-down to bottom-up

2.1.1 — Addressing the 15 minutes city

Walking and cycling have almost no adverse environmental effects and help to reduce greenhouse gas emissions and urban traffic. They are the preferable option to using public transportation for commuting since they negatively correlate with mortality and cancer and offer benefits to the cardio-respiratory system even with moderate activity. From an economic perspective, they are affordable for consumers and infrastructures and only occupy a small area. They are "environmentally, socially, and economically sustainable," to put it another way.
The goal of ensuring "access to safe, affordable, accessible and sustainable transport systems for all, enhancing road safety" is expressly stated in Agenda 2030 ("Transforming Our World: The 2030 Agenda for Sustainable Development," 2015), which lists "Sustainable Cities and Communities" as one of the 17 Sustainable Development Goals (SDGs) to be accomplished by 2030. In this sense, it is helpful to think about a model that can make active mobility a suitable and preferable choice for many people. The most significant difficulties are related to the construction of infrastructure, such as bicycle lanes: to make a bicycle lane within a road section, one must either remove parking spaces or reduce the number of lanes for vehicle travel. Bike-friendly infrastructure initially provokes strong criticism because it penalizes a robust and widely used mode of transportation, such as the private car, in favor of another much less common and less used one. Therefore, it is necessary to act on two levels: to immediately identify viable alternatives for the penalized users, such as increasing LPT rides to those areas to compensate for the lack of parking or identifying exchange parking or parking in neighboring facilities; to immediately activate participatory and information processes toward the whole community, to specify the reasons for the choices, the different options, and above all to make known the alternatives that led to those choices.

Furthermore, more than bike lanes are needed to generate a modal shift in favor of bicycling. Generally, public administrations, when they want to implement sustainable mobility policies, implement, often out of the blue, a network of bicycle lanes, imagining that this is sufficient to encourage bicycle use. The adoption punctually does not happen, but rather this generates, as mentioned, frequent protests and opposition to the use of bicycles. To overcome these critical issues, it is necessary, on the contrary, to carry out the right mix of infrastructural interventions and actions of incentive and promotion, training and dissemination of bicycle use. Actions without which infrastructural interventions alone have little impact.

Given the need to improve active mobility, it is crucial to pinpoint the policies that will work best in each situation to guide planners and decision-makers

Fig.11 - Visual concept of the 15 minutes city of Carlos Moreno

in attaining their transport policy objectives and maximizing investment returns. Many studies indicate that the built environment can influence people's travel behavior, even when controlling for self-selection effects (Cao, Handy and Mokhtarian, 2006). In cities nowadays, the traditional role of urban areas as gathering places and social forums for city residents has been diminished, endangered, or eliminated (Gehl and Rogers, 2010). By addressing the theme of cities in the way of seeing them as a place of connection for people other than being the infrastructural support for people's activities, building new political and cultural frameworks that can encourage the emergence of novel economic and social systems has become vital. The city of proximity, often called a 15-minute city, is where everything is conveniently close by and can be reached on foot or by bicycle. In this kind of city, the relational form of proximity is linked with the functional form. As a result, there are more possibilities to socialize, help others, protect the environment, and work together to accomplish goals in the nearby metropolis. It is appropriate to distinguish between the two main typologies of proximity: relational, which can foster sociality and communities, and functional, which enables people to live in a particular context. In this sense, the 15-minute dimension implies a new distribution and organization of places and services within the city that can reduce traffic and increase people's free time (Manzini and Pais, 2021). This new kind of city favors the creation of communities of people motivated by their interest in the environment in which they live, which can be transformed. In this sense, by favoring the birth of new communities, the city of proximity increases the probability of the development of new projects carried out by these communities. Obviously, for this to happen, people must have interests in common: proximity alone is not enough.

Given this idea of a city as the optimal one for urban regeneration, it is necessary to understand how within it, people might find the idea of getting around on foot or by bicycle more or less attractive.

2.1.2 — Active commuting attractiveness

A recent study (Kamel, Sayed and Bigazzi, 2020) explains how calculating the likelihood of bicycle adoption by a group of people is a complex matter and is sometimes related to the individual's perception and the conditions of the sur-

rounding environment. In this sense, behavior and perception are complementary. Two factors are defined to calculate an overall index for bicycle adoption: the bike attractiveness index and the bike safety index.

The bike attractiveness model estimates show that the land use mix is positively associated with kilometers traveled by bike. Residents living in mixed land-use environments are more likely to commute by bike. Recreational density encourages road users to conduct more biking trips. Network connectivity and density were positively associated with biking levels. On the other hand, the safety index addresses the risks of using a bicycle. Higher traffic signal density implies the existence of wider intersections that increase the crash risk for cyclists, while higher recreational density finds an association with a decrease in crashes.

The highest statistically significant effect is 'tailored' interventions targeting motivated groups and groups with specific requirements (Forsyth and Krizek, 2010). Soft measures are particularly effective when focusing on specific motivators: such as those facing significant life changes who must adjust to new circumstances, people who are low income and are sensitive to pricing strategies, or those who have limited access to driving (low self-confidence or no driving license) and need alternatives. People may respond differently to strategies depending on their psychological makeup or environmental factors. Those strategies impact the communication channels for messages and the motivations influencing people's behaviors. Focusing on particular groups can significantly boost an intervention's effectiveness.

In defining the factors that contribute to the use of bicycles as a means of transportation, we find four main elements:
→   Existing travel behaviors
→   Spatial variables in own environments
→   Socio-demographics and socio-economics variables
→   Attitude based approach

By analyzing the last two points in detail, there are psychological and cultural elements that can encourage or deter the use of bicycles as a form of travel. The fear of bicycle theft and the lack of safe parking spaces in the usual areas of travel act as deterrents; on the contrary, people with a progressive ideology or an average level of education are the most likely to adopt the bicycle as a means of personal transportation.

Nudges, information sharing, legal and tax legislation requirements, monetary penalties/rewards, prizes and contests, mathematical examples, and training sessions are a few strategies to change mobility behavior. As shown, there is a wide variety of potential "hard" and "soft" criteria. Diverse actions are made in various nations to encourage active mobility. This tactic is especially true for cycling in Austria, where there are competitions at the national level to promote riding for commuting in addition to initiatives aimed at the existing shortages

(Markvica et al., 2020). Additionally, studies show that life-changing events are an excellent place to start for interventions since people who move into new residences, change their residential region, or change their place of employment tend to reevaluate their mobility patterns (Understanding Social Behaviour for Eco-Friendly Multimodal Mobility, 2011).

Governance & regulatory:
create conditions, partnership,
cross-departmental policies

Behaviour
change

Infrastructures,
services, information,
integrated planning,
accessibility

Policy process:
consult, co-creation,
ensure positive
expereince with
sustainable modes
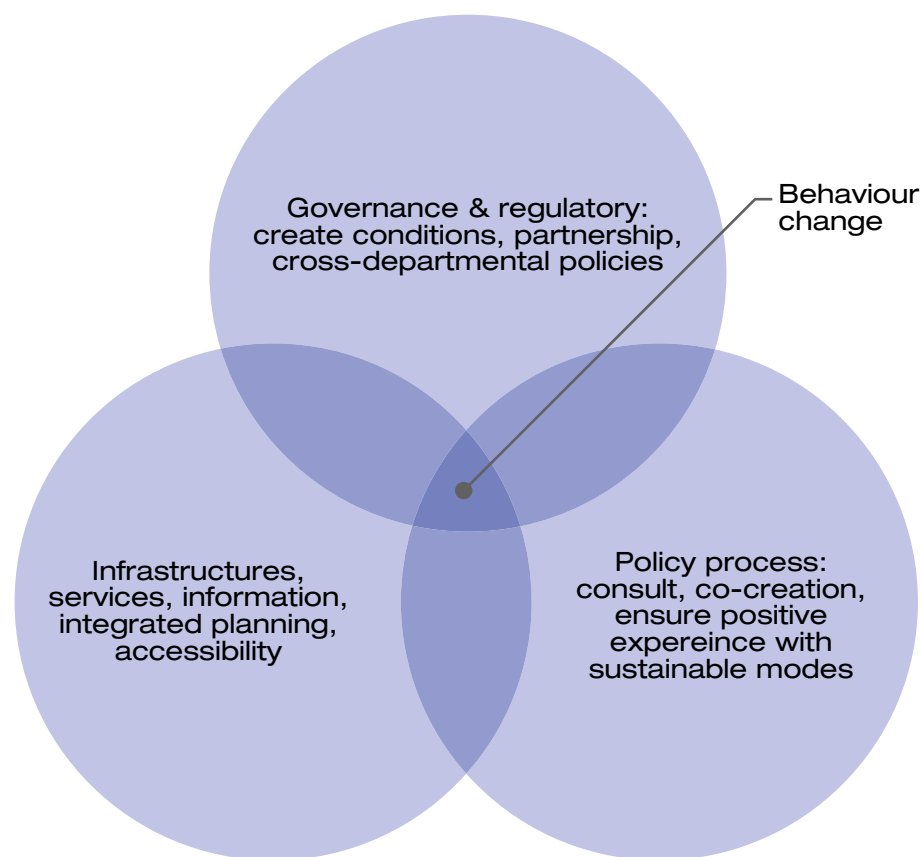
Fig.12 - Understanding mobility behaviour, Urban innovation action, Europena regional development fund.

Younger age groups, in particular, are adaptable consumers since changes in their circumstances are possible. They, therefore, make an intriguing target population for behavior change interventions in the area of mobility. Speak their language and take action using the appropriate information channels to take advantage of this window of opportunity. For a youth age group, one can relate to Generation Z, which has been particularly vocal in recent years, primarily through the sprawl in the use of social networks. This generation faces a growing middle-class income gap, which increases the population's stress level. As a generation born and raised in a period of economic recession, members of this group of

people have experienced firsthand the fear and discouragement involved in being out of work; as a result, members of Generation Z seek personal satisfaction in employment related to their passions rather than a high salary. Since they are digital natives, the impact of social media on their daily routine, feelings, and needs is enormous. Even if this generation generally suffers from mental health and stresses about the future, they want to impact the world in which they live. This research makes up for the project target we will see in chapter four.

2.2 →
Nudging habits for a collective change

2.2.1 — Science of habits

To achieve the goals as a society there are the 17 sdgs, these have two possible futures two general scenarios,if we exceed 1.5 °C or if we stay below, these are either in a worsening or general improvement perspective.

Let's borrow from Atomic Habits (Clear, 2018) (text we will pick up again later) the example of the cycling team in which the British Cycling coach who took the team from having a very long loss pattern and overnight to getting to the 2004 Olympic Games where precisely Great Britain won two gold medals in cycling, its best performance since 1908.
His innovative philosophy for getting the team to such heights in so few years is that of marginal gains:

"The whole principle came from the idea that if you broke down everything you could think of that goes into riding a bike, and then improved it by 1 percent, you will get a significant increase when you put them all together."

(Groves and Griggs, 2014).

In Brailsford's strategy, training adjustments were aimed at determining deficiencies (Groves and Griggs, 2014). The strategy called for a more holistic approach that took into account advances in technology, athlete psychology, and daily life, in addition to traditional success factors such as physical conditioning and tactics. Brailsford himself on a more general level in an interview (Groves and Griggs, 2014) says to give an example of the logic of marginal gains:

"Do you really know how to clean your hands? Without leaving the bits between your fingers? If you do things like that properly, you will get a little bit less ill. They're tiny things but if you clump them together it makes a big difference."

(Groves and Griggs, 2014).

This theory of marginal gains has been simplified to the bone (Clear, 2018) into the formula 1% improvement per day, highlighting how slow changes are as they are incremental. Improving by 1 percent means giving 1 percent more each day. If you start with 1, the extra one percent leads to 1.01. But if you give the extra one percent at 1.01 it leads to 1.01^2. For one year in a row a marginal daily improvement of one percent can lead to 1.01^{365} or 37.78. Conversely, a marginal worsening of one percent would be 0.99^{365} or 0.03 (Fig.13).

1% better every day $\quad 1.01^{365} = 37.78$
1% worse every day $\quad 0.99^{365} = 0.03$
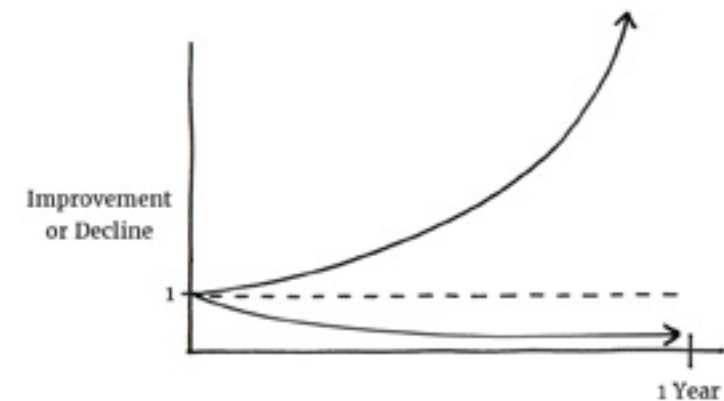
Fig.13 - The power of tiny gains graph, visually rapresent the incremental difference of tiny actions.

This habit-related concept is interesting because it can be applied from an individual benefit perspective and simultaneously pursue collective improvement. Athletes in Brailsford, to improve their performance, have applied habits, such as changing their sleeping pillow, that has generally improved their lifestyle as well as their athletic performance.
Returning to the issue of global warming that stirs up the design debate, the proposal is to apply the 1% logic in observing the trend of possible scenarios in emissions toward the famous 1.5° beyond pre-industrial temperatures, the temperature needed to initiate irreversible environmental processes.
If the same logic of progressively improving all areas by one percent and spreading it over the global population were applied, the goal would not be as impossible as its risks.
Activities that are repeated consistently over time are called habits, and most human activities have frequent and continuous constancy. Minimal but steady improvements in each of these habits benefit the individual as much as the community, more so as it slowly participates in them. In his book, James Clear writes that goals conflict with long-term progress, as they risk producing a yo-yo effect in moving from one goal to another, whereas it is more appropriate to invest in a method. Dedication to the process that determines its progress. The human system as a whole of habits should go through what method?
Habits emerge from the identity or outcomes attached to them; their connection is precisely the process. If we think of the habit of leaving home to go to work,

Metric gigatons of CO₂ (GtCO₂) per year
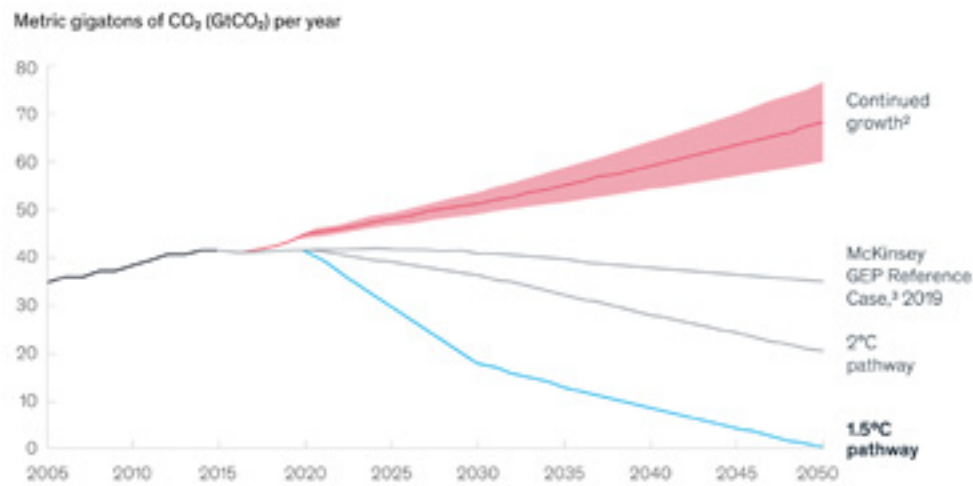
Fig.14 - Rapid declines in co2 emission would be required to reach a 1.5C° pathway, McKinsey's Global Energy Perspective 2019: Reference Case

in which we are mainly involved, the goal is to get to work; identity determines the nuances of the same by influencing the means we choose. An athletic person who lives close enough to where he or she works will walk to work, while a person with other needs will move another way. In this sense, we can see how identity determines processes that determine goals. Collective identity, in order for it to share constructive processes, needs continuous expansion and updating from the moment even before it can share goals.

A habit is behavior repeated enough times to make it automatic, and these tend to solve daily problems with as little energy and effort as possible. Each of them goes through four stages to become established:

→　**Signal:** alarm clock rings.
→　**Desire:** Arrive at the university on time to get a seat.
→　**Response:** We take transportation and leave on time
→　**Gratification:** We satisfy the need to arrive on time to take a seat and associate the time of leaving and the means taken.

Analyzing habits as collective, as well as individual and frequent behavioral declinations, can give us a broader picture of the investigation of urban mobility. It allows us to see it as a behavioral phenomenon that has both individual (health) and collective (environment) effects. In the following chapters, we will look at how to apply these concepts to active mobility.

2.2.2 — What does it mean to nudge?

In the social economy classic book, the authors Sunstein, Thaler and Pratt (2008) define the role of choice architects as all those who, in one way or another, find themselves designing services or objects that present humans with choices to make. This role is much more widespread than one might think in that we humans always make choices that more or less influence our lives. Often the choices we make are influenced by how the system in which we make them is designed; the default choices depend much on our behavior. The attitude that the authors suggest for all choice designers is that of Libertarian Paternalism: paternalistic because they influence individuals' choices to make them longer, healthier, and generally better, libertarian because they preserve their freedom of choice, even the one that would bring them harm.

The authors state that individuals tend only sometimes to make rational decisions. Humans differ from econ or those whose thinking is exclusively economic and purely rational. They make choices that emotions can drive, and although neither is a perfect being, the particularity of the human is that he or she can err in a remarkably predictable way. One example is the planning fallacy, which is the systematic tendency to be overly optimistic about the time needed to complete a task. This contradiction is explained by the authors using the description of many psychologists and neuroscientists that our thinking is based on two cognitive systems:

→　**The impulsive system:** Uncontrolled, Spontaneous, Associative, Rapid, Unconscious, Skillful.
→　**The rational system:** Controlled, Thoughtful, Deductive, Slow. Aware, Rule-abiding.

Being that people cannot always be relied on to use the rational system to make choices, the author's suggestion is to limit as much as possible the dangers that could loom if choices are made with the impulsive system. In addition, sociality strongly influences each individual's choices. These may occur because of an informational issue, that is, one thinks of many people doing or thinking the same thing; through their actions and thoughts, they convey information about what others might also want to do or think. In other situations, a peer group may exercise a peer group, and the individual's actions may distort to appease or ingratiate others. In practice, human beings are easily goaded by their peers, as they generally like to be conformists. Within groups, the most resolute and consistent individuals can steer customs in the desired direction. In this context, a considerable problem emerges, namely that of pluralistic ignorance, that

is, ignorance on the part of most individuals of what others think. Sometimes people follow a custom or tradition not because they like it but because they think to please most other people.

For this reason, many social customs that are not really appreciated persist, but a little culture shock or prod can help eradicate them (Kuran, 1998). In some cases, to influence individual behavior, it is enough to inform individuals about what others are doing; sometimes, others' behaviors are surprising, and individuals are impressed by what they learn. The authors also point out that to induce socially desirable behavior, one should never imply that one's actions are better than average. This reasoning comes from an analysis of a study done in 2007 (Schultz et al., 2007) on household energy consumption. In cases where households noticed that they had consumed less than others, then in the following month, they would consume more to compensate (while those who noticed they had consumed more reduced their consumption) of others: this is called the boomerang effect.
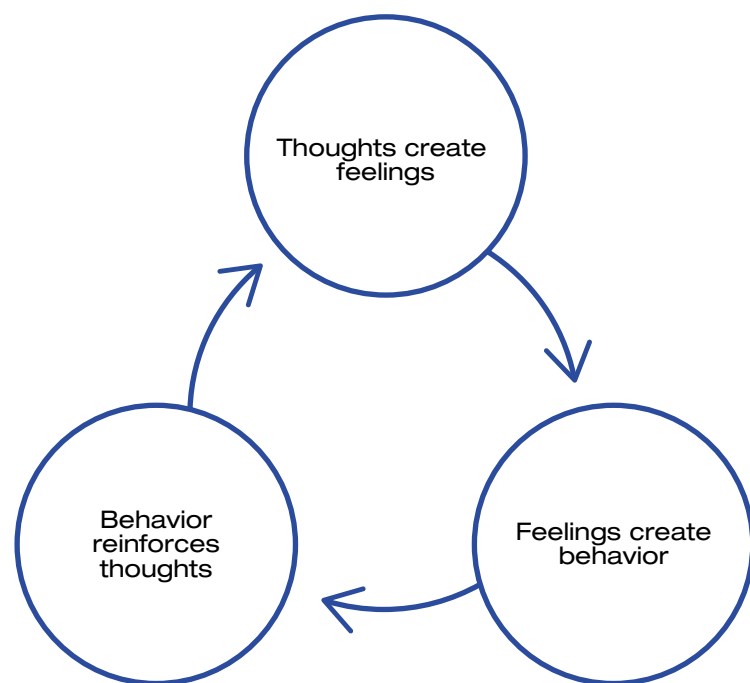

Fig.15 - Behavior, thoughts and feelings feedback loop, (Beck and Beck, 2020)

Interestingly, however, the boomerang effect disappears completely when the feedback is not informational but emotional. In this case, simply a smiling emoticon has been given if consumption is below average or a sad one if above. In both cases, generally, households have committed to reducing their consumption.

Markets often incentivize companies to pander to human weaknesses to make a profit rather than trying to minimize the effects. Individuals become subjugated by these dynamics, especially when the consequences of their choices are far in the future. It is even more challenging to make good decisions when one cannot translate the choices one may make into the experiences one will have.

These elements of behavioral science and economics are of great help in understanding how to act as a designer to improve people's travel habits.

2.2.3 — Nudging a collective change in mobility

In sustainable mobility, nudges are increasingly used in conjunction with public interventions. Rather than attempting to alter values or enhance access to knowledge, nudges concentrate on personal choices and actions that benefit both the individual and, subsequently, society. Although nudge promotes an empirical approach, evaluation and monitoring of the experience is the key component of any intervention designed with the understanding that the actual results of interventions-even more so when embedded in specific local contexts-remain challenging to measure, especially in the medium to long term.

The European Union-sponsored project SaMBA: Sustainable Mobility Behaviors in the Alpine Region (2022), is an interesting case study and a source itself of case studies on nudging sustainable behaviors in mobility. This project started because individuals frequently travel in the Alps by private vehicle while disregarding alternative environmentally friendly modes of transportation. SaMBA investigates novel strategies for utilizing incentives and prices to influence changes in mobility behavior.

They identify four ways in which to group best practices for nudging sustainable mobility:

→ **Framing & Rating:** Defining and simplifying the "framing" of information to promote motivation, for cognitive evaluation of alternatives in the circumstances involving a high level of information complexity, and to explain what happens when the default choice option changes.

→ **Context:** Changes in the physical environment (e.g., changes in available infrastructure) to incentivize the use of sustainable alternatives.

→ **Social Labeling:** Use descriptive positive social norms to make people

more aware of how they travel, especially how others travel.

→ **Pricing and Reward:** Use competitive pricing and incentives, such as the distribution of vouchers.

For the directions taken so far in the research, the first and third practices are particularly interesting. Acting on the context poses limitations for future design since the thesis does not delve into environmental design issues. For this type of intervention, the support of institutions and the localization of solutions are crucial. At the same time, rewarding policies are too tied to economic and political environments. In contrast, framing and social labeling practices interestingly marry interaction design issues in which we apply concepts from sociology and neuroscience to study how people interact.

Some interesting case studies on interventions that have enhanced sustainable mobility can help us understand how to approach this complex and intricate issue. An interesting first case study is that of Durham, North Carolina. The city council set a goal of reducing car use by targeting 1,500 downtown workers over six months (B., 2018). With the Program, the city emailed customized home-to-work route maps (provided by participants with enrollment) that showed bicycle, GoDurham bus, and walking routes compared to those by car. The emails also included a comparison of travel times. They listed the benefits of alternatives to

Fig.16 - A similar initiative to Britain's WOW is the Italian "Pedibus"with the same goal sustainable mobility and mechanics of the british project. It is still runned from the early 2000 by the ATA Associazione traffico e ambiente

autonomous driving, including the potential for weight loss, weight loss, fuel savings, and time commuters could recover from city traffic. As a result of the intervention, the percentage of commuters who reported driving to work alone

was 12 percent lower among those who received the alternative route maps than among those who did not. Moreover, the percentage of driving alone decreased by 16 percent among those who received the maps and took transportation for rewards. Another interesting case is that of the town of Oxfordshire in the United Kingdom, where the county council involved elementary school children in increasing the percentage of them walking to school. The project is called WOW (Why Oxfordshire WOWs, 2022) and involves using a tracker to participate in the annual walking-to-school challenge to record pupils' daily journeys and earn monthly badges. Each class is provided with an eye-catching dashboard to see which classes are leading the active commute. Pupils record daily trips to school on the system. The WOW Travel Tracker also confirms which pupils have walked enough to earn a badge each month through a gamification mechanism of behavioral sciences. As a result, walking trips increased from 47% to 54%, while car trips to school decreased from 31% to 16%.

In the end, a final look at some entities that, simply by appreciating and using the bicycle as a means of transportation, have succeeded in creating a movement involving other people in bicycle use. The list could be endless, but here we limit ourselves to mentioning two.

The first interesting case is that of Dom Whiting, a British mechanic who has perpetuated a project called Drum & Bass On The Bike over the past year. The guy has installed a stand on his bicycle to allow himself to mix music while pedaling. In front of the console, a camera captures him pedaling and mixing; the audio is transmitted directly from a stereo system which streams the whole thing on the net. On his youtube channel, one can find recordings of the various sessions he has done on his project, each in a different English city. An interesting case is to see how it has become a gathering time for other fans of both the active media and the music genre over time. If in the first episode from 2021 (Fig.17), Dom moves alone through the cities, in the last one, thousands of other cyclists follow him (Fig.18). The exciting factor of this initiative is the naturalness with which it has developed and achieved enormous involvement, both media and real.
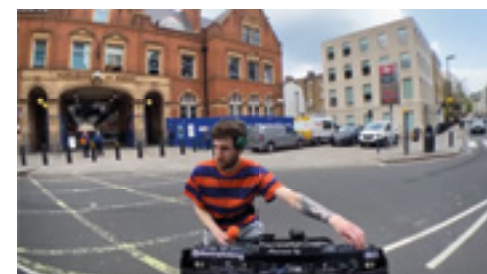
Fig.17 - Drum & Bass On The Bike - London Hyde Park Special, 24 apr 2021
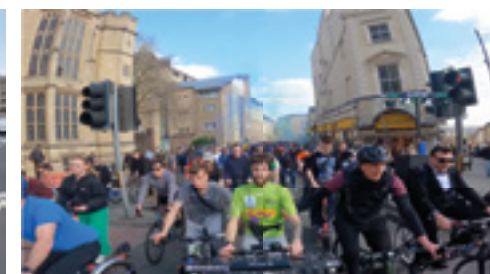
Fig.18 - Drum & Bass On The Bike - Bristol City, 24 mar 2022

The second case is that of an open group of young people who ride bikes together, whose focus is on friendship rather than competition. "Gggg" is an open group that mainly communicates with the outside world through Instagram; they organize day rides or multi-day trips starting from Milan, exploring the natural landscape. One element that characterizes them is a very spontaneous communication with photographs taken with a phone or an analog point-and-shoot camera; their activities' posters are often hand-drawn. One event of research interest that can give an idea of the size of the influence such a spontaneous group can have is the competition they organized in April 2022, "Damn Spring." The event, sponsored by Iuter, a Milan-based streetwear brand, and Cinelli, a historic Italian bike manufacturer, was held at the "Parco Delle Cave" in Milan and was attended by several hundred people. Realities of this kind can be elements of strong social cohesion and inclusiveness. They promote a contemporary culture of the bicycle as a means of emancipation without the filter of institutions.
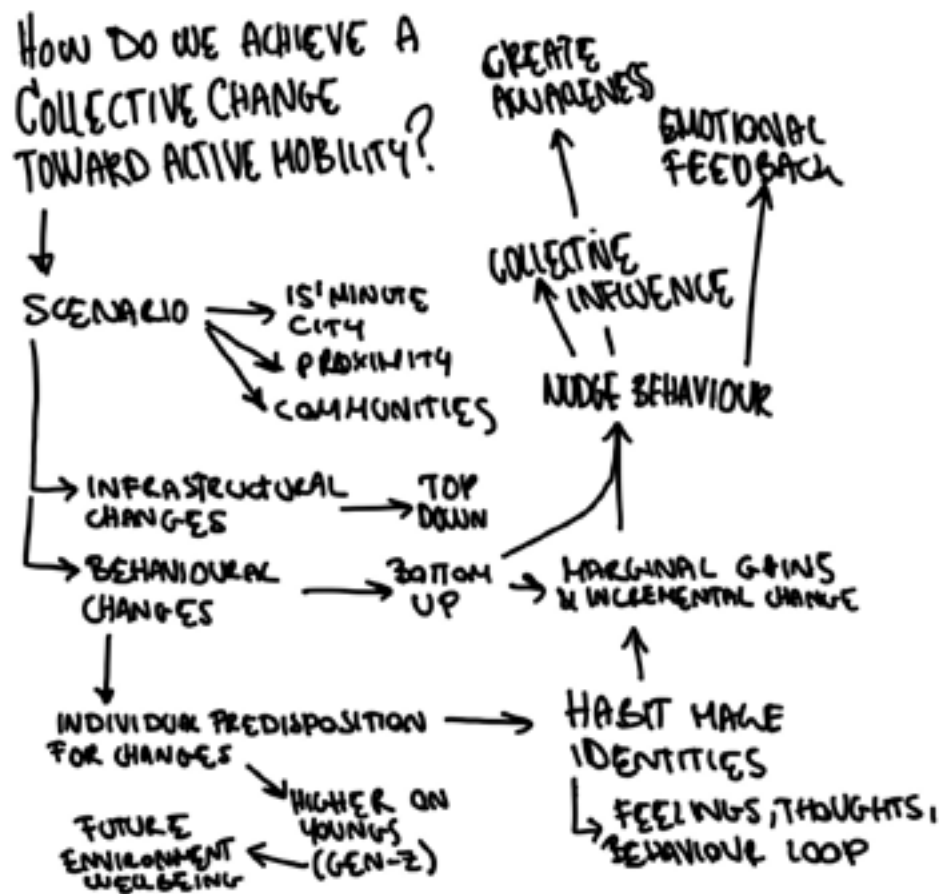
Fig.19 - Chapther synthesis based on the second research question

CHAPTER 3

ART AS A DESIGN PRACTICE

3.1 →
Design for the society

3.1.1 — Society centered design for social innovation

In design theory, the approach that most emerges is Human-centered design (HCD for convenience), an approach to problem-solving that develops solutions to problems by involving the human perspective at all stages.

Human-centered design is an approach to developing interactive systems that aim to make systems usable and useful by focusing on users, their needs and requirements, and applying human factors/ergonomics and usability knowledge and techniques. This approach improves effectiveness and efficiency; enhances human well-being, user satisfaction, accessibility, and sustainability; and counteracts possible adverse effects of use on human health, safety, and performance (Asemi and Tahaei, 2022).

In the early days of HCD, the discipline focused on human factors in developing computer interfaces for operators. The goal was to create interfaces that were within everyone's physiological or cognitive capabilities. In many cases, operators were designing the interfaces for themselves. HCD evolved again to focus on experience design, adding this lens to the previous lenses of human factors and user-centered design. This lens focused on deeply understanding users' needs in all areas of life. Design, in this sense, cannot be limited to the needs of the individual but necessarily considers all the entities involved in delivering the experience. Service design is the stakeholder-centered design (Forlizzi, 2018), which considers the notion of different entities interacting with and through products, services, and systems to achieve the desired outcome.

In an era when service and user experience design apply to big brands, we can see signs of patriarchal capitalism and exploitative business models that put pro-

fit over privacy and efficiency over the agency by pitting individuals against the collective. At their core, they are hierarchical and exclusionary. What user-centered design has done is, yes, to put the focus of the design function on the human being, but in an all too reliable way; we have become so good at HCD that we have achieved what can be called hyper-efficiency. We look at smartphones as our era's flagship product, super powerful, widespread, and commercialized. What makes it unique is all the services we can use through this device. The most successful apps and digital products are the social networks that have turned smartphones into actual addictive products. In the history of humankind, it has never been easier to access the satisfaction of our desires, whether it is sex, entertainment, shopping, news, or junk food, activities linked by an easy and widespread release of dopamine, the pleasure-inducing neurotransmitter. Today everything is within reach of a few gestures on the smartphone. On the other hand, addiction perpetuates the reward-seeking cycle, eventually replacing feelings of pleasure with those of pain and dissatisfaction (Lembke, 2021). Twentieth-century approaches, such as design thinking, human-centered design, and jobs to be done, too often look at people only as individuals. Or, even worse, only as consumers. They do not consider people concerning their communities or society at large. Furthermore, society itself is ignored by design. The contemporary digital design takes advantage of data to create super-personalized user experiences and, in some cases, even intrusive of our freedoms of choice. For example, Instagram's content recommendation algorithms gratify our most animal tendencies to micro-satisfaction in exchange for targeting information on consumer elements on which to target advertising. Advertiser stakeholders' economic needs go to override the interests of individuals. This individualistic attitude has shaped the way we design today. However, data rarely represents a single person: it usually describes many people, which is why the society-centered design was born (If, 2020).

> "We want to move beyond human-centered design to society-centered design. We must design for the collective. We must design for society."
>
> (If, 2020)

Society Centered Design is not a new idea, far from it; it is the model toward which we are slowly moving. The logical outgrowth of the Human Centered Design approach redefined our discipline. This approach considered society in

its scope but got a narrower version of it in practice.

Designing for society means designing for the larger context of the systems we influence and model. We can redefine our social contract with others and the world we administer. To do so, we must intentionally attend to the following:

→ **Citizen empowerment:** how to give citizens more rights and capabilities
→ **Civic commons:** building shared resources that strengthen communities
→ **Public health:** protecting safety while improving the physical and mental health of individuals
→ **Equity:** how to design without privileging some communities over others
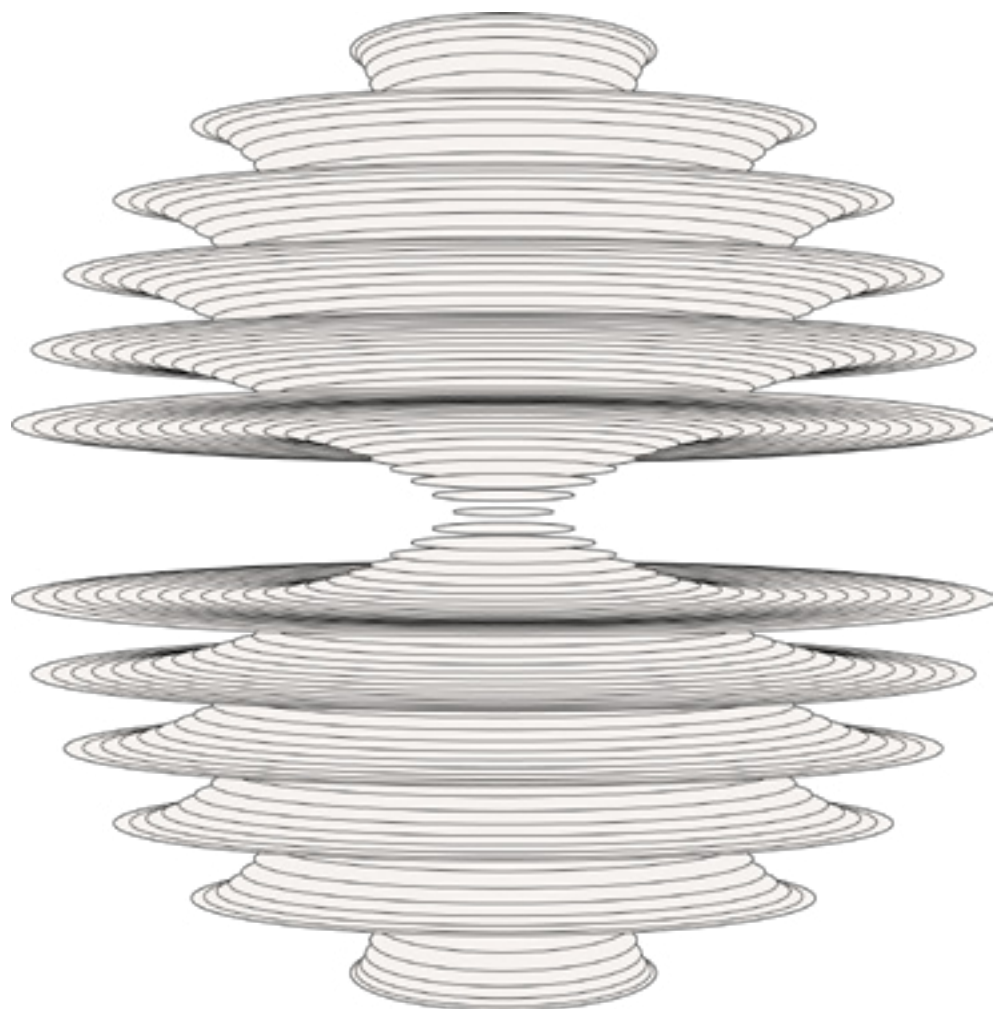→ **Planet:** how to take better care of the ecosystem

Fig.20 - Visual representation of the Society centered design approach (If, 2020).

An approach characterized by the involvement of people can lead to enormous benefits. In the book "the wisdom of the crowd," the author emphasizes how in the field of decision-making, it is statistically proven that, in the extended run, groups know how to make better choices than individuals (Suowiecki, 2004). Even the brightest experts have biases and blind spots, so that they can make mistakes. The crowd's judgment will give us the best chance of making the right decision. In the face of this realization, traditional notions of power and leadership should begin to pale. The most brilliant groups are composed of people with different perspectives. You may be biased and irrational, but as long as you are independent, you will not make the group dumber. Encouraging people to make wrong assumptions made the group as a whole smarter.

This design approach is therefore based on ten basic principles:

→ **Care first:** We can get away from providing services only to serve the interests of individuals and businesses if we prioritize and put care at the forefront of our efforts. Care enables us to improve public health and the environment through compassion and reciprocity.
→ **Earn trust:** As more aspects of our lives become interconnected, we must develop mechanisms that foster public trust: standards, services, and goods that can be robust, open, and support citizen empowerment.
→ **Empower collective agency:** the communal agency is empowered by starting with a radical inclusion of the most vulnerable. We should be building a new civic commons by ensuring that everyone has access to economic opportunity.
→ **Reimagine public value:** We can develop new tools and norms that prioritize the welfare of the general populace over private gain and the success of a select few.
→ **Design for people's rights:** It is our duty because it is a political act. For those with the means, privacy is not a luxury. Humans have the right to privacy. Systems that eliminate power disparities and support equity and citizen empowerment must be developed.
→ **Ensure fair and just oversight:** Equity is impossible without fairness and justice. "The commons" is too frequently used as a synonym for "the majority." Therefore, we must incorporate fair and just supervision mechanisms into our design systems so society can hold the solid accountable.
→ **Redistribute the power of technology:** The best single distribution channel ever developed is the internet. As a result, it has a disproportionate effect on everything, harming those who are most marginalized and at the most risk. The design should aim to disperse that power for equity and public empowerment.
→ **Create compassion at a scale:** The world is fast changing due to automation and AI. However, they are today more concerned with business objectives than with societal demands. We can redefine AI and automa-

tion to strengthen civic commons and promote equity. Always maintain human control.

→ **Design for regenerative action:** Humanity is in existential jeopardy from the climate disaster. Narratives and attention must turn from abundance and scarcity to regeneration. We need sustainable and regenerative practices for society, the earth, public health, and economic models.

→ **Confront uncertainty:** Our problems are complicated, interwoven, and ever-evolving. We are in a revolutionary era. Furthermore, radical times call for extreme responses. We must take bold and assertive action because doing nothing supports a terrible status quo.

In the contemporary, interconnected world, it is necessary to think about a design dedicated to social innovation, in which co-design together with end users is of paramount importance. In order to design, the expert designer uses a range of content and tools that determine his or her knowledge and culture. Culture can be a shared knowledge that different people can draw on in the case of problem-solving design. Design can only be an exploratory process when dealing with issues as new as they are complex. However, it can also take the form of research, as an actor capable of producing knowledge that is useful to the designer, that is, design knowledge. Faced with complex issues and different possibilities for solutions, problem-solving and sensemaking cannot be separated (Manzini and Coad, 2015) for a design that succeeds in keeping all participants in the design activity involved and agreeing on the meaning of what they are doing. In this context, several areas to explore in which design manifests itself; among several involving more or less expert or diffuse design (Fig.21), we delve into the role of the cultural activist. Design activists are converging on a range

Fig.21 - Matrix of the areas to explore through the design practice in the social context (Manzini, 2015)

of initiatives whose purpose is not to offer immediate solutions to problems but to arouse interest in these areas. However, they show different ways of seeing and solving them. The methods and the environments in which they operate vary widely, to name a couple: raising awareness of the public green issue by creating a garden on a sidewalk (Guerrilla Gardening) or defending the rights of cyclists by organizing bicycle rallies in city traffic (Critical Mass). These groups could be accepted by institutions, as opposed to them, or both. Create planning groups that include both volunteers and professional designers. For example, planning a festival or creating and managing a self-managed community center requires creative thinking, strategic planning, and collaboration. Co-design processes are often highly dynamic, including consensus-building dynamics, and as proactive as they are complex, where the knowledge and tools of interpretation brought by the more experienced designer can trigger social conversations that nurture the process of new ideas. The forms these processes can take are many. They can become networks where different initiatives interact by influencing each other and creating an outcome that does not result from a shared idea. Alternatively, they become coalitions, where a more coordinated set of actors in socio-technical networks share a vision of what to do and how to do it and decide to do it together.

"Design experts play a special and crucial role: they collaborate in creating an environment conducive to such coalitions. I.e., ecosystems (social, economic, and technological) in which overall design capacity can emerge, increase its competence, and give rise to a variety of design processes. In this case, design experts must use their design culture (and its characteristic critical constructiveness) to direct the turbulence around us toward sustainability"

(Manzini and Coad, 2015).

In this context, the designer can make visible elements to bring these processes to life. Among the different forms that the designer can give to the elements of communication, he should focus on making the complex accessible both in its analysis and in its operativity, thus providing tools for personal reading and orientation. Visualization, as a tool of social organization, acts as an amplifier of weak signals. This process highlights little-known elements, with their characteristics and outcomes and their corresponding underlying values, In a way that feeds into a broader conversation about socially recognized values.

3.1.2 — Social and ecological sustainability through public and participatory arts

The notion that the arts have an educative function has a long pedigree. Social Identity Theory suggests that the group becomes a key determinant of individual behavior, as we deepened in chapter 2.2.2 while arguing the implicit effect of rigorous behavior conducted in societies able to inspire and suggest socially accepted behaviors. The arts showed to maintain group or social norms (Alexander, 2017). While the same concept of Art is hard to define in itself, it is, of course, defined by the context in which it is placed and if people around it say that it is Art. Assuming that we cannot define Art formally and abstractly, there are, nevertheless, some elements that characterize most forms of Art:

→ **There is an artistic product.** It could be palpable, auditory, or apparent. A physical item like a book or record can be the product. A play or a concert are examples of performances.

→ **It communicates publicly.** The cultural product must be seen, heard, touched, or experienced by an audience in either public or private settings in order for it to qualify as Art. Art is a form of communication, but not all communication is creative.

→ **It is experienced for enjoyment.** There are numerous ways to "enjoy." Consuming Art can be done for various reasons, including aesthetic enjoyment, sociability and fun, mental stimulation, and escape. However, on occasion, such as during a field trip for students to a museum, individuals are exposed to Art because "it is culturally conceived as beneficial for them."

→ **Art is an expressive form.** Art presents fiction or an interpretation when it refers to reality. If Art takes the idea of telling the "truth" too literally, it enters the realm of documentary, non-fiction, or journalism.

→ **Art is defined by its context, both physical and social.** Art in a gallery or theater may only be unusual objects or odd conduct in other contexts. Diverse social groups may have different opinions on whether or not an expressive output is an Art when they view the same thing.

The notion of context helps us realize how it may influence our perception of a particular object, action, notion, or sound. Indeed a categorization regarding the context of perceivable Art is:

→ **Fine Art**
→ **Popular Art**
→ **Folks Art**
→ **Subcultural Art**
→ **Internet Art**

As an expressive form, Art may also be filled with purpose. Art can be executed without any conscious motivational factor from the very own nature of humans and is therefore beyond utility in a strict and economic sense (Schiuma, 2012): like the basic instinct for beauty, balance, and rhythm, as a way to experience one's self in relation to the universe with not a very logical and formalized sense, an experience of the mysterious; indeed as a chaotic and irregular form of expression that goes beyond writing. In other ways, art purposes may be functional and be a conscious expression of the artist's thoughts as a form of mere communication. Indeed it can be done for a political change, as an act of anarchy or subversion, or for a social cause rather than for psychological or healing purposes. Let us consider Art as an expression of nature (Ruskin, 1843). Arts are also an expression of society (if we consider society a manifestation of human nature). In this sense, we can acknowledge how Art may help in understanding how problems are social and not just for those at the center of the issues. In this sense, we can insert the art world in the context of social innovation and appreciate its long culture of it to orient the scope of the research. Exploring the artistic context, one of the artistic movements that fit social engagement is the one of Public Art.

Public Art

Public Art tries to express public or universal notions rather than commercial, partisan, or personal concepts or interests; it is put in public space in both outdoor and interior settings. Public Art is physically and aesthetically accessible

to the public. Public Art is also a direct or indirect outcome of a public creation, acquisition, and upkeep process. By its very nature, public Art presents a design challenge: how best to engage the images around it. The idea of "sustainability" developed in response to a city's alleged environmental deficiencies. Since the 1980s, the United Nations has promoted sustainable development, considering economic, social, and environmental factors. Many environmental design projects and public art installations widely embrace sustainability, regeneration, and redevelopment. However, it cannot be easy to meet the needs of a newly opened public space. For Art and artists to be independent and able to present alternatives to established ideological paradigms, autonomy is essential in the public and sustainable art process (Temos, 2009). With a view to socially and ecologically sustainable engagement, one can make the public itself a participant in this autonomy.

Fig.22 - Alberto Burri's Cretto, an example of participatory Art in the form of Land Art, 1984-1989.

Fig.23 - Architectural Data Sculpture Installation from Ouchhh studio: DATAMONOLITH_AI, 2020. A contemporary example of public art. The studio names it, amongs the other techniques, data painting.

Participatory Art

An art form that directly involves the audience in the creative process and makes them participants in the event is "participatory art."In this sense, the artist is considered a collaborator and co-producer of the situation and the audience, where the beginning or end of this situational process is often unclear. It first emerged in the futurist and Dadaist performances of the early 20th century, intending to agitate, shock, and offend the audience. In the late 1950s, in Allan Kaprow's "happenings," the audience was encouraged to participate in the experience (Participatory art, 2016). Among the contemporary and social practices of participatory Art, we find socially engaged practice, an artistic medium that focuses on engagement through human interaction and social discourse. Projects are made in a variety of visual or social forms (depending on varying contexts

Fig.24 - Installation view, Two Happening Concepts: Allan Kaprow and Wolf Vostell, MCA Chicago

and participant demographics), such as performance, social activism, or community mobilization toward a common goal, and the diversity of approaches poses specific challenges for documenting social practice work as the aesthetics of human interaction change rapidly and involve many people simultaneously. Participatory Art requires that the artist not be present or be able to step back far enough to become equal to the participants: the only way to offer participants the agency of creation; without this detail, participants will always respond within the domain of the artist's authority; thus they will be subjugated, and the work will fail to be participatory. This detail is of paramount importance in affirming participation as a form in its own right. It effectively differentiates

participation from interactive Art (Mount, 2012) which we will elaborate on in the following chapters. Although it may seem paradoxical, it is essential to understand that the fact that a work of Art engages with the audience does not necessarily make it participatory. There are many examples of artists using the term "participatory art" on projects that were interactive, socially engaged, or community-based. Participatory Art is a form in its own right. Before delving into the technicalities of each category, let us go into how the substance of the subject matter investigated in this research, namely scientific complexity, is treated.

3.2 →
Art and science

3.2.1 — Communicate complexity

If the design is about solving problems and providing elegant solutions, then information design is about solving information problems. A constant overload of information characterizes the nowadays age. All the different media constantly shout out different numbers and opinions, and we often feel like we have a lot of problems in our society. From the overload and the saturation to the breakdown of trust and reliability and runaway skepticism and lack of transparency, used by capitalists to shape a vision to make profits.

If the 19th-century culture was defined by the novel, and the 20th-century culture was defined by the cinema, the culture of the 21st century would be defined

by the interface (Koblin, 2011).

As data is continually collected, there is an opportunity to use them to tell the stories of humanity and design over the problems of the information era. An interface can be a powerful narrative device. Even if it is true that we are producing and collecting more and more data, the struggle is that data alone needs to make more sense: they are meaningless without context, or their presentation is raw and messy. The only way to understand it is visually and relatively. Data is considered the new soil (McCandless, 2010); it feels like a fertile, creative medium
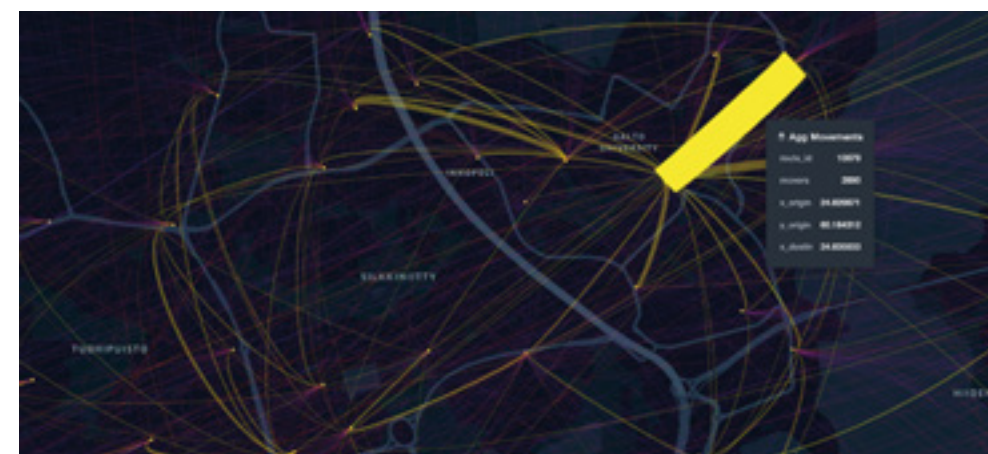
Fig.25 - An interactive data visualization of the Bike Sharing System movements in Helsinki. This data vis take placer in a website where each flux of data can be explored and andalyzed. The power of this visualization is that it is clear to read just from the overview.

sidered the new soil (McCandless, 2010); it feels like a fertile, creative medium where massive online amounts of information and data are layered down and connected through networks (like mycelium) over the years. Those data fields

feel like data visualizations are flowers blooming from them. From a messed up, intricate amount of information, with a small quantity of dedication, interesting things can appear, and different patterns can be revealed. People have a different relationship to the numbers with any data visualization, even with the more basic information. They can see them and start to see patterns and connections between numbers that would otherwise be scattered across multiple sources. By visualizing data, we turned them into a landscape that can be explored with our eyes, a sort of information map that may be useful when we are lost in data. But why visualization? The sense of sight is the fastest among the conventional senses, followed by touch, hearing, smell, and taste. The eye is exquisitely sensitive to patterns in variations in color, shape, and pattern. It loves them, and it calls them beautiful. It is the language of the eye. Suppose the language of the eye is combined with the language of the mind, which is about words, numbers, and concepts. In that case, who sees start speaking two languages simultaneously, each enhancing the other. Often science is seen as the opposite of Art, but in truth, they are, in fact, two sides of the same coin, both a way to explain and understand abstract ideas.

By rearranging numeric data, reinterpreting qualitative information, locating information geographically, and building visual taxonomies, information designers can develop a diagrammatic visualization—a sort of graphic shortcut— to describe and unveil the hidden connections of complex systems. The visualizations are open and inclusive and preserve multiple interpretations of complex phenomena (Manzini and Coad, 2015). Research in the field of data visualization has gone beyond the concept of the visual by integrating other senses besides sight into

transpositions in a way that tries to tell complex concepts through different sensations. The first sense that comes to mind is that of sound, which in addition to sight, represents the bulk of the media we consume. However, it predates it in a sense: radio came before television and brought the real technological revolution in global and mass communication. When thinking about people with visual impairments, it makes sense to think in the direction of sound; in the 1990s, the international community for auditory display was born. In the same years, the concept of Data sonification was born. *Sound* is a sensory modality that engages listeners on a visceral and intuitive level. Data sonification can be an exciting tool at a time when data are abstract and increasingly complex, with relative difficulty in building awareness and knowledge concerning the phenomena they describe through visualization alone. It is the systematic data-driven generation of nonspeech sounds to communicate information about a data source to an embodied listener, who is tasked with perceiving the appropriate meaning within that sound and assigning it to that sound (Roddy and Bridges, 2020). Interesting results can be obtained when complex information is told using visualization and sonification. A prominent example is a sonification visualization of noise pollution data for Brussels (*Brussels - A Noisy City*). Operation is simple and intuitive; a map shows an area visualization of intensity, but moving with the cursor allows the user to hear a representation of the average sound in the same city areas (Fig.26).

Using audio and visuals to tell complex phenomena may be a future design tool in a way that engages people on the issues that matter most.
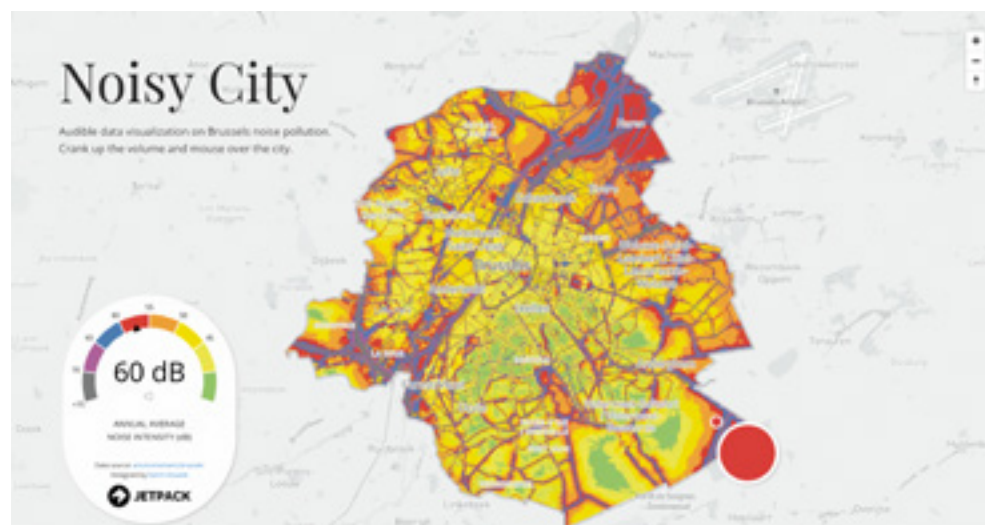

Fig.26 - Noisy City, Audible data visualization on Brussels's level of noise pollution. The interactive map allows the user to listen a sound sample that represent the noise level.

3.2.2 — Sustainable design and ecological Art

Environmental transformations are not independent of class, gender, ethnic or other struggles (Swyngedouw, 2006). In today's days, the topic of sustainability is in everyone's mouth so much so that the first to share their progress were brands, always seeking customer loyalty. However, it often happens that people, seen as consumers are victims of "greenwashing," which merely creates the illusion of true sustainability. That is "the selective display of one or two virtuous attributes of a product, which is meant to lend goodness to the whole," while the negative impacts of a product remain hidden. At worst, it is profit-driven

marketing that highlights only a couple of aspects. Greenwashing has an additional negative impact on our society's knowledge sharing, as it misleads people from true sustainability or discourages people from approaching sustainability.

"Everything made has innumerable consequences; to focus on one problem in isolation leaves all the other consequences unchanged"

(Goleman, 2010)

In this sense, we realize that in order to research a concept of true sustainability, it is necessary to have a holistic view of processes, to understand the life cycle and the various interconnected interactions that represent it. Maintaining the biological livability of the earth, producing more accurate patterns of social interaction, understanding the growing symbiosis in human-machine relations, setting priorities for the use and conservation of natural resources, and defining alternative patterns of education, productivity and leisure (Skrebowski, 2016). As much as the detailed investigation of these processes is a topic that could be endless, the theorization of systems ecology has nevertheless been able to open up a range of artistic practices dedicated to the complex interconnectedness of biological, technological, social and political ecologies that construct an "environment" that can no longer be considered simply "natural," and where each "output," according to cybernetic feedback operations, has been simultaneously understood as an influence on the functioning of the system. Looking at the ecological issue as a system, a system that is more than the sum of its parts. It can exhibit adaptive, dynamic, goal-seeking, self-preservation and sometimes evolutionary behavior. From the perspective of true sustainable design, we need to understand how design itself defines the interactions, positive or negative, between human and natural systems. In this sense, everything we do should serve to leave the environment in a better state than we found it. Reversing the course of generations and generations that since the industrial age have transformed our society into the society of consumption, and waste production. In this context at the cultural level cultural exploration in art contexts has helped to define an emotional approach to ecological issues. An incredible exhibition of ecological art was Beyond Green: Toward a Sustainable Art, which among the most provocative and sophisticated recent exhibitions to introduce critical at-

Fig.27 - A visualization of holistic approach to the design for the real world. Different circumstances across a city might require the integration of different solution sets will be crucial to the delivering of desired outcomes.

tention to "sustainability," a term that has come to replace the earlier 1970s focus on ecological homeostasis and balance, and responds to emerging imperatives related to global warming (Rhamachandra and Madhav, 1995). In general, the exhibition has represented a prevailing trend in art that relates technological systems, economies, and political sociability to biological systems, refusing to see nature as a separate entity, whether commodified by developers, exploited by industry and agribusiness, or worshipped spiritually by eco-activists. Within this dichotomy between biology and technology we can find the space to build empathy. Rather the superstructures that humans have built within society are what make them so, likewise there is to be no rejection of the natural and biological origins of individuals. Designing for sustainability also means reconstructing the link between man and the natural environment, or rather making visible and explicit the enormous synergy that takes place with the environment. Building on these assumptions, cultural identity can be reconstructed in such a way that cradle-to-cradle processes occur spontaneously. Creative imagination, artistic sensibility, can serve as one of our basic collective, self-regulating devices that can help us register and reject what is toxic in our lives (Kepes, 1972).
These are the requirements of contemporary environmental art:
to advance innovative proposals for alternative ways of life based on environmental justice in a global context, to contribute to ongoing public engagement with sustainability policies.

3.3 →
The intrinsic power of new media

3.3.1 — Generative Art

Building on the complexity left by the ecological context and design basis of data visualization, we explore an expressive model that has been changing design and prototyping in recent years, namely procedural design. *Generative design* is an iterative process involving the designer's use of a program that generates several outputs that satisfy certain constraints, finally fine-tuning the feasible region by selecting specific outputs or changing the values, ranges, and distribution of inputs. The designer need not be a human being; it can be a test program in a test environment or an artificial intelligence, such as an adversarial neural network. The results include images, sounds, architectural models, animations, and more. It is, therefore, a rapid method for exploring design possibilities and is used in various design fields such as Art, architecture, communication design, and product design. The process, combined with the power of digital computers that can explore a vast number of possible permutations of a solution, enables designers to generate and test novel options beyond what a human could do to arrive at a practical and optimized design. It mimics nature's evolutionary approach to design through variation and genetic selection. Here we will explore the topic of generative Art, which founded the basis for generative design. Which earliest explorations in the computer age were performed by programmers and technicians rather than artists per se. In the first international conference on generative Art, held at the Milan Polytechnic (Soddu, 1998), an interesting definition of generative Art is given: it is not a technology, it is not just a computer tool, but it is a way of thinking the possible, a way of living one's creativity. It constructs the possible by creating evolutionary rules that generate events that, while unpredictable and surprising, faithfully reflect the identity and recognizability of the idea and are its natural representation. It is a way of thinking
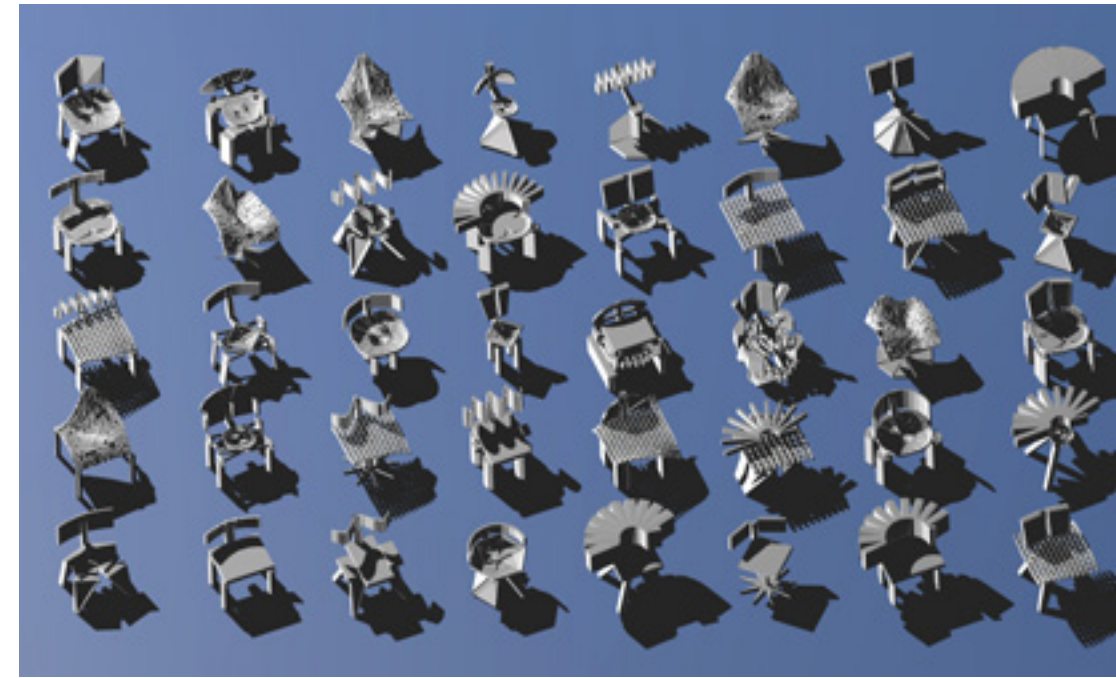

Fig.28 - Celestino Soddu, Endless variation of Chair, 1998-2004. A detailed example of generative design.

and designing that finds architects and mathematicians, poets and musicians, physicists and semiologists, philosophers and painters, engineers and designers united by the same enthusiasm. Generative Art is almost always an interdisciplinary effort and also encourages interdisciplinary involvement. It is composed of four primary elements:

→ **Entities:** represent the smallest virtual or physical materials of the work
→ **Processes:** are formed by various processes, digital, physical, or mechanical
→ **Environmental interactions:** enable inputs and responses from the surroundings
→ **Sensory outcomes:** refer to the experiential aspects of the artwork

This overall context reflects the complexity inherent in our current socio-environmental reality. The re-combinatorial poetics of generative Art brings together community diversity with knowledge of the environment. By doing so, the dynamics of form and content within generative Art allow the creation of meaning that reflects our world (Monro, 2009). By recovering the concept of sustainability as a holistic idea, generative Art can lead us to understand the mutual impacts between our surroundings and ourselves. Through ontological reflexivity and creative engagement, installation art enables people to be more involved and become agents of social transformation and change.
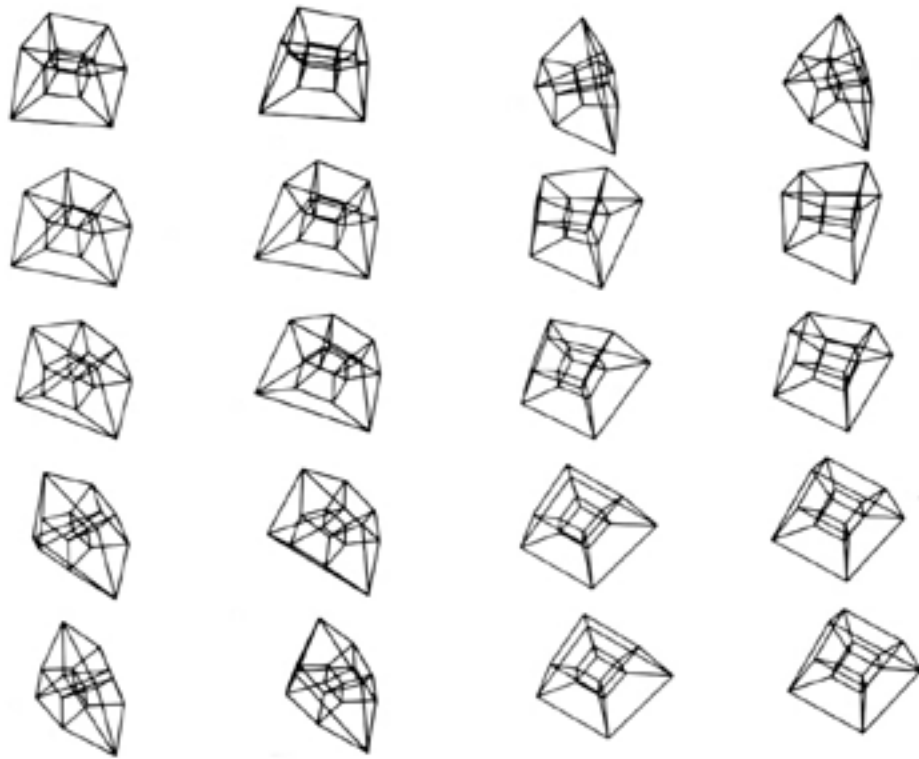
Fig.29 - Selected frames from movie of the three-dimensional projection of a rotating four-dimensional hypercube, 1960, Michael Noll.

Fig.230 - Personal exploration of generative design, variations of a texture for a sphere to look like a sun, Jacopo W. de Denaro, 2020.

In the field of generative Art, Artificial Life, or a-life, is a young and interdisciplinary scientific field concerned with creating and studying artificial systems that mimic or manifest the properties of living systems (Whitelaw, 2006). These artificial systems can illustrate the dynamic structures of the material world. Computers serve as tools for understanding natural processes and tracing these dynamics over time, revealing the patterns found within the most significant emergent phenomena of systems. Technological limits and edges are implicit in a-life art, but its appearance of autonomy provokes empathy or raises questions about human agency.

Generative Art, in this sense, is also created for those who have made it. Users look at the graphics generated by their behaviors, and the visual and sound effects of these graphics conveying the effect of them on climate and health can trigger psychological states, navigate space and time to address their state of mind, and examine their inner state. This process can lead to the realization of an art therapy effect, where communication occurs between oneself, society, and the ecosystem.
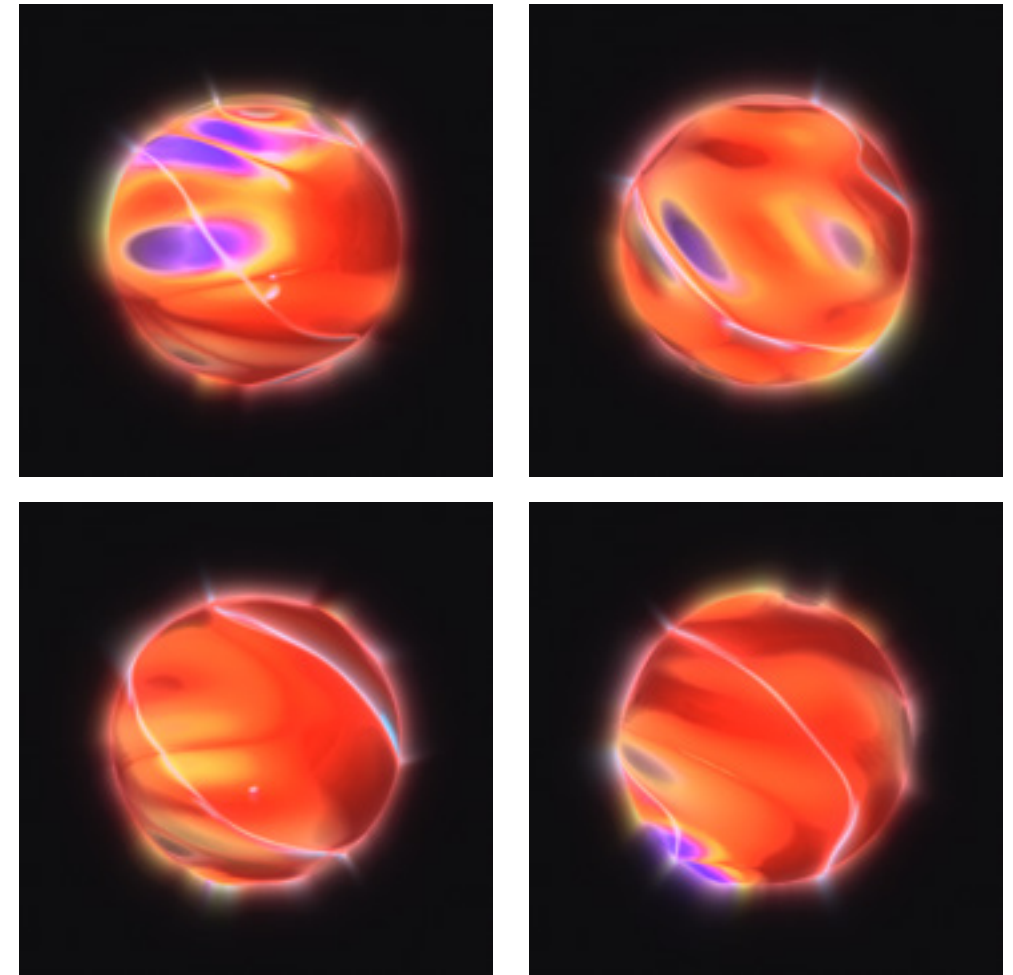
3.3.2 — Interactive Art

"We are incredibly attuned to the idea that the sole purpose of our technology is to solve problems. It also creates concepts and philosophy. We must more fully explore these aspects of our inventions because the next generation of technology will speak to us, understand us, and perceive our behavior. It will enter every home and office and intercede between us and much of the information and experience we receive. The design of such intimate technology is an aesthetic issue as much as an engineering one. We must recognize this if we are to understand and choose what we become due to what we have made."

(Krueger, 1977)

With a Myron W. Krueger quote, one of the pioneers of interactive Art, we delve into this topic. He envisioned the Art of interactivity as opposed to Art that happens to be interactive. In other words, exploring the space of interactions between humans and computers was interesting. The focus was on the possibilities of the interaction itself rather than on an art project that happens to have some responsibility for the user. Interactive Art is a genre of Art in which viewers participate in some way by providing input to determine the outcome. Unlike traditional art forms, in which viewer interaction is only a mental event, interactivity allows for various types of navigation, assembly, and contribution to an artwork, which go far beyond purely psychological activity. Interactivity

as a medium produces meaning. Interactive art installations are generally computer-based and often rely on sensors that measure elements such as temperature, movement, proximity, and other weather phenomena that the creator has programmed to elicit action-based responses from participants. In interactive artworks, both the audience and the machine work together and converse to produce a unique work of Art that every viewer can observe. However, not all viewers view the same image. Since this is interactive Art, each observer gives his or her own interpretation of the artwork, which may be completely different

Fig.31 - The legible city by Jeffrey Shaw

from that of another observer (Muller, Edmonds and Connell, 2006). Interactive Art differs from generative Art in that it constitutes a dialogue between the artwork and the participant; specifically, the participant has agency, that is, the ability, even unintentional, to act on the artwork and is also invited to do so within the context of the artwork, that is, the artwork allows for interaction. More often, the work takes the visitor into account. In increasing cases, an installation can be defined as a responsive or immersive environment, especially those created by architects and designers. In contrast, generative Art, which may be interactive but not responsive per se, tends to be a monologue: the artwork may change or evolve in the viewer's presence, but the viewer may

not be invited to engage in the reaction, only to enjoy it (Soler-Adillon, 2015). We would go beyond the distinction between interactive and generative by engaging with the components of an interactive process with the production of generative outcomes.

An interesting example in this context is the immersive artwork The Legible City (Shaw, 1989), a significant work of the 1990s by Australian artist Jeffrey Shaw. In this installation, the viewer pedals a stationary bicycle within a dark space, experiencing a virtual journey through projected views of Manhattan, Amsterdam, and Karlsruhe (Fig.31). The handlebars and pedals of the bicycle interface give the viewer interactive control over the direction and speed of travel. The physical effort of cycling in the real world is gratuitously transposed into the virtual environment, creating a kinesthetic conjunction of the energetic body in the virtual domain. A video projector projects the computer-generated image onto a large screen, and a small LCD monitor in front of the bicycle shows a simple ground plan of each city and the immediate position of the cyclist there. City buildings take the form of large three-dimensional letters, which go to form words and phrases with a literary or historical connection to the visualized place. Thus, viewing a city becomes a reading experience, which each visitor can shape according to his or her desires. The physical effort on the bicycle is converted into a virtual distance traveled. Applying these aspects of immersive environments to generative Art can create accurate ecosystem representations of sustainable mobility.

Through interactive touchpoints of a generative art piece, the visitor will perceive the context of the whole, an interconnection between him and the surrounding, between him and the ecosystem and the society—an ecstatic way of forming awareness.

3.3.3 — Aesthetic Experience

An aesthetic experience arises in response to works of Art or other aesthetic objects. Although the term aesthetics itself was not introduced until the 18th century, it is clear that what is identified in contemporary discussions as "aesthetic experiences" were "felt" by individuals long before. For example, when Plato was concerned about overly emotional reactions to poetry recitations or when Aristotle described the positive effects of attending the theater. However, the exact nature of aesthetic experience -even the idea that there is a unique form of experience- remains a controversial issue.

According to the view of philosopher John Dewey (Miller, 1959), aesthetic experiences are the most complete, the richest, and the highest possible. One is actively engaged and aware of the world's effect on us, but at the same time, one appreciates one's possibilities for acting on the world. One perceives an organization, coherence and satisfaction, and an integration of the past, present, and future that average non-aesthetic experiences lack. The aesthetic experience is similar to the phenomenon referred to by the concept of optimal mental flow or processing, as an effortless flow of mental energy caused by awareness of the congruence between incoming information and our goals. During this mental state, people are intensely immersed in what they are doing, with strong involvement in the activity process (Csíkszentmihályi and Rathunde, 1993). Similar to aesthetic experience, in this state of mind, attention is highly focused on a

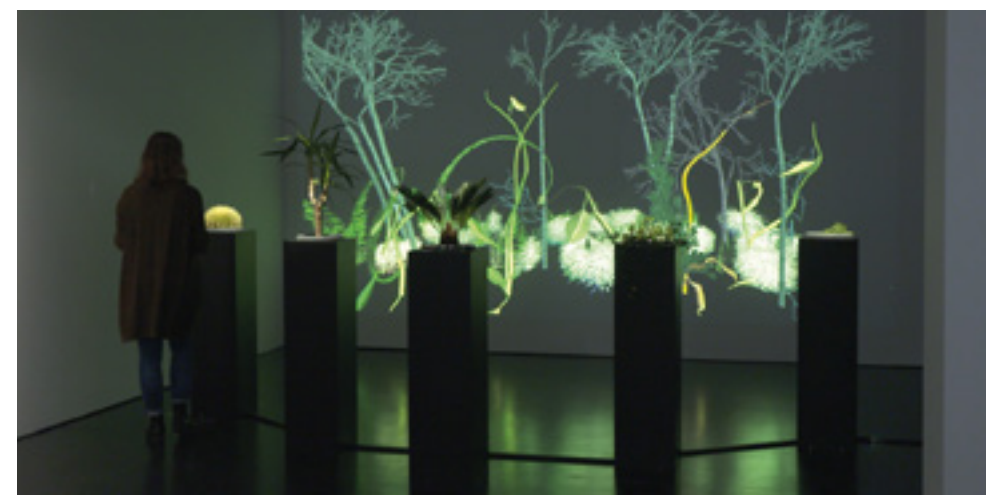Fig.32 - Japanese studio Teamlab develop immersive and interactive installations.

Fig.33 - Interactive plant growing from Laurent Mignonneau and Christa Sommerer

particular object or activity, which induces a distortion of the sense of time and a loss of self-awareness. One of the characteristics of media art is the combination of various senses that we can see, hear, and feel. Thus, artworks that seem wondrous are often produced by drawing inspiration from our daily activities. In this sense, interactive Art can produce aesthetic experiences that are deeply connected to the viewer's everyday life, in which he or she can reason and think about the effects and consequences of being in the world and life.

With regard to communicating environmental sustainability values and health improvements from a behavioral and motivational perspective: one can analyze the arts.

> We must consider "nature not just as the stage upon which the human story is acted out, but as an actor in the drama," and we humans as "ecologically embedded rather than immune"
>
> (McClanahan, 2013).

The ability to evoke strong engagement lies in the more humanistic nature of Art rather than the technical. Questions of vision, values, ethics, and culture are at least as fundamental as scientific research, technological know-how, and legislative regulation.

In the arts resides the freedom to include human and nonhuman species and to be able to elicit strong feelings such as empathy for all, including soil, water, and air. This condition allows certain cultural barriers to be overcome with ease, partly because, at these junctures, it is not necessary to justify breaking down certain boundaries for them to be perceived. Within an aesthetic simulation of the system, user interaction and involvement creates a symbiosis between the work and the user. In the case of a collective experience, this element is replicated for each individual. The form of the work, whether physical or digital, constitutes the dimension of an immersive experience that blurs the barriers that separate individuals from society. In the context of this research, such a profound invitation to a social and individual reflection between the person and the ecosystem in which he or she is immersed, between one's behaviors and the effect they reproduce, can be considered a point of arrival for the research and inspiration for the design. It is intended to transpose the methodologies and peculiarities of

generative and interactive Art and design for social and sustainable innovation to create a gentle push toward the adoption of active mobility in the interests of a healthier lifestyle and respect for the ecosystem. From person to person, from community to community, citizens will be empowered to be agents of social change by transforming their urban travel habits.
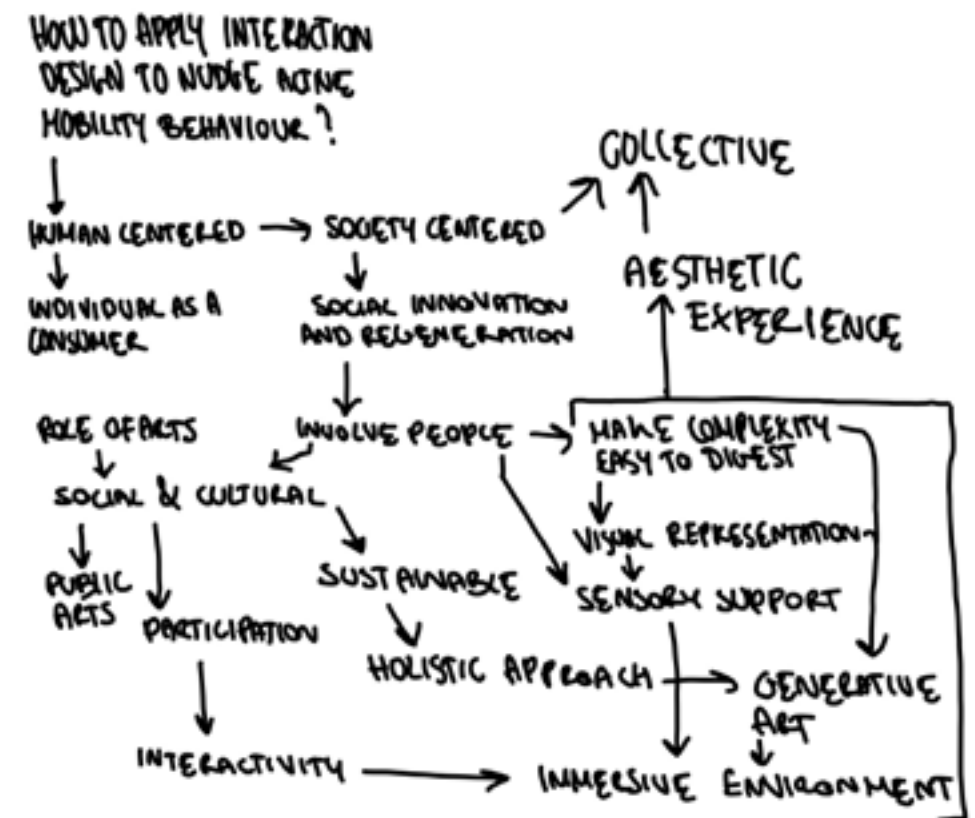
Fig.34 - Chaphter synthesis based on the third research question

CHAPTER 4

INTERACTIVE INSTALLATION PROJECT

The project will consist in a collective aesthetic experience where to enjoy generative audio-video content that represents all the travel habits of those involved. A collective immersion involves the participants with the interconnected system of urban mobility.

The experience starts by entering basic information about one's travel habits into an interface. The collected, non-sensitive data allow drawing through a generative process the main content. Audio-visual content is projected in a suitable space where a group of people experiences a summary of their habits. Finally, in a personalized web app, the user can delve into the personal impact of travel habits and realize how these would change with the adoption of active transportation. Finally, by playing with grafic elements, the user constructs his or her significance of the experience.

This chapter will observe different aspects of its design, starting with its methods. After that, the concept ideation, the prototyping, and the testing.

4.1 →
Method

4.1.1 — Design thinking: Combining the Double Diamond with the desk research

In the following chapter, we will discuss the methodologies that accompanied the project through its different stages: from the embryonic conception to the concrete structuring and prototyping. The theoretical pillar on which the project was developed is undoubtedly that of *Design Thinking*.

However, what is *Design Thinking* briefly?
Designers employ *Design Thinking*, a non-linear, iterative approach, to comprehend users, question presumptions, reframe challenges, and develop original solutions for prototyping and testing. This method, which entails five steps (Empathize, Define, Ideate, Prototype, and Test), is particularly beneficial when used for unclear or unidentified problems (*What is Design Thinking?*, 2022). Because they can reframe these issues in human-centric ways and concentrate on what is most crucial for users, design teams utilize *design thinking* to address poorly defined/unknown challenges. It is unquestionably the best methodology for "thinking beyond the box" among all design methodologies.
As we have just seen, this methodology consists of five moments, which in the jargon, are summarized in the double-diamond structure. Although it is more fancy than practical, this name is highly descriptive of the process. Just by drawing it, we can guess the mental path that the designer has to take. Even if it may be correct to call it a double rhombus or a rotated double square: the term double diamond also makes us realize that each step can potentially be

repeated indefinitely until we arrive at the quality of diamond machining (IDEO Design Thinking, 2018).

However, let us dive into each of the five phases for a moment:

→ **Empathize:** The primary goal of the Empathize stage is to generate the best understanding of the users, their wants, and the issues at the root of the product or service creation. We will deepen the tools and methodologies to achieve these results more effectively in the next chapter (4.1.2).

→ **Define:** The Define stage will assist the design team in gathering excellent ideas to establish features, functions, and other elements to address the current problem—or, at the very least, make it as simple as possible for actual users to solve problems on their own. Defining the issue and problem statement from a human-centered perspective is necessary.

→ **Ideate:** The designers may begin to consider the issue from several angles and come up with creative solutions to the problem statement thanks to the strong foundation created in the previous phases.

→ **Prototype:** In this experimental stage, the goal is to find the best solution for each of the issues discovered. The answers are incorporated into the prototypes, each examined before being approved, modified, or rejected in light of user feedback. At this time, it would be appropriate to explore the nature of prototypes and prototyping, but this will be left to later chapters.

→ **Testing:** The five-stage model's final stage, although in an iterative process like design thinking, the outcomes are frequently utilized to redefine one or more additional challenges. This deeper degree of comprehension might enable the designers to look into the circumstances of use and how users interact with the product. It might even prompt them to go back to an earlier step in the design thinking process.

In the case of this research, this process was taken over after conducting exhaustive desk research on the issues we discussed in the previous chapters. We can
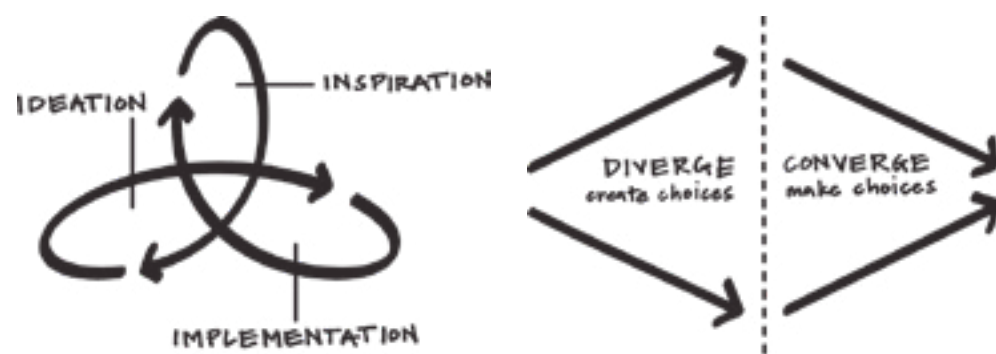

Fig.35 - Recursive approach for each phase of the design thinking combined with an attitude of expansion for creation and of narrowing for definition

summarize the main insights from the research in these points again:

1. The issue of urban mobility is interconnected by several factors and is related to a collective and an individual dimension.
2. Urban mobility is a habit and, as such, has a mental and physical impact on people.
3. The benefits of active mobility outweigh its risks.
4. Living and knowing a culture of mobility can make a decisive dent in behavioral factors.
5. The generation around the age of twenty is most likely to revolutionize their habits.

As we will see later, these elements have helped apply the double diamond methodology most appropriately. There are flexible methodologies that must be followed point by point; instead, methods should be adapted according to the moment's needs. In this case, Design Thinking was adapted to enable Design to create empathy between people, society, and the environment through the filter of urban mobility.

4.1.2 — UX Research: Interviews, Empathy Maps and Questionnaires

The first step of Design through design thinking is empathy, an extensive topic, mainly when applied to experience design. A whole range of methodologies and practices used at this stage are usually lumped together under the term UX Research. There are tools for gathering qualitative information, such as interviews and observations, or quantitative, such as questionnaires.

A qualitative approach was chosen to create an experience that could communicate directly with the deepest part of people.

At the center of the field research that was done were the so-called UX Design Principles, namely:

1. Putting people at the center to understand their needs, problems, motivations, and expectations.
2. Collect qualitative information for recurrence and evidence.

3. Leave aside preconceptions and listen to people's problems; put yourself as a designer in their shoes and investigate the deeper motivations.
4. Bringing together different points of view is an added value that leads to the search for unexpected solutions.
5. Solutions must be innovative, yes, but they must be desirable, feasible, and sustainable.

Qualitative information about the users through semi-structured interviews was chosen, that is, those interviews with much preliminary preparation but which, in their execution, left room for the interviewees to wander with their thoughts in order to obtain unexpected results.

Interviews

The interviews were conducted among ten participants by following 3 phases: Preparation, Execution, and Analysis.

Preparation

First, the objectives of the interview were defined:
→ Understand personal motivations related to one's movement habits to gain a more comprehensive view of personal choices.
→ To understand how the habit was perceived, emotional involvement related to habit change.
→ Opinion about one's impact on the community
→ Opinion about one's impact on the ecosystem

These last two points were addressed to understand how one of the load-bearing conceptual levers of the research, namely the collective dimension behind one's movement habits, could be grafted onto the users.
In the second step, the pool of respondents was identified. Since it was recognized in the demographic spectrum of young people, people in their 20s and 30s were interviewed. Among the respondents, some were students, some were freelancers or employees, and some were student workers, so people with different mobility needs could be included. Finally, people with different transportation choice habits were sought, and the final set of the question was formulated.

→ What do you think about habits and routines?
→ Do you feel a connection between your habits/behaviors and the surrounding community? (friends, relatives, colleagues, acquaintances, Etc.)
→ Do you feel a connection between your habits/behaviors and the environment you live in?
→ Give a rating from one to ten on how much your habits/behaviors are influenced by:
   1. Personal motivations and needs
   2. Social motivations and needs
   3. Environmental motivations and needs
→ Do you feel the predisposition to change habits or behaviors at this time of life?
→ How do you get around in Milan? Tell about your typical commute.
→ Tell about the positive, negative, or neutral feelings you experience in your various movements.
→ Tell me about the first biking experience you can think of.

Execution

Twelve interviews (sufficient sample for qualitative research[1]) were conducted in different ways: live, by video call, or directly on the phone. Although the live interviews yielded more synergy during the sessions, the interview structure was respected in all cases, and the interviewee did not ask personal questions during the chat. The interview formula was constructed in 3 stages: questions on habit perception, opinions on habit change, and questions on mobility habits. The questions were iterated and refined through each interview to make each session feel better for the interviewee. Interviews lasted an average of 45 minutes and sometimes up to an hour, although it was explicit that there was no strict timeline and the interviewee could end the interview at any time. At the beginning of the interview, purely academic purposes and confidentiality about the information collected were enunciated, thus demanding complete transparency about one's habits. The interview was posed without judgment but with an exploratory approach.

Analysis

The interviews were recorded, and at the end of each session, they were transcribed and underlined, finally collecting the insights and takeaways into points. Once the interviews were concluded, the results were then analyzed to generate the desired insights.

Fig.36 - Insights out of the interviews (they are all written in Italian because all the people were resident in the city of Milan and the interviews were performed in native language)

Empathy Mapping

One tool that can be used to empathize with users, summarize observations from the research phase, and discover surprising insights into their needs is the empathy map. The empathy map consists of four quadrants where user actions are represented:

→ **Said and done:** What is her attitude towards others? What does she do in public? How has her behavior changed?

→ **Thought and felt:** What matters to the users? What occupies their thinking? What worries and aspirations do they have?

To analyze the interviews: several empathy maps were drawn by taking advantage of the analysis, the first one for each interviewee and then combined under one empathy map. The latter collected about a hundred insights that, by affinity, were united into different categories and derived from the interview topic (Fig.36). These were Active and Motorized Movement and the relationship of habits to environment, society, and individual, respectively. From the insights, several common themes emerged among the different interviews; a list of the main themes that emerged as follows:

→ Interactions on means of transportation
→ The impact of visual space
→ The time spent getting around
→ Orientation
→ The sensations experienced during movement
→ The change in habits
→ The reason for habits
→ The power that habits have
→ Sharing one's habits
→ Consciously absorbing habits from others
→ Being unconsciously influenced by the habits of others
→ The social effect of habits
→ Perception of the impact habits have on the ecosystem
→ The influence that the environment has on one's habits
→ The value of the ecosystem

Several observations were made on these issues, forming a solid foundation that formed a starting point for the project's Design.
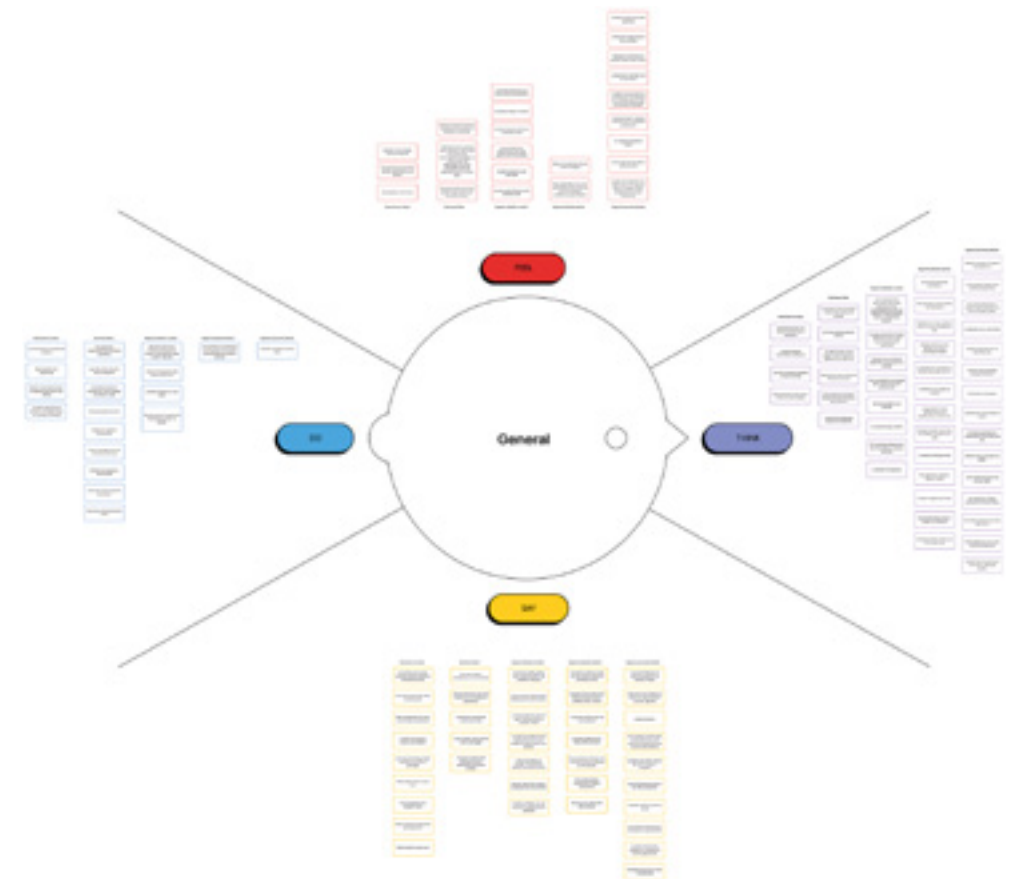
Fig.37 - Collective empathy map diagram deriving from all the interviews

Questionnaire

In order to implement quantitative data on the assets of the research, a questionnaire was conducted. The questionnaire was developed to gather demographic information; a sample of about one hundred individuals, all born between the early 1980s and the end of the first decade of the 2000s, was analyzed. The questionnaire results showed that slightly more than half commute by subway or train, and almost all trips had their destination as their workplace or university. On average, the commute experience is experienced as more than sufficient, never excellent. Most respondents reviewed themselves as having an above-average lifestyle concerning physical activity (responding on a scale of 0 to 7, where 0 was sedentary life while seven was sporty).
Data on travel quality were cross-referenced with travel duration and length, showing that the most pleasant travel experiences are found in lengths of 2 to

5 kilometers, with a duration of 10 to 30 minutes. Finally, 86% of respondents were proactive about changing their commuting habits for a healthier lifestyle.
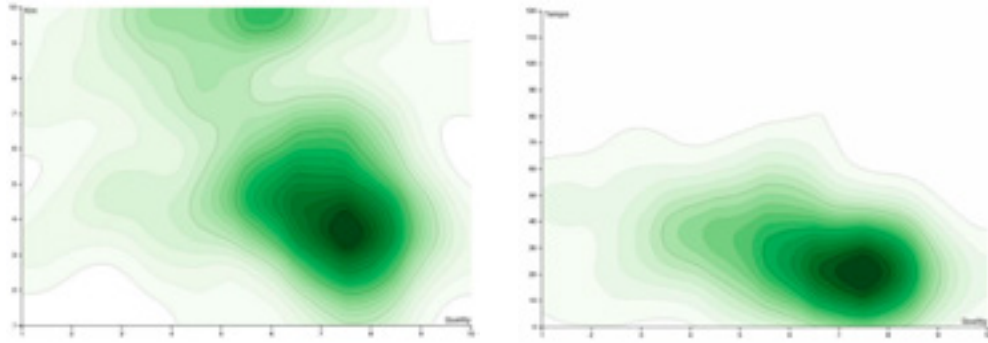
Fig.38 - contour plot graph of the trip quality compared with the length of the trips, and compared with the duration of the trips. Highest quality with trips around 3-5km and between 10 to 20 minutes.

Personas

Personas are made-up characters developed based on research to represent the many user types that may utilize any service, product, website, or brand comparably. The development of personas facilitates the designer in comprehending the user's needs, experiences, behaviors, and goals.

"Personas are the single most powerful design tool that we use. They are the foundation for all subsequent goal-directed Designs. Personas allow us to see the scope and nature of the design problem... [They] are the bright light under which we do surgery."

Alan Cooper, Software designer, programmer and the "Father of Visual Basic."

Personas are deliverables from the Define step of design thinking. They should be adopted into design processes early because they are quite advantageous for ideation. Using personas is just one method, among others, that can help designers move on to the third phase, the Ideation phase.

In order to develop personas that will be useful for the ideation phase later, it is essential to make them not just an academic exercise; personas have been developed with the experience in mind. First of all, the demographic information has been narrowed down to the bone: limiting the age group to that eighteen to twenty-eight (which, as we mentioned earlier, represents the main target audience of the project), incorporating the city to contextualize the movements in a specific location (Milan and province were chosen to facilitate the later execution of the prototypes since the various modes of transportation in it are already known), and the employment to intuit the type of routine.
A brief story that describes the way of thinking and cultural background and determines the relationships with mobility and habits. In the end, bullet points about goals, wants, and fears were written to give insights into people's habits, things in their routines that already works, and niches for something new.

Fig.39 - Personas

4.2 →
Project concept

Having concluded the research/empathy and definition phases, I moved on to the crucial phase of Design, namely the ideation phase. The Design Sprint methodology was used to approach this phase with valuable tools.

4.2.1 — Design Sprint: From definition to ideation

Design Sprint is a method optimized and later formulated in the book "Sprint, How to solve big problems and test new ideas in just five days," by Jake Knapp with John Zeratsky and Braden Kowitz of the Google Ventures team. I was fortunate enough to delve into and study this method during the "Final Design Studio" of my master's degree program at Politecnico di Milano in Digital and Interaction Design. The book written by Knapp is a "DIY guide for running your spirit to answer your pressing business questions" (Knapp, Zeratsky and Kowitz, 2016). Although in my case, it was about more than answering a business question or compressing the design activity into five days, the Sprint method is helpful since it gathers a varied selection of activities to advance design practice while respecting design thinking theory. The first phase of the design sprint is mapping, practiced on Monday's day, in the sense of defining the goals and direction of the project and being clear about which part of the problem you want to solve. It could be compared to the Double Diamond definition phase. To prepare for this first phase, all the foundational elements derived from the field and desk research part were then gathered:
→   Displacement is perceived as personal.
→   Time and space are fundamental elements of the displacement experience that determine its choice of means.
→   The urban environment perceived during commuting in its sensations

dramatically influences the experience.
→   Sharing habits reinforce them and have an impact on the sharing society.
→   The first phase of a new habit, or changing an existing one, for personal good is stimulating.
→   Although perceiving the relationship between personal habits and the environment is challenging, following habits blindly is not healthy.
→   The influence of context on one's habits is enormous.

In the 1970s the How Might We method was developed at Procter & Gamble, and later popularized by IDEO. The way it works is simple: freewheeling, one writes on notes a portion of a problem that can be solved, and at the end of the session, one rearranges the notes by affinity and with an overview, sketches the problem in a bounded way. The result of these notes will moreover be useful in getting an idea of what to sketch.
The strength of this method lies in the incipit "How Might We"
During the Design and practical application of HMWs, the need was felt to revolutionize the phrase "How Might We?" into "How Do We Sensitize?" The sense of the word sensitization already includes part of the solution. It satisfies the interest in investigating immersive or new media art environments as an innovative solution to "being able to" address particular problems. Sensitize not exclusively in its informational or engaging sense but as a conscious awareness amplified by the senses, such as sight, hearing, thermal perception, or kinesthesia.

The main notes that stood during the HMW/HDWS session are listed below:
→   How Do We Sensitize a sense of independence in the choice of means of transportation?
→   How Do We Sensitize a personal reflection?
→   How Do We Sensitize the relationship between behavior and the ecosystem?
→   How Do We Sensitize a fresh and inspiring change of habits?
→   How Do We Sensitize the health impact of mobility?
→   How Do We Sensitize the social purpose of mobility?

These concepts were later elaborated to provide concepts that could be more easily materialized into a design proposal, forming real design drivers. The positive values of independence, emancipation, and self-love (in a broad sense of reflection leading to environment and sociality) were conveyed. Thus, the goal was to provide awareness that could produce a personal reflection on the user. On a practical level, measuring the impact of transportation was conceived as foundational to foster actual user identification with the medium of the project. Moreover, along the same lines, the driver of personalization was recognized as crucial in building an experience capable of providing complete immersion.
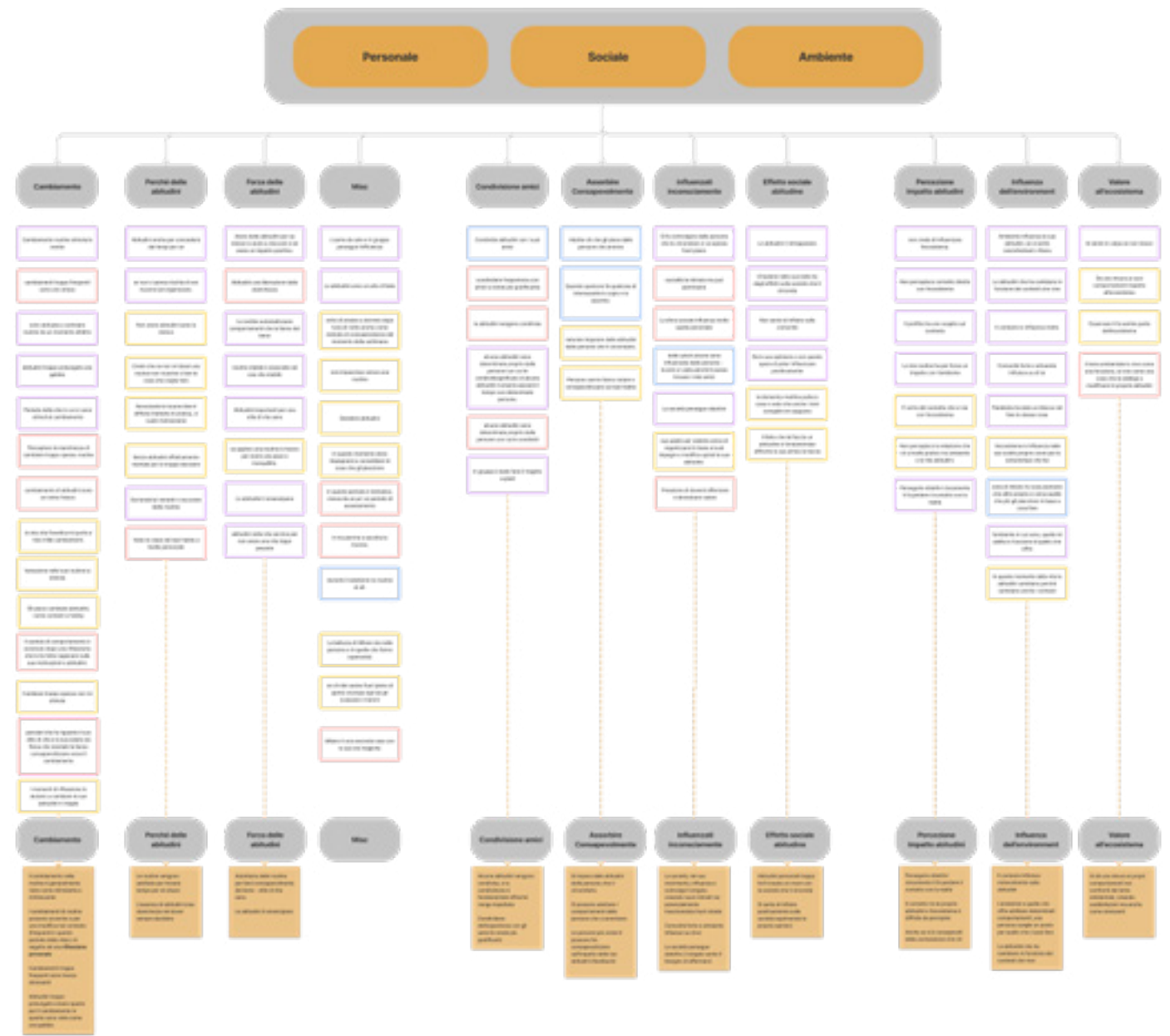
Fig.40 - Map of the clustering of the insights and dthe definition of the collected knowledge (again all the reasonings were made and written in Italian).

The second day of the Sprint method is devoted to sketching, and among the various techniques listed within the book, one of the most interesting is the Crazy 8s, part of a 4-step process. This method allows us to think of a wide variety of solutions through rapid solution sketching, eight solutions in a maximum of 8 minutes each. While sometimes Crazy 8s leads to revelations, other times it seems unproductive, and the first idea is the best. Either way, as it was for this project, it is a great help to consider alternatives and get fresh perspectives on one's idea.

Before starting the four-step sketch session, were formulated extensively:
1. *Project target audience.*
   → **Generally anyone:** On whom to think of a 'pleasant, immersive, clear, and engaging experience.
   → **Specifically, GenZ:** Because they are more readily willing to change and modify their habits. Habits acquired today will be more easily maintained in the future. Inhabiting the future, from a forward-looking perspective, they are the most suitable and the group most sensitive to environmental issues.
2. *Project Goal.* To raise awareness and prod the general public about the effect of their choices of moving around the city in three dimensions:
   → **Urban environment:** The means we use to deform our environment have an acoustic dimension-social dimension-safety (e.g., crossing the street)-general traffic-visual dimension.
   → **Health:** How we move impacts our mental health - nervousness, stress, and depression - and our physical fitness - rampant sedentariness and physical inactivity phenomenon that are driving populations toward high levels of obesity and overweight that consequently lead to cardiovascular disease as well as cancer.
   → **Ecosystem:** Emissions resulting from urban displacement have a substantial impact on two main issues of climate change and citizens' health: Air quality with the release of delicate particulate matter (PM10, PM2) and the greenhouse effect, of which a substantial portion is accounted for by short trips (less than 5km).
3. *Other desirable goals.*
   → Tell the enormous complexity behind travel habits but simultaneously simplify it in a way that has a direct message.
   → Prod participants toward choices in their habits that move more toward an active mobility pattern.

Once this phase was addressed, a different set of solutions that served as the foundation for drawing the final version of the design idea (not in a final form for practical limits) were found. Here is a quick summary of the concepts sketched during the crazy 8s phase:

1. Sketch 1: Physical input of means of transportation used; indoor space enclosed and dark; sound generated based on responses from last 25 people; wall at bottom with generative graphics; invitation to share images and videos of the experience.
2. Sketch 2: Physical input in the shape of a table: half kilometers and confirmation; projected visualization; map of Milan with lines and color spots generated based on input data; DataViz on corners: how does the city evolve?
3. Sketch 3: Mega led-wall, QR-code to participate, web app with simple form: means, start and end point; graphics with a map of Milan track input data and does things; generated sounds make an ambient background track; 24/7 youtube radio of the installation; active mobility information labels.
4. Sketch 4: Tunnel with projectors and sprinkler speakers; projected urban environment scenario; as one proceeds through the tunnel, the scenario changes from the current busy street (worst situation) to that of a utopia; placed motion sensors trigger special horn-like sounds with dedicated car-passing type animations.

5. Sketch 5: Vertical screens with Kinect; sprinkler speakers; octagonal screen arrangement, people are in the same room; audio generated by responses from everyone in the room and then shared; experience with data input via Kinect sensor; mirror function; focus on health and movement; follow up with feedback and know more.
6. Sketch 6: Real-time web app; landing page with primary data collection questionnaire; generative visualization of all users who used the web page and their responses; chaotic generative audio; active mobility utopia presented on another page; emotional video narrating scenario; action/roadmap list toward a personal utopia.
7. Sketch 7: Screen with physical sliders below; sliders enter percentage with which you use each means; again, small speaker with generative audio; sliders become volume mixer; DataViz screen that tells you if everyone moved like you then what the city would look like: economy - health - pollution.
8. Sketch 8: QR-Code at the entrance; web app where you put input, this generates a personal ID, data sent inside for installation; inside the tunnel where you see people's various trails drawn with underlying history of all input slowly fading away; generative audio based on 100 responses; output a printer object, where you put ID code, prints a postcard with an image of the tunnel and personal line highlighted; claim and call to action directed to a custom web page.

Fig.42 - Concept sketches, from idea 1 to idea 4
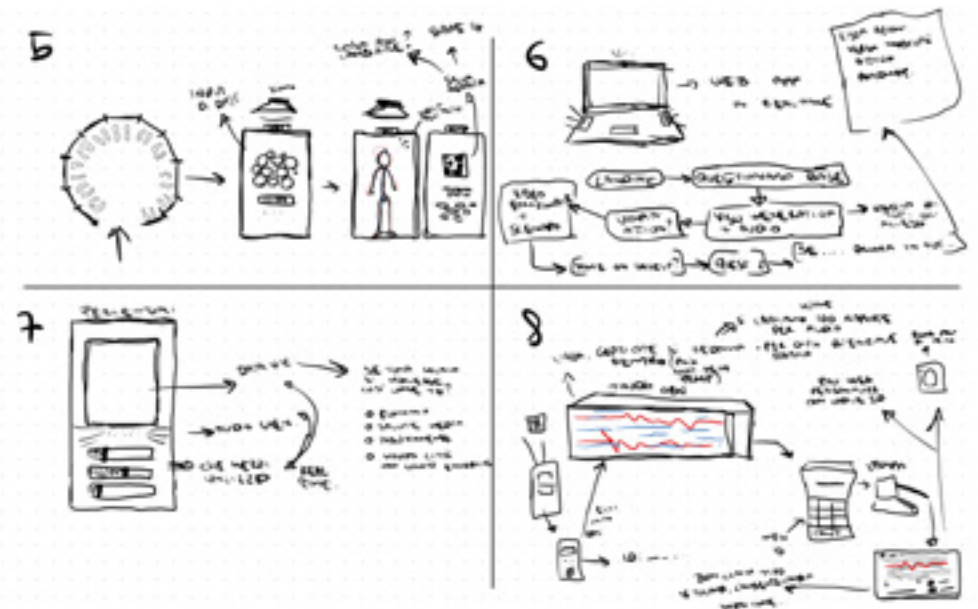
Fig.43 - Concept sketches, from idea 5 to idea 8

4.2.2 — Design an audiovisual experience

Starting from the result of the sketches in the previous chapter, we had to define what traits are most present in the solutions found:

→ Collective and individual personalization of the experience
→ Data Visualization refers to the habits of the sample of people participating in the installation
→ Use of audio to reflect noise pollution.

These elements formed the basis of the final solution.

Since the idea is to develop a feasible design that can be applied to a real audience, it is convenient to think of it as a system. So, starting from the central core of the installation, the audio-visual-generative experience, and then thinking about all the elements that had to coexist with it to enable it to function in an authentic context.

So we start from the beating center of the installation, which we want to be an immersive space where the user can have a collective experience. An experience capable of reflecting the personal commuting habits of each present within the environment. A visual transposition of their habits capable of arousing in them a sort of epiphany towards mobility, combined with an acoustic experience that simulates their perception of noise pollution.

Thus, the character of the installation is twofold: on the one hand, the personal and emotional experience and, on the other hand, the didactic, therefore informative and scientific function. Priority was given in the first place to the emotional, sensory, immersive, and ecstatic character to add elements capable of providing information of a didactic nature at a later stage. In this way, an attempt is made to bring the public to awareness as we defined it earlier (Chapter 4.2.1) in such a way as to provide tools and notions that each individual could use to apply choices in everyday life (fig. 44). One should remember that at this point in the project, one of the research's main goals is to build a sensory experience capable of pushing its visitors toward more conscious choices that could even go so far as to change their habits in terms of travel. This intention places no particular constraints on the type of environment that should lend itself to the project and have no particular expertise in space design; it was chosen to exploit this lack instead. The non-need for a specific space turns into flexibility. This installation could be replicated anywhere, in any enclosed space with a variable number of people it can accommodate at once. This choice was made to give a replicability character to the project in line with the generative approach, which could be replicated by anyone anywhere in the world, in any local context.

Leaving the discussion of the spatial flexibility of the project in abeyance for a moment, let us go instead to understand what limitations this choice produces. To understand this, we need to take a small step back and understand the heart of the experience. As mentioned earlier, the experience revolves around the collective data visualization of the travel habits of those experiencing the experience. First, we need to figure out what data to work with that represents habits and then figure out how to request that data from users and how to get them to enter it.

The data needed to represent, even partially, a daily habit are those related to the primary displacement, that is, the home-work (or home-university, school, gym, Etc) commute.
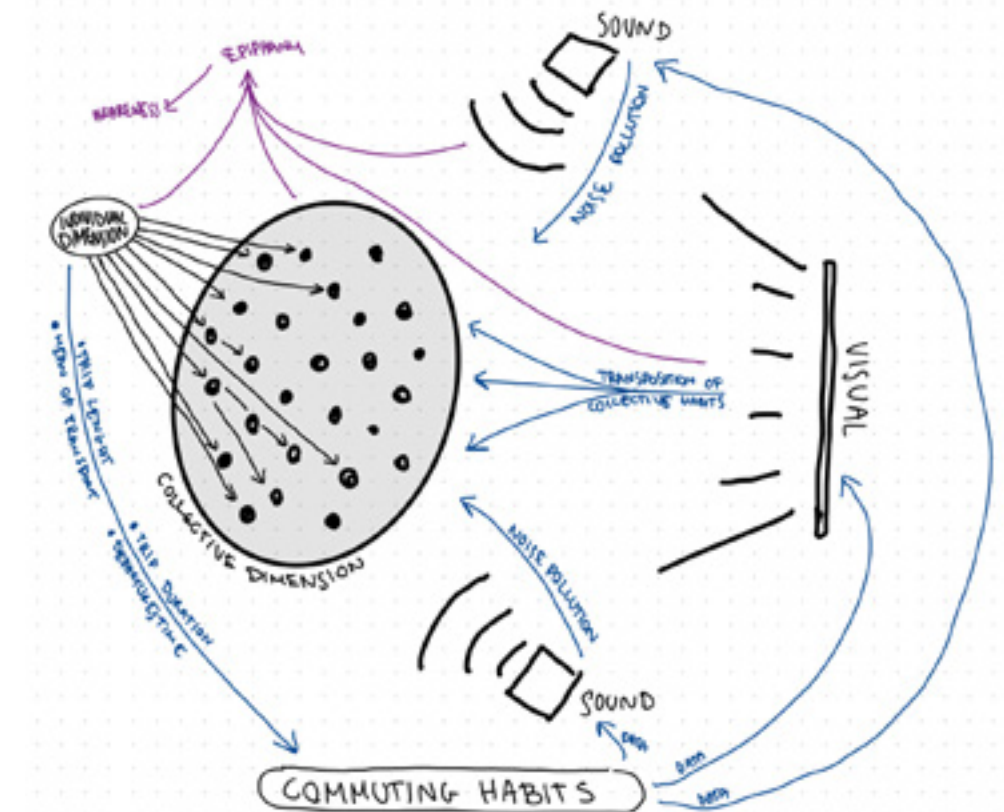
Fig.44 - Conceptual frame of the collective experience

Departure and arrival location data were discarded from the request at the outset since they are designed as sensitive data. The data requested at the end are few, also to imagine a simple and not annoying interaction for the user: means of transportation used mainly (we are aware of the possibility of combining dif-

ferent modes of travel to end a trip, but for a first conceptual stage we chose to simplify), time of departure to go to work, time of return home, average distance of the route and average duration of the journey.

Once the data inputs were defined, it was necessary to figure out how to engage the user to request it. Given the need for a background in designing physical products, a path more related to the digital environment was chosen, partly because building a physical apparatus for this activity would have reduced its flexibility, as seen above. On the practical side, this activity, which we can describe as preliminary, is reflected in a web app that then serves as a questionnaire. Then, it was possible to focus on the details of the central experience, which from research would be devoted to the ecstatic moment, the epiphanic drive. The work was harnessing the data collected to construct a dynamic set of experiences, in which each would change form depending on the participants in it (linking back to the potential of participatory and collective art described in chapter 3.1.3 and the intentions of flexibility mentioned earlier). Thus, the idea was to simultaneously represent the different habits of the participants in the experience: both visually to allow them to read a picture of people's moving habits and acoustically so that they could perceive the impact of the same group reproduces in the environment. In this way, the dynamic character of the experience is brought out. As for the informational character, on the other hand, some data and information on the estimates of the environmental impact and collective physical activity would be included. To avoid leaving the needle of the balance between art and Design leaning too much toward the artistic one, it was necessary to think of follow-up elements to complement the educational aspect of the experience.

This part was thought to take advantage of the same support as the onboarding questionnaire, namely the web app. Following the principle of customization defined earlier, the generation of customized web pages was thought. Within the web app, users are allowed to:
→   Learn about the objectives and scientific background of the project,
→   Observe estimates of the collective and individual impact related to commuting habits,
→   And observe how in a utopian landscape - in which all individuals make active choices (a theme that emerged several times in the practice of crazy 8s) - and how its impact on the environment and on health would change.

User Journey Map

User journey maps map an individual's relationship with an experience across time and all channels through which they interact with the business. Design
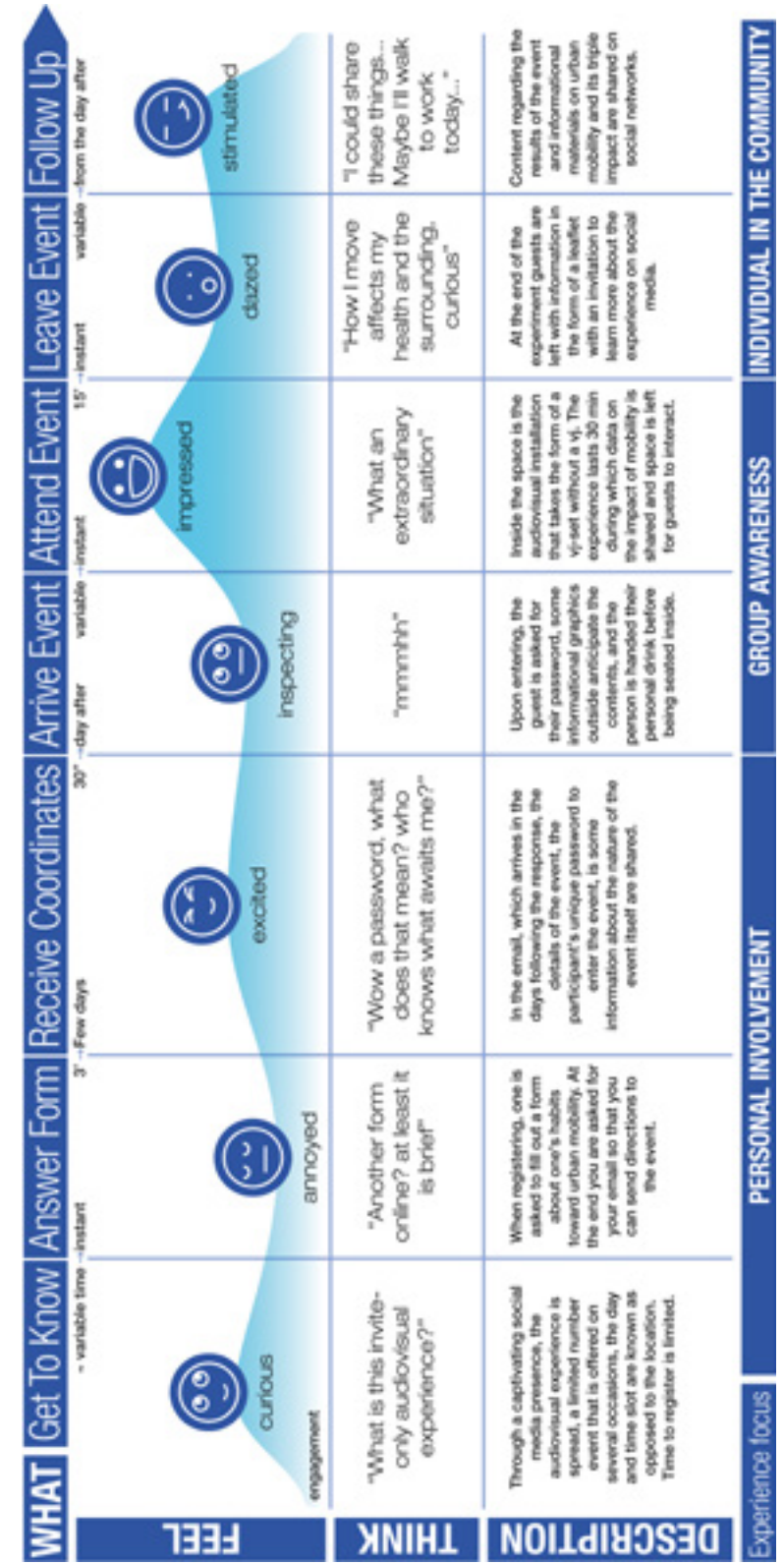
Fig.45 - User Journey Map - Emotional involvement and topic awareness.

teams use user journey maps to examine how user experiences match user expectations and identify where the Design needs improvement. They reveal experiences over time and visualize the many dimensions and factors involved. As a result, these maps should include detailed timelines that highlight the most significant events and subtasks. As the chronology moves, insights into the thoughts and feelings of the participants are added. In order to develop a more suitable tool for the type of project that was wanted to be undertaken, it was decided to give a more emotional slant to the construction of the User Journey Map.

An emotional journey map associates an indication of the user's emotional state at each stage of the experience to add a more qualitative dimension to the analysis of the functional experience. A graph represents emotion from moments of frustration to moments of pleasure, and the reading is simplified if emojis are added to designate the emotion involved.

Recovering the work on personas done earlier, the user journey map was drawn with Sara's personas in mind (Fig. 39, chapter 4.1.2). She was chosen since she was the one in the registry sample, which was at the center. Because of the independent but, at the same time, habitual nature of her story, her fears include being trapped in a routine, but she is at the same time very fond of her scooter, which allows her to build her other habits.

Since this is an exercise to shape a concept and not an exercise to improve an existing service, the different moments of the experience and related emotions were hypothesized and do not reflect pragmatic data. However, the usefulness of the exercise was still valid since it allowed us to design an experience in detail from the user's point of view and still identify key elements of the experience, such as its different phases and timing and points of concentration.

The experience is divided into these three areas that made sense of the project in its different content and experiential phases: the onboarding part dedicated to personal involvement, the generative audiovisual experience dedicated to collective awareness, and the follow-up to slightly push toward an individual awakening of role within the community.

System Thinking

"A system must consist of three things: elements, interconnections, and a function or purpose."
(Meadows and Wright, 2008)

Suppose the central part of the total experience has been defined at the design level. In that case, the same cannot be said of the other two, namely the onboarding and the follow-up (although the objectives of the same parts have been defined, and it is understood that in the initial one, data must be collected to generate the central experience). Systemic thinking was chosen as the approach to "ground" these two parts of the experience and give them a form capable of supporting the existence of the audiovisual experience.

Systemic thinking is an approach that designers use to analyze problems in an appropriate context. By looking beyond apparent problems to consider a system as a whole, designers can identify root causes and avoid simply treating symptoms. They can then address deeper problems and be more likely to find practical solutions.

If one of the foundational concepts behind the technical formulation of the audiovisual generative experience is its flexibility and adaptability, the understood form then of the system falls into its very meaning, which is a collection of things, people, cells, molecules, or otherwise interconnected in such a way as to produce its own pattern of behavior over time (Meadows and Wright, 2008). System map design was undertaken to create a system that, in all its parts, could be sustainable, replicable, and autonomous.

The concept of systems thinking emerged in 1956 when Professor Jay W. Forrester of MIT's Sloan School of Management created the Systems Dynamic Group.
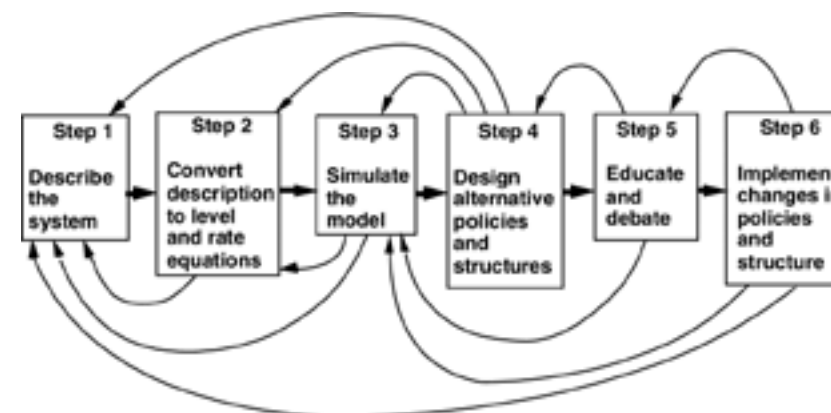
Fig.46 - System dynamics steps from problem symptoms to improvement.(Forrester, 1994)

The danger of not using a systems approach is that one can oversimplify a situation, take problems out of context, treat the symptoms, and make the situation even worse (Fig.47). Norman sees electric vehicles as an example of a seemingly reasonable solution (to pollution) that can obscure what should be the real goal. Suppose the fuel source that generates the electricity comes from coal. In that

case, the purpose is thwarted and, worse yet, could cause even more harmful pollution to the world, especially if so much electricity is dispersed between the generating source and the consumers' power supply (Knapp, Zeratsky and Kowitz, 2016).

System mapping is approached by following five steps:

1. The Purpose: This is the one of supporting an overall experience of engagement of the user in the social and ecological matter of sustainable mobility, fueling their awareness about the topic in a collective dimension, making this realization spread, and helping the system to expand its public.
2. The Choices: These were to be pretty open but to make the overall experience path simple and suitable for automatization processes.
3. A visual overview of the system of all the elements on the board
4. Dimensions of the system and the Environment: The physical dimension is localized in any city's environment with an expansion of his presence through the digital dimension, while the temporal dimension was formulated in the journey map: giving a few days for the onboarding, an hour for the central part and an available time span for the follow-up.
5. Adding Links and relations

The actors in the system, and the relationships that characterize it, were therefore conceived in this design phase, going precisely to fill the design gap for the onboarding and follow-up. The map was designed starting with the user, but considering it is intended for a collective moment, the overall system for each experience is to be considered the whole of all the individuals who participate in it. To reach the collective experience, each person must first get to know it, thus remaining in his or her dimension. A more immediate and close way to the chosen target audience is found in the digital dimension of content usable on social networks: Instagram and Tik Tok. The large presence of short-form video content characterizes the two platforms (first one and then the other). These, in turn, are characterized by a reasonably spontaneous broadcasting system adapted to an algorithm that associates their appearance on the screen with user behavior. Since the output of the experience is audiovisual content, this can be recycled as video content for social network presence, with a teaser aspect and related to mobility issues participatory art. This same channel will come in handy later in a follow-up moment. A more or less broad editorial team should take care of content curation with a process that is as automated and generative as possible. The user, through social or other places (such as a QR code applied to any medium), will land on the web app through which to "register" for the experience. Registration, which will be explored further in prototyping, supports an informational role like the experience and logistics. It introduces the user to the habits by allowing them to fill out the participation form. Data are thus collected, and the user is informed about the ethical treatment directly
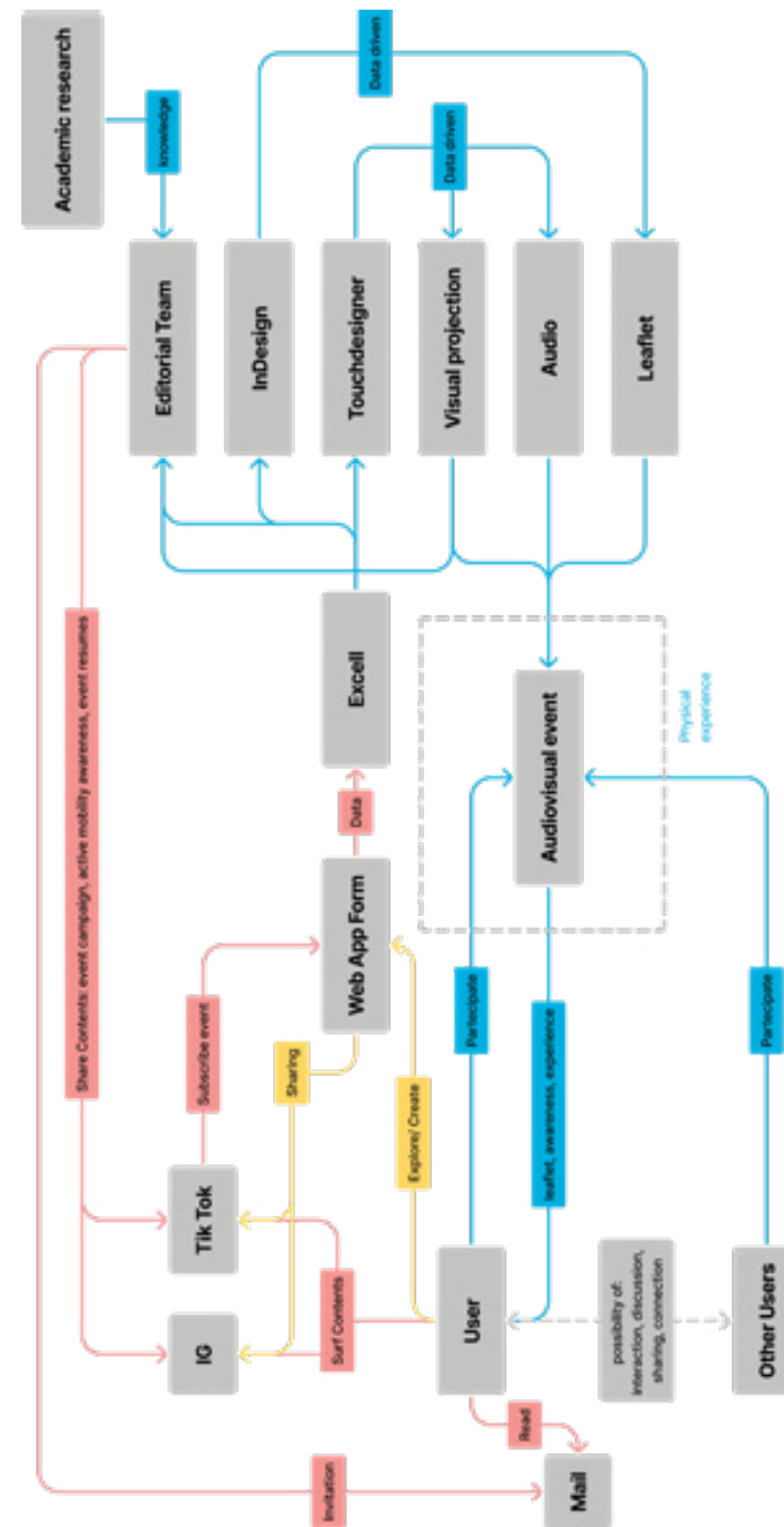
Fig.47 - System map: red for the on-boarding, blue for central expereince and yellow for the followup

and transparently; the last piece of data required is the email to which to send the material to access the experience. The data uploaded by the user at this point enter the automation process, first on excel, then on Touchdesigner, InDesign, and back to the Editorial Team. On Touchdesigner, you can automate the audiovisual generation process, basically the content of the experience. On InDesign, on the other hand, an informational leaflet helpful in following up on the experience is generated and personalized with each individual's data. Users can receive their leaflets at the beginning of the experience. In the email, users are given a password and how to get to the experience and to choose their preferred time, with the option to update it up to a hypothetical half hour before. Participants introduce themselves at the predetermined location and time by presenting their passwords. At the end of the experience, participants will be

able to access through the web app a portal page that allows them to explore the themes of the exhibition in a written form and an interactive player to give their form to the generative graphics of the exhibition and create their content for sharing on social or any other use. This content, along with content produced in the installation itself, contributes to the creation of initial material that, along with user participation, allows the system to get going.

As anticipated earlier, the size of the system is flexible and variable depending on the participants (Fig.48). The very limit of participants per session is given by the size of the space in which the experience is performed. The system can then be viewed in a time progression in which each session represents a moment, and the sum of the sessions represents the whole system as it evolves.

In this final form, the study took the name of *"Feell your mobility,"* an intentional misnomer derived from the crasis of the terms *Fill* and *Feel*. This union in the name contains the inner meanings of the installation. Through the honest contribution of each one data, deriving from an autonalysis of own habits, it become possible to feel the impact and underlining motives of the mobility system, from both an individual and collective point of view.
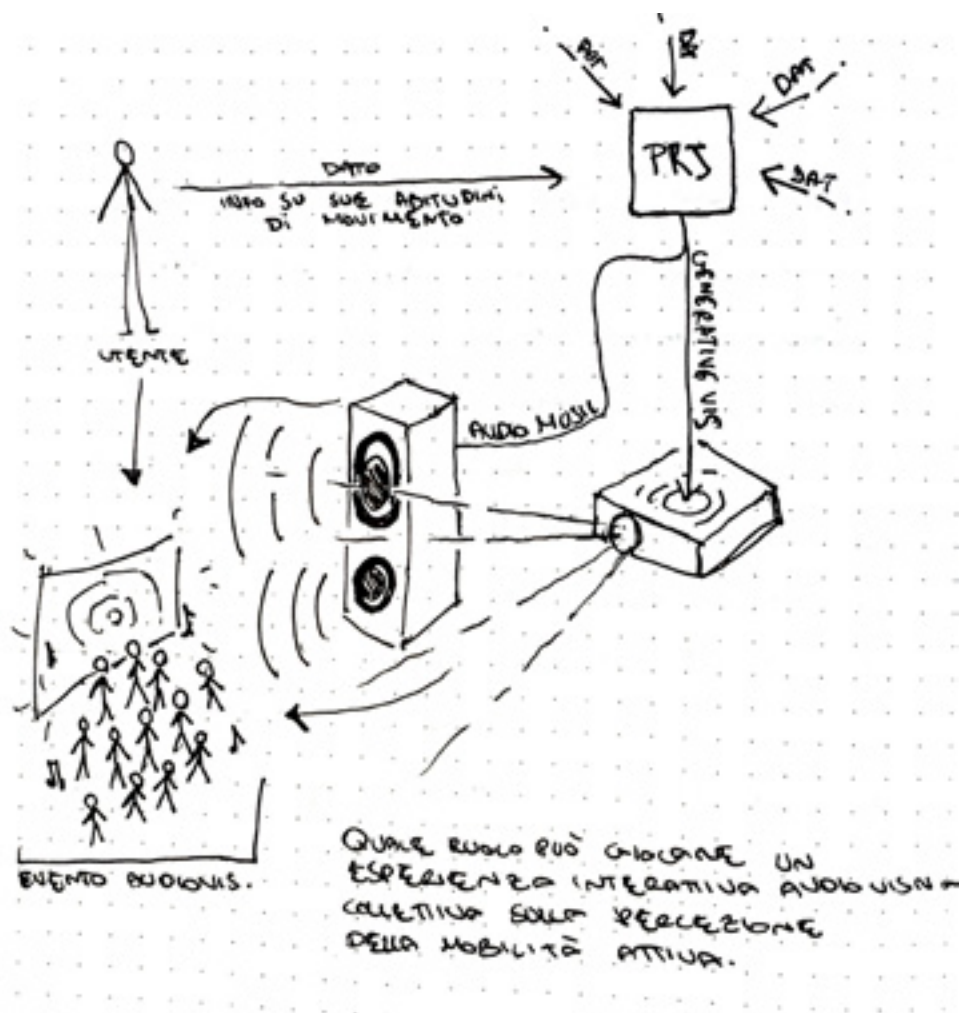
Fig.48 - Essential elements of the system

4.3 →
Development and prototyping

Having finished the ideation phase and thus arrived at formulating a solid design concept, the prototyping phase has begun. This phase, along with the testing phase, will be decisive for the validation and verification of the project. Concerning prototyping, the work was divided again into three focus areas: onboarding, an audiovisual experience, and follow-up. Each of these was treated with a different level of depth because of the different difficulties and challenges and personal interests in deepening the executive and practical subject of Design.

4.3.1 — Questionnaire and web app

As for prototyping the onboarding phase of the experience, work was done on designing a dedicated user interface. An interface designed for use from a phone was designed using the "Figma" platform, as it is imagined that the web app will be opened from mobile by arriving directly from social media primarily used on mobile. The idea behind this prototyping phase was to build a platform that would simplify the process of entering habits data to the user. At the same time, the app must be able to convey to the user the purpose of the installation by making them aware of their role and the ethical treatment that is applied to their data. The app's structure is very straightforward in that it directly accompanies the user from the arrival on the web page and leaves him after completing all data entry. Since the structure is simple, the wireframe part was skipped by investigating the components of each page suitable for entering the necessary

data. To begin the project, a consistent typography, color palette, and graphical style were chosen for the entire interface. This phase is critical to creating an aesthetic that runs through the entire experience and never makes the user feel out of place.

In terms of typography, two leading font families were chosen. The first was Helvetica, a widely used sans serif font family that became extremely popular with the work of Unimark and the well-known Italian designer Vignelli. It was chosen, however, in its two variations: compressed, since in mobile use and vertical screens it allows a larger font size to be used to convey the same message and fit it on a single line, and extended, which on the contrary has much more "air" between its letters to balance the condensed and to make paragraphs of text visually lighter and thus favoring fast reading. The second font family contrasts in fame, and usage is the Fuga font family from the Sumotype foundry. Quoting the foundry's own words on the Future-Font independent foundry site, "Fuga is a hybrid sans serif typeface designed to explore the principles of the broad nib pen in a contemporary context. The concept behind the Design responds to generating distinctive letterforms that enhance the message by creating hierarchy and emphasis in the word." The latter font was chosen precisely to give the Design a digital and contemporary character.

As for the color palette, the digital side was again emphasized. A very dark gray was thought to be applied to the background, adapting to the trend of making interfaces with a dark theme to have less impact on the retina, make the text come out better from the background, and reduce the number of lit pixels on the screen. In addition to white for text, electric blue was chosen as the primary color, again to refer to the technological and contemporary nature of the project. The graphic line that has been adopted has a decidedly typographic slant to convey the messages and requests to be made to the user. Typography has been flanked where necessary by icons with a simple and light style. In order not to have too impersonal a style, some emojis have been added to make the interaction more youthful and playful.

The first screens of the web app were structured around copywriting, text capable of making the user aware of the issues and nature of the experience. Two introductory screens welcome him, one a bit more generic and the second with more direct details on habits and mobility. A final screen was set up for additional information on data use.

At this stage, the experience was named "Feel your mobility," an intentional misspelling to give it a double meaning. Fill in the sense filling out the questionnaire, thus stopping to think about one's mobility and then entering to feel how to perceive one's mobility and its effects. On the first screen, the same one in which the experience title appears, horizontally scrolling lettering runs across the screen's background. One reads, "You are everything. Everything is you." and in the other, "What you do is what you are; what everyone does is what

Fig.49 - Interface and relative experience of the on-boarding questionnaire

the environment is." These two copies anticipate the content of the audiovisual installation and its ecological and pushing purposes. However, by keeping them in the background, they are not given too much relevance to the user.

The following screens are devoted to filling out the form. What guided the Design of these screens was the simplicity and intuitiveness of the interaction elements about the explicit requests. The choice was made to devote each screen solely to a task in a way that would make the experience as straightforward as possible, dedicating all the visual solids and voids of the screen to what the user needs to do without confusing the user. If, on the contrary, one had chosen to put all the questions on one screen, one would have run the risk of making the page too heavy, thus creating a sense of listlessness in the user to go through this experiential phase. The idea was to create a smooth and quick experience so the user would retain the rhythm of entering. Once the form responses are completed, and the email is entered, a final screen reminds the user that more information about the experience will be coming via email. As mentioned in the previous chapter, credentials will arrive in the email, a sort of password or password that will allow the user to access the experience. Instead, in the next chapter, we will look at the prototyping of the generative experience.

4.3.2 — Engineering an animated data visualization

This phase of the design experience was, without a shadow of a doubt, the most complex one to deal with in my dissertation journey. It can be traced back to personal choices that made this phase a time of technical and practical study rather than a simple visualization exercise. In a practical sense, this prototype could have been treated with low fidelity, going solely to create an animated representation of the imaginary data with after-effects. Instead, the more complicated route was chosen, thus that of building software capable of generating videos according to the data uploaded through an excel sheet. This was to be able to build a prototype with the highest possible level of fidelity. This choice was also made as a function of personal interest in learning more about the use of parametric and procedural design tools. *Generative Design* is an iterative process that involves the designer using software in which the parameters representing it can be modified by the designer in order to achieve a wide variation in the desired results.

The main difference between traditional design tools and generative Design is that instead of directly drawing the object, or in this case, the video, a series of instructions are drawn that lead the computer to produce the desired result. This methodology may be slower at first because it requires more advanced planning, but it brings incredible benefits. The greatest of all is to form a nondestructive sequence for Design. This means that if in the process leading to the production of the final object, one realizes that some elements of the initial stages might be varied, there is no need to start the production all over again but go and change the initial parameters and see the differences in the outputs. This methodology gives the designer complete freedom in producing a wide variety of different solutions, and most importantly, it allows the full use of the algorithmic potential for Design. It means using the computer as an essential tool for production and not as a means of imitating fundamental tools.
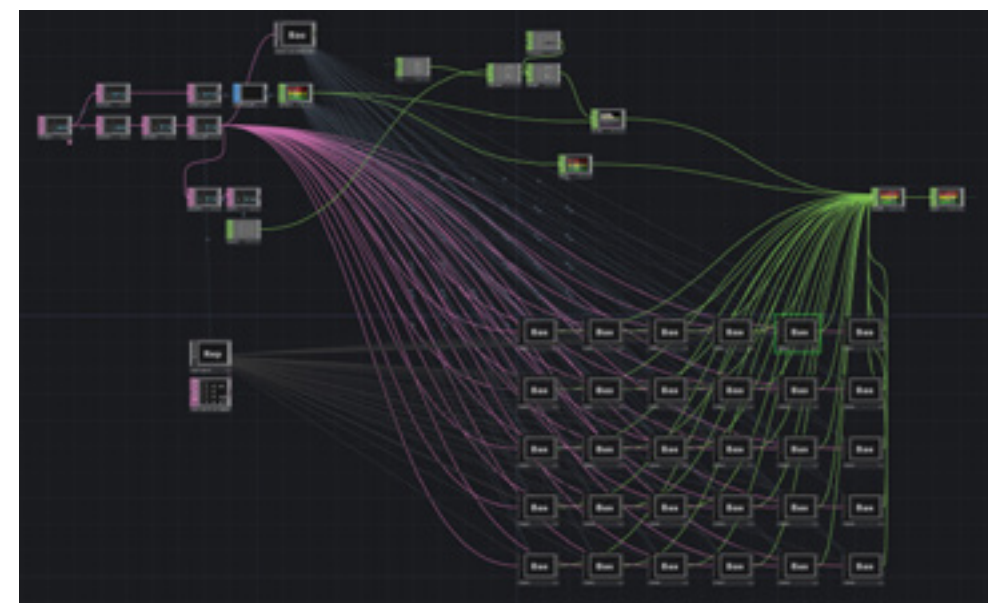
Fig.50 - Interface of TouchDesigner a software node-based to design audiovisual performances in real time.

Moving beyond this brief digression on the nature of generative Design, let us enter the process of prototyping the audiovisual experience. In the first instance, we devoted ourselves to the visual side of the experience, whose goal was to transform user data into animated graphics. The idea behind it (about the talk given on generative art in Chapter 3.3.2) was to create a graphical representation of a natural, organic pattern. To represent the set of habits of all participants in the experience. Moreover, the temporal dimension in this context is crucial to draw a habit. What distinguishes us from each other, if we consider a universal

habit among humans, such as mobility, is how and when we perform it. In mobility, the how is distinct from the transportation choice, whether it is related to active rather than public or motorized mobility, and the distance we cover. On the other hand, the when is represented by the times we perform it and how much each activity occupies our time. The five data requested from users are:

→ Means used
→ Kilometers traveled
→ Minutes spent traveling the route
→ Time of exit
→ Return time

With the last two items, it was assumed that in a routine, which may be more or less rigid, there are at least two moments, one of departure and one of return. It was intended to limit the volume of data collected to describe an experience as familiar as possible among the participants. The animation was then to represent this trend in an imaginary timeline showing the set of entities moving to leave in the morning and then return home in the evening. Each entity with an animation of a different duration becomes the raw representation of an individual's habit. The set of all animations unfolds the collective organism into its small parts. A graphic form was chosen that these entities could cover to represent this whole and concisely. If temporal data were going to define the moments of the animation, it was necessary to visualize what this animation was. Imagining the presence of real-time data of a person making the home-to-work commute, this can be visualized as a line completed on a zenith view of the referenced city. The outward journey shows the line crossing from point A to point B, while the return journey shows the line from point B to point A. If, in this real-time visualization, the shape of the line route is given by the geographic coordinates it crosses, in this context, a standard shape had to be found since that specific information is missing. However, how to translate these complex forms (the home-work routes) into a cohesive visualization representative of the collectivity of habits—with a formalist approach, going to emphasize shape, line, color, and perceptual aspects in general. Thus overturning the exclusively content-based nature of the installation and enhancing its formal aspect. From the outside, the mathematical or geometric concept has a transcendental aspect in the Kantian sense: form is a cognitive process, not an object, since the process must be possible a priori (Kant and Meiklejohn, 2017). Kant wants to explain not what is known but how knowledge occurs, that is, to define the theoretical presuppositions that make knowledge possible. Form as an opaque and productive symbol, which does not refer exclusively to pre-established meanings but produces new ones (Gal, 2015). Therefore, starting from elementary symbols and figures, the figure that was intuitively approached and proved to be appropriate is the circle. The circle has been well-known since before history began to be written down.

The wheel, along with related technologies like gears, is based on the circle and allows for much of today's means of transportation. The circle is the extension of the point, thus the manifestation of the characteristics of the individual. Delving deeper into the symbol of the circle, several meanings historically and culturally live in it: harmony, cycle and circularity, inclusion, and initiation. If for Jung, the circle is the self and the psyche (Jung and Hull, 1981); for Buddhism, it is the wheel of life in the phenomenal world, that is, the manifestation of the self in perceivable and sensible reality. These meanings suit the circle as well as the aspirations of the installation. Nevertheless, the circle symbolizes perfection, and not wanting to demand this from the habits of the installation participants is an assiduous search for nonexistent perfection. The circle was made irregular; the path it follows is circular but makes many slight irregular variations making it undulating.

If a circular animation of a line thus represents each routine, the set of all the different routines is represented by a set of circles. By exploiting the data on the length of the home-work route, this can be applied to the size of the circle itself, arriving at a visualization of concentric circles. The concentric circles manifest the totality of all manifestations, a unique view of the variety of each participant immersed in the collective. Going into the final details of the visual Design, the appearance to be given to the concentric lines was chosen. Since appearance is related to the data on the individual's chosen mode of transportation, the optimal course of action would have been to create a different visual style for each mode of transportation. However, reflecting on the nature of the installation, there was some interest in telling the weights of different choices on means of transportation, but without putting one in particular on the pedestal (the bicycle) or in hell (the car). So the various forms of transportation were divided into three macro categories: active mobility, mobility on public transportation, and mobility on motorized transportation. In this sense, a more generalist view of the different habits of visitors can be given by dividing them into these three groups. Therefore, three different visual aspects were intended to be created for these three groups. The line regarding active mobility was designed in green color, with a subtle and light trace, to remind the lightness of the impact these means have on the environment.

In contrast, the line of motorized vehicles represents the considerable impact these have on the ecosystem: thus, a thicker line, the color of the line red, and a black trail that expands from the line as it passes. Finally, the appearance of public transportation was taken care of, playing with a thickness that was somewhere in between the previous ones; the blue color also closer to the world of electricity since most public transportation is electrically powered, and a light blue wake. To engineer these reasonings into software capable of generating videos based on input data, another software was used: Touchdesigner. TouchDesigner is a node-based visual programming language for real-time

interactive multimedia content developed by Toronto-based Derivative. It has been used by artists, programmers, creative coders, software designers, and performers to create performances, installations, and stationary multimedia works. The environment is developed in Python, and within it is an extensive library of nodes that allow you to do different things. However, you can always write the functions you want from scratch in Python and apply them within the environment. Using this language has been a formative part of my thesis and design path—fewer difficulties in realizing this software's working prototype. However, in the following paragraphs, the procedure for its creation will be explained without dwelling on the snags.

Before programming began, a questionnaire simulating the participation form was made to collect a sample number of responses that could be used for visualization testing. Starting from the collected data, these were imported into Touchdesigner in TSV format to read as a table. Within Touchdesigner, we created a circle and managed its animation. Within the program, there is a timeline that can be modified in such a way as to make animations related to the duration of the timeline. Departure and return times collected from the questionnaire were converted into frames, pretending that the timeline's duration represents a full 24-hour day. It was then possible to attach a precise moment in the timeline to each time of departure or arrival. The animation was then performed using the trip duration collected with the questionnaire as the reference for the animation duration. The length was not converted to frames on the 24-hour timeline report because it would have made the animation too fast and empty for much of it, so it was reproportioned to the datum. Once the length of the animation and its timings were set, these were structured by so-called easing, that is, slowing down the speed of the animation at its two extremes (Fig.52). This first step allowed us to arrive at a complete forward and outward animation of the circle according to the two moments derived from the dataset. For the stylization and appearance then of the animation, the two data points of kilometers traveled, and the means of transportation used were used. While the kilometers data was normalized and linked directly to the circle size, the one related to means of transportation was processed more (Fig.51). A custom script was written with Python to recognize which category the means of transportation was part of and, based on the category, modify some values on the appearance of the rendered circle. As mentioned above, we will work on the line thickness of the circle, the rendering color, and the wake. In order to implement a wake, a feedback loop has been designed to precisely resume the animation of the circle in the duration of the animation, working with blur and transformation to have an aesthetically pleasing-looking wake (Fig.53). Finished coding these steps, the software could read a line of data and draw a single circle, but the interest was precisely in drawing them all together (Fig.54). A very interesting node within
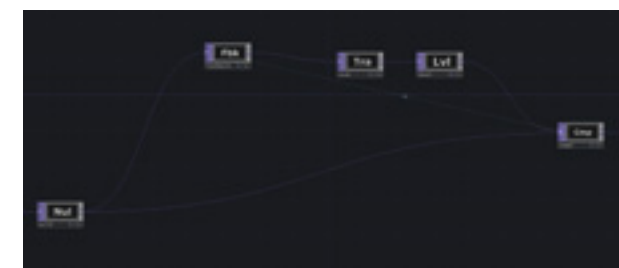
Fig.51, 52, 53, 54 - The nodes relatively to generate the circle animating, the temporal animation, the feedback loop and the whole circle animation.

Touchdesigner called *Replicator* was used to achieve this. This node allows one to replicate another node based on some predetermined data, even based on the size of a table. So the node to be replicated was a composition of all the previous steps, those for drawing an animated circle, and was replicated for each row in the table (Fig.55). A direct correlation was associated within the code between
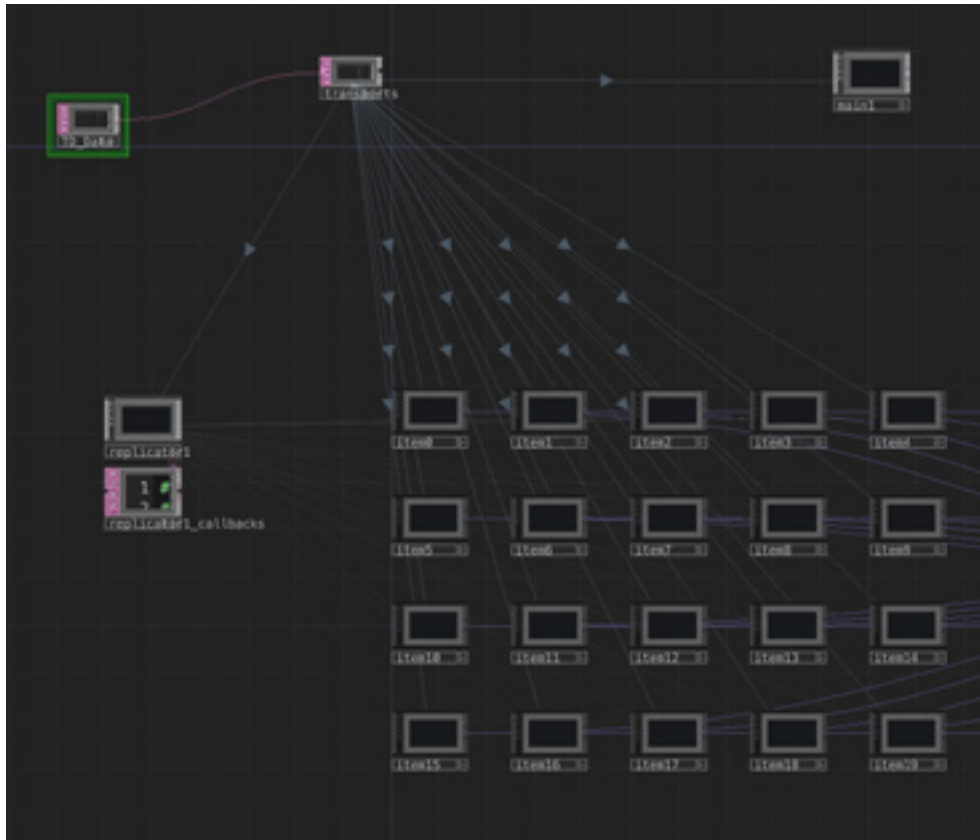
Fig.55 - Replication of the circle animation for each line of the database. Main1 is the parent node, replicated in all the item and child nodes.

the number of the row to be investigated and the name of the composition being replicated so that duplicates of the same animation would not be created.
At this point, the software prototype was completed by loading a table of data, and the software could generate the desired animation that, among other things, could run in a loop. The desire to loop with this animation was to have a video that could be replicated and adapted to situations and content of different formats and lengths but could potentially go on forever.

In the next chapter, we will see how audio, a critical sensory element for user immersion in the environment, was implemented.

↓(next pages) Fig.57 - Frames of the animation generated through the data of the testing questionnaire
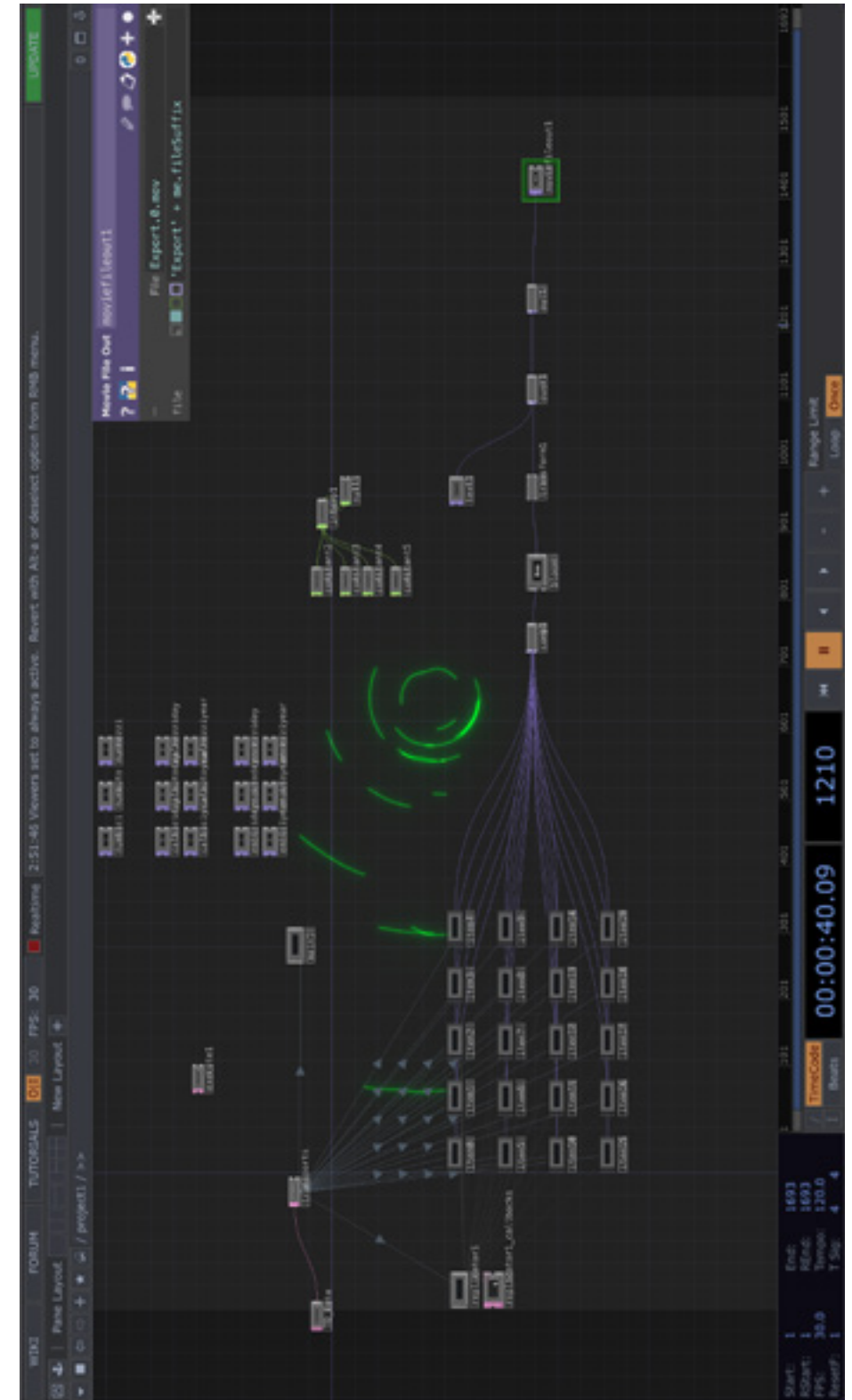
Fig.56 - Final look of the software ready for exporting the visuals.
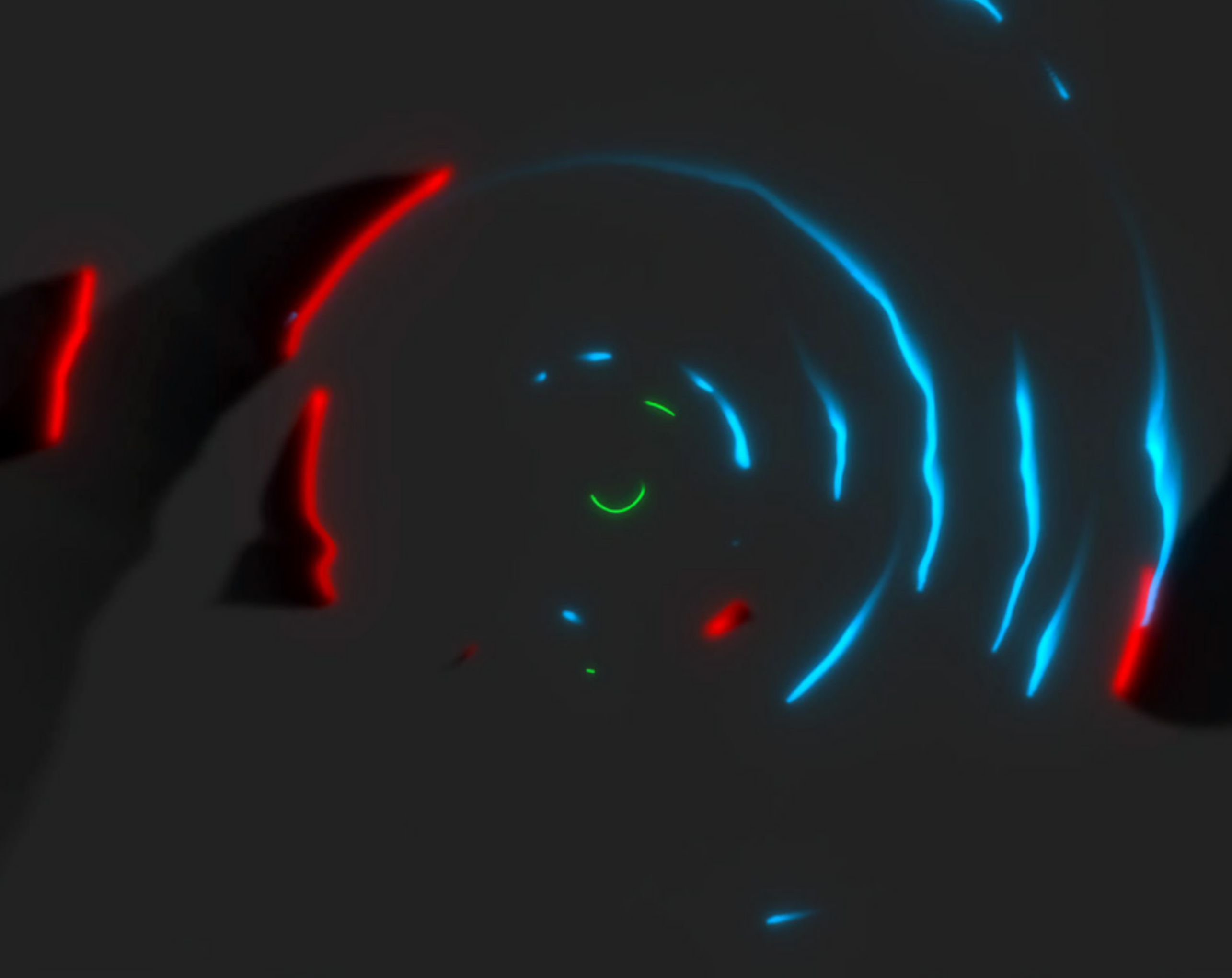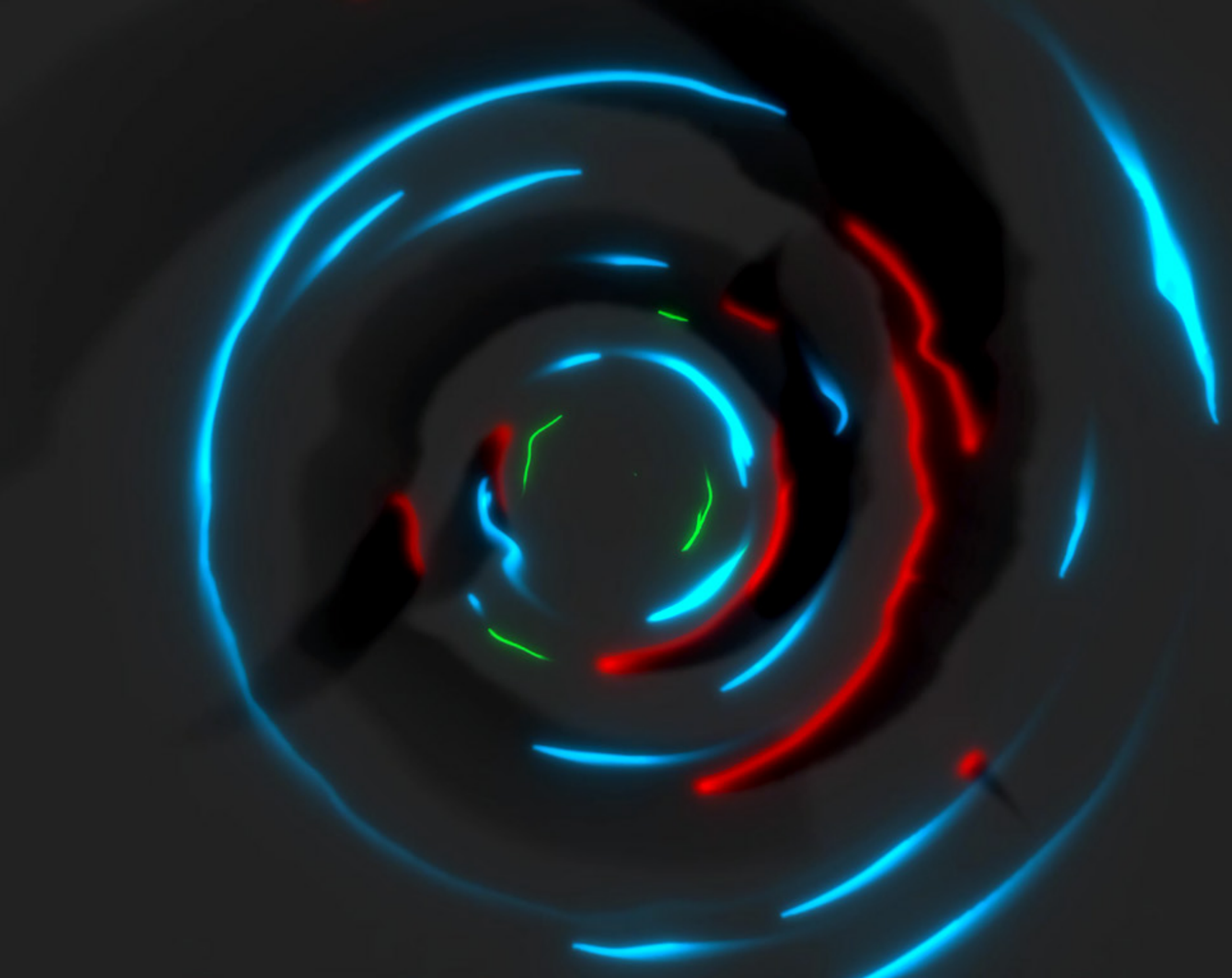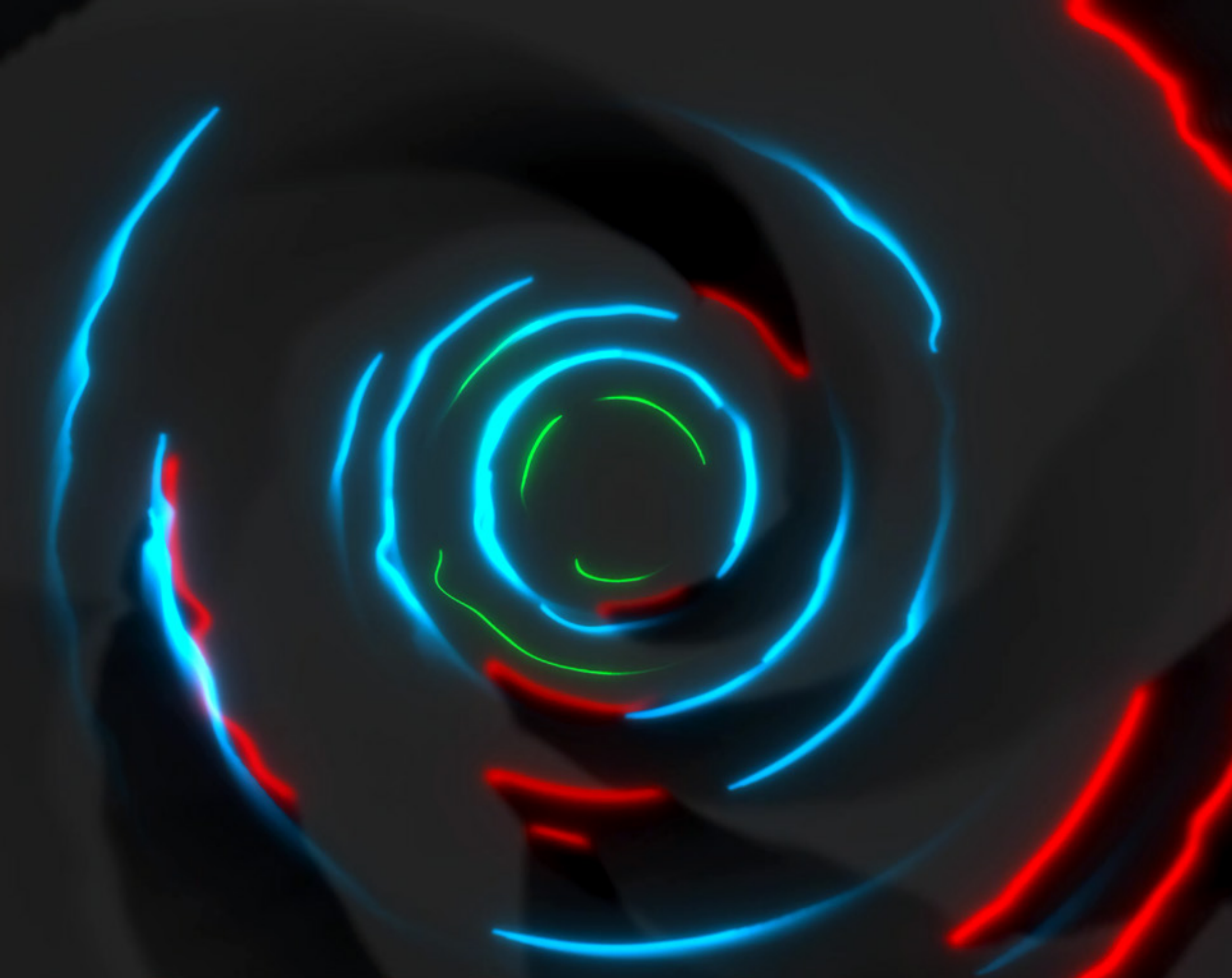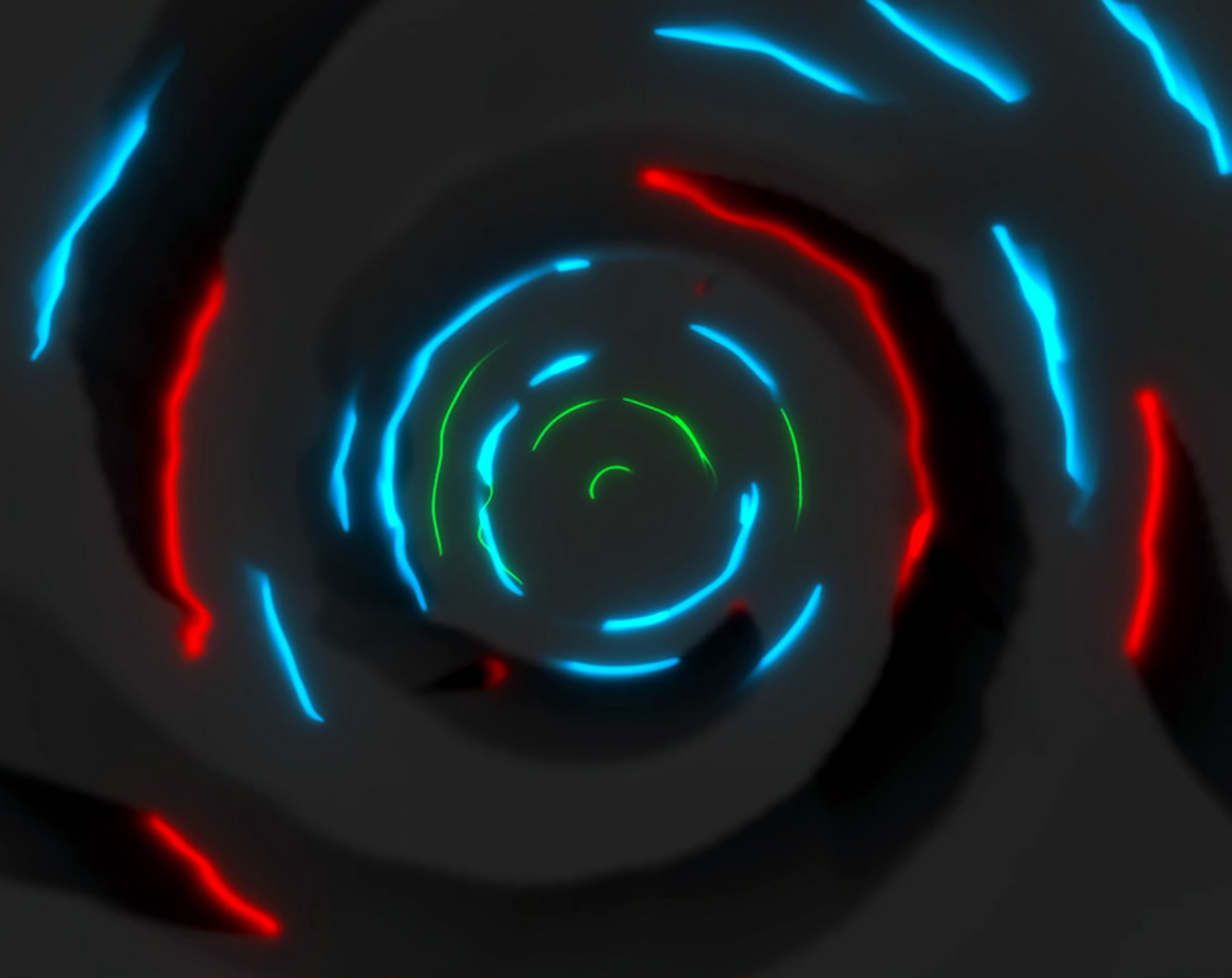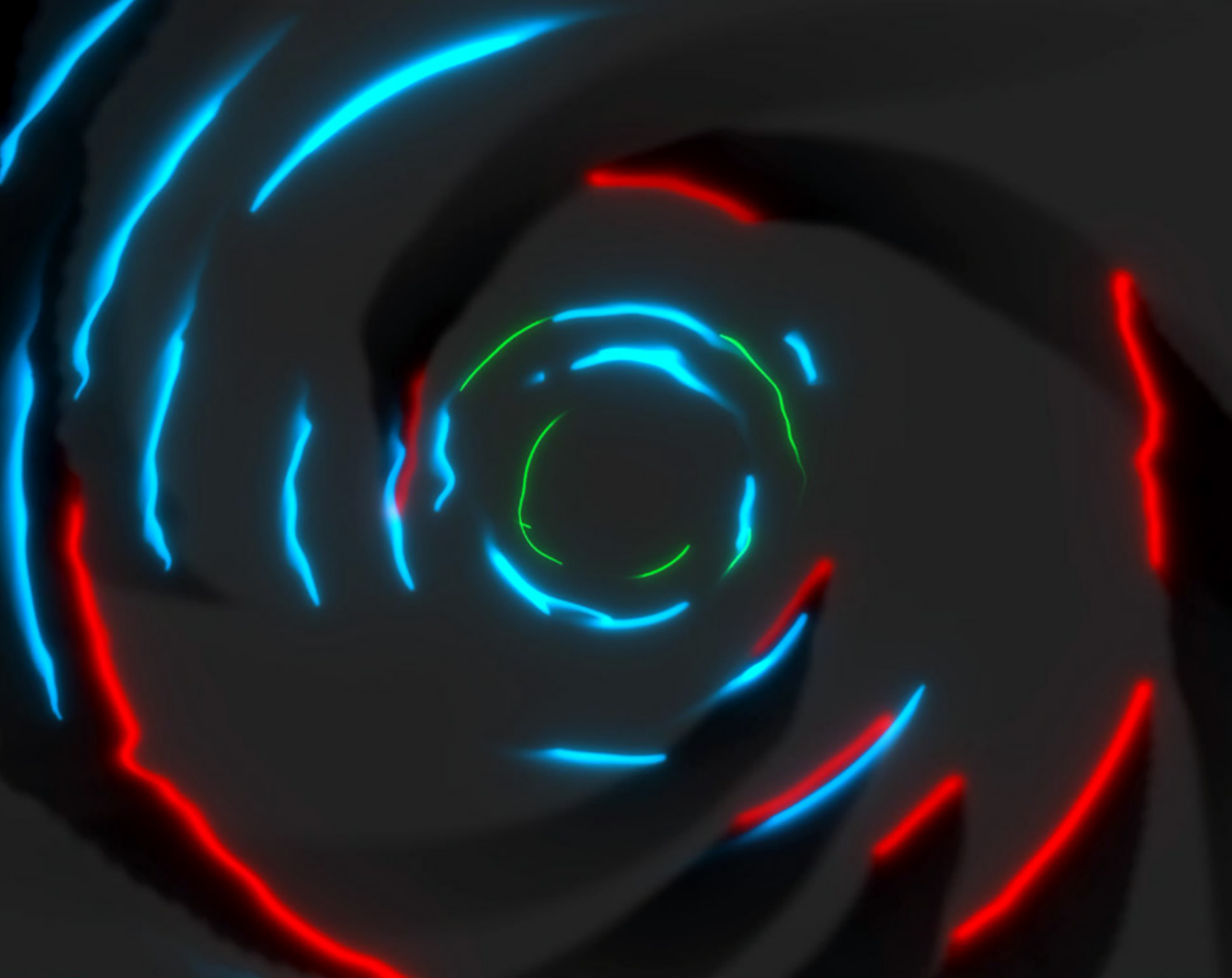
4.3.3 — Sound and the immersive environment

The sound of the installation followed an exciting process that we will open in this chapter and conclude in chapter 4.4.2. In fact, despite my great interest in music and on the use of audio effects (SFX) in multimedia content design, dealing with this topic with adequate technical seriousness was beyond my expertise. Therefore, I enlisted the help of a friend and musical artist who was able, expert, and willing to support this side of Design.

[The artist in question is named Michelangelo Petronella, who has been working on his pop singer-songwriter project "Adamøri" for the past three years, after years of musical activity in different bands, developing multi-instrumental and music composition skills as well as singing. For the "Adamøri" project, we formed a collaboration within which I had complete freedom in the visual communication of his music and artistic identity]

The idea behind prototyping the acoustic side of the experience was to represent the effect of noise pollution on mobility. In this sense, the utopian representation was that of the acoustic simulation once again of the community. Based on the questionnaire responses, we are then the generation of a musical background. Imagine a 3-axis graph in which we have an axis for motor vehicles, one for active vehicles, and another for public vehicles. The dot on this graph on the extreme of motor vehicles means that the users' responses determine that 100% of them use motor vehicles. The resulting audio should represent the noise pollution chaos produced by these vehicles. In contrast, on the extreme of active means, the spatial audio is a light background simulating an environment free of noise pollution. Playing on this graph, we can only have some of the three axes 100% as the sum of the percentages where the response on a given transportation category within the audience is present is the number of total responses. Based on this reasoning, several audio effects were collected related to the means of transportation in question. A folder of about 5 to 7 stock sounds was produced for each means of transportation available in the user questionnaire. With these items, several brainstorms were done with Michelangelo to understand how to apply the design idea to the experience and create a pleasant and engaging sound product for the installation user. The direction was finally set to create three "ambient" tracks that would represent the acoustic effect of the three transportation categories in the natural environment yet still maintain elements of musicality. Hypothetically as the animation was loopable, the tracks would also work in loops.

Furthermore, for the sake of catchiness, each track would have to be loopable over the other in such a way that they could be contemplated simultaneously. Finally, these would have been treated from a generative point of view in their presence, from the volume they would take on as a function of the data collected, making it so that in particular cases, the responses would lead to the absence of the volume of some tracks in favor of the others. Then we began to proceed in this direction in such a way as to construct the different parts of the total experience for the next testing phase. The completion of the audio and visual sides, for the possibilities that have been achieved in this thesis process, will be seen in the following chapter on testing, specifically in chapter 4.4.2.

4.3.4 — The Experience Follow-up

Once the prototyping of the first two phases of the experience was finished, we moved on to the follow-up phase. This is more related to education and raising awareness about the relationship between movement habits and personal and ecosystem health. From the data collected, it is possible to make an approximate count of each participant's emissions and roughly calculate the Calories consumed during movement. This information is helpful for awareness raising regarding the impact of a given collective versus individual data, as well as giving a quick representation of the effect of one's habits (Fig.58). The same data can be used to calculate hypothetical changes in participants' habits. Imagine the participants' change of means by shifting the bar to active mobility: in this way, the delta of emissions, savings, and calories consumed, extra physical activity, can be calculated (Fig.59). This way, a utopian model can be visualized and contrasted with a more realistic (albeit limited and approximate) one (Fig.60). These data can be interpreted from an individual and collective perspective, reinforcing the concept of an individual immersed in the collective, projecting a social and cohesive effect of one's habits. A narrative must be structured to accompany the reading of the data. For this motivation, a foldable was prototyped at first, a printed medium that, in the small booklet format, would help the visitor read and understand the data derived from the audiovisual experience. On a printed medium, the limits were self-imposed by the format. The one chosen is

of a foldable where one takes an A3 and divides it into eight equal parts through the folds to obtain an 8-sided booklet (including the cover) that, if opened to the bottom, hides a poster on the back.

Phisycal activity difference

Actual Scenario
2.800 KCal

Utopic Scenario
11.520 KCal

Pollution difference

Actual Scenario
66.450 Kg

Utopic Scenario
9620 Kg

Fig.59 - Comparison of actual scenario data with that of an utopic scenario.
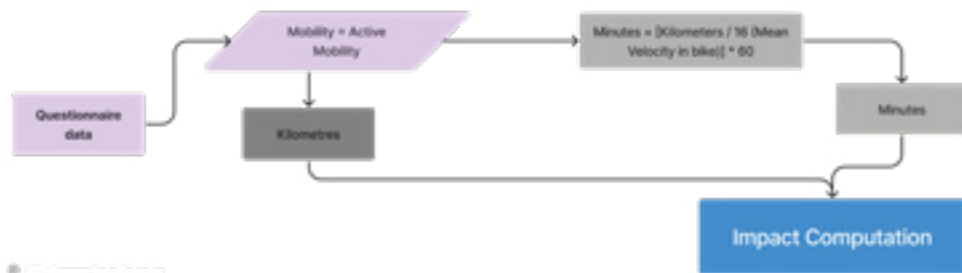
Fig.60 - Feell your mobility, impact computation for utopic variation.

This constituted a small booklet (Fig. 61), so it was reasoned from an editorial rudder—first-page cover, with data referring to the experience and title. The second is dedicated to introducing the project's goals and unveiling the installation's intent—the Third is an in-depth look at the data, first about emissions and then health. On the fifth page, an in-depth look at active mobility leads to the sixth and seventh, where the utopian comparison is made between emissions and physical activity. Finally, the back cover remained, which was thought to

Fig.58 - Feell your mobility, impact computation.

FEELL YOUR ROUTINE!

tribe

28 november 2022
Milano, Italy

What you do is what you are, what everyone does is what the environment is.

The goal of the audiovisual experience is to create a moment of common reflection on the topic of habits in the sphere of urban mobility.

Each of us more or less firmly develops habits about the ways we use to move from one part of the city to another. It is interesting to reflect on the impact these have on one's own life and the lives of others. From the collection of everyone's data, the installation offers a perceptual cue, a visual and auditory transposition of the habits of those around you.

Each of you is co-creating the experience.

57
partecipants divided in

- ACTIVE TRANSPORT - 8
- PUBLIC TRANSPORT - 33
- MOTORIZED TRANSPORT - 16

allocation

"It is so easy to overestimate the importance of one defining moment and underestimate the value of making small improvements on a daily basis."

James Clear

The modes of transportation that are used have a strong impact on the environment because of emissions: if we think that 7.46% of total greenhouse gas emissions in Europe come from short trips made by car (those of less than 5km).

In cities, these modes shape the environment even more: urban spaces are mostly devoted to car transit, noise pollution has become the "background music" of the city.

What shape could cities take if alternative forms of mobility were gradually adopted to a greater extent?

Yearly emission for each group (Kg of CO2)

public transport 31.851
motorized transport 34.492
active transport 298

368 — the kilograms of CO2 you emit while commuting during the year

Environment

How many emissions would you save a year if you switch to an active form of commuting (Kg of CO2)

292

How many emissions would be saved a year if everyone there switch to an active form of commuting (Kg of CO2)

57.014

31.851 KgCo2 — 34.492 KgCo2 — 298 KgCo2 — 9627 KgCo2

Current situation —————— Utopic situation

A more personal aspect on mobility is that of health. Data tell us how in the most industrialized countries there is a steady growth in physical inactivity. More and more young people and adults are suffering from it, leaving room for cardiovascular risks.

The choices we make to get around can contribute more or less to physical activity, and in some cases meet the minimum amount of cardio exercise to stay fit.

Mental health likewise is affected by the choices we make: getting stuck in traffic or other unpleasant experiences have an influence on our mood.

Kilo Calories you burn in a year while commuting

public transport 1.492
motorized transport 527
active transport 821

17

Health

How many calories will you burn in addition per year if you switch to an active form of commuting (KiloCalories)

74

How many calories will be burnt more per year if everybody switch to an active form of commuting (KiloCalories)

8640

1492 Kcal — 527 KCal — 991 KCal — 11,820 KCal

Current situation —————— Utopic situation

Active Mobility

Active mobility is that mode of travel that involves using one's own physical forces to move. The oldest are those of moving by walking or using a bicycle.

There are a flood of studies explaining how beneficial these modes of travel are for individuals who choose it, how the benefits far outweigh the risks that may occur.

Pursuing a more active style of mobility, as much as possible, is a choice that minimizes carbon emissions (as well as all other forms of pollution that revolve around the production and disposal of other means) and maximizes the amount of physical activity done.

Finally, also on the economic aspect: the relative costs are minimized for the individual person and for public institutions result in actual savings for medical expenses; having healthier people means a lower expenditure of resources in the long run.

Fig.61 - Unfolded leaflet containing all the content for each individual.

What you do
is what you are,

what everyone does
is what the environment is.

Fig.62 - Back poster of the unfolded leaflet.

leave room for a quote. The quotation was taken from James Clear's book "Atomic Habits," in which he analyzes the study of habits, trying to intrigue

"It is so easy to overestimate the importance of one defining moment and underestimate the value of making small improvements on a daily basis."

(Clear, 2018)

the visitor with a sense of control over the small choices in one's life.
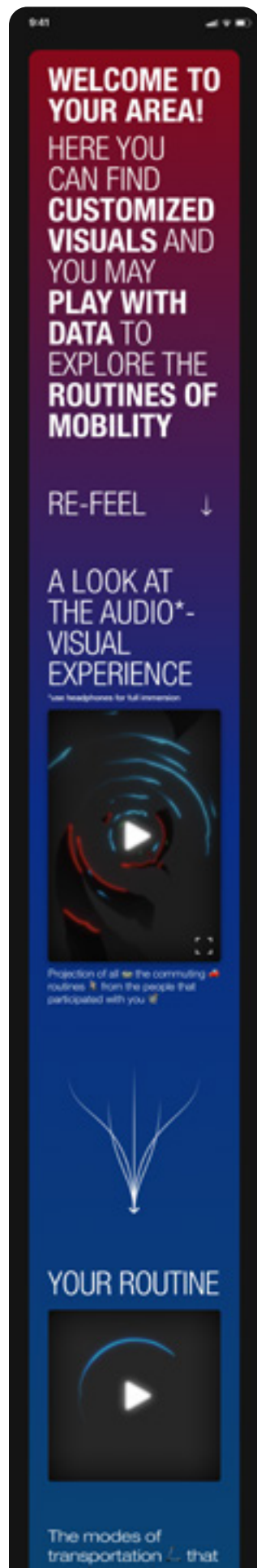On the back of the foldable, on the other hand, the choice went straight to using the generated background of the experience to create a poster. An instant of the data visualization was inserted, and the wording was added above it: "What you do is what you are; what everyone does is what the environment is." (Fig.62)

Although a sense of completeness was recognized in the information conveyed by the foldable, from an experiential point of view, it does not fully occupy the follow-up role. Because of the paper nature, this must necessarily be collected during the moment of the overall experience, limiting the duration of its long-term effect. Moreover, a foldable, however engaging the content may be, after reading it does not engage to the bitter end because of its paper nature. In contrast, a digital medium might reveal an interactive and informa-

tive nature. It was thus decided to repurpose the leaflet contents within a personal section of the web app designed for onboarding the experience. These were adapted into a fresher, digitally-related visual form, using different emojis to amplify the text's expressiveness and language familiar to the target audience. In addition to allowing the user to review the video of the experience, he or she can view an animation of his or her isolated routine and a utopian version of the routine (Fig.63).

Finally, to reinforce the concept of customization, a whole section has been created where the user can play with specific visualization parameters. With some sliders, the user can go to change the appearance of the lines of the means of transportation, for each category of means, up to even changing the shape of the track and making it oval, square or triangular. These commands allow him to create unique and original content (Fig.64), a user's expression of the collective set of data collected during his experience: his personal perception of the collective.
Finally, the user can download and make the images they have created. In addition to being a co-creator of the overall experience through his or her data and participation, he or she also becomes a co-creator and owner of a unique animated visualization representative of the concepts developed in the "Fell Your Routine" project. The creation of customized content is unique and can only be done once after each time the experience is performed. This not only stimulates a return to the experience in a future time to make a new display but also enhances the unique generative image of each visitor. This value is doubly rewarded by allowing him to use the images for any reason. To stimulate sharing on social media, users are invited to share by tagging the project pages and the relevant hashtags. One of the hashtags is intended to be unique to the session experienced by the participants in such a way that they can be found in

their expressions on social.

Once this prototyping session was over, we moved on to the testing phase, during which we wanted to explore the holistic effect of the different phases of the experience. The final design phase will be discussed in the next chapter.

→(and previous pages) Fig.63 - Personalized web-app alternative for the follow-up.

4.4 →
Testing

The last testing phase was devoted to evaluating and measuring the sensory experience, thus simulating the designed experience in reality and seeing if it approached the goal of stimulating the perception of the role of movement habits in the community and stimulating a change toward active mobility.

4.4.1 — Measure an aesthetic experience

As we said in Chapter 3.1.3, the complete form of the project would be that of a collective and participatory experience of an aesthetic/emotional, and educational nature. In the subsequent Design, elements of such an experience were conceived and prototyped. Although each part had its level of detail and fidelity, a prototype of the total experience could be assembled at medium fidelity. Testing could be carried out on the whole experience, involving about ten or so people in a workshop, and collectively simulate each individual's perception of the research issues. In these workshops, participants would experience a rough version of the onboarding and follow-up phases and as realistic a version as
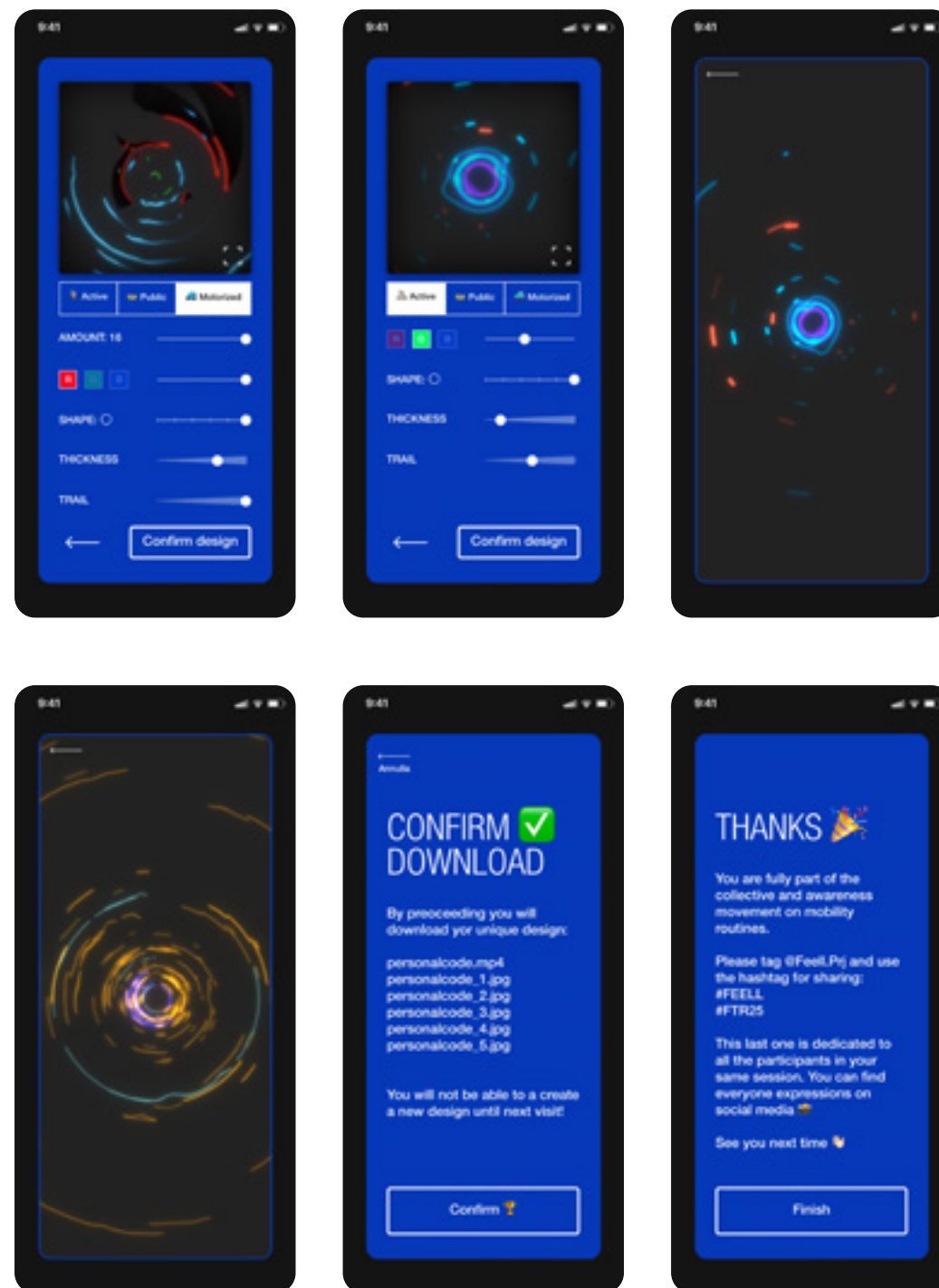

Fig.63 - Customization and download

possible for the central experience. They would then be asked to answer a series of questions to measure their perception of the experience, both from a content and aesthetic/emotional perspective. On the latter, it is handy for us to revisit the discussion of AESTHEMOS: the Aesthetic Emotions Scale (Schindler, I. et al. 2017). Based on theoretical accounts of aesthetic emotions and an extensive review of extant measures of aesthetic emotions within specific domains like music, literature, film, painting, advertisement, Design, and architecture, the AESTHEMOS is an assessment tool formed of a set of items, to study aesthetic emotions. So if we immediately have a set of questions helpful in measuring emotional experience, another set of questions on the teaching and awareness part had to be formulated from scratch. The AESTHEMOS questions are based on the Likert scale (1 to 5, where one does not agree and five completely agree). Questions are submitted to measure seven subcategories of aesthetic emotion: prototypical aesthetic emotion, epistemic aesthetic emotion, animation aesthetic emotion, nostalgia and relaxation aesthetic emotion, sadness aesthetic emotion, amusement aesthetic emotion, and negative aesthetic emotion. In order to maintain linearity in the questionnaire, additional questions on mindfulness were developed by facilitating responses always using the Likert scale.

A series of statements are then developed with which the users could have felt more or less in agreement at the end of the experience: on the relationship between mobility and the environment, between mobility and health, on the relationship with habits, on the perception of their impact on one's life and our surroundings, on the perception of climate emergency, and on the effectiveness of the experience itself.

Having conceived the questionnaire at the end of the workshop and understood that it would be submitted in a google form through a projected QR code, it remained to organize the workshop itself. Its planning and execution took about three weeks, allowing me time to make changes and produce the desired material. First, I needed to find a space to execute the workshop. Fortunately, I had the support of the polytechnic spaces in the ED-ME (Laboratory for Environmental Design and Multisensory Experiences) laboratory, which through the figure of Alessandro Ianniello (Ph.D. student in Design at the Politecnico di Milano) in the stead of Professor Mario Bisson hosted and made possible my workshop. Having identified a suitable date on Saturday, October 8, 2022, it was decided to schedule two workshop sessions in the afternoon involving a good ten people. Thus the onboarding phase was initiated and simplified at this stage through the creation of google questionnaires. It was necessary to break down the data by first asking participants to choose which workshop session they wanted to attend. Ten and nineteen volunteers showed up for the two sessions to try the experience, mainly friends and acquaintances interested in the project issues. With the data collected, the focus turned to content creation for the central part of the experience. As mentioned at the end of Chapter 4.3.3, some adjust-

Copy of the text overlays for the video

Imagine a utopian city, a city in which space is public
green spaces are everywhere
the sound around is pleasant
everything very light, is not stressful
the air is clean , it smells good
the city is alive
getting around is easy and safe, it is active

but the reality is different

your habits, your behaviors
shape the environment

all of your habits, are reflected here

Together each year you emit approx.
— Kg of CO2

— Kg on public transportation
— Kg on motor vehicles
— Kg on active vehicles

Your habits also affect you
your stress levels, your physical activity

Together each year you burn about
— Kilo Calories

— KCal on public transportation
— KCal on motor vehicles
— KCal on active means of transportation

Your answers, your habits
have shaped this environment

What you do, is what you are
what everyone does, is what the environment is

Can you imagine a different future?
Would you take part in utopia?

Fig.65 - Photographic report of the workshop session for the testing phase

ments were made to the prototype of the experience in order to adapt it to the actual testing. An initial version of the pure animation was exported. For the fruition of immersive space, the support of some writings would guide the visitor in understanding the multimedia content in its conceptual and pedagogical aspects. Given the lack of resources, these elements would be placed directly as an overlay on the animation to convey a direct message while keeping the animation looping in the background. The text was then written to serve as a visual content storyboard. It was chosen to set the duration of the experience at 5 minutes maximum so that it would not create content that was too heavy to digest but could simulate the lightness of the imagined experience. At this point, we return to the audio side of the experience. In writing the text to be placed

on the overlay, a dialogue was initiated about the storytelling of the experience built for testing; the audio side for this juncture could also have followed, indeed amplified, this dynamic. Together with Michelangelo, the structure of the text and audio was restructured in such a way as to go about building climaxes in the experience so that it could achieve maximum emotional engagement. This step was executed by playing on our sensitivity and ability to convey. The experience was structured as follows:

→　An initial phase transports me to an unreal world, a utopian world in which everyone moves by active means in the city. This emotional transport occurs through the cues derived from the text, the serene audio, and the data visualization that is precisely transposed to this scenario.

→　At a later time, the tone of the music changes, and one is brought back with one's feet on solid ground. The effects of moving habits on emissions and low physical activity are highlighted.

→　Finally, after a musical climax, there is a return to the initial calm in which an open-ended question is left asking those who are participating what their role is, encouraging them to critically thinking.

Following these three steps, the text and the soundtrack were structured, all on a series of 3 loops to encapsulate and synthesize the experience.
Having decided on these final parameters, data were collected from the different questionnaires, and videos were exported for each group to arrive at the workshop with all the material ready. On the follow-up side, it would have been challenging to have a satisfactory prototype for graphic customization and a customized digital medium. It was decided to go with custom-printed folders. Taking advantage of InDesign's ability to create copies of the same document
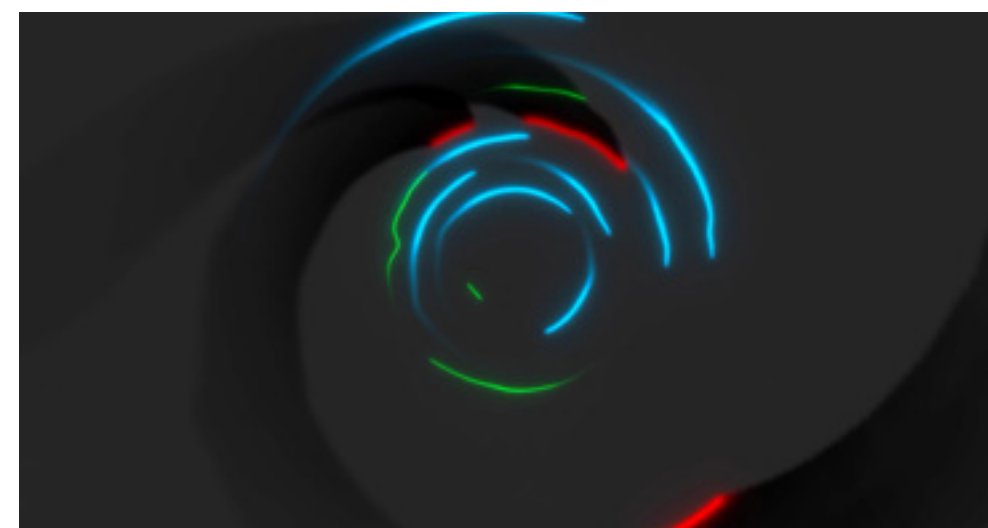
with different information by linking a data table, all the flyers were printed and then folded by hand, one for each person. Once all the materials were ready, it was possible to carry out the workshop, which, as mentioned before, was attended by about thirty people (Fig.65). It was a good time to share, and there was much feedback, both direct verbally and on Google forms. There was a broad interest in the data-related nature of animation. It was generally seen as an innovative engagement element and appreciated even by those from cultural backgrounds other than Design or art. The workshop session had as its output the test results that we will analyze in the following chapter.
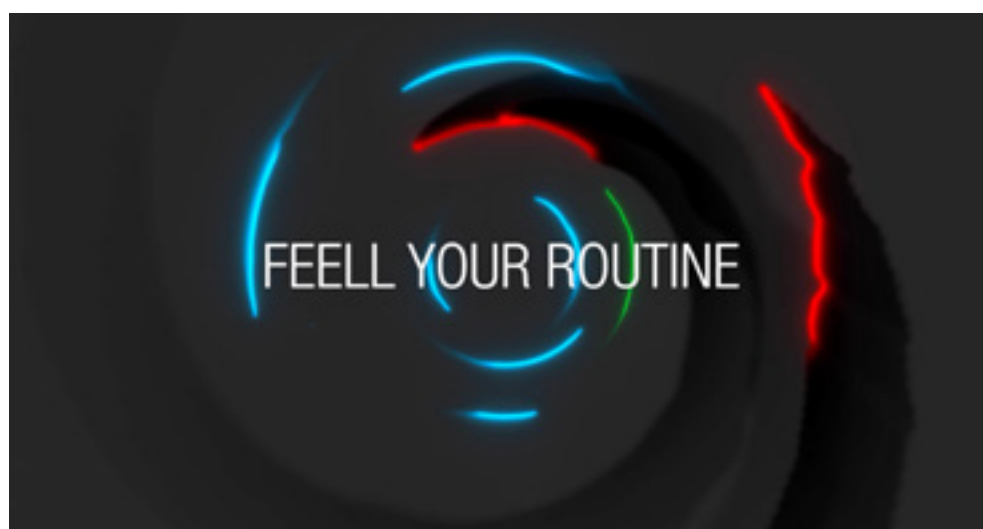
↑(and previous pages) Fig.66 - Frames of the visual used for the workshop, written in Italian because it was delivered to Italians

4.4.2 — Workshop results

At the end of the workshop, the results of the two sessions were collected. For convenience, they were called Group A, ten total participants, and Group B, 19 participants. As anticipated in the previous chapter, the participants were subjected at the end of the experience to an extensive test on their aesthetic/emotional experience and their opinion about the topics covered by the installation. The responses to the questionnaire were measured and studied individually. Although this was not intended, the two workshop sessions had different attendance, the second about twice as high as the first, so studying the data separately might have revealed differences in perception depending on the number of people present.

Beginning with the first part of the questionnaire, we analyze the results of the AESTHEMOS, using the notions for studying it described by Ines Schindler's team in her paper (Schindler et al., 2017). The 42 questions in the questionnaire were constructed by segmenting into 21 categories that have been scientifically encapsulated into five categories, even though the world of emotions is difficult to delimit and a precise definition is still far away.

→ **Prototypical Emotions:** All emotions with positive valence and which are therefore considered pleasant. Within this group, we also find those emotions that determine aesthetic appreciation regardless of its pleasantness. Within, we find six categories:
  → The feeling of beauty/liking
  → Fascination
  → Being moved
  → Awe
  → Enchantment
  → Nostalgia
→ **Pleasing Emotions:** All emotions with a positive valence are therefore considered pleasant. Within this group, we find:
  → Joy
  → Humour
  → Vitality
  → Energy
  → Relaxation
→ **Epistemic Emotions:** The set of emotions related to searching and finding meaning during aesthetic experiences. Within it, we can identify the following:
  → Surprise
  → Interest

→   Intellectual Challenge

→   Insight

→ **Negative Emotions:** unpleasant emotions contribute to a negative evaluation of aesthetic merit. Within this category, we find:

    →   Feeling of ugliness

    →   Boredom

    →   Confusion

    →   Anger

    →   Uneasiness

    →   Sadness (about these last emotion, it may be described as a category per se because often sadness may lead to positive outcomes inside one's personal experience so that it may be analyzed differently)

Based on the different emotions, the questions were posed as statements to be answered with a level of agreement from 1 (not at all agree) to 5 (completely agree). For the analysis of the results, the value of each response was then taken, and the value that came out for each question was averaged. Then since each emotion is related to two questions, the averages for each question per emotion were summed to get a value that could describe on a scale from 2 to 10 (2 since on the Likert scale, the minimum value to be entered was 1).

As for group A, the emotions found on average with a high level of intensity (above 8) were: Interest (8.8), Feeling of beauty/liking (8.2), and Intellectual Challenge (8.1). Two emotions with epistemic character and one prototypical.

Emotions found with medium to high intensity (6 to 8), on the other hand, were Joy (6.7), Relaxation (6.7), Insight (6.7), Vitality (6.4), Energy (6.2), Surprise (6.1), and Fascination (6.1). In this case, four pleasant emotions, two epistemic emotions, and one prototypical emotion.

The emotions with medium to low intensity (i.e., 4 to 6) were as follows: Enchantment (5.7), Being Moved (5.4), Awe (4.9), Uneasiness (4.8), and Sadness (4.2). Three from the group of prototypical emotions and the last two of the negative emotions.

Finally, the emotions experienced with low intensity (2 to 4) to almost zero were: Nostalgia (3.9), Confusion (3.8), Anger(3.5), Humor (3.3), Boredom (2.6), and Ugliness (2.2). Those lasts were almost all negative emotions apart from one coming from the prototypical emotions and another from the pleasant ones.

On the other hand, as for group B, the data collected can be similar, although more intense. Let us analyze them in detail. Emotions with high intensity (8 and up): Interest (9.1) and Feeling of beauty/liking (9.1). Emotions with medium-high intensity: Fascination (7.8), Intellectual Challenge (7.7), Joy (6.9), Energy (6.6), Relaxation (6.6), Vitality (6.5), Enchantment (6.5), and Sadness (6.1). Emotions with medium to low intensity (4 to 6): Being Moved (5.9), Insight (5.7), Nostalgia

(5.3), Surprise (5.3), Awe(5.2), Uneasiness (5), Humor (4). Finally, Low-intensity Emotions (2 to 4): Anger (3.8), Confusion (3.5), Boredom (2.5), and feeling of ugliness (2.2).

Comparing the results of the two tests, it can be seen that generally, the pattern of responses was similar between the two groups, that the most intensely perceived emotions were Beauty and Interest, which enhances the project in its goals. It can be seen that for prototypical emotions, the larger group generally demonstrated greater intensity, especially concerning Fascination and Nostalgia. Were emotions of this type amplified by the experience in a larger group? In contrast, in the small group, epistemic emotions were generally found to be more intense, especially on Surprise and Insight: do small groups promote greater mental involvement than large groups? Finally, a few words should be spent on sadness, as it was experienced significantly more intensely in the second, larger group. Having more people nearby reflecting on this issue and viewing a larger collective sample increases an overall sense of sadness.

These results proved interesting because they showed how people who participated in the workshop experienced the experience emotionally and aesthetically. What kind of reactions occurred in their subconscious, and how they manifested themselves in different emotions? Pleasantly, the emotions of interest and pleasure towards the experience were the most intense, as opposed to the negative ones, which were significantly lower.

At this point, let us analyze the questions about the content of the experience instead. In general, statements were made to which again the participants responded with a Likert scale of 1 to 5. Analyzing the results of the questions, one can see that regarding the topic of mobility, there is a reasonable awareness of its general importance and how personal mobility influences emissions and one's health, both physically and mentally. Similarly, there is good agreement on the statements made regarding habits and their general impact. Regarding climate change, ecology and sustainability: in general, the topic is perceived as necessary for their future. They realize that a change must be made in two directions simultaneously, both on the institutional and cultural sides. They do not feel utterly powerless towards climate change. They want to make their own contribution towards sustainable change even if, at the same time, they are still determining about giving their views on sustainability.

Finally, feedback was asked about the experience itself, which was positive: participants felt that the customized materials helped them understand interconnected habits and a collective experience, which helped them empathize more.
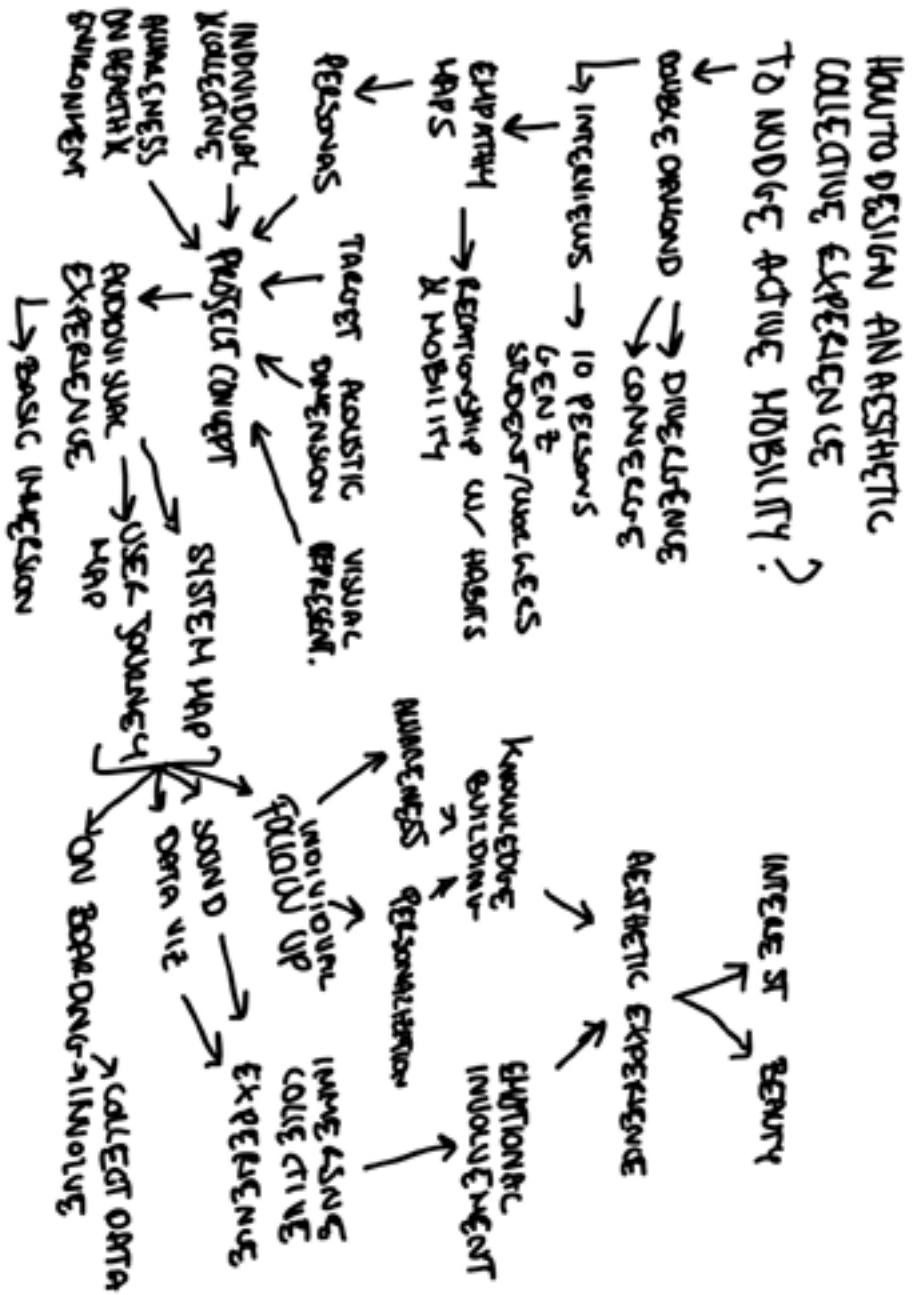
Fig.67 - Chapther synthesis based on the fourth research question

CHAPTER 5

CONCLUSION

The research project was finalized by prototyping a collective experience of an aesthetic-emotional nature. A program capable of generating a generative video of travel habits flanked by immersive sound was developed. The experience, with its beginning and follow-up parts included, aimed to encourage sustainable habits so that personal and collective lifestyle benefits would manifest. This is because active mobility sharply cuts transportation-related costs and emissions and provides a free moment of exercise. In the testing conducted during an ad hoc workshop organized at the Politecnico di Milano, the 30 participants experienced a rough version of the onboarding and follow-up phases and as realistic a version of the central experience as possible.

For this reason, the most indicative results came from the analysis of emotional perception, carried out according to the liker scale questionnaire model "Aesthemos." Generally, emotions of interest and appreciation toward the experience were the most intense, compared to negative emotions, which were significantly lower. However, the workshop was performed in two sessions of 10 and 20 people. In the larger group, prototypical emotions, especially fascination and nostalgia, were most intense. In contrast, epistemic ones were more intense in the small group. Is it possible that the size of the group experiencing the experience influences the different perceived emotions? This and other questions that could be cascaded from the same could become the stimulus for further investigation. In this sense, further development of this research could be addressed by increasing the number of tests performed on different sample sizes and contexts. Thus initiating a social survey to investigate active mobility. Advanced tools such as face tracking and possible emotion recognition could be used to refine feedback on emotional perception. In this direction, the prototype needs some revisions to make the experience as smooth and verisimilar as possible, possibly incorporating the development of the early and late stages.

In general, the group that participated in the workshop was interested in climate change, ecology, and sustainability: perceiving these issues as influential on their future. Since these results reflected the expectations of the Gen-Z target group, another survey could delve into the perceptions of other age groups by deepening the scope of social mapping.

Participants generally liked the experience and felt that the customized materials helped them understand the role of their habits. Some participants indicated they wished they had more awareness of how to read the graphics they saw, as the link between the colored trails in a circular motion and movement habits are not directly made explicit. In this sense, one could provide clues in the onboarding phase and investigate how to make the intellectual understanding of the visual stimulus more direct. For the same goal, one could investigate the inclusion of other elements in the immersive environment. On the other hand, as for the follow-up of the experience, the personalization interaction could be investigated further to make it easier for individuals to express their perspective on sustainability.

Through the honest contribution of each one data, deriving from an autonalysis of own habits, in *Feell your mobility* become possible to feel the impact and underlining motives of the mobility system, from both an individual and collective point of view. For the role that habits and data have, in future researches may also be deepened the field of data ethics, as a tool for understanding the power and principles of it, to use data as a tool for citizien empowerment, active participation and civic engagement.

In this final form, the study took the name of *"Feell your mobility,"* an intentional misnomer derived from the crasis of the terms *Fill* and *Feel*. This union in the name contains the inner meanings of the installation.

This research project could be deepened to create a replicable generative model that uses a projector and sound system to enable anyone to organize immersive experiences. Particularly in-depth work could lead to the search for customizable models that allow the same concepts to be applied to other habits and thus provide a social economy tool powered by society for society, for the planet, and each of us.

BIBLIOGRAPHY

AINSWORTH, B.E. *et al.* (1993) "Compendium of Physical Activities: classification of energy costs of human physical activities," *Medicine &Amp; Science in Sports &Amp; Exercise*, 25(1), pp. 71–80. Available at: https://doi.org/10.1249/00005768-199301000-00011.

Air pollutions sources and Health impacts of air pollution (2021). Available at: https://www.eea.europa.eu/themes/air (Accessed: November 10, 2022).

Alexander, V. (2017) *Sociology of the Arts: Exploring Fine and Popular Forms.* Wiley-Blackwell.

Anderson, M.L., Lu, F. and Yang, J. (2019) "Physical activity and weight following car ownership in Beijing, China: quasi-experimental cross sectional study," *BMJ*, p. l6491. Available at: https://doi.org/10.1136/bmj.l6491.

Arbab, P. *et al.* (2022) "Active Mobility as a Response to Physical Inactivity in Cities," *SHAPING URBAN CHANGE – Livable City Regions for the 21st Century*, 25th International Conference on Urban Development.

Asemi, A. and Tahaei, H. (2022) "Non-empirical ISO 9241-210:2019-based usability evaluation using fuzzy inference analyser: a special issue oninteractive social robots," *Library Hi Tech*, 40(4), pp. 976–993. Available at: https://doi.org/10.1108/lht-02-2022-0091.

ATA Associazione traffico e ambiente (no date) *Pedibus*. Available at: https://pedibus.ch/it/.

B., L. (2018) *Durham's Plan to 'Nudge' Drivers Out of Cars*. Available at: https://www.bloomberg.com/tosv2.html?vid=&uuid=39c5ba98-6da3-11ed-b04c-65417a585649&url=L25ld3MvYXJoaWNsZXMvMjAxOC0xMCozMC9k-dXJoYW0tcy0xLW1pbGxpb24tcGxhbi1oby1udWRnZS1kcml2ZXJzLW91dC-1vZi1jYXJz.

Basner, M. *et al.* (2014) "Auditory and non-auditory effects of noise on health," *The Lancet*, 383(9925), pp. 1325–1332. Available at: https://doi.org/10.1016/s0140-6736(13)61613-x.

Beck, J. and Beck, A. (2020) *Cognitive Behavior Therapy: Basics and Beyond*. Third. The Guilford Press.

Brand, C. *et al.* (2021) "The climate change mitigation impacts of active travel: Evidence from a longitudinal panel study in seven European cities," *Global Environmental Change*, 67, p. 102224. Available at: https://doi.org/10.1016/j.gloenvcha.2021.102224.

Brussels - A Noisy City (no date). Available at: https://noisy-city.jetpack.ai/.

Cao, X., Handy, S.L. and Mokhtarian, P.L. (2006) "The Influences of the Built Environment and Residential Self-Selection on Pedestrian Behavior: Evidence from Austin, TX," *Transportation*, 33(1), pp. 1–20. Available at: https://doi.org/10.1007/s11116-005-7027-2.

Celis-Morales, C.A. *et al.* (2017) "Association between active commuting and incident cardiovascular disease, cancer, and mortality: prospective cohort study," *BMJ*, p. j1456. Available at: https://doi.org/10.1136/bmj.j1456.

Clear, J. (2018) *Atomic habits : An easy & proven way to build good habits & break bad ones* [Paperback]. Avery Publishing Group.

Csíkszentmihályi, M. and Rathunde, K. (1993) *The measurement of flow in everyday life: Towards a theory of emergent motivation*. University of Nebraska Press.

David Herlihy (2005) "Bicycle: the history," *Choice Reviews Online*, 42(10), pp. 42–5825. Available at: https://doi.org/10.5860/choice.42-5825.

European Environment Agency (2019) *Greenhouse gas emissions from transport in Europe*. Available at: https://www.eea.europa.eu/ims (Accessed: November 15, 2022).

Fishman, E. (2016) "Cycling as transport," *Transport Reviews*, 36.

Forlizzi, J. (2018) "Moving beyond user-centered design," *Interactions*, 25(5), pp. 22–23. Available at: https://doi.org/10.1145/3239558.

Forrester, J.W. (1994) "System dynamics, systems thinking, and soft OR," *System Dynamics Review*, 10(2–3), pp. 245–256. Available at: https://doi.org/10.1002/sdr.4260100211.

Forsyth, A. and Krizek, K.J. (2010) "Promoting Walking and Bicycling: Assessing the Evidence to Assist Planners," *Built Environment*, 36(4), pp. 429–446. Available at: https://doi.org/10.2148/benv.36.4.429.

Gal, M. (2015) *Aestheticism: Deep Formalism and the Emergence of Modernist Aesthetics (Natur, Wissenschaft und die Künste / Nature, Science and the Arts / Nature, Science et les Arts)*. New. Peter Lang AG, Internationaler Verlag der Wissenschaften.

Gehl, J. and Rogers, L.R. (2010) *Cities for People*. Illustrated. Island Press.

Gli spostamenti sul territorio prima del Covid-19 (2020). Available at: https://www.istat.it/it/archivio/242574 (Accessed: November 10, 2022).

Goleman, D. (2010) *Ecological intelligence: how knowing the hidden impacts of what we buy can change everything*. Currency.

Gordon-Larsen, P. *et al.* (2009) "Active Commuting and Cardiovascular Disease Risk," *Archives of Internal Medicine*, 169(13), p. 1216. Available at: https://doi.org/10.1001/archinternmed.2009.163.

Gössling, S. (2020) "Why cities need to take road space from cars - and how this could be done," *Journal of Urban Design*, 25(4), pp. 443–448. Available at: https://doi.org/10.1080/13574809.2020.1727318.

Green, C. (2022) *Thinking in Systems, A primer, Donella H. Meadows*. Donella H. Meadows.

Grindlay, A.L. (2021) "Sustainable mobility and Urban space quality: The case of Granada, Spain," *Transport Journal*, 4(5), pp. 309–326.

Groves, M. and Griggs, G. (2014) "Riding in the shadows: The reaction of the British print media to Chris Froome's victory in the 2013 Tour de France," *International Review for the Sociology of Sport*, 51(4), pp. 428–445. Available at: https://doi.org/10.1177/1012690214534848.

Harper, I.H.H. and Husted (2010) "The Life and Work of Susan B. Anthony:

Including Public Addresses, Her Own Letters and Many from Her Contemporaries During Fifty Years," *A Story of the Evolution of the Status of Women*., 2. Herlihy, D., V. (2006) *Bicycle: The History*. New edition. Yale University Press.

IDEO Design Thinking (2018). Available at: https://designthinking.ideo.com/.

If, S. (2020) *Society Centered Design*. Available at: https://societycentered.design/.

Italy Physical Activity Factsheet (2021). Available at: https://www.euro.who.int/__data/assets/pdf_file/0006/288267/ITALY-Physical-Activity-Factsheet.pdf.

Jung, C. and Hull, R.F.C. (1981) *The Archetypes and The Collective Unconscious (Collected Works of C.G. Jung Vol.9 Part 1) (Collected Works of C.G. Jung, 10)*. 2nd ed.

Princeton University Press.

Kamel, M.B., Sayed, T. and Bigazzi, A. (2020) "A composite zonal index for biking attractiveness and safety," *Accident Analysis &Amp; Prevention*, 137, p. 105439. Available at: https://doi.org/10.1016/j.aap.2020.105439.

KAMPHUIS, M.H. *et al.* (2007) "Physical Inactivity, Depression, and Risk of Cardiovascular Mortality," *Medicine &Amp; Science in Sports &Amp; Exercise*, 39(10), pp. 1693–1699. Available at: https://doi.org/10.1249/mss.0b013e3180f6109f.

Kant, I. and Meiklejohn, J. (2017) *The Critique of Pure Reason (Classic Philosophy)*. CreateSpace Independent Publishing Platform.

Kelly, P. *et al.* (2014) "Systematic review and meta-analysis of reduction in all-cause mortality from walking and cycling and shape of dose response relationship," *International Journal of Behavioral Nutrition and Physical Activity*, 11(1). Available at: https://doi.org/10.1186/s12966-014-0132-x.

Khan, K.M. (2009) "Mid-year review: physical inactivity universally accepted as the biggest public health problem of the 21st century, shoulder exam challenges, and progress against the scourges of anterior knee pain and ACL injuries," *British Journal of Sports Medicine*, 43(7), pp. 469–470. Available at: https://doi.org/10.1136/bjsm.2009.062794.

Knapp, J., Zeratsky, J. and Kowitz, B. (2016) *Sprint: How to Solve Big Problems and Test New Ideas in Just Five Days*. Illustrated. Simon & Schuster.

Koblin, A. (2011) "Visualizing ourselves ... with crowd-sourced data," *TED Talks*. Available at: https://www.ted.com/talks/aaron_koblin_visualizing_ourselves_with_crowd_sourced_data/.

Kohl, H.W. *et al.* (2012) "The pandemic of physical inactivity: global action for public health," *The Lancet*, 380(9838), pp. 294–305. Available at: https://doi.org/10.1016/s0140-6736(12)60898-8.

Krueger, M. (1977) *Responsive Environments*. University of Winsconsin Press.

Kuran, T. (1998) "Ethnic Norms And Their Transformation Through Reputational Cascades," *The Journal of Legal Studies*, 27(S2), pp. 623–659. Available at: https://doi.org/10.1086/468038.

Lembke, A. (2021) *Dopamine Nation: Finding Balance in the Age of Indulgence*. Dutton, Penguin Publishing Group.

Lolli, S. *et al.* (2020) "Impact of meteorological conditions and air pollution on COVID-19 pandemic transmission in Italy," *Scientific Reports*, 10(1). Available at: https://doi.org/10.1038/s41598-020-73197-8.

Manzini, E. and Coad, R. (2015) *Design, When Everybody Designs: An Introduction to Design for Social Innovation (Design Thinking, Design Theory)*. The MIT Press.

Manzini, E. and Pais, I. (2021) *Abitare la prossimità: Idee per la città dei 15 minuti (Italian Edition)*. Egea.

Markvica, K. *et al.* (2020) "Promoting active mobility behavior by addressing information target groups: The case of Austria," *Journal of Transport Geography*, 83, p. 102664. Available at: https://doi.org/10.1016/j.jtrangeo.2020.102664.

McCandless, D. (2010) "The beauty of data visualization," *TED Talks*. Available at: https://www.ted.com/talks/david_mccandless_the_beauty_of_data_visualization.

McClanahan, L.G. (2013) "The Greening of the Language Arts: Considering Sustainability Outside of the Science Classroom," *Western Washington University* [Preprint].

Meadows and Wright, D. (2008) *Thinking in Systems: A Primer.*

Miller, D.L. (1959) "John Dewey in Perspective," *The Journal of Higher Education*, 30(9), pp. 505–506. Available at: https://doi.org/10.1080/00221546.1959.11777503.

Mobility Strategy and Action Plan, (2021). Available at: https://transport.ec.europa.eu/system/files/2021-04/2021-mobility-strategy-and-action-plan.pdf (Accessed: November 15, 2022).

Monro, G. (2009) "Emergence and Generative Art," *Leonardo*, 42(5), pp. 476–477. Available at: https://doi.org/10.1162/leon.2009.42.5.476.

Mount, A.L. (2012) *Participation, Hosting And Mimesis: The Double Being.*

Muller, L., Edmonds, E. and Connell, M. (2006) "Living laboratories for interactive art," *CoDesign*, 2(4), pp. 195–207. Available at: https://doi.org/10.1080/15710880601008109.

Münzel, T., Sørensen, M. and Daiber, A. (2021) "Transportation noise pollution and cardiovascular disease," *Nature Reviews Cardiology*, 18(9), pp. 619–636. Available at: https://doi.org/10.1038/s41569-021-00532-5.

Murphy, E. and King, E.A. (2014) "Environmental Noise and Health, Environmental Noise Pollution," *Elsevier* [Preprint].

Newman, P. and Kenworthy, J. (1999) "Sustainability and Cities. Overcoming Automobile Dependence," *Washington D.C.: Island Press.*

Participatory art (2016). Available at: https://www.tate.org.uk/art/art-terms/p/participatory-art.

Passenger mobility statistics (2019). Available at: https://ec.europa.eu/eurostat.

Pautad, J. *et al.* (2021) "Impacts of the COVID-19 lockdown on air pollution at regional and urban background sites in northern Italy.," *Atmos. Chem. Phys.*, 21(10), pp. 7597–7609.

Pisoni, E., Christidis, P. and Navajas Cawood, E. (2022) "Active mobility versus motorized transport? User choices and benefits for the society," *Science of the Total Environment*, 806, p. 150627. Available at: https://doi.org/10.1016/j.scitotenv.2021.150627.

Ravazzoli, E. and Torricelli, G.P. (2017b) "Urban mobility and public space. A challenge for the sustainable liveable city of the future," *The Journal of Public Space*, 2(2), pp. 37–53.

Rhamachandra, G. [Madhav G. and Madhav, G. [Ramachandra G. (1995) "Ecology and Equity: The Use and Abuse of Nature in Contemporary India," *Ideologies of Environmentalism* [Preprint].

Rissel, C. (2015) "Health benefits of cycling," *Cycling Futures*, p. 43.

Roddy, S. and Bridges, B. (2020) "Mapping for meaning: the embodied sonification listening model and its implications for the mapping problem in sonic information design," *Journal on Multimodal User Interfaces*, 14(2), pp. 143–151. Available at: https://doi.org/10.1007/s12193-020-00318-y.

Ruskin, J. (1843) *Modern Painters*. London smith elder.

Sahlqvist, S., Song, Y. and Ogilvie, D. (2012) "Is active travel associated with greater physical activity? The contribution of commuting and non-commuting active travel to total physical activity in adults," *Preventive Medicine*, 55(3), pp. 206–211. Available at: https://doi.org/10.1016/j.ypmed.2012.06.028.

SaMBA: Sustainable Mobility Behaviors in the Alpine Region (2022). Available at: https://www.alpine-space.eu/project/samba/.

Schindler, I. *et al.* (2017) "Measuring aesthetic emotions: A review of the literature and a new assessment tool," *PLOS ONE*. Edited by M.E. Kret, 12(6), p. e0178899. Available at: https://doi.org/10.1371/journal.pone.0178899.

Schiuma, G. (2012) *The Value of Arts for Business*. Cambridge, United Kingdom: Cambridge University Press.

Schultz, P.W. *et al.* (2007) "The Constructive, Destructive, and Reconstructive Power of Social Norms," *Psychological Science*, 18(5), pp. 429–434. Available at: https://doi.org/10.1111/j.1467-9280.2007.01917.x.

"Sedentary Behaviors, and Obesity" (2008) *Hu FB*, Obesity Epidemiology.

Shaw, J. (no date) *Legible City* [Immersive environment]. available at: https://www.jeffreyshawcompendium.com/portfolio/legible-city/

Singhal, G. (2013) *Bicycle: The Unnoticed Potential*. Available at: http://www.bicyclepotential.org/ (Accessed: November 15, 2022).

Skrebowski, L. (2016) "Jack Burnham Redux: The Obsolete in Reverse?," *Grey Room*, 65, pp. 88–113. Available at: https://doi.org/10.1162/grey_a_00205.
Soddu, C. (no date) "GENERATIVE ART '98: First International Conference."

Soler-Adillon, J. (2015) "The intangible material of interactive art: agency, behavior and emergence," *Artnodes* [Preprint], (16). Available at: https://doi.org/10.7238/a.v0i16.2744.

Sonja Kahlmeier *et al.* (2017) "Health economic assessment tool (HEAT) for walking and for cycling. methods and user guide on physical activity, air pollution, injuries and carbon impact assessments," *Kahlmeier, Sonja; Götschi, Thomas; Cavill, Nick; Castro Fernandez, Alberto; Brand, Christian; Rojas Rueda, David; Woodcock, James; Kelly, Paul; Lieb, Christoph; Oja, Pekka; Foster, Charlie; Rutter, Harry; Racioppi, Francesca (2017). Health Economic Assessment Tool (HEAT) for Walking and for Cycling. Methods and User Guide on Physical Activity, Air Pollution, Injuries and Carbon Impact Assessments. Copenhagen: World Health Organization, Regional Office for Europe.* [Preprint]. Available at: https://doi.org/10.5167/uzh-151107.

Sunstein, C., Thaler, R. and Pratt, S. (2008) *Nudge: Improving Decisions About Health, Wealth, and Happiness (Your Coach in a Box)*. Yale University Press.

Suowiecki, J. (2004) "The wisdom of crowds: why the many are smarter than the few and how collective wisdom shapes business, economies, societies and nations," *Choice Reviews Online*, 42(03). Available at: https://doi.org/10.5860/choice.42-1645.

Swyngedouw, E. (2006) "Circulations and metabolisms: (Hybrid) Natures and (Cyborg) cities," *Science as Culture*, 15(2), pp. 105–121. Available at: https://doi.org/10.1080/09505430600707970.

System Thinking, Design for the 21st Century With Donald Norman (2015).

Temos, T.J. (2009) "The Politics of Sustainability: Contemporary Art and Ecology," *Radical Nature: Art and Architecture for a Changing Planet [Preprint]*.

Traffic noise: exposure and annoyance (2001). Available at: https://www.eea.europa.eu/data-and-maps/indicators/traffic-noise-exposure-and-annoyance/noise-term-2001.

"Transforming Our World: The 2030 Agenda for Sustainable Development" (2015) *A New Era in Global Health* [Preprint]. Available at: https://doi.org/10.1891/9780826190123.ap02.

Ulijaszek, S. (2018) "Physical activity and the human body in the (increasingly smart) built environment," *Obesity Reviews,* 19, pp. 84–93. Available at: https://doi.org/10.1111/obr.12790.

Understanding Social Behaviour for Eco-Friendly Multimodal Mobility (2011). Available at: https://cordis.europa.eu/result/rcn/57984_en.html+15/6/2018.

What is Design Thinking? (2022). Available at: https://www.interaction-design.org/literature/topics/design-thinking.

Whitelaw, M. (2006) *Metacreation: Art and Artificial Life (The MIT Press).* MIT Press.

Why Oxfordshire WOWs (2022). Available at: https://www.livingstreets.org.uk/about-us/our-work-in-action/why-oxfordshire-council-runs-wow.

Wilson, S.S. (1973) "Bicycle Technology," *Scientific American*, 228(3), pp. 81–91. Available at: https://doi.org/10.1038/scientificamerican0373-81.