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Gaia Sgaramella

Future Motorway

Design strategy for next generation infrastructure

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Supervisors
Chiara Rizzi (Unibas)
Giuseppe Pino Scaglione (Unitn)

Co-supervisor
Hillary Brown (CCNY)

Credits of the cover image: Gaia Sgaramella

University of Trento
Doctoral School in Civil, Environmental and Mechanical Engineering
http://web.unitn.it/en/dricam
Via Mesiano 77, I-38123 Trento
Tel. +39 0461 282670 / 2611 - *dicamphd@unitn.it*

0.

0. Introduction

The research "Future motorway. Design strategies for next generation infrastructure", in its path, deals with a double important and urgent issue: the need to consider mobility infrastructures as landscape devices and the definition of a new paradigm for the motorways of the future.

The main objective of the thesis is the definition of a planning strategy for the infrastructures of the future, starting from the TechnoEcoSystem concept. It is based around a double hypothesis: one theoretical, the other experimental. The first observes the definition of TechnoEcoSystem (Naveh, Lieberman, 1990) from the ecology of the landscape and transfers it to the project / transformation process of the motorways. The second one identifies one of the prototypes of the Motorway TechnoEcoSystem into the service areas.

As a whole, the work combines theoretical and experimental aspects, within a path of design process that through qualitative and quantitative observations, defines the 4.0 motorway through a holistic view of the system.

0.1 Thesis, hypothesis and methodology

Path of research

Thesis: TechnoEcoSystem as design strategy for resilient motorway.

Hp 1: TechnoEcoSystem from descriptive concept of processes, to an active strategy.

Hp 2: Service area as prototype of TechnoEcoSystem.

The definition of thesis and hypothesis could be retraced through three different phases of research.

First phase| The first phase of research has focused on knowledge of the theme of the roads in general, especially in relationship with the landscape. The review of existing literature on this topic ranges from theories of perception on the street-scape, to technical and specific analysis on the design of road and its devices such as roadside, service areas, interchanges and overpasses.

The previous research activities, "Reinventing A22", carried out by DICAM between 2009 and 2010, focused on the relationship between the infrastructure and the crossed contexts, in particular to ecological and energetic potentialities of the highway system. For this reason, in a second phase, a review of existing literature has paid more attention to landscape and road ecology aspects. Investigating the practical aspects and applications, not only theoretical, some issues came to light.
One issue concerns the negative effects of the road within ecosystems instead of its potential value for the landscape. Another one concerns the evaluation instruments in Italy, which do not satisfy the real needs related to the problems of linear infrastructures.

In order to identify these issues, a linear path of research was built, responding to two main goals:
1_ Identify characteristics which potentially make the motorway an ecological system. These can provide regulation, support and supply as well as cultural services for the surrounding ecosystems, instead of disturbance.
2_ Define an evaluation process which is representative and able to identify clear design strategies for next generation infrastructure.

In order to identify the features of an ecosystem in a motorway, the literature research moved on the analysis of other types of not natural ecosystems, as cities. This was the initial step that moved the research toward the definition of the thesis.

Second phase| The second phase of research has focused on a deep

knowledge of the theme of the roads in relationship with ecosystems. After the review of existing literature on this topic, ranging from theories of perception on the street-scape, to technical and specific analysis on the design of road, the theoretical review has moved to a focus on the landscape ecology approach and theory.

In the first part of this phase, there was the definition of the first hypothesis in which motorway can be described as a TechnoEcoSystem. This hypothesis was discussed and implemented in three different conferences:

- in XIX Conferenza Nazionale SIU "Cambiamenti. Responsabilità E Strumenti Per L'urbanistica Al Servizio Del Paese." Catania, 16-18 giugno 2016, during the workshop 11, about the new words that could change the role of the urban planner,

- in Territories Rural-urban strategies, International research conference - Daad Hochschuldialog Leibniz Universität Hannover, Institut Für Entwerfen Und Städtebau, Università degli Studi di Palermo, during a PhD colloquium session, where the hypothesis was discussed as a way to think the resilience of motorway,

- in the 5th IENE International Conference on Ecology and Transportation, in Lyon from August 30th to September 2nd, where the proposal was selected as a poster and the topic was central as a type of mitigation procedure for infrastructure.

The research worked in parallel both on a strategic and experimental overview. The theoretical and strategic part focus on the idea of imagining the motorway infrastructure as osmotic device, as a technoecosystem that provides ecosystemic and cultural services to the surrounding areas, also through the use of technological systems; while the experimental part translated the theorized tactics in projects.

One of the researchers on the experimental part was a transdisciplinary group InfrA22Lab of the Department of Civil, Environmental and Mechanical Engineering (DICAM) of University of Trento, who worked on the idea of Autobrennero as TechnoEcoSystem. In particular the group with chemists, environmental engineers and architects worked on three case studies. This research work focused on two of them, the noise barrier near Trento and the service area, Plose East, near Bressanone. The outcome of this experimental part was a preliminary project of a service area that could considered as prototype of the TechnoEcoSystem concept.
This type of work was helpful to have instant feedback, between what is theorized and the application results, establishing a link between method and action that is often missing in research on landscape planning. The objective of InfrA22Lab work will be to show the A22 experience as a theoretical and experimental base for the evaluation of possible transformations of existing

devices along a TechnoEcoSystemic infrastructure.

By combining the steps of this phase to prove these two hypotheses, the research:
- to define the TechnoEcoSystem as strategy for a resilient infrastructure,
- to focus the attention on the service area as prototype of TechnoEcoSystem,
- to implement the concept of TechnoEcoSystem through the experimental results,
- to find the strategic elements for a resilient motorway.

Third phase| After the initial literature review and the definition of the concept of TechnoEcoSystem both under the theoretical and design point of view, the third year completes the research through a focus on the future development of the design of motorway infrastructure.
This phase is characterized by two key steps that allow the research to reach a defined point, leaving new paths open for future development scenarios.
The first important step was to deepen the project on the Plose East service station. After a series of advices, the project has been defined in its general design after:

- two PhD Colloquium in "Dynamics of Periphery" in Hannover and FUTURINFRASTRUCTURE in Trento;

- meetings with Brennero Motorway's board.

The developed points place more emphasis on the crossed context than on the motorway service, suggesting a possible reading of the techno-ecosystem strategy, in the specific context of the analyzed case.

The second important step was the visiting period at CUNY, Bernard & Anne Spitzer School of Architecture, City College of New York, from August to November 2017. Here, under the supervision of Hillary Brown, Professor in Sustainability and Infrastructure, the research met experts and large firms of New York, which work in professional field of infrastructure. The aim was to collect points of view on the concept of techno-ecosystemic infrastructure, trying to clarify the value of the approach. Interviews cover various disciplines: ecology, engineering, landscape, and architecture.

At the end, the goal of this period was to have a critical overview of the idea of a techno-ecosystem strategy and also of design application, used as a prototype of the concept. The comparison between different fields on this specific topic, both collected in Italy and the United States, will suggest a vision of possible future research developments, as well as stimulating the connection between two different universities' environments, using a resilient approach to apply to infrastructures.

These two steps allow the research to summarize the path developed during

the three phases. Starting from the problem that the design of future infrastructures is required to be resilient, the thesis defines the TecnoEcoSystem as a design strategy that can be opened for future scenarios and medium of thinking. The technoecosystemic approach will provide tools to translate the possibilities offered by the territory, useful to design the next generation of infrastructures.

In conclusion, using the interviews, the project and the tools derived from the reading of theoretical and application case studies, in the last phase, a toolbox of elements was defined as an open instrument for design the territory in relation to the motorway infrastructures, opening new future scenarios.

Methodology

The methodology of research uses the combination and the parallel investigations of experimental and theoretical parts, to demonstrate the final research thesis. Starting from a concept, a new motorway paradigm was defined to respond to the dynamic processes underway in the Anthropocene. It was possible to have a first qualitative reading on the role and the importance of resilient infrastructures. In the meanwhile, the experimentation gave the opportunity to make clear the translation of the concept of TechnoEcoSystem in design strategies. The reading of the case studies (at two different scales) and the project have enriched the final considerations in the toolbox and the re-elaborated methodological path in order to redefine the infrastructures of the future.

Each hypothesis has been investigated in different phases, which also are the structure of the research.

Hp 1: TechnoEcoSystem from descriptive concept of processes, to an active strategy.

Diachronic reading|Critical reading of the historical phases that have marked the development of the motorway, from its origins to the present day and beyond. This sets up the evolution of road / motorway development, in relation to technological evolution and to the theories and visions of cities, which were simultaneously developing. These underline how the vision of the future really influenced the future.

Identification of the field of investigation| Reconstruction of the main theories, trends and actions that define the disciplinary field of the thesis, following explicitly the different techno-ecosystem services (cultural, provisioning, regulating) as classification. Following the recognition of the role of motorways within a holistic system scenario, boards profile were developed to highlight and identify the design potentials that occur in the relationship between infrastructure and different landscape ecotopes.

Hp 2: Service areas as prototype of TechnoEcoSystem.

Experimentation | The research identifies in the Autobrennero (A22) a context in which to experiment the idea of TechnoEcoSystem, through the design of its devices. The occasion is given by at least two factors: the existence of a real demand; a singular story within the national panorama marked by an emphasis on environmental and landscape quality. This allowed to validate and modify the premises in the definition of the design strategies of a technoecosystemic motorway.

Comparison | The definition of a service area as ecotone of the TechnoEcoSystem takes advantage of an anthology of case studies that support its definition. The categories in which the projects were investigated refer explicitly to the various technoecosystemic services (cultural, provisioning, regulating). The comparison provides a sort of collection of solutions for to improve the project of the previous phase.

This part of the research also uses a process of internal control of the transversal results that is developed through interviews with practitioners and researchers interested in their work on infrastructures. These support specific parts of the research and also deal with issues that are transversally addressed in the reading, investigation, experimentation and comparison phases.
The whole study is also supplemented by a consistent iconography support of drawings and images to illustrate the contents addressed in the various research phases.

0.2 Content of the chapters

Chapter1 | In the first chapter the resilience is the central topic. Starting from an apparently contradiction (resilience as concept of adaptability and plasmatic configuration of elements; infrastructure as concept of strong and unchangeable support for stability of other elements), through the history, the Motorway is described in time from a 'Stone Age' state until now, to examine which could be its future.
After the first technological / industrial revolution, the motorways became the consequence and the outcome of: communication technology development; the cultural perception of space; and the development of urban shape over time. From this moment, the motorways started theirs genealogy, following three principal steps. From an initial stage 1.0, based upon the need to move, through a 2.0 level concerned with the development of the motorway between innovation and standardization, we arrive to a 3.0 stage related to the unexpected ecological impact that motorway has had on the territories, even now ongoing.
Destruction of the natural ecosystem, engine of territorial fragmentation, and detractor of landscape quality are few epithets assigned to motorway in the last decades. Starting from this perception, the chapter close is focus on the possible future, that will be discuss on the other ones. Reaching the 4.0 stage

is crucial. Motorway 4.0 will be the answer to the need for a new generational change for mobility infrastructures, which over time have remained the same, limiting their propulsive and visionary objective for the surrounding territories.

Chapter 2| Following the comparison of perception of the motorway infrastructure over time, in this second chapter the attention moves towards a new vision of infrastructure, particularly Motorway 4.0. Starting from the premises of the osmotic concept of the first part of the research "Reinventing A22", the theme of Resilience is used as a design strategy. In the paradigm of resilience, the motorway will have to be reinterpreted more and more by technological and environmental transformations. The space should be analyzed in its complex system, in which nature, technology and society interact. Following the ecology, as a medium between nature and the anthropocentric sphere and technology as a medium for innovation toward the future, in this chapter the concept of TechnoEcoSystem as a tool to select design strategies for next generation motorways is defined. The aim is rethinking the traditional elements such as noise barriers, overpasses, underpasses, rest areas and toll booths in accordance with a landscape-sensitive design approach and following the potential services that a TechnoEcoSystem could offer.
In order to better understand how ecosystem services can be defined for a category of technoecosystems (motorway) instead of natural ecosystems, we will analyze a series of case studies following a classification related to goals. The classification recognizes examples of theoretical premises, national and international policy trends and application, that allow us to extrapolate useful elements to clarify the features of a technoecosystemic motorway. The cases study are defined into three categories.

Theory| The theory highlights the origin of principles related to enhancement of cultural, ecological and technical-energetic parameters related to infrastructures.

Trends| Trends are highlighted by European documents, norms and calls, expressing the current policies on the theme of motorway infrastructures, underlining the techno-ecosystem services' features.

Action| Actions are showed by real projects which describe potential enrichment and aspects of technoecosistemic approach.

According to their peculiarities, these case studies, as well as in typological categories, will be subdivided into kind of techno-ecosystem services: cultural, provisioning and regulating.

Chapter 3| In this chapter the focus is the experimental part of research. The case study of "Reinventing A22" research is the Brenner Motorway A22, protagonist of debates on the development of the European infrastructure network because of its settlement logic. The theoretical framework, in the

second chapter, has been applied in two different case studies, a smart barrier and on a smart oasis (service area). Both elements of the motorway system are considered prototypes of TechnoEcoSystem, which, as mentioned, services the landscape that surrounds the infrastructure.
The project of smart barrier is a noise barrier, with multilevel goals. It could be an ecotonal element useful to balance the ecological equilibrium between natural and artificial ecosystems, through the production of cultural, provisioning and regulating services.

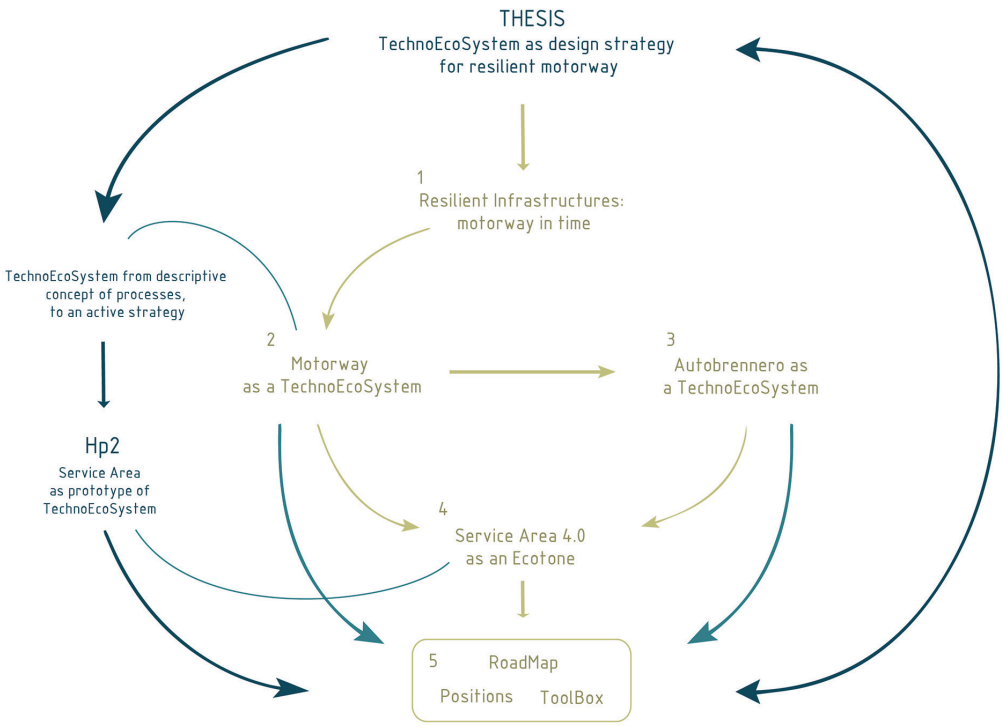
The smart oasis, service area, is another example of a prototype of TechnoEcoSystem. The state of transition between a fast and slow use of space is a feature particular to the service area that makes it a useful venue for experimentation. The application has been implemented on two spaces around A22. One in the North near Bressanone to Plose East service area and the other in the South, near Ala to Adige West service area. With the application of two design strategies, one more performative and one more adaptive, the multidisciplinary group, InfrA22Lab worked to redefine the layout and peculiarities of a service station following the technoecosystemic approach. The service area became in this scenario a hub of change and experimentation with the TechnoEcoSystem, where the provisioning, cultural, supporting and regulating services converge to articulate the design strategies linked with landscape.

Chapter 4| The service area is a tool that have the capability to response to the time's dynamic and changes, easily than the others. For this reasons in this chapter it is described as a prototype of TechnoEcoSystemic approach. Starting from the origin of this kind of architecture, the new concept that the service station assumes to be more resilient to the changes will be defined.
From a necessity, through a standard and a *non place*[1] meaning, the service station assumes another position into the Techno Ecological System of motorway. Service area could be a transitional experience between the speed of the motorway and the slower features of the crossed territories, performing the integrative function of an Ecotone.
In order to define the peculiarity for the application of the case studies, in this chapter the methodological approach is explained through examples. Service area as a cultural service. Service area as energetic hub, provisioning service. Service area as techno-ecologic system, regulating service.
The service area becomes in this scenario a hub of change and experimentation with the TechnoEcoSystem, where the provisioning, cultural, supporting and regulating services converge to articulate the design strategies linked with landscape. At the end, mixing an inductive with a deductive way to research, the chapter show the outcome of application on Plose East service areas.

Chapter 5| At the end, using the interviews, the project and the tools derived from the reading of theoretical and application case studies, a road-

[1] M. Augè, Nonluoghi. Introduzione a una antropologia della surmodernità, Elèuthera, 2009

map is set up as an open reading tool of the territory in relation to motorway infrastructures.
Considering a double process of knowledge, before and after the selection of an action, the best technoecosystemic service is defined, useful to balance the relationship between motorway and the built and open landscape. The action is into an open tool box of options, classified into three macro categories, where the risk is controlled by the use of alternative possibilities. Each kind of landscape, in relationship with motorway have different actions and possibilities to control and balance the relationship between systems. Under three categories: Zero Action, Regulation&Control and Design&Technologies.
Through the use of three elements: roadmap, toolbox and position, the research closes its path showing that the TechnoEcoSystem could be a design strategy open to future applications and implementations. The technoecosystemic approach will provide tools to find the possible technoecosystemic services offered by the territories, to design next generation of infrastructures.



1.

1. Resilient infrastructures: as the motorway changes in the time

1.1 The resilience of the infrastructures

The literature, that faces the theme of resilient infrastructures, associates between them, two concepts apparently in strong antithesis. Used in various disciplinary fields[1], the oxymoron hides an intense game of meanings of the terms infrastructure and resilience. These hints of meanings move the reader's reflection from the apparent initial contradiction. Using the definition of the dictionary, the infrastructure is "generally the structure or complex of elements that constitute the support base or in any case the underlying part of other structures"[2], which in the urban disciplines becomes the network of the public services necessary for the development of the city, which are the basis of the economic-social growth of a country, such as: aqueducts, electric network, motorways etc. It is therefore something physical and artificial created with the aim of improving the efficiency and quality of human life. When the term infrastructure approaches the word resilience, it seems that its meaning loses consistency and obtains elasticity. The idea of "backbone" infrastructure within the urban contexts disappears. At the end in its infinity of meaning, resilience should be understood as the capability for adaptation and transformation of a natural or an artificial system, into a change of a different nature and type, intensity and impetuosity[3]. It is the ability to re-establish a balance after an economic and environmental crisis, or a technological revolution. It performs in this slice of meaning a function to respond to the new paradigms that refer to a science in which technologies or new discoveries can completely change the way people think or it acts[4]. This leads us to a new way of looking at living spaces and their change, from a system of measures given by the territory to a system of values given by the landscape[5] and also lead us from a real physical dimension, towards a more abstract and virtual one. In force since November 4th 2016, the Paris Climate agreement bets to ensure resilient and sustainable infrastructures for the future among the objective challenges. To draw up the investment plan necessary to meet the objectives set by the agreement, many experts in different fields of the international commission argue that the biggest challenge will be to make the infrastructures of the future sustainable and adaptive. Resilient infrastructures will be a key sector in which they will invest over the next 15 years[6]. The term infrastructure in this European study has been analyzed in all its meanings: into the supply of energy to public transport, into the water and sanitary systems of buildings, up to what is called the "natural infrastructure" of forests and wetlands. This multiplicity of readings is linked to the different interpretation of the term resilience, which from engineering, read as probabilistic behavior, to ecology, read as a dynamic response to equilibrium, is articulated to give an overall reading of the issue linked to resilient infrastructures. The combination of technical, ecological and social aspects linked to each other can only enrich a more solid approach to the design of gray infrastructures. Therefore, to the sudden ecological, technological and cultural changes of the Anthropocene[7], we must prepare ourselves by repairing the abrupt

balance breaks and also by trying to prevent them through a design that proves to be resilient in the different disciplines compared in its strategy. This will be the direction that will try to undertake this research work, that is to demonstrate how through careful planning, even what is man-made could become easily adaptable to changes. The resilient infrastructure therefore will not have a reactive connotation, but rather proactive with respect to the breaking of an equilibrium, molding itself to the small changes that are source of more violent ones. The infrastructure in this vision will not be "on hold", it will not reach a condition of obsolescence[8], but through strategies of compensation, mitigation and proactive planning towards change, it will act *ex-ante*, planning a phase of transition to technological, ecological and cultural changes in which it is inevitably involved. In this introductive chapter as well as in the entire research, the motorways will be protagonists and example of gray territorial infrastructures that deal with the theme of change through three different points of view: cultural, technological and ecological. The motorway and the devices that compose it through urban utopias, the technical-rules of innovation and the ecological-environmental vision will help us to image what types of changes we will face in future challenges, through the reconstruction of the past.

Image1| *Motorway A4. Autogrill bridge. Soave.*
Ph: Gaia Sgaramella

Motorway 0.0

TECHNOLOGY AS A NEED

CO2 Emission

Techno growth

Network growth

TECHN

V | II | a.C. 0 d.C | X | 1760 | XIX

TREND

Via Reale di Persia

312 a. C.
Via Appia

138 a. C.
Via della seta

1730 d. C.
Transiberiana

1760
First Industrial Revolution
1760-1850

• 1789
French Revolution

• 1751-1766
Encyclopedie

TECHNOLOGY

• 4000 a. C
Wooden Disk

1595 d. C •
Discover of the first depsit of natural Asphalt

• 1790
Electic battery

• 1801
First
powe

THEORY & UTOPIA

Roman City

Motorway 1.0

TWORK
AS
NEED

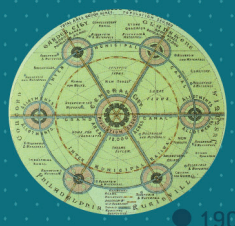
OLOGY

CO2

XX

1913

- 1820 First macadam street
- steam red vehicle
- 1830 Establisment of steam power railroad network
- 1834 Asphalt was used for the first time
- 1850 Pennsylvania Rock Oil Company
- 1859-1869 Suez Canal Open
- 1860 US export petroleum in Europe
- 1885 First Atomobile, Karl Benz
- 1890 Diesel engine
- 1895 Elettric streetcar
- 1903 Wright brother first flight
- 1903 Legue against Dust
- Universal exhibition Paris
- 1905 Relativity Theory
- 1908 Long Island Motor Parkway
- 1909 Futuristic Manifesto
- 1910 First Automobile assembly factory
- 1910 Roadtown
- 1911 Tesla Theory
- 1913 Lincoln Highway open



1902 Garden City

1.2 Motorway 0.0 | Preface

Nowadays, when motorway is mentioned, we visualize asphalt surfaces, roadways, guard-rails, large road axes that lead us through unlimited territories toward multiple destinations. This simple description feeds the modern vision of the motorway, which instead is more complex than what we can see. Influenced by temporal, social and technological dynamics of its time, motorways have assumed different meanings and roles in time, until the current definition. The streets have always existed in the urban areas, like the negative of the built-up area, which allowed those who traversed the urban space to easily arrive a well-defined place. We begin to speak for the first time of 'Motorway' *ante litteram* in the fifth century BC, when it was built thanks to Dario I, the famous Royal Route of Persia. Even today we transmit within our culture the memory and meaning that this infrastructure has had in its time. The road that connected Susa to Sardi, 2699 km long, allowed to facilitate trade, speeding up and reducing the journey time by ten times compared to the times normally recorded in that trip[9]. This is the first example of a large communication artery spread because of the need of efficiency and improvement of commercial exchange processes, influenced by the change of the shape of space.
Instead a more complex meaning had the *Viae Romanae*. They were extra-urban roads that were built for purely military and political purposes, as well as commercial The etymology of the word, of Indo-European origin, recalls the idea of transport[10], of movement linked to the passage of resources, but we know that in reality it was a way for the Romans to reach and to control the hegemony on the territory. The first extra-urban artery was the *Via Appia*, built in 312 B.C., to arrive in *Magna Graecia*.
This was followed by numerous other routes that, in addition to cover the Italian territory, expanded from the Pillars of Hercules to the Caspian Sea, from Mesopotamia to Britain. 80000 km of roads of a system of 29 arteries departed from the central core of Rome, built using techniques inherited from the Etruscan tradition of the stratification of the roadway[11]. All the roads were characterized by the presence of *milia passum*, milestones that indicated the distance between the localized point and the ideal point of origin represented by the Roman Forum[12]. The milestones, in addition to act as a signal step, reported information about the reference station, almost as a preliminary standardization of signs that we know today on our roads, a real system of generalized information.
Another example of the great way of exchange is the Silk Road. Traditionally this connected the east with the west, the Chinese empire with the Roman one, and in addition to transport products foreign to the two different contexts, this path is a symbol of diffusion and mixing of different cultures. 8000 km of land, sea and river routes that have animated relations and exchanges between two realities on opposite sides of the known world. All these routes are similar from the existing motorways except for them form. The objectives on which they are based are basically two: to connect different realities of the territory, for exchanging resources and cultures and to make the link be-

tween people and territories stronger and richer. We could list many others examples of great routes, like the Siberian[13] one, that have characterized and changed the articulation of places, influencing the intercepted territories culturally and socially. All these examples differ from the existent motorways in shape, but not in their objectives. The principles for them are basically three: 1) to connect different territories, 2) to exchange resources and culture and 3) to define a link between people and territories, reinforcing power and wealth. These connections changed the territories that they cross, rather than influencing the change of the technologies for traveling.
From the parallel analysis of the different scenarios (technologies, trends and visions of the city) over time in relation to the motorways, will be evident the inversion of the rhythms in which innovation and visions travel. If once the vision of the future was an incentive to the evolution of cities, to enrich the collective imaginary, now the technological development is so fast that the imaginary about future is built on innovation technology. For the infrastructures, in particular the motorways, is different. The complex vision seems to have vanished completely, due to the implementation of technical performance, aimed to solve specific localized problems, rather than effects on a general scale. This condition necessarily leads us to define a new generation of motorway infrastructures, through a new overall vision, which is capable of responding to current social, cultural and ecological trends and also which becomes a visionary and strategic image for the future of infrastructures. Following a timeline, you will see how the highway from an initial stage 1.0, based upon the need to move, through a 2.0 level concerned with the development of the motorway between innovation and standardization, we arrive to a 3.0 stage related to the unexpected ecological impact that motorway has had on the territories, even now ongoing. The goal is to define a new 4.0 stage and osmotic link to the territories, resilient to changes. Motorway 4.0 will be the answer to the need for a new generational change for mobility infrastructures, which over time have remained the same, limiting their propulsive and visionary objective for the surrounding territories.

1.3 | Motorway 1.0 | Need

Thinking in terms of time, the first generation of motorways, we can insert it in a range from the first industrial revolution (1760 - 1830), until 1913, when Henry Ford introduced for the first time the concept of mass production. Still in a beginning stage that does not respond to the current idea that we have on infrastructure, the motorway starts to develop quickly throughout the European territory[14]. One of the cause that sped up the pace of development was the transport revolution, which, in parallel with technological progress, allowed an easier supply of resources to urban centers. The roads at this early stage are still dirty and dusty, with the unique purpose to speed up the movement between the countryside and the city. From a formal point of view, they did not change their features, but their development was concentrated to the implementation of the network, without varying its peculiarities. For this reason, during the first industrial revolution, in order to grow exponentially,

an acceleration of the development of communication and displacement tools left the road design in the background. Due to a demographic increase of population poured into urban centers, due to the enormous possibilities of work in the industries, the urban growth caused a rapid decrease in the healthiness of the urban space. The birth of urbanism is[15] known to be the result of an attempt to govern the problems due to an uncontrolled growth of the cities that characterized the nineteenth century. In response to this, the season of urban utopias began, linked to the idea of garden city[16], and also started the functionalist current, as concrete answers to immediate tangible necessities.

From the desire of smooth, frictionless and easy-to-travel roads studied by Trésaguet, Telford and McAdam[17], at the end of the nineteenth century, the focus shifted to the healthiness of urban space, in response to the effects of dust and humidity on the roads. The solution to this problem was given by the introduction of natural asphalt as a cover of road surfaces[18]. The use of asphalt spread only when similar materials, such as tar, became available in enormous quantities at low cost. Basically, the spread of gas production within the cities produced tarry residues, reusable for the waterproofing of roads[19]. This was also possible thanks to a technological evolution of the supply networks, which in parallel was slowly taking possession of the cities, making them increasingly dense and full of infrastructural stratifications.

In this period started the second industrial revolution characterized by new discoveries related to energy[20], with the consequent development of means of transport and intensification of businesses. Although now it may seem ridiculous as problem, dust in this historical phase can be considered as the smog present in our cities today. With the physician Guglielmetti of Montecarlo, even in 1903 the League against Dust was established, a committee created specifically to sensitize the institutions to the taring of roads. This brought benefits related to the hygiene and health of the city and also gave efficiency and safety to the performance behavior of the streets. As reported in the American magazine "The Manufacturer and Builder" of 1874[21], the asphalt, compared to other used flooring materials, presented a better performance in terms of efficiency by friction and resistance, which brought the material quickly to its diffusion in the street design.

As Geoffrey Barraclough said "the quicker the effect, the more prodigious the results that led to a revolutionary transformation in man's life and prospects"[22], referring to the second industrial revolution: speed can be considered the key to this period. All processes seem to move faster. Faster is the answer to the problems that change has brought, increasingly fast are the new tools of communication, and the artistic and cultural approach of this period is on the move as an impetuous 'revolutionary movement'[23].

This aimed at shaking a culture in delay with respect to the technological evolution under way, which also underlines a perception of the dimension, spatial and also temporal[24].

The myth of speed embodied in the paintings of Dottori, in the statues of Balla between the first and the second Futurism is also a status that gradually was reached by vehicles of transport in a previous period. In 1885 Karl Benz

produced the first automobile, in 1890 the first diesel engine was invented, in 1894 the first electric battery powered vehicle was introduced and in 1910 the first automobile production plant was opened. All these passages will fuel our modern idea of motorway infrastructure, but what affected more the morphological evolution of the first generation of motorways, was in particular the speed.

The Long Island Motor Parkway[25] was the first road designed exclusively for cars. The road was built by a private individual, William Kissam Vanderbilt II, a great lover of car racing and the founder of the prestigious Vanderbilt Cup race. He built the parkway after an accident, which occurred during a long run in an inhabited road. This run led to the deaths of two spectators and numerous wounded. Feeling responsible for the event, Vanderbilt founded a team that could take care of the realization of a road, in its kind, similar to the current technical morphology of the motorways[26]. Overhead curves, overpasses and bridges to eliminate intersections, asphalted and cemented surfaces, guard rails and controlled access began to be the innovation that preserved the dynamism of the races, but at the same time ensured the safety of the spectators.

However, the premises of the inauguration of the Long Island Motor Parkway in 1908, were overlooked. The speed made its first victims in 1910, leading to the interruption of car races along the Vanderbilt Parkway[27]. Despite the unhappy interlude, this infrastructural artery left us the engineering and formal techniques that was the base for a more and more widespread and attentive development to the safety of the roads set only for cars. In their use, the road for the exclusive use of cars preserved the myth of speed. While the great road infrastructure was beginning to take shape, what was happening in the cities? As imaginable, they continued to grow and thicken, trying to regulate themselves following the processes underway. This through a functionalist and pragmatic current in response to tangible problems and also through a more Utopian current developed in parallel. In addition to the structure of the garden city in which the landscape enters in the city defining a shape of the balanced space between city and nature, there were other Utopian currents, which brought modernism and infrastructure to be central to urban development.

In the Ciaudad linear[28] by Arturo Soria y Mata and in the Roadtown by Edgar Chambless, the urban dimension is linear and structure for the other parts of the city. While the former sees the centrality of infrastructures and transport to improve the hygienic conditions of urban life, the latter focuses more on a linear and dense architecture that preserves and maintains the link between the city and the countryside. Here the city is a machine for living in movement in which "the city workers are surrounded by the trees and the forests and meadows and the farmers by all the advantages of city life"[29]. The idea of a continuous and dense city is influenced by the pioneering approach of those years, in the early 1900s, when the first 'coast to coast' arteries were concluded in the United States.

The opening of the Lincoln Highway[30] in 1913, in addition to the implementation of the railway network, began to spread more and more the avail-

ability and flexibility of moving the masses. The year 1913 is also a decisive year in the field of industrial production. With his Model T Ford, Henry Ford[31] began the mass production of the car, making the costs lower and the vehicle accessible to all people. This was a turning point for the motorways. The concept of autonomous movement begun to be within everyone's opportunity and the turnout on the roads increased dramatically.
People prefer the freedom to travel free from a train schedules. They can more easily afford their own vehicles, driven by wanting to be in step with the times, in which technology becomes accessible to everyone and desired by all "... the magnificence of the world has been enriched with a new beauty: the beauty of speed. A race car with its bonnet adorned with big tubes like snakes from the explosive breath ... a roaring car, which seems to run on the machine gun, is more beautiful than the Victory of Samothrace "[32].
Of all the scientific and technological discoveries that characterized the years of the second industrial revolution, such as the use of asphalt on carriageways, access to toll roads, or the car, none of them was so decisive in the transition between a phase of necessity and development of the motorway as the Fordist revolution. Basically, mass production changed the meaning of motorway infrastructures, activating processes that create a new 2.0 generation of motorways.

1.4 | Motorway 2.0 | Development

In this phase motorway is a paradigm of development, as an emblem of change in a historical / cultural scenario, in which the new technologies and experiments available require space to be used. From a phase of fast innovation, necessarily follows a transition phase in which people and spaces adapt to new ways of using technological objects. Cities and territories change and adapt to the new demands of society driven by a goal of economic and cultural development of the populations. Compared to the first generation of motorways, the latter does not merely respond to specific problems, but becomes a driving force and activator of new processes. Taking into account the time, in this section there are two phases :
Phase 1_ (1913-1945): the limit dates of the range refer to the automobile production boom that occurred in the United States (1913) and in Italy (1945) with the conclusion of the Second World War.
Phase 2_ (1945-1962): the first date (1945) is the beginning of a European infrastructural growth after World War II with the reconstruction and the diffusion of the purchase of the own vehicle, while the second (1962)) is the date of publication of the book Silent Spring, by Rachel Carson, manifesto of the environmental movement that started the transition toward the third generation of motorways (Motorway 3.0). Even if full of changes, the first phase cannot be considered as a real development phase for infrastructures. The first world war, the crisis of the 29th and the Second World War[33], are events that have slowed down the technological development and cultural ferment of the '*Belle époque*' that characterized the end of the nineteenth century and the early twentieth century.

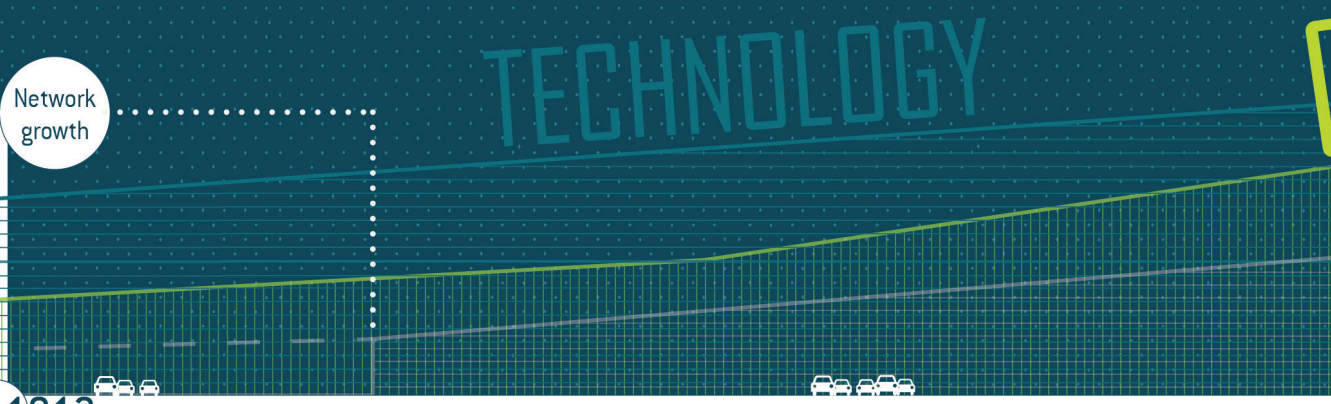
While in the United States until now, General Motors conditioned the economy of the country, in Europe totalitarianisms were increasingly influential. The construction of the first motorways in Europe took place in the early 20th century, after the First World War, importing construction techniques from USA. The record relating to the construction of the first European motorway is a dispute between Germans and Italians. The AVUS[34] (acronym for Automobil Verkehrs und Übungs-Straße) had a tolled car circuit built in the years following the first world war, with dual purposes of travel by individuals and as a test platform for automotive tests. The double rectilinear, which subsequently became a circuit, was studied since 1909, before being completed and opened to public traffic in October 1921. Instead in Italy the same year, Ing. Puricelli obtained expropriation for public use of the territories that be crossed by the Milan-Lakes motorway, opened on September 1924. From a temporal point of view, the primacy is attributable to the AVUS, but if is carefully analyzed the hybrid function that the German motorway was having, we realize that the real motorway knew today is more similar to the Milan-Lakes model of Puricelli.

Ing. Puricelli, even if he is remembered as the inventor of the motorway, we can not recognize all the merits attributed to him by fascist propaganda. He had as its forerunner the European experience of the AVUS and the Vanderbilt Parkway in the United States. With the construction of the Milan-Lakes section, the development of the motorway network from the first generation began (1924-1935). The characteristic of these motorways was that they were all completely covered with concrete slabs, an Italian product, following the autarkic policy established by the Fascist regime, with the exception of the Padua-Mestre and the Genoa-Serravalle[35].

In this first phase, the services began to be implemented with signage, the street limits (New Jersey) and service stations. Compared to second-generation motorways of post-war, there was not yet a typological architectural standard to be respected, the motorway architectures are experimental and adaptive to the needs that motorway transport implementing over time. As reported in various economic, technical and legislative essays, on the beginnings of developments in the Italian motorway policy between the two world wars, this phase disappointed the expectations that the regime envisaged. As the economists I.Gasparini and E. Marelli said, probably the construction of the first Italian motorways can be considered as a 'positive operation' but not strictly necessary for those times, because in Italy in those years we were meeting more urgent collective needs, which made car traffic more precarious[36].

During the beginning of the Ethiopian War (1935) there was a reduction in the trades of goods and fuel due to the increase of taxes and the imposition of new sanctions. This first phase of motorway infrastructure ended with the war at the gates, with a clearly negative balance, as the acceleration desired by the regime produced confusion and little organicity in the development of the country. As A. Giuntini says "Overcoming of the contradiction between private individuals, bearers of short-term local needs, and the State was never managed, from which a concrete and thought-out national network project

Motorway 2.0

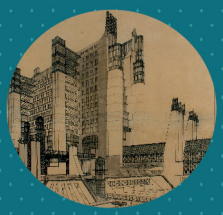


1913
Mass Production
Ford T Model

- 1914-1918
  I World War
- 1921
  Fascist Party
- 1929
  The Crash of 29
- 1931
  Motorway:
  Bergamo-Brescia
- 1933
  Nazi regime
- 1933
  Motorway:
  Firenze-Mare
  Padova-Mestre
- 1935
  Motorway:
  Genova-Serravalle
- 1935
  War in Etiopia
- 1939-1945
  II World War
- 194
  First
- 194
  ONU

- 1920 -1940
  Construction of hydroelectric plants in America
- 1921
  AVUS Motorway
- 1924
  First generation:
  Milano-Laghi
- 1930
  The first helicopter flies
- 1933
  Radio patent
  Edwin Armstrong
- 1939
  Paul Mueller DDT, the first insecticide
- 1943
  «Colossus» the first calcultor
- 194
  Clark
  nary
  telec

- 1914
  The new city, Sant'Elia



- 1931
  Metropolis of Tomorrow,
  Hugh Ferriss
- 1932
  Broadacre City,
  Frank L. Wright

TECHNOLOGY AS A TOOL

DEVELOPEMENT AND PLANNED NETWORK

C02 NETWORK

1962

• 1946
A.N.A.S. was founded

5
Atomic Bomb

5
Fondation

1951
Agreement between A.N.A.S. and Cassa del Mezzogiorno

1955
Romita Plan

• 1956
Autostrada del Sole

1960
A1 viable between Milan and Florence

• 1961
Gagarin first man in the space

• 1946
First electronic calculator satellites

5
ke, the geostatio-
orbit for future
communication

• 1954
First photovoltaic cell

1956
Construction of US Highway System Underway

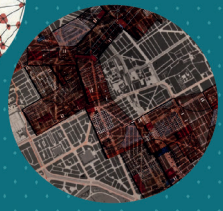
• 1956
Fiber Optics

• 1957
First successful launch of man-made satellite, Sputnik

1958
Mobile Architectur
Yona Friedman

1958
Continent city
Yona Friedman

1962
New Babylon
Constant



did not arise "[37]. At least in the Italian context, the inability of this first phase of development was to be not able to have a general strategic image of the country's infrastructural future, without to have an organic plan built on a network vision, which had the ability to interconnect the various transport systems between them. Important is the parallel comparison with the utopias on the city developed in this period, which were influenced by the artistic avant-garde of the first half-part of the twentieth century. These were able to anticipate through visions of city and territory, images of futuristic inhabited places. Among them there were the Neutra Rush City[38], Hugh Ferriss's City of tomorrow[39]and Wright's Broadacare city. The first two utopias also seen as dystopia, considering the austerity of the urban spaces represented, build the city on the infrastructures, articulating it according to the influence that the zooning was having in those years in the great metropolises. Indeed, the represented places recall the utopian idea of the industrial city of Sant'Elia, but also an extension of the upward growth that was taking place in the great American cities, as New York.

The presence of the 'city'[40] linked to a logic of zooning not have roots in Europe, even if it is developed in the main cities in the last thirty years. Nevertheless, these utopias anticipated, in their futuristic imaginary, a stratified view of the city, linked to infrastructures. The shown technology in the drawings of Neutra and Ferriss is nothing more than a revival of what was already present a century ago. Looking carefully these technology, they are not so different from those currently in use. Very different is in the utopia represented in Broadacre City by Frank L. Wright. He prefigures a city dispersed in the territory, opposed to the rigid and hard vision of the dense city, through huge spaces were served by an effective road system that defines a grid which hosts residences, factories and urban facilities. Mobility is individual and hybrid between imaginary (with flying cars) and reality (automobiles).

As G. Ciucci says: "Broadacre is neither utopian nor real, but it is only outside of time; born late, it is the answer to the problems of urban development in the last years of the nineteenth and early twentieth century as he had caught Wright "[41], for him more than foreshadowing a future world, Wright is a nostalgic of what it could have become the city. Rather than reading it this way, but referring to what Lewis Mumford said before 1934, Wright had the desire to rebuild and to change what was taking place in those years, becoming the promoter of a "utopia of reconstruction" and not of a "utopia of escape"[42]. The latter does not promote originality, while the former favors visible processes already in progress.

Wright's "reconstruction utopia" was the applied approach in European cities after the war to start and support the country's recovery.

At the end of the Second World War, the second generation of motorways began a subsequent phase of development in which both the intent and the procedures aim at an organic and homogeneous growth of the territory. In 1945, there was a recovery in post-conflict automotive production in Italy and also in the rest of Europe. All this process was accompanied by an idea of freedom of movement, as happened in the United States in previous decades, marking the 'collective psychology' over the years of reconstruc-

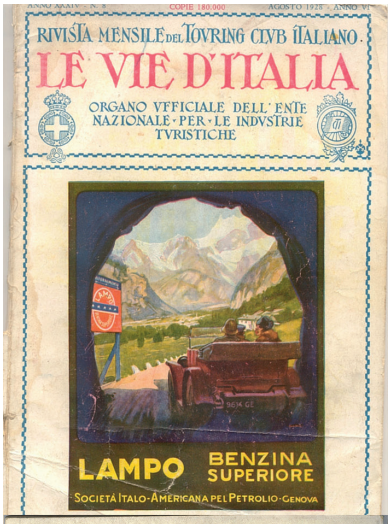
tion. There was no innovation in this phase, but simply the continuity of what began to shape during the Fascist period. In 1946 the A.N.A.S.[43] was established, starting all the work to restore the existing road and motorway network, including 300 km of motorways and 21146 km of roads[44]. The emergency was forced to focus on the development of what was to be restored, in order to restart the economy of the country, which was arrested and blocked by the conflict.
While in the United States there was a deepening of the already organic and well-defined network and in Germany it was completed and rebuilt what was already planned during the Nazist regime, Italy began to worry about defining a general growth strategy, with central development of the motorway network.
Following the same aim, an important step was made on June 16th 1951, through the signing of an agreement between Anas and Cassa per il Mezzogiorno[45] to implement the country's road network. This step was important to lay the foundations of what would have been the 1925 Piano Romita[46]. To follow the objectives of the ten-years Piano Vanoni[47] for economic development and the implementation of employment, the infrastructural network had to be adapted to the new needs of the country. At the end, it just was. The network with the Piano Romita became a unifying factor of the territory, that was able to reduce the distance not only physical but also cultural between north and south. In the same year the Fiat 600 was introduced into the market, which became the symbol of the "economic boom" of those years, because it concretely started mass motorization in Italy as well. The economic interests of companies belonging to the automobile industry were not lacking. Both the SISI group (consisting of Pirelli, Fiat, Italcementi and ENI) and IRI (Institute for Industrial Reconstruction) were at the forefront. In the Piano Romita, IRI was responsible for the construction of the infrastructures with the possibility, through implementation and maintenance of the same, to open the market to new economic and employment initiatives[48]. With these premises, the agreement between Anas and Società Autostrade was signed on April 14, 1956, to start the construction of the Autostrada del Sole, Milan-Rome-Naples, which opened the door to a new season for Italian motorways[49].
The significant moment of development that from that point characterized Italy, can be read through the numbers and legacy that still remains today of this season. With the global conflict just around the corner, Italy was at 479 km of motorway network, and only in 1960 it doubled to 1169km, growing more and more exponentially through a process of standardization of the manufactured products still applied today.
Wright's utopia is increasingly shaped, at least in the territorial vision of the city's spread in countryside, and the continuous coverage of the network reaches even the most peripheral territories, guaranteeing its progressive development. The country grows both from the cultural and economic point of view, the territories and the cities begin to define themselves following the layering processes described in the drawings of Sant'Elia and Ferriss[50]. During the years of the Cold War, of the race towards space and the begin-

ning of the post-modern phase, the utopias began to prefigure new scenarios, re-reading the inhabited space in an undefined and more abstract way. These are the years of transition between the industrial "Second wave" and the post-industrial "Third wave"[51], in which the information age is started with new communication technologies and the refusal of standardization imposed by rationalism and modernism of previous years. The utopias of the late 50s and early 60s are characterized by a common idea linked to the unspecified space.
Until now, these had described and imagined hyper-structured, rigid and inflexible spaces for change, while at this stage we are moving towards a definition of nomadic and changing space based on time and the society it was meeting. Yona Friedman in Mobile Architecture, Constant in New Babylon and Archigram in Walking City and Instant City, foreshadow utopias as "non places" that embody the idea of nomadism and inconstancy in space and time. The space in these visions became temporary and variable, maintaining invariants that allow the space to be real and recognizable. Mobility favors man's need in relation to the space in which he lives and is interpreted through different instruments.
In Walking City[52], through technology, mobile, robotic and inhabited structures were defined, moving and living space according to the needs expressed by those who live in New Babylon[53], through a universal branched net, the territory is colonized by the nomadism of the homo ludens[54]. While in Mobile Architecture, the city grew flexibly without canceling the existing, also changing in relation to other urban conditions. Space is not yet abstract but dynamic, as is the approach to the public space of increasingly networked and systematized cities. In the Continent city of Friedman[55], cities became center of a much more complex and hyper-connected network system, announcing the design dynamics that occurred for the next generation of motorways. In the meanwhile motorway infrastructures did not stop their race as a development engine for the territories, but they grew according to a standardized model, linked to security principles, dating back to half a century earlier. This process of growth is continuing to this day, assuming a new meaning[56]. The new meaning that the infrastructure assumed, it is given by the new point of view that was slowly spreading in the early sixties after the publication of the book Silent Spring, which gave rise to the environmental consciousness, interpreting the impact of man on nature.

Image 2| Cover Le vie d'Italia. From high left: Società Italo-Americana Pel Petrolio (8/1928), Bassi (3/1933), Bernazzoli (3/1934), Angoletta-Puricelli, Italstrade s.a. (2/1941), Angoletta-Puricelli, Italstrade s.a. (6/1941), Duse-Puricelli, Italstrade s.a. (8/1941), Duse-Puricelli, Italstrade s.a. (2/1942), Duse-Puricelli, Italstrade s.a. (6/1942), Di Massa-Puricelli, Italstrade s.a. (8/1943).

1.5 Motorway 3.0 | Impact

"Man has lost the capacity to foresee and to forestall. He will end by destroying the earth"[57]. Starting from this statement on which the book Silent Spring is based, we will see through the European policies activated in the last forty years, the evolution of an ecosophic[58] vision of man's action in nature.
This phase, perhaps more than the others, can be considered a transition to change, since 1962 and still in progress. To a first period of strong growth, linked to the reconstruction and development of the country included in a scenario of gradual growth of awareness of the action of man in nature, a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Esso il super carburante


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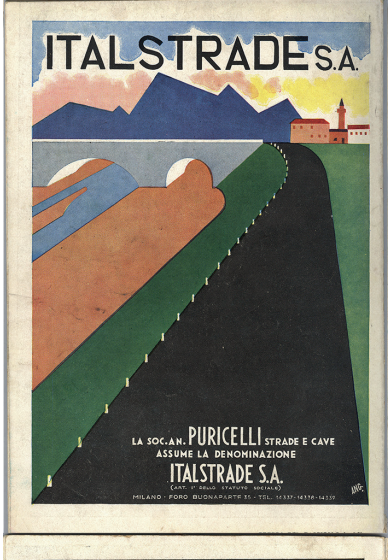
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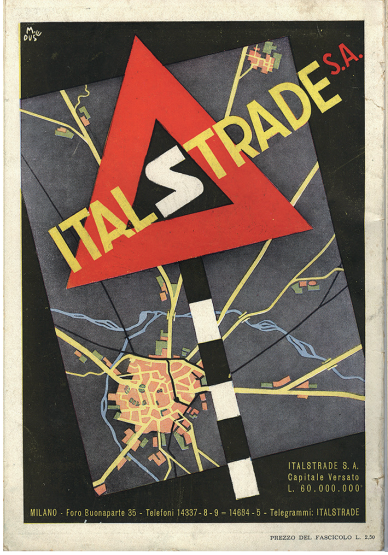
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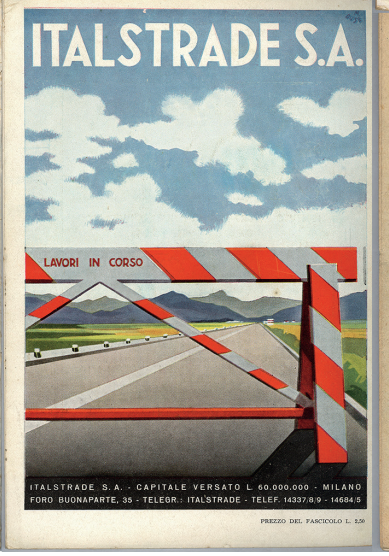
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Motorway 3.0

ENVIRONMENTAL VISION

CO2 NETWORK

1962
"Silent Spring"
Rechael Carson

1963
Vajont Tragedy

1965
Mont Blanc Tunnel

1968
A22 opening

1969
First men walks on the moon

1970
First Earth Day

1970
Environmental Protection Agency

1973
Energy crisis

1976
Barcellona Convention

1979
Oil energetic crisis

1986
Chernobyl disaster

1989
Montréal protocol

1992
Origin TEN-T program

1992
United Nation Earth Summit in Rio de Janeiro

1993
European Uni
Community

1994
European
Sustainabl

1965
First personal computer, Olivetti

1968
First Superbike, Honda

1979
First Compact Disk

1981
First Space shuttle launch

1982
Introduction of PC

1985
Introduction of consumer Mobile phone

1989
World wide web

1964
Instant & Walking City, Archigram

1970
Non- Stop City Archigram

1973
The limits to growth

1975
The quest for Gaia

TECHNOLOGY

TECHNOLOGY AS WAWE OF CHANGE

NETWORK AS IMPACT

2020

1997
Kyoto Protocol

1999
Dioxins scandal

2001
Stoccolm convention

2003
ONU Climate Change Convention (2003-2010)

2009
European Directive renewable energy

2008
Global Crisis

2010
European strategy EU2020

2015
Climate Changes Conference, Paris

2016
A3 Salerno-Reggio Calabria

1997
First Toyota Hybrid Car

2004
Web 2.0 technology

2006
Tesla Roadster Electric Car

2014
SAE International J3016 Automation standard

2017
Hyundai FE Concept Hydrogen car

2001
3D city, MVRDV

2004
Non-city,
Félix Duque

2006
Skycar City
MVRDV

more pragmatic and strategic phase of European policies followed.
More than denounce for the chemical industries, the book of Carson concludes underlining how in nature in order to ensure life, mankind and other species must remain in a relationship of constant balance. The ecological consciousness, which started from this point, is influencing the management policies of the territories and also the design of both small and large infrastructures.
In the meantime, infrastructural growth did not stop. In Italy in the 60s-70s, the economic boom brought the country to develop exponentially with large investments and major works that were planned during the fascist regime. While the railway development stopped its run, for the motorways a new phase of implementation of the network begun. The protagonists were the Adriatic backbone with the A14 (1961-1975) and also innovative motorways for their approach, such as the Autostrada del Brennero (1962-1974)[59]. In those years, however, the cultural great activity and student protests were so significant that they started a process of movements all over the world, both pacifists and in support of the environment.
The origin of Earth Day, April 22, 1970, was a university movement, that now is still remaining a symbolic and informative day linked to respect of the environment. Thanks to Gaylord Nelson[60], 20 million American citizens were mobilized for a demonstration in defense of the planet, initiating environmental activism. The subsequent 1972 United Nations conference on the urban environment in Stockholm established for the first time some fundamental principles on human rights and responsibilities on the natural environment, which will be implemented over the years[61].
The assumption that links up with the Ecosophic vision and the first conclusions of Carson is fundamental. Man "at the same time the creature and creator of his environment" must conduct "his actions with more prudent attention to their consequences"[62] recognizing the duplicity between human actions and the state of the environment, which characterized this period. In the same year of the Stockholm conference, the Report on Limits to Growth[63] was published and it gave the decisive push to environmental movements. The conclusion of the report was to maintain a stable rate of growth of pollution, industrialization and consumption of resources. The condition of life will tend to precipitate, progressively reducing the growth of the planet. To avoid this vision, it was proposed as a general strategy to aim at the general equilibrium of ecological and economic stability, to preserve and to guarantee in equal terms the rights of the human condition on earth. In this scenario, ecology started to be a dogmatic science to follow, for which the motorway and the large scale works of man, became symbols and generators of impact, through fragmentation and pollution in all its features.
With the energy crisis of 1973[64], the research of alternative energy sources brought the application of the previous years to be implemented immediately. The entire production system was in crisis, thus leading to greater awareness of the risks related to the use of non-renewable resources, such as oil. Ecology and energy economy linked to savings are affecting the real ecological change in the postmodern era. In this scenario, the utopias about

the city and the organization of the communities, were oriented towards an ecological but abstract direction. In the first decade of the Motorway 3.0, significant utopias were still affected by the indeterminacy of space, which slowly began to abstract itself as in No-Stop City. Here there is no identifying image of space, there is no preordained form dictated also by the function itself, but space is conceived as a result of "a quantitative accumulation" of uses that cancel the same urban morphology, through a continuous concept of spatiality. In this image the prevision linked to the representation of the territory, idealizes the continuous and monumental urban space in its dimensions, but not characteristic in its form, canceling at the same time the urban space that was linked by mobility.

In addition to the radical vision of Superstudio, in 1975 there was a more ecological vision of the city, or rather of the society, influenced by the hyppi ideology of the previous decade. Ernest Callenbach's novel, Ecotopia[65], described in an almost astonishing manner what, twenty years later, was turning into reality. Limiting pollution production as much as possible, using rail vehicles, replacing road transport, using urban public vehicles such as buses, taxis and trams, using renewable energy, producing everything so that it can be recycled and reused, are pragmatic utopias for the city of today and tomorrow, which shortly took shape through European and international protocols and conferences. The Montreal Protocol (1987), Earth Summit in Rio de Janeiro (1992), the Kyoto Protocol (1997) and the European programs implemented by these meetings[66] are the result of an ecological utopia towards which we are directing, also thanks to the innovation technologies.

Urban planning has the ability to define a possible path, that is able to change the current state of things, as it manages to intersect interdisciplinary aspects that characterize those that Guattari defined the "Three Ecologies": mental, social and environmental[67]. We are no longer in the era in which planning can be arbitrarily imposed, but we must take full advantage of the potential and the restrictive conditions that nature offers, not forgetting the technological evolution that is progressing exponentially. While the network was born with the WordWideWeb (1989) and the imaginary on the city moved from the physical connection to the virtual connection, the European strategies was aiming to improve the mobile network, building new infrastructures.

The Datatown[68] of the MVRDV and the Non-City[69] of Félix Duque of the early 2000s are the new utopias, in which the form is completely canceled, leaving space for the abstract information dimension. Datatown imagines a megalopolis of the future, reconstructing space and its dynamics through data and sequences that articulate the self-regenerating city. There are no infrastructures related to mobility, there are no roads, motorways that cover huge distances and connect different poles, because there are no poles, there are no points to reach, everything is instantly reachable and hyper-connected.

This is the condition also in Non-City, where space is not recognizable and is disconnected from any form of imaginable city. This is the utopic perception, but what is happening in this last phase of Motorway 3.0 is different. This phase is following the European strategies like TEN-T and the European

Climate Actions[70], which somehow pursue the idea of Ecotopia of the 70s. However, unlike the previous phase M2.0, these years are faster and more dynamic, requiring a visionary and also a concrete effort to change infrastructures, which are increasingly digital and less built.
This "Third wave" of innovation, or better "Forth wave", recalls the final phase of the Motorway 1.0, where technical innovation influenced the change in the territory that happened in the next phase (M2.0). "Recurring cycles in the history of civilization" would say Giambattista Vico. From a M1.0 state of necessity, we had reached a development phase M2.0, so from the M3.0 phase in which the infrastructure is seen as impact, we should achieve a state of perpetual perfectibility, defining a new generation 4.0 of motorways, resilient and osmotic in changes.

1.6| Motorway 4.0 | System

Why a change is it important?
Reaching a 4.0 stage for motorways is essential. As technology is making great strides, also infrastructures should be able to respond quickly to the dynamics that innovation activates in urban and extra-urban contexts. The motorways in this are almost emblematic of a change that has not yet been done and that has yet to take place as soon as possible. Roads and motorways are planned and constructed as half a century ago (the form has not changed) and little experimentation is being carried out. The widespread sentiment is a discomfort towards what is in the news, especially in recent years in Italy. The closure of the Salerno-Reggio Calabria construction site, now after 50 years from the beginning of the works, completes a bitter path that highlights the problems, such as: the delays process and the bad construction solutions. The A2 has been saved from bad end of history in the last phase thanks to the new concept of Smart Road introduced by ANAS[71].
Selecting only the events of the last three years, the lack of confidence in infrastructure increases significantly in terms of quality, safety, efficiency, both in performance and in ecological term. Defects in the construction of protective barriers on some viaducts of the Autostrada del Sole between Florence and Bologna (May 2014), the collapse of the Scorciavacche viaduct on the Palermo-Agrigento motorway (1st January 2015), the collapse of the Himera viaduct on Palermo-Catania motorway (10 April 2015), the collapse of the 'Italy' viaduct on the old A3 Salerno-Reggio Calabria (April 2015) and the very recent collapse of the overpass on the A14 near Ancona (9 March 2017), are some examples of precariousness of the infrastructures in time. We can also mention the "incomplete" and what has been done unnecessarily or planned and never realized. In Italy there is a movement, a new style "L'incompliuto Siciliano"[72] of Alterazioni Video, which has cataloged unfinished public works, in a research, mapping and study, collecting more than 750 incomplete works on the whole Italian territory, of which only 350 in Sicily. In addiction there are examples as the failure of the Brebemi[73] motorway and the controversys that there are on the great works construction such as in Val di Susa, in Veneto with Valdastico. This is not the result of a syndrome

NIMBY[74], but also of awareness of the failure that an old-fashioned design would provide the territories , both from an ecological and economic point of view. To cite the title of the 2012 Censis magazine dedicated to Martinoli, it is necessary "to desire again the infrastructures"[75], perhaps aiming at a change, using an adaptive and perfectible approach to the natural changes in the environment. But this is the present and the recent past, the question is: what will hold the future for us?

The paradox of the future.

Motorways, like all infrastructures, are designed to be long-term investments, as support and development security for the territories. Unfortunately, as the futurologist Thomas Frey claims, what happens is "...as we build our elaborate networks of pipes, wires, roads, bridges, tunnels, buildings, and waterways, we become very focused on the here and now, with little thought as to whether there might be a better way" [76]. We talk about the future but in the shapes and in the way we plan, we are stuck in the present. Perhaps because, as Paolo Attivissimo says "it is difficult to make predictions, especially for the future"[77], or we are simply not ready to face it, to tend towards a net change, but we are inclined to keep our certainties stable. This is what is happening now with the infrastructures. In addition to not be resilient to the changes to which nature undergoes, they are not even comparable to the technological development ongoing. The design becomes an overlay of elements and a continuous patching against the found problems in the manufactured artifacts[78]. If we try to make a small survey on the technologies, we can realize the difficult spread on a large scale of the inventions, such as the flying machine. The technology has existed since 1937, then it has been implemented over the years and since 2009 with the Moller M400 Skycar, we have the perfect model. Then, why do not we use flying machines as in all utopias and dystopias on the 2000s?[79] The reasons can be two and each one a consequence of effect of the other. The first is that we are not ready to change a tested mobility system. There is less experimentation than planning in order not to fall into errors and risky design choices. This because of the impact that the change brings, but also in terms of safety, because technology affects new projects also related to recycle of existent.

The planning slows down the design and construction cycle, but also to a preventive attitude that simplified the obtained results. In the MVRDV "SkycarCity"[80] research project, we see a forward-looking approach to the relationship between infrastructural and medium spaces, in this case represented by the flying machine. The focus of the group is important, as they completely cancel the existing, overcoming any limit imposed by existing urban forms and configure dynamic cities in which urban spaces and architecture have another role, even at the service of the vehicles. This utopian reflection allows us to think more openly about the problems and needs that technology would have if it could fully express its potential. This does not mean that we have to raze what we have built so far, but we should focus on the design of space as a consequence of the technology itself, overcoming the standard and the ordinary of the forms we are used to be able to adapt to the existing.

The second reason is due to that society is not ready to handle an immediate change. The existence of the technology does not assume its diffusion (besides the skycar we could list many examples in this regard). We imagine the future but we do not change ourselves, as well as infrastructure. An example of this is the Jetson cartoon, which tells the adventures of an American family of the future, in which the technology is hyper-advanced and the image presented to the public is as follows: a typical 60's family (cartoon production period) where the father is driving the car, his wife sits next to him and the children and the dog are sitting in the back of a small flying ship. He works in the factory and his wife is always at home and takes care of the family, along with a robot colf (dressed as a woman). An image not so different from the American conventions of those years and also from the Flinstone cartoon, instead set in the Stone Age. What are the changes in the three time levels? Only technology. The people and their behavior are unchanged and are not projected in the time in which they are living. And that is what happens to us today, we imagine hyper technological worlds, but we do not think about as to change the habits of our society.
Perhaps the complete change can be had only if we are willing to leave our certainties behind and to commit mistakes overcoming those limits that our knowledge and our habits impose on us, as Thomas Frey would say, "aiming at the stars"[81], and overcoming the paradox of the future.

Next generation of motorway: from state to system.
Knowing that to reach a new generation of motorways the goal is to move from a perpetual state of static, to a more dynamic system, it is important to understand which tools can potentially be followed and reinterpreted. Considering the time in which we live between the ecological era and the fourth technological wave, we cannot ignore the idea of linking ecology and technology through a systemic approach. But to this day, what are the potentials of one and the other that look to the future?

Ecology. The introduction of ecology in environmental planning allows planning in terms of thinking about the future, because the concept of form is transformed into flow, while the function is shaped with respect to the fluidity of the form itself. We then move from "form to flow" and from "function to fluidity"[82]. This allows one to go from a programmed state of space to a more generative and ecological process of the same. The infrastructure in this use of ecology identifies its form in action, since it is neither an object form like buildings nor an active form as for software bits and codes, but it is "an updating platform unfolding" in time"[83].
Ecology becoming "projective" establishes a physical and creative relationship between project and environment, reinterpreting natural behaviors, strategies for the design of infrastructures. The resilience, adaptability and dynamism of nature are attitudes that, if applied to the project, allow reinventing future motorways, not as infra, super and sub-structures, but as "imagined environments", "sensed spaces" and "lived experiences" [84].
Technology. In recent years, experimentation with technology linked to mobil-

ity has been making great strides. Thanks also to European and international policies, our vehicles are changing into hybrids, electric and autonomous. This will inevitably lead the motorways to change in the short and long time. The technology that most concerns the world of motorways is the Driverless Car. When it will be on the market it will probably be used as a luxury option for cars, until to become standard in automotive systems. The car will be in an increasingly complex sensor system, which interacts with the motorway, with a continuous flow of sensory information, in which the vehicles will begin to form a symbiotic relationship with the environment. The Smart Road is already a reality on the A2. In addition, this type of technology acts on time compression, as when it comes to full capacity and we will all use these information and regulation systems in our cars, the roads will be faster and instantly less congested. Smart motorways will be able to accommodate 50-100 times the number of vehicles of today. Paradoxically, there will be more vehicles, more security, more speed and less traffic[85].

Google and Tesla's forecasts are a bit exaggerated. They hypothesize completely autonomous cars, in which hypothetically you could go to sleep and wake up at your destination, already in 2020[86]. But we know very well that this is impossible, both for technical problems that will occur only with the use of the object and for a legal regulation of the use of the vehicles themselves, even in penal procedures in the case of "machine error". Whose responsibility will it be in the event of a fatal accident? Somewhere perhaps in the 2030-2035 period we will begin to see "driverless" designated motorways, allowing vehicles to be used independently. Meanwhile, we are preparing to imagine useful spaces for this type of needs.

Another American popular technology, spread in the fantasies of the Middle East is the Hyperloop[87], a tube transport system, which allows to reach speeds of 4000 mph compared to 300 mph that can be guaranteed by a train. The big element missing for this type of mobility system is the tube infrastructure, which can not be ruled out if we think of a scenario in which the motorways can be reused in another way, due to the absence of use by vehicles. But does make it sense to focus on saving time? Perhaps today it is not a priority, but it could become it.

Other examples of technicalities that look more to consumption than efficiency, are all energy collection systems, increasingly impacting and increasingly efficient, from asphalt to solar paints, from the use of coatings that capture smog to systems recycling and atmospheric water collectors. There are many technologies that we could still cite and that could change the way we move as well as the concept of motorway itself, we just have to be ready to welcome them and through a perfect design, adapt them to any eventuality. Starting from ecology, as a medium between nature and the anthropocentric sphere and technology as a medium for innovation toward the future, we should go further, towards a stage 4.0, through a vision and a leadership to create policies and vehicles for financing to make future challenges possible [88].

Conversation with Hillary Brown | CCNY

Hillary Brown FAIA is Professor of Architecture at the City College of New York's Spitzer School of Architecture. She is also the Program Director of City College's interdisciplinary masters program: Sustainability in the Urban Environment developed with the Grove School of Engineering, Spitzer School of Architecture and CCNY's Division of Science. Her first book, Next Generation Infrastructure: Principles for Post Industrial Public Works (Island Press 2014) has been widely acclaimed. A subsequent book, Infrastructural Ecologies: Alternative Development Models for Emerging Economies, was published by MIT Press, Spring 2017.

1_Felix Guattari said: "More than ever today, nature has become inseparable from culture; and if we are to understand the interactions between ecosystems, the mechanosphere, and the social and individual universes of reference, we have to learn to think 'transversally'"[89]. Do you agree with this statement?

I would affirm that nature today is inextricable from culture. In 20th ct, nature had become too far removed from culture but given the concerns of the Anthropocene, we need to acquire more means for integration. Yes, I profoundly agree with this statement. It means that we have to get out our "silos" (fragmentation of our disciplinary thinking) and start to think horizontally across boundaries. Not just our professional boundaries but thinking across the boundaries of time and space. We need to think "upstream" and "downstream." We have to practice "relational thinking," how is this component related to that component, even though a component may not at present be in the picture. What are the interactive relationships between cause and effect. Thinking in larger systems and looking at all the formal/informal, visible/invisible reactions between natural systems and constructed systems. Mostly today, we have to enlarge the systems boundaries to include environmental externalities, the upstream and downstream damage we do to natural systems inadvertently. For example, utilization of cars and roadways, as we know, contribute to soil, air and water pollution and so on.

2_From a holistic approach to design, how can natural ecosystems and human-made infrastructures work together?

It is a really good question and I don't think there is an easy answer. I'm going to say they have not readily worked together, but rather have to be force fitted to each other, if we wish to take advantage of natural processes. We can do this, but the problem is that nature works at different pace than our mechanical systems do, so we need more time and space to accomplish what our constructed infrastructure can do in a short time and in a limited space. For example, if we want to harness a wetland to clean wastewater, we can do this, but is will have to be at the pace of the nature works: a slow-moving process, involving natural water flow, and the slow digestion of microbes. We can't expedite that pace if we want nature to do to the work well. So that's a limitation on working with nature. Ultimately we have to

allow for, through observation of natural world, the right amount of space and time for chemical, biological and/or geological processes to unfold. But, we want everything in a hurry; we want transport that moves us, or our goods immediately place to place, whereas transport by canal or river, reliant on relatively passive energetic means would take much longer, although we might enjoy the experience. Nature takes her time!

3_Your book, "Next Generation Infrastructure", starts with the emblematic example of the collapse of the Mississippi bridge in 2007. This is similar to some recent collapse events in Italy. In your opinion, based on what happened and is still happening, how do you think the roadways of the future should be?

One of the problems with our infrastructure systems is that we are thinking in silos, namely, we compartmentalize our disciplines. Somebody does design, somebody else does construction, somebody else does operation, another part does maintenance and another part deconstruction. None of these entities talk to each others. The failure of a bridge in Minnesota is one example. The bridge had a design error (truss members were under-designed). But that alone would not have caused the failure. What happened was that there was repair work and maintenance work going on (storing heavy materials on the bridge) plus they diverted the traffic so the loading was asymmetrical. These separate activities – none of which anyone person saw simultaneously-- combined to make the failure.

4_According with your research field. What are the principles to be followed and the elements to use in order to avoid that today's interventions are obsolete for the future?

Design for multipurpose use is one key principles, designing for low impact, design to incorporate passive, natural processes wherever possible.. We have to design for zero carbon and for climate instability. And finally we need to be not only considerate but beneficial to communities that host an infrastructure facility.

5_How can infrastructure be adaptable and incorporating (resilient) into natural processes?

Under the topic of climate stress, I can give an example of my second book. There is a case study in
Curitiba in Brazil, where they had very low-lying floodplain and every time they have a major flood upstream, all the dwellings in the plain will be inundated. The mayor (Jaime Lerner) had certain funding for flood control and he said : " I can spend this for pipes and bridges or I can spend that basically buying out the people that have buildings in the flood plain, relocating them into suitable housing, and turning that food plain into a park.". He did accomplish just that. He evacuated the favelas, built housing along a new

transportation spine that used high speed buses. In Curtiba, where there was formerly 2/3 mq per person of green space today there is something like 25 mq of green space per person. So he solved the flooding problem and simultaneously created an incredible asset. He transformed the use of pipes, and bridges and concrete, channels into beautiful parkland, with major social and environmental returns. That's my best example of incorporating natural processes into infrastructure.

Image 25| Curitiba From Barigui Park.

Note

1. Ecology, economy and the disciplines related to the design of the territory.
2. Infrastruttura in Vocabolario - Treccani. *(Retrieved from http://www.treccani.it/vocabolario/infrastruttura/)*
3. Bignotti, I. (2016). Resilience. In S. Marini & G. Corbellini (Eds.), Recycled theory: Dizionario illustrato = illustrated dictionary. Macerata: Quodlibet.
4. Ricci M. (2012), Nuovi Paradigmi, Actar, Barcellona, Barcelona-List Laboratorio Internazionale Editoriale.
5. Ibidem.
6. Greener infrastructure said key to Paris climate deal: study. (2016, October 6). (*Retrieved from http://www.reuters.com/article/us-climatechange-summit-infrastructure-idUSKCN1260NE)*
7. Term, used to define the geological era in which the terrestrial environment, described as the set of physical, chemical and biological features in which life is developping and evolving, is strongly conditioned at both local and global scale by the effects of the human action. This period coincides with the range of time ongoing, that started from the industrial revolution of the 18th century, when there was the first significant increase of the concentrations of CO2 and CH4 in the atmosphere. *(Antropocene in "Lessico del XXI Secolo" in Enciclopedia - Treccani)*
8. Favargiotti S. (2016), Airport on-hold, Towards resilient infrastructures, Barcellona, Barcelona-List Laboratorio Internazionale Editoriale.
9. There are numerous anecdotes related to the efficiency of Persian trade, among which we find the testimonies of the Greek historian Herodotus. Among the many techniques of speeding up the transport, the relay between messengers and traders, would seem the most reliable, which actually allows to drastically reduce the travel time of the Via Reale route. In his Stories, Herodotus reports: "Neither snow nor rain nor heat nor gloom of night stays these couriers from the swift completion of their appointed rounds" And still today we read this message as the motto of the postal couriers, reported on the front of the central posts of New York. Iran Chamber Society: History of Iran: Royal Road. Retrieved from http://www.iranchamber.com/history/achaemenids/royal_road.php
10. Wegh- with the suffix -ya, which means "to go", but which also expresses the sense of "transport". In Calvert Watkins (2000), The American Heritage Dictionary of Indo-European Roots, Houghton Mifflin Harcourt, 2000, pp. 95-96
11. To build a Roman road a pit was filled with different materials. The content was variable compared to the material available in the places in which it was located (rocks, debrits, stone and sand). The whole was smoothed "paved" and could be used already in this way or was implemented by further layers cemented by mortar (rough cement, rudus and necleus) and then covered with polycarbonate basalt sheets. (Malacrino, 2010)
12. In particular, reference is to the point where, in 20th BC, Octavianus Augustus placed the golden milestone between the Rostra and the temple of Saturn.
13. The Siberian Way is the road that connects Russia to China, built starting in 1730, considered the tea road for the type of its trade.
14. In France the road system was extended starting from 1738 and in 1780 already counting over 25,000 kilometers of built roads (Ashton, 1975).
15. Hygienic problem, economic and social conditions of the cities started to be faced simultaneously, when the urban system was affected by the imminent progress and also the social protests of the workers. (Calabi, 2008)
16. Among the utopias developed in response to the gradual loss of quality of industrial cities, the Garden City of Ebenezer Howard is the one closest to the concept of urban ecology into natural metabolism. (Calabi, 2008)
17. They are three engineers who have worked on the standardization of roads during the period of the industrial revolution. The first Tresaguet, is remembered as a pioneer in the definition of a standardized scientific approach to road construction; the second Telford, has deepened aspects related to the construction of new roads and bridges, using foundations as profound systems of resistance of the structures; the third McAdam, introduced the covering mantle of the drivable surfaces, called "macadam", consisting of crushed stone and compressed glue material, which allowed the permeability and flow of water. (Schnapp, 2003)
18. As a material, Asphalt was previously known as a covering material, but also as a structural material. Its discovery dates back to 1595, in a natural deposit that was found with the discovery of the new world on the island of Trinidad in the Lesser Antilles. (Schnapp, 2003)
19. For the first time, natural tar was used in 1834 to eliminate dust and mud from the streets of the steel mill in Winchester, England.
20. In 1850 the first oil company in America, Incorporation of the Pennsylvania Rock Oil Company, was born and in 1880 the first power plants were built.
21. AA. W. Pavements in London. (1874). The Manufacturer and Builder, 6(10), 229-230.
22. Barraclough, G. (1990). An introduction to contemporary history. London: Penguin.
23. Donini, G. (2008). Margini della mobilità. Roma: Meltemi.
24. In 1905, time become central in research with the scientific discoveries of A. Einstein on the Theory of Relativity.
25. Kroplick, H., & Velocci, A. (2008). The Long Island Motor Parkway. Charleston, SC: Arcadia Pub.
26. Lay, M. G. (1992). Ways of the world: A history of the world's roads and of the vehicles that used them. New Brunswick, NJ: Rutgers Univ. Press.

27. The peculiarities of infrastructures are under rediscovery and conservation. Almost 100 people came out to view the recently discovered surveys and maps and a wonderful presentation of "Hidden History of Long Island" by author Richard Panchyk at the April 20th (2017) meeting of the Long Island Motor Parkway Preservation Society.
28. "The project creates a 5.2 km long district on the eastern part of Madrid. Starting from a linear structuring element, the tram way line, the linear city model develops on the pre-existing nuclei, the "city points". Surface networks dictate the urban articulation of the linear city." Soria y Mata - Ciudad lineal 1882 in Fasi della trasformazione urbana, FORMAZIONE DELLA CITTA' INDUSTRIALE XIX secolo. Retrieved from http://www.cittasostenibili.it/industriale/industriale_Scheda_4.htm. (Gabellini, 2009), (Calabi, 2008).
29. Chambless, E. (2010). Roadtown. Breinigsville: BiblioLife.
30. The Lincoln highway was the first transcontinental road used for cars, which connected Time Square in New York City with Lincoln Park in San Francisco. (Davies et Pete, 2002)
31. Founder of the Ford Motor Company, he is known for introducing the assembly line concept in cars manufacturing. The consequences of this new industrial process led to a reduction in assembly times and a reduction in the costs of the work. This particular form of production affected the reduction in prices and came into force starting from 1913 under the name of "Fordism". (Lipietz, 1997)
32. Extract from the Futurist Manifesto. Marinetti, F. T. (1911).
33. The documentary "The crash of 1929" contains many testimonies related to the 1920s. Robert Sobel, an American historian says "There was great hope, America had come out of the world war with the economy intact." We were the only strong country in world, the dollar was the king. " The economy was changing and seemed to be the sunrise of the consumer revolution. New inventions, the mass market, the factories that produced amazing products, "What will they invent again" was the saying of the 20s. (*Il crash del 1929 in DOCUMENTAZIONE - Storia e politica italiana e internazionale. Retrieved from http://documentazione.altervista.org/crash_1929.htm)*
34. The AVUS was created as a motorway and a test track for the automotive industry.
35. Lamberti, A. (2004). STRADE D'ITALIA - DALLE ORIGINI ALLE AUTOSTRADE. In CRONOLOGIA - PANORAMA DI 2000 ANNI DI STORIA - LA REPUBBLICA IT. Retrieved from http://cronologia.leonardo.it/storia/a1950c.htm
36. Ibidem.
37. Giuntini, A. (2013). Le grandi infrastrutture: il sistema delle ferrovie e delle autostrade in "Il Contributo italiano alla storia del Pensiero: Tecnica". (2013). In Treccani, il portale del sapere. Retrieved from http://www.treccani.it/enciclopedia/
38. Lamprecht, B. M., & Neutra, R. J. (2006). Richard Neutra, 1892-1970: Survival through design. Köln: Taschen.
39. Ferriss, H. (2012). Metropolis of Tomorrow. Dover Publications.
40. Means the higher part of the city.
41. Ciucci, G. (1983). The city in agrarian ideology and Frank Lioyd Wright: origin and development of Broadacres. In The American city: From the Civil War to the New Deal. Cambridge, MA: MIT Press.
42. Munford, L., & Van, L. H. (1923). The story of utopias. New York: Boni and Liveright.
43. A.N.A.S. (Autonomous National Road Company), previously defined AASS (Autonomous State Road Company)
44. A.N.A.S.: La nostra storia. Retrieved from http://www.stradeanas.it/it/la-nostra-storia
45. Cassa per il Mezzogiorno, is a fund established in 1950 for the construction of extraordinary works of public interest, with the aim of focusing on the economic and social progress of southern Italy. Cassa per il Mezzogiorno nell'Enciclopedia Treccani. In Treccani, il portale del sapere. Retrieved from http://www.treccani.it/enciclopedia/cassa-per-il-mezzogiorno/
46. The Romita law, launched on May 21st 1955, n. 463, had the funding of the tripartite work. 40% was charged to the State, a part was given by the market that the construction of the infrastructure would have powered and a third part would have been result of compensation and stabilization, given by the payment of the toll of the cars. Lamberti, A. (2004). STRADE D'ITALIA - DALLE ORIGINI ALLE AUTOSTRADE. In CRONOLOGIA - PANORAMA DI 2000 ANNI DI STORIA - LA REPUBBLICA IT. Retrieved from http://cronologia.leonardo.it/storia/a1950c.htm
47. The Piano Vanoni had among its objectives the reduction of the disparity between the North and the South and the reorganization of public financial resources.
48. Lamberti, A. (2004). STRADE D'ITALIA - DALLE ORIGINI ALLE AUTOSTRADE. In CRONOLOGIA - PANORAMA DI 2000 ANNI DI STORIA - LA REPUBBLICA IT. Retrieved from http://cronologia.leonardo.it/storia/a1950c.htm
49. Menduni, E. (1999). L'autostrada del sole. Bologna: Mulino.
50. The first Italian underground was born in Rome in 1955, followed by Milan a few years later in 1964, becoming the first line of the state, by length (about 101 km).
51. Third wave is the definition taken from the book "The Third Wave" by Alvin Toffler, published in 1980. Toffler, A. (1990). The third wave. New York: Bantam Books.
52. Sadler, & Simon. (2005). Archigram: Architecture Without Architecture. MIT Press.
53. Careri, F., & Nieuwenhuys, C. (2001). Constant: New Babylon, una città nomade. Torino: Testo & immagine.
54. Homo ludens is the creative man, fully free and conscious of being able to act on the world through fun and play. The driver of homo ludens to be a nomad is the desire for adventure and to experience creativity in the places where it lives. (Careri, F., & Nieuwenhuys, C. (2001). Constant: New Babylon, una città nomade. Torino: Testo & immagine)
55. Text by Lara Vinca Masini written for the meeting, which held on 21 June 2004 at the Targetti-La Sfacciata Foundation,

with Yona Friedman as part of the Architectural Observatory project curated by Pino Brugellis.
(ARCHPHOTO » Archive » Lara Vinca Masini_L'utopia tecnologica nel dopoguerra. (2004, June 22). In Archphoto rivista digitale di architettura arti visive e culture. Retrieved from http://archivio.archphoto.it/2004/06/22)
56. According to the recent conclusion of the works on the Salerno-Reggio Calabria, on December 22nd 2016.
57. Strong sentence elaborated by the philosopher Albert Schweitzer, to whom Rachel Carson dedicated her book Silent Spring. Quote in pag. 19, Silent Spring. (Carson, R. (1962). Silent spring. London: Penguin Books, in association with Hamish Hamilton)
58. Ecosophy means (from the Greek oikos- home, -sofia wisdom) the principle underlying the deep Ecology in which the role of man is reduced, within the ecosphere, reversing the anthropocentric vision of the world. (Definition of Dekke Eide Næss).
59.Thanks to the work of Porcinai, with his American training, the infrastructure arrived to a different perception, closer to the landscape. The use of local essences, of the guardrail in cortain, the relationship with the territorial diversity intercepted by the A22, made the motorway space a cultural richness for the traveler and commuters who uses it. Only today, the concentration of traffic makes secondary the choices made in the past by the landscape designer Porcinai. Now the priority seems to be the performance efficiency of the motorway. (Scaglione, P., & Ricci, M., 2013).
60. He received the Presidential Medal of Freedom in 1995 for his contribution in terms of environmental protection and became an advisor to the Wilderness Society since 1981. (Earth Day Italia Onlus. Earth Day Italia. Retrieved from http://www.earthdayitalia.org and Nelson, G., Campbell, S., & Wozniak, P. R. (2012). Beyond Earth Day: Fulfilling the promise. Madison, Wis: University of Wisconsin Press)
61. There are a total of 26 princes among these: "the earth's natural resources must be protected for the benefit of present and future generations, the ability of the earth to produce viable renewable resources must be maintained and restored wherever possible, in building planning and urban, it is necessary to avoid the negative effects on the environment, obtaining the maximum social, economic and ecological advantages for everyone ". (United Nations Conference on the Human Environment. (1972). Declaration of the United Nations Conference on the Human Environment - A/CONF.48/14/Rev.1 Chapter I - UN Documents: Gathering a body of global agreements. Retrieved from http://www.un-documents.net/unchedec.htm)
62. United Nations Conference on the Human Environment. (1972). Declaration of the United Nations Conference on the Human Environment - A/CONF.48/14/Rev.1 Chapter I - UN Documents: Gathering a body of global agreements. Retrieved from http://www.un-documents.net/unchedec.htm
63. Made by MIT for the will of the club of Rome, a non-governmental association founded in 1969 which made up of researchers and experts from different sectors, including heads of state all over the world. The report was published in 1972 by Donella H. Meadows, Dennis L. Meadows; Jørgen Randers; William W. Behrens III, with the title "The Limits to Growth". (Meadows, D. H., Randers, J., & Meadows, D. L. , 2005).
64. Saudi Arabia's blocking of oil supply to Western countries led to a search for other alternative sources, such as natural gas and nuclear, reducing the demand for crude oil from the main supplier countries.
65. Callenbach, E. (1978). Ecotopia: A novel about ecology, people an politics in 1999. London: Pluto Press.
66. The Montreal Protocol (1987) aims to reduce the emission of substances that reduce the ozone layer of the atmosphere. Earth Summit in Rio de Janeiro (1992), was the first international conference on the environment that involved 172, addressing the issue of sustainable development, producing as results the Agenda 21, the Convention on Biological Diversity, the Principles on forests and the Convention on Climate Change. The Kyoto Protocol (1997) is a protocol that aims to reduce the overheating of the earth by reducing CO2 emissions mainly, as well as methane and nitric oxide.
67. Guattari, F. (2014). The three ecologies. London: Bloomsbury Academic.
68. MVRDV (Firm), Maas, W., & Berlage Instituut. (2005). KM3, excursions on capacities. Barcelona, ES: Actar.
69. BARJA, Juan; DUQUE, Félix; GALLEGO, Joaquín (eds.) No ciudad. Revista Sileno nº14-15. Madrid: Abada Editores, 2004.
70. TEN-T is the implementation of the European network of infrastructures, developing the strategy of the international corridors, through the road systems and the railway network. The European climate strategy envisages the reduction of CO2 emissions with intermediate steps ranging from 2020 to 2050. EU Action - Azione per il clima - European Commission. (2016, November 23). Retrieved from https://ec.europa.eu/clima/policies_it
71. The Salerno-Reggio Calabria, renamed A2, Autostrada del Mediterraneo, has become the first Smart Road in Italy, following an ANAS project plan. Smart Road Anas. (2017, September 4). Retrieved from http://www.stradeanas.it/it/smart-road-anas
72. Incompiuto Siciliano. (2017). Retrieved from http://incompiutosiciliano.org/index
73. The failure is not economical, because the investors recovered the spendings , but it is ecological. If a public construction is not used, the outcome is a failure. Online, R. (2017, 31). Brebemi e bretella con l'A4, Legambiente: «Un flop a carico dello Stato». Retrieved from http://brescia.corriere.it/notizie/cronaca/17_luglio_31
74. NIMBY: "Not In My BackYard", to indicate the attitude of exploited protest that often characterizes the construction of large works such as infrastructures, waste-to-energy plants, etc. that may have negative effects on the crossed territories.
75. TORNARE A DESIDERARE LE INFRASTRUTTURE Trasformazione del territorio e consenso sociale (3/4). (2012). Retrieved from Censis - La Rivista website: http://www.censis.it

76. Frey, T. (2014) 2050 and the Future of Infrastructure. In DaVinci Institute. Futurist Speaker. (Retrieved from http://www.futuristspeaker.com)
77. "It is difficult to make predictions, especially for the future" is a review of the less fortunate predictions of the scientists of the past, to learn from their mistakes, made by Paolo Attivissimo, journalist and IT consultant, at a conference held in Trento at the Sambapolis theater the 24/08/16.
78. There are a lot of example related to solve the urban traffic problem. All of them not shape the city, but they add other elements, stopping the city in the present. Tip Bandit. (2017, August 10). Futuristic Gyroscopic Transportation Concept [Video file].
79. The film, Blade Runner of the 80s, describes a dystopin Los Angeles of 2019, with flying machines and technological systems that at the time of the film production did not be using even if easily producible.
80. In Maas, W., La, G., O'Connor, R., MVRDV (Firma), & University of Wisconsin-Milwaukee. (2007). Skycar city: A pre-emptive history. Barcelona: Actar.
81. Frey, T. (2014) 2050 and the Future of Infrastructure. In DaVinci Institute ? Futurist Speaker. Retrieved from http://www.futuristspeaker.com/business-trends/2050-and-the-future-of-infrastructure/
82. OPSYS, & Bélanger, P. (2015). Going live: From states to systems. New York (N.Y.: Princeton Architectural Press.
83. Easterling, K. (2014). Exstrastatecraft: The power of Infrastructure Space. Brooklyn: Verso Books.
84. Williams, R. (2012, March). Infrastructure as Lived Experience. Landscape Infrastructure Conference. Symposium conducted at Harvard Graduate School of Design, Piper Auditorium, Gund Hall, Cambridge, MA.
85. Frey, T. (2014) 2050 and the Future of Infrastructure. In DaVinci Institute. Futurist Speaker. (Retrieved from http://www.futuristspeaker.com)
86. Danielle Muoio, Business Insider. (2016, April 7). Here are all the companies racing to put driverless cars on the road by 2020. Retrieved from http://www.businessinsider.com
87. Hyperloop One. (2017). Retrieved from https://hyperloop-one.com/
88. Brown, H. (2014). Next generation infrastructure. Principles for post-industrial public works. Covelo: Island Press.
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2.

2. From the osmotic motorway to TechnoEcoSystem. The role of anthropic devices in the landscape

After the historical path related to the perception of the motorway infrastructure over time in the first chapter, this second chapter moves towards a new vision of infrastructure 4.0. Starting from some points already described in the first part of the research, "Reinventing A22"*, this part intercepts the theme of resilience as a planning strategy. Under the resilience paradigm, the motorway will be reinterpreted more and more as a process of technological-environmental transformation of the settlement space. The motorway must be seen in a complex system, in which nature, technology and society interact.

2.1 From the osmotic Motorway to the TechnoEcoSystem

From 2010, there was the idea to collect a set of researches of the old Engineering Faculty of Trento, through the TALL laboratory* (Trentino AltoAdige advanced Land-scape design Lab). This research was under a common thread: the relationship between infrastructure and landscape, born from ideas of an important research promoted by the Department of Environmental Networks and Territory (DART) of the University of Chieti-Pescara. The addresses of INFRASCAPE, the name of the research, are divided into ten thematic sections:
"A1 VALUES: Importance of the landscape: the landscape as the determinant of the project, as well as the functionality, cost and safety of the works
A2 ROOTING. Network context: the design characteristics of the works must adapt to the diversity of the crossed landscape contexts
A3 RATINGS. Landscape sustainability: specificity of landscape sustainability assessments with respect to environmental impact assessments
A4 QUALITY. Sensitive design to the landscape: sensitivity to the values of the local landscape context as a condition of quality of the project
A5 ART. New aesthetics of networks: the aesthetic value of networks as an opportunity for critical reinterpretation of contemporary territory
A6 TRANSIT. Experiences of crossing: transit as a source of learning of the meanings accumulated over time in the territories crossed
A7 NODES. New spatiality: infrastructural nodes as incubators of new forms of spatiality in the contemporary city
A8 RULES. Against regulatory proliferation: integration entrusted to the project as an antidote to excessive fragmentation of sector regulations
A9 POLITICS. Effective planning: recognizing landscape values right from the planning stage of the works design process
A10 INNOVATIONS. Urgency of experimentation: to favor the creation of a new design culture through high quality experimental programs"[1].
Starting from these ten points, the research carried out by the TALL group of Trento, has developed a first theoretical vision towards a new relationship between motorway and landscape, able to activate processes of economic and territorial development. The infrastructure in this first part of research

*The content of "Reinventing A22" research is reported in Scaglione, P., & Ricci, M. (2013). A22, nuove ecologie per infrastrutture osmotiche =: A22, new ecologies for osmotic infrastructures. Rovereto: List

is interpreted as organic material of a new settlement condition with other goals, which take into account new opportunities and new conditions. The motorway, therefore, as an osmotic membrane, supports and promotes the compensation of flows within environment settlement oriented towards sustainable, ecological and landscape-sensitive development[2]. The research in this second phase, theoretical-experimental, which is deepened in this work, will go further, identifying resilient strategies for design, able to support processes of adaptation to cultural, technological and environmental change, using the A22 as a field of test.

2.1.1 | The osmotic motorway and its devices

The premises of the research.
The premises, from which the "Reinventing A22"* research starts[2] an analytical-theoretical phase, are due to a housing condition of the postmodern liquid society[3], in which the interconnection is central for development. We can simplify these premises in three macro-issues, which directly or indirectly have influenced the development of infrastructural networks in the territory. First of all is the economic and environmental crisis. The latter, with its success, especially in recent years, in which the effects of the Anthropocene era (see 1.5) has led European policies to pay particular attention to the redistribution of future investments. Aimed to follow the objectives of European TEN-T[4] program, in the public works, priority has been given to works on railways, strengthening high-speed lines (AV), creating new rails in the main Italian stations. Only recently, at the end of 2016, we have heard of Motorway. This thanks to the conclusion of the last section of the Salerno-Reggio Calabria that completes the Italian "continental" segment of European Corridor 1, Palermo-Berlin. The environmental crisis is bringing us gradually towards a point: we do not need strengthening the connections of the networks, but we should evaluate as these have negative effects on the crossed territories. The Paris conference, whose agreements entered into force last November 2016, pushes the world countries to a much more complex focus on infrastructures. The former Mexican president, Felipe Calderon, is the head of the global commission, said: "Investing in sustainable infrastructure is the wisest decision we can take for our future"; and so it will be, considering that the investments will be conspicuous in this direction in the next 15 years[5]. The European targets for 2020, 2030 and 2050[6], with respect to climate change and energy are clear; and building infrastructure in the territory will no longer be a priority, at least for the motorway arteries. We are a liquid society in which the boundaries and points of reference (in this case physical and not social), are lost and no longer need to exist in the digital interconnection systems of information and communication technologies (ICT), which make the concept of relative marginality. So if infrastructures are born to be the engine of economic development for the peripheral territories, they have no reason to exist, because they are driven towards an inevitable state of obsolescence, due to the inability to follow the time and to meet the needs of society, which inevitably and impetuously changes between the design phase and the building phase.

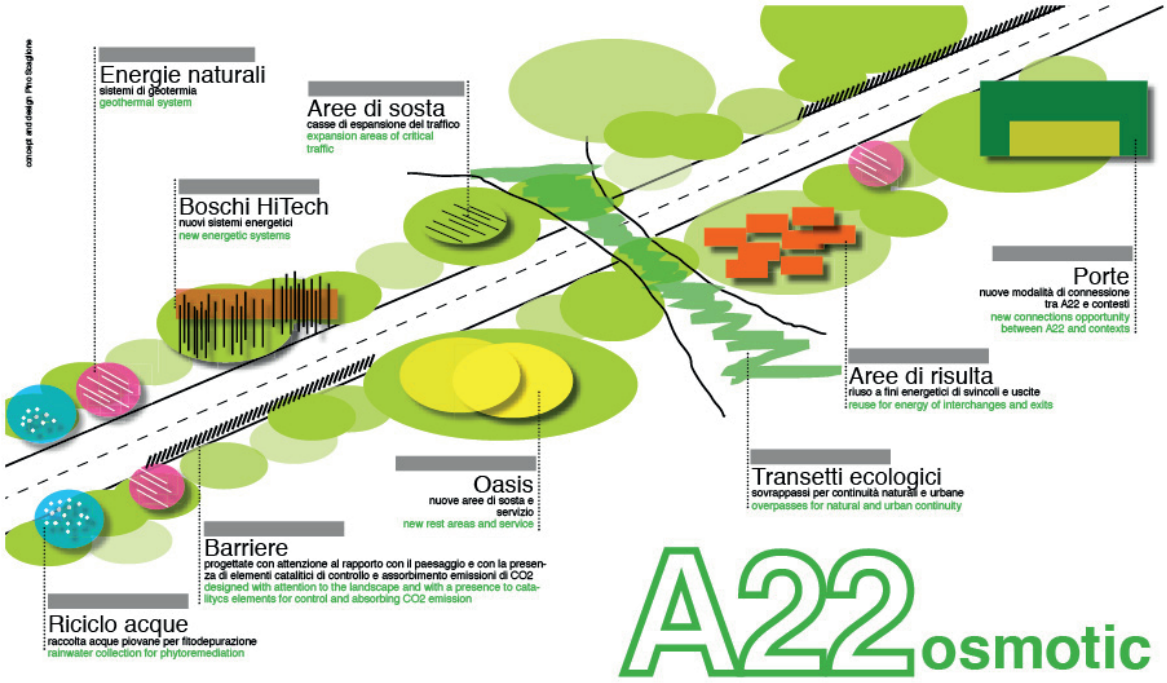
This point leads us to the second premise relating to saturated territories. Perhaps this is among the three, the most central because in some way is affected by the other two in its formulation. Territory are saturated both according to the concept of land consumption and in relation to the concept of marginality. As reported in the recent ISPRA[7] report on land use, in addition to the goals expressed by the European community that provide for zero consumption for 2050, the law[8] approved by the Chamber in May 2016 recognizes the importance of the land as a commons and a non-renewable resource, "fundamental for the ecosystem services it produces, also in relation to the prevention and mitigation of hydrogeological instability events and adaptation strategies to climate change". This position related to land use does not directly concern infrastructures, which are recognized as a public utility. Somehow, considering a decrease in urban growth, the impossibility that small towns can increase the force and consequently the restriction imposed by European objectives, there is weakening infrastructure development. This limitation to build leads the motorway infrastructures to lose more and more consistency in future, in favor of rail infrastructures. For this reason it is important to analyze the consumption of land also for motorways, especially to avoid errors of assessment, as it occurred in the past in the works for BREBEMI motorway. This is an example of a strategic assessment error. In the budget, the company always closes in deficit. Initial estimation indicated 60-80 thousand daily vehicles, whereas according to Aiscat data[9], 15-20 thousand vehicles travel on the 62 kilometers of motorway. Legambiente of Brescia is making a big battle against the company, to avoid increasing the expected disaster with the expansion of the BREBEMI, a stretch that will connect the deserted motorway to the A4, intercepting the Municipalities of Travagliato, Castegnato, Cazzago San Martino , Ospitaletto and Roncadelle[10]. Supported by the environmental crisis, the environmental culture is pushing towards an increasingly careful assessment of saturated territories, which need to reevaluate their relationships and their physical state, rather than aiming at a new urban structure. Precisely with reference to this, the concept of marginality starts the game. In the ESPON 2020 cooperation program[11], among the priority objectives, attention is paid to internal areas, such as marginal territories that are affected by the accessibility to priority services of general interest, such as schools and health services. Accessibility is the key element, also a key player in the ESPON 2013 program, TRACC (TRANSPORT ACCessibility at regional / local scales and patterns in Europe) [12]. In the analysis made on the case study in Northern Italy, which involves the entire Alpine area, it emerges that the accessibility is not necessarily linked to the economic development of the territory. Proof of that is the alpine areas of Tentino-Alto Adige, which for sure they are not affected by the lack of resources or tourist attention, despite their difficult position to reach, compared to other areas of the rest of northern Italy. Another fundamental aspect that emerged is that the impact of new road and rail infrastructures, planned by the European TEN-T program, is significant on the potential accessibility of the population at local level[13]. On contrary, it is not so decisive as to modify the current accessibility model, which is significantly affected by the distribution of the population in

the territory. Therefore, according to the problems of marginal areas, large infrastructures will do little, will bypass them and will not connect them. Even if partial following these data, the conclusion reveals that the marginality is relative to the contexts and the sphere in which it is declined. Each place can therefore be considered peripheral and central at the same time[14]. This reflection leads us more and more towards the idea that the territory is saturated both by necessity and by contingency, and that therefore the strategies should turn towards a more careful use of existing infrastructures, in disuse or not, through tactics that aim to reuse and increase their skills.

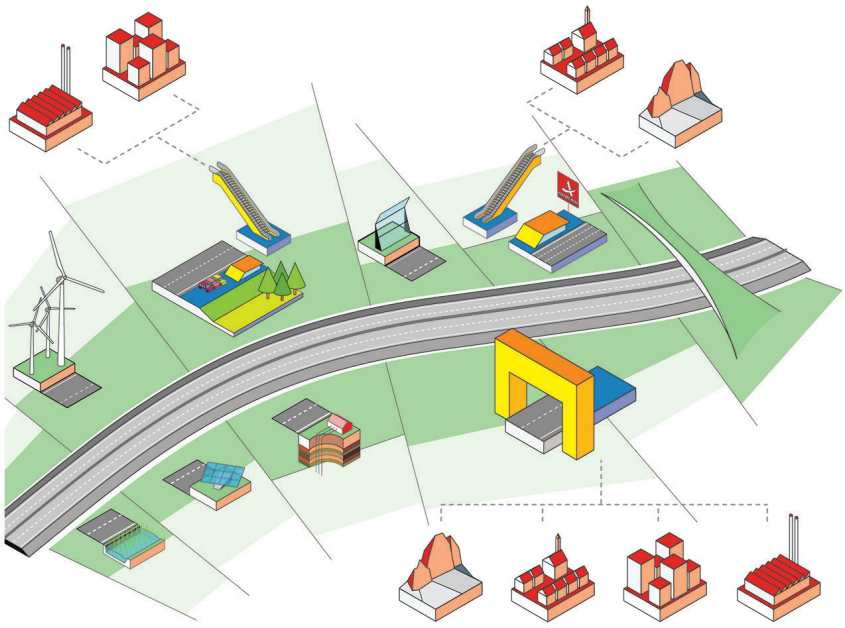
The third premise of "Reinventing A22"* research focus on change of paradigm, defined into the European Landscape Convention, which leads us to evaluate everything around us, not just through a dimensional scale, but above all through a scale of values. The convention becomes an epistemological foundation, because it analyzes the concept of the value of places, so "it concerns both landscapes that can be considered exceptional, that landscapes of everyday life and dross landscapes"[15]. Therefore, as already supported by the INFRASCAPE research, the landscape is crucial in the infrastructure project, as also "the functionality, cost and safety of the works". This brings with it a series of consequences related to the contextualization of the networks, aesthetics and quality of the project. The evaluation and recognition became available to everyone, making any action on the ordinary territory, if the place is recognized a value from the community. The landscape, in its infinite nuances, becomes the base of the integral project, which leads to a more ecological and social attention on territories. In INFRASCAPE, the axiom of "rooting" underlines the need to adapt the design to the peculiarities of the places and contexts crossed. This overcoming the indifference given by the fast connection that characterizes the great built infrastructures. We can no longer be insensitive to need of what is crossed by motorway, but we should take into account the local oppositions, recognizing the value of places, since this changes according to the scale of intervention.
Linked to the dynamics of the last twenty years, the three points of research are addressed through an innovative approach through a deductive process, using the specific case study of the A22. This became a field of experimentation in a new design culture through high quality experimental programs, from specific to general reflection on the theme of infrastructures.

Autobrennero as an interchange platform.
The focus case study of "Reinventing A22"* research is the Brenner Motorway A22, protagonist of debates on the development of the European infrastructure network because of its settlement logic. Autobrennero intercepts different territorial realities, from the Padana Plain to the Alpine landscape, moving towards the center of Europe and defining the end of the Italian section of the European Corridor 1 (Palermo-Berlin). This region of sloping sites, flat, hilly and alpine, share the positive and negative effects caused by the infrastructural axes that settle in the Adige and Isarco valleys. Brenner is the gateway to Europe, where the major traffic percentage of Italian corridor

*These contents are completley described in Scaglione, P., & Ricci, M. (2013). A22, nuove ecologie per infrastrutture osmotiche =: A22, new ecologies for osmotic infrastructures. Rovereto: List



NUOVI DISPOSITIVI PER INFRASTRUTTURE OSMOTICHE
NEW DEVICES FOR OSMOTIC INFRASTRUCTURES



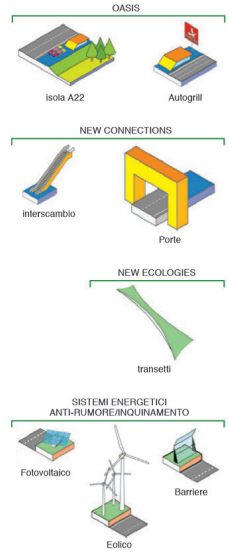


Image1| A22 osmotic concept. Research "reinventing A22".

Image2| Osmotic devices. Research "reinventing A22".

is concentrated, namely 41%[16]. The large number of vehicles crossing the Alpine border declined in the last year by 2%, but remained at the top of the European charts with an average of 26855 daily, heavy and light vehicles (8608 + 1247)[17]. The consequence of this intensity of use of the passageway leads to negative ecological impacts associated with NO_2 and PM_{10} emissions, which, though diminished in recent years, remain above average. This traffic, in terms of estimates, is mainly concentrated on brief tracts (Modena-Mantova, Mantova-Verona,
Verona-Trento, Trento-Bolzano), accentuating its peaks during peak periods of summer and winter tourist turnout, with a constant average of freight traffic. At the conclusion of construction of the Brenner tunnel the situation should improve. Tire freight transport will go on rails, and high capacity will become the main carrier of transport through the Brenner highland. There are currently four construction sites, two Austrian and two Italian, others will follow, estimated to conclude construction in 2019. This upcoming project will considerably reduce the problem of traffic intensity along the Brenner Motorway and bring the infrastructure to new design scenarios . The MoMo motorway platform (Modena-Monaco beyond the Brenner)[18] will bring new synchronies between the infrastructure and crossed territories, through variable and adaptable exchange plans and contexts, becoming the generator of the concept of osmotic infrastructure.

The osmotic motorway.*
Osmosis in general is a spontaneous process that leads to the reciprocal exchange between portions divided with a permeable surface, physical or abstract, with the aim of balancing knowledge, intensity and concentration between the parts[19]. The exchange goal is fundamental in the concept of osmotic infrastructure. The simple vision of a motorway changes the purpose: from connecting tool as a closed pipe, to an organic part of the complex system represented by the landscape. Therefore, the motorway, from a backbone that unites a fragmented urban structure, potentially becomes a collective space with variable intensity, favoring balance exchanges and new relations with the crossed territories[20] . The concept of Osmotic infrastructure is therefore born as an alternative solution to the Autobrennero infrastructure to reduce traffic volumes, through a precise reasoning on the existing devices that make up the infrastructure. The approach on new alternative uses of motorway spaces, which re-functionalize and increase the quality of the same, uses devices called osmotic: Barriers, Soil, Transects, Islands and Doors.

BARRIERS: are simple instruments to limit noise in the proximity of urban settlements, they become energy and environmental monitoring systems, as well as architectures that are designed as landscape installations, both for traveler and the territories that interface this system.

SOILS: the impermeable surfaces become an opportunity to collect and purify the water, which are filtered and eventually reused in the crossed agricultural territories.

*These contents are completley described in the articles of Vincenzo Cribari and Mosè Ricci in Scaglione, P., & Ricci, M. (2013). A22, nuove ecologie per infrastrutture osmotiche =: A22, new ecologies for osmotic infrastructures. Rovereto: List

TRANSECTS: these are transversal connections, whose use is shaped by the need. They guarantee ecological and urban continuity relations, limiting the fragmentation of the territories represented by large infrastructures.

ISLANDS: rest and service areas, which become places, platforms of exchange as well as service, which open up to the contexts, offering alternative opportunities for getting to know the places for the traveler.

DOORS: not as limits to cross, but as real territorial gates to other places, which become true functional interchange platforms between local and non-local networks. The doors become opportunity to alternative solutions, to solve traffic problems.
These devices, properly rethought, make the motorway engine of new processes of interaction between the motorway spaces and the crossed contexts.

Therefore the research, going towards the creation of a new design culture, becomes osmotic in the approach and in the process, as well as in the project, towards "a mutual interpretation of ideas, attitudes, experiences" between different disciplines[21]. The infrastructure is enriched with disciplinary complexities in its synthesis, overcoming the logic of the 'regional ontologies'[22] in a holistic view of the design. We will no longer speak only of bases of standardization, mono-functionality, stability and durability but rather "of multiple disciplinary contributions, recomposed into a single landscape vision"[23].

2.1.2 Motorway as TechnoEcoSystem*

Focusing our attention on the motorway system, we realize how much this network has an important spatial influence on the environment. The motorway network is not only a set of aliens portion in the landscape, which shall perform a link function between the various urban centers, but it is a set of 'dense fibers'[24] that define spaces and affect entire levels of terrain, limiting and changing the use. In Italy the motorways occupy a surface area of 954 kmq[25]. Taking into account only the buffer zones of motorways, 60 m per side, provided by the motorway Code, these are the three-quarters of the total surface, more than the surface of Paris, Milan and Barcelona combined together. To this should be added the Road Effect Zone[26], which is the variable spatial buffer that represents the infrastructure effect on habitats. It is the distance between the road axis and the point on which a specific effect is materialized. This distance could be up to 1200 m from the roadway[27], defining an area clearly larger than the visible influence area. Faced with this evidence, how can we talk about motorways as networks locked in their boundaries, when in Italy, only their physical size is greater than the area of three major European cities?
Over the past years, comparing the data reported by AISCAT[28] 2009-2016, related to ecological potential of motorways, in Italy there was a sudden change of direction, mainly related to increased adoption of sustainable

* Part of this paragraph is in Sgaramella, Gaia (2017) "Motorway as a TechnoEcoSystem" in Schroeder, Joerg, ed. Carta, Maurizio, ed. Ferretti, Maddalena, ed. Lino, Barbara, ed. (2017). Territories: Rural-urban strategies. Berlin: Jovis.

approach, due also to the objectives of European policies about energy[29]. In particular, from the annual statistical reports, in 2011 there was an increase of energy production from the motorways, 6 times higher than the previous year, together with the increase of energy devices of renewable energy (RES) in the owned space of the motorway companies. This scenario goes in parallel with an increasing attention related to the quality of the motorway devices, more and more suitable to limit the effects caused by the different types of pollution that produces the infrastructure itself.
In this general framework, in a spontaneous way, the motorways and the residual spaces started to have an active role in the relationship with the surroundings. This through providing services aimed to the connection of spread urbanity and to activate exchanges with close contexts, providing regulating and cultural ecosystem services, as in true natural ecosystems. Exactly as an ecosystem, or rather, as a TechnoEcoSystem[30], the motorway begins to use its structural, metabolic and potential morphology to produce energy, ecosystemic and functional services for the surrounding territories.

The context of Technoecosystem.
The word technoecosystem was used for the first time in the landscape ecology, observing the phase of transition between the industrial era and the post-industrial global information age. Although apparently distant from the study of landscape disciplines, this moment marks a turning point in the relationship between man and nature. It unquestionably leads humanity towards the need to understand whether to aim at a cultural and biological evolution of the life, or go towards extinction continuing to negatively affect nature[31]. Actually, this general point shows as the disciplines should not be reduced to a reductionist analysis of the measurable in their closed and theoretical schemes, but widen their vision of the world through a holistic approach that contextualizes the dynamics in place, to better to interpret them. The ecology of the landscape, among the many disciplines, is the one that best lends itself to support this change of paradigm[32], as it relates the ecological sciences, linked to objective and measurable principles, with cultural aspects linked to the landscape. While the former are based on the ecosystem as a reference unit for the study of natural phenomena[33], the landscape introduces a complexity of systems analysis that makes the action of man protagonist. It (P) to obtain value, needs a subject that recognizes it (S) and a place in which it can be identified (N), answering to the formula $P = S + N$[34]. Therefore (P) does not exist if a subject or a reference dimension is missing. In the definition of landscape of the European Convention, the value of places, does not necessarily to be shared[35], as it is extended to the whole environment that surrounds us, natural and artificial. This leads to an overall vision on natural and artificial systems, where man and nature converge within a unique and global system, which in the ecology of the landscape is called Total Human Ecosystem (THE)[36].

Total Human Ecosystem and the TechnoEcoSystem.
In THE the ecosystems theory is extended to the artificial and human sphere,

respecting the same identification criteria theorized by the ecological sciences. In general, ecology uses the ecosystem as a reference element, which is defined as a functional unit in which biotic and abiotic organisms are connected to each other and to the surrounding environment through biogeochemical exchanges[37]. With the landscape ecology, Naveh introduces the spatial element given by the landscape, which is interpreted as a holistic unit that includes biotic and abiotic elements, their connected processes and man[38] with his noosphere[39]. Defining space as a tangible and physical element in which ecosystems interact, he also introduces the term ecotope to classify space in elementary units of an ecosystem, with structural and functional features homogeneous with the exterior.

Heinz Ellenberg, a supporter of the holistic concept of ecological systems, divides the biosphere[40] into sub-categories that respect six main functional criteria, including human influence in the creation of ecosystems and their cycles of exchange of resources, both material and energetic[41]. The systems are subdivided into two macro groups: natural and semi-natural ecosystems and urban and industrial artificial ecosystems. The former are dependent on solar radiation as an energy resource; while the latter depend on human supply and on fossil and non-renewable energy resources[41].

Introducing the physical ecotope elements, among the macrogroups theorized by Ellenberg, in a classification of units that goes from the natural to the artificial, we realize that only the first group (natural and semi-natural ecosystems) is part of the biosphere. These kind of ecosystems are part of

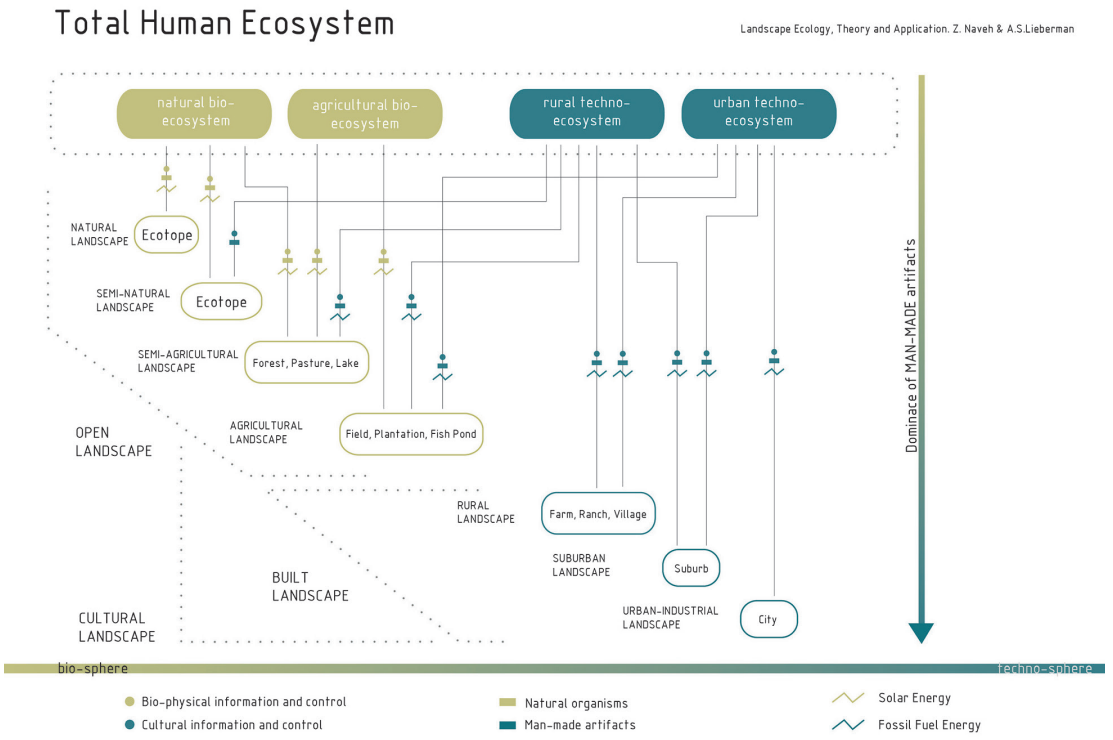


Image 3| Total Human Ecosystem. Landscape Ecology.

this set that, having characteristics close to natural, use renewable energies as energy resources (agricultural systems) and are called bioecosystems[42]. All elements that are part of the artificial sphere of ecosystems, which depends on the use of technologies and non-renewable resources, are instead called technoecosystems. As the bioecosystems, even the technoecosystems have their own technosphere "which is the greatest functional technological unit, powered with inputs given by man through energy and material resources directly produced or converted by the geosphere and the biosphere"[43]. All of this in turn is regulated by the noospheric culture processed by man, in which he becomes the only heterotrophic[44] producer of the system.
Biosphere and technosphere are related to each other, but they are antagonistic within a super system called ecosphere, which is the maximum spatial physical dimension within the Total Human Ecosystem. The ecotopes, as functional units, differ in degree of naturalness (natural and artificial), for the type of control and information exchanged (cultural or biophysical) and for the type of energy used (solar or fossil fuel), going to distinguish the technoecosystems from bioecosystems[45]. The holistic vision of the Gestald Systems theory[46] is another proof that the concept of osmotic infrastructure should be analyzed and inserted into the larger systemic superstructures, as part of THE affected by the surrounding landscape.

As the motorway becomes a TechnoEcoSystem.
The technosphere is not a term invented by Naveh and Lieberman in the Landscape Ecology, but it is an expression used for the first time by the futurist writer Toffler in the book "The Third Waves"[47], implied "of change" , which tells the change related to the transition from the agricultural revolution to the current post-industrial revolution. In this book the transition described in the different periods is determined by the technoecosphere, which changes, conditions and influences the social, economic and natural dimension of the processes that dictate the change of reference paradigms[47]. Also in the case of this research work, the osmotic infrastructure becomes technoecosystem

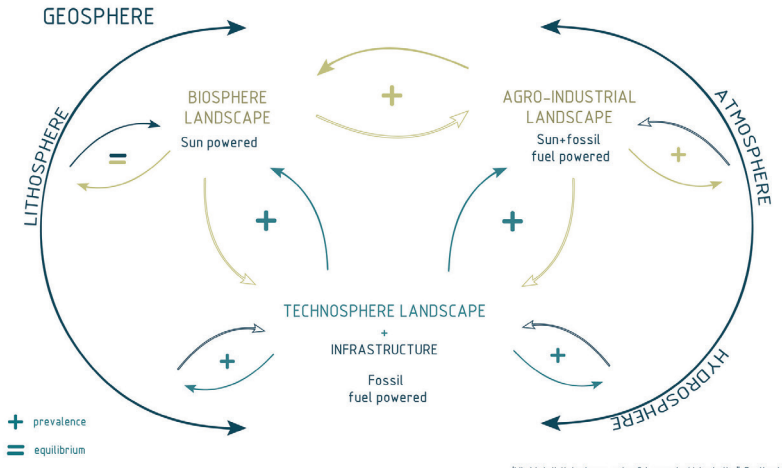


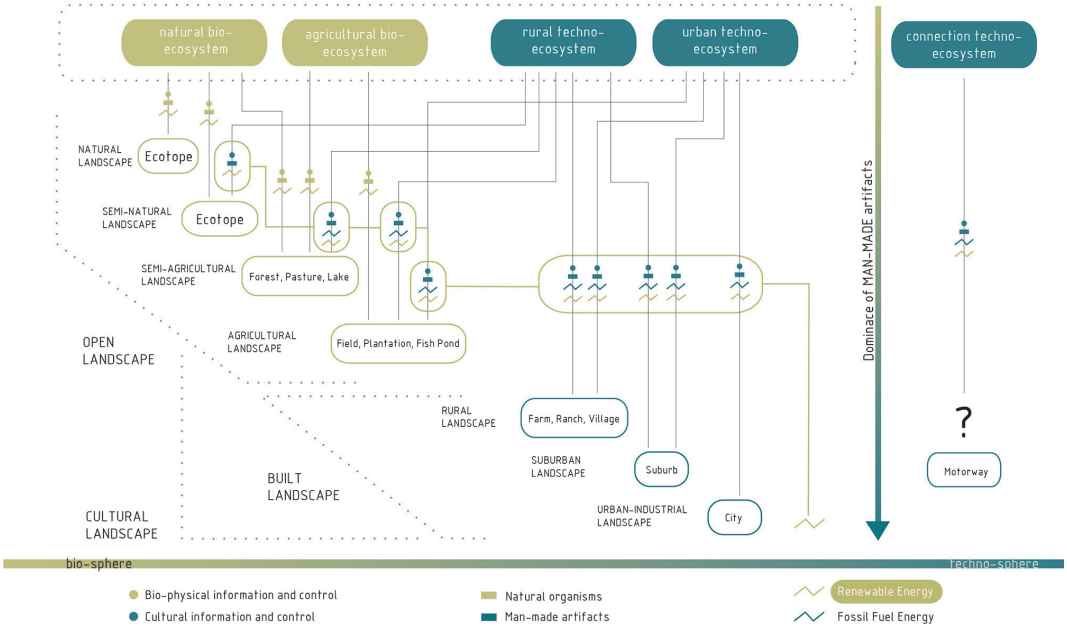
Image 4| Total Human Ecosystem Ecosphere. Actual prevalence situation. "What is holistic landscape ecology? A conceptual introduction". Zev Naveh.

thanks to the ongoing technological evolution, reversing and revolutionizing the cultural perception as the negative ecological effect that motorway has in the ecosphere.
Taking into account Naveh's theory on the systems classification within the Ecosphere, infrastructures in general are defined as tecnoecotopes, therefore as physical and anthropic elements within the THE, but not as technoecosystems. The reason is simply linked to the definition of an ecological system, which must be in relation to the other open systems through energy exchanges[48]. In the case of infrastructures, this did not happen until a few years ago, because their effect on the biosphere was simply negative, without having any kind of bond dictated by the exchange of energy with other functional systems.
Generally, the tecnoecotopes, the structural units of the Technoecosystems, occupy the landscape along with the biological systems, maintaining a functional relationship of contrast with them. On the other hand, Technoecosystems are detractors of quality within the "Gaia Hypothesis"[49] in which the biosphere and atmosphere work autonomously thanks to the biogeochemical exchanges that exist between each other. In this theoretical background, the ecosphere is destabilized by the effect of Technoecosystems and infrastructures, breaking the balance of natural mechanisms of energy exchanges. This gradually leads nature to experiment the effects of the environmental crisis. Thus "The wave of change" for the landscape ecology, it may be precisely recognizing the infrastructures like Technoecosystems, which both connect other functional systems, natural and artificial, and mitigate and offset the negative effects which destabilize the ecosphere. All this through the use of new technologies, supporting new processes in progress.
The process is consequential. Starting from the THE architecture, Naveh and Lieberman defined the general sphere as an ensemble of systems different from each others for the natural degree, the exchanged information for control and the energy that their used to use. (Image 3)
In an energy transition scenario, still ongoing, the way to interact between natural and non natural system is changing with the use of renewable energy. In these framework the infrastructure start to have an active role that compensate in some way the impact. (Image 5)
The infrastructure, as a natural ecosystem, interacts with the others systems through bio-geo-chemical exchanges. It find its place into the urban techno ecosystem sphere (with a new subcategory, where the technology works to balance the equilibrium between nature and antroposphere). In particular, the motorway is classified as an extra urban infrastructure into connection technoecosystem, that works with use both renewable and fossil fuel energy. (Image 6)
In a scenario 4.0, when the transition of energy will be competed, all the systems should reach a stable equilibrium between each other. This is possible when will arrive to use only renewable energy. (Image 7)
Within this theoretical framework, the infrastructure become active in the energy exchange processes with other ecosystems and enter in a new category, the connecting TechnoEcoSystems. These join in those natural biogeochemical cycles that allow energy flows exchange between various open functional

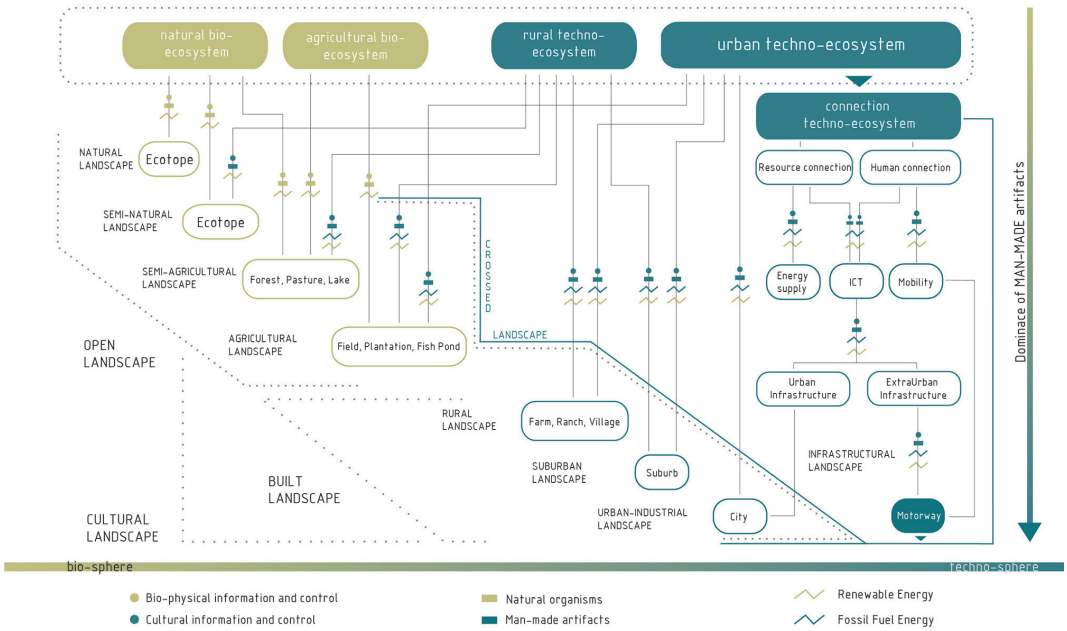
Image 5| Total Human Ecosystem.
Transition towards a 4.0 scenario.

Image 6| Total Human Ecosystem.
Transition towards a 4.0 scenario. Role of the motorway in the Technoecosphere.

Total Human Ecosystem transition towards a 4.0 Scenario



Total Human Ecosystem transition towards a 4.0 Scenario



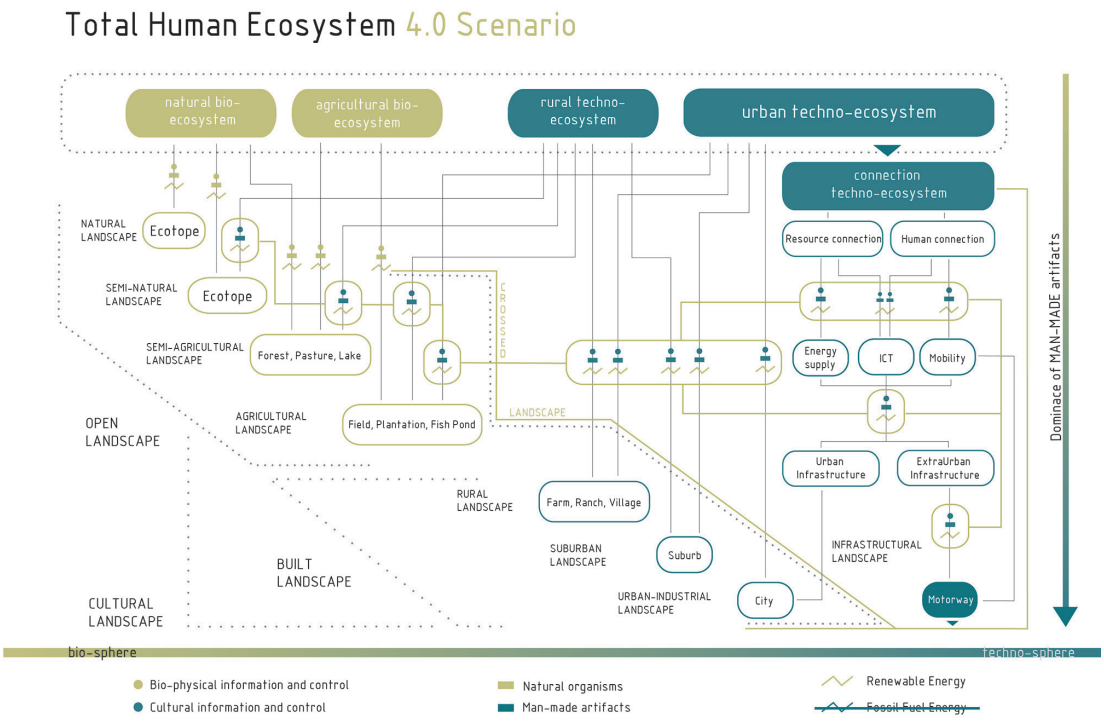


Image 7| Total Human Ecosystem 4.0 scenario. Complete passage to renewable energy.

systems[50]. The motorway as TechnoEcoSystem become a promoter of new processes, which allow regional planning to open a new chapter that sees the motorway not as a quality detractor in the landscape, but as space and basin for reusing, designing, controlling, and monitoring. The motorway becomes: Techno, that is smart, innovative and artificial, in a permanent state of relationship, networking, "glocal" and resilient to changes in the context and for the context; Eco, that is ecological, ecosystemic and energetic, in a state of perpetual and dynamic metabolic exchange, which acts in the environment and for the environment; System, that is the structure, function and ensemble, in a state of interacting support, articulated and constant in the territories and for the territories. In summary, the TechnoEcoSystem is a motorway that works within the landscape and for the landscape. In this new vision, in addiction to switch the apocalyptic point of view related to the infrastructure network concept in relation with the environment, there is also an intention to overcome the logic of 'regional ontologies'[51] thinking in a holistic view of design. Bringing together technological and ecological aspects in devices that perform mitigation and compensation functions for habitats, it could become a challenge that seeks to exceed the sector regionalisms in which the planner could become a coordinator.

The TechnoEcoSystem Motorway.

According to the data of the annual Aiscat report of 2016[52], we can identify some significant numbers, which show as the TechnoEcoSystem is actually a strategic process in progress for motorway infrastructures. European poli-

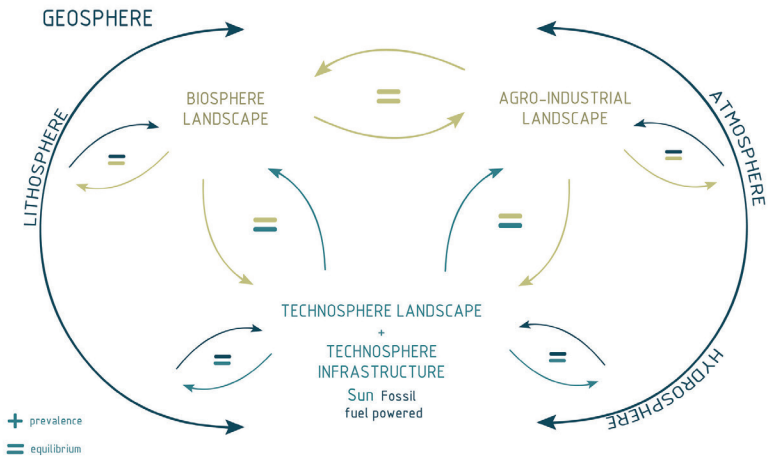


Image 8| Total Human Ecosystem 4.0 scenario. Balance between natural sphere and technosphere.

cies related to energy production and climate change are pushing motorway companies towards a careful analysis of the investments, to do along the dross spaces annexed to the infrastructure. These investments are primarily on maintenance and for provisioning service and recently they aim to implement actions to offset and mitigate the impact on the crossed territories. The collected data from 2009 to 2016 show a gradual growth in services related to the principles of environmental sustainability that Italian motorways ensure in their spaces. 8,604 km of sound-absorbing draining pavement, 828.3 km of noise barriers, 636 Photovoltaic pannels fields, 12,826 MWh Energy produced and 5,927 t / year CO2 saved. Taking into consideration the entire European territory and the North American, this phenomenon is huger. Although not stated, the implemented approach can be traced back to the same strategic overview that the concept of TechnoEcoSystem summarizes.
The osmotic motorway, TechnoEcoSystemic, will use its devices as tools able to implement energy exchanges and compensation with crossed bioecological and technoecological systems, through the new technologies of the techno-digital revolution. A motorway, or more generally an infrastructure, needs three fundamental features to be a TechnoEcoSystem. The three adjectives are: technological, ecological and systemic. Concisely contained in the word TechnoEcoSystem, these three prerogatives respond to the impact of the technoecosphere on the ecosphere.

Technological. The motorway becomes technological, resilient to the processes of transformation and to the relative products of the spiritual and material culture of man[53]. Technology becomes a tool to enhance the infrastructure, making it smart, innovative and adaptive to changes, responding to the needs of man and nature, balancing the two poles of the ecosphere. Technology, from a destabilizing element, becomes a medium in the balance between natural and artificial systems, through "hard" and "soft" instruments[54] that interact with the bio and techno-ecological systems.

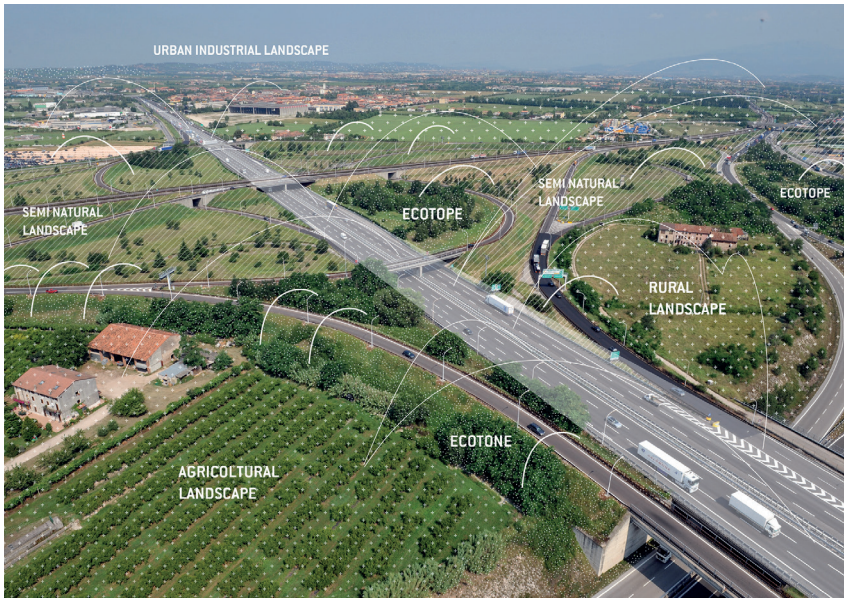


Image 9|Motorway as a TechnoEcoSystem. Relation with landscape systems.

Ecological. The motorway becomes ecological, attentive to the relationships between natural and artificial systems and capable of starting metabolic mechanisms within it. This make possible to compensate and mitigate the effects and the waste produced by the system. The ecological adjective is referred to sustainable and energetic aspects, which can be summarized, in a project, within ecosystem services that the same motorway offers in some way. As a natural system, the techno-ecosystem infrastructure would become a source of services able to regulate, compensate, adapt and mitigate the dynamism of the impacts that are caused by the technoecosphere on the biosphere.

Systemic. The motorway becomes an open, autonomous and interacting system with the others, maintaining its role of backbone of an articulated environmental system. It is a vertebral column that holds together urban technoecosystems, dispersed in different natural settlement environments. Set of osmotic devices, physical support for the operation and the maintenance of technology useful for satisfying ecosystem functions.

The technological, ecological and systemic motorway, through the design of osmotic devices, such as service areas to support transit, transects and noise barriers, becomes TechnoEcoSystemic, switching the logic of an eco-environmental culture. This often embodies a blindness that leads to making design decisions, relating to infrastructure, little decisive, close to the idea that the 'not acting' on the existing, is better of 'doing well'. The consequence is an ineptitude in understanding what might be the potential that a space, such as an infrastructure, could offer to the regeneration of the landscape through restoration, mitigation and ecological compensation tactics, taking into account not a manuals of 'repetition approach' but a 'context sensitive' ones[55].

2.2 TechnoEcoSystem as strategy for resilient infrastructure: cultural, provisioning and regulating technoecosystemic services.

In order to transform the Tecnoecosystem, from pure and simple theoretical definition to an action strategy to make the motorway a resilient infrastructure, we needs some criteria to follow, with consequences in landscape ecology. These action criteria can be traced back to the services that a TechnoEcoSystem can guarantee.
According to the Millennium Ecosystem Assessment (MA, Evaluation of the Millennium of Ecosystems), the "multiple benefits provided by ecosystems to humankind" are defined as ecosystem services[56].
"The Millennium Ecosystem Assessment distinguishes four categories of ecosystem services:

- Cultural services: include non-material benefits such as heritage and cultural identity, spiritual and intellectual enrichment and aesthetic and recreational values
- Supply or provisioning services: supply the real goods, such as food, water, timber, fibers, fuel and other raw materials, but also genetic materials and ornamental species
- Regulation services: regulate climate, air quality and water, soil formation, pollination, waste assimilation, and mitigate natural hazards such as erosion, pests, etc.
- Support services: include the creation of habitats and the conservation of genetic biodiversity"[57].

These services, associated to a type of natural or semi-natural ecosystem, are quantified according with the benefits that can be made to the environmental system, to neighboring ecosystems, reducing the impact that the technosystemic settlement matrix has on the territories.
Considering the new role of equilibrium agent that the osmotic and technoecosystemic infrastructure has within the Gestalt holistic scenario, we can recognize this type of services also in techno-ecological systems. As will be showed in the case studies presented later, these services are partly intuited, planned and applied within real cases. These deliberately do not support the idea of the Technoecosystem of this research work, but in some ways these reinforce the thesis, through design strategies for existing infrastructures in a future scenario.
Following the definition reported in the Millennium Ecosystem Assessment, these TechnoEcoSystem services are defined as follows:

- *Cultural services:* include non-material benefits such as "cultural identity, spiritual and intellectual enrichment and aesthetic and recreational values" that the motorway has the ability to intercept and to enhance in the surrounding landscape;
- *Provisioning services:* provide real resources, in this case as a result of renewable energies that are produced in the residual and functional spaces

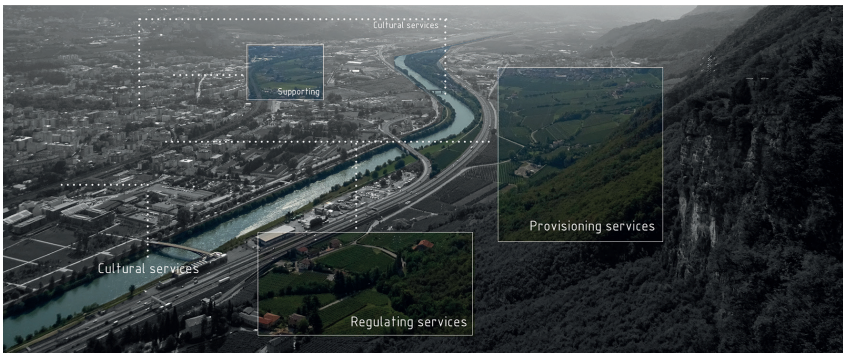


Image 10| Systemic services. Adige Valley.

owned by the motorway or by the devices that compose it, or data resources;
- *Regulating services:* protect fauna from the impacts of fragmentation, treat solid waste of motorway services, regulate air quality and water. They generally mitigate impacts through technologies that exploit chemical and physical principles to fulfill their ecological functions;
- *Supporting Services:* Include all those services that can support the motorway system, so that it can respond to all other techno-ecosystem services. These are in particular: maintenance, 'hard' and 'soft' technologies, and finally the motorway spaces.

All these elements define a general strategy for the motorway design, starting from the existent.
The technoEcoSystem motorway is not something new, but is based on what we already have.

Case studies: theory, trends, action.
To better understand as ecosystem services, defined for a category of natural ecosystems, can be used for a category of technoecosystems such as infrastructure, we will analyze theory, trend and action. Motorway is under the category of connection TechnoEcoSystem and it will be analyzed in a series of case studies. The classification recognizes in the examples: the theoretical premises, the national and international political tendencies ongoing and the application cases. All these examples will allow us to clarify the characteristics that distinguish a TechnoEcoSystem in what the landscape already have.

Each section will be characterized by several case studies, one more significant well described and one or more additional to the principal.

The roundup of case studies, that goes from theory to action, reinforce the concept of transition of TechnoEcoSystem. From a theoretical term due to the ecology of the landscape, in this research the TechnoEcoSystem becomes strategy and instrument of action, to implement projects which aim to enhance the motorway, changing the negative perception of our environmental culture.

Theory. The theory will highlight the headings and concepts from which the

principles relating to the promotion of cultural, ecological and technical-energy parameters related to infrastructures, have been started.

Trends. Trends will highlight documents, calls of project and territorial policies, which highlight the sensitivities expressed by the strategies under way, on the theme of motorway infrastructures, following the categories of technoecosystemic services.

Action. In the actions will be presented real projects that can be applications of the theory and trends, which respond to those services that a technoecosystem should strategically guarantee.
These case studies, as well as typological categories, will be distinguished according to the type of technoecosystem service to which they are related: cultural, provisioning and regulating. In the classification of the services that will be made subsequently, the technoecosystemic supporting services will not be explicitly declared, as they are transversal in guaranteeing the efficiency of the other services identified in the cases that will be presented below.

Card Profile

THEORIES

Cultural context	Historical / cultural background of the theory
Author	Author Background
Key points of the theory	Main points that define and clarify the theory
TES features	Principles | Theories related to TES services

TREND

Cultural context	Cutural / historical premises
Document description	Principal points of the document/law
Objectives & Effects	Summary list of short and long term objectives and effects
TES features	Scenarios | Trends related to TES services

ACTION

Cultural context	Time, place, conditions (Theories e Trend)
Territorial context	Territorial data
Project	Objectives and description
TES features	Tools | Applications related to TES services

Case Studies

2.2.1. Motorway as cultural tool. [cultural technoecosystemic service]

THEORY

The view from the road
Donald Appleyard, Kevin Lynch, John R. Myer

"We became interested in the esthetics of highways[...] it is a good example of a design issue typical of the city: the problem of designing visual sequences for observer in motion [...] the deal is the esthetics of highways. We emphasize the potential beauty of this great engineering achievements, as contrasted with their current ugliness"[58].

Cultural context

The cultural context in which the book is inserted is strongly influenced by theories of perception. Especially in the United States, the post-war years were characterized by the need to think differently[59], as often happens after a period of crisis, activating a process of change, central in the Beat and Pop culture of these years and also in the interpretation of the environment of cities. The emerging logic linked to the Gestalt theory[60] and the Optical Vision, later defined by Gibson ecological optics[61], greatly influenced theories and reflections on the city in Townscape[62] and in The image of city[63]. These two interpretations of the urban environment are both based on the importance of the aesthetics of the urban space: the former of overall meaning of the visual landscape of subject and the latter of a subjective perception of the meaning of the places. These books, both with the aim of identifying the pros and cons of the perceived space in the urban environment, for an ex-post reflection on the definition of the city, will be published in the 1960s and 1960s. A few years later, the attention on the urban environment went further. Examining in depth the perceptive theories and trying to improve human life through them, it was realized that the environment analyzed was very often limited. The well-being of man had to be achieved in the city, in circumscribed spaces by walls and also it had to be guaranteed in moving conditions. If the man spends most of his time in the car, it is there that we should guarantee the welfare to bear the stress given by the vehicle's constrain[64]. If before the car was a further point of view on the city, as in Image of city, in The view from the road the driver is the privileged point of view for the analysis[65]. The goal is to guarantee a certain quality in the perception of urban space within the limits of interaction given by the car. The landscape seen from the street generates landmarks, orientating the driver in a space of moving sequences , a symbol of the desire for change and rebirth of the 60s.

Author

The authors Donald Appleyard, Kevin Lynch, John R. Myer are a group of researchers from the Joint Center for Urban Studies at MIT and Harvard University. Their research was strongly influenced by the presence of K. Lynch in the working group, as previously in the publications of City Planning and Image of city, he had shown his attention in the analysis of the perceived environment. Lynch's studies "are connected to environmental psychology, which seeks visible references to behavior and social and individual orientation in space"[67]. These reflections of Gyorgy Kepes[68] influenced the research group of MIT from 1947. He with his theories of Vision Design, stimulated the work of the urbanist, but also many other researchers. Kepes enriches Lynch's vocabulary through concepts related to cinematography, rhythm and luminosity in which "everything can become significant and units are

uncertain"[69], but through experience these variables can be reinterpreted and made visible. The intuition of translating this reading into projective images is decisive to be attributed to Lynch, who plays a central role in writing *The view from the road*. He became the group's guide, following the experiments of Appleyard and Myer on the theme of the street, as a place of living in moving. Later in addition to Lynch, only Appleyard will examine in depth the theme of perception, first in Planning a Pluralistic city and later in Liviable street.

Key points of the theory

The book in its construction translates the importance of narrative that can be built through the perception of a moving landscape. The story that the authors try to reconstruct along the road, influences the construction and the design of the infrastructure. These are the premises that define the theory, divided into four chapters that significantly describe the key points of the research.

The highway landscape is the introductory chapter in which the main elements of the research are clarified, emphasizing the importance of the user compared to the perceptive experience in moving.

Recording highway sequences is the chapter that through a projective language, allows to represent the perception of movement, making it interpretable through the use of simple graphic symbols.

Analysis of an existing highway refers to the application of topological language to a case study: the Northeast expressway in Boston.

Methods of design illustrates how to design a new road based on previously described criteria, using the motorist's perception as a camera of a film.

The book starts from a very simple premise of comparison: while the pedestrian circulates through the city without having any kind of sensory limits, stopping and reflecting on the environment that surrounds him, the driver is immobile and limited in the border of the motor vehicle. The driver is influenced by the speed in which it travels in the transposition of the information to which the view submits it. Thanks to the influence of theories of perception, the study of the moving landscape is done through a reconstruction of the following points of the perceived space[70]. (The following points are refered to the note 70)

The elements of attention. They are the landmarks, the recognizable elements without any difficulty, that are perceptible even at long distances and that remaining fixed in space in speed for a long time. They become focal points to reconstruct the perspective of the motorist's landscape. Here the driver manages to frame the surrounding space by defining landmarks such as: bridges, guardrails, etc.

The sense of motion. The perception of movement is given by the relationship established between the driver and the external elements that reinforce the concept of speed. The frequency and the alternation of objects, such as trees, noise barriers and their continuity along the path, change the intensity of the speed that the driver perceives, as well as the awareness of the interpreted space.

Road Alignment. The continuity of the road route line is essential to obtain its abstraction. The road follows the orography of the landscape and makes the journey slower and also tool for the visual story of the crossed places.

The motion of the field. The relative movement of objects outside the motor vehicle creates an apparent dynamic scene of objects that seem to fall, to speed or to slide along the highway.

The sense of space. The visual field is not only represented by sequences of images and moving objects, but represents a real space, full and empty in which observer moves. Like every space has its limits, represented by the front window constraint that frames the perceived space and external spaces. the car represents moving margins.

Extension of self. The observer relates to the space trying to control it and know it. The full awareness of the environment makes the observer sure of himself, while in front of the grandeur and the sublime of the landscape, he feels disoriented. This condition of being in boundless territories, but able to control them, is found in a driver who speed along the highway, in his vehicle, extending the vision of the self.

Goal approach. In the journey, the driver defines progressive goals, following the final objective. This perception of precarious reference creates a climax construction in the landscape perceived by the observer in motion.

Orientation. Having points of reference or objectives, changes the perception of space, dispersing the sense of disorientation that the traveler might have during his journey.

Rhythm and continuity. Rhythm and continuity are fundamental within a moving landscape. The speed of the perception of space causes the observer's lack of attention and stops the memory process. The space cannot be reconstructed in the mind. Therefore, the rhythm and the continuity reinforce the identity of the crossed place, reducing the sense of disorientation in the observer and also it makes the experience unique, with the use of figurative exception along the way.

Sequential form. The sequence is difficult to interpret because it is linked to the different ways in which the road is traveled. The passage between one space and another can be clear, gradual, with a continuous invariant (guardrail) having points of reference (partial objectives), which serve to limit sudden reactions and sense of disorientation for the observer.

The objectives emerge from the overview of principles of The view from the road, are summarized in the idea in which the journey should be translated into a real book to read. The trip is a continuous story on the landscape, a visual experience in which the negative perception, the stress and the monotony of the traveler disappear.

TechnoEcoSystem features

In the work of Donald Appleyard, Kevin Lynch and John R. Myer, the perceptive approach

focuses on fundamental points such as identity, figurability and the meaning of places. This allows the motorway to become an instrument of spiritual enrichment, enhancing the aesthetic values of the crossed territory and to be the guarantor of a TechnoEcoSyistemic cultural service.
The principal points of the perceptive approach of the visual space become an instruments of valorization of the places. These interact with motorway infrastructure, making the TechnoEcoSystem a tool to produce cultural services for the travelers.

In the Lynch's approach, the principles that satisfy the cultural function are:
- the perception of moving space
- the recognizability of the places crossed and enhancement of the same
- the redefinition of the motorway space through the eye of the observer in movement

Missing elements:
- the attention to the perception of the space in motion from the crossed places
- the definition of the motorway space through the eye of the inhabitants of crossed places by motorway.

TREND

1% paysage et développement

Ministry of the French Republic

"Elle est fondée sur la volonté de conduire la démarche en étroite collaboration avec les collectivités et les acteurs locaux. Cette politique vise à faire de la valorisation des paysages des territoires traversés un facteur de développement économique et touristique."[71]

Cultural context

The "1% paysages et dévelopment" policy was applied for the first time in 1989 for the A75 and A20 motorways. These were the first motorways built in 1987 in France[72], called respectively, the Méridienne, which goes from Clermont-Ferrand to Béziers, and the Occitane, which runs from Vioerzon to Brive. This considerable delay[73] in building infrastructure in French territory was mainly affected by people who lived in the places around the upgrading of existing long-distance infrastructures. The French feared that their landscape could be compromised by the great constructions, going to deface the excellence of the territory and also to reduce the earn the small local economies[74].
For this reason, the Ministry of Transport started a planning policy, both attentive to the performance of the road network, which needed to be developed, and also to activate a cultural approach, attentive to contexts. In the planning phase in 1990, the Collège d'experts Paysage et Environnement was established by the Ministry of Transport. Around it, there were various competences for the protection and enhancement of the landscape[75].
Progressively, this policy of attention and of involvement of the territory in the construction of the infrastructures spread more and more. It was extended and adapted to the whole national network, becoming part of the long-term national strategy, approved on 3 June 2003, from the interministerial committee of the territorial government. Its effective use on the national network was clarified in detail in the circular of March 31st, 2005, relating to the policy of 1% paysage and développement.

Document description

The interministerial circular, which extends the policy of 1% paysage and développement on the entire national road network, is signed on 31 March 2005. In addition to highlighting the premises that lead to the definition of this document, the text defines a kind of guidelines to follow, in order to approve the action plans shared between the community and the state. The premises consider the infrastructural project as an incentive to enhance the crossed places "avec les collectivités et les acteurs locaux"[76].

The text is a set of two parts: one more descriptive, which highlights the key points of the 1% paysage and développement politics, and one part is dedicated to 5 technical annexes, useful to set up a promotion and land management plan.
The descriptive part highlights the objectives of the document, the conditions, the approach and the financing condition and the management of the project, responding to the current policy.

TARGET. The goal of 1% paysage et développement is to highlight the problems related to the effect that infrastructures would induce on the territory, and then use them as an oppor-

tunity to promote "the natural, cultural, functional, aesthetic and emotional values of the landscape"[77]. The document, which is influenced by the European Landscape Convention, aims to enhance the landscape as a tool for the development of the territories.

THE APPLICATION FIELD. The application of the document is reserved to a list contained in annex 2. The list can be updated and modified according to need, reporting the motorway sections where the document may or may not be applied.
The areas involved in the 1% paysage and développement policy are the areas next to the infrastructure, which are affected to its passage. These include the motorway rest and service areas, which can host activities for the benefit of user and also of the neighboring population. For each section or motorway section that falls within the action plan of the area of interest, a district manager is appointed who has contacts with the prefect of the region and with the related coordinator prefect.

THE APPROACH[78]. The approach used in the 1% paysage and développement policy is a partnership between the State and the local communities interested in signing it. The signed agreement can be developed after the definition of a document called "dossier d'ax".It is important for the development of the project and it is re-elaborated by local representatives of the different ministerial departments, by local representatives of the citizenship and by local representatives of social and economic actors, directly involved in the investment. This document is preliminary to any subsequent action, because it performs a screening on the territory invested by the project. Among the parts of the "dossier d'ax" we find:

- Landscape diagnostics, in which the initial state of the infrastructure is analyzed and its relationship with the crossed contexts, highlighting the potential of this relationship (cultural, natural, architectural heritage, etc.), the development of territorial goals of the medium and long-term and the objectives and problems in terms of enhancing the landscape.

- File of objectives, in which after identifying the areas suitable for action, the individual objectives and envisaged strategies are identified for each of them. In order to facilitate the comprientionof the parts and objectives to each of the identified areas, support maps are defined for the dossier.

- Program of action, fits into a global system focus. The main objective is to obtain an enhancement and management of spaces in a logic of local development, which must be validated by the national management commission within a general planning and must follow the principles which are expressed by the policy 1% paysage et développement.

IMPLEMENTATION[79]. For the implementation of the action plan, the dossier must first be examined by the national committee on 1% paysage et développement and then must be showed to the prefect of the region for validation. All stakeholders, representatives, financiers, coordinators will sign the dossier to confirm it. If well drafted, it will allow the competent authorities to approve the proposed intervention, verifying land concessions as well as conformity of the objectives of 1% paysage et developpement policy.

FINANCING 1% PAYSAGE ET DEVELOPPEMENT[80]. The partners involved for financing the infrastructure, as stakeholders, are invited to contribute to the realization of works. Part of

them are on the landscape within the co-visible field of the road, with a value of 1% of the foreseen expenses for its construction. At least, one contribution equivalent to 1% of the total work of the infrastructure shall be paid to the promoter of the action. In any case, the state or who commissions the work, will pay 50%, usually to be accepted for the foreseen analysis costs in the dossier. Instead for the other interventions it is necessary to intercept other financing. However, in case of need those who promote the action may request financial support to the state with notice or after the completation of the work.

MANAGEMENT AND MONITORING[82]. This is a delicate phase that is entrusted to a competent committee that:
- will specify the methods of application of the 1% paysage et développement in according to the intercepted local realities,
- will evaluate the content of the dossier,
- will evaluate the implementation of the projects which is envisaged by the action.

ANNUAL BALANCE[83]. It is requested by the circular, to carry out an annual budget of the envisaged activities, corresponding to the 1% paysage and développement policy.

Objectives & Effects.
Starting from the general perception that the road and the motorway are privileged vectors that allow users to enter into a privilage relationship with a landscape and an heritage more easily, the 1% paysage and développement policy uses the motorway infrastructure as a great accelerator of econimic development of local realities.
The objectives set by this policy can be summarized in two fundamental points:
- participation, as a search for a shared vision of the problems related to the effects that an infrastructure has on the crossed territory, through the involvement of the various local actors;
- the definition of a transversal improvement strategy that integrates the different approaches to sustainable development (economic, social, environmental, cultural, ...) for the enhancement of local territories, after a territorial diagnosis of potentialities.

The effects of the application of this procedure are considerable. For the motorways now completed in their construction it is possible to notice the quality and quantity of produced services, thanks to Livres Blancs, chartes d'itinéraires and chartes locales produced before the circular of 31 March 2005[84]. Using the policy of 1% paysage et développement, the first motorway built in the late 80s, the Méridienne A75, has created around the motorway a feeling of community. This created the Méridienne association[85], which with its work for more than thirty years, defends the touristic, economic and cultural interests of the Clermont-Ferrand / Béziers section. The association promotes the infrastructure as a value of the territory, through the promotion of the landscape and of local products, with a tourist information guide, Autoroute du saveurs, for travelers who aim to discover the territories. On the intercepted sites of the regions and departments, the motorways that are still under construction with a dossier d'ax, report the general objectives they are performing (from economic promotion to tourism). This in order to take into consideration the actions for the context through the objectives, using public funding. These founding could be mobilized for the implementation of 1% paysage and développement also through other public subsidies.

TechnoEcoSystem features

The territorial promotion approach through a partnership involvement of the local economic dimensions implemented by the 1% paysage and développement policy, make the motorway service complete in its approach. In this way, involving the local stakeholders in identifying potential of places, the motorway space has made the French infrastructure a remarkable example of landscape architecture. The multidisciplinary attention to the theme of the construction of infrastructures, makes the motorway a engine for the development of the territories and an enhancement of itself.

The trends that satisfy the cultural function are:
- the promotion and enhancement of the natural, cultural, functional, aesthetic and emotional values of the landscape
- the stakeholder involvement in the definition of an action program
- the compensation for local realities through development strategies

Missing elements:
- the attention to the perception of the space in motion in the co-visible area
- the definition of the motorway space through the eye of the inhabitants of crossed places by motorway.

Routeontwerp

Ministerie van Verkeer en Waterstaat, Directoraat-Generaal Rijkswaterstaat, Dienst Weg- en Waterbouwkunde

"... routeontwerp has transcended its initially fairly narrow focus on visual appearance and has assumed a more substantial role in establishing a relationship between the road and its surroundings. Route design thus complements the reality of contemporary infrastructural planning, in which the emphasis has shifted from road planning to designing motorway landscapes."[85]

Cultural context

The cultural context of the Routeontwerp project is conditioned by a particular focus on architecture and the environment that distinguishes the Netherlands. Dutch architecture has always had many appreciations from all over the world, but nevertheless, it has always shown a particular inclination to go beyond the limits of perfection and satisfaction. The Dutch pavilion at the MVRDV World Expo in Hannover was praised worldwide as the most interesting architectural contribution to the Expo[86]. Despite these positive signs, at the beginning of the 2000s, paradoxically prevailed in the Dutch population, an ever more intense preoccupation with the proliferation of residential neighborhoods in the cities, the sad state of public spaces in the cities and the apparently casual growth of offices and centers commercial. What was criticized was generally the tendency of the country to be "occupied" in an uncontrolled manner[87]. The spread of wiliness to manage the territory therefore drived the Dutch government to take care of the "reputation of the Netherlands", giving more space to the essential contributions of the disciplines related to the design.
Through Ontwerpen aan Nederland, Architectuurbeleid 2001-2004[88], the government allocated greater emphasis on supporting topics such as architecture, urban planning, landscape and infrastructure.
The two general themes addressed are: "Architecture is a matter for everyone" and "Designing the Netherlands"[89]. The latter, which consists of giving advice and of anticipating actions to implement nine concrete projects in the Dutch territory, appeared to be considerably easier to make than the former.
The idea for big projects was supported by a combination of factors:
- the growing threat to rural areas,
- the renewed attention to the cultural and historical component in the design,
- the work on large infrastructures
- the possibility of being able to achieve all this if presented in the right way.

Among the 9 objectives expressed by the Ontwerpen aan Nederland program, the following emerges: "designing the environment for an existing road" as the chaos of architecture makes the aesthetics of travel secondary. The need to act on infrastructures therefore leads to work for an aesthetic of mobility that requires integration between architecture, infrastructure and landscape.
The prerequisites for the Routeontwerp are linked to a state promotion as well as territorial, design and architecture, as a tool for the enhancement of infrastructure; supported this by the desire to establish internal coordination between the various levels of governance, for the promotion of projects.

Document description

The general objective of the Routeontwerp approach is to overcome the present model of motorways, confused and fragmented, following the landscape paradigms, in order to

obtain a coherent development of their integration into the environment.
Routeontwerp can be described as a way of working that creates coherence in the design of a road and its surroundings. In each work area, the different parts of the regional governments work closely together. This can lead to the strengthening of regional identities, distinguishing, for example, a road that crosses a metropolis or a road along a magnificent rural landscape[90].
According to the Routeontwerp project, the economic and urban functions are combined through an efficient road network so that the route creates a whole quality environment. The development of motorways is no longer a simple declaration, but a precise project of integrated spaces. This is a place project that stakeholders should take under their responsibility.

Objectives & Effects
The three objectives or challenges that the Routeontwerp project sets out are the following:
- To ensure the consistency and continuity of road works with the peculiarities of the area. This can be done by working on the co-visible space, where the perception of movement intercepts a constant, which articulates and interprets the places crossed.
- To guarantee the maintenance, the strengthening and the development of identity and of landscape diversity in the proximity of road areas. This is achieved by working on the transversal links that the motorway creates along its path, making diversity a value that must be preserved and be highlighted.
- To achieve effective cooperation between the parties in terms of road design and project development. This is done not only by favoring interdisciplinary, but also by working with the local dimension of the territories[91].
The application of "Designing the Netherlands" program realized the concepts expressed by the principles of the Routeontewerp on four major Dutch roads. In addition to the A12 , which as a great project of the 2001-2004 Architecture Book can be considered as the origin of Route Design, the concept is applied to the A2, A4 and A27. Differentiated on the various Dutch motorways, this type of action has had different results on the actors who have directly involved into design action on the territories.
For travelers, Routeontwerp represents security and bonds with the territory, the motorway opens its doors to a knowledge of the landscape.
For administrations, Routeontwerp represents an effective way to design and to unify different territorial realities into communication and project management.
For the territories (the local population, municipalities and provinces, companies, associations for the protection of nature and landscape) Routeontwerp contributes to strengthening the identity and cohesion between urban and rural areas, becoming an engine for development and enhancement of the natural and urban environment[92].

TechnoEcoSystem features
Differently to the previous case (1% paysage et developpement), the Routeontwerp works more on the aesthetic quality of the project, making central the role of the architect who interfaces with other figures of the different technical-landscape fields. Tthe project aims to enhance the cultural values of the Dutch territory, using as a tool to do it the quality of project, in which the Netherlands are always distiguished.

What is attributable to a cultural TechnoEcoSystem service:

- the promotion and enhancement of the natural, cultural, functional, aesthetic and emotional values of the landscape
- the attention to the quality of the project that enriches the aesthetic values of the anthropic landscape

Missing elements:
- the attention to the perception of the space in motion of the co-visible space
- the attention to the interest of small local economic realities, as a tool for enhancing the project

ACTION

Regenboogroute A12: il percorso arcobaleno

Ministerie van Verkeer en Waterstaat, Directoraat-Generaal Rijkswaterstaat, Dienst Weg- en Waterbouwkunde

Cultural context

The context of action is the Dutch, strongly sensitive to the dynamics of the landscape and the environment, especially after the European Landscape Convention.

The Regenboogroute A12 project, starting from the Routeontwerp concept, is one of the ten macro projects of the "Planning the Netherlands" 2001-2004 program[93]. In general, the goal of the strategic approach is to focus on the concept of Dutch spatial and architectural quality within the public dimension, under the slogan: 'architecture is a theme that concerns everyone'[94]. Motorways are a public affair, because the road is for everyone and through it, the Netherlands presents themselves. The mission of the great Routeontwerp project is to find integrated design solutions. The A12 motorway was chosen as a design prototype adopted by the Minister of Transport.

During the execution the group of architects worked closely with the various ministries, provinces, municipalities, planners and social institutions. Thanks to a shared vision of the development of a path that was architecturally and perceptually of quality, a kit of recognizable elements and feasible design principles was defined, in order to be able to design the motorways based on the experience of the A12[95]. The central objective of the 'architectural' policy of the government is to use the creative ideas of designers in an initial phase of planning and to stimulate public debate on the spatial quality of the motorway and its surroundings.

Action's context

The A12 motorway crosses the Dutch territory from the coast to the Germany border. 85% of the traffic is characterized by short local transfers (less than 15km), because crossing urban centers and small villages with internal roads slows down the distance. It is called the Rainbow motorway, Regenboogroute, because it crosses a rich diversity of cities and landscapes. Already during its construction, between 1930 and 1967, little attention was given to the continuity of the design of the elements that characterize the infrastructure, creating an unpleasant perceptive diversity for those who traveled it[96].

While the road was still under construction, the parts already completed underwent transformations, influenced by regulatory changes. With the introduction of noise pollution limits, noise barriers have been built, without a common approach, compared to an overall design, making the motorway without an apparent identity. The Routeontwerp A12 consists of thirty exits, nine nodes, forty-eight viaducts, fourteen industrial service areas, thirteen car pooling spaces, two transfer points and also it is transversally characterized by three different directions, three counties, three urban regions and thirty-six municipalities[97]. The A12 therefore, thanks to the approach of the Routeontwerp, exploits this variability to become a rainbow motorway that recalls the crossed territorial differences, hiding its presence through a linear and organic design.

Project

The project aims at the quality of road design, helping to determine the effectiveness of design policy.

Problems and objectives

The fundamental problem is linked to the lack of coordination between the involved parts, responsible of the planning and design of the road and its surroundings. Along the A12, the management of project was defined in two ways: through a general supervision of road authorities on the entire road and through a local division of the management tasks into smaller areas, between road authorities and local authorities[98].

The main objective was to define the general characteristics of the Routeontwerp (motorway design guidelines). A good route design contributes to the spatial quality of the areas. This is could happen with an effective cooperation between the various parties involved in road planning and land development. The approach allows condensation of attention to the content but also to the process that starts.

The specific objectives can be classified in:

- to create coherence and continuity between the road network and the predominant features of the area;
- to conserve, strengthen and develop landscapes near the road;
- to achieve effective cooperation within the Transport Ministry and the other stakeholders involved in planning the route[99].

As a project outcome, a document is produced, as a package of perspectives, concepts, and indications recommendations for the spatial planning of motorways and their contexts.

Subjects involved

The Regenboogroute A12 project was supported by the Ministry of Transport mediation with the cooperation of the Ministries of the Environment, Education, Agriculture and Economic Affairs.

In the first phase, the transport ministry had a role as a road manager, which simplifies tasks and distributes responsibilities. This required particularly cooperation and coordination in the Rijkswaterstaat (Ministry of Infrastructure and the Environment), in the area of South Holland, Utrecht and the Eastern Netherlands, as well as a good basis of project disciplines with to deal with. The Rijksbouwmeester (Ministry of Housing, Spatial Planning and the Environment) plays an important role as a quality guarantor in this project. In the second phase, the Rijkswaterstaat invited the subjects interested in the territorial planning of the areas[100]. This type of transition requires particularly cooperation with the parties outside the Ministry of Transport. At local level, other public bodies such as provinces, metropolitan regions and municipalities collaborated. In this case, the quality assurance was provided by the management given by the Rijksbouwmeester laboratory.

The general outline of the route were traced by the interested administrations of South Holland, Utrecht and the Eastern Netherlands, while the technical aspects of the road were controlled by the ministry van Verkeer & Waterstaat (ministry of transport). They were supported by the Minister of Public Works (Ministry Vrom) and by a team of architects, a central review committee and other external experts[101].

Method

The Routeontwerp approach consists of three components: research, design and implementation. Each of these blocks is based on the experience of the Regenboogroute A12. Attention to the content of the project (ideas and programs) and the process of organization quality (methods of cooperation and coordination) are important and transversal

elements in the process.

1_Research. It consists in identifying the opportunities offered by the context and the limitations given by the use of the spaces in which the project takes shape.
2_Designing. It consists in developing principles and solutions through integrated processes.
3_ Creation. In this case it consists in elaborating general guidelines starting from the specific case of the A12. The result is an image of the unique nature of the road's path, with a zoom on each area with specific statements of actions and guidelines.

Research
The research step was proposed to investigate through 6 different steps, conditions, opportunities, limitations of use and the value of the motorway A12 and its surroundings.

A. EXPLORATION OF THE PROBLEM. Identify problems with the Routeontwerp from different prospectives (integrated survey through architecture, art, landscape architecture and urban planning). This survey has allowed the designer to have an overall view of the route A12, emphasizing the relationship with the context, which is perceived on the motorway both by those who travel for short distances, and by those who travel for long ones.

B. ANALYSIS OF THE ROUTE. The analysis focus on the standard design of the road in relation to the context, such as: the altitude and the insertion of the infrastructure into the entire road network in relation to the flows and land use of the crossed territories.

C. SURVEY ON THE FIELD. The areas of proximity to the A12 have been classified into four types: city, forest, lawn and mosaic.
D. RESEARCH SERVICES. There is already a lot of material and there are a lot of experiences inside and outside the Netherlands, under the topic of 'design of motorways' (1% paysage and developpement). These experiences are collected as examples, focusing on three points: vision, perception and security.

E. ANALYSIS OF THE GAME FORCES. An analysis of the involved forces clarifies the values and interests of stakeholders.

F. RESEARCH ON DESIGN. It consists in the definition of a concept that, following the analytical part, starts a general project draft[103].

In conclusion, from the survey phase, the following elements relevant to the design of the Routeontwerp A12 motorway are identified.
1_ The A12 motorway is a fragmented route, with no coherence in the design, which ereases its peculiaritiess.
2_L'A12 is a line that cuts the Netherlands from the coast, up to the Germany borders, through 11 different landscapes, losing its identity.
3_These landscapes can be classified into four types: city, forest, lawn and mosaic.
4_ Near the central axis, there are opportunities for new spatial developments to preserve and strengthen quality.
5.The traveler's perception of the landscape is not very cohesive and attractive.

6_The eleven landscape areas are well suited to the needs of road users[104].

Design
All perspectives of the preliminary survey on the A12 road system, in this section they are translated into a design concept, to solve the fragmentary perception of the system.
The process-oriented vision is based on a double role of the Ministry of Transport, both as a road manager and as a stakeholder for the development of areas close to the A12.
The design path is therefore divided into two parts, one related to the technical aspects of the design of the infrastructure and the other related to the relationship with the crossed environment. The huge amount of instruments produced by architecture and design studios reinterpret a coherent expression of design in the style, composition and image of the road path[105].
The road design principles are simplified in the following table and generalized along the whole A12 route, ranked according to the 4 areas identified in the analytical phase: city, forest, lawn and mosaic.

The points of the Rainbow motorway can be summarized in the following scheme, where there are the eleven landscapes with the design elements that will be investigated. From top to bottom are: the eleven provinces; the edges; the traffic divider; lighting; the nodes; the exits; service areas, structures, overpasses, underpasses and noise barriers.
The design principles related to the relationship with the environment can be summarized as in the following scheme.
Summarizing the two levels of the project, one related to the design of the infrastructure and the other to the relationship with the contest, the following results are obtained.
1. Continuity: the main road is uniform, using distinctive lighting, clear lines, asphalt, signage and unique design that intersects with main corridors, waterways and main water lines.
2. Recognition: the development and maintenance of landscapes features of the entire motorway increases the opportunities to perceive beauty.
3. Spatial quality: the overlaps of the infrastructural space intersections.
4. Sustainability: good design lasts longer and standardizing road elements such as noise barriers reduce the maintenance of the elements.
5. Policy coordination: the Ministry of Transport gives concrete contributions to improve the quality of life in the country as well as it affect the planning with its territorial vision[106].

Realization
After identifying the most important points, the main premise is that all these scenarios can not be developed at the same time. For the purposes of the application of the projects, for each area near the Rainbow Motorway, images were highlighted showing the peculiaritis of the elements in the proximity of the area. The 12 final objectives are reported in the final executive document by means of identy sheets, following the territorial implementation plans of places crossed by the A12. The data sheets show the location, an image of the typical landscape, the description of the action and a visionary simulation of the effect that the design action would give.
The project is specific for the A12, so it can be replicated in the method and in the process, but not in the result and in the specific objectives. This type of process facilitates the exchange between the Ministry of Transport and of Environment, often in contradiction

in public works for some procedures such as EIA and SEA. The developed points can be summarized into following examples.

- Droogmakerijen between Aia and Gouda: transformation of the area into a mosaic of life, work, water, vegetation and coherent development of the road network.
- Green Heart National Landscape between Gouda and Utrecht: development of recreational, tourism and nature spots in the area of tourism and leisure networks and the transformation of the Rainbow A12 route towards the main road, where it is solved through new connections.
- Utrecht: the development of buildings and industrial sites along the Rainbow A12 route to the urban front, the development of a suburb, the green area, the Kromme Rijn and the transformation of the A12 into Boulevard City
- National Landscape Area of the Rhine at the east corner of Utrecht: transformation of the area into a mosaic of landscapes of life, work, water, vegetation and coherent development of the road network.
- Utrecht Ridge: development of recreational activities, tourism and nature in the area, recreational networks and the transformation of the main road A12 where there are new connections.
- Valle Gelderland: transformation of the area in a park of life, work, water, vegetation and coherent development of the road network.
- Veluwe National landscape: development of recreational activities, tourism and nature in the area
-etc...[107]

Lessons
After three years, in addition to a coherent design of the infrastructure and the creation of synergies within the collaboration networka, there were considerations on the type of implemented process. The teachings should be applied to future projects with the same key, that is:
- it is always better to have an initial design of the process development times of the project,
- the roles of the involved subjects must immediately clarify,
- an ever wider support must be seeked, not limiting it to the initial one,
- it is never too late to decide to change something that already exists whose design is not recognized
- you have to experiment to learn which are the correct solutions to adopt [108].

TechnoEcoSystem features
The tactics applied on the A12 motorway can be summarized in a single main objective: the creation of a coherent language of an infrastructure route,which at the same time is a tool to enrich the values of the territory. From the most bureaucratic actions to those more specific design, the implemented tactics are useful and exemplary to define the objectives that a TechnoEcoSystem strategy wants to propose.
Specifically, the propose is insert into guidelines that aim to achieve the general objectives. These guidelines, through timely design interventions of the object, are able to increase non-material benefits such as "cultural identity, spiritual and intellectual enrichment and aesthetic and recreational values"[109], which the motorway has the ability to intercept and enhance in the crossed landscape. How is it possible this? Through specific guidelines for

the object A12. The theme is not a generalized manual for the whole of Holland, but a collection of project principles to be followed, adaptable to the specific object. In this way the infrastructure is articulated according to the territorial peculiarities and it becomes unique and recognizable for continuity of identity. This is not the 'standard' approach reached during the developpement period of Motorway 2.0, but it is a glocal cultural approach, applied to infrastructures.

Una rotatoria per Fiorinda

Comune di Predaia,TN e Dipartimento di Ingegneria Civile, Ambientale e Meccanica.

Image 11| UniAmo il territorio. Render of the project.

Cultural context

In May 2016, the Predaia municipality called the research group of urban and landscape planning of the University of Trento, as consultant of "drosscape"[110] areas management of the state road SS43 of the Val di Non. The first meeting between the administration and the university group developed a path, having as object: "the definition of guidelines for the residual green areas and of a pilot project for a roundabout"[111]. The pilot project was planned along the SS43 between the centers of Dermulo and Mollaro to be realized within the event of "Fiorinda 2017"[112], while the guidelines were to focus to a larger area that includes the entire territory of the municipality of Predaia.

With these premises, the challenge was to propose a tool able to simplify a dialogue between two apparently opposed areas: road design and landscape preservation. With this opportunity, the road from a functional element becomes an element useful to landscape promotion.

The guidelines, elaborated by the research group, show specific cases, but not offer an univocal and an uncritical solutions. They indicate a path, outcome of the collaboration between different competences and of the involvement of local realities, in order to reach a shared project elaboration, integrating features, community and territory[113]. Medium between administration and economic stakeholders, the role of the University of Trento was a test of collaborative process between private and public management of spaces between public / private property. The role of the administration was to involve local private companies to invest in the territory, taking care of spaces adjacent to the infrastructure, ensuring for the investors a small branding promotion.

Territorial context

The territorial survey for the guidelines definition is divided into multiple levels of scale,

from a broader view of the valley to a more precise individual analyzed areas .
The valley. Val di Non is a polycentric territory where the division in school, commercial, social-health districts is distributed throughout the valley. These slices of territory structure also the different tourist areas. The complex and articulated settlement organization has the effect and the aim to balance the predominance of the principal cities of the valley.
Looking at the landscape, the principal feature is clearly the agricultural / fruit production, which characterizes the slopes of the valley in the different seasons.
The economy is almost exclusively supported by the production of Golden Delicious apples commercially known under the brand name "Melinda", DOP brand. Less important are tourism and craftsmanship. The intensive agricultural production of the valley and the use of pesticides to guarantee the production, have produced an negative image of the territory. A shame for the Province. This has penalized the development of other fields, especially tourism, compared to the other valleys such as Val di Sole. As a citizen said during an open meeting between administration, stakeholders and university group: "Val di Non is more than a polluted territory, it is also a territory that produces clean energy"[114], referring to Santa Giustina power plant, which uses the waters of the river Noce to energetically feed the territory, maintaining a European record in terms of the size of production at this scale.

The municipality. The Predaia Municipality was born on January 1st 2015 from the union of Taio, Tres, Vervò, Coredo and Smarano Municipalities. The territory under a single administration is extremely huge and diversified, rich of landscape and naturalistic, but also of anthropic and cultural resources.
The territory of Predaia, both for the anthropic / cultural resources and for the economic / productive ones, is multifunctional. Indeed, it stands out for its strong competitiveness in all economic sectors, instead of the image of specialist territory (agricultural) that usually describes the valley[115].
The micro-business fabric is widespread, organized and strongly rooted in the territory.
In the same way, the territory is qualified by a considerable historical-architectural heritage (such as the sanctuary of San Romedio, the power plant and residences for the workers of Gio Ponti built for the Edison company), by a vast rural heritage[116], and by different touristic and sportive opportunities.

Scope of intervention. The guidelines have focused on the road section of the SS43, between the urban centers of Taio and Mollaro. In this section of infrastructure there are three main areas, each one for the three principal points of entrance that allow the population to enter into Mollaro, Segno and Taio centers.
The boundaries of the areas take into account the "morphology of the territory, of the matrix of the field, of the viability and of the settlements distribution." The main element of these three areas are the three roundabouts of junction and access to the small towns of the valley.
Each area is characterized by a "prevalent matrix" of territory:

- SCOPE 1: Entrance roundabout to the town center of Mollaro
Prevalent matrix: Urban fringe area with prevalent industrial / commercial function
This area is characterized by the presence of two elements: the double level (indeed roundabout is located under the viaduct of the SS43) and the two major industrial complexes in addition to some commercial areas.

- SCOPE 2: Entrance roundabout to the town center of Segno
Prevalent matrix: productive agricultural landscape

- SCOPE 3: Entrance roundabout to the town center of Taio
Prevalent matrix: not present. Agricultural production landscape / road infrastructure / industrial plant.

For each area the elements that increase or decrease the value of the area have been identified.
The visual impact of an element is fundamental on an infrastructural route, as it constitutes a privileged point of view. In addition to the quality of the object, the effect of perception "also concerns several factors related to the ability to access more or less easily to the vision of the element itself (visual probability: number of subjects exposed to the view) and the modalities of seeing it (type of visual: fixed, moving, short or long range, point or visual series, open or closed). These possibilities can be transformed into parameters to evaluate the overall visual quality of the road"[118].
Within the individual areas, the guidelines define detractors and enhancers that respectively add value to the landscape or start degradation processes, leading to the disappearance of diversity and historical identity. The following images are an example of analysis of values and detractors, related to scope 2, which highlights the elements to be mitigated and those to enhance.

Project
The working method for the definition of the guidelines has been structured as follows:

First Phase
1. Analysis of the context and the road section of the SS43 that develops between the urban centers of Dermulo and Mollaro.
2. Identification of the study areas, definition of analysis maps and outlining of critical issues.
3. Specific analysis of the case study of the roundabout that connects the SS43 to the municipal roads of Mollaro (Scope 1) and identification of specific guidelines related to the pilot project.
4. Meeting with the companies of the territory.
5. Meeting with the Mobility Office of the Provincia Autonoma di Trento to discuss about the applicability of the proposed solutions, according to the specific legislation and the Highway Code.
6. According with the Municipality of Predaia, the stakeholders and with the opinion of the Mobility Office, definition of the themes to developed within the pilot project.
7. Elaboration of the basic material for the design workshop with the students of Building Architecture Engineering course of the University of Trento[119].

Second phase
Design workshop "Una rotatoria per Fiorinda" with the students of Building Architecture Engineering course of the University of Trento. The workshop was organized as follows:
- survey in the valley and meeting with administration and stakeholders

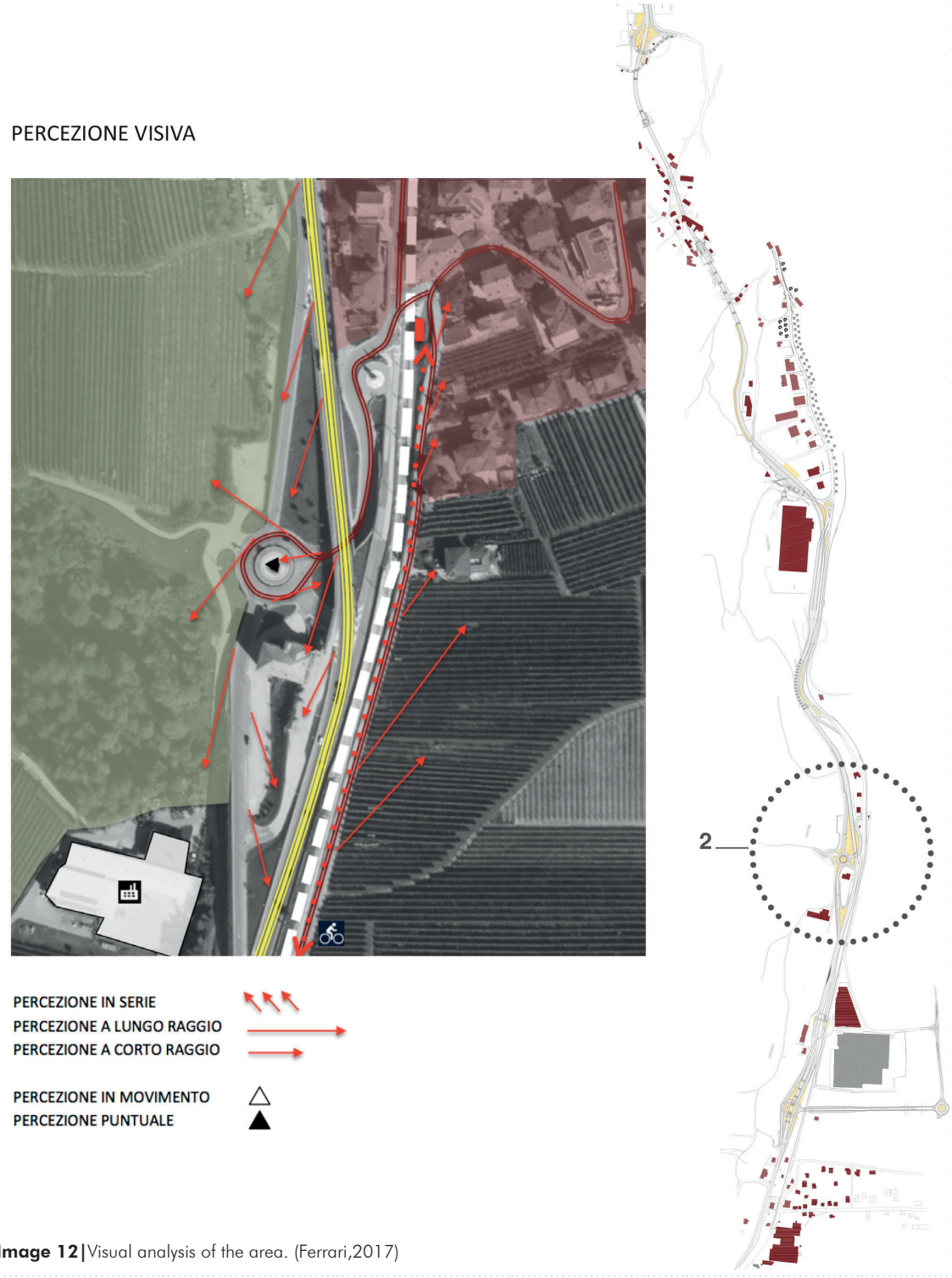


Image 12|Visual analysis of the area. (Ferrari,2017)

- intensive four-day design
- final presentation and evaluation of all proposals
- awarding of the winning proposal and meetings with the local community

Third phase:
Elaboration of the guidelines for the residual green areas and for roundabouts of the municipality of Predaia with the following reference group: Prof. Arch. Mosè Ricci, Scientific Commettee; PhD Arch. Chiara Rizzi, PhD Arch. Sara Favargiotti, Coordination; PhD candidate Gaia Sgaramella, Referent and Arch. Francesca Ferrari, external consultant.

The results of the route with the administration of Predaia, produced an executive project (winner of the student ideas competition) on the Mollaro roundabout awaiting completion and the guidelines document. The latter analyzes the context in a detailed way and has clarified regulatory issues related to visibility and advertising along the infrastructures, starting from the competition projects and suggesting design strategies[120].

The Design Workshop organized by the University of Trento with the students of the Building Architecture Engineering course, with the support of the Municipality of Predaia, local companies and the collaboration of the Acropolis association, was held 20 to 24 February 2017. The aim was to identify a prototype roundabout that had the function to promote the territory.
The road intersection object of study was in Mollaro territory, located below the SS43 viaduct, near the industrial plants of Melinda and Trentingrana and a retail area.
The purposes of the design were to enhanche the following aspects:
- landscape value (protection and enhancement of existing and potential values)
- educational, cultural and informative value
- modality of perception, visual relevance
- contribution to the enhancement of tourism, commercial and recreational resources.

Moreover, the design objective was to suggest solutions that could be extended to a system, in order to organize and provide a set of landscape interventions along the infrastructure. Taking into account the rules limits, we tried to respond to the objectives of the project in the best possible way: D. M. 19 April 2006 Functional and geometric rules for the construction of road intersections, "New Highway Code", DDL 30 April 1992 n. 285 (Article 2, 3, 23), DPR 16, 1992, n. 495 (Art. 26 and 28)

Pilot project. UniAMO il territorio
In addition to the strong concept of the territory union and enhancing the value of the same, giving centrality to the landscape framed by the overhead infrastructure viaduct, the winning project aims to use low-maintenance materials.
The materials used for the Mollaro roundabout pilot project establish a "single code" for the entire specific area of intervention (Scope 1). Wherever possible, the code must be used also in the interventions related to the parking area of the commercial zone and in the underpass that across the SS43.
The materials used in the pilot project are the following:
- Natural stone
- Galvanized steel (Galvanized steel gabions)

- Satin aluminum (Satin aluminum plates)

The interventions must take into account these choices, supporting a homogeneity language in the materials and architectural solutions that make clear the intention of a unitary and coordinated project.

Taking into account the previous considerations and the results of the others involved projects into the competition, some furnishing elements have been identified. Through a

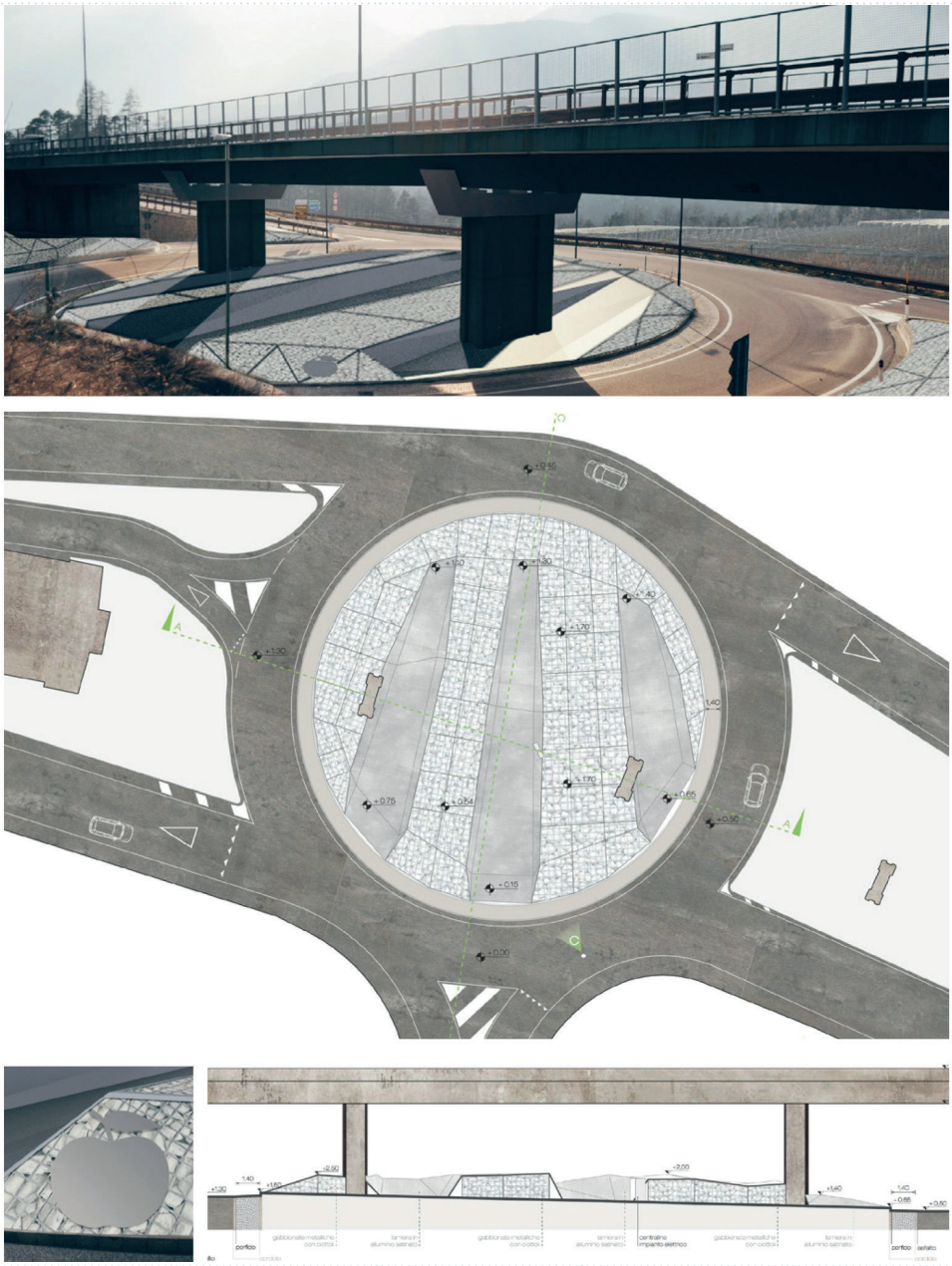
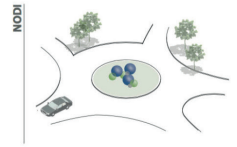
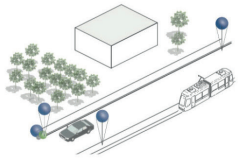


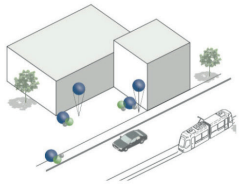
Image 13|Winner project details. UniAMO il territorio. (Ferrari,2017)

general, open and implementable catalog, the guidelines will become for the administration a tool able to define and filter the individual choices of the company or individual citizen who wants to take care of an area near to the municipal or provincial road, without affecting a general system of image of the Predaia Municipality.
At the end of the guidelines, some general indications are reported according with the pilot project materials with some suggestion of maintenance procedure to follow for each objects.
The guidelines were delivered to the city council in July 2017 and the pilot project of the Mollaro roundabout will be realized for Fiorinda event in 2018.

ISOLA CENTRALE 03	I03
Progetto	FRAMMENTI DI RICCHEZZA
Prodotto	
Riferimento INTERVENTI DISTRIBUITI SUL TERRITORIO	Immagini e dettagli di riferimento
Specifiche I pannelli o le lastre che compongono questi elementi possono essere personalizzati e ospitare loghi o messaggi pubblicitari	
Note:	







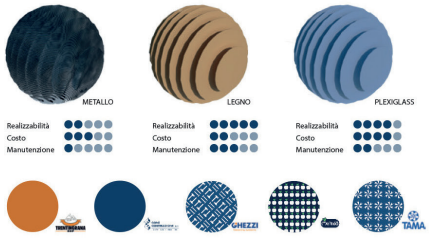


Image 14|Features of the project: frammenti di ricchezza (Ferrari,2017)

TechnoEcoSystem features.

In order to have a territorial promotion, this project highlights principles that the TechnoEcoSystem infrastructure as a cultural service could potentially perform and these are:

- the design research as a promotional language
- the territorial promotion linked to local companies (not only tourism but also trade and production)
- the cooperation with the main institutions of the territory
- the infrastructure and its adjacent spaces become under private care through the stipulation of a collaborative contract between administration and private company (co-management and cooperation for public spaces)
- the unique language, rather than differentiated, reinforces the local identity, making the physically fragmented Predaia municipality, distinguishable from the other main places in the valley
- the transversal cooperation of various public and private groups allows to enrich the value and quality of the final project.

Conversation with Paolo Pileri| VENTO | Polimi

Full Professor in Urban and Territorial Planning, Department of Architecture and Urban Studies, Milan Polytechnic. Founder of VENTO project, cycling path along the Pò.

Summer School FUTURINFRASTRUCTURE, 18/07/17, Trento.

Secondo lei un'infrastruttura veloce, può trasmettere gli stessi valori culturali e paesaggistico-ambientali dei territori attraversati, come accade per le infrastrutture più lente?

No. Assolutamente no. Nel senso che esiste una capacità di percezione, ma anche una capacità di rendersi conto delle diverse dimensioni di paesaggio che non può completamente avvenire in auto. In auto io viaggio con i finestrini chiusi, quindi già odori = zero, suoni = zero, le temperature = zero (il fresco il caldo, passo da ombra a sole). La dimensione sensoriale si riduce. I finestrini sono un surrogato di uno schermo. Treno, auto e camion sono, in via essenziale, delle scatole chiuse con noi dentro: gusci interposti tra noi e il paesaggio. È impossibile percepire tutto e molto ci sfugge, e se ci sfugge esce dalla nostra storia esperienziale. Andare a 80, 130, 150 Km/h per 1, 2, 3 ore di seguito è un'esperienza che rende confusi e cangianti i paesaggi. Tutto si mescola e quasi non ci si rende conto di dove ci si trova. Intere regioni si comprimono a una impressione unica. La lentezza è invece un'altra cosa. Totalmente un'altra cosa. A piedi, in bicicletta, in moto o in canoa le sensazioni e le relazioni con l'intorno esplodono, aumentano e ti saltano addosso. Questo è viaggio, non movimento.
Se vogliamo spingerci ancora più in là nell'immaginare la mobilità nuova per questo Paese delicato e bello, ciò che assolutamente mi interessa – e molto – è addirittura lavorare a progetti che accendano l'interesse su quello che noi chiamiamo "i paesaggi ordinari", non l'eccellenza. Le campagne sono tutte diverse, ma diventano tutte uguali se andiamo veloci. I boschi, i borghi, le ondulazioni del terreno, le valli…tutte immagini ordinarie su cui non posiamo più lo sguardo, immagini svilite ed espulse da un'idea di paesaggio quando invece lo sono e pienamente. Intercettare, soffermarsi, uscire, guardare, capire, apprendere….tutte cose che l'alta velocità ti vieta nel modo più assoluto ma che non possiamo permetterci il lusso di perdere. Le infrastrutture veloci ti depositano solamente lì nell'uscita, come un pacco. Per quello anche l'idea del Villages étapes è una cosa che mi stuzzica molto, nel senso che ti propongono un ritmo diverso ed è bello che territorio e gestore dell'infrastruttura si siano spesi in un progetto che propone a chi si muove di muoversi in modo diverso e di fermarsi. Già perché anche la sosta fa parte del movimento. Con i Villages étapes ti propongono di staccarti un attimo dall'autostrada e di perderti altrove, perché l'esperienza dell'altrove è quella del paesaggio che altrimenti ti scivolerebbe accanto anonimo, cancellando nella tua testa l'idea stessa di paesaggio.

Eh VENTO sta lavorando per questo? Per trasmettere queste idee? Per far conoscere più paesaggi ordinari anche?

VENTO vuole essere una proposta di riammagliatura tra noi e il paesaggio. E l'idea dell'osmosi si adatta a VENTO, ma non va dimenticato che l'osmosi è qualcosa che è possibile perchè c'è una membrana. C'è un solvente e un soluto che passano selettivamente attraverso una membrana pensata e fatta apposta per farli incontrare secondo un preciso progetto. La membrana è l'infrastruttura per la bicicletta, ma quello che ci interessa connettere sono i paesaggi ordinari ai cittadini. Mi piace pensare e far pensare a tutti che quando si va in bicicletta, uno guarda un paesaggio ma in realtà si sta specchiando. Mi interessa che la gente guardando una valle, un'ansa di un fiume, il profilo di un paesello con il suo campanile capisce che sta guardando se stesso. Ma questo è un processo che oggi dobbiamo riconquistare. Come dobbiamo riconquistare l'idea di gradualità e di sequenza. Quando ti muovi lentamente hai un'assimilazione più consapevole di quello che vedi grazie alla gradualità di ciò che si dipana accanto. Quando io vado da Venezia a Torino in bicicletta non solo mi inoltro in una sequenza di paesaggi che cambiano poco alla volta, ma passo attraverso ad altre gradualità e altre sequenze che mi sfuggono se vado veloce: le ricette, i linguaggi, le paste ripiene, le parole, le forme delle cascine….Non c'è niente da fare, la lentezza è un libro aperto.

3_Inerente alle infrastrutture obsolescenti, quelle che stanno per essere abbandonate o sono già abbandonate. Quali sono secondo lei gli elementi da utilizzare o le strategie con le quali intervenire su queste tipologie di infrastrutture, anzi anticipare in qualche modo il fatto che possano diventare obsolete, aumentare questo carico di inutilizzato che esiste?

La domanda è gigantesca. Nel senso che dovremmo vedere caso per caso cosa vuol dire inutilizzato su una ferrovia dismessa e cosa vuol dire inutilizzato su una vecchia strada dell'ANAS e cosa vuol dire inutilizzato in un parcheggio e così via. C'è anche tutto il tema delle ferrovie non presenziate che è gigantesco. C'è poi il tema, un po' più sottile e perverso ma di enorme responsabilità, che oggi costruiamo cose che diventano obsolete prestissimo lasciando a terra cadaveri di cemento ingombranti sui quali poi pretendiamo che il soggetto pubblico trovi risorse e uomini per recuperare il tutto. Oggi la rigenerazione può essere una grande chance per il Paese ma a patto che ci si concentra su questa e per un po' si ferma questa bulimia per cui si vogliono sempre costruire nuovi centri commerciali, nuovi quartieri, nuove infrastrutture su suoli liberi e spazi aperti. Ogni cosa nuova che arriva dal consumo di suolo libero e di paesaggio, frena le energie della rigenerazione. Senza un serio 'zero consumo di suolo ora', gli slanci di mercato e di creatività per il recupero dell'esistente rimangono schiacciati a terra. Si recupererà poco o nulla perchè non ci saranno le condizioni di mercato... Tornando alle infrastrutture, è evidente che ogni ipotesi di recupero delle vecchie strade e di ciò che vi sta intorno ha bisogno (anche) di investire

nel paradigma del godimento del tempo libero e ciò implica una volontà precisa nel progettista e nel policy maker consistente nel voler riportare fuori casa i cittadini. Siamo eccessivamente diventati figli di una cultura di interni, c'è poco da fare. A me interessa provare a ribaltare la visione e lavorare su una cultura di esterni, perchè se questa cosa qui funziona, allora noi anzichè passare le sere con i nostri amici dentro un qualcosa raggiunto con la nostra auto, impareremo a spendere il tempo muovendoci lenti magari per raggiungere un locale che prima era una stazione impresenziata e che ora è un bar molto carino o un teatro lungo una ciclabile gradevole da fare... il problema è che io devo riuscire a riaccendere il desiderio di muovere le persone con altre forme di mobilità e aumentando la consapevolezza in altri racconti di territori. È questo importante secondo me.

3 aggettivi per FUTURINFRASTRUCTURE

Leggero. Infrastrutture leggere. Leggere perché ci vuole poco per realizzarle, perché non impattano, perché percepite con gradevolezza e benevolenza, perché tutti possono percorrerle senza avere prerequisiti selettivi. Durabile. Oggi siamo in un'epoca in cui siamo circondati da cose dall'obsolescenza programmata e rapida. Prepariamo per giorni, eventi che durano un'ora. Costruiamo volumi che durano poco e non ci curiamo di cosa ne sarà domani di questi nuovi rifiuti. Amiamo mode effimere. E ci piace cambiare idea e partito a seconda di dove vanno i vincitori. Invece io voglio un'infrastruttura che duri per sempre, che metta in moto economie che durano e che invitino terzi a investire immaginando di costruirci il lavoro di una vita. Quindi leggero e che duri...e poi per terzo aggettivo chiedo di poter scegliere in un sostantivo: bellezza. Se mi devo muovere devo pretendere di fare esperienza di bellezza. La bellezza dei luoghi deve tornare a interessarci e bisogno re-insegnare a riconoscerla. Dobbiamo andare a cercarla. E la bellezza, di nuovo, non è seduta solo sui luoghi eccellenti o rincantucciata nelle città d'arte. Nel nostro Paese la bellezza è un po' ovunque e di questo occorre tornare a parlare. La possiamo trovare davanti o dentro una centrale elettrica che oggi è chiusa, lungo un canale di derivazione costruito nel secolo scorso, sotto un ponte del '900 e così via. È importante la bellezza, da quella scende giù tutto il resto…come ci ha insegnato Peppino Impastato.

2.2.2. Motorway as energetic basin. [provisioning technoecosystemic service]

THEORY

Smart Energy Conduit

"Smart is...being in a permanent state of relationship, in a "web", being always available for something unpredictable, as each process changes in the context and for the context. Being smart means knowing the rules of the game to try to "floor them"; means knowing how to transform the complex into simple and simple into complex and considering every synthesis both as process and scenario."[121]

Cultural context

The cultural premises which affected the spread of Smart Land, Smart Energy Grid, Energy Community, Zero Energy Building and Conduit Urbanism concepts, are common. As descript in the first chapter, since the industrial revolution we have changed the way we are living, influenced by the use of fossil fuel as engine of energy. The history of awareness of the impact, caused by the use of fossil fuel energy[122], explains the reasons of some European and World trend. Montreal protocol (1987); Earth Summit in Rio de Janeiro, 21 Agenda, the Convention on Biological Diversity, the Forests Principle and the Convention on Climate Change (1992); Kyoto Protocol (1997) are the pillar of this historical path, that can be summarized into two premises:
- reduction of CO2 emission;
- increase of clean energy production.

Both should be reach following a smart and sustainable approach, applied into different land scale, through different visions of spatial identity: territory, environment and landscape, respectively from political, ecological and cultural point of view.
Each concept, that will be analyzed in the following paragraph, starts from this general framework, but goes beyond with a specific strategy of application, that converge into a general Smart Energy Conduit strategy.

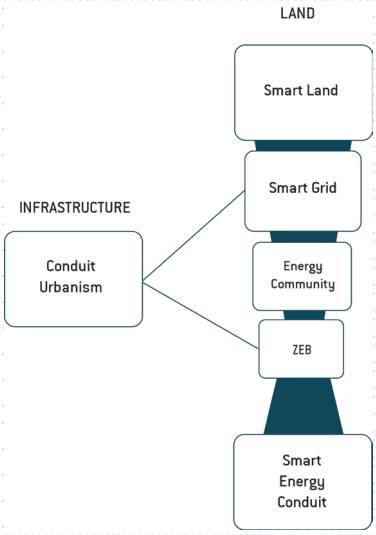
Concepts

In this section there is not a specific theory applied on the motorway. Starting from general concepts, outlined from energetic systems field and from researches related to motorway thru European documents, TechnoEcoSystem strategies combined with energy will be set out.
As a matrioske, we will start from a wider scale to move through a more punctual one, extrapolating from each concept the following one, clarifying the potentialities of each scale level from a managerial and energetic point of view and at the end summing up all in a general vision of Smart Energy Conduit.

Smart Land.

The forward concept is concerned to the Smart Land. This description started from A. Bonomi and R. Masiero analysis, where there is an holistic vision of the glocal territory. "A smart land is a territorial sphere where through widespread and shared policies increases the competitiveness and attractiveness of the territory, with particular attention to social cohesion, the diffusion of knowledge, the creativity of growth, accessibility and freedom of movement , the usability of the environment (natural, historical-architectural, urban and

diffuse) and the quality of the landscape and the life of the citizens."[123]
The concept, organized into different categories, allow to simplify the complex image of a territory that involves citizens as individuals, also inserted within a network of community. Through themes such as landscape, energy, mobility, development and identity, the concept of Smart Land takes shape, defining a territorial homogeneity. The following elements are both origin and consequence of the Smart Territory and show an energy perspective of territorial strategy.



As a matrioske, we will start from a wider scale to move through a more punctual one, extrapolating from each concept the following one, clarifying the potentialities of each scale level from a managerial and energetic point of view and at the end summing up all in a general vision of Smart Energy Conduit.

Smart Energy Grid.
The second concept, part of the first, came out from the Clean Energy Act of 2007, where was discussed the future energy management of United States. In this document was born the ideas of grid as a smart element " to maintain a reliable and secure power infrastructure that can meet future demand growth and achieve..."[124] particular objectives. These objectives are the core values of the concept of smart grid and are in general based on the use of digital information and control technology, improving the spread of integration of renewable resources. Starting from these points, Smart Grid is the energy structure of a homogeneous and dynamic territory such as smart land, which provides widespread and articulated energy management through incentives that promote actions in terms of use of renewable resources and energy saving, from building to city[125].

Energy community.
The third concept is a subcategory in a smart grid. The community is the hub of a land, but also the source of a territorial development. In the same way the energy community is the polar idea of a generation and cogeneration network of energy. Energy community

is a community of utilities that cooperate in the development of energy management levels through "smart" procedures, using technologies that promote the use of renewable energies, with the aim of gaining economic and sustainable benefits and energy security . From a smart land (territory), with a smart grid (system), the energy community is a point of convergence of the grid, where the "smart" is possible through the cooperation between citizen and private and public entities.

Zero Energy Building.
The fourth concept could be a subcategory in a energy community. In this ideas of building, you store what you need and use what you produce. "ZEB concept is the idea that buildings can meet all their energy requirements from low-cost, locally available, nonpolluting, renewable sources." The autonomy of building in energy production solves problems related to the overloaded request of electrical power. The autonomy also produce usually more energy that the building needs, for this reason it enter in synergy with the system (smart grid), as a small hub in an archipelago community.

Conduit Urbanism.
The fifth concept is opposite, but also complementary to the first. While smart land defines a homogeneous and indefinite spatial dimension on the inhabited territories, Conduit Urbanism works on infrastructure as an energy conduit that promotes innovative dynamics for the territories crossed by it. Conduit Urbanism[128] is an ecological synthesis of energy, mobility and economy[129]. This concept overlaps the others and define a linear dimension of energy storage. In this perspective the line of grid network is also a cluster of urbanity and a source of generation and cogeneration of energy.

The last concept is the one that permits to develop the general vision of a Smart Energy Conduit, not static but dynamic and operative in the function that support. Smart Energy Conduit is an infrastructure that works for territories and in the territories, for community and into the community, as system and provisioning service, as a techno basin of energy.

Key points of the concepts
Each concept have key points in common with the others, but to understand the differences of scale and approach, in this section will be highlight all the perspective of each ones.

1_Starting from the smart land, the principal values of it are: citizenship, development, energy, mobility, economy, knowledge, identity and landscape. According with the Manifesto of A. Bonomi and R. Masiero, the spectrum of the description of this idea of territories covers all the elements to bring a context beyond a smart future.

Citizenship is central in the growing of the land. Following the subsidiary principle, the local forces, stakeholders or simple citizens, should be involved in the decision process through technologies. This perspective is not least than the others, but is the most important to have a smart condition. If the users of shearing technologies do not exist, the smart land does not work. Thus the long life learning needs to help a widespread technologic literacy process[130].

Development is the second step. When the citizenship is ready to connect, it is time to build a network of spread active communities, which work to improve and highlight the pecu-

liarities of the land. This is possible with and without technological tools, defining general strategies for land and community.

Energy is a need. Changing our behaviors to save the planet from environmental disaster, the request of energy changes to be more clean and efficient. In this framework using a smart approach to produce resources, with also a smart management of them (See smart grid principles in the following concept).

Mobility is a support. Improving the mobility into an ecological way is necessary to increase the quality of land. Sharing mobility is a consequence of a behavioral attitude of citizens[131] and not only a problem of available services. Smart land is possible with smart citizens and smart mobility is possible with smart users. Mobility is also a problem of planning and management that could be solved with strategic approach from cities to the land, offering a support of interchanges of alternative way of moving[132].

Economy is the guide of strategy. The relationship between territories and small companies produces business and education to develop the free initiatives for start up and innovation cluster. The combination between creativity and entrepreneurial is a general strategy for a smart land.

Identity is the value. Without identity the homogeneity of the land does not exist. Cultural, craftsmanship, environmental, economic and productive values are a perspective of a future condition of a land, is not the arrival point but the start one. "Identity cannot be <as we were> but have to be <as we can and want be>"[133] through the use of smart communities.

Knowledge is the power. Without culture, there is not development, economy and valorization of the land. The technology support the spread of knowledge.

Landscape is the land. The value assumed by the landscape after the European Convention is to preserve the peculiarities of a everyday life spaces. The conservation and preservation of a common recognized special places, identify a value for a territory and land (related to the administrative spaces and pragmatic definition of the land).

2_Following the matrioska path, the second element is the Smart Grid. The main features, to have an electrical smart system, can be summarized into ten categories highlighted in the Energy independence and security act of 2007.
(1) The first one is the use of digital information controls to improve the security and efficiency of the distribution of energy.
(2) The dynamic solutions to the management of the grid.
(3) Polar distribution and production of energy, using renewable energy.
(4) Fast answer to demand-side resources.
(5) Use of smart technologies to improve the physical operation on the grid, only through information and automation systems.
(6) Integration between smart users and tools.
(7) Deployment of innovative storage system to use the energy from electric vehicles to thermal storage air conditioning.

(8) Efficient information system, in right time.
(9) Development of standard and infrastructure useful for the grid.
(10) Reduce barriers against the implementation of the smart grid system[134].

These are general principles to follow to start a new system of distribution of energy, without the instability problems related to double direction furniture. As a network and a circuit, the land act, involving also citizens to produce and use the energy, working with the articulated system.

3_The third concept is related to Energy Community. To define an energy community are important: the structure of the energy distribution, the financial coverage, norms and regulations open to this concept of energy trade in a community and the spread of sustainable technologies. The management of this energy distribution should be divided between promoters, local authority and consumers position. To start an energy community, this elements should be clear. The principal consequences of the energy community spread are: the reduction of the daily peak shaving of energy, the load shifting of energy for handling them and in case of storage, the reduction of the impact and variability into the energy production.

4_The forth concept is the Zero Energy Building. The concept of Zero Energy could be described through four different concepts, according with National Renewable Energy Laboratory[135]:

1_Zero Site Energy. It is related to the position of the building and to define how it produces energy. In these specific case the building should guarantee produced energy in the site, without waste it. (Off-Site)
2_Zero Source Energy. It is related to the energy of the site, including the energy that can be lost or waste during the processes of production, generation and transportation, that could be recycled.
3_Zero Energy Costs. It is related to the cost of bill of the owner. Sometimes the energy produced by the building could be shared into the net of buildings, earning money.
4_Zero Energy Emissions. It is related to the kind of energy that building uses. If the energy is renewable, also there are not carbon dioxide, nitrogen oxides, sulfur dioxide ect.

These point should be respect to reach the level required by the Energy Perfomance Building Directive. The objective is: "all new buildings to be nearly zero-energy by the end of 2020 and all new public buildings must be nearly zero-energy by 2018."[136]

5_According with the concept of the Conduit Urbanism, the energy cluster are also full of urbanity. The infrastructural systems are dense network of function classified into four big 'sheds': Mobility, Economy, Environment and Energy. All of them are interrelated into other big groups of classification where the enviro-impacts, agri-nature, mobility for trade and general commuting, power distribution are combined with territories and mobility infrastructure. The peculiarities that we can identified into a Smart Land, such as Energy, Mobility, Knowledge and Landscape, could be concentrated into an idealistic tube of functions, interconnected with territories that crosses[137].

TechnoEcoSystem features

Starting from the previous concepts of different fields, it is possible to extract useful elements to define a strategic definition of a TechnoEcoSystem in the mobility framework. From a huge territory, as a Land, to a linear one, as a motorway system, the small hubs of singular buildings and a zero communities system, combined with a network of distribution, define a Smart Energy Conduit.

For its capabilities and richness, the Smart Energy Conduit recollects elements that produce services, in particular provisioning. A linear element, produce and store energy for territories using:

- the mobility system as a conduit for the grid;
- the population around the line to define singular and community hub to use, to produce and to store energy and data both from the network and for the network;
- the grid to insert the potential storage into the global European System of provisioning.

From this theory, the TechnoEcoSystem learns the combined use of technology and system to produce energy and data as service for the contexts.

TREND

Energy Exhibition.

"... we are looking forward to a new and different modernity, in which we do not simply ask the technology to invent devices that allow us to do the same things, consuming less. What we are looking for is a thought on form and space, which makes the new desirable and exciting behaviors..."[138]

Cultural context

The energy exhibition held at MAXXI from March 22 to November 10, 2013, started from fundamental preconditions that characterize the years of energy transition that we are experiencing. According to data from the International Energy Agency (IEA) on the demand and supply of energy resources, it is estimated that demand from now on will be growing because of population growth and Economies development of countries like China. It is also clear from the report that in 2040 this demand for energy in the transport sector will reach 40%[139]. According with this premise, the exhibition inspects some themes and define some points to take into account. Which will be the tools and spaces that allows to people to access at moving energy in the future? Which kind of fuel we will use? What will be in this framework the role of the architecture? Starting from the story after war in Italy, when there was a concentration of creativity, development and innovation through infrastructure at all levels, the exhibition goes behind the present through a vision of the future.

Exhibition description content

The curator Pippo Ciorra defines the exhibition as a path that brings the visitor, not necessarily an architect or expert in the field, to enjoy installations that cross past, present and future scenarios, linked to the relationship between space and energy. The exhibition is divided into three great macro areas: stories, frames and visions, representing past, present and future.

STORIES. This section is dedicated to a period of discoveries and rebirth of Italy. Thanks to the collaboration of Eni, Autogrill, IUAV and MAXXI archives, images and drawings related to the myth of oil infrastructures have come to light. The stories through the archive images recall the history of the post-war through the refueling and parking services that characterized a period of innovation for the Italian architecture, between the standard and the charm of the moving landscape.

FRAMES. This section illustrates the present, met through three photographic tales that stand out for approach and content between them. The general purpose is to read the places of energy, from production to consumption. The three works have been entrusted to three professional photographers on the commission of the museum, who face through different pictures and themes. The first is a reportage on production sites by Paolo Pellegrin, such as refineries, on which he catches the relationship with the surrounding landscape. The second is a documentary by Alessandro Cimmino, from the city to the architecture of the supply station, energy is seen through the lights of the city and through the source that represents the supply. The third reportage is more related to the social aspects, the people who attend these spaces of energy and mobility and is a work by Paola Di Bello. All of them tell a story the present through the energy spaces.

VISIONS. This section compares two realities: research and architectural design. Seven studio from five different continents have been invited and compared with different researches about new energies. The request, that has been made, is to imagine the future and the shape of networks that will distribute energy.
This last session is the most interesting, it is a door toward the future. Specifically we will only focus on some of these vision reported, which are connected with the theme of motorway architectur. This session acts to join the creativity with the new technologies and tools available, hypothesizing almost utopian scenarios, which, as mentioned in the publication of the exhibition, are "energy for the mind"[140].

The most important topic is the vision section about the future of energy supply in a post carbon era. The two projects that tackle this topic most closely focusing on the highway space are: Heads Up Highway! Cultivating Energy 2050 from MODUS Architect and Buffer-site to Hydrogen by Freddy Paul Grunert and IaN +. Both focus on the idea of using the motorways and infrastructure devices to produce energy.

The first, MODUS project, tries to give an architectural identity to an element that is usually not visible. The system provide an evocative shape of a purely functional space, occupying the highway surface to produce energy through solar panels (assuming a production equivalent to the needs useful to cover more than half of the household energy use). The proposal is very provocative and not only drives us to imagine an aesthetic shape of energy, but it also leads us to identify what the future of the motorway infrastructure will be when it will be in decline[141].

The second project, on the same footing, is part of an European project that plans to define between Brussels-Berlin and Palermo an ecological infrastructural corridor where the hydrogen is the produced, supplied and distributed energy. All this is represented through an image of the Autogrill bridge, which condenses the motorway landscape with production hubs. The bridge has a deeper abstract meaning. From a source of connection between two side, becomes part of a production system linked to the highway. Autogrill is no longer just a deposit but a producer of bio energy through the algae[142].

Objectives & Effects

The effect of this exhibition was to put architecture at the center in a energy transition process. It is the energy that defines the space and that affects urban aesthetics, using infrastructural spaces.

TechnoEcoSystem features

This exhibition opens up a challenging scenario that combines research and vision, in an utopian outlook that promotes the imagination of the future of energy spaces. It sets out the prerogatives that go to outline the assumptions that define an energy supply service of the technoecosystem by means:
- to reuse space and motorway devices such as energy collectors,
- to forecast production, distribution and supply of the network, both for infrastructures and intercepted places,
- to rethink spaces, not in formal, but in performance and in functional terms.

Smart Road

" Within the Strategy of 'Valorizing the infrastructural heritage', DIGITAL TRANSFORMATION is a process of innovation aimed at improving the standards of insurances and quality of works, ensuring continuity in maintenance programs through actions aimed at the use of innovative technologies."[143]

Cultural context

The technological innovation required today for infrastructures has a very precise origin that we find in Directive 2010/40 / EU. In addition to stressing the need for technological and innovative development of transport infrastructures through intelligent systems, this directive sets out common standards from which European Community countries have to start to define their strategy.

Italy, due to its territory dense of roads (179,024 km)[144], and considering the 43 million vehicles crossing it, decides to start off its own strategies, applied on motorway infrastructure. Observing other megatrends, such as technological development and the rise of the world's population, we see data suggesting that the amount of car will increase, although it will be different in its technologies, and that 90% of the population in 2020 will come to possess a smartphone. Hence the need to aim at redefining and enhancing the infrastructural heritage through a digital transformation. By changing the fleet of vehicles, they will need to have a new infrastructure capable to host new features of them, as we now have regulations in Italy that are suitable for designing and maintaining roads capable of hosting vehicles of post-war.

How do we think we can have an automatic machine if we do not have a road with control systems that handle its behaviors? This is one of the first questions that the national strategy is facing through the Ministry of Infrastructure and Transport in Italy, starting from the road and motorways that was the symbol of country's development during the economic boom.

Objectives and contents of the program

Smart Road was born as a sustainable project for the improvement of existing infrastructure, using technological innovation. The scope of application are SNIT[145] and the European TEN-T network. If we look at the specific goals of Smart Road, we can categorize them into four macro categories: security, infrastructure resilience, management and collection of data for users and managers. Keeping these four points ahead is obviously an immediate improvement in the management of infrastructure resources as well as work-related maintenance costs. Data collection improves the traveler's experience by implementing the security and cultural services offered by the connectivity that can be between vehicle and vehicle or between infrastructure and vehicle, and also becomes a way to produce useful information for future management of the 'infrastructure. This obviously opens up new development and investment scenarios, enhancing existing infrastructure assets[146].

Currently, the Ministry, through the document "Functional Standards for Smart Roads" published in 2016, is addressing a phase of minimum standards definition that this new concept of technological infrastructure should have. Sharing with the stakeholders of these first set goals is paramount and allows the implementation of the document, in a more applicative part. The document consists of three significant parts:

- the first analyzes the potential and effects that by defining a smart road would have, according to qualitative considerations;
- the second is a more technical and architectural characterization of the envisaged sys-

tems, defining platforms of enabling technologies and functions that activate them;
- The third defines the performance specifications that allow a Smart Road classification into traffic management.
As this evolutionary system is, we expect that from a general basis and system predisposition will be then integrated and expanded according to the requirements that will gradually manifest.
This, however, is trying to fulfill those that are the main goals: to connect all subjects along the infrastructure through new technology systems that can become a driving force for the country's economic development .

Preliminary effects
The first effects of this first European and then national planning have prompted ANAS to apply these principles, launching the first experiments at European level in this direction. The company, investing 160 million euros, is busy making Smart 3000 km of running roads, including: A2 - GRA - ROME FIUMICINO - A19 - E45 / E55.
The services provided by the ANAS network are more specific than the MIT's strategic document and are in details: Multi Protocol Label Switch, Wireless Wi-Fi in Motion System, DSRC-ETSI ITS Wireless System -G5, Road Anas Network Internet of Things, Energy - Green Island, Smart Services for Mobile and Big Data Management Platform. In general, these services respond to specific connectivity features to provide informations, connectivity between vehicle to vehicle (V2) or vehicle to infrastructure (V2I), logistics and infrastructure maintenance, as well as useful data for real-time infomobility . What introduces ANAS as a supplementary system to Smart Road is the concept of Green Island. This concept includes every 30 km of motorway length, a multi-technology site for generating and transforming energy from renewable sources, allowing autonomous power supply infrastructure, maximizing performance and reducing management costs.

In addition to fostering self-sufficient infrastructure, this planning would have the energy infrastructure hubs, useful both for motorway services (such as power supply for electric vehicles) and for crossed context services.
On July 5, 2017, ANAS gained access to fund from the National Operational Plan for Infrastructure and Networks 2014-2020 by the Ministry of Infrastructure and Transport, thus initiating the Smart Road project along the Mediterranean A2 Motorway with an investment Of 21 million. In somehow this hides the troubled past that has been on this motorway for the last fifty years[149].

TechnoEcoSystem features
Smart Road is a scenario for designing and repurposing existing infrastructure for the future. We can no longer ignore the intelligent design systems. As an approach it fulfills what is termed as a techno-ecosystemic supply service. The motorway becomes an information service for infrastructure users and self-sufficient at the energy frame.
As it supports strategic ministerial planning, Anas works in different ways. If co-financing from the crossed territories is added to the systems provided, the energy and data collected can potentially be at the service of small villages or large connected centers. Exchange can become bi-directional, defining and implementing those principles of smart grid and smart land that define the concept of smart energy conduit. The factors that determine it are:

- data control and management systems,
- direct communication between users and infrastructure (potentially also between infrastructures and territory, vehicle and territory to feed cultural services at the disposal of the traveler)
- creation of energy hubs, collectors and power supplies of the infrastructure system and beyond.

ACTION

Solar Park South

Cultural context

The history of the A3 Salerno-Reggio Calabria motorway is known for its hard development process. The peculiarities of the Calabrian territory, where most of the route is inserted, is marked by the morphology and the strong hydrogeological instability of the soils. This led to the design and construction of numerous viaducts, suspended bridges and galleries, largely made in the 1960s and 1970s, for the innovative era from the engineering point of view. In the section between the Municipalities of Scilla and Bagnara, these works have been dismantled following the construction of a new motorway axis mainly made in the gallery for the new A2 Autostrada del Mediterraneo, for functional and safety modernization compared to the old route. Before arriving at this outcome, however, there was a failed attempt to reuse old layout as territorial promotion sites within the Landscape & Identity Program promoted by the Regional Planning and Territorial Governance Department. The purpose of this proposal, called Solar Park South, was to reuse the motorway space as "a laboratory of study and research, as a site for the production of clean energy and for naturalistic and environmental activities, implying both economic and environmental savings"[150].

On 2008 the Department presented the "Solar Park South" project to the primary subjects involved (Anas SpA – Italian Highway Authority; Calabrian Universities; Enea – Italian National Council for New Technology, Energy and the Environment; Enel – Italian National Electricity Board; Local Authorities and other regional departments dealing with related topics) starting to complete the technical board for this strategic project. From this moment the Town Planning and Territorial Governance Department of the Regione Calabria, the Province of Reggio Calabria, the Mediterranea University of Reggio Calabria and the municipalities signed a Memorandum which established the foundations of the Solar Park South proposal for an Energy Park to be built as an alternative to the integral demolition of the motorway.

On 2010, the Regional Government approved the priority thematic fields to allocate 38 million Euros for pilot/experimental projects directly controlled by the Region as the "Solar Park South" and the competition was announced. "The purpose was to find innovative proposals and models of territorial organization for the rehabilitated motorway sections, which follow an approach of eco-sustainable development and apply mature and/or experimental clean energy systems."[151] Although it did not have a positive result, the competition has proved to be a good benchmark for reflecting on the abandoned infrastructure. Big architectural and engineering firms from all over the world have faced an innovative recycle theme of the existing, with a clear need for innovative and experimental vision of the architectural object.

Territorial context

The context in which the Solar Park South viaduct was planned, was among the municipalities of Scilla and Bagnara. The affected stretch is about ten kilometers and includes viaducts and tunnel trails. Many of these works are the result of the genius of Nervi, Zorzi and Morandi, who have created a wealth of infrastructural works that intercept spectacular views over the Costa Viola, between terracing and sea views where you can admire Sicily,

the Strait of Messina and the Elolie archipelago. The beaches and the various coasts are sometimes rocky, sometimes sandy and gravelly, dominated by the rivers of Aspromonte and Monte Poro, which rush directly to the sea. The geological composition of the territory has greatly influenced the engineering choices and the complex delays in the infrastructure construction work. The exploitation of the works of this area has been extensively documented by the work presented at the MAXXI until February 2017: "Towards the Mediterranean Sections of the Landscape from Salerno to Reggio Calabria"[152], inspired by the research "Sections of Italian Landscape" by Gabriele Basilico and Stefano Boeri.

Design competition

"Solar Park South adopts a conceptually opposite approach of environmental acupuncture, promoting the re-use of the existing before consuming new land, pursuing landscape integration, energy self-production and economic self-sustainability."[153] The competition aims to use the infrastructure as a means of promoting the Calabrian territory through the development of strategies that intercept not only what the territory already offers, but pushing it towards research, experimentation and application of technologies and new knowledge for sustainable agricultural production and tourism.

The jury used the 10 km motorway (viaducts and galleries) between Scilla and Bagnara to assess the sustainability of the proposals by focusing on:

- Aesthetic Quality
- Environmental Compatibility
- Economic
- Environmental Synergies
- Innovation and Research
- Social Impact

The competition explored applications in the field of alternative energies, promoting a strong social message focused on the widespread diffusion of a culture of sustainability also into the recyclable infrastructure spaces.

The competition had three winners and ten honorable mentions. The results are all very interesting, as they intercept the theme of sustainability through various aspects and have innovative ideas for the recovery of decommissioned works, looking to the future. The mixed jury of local and international experts (such as ETHC researchers in Zurich) considered the following projects as worthy of a podium.

First Prize: PR+OFF (France). Philippe Rizzotti, Vermet Tanguy, Manal Rachdi, Samuel Nageotte.

The concept of the project said: " This contemporary archeology (the bridge over the bridge) results in a process where urban falls meet the climbing nature. The vertical privacy of the inhabited piles supports the horizontal sociability of the public equipped decks, while providing a unique view for each one, at every level. The combination between the infrastructure and the environment is efficient enough to establish a new responsible high quality way of living."[154]

The image is very strong and very provocative in some ways. The infrastructure becomes the support and structure of a human living habitat, but exceptional in the only occupied position. The motorway is not in support of an urban settlement but it becomes the urban system itself.

Second Prize: coffice (Italy). Francesco Colarossi, Giovanna Saracino, Luisa Saracino.

The description of the project says: "The hybrid system proposed (combining solar and wind power) allows for a continuous production of Energy. The project is based on the idea of utilizing the space between the pillars of the existing viaducts to house a system of wind-powered turbines which will be integrated into the structure. This ensures contained land use and therefore a reduced impact on both landscape and environment in addition to re-designing the visual profile of the viaduct. The solar park proposed in the competition will stretch the full length of the inner carriageway, with the outer carriageway remaining reserved for the transit of vehicles. The solar park is conceived as a green "promenade", along which there alternate panoramic viewing points and entirely self-sufficient solar greenhouses. As with city farms, visitors to the park will be able to stop and buy the local produce
grow in these greenhouses. The asphalt will be
substituted with a technological road surface.
The road surface itself will, therefore, collect energy as a part of a power-generating system composed of a dense grid of solar cells coated with a transparent ad highly resistant form of plastic." [155]
The project as a general idea is a real energy machine. The infrastructure becomes a sustainable system that comes into contact with the crossed environment by providing it with energy.

Third Prize: J-A (Colombia). Daniel Azuero, Tomas Jaramillo, Andres Gutierrez, Juan Jaramillo.
From the project description "SEEDING GREEN EDUCATION is the attitude which best describes SOLAR PARK SOUTH, for that reason this intervention establishes three main goals to accomplish this purpose. First of all, to set up a connection between Scilla and Bagnara Calabra throughout a multi-mobility circuit that simultaneously will conform and protect what is established as natural reserve.
Secondly to enhance progress in a very big extension of territory within simple overpowering approaches as civic education and the implementation of native vegetation reproduction as the main design strategy. Finally utilize this old highway as a detonator for the development of a larger extension of territory combining conflictive topics as renewable energy technologies, new mobility systems and economic development, all at once."[156]
The third project has a more educational link then the others. In addiction to be an autonomous system, compared to other podium projects, it has a much broader goal, namely to instill sustainability principles by experiencing space with didactic laboratories and experimental research.

Among the projects submitted, many would deserve for the quality of the design presented, as they are innovative and unique often in the proposals formulated. Though it had excellent preconditions as well as extraordinary results, the competition ended with the award of the winners, without having an effective follow-up. In July 2015, the work on the disposal of the viaduct that was the subject of competition was completed, among the many controversy related to the damage that this disposal has caused to the underlying terraced crops. The proposal of the competition, farsighted in the approach, has shown an opportunity missed for the territory of the Costa Viola. If the winning project had not been

a suspended city, but had actually been more responsive to the demands of creating a space of experimentation and sustainable landscape, probably today Costa Viola would enjoy a unique territorial excellence in innovation, in addiction to its landscape. It would have been a project of recycled infrastructure, similar for the impact and the message of the High Line in New York[157].

TechnoEcoSystem features

The competition, unique in its kind (until Reinventa Cavalcavia), shows us how reflection on changing infrastructure, can be diversified in the outputs obtained. The projects presented show the abandoned motorway as a linear park, as energetic and experimental device, used through different forms of living. A true technoecosystem in all its cultural and provisioning services.

Specifically, referring to the award-winning projects on the podium, the elements that make a motorway capable of serving and being an energy collector for the crossed territories are showed in a variety of shapes, ranging from solar, wind and piezoelectric. They all observe the features of the existing, exploiting it fully and making the project unique in its forms.

All the projects presented, which are not the solution of all the problems, face a theme and deepen it better than others, often failing (as in the second classified project, where the impact of wind with the avifauna probably has to be handled more carefully and not superficial, considering the size of the work).

Positive elements:

- the motorway is an answer for territory needs, such as promotion of the coast;
- the motorway is a platform of example and research, resilient to the changes;
- integration of different realities (as university, municipality and so on..) into the process of management.

Negative elements:

- the motorway need more attention to the regulating services and ecological aspect that it could be offer.

Smart Highway Cultural context

Cultural context

In recent years, the debate on energy production without compromising soil consumption has led us to focus on solutions that see objects already built, as part of those potentially usable areas to produce energy. Today, solar panels[158] are the least expensive and best-performing renewable energy production systems. Their yield is proportional to the surface on which they insist, and for this reason, looking to the future, many aim to identify surfaces on which to invest without consuming soil. For this reason, research on renewable energies has pushed to surfaces already occupied by man, through a concept of solar roadway[159], to which more complex reflections have been added, such as the Smart Highway of Studio Roosegartner.

Projects

The following list of projects shows applications and technological concepts, using the motorway as a vector of energy. All these examples work in to the context, but not work for that, sometimes losing the connection that the motorway's axes have.

The first project is the SMART HIGHWAY designed by Daan Roosegaarde and Heijmans Infrastructure. Its goal is to define a smart and sustainable infrastructure, using digital technologies, glow light and energy for the user primarily, losing the relationship with the context.

Glowing Lines are charged during day-time and glow at night for eight hours. Dynamic Paint, Interactive Light, Induction Priority Lane and Road Printer are the next steps for this project. The collaboration is trying to create innovation into the Dutch landscape through infrastructures. Smart Highway has been awarded a Dutch Design Award and an Accenture Innovation Award, and won the INDEX Award 2013[160].

The second project is the result of technical speculation used in recent years. So can we use the surface of the roads to produce energy? Of course the answer is yes, but the attentions to consider are many. Solar surfaces can be directly replaced by asphalt or applied to infrastructure devices, but the maintenance they need is remarkable. Among the many example on this topic, notable is the 'Solar Serpents in Paradise'[161]. It is not a solar asphalt, but it is a project that puts in the infrastructure a continuous device, a tunnel, capable of producing useful energy for the city of Los Angeles. Although the objectives of this project are without big innovation, without declaring it in the objectives of the project, the design of the tunnel creates a closed box that would allow the road to isolate itself from the crossed environment by reducing noise and even smog of the car. The device is not designed for this, but potentially lends itself to have this function, adding the right technology.

Considering the project of the recent first solar road[162], the results are not extraordinary, because of the panel has to be covered with a silicone protective layer, which reduces the performance. So, why can not we use useful objects that design the motorway landscape and are able to perform other functions than to produce energy?

This somehow is what the third following example did. This is the KMZero Road of the TotalTool studio.

This project, even if its final design is questionable, has the strength to encapsulate the idea of an infrastructure technoecosystemic. Indeed "KMZERO ROAD[163] is a concept for a road system that acts as an organism with its own internal metabolism, able to interact

with the external environment and to derive its operating advantages: the road becomes an energy resource, contributing to the safety and the integration of active functions of different functions"[164], says Giulio Ceppi.The data that was collected from this research shows how with the kW of energy produced by the infrastructure they can cushion their costs in a few years[165], making it so convenient to use. The maintenance aspects of this type of object remain unclear and how this can be a potential risk to the benefits of its hyper-technology.

TechnoEcoSystem features

Projects similar to those listed above that use roads as energy and information collectors are many. There are applications of all kinds, so over and above hyper-tech approach and the technological system itself, the attention to these projects must be made on their shortcomings. The strategic idea of the technoecosystem focuses more on what is lacking in these example, trying to send the infrastructure production to the crossed context. The motorway produces not only energy and information, but it should also do it to offset its impact and not limit its consumption.

For this reason a techno-ecosystem service should:
- to respond to the needs of the territory through energy and information gathered;
- to use technologies that are responsive to time, resilient to the changes;
- to join different realities in the process of management, from cities to the motorway management

Negative elements:
- the motorway needs more attention to the regulation services and ecological goals, focusing on the needs of the territories and not only on the needs of users of the motorway.

Conversation with Francesca Moraci|ANAS

Francesca Moraci è Architetto, Phd in pianificazione territoriale e MS in Economic Policy &Planning (NU Boston), è full professor di Urbanistica presso l'Università Mediterranea di Reggio Calabria. E' stata uno dei tre componenti del CdA di ANAS S.p.a. fino a dicembre 2017. Oggi è componente del CdA della Holding Ferrovie dello Stato Italiane

Summer School FUTURINFRASTRUCTURE, 19/07/17, Trento.
(This is a part of the entire conversation)

1. Crede che la progettualità innescata da ANAS negli ultimi anni (manutenzione programmata, concorso case cantoniere, Smart Road) sia una soluzione o un punto di partenza per le infrastrutture del futuro? In che modo?

Anas sta lavorando molto intensamente per potenziare la tecnologia e l'innovazione delle proprie infrastrutture. Questo impegno è essenziale per rendere migliori le nostre strade attraverso progetti che portino cambiamenti favorevoli per la vita quotidiana dei nostri utenti.

Tutto questo viene fatto in moltissimi modi. In primis, attraverso la svolta della manutenzione programmata, che a partire dal 2015 ha sintetizzato in tre obiettivi essenziali: recuperare il rilevante deficit accumulato negli anni dalla rete, migliorare la sicurezza della stessa e massimizzare il ritorno degli investimenti per gli utenti della strada, in termini di benefici diretti. Per il quinquennio 2016-2020 su 23 miliardi di euro di finanziamenti previsti quasi 11 miliardi (il 46 %) sono destinati alla manutenzione programmata.

Questa visione programmatica comporta concreti benefici, da un lato diretti, per gli utenti della strada, in termini di maggior continuità e qualità dei servizi, e per la collettività, in termini di contenimento dei costi complessivi di intervento; indiretti, per il Paese, in termini di valorizzazione e riqualificazione di un patrimonio stradale imponente, oggi mediamente in fase avanzata del suo ciclo di vita.

Dall'altro lato abbiamo il progetto Smart Road, che punta invece a portare le strade italiane nel futuro dotandole di energia e comunicazione, a cominciare dall'A2 "Autostrada del Mediterraneo", designata per essere la capofila europea di questo cambiamento. La vision della Smart Road è quella di un viaggio sicuro, senza difficoltà, con guida assistita e/o autonoma. Grazie agli studi del team condotto dal Professor Alberto Broggi dell'Università di Parma sono a tal proposito stati anche sperimentati i primi veicoli senza conducente proprio sulla A2, facendola diventare la prima autostrada in Italia predisposta per la "guida autonoma" con servizi all'avanguardia, basati sul dialogo veicolo-infrastruttura e veicolo-veicolo. In futuro sarà possibile partire dalla Finlandia e arrivare in Sicilia attraverso lo SCanMEd con auto senza guidatore!

Senza dimenticare il progetto delle case cantoniere, il cui obiettivo è non solo valorizzare e manutenere opere che fanno parte del nostro panorama architettonico, site spesso in contesti naturalistici meravigliosi, ma anche creare servizi, sviluppare un brand associabile a concetti di autenticità, genuinità e legame con il territorio, con grande attenzione alla sostenibili-

tà ambientale, all'efficienza energetica, alla sicurezza. Per rispondere alla sua domanda, vedo tutto questo come un punto di partenza. La tecnologia evolve continuamente e oggi lavoriamo su cose che dieci anni fa avremmo creduto impossibili.

2. Quali sono secondo lei gli elementi da utilizzare per non rendere obsolescenti gli interventi sulle/per le infrastrutture che progettiamo oggi per il futuro?

Fondamentale sarà nei prossimi anni, anche in ambito legislativo, il processo di cambiamento dell'approccio non solo all'infrastruttura stessa, ma alla sua stessa concezione. In questo modo non cambia sul campo solo la strada o la tecnologia utilizzata per la sua progettazione, costruzione e manutenzione, ma anche la sua stessa definizione, non più intesa come semplice infrastruttura civile, ma come "strada di comunicazione" e "strada di energia". Tutto questo non è solo progettazione del futuro ma riveste un ruolo sociale, in una prospettiva di contemporaneità di risposte alle nuove geografie del vivere dettate dalla loro influenza e posizionamento sul mercato dei prossimi decenni.

Analizzando l'aspetto sotto una veste più pratica, Anas ha attivato, così da intervenire tempestivamente su eventuali criticità dettate proprio dall'obsolescenza o altre problematiche, due schemi di monitoraggio: quello dei cantonieri (sulle opere d'arte) e quello satellitare (opere d'arte e territorio a rischio idrogeologico e frane). Quello dei cantonieri consiste essenzialmente nel sorvegliare giornalmente i tronchi stradali di propria competenza e trasmettere in tempo reale con i moderni sistemi tecnologici i dati rilevati alle centrali operative territoriali. Il personale di esercizio invece effettua ispezioni periodiche delle opere d'arte maggiori per verificarne lo stato di conservazione o il presentarsi di criticità.

I dati raccolti in queste ispezioni vengono archiviati sul sistema SOAWE, una banca dati che ci permette di avere sotto controllo la situazione della rete e delle opere d'arte.

A questo si aggiungono specifiche campagne di indagine per il controllo qualitativo delle caratteristiche di resistenza o durabilità dei materiali di particolari tipologie di opere, come ad esempio quella effettuata sui ponti a travi precompresse con cavi scorrevoli.

Il monitoraggio satellitare invece è nato per superare la logica dell'intervento episodico o emergenziale così da poter avere un quadro complessivo dell'infrastruttura e degli eventi che su questa o al suo intorno si verificano e intervenire prevenendo le criticità di sicurezza, funzionalità o confort della rete.

Nel campo del monitoraggio strutturale e geotecnico, Anas ha avviato nuove sperimentazioni per l'utilizzo di tecnologie innovative, quali l'utilizzo di micro-sensori MEMS e di sensori in fibra ottica e della tecnica dell'Interferometria Differenziale da Sensori Satellitari – DInSAR.

L'azienda ha inoltre stretto una convenzione con ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale) per il continuo scambio di dati circa i fenomeni franosi che coinvolgono la rete stradale e l'attività di studio e ricer-

ca, anche in convenzione con i principali atenei italiani, sulla vulnerabilità idrogeologica e sismica della rete Anas.

3. Secondo lei, se considerassimo le infrastrutture della mobilità come dei servizi energetici e culturali oltre che di connessione, a supporto dei territori attraversati, saremmo in grado di rispondere ai cambiamenti tecnologici dettati dal futuro?

Questo sta già accadendo. Ad esempio sul piano culturale è stata creata ad hoc da Anas una campagna di comunicazione istituzionale per la valorizzazione turistica della nuova A2 'Autostrada del Mediterraneo', realizzata insieme al MIT e con il patrocinio del Ministero dei Beni e delle Attività Culturali. È la prima infrastruttura con un piano che promuove l'offerta culturale, spirituale, artistica ed enogastronomica.

La campagna ha infatti lo scopo di proporre un nuovo, dinamico e moderno modello di sviluppo, trainato dalla sinergia tra tutte le realtà locali interessate, mettere in campo iniziative concrete di sviluppo, di conoscenza e di fruizione del territorio in grado di definire, nel loro insieme, la forza e il valore del Meridione. Attraverso la sua forza, la campagna lancia a tutti il messaggio di come, viaggiando lungo la A2, si possano scoprire e riscoprire continuamente angoli d'Italia pieni di bellezza, natura, paesaggi mozzafiato, spiritualità, cultura e arte. Senza dimenticare anche i prodotti della terra unici e l'eccezionale offerta enogastronomica per cui il Sud è famoso in tutto il mondo. Per far conoscere alcune delle enormi potenzialità che la A2 può esprimere, sono state individuate con istituzioni e ed enti locali, attraverso i 51 svincoli dell'autostrada, dieci 'Vie' che lambiscono l'Autostrada del Mediterraneo e si snodano attraverso terre piene di storia, memoria e bellezza. Dieci percorsi che saranno richiamati dalla cartellonistica autostradale, invitando gli automobilisti a concedersi magari una deviazione dal proprio tragitto per scoprire mito, arte, profumi e sapori del Meridione.

Se si pensa a questo e poi si sposta il pensiero sulla Smart Road la risposta è semplice: connessione. Fare tutto sarà più facile, attraverso il wireless e la sostenibilità energetica, attraverso le cosiddette Green Island, che produrranno energia elettrica rinnovabile, fotovoltaica e/o eolica, ogni 30 km circa. Dalle Green Island sarà distribuita energia pulita che alimenterà tutti gli apparati della Smart Road. Verranno installati sistemi di ricarica veicoli e di droni per il monitoraggio e le ispezioni di opere civili strategiche, che saranno utilizzati anche per una sorveglianza continua a fini della sicurezza. Non dimentichiamo poi che sotto il profilo culturale qualche mese fa Anas ha lanciato anche il progetto GRArt, volto alla riqualificazione della periferia della capitale lungo il Grande Raccordo Anulare attraverso la realizzazione di murales firmati da urban artist dal profilo internazionale, guidati da David Diavù Vecchiato, così da valorizzare l'arte contemporanea e il territorio ma coinvolgendo anche le imprese. Per ANAS il futuro è già oggi.

4. Futurinfrastructure in 3 aggettivi

Affidabili/sicure, Smart/4.0, Interculture/Interculturali/Intergenerazionali

2.2.3. Motorway as techno-ecological system. [regulation technoecosystemic service]

THEORY

Road Ecology, science and solution

Richard T. T. Forman, Daniel Sperling et al.

"Our premise is that the land-use patterns, the types and arrangement of human uses of the land, strongly influence the pattern roads in a landscape. Furthermore, the interactions between roads and the ecosystems and watersheds in which they reside fundamentally shape of the flows and movements across the land, in effect determining how landscape works."[166]

Cultural context

Road Ecology, as a science, was born from the conflict about the relationship between man and his environment that characterized and influenced American culture in the last century. The word "freedom", which symbolizes the American principle on which the history of the United States is based, contains an internal dichotomy: the affirmation of a right of freedom often causes of the negation of the same, in favor of other forms in which this right manifests. This concept can be placed in a particular historical period in the United States, when the mass production of Ford's Model T started in 1915 (M2.0, 1.4). The spread of individual vehicle established the emergence of emancipation of man's immobility compared to the boundless landscapes of US territories. From the "mass production" it has been passed to the "mass spread" of the car, which led only in 1929 to a percentage of a car every 5 Americans, reached in Europe only in the 60s[167]. This evolutionary process of the individuality and the independence of man influenced a utopian vision of the city[168], seen more and more widespread and extended in the boundless territories, defined on the networks of roads that connect and guarantee the movements, "connecting everywhere to everywhere"[169]. The cars reshaped every activity of American life and influenced the US road system expansion. With spread of eco-environmental culture, and with the use of ecology in planning field , the man freedom was translated into a shock for the functionality of natural system. Gradually the interest in the ecological field increased and the attention on the effect of the infrastructure on the landscape became central in the planning and design approach. In parallel, the research in Netherland , about fauna movement and fragmentation, influenced the ecological field in United States and infrastructures became a symbol of impact in all natural elements of ecosystems: air, water, field and so on. During the last decade of the last century, to spread awareness of these ecological themes, there were organized conferences between Netherland and USA that have created an active group of researchers from Europe and USA, they are ongoing in their work, called IENE Infra Eco Network Europe with the program COST 341[170].

Authors

The work was written by several authors of different disciplinary fields[171]. This underlines the complexity of the theme, but also the interdisciplinary necessary to understand the complexity of natural phenomena in relation to the infrastructural system of roads and vehicles. The main authors, who directed the writing of the book, are Richard Forman, researcher and father of Landscape Ecology and Daniel Sperling, an Environmental Engineer and an Urban Planner, Director of the Institute of Transportation Studies at the University of Califor-

nia. In order to understand the state of art in the ecology of the road, the group collected interventions and reflections on the relationship between road, landscape and vehicles, becoming a pioneer and founder of a new theory related to the Road Ecology, strongly influenced by the disciplines of ecology and environmental engineering as well as civil.
Until then, the debate was on the ecosystems and effects that human action caused on these. With landscape ecology, these aspect had been projected into a spatial dimension[172] that had made the road the protagonist of the impacts, but at the same time a medium of reasoning into the ecology of ecosystems "... a road system intersects almost all areas of the ecology: the principles are linked to the water cycle and its relative flows, followed by microclimate, wind, atmospheric effects, soil, vegetation, biodiversity, population, fauna and habitat fragmentation".[173]

Key points of the theory
The book Road Ecology, published in 2003, can be considered as a real collection of issues related to the relationship between ecosystems, roads and vehicles. This relationship is described transversally throughout the chapters of the book, with an encyclopedic wealth of references[174]. The core object of this book is to recollect the dispersed theory, concepts and models important to road ecology in order to build a state of art framework about this theme useful to transportation planning, policy and practice.
The book starts with the first chapter as a description of the singular elements of the field: the road, the vehicles and the ecology. Through the explanation of the singular effect on each natural element: vegetation, wildlife, water and atmosphere, at the end there is a focus on the relationship between infrastructure system and its surrounding. As the authors say in the preface of the book "the road system ties the land together for us yet slices nature into pieces. Natural processes requiring management and mitigation for nature. Both effects are costly to society"[175]. This is the general theme of the described research, to analyze each aspect of the production, to develop suggestions and example approaches as general strategy.

Structure of the book
Starting from the introduction, the general approach intersects all aspect of the research. The book starts with a focus through the relationship between road and ecology and in each chapter describes effects and impacts on natural living: from biotic and abiotic world. The book is subdivided in four parts.

Roads, vehicles, and ecology. This first group of chapters underlines how is important the link between transportation and ecological field to have a solid analytical and scientific framework for decision making, through the description of transportation planning features and ecological aspect.

Vegetation and wildlife. In this second part there is the description of biotic and abiotic aspect of life in relationship with road network. The roadsides, which cover the 0.5% of surface in the USA, represent an opportunity to planning and preserve ecological condition near road lanes. On the other hand, the impact related to mortality of wildlife need to be mitigate. The permeability of road system is highlighted as the principal goal of road ecology, to preserve the freedom of different species of animals.

Water, chemicals, and atmosphere. The interaction of road system with water and atmosphere is analyzed in all complex perspectives. In particular the water create a double effect. It is negative for the road because of freezing, flowing with erosion and so on, but also is negative in contact with road systems because is a medium for transportation of chemical dust from the asphalt. For the atmosphere the described effect is quite clear. The pollutant dispersed in the air, are transported by wind water in the surrounding ecosystem. Road system directly and indirectly produce pollution, disturbances and climate change.

Road system and further perspectives. Starting from the previous introduction, the last part of the book tries to upload the scientific concept to the landscape, underlining the link between landscape and road system. The planning prospective deals to change the point of view and uses the analysis of the effect on landscape as a base of decision making processes.

Until the early stage of Road Ecology, in landscape planning there was simply the spatial and the territorial analysis, using the principles of landscape ecology that combine the interaction between geography and ecology[176]. Whit the Landscape ecology, ecological systems became both spatial and functional as in the ecology of ecosystems. As the road is an element able to bring together more ecological aspects in its analysis, the network of infrastructures became the cumulative box for gathering the overall vision of the ecological effects on the landscape.
Still now (M3.0, 1.5), the road is perceived as the negative of the environmental systems [177] of the landscape. In some ways in this new discipline of 2000s, it takes on a central role, always negative, but able to catalyze a complex and complete vision on the effects that the anthropic infrastructures have on the landscape. The work of Forman and Sperling opened the done observations on landscape ecology, also in this discipline. The main goals was to understand how landscape properties, such as topography and land use, could influence the road pattern and vice versa, taking into account the dynamic ecological cycles of the landscape that was crossed by the road.
The premises are based on the "network theory"[178], because in Road Ecology are outlined the spatial and temporal attributes of the road system, such as density and its changes over time. These elements are used in order to understand how the road pattern influences the environment and ecological systems and vice versa, how the environment in turn influences the use density of road space over time.

For the Road ecology, to study network system is important both for roads and for habitats. Multiple matrixes overlap and intersect themselves, making necessary interventions that are able to mitigate any impacts. To dense road network linked to the territorial morphology[179], useful parameters are associated. These are variable according to the type of road shape, which causes the ecological effects:

1) The road density and the mesh size. Road density is expressed in the length of the road per unit area of landscape and is a unit of measurement, which is usually interpreted as a first approximation of the effect that the road has on the crossed territories. The mesh is within the road system and for its size is proportional inverse to the density. When the density increases, the mesh narrows. Through the study of mesh and density we can make considerations related to road planning, as increasing density, decreases the space necessary

for a species to have more flexibility in its habitat. With significant effects on ecosystems, fragmentation related to the landscape, gradually leads to the reduction of biodiversity[180].

2) The surface of the road. Many phenomena depend on this parameter of measure, because for example, the greater the road surface and the greater the polluted surface affected by flow of rainwater, which will be polluted by the harmful dust present on the asphalt[181].

3) The traffic volume, to which the area of road influence, is associated (road effect zone). This factor does not depend on density, but on the single effect. Basically, it is defined as distance from the carriageway. Road effect zone is he spatial length on which the single pollutant acts on the single receptor. For example, how far the road axis intercepts a single species of birds, or how far is the point in which the vegetation usually is affected by the smog[182].

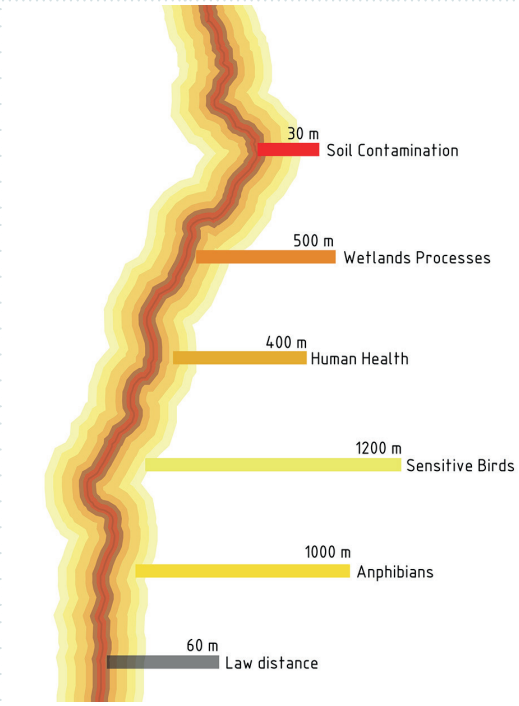


Image 15|Road Effect Zone.

According to the authors, these three parameters allow us to have an overall view of the functionality of the territories, allowing them to be managed from both a functional and ecological point of view. The case studies about road system inserts into environmental units should be analyzed case-by-case, bearing in mind the elements described in the book.

The TechnoEcoSystem features.

The ecological approach described in the work of Forman and Sperling, focuses on key points such as attention to impacts and the ecological relationship between infrastructure and landscape.
From the policy point of view, the road ecology simplifies the objectives to follow in six tactics. In a practical way these summarize the principles emerged from the state of the art of the discipline. These are:

1) Making the infrastructure permeable through the opening of ecological corridors, which allow the fauna and water do not meet infrastructural barriers in their path, reducing the fragmentation of the habitats.
2) Using naturalistic engineering and landscape architecture design strategies to implement the infrastructure's cultural services, as well as reduce the impact of sound disturbance;
3) Distributing the traffic on the main and already impermeable arteries for their physical conformation, thus decreasing the distribution of vehicular traffic on the network, which makes the fragmentation and the barrier effect[183] more widespread;
4) Aiming for a more sustainable process of production of cars and vehicles;
5) Using ecological fuels to reduce the polluting components in the atmosphere;

6) Decreasing the accessibility of driveways in protected areas, to reduce the disturbance of the species in a particular environment[184].

Through these tactics the design of motorway become a tool to mitigate the impacts such as fragmentation and the quality of air and water, becoming the producer of a technoecosystemic regulating services.
In this way, in general, the landscape planning of infrastructures becomes an instrument to enhance the places that are crossed by the motorway, through technoecosystemic strategies, producing regulating services for the surrounding environment.

Elements that are following the regulating service principles of a TechnoEcoSystem:
- the attention to ecological connectivity and to mitigation of impacts
- the attention to create support for the territories already during the design stage of a road

Missing elements:
- the attention to the point of view of the travelers
- the attention to man and his environment, as an species in nature and not only against nature.

TREND

COST Action 341| Habitat Fragmentation due to Transportation Infrastructure IENE, Infra Eco Network Europe

"Land is under continuous pressure for new transport infrastructure: between 1990 and 1998 some 33000 ha, about 10 ha of land every day, were taken for motorway construction in the EU. ... Most areas in the EU are highly fragmented by transport infrastructure. The average size of contiguous land units that are not cut through by major transport infrastructure ranges from about 20 km2 in Belgium to nearly 600 km2 in Finland, with an EU average of about 130 km2."[185]

Cultural context

After the entry into force of the Single European Act in 1987, environmental policies also began to have a community focus, especially into aspects related to nature conservation. With the Earth Summit of the United Nations Conference on Environment and Development (UNCED, Rio de Janeiro, June 1992), the Convention on Biodiversity was signed, where for the first time, conservation and protection become the prerogatives for start sustainable development processes[186]. The pan-European strategy for biological diversity and landscape[187] allowed to define general strategies on protection and conservation, which influenced European policies in the following years. Among these, central is to fight the process of fragmentation of ecosystems and landscape, reducing anthropogenic pressures on the environment. On the regulation level, with the approval of the "Birds" (2.04.1979) and "Habitat" (21.05.1992) Directives, finally we arrived to the definition of guidelines for the construction of a European network, called "Nature 2000", with sites of important biological and landscape value[188].

The European political scenario has conditioned a local attention on the applicability of some strategies at a territorial level. Among the initiatives, in 1996 IENE (Infra Eco Network Europe)[189] was born as an initiative of the Road and Hydraulic Engineering Division of the Ministry of Transport, Public Works and Water Resources of the Netherlands, after a conference on infrastructures and habitat fragmentation. During the symposium, 135 participants from over 25 countries discussed the topic and founded an international network, IENE, to improve the information about the topic of fragmentation. At the same time, in order to open the relationship between environment and transport, the Council of Europe's Activities Committee set up the "Environment and Transport" Working Group in 1998, whose activities enabled the drafting of the "Code of Practice for the Introduction of Biological and landscape diversity into the transport sector "[190]. After that IENE group stared a project of European cooperation in the field of scientific and technical research, called "COST Action 341 - Habitat Fragmentation due to Transportation Infrastructure", to which 16 countries[191] have joined. The group through this document was summarized and simplified the topic in order to be clear in all field involved in the transportation field. The Project presented in Brussels in November 2003, produced a series of documents that are still fundamental for the development of research applications related to road ecology[192].

Document description

COST 341 is a document that summarizes a strategic and tactical approach for solving problems related to territorial fragmentation. The document addresses the theme of road ecology both in terms of strategic planning and in terms of monitoring and management of individual interventions after their timely implementation. In particular, the topics ad-

dressed range from the development of an integrated approach that through planning can avoid or reduce the processes of landscape fragmentation. For this reason, the document illustrates technical and alternative solutions able to mitigate and compensate the impact of the infrastructure in the territory, suggesting methods of management and application of the same.

Approach.
The document approach is divided into three possible alternatives, which aim to avoid, mitigate and compensate for the negative impacts that infrastructures have on the territory. The general philosophy is to avoid the effects of habitat fragmentation rather than cure them[193]. Where it is impossible to avoid, we should move on to mitigate these impacts, while where the mitigation turns out to be insufficient or not very decisive, we should move to compensation as the last possibility. The document is referred to new infrastructures, even if the same principles should also be applied to existing ones,as tool useful to reduce the impacts present on the ecosphere. All these approaches should be controlled in order that all actions should be conform to the design and quality standards.

Effects
The effects that the document tries to contrast can be summarized in four points.

1. Loss of habitats.
Road construction changes the morphology of the land surface that compromises the natural balance of habitats. In particular, when the infrastructure crosses non-urbanized spaces, the impacts often cause a breakdown of ecological systems. The interruption of the continuity of use of a space, gradually leads to phenomena of isolation of the species, which inevitably affect their localized diffusion in the territory.

2. The barrier effect.
This is the greatest impact for the habitat isolation because for the continuity of the species is necessary to feed, to move and to procreate. With the isolation this is impossible. The permeability of the infrastructures identifies the degree of difficulty of crossing that a species can encounter in its free movement. The more the infrastructure is impermeable, the more is the probability of the species to be isolated. To solve this problem the solution is applied the concept of ecological corridor[194] to guarantee the continuity between the opposite sides of the road. In combination with roads, these corridors can be opened in some point, reducing the difficult moving of the species, as strategy of mitigation.

3. The collision between the wildlife with vehicles.
The most known impact is the mortality of wildlife. There are millions of species that lose their lives along linear infrastructures, also for collision with cars. In addition to this, we must not underestimate the traffic that affects the behavior of the most sensitive species, becoming a cause of mortality and a significant influence factor on the survival of the entire population. Roads that run parallel or intersect edges of forests or pastures are particularly dangerous for animals that move regularly within habitats that are apparently untouched by human presence.

4. Noise and air pollution.

The passage of the infrastructures causes a process of disturbance and an inevitable change of the crossed contexts. These disorders can be classified into four categories: erosion due to water flow, chemical pollution both atmospheric and water and soil, noise pollution and vibrations and finally pollution and light disturbance caused by the passage of vehicles.

Solutions
According with the document, to contrast the process of fragmentation, we must act punctually and strategically avoiding, mitigating and compensating the effects of human action, identifying in specific cases the type of action to use.

Avoid
If building the infrastructure is strictly necessary, we should adopt a careful planning, to avoid or reduce the fragmentation processes that occur with its implementation. This is guaranteed both in the planning of the processes and in the realization of the projects through the SEA (Strategic Environmental Assessment) and the EIA (Environmental Impact Assessment)[195]. The general objective of the SEA and the EIA is to identify the possible environmental impacts of the projects and planning processes before proceeding with the execution of the works. Another objective is to guarantee a public consultation on the project. The minimum contents that the VIA provides are[196]:
- a description of the project with details relating to the site and the relative scales in which the project is inserted;
- a detailed list of all the applied alternatives (including the zero option) with the relative reasons for their environmental impact;
- a description of the proposed measures to avoid, to reduce the effects of inevitable impacts;
- a complete description of the used methodology for the made choices[197];
- a non-technical but descriptive summary of the made evaluation.

These minimum contents should be used to find main factors (values) that should be evaluated both in the case of new infrastructures and in case of mitigation and analysis of the impacts of existing infrastructures. In general, they are fundamental to understand which kind of approach should be to apply . Among these, there are[198]:
- special conservation areas (International and EU-habitat sites, Ramsar areas, etc.[199]);
- rare and endangered species of fauna (such as species on the IUCN Red List[200]);
- specific sensitive habitats;
- landscapes of high natural and cultural value;
- important ecological networks and dispersion corridors in areas already highly fragmented.
Therefore, to minimize fragmentation in planning and in decision-making processes, it could be useful[201]:
- to incorporate fragmentation problems as much as possible in the evaluations and analyzes that are carried out in the SEA and EIA processes;
- to deepen the analytical and cognitive part, focusing on the ecological and environmental effects, due to a new or existing infrastructures;
- to apply the assessment procedures for new infrastructures to existing ones;
- to outline a cost-benefit analysis in terms of both environmental costs and economic costs.

Mitigate.
The construction of a new infrastructure must be integrated harmoniously and linearly in the natural environment, without interrupting the connectivity of the corridors of flora and fauna. This can be achieved through processes and mitigation techniques to limit the ecological fragmentation of the territories crossed by linear infrastructures. The COST Handbook focuses particular attention on the detailed design of the points of union between the natural and the anthropic elements. These usually are the most sensitive points where mitigation could be applied if there is a perfect mix with the peculiarities of both landscape and infrastructure. Depending on the intercepted territory, the mitigation techniques are differentiated through alignments of the terrain, viaducts and embankments that articulate the types of road sections.
The mitigation techniques of the bio-engineering, try to ensure a landscape continuity of the infrastructural systems. These can be simplified in: tunnel, use of vegetation, fences, walls and perimeters, environmental barriers, lighting and drainage.

Tunnel. They can be considered as the best solution able to preserve the landscape values of the territory. Although the costs of implementation are significant, the benefits to the natural environment are inestimable.

Vegetation. In the planning phase it is important to know which are the native vegetations and the species around the infrastructure. It generally opts to native species that do not require care and maintenance, aiming towards more possible self-generative solutions. The function of each species is analyzed carefully, to understand the behaviors and movements of the fauna and also the role of shrubs or trees[202].

Fences, walls and perimeters. These are strictly necessary to isolate the fauna from particular areas to avoid dangerouse situation, both for the user of the infrastructure, and for the animal itself. These are usually done with local design and materials or are made through the use of vegetation in delicate points such as junctions between bridges and roads.

Environmental barriers. They serve to minimize impacts with neighboring areas. When these are very long, it is necessary to foresee points where the animals can cross them, because with their visibility, the fragmentation increases.

Lighting. This must have the least possible impact on animals, reducing the intensity and the spread of the light.

Drainage. The drainage of the surfaces is essential to ensure the flow of water near the infrastructure, avoiding blockages and floodings that would compromise both the environmental stability of the site and the safety of vehicles. For this reason drainage elements are suggested, using geotextile and vegetal material, to create wetlands in which many species can seek refuge.

To solve problems related to environmental fragmentation, technical and design solutions are applied in each specific case where a mitigation action is required, to preserve the spontaneous behavior of the species. To guarantee the permeability of the infrastructures specific elements are adopted such as overpasses and underpasses, sized according to the

species that use them. In the COST 341 Handbook, the measures are deepened for the different living categories which usually are effected by the effects of the infrastructure. The document collects: the passages built for the individual species, the adaptation techniques of the infrastructural elements to implement the fauna route and the techniques to boundary the animals movements to avoid their death. Specific attention is given to mammals, birds, fish and amphibians, creating a real manual of principles to follow in the design of mitigation measures to ensure the passage of fauna.

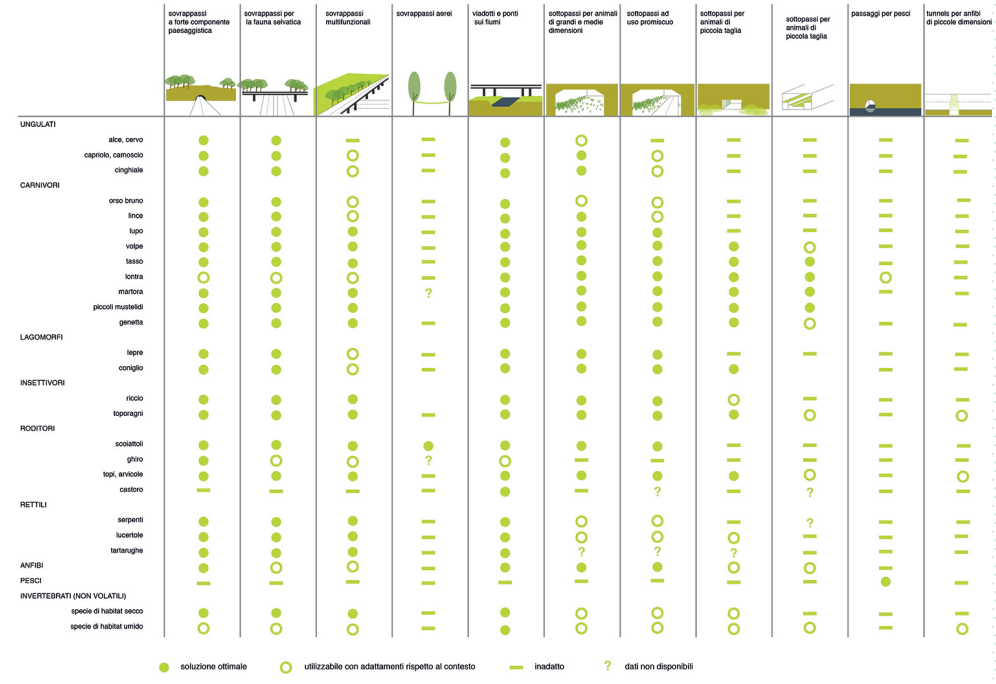


Image 16|COST design solutions for wildlife overpasses and underpasses. (Rizzi, 2016)

Compensate

When the mitigation is difficult to apply, the compensation as a procedure in exstremis can be adopted. Ecological compensation implies that specific natural habitats with their qualities, such as wetlands or old forests, should be recreated elsewhere if they are affected by the impact of a project. Therefore, with the compensation procedure, the ecological damage is somehow refund. This is the last possible option and not a way to simplify any procedures for interventions that have negative effects on the ecosystems. As a first approach the action is to preserve, if this is not possible, the alternative is to do nothing or compensate. Since there is no legislation that provides expropriations for public utility related to compensation, this is done as a choice by investors, by landowners or by who manage the nature conservation funds[203].

The way in which compensating measures are applied varies according to the geographical and cultural context in which they are provided for. These include for example: the creation of new habitats, artificial wetlands to attract species such as reptiles and amphibians, woodlands or even to recreate energy and nutrient flows.

Monitoring
After the application of mitigation and compensation measures, in this case the most important thing to evaluate is the monitoring and operation of the adopted systems.
This is useful to guarantee the effectiveness of the adopted systems, often oversized if it is compared to the real needs[204]. Monitoring helps to establish if the measures guarantee the minimum impact of fragmentation of animal populations and habitats. The publication of the results during the monitoring phase, it is useful to evaluate the investment in ecological terms. In addition, the data are a guide for future interventions and to allow designers / planners to prevent errors, improving the design of mitigation systems .
Monitoring should be adopted as part of the technical management process, improving the adaptation of used design techniques for transport infrastructure.

Objectives & Effects
The objectives of the Handbook 341 COST are to create a collection of principles and techniques useful for preserving natural habitats. The handbook is not seen as an arrival point, but a starting point that helps to sustain the debate on the topic of territorial fragmentation due to linear infrastructures. This project, as seen before, involves 16 countries, in which, individually, scholars and experts from various disciplines related to infrastructure. The document is the result of the knowledge of a large number of experts, which allows European network to outline a practical guide for planners and engineers, sensitizing different fields to the fragmentation problem.

After COST 341 handbook, other dissemination tools were defined with the same goal. These are reported in the final part of the document[205]:

- National State-of-the-Art Reports from 16 countries. Each report describes existing practices highlighting the method, indicators, technical details and procedures to avoid, mitigate and compensate for adverse effects on nature. These reports are the basis for the European Review.

- COST 341 - Habitat Fragmentation due to Transportation Infrastructure: The European Review.

- An online database containing information on existing national and international literature, as well as projects relating to habitat fragmentation. Accessible through the IENE website.

- The Final Report, which describes and defines a summary of project results and possible future solutions.

TechnoEcoSystem features
The document, previous described, shows an European trend to take care of the impacts caused by the road through an handbook. More emphasis is given to new infrastructures, rather than the existing one. From this point of view, research in Italy is far behind. According to Marco Dinetti, one of the few Italians into IENE network, the only interesting activity developed on the theme of Road Ecology in Italy is the ISPRA[206] ones. The ISPRA network tries in some way to standardize the policies of the national territory, focusing on the issues

of ecological fragmentation and of others impacts of infrastructures on the territories. In Italy there are specific actions, but little general interest on the topic, compared to what was agreed in the conference of 2004[207]. There are little phenomena related to improvised interventions that are far from the practices applied in the world. At the end, to solve this lack of attention to the issue, we should define: a sinergic scenario with cross-collaboration in mixed working groups, a dissemination of good practices, a widespread training and an involvement of individuals with experience to start this process[208].

Taking into account the content of the COST 341, the mitigation and compensation actions follow the idea of a technoecosystemic infrastructure, producing regulation services for the other natural and antrophic ecosystems. These two strategies, as well as being able to be applied to new infrastructures, can be used as refunding tools for the territories crossed by motorway.

Elements which are useful for regulating service scenarios of a TechnoEcoSystem:
- both compensation and mitigation strategies related to chemical and physical impacts on flora and fauna, as well as on anthropic ecosystems,
- the open manual which makes the adopted ecological approach, resilient over time.

Missing elements:
- more attention to existing infrastructures. In a scenario where it will no longer be necessary to build new infrastructures, the goal will be to transform the old into something new.

ACTION.

Trans Canada Highway
Transcontinental federal-provincial highway

Cultural context

The history of roads in Canada is distinct from USA because of the geography, governing and peculiarity of the culture. Canada is a federation of 10 provinces, with a population of ten time minor than USA. The density of residents is major in metropolitan areas as Montreal, Toronto and Vancouver. In 1975s the system of roads sprawled behind the metropolitan areas for developing economic sector, which allow to grow the access to the major transport modes of the time, as waterways and railways. In general Canada has the major km of road per person and the lowest road density[209] but for its natural context has the major problems related to the impact on the wildlife. In general, roads are known to affect wildlife populations by increasing mortality, creating a barrier to movement, removing habitat, and facilitating the spread of invasive species[210].The most negative impact of road on wildlife is mortality due to wildlife-vehicle collisions. When Trans-Canada-Highway (TCH) was built in the 1950s in the Bow Valley of Banff National Park, the impact on wildlife was insignificant. After some years, highway has transformed into major commercial highway, which connected Atlantic and Pacific coasts. With this change, in the last 20 years, the TCH was recognized not only as an important source of mortality but also as a potential barrier for large mammal movement in the mountain parks and the substantially larger Central Rocky Mountain ecosystem[211]. Actually, Banff sustain about 4 million visitors per year, with 25000 vehicles per day in summer on TCH, because Banff with Yoho National Park are the only protected areas in North America crossed by four lane highway[212].
For this reason, Parks Canada emphasized the necessity to mitigate the effect of the roadway on wildlife and ecosystems, though ensuring the access to food, shelter and mates of wildlife across the landscape. Achieving this goal requires a cooperation into a set of disciplines such as civil engineering, environmental design, transportation planning, and biological sciences, useful to understand better the problem.

Territorial context

The Trans-Canada Highway is the world's longest national highway with a length of 8,030 km (4,990 mi.). The highest point on the Trans-Canada is Kicking Horse Pass, high 1643 m, which is 316 m higher than the Rogers Pass. The Roger Pass portion of the highway was paved in 1963, completing the coast-to-coast highway. The Trans-Canada Highway links several provincial highways, some of which are 4 lane divided, but many stretches are still 2 lanes. The transcontinental federal-provincial highway system that travels through all ten provinces of Canada from the Pacific Ocean on the west to the Atlantic on the east. It bisects Banff and Yoho National Parks and for this reason is necessary to mitigate the impacts of the TCH on wildlife mortality and habitat fragmentation[213].

Project

In the 1970s, safety issues compelled planners to upgrade the TCH within Banff National Park from two to four lanes beginning at the eastern park boundary, and expanding west up the Bow River Valley. In the 1979 Federal Environmental Assessment and Review Process for Phase I identified that wildlife collisions were a major concern for human safety and

wildlife conservation values for this territory[214]. For this reason the first 27 km of highway (Part I and II) twinning included 10 wildlife underpasses. It was completed in 1988. With the advent of ecological-integrity based management in the national parks system, the Part III was the example of a new era of highway mitigation[215]. This phase was designed to have the smallest footprint possible and was situated at the minimum distance from the road as possible, that is called clear zone[216].The next 18 km section was completed in late 1997 with 11 additional wildlife underpasses and two wildlife overpasses. This overpasses useful for primarily grizzly bears, wolves and cougars are in two 50 meters-wide.

The final 30 km of four-lane highway to the western park boundary has been divided into phased twinning projects. The first phase is a 10-km section with eight more wildlife crossing structures including two that are 60-m wide wildlife overpasses. The second phase recently completed by the federal government twined the remaining two sections.

In Banff National Park, there are currently "41 wildlife crossing structures (6 overpasses and 35 underpasses) that help wildlife safely cross the busy Trans-Canada Highway. Since monitoring began in 1996, 11 species of large mammals—including bears, elk and cougar, have used crossing structures more than 200,000 times"[217].

The Banff wildlife crossings can be summarized into five structures for different alternative of passages. These structure types are, as reported by A. Scott:

"1) Creek bridge underpass [3 m high x 11 m wide spanning waterway]
2) Elliptical, metal culvert underpass [4 m high x 7 m wide]
3) Prefabricated concrete box underpass [2.5 m x 3 m]
4) Open-span concrete bridge underpass [3 m high x 11 m wide]
5) 50 m wide overpass (Parks Canada)"[218].

Parks Canada has been responsible for managing the construction and maintenance of the wildlife crossings and provided funding support for the BWCP research and monitoring from 1996 to now through its Highway Service Centre[219].

The project can be explained by its numbers reported by the Highway Wilding research:
"1.7 – Average number of kilometers between wildlife crossing structures on the Trans-Canada Highway (TCH) Phases 1, 2, 3A and 3B
Two - Banff and Yoho National Parks are the only national parks in North America that have a major multi-lane highway running through them
Four – The number of phases of TCH twinning (expansion from 2 to 4 lanes) in Banff National Park since 1980
Five - The number of distinct crossing design types in Banff
Six – The number of wildlife overpasses on the TCH after completion of phase 3 in 2013;
10-15 - Percent of phase 1 and 2 twinning project budget dedicated to "environmental mitigations"
39 – The number of wildlife underpasses on 83 km of the TCH after completion of phase 3 in 2013- the most anywhere in the world for one single stretch of highway
50 - The number of miles of TCH in Banff National Park (east gate of Banff National Park to Kicking Horse Pass/B.C. border)

83 – The number of kilometres of TCH in Banff National Park (east gate of Banff National Park to Kicking Horse Pass/B.C. border)
166 – The number of kilometres of fencing along the TCH in Banff National Park to keep wildlife off the highway and direct them to wildlife crossing structures
1950 – Year the two-lane Trans-Canada Highway in Banff National Park was built; since then, it has become a major commercial thoroughfare
1982 – Year the first wildlife crossing structure was installed along the TCH between Banff's east boundary and Sunshine interchange
1988 – Year that 12 wildlife underpasses were completed with 2.4 m high wildlife fencing along the TCH from Banff National Park's east gate to Sunshine interchange
1997 – Year that an additional 12 wildlife crossing structures (2 overpasses and 10 underpasses) were built between Sunshine interchange and Castle Junction
2013 – Year that the TCH in Banff will be fully mitigated with a total of 45 wildlife crossing structures on 83 km of highway"[220].
Monitoring.
In order to perform the efficiency of the mitigation structure, it is necessary measured the reduction of the wildlife collision, the rates of passage of animals through the crossing passages and the effect of individual population.
Parks Canada has taken a long-term approach to monitoring wildlife-vehicle collisions and crossing structure use, maintaining monitoring operations in the Park since 1996[221].
The process of post construction is most important. The stages are: monitoring of crossing structures, examines annual trends and patterns of species use and at the end provides some comparison of species response to structure types. This is a baseline important to understand the efficiency of passages and the behavior of species, in order to have a feedback about the design approach used[222].

According with Clevenger publication for monitoring the mitigation structure, there is a set of six criteria of effectiveness:
- developed and examine the reduction of both road-related mortality and barrier effects on habitat connectivity,
- genetic interchange,
- the fulfillment of biological requirements,
- allowance of dispersal and re-colonization,
- long-term maintenance of meta-population and ecosystem processes.
These are criteria of priority to guarantee with a project[223].
Parks Canada is responsible of monitoring of numerical and spatial distribution of wildlife-vehicle collisions. The database include:
- the date of road mortality,
- GPS coordinate and descriptive location, species, number of individuals
- physiological information from necropsies[224].
The process is long. Wildlife usage data are controlled by researcher, focusing on recording: the species, direction of movement, number of individuals, and evidence of human activity near the passage during each visit.
Usually happens that when a new structure is insert in a place, wildlife need a time to explore the new before using it. For this reason continuous long-term monitoring is needed to determine the efficacy of design characteristics for multiple species and to allow species to adapt to crossing structures[225].

One of the objectives of this infrastructure is being a research platform and education for people that studying in this field but also visiting the park. The Banff Wildlife Crossings Project could be consider a sharing resource that informs the general public, students, and transportation professionals about the efficiency of underpasses and overpasses.
The project aims to present its monitoring and research findings as widely as possible to improve a professional understanding and knowledge base around wildlife crossings and road ecology, from the student level to the academic ones[226].

To recap the monitoring numbers, we have:
"One - The number of long-term research projects on highway mitigation research
Ten – The number of times wolverines have used the Banff crossings (as of February 2012)
15 – The number of years that the Banff research has been conducted so far…
80 – The percent reduction in collisions with all large mammals on the TCH due to fencing and wildlife crossings
95 – The percent reduction in collisions with ungulates (elk, deer, moose, bighorn sheep) on the TCH due to fencing and wildlife crossings
200,000 - The number of times that 11 species of large mammals have been detected using the Banff wildlife crossings as of summer 2011"[227].

TechnoEcoSystem features
In the project, the highway is a tool of mitigation of the impact that itself produces. The strategies of monitoring, controlling and definition of a design resilient in time are sources of the regulating TecnoEcoSystems.
The landscape planning ecological approach is a way to add value to the territory, through the TechnoEcoSystem as a tool to produce controlling services for the environment.

Elements of TES:
- the highway is an answer for ecological needs, such as the attention for the wildlife preservation;
- adaptable to the necessities of time
- the highway is a platform of example and research, resilient to the changes;
- participation of different realities (as university, Parks Canada and so on..) into the process of monitoring.

Negative elements:
- the highway need more attention to the provisioning and cultural services that it could be offer, not only for the park, but for the community around it.

The ARC International Wildlife Crossing Infrastructure Design Competition

Cultural context

Nowadays, the transports are in relationship with some megatrends as the increase of population in the urban areas, the application of old technology on the transportation and the consequences of climate change. These issues could be faced by the use of design devices, which will address the transportation needs of contemporary society. The objectives of design following these trends are: maintaining ecosystem integrity and connectivity, reducing the carbon footprint, minimizing consumption of non-renewable materials recycled resources, extends the life cycle of transportation infrastructure and operates efficiently[228]. Starting from these premises the ARC[229] competition was held as a design challenge in the context of road infrastructure. Beginning with the competition, ARC engaged the best and most innovative international, interdisciplinary design teams with landscape architects, architects, engineers, ecologists, and other experts to create the next generation of wildlife crossing structures for North America's roadways. The protection of wildlife corridors and ecological connectivity is central in the public policy agendas in North America. There are many example of policy applied in relationship with this issue such as Wildlife Corridors Initiative report, promoted by the Western Governors' Association (WGA), in which there was a chapter on transportation and wildlife crossing[230]. In this framework, the ARC International Design Competition offers a new vision for transportation infrastructure for safe, efficient, cost-effective, and ecologically responsive wildlife crossings to reconnect ecosystems.

Territorial context

The site of the design competition is between the area of Denver and the communities of Aspen, Vail, and Breckenridge, Colorado, along the Interstate Highway 70 (I-70) Mountain Corridor. This region of the Rocky Mountains is characterized by particular species such as black bear, cougar, bobcat, Canada lynx, coyote, elk, deer and American marten. The West Vail Pass near there is an example to follow for the competition. The site boarder for the competition is 400 m along the roadway on either side, and 150 meters to the approximate east and west into the forested lands on either side of the highway. The total site area recommended is therefore 24 hectares that can be exceeded[231].

Design competition

The most important value of ARC design competition is the procedure and the effects on the theme of wildlife crossing that this opportunity produced. In general the parallel aims of the competition can be summarized into five categories:

- involve international design firm into the challenge where there are combination values of transportation safety, structural engineering, wildlife conservation and landscape ecology;
- explore new approaches and use of materials through cost efficiency, ecological response, innovation of design that can be adapted for widespread use in other locations;
- produce adaptive design infrastructures to flexibility of dynamic of ecosystem conditions;
- create a design harmony, according with the existent program and policy of West Vail Pass;
- image a new generation of wildlife crossing design[232].

In general, the ARC aims to raise international awareness of a need to better solve the limits that are in the relationship between human and wildlife mobility. This is possible with

a more innovative and resilient design approach for road system and habitat network.
For the evaluation of the best project, the jury[233], with experts of different field, look for design excellence that fulfill the competition objectives, subdivided into three different macro groups, where the design is ever central.

1_Innovation of design. The objective is to go beyond conventional solutions exploring new methods, new materials and new alternatives. The inspiration is a key fundamental also to create cultural value in the intimate relationship between people and landscape. The project should be a synthesis of complex and adaptive modularity, that can be transferred to several scale.

2_Quality of design. The quality focus on the perception of the infrastructure that is both iconic and feasible, responsive to ecological aspects but also esthetically insert in the context. The sustainability to create long-lasting economic, ecological and social value is guaranteed through the design, which is adaptable to the reciprocal relationship of local and regional development and addresses ecological, architectural, engineering, transportation, landscape and socio-cultural demands of the site.

3_Cost effective design. The cost effectiveness proves the reality of the purpose in term of innovation, long term maintenance and economic and ecological sustainability of new design approaches[234].

These parameters are the base of the evaluation that select the following final five projects. The final projects that are presented for the competition, had the contribute of five big firm: Balmori Associates (New York), HNTB Engineering with Michael Van Valkenburgh & Associates (New York), The Olin Studio (Philadelphia), Janet Rosenberg & Associates (Toronto) and Zwarts & Jansma (Amsterdam).

MCS Modular Crossing System|Balmori Associates

The first project could be summarized into a kit of concepts as reached objectives: modular and efficient construction system with wood technology, adaptive management with use of vegetation, substrate and topography.

The steps of the process, in which the project is declined, are the followed: tracing the animal paths, locating the bridge, transporting the modular system, installing without disruption, placing the landscape, collect data from the bridge, creating new bridge. This is a process thought to be replicable along the entire highway.
For the monitoring and educational part, the Balmori group though electronic display useful to collect data and optimize crossing system. These data are also shared to have an educational outcome.
For the definition of the conceptual shape, this wildlife crossing uses the surrounding landscape in order to create a new figure inspired by nature. The design employs a low tech system of layering wood planes to create an easily modifiable shape. The main design aim of the crossings is the abstraction of the topographical layers in the landscape. "The smooth organic curves of the topography in the natural environment of the crossing's surface are reconstituted below in the rigid stratification of the structural layers in the built environment for vehicular traffic."[235]The result is a design that seems carved from a single

block of wood and which is able to respond to the dynamics attitudes of the ecosystems.
"The monolithic bridge corpus designed as a wide continuous beam whose section height varies with stress demands. The appearance from below is also the result of structural system of the continuous beam is designed with a high redundancy and robustness, without any joints."[236]

Wildlife connection|Janet Rosenberg & Associates (Toronto)

The principal approach of this second project has been to adapt the built environment to the needs of wildlife. The firm group thought that the behaviors of wildlife should be followed by the designed structures, and not the contrary. For this reason the crossing structure presents a variety of conditions suitable for diverse species, adaptable to different preferences of behavioral attitude of singular specie.
"The structure has multiple landings that build variation into a single crossing by providing many different ways (eighteen at this site) to cross the bridge rather than just two." [237]
The space in between the different strips becomes available for increased planting in the ground and not on the structure. This is useful to reduce the weight on the module but also the dimensions of the structural part of the wildlife bridge. The vegetation helps the wildlife approach to cross the bridge and the pre-unit of that is also defined to respond to the several factors that describe a crossing structure, such as slope and drainage.
The group in this project have identified two staging areas as natural pause points for wildlife that can offer entries to the crossing structure, making use of the existing landscape without intensive disturbance of existing habitat. They have identified 6 key interception areas which are also the base points of the bridge. Each one underlines the different wildlife species behavior, because they select a movement path based on particular experience, instinct, terrain, land-use types, and vegetation.
The decision-making and approach of the group with a modular design, emphasize the concepts of 'adaptability' and 'flexibility'. A module is also by necessity determined by structure. The identified module can produce with different orientation both linear and curved form. Thought this form Janet Rosenberg & Associates generate a structure that is "a series of individual strands that are bundled at the road, yet move freely into the forest to reach areas with a the gentlest slopes possible, recognizing a laziness factor even in animals." [237] The necessity to have a greater reach to collect wildlife, determined there are 18 ways cross the road, each strand leading to different environment.

Wild (X)ING|Olin studio.

The Olin Studio project could be summarized into all concepts underlined by the call of proposals.

The form of the canopy used to create the wildlife passage is a rhomboid. This form is used for the structural strength, dynamic flexibility and efficient modular patterning. The inspiration of the concept of the wildlife crossing is the union of living and static system. The project proposed is:
"MODULAR The grid of structure of the crossing and the habitat modules within it can be easily modified or edited, depending upon changing needs.
ADAPTABLE. The use of the toroid geometry as a framework for the grid superstructure and habitat module offers adaptability to any wildlife crossing, using a universal geometry to generate the system's form. It will accommodate growth and change of the transportation

infrastructure network, allowing highways to be increased in width and corresponding crossings to be enlarged, reduced or removed for re-use at any given time.
EFFICIENT. The doubly-curving shape of the grid structure resembles and reinforces existing corridor conditions, supports a mosaic of habitat modules and creates a divisible geometry which can be segmented into a set of identical structural components. This landscape system allows multiple, independent and geographically separated contractors to build similar crossings across the United States.
ELEGANT, LIGHTWEIGHT, INSPIRING DESIGN. Viewed from the road, the crossing is light, airy and iconic; from within, the crossing is visually and acoustically shielded, corridor-like and responsive to the need for dynamic connections.
PEDAGOGIC. The form of the crossing not only fulfills the goals of terrain connection and improved highway safety-it's intriguing grid form stimulates the imagination as to what it contains and whom it serves.
FEASIBLE. This extraordinary form of ecological infrastructure is both inspirational and capable of being realized as a safe, effective and iconic design. It will be the new cost-effective standard for department of transportation." [238]
For the vegetation, the modules are pre-planted at local nurseries using plant material appropriate for the corridor condition, creating a larger landscape mosaic.

LANDSHAPE| Zwarts & Jansma (Amsterdam)

The project is called Landshape. It intervenes in the collision between the natural and human-dominated world of the west Vail pass, with a dynamic wildlife.
The shape is a result of connection between artificial surface and the natural one, identify in the eco passage. Three curves connect both parts of the valley split by the Interstate-70. Through the curves there is a junction between the actual bridge and the ground level that advances over the bridge that transforms from mature forest to shrubs on the centre of the bridge itself. Curves are the main architectural element, that summarize the module of the landscape and the wildlife that overpasses. "These two main organizing curves are combined to a double curved surface from which a thin shell structure is generated. This 'ideal' symmetrical surface combined with the not symmetrical geo contours derived from the sites topology and morphology generates a form that is both contexts sensitive and at the same time artificial shape, a 'Landshape' is created."[239]
Landshape is a cost effective and innovative solution for road ecology. Combining proven technology with forward and state of the art materials and forward parametric design tools into a cost effective and feasible solution yet compelling to the public and suitable to the scale of the Great American landscape of the southern Rockies.

HYPAR-NATURE| HNTB + MVVA TEAM

The last finalist that is also the winner had am hypar (hyperbolic parabaloid) vault: "a modular unit that pairs a doubly-curved surface with a form that depends on a counter resistance to the exertion of lateral thrust."[240]
The landscape created by the project, called the hypar-nature bridging system, is driven by the demands of ecological engineering. Instead of attempting to recreate the surrounding nature, the design condenses and amplifies multiple landscape bands (Forest, Meadow, Shrub, Scree) into habitat corridors that provide connections for a larger cross-section of species"[241]. The structure itself is a modular and cost-effective system of hypar forms that allows for minimal site disturbance and easy creation, assembly, and deployment, and can

be expanded or adapted as migration pressures dictate. By combining a flexible structural solution with an adaptable approach to broad landscape management, the hypar-nature bridging system offers a new hybrid vision for addressing habitat fragmentation" [242]. Following there are the principal features of the project.

Wide Span, Far Reach. The bridge landscape for West Vail Pass is designed to be a prototype for a regional network of wildlife overpasses. The flexibility and efficiency of the bridge's structural component makes it extremely suitable for widespread use, and its adaptation allow to be apply to any location.

Thick Infrastructure. Hypar nature uses the conflicting demands, as a key to develop the two layer of passage, of human and animal transportation, in 3 dimensional way by pursuing an adaptable framework for both vegetal and structural systems. In this new prototype of landscape and structural collaboration, the ground can extend from a specific point to a regional land management strategy.

Linking Public and Science. This design unites the various constituencies that will ultimately be responsible for the success of preserving the Rocky Mountain wildlife. Success could be reached in the connection with the general population that can be attained through outreach and education. For any one bridge, there is a physical observation point with digital observation platform to observe a series of overpasses in real-time, as well as access information on particular species, habitats, and changes in migration behavior.

Complex Habitat Compression. "Multiple habitat types from the surrounding landscape are selectively distilled and then condensed into a series of parallel bands that act as crossing corridors for various animal species. The wide foraging bands provide an open field of view while narrow forest and shrub bands provide enclosed, covered corridors"[243].

Structural Efficiency. Standard bridge construction requires the use of three individual structural components: abutment, beam and deck slab. The concept anticipates precast elements similar to pre stressed AASHTO girders with type designations as a function of span length.

Kit of Parts. The hypar module can be deployed in other capacities as various sites demand. In an expanded option, the bike lane could be routed through a bike-dedicated tunnel adjacent to but separated from the road traffic. The hypar vault accommodates the expanded width of I-70 including the AGS rail, three lanes of traffic in each direction, and a bike lane.

Cultivating Complexity. Animal movement corridors can be induced by understory planting of browse grasses and sedges, selective thinning of forest canopy, and localized controlled burns. Landscape management strategies can create enhanced browse corridors starting at the overpass and moving out into surrounding habitat patches along desired routes.

Jury decision

The winner project is HYPAR-NATURE by HNTB + MVVA TEAM. The evaluation was complicated for the jury, because of they said in the final report " We were favorably impressed with all five of the finalist projects. Among our impressions of the five finalists, we were collectively struck by three things:

- The quality and innovation of design proposals submitted by finalist teams.
- The thoroughness of research into the problem and the potential for prototypical solutions.
- The potential impact and historic importance of proposals for the practices of landscape architecture, ecology, and engineering"[244].

At the end the decision was for Hypar-Nature, because was the most complete in absolute and also, as the report said: "The project / team directed by HNTB+MVVA was unanimously identified as the most elegant and compelling solution. Their proposal was at once simple and straightforward, while embodying the complexity and contradictions inherent in the competition brief...and is not only eminently possible; it has the capacity to transform what we think of as possible"[245].

TechnoEcoSystem features

What do we expect from an ecosystemic regulation service? Simply to set up ecological and environmental processes that are the consequences of human action. The attention given to the individual finalists of the ARC wildlife crossing competition highlighted a central focus on the involvement of multiple areas of reflection on the same project. Design is not secondary in this. Ecology, engineering, landscape and architecture seem to find a unique axiom that binds them. The result is a project, or rather more projects that succeed with their peculiarities to respond to local needs not only through regulation services but also through cultural services. In the project, the wildlife crossing is a tool of mitigation of the impact that the highway produces. The strategies of monitoring, controlling and definition of a design resilient in the time are sources of the regulating TecnoEcoSystems.
The landscape planning ecological approach is a way to add value to the territory, through the TechnoEcoSystem as a tool to produce controlling services for the environment. But the central point in this specific scenario of the competition is the attention to the shape and design attitude of the choices.

Elements of TES:
- the design follows the ecological needs, such as the attention for the wildlife preservation;
- adaptable to the necessities of territories
- the highway became a platform of experimental application, resilient to the changes and educational tool;
- the quality of design is not secondary, but has the same value of the mitigation of ecological impacts.

Negative elements:
- the highway needs more attention to the energetic and cultural services that could be offered

2.2.4. Recap

In this second chapter, a path and an osmotic research approach are proposed, starting from the premise of the "Reinventing A22" research, which pays particular attention to: the environmental economic crisis, the density of the inhabited territory and the new paradigm of landscape (By European convention of 2000). In addition, osmotic is the idea of the motorway infrastructure, which, as the membrane during the physical process, becomes a catalyst for connections between and with the ecosystems that surround it. The motorway almost autonomously, over time, defines a framework of opportunities for the contexts, producing ecosystem services for the landscape, responding to the initial premises.

The general key is the Total Human Ecosystem theory, where the concept of a complex system is based on the idea that 'everything is related to everything'. Here there are logics of interdependence between natural and artificial systems, which also include infrastructures. Reading the case studies described in this chapter, "The wave of change" for motorways 4.0 is clear. This change coincides with the assumption of the active role of motorways in the global system balance, into the landscape ecology framework. The 4.0 motorway is a TechnoEcoSystem, connecting with other functional systems (natural and artificial), but mitigating and compensating for the negative effects that destabilize the ecosphere. This is possible through new technologies, supporting new processes in progress and producing services.
The services that a motorway produces, thanks to design and technology, are traced back to principles, strategies and tactics for each service categories produced by natural systems. Through a careful investigation of case studies related to the project process around the motorway, it was possible to summarize the meaning that each type of service (cultural, regulating and provisioning) assumes for the 4.0 technoecosystemic motorway.

The motorway as a cultural tool starts from well-established theoretical premises in the 60s, when the myth and the charm of the machine allowed researchers to develop consideration on the infrastructures landscape, focusing on the perception of the user of the road (The view from the road). Perception, in a cultural service, is a source of value, as it allows the recognizability of places (stable or in motion). The action goals enhance the peculiarities of the places, through the involvement of the stakeholders and through the compensation of the local realities through development strategies (1% paysage et développement). The promotion and enhancement of the cultural, natural, functional and aesthetic values of the territory are also carried out through timely design actions of the infrastructure, which assumes a specific and distinguishable language in design (Routeontwerp A12). At the end, the recognition of the road and the spaces that surround it, as elements useful for the territory's project and the promotion of local economic realities through cooperation agreements (Una rotatoria per Fiorinda), enriches the idea of a TechnoEcoSystem. This produces non-material benefits of cultural

identity, which a road has the ability to intercept and enhance in the crossed landscape.

The motorway as an energy basin becomes a tool to support the network, which supplies real resouces, in this case as renewable energy and digital information, produced in the residual and functional spaces of the motorway. This productive function makes central motorways infrastructures in the Smart Grid distribution processes. Their strategic position in the territories allows them to be surrounded by communities that use and produce data and energy, for the network or from the network (Conduit Urbanism). In a future scenario of redefinition of the infrastructure, the use of motorway spaces as energy collectors and as a design prerogative for the infrastructure and for crossed territories, transforms motorway space into a supply space (Energy). In this perspective, the scenarios that allow the motorway, through technology, to become an hub of information, in communication with the vehicle systems and the territorial ones (Smart Road) are also included. However, the motorway must respect the standards, but should go further, becoming an experimental basin of ideas (Solar Park South) related to technological innovation on the territory (Smart Highway and ZeroKM Road), producing provisioning services.

The motorway as a techno-ecological corridor follows regulating services principles, using compensation and mitigation tactics to reduce the impacts. In general, regulating services aim: to protect wildlife from the impact of fragmentation, to treat solid waste from motorway services and to regulate air and water quality. To perform their ecological functions, motorways use design tactics (Road Ecology) and technologies that follow chemical and physical principles. The general key to be followed to respond to the functions required by a regulating service is linked to: to try to avoid an action if it produces too much impact, to mitigate it if it is necessary, to compensate where it is not possible to mitigate it and finally to act through a ecological restoration to minimize the damage effected by infrastructure (COST 341). All this should be done though a project where the aesthetics and quality of the project have the same importance, using an ecological and experimental design (The ARC). In order to verify the effectiveness of the interventions, the experimental part is not less important, rather it becomes a priority to show the level of ecological regulating service of the TechnoEcoSystem (Trans Canadian Highway).

Therefore, from a purely theoretical concept, through cultural, provisioning and regulating services, the TechnoEcoSystem is transformed into a design strategy. This is done by using the case studies' principles, strategies, and applications which respond to the integral functions of each type of service. Each answer is related to a design of the territory, which gives the infrastructure a new active and propulsive meaning in relation to the context in which it is inserted. Starting from the project elements that already exist and describing the TechnoEcoSystem through its services, the research through

a working group of the DICAM (Department of Civil, Environmental and Mechanical Engineering) of Trento, will apply the new concepts on specific projects proposed by the Autostrada del Brennero. In addition, the idea will be integrated to make each project a compendium of technoecosystemic services for the crossed territories, using concepts of ecology and technological innovation as general reference parameters to be followed.

NOTE

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17. Ibidem.
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22. Bonomi, A., & Masiero, R. (2014). Dalla smart city alla smart land. Venezia: Marsilio.
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27. The value is reported in a research developed by the Sustainable Transportation Center at the University of California at Davis, with funding from the US Department of Transportation. In particular, as Road Effect Zone, it will consider the following distances: Amphibians 1000 m, 1200 m birdlife, large mammals 600 m, soil pollution 30 m, wetlands 500 m, 400 m human health; in reference to articles and previous publications (Shilling, Waetjen, 2012).
28. AISCAT_Associazione Italiana Società Concessionarie Autostrade e Trafori. Aiscat in cifre: http://www.aiscat.it
29. European Union, energetic policy 2020: to reduce the gas emission at least of 20% in comparison to the levels of 1990, to get 20% of the energy from renewable sources, to improve the 20% energetic efficiency (http://europa.eu/).
30. TechnoEcosystem (Naveh, Lieberman, 1990). The total of human ecosystems is defined as ecosphere in which it is

possible to distinguish the Biosphere from Technoecosphere, using three basic categories: the exchange of information within the system, which can be natural or cultural; the type of physical structure, natural or artificial; and finally the type of energy exchanged, solar or related to the use of fossil fuels. These three categories allow us to select the systems, by Bio to Techno, according to their degree of 'naturalness' defined by these three categories (Image 3).
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35. "Subject to the provisions contained in Article 15, this Convention applies to the entire territory of the Parties and covers natural, rural, urban and peri-urban areas. It includes land, inland water and marine areas. It concerns landscapes that might be considered outstanding as well as everyday or degraded landscapes." European Convention of Landscape, Cap. I, Article 2.
36. Naveh, Z., & Lieberman, A. S. (1994). Landscape ecology: Theory and application. New York: Springer.
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39. The noosphere is the sphere of human thought. The word derives from the Greek means "mind sphere". (Levit, 2001) The noosphere is identified into the holistic vision, as the sphere of man and his actions.
40. "Biosphere is the part of the Earth in which the indispensable conditions for animal and plant life are found. It includes the lower part of the atmosphere, the whole hydrosphere and the superficial part of the lithosphere, up to 2 km deep. Together with the forms of life it hosts, it constitutes a complex system, in dynamic equilibrium with the other components of the Earth." Biosfera nell'Enciclopedia Treccani. (2016). In Treccani, il portale del sapere. (Retrieved from http://www.treccani.it/enciclopedia/)
41. Ellenberg, H. (1983). Ökologische Beiträge zur Umweltgestaltung. Stuttgart: Ulmer.
42. Naveh, Z., & Lieberman, A. S. (1994). Landscape ecology: Theory and application. New York: Springer.
43. Ibidem.
44. In this case the term identifies man as the unique producer of logic and thought who regulates the artificial systems. But in general the meaning is : "Organism acquires energy and chemical compounds starting from organic substances processed by autotrophic organisms or coming from other heterotrophic organisms." (Eterotrofo in "Enciclopedia della Scienza e della Tecnica". (2016). In Treccani, il portale del sapere. Retrieved from http://www.treccani.it/enciclopedia)
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46. In which complexity assumes a more important meaning than the single parts that compose it.
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52. AISCAT - Associazione Italiana Società Concessionarie Autostrade e Trafori. (2016). Annual Report. (Retrieved from AISCAT website: http://www.aiscat.it/)
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54. Ibidem.
55. Rizzi, C. (2014). Quarto paesaggio. Trento: LISt Lab.
56. Ecosystem services — Biodiversity Information system for Europe. (2016). (Retrieved from http://biodiversity.europa.eu/topics/ecosystem-services)
57. Ibidem.
58. Appleyard, D., Lynch, K., & Myer, J. R. (1971). Preface. In The view from the road(p. 2). Cambridge, MA: MIT.
59. Giordani, P. L. (1976). Introduzione. In G. Cullen (Ed.), Il paesaggio urbano. Morfologia e progettazione. Bologna: Calderini.
60. Gestalt psychology is focused on the themes of perception and experience. As seen before (2.1), in the concept of THE: "The whole is more than the sum of its parts "(Köhler, 1980).
61. James Gibson developed the idea that the moving objects amplify the perception than static ones. (Gibson, 1950).
62. In Townscape the city was reshaped thanks to the movement: "If we design our towns from the point of view of the moving person, it is easy to see how the whole city becomes a plastic experience, a journey through pressures and vacuums, a sequence of exposures and enclosures, of constraint and relief." (Cullen, 1976)
63. Lynch, K. (1960). The image of the city. Cambridge, Massachusetts: The MIT Press.
64. Appleyard, D., Lynch, K., & Myer, J. R. (1971). The view from the road. Cambridge, MA: MIT.
65. View From The Road'Kevin Lynch (1965) [Video file]. (2013, August 6). (Retrieved from https://www.youtube.com/)

66. MARCEL SMETS, Il nuovo paesaggio delle infrastrutture in Europa, "Lotus" 110, Arnoldo Mondadori Editore, Milano 2001, pag. 118.
67. Andriello, V. (1994). Kevin Lynch e la cultura urbanistica italiana. Urbanistica, (102), 134-137.
68. Morelli, E. (2005). Disegnare linee nel paesaggio: Metodologie di progettazione paesistica delle grandi infrastrutture viarie. Firenze: Firenze University Press. pag. 122
69. Ibidem.
70. Description of the content of the first and second chapters. Appleyard, D., Lynch, K., & Myer, J. R. (1971). The view from the road. Cambridge, MA: MIT.
71. Circulaire du 31 Mars 2005, relative à la politique du "1% paysage et développement" sur le réseau routier national, Republique Francaise
72. Morelli, E. (2005). Disegnare linee nel paesaggio: Metodologie di progettazione paesistica delle grandi infrastrutture viarie. Firenze: Firenze University Press. pag. 150
73. In the 70s, in France there were about 70 km of motorways, while with the completion of the works in 1964 of the Autostrada del Sole, Milan-Naples, Italy reached 755 km.
74. Morelli, E. (2005). Disegnare linee nel paesaggio: Metodologie di progettazione paesistica delle grandi infrastrutture viarie. Firenze: Firenze University Press. pag. 146
75. The group leader was the landscape architect Bernard Lassus, author of Autoroute et Paysage.
76. Circulaire du 31 mars 2005 relative à la politique du "1% paysage et développement"sur le réseau routier national.
77. I- L'objectif in Circulaire du 31 mars 2005 relative à la politique du "1% paysage et développement"sur le réseau routier national. Pag.2
78. III- La démarche in Circulaire du 31 mars 2005 relative à la politique du "1% paysage et développement"sur le réseau routier national. Pag.2-3
79. IV La mise en œuvre de la politique du « 1% paysage et développement » in Circulaire du 31 mars 2005 relative à la politique du "1% paysage et développement"sur le réseau routier national. Pag.3-4
80. V- Financement du « l% paysage et développement » in Circulaire du 31 mars 2005 relative à la politique du "1% paysage et développement"sur le réseau routier national. Pag.4
81. VI - Gestion et suivi in Circulaire du 31 mars 2005 relative à la politique du "1% paysage et développement"sur le réseau routier national. Pag.4-5
82. VII- Bilan annuel in Circulaire du 31 mars 2005 relative à la politique du "1% paysage et développement"sur le réseau routier national. Pag.5-6
83. By consulting the Terres Neuves group website, involved in many activities of assessment of territorial dynamics, there is attention on the theme of the relationship between motorways and landscapes. Numerically, this attention can be translated into: 8 white books, 16 itinerary maps and local maps, two discovery itineraries and an evaluation made for the 1% paysage et développement policy.
84. A75 Autoroute Méridienne Auvergne Languedoc-Roussillon Midi-Pyrénées accès Sud France > Accueil. (2016). (Retrieved from http://www.a75lameridienne.com/)
85. Van Zelm Van Eldik, D. (2010). From Road Planning to Route Design. Interview by B. De Zwart. N.A.L. Meijsmans , 92-97. Dirk Sijmons is a landscape architect, who worked for the conservation management of the Ministry of CRM. From 1981 to 1984 he was director of the Strategic Policy Department for Research Development and Coordination at the then the Ministry of Agriculture, Nature Management and Fisheries.
86. Ministeris Onderwijs, Cultuur en Wetenschappen Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer Verkeer en Waterstaat Landbouw, Natuurbeheer en Visserij. (2000). Voorwoord in ONTWERPEN AAN NEDERLAND. ARCHITECTUURBELEID 2001-2004 Een nota van de ministeries van OCenW, VROM, V&W en LNV.
87. Ibidem.
88. The plan was presented to the Chamber on October 5, 2000 by the Minister of Education, Culture and Science, Dr. F. van der Ploeg, Minister of Spatial Planning and the Environment, J.W. Remkes, the Minister of Transport, T. NETELENBOS and the Secretary of State for Agriculture, Nature and Fisheries, G. H. Faber.
89. Ministeris Onderwijs, Cultuur en Wetenschappen Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer Verkeer en Waterstaat Landbouw, Natuurbeheer en Visserij. (2000). ONTWERPEN AAN NEDERLAND. ARCHITECTUURBELEID 2001-2004 Een nota van de ministeries van OCenW, VROM, V&W en LNV.
90. Van Zelm Van Eldik, D. (2010). From Road Planning to Route Design. Interview by B. De Zwart. N.A.L. Meijsmans (pp. 92-97).
91. Scaglione, G. P., & Ricci, M. (2013). Routeontwerp, ecology and landscape along the dutch highway. In A22, nuove ecologie per infrastrutture osmotiche (pp. 250-255). Rovereto: List.
92. Routeontwerp voor snelwegen | Rijkswaterstaat. Retrieved from https://www.rijkswaterstaat.nl/wegen/wegbeheer/aanleg-wegen/routeontwerp-van-snelwegen/index.aspx
93. Ministeris Onderwijs, Cultuur en Wetenschappen Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer Verkeer en Waterstaat Landbouw, Natuurbeheer en Visserij. (2000). ONTWERPEN AAN NEDERLAND. ARCHITECTUURBELEID 2001-2004 Een nota van de ministeries van OCenW, VROM, V&W en LNV.

94. Ibidem.
95. Projectbureau Regenboogroute A12. (2004). DE KOERS VOOR HET ROUTEONTWERP. Perspectieven voor het routeontwerp van snelwegen op basis van de Regenboogroute A12. Eindrapport (DWW-2004-079). Directoraat-Generaal Rijkswaterstaat, Ministerie van Verkeer en Waterstaat, Dienst Weg- en Waterbouwkunde.
96. Projectbureau Regenboogroute A12. (2004). PROBLEEMSTELLING EN OPDRACHT in DE KOERS VOOR HET ROUTEONTWERP. Perspectieven voor het routeontwerp van snelwegen op basis van de Regenboogroute A12. Eindrapport (DWW-2004-079). Directoraat-Generaal Rijkswaterstaat, Ministerie van Verkeer en Waterstaat, Dienst Weg- en Waterbouwkunde. Pag. 13-20.
97. Ibidem.
98. Scaglione, G. P., & Ricci, M. (2013). Routeontwerp, ecology and landscape along the dutch highway. In A22, nuove ecologie per infrastrutture osmotiche (pp. 253). Rovereto: List.
99. Ibidem. Pag. 252
100. Projectbureau Regenboogroute A12. (2004). PROBLEEMSTELLING EN OPDRACHT in DE KOERS VOOR HET ROUTEONTWERP. Perspectieven voor het routeontwerp van snelwegen op basis van de Regenboogroute A12. Eindrapport (DWW-2004-079). Directoraat-Generaal Rijkswaterstaat, Ministerie van Verkeer en Waterstaat, Dienst Weg- en Waterbouwkunde. Pag. 17-19.
101. Ibidem.
102. Ibidem. Pag. 19-20
103. Ibidem. Pag. 21-44
104. Ibidem. Pag. 45
105. Ibidem. Pag. 47
106. Ibidem. Pag. 73
107. Ibidem. Pag. 75-87
108. Ibidem. Pag. 95-96
109. Cultural service in Ecosystem services — Biodiversity Information system for Europe. (2016). (Retrieved from http://biodiversity.europa.eu)
110. Drosscape are residual area, which like a dross can be recycled and reused with other functionality (Berger, 2007).
111. Ferrari, F. (2017). LINEE GUIDA PER LE AREE VERDI PERISTRADALI E PER LA SISTEMAZIONE PAESAGGISTICA DELLE ROTATORIE. Comune di Predaia e UniTN (DICAM).
112. Apple trees blossom festival.
113. Ferrari, F. (2017). LINEE GUIDA PER LE AREE VERDI PERISTRADALI E PER LA SISTEMAZIONE PAESAGGISTICA DELLE ROTATORIE. Comune di Predaia e UniTN (DICAM).
114. Meeting during the workshop: "Una rotatoria per Fiorinda", on 19th-25th February 2017.
115. In general, the Val di Non landscape is characterized by widespread anthropogenic influence. Looking at the consistency of the high quality agricultural areas - among those identified by the PUP as invariants - this is high in more than half of the Valley Municipalities. Always looking at the strength factors of the local landscape, even the specific invariants (identity and historical-cultural values of the landscape) are widespread, with high concentrations in Coredo, Taio, Tassullo, Vervò. A the end, as the scenic values of the landscape, the high value fronts are mainly situated in the prestigious agricultural areas or along the hydrographic network, as the PUP says. (Ferrari, 2017)
116. The extension of the productive territory (fields, orchards, productions and pastures) and the great natural heritage of the Val di Non (Protected areas, geological peculiarities, water courses, woods and forests, Dolomiti (UNESCO Heritage) show different components of a unique ecological system, essential to guarantee the production of the resources of the valley and necessary for its landscape quality. (Ferrari, 2017)
117. (Ferrari, 2017) pag. 17
118. Ibidem.
119. Content of (Ferrari, 2017) pag. 5-6
120. Ibidem.
121. Bonomi, A., & Masiero, R. (2014). Dalla smart city alla smart land. Venezia: Marsilio.
122. See the chapter 1, Motorway 3.0 (1.5)
123. Manifesto in the book. (Bonomi, Masiero, 2014).
124. TITLE XIII--SMART GRID, [[Page 121 STAT. 1784]] ENERGY INDEPENDENCE AND SECURITY ACT OF 2007
125. Bonomi, A., & Masiero, R. (2014). Dalla smart city alla smart land. Venezia: Marsilio.
126. Torcellini, P., Pless, S., Deru, M., & Crawley, D. (2006). Zero Energy Buildings: A Critical Look at the Definition. A national laboratory of the U.S. Department of Energy Office of Energy Efficiency & Renewable Energy.
127. Zero Energy Buildings: A Critical Look at the Definition, P. Torcellini, S. Pless, and M. Deru National Renewable Energy Laboratory D. Crawley U.S. Department of Energy To be presented at ACEEE Summer Study Pacific Grove, California August 14—18, 2006
128. Conduit Urbanism is a research on large-scale urban systems and networks within the Great Lakes Megaregion of North America. The proposal begins with a "restructuring of the highway's constituent DNA from a simple, single-purpose

and single-access surface to an intelligent network of bundled modes of mobility, energy and services." (Thun, 2015)
129. Thün, G., Fishman, R., & McMorrough, J. (2015). Infra eco logi urbanism: A project for the Great Lakes megaregion. Park Books.
130. Bonomi, A., & Masiero, R. (2014). Dalla smart city alla smart land. Venezia: Marsilio.
131. Ratti, C., & Mattei, M. G. (2014). Smart city, smart citizen. Milano: EGEA.
132. Bonomi, A., & Masiero, R. (2014). Dalla smart city alla smart land. Venezia: Marsilio.
133. Ibidem.
134. U.S Government. (2007). ENERGY INDEPENDENCE AND SECURITY ACT OF 2007-TITLE XIII—SMART GRID. Sec. 1301 (Public Law 110–140 110th Congress).
135. Paper presented at ACEEE Summer Study Pacific Grove, California August 14—18, 2006. Torcellini, P., Pless, S., Deru, M., & Crawley, D. (2006). Zero Energy Buildings: A Critical Look at the Definition. A national laboratory of the U.S. Department of Energy Office of Energy Efficiency & Renewable Energy.
136. Article 9 Nearly zero-energy buildings THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION. (2010). Article 9 Nearly zero-energy buildings in DIRECTIVE 2010/31/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 May 2010 on the energy performance of buildings (L 153/13). Official Journal of the European Union.
137. Thün, G., Fishman, R., & McMorrough, J. (2015). Infra eco logi urbanism: A project for the Great Lakes megaregion. Park Books.
138. Ciorra, P. (2013). "Fueling Architecture". In Energy: Oil and post-oil architecture and grids. Roma: MAXXI, Museo nazionale delle arti del XXI secolo.
139. "The transportation sector accounted for 25% of total world delivered energy consumption in 2012, and transportation energy use increases by 1.4%/year from 2012 to 2040 in the IEO2016 Reference case." World Energy Outlook , IEA, 2017
140. Sanmarco, G. (2013). Finalmente l'auto volerà? Scenari per il trasporto del futuro. In P. Ciorra (Ed.), Energy: Oil and post-oil architecture and grids. Roma: MAXXI, Museo nazionale delle arti del XXI secolo.
141. Ibelins, H. (2013). Architetture sotto la linea di galleggiamento. In P. Ciorra (Ed.), Energy: Oil and post-oil architecture and grids. Roma: MAXXI, Museo nazionale delle arti del XXI secolo.
142. Ciorra, P., & Grunert, F. P. (2013). Buffer site all'idrogeno. In P. Ciorra (Ed.), Energy: Oil and post-oil architecture and grids. Roma: MAXXI, Museo nazionale delle arti del XXI secolo.
143. "Smart road, connected vehicles and mobility of the future" Graziano Del Rio, Ministry of Infrastructures and Transport (MIT), 22 June 2016. 144. 5,872 km of motorways assigned to 24 managment company, and 25,566 km, of which 937 of motorways, entrusted to Anas. Data retrieved from the site of the Ministry of Infrastructure ("Smart road, veicoli connessi e mobilità del futuro" | mit. (2017). Retrieved from http://www.mit.gov.it)
145. Sistema Nazionale Integrato dei Trasporti.
146. Ministero delle Infrastrutture e dei Trasporti. (2016). Standard Funzionali per le Smart Road.
147. Ibidem.
148. Intervento del Presidente di Anas S.p.A. Ing. Gianni Vittorio Armani. (2017). SMART ROAD La strada all'avanguardia che corre con il progresso. ANAS spa, Parma, 23 marzo.
149. Anas ottiene finanziamento per Smart Road lungo la A2 "Autostrada del Mediterraneo" - Strade & Autostrade Online. (2017, 15). (Retrieved from http://www.stradeeautostrade.it/)
150. Gruppo tecnico Parco Solare Sud, Regione Calabria Urbanistica e Governo del Territorio. (2010). INTERNATIONAL ONLINE COMPETITION SOLAR PARK SOUTH. Parco Solare Sud.
151. Ibidem.
152. The exhibition, edited by Emilia Giorgi and Antonio Ottomanelli, is made up of over 100 works by 11 important Italian contemporary photographers who have followed the theme of landscape change between Campania, Basilicata and Calabria through different approaches (Andrea Botto, Gaia Cambiaggi, Martin Errichiello and Filippo Menichetti, Marco Introini, Allegra Martin, Maurizio Montagna, Armando Perna, Filippo Romano, Marcello Ruvidotti, Francesco Stelitano, Giulia Ticozzi). A section of the exhibition was tied to the work on the strait of Messina of two great photographers such as Gabriele Basilico and Olivo Barbieri, alongside pictures and drawings of the ANAS archive, for the first time shown to the public.
153. Gruppo tecnico Parco Solare Sud, Regione Calabria Urbanistica e Governo del Territorio. (2010). INTERNATIONAL ONLINE COMPETITION SOLAR PARK SOUTH. Parco Solare Sud.
154. Solar Park South - International Online Competition - FIRST PRIZE - PR+OFF : page 1 - newitalianblood.com. (2010). Retrieved from http://www.newitalianblood.com/solarparksouth
155. Solar Park South - International Online Competition - SECOND PRIZE - coffice : page 1 - newitalianblood.com. (2010). Retrieved from http://www.newitalianblood.com/solarparksouth
156. Solar Park South - International Online Competition - THIRD PRIZE - J-A : page 1 - newitalianblood.com. (2010). Retrieved from http://www.newitalianblood.com/solarparksouth
157. High Line in New York is a symbol of "re-cycle" approach. The proposal activated the reconvention of the all west side in Mahanattan, driving an new process of the development of the city. Now this abandoned place, after his recycle, is one of the central point into the city.

158. Thanks to the simple accessibility of the solar source, this kind of energy production is much wider than others as it is easily available. Even privately, through financial facilitations, the individual manages to amortize the investment made in a few years, benefiting from regional or community funds.
159. The panels applied on the road surface create a decentralized Smart Grid, solving power issues but also could be seen as a starting point of electric and automatic vehicles spread.
160. Van Gogh Path | Smart Highway | Studio Roosegaarde. (2015). (Retrieved from https://www.studioroosegaarde.net)
161. Solar Serpents in Paradise – MÅNS THAM. (2017). (Retrieved from http://manstham.com/solar-serpents-in-paradise/)
162. In village of Tourouvre-au-Perche in Normandy, France, 1 kilometer road was opened by French Ecology Minister Ségolène Royal and could generate enough electricity to power the street lights.
163. KM ZERO ROAD | Total Tool. (2012). (Retrieved from http://www.totaltool.it)
164. Ibidem.
165. The average investment for the realization of the project (on one kilometer of road) is about 7 million euros, amortizable over about six years thanks to the annual turnover of 1,190,000 euros. G. Ceppi in (Scaglione, Sgaramella, 2015)
166. Forman R.T.T., Sperling D., Bissonette J. A., Clevenger A. P., Cutshall C. D., Dale V. D. (2002), Road Ecology: Science and Solutions. Washington DC: EditoreIsland Press. Pag. 293
167. Ling, P. J. (1992). America and the automobile: Technology, reform and social change. Manchester: Manchester University Press.
168. The utopian vision of the city of Disappearing City of F.L. Wright. (M2.0, 1.4)
169. Quote reported in Road Ecology at pag. 25 from the book: Webber, M. M., & University of California (System). (1992). The joys of automobility. Berkeley: University of California Transportation Center, University of California.
170. Morelli, E. (2005). Road Ecology, Science & Solution. In Disegnare linee nel paesaggio: Metodologie di progettazione paesistica delle grandi infrastrutture viarie (p. 159). Firenze: Firenze University Press.
171. Richard Forman, Daniel Sperling, John A. Bisonette, Anthony P. Clevenger, Carol D. Cutshall, Virginia H. Dale, Lenore Fahrig, Robert France, Charles R. Goldman, Kevin Heanue, Julia A. Jones, Frederick J. Swanson, Thomas Turrentine, Thomas C. Winter.
172. Dramstad, W. E., Olson, J. D., & Forman, R. T. (1996). Landscape ecology principles in landscape architecture and land- use planning. Cambridge, Mass.: Harvard University Graduate School of Design.
173. Morelli, E. (2005). Road Ecology, Science & Solution. In Disegnare linee nel paesaggio: Metodologie di progettazione paesistica delle grandi infrastrutture viarie (p. 158). Firenze: Firenze University Press.
174. The bibliography has 1078 quotes.
175. Forman R.T.T., Sperling D., Bissonette J. A., Clevenger A. P., Cutshall C. D., Dale V. D. (2002), Praface in Road Ecology: Science and Solutions. (p. xiii) Washington DC: EditoreIsland Press.
176. As reported by Almo Farina in many of his texts, after the recognition the potential descriptive of aerial photos for the interpretation of environmental mosaics with Carl Troll, Landscape ecology has changed course. (Farina, 2004) The use of aerial photography was used for military purposes in the two world wars, constituting a useful research database for ecological disciplines. Landscape ecology is definitively affirmed as an applied science to manage natural resources in anthropized environments, after the work of Naveh & Lieberman (1984) and Forman & Godron (1986) and the foundation in 1987 of the first Landscape ecology magazine, directed by Frank Golley. (Farina, 2004)
177. "An environmental system is defined as the spatial representation of the ecosystem, through this vision we pass from an entity described only under the functional aspect (the ecosystem) to an entity defined in space (the environmental system). In an environmental system each species-specific is bounded by the species that recognizes the boundaries and the characters favorable to it and with which it interacts with a species-specific scale. " The road network from many species is experienced as a border, determining the fragmentation of land and habitats. Farina, A. (1999). Sistemi ambientali e loro componenti ecologiche in "Frontiere della Vita". In Treccani, il portale del sapere. (Retrieved from http://www.treccani.it/enciclopedia)
178. Morelli, E. (2005). Road Ecology, Science & Solution. In Disegnare linee nel paesaggio: Metodologie di progettazione paesistica delle grandi infrastrutture viarie (p. 165). Firenze: Firenze University Press.
179. Thinking to an urban territory and a mountain one, the type of road network changes its design in the territory strongly influenced by the orography of the crossed spaces . For the motorways is different, which usually tend to be the most linear possible for issues related to safety.
180. During the Earth Summit of the United Nations Conference on Environment and Development (UNCED, Rio de Janeiro, June 1992), the Convention on Biodiversity was signed, which has become an important element to preserve, against the process of territorial fragmentation. (ISPRA, 2011)
181. The road in contact with water can assume different connotations: as source, when water flows away on impermeable surfaces, transporting pollutants that are on the asphalt or along the roads side; as sinks, accumulations of water due to sliding processes or simply due to irregularities on the road surface; as barrier, contrasts the flow; as conduit, supports the sliding. (Forman R.T.T., Sperling D., Bissonette J. A., Clevenger A. P., Cutshall C. D., Dale V. D. (2002), Road Ecology: Science and Solutions. (p. 16) Washington DC: EditoreIsland Press).
182. In the definition of the individual effects summarized studies of numerous researchers. The individual negative impacts recorded on flora and fauna are translate in distance from the road.

183. "Barrier effect, in ecology it is related to the possibility of reduced movement and relationship for the presence of linear infrastructures, between meta-populations (or groups of biological populations distributed over a geographical area) of wild terrestrial animals, especially the smallest species and lens (micromammals, amphibians, invertebrates) " (Battisti, 2004)
184. Forman R.T.T., Sperling D., Bissonette J. A., Clevenger A. P., Cutshall C. D., Dale V. D. (2002), Policy in Road Ecology: Science and Solutions. (p. 16) Washington DC: EditoreIsland Press.
185. European Environment Agency. (2002). 2001: The year in brief. Luxembourg: Office for Official Publications of the European Communities.
186. Rizzi, C. (2014). Quarto paesaggio. Trento: LISt Lab.
187. Pan-European Strategy for Biological Diversity and Landscape was outlined by the Maastricht Declaration on the Conservation of European Natural Heritage (1993) and was revised during the conference, "Environment for Europe", held in Sofia in 1997.(Rizzi, 2014)
188. Rizzi, C. (2014). Quarto paesaggio. Trento: LISt Lab.
189. "IENE is a network of experts working with various aspects of transportation, infrastructure and ecology. The network was initiated in 1996 to provide an independent, international and interdisciplinary arena for the exchange and development of expert knowledge – and with the aim to promote a safe and ecologically sustainable pan-European transport infrastructure. IENE arranges international conferences, workshops and symposia, initiates collaboration projects and helps answering questions that require a joint international expertise." IENE| Infra Eco Network Europe. (2016, June 27). (Retrieved from http://www.iene.info/)
190. Published in n. 131 of the "Nature and Environment" series of the Europe Council "The Code of Practice for the Introduction of Biological and Landscape Diversity Considerations into the Transport Sector provides a practical instrument that will help national governments and others involved in the linear transport sector to consider and implement measures relating to the maintenance and enhancement of biological and landscape diversity." Code of practices for the introduction of biological and landscape diversity considerations into the transport sector (Nature and environment No. 131). (2003)
191. 16 countries: Austria, Belgium, Cyprus, Czech Republic, Denmark, France, Hungary, Norway, Portugal, Romania, Spain, Sweden, Switzerland, The Netherlands, The Republic of Ireland, United Kingdom, The European Centre for Nature Conservation
192. ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale. (2008). Tutela della connettività ecologica del territorio e infrastrutture lineari (87/2008). ISPRA, Rapporti.
193. Iuell, B., Bekker, G.J., Cuperus, R., Dufek, J., Fry, G., Hicks, C., Hlavá˘c, V., Keller, V., B., Rosell, C., Sangwine, T., Tørsløv, N., Wandall, B. le Maire, (Eds.) 2003. Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions. (p. 3)
194. "Ecological corridor: an element of the landscape that connects two or more spots of natural habitat, it acts as habitat and channel for the movement of animals and spores and the area through which genetic exchange takes place among the populations." Corridoio ecologico — Arpa Piemonte. (2017). In Arpa Piemonte. (Retrieved from http://www.arpa.piemonte.gov.it)
195. All new regional programs and plans in the European Union and in other states must apply the SEA, according to Directive 2001/42 / EC of the European Parliament, while all projects that have significant environmental influence must necessarily outline an EIA according to the Directive 97/11 / EC. (Rizzi, 2014)
196. Iuell, B., Bekker, G.J., Cuperus, R., Dufek, J., Fry, G., Hicks, C., Hlavá˘c, V., Keller, V., B., Rosell, C., Sangwine, T., Tørsløv, N., Wandall, B. le Maire, (Eds.) 2003. Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions. (cap. 5, p. 4)
197. The approach often used, through GIS tools, can be traced back to the analytical bases theorized by the father of Ecological Planning, Ian Mc Harg. Through the overlay mapping technique, he identifies the processes of social values (historical, hydrological, panoramic, recreational, residential, faunistic, forest, institutional) in the project area and draws up a map for each of them in order to highlight through three shades of gray the degree of importance of each area in relation to the social cost.(McHarg,1975) Although modernized, the selection process for a new settlement road layout is the same and it is used in the Spacial Multicriteria Analysis processes.
198. Iuell, B., et al. (Eds.) 2003. Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions. (cap. 5)
199. Special sites that are identified into Habitat Directive and Ramsar Convention.
200. International Union for the Conservation of Nature and Natural Resources (IUCN)
201. Iuell, B., et al. (Eds.) 2003. Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions. (cap. 5)
202. High plant barriers can be an obstacle for some species of birds such as barn owl, who used to hunt along the road lines. Iuell, B., et al. (Eds.) 2003. Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions. (cap. 6, p.12)
203. The compensation measures can be required in three ways:
    I. a. International legislation: European Birds Directive (1979) and the European Habitat Directive (1992).
       b. National legislation about compensation.

II. Compensation policy: non-regulation, e.g. if it is in national policy planning.
III. Compensation based on voluntary agreements, implies that it is basic neither political nor normative.Iuell, B., et al. (Eds.) 2003. Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions. (chapter 8.2)
204. Many scientific articles examine the issue of effective efficiency of mitigation measures that are adopted for the infrastructure construction.
205. The last page of the report reports the others documents. Iuell, B., et al. (Eds.) 2003. Wildlife and Traffic: A European Handbook for Identifying Conflicts and Designing Solutions. (chapter 10)
206. Istituto Superiore per la Protezione e la Ricerca Ambientale
207. "Infrastrutture viarie e biodiversità. Impatti ambientali e soluzioni di mitigazione" organized By Provincia di Pisa, ARSIA of Regione Toscana, Dipartimento di Ingegneria Civile dell'Università degli Studi di Pisa and LIPU. Pisa, November 25th 2004.
208. Dinetti, M. (2016). Road ecology in Italia:Gioie e dolori. Retrieved from IENE - Infra Eco Network Europe - LIPU/BirdLife Italy. ISPRA website: http://www.isprambiente.gov.it
209. From the annual reports, Transportation in Canada 2015: there are more than 1.3 million two-lane equivalent lane-kilometres of public road in Canada. Approximately 34% of the road network is paved, while 66% is unpaved. Four provinces – Ontario, Québec, Saskatchewan, and Alberta – account for over 77% of the total road length. In 2014 the National Highway System (NHS) included over 38,000 lane-kilometres (3.7% of the public road network).
210. (Forman et al. 2003).
211. "The Banff-Bow Valley Study had three major objectives: to develop a vision and goals for the Banff Bow Valley that will integrate ecological, social and economic values; to complete a comprehensive analysis of existing information, and to provide direction for future collection and analysis of data to achieve ongoing goals; and to provide direction on the management of human use and development in a manner that will maintain ecological values and provide sustainable tourism." (Page 2013).
212. (Ford et al., 2010).
213. Trans-Canada Highway Road Trip & Vacation Planner (2017). (Retrieved from http://transcanadahighway.com)
214. 45% of the 780 ungulate road mortalities between 1964 and 1979 within Banff occurred along this 13 kilometer stretch and in a single year over 110 elk-vehicle collisions were recorded. (Ford et al.,2010)
215. The recommendations in this phase are related to the large carnivore conservation. (Ford et al.,2010)
216. "The Roadside Design Guide defines a clear zone as the total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a non-recoverable slope, and/or a clear run-out area. The desired minimum width is dependent upon traffic volumes and speeds and on the roadside geometry. Simply stated, it is an unobstructed, relatively flat area beyond the edge of the traveled way that allows a driver to stop safely or regain control of a vehicle that leaves the traveled way." U.S. Department of Transportation, Federal Highway Administration in Clear Zone and Horizontal Clearance - Geometric Design - Design - Federal Highway Administration. (2017, June 27). (Retrieved from https://www.fhwa.dot.gov)
217. Unusual Bridges For Animals - Wildlife Overpasses. (2012, June 29). (Retrieved from http://www.theworldgeography.com)
218. Sott, A. (2012). THE EFFICACY OF WILDLIFE CROSSINGS AS CONSTRUCTED CORRIDORS: LESSONS FOR PLANNING NATURAL HERITAGE SYSTEMS IN ONTARIO. School of Urban & Regional Planning, Queen's University Kingston, Ontario, Canada. Pag. 66.
219. (Ford et al., 2010).
220. Highway wilding. (2012). Banff wildlife crossing research by numbers. wildlife monitoring and research collaborative in the Canadian Rocky mountain. (Retrieved from http://www.highwaywilding.org/)
221. Since 1996, the Parks became unique for its continuous research and monitoring of the wildlife crossing through sound science, innovation and collaboration. For this reason Parks Canada has become a world leader in highway wildlife mitigations. The organization also is collaborating with the Western Transportation Institute (Montana State University), the Miistakis Institute of the Rockies, and the Woodcock and Wilburforce Foundations on research and monitoring of the wildlife crossings. (In Wildlife crossings research and monitoring. (2017, April 1). (Retrieved from https://www.pc.gc.ca)
222. (Clevenger et al., 2002)
223. Ibidem.
224. (Ford et al., 2010)
225. (Clevenger et al., 2002)
226. (Scott, 2012)
227. Highway wilding. (2012). Banff wildlife crossing research by numbers. wildlife monitoring and research collaborative in the Canadian Rocky mountain. (Retrieved from http://www.highwaywilding.org/)
228. ARC InternationalWildlife Crossing Infrastructure Design Competition(ARC). (2010). COMPETITION TO DEVELOP INNOVATIVE DESIGN SOLUTIONS FOR WILDLIFE CROSSING INFRASTRUCTURE. Competition brief. (pg. 3)
229. "ARC IS MORE THAN A COMPETITION; IT IS AN IDEOLOGY" this is the core value that spans disciplines, species, geography and aspirations. ARC emerged directly from the science of road ecology. The group worked with Studio: Blackwell,

Chris Harrison, a PhD candidate at the Human-Computer Interaction Institute at Carnegie Mellon University, and Dr. Tony Clevenger of the Western Transportation Institute.
230. ARC InternationalWildlife Crossing Infrastructure Design Competition(ARC). (2010). COMPETITION TO DEVELOP INNOVATIVE DESIGN SOLUTIONS FOR WILDLIFE CROSSING INFRASTRUCTURE. Competition brief. (p. 5)
231. Ibidem. (Pag. 8-16)
232. Ibidem. (Pag. 6)
233. The jury has four members of different field of research: Dr. Anthony Clevenger Senior Research Scientist, Western Transportation Institute Montana State University; Charles Waldheim John E. Irving Professor and Chair of Landscape Architecture Harvard University Graduate School of Design; Jane Wernick Director Jane Wernick Associates Ltd., London William L. Withuhn Curator Emeritus, Technology & Transportation History Smithsonian Institution; Jane Wolff Associate Professor and Program Director of Landscape Architecture University of Toronto.
234. ARC InternationalWildlife Crossing Infrastructure Design Competition(ARC). (2010). COMPETITION TO DEVELOP INNOVATIVE DESIGN SOLUTIONS FOR WILDLIFE CROSSING INFRASTRUCTURE. Competition brief. (p. 32)
235. Wildlife crossing ARC competition, panel: MCS Modular Crossing System by Balmori Associates
236. Ibidem.
237. Wildlife crossing ARC competition, panel: Wildlife connection_Janet Rosenberg & Associates (Toronto)
238. Ibidem.
239. Wildlife crossing ARC competition, panel: Wild (X)ING_ Olin studio
240. Wildlife crossing ARC competition, panel: LANDSHAPE_ Zwarts & Jansma
241. Wildlife crossing ARC competition, panel: HYPAR-NATURE_HNTB + MVVA TEAM
242. Ibidem.
243. Ibidem
244. ARC DESIGN COMPETITION JURY REPORT / Recommendation of HNTB+MVVA, January 18, 2011, Prof. Nina Marie Lister Professional Advisor, ARC International Design Competition Jury, Ryerson University, Toronto, ON, Canada
245. Ibidem.

3.

3. Brenner Motorway as TechnoEcoSystem

Since its construction, the Brennero Motorway has always been characterized by a design research that has made it one of the most efficient and modern motorway infrastructures in Europe.
It was the 1960s when the cross-border route was built that still connects Europe with the Po Valley. A courageous choice of considerable trust in innovation has seen landscape designers and designers challenge a complex territorial morphological configuration as well as addressing the issue of impact towards territories, at that time uncontaminated.
Over time, the Brennero Motorway company has maintained constant this approach of cultural and technical challenge towards the future. In 2009, in cooperation with the Municipality of Isera, the first high efficiency solar panels noise barrier[1] in Italy was created, which represents an element of great interest for its dual function of noise protection and the production of clean energy that is inserted in a timely manner, in a much broader European framework for energy transition[2].
With the 36.21%of society, the Autostrada del Brennero is part of the Institute for Technological Innovations S.c.a.r.l. (I.T.T.)[3]. As a core value, this company is committed to create an industrial background, focusing on the production of hydrogen through the use of renewable resources. The first hydrogen production plant in Bolzano south was also born from this interest. This is the first structure of the production and distribution of green hydrogen, generated with the use of renewable energy sources (the sun, wind and water, with solar wind and hydroelectric energy). This opens the way for the development of a true green corridor that is already foreseen in the company development plan through implementation of future installations at the Brennero pass, at Nogaredo and at the intersections with the A4 and A1 motorways. All this, it is part of a European planning framework, which sees the Autostrada del Brennero as a protagonist in numerous projects. Brenner LEC (lower emission corridor) LIFE[4] is one of the main project, which aims to achieve the best possible compromise between environmental benefits, quality and safety of the offered service and maximum degree of acceptance by users. This focuses the attention on environmental monitoring (air quality and noise), transport (traffic data) and the social impact.
In addition, there are artistic works realized in the access roundabouts of the exits of Chiusa, Trento sud and Rovereto. The motorway travel, in this continuous scenario of innovation and experimentation, becomes a pleasure moment of the journey, connecting the surrounding landscape and knowledge of the local communities along the way.
This approach to innovation and to change, makes Autobrennero an excellent prototype of TechnoEcoSystem, allowing the theoretical concept to become a strategy for future infrastructures. The technological, ecological and systemic motorway, through the design of osmotic devices, such as service areas to support transit, transects and noise barriers, becomes TechnoEcoSystem. This is possible changing the logic of an eco-environmental culture, overcoming the state of ineptitude, designing something that could be a

potentiality for the landscape and not an impact. In this specific case, the infrastructures can offer spaces for the regeneration of the landscape not from a perspective of standardization, but of context sensitive design.
This framework of research also includes the work developed by the DICAM (Department of Civil, Environmental and Mechanical Engineering) of the University of Trento, in a logic in which, a complex structure like a motorway becomes increasingly sensitive both to the incentives given by technological innovation and to aesthetic and environmental demands.

3.1 Design research on A22: from ecological corridor to technoecosystemic motorway

The research "Reinventing A22", which is the origin of the INFA22lab research has explored an innovative vision of infrastructures: from a motorway as a closed tube in its functional limits, to a motorway as an osmotic membrane able to activate relationships with the surrounding landscape.
All the motorway devices, while maintaining their original function, become real production and exchange systems, producing technoecosystemic services that define the motorway system within a holistic view of the ecosphere.
In this research it was possible to deepen the theme, rethinking two types of significant devices in the motorway landscape:
- the noise barrier (Smart Barrier)
- the service area (Smart Oasis)

Both applications have been studied and deepened by a multidisciplinary group of the Department of Civil and Environmental Engineering of the University of Trento (DICAM). The design was developed in various steps shared with the technical managers of the company. This process of continuous exchange between the different disciplines and with the company, it has allowed the group to develop unique projects for their innovation and attention to the context, suggesting a virtuous and quality design of infrastructures.

3.2 Application

Following the premises of the second chapter, which emerged during the research "Reinventing A22"[5], in this chapter both theoretical and design aspects related to the concept of osmotic infrastructure will be investigated.
In the first part, as already seen, through a deepening of strategies of Sensitive Design Approach, the concept of a TechnoEcoSystem motorway was developed, in continuity with the osmotic vision of the infrastructure. The design part of the research has allowed the group to translate this concept into application, through specific osmotic devices: service areas and noise barriers. Both have been reworked in a perspective of conceptual and experimental innovation.
The theme of service areas as devices able to connect the landscape to the infrastructure, constitutes the experimental part of this doctoral research. The hypothesis is based on the concept of TecnoEcoSystem. It can be used as an interpretative and operative category of a transformation process of the

motorway, from a functional structure to a resilient system for the landscape. However, the design of the barriers is the preliminary hypothesis for the development of an experimental project of "integrated barrier". Both proposals respond to the overall goal of transforming the A22 into a sustainable and integrated infrastructure in the landscape.
Finally, through the PhD research it was possible to develop a general method of designing existing infrastructures, using the A22 as a model of an ecological and resilient system, serving the crossed contexts.

3.2.1 The noise barrier (Smart Barrier)

Smart Barrier develops a design hypothesis that integrates performance aspects and technological solutions in a vision of sensitive barrier that contributes to services for the context.
A first hypothesis was presented in the first part of the research "Reinventing A22" with the project dolo.MITI.
In this second phase, starting from the conceptual premises that are emerged previously, InfA22lab has developed a project that takes into account the specific characteristics of the context indicated by Autostrada del Brennero S.p.A., through a preliminary analytical process. The barrier design develops a clear focus on the relationship with the context between Trento Center and Trento North in which it is planned.
After a first study of the barrier, as a performance device that simultaneously performed multiple functions - soundproofing, water treatment, energy production, mitigation of atmospheric pollution, data transmission and safety management - a focus was developed on the identity value of the landscape. Therefore, the barrier, as a true integral technological prototype, embodies the conceptual idea of TechnoEcoSystem. It becomes simplification of an easily scalable concept that from the motorway can be applied to all the devices designed for the infrastructure.
The design hypothesis is based on three fundamental principles:

- innovation: for the multifunctional and integrated barrier concept, as well as for the materials used (silk-screen printed transparent sound-absorbing panels);

- landscape compatibility: the relationship with the surrounding fields and mountains is highlighted by the weaving of the structure and by the profile line, associated with the noise peaks recorded along the section road between Trento center and Trento north;

- environmental compatibility: through the use of eco-compatible materials (photovoltaic and photocatalytic coatings) and the integration of devices for water treatment. This goal is the experimental part applied to the barrier.

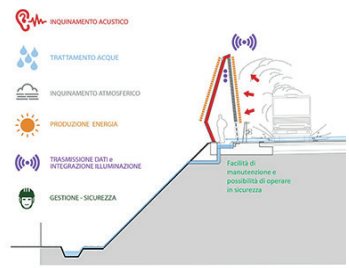


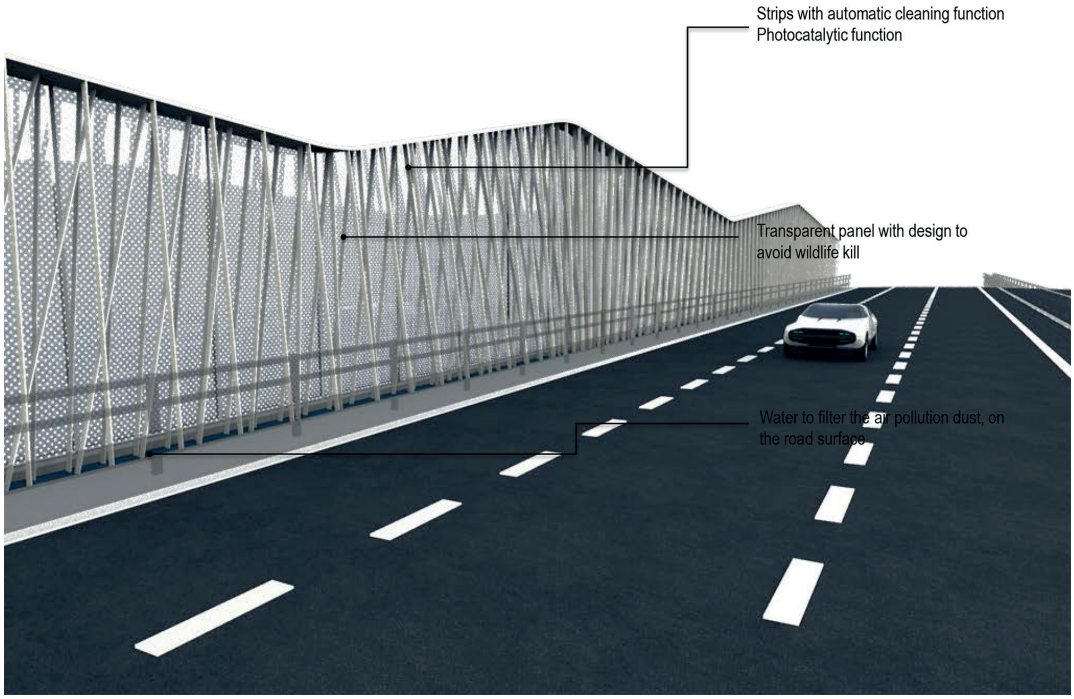
Image 1| Functional options

Through the use of titanium dioxide (TiO2) applied to the structural white strips, the dust converts the Nitrogen Oxides (NOX) and other pollutants

into neutralized components, through a catalytic process that reacts with the action of the sun[6]. Through water blades, the collected material arrives at the base of the barrier, to be then separated into appropriate filters[7].

These three principles translate into cultural, provisioning and regulating services for contexts and travelers. In general, the intelligent barrier, covering two sides of road lanes on one kilometer of length, works as an environmental mitigation tool. Its functions reduce impacts such as noise, air and water pollution through an integrated technology system.
The final design configuration simulates the shape of the vineyards, proposing it in a stylized manner on the structure of the sound-absorbing panel. The barrier can also be covered by photovoltaic diodes, applicable on transparent panels or in the top part of the structure, in order to collect energy and environmental data.
In the end, with its multi-level objectives, the barrier acts as a transition element, useful for balancing the ecological equilibrium between natural and artificial ecosystems, through the production of cultural, provisioning and regulating services.

Image 2| Smart barrier



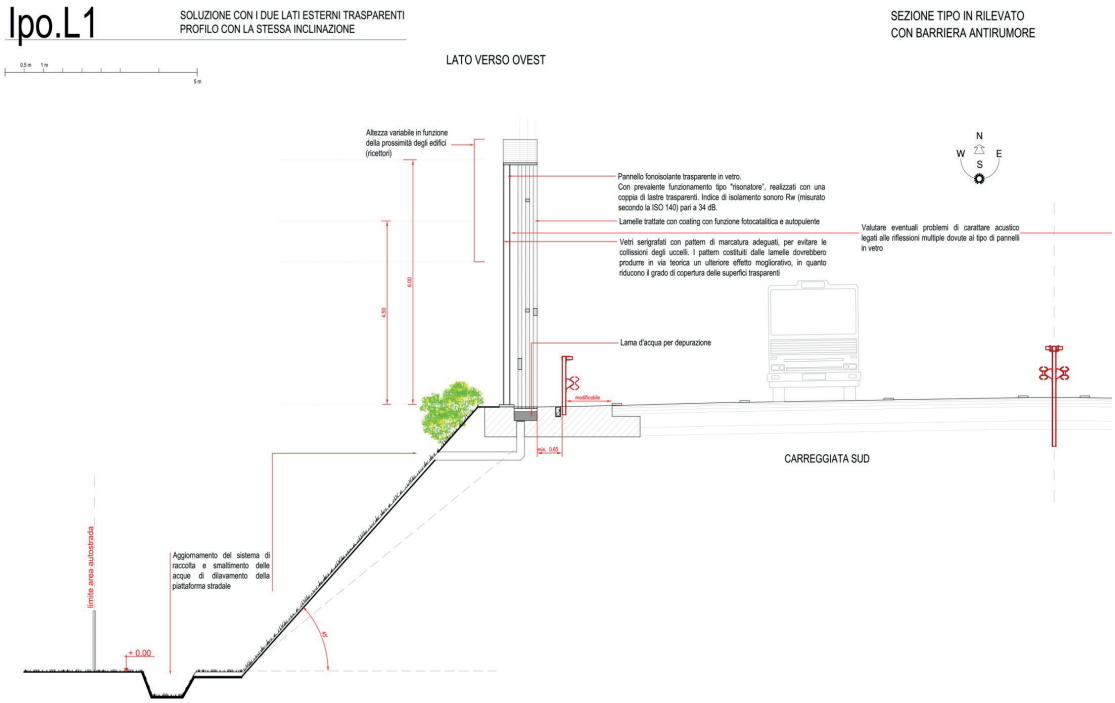
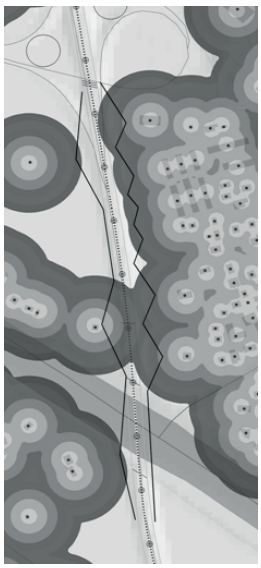


Image 3| Technological section.



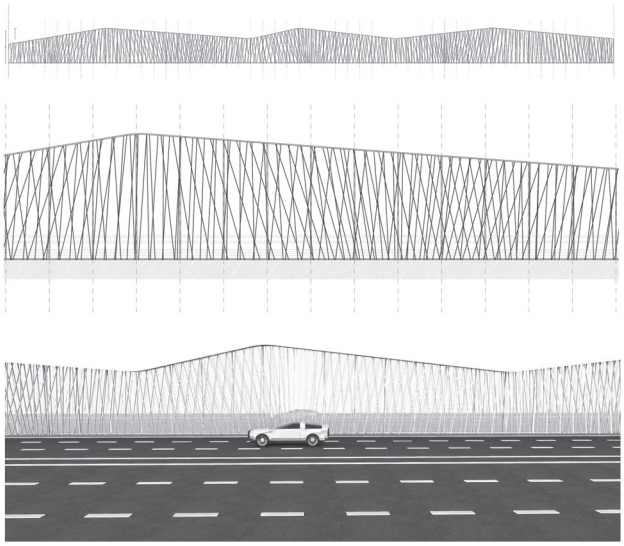


Image 4| Conceptual diagrams. The barrier shape is the result of the sound.

3.2.1 The service station (Smart Oasis). Adaptive and Responsive strategies.

After the first phase of a formal and symbolic research of the design architecture of the service areas, during the 60s and 70s of the last century, there was a process of exemplification of the architectural language, linked to a standardization process.
The first phase of the research "Reinventing A22" ended with a proposal of smart oasis, areas of entertainment and quality services, opened to the territory as well as to users of the motorway.
With a deep analysis of the Plose Est and Adige Ovest service area, InfrA22lab overcame a logic of pure necessity, planning and deepening functionality and design aspects of structures through the strategy of technoecosystemic services: cultural, provisioning and regulating.

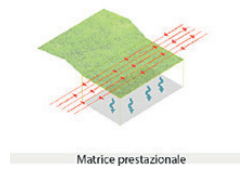
Adaptive and responsive strategy: Plose Est service area and Adige Ovest service area

Starting from these premises, two concepts have been proposed that have allowed creation of a dynamic and adaptive relationship with the context: Hill and Canopy.

Hill. For Plose East was developed a project based on the morphological characteristics of the site. The concept is the inhabited hill. All services are transferred under the hill, so the top becomes a park, designed in continuity with the morphology of the surrounding landscape.
In this project, seen more in-depth in the PhD research through the concept of ecotone (chapter 4), the centrality is given to the development of relationship between context and motorway.

Canopy. For the Adige Ovest service area, a more performative concept was developed, linked to the inclusion of a continuous and responsive canopy into the context. This responds through energy and environmental performance to the needs of the context, without denying the existing.
After a careful survey of national and international case studies, the characteristics and tools useful for defining the service area of the future have been identified. The collected features can be traced into the definition of three categories. These combined categories make the service area complete and rich from the point of view of both the contexts and the users.

After a careful survey of national and international case studies (many detailed in chapter 4)[8], the characteristics and tools useful for defining the service area of the future have been identified. The peculiarities collected can be simplified into the definition of three categories. These, combined, make the service area complete and rich both from the point of view of the contexts and of the users.
These three categories are Energy, Landscape and Function. In order to es-



cape the standardization logic, from the comparison with other typological examples of service station, multiple results will emerge, looking at the service building as a functional device of landscape.

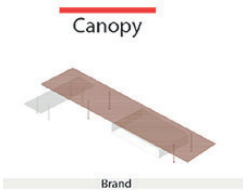
Power. Many of the service stations are energy collectors, both using the service area spaces and the roofs of the buildings. The collected energy is used not only for the building supply, but also for the contexts supply as well as for the production of ecological fuel (eclectic energy).

Landscape. Many examples show specific attention to the morphological relation between service buildings and the landscape. High attention is also paid to the use of 'ecosystemic' devices to support the balance and to mitigate the impacts of air, water and noise pollution.

Functionality. Many examples use the canopy to functionally articulate the available space of the service area, opening the service area also to the neighbor communities.
Starting from these readings the two strategies of Hill and Canopy have been hypothesized, which are characterized by their peculiarities in relation to the service building and their context. The elements of the two strategies are mainly three, namely: Brand, Landscape and Smartness.

Brand. The direct reference of the Brand of the Autobrennero is the use of the Corten as a unifying element of the organic route of the motorway.

Landscape. The link with the landscape happens through a process of mitigation and continuity between the morphology of the context and the service buildings or it can occur through physical contrast and chromatic continuity between them.



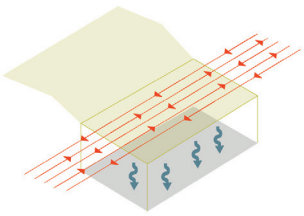
Smartness. The performance is given by the technologies and the performance potential that the building or service area presents.

These are implemented differently in the two strategic hypotheses presented.

Hill. The general objective of the strategy is to camouflage the building on the site in which it is inserted. In this specific case, the Brand is subtended and highlighted by small details that would characterize the building. Through the mitigation and the morphological continuity the link with the Landscape is reached, while the Smartness is underlined to the bioclimatic performance of the building.

Canopy. The general objective of the strategy is to manifest its presence. Therefore, the Brand in this case is highlighted by the roof materials and by the use of local materials. The link with the landscape is declared in the creation of an "underwood" space in chromatic continuity with the context, while the Smartness is underlined by the energetic Canopy and by water collection performance.

Hill



Prestazioni Bioclimatiche

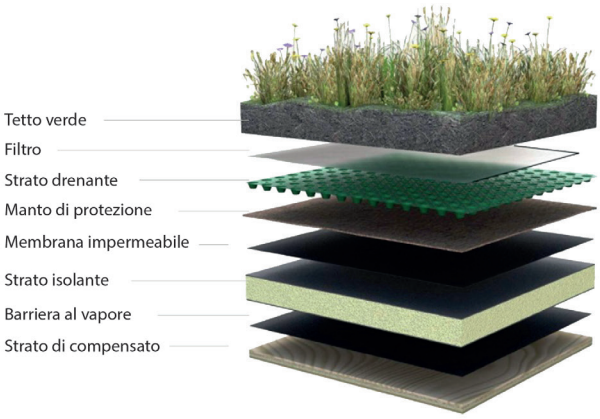
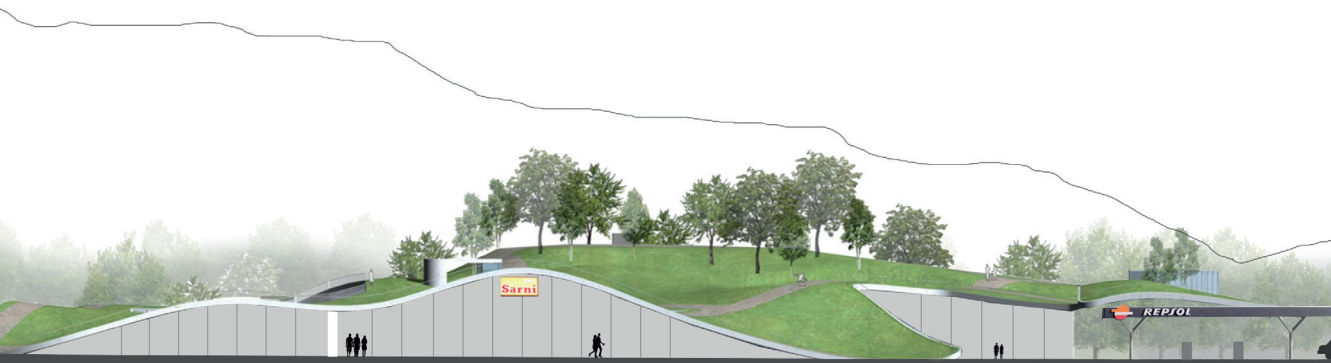
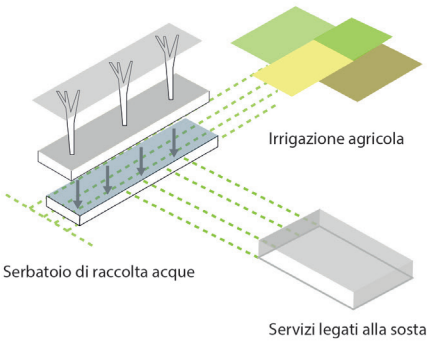


Illustration: greenerheights.wordpress.com



Concept Collage

Canopy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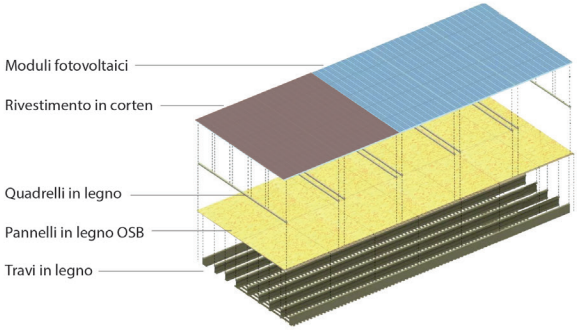
Serbatoio di raccolta acque
Servizi legati alla sosta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Rivestimento in corten
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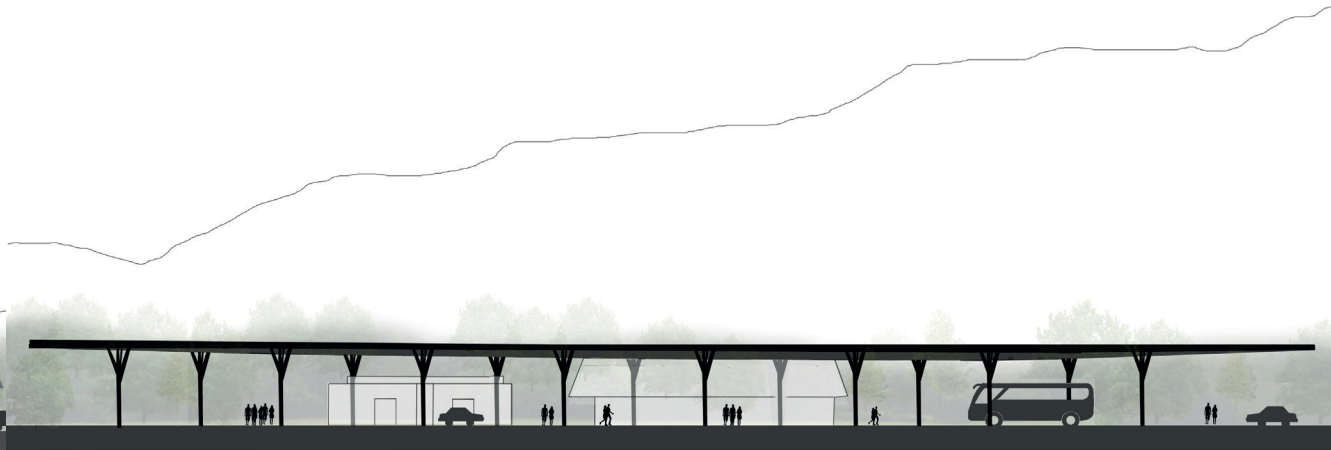
Travi in legno



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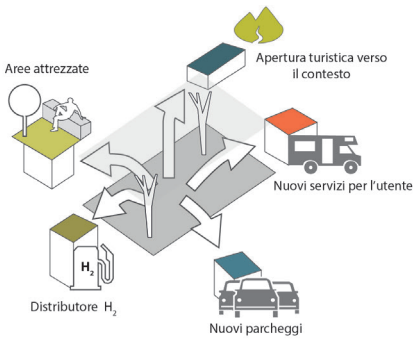
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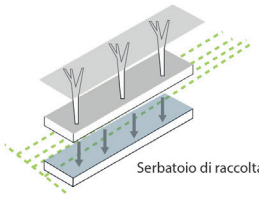
Apertura turistica verso il contesto
Nuovi servizi per l'utente
H_2
Distributore H_2
Nuovi parcheggi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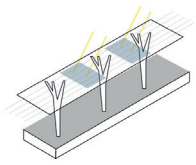
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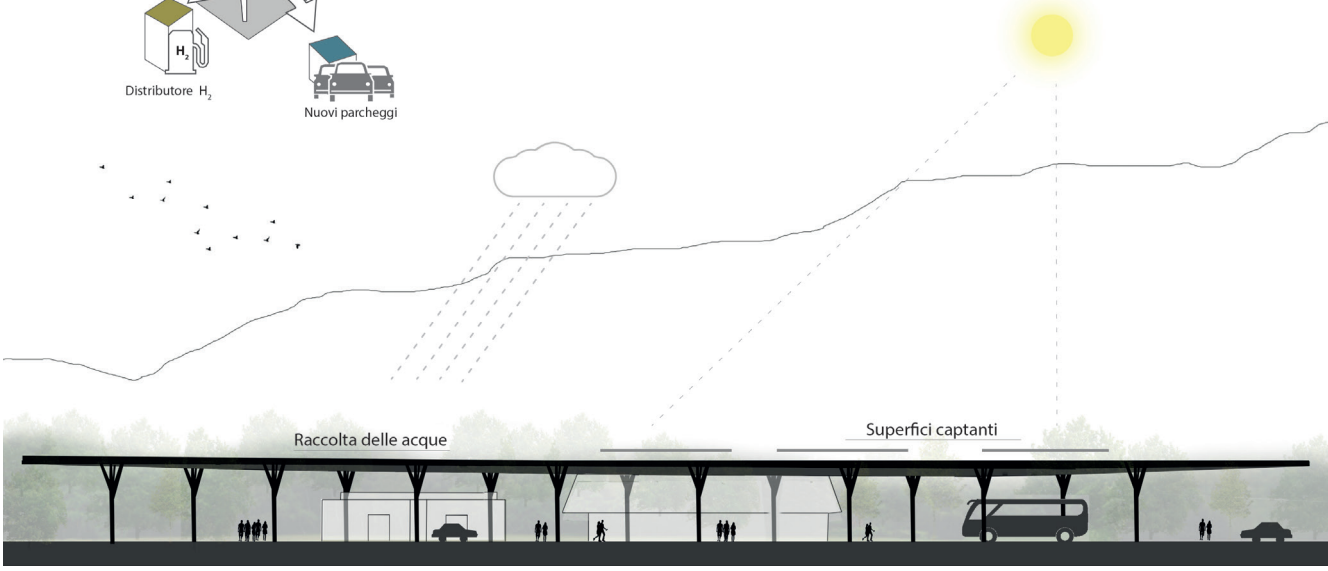
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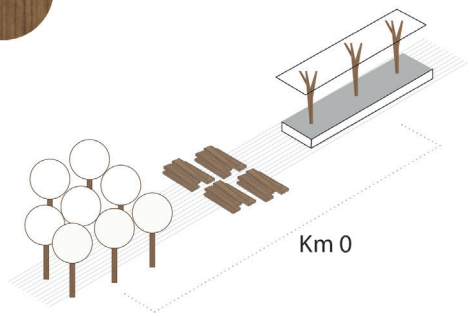
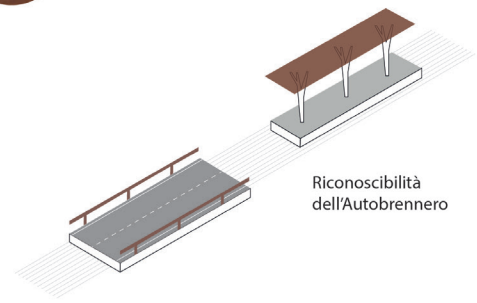
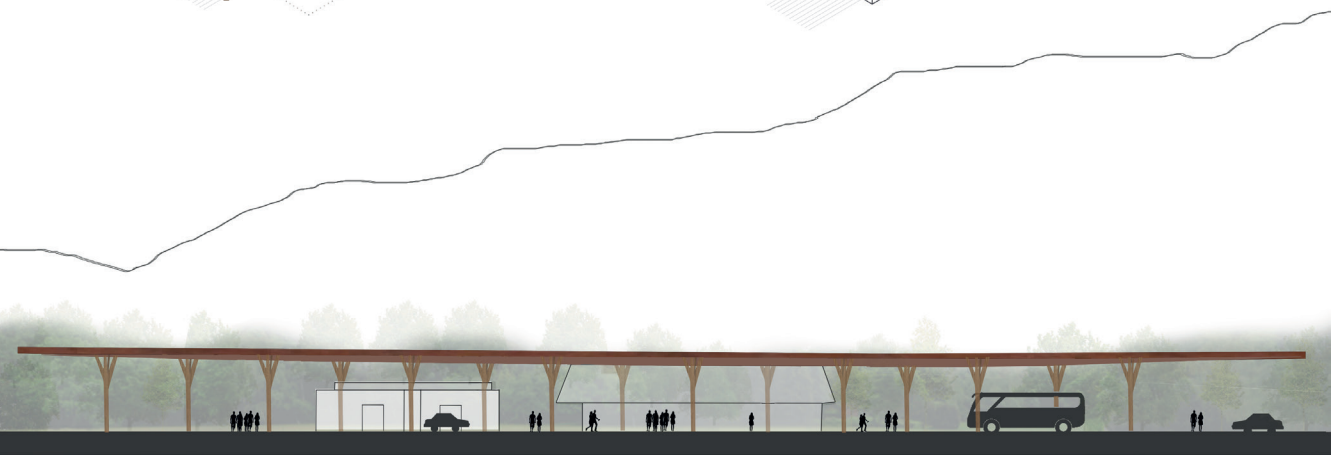
Superfici captanti

Legno lamellare

Acciaio Corten







Conversation with Mosè Ricci | InfrA22Lab |UNITN

Mosè Ricci is a full professor of Architectural Design and Urban Planning. He teaches Architectural Composition at the Department of Civil, Environmental and Mechanical Engineering of the University of Trento. With Prof. Giuseppe Scaglione, he was scientific coordinator of both "reinventing A22" and "InfrA22" researches.

A quali risultati ha portato questa seconda fase di ricerca?
La seconda parte della ricerca ha portato ad un risultato fondamentale cioè quello della verifica sperimentale delle ipotesi di ricerca messe a fuoco durante la prima fase. La possibilità di applicare le ipotesi sul campo, sul contesto autostradale dell'A22, sia per quanto riguarda la barriera antirumore e sia per quanto riguarda l'area di servizio. Naturalmente, come sempre la sperimentazione ha affinato sia le scelte sia alcune caratteristiche prestazionali e anche estetiche in senso lato nei progetti di barriera e di area di servizio. Questi progetti non sono modellistici, nel senso che possono essere riprodotti in qualsiasi contesto ed in qualsiasi caso, però sono degli esempi replicabili con gli adattamenti dovuti, trasferibili ad altri contesti autostradali e forse anche ad altri contesti infrastrutturali nel metodo e nell'approccio concettuale.
Secondo la mia personale opinione, i grandi risultati raggiunti sono: il primo della barriera è quello riguardante la verifica e la possibilità reale di creare la barriera integrale, che non serva solo a mitigare il suono, ma che rappresenti anche un elemento di mitigazione per gli inquinati e che influisca nella sistemazione dell'area e del terreno, ma che allo stesso tempo anche sia un elemento di interazione con gli utenti e con chi da fuori guarda all'autostrada. Quindi diviene un elemento più narrativo, più descrittivo che in qualche modo da dentro descrive il paesaggio e da fuori lo caratterizza nella sua infrastruttura. per quanto riguarda l'area di servizio invece, il risultato più significativo, direi che è la possibilità di aumento di legame di caratteristiche osmotiche, cioè di scambio con l'esterno dell'infrastruttura proprio attraverso queste aree che diventano al tempo stesso un punto importante, dalle caratteristiche prestazionali (come ad esempio puntare a riorganizzare al meglio la sosta dei camion e delle auto)...ma diventa anche un luogo sociale rilevante nel paesaggio per la conoscenza del territorio...

Qual è stato il valore aggiunto rispetto alla prima fase?
Il valore aggiunto è notevole perchè vuol dire aver trasformato in un progetto spaziale delle ipotesi che sono di natura teorica e che hanno relazione con dei fatti ecologici. Direi che l'ipotesi principale riguarda la possibilità di innovazione della linea infrastrutturale. Questa senz'altro c'è. Questi progetti per l'area di servizio e per la barriera antirumore dimostrano che a partire dai ragionamenti e dalle ipotesi sviluppate nella prima fase della ricerca, l'esito progettuale è fortemente innovativo sul campo, o almeno produce qualcosa che è completamente diverso da quello a cui siamo abituati e che prima avveniva abitualmente, sia per quanto riguarda le barriere antirumore sia per quanto riguarda le aree di sosta e di servizio. Nella prima fase

erano stati già ipotizzati dei modelli a cui ci si poteva avvicinare, però direi che i risultati sono ancora più decisi e chiari dal punto di vista concettuale e nuovi rispetto all'esperienza precedente...originali. Questo è il primo valore aggiunto, l'idea che l'infrastruttura possa scambiare con l'ambiente, con il territorio e con il paesaggio è rappresentata da questi due spunti progettuali. L'altro valore aggiunto è la conferma che con dispositivi come questi si può pensare all'infrastruttura come un ecosistema e questo è un altro punto originale ed innovativo della tesi, cioè si rompe la barriera tra quelle che vengono definite green & blue infrastructure, cioè le infrastrutture ambientali e di paesaggio, con le gray infrastructure, strade, ferrovie ecc...
Una grey infrastructure che diventa quasi una green infrastructure o che inizia a comportarsi come si comportano le green infrastructure, sballa completamente una divisione che fino ad oggi era stata rigida anche nelle ipotesi più interessanti degli studiosi delle infrastrutture di paesaggio, quindi questo è un valore aggiunto in termini di originalità e di innovazione importante della tesi. Non solo si sono prodotti progetti spaziali che risultano essere innovativi nel modo in cui occupano spazio sul territorio, nel modo in cui si presentano, nel modo in cui sovvertono il rapporto tra paesaggio ed infrastruttura o ambiente ed infrastruttura, si sono prodotti due dispositivi che rendono una infrastruttura grigia, un'infrastruttura ambientale, che possono contribuire a rendere l'infrastruttura stradale un'infrastruttura ambientale, come una sorta di ecosistema. Questo valica un confine che fino ad oggi tutti quanti definivano in maniera rigida, si vedeva come poteva essere l'insediamento dell'infrastruttura grigia all'interno dei sistemi ambientali, nell'inserimento paesaggistico ecc... Fino ad ora sono stati fatti progetti puntuali, di produzione energetica, come la barriera antirumore fotovoltaica dell'A22...ma il fatto di trasformare un'infrastruttura stradale in un'infrastruttura ambientale e che questo limite potesse essere valicato, rappresenta un punto di vista assolutamente nuovo, sul quale la ricerca deve continuare a lavorare.

Come definirebbe a fronte di tutto ciò le infrastrutture del futuro?
Non lo so, perchè già questo risultato ci sorprende. Le infrastrutture ambientali si occupano di soddisfare le esigenze di trasporto e di percorrenza dei mezzi e delle persone. Può darsi che si verificherà quanto definito dagli MVRDV in SkycarCity, o da noi in High Space qualche anno fa. Il sistema delle infrastrutture per la comunicazione materiale ed il trasporto può essere che esploda per effetto di nuovi modelli di vettori, come la macchina portata dai droni come in skycare, oppure gli skybus, questo non è dato saperlo. La cosa importante che fa questo lavoro di ricerca è che trasforma un'infrastruttura di oggi, in una delle possibili di domani, si preoccupa del presente e fa vedere piuttosto chiaramente come da subito le infrastrutture esistenti possono diventare tutto un altro dispositivo che abbia meno impatti con l'ambiente, che produca energia, che diventi un luogo accogliente per diverse funzioni e soprattutto per diverse prestazioni di qualità ambientale molto più sostenibili all'interno dei nostri paesaggi e delle nostre città.

Qual è la sua idea di Autostrada del futuro e come questa si sta concretizzando nell'operato di A22?

Secondo me ci sono due ambiti di valutazione rilevati rispetto al concetto di mobilità del futuro. La prima è la modifica del concetto di infrastruttura stradale, in generale rispetto al contesto territoriale. Negli anni quando si cominciò ad infrastrutturare il paese in Italia come nel resto d'Europa, l'idea di infrastruttura era legata al fatto esclusivo della mobilità, quindi doveva creare un tessuto che consentisse alle merci e alle persone di muoversi in maniera libera. L'idea che stava alla base era un'idea di efficentamento economico e sviluppo culturale attraverso i territori, attraverso la possibilità di spostamento. Sin dall'inizio però, soprattutto in questa terra, percorsa da Autobrennero longitudinalmente, passando dal passo del Brennero alla Pianura Padana, l'autostrada è stata percepita come portatrice di inquinamento da rumore e da emissione di inquinanti dei mezzi e dei motori. La percezione dei territori rispetto all'autostrada era di cesura, un taglio nel paesaggio che sì, dava opportunità, ma molto spesso era anche un elemento che attraversava longitudinalmente tutto il territorio senza portare benefici diffusi se non quelli di carattere economico. Un lavoro che è stato fatto fin dall'inizio qui in Autobrennero, che ormai risale a quindici anni fa, è stato quello di cambiare la percezione rispetto al valore di un'arteria autostradale e lì secondo me si è innescato quello che prima aveva interessato la riqualificazione per esempio delle aree industriali delle città, cioè immaginare di dare una valenza diversa a un territorio. Quello poi dell'autostrada è un territorio vero e proprio. Io faccio sempre l'esempio delle aree di servizio che rappresentano un macro-ambito urbano, perché alla fine ci si va per fermarsi e per esigenze fondamentali: mangiare, sgranchirsi ecc... per cui immaginare queste aree che erano dei non luoghi, in luoghi con una diversa attrattività è stato uno degli elementi più rilevanti. Tutta l'autostrada è stata immaginata diversa, facendo nascere una serie di progetti come quello dei sovrappassi, pensati non come strutture modulari che si ripetevano ma come elementi architettonici che arricchivano il territorio, un'esposizione architettonica di diversi stili costruttivi. Caratterizzare le uscite autostradali come delle porte verso i singoli territori e arricchendole con delle opere d'arte di artisti che connotavano il legame tra territorio e autostrada; immaginare dispositivi che fossero uno spunto per produrre energie rinnovabili, quindi la barriera fotovoltaica d'Isera e altre iniziative di quel tipo, come l'eolico; e poi creare i presupposti perchè la mobilità del futuro potesse radicarsi in questa autostrada attraverso il centro per la produzione e la distribuzione dell'idrogeno ecc... Tutto questo ha consentito di cambiare il rapporto tra l'infrastruttura e il territorio. Nelle idee di quello che stiamo facendo ci sta anche immaginare che diventino le aree di servizio dei punti di opportunità territoriale di promozione e legame con il territorio. C'è stata l'idea del museo Plessi che ha portato l'arte all'interno del tracciato autostradale, quindi un luogo dove le persone potessero fermarsi ad ammirare delle opere d'arte in un contesto completamente diverso da quello rispetto al quale siamo abituati. La gente

è abituata ad andare al museo al Louvre o agli Uffizi a Firenze, ma non è abituata a fermarsi in autostrada per poter apprezzare oltre alla sosta, una proposta di carattere culturale. Devo dire che anche quel luogo è diventato di grande attrattività e riferimento. Abbiamo una serie di richieste di artisti che vogliono esporre lì. Dall'altra parte, in Austria, è stata costruita una struttura classica, tipicamente improntata sulla gastronomia locale e l'architettura locale con strutture in legno (tipica baita tirolese). Ed è praticamente inesistente, tutti sanno che al Brennero c'è il Plessi Museum e questo è stato un elemento che ha trasformato un non luogo in un superluogo.
Adesso c'è tutta la partita che riguarda la smart road, quindi il portare la tecnologia all'interno dell'arteria autostradale per tutto quello che riguarda la mobilità ma anche l'informazione e quindi creare le condizioni perchè qui si possa sperimentare tecnologia utile per coloro che passano molte ore della propria giornata su una strada. Poi quando si fa il conto di dove le persone passano il tempo, molta gente ormai lavora muovendosi e quindi creare un'autostrada intelligente che sia in grado di garantire mobilità sicura e creare condizioni per avere informazioni e scambio di dati è un elemento rilevante.

Quali vantaggi ha portato la collaborazione tra Autobrennero e università?
Io sono dell'idea che comunque il più grande investimento che si possa fare è in intelligenze e in innovazione. Questa è un'autostrada che ha dimostrato, pur avendo una struttura dal punto di vista geometrico meno performante di altre, perchè è ancora un'autostrada a due corsie, di poter assolvere alle proprie funzioni usando la tecnologia, diventando un laboratorio importante per testare progetti...e credo che la scelta di avere una struttura tecnica e progettuale interna, sia una scelta di campo importante. L'opportunità di poter lavorare con l'idealità di chi sta facendo ricerche, di chi studia per formare una classe dirigente futura, credo sia un valore importante. Le università hanno le migliori forze dei ragazzi che si immaginano il futuro attraverso delle idee. Questa è una delle poche fasi in cui si può ancora idealizzare un processo, molto spesso dopo si è impegnati nella quotidianità e bisogna confrontarsi con il *Primum vivere deinde philosophari*, perchè è così. Mentre la ricerca che si fa nelle università consente di traguardare più lontano, di non confrontarsi con l'esigenza quotidiana di un risultato a breve termine, quindi per noi è stata un'opportunità importante mixare le due cose, immaginare di guardare lontano anche con gli occhi di chi è completamente libero nel pensiero e cercare di metterla a sistema con chi può invece produrre un progetto che poi viene realizzato. Io credo che in Italia l'industria non è andata di pari passo con chi fa ricerca e didattica. Queste cose insieme si devono combinare. Quindi avere una realtà industriale come Autobrennero qui sul territorio è un valore poter progettare cose importanti, perchè oggi la frustrazione del progettista è che si lavora per tanti progetti che poi non si sono mai realizzati. Qui invece i progetti li vediamo crescere, mettendo insieme un laboratorio di pensiero.

Quali sono i programmi futuri di A22?

Oltre alle questioni tecnologiche ci sono molti progetti di carattere infrastrutturale. Comunque è prevista la realizzazione della terza corsia vera fra Verona- Modena. È prevista l'attivazione della terza corsia dinamica tra Bolzano e Verona, è prevista la riqualificazione completa di tutte le aree di servizio, verranno rifatti tutti i sovrappassi per motivi di prestazione strutturale, ma anche per motivi di modifica di quella che era stata la scelta di allora, perchè allora, questa come altre autostrade, si erano basati sulla ripetizione modulare di elementi che nascevano dalla cultura di prefabbricazione che in Italia è una cultura che ha avuto maggior successo che in altri paesi sfortunatamente. Adesso queste cose vengono modificate e sono dell'opinione che ogni opera strutturale ed ingegneristica debba avere un legame importante con il luogo dove viene realizzata. Non esistono balsami meravigliosi, cioè un ponte che è fatto a Modena, con le caratteristiche geometriche e orografiche che interessano quel luogo, non può essere uguale ad un ponte che viene realizzato a Colle Isarco. Quindi questo è quello che questa autostrada cerca di riportare. Non esiste niente di peggiore al mondo che la ripetitività, che non ti permette di accorgerti dove sei. Questo è come correre in un tubo chiuso e non hai davvero la percezione del territorio che vieni ad attraversare. Io mi oppongo in maniera totale a questa cultura. Mentre la grande qualità e intelligenza di Moretti ha prodotto quello che si è visto nelle stazioni dell'Alta Velocità Ferroviaria italiana che quando saranno collegate da Bologna, a Milano, a Reggio Emilia, a Roma...avranno comunque riportato degli elementi distintivi rispetto alla terra che tu attraversi.

Image 5| Plessi Museum. © Oskar-Da-Riz

Note

1. More information about the project are in the website of Brennero motorway. A22 Autostrada del Brennero: previsioni traffico e viabilità - A22. (2017). Retrieved from http://www.autobrennero.it
2. During the interview with Hillary Brown of CCNY emerged the particular importance of this case study also in the other part of the world. She putted this example in her book "Next generation infrastructure". At the question: In your opinion, why PV noise barrier in Autostrada del Brennero, could be consider as a good practice to follow? She said: "It is a great practice, it has a multipurpose functionality and we increasingly we need to think in that way. In the U.S. the majority of major interstate highways are running East to West. Some of these highways have noise barriers where they pass through suburbs, but I've never seen any that incorporate PV. I only saw one example in Australia and one in Italy. For our interstate system it means that we could have south-facing combined noise and PV barriers running thousands of miles. They could reduce the stress of noise to the neighbors and provide renewable energy."
3. More information about the project are in the website of Brennero motorway. A22 Autostrada del Brennero: previsioni traffico e viabilità - A22. (2017). Retrieved from http://www.autobrennero.it
4. Ibidem.
5. The results were published in the book "New Ecologies for Infra / Osmotic Structures". Scaglione, P., & Ricci, M. (2013). A22, nuove ecologie per infrastrutture osmotiche =: A22, new ecologies for osmotic infrastructures. Rovereto: List
6. Below there are the observations related to the specific case of the Smart barrier provided between Trento Center and Trento North: "In this case there is no energy source, only the sun, but the sun is not there all day and then the effect is reduced by several times, assuming that the mentioned material (TiO2) is obtainable in an adequate quantity it could also provide a yield of 4 to 10 times lower due to the different exposure time to bright light of the south.
The lack of forced draught should not be a problem if the average wind is around 1 m / s.
The surface of active material in the range of thousand square meters (2000 meters of barrier x 4-4.5 meters of height, are about 8-9000 square meters, approximately one hectare or less).
An action similar to that of the lower value of the previous case (reduction to 50% of the initial NOx value) could be expected, further reduced due to the shorter exposure time to a total fraction of affected cars (from 4 to 10 times, from 100 at 250 cars / hour throughout the day). "Passive filters based on mixed oxides (contribution of Prof. Claudio Della Volpe, of the Department of Civil, Environmental and Mechanical Engineering in the INFRA-22Lab research report)
7. The approach is experimental. As reported by the Healtly Building Network, there are ongoing studies that detect the possibility that TiO2 particles may be the cancer-causing at nano-scale. Reaction process of NOx reduction with the TX active. (2017). ASLA/ Landscape Architecture Magazine, 7/2017.
8. Part of the case studies have been deepened in chapter 4. Among the others there are: the Acheo Mall Casilina Est (CMR Project), Autogrill Villoresi Est (Studio TotalTool), Service area Bay of Somme (Bruno Mader), Trollstingen Service Station (Reiulf Ramstad Architects), CS Gas (Atelier SAD), Viamala Rastatte Service Station (Iseppi Kurath).

4.

4. Service Stations 4.0_Ecotonal TechnoEcoSystem.

The projects presented into the previous chapter are a part of the general system techno-ecological. The noise barrier is a definite project, while the service station is a preliminary concept that need to be developed. To better understand what is the future role of the service station into a 4.0 scenario for the motorway, we need to have an overview of the general position of the service areas into the historical process. In general opinion, the service area is a tool that have the capability to response to the time's dynamic and changes, easily than the others elements of the motorway. It has always been a space for change experimentation. For this reasons this research use it as a prototype of technoecosystemic approach. Starting from the origin of this kind of architecture, the new concept that the service station assumes to be more resilient to the changes will be defined.
From a necessity, through a standard and a *non place*[1] meaning, the service station assumes another position into the Techno Ecological System of motorway.

4.1 Service station toward a 4.0 scenario.

The origin of the service stations is complex, because it is characterized by a typological and architectural richness over time. The service to infrastructure users has always existed on long distance route, but its growth has been impressive with the spread of the car and big highways, in a development season that in this research it is called Motorway 2.0. With the spread of the automobile at the beginning of the 20th century, there was a passage from the sale of petrol cans, to the localization of "fixed station can" with the simple dispensing pump. From then, they gradually grew more and more spaces full of functions for users[2]. Compared to Europe, in the United States a trend towards expanding the service began, which was no longer to satisfying only the needs of the car, but also of the users. Between 1907 and 1913, the first prototypes of petrol stations took shape with the Central Oil Company and Standard Oil, which were still far from the modern idea of the road service[3]. Some examples of early neoclassical buildings can be found in American cities, where the influence of the City Beautiful[4] movement was remarkable.
Only after the First World War there was the first fueling buildings, designed following a particular architectural rigor. The shapes developed in these years were influenced by the Art Decò[5] and by the advertising image of the main oil companies. Each company personalized its station and made it recognizable through icons and signals that began to characterize the road landscape. The architectures take on a descriptive language of the time in which they were inserted and also became a representation of the company itself, overdoing the shapes of the buildings in their style[6].
The '30s, however, are also the years when functionalism gradually began to assert through the modernist principles. The forms of service buildings begin implemented their functions, going from simple fueling to TBA stations[7]. The building took on more and more complex appearances, arriving to articulate

itself in larger plant surfaces, passing from the simple House with Canopy, to the Oblong Boxes in the United States[8].
The Canopy assumed different forms, from wing profiles like in the Agip-Tagliero[9] building, to the simple curved and flat forms of many examples previous to the Second World War. While in the United States from the 'roaring' years onwards, a continuous applied research on the types of service connected to the motorway is defined, in Italy this stopped with the outbreak of the Second World War (Motorway 2.0). Typologically, we can consider as the first true Italian service station, the one in Genoa, the Autocamionale Genoa-Valle del Pò. In this example there is no distinction between what is a toll, a supply area and a service area, because all the necessary functions are concentrated in the building[10]. The minor service, mainly for fueling and rescued assistence, can be compared to the Cantoniere[11] houses and in the intermediate stations along the road route. During the development of the first generation of motorways (1924-1935) in Italy there was not a particular design incisiveness comparable to what there was during the second generation (1955-1975). The service stations was affected by what was happening overseas with the influence of the neoclassical style, with the exception of the stations[12] on the Venice-Padua[13].
Between the 40s and 50s the development of motorway architectures lived a double experience that was showed through engineering and architectural experimentation. The big oil companies of this time, such as Total in France, Aquila and Agip in Italy and the Standard oil in America, were promoters of the process of typology and standardization that began after the post-World War. These are the years of experimentation of structural engineering[14], the years of development of design manuals to speed up the post-conflict reconstruction process[15], but are also the years of a model of motorway service that we still have, in fact "the buildings for assistance they are formed in this context and they record a similar oscillation between the aspiration to the typification of the artifacts and the research of the architectural and constructive singularity of the interventions"[16]. The hypotheses of Andrea Marchetti[17] for the Shell stations, the tests of Jean Prouvé for Mobiloil[18], similar to the lantern models of the SIAP (later become Esso) by Willelm Marinos Dudok, and the typologies of Mario Bocciocchi[19] for Agip, marked the passage of an era that made the service area increasingly a place outcome of the standard.
In Italy in 1954 with the birth of the SISI[20] and the first draft of the Autostrada del Sole[21] project, the oil companies began to catch the best places along the route. The motorway provided a service every 25 km and this could guarantee minimum supply service with basic necessities or in some cases a complete service more distributed. The latter characterized the historical value of the production of motorway architecture of these years in Italy. While Agip aimed at the process of its constructions as well as the representation of its brand in a distinctive way, the other companies were managing the refreshment buildings of large companies like Pavesi and Motta. The corporate symbolism of a clear advertising matrix of the brand was showed through the buildings of Bega, Bianchetti and Nervi. The priority reference was to the

first European building on a bridge[22] that was created by Bianchetti in Fiorenzuola D'Adda, for Pavesi. As well as being innovative for its peculiarities, this typology began to spread slowly, even in the buildings of Bega and Nervi made for the Motta, on the sections of the A1 and A4 motorway. The shown advantages of this solution seem to be multiple: first, they allowed company to reduce costs in terms of services and facilities, as they were accessible from both roadways direction and made the company's promotion greater, due to its central position on the road axis. In these new bridge types, "the motorway becomes the cavea of a huge theater, in which vehicles dart as protagonists of the scenes"[23].

Despite the advantages reported in this solution, on the motorways this was abandoned, giving more room for new reflections to the articulation of outdoor spaces such as: asymmetrical service areas with pedestrian bridge and the most common solutions, to facilitate the plant layout of services. This external spatial hypothesis contrasted with a typification of the main service buildings. With the Agip experience, the tradition moved from model 59, with the classic canopy incorporated into the fueling station, to model 61, in which the two elements were separated from each other[24]. It was the season of the 60s and 70s competitions banned by Agip and Esso, which emphasized the need to research on the standard (during the industrial prefabrication processes), tending towards something more qualitatively acceptable than the articulation of places[25]. On the standard was a point of conflicting opinions. There were those who see it necessary to standardize to give quality to the service space[26] and those who did not consider it sufficient, but rather responsible for the lack of adaptability that these service structures had with the context[27]. The myth of the great motorway infrastructures grew over the years to reach the peak of its expression in the '80s and' 90s, demonstrating through the rest areas and its devices the only possible margin of change.

The image of the break on the roads changed over the years and told the cultural evolution that characterized it. From a pause of discovery of the place , there was more attention to search the rest area for the brand and the quality of the service offered by a specific company[29]. This even erased everything else, as it is highlighted in the works of Ed Ruscha[30] and Alan D'Arcangelo[31].

The service area assumed a transition role, changeable over time and in its meaning, which is completely abstracted and simplified into a logo, which contains its most pragmatic objective. "If the place can be defined as identity, relational, historical, a space that does not have the same characteristics is a non-place"[32]. The service area is a "practiced place" [33], that is a crossroads of dynamics and mobility that articulate it and characterize it. This dynamics leave the place without a precise meaning, which could create an intimate bond between the observer and his surroundings. Space becomes a place when it receives a meaning from a historical event[34]. Until this happens, a space like a motorway service area causes the effect of disorientation in those who live it. Time is fundamental in this and often establishes the lack of attention that is created between those who live in the motorway space and the context around the service area. The risk is that in service areas the

traveler is catapulted in a promotional place that, if not habitual, will end up forgetting. How can we slow down the perception of these spaces? How can the motorway through its devices connect the traveler with the context? How can the service area assume its identity?
This is the challenge that the TechnoEcoSystemic motorway faces in a 4.0 scenario, where the service area taking on a fundamental role, summarized in the image of the Ecotone[35], in a transitional position between living in speed and urban/natural dynamics that travel at different velocity.

Service area 4.0.
If we imagine the motorway as a technological system, it is necessary to classify its parts and characterize them for their functions within the system. Service areas can be identified as locations which enrich the motorway in its services, but potentially move the territory closer to the infrastructure. Starting from the definition in the second chapter, where the motorway becomes active in the exchange processes with the territories, we must define even its components through a parallelism, following the technoecosystemic strategy. In the landscape ecology, in the framework of natural and semi-natural ecosystems and their physical space, we define Ecotons, the transition environments between two different ecosystems[36]. As the etymology of the word says[37], the ecotone is a tense environment, active and decisive in the change processes. According with this definition, however, it is important to focus on the difference between natural and artificial ecotones[38]. While natural ecotones are transition environments between two natural ecosystems, artificial ecotones are transitional environments between ecosystems whose are man-made[39]. The landscape ecology of Almo Farina in this distinction, in defining the artificial environment, refers to non-natural ecosystems with natural look (agricultural fields, rows of trees, etc.), neglecting those environments that in the holistic view of the landscape ecology[40] are defined as technoecosystems, in which there are environments with an almost total percentage of artificiality.
Looking at an urban ecosystem, considered as a TechnoEcoSystem because of its peculiarities, both physical and functional[41], the transitional buffer between the city and the countryside is called Ecotone (passing through artificial and semi-natural environment). What happens if the transition space is between two urban systems (both artificial)? Does it make sense to talk about Ecotone? Functionally yes, because in the peripheral dynamics similar identity but with different cultures meet. These enrich the transition environment. In this case, in order not to fall into the equivocation of equating biological systems with not natural systems, perhaps talking about cities and infrastructures it makes sense to use the word techno-ecotones. The techno-ecotono,

is an ecotone that has a different percentage of natural degree, keeping its characteristics and functions unchanged. This is a tense environment between two similar or different living dynamics, which has the function of acting as a contact filter and enriching the natural and non-surrounding environments. The non-natural Ecotone can be maintained and managed only by anthropic processes, varying in its shape, size, heterogeneity and density of cultural meaning. Its wealth is in the diversity of meanings that it earns from the relation to the surrounding environments.
Therefore, in a 4.0 scenario of the TechnoEcoSystem motorway, the service area becomes a techno Ecotono, which overcomes its non-place[42] condition, deleting out the equality between the 'here' and the 'elsewhere'. It intercepts the crossed territories, and enriches the (motorway and non-motorway) environments with which interaction occur.
The service area will assume a characterization both for the type of morphology it will have in each territory and above all for the technoecosystemic services that it is able to provide for the environments, in which it is a direct or indirect interface.

4.2 The peculiarities of a technoecosistemic services in an Ecotonal Service Station.

Becoming an ecotonal interface, the service area develops specific and unique services to satisfy both the motorway users and crossed contexts. The technoecosystemic services described in the second chapter, through case studies and actions about long-distance road infrastructures, between theory and specific applications, are enriched in this paragraph, focusing on the specific function that the service area assumes in the motorway context. The peculiarity of the place makes possible to develop the service according with cultural enrichment, energy supply and balance of systems that are intercepted. In the following pages there will be showed how each service can be expressed in the motorway ecotonal spaces. At the end, each kind of services will be displayed through a precise description of an emblematic case study of service areas, as a prototype of the ecotone concept in a technoecosystemic motorway.

Cultural service
The cultural service is defined as the "non-material benefit that people obtain through spiritual enrichment, cognitive development, reflection and aesthetic experiences"[43]. This definition includes recreation, ecotourism, social relations, aesthetic values and inspiration, elements that can easily be find to ecotonal spaces as the service area, because they are rich in the values that emerge from the crossed landscapes. The advantage of the service area is to be a 'door to the landscape'[44] that is able to connect two different dimensions to live the infrastructure. The motorway infrastructure is also able to project the traveler towards multiple distances following the planned destination and it is able to open the journey to the local experience encountered, through transitional spaces such as service and rest areas. The touristic element in

this is not secondary, as it allows the interest of both the communities of the territories and of the traveler to converge. The target of the users, obviously depends on the traveled motorway route[45].
However, this does not mean that the cultural service from one area to another should be changed, varying the type of target. An heterogeneity of minimum services should be guarantee, in order to respond to the needs of the specific customer. To do this, in addition to an "inventive"[46] analysis of the places around the motorway, it is necessary to point out a complex and complete cognitive framework. The objective is to draw from the analytical process, the needs of the cultural service. The analysis should go further the historical / cultural research and to intercept fields such as the territorial economy, often connected to the composition of the social fabric of places. The ecotourism approach can in some ways be the key to the discovery of places, based on: conservation, community and interpretation. The International Ecotourism Society (TIES)[47] explains as through the promotion of sustainable tourism, the action on places is through: processes of conservation of cultural and natural heritage, the enrichment of communities and the understanding and interpretation of the values of the places. In the field of motorways, it may seem rather unusual to talk about ecotourism, if it remains within the infrastructure boundaries. If instead the ecotourism focuses on the opportunity given by the strategic position of the motorway, the perception is different. The advantages, for man in terms of benefits and for the territory in terms of quality and protection of territorial values, lead to a balance in the relation between the technoecosystemic motorway and its environment. In this framework, the service area becomes a tool to open the motorway conduit to the crossed territories, enhancing it through an eco-centric conscience and in connection with nature.
To preserve the interest of the traveler but at the same time to enhance the places, it is a type of double approach applied in many case studies, both as a systemic territorial strategy and punctual opportunity. Among the model case studies that follow a landscape approach for production of cultural service, there are the French motorways. The role of Bernard Lassus[48] has been decisive in this. His considerations related to the perception of the moving landscape and the role of rest area on the motorway have been applied to the Aire des Carrièr de Crazannes and the Aires the Nîmes Caissargues. The deepen survey of the places on these two areas has allowed to enhance the shape of the places, creating signs in the landscape, which the community feels as its own. In general, the main objective of the applied approach is to define a relationship between several objects and more intervention sites: "defining this relationship is a matter of artistic ethics, since it exists as a habit of carrying all before it"[49]. In this way, the service area becomes an element of the landscape system, through the activation of cultural processes, linked to the anthropological ones of the area. In the example of the Aire the Nîmes Caissargues, the design choices are the outcome of the construction process of the motorway. The presence of a quarry in the site, the archaeological findings of the Dame de Caissargues and other archaeological remains gave unique and original value to the site, creating a place both for tourist and

for the city of Nîmes. The overlapping of historical traces gives the service area a deeper meaning, characterized by a large avenue perpendicular to the road axis and to the colonnade and the belvedere near the tree-lined avenue. In its majesty, the area hides the motorway layout, giving more importance to the memory of the place[50].
Another example of Lassus' proposal, with a modus operandi where the landscape is at the center of the focus of design, is the Aires des Carrièr de Crazannes[51]. Here the extractive landscape becomes a reason for enhancing the memory of a place that, with the action of the landscape designer, enhances the dynamics of its relationship with the moving traveler, creating primarily a perceptive landscape[52].
In this case, as well as bringing out a physical trace in the extractive landscape, the aim is to enhance the perceptive balance that is established between the traveler and the moving scenario, aiming at a cultural service of cognitive development and spiritual enrichment. To do this, Lassus uses differentiated paths to create different experiential dynamics in the relationship with the landscape. These are: places to walk, which are divided into catwalks and meeting places; the lookout places, where it is possible to observe; and finally the places to admire, in this specific case represented by quarries and vegetation[53].
However, the French example is not only the work of Lassus. The French service and rest areas for their services and attention to the crossed territories, can be considered as good practices related to the application of the concept of cultural technoecosystemic service of the ecotonal buffer along the motorways. Considering the data reported by the magazine KINEO, relating to a sample of people surveyed during 1997 on the Asf network (Autoroute du Sud de la France), more than 215 thousand people have benefited the sports services in the rest areas of the motorway system. The most important datum, however, is that 60% of these people have stopped by for over 30 minutes[54].
On other French networks, such as the Saprr (Société des Autoruts Paris Rhin Rhone), there are services related to animation and entertainment, variable during the seasons (clown shows, musicians, folk groups)[55], sometimes even specific offers such as the Relais Bébé Nestlé which offers a complete service of free refreshment for newborns. To the variability offered by the management network, a range of specific options linked to local peculiarities is added. Port Lauragais, on the A61, where the motorway intersects the Canal du Midi, the water was channeled into the excavation, creating a sports area through a compensation action. Ruralees, on the A10 motorway, the service area becomes a tool for rediscovering the regional agricultural world. Hastingues on the A64, is located at the intersection of three of the four main streets towards Santiago de Compostela, for which the pilgrimage museum[56] is located. And so on. We could list a lot of similar examples, at the end the outcome is that each one offers opportunities always different, while maintaining a base of common offers of services to users. This allows us to work on the transversality of places in producing and / or receiving cultural services both for travelers and for the territories. Even the Japanese have a localized management system, able to respect the value of the local territory,

enhancing its preciousness. This system of Michi-no-Eki tries to bring in its principle of management three fundamentals, namely: refresh, community and information. While the other two objectives are commonly spread, the third "Community" works with "regional co-operation where cultural centers, tourist attractions, recreation and other local development facilities promote interaction with the region."[57]

Many examples, both Japanese and French, usually force a non-existent relationship, which often results kitsh. Often installations, museum proposals and the celebration of impressive architectures, risk to delete a potential relationship with the context, rather than to enrich it[58]. The design of the landscape and architectural structures is lost in the extreme opulence of these interventions. Looking at the informative / cultural aspect, they cancel the aesthetic and spiritual and cognitive enrichment value that the direct relationship with nature can give. This is what is happening in Italy with the proposal of Autostrade per l'Italia. The project "You are in a wonderful country", promoted by the Ministry of Infrastructure and Transport[59], is invading the service areas of the Autostrade per l'Italia motorway network, with huge gilded frames, decorated with floral motifs. Although the information project is optimistic and rich in itineraries to be discovered, it is not "enhancing the extraordinary Italian artistic, cultural, environmental and enogastronomic heritage"[60], citing the project mission. The service areas of the network are "a showcase of the beauties of our country, which tells exciting travel experiences proposed on the territory surrounding the motorway network" in a passive manner, enclosing everything in a frame set on a synthetic grass base and a location map with a short description of the places. If the service areas must be "doors" to the landscape and the territories, is this the way to make it? Using an installation physically alien to the story of the place? The cultural technoecosystemic service should offer a more complete sensory experience, able to bring the traveler closer to the knowledge of what surrounds him, through food, images and stories, introducing the user to alternative possibilities on places to discover. This can be done through a careful and detailed analysis of the various cultural and social layering that permeates the places. Simplify communication or making it standard, into a wider system, makes the motorway object recognizable, but the experience is not unique and does not allow to overcome the condition of 'non-place', making equal the here and the somewhere else.

Tebay & Gloucester Service Station

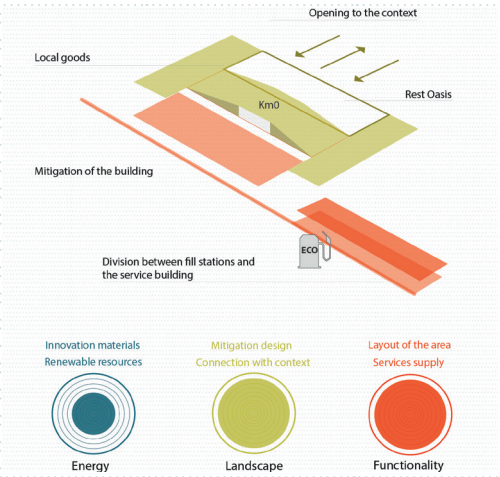
"A place has quality when, in some way appropriate to the person and its culture, it makes the individual aware of belonging to a community, of his own history, of the unfolding of life, and of the space-time universe that includes everything" (Kevin Lynch)

The history of these two service stations is quite unique. We can define it as a family story, born in a unique land, which inspired English painters as Turner[61]. For its Celtic landscapes in the north-west of England, it still shows its excellence.
The farmer family, Dunning, after the passage of the M6, through a corner of their land, decided to take the opportunity to use their potential position to set up a small service station with a couple of petrol pumps, a shop and a little cafe. "They were hands-on and made it work, approaching the services as an extension of the farm. They worked with local producers and builders they knew, and used their own meat. It sounds simple, but I soon realized how progressive it was – particularly for that time"[62]. The core value of this family's work was to work in weaving a community under the production of the catering service, making the Tebay Service[63] station unique in its peculiarities.
Being a family-run area, the products are absolutely linked to the local tradition. Having a farmer lifestyle, the family produces the food that after cooks for the users of the motorway service, according to tradition and connecting the local community to enhance the place. After the official opening, in 1972, with the partnership between the Dunning and local bakers family, in the following ten years the area was implemented to serve the Caravan and Truck.
After that, the innovation for the work on this area has not stopped, from the opening in 2000 of the Rheged Center[64], to 2004 when the family decided to enhance their role as farmers, showing their work and applying a 'nose to tail' approach[65]. Showing the sustainability of the products in sale emphasizes the quality of the cultural service offered by Tebay service, and it feeds the knowledge of the production tradition of these places. In 2014, the same approach was implemented for Gloucester service station.
After that, the innovation for the work on this area has not stopped, from the opening in 2000 of the Rheged Center , to 2004 when the family decided to enhance their role as farmers, showing their work and applying a 'nose to tail' approach . Showing the sustainability of the products in sale emphasizes the quality of the cultural service offered by Tebay service, and it feeds the knowledge of the production tradition of these places. In 2014, the same approach was implemented for Gloucester service station. The service area is located near the city of Gloucester, in the south of England, near the intersection of 11A and 12 of the M5 motorway. The opportunity for the Westmorland family was born in Gloucestershire, by Mark Gale, CEO of Gloucestershire Gateway Trust, who was looking to define a sustainable income to support local communities. The common goal created a direct link between the family and local communities, establishing a percentage of donation for the territory on economic profits of the service area. In addition to this, there was the territorial promotion, on which the Westmorland family has aimed as a food business, exploiting the quality and abundance of food products of Gloucestershire and its surrounding counties[66].
In both areas of service, you do not perceive to be anywhere, to stop for a coffee before leaving for your destination. The preciousness and uniqueness of the spaces of the settled architectures lead the user back to the idea that he is actually there, in that place, as a real

destination. These places are a stage of travel and they are not perceived as stops between departure and arrival.

The project

The project changed the perception of the motorway in the common opinion. The M5 motorway, from an impact, became a community heritage for the Glocestershire area.
The service area covers an area of about 5600 square meters. The project by Glenn Howells Architects (GHA) pays particular attention to the insertion of the building in the context, following the client's far-sighted requests[67]. The architects worked mainly by choosing an organic approach, trying to limit the visual relationship between the service station and the motorway. For this reason they used two hills in the area, creating a continuous green roof. The area is attentive to the relationship with the context, because is surrounded by the hills of the Cotswolds[68] on one side and the Robinswood Hill Park[69] on the other.
Forward-looking is the design approach for the building and also the type of distribution of services in the area. As usually it happens, here the short stop is differentiated from the long one, but in this specific case, to speed up the restart for those who are in a short stop, the main building does not appear for those who do not have time to stop. It almost seems like an invitation to take some time to enjoy the break. In fact, the perception is absolutely of being elsewhere, compared to the fueling station area, as there is a visual discontinuity between the two parts. The main building, takes shape from the territorial morphology, with a cut in the ground that defines the entrance. Entering in the building as well as finding a comprehensive offer of local products, the client acrosses a large space, with details in wood and local stone.
The back area is the most amazing part. With a compensation action, the architects have recreated a lacustrine habitat, as well as encouraging the development of "spiritual enrichment, cognitive development, reflection and aesthetic experiences"[70]. The traveler is therefore able to have a unique experience in this service area, from food to the relationship with the context, which is privileged. The opening of the building towards the landscape, the closure of the same behind the motorway, the involvement of the community both in production and in the management of the service, the quality and attention to the internal and external spaces, make the Gloucester Service area a true example of ecotonal space, a producer of cultural services for different ecosystems[71]. As Sarah Dunning says in one of her interviews, perhaps "pulling ourselves back to the way communities behaved in a really resourceful way is increasingly relevant today, and it's as progressive as it is traditional"[72].



Provisioning service

As the definition says, provisioning services are "the products people obtain from ecosystems, such as food, fuel, fiber, fresh water, and genetic resources"[73]. In our case, the definition is based on the concept of a technoecosystem. Provisioning services are produced by the motorway as real resources. In this case as renewable energy and monitoring and management data and information. The Both are produced in the residual and functional spaces of motorway or by the devices that compose it, to support the other services provided. The role of service areas in this case can be fundamental in terms of managing the products (energy and data) of the motorway production system. The type of connection can be established at a service station is either off-shore[74] or grid-based. Networking defines a more complex management relationship, which aims to be "Smart" in a future vision of management and distribution of resources, to reach the European objectives[75].

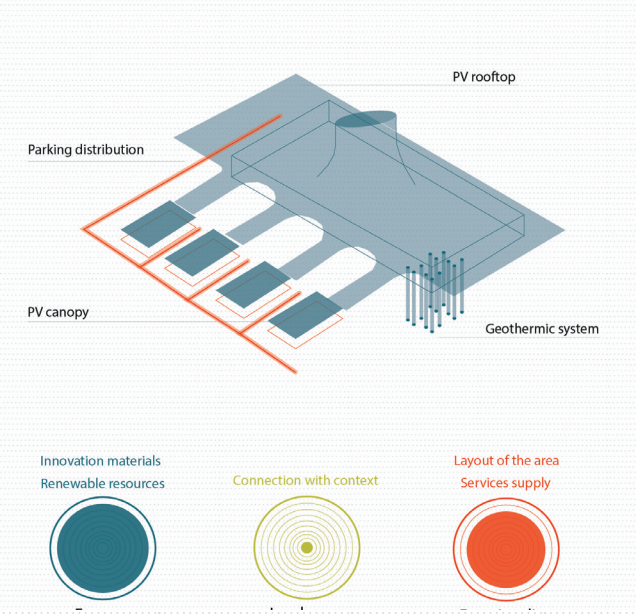
However, the service area can work using a transversal approach, in which the collection and distribution take place at reduced scales compared to a more complex distribution system. Outlining the concept, if we imagine the motorway as an energetic and smart conduit (defined in the second chapter), inside it will establish micro hubs for the collection and distribution of data and energy. These micro hubs work both in a global system and as an archipelago of micro networks, in relation to the crossed contexts. For example, taking into account the service areas, these produce energy and data, through the technologies. This production is both for the consumption within the motorway system and for generate contact and cross-link with the territories. This transversal system is singularly a micro smart grid[76], which is part of the archipelago of micro networks, creating peer to peer[77] relationships of supply between the motorway and contexts. This kind of relationship ensures an exchange of information and resources and scales up the dynamics and processes of management and transformation of the territories, at different scale. All this is already happening, on the Brenner motorway with the photovoltaic barrier in Isera[78] and strategically in the Anas Smart Road concept (2.2.2). Many projects are working on the use of motorway spaces to produce and save energy. Among these, there is the cycle path in South Korea[79] and many examples of buildings that use the principles of savings and low energy consumption, implementing the technologies of their building envelopes. What is missing in these applications? The interaction with the crossed places. This lack of interaction with places is due to the localized consumption of the product (the use of energy by motorway), or is due to the distribution of the exceeded consumption in the main network. This happens in many examples of Autogrill[80] company, developed in the last decade.

What should we do? The answer, which is also useful for other technoecosystemic services, is: to work with neighbor communities to motorway spaces, in order to avoid the exclusive consumption of energy by motorways and large distribution companies; to optimize the management system for the crossed contexts, through accumulation systems sized on the settlement. This can be done by using ecotonal motorway spaces to provide community provisioning services through a peer to peer relationship. The use of the

technologies enables the optimization process thus allowing: "the reduction of the daily peak of energy, the load shifting of energy for the handling of them, and the reduction of the impact and the variability into the energy production" in favor of the surrounding contexts. Working on subcategories in a smart grid is essential for the definition of a smart energy community. in this way the community becomes a resource for the territory: "From a smart land (territory), with a smart grid (system), the energy community is a point of convergence of the grid, where the "smart" is possible through the cooperation between citizen and private and public entities "(chapter 2).
The ecotonal spaces in this perspective are transformed into real energy farms, which provide energy services and environmental and supply data along the infrastructure. The balance and the equilibrium of the system directly puts in relation, also from the economic point of view, the various parties involved, in which the positions between consumers, promoters and local authorities are clear. There are many projects that are working on the partitioning of the motorway segment in terms of management. In these framework there is "Adopt an Highway"[81], a program used a lot in the United States to balance the investment on maintenance between privates/communities and state authorities. This system reduces running costs, but at the same time splits the control on the motorway route. In the same way in terms of management and distribution, having a constant pace in space[82], the service areas allow to easily define and identify the reference poles between the different scales of the grid. According to this scheme it is simple to localize the communities directly adjacent to the service spaces. Energy production, in this scenario, also becomes a form of compensation for the territories and communities affected by the direct impact of the motorway, benefiting but at the same time offering services to the network / hub of the grid. In a European strategy that sees the achievement of the use of renewable resources equal to 33% in 2040[83], the motorways and the system of micro grid communities become priority. This in order to reduce the consumption of soil, optimizing resources and starting from use, as far as possible, of efficient energy clusters[84]: ecotones and adjacent urban systems.

Autogrill Villoresi Est

"The building is an organism that breathes, lives and exists" (G.Ceppi)



Autogrill Villoresi Est has a story of excellence[85]. The service area is located along one of the busiest roads in Italy, as well as the most important for its history: the Milano-Laghi[86] motorway. The building is located exactly opposite to one of the most significant buildings for the Italian motorway stations, Villoresi Ovest[87], which was built by the architect Bianchetti for Pavesi and opened in 1958.

Since the elaboration of the concept, the building, designed by Giulio Ceppi's TotalTool studio, has been linked to the historic building of Pavesi, creating a perspective entry / exit portal from Milan. The two landmark buildings thus become 'Propilei' that symbolically represent the transition between tradition and innovation of half a century of Italian history for the service of motorways.

The performance of the building drives us to look at this Autogrill as an example of ecotonal space, which underlines preventive actions that should be prioritized at the design stage. The variety and wealth of analyzed elements in the definition of the final design both of the building and of the entire service area, helps to find the best solution for the service area system.

From the energetic point of view, the building was conceived as a real living organism, which through technology becomes sensitive to the natural cycles with, as a real prototype of a TechnoEcoSystem. Cycles are principally of energy exchange, as geothermal and photovoltaic are used to produce energy that feeds the various internal systems of the area; as well as the collection of rainwater and groundwater for air conditioning, irrigation of the surrounding greenery, the toilets and the fire reserve[88].

The client Autogrill made the building a true example of sustainability, researching the principles required in the LEED certification protocol[89].

Thanks to an integrated design process, the Gold level was reached. Important in this was

the construction phase supported by the Leed Team ICMQ, which allowed to have:
"- 96% recycling of construction waste,
- 22% of recycled building materials and 86% of regional origin,
- 82% of wood certified Fsc (Forest Stewardship Council),
- 45% savings in electrical energy consumption for heating and cooling,
- 59% reduction in CO2 emissions,
- 30% savings in water resources".[90]

These are important data to which are added the performance of the building. The geothermal system[91] covers 85% of consumption and in combination with the PV roof[92] it covers 45% of consumption for heat treatment during the winter and summer season. The free cooling system uses the natural ventilation and the shape of the roof, while the external area of 19.000sqm creates a landscape continuity with the surrounding territory by planting trees in proportion to the parking spaces[93].

The excellence of Villoresi is not only its sustainability. One of the distinguishing features of this area is the accessibility, which has made the building the first in Italy to receive the Design for All[94] certification, as well as the DASA Register[95]. In the design phase, the TotalTool studio worked a lot on interior design, trying to satisfy the multiple needs of all types of users. From the lowered shelves reachable by a child, to the clear signage and to the support of the blind, to the study of materials for the external paved surfaces that accompany the disabled from the parking lot to the entrance, etc..the service area shows inclusiveness in all its offer.

Summarizing the impact of the Villoresi Est project in numbers there are:
"Total area: 78,000 square meters
Green areas: 19.000 sqm Building area: 2.500 sqm
Parking area:
Car parking: 198 seats (of which 8 disabled and 15 for mothers / families)
Parking lots for trucks: 62 seats
Tour bus parking: 8
Motorcycle parking: 10
Savings and self-production:
Energy - 85% reduction in CO2 emissions
Energy - 45% reduction in overall energy savings
Energy - 55% reduction in consumption for heating and cooling compared to a room
Traditional Autogrill, which corresponds to the average consumption of 80 families
Water - Savings of about 25,550mc per year, the equivalent of over 10 Olympic swimming pools or consumption average household of 128 families 20 Kwh of photovoltaic production".[96]

Despite the approach is admirable, in term of technoecosystemic services the results are critical. The services of Autogrill Villoresi fully satisfies the needs of the users. Excellence should be the basis of every service and should not be an exception that confirms a rule that evokes poor quality. In this service area is missed the relationship with the crossed contexts. The produced energy could become part of a more complex grid distribution system (micro grid), the outdoor spaces available could implement a cultural relationship with the unique places close to the area, following the logic of ecotourism. An opening and interchange with existing cycle systems could be envisaged, as well as a relationship with neighbor local producers. But the action of Autogrill stops to the performances seen

before. Villoresi Est offers a base useful to start, since in a certain way it reduces the impact in its insertion into the territory, closing itself in an idea of a closed-loop machine, which aims to maximize its performance. If the building was thought as an organism, as such it should work, going further and looking for more contact with the other types of encountered landscapes. Villoresi Est, in its results, represents an ecotonal landscape that uses its own wealth, free from external influences, to offer services to the users. In this way it faces the risk of following the logic of non-places, which the idea of TechnoEcoSystem tries to overcome. In this case it is necessary to take a further step, which aims at establishing a direct relationship between the managing body, in this case Autogrill, the communities and the administrations related to this section of motorway.

Regulating service

As the definition says, regulating services are "the benefits people obtain from the regulation of ecosystem processes, including air quality maintenance, climate regulation, erosion control, regulation of human diseases, and water purification"[97]. In this specific case the definition referes to a techno-ecosystemic regulating services that the motorway produces in the crossed contexts. Thinking of the motorway as a system that works to improve air quality, to regulate the purification processes of drained water in neighbor systems and to alleviate any form of pollution is apparently a contradiction. The motorway as a technological system can work on the reduction of impacts and specifically on the mitigation and compensation of the same. Technology can help in this by making human systems work like machines with a natural metabolism. To allow the service areas to work in this direction by producing ecological services, attention must be focused on the impacts that they produce, in relation to the motorway. Starting from the building up to the settlement system of the area, the ecotonal spaces act as a medium between the crossed landscape and the extra-urban TechnoEcoSystem. According to the reference context, the ecotonal spaces act, trying to balance the equilibrium between the two reference systems through natural processes by using technology. From this point of view, to produce regulating services on a service area is important to analyze the individual processes that need to be controlled and balanced, in order to act on them on time. These are: the drainage of water, fragmentation, air pollution, noise pollution and light pollution[98]. For each impact the response is with different strategies and solutions, trying to ensure those services that the ecotonal TechnoEcoSystem can provide.

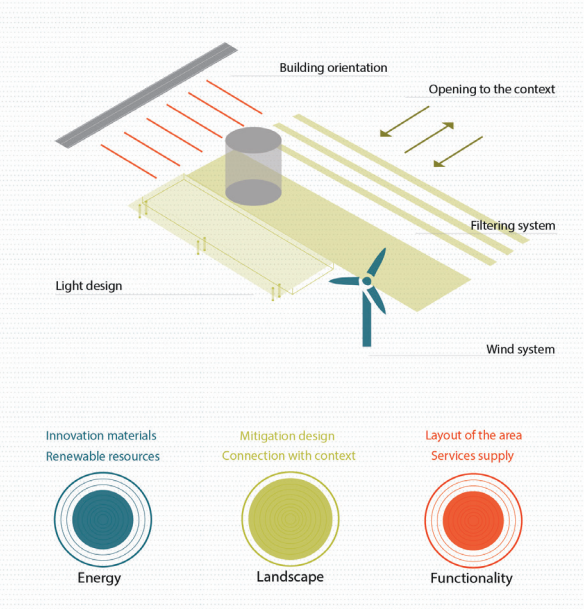
The first action that can be implemented is the preventive one. Working on reducing the impact upstream means supporting a sustainable behavior already taking place on motorways[99]. Using alternative vehicles of low CO2 emissions, offering different refueling services, reducing energy consumption and controlling the release of pollutant components in water, are necessary actions in a period of energy transition that we are facing. Science and technology are not enough to achieve a circular approach to the economy[100], but cultural and moral challenges must also be activated to ensure that the transition end[101]. How can the service areas project intervene in this complex system vision? Simply through an adequate planning of the offered possibilities, which becomes dynamic in a process in transition. To ensure a widespread use of alternative energy cars, infrastructure needs to be implemented. If there is not a service that allows us to refuel the car, there is no reason why we should invest in this type of consumption, if not for moral and cultural reasons[102].

Starting from this premise, preventing impacts through a careful plan that looks both the environment and the technological dynamics in place, would partially reduce the problem. However, being in a transition phase, the service area must be thought as an organism in relation to other anthropic and natural systems through tools that allow, with the project, to mitigate and to compensate impacts caused by the motorway on the surrounding. In

addition to examples of service areas, seen in the previous section[103], which discuss the reduction of energy consumption in the main service building, in this paragraph there are other exemplary cases to refer to. The adaptive approach, seen in chapter 3, in addition to producing a cultural service for the context crossed, pays attention to the ecological impact that represents the area in terms of habitat fragmentation. Through a morphological continuity with the context in which it is inserted, the roof of the building allows the service area to reduce the impact on the fauna, decreasing and eventually eliminating the barrier effect in individual ecotones[104].
The performative strategy, seen in chapter 3, is based on the implementation of parasitic systems in the service area, without compromising functionality and use. The integration of technological canopy that uses an integral approach to technology, such as the Smart barrier (Cap.3), helps the area and the other ecotonal spaces of the motorway, to be mediums in a process of balance between systems. Energy collection, reduction of Pm10, conversion of NOx components of the atmosphere and filtering of the water along the asphalt, are objectives achievable through the use of appropriate technologies (such as phytodepuration in the case of water filtration) . However, the future challenge is to think of the technological tool as an autonomous system, independent of networks, which works as an activator of mitigation processes, but which uses closed cycles to satisfy its function. An example of this is the Smog Free Tower of the Roosegaarde studio. This "uses patented ion technology to produce smog free air in public space, allowing people to breathe and experience clean air for free."[105]
The Smog Free Tower uses ionization processes to catch the Pm10, cleaning 30000 m3 of air per hour using 1170 watts of power. The innovative approach of the project both is to "clean" the air and especially is to capture components and using them as souvenirs. These are inserted into design objects, such as rings, which represent 1000 cubic meters of clean air[106]. In this way the project shows an important message, because it closes a cycle, following the idea of circular economy. Using a technological tool, a problem is solved, giving it new shape as well as a new life cycle. The autonomy from the networks of the intervention, allows us to imagine a similar use of the service area. The area potentially could be a tool kit of instruments that over time are readjusted and replaced according to the needs and changes due to innovation. Experimentation in this is fundamental, overcoming a conservationist approach. Even technology should be contemplated among the possible solutions. Through adaptive strategies and tools, from landscape design interventions to specific technological applications, the service area and the ecotonal spaces become pro-active in the environmental dynamics, favoring and using regulation principles, in which design also becomes the protagonist.

Bay of Somme

"Proposing a stop in the countryside, forgetting the car world, perceiving the identity of the crossed territory and developing an area of high environmental quality are part of the challenges of the project" B. Mader



Between the exit 23 and 24, along the A16 motorway, towards the Bay of the Somme you can stop for a rest near the large windmill at Sailly-Flibecourt. The Baia delle Somme service area hosts it, a meeting point for travelers heading towards the north-west coast of France. This place, strongly desired by the Somme department, was realized in all its details by the French architect Bruno Mader.

The attention placed in unify the building and the area to the landscape of the bay, have made the stopover a unique and exemplary place for its relationship with the motorway landscape. Here it is offered a stop in the countryside bordering the bay, moving away from the world of cars, pushing towards a first approach and contact with the identity of the territory.

For its environmental quality, the service station is perceived from far away, thanks to its 40-meter-high wind turbine, which supplies part of the electricity required for the site.

In the weave of agricultural land, the site is oriented towards the Bay of the Somme, giving its back to the motorway. The restaurant, the shop, the toilets, the reception and the exhibition areas are grouped in a large linear building perpendicular to the motorway axis, thus changing the priority point of view usually adopted by the services.

The 50-hectare site is home to natural beauties that introduce the traveler to the bay. A pond hosts ducks and fishes, while canals, paths, starting points for hikes and bike rides open the area to the context offering facilities and spaces for different recreational activities. The building, in wood and glass, blends perfectly with the area.

The Baia delle Somme is an area of rest and service, but it is also a showcase for the local offer, home to a tourist information center. The administration of the Somme department

uses its strategic position to promote the beauty of the coast in this outpost. Here you can eat, stop, as well as walk and have a taste of the beauty of the local area. This space recalls the idea of the service stations desired and designed by Bernard Lassus in the south of France, which produce a cultural service both for the traveler and for local communities, accessible by car, by bicycle or by foot.
The service area of the Baia delle Somme, opened in 1998[107], includes a commercial hall and a structure that serves as a lookout on the landscapes of the Mercanter basin. Inside the building houses a permanent exhibition. But the public is fascinated by the nature, water, the landscape, the view from the Belvedere and the spirit of the Baie de Somme.
The architecture of the building reinterprets the components of vernacular architecture through careful use of materials such as pebbles and wood, while the large windows that revolve around the internal distribution system maintain a continuous and direct visual relationship between the interior spaces and the external natural environment.
The only element that seems a separate entity is the cylindrical volume that houses a projection area and at the top the belvedere space. The structure has a double skin, inside which the vertical ascent system is inserted.
To conclude, the attention to the peculiarities of the bay landscape, the openness and accessibility to the outside context, as well as the production of sustainable energy, make the Baia delle Somme service area an excellent example of cultural and regulating tecnoecosystemic service. In this specific case the value of the project itself is important. The existing landscape elements are not only preserved and maintained in their state, but are combined with the architecture. In performing their function as a service area, the buildings are able to obtain their own space in the landscape without eliminating themselves in conservative strategies. The case of the Baia delle Somme teaches us how the architectural design is able to produce cultural and regulating bonds with the surrounding anthropic and natural systems. This happens only if the design manages to achieve a balance dictated by the peculiarities of the surrounding place. In this case, the creation of an ecotonal technoecosystem under the human action is not an impact, but a tool to support a balance and an equilibrium between diametrically opposite systems, such as the motorway and the natural landscape (open landscape).

Recap

This chapter allows us to have valid alternatives and possibilities that can be adopted in a specific ecotonal project of the technoecosystemic motorway. The service areas are the physical space that best embodies this concept. The principles recalled and the exemplary case studies described for their specific excellences, slow down the user run and connect him with the landscape. In this way the service area obtains its own identity, deleting the idea of non-place. The service area as an ecotonal space enriches a resilient and Techno-EcoSystemical strategy of the project and becomes a place in which stopping, overcoming the perception of standardized and common spaces. In all the examples seen, the fundamental elements that have made the service areas unique, are basically two: a forward-looking client and an integrated approach to the project.
The first aspect emerges above all in the examples of Gloucester Service area and in the Autogrill Villoresi Est, where the choices were dictated by different interpretation of the resting experience. While the first client has acted seeking a direct link with the places and communities close to the infrastructure, starting from a family as promoter; in the second case, the client company focused more on the sustainability of the object, seeking an image of quality and appeal for the company itself. In the case of the Baia delle Somme instead, the client, represented by the administration, basically used the local potential. Simply, the administration built a service area to support the natural attraction already represented by the bay of Somme. The creation of regulating and cultural technoecosystemic services was a consequence of the will to respect and to enhance local peculiarities. In this last case the credit of the action is the quality of the project, instead of to the preliminary objectives that activated the design process.
The integrated approach to planning is the second fundamental relevant element in all the presented cases. The mix of the disciplines both enriched the analysis on the project and gave quality to the outcome, according to a complex vision of the system in which all our project interventions is inserted. Quoting Felix Guattari "More than ever today, nature has become inseparable from culture; and interactions between ecosystems, the mechanosphere, and the social and individual universes of reference, we have to learn to think 'transversally'"[108]. In this way, through a transdisciplinary approach[109] we overcome an idea of fragmentation of the disciplines, which in the complexity of a systemic technoecological project, appears to be necessary, because "Real problems do not observe academic boundaries"[110].
In order to respond to the technological and ecological needs necessary to balance the systemic exchange processes, the research of design becomes the base for the definition of strategic and tactic actions of the TechnoEcoSystem. The research is influenced by the place, in order to characterize the interventions along the motorways, making them unique in their peculiarities. According to this, for transition spaces such as service areas, the overcoming of non-place condition is given by the strong value that is expressed both by a 'motorway location' and by the design process. All this is possible to reach,

if the promoter and the lender of the action aim, through a techno-ecologic project, for a unique and special result.

4.3 Plose East Service Station as an Ecotone

Starting from the premises seen in the previous chapters and trying to re-elaborate the concept of ecotone applied to the service area, in this second phase, the Hill project concerning the Plose East service area was examined. The focus is on the will to guarantee and to produce services for travelers and for contexts, starting from specific attentions on the site.

Images 1|Survey on the service station Plose East. All the images rappresent the relationship with the landscap e of the valley.
Basically, there is a wall between the infrastructure and the beauty of the valley.

With the elaboration of cognitive frameworks, through data obtained from Web GIS sources by Autonomous Province of Bolzano, it was possible to reconstruct a set of needs and potentials of the place, then translated into project strategies.
These frameworks are: recognition of landscape units through photographic survey, distinction of surrounding forest types, identification of the level of noise pollution along the motorway, identification of morphological and cultural relations with the landscape close to the area and specific internal and external functions of the service building to support travelers.

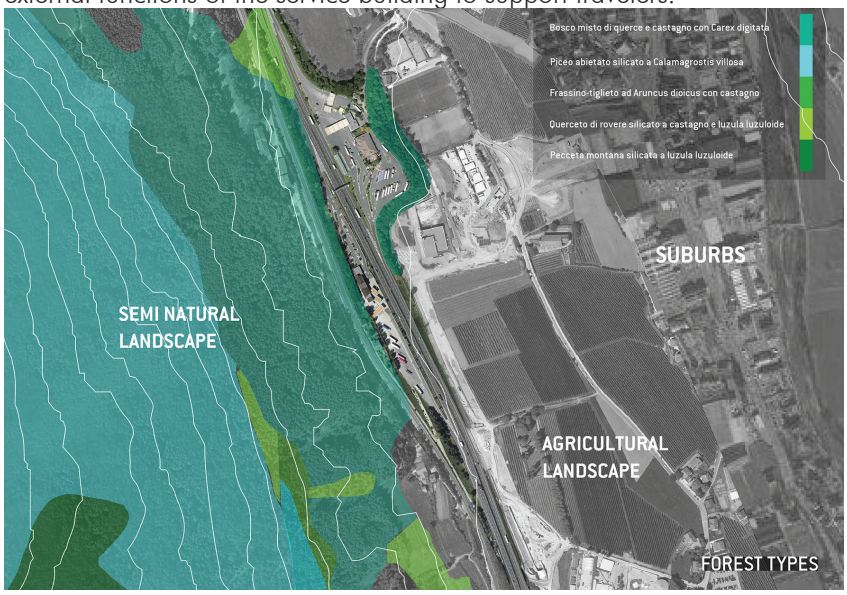


Image 2| Forest type. From the peculiarities of vegetation emerges the split in two part of the mixed forest of oaks and chestnuts around the service space. Data: WebGis Bolzano Province.

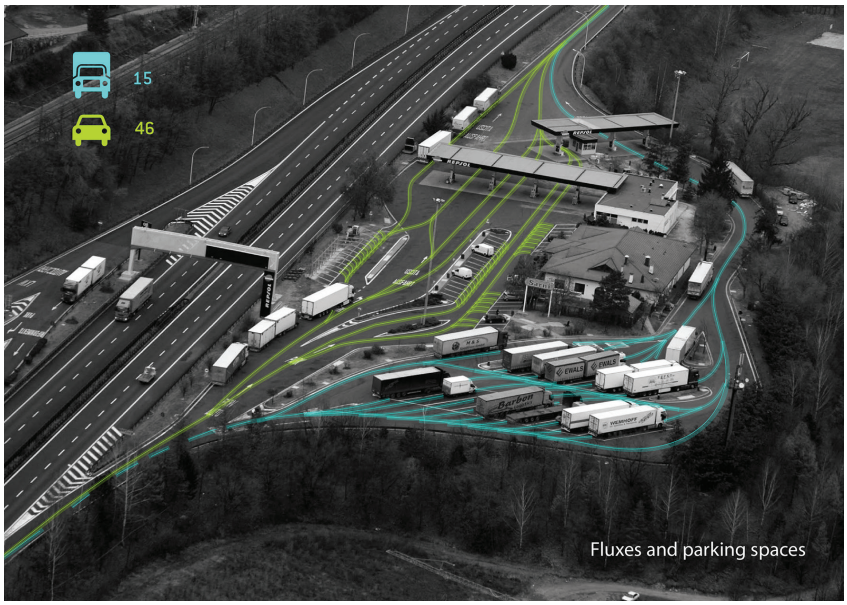


Image 3| The functionality and distribution of the spaces into the area, with parking areas and double typology of fluxes, both for car and truck.

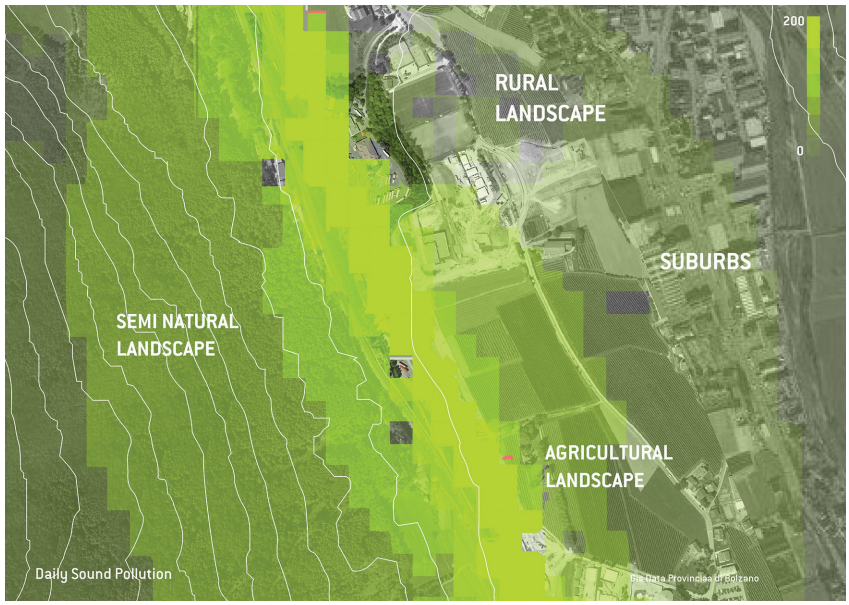


Image 4| Daily Sound Pollution near along the motorway. Here it is clear the effect of the noice on the differente type of landscape: Semi natural Landscape, Agricultural landscape, Suburbs and Rural landscape. Data: WebGis Bolzano Province.

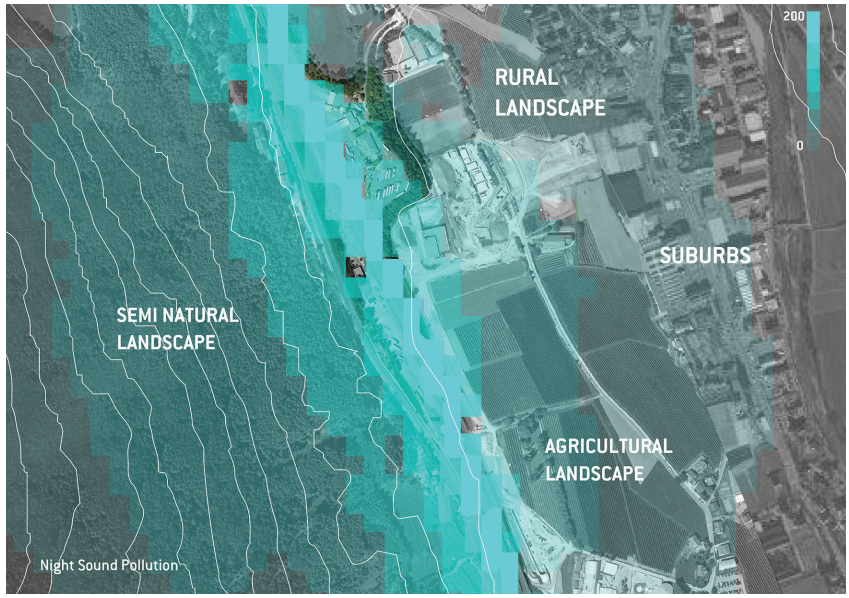


Image 5| Night Sound Pollution near along the motorway and on Plose East. Here it is clear the effect of the noice on the differente type of landscape: Semi natural Landscape, Agricultural landscape, Suburbs and Rural landscape. Data: WebGis Bolzano Province.

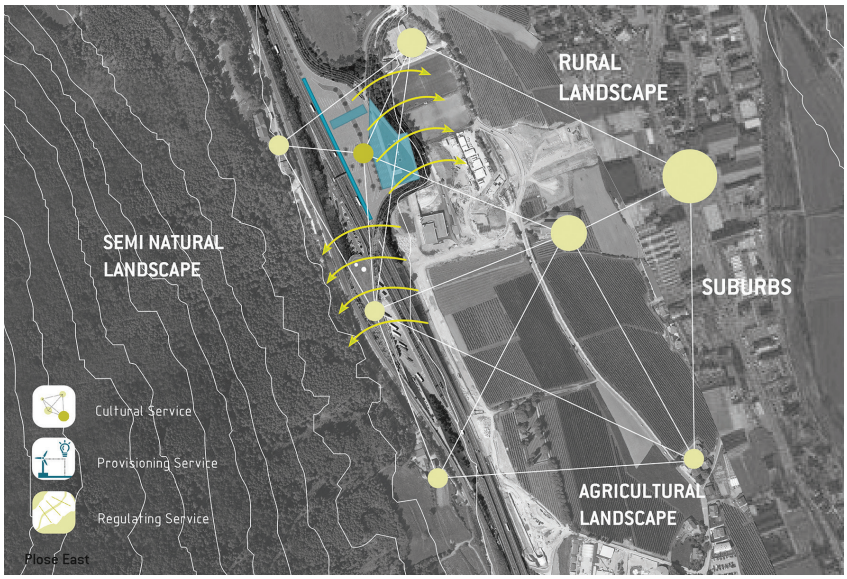


Image 6| Strategies that aim to reduce noise pollution, to connect the two side of the motorway with an ecological crossing passage for animal and people and to improve the landscape cultural value of the Plose valley. All these goals could be reached also through the management of the functionality of the service area.

Generally, from the reconstructed cognitive frameworks and from the inspections emerges the need to strengthen an opening towards the landscape of the Isarco Valley, both from a physical point of view (connecting) and from a cultural point of view (promoting the territory).
The service area is located near the Municipality of Varna, recognized in South Tyrol as the 'gateway to the south' for its mild climate and the productions that characterize its territory (vineyards, chestnut trees and apple orchards). This, together with other local peculiarities, allow the area to become a point of attraction for tourists, both from the north and from the south, promoting cultural services for the territory.
The motorway junction, between units of landscape that surrounding the two road sides, creates discontinuity between different forest types that articulate the valley. In addition to a visual closure towards the surrounding landscape, this discontinuity of ecological unit opens up design opportunities for the service areas in this Autobrennero section.

Indeed the opposite service area, Plose West, is a very small area in terms of surface, not allowing to offer complete services for the traveler and availability of parking spaces.
In one of the first hypothesis suggested by the survey on the two areas, the possibility emerged to strategically define a single complete service area in its offer. This vision, then applied in the final phase to the preliminary design, would allow the West Plose area to be completely used as a parking space. According to that, there was the possibility to insert a pedestrian crossing passage between the two parts to access the service, in order to allow the motorway ecotonal system to establish ecological continuity.
Another aspect that emerged from the analysis of the area occupied by Plose Est is an average height difference of about 13 m between the motorway and the surrounding fields. This difference allows us to re-elaborate the Hill

hypothesis of morphological continuity between building and landscape, burying the main functions of service to users.
The consequences of this operation are two:
- the increase of parking lots for trucks and cars,
- the increase of recreational spaces for the motorway users.

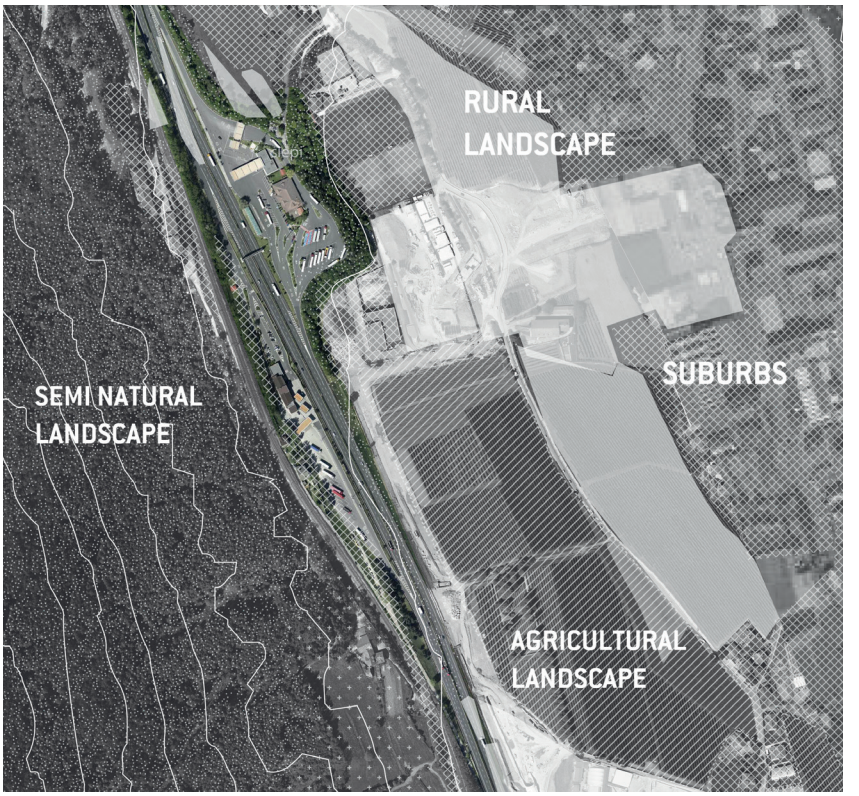
Starting from the cognitive frameworks, the aspects emerged were identified and translated into design strategies in terms of technoecosystemic services offered by the econton service station.

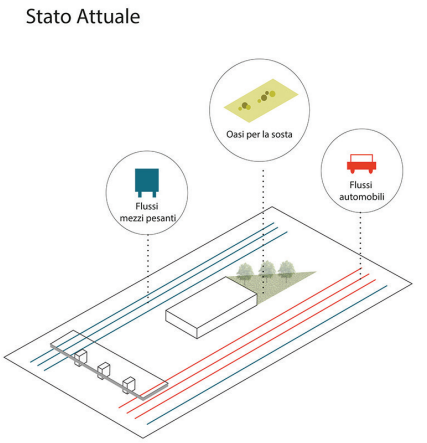
Cultural Services. The intervention with a 'door on the landscape', through the definition of a large and open building towards the Valle d'Isarco, enriches the cultural, spiritual and intellectual identity, implementing the aesthetic and recreational values that the surrounding landscape offers. This also adds the possibility of involving the neighbor communities in the management of the area, such as producers and local administrations.

Provisioning services. The intervention makes it possible to provide real resources to the contexts as renewable energy and environmental data, produced by the canopies of parking areas that become PV surfaces. The energy collection system favors the insertion of columns for the supply of ecologic fuels, also taking advantage of the proximity of the Varna district heating production pole[111]. This allows service area to work transversally with the territories, promoting joint management, through Micro Smart Grid systems, which work on the energy balance between territories and the motorway.

Regulation services. The intervention works in terms of mitigation and compensation. This through the construction of a dual-use (man and fauna) ecoduct, the regulation of air and water quality and the insertion of systems similar to the Smart Barrier close to the roadways. In addiction the area works on reducing the impact through a Zero Emission policy of the service building. In functional terms, the service area increases the recreational spaces for travelers, aiming at a Design for All approach without limiting, but increasing, the available parking spaces, reversing the usual logic of internal flows in the area.

Plose East





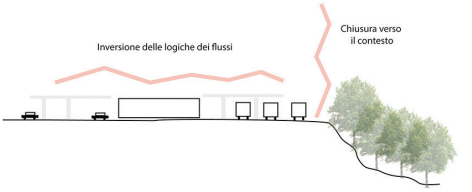


Image 7| Project of the service area through the idea of an Ecotonal space.

Stato di progetto

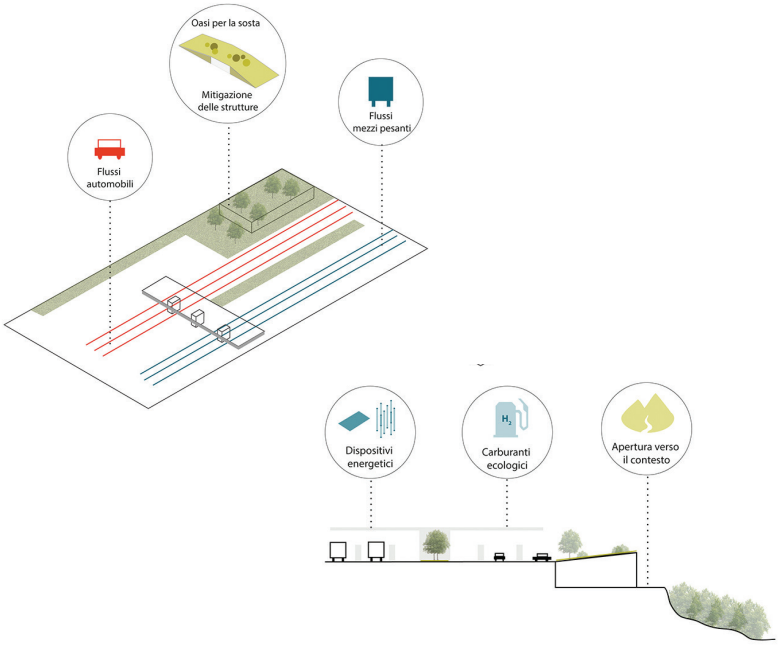


Image 8| The idea of the service area is an interface, interconnected with the other systems of the geosphere. In order to change also the usual distribution of the fluxes, to increase the parking spaces and to invert the fluxes.
The result is this, a conceptual vision of a park space along the motorway.

TechnoEcoSystem Services


Cultural Service


Provisioning Service

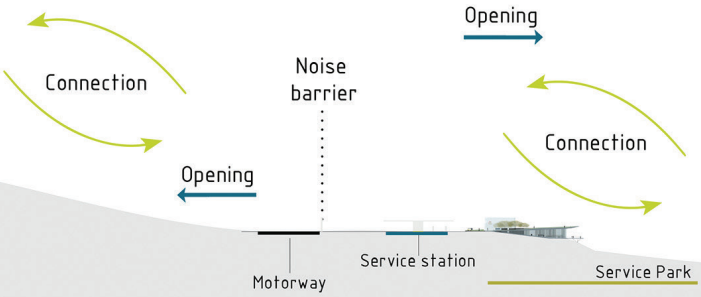

Regulating Service

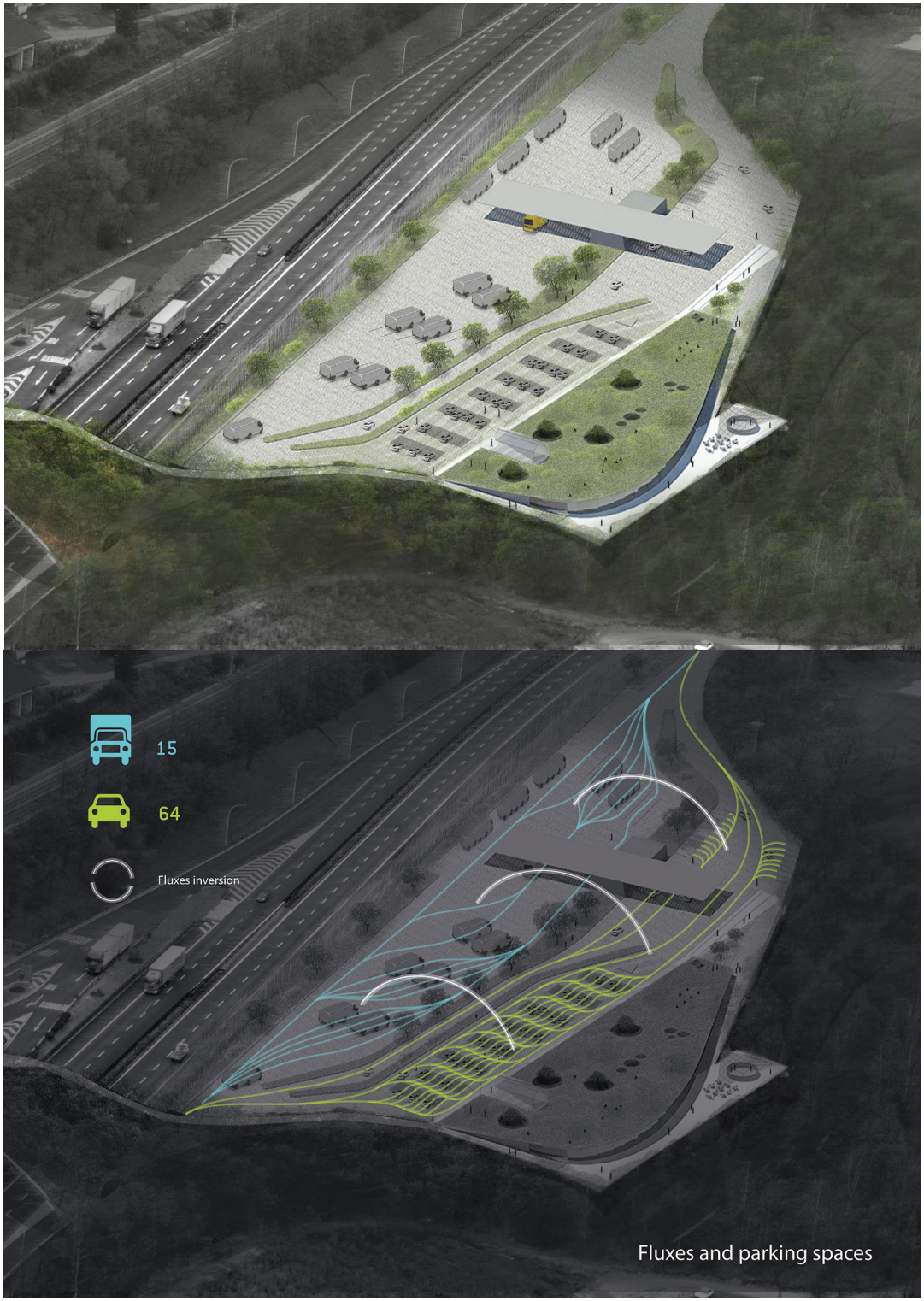
Ecological connection
Smart Barrier

Smart technologies
Sustainable building
Energy storage

Promotion of the context
Opening to the context

SEMI NATURAL LANDSCAPE




15
64
Fluxes inversion
Fluxes and parking spaces

Hill

Image 9| The building disappears and the valley landscape is the protagonist of the scene.

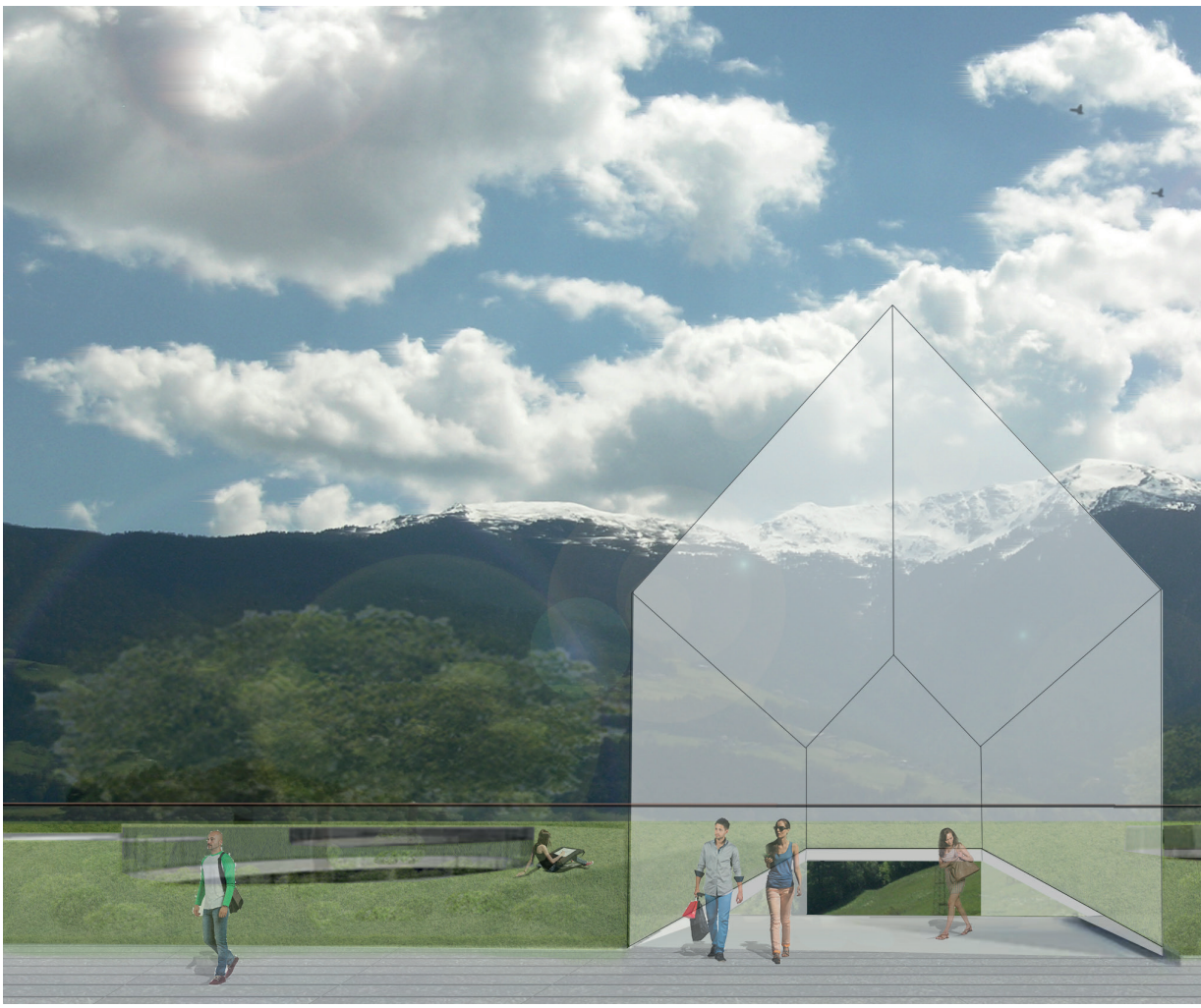


Image 10| Abstract concept of the building that is the principal entrance.

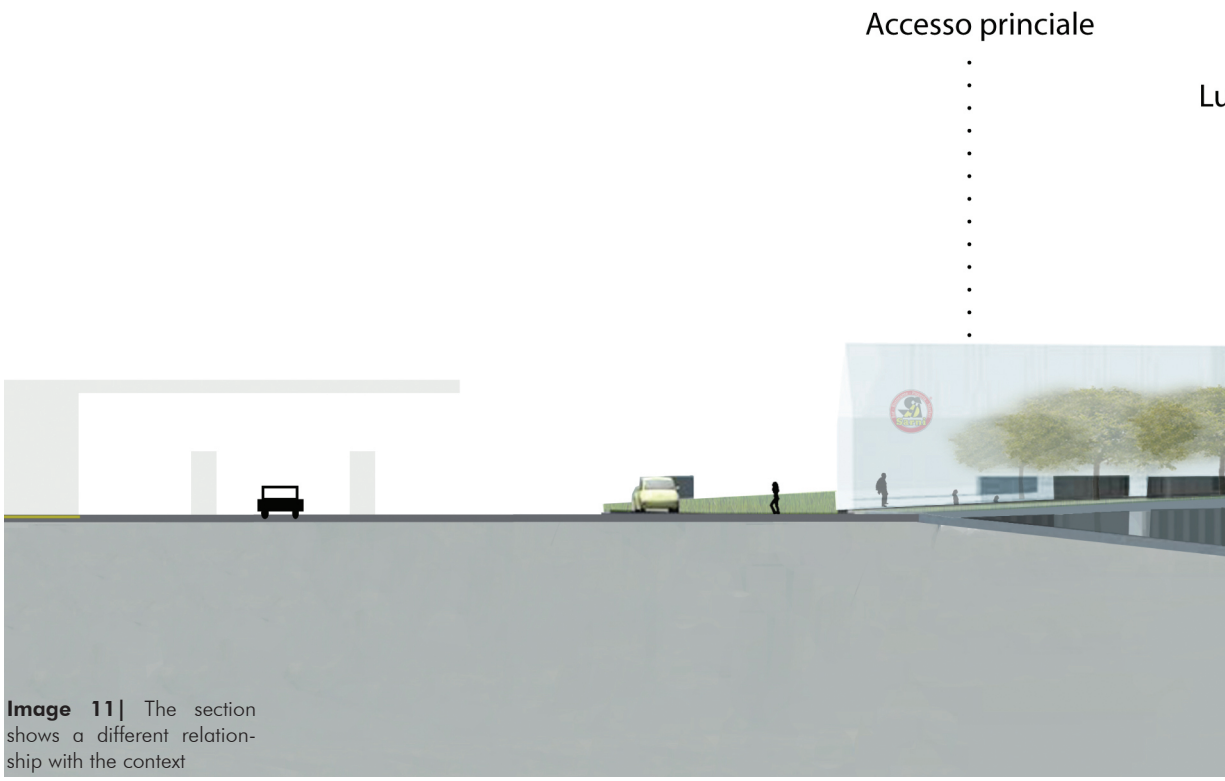
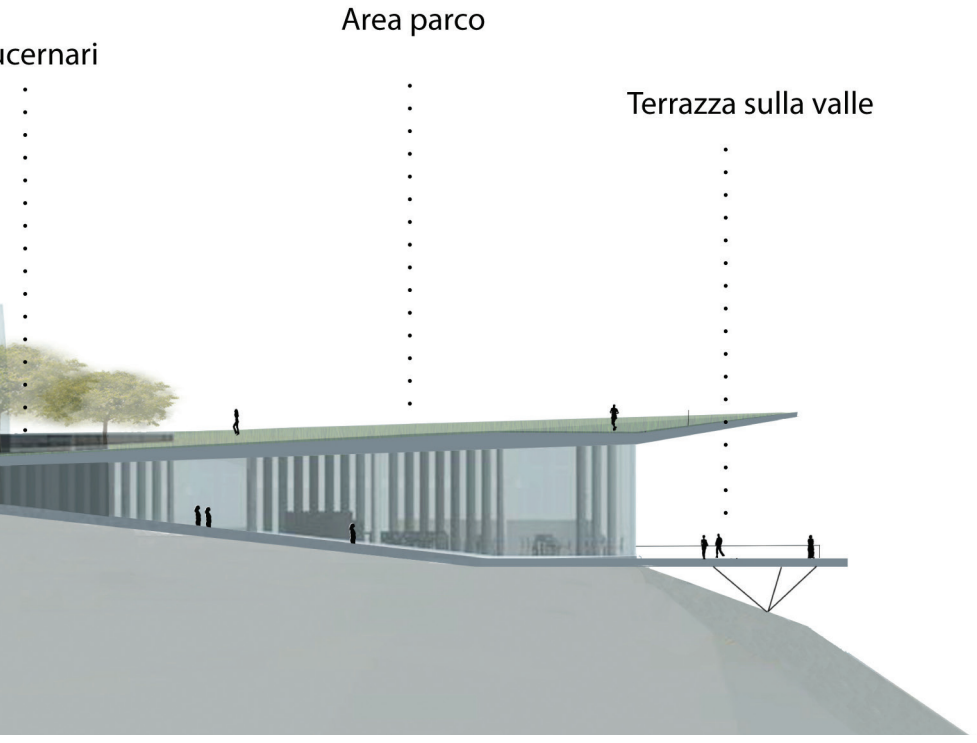


Image 11| The section shows a different relationship with the context


ucernari
Area parco
Terrazza sulla valle

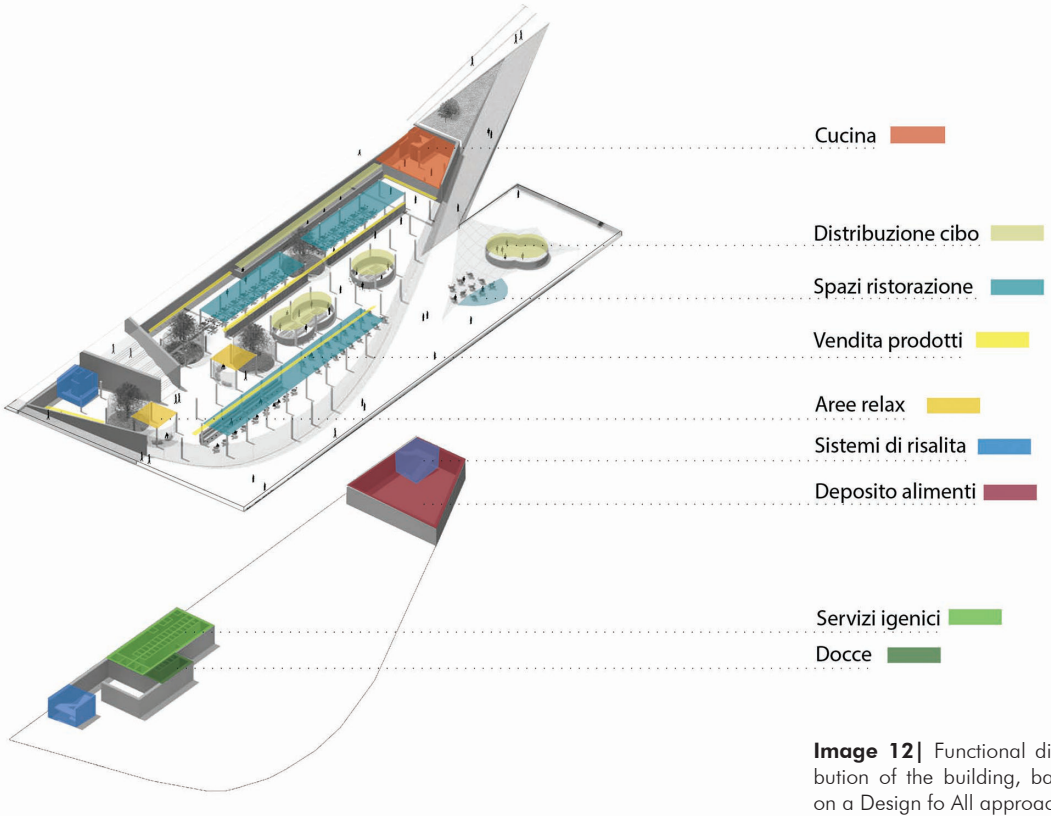


Image 12| Functional distribution of the building, based on a Design fo All approach.

Note

1. M. Augè, Nonluoghi. Introduzione a una antropologia della surmodernità, Elèuthera, 2009
2. Caccia, S. (2012). Tutela e restauro delle stazioni di servizio =: Preservation and restoration of service stations. Milano: FrancoAngeli.
3. Jakle, J. A., & Sculle, K. A. (2002). The gas station in America. Baltimore, MD: Johns Hopkins University Press.
4. The City Beautiful Movement was born following the Columbian exhibition in Chicago in the United States at the end of the 19th century. Its motto leads to define the architectural forms through parameters of neoclassical beauty that monumentalize the city. The modernity represented by the car, also becomes a central tool to enhance the city along the streets through its architecture. (Finkel, 2013)
5. The movement born in 1925 greatly influenced the architectural development of fueling service buildings, especially in the United States. Looking at the large collection of Californian stations such as Ragsdale and Hansen's Station No. 1., it is possible to see the first examples of application of V shapes opposed to sinuous forms of the neoclassical period. This trend increasingly gained ground in the 1930s, an example of this was the Conoco gasoline station in Shamrock, Texas.
6. An example of this is the shell shape of the Shell's building in Winston-Salem, North Carolina.
7. Tabacco, Batteries and Accessorises Station (Jakle, Sculle, 2002)
8. Jakle, J. A., & Sculle, K. A. (2002). The gas station in America. Baltimore, MD: Johns Hopkins University Press.
9. Central building in Asmara in Eritrea, designed by Arch. Giuseppe Pettazzi in 1938. Its forms revokes the myth of technology and speed, typical of futurism. The building seems in its forms that it is taking off, as a plane.
10. Livini, G. (1998). Radici italiane per i servizi all'utenza in autostrada. rivista Kineo, 16.
11. The Cantoniere houses, owned by Anas, are buildings built for the maintenance of national state roads. In these buildings, characterized by the Pompeian red color of the walls, the maintenance workers lived there to control the canton, a saction of road generally of 4-5 kilometers. (Armani, 2015).
12. "Concorso per le stanzioncine di servizio sull'Autostrada Venezia-Padova", in 'Architettura' XII, 1933.
13. Greco, L. (2010). Architetture autostradali in Italia: Progetto e costruzione negli edifici per l'assistenza ai viaggiatori. Roma: Gangemi.
14. Pier Luigi Nervi with his research on structural prefabrication, highlighted the potential of megastructures that were tested on new models of service stations. (Greco, 2010)
15. For the first time, the service area entered into the design manuals such as of Neufert in the Practical Encyclopedia to design and construct (1936), of R. Campanini in Transport Buildings (1945) and of B. Bolis in Buildings for transport: stations for railways and subways, electrical substations, maritime stations ... (1947). (Caccia, 2012)
16. Greco, L. (2010). Architetture autostradali in Italia: Progetto e costruzione negli edifici per l'assistenza ai viaggiatori. Roma: Gangemi.
17. Andrea Marchetti in an article published in the magazine "L'ingegnere" of 1949, underlines the importance of the standard as the main base from which to define the minimum service spaces, guaranteeing accessibility and recognition of the oil company's brand (Caccia, 2012)
18. One of the three surviving station examples of this type is currently at the Weil am Rhein Museum in Vitra. Vitra | Petrol Station. (2017). (Retrieved from https://www.vitra.com)
19. The Agip with Mario Bocciocchi reaches the maximum of experimentation in the standardization process, since he with his "Standard projects for road systems" defines thirteen variants of service station, adaptable to the needs of the context in which they are (Caccia, 2012).
20. Sviluppo Iniziative Stradali Italiane (SISI) with Eni , Fiat, Pirelli ed Italcementi companies.
21. The Autostrada del Sole due to its peculiarities was based on the types of roads developed in the United States, where research on infrastructures had evolved despite the World Wars. This defined the roads on dual roadways direction with a central traffic divider (Livini, 1998).
22. The world's first bridge restaurant is a McDonald in Vinita, Oklahoma, built in 1957 (Cavalli, 1996).
23. Livini, G. (1998). Radici italiane per i servizi all'utenza in autostrada. rivista Kineo, 16.
24. Greco, L. (2010). Architetture autostradali in Italia: Progetto e costruzione negli edifici per l'assistenza ai viaggiatori. Roma: Gangemi.
25. From the competition promoted by Agip emerges the will to make the prefabricated element standard, flexible with respect to the needs of time. (Archivio progetti IUAV, Fondo Costantino Dardi)(in Greco, 2010)
26. Andrea Marchetti in "L'ingegnere" del 1949 (Caccia, 2012).
27. Vahlefeld, R., & Jacques, F. (1960). Garages and service stations. University of Michigan: L. Hill Books.
28. Type of break showed for example in the film "Ossessione" by Luchino Visconti of 1943.
29. The families organized days in the Pavesi and Motta service areas, supporting the myth of the mobility of these years, during the economic boom in Italy. (Colafranceschi, 2007)
30. In the photographic project by Ed Ruscha "Twentisix Gasoline Station" 1963, the loneliness of the service

structures of mobility emerges, in the boundless landscapes of the United States. As he says in one of his 1981 interviews, they are places "where everything behind is just nothing". Bourdon, D. (2004). Ruscha as publisher. In E. Ruscha & A. Schwartz (Eds.), Leave any information at the signal: Writings, interviews, bits, pages (p. 43). Cambridge, MA: MIT Press.
31. The Pop works of D'Arcangelo highlight the elements of the motorway landscape, underlining signs and road signs, in opposition with the lines in the shadow of a context that is not there, during the journey.
32. Augé, M. (2009). Nonluoghi: Introduzione a una antropologia della surmodernità (p. 77). Milano: Elèuthera.
33. Certeau, M, & Giard, L. (2010). L'invenzione del quotidiano. Roma: Lavoro.
34. Augé, M. (2019). Nonluoghi: Introduzione a una antropologia della surmodernità. Milano: Elèuthera.
35. "Ecotone: transition zone between two distinct ecosystems. In the ecotone there is a gradual passage between the characteristic species of an ecosystem and the species characteristic of the other. The importance of the ecotone is due to the greater biodiversity and wealth than the homogeneous areas that it divides. " Ecotono — Arpa Piemonte. Agenzia regionale per la protezione ambientale.
36. Farina, A. (2014). Principles and methods in landscape ecology: Towards a science of the landscape. Place of publication not identified: Springer.
37. From the Greek: Eco (home, environment) and tonos (tension).
38. Battisti, C. (2004). Frammentazione ambientale, connettività, reti ecologiche: Un contributo teorico e metodologico con particolare riferimento alla fauna selvatica. Roma: Stilgrafica.
39. Farina, A. (2014). Principles and methods in landscape ecology: Towards a science of the landscape. Springer.
40. Naveh, Z., & Lieberman, A. S. (1994). Landscape ecology: Theory and application. New York: Springer.
41. Ibidem.
42. Augé, M. (2009). Nonluoghi: Introduzione a una antropologia della surmodernità. Milano: Elèuthera.
43. The Millennium Ecosystem Assessment assessed the consequences of ecosystem change for human well-being, defining for the first time the possibility to produce services from them. Millennium Ecosystem Assessment (Program). (2005).
44. "Port Paysage" concept introduced by Bernard Lassus. In this case along the great infrastructural arteries, the rest areas are able to introduce the traveler to the landscape, without replacing it. Lassus, B. (1998). The Rest Area of Nîmes-Caissaurgues. In P. Jacobs, R. B. Riley, & S. Bann (Eds.), The landscape approach (164-167th ed.). Philadelphia (Pa): PENN-University of Pennsylvania Press.
45. The uses of the motorway are varied: there are those who travel for work (trucker, commuters ...), those for vacation. This also depends on the connection routes of the same infrastructure, which influences the prevalence of use. Considering the Autobrennero, about 30% (obtained from Aiscat 2016 data) of the vehicles on the motorway were trucks in 2016. This means that the service for truckers can not be overlooked along the Autobrennero. Instead, the value will be lower on motorways that are not priority routes of business exchange. In this case, the type of service specific for the trucks can be located and not necessarily spread throughout all the route.
46. The inventive analysis is considered by Bernard Lassus, important to reach a cognitive vision of the places between work and landscape, trying to reach from these: historical relationships, stories and cultural experiences. (Lassus, 1998)
47. The International Ecotourism Society | Uniting Conservation, Communities, and Sustainable Travel. (2017). Retrieved from http://www.ecotourism.org/
48. In "Autoroute et Paysage" Lassus aims to preserve the transversal dimension of the crossed places, through a physical and also cultural connection, which implements the functionality of the places. The motorway through service areas is conceived as a tool of knowledge.
49. Lassus, B. (1998). The Rest Area of Nîmes-Caissaurgues. In P. Jacobs, R. B. Riley, & S. Bann (Eds.), The landscape approach (164-167th ed.). Philadelphia (Pa): PENN-University of Pennsylvania Press.
50. The route traces the connection of the via Domiziana between Spain and Italy, along the Autoroute Arles.
51. The service area is near Crazannes, a town located in the central-western part of France near the Atlantic Ocean.
52. Morelli, E. (2005). Disegnare linee nel paesaggio: Metodologie di progettazione paesistica delle grandi infrastrutture viarie. Firenze: Firenze University Press.
53. Lassus, B. (1998). The Rest Area of Nîmes-Caissaurgues. In P. Jacobs, R. B. Riley, & S. Bann (Eds.), The landscape approach (164-167th ed.). Philadelphia (Pa): PENN-University of Pennsylvania Press.
54. AA.VV. (1998). Aree di servizio. Aree di sosta autostradali, 16(rivista Kineo), 24.
55. If you visit the official VINCI Autoroutes website, there are numerous management and entertainment services. VINCI Autoroutes : prévisions de trafic, état de la circulation, télépéage... (2017). Retrieved from https://www.vinci-autoroutes.com/fr
56. AA.VV. (1998). Aree di sosta autostradali, 16(rivista Kineo), 43.
57. "All Nippon Michi-no-Eki Network is organized into region blocks to facilitate information exchange and

mutual co-operation. The network aims to maintain and improve the quality of Michi-no-Eki and contribute to improving the services provided to the users and local communities. All Nippon Michi-no-Eki Network is separated into nine region blocks. Region blocks share information, provide liaison and coordination services to Michi-no-Eki locations, and operate training sessions, seminars and other events to make every Michi-no-Eki under their jurisdiction even better." About Us - All Nippon Michi-no-Eki Network. (2017). (Retrieved from https://www.michi-no-eki.jp)

58. An example of this is the Beaune Aire. The largest service area on a French national scale located on the A6, the central point of the Saprr network conceived as a small village. The number of services offered makes the space a real non-place without personality in the type of service offered. From the Motel to the Truck Store for truck drivers, up to the Archedrome, the largest museum space on service areas. The latter does not contain local finds, does not reflect on the place in which it is inserted, but reconstructs "the history of man in general and history and the culture of Burgundy in particular, from Prehistory to the year one thousand, and is divided into a a series of didactic spaces created inside the building, integrated by installations and historical reconstructions in a vast outdoor area. " (AA.VV. (1998). The areas of Baune in Motorway rest areas. rivista Kineo , 16, 43.) The content is not selective, forced, recalling contents of other places, as a real Disneyland.

59. With the cooperation of regional authorities, through a survey of places and itineraries promoted by the Italian Touring Club and Slow Food.

60. Autostrade - Tuscia. (2017). Retrieved from https://www.autostrade.it/sei-in-un-paese-meraviglioso/progetto.html

61. The landscapes of Cumbria, of the Lake District National Park, have inspired many romantic English painters, including Turner with his many Lake District views.

62. Dunning, S. (2014, June 7). Glad to be of service. Interview by R. Birkett. The guardian.

63. Tebay Services | UK M6 Motorway Services | Westmorland Ltd. (2017). Retrieved from http://www.tebay-services.com/

64. A few kilometers further north along the M6, it offers a much more entertainment for the travelers.

65. No waste anything.

66. Gloucester Services | M5 Services | Farmshop | Gloucester Jobs. (2017). (Retrieved from http://www.gloucesterservices.com/our-story)

67. Among the numerous awards won, Gloucester service was recognized in 2016 from the Royal Institute of British Architects (RIBA). Westmorland Limited won the 2016 RIBA Client of the Year award. The annual award, supported by The Bloxham Charitable Trust, recognises the key role that a good client plays in the creation of fine architecture. "We were looking to build a new motorway service area on a greenfield site and wanted to create something sleek and contemporary, but at the same time, crafted, with a strong presence of natural materials." Sarah Dunning, CEO, Westmorland in GHA Project | Gloucester Services. (2017). (Retrieved from https://glennhowells.co.uk/project/gloucester-services)

68. Cotswolds are a hilly chain located in the central area of England, most present in Gloucestershire, declared Area of Outstanding Natural Beauty, or of naturalistic interest in the United Kingdom.

69. The park is a hill and country park to the south of the city centre of Gloucester and is a Local Nature Reserve.

70. Definition of cultural services in the second chapter. MEA 2006

71. To underline the widely recognized quality of the intervention, it is worth noting the transversal awards that the service area has obtained in different areas. These include: RICS Awards, South West 2017 (Project of the Year Award, Community Benefit Award, Infrastructure Award), RIBA Awards 2016 (National Award, Client of the Year (for Westmorland), South West Regional Award, South West Sustainability Award), Civic Trust Awards 2016 (Commendation), Civic Voice National Design Award 2015 (Overall Award, New Build Award)

72. Dunning, S. (2014, June 7). Glad to be of service. Interview by R. Birkett. The guardian.

73. Millennium Ecosystem Assessment (Program). (2005). Ecosystems and human well-being: Our human planet : summary for decision-makers. Washington D.C.: Island Press.

74. The offshore system makes possible to make a model of production and consumption autonomous, favoring immediate processes of energy transition of the same. (Nava, 2017)

75. U.S Government. (2007). ENERGY INDEPENDENCE AND SECURITY ACT OF 2007-TITLE XIII—SMART GRID. Sec. 1301 (Public Law 110–140 110th Congress).

76. Micro Smart Grid, responds to a self-sufficient and a smart model, but at the same time is adaptive and flexible. This model refers to the concepts of interoperability and accountability. The first occurs between different systems that are managed in an integrated way and are ready to respond to any asset in a convenient and efficient way; while the latter occurs through the use of catalysts that regulate the operation of specific technologies (devices), flexible in implementing regeneration processes within the grid system. (Concept described by the architect Consuelo Nava during the contribution in "L.I.D.O. LEARNIG ISLAND DESIGN OPPORTUNITIES" at R.E.D.S.4 Biennale Session, Univercity, Reporting from italian fronts, November 26th, 2016, Venice).

77. Peer to peer relationship is an equivalent relations, in which the exchange nodes act both as a customer and

as a servant. The definition refers to the computer language of networks. Peer-to-peer nell'Enciclopedia Treccani. (n.d.). In Treccani, il portale del sapere. (Retrieved from http://www.treccani.it/enciclopedia/)
78. In 2009 Autostrada del Brennero with the cooperation of the Municipality of Isera designed the first high efficiency photovoltaic noise barrier in Italy. The 1067 m long and 5.6 m high barrier uses a 60% and 35 degree slope storing surface to increase production efficiency. The annual productivity of about 689,000 KWh is able to satisfy (according to the total electricity consumption average in Trentino Alto Adige) domestic consumption of about 600 inhabitants. FOTOVOLTAICO - A22. (2016). (Retrieved from http://www.autobrennero.it)
79. The 32 km path between Daejeon and Sejong runs down the middle of a six lane motorway, with a solar panel roof. the production of energy is a goal into Sejong objectives for the development of its future. (AA.VV. (2014). SEJONG. Asia's Green Metropolis of the Futur. Multifunctional Administrative City Construction Agency.)
80. The projects are: Autogrill Mensa di Ravenna (Total tool studio), Archeo Mall Casilina Est (Studio CMR) and Autogrill Montefeltro Ovest (Lombardini 22). All these projects work with carefully use of materials and performance required by the external building envelope, aiming for maximum efficiency required by energy certifications, such as LEED (Leadership in Energy and Environmental Design).
81. "Approximately 5,000 miles of New York State highway roadsides are adopted. Volunteer groups, organizations, businesses or individuals may adopt a segment of highway as long as there are no other adopters of that segment.
An adopted highway segment is usually two miles long but this length may vary and the Each Adopt-A-Highway agreement is for two years and is renewable provided the adopters have functioned in accordance with their previous agreement". This is a project that involves the community and the interest of individuals and groups, both to take care of the streets and to ensure that the streets become a way to promote activities, in case of companies. New York State Department of Transportation. (2017). Adopt a Highway Program. (Retrieved from https://www.dot.ny.gov/programs/adopt-highway)
82. The distance between a service area and the next one is on average of 25 km.
83. For the IEA (International Energy Agency).
84. In terms of clusters, the efficiency of the single element that composes it, increases exponentially, aggregating the network service system that makes up the cluster itself. (Nava, Astorino, 2017)
85. Winner of the Prize of the Presidente della Repubblica awards (2013), of the Dedalo Minosse Prize for the client (2014) and is the first certified Design for All building in Italy.
86. Historically considered the oldest motorway in the world, although there are disagreements about it. Surely however we can consider it the first Italian motorway. (Chapter 1, Motorway 2.0)
87. The Autogrill Bar Pavesi, on Milan-Turin motorway, included a restaurant area and became the first real refreshment area for motorists in Italy. An iconic structure of Italian modernism, which had its space on the cover of Life magazine in the 60s.
88. Ceppi, G. (2015). Progettare i nuovi modelli di infrastrutture per la mobilità del Terzo Millennio. In P. Scaglione & G. Sgaramella (Eds.), Spostamenti intelligenti verso nuovi paesaggi ecologici. Trento: LISt Lab.
89. LEED (Leadership in Energy and Environmental Design) is a certification system that "provides a framework that projects teams can apply to create healthy, highly efficient, and cost-saving green buildings." Currently it is recognized as an international sustainability brand. To obtain a score, the building must guarantee the minimum prerequisites to which other services must be added to reach an ever higher score, linked to specific criteria. (Performance Score to LEED Certification | U.S. Green Building Council. (2017). Retrieved from https://www.usgbc.org/buildingperformance)
90. "Villoresi Est, first autogrill in Italy certified LEED with the coordination of ICMQ obtained the prestigious certification of sustainability" final evaluation document in ICMQ - certificazione e qualità per prodotti e servizi per le costruzioni. (2017). Retrieved from https://www.icmq.it/)
91. The system is a "thermal cell" with 420 probes inserted underground.
92. The roof is shaped as a "volcano", maximizing the storing surface, reaching a height of 27.5m.
93. For every six parking spaces a tree was planted in continuity with the local vegetation. The surrounding area is characterized by numerous natural beauties such as the Parco delle Groane, the WWF oasis of Vanzago and the Villoresi cannel.
94. This certification promotes the use of products, services and systems that can be used by as many people as possible, making the architectures as inclusive as possible. As stated in the EIDD Stockholm Declaration of 2004, the objective is "Enhancing the quality of life through Design for All ... that is design for human diversity, social inclusion and equality ". Design for All Europe. (2017). (Retrieved from http://dfaeurope.eu)
95. This certification service allows the assessment of the reference company in relation to its organization in terms of human resources, environment and activities. Cardone, D. (2017). Dasa-Rägister S.p.A. - Home Page. Retrieved from http://www.dasa-raegister.com/default.asp
96. Ceppi, G. (2015). Progettare i nuovi modelli di infrastrutture per la mobilità del Terzo Millennio. In P. Scaglione & G. Sgaramella (Eds.), Spostamenti intelligenti verso nuovi paesaggi ecologici. Trento: LISt Lab.

97. Millennium Ecosystem Assessment (Program). (2005). Ecosystems and human well-being: Our human planet : summary for decision-makers. Washington D.C.: Island Press.
98. Forman R.T.T., Sperling D., Bissonette J. A., Clevenger A. P., Cutshall C. D., Dale V. D. (2002), Road Ecology: Science and Solutions. Washington DC: EditoreIsland Press.
99. In recent years, comparing the data reported by AISCAT from 2009 to 2016, related to the behavior of the motorways in terms of impact mitigation, in Italy it is possible to notice a strong change of direction linked above all to a growing diffusion of a sustainable conscience, outcome of the objectives of European energy policies. (Chap 2.1.2)
100. "A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times. A concept that distinguishes between technical and biological cycles, the circular economy is a continuous, positive development cycle. It preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows. A circular economy works effectively at every scale." Definition of Ellen MacArthur Foundation.
101. Armaroli, N., & Balzani, V. (2017). Energia per l'astronave Terra. Terza edizione: l'era delle rinnovabili. F. Tibone (Ed.). Bologna: Zanichelli editore.
102. The spread of electric cars currently has three fundamental problems to solve:
- the first is linked to the diffusion of special filling stations that ensure a widespread coverage of the service;
- the second is linked to the cost of cars higher than those of diesel cars;
- the third is linked to recharge times. If you think about using the car in the city it is not very relevant, while the problem during long journeys is relevant.
On this last point the research is working on two sides: the first is to increase the battery life, the second is to think of alternative charging systems instead of supply columns. The Polito Charge While Driving prototype is working in this direction. The prototype developed by the Polytechnic University of Turin, allows the car to be recharged using the same principle of induction plates, even when the car is moving, freeing the traveler from long stops. (POLIFLASH MAGAZINE - Arriva l'autostrada che ricarica le auto elettriche. (2017). In POLIFLASH MAGAZINE. Retrieved from https://poliflash.polito.it)
103. Autogrill Villoresi Est (Total Tool Studio).
104. As previously seen in the Gloucester service area, where the building is integrated into the ground and its construction allows the creation of a new lake habitat.
105. Smog Free Tower | Smog Free Project | Studio Roosegaarde. (2017). (Retrieved from https://www.studioroosegaarde.net)
106. The Smog Free Tower has been validated by the results compiled by the Eindhoven University of Technology
107. It was recognized nationally in 1999 with the Ruban d'Or and the Grand Jury Prize from the Roadscapes list. (Aire autoroutière de la Baie de Somme (A16) | Comment, bureau d'études audiovisuel et multimédia. (2016). Retrieved from http://www.comment.fr/projet/aire-autoroutiere-de-la-baie-de-somme-a16/)
108. Guattari, F. (2014). The three ecologies. London: Bloomsbury Academic.
109. Transdisciplinarity establishes relational logics among disciplines that, initially, may have very little in common.
110. Daly, H. E., & Farley, J. (2011). Ecological economics: Principles and applications. Washington, DC: Island Press.
111. Centrale a biomassa di Varna, non solo teleriscaldamento – Enertour - TIS innovation park. (2017). (Retrieved from https://enertour.bz.it/)

5.

5. RoadMap

After analyzing the good practices and projects on the Autostrada del Brennero, it is possible to define a Roadmap of strategies that can be outlined through the relationship between motorway and intercepted landscapes.
The proposed method starts from the analysis of the link between motorway and landscape units, following the classification of landscape ecology in which the systems differ according to their degree of naturalness in an holistic framework.
The methodological proposal aims, through a closed structure, to have an open content. Each section can be implemented, making general strategies resilient to cultural, economic and technological changes over time. The method is general for the connection TechnoEcoSystems, but specifically looks at the existing motorway infrastructure as an trial space. This is not a useful tool to draw lines in the landscape. Through the relationship between motorway and different types of landscape, the methodological tool allows the design process to identify the potentials and the services that are able to produce two systems in apparent opposition. The functional interface between the two systems allows us to work on balancing the relationship between anthropic and non-human environments, also in order to keep aware to the possible loss of functionality of one of the two.
Starting from the identification of general objectives, specific goals are defined for the possible type of applicable design approach. The goals are outlined by the comprehension of systems interaction. Setting a goal becomes a first selection criteria, useful to ensure that the project action, if necessary, is implemented. In a process logic, however, we must start from the knowledge of the system and its mechanisms. (Image 1)
For this reason, the first step (knowledge) of the method provides that there is a level of preliminary knowledge that allows to recognize the problems and potentials useful to produce technoecosystemic services in the interface between two systems (motorway and landscape unit).
After an initial screening, the second step is the definition of strategic objectives that allow us to take a subsequent step towards the most design definition and to evaluate the field of possibilities.
For each general strategy of the three categories of technoecosystemic services (cultural, provisioning and regulating), several ways of acting can be associated, which constitute a great tool box represented by the applicable specific tactics. Regardless of the technoecosystemic services that each action can guarantee, these tactics can be summarized in some categories: Zero Actions, Regulation & Control and Design & Technologies. Each of them, different for the three type of technoecosystemic service, reveals the risks that the method could have, in order to better evaluate the final choice to be adopted for the final design. The thesis then takes shape through a method that is perfectible for changes, which can be implemented over time, suggesting objectives that look to the motorway as part and sub-category of a broader and more complex system. The motorway behavior becomes variable and functional to the relationship with the other systems, losing the

indifference towards the contexts, reasoning in a logic of balance and implementation of its peculiarities. (Image 1)
The main features that emerge from the elaborated process will be presented below.
Process of knowledge.

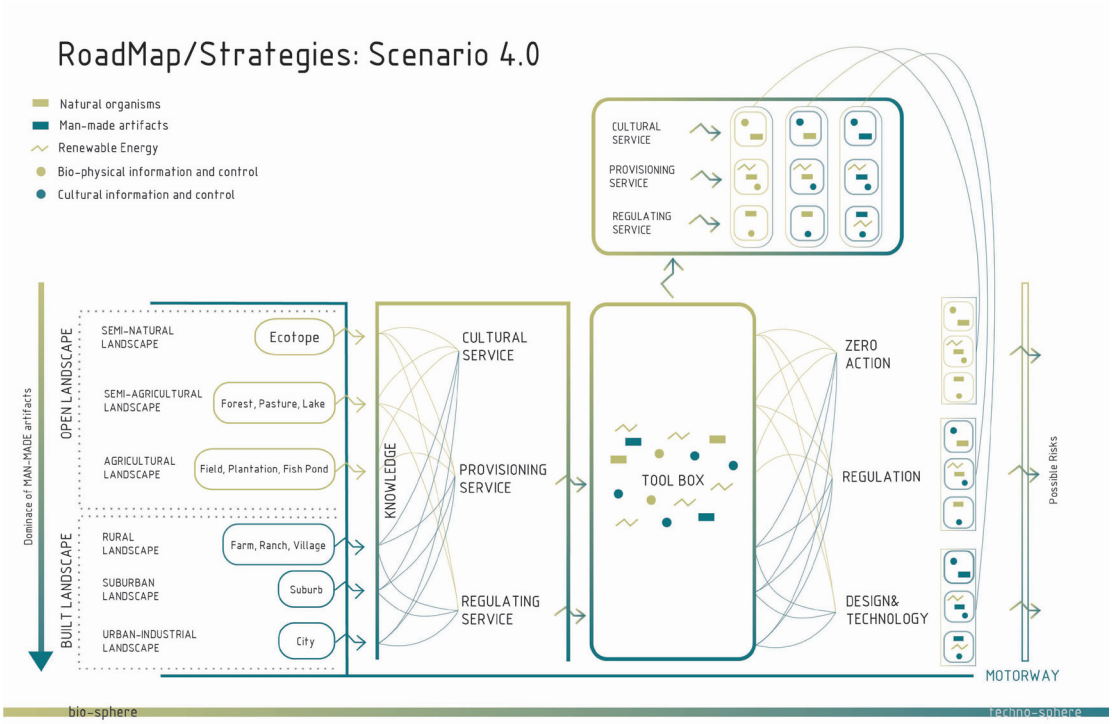


Image 1| The methodology has a double process of knowledge, before and after the selection of the type of service. The action is into an open tool box of options, classified into three macro categories, where the risk is controlled by the use of alternative possibilities.

Knowledge. The level of knowledge is double and is reached through the tools that are used in the analysis of the territory at all scales. From the photographic survey to the specific GIS data, the place takes on objective characteristics that allow in the best way to recognize specific problems and potentialities. Knowledge must necessarily have a double reading. In a preliminary phase, it is useful to define a general framework of the system. After having identified the strategic objectives, instead it is necessary to deepen the system investigation in order to chose the most suitable action to achieve the goal. In the analyzed case studies, the approach implemented by 1% paysage et développement is exemplary. Here the "dossier d'ax" is a preliminary document for any action, as it carries out a screening on the territory invested by the project. Among the parts that make up the "dossier d'ax" there is one dedicated to landscape diagnostics. This part analyzes the initial state of the infrastructure and it outlines: the potentials of its relationships (cultural, natural, architectural heritage, etc.), the medium and long-term development prospective of the territory and the objectives and problems in the enhancement of the landscape[1]. According with this logic, using the technoecosystemic services as tool for the project, a screening is carried out

on the relationship between the motorway and the Open and the Built Landscape, following a timely and system design logic.
As described in the second chapter, during the acceleration of industrial processes, the landscape of the Total Human Ecosystem has been classified into biosphere and technoecosphere, which includes ecotopes with biological and non-biological mechanisms. Most of the natural landscapes have been converted into manmade semi-natural, agricultural and urban-industrial systems, which can be considered as cultural landscapes for their processes[2].

Crossed landscape.
To better understand how the strategy can change to the reference context in which a project action is faced, it is important to distinguish the peculiarities of the reference landscapes of the Open and Built landscape. These are diversified by: the degree of naturalness, exchanged energy[3] and information for the system control[4]. (Chapter 2)

Open Landscape. Concern anything that is natural or physically has natural features in its behavior. In a holistic view of the system, the percentage of naturalness of the system is almost total and the processes that control the activity of the systems are predominantly bio-natural. In this category we find the natural, semi-natural, semi-agricultural and agricultural landscapes.
Natural and semi-natural landscapes are guided by biogeochemical processes that, through the use of solar energy (essential for activating photosynthesis processes), organize themselves autonomously in dynamic processes, maintaining their physical peculiarities, such as forests, woodlands, grasslands, wetlands, rivers and lakes[5].
Agricultural and semi-agricultural landscapes are also traceable within the biosphere for their peculiarities, as they use solar energy for their operation. Despite having a strong control by the man who maintains and manages them, these landscapes naturally regenerate and control their abilities. Everything which is productive countryside landscape can be defined as agricultural. The type and process of production distinguishes semi-agricultural from agricultural spaces, which if excessively intensive, determines an agro-industrial landscape, more technoecosystemic than natural. Those that we can consider as "natural" farming sites or semi-agrarian landscapes are those that use traditional agriculture, in which the human intervention is calibrated and almost seems to translate an artistic approach to the landscape. "Undermining a land to make it cultivable means: transforming the consistency of the soil, changing the forms of water runoff, introducing plant species, attracting and moving animals away, varying the microclimate and the surrounding ecosystem"[6]. The more we increase the change, the more the landscape becomes agricultural, tending more and more towards agro-industrialization. Even if using natural exchange mechanisms for nutriment, the agro industrial landscape, in order to increase productivity to reduce costs, creates large variations and impacts on the surrounding natural ecosystems[7]. So this type of ecotope is closer to the technoecosphere than to the biosphere, both for the control processes and for the dissipative effects that affect the

balance between the systems.

Built Landscape. Concern anything that is built by man and that uses cultural information in its processes of control. Instead of self-generative systems of the biosphere, urban-industrial techno-ecotopes are human "transmission systems"[8].
In a transition scenario, these systems work both through the use of fossil and renewable energies. The aspect that physically lacks, but which can be achieved through the use of technology, is the ability to self organize and regenerate the system. In this category, the "entropy outputs"[9] are remarkable. The consequence in the regeneration and design processes is a more invasive approach, in order to balance the stability between the systems. In this category we find rural landscape (as villages, ranch, farm), suburban landscape (as landscapes of transition between city and countryside) and finally urban-industrial landscape. These differ from each other for the complexity of structure and functionality of the systems and also for the human settlement density in the habitat. The rural landscapes for their peculiarities, we can consider them as agricultural landscapes that do not produce, but that in part, even if limited, follow processes of balance and exchange, typical of natural systems. The suburban landscapes are landscapes of transition between rural and urban. They are totally TechnoEcoSystems, for cultural control processes and hybrid energy mode of operation (fossil and renewable), but have a reduced density of human presence. This makes them less aggressive than urban and industrial systems and less complex. Finally, the city, the industrial systems, and the urban and suburban infrastructures, are TechnoEcoSistems in all their parts. In this categories the self-balancing requires a medium, which only resilient strategies with design and technology can guarantee.

Goals and Strategies.
Stategic Goals. The strategic objectives refer to the three categories of techno-ecosystem services that an infrastructure can guarantee. These are, as already defined in chapter two:

- cultural services: include non-material benefits such as "cultural identity, spiritual and intellectual enrichment and aesthetic and recreational values", which the motorway has the ability to intercept and enhance in the landscape;
- supply services: supply the real resources, in this case as renewable energy and information produced in the residual and functional spaces or by devices of the motorway;
- regulation services: protect the wildlife from the impacts related to fragmentation, treat solid waste from motorway services, regulate the quality of air and water. In general, they mitigate impacts through technologies that exploit chemical and physical principles to fulfill their ecological functions.

The toolbox provides a range of possible actions to achieve these goals, even simultaneously.

Toolbox. Taken from the case studies and from the experimental projects previously analyzed, the tools are collected in the tool box and are traced back into three macro categories. These three categories respond to a type of actionable modality, regardless of the type of objective to be achieved. These are distinguished according to the type of action to be carried out in relation to the specific landscape unit. The strategy then, after a preliminary process of knowledge, is implemented through a tactic that takes into consideration the degree of naturalness of the landscape system in connection with technoecosystemic motorway. These three categories are: Zero Action, Regulation & Control and Design & Technology

1. Zero Action. The decision not to act is recognized as an action, defining the zero option. This is characterized by the definition of a value recognized in the preliminary step of Knowledge. In the three service categories (cultural, provisioning and regulating), Zero Action is applied for different reasons. In the process of knowledge there is a cultural, regulating and provisioning value that emerges from the analysis of the reference ecotope in relation to the motorway. If the process works without the man intervation, the Zero Action is suggest to guarantee a stability that is already there.This is, for example, the approach used for the EIA (Environmental Impact Assessment) which in its implementation logic, to prevent any environmental impacts, recognizes the zero option as a project action.

However, the possible risk is of not being able to maintain a constant balance between the two systems. For this reason, the application of a different action is necessary, in which preservation becomes the main objective. Every system and organism behaves dynamically with the surrounding systems. This dynamism provokes an easy instability of relationship, even short, which can self-balance or requires other interventions to guarantee its functioning. For this reason, even in the EIA, other alternatives regulate the measures proposed to avoid and reduce the effects of unavoidable impacts (Chap.2.2.3, in Cost 341), in addition to the zero option.

2. Regulation & control. The regulation prescribes a behavior to preserve the landscape in its natural and non-natural peculiarities. Through cultural information and control, this type of action is necessery to limit actions and to prescribe general parameters useful to preserve the characteristics of the places that the motorway meets, respecting the three categories of technoecosystemic services.
There is no mention of specific project action, but parameters are defined on possible intervention scenarios, as well as the monitoring of the relationship between the motorway TechnoEcoSystem and the other systems is ensured. The previously seen examples are working in this direction, such as the document Cost341 and the 1% Paysage et Développement. While the former applies logics to protect environmental values, the latter works more on the promotion and management control of the territory through cultural dynamics. Both modes of action are to be considered as intermediate strategic

steps, between the zero option and the design approach.

The possible risk is to define a restrictive action that constrains and prevents other possible more invasive actions. The preservation often conditions the intervention, being inactive with respect to the type of context in which it acts. Taking into account only preservation and monitoring processes, this is what somehow try to solve the mitigation and compensation processes in case of significant environmental damage, unsolvable by the processes of EIA and SEA.

3. Design & Technology. The design and the production are applicable to all technoecosystemic services. Following the use of technology and the principles of ecology, this category implements monitoring, mitigation and compensation actions that balance the stability in the exchange between the two reference systems. Through the use of technology or simply bio-engineering, all the projects described in the second and fourth chapter simulate and activate exchange processes with natural and non-natural systems, for which they are planned and designed.

The possible risk of this type of action is to be too invasive if it is applied to a semi-natural context. In this category the designer should be aware to the used technology, which must be adaptive and adaptable to the needs of the context. This in order to avoid the weaken level of relationship between the two systems and to make it stronger through mitigation and compensation actions . Another risk is the lack of control during the process of realization and planning of the hypothesized technological systems. These must necessarily follow processes of circular economy[10], eliminating the impacts during their use and thinking about the sustainability of the LCA (Life Cycle Assessment) of the materials.

Each category of action should be associated with a risk feedback that could emerge from the projects analyzed or also from the direct experience in the field of infrastructure design. The recognition of a risk level already makes possible to prevent any malfunctions in the process dynamics and to suggest different and alternative actions, according to the planned intervention.

5.1 ToolBox

The Tool Box is a tool that allows us to gather elements and principles through theories, trends and projects analyzed so far. This "box" is able to translate these elements into design actions under a technoecosystemic logic. The outcome is a tool to design. The "box" is without a borders, it is a "cornucopia" of good practices and strategies that can be implemented in different specific contexts in time. The objective is to have an open and resilient tool over time that allows us to relocate existing projects related to the motorway under a technoecosystemic key, becoming at the same time modus operandi for the design of all anthropic systems.

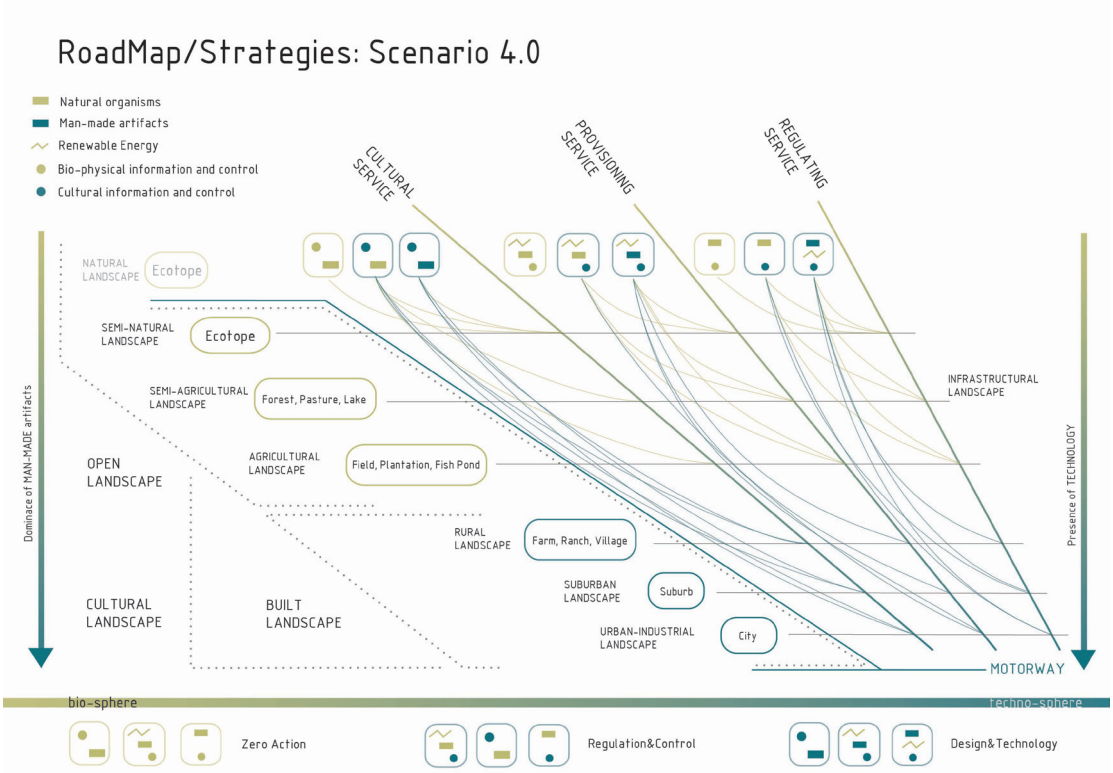


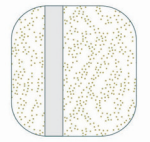
Image 2| Each kind of landscape, in relationship with motorway have different actions and possibilities to control and balance the relationship between systems.

The collection of the selected elements is classified following three categories Zero Action, Regulation & Control and Design & Technology; and also following the Techno and Eco systems typologies intercepted by the motorway: Open Landscape (Semi-Natural Landscape, Semi-Agricultural Landscape) and Built Landscape (Rural Landscape, Suburban Landscape, Urban-Industrial Landscape). In the different categories of Open Landscape, the uncontaminated natural landscape[11] must be excluded. The reason is because natural landscape is without any relation with the motorway. In this case the hypothesis of lack of balance due to the impact of the roads on the landscape is lost.
There are few areas in the world that we can still consider completely natural. If we think of inbuilt landscapes, like the Amazon forest, there maybe the landscape can be considered completely natural. Even if with the deforestation started in the 60s with the construction of the first Trans Highway, the effects of the impact were felt and the landscape close to the infrastructure can be considered semi-natural[12].

Open Landscape

The first tools to analyze are those related to the relationship between motorway and semi-natural ecotopes, ranging from the semi-uncontaminated landscape to the agricultural landscape. For each category of landscape is reported the associated strategies, following the type of needed and sought service.

Semi-Natural Landscape



Cultural Service
If from the first phase of knowledge the potentiality of a cultural service has been detected (able to enhance the aesthetic and recreational values of a place), the applicable actions can be: simple recognition of the value or of preservation and enhancement of the same.

1_Zero Action. The zero action is defined in the preliminary cognitive phase, observing a link in the relationship between motorway and semi-natural ecotopes. Cultural identity, spiritual and intellectual enrichment and aesthetic and recreational values are recognized. In cultural service this is possible, since among its aspects it considers central perception as a tool for spiritual enrichment and the recognition of aesthetic values. The example that best reproduces the service is Lynch's approach to "The view from the road", in which the importance of narrative can be built through the perception of a moving landscape. The traced story, in this theory along the road, influences the construction and design of the infrastructure, giving it a cultural value that enhances the forms of the territory through sequences and frames of the landscape (2.2.1). However, since it is a zero option, the aim is to recognize the forms of the territory and the opportunities for cultural enrichment it offers in the existing landscape and infrastructure relationship. Considering the case study of the Autostrada del Brennero, the cultural value is recognized in the design of the motorway. It was able to establish a continuity with the context, following the morphology of the territory of the semi-natural landscape that in this case is represented by the mountains and forests overlooking the valley in the Alpine section of the route[13].

2_Regulation & control. Defining a relationship that produces a cultural service, the relationship between motorway and semi-natural landscapes must necessarily be preserved and maintained in its state of origin, balancing any imbalances that interventions can affect. An example of this way of acting is the application of the 1% paysage et développement policy (2.2.1), which through a series of agreements between the stakeholders and the administrations, outlines a "dossier d'ax" as base to any consideration and action on the territory. This document provides a diagnostic on the landscape through the potential related to the cultural, natural, architectural, etc., between motorway and landscape. The identified elements are reused in drafting a list of objectives with maps to support the dossier, in which the dual intention to regulate, to control and to enhance what emerged in a knowledge process is clear. In many outcomes of the policy of 1% paysage et développement emerges the theme of the promotion and protection of rural landscapes

through environmental restoration. An investment in an infrastructure, which translates into ecological control and restoration of a cultural value of a semi-natural landscape in the context of, for example, Perron Pond along the A28[14].

3_Design & Technology. In order to be recognized as well as preserved, the cultural value in semi-natural contexts, very often needs a stronger design action that supports the process of knowledge and enrichment of the context. This is what happened with the Bay of Somme service area. The case study seen in chapter 4 (4.2) is a complete service area in its approach to enhance cultural, provisioning and regulating services. In this specific case, the focus is opening it to the natural landscape of the bay. The area is mostly surrounded by agricultural ecotones, but the potential that expresses in this place is an opportunity for opening an outpost towards an uncontaminated landscape, a connection both visual and physical. The slow accessibility to the territory through cycle paths, allows the motorway to create an indirect link with semi-natural places, which enrich the knowledge of the territory and improve the relationship between the landscape and the observer that determines it[15].

Provisioning Service.
If in the first phase of knowledge the potentiality of a provisioning service has been found (able to supply real resource as renewable energy and information in the residual and functional spaces of the motorway), the applicable actions can be: preserving and / or enhancing the relationship between the two reference systems.

1_Regulation & control. It is difficult to imagine that provisioning service can be produced by monitoring and preserving a relationship between motorway and semi-natural systems. However, if this possibility were to occur, the only way in which this could happen naturally is through the flow of rainwater from the road surface to the surrounding land. The aim to guarantee is that the type of waste coming from the motorway is at the same time well metabolized by the natural system, providing nourishment for the same. The type of control must therefore be combined with principles linked to a regulatory service approach (see Regulating Service paragraph). It limits the pollution of rainwater, which is collected close to the roadway and can be used to feed the surrounding semi-natural ecotopes. To avoid impacts and pollution, it mediates with control and regulation based on anti-emission regulations[16] of the administrations that manage the infrastructure and monitor the antifreeze products placed on the asphalt[17].

2_Design & Technology. In this case the intervention is aimed at producing data useful for monitoring and managing the systems. Energy production could be integrated on existing systems, but it would be aimed not directly for natural ecotopes in the natural surroundings, but for communities in rural and / or urban ecotopes, not directly and physically linked to the motorway.

An example of this is the installation of environmental monitoring technologies[18].

Regulating Service.
If in the first phase of knowledge the potential and the need to create a regulating service has been found (able to protect the fauna from the impact linked to fragmentation, to treat solid waste from motorway services and to regulate air quality and of the waters), the applicable actions can be: recognizing, preserving and / or enhancing the relationship between the two parts. The regulating service in this case is represented by the respect of the ecological systems belonging to the natural unit systems.

1_Zero Action. For regulating services as well as recognizing the behavior of eco- and technoecosystemic systems, the goal is avoid the impact that in a prevalence condition of the artificial system, can generate negative impacts on natural systems. The process is basically the one described in the document Cost 341 (2.2.3), which is, trying to prevent the impact, "prevention is better than cure in avoiding the negative effects". The principal achievable objective is to respect the functionality of the systems. The Cost 341 for existing infrastructures suggests to understand, for example, considering the impact of fragmentation, the conflict points between existing infrastructure and habitats. To understand whether or not to improve the existing condition, there is a general methodology to follow in order to avoid the barrier effect. For the fragmentation is: identification of the conflict points, survey and description of the points of conflict[19].

2_Regulation & control. Considering the ecological fragmentation as a exemplary impact, after an initial analysis and identification of the actual situation, the method provides to: identify the measures to reduce the barrier effect and define a list of priorities for each[20]. In this case, relating to the habitat relationship (semi-natural landscapes) and infrastructure, it is difficult to establish general guidelines as ecological conditions are variable from place to place. This is demonstrated by the type of manuals produced so far in the context of road ecology, based on both objective data and on the accumulated experiences of the editors[21]. For example, in some situations it is necessary to preserve a single species, in others it is impossible because of the position of the road in the ground or other conditions in which the conflict is not easily to mitigate.

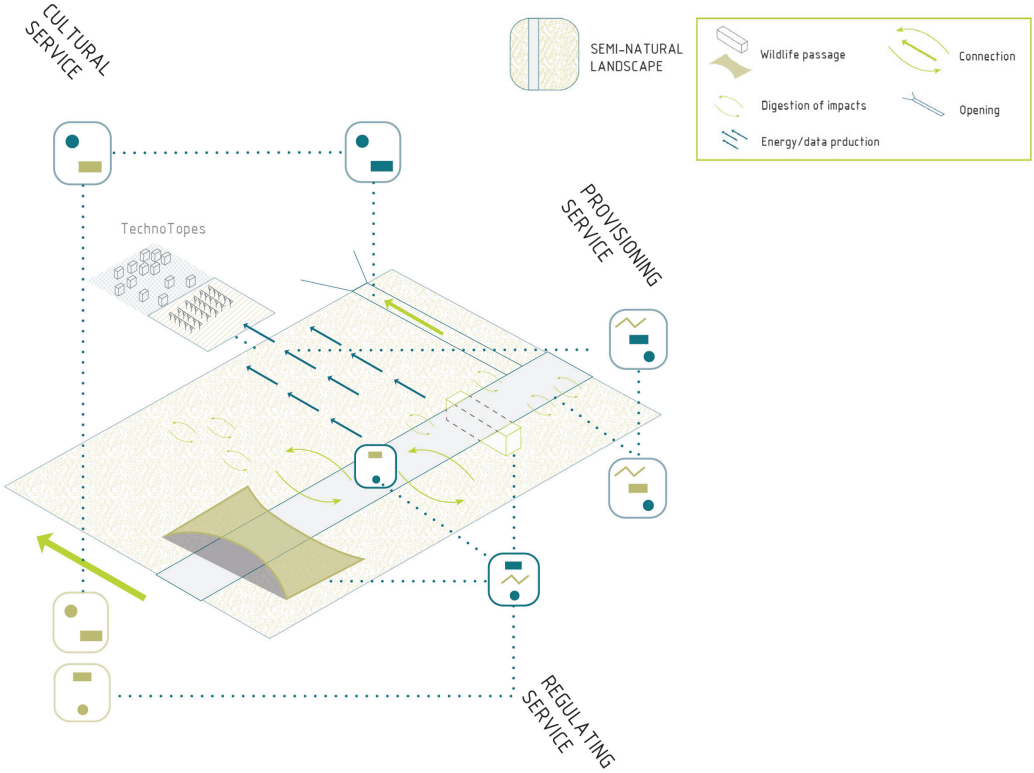
3_Design & Technology. In this case the design actions are due to the construction of small interventions useful to mitigate the behavior of the fauna and flora species of semi-natural ecotopes.
The choice of the intervention depends on the type of impact to be mitigated and compensated, thet are: pollution in general (air, water, light and sound), fragmentation and roadkill.
Air pollution. For air pollution, the applicable projects are many. Among them there is the solution suggested by the Rosengarden studio (4.2) in which

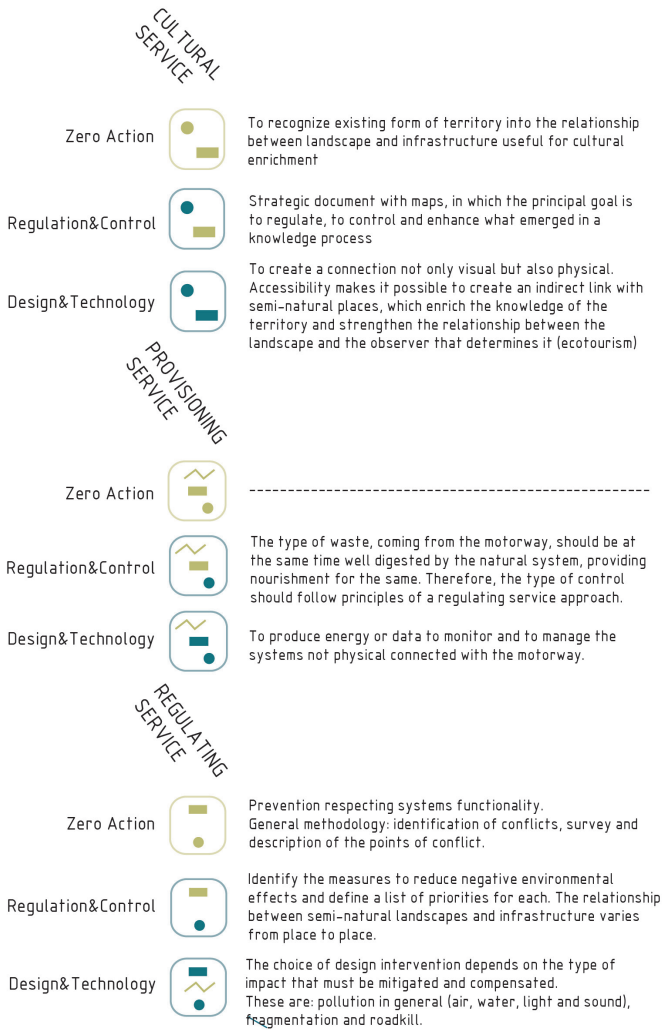
the technological tools functions as a real filter, or the Is Clean Air technology[22] which is much more complete in the operating cycle.

Water pollution. For water pollution, the drainage and the flow of rainwater should be controlled. The PM10 particulate with other compounds on the roadway asphalt are absorbed and / or deposited in the "riparian" bands of the motorway. To avoid this, destroying or otherwise impacting the flora along the motorway, filtering systems are installed to exploit the principles of sedimentation, flotation, filtration, absorption and biological transformations[23].

Light pollution. In order to avoid a surplus of brightness along the motorways, impacting the fauna, already Porcinai in the initial project of the A22 proposed a solution that favored towers street light. During the day these have a minimal impact and at night guarantee a high and diffused light[24]. This mode is now the most widespread. Another problem is that street lights attract insects, prey to bats and nocturnal birds, bringing them to death. For these reasons sodium lights are also recommended[25].

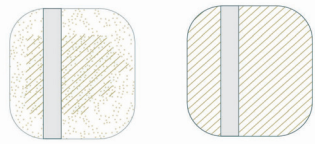
Noise pollution. In this case the noise pollution on avifauna or other types of species is not considered in terms of mitigation. The use of noise barriers or sound insulation is provided only close to inhabited areas.





Fragmentation and roadkill. In order to mitigate and to compensate the effect of fragmentation along the road infrastructures, there are numerous strategies used. Referring to the document Cost 341, there are different alternatives of viaducts and underpasses to ensure ecological connectivity between the two areas divided by the passage of the infrastructure, but also many types of fence that prevent the passage of amphibians, mammals etc. .
The didactic and exemplary project of the Trans Canada Highway (2.2.3), contains the intentions and the aspects necessary to rebalance and mitigate the impacts, offering a regulating service and balance in the relationship between natural and artificial systems.

Semi-Agricoltural & Agricoltural Landscape



Cultural Service
If in a phase of knowledge the potential of a cultural service has been found in the relationship between agricultural / semi-agricultural ecotopes and the motorway, the applicable actions are: preservation and valorization of cultural value.

1_Regulation & control. In the case in which the infrastructure intercepts an agricultural or semi-agricultural landscape, the enhancement of the context as a cultural value, through the activation of services is according to: both the possibility of opening the agricultural landscape to travelers and the possibility of creating an alternative consumption of productions along the road axis. As seen on the A12 (2.2.1), the objective of the "rainbow" policy allowed the development and maintenance of landscape features of the agricultural mosaic. In addition the program encouraged the policies of management and activation of specific projects, with the cooperation between the Ministry of Transport and Local societies. Among these we must remember Liemers and Montferland between Arnhem in the Netherlands on the border with Germany that allowed the transformation of the area into a mosaic landscape (among the actions implemented along the A12 Routeontwerp, 2.2.1).

2_Design & Technology. In this case the cultural service can be produced by selling the products grown along the motorway. Through agreements and opportunities to open the motorway to the context, possibilities for coordinated management of motorway spaces are created. The example that best embodies this strategy is the Gloucester service area along the M5. The community, thanks to an interest to the promotion of the territory and its preservation, makes the productive landscape, a resource that gives value to the territory (Chapter 4).

Provisioning Service
If the potential of a provisioning service is found, capable of supplying real resources as renewable energy and information in the residual and functional spaces of the motorway, the applicable actions are: preserving and / or enhancing this relationship between the motorway and the agricultural spaces.

1_Regulation & control. In addition to produce resources for direct consumption, especially if industrial, agricultural production produces waste. Many of these are excluded from a specific sector of regulation: "faecal matter, straw, mowing, pruning, as well as other non-hazardous natural agricultural

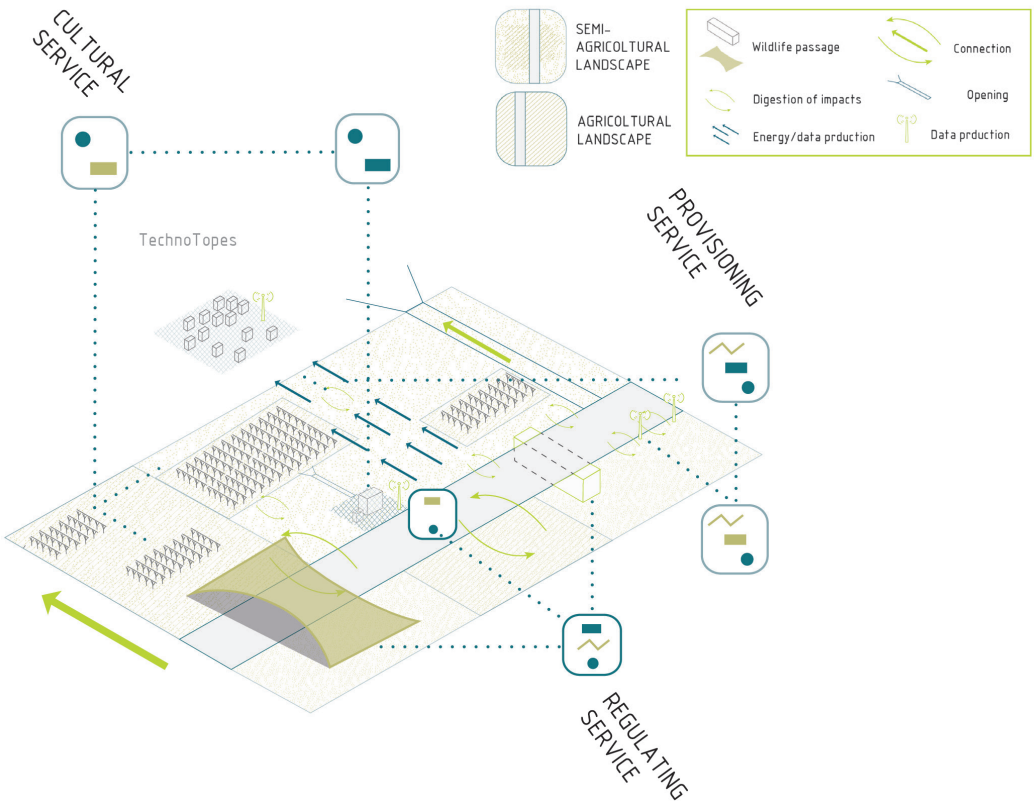
or forestry material used in agriculture, in silviculture or for the production of energy from this biomass by processes or methods that do not harm the environment or endanger human health"[26].
Looking at the waste in this management perspective, following the provisions of the Consolidated Act on the environment, the expectation is to use the waste as an opportunity to produce energy and feed a micro smart grid system, exploiting the existing plants that produce energy near the motorway. For this reason it is possible to start a cooperation agreement between the company that offers the service, the waste producers and the infrastructure managers, to ensure correct optimization in energy management. Example in which this option is suggested and is possible, is the Plose East service area. In this example there is a district heating plant in the municipality of Varna[27]. (4.3)

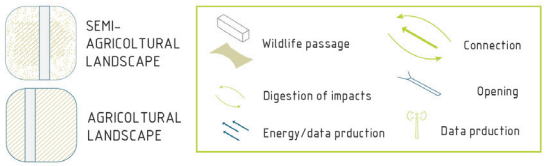
2_Design & Technology. Agricultural production needs to set up a water supply system, using the possibilities of the context, without forcing the flow and the water cycle. The collection of water along the motorway is a way of supplying the crossed contexts. The installation of rainwater filtering systems [28], allows to collect and distribute water along productive and semi-productive agricultural areas. The Canopy strategy (Chap.3) is based on these principles. If necessary, the motorway can provide to fuel systems useful for the collection of water, in order to feed the agricultural systems. The canopy itself produces solar energy for the service area. This energy is useful in a micro grid system to supply, where necessary, the agricultural ecotopes and agricultural seeds for their production. Other possibilities as productive potential are those which produce digital information. Weather monitoring stations and / or general data collection sensors along the motorway help to improve production of fields[29].

Regulating Service
In the relationship between agricultural ecotopes and agricultural seeds if the potential and the need to create a regulating service is found, the applicable actions are: to recognize, to protect and / or to improve the relationship between the two parties. In this case, regulating service is represented by the mitigation of the impacts that are recorded on organic and / or intensive production systems, in order to avoid fertilizers or chemical additives to improve production.

1_Regulation & control. In this case, the emission of pollutants in the atmosphere such as Pm, NOx, SOx, CO, O3, CH4, benzene, alcohol, acetylene and LPG must be controlled . These components must be balanced both in the water and in the air. This is combined with all the anti-fragmentation strategies reported in the ISPRA manuals and the Cost341 Handbook (see Regulation & Control in the Regulation Service for semi-natural ecotopes and Cap2).

2_Design & Technology. Also in this case, the choice of the intervention de-





CULTURAL SERVICE

Zero Action

Regulation&Control

To open the agricoltural landscape to travelers and to create alternative consumption of productions along the road axis.

Design&Technology

The cultural service can be produced by selling the products grown along the motorway. Through agreements and opportunities to open the motorway to the context, the service areas became 'door on the landscape'.

PROVISIONING SERVICE

Zero Action

Regulation&Control

To use the waste of intensive agricoltural production as an opportunity to produce energy and feed a micro smart grid system, exploiting the existing plants that produce energy near the motorway.

Design&Technology

The installation of rainwater filtering systems , allows to collect and distribute water along productive and semi-productive agricultural areas.

REGULATING SERVICE

Zero Action

Regulation&Control

The emission of pollutants in the atmosphere such as Pm, NOx, SOx, CO, O3, CH4, benzene, alcohol, acetylene and LPG must be controlled . These components must be balanced both in the water and in the air.

Design&Technology

The choice of design intervention depends on the type of impact that must be mitigated and compensated.
These are: pollution in general (air, water, light and sound), fragmentation and roadkill.

pends on the type of impact to be mitigated and compensated, that are: pollution in general (air, water, light and sound), fragmentation and roadkill. Everything will be used to limit the impact on the fauna and flora of semi-agricultural landscapes and on the intensive production of agricultural landscapes (see Design & Technology in Regulation Service for semi-natural ecotopes).

Built Landscape

The tools in this section are those related to the relationship between the motorway and artificial ecotopes, which range from the rural landscape to the urban and industrial landscape. Below, for each category of landscape is reported the associated strategies, following the type of needed and sought service.

Rural Landscape

Cultural Service

If in the knowledge step the potential of a cultural service has been detected, the applicable actions are: preservation and valorization of the relationship between rural ecotopes and the motorway.

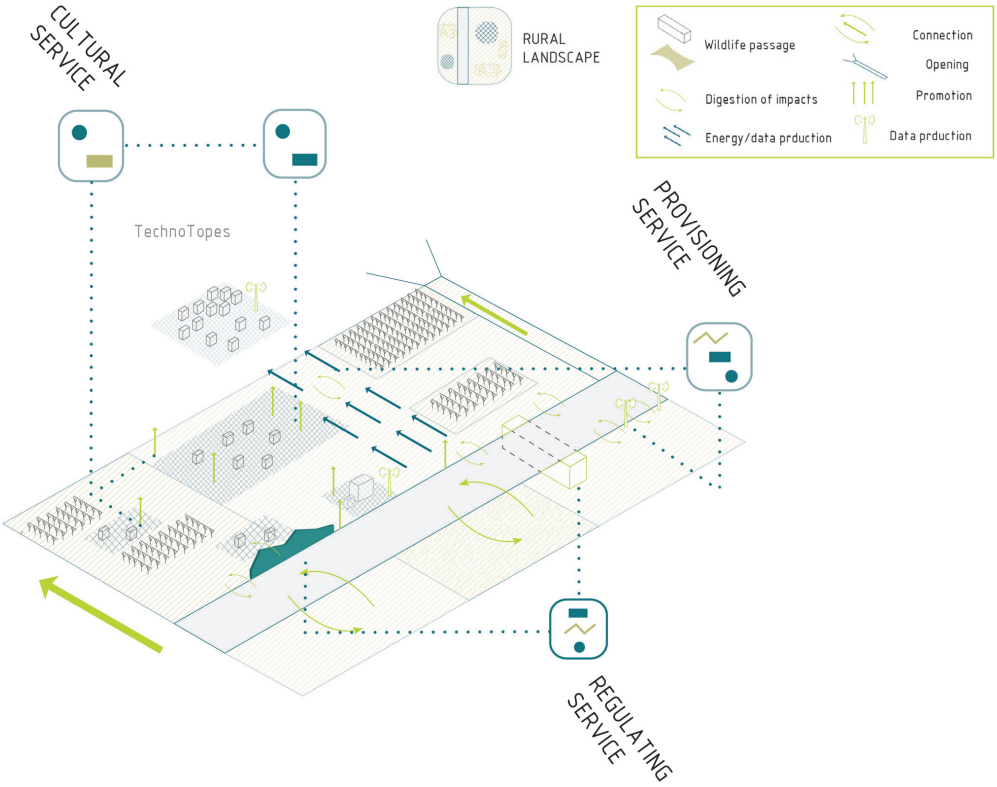
1_Regulation & control. A rural area, therefore inhabited and somehow urbanized, offers various opportunities for applying the cultural service. The landscape usually in these areas consists of a mosaic of different ecotopes, ranging from the productive landscape of the countryside to the semi-natural one (wetlands, woods, etc.). The type of management that can be inserted in these spaces is related to the promotion of the territory, as a cultural value. The case of the municipality of Predaia, in this can be an example. As seen in the second chapter, for the territorial promotion, this project sets up various principles that the technoecosystemic infrastructure as a cultural service could potentially accomplish. This through the definition of guidelines that focus on both design research for a promotional purposes and collaboration of various public and non public bodies. All this in order to give unity to the physical and management fragmentation of the infrastructure.

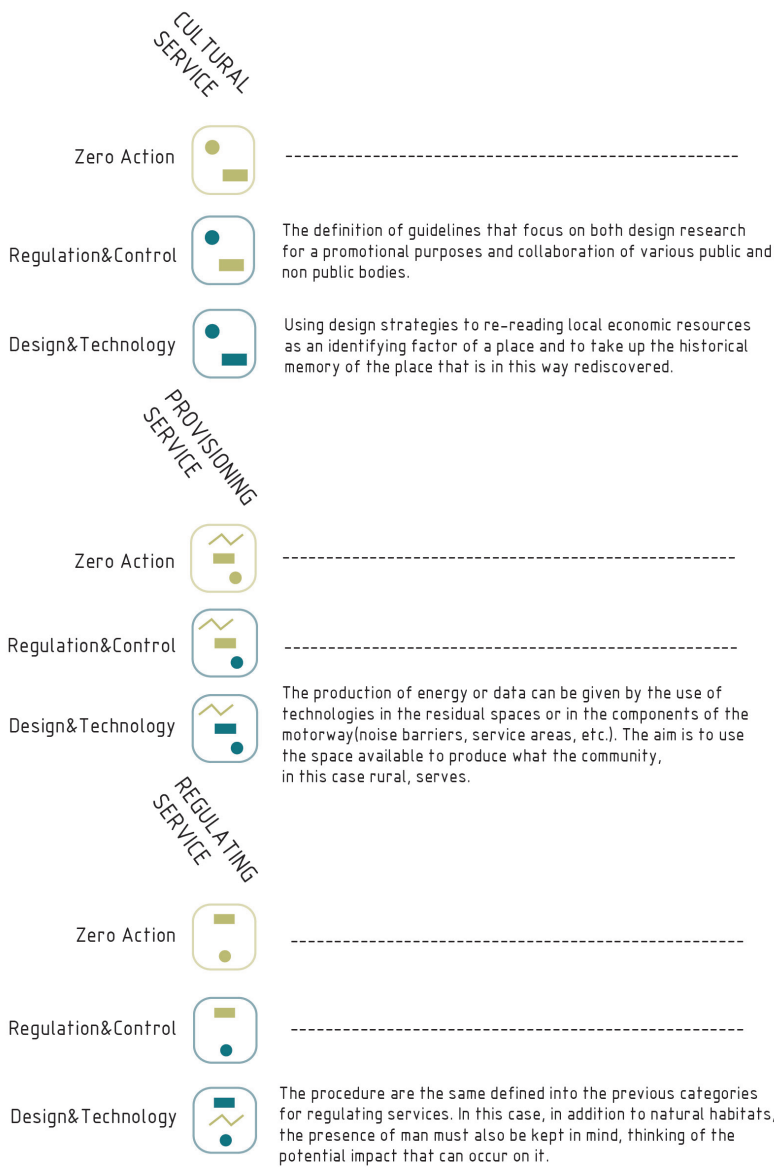
2_Design & Technology. From the design point of view, the examples that best develop the theme of territorial promotion, combined with the enhancement of particularities that emerge from small project interventions, are both the results of the Predaia student competition(2.2.1), and the design strategies of Bernard Lassus (4.2). The former are aimed to re-reading local economic resources as an identifying factor of a place. In this case the Val di Non hides the other beauties of the valley because of the Melinda company, in which the valley usually is identified. The Bernard Lassus strategies, on the

other hand, re-reads the rural territory, taking up again the historical memory of the place that is in this way rediscovered (Aire di Nimes, 4.2).

Provisioning Service.
If in the knowledge phase the potential of a provisioning service is found, the applicable actions are: design action that use technology to provide services of renewable energy and information produced in the residual and functional spaces of the motorway.

1_Design & Technology. In an environment in which the motorway and inhabited countryside are in contact, the production of energy or data can be given by the use of technologies in the residual spaces or in the components of the motorway(noise barriers, service areas, etc.). The aim is to use the space available to produce what the community, in this case rural, serves. As seen in the second chapter, the peer-to-peer relationships between the community and the reference motorway segment should be intensified, in order to well redistribute the storing energy, avoiding shortcomings during peak use. To work for closed systems but at the same time to connect with the superior network system. This is what the Autobrennero photovoltaic barrier does. Others examples are the proposal of the Solar Park South competition for the Calabrese Costa Viola.

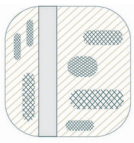




Regulating Service.
In the relationship between rural ecotopes and motorway if the potential and the need to create a regulating service is found, the applicable actions are: to recognize, to protect and / or to improve the relationship between the two parties. The regulating service in this case is represented by mitigating the impact that is recorded on production systems, flora, fauna and man (rural settlements).

1_Design & Technology. In the production systems and to the flora and fauna, taking into account the type of pollution, essential elements are designed to mitigate and compensate the effects produced by the motorway. The procedure are the same defined into the previous categories for regulating services. In this case, in addition to natural habitats, the presence of man must also be kept in mind, thinking of the potential impact that can occur on it. According with this point, the direct reference that can be made is to pay attention to the Integral Noise Barrier seen in the third chapter. Working as a machine, the barrier mitigates multiple impacts simultaneously through a single object, also producing cultural services for its perception into the landscape.

Suburban Landscape



Cultural Service
If in the knowledge phase the potentiality of a cultural service is found, the applicable actions are: preservation and strengthening of the relation between motorway and the suburban area.

1_Regulation & control. In order to define actions that can enhance the suburban context as cultural service, the best examples to follow are: Rainbow Motorway (Routeontwerp A12), 1% paysage and développement policy and also Adopt an Highway project, widely spread strategy in the United States[30].

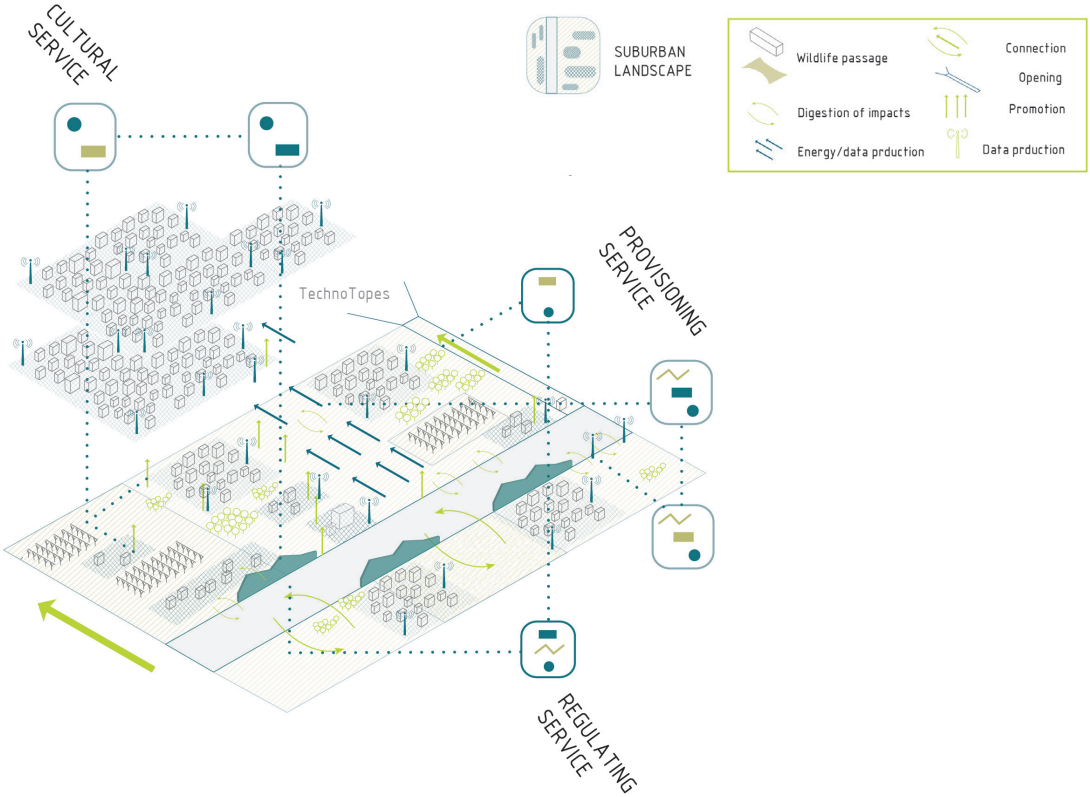
2_Design & Technology. In this case, when we think of a project in a technoecosystemic suburban context, the best example to follow is the project of "Una rotatoria per Fiorinda". The central theme is working for the territorial promotion along a provincial road of intense travel. Being a predominantly agricultural context, urban centers are real suburbs (small villages), whose goal is to promote their activities along the infrastructure (2.2.1). The differences between Adopt an Highway and the Predaia project are in the expected result. While in the former, the goal is to get publicity by investing on infrastructure, in the latter the goal is promotional, but also linked to a project to regenerate the drosscape of the infrastructure.

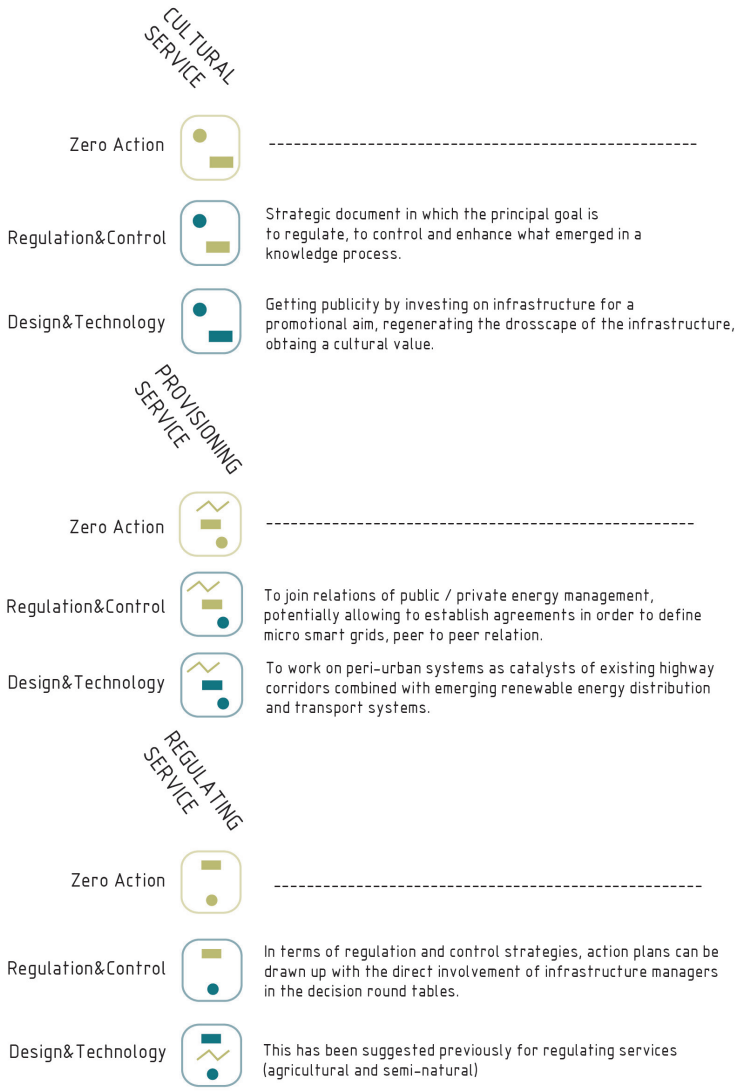
Provisioning Service
On the other hand, if the potential of a provisioning service has been detected, the applicable actions are: to control and to design simple technological tools to provide fuel, information and energy services.

1_Regulation & control. The suburban area is under the management control of the municipal administration. This has the opportunity to take advantage

from the Covenant of Mayors[31]. The objectives of the agreement include the increasing cooperation with local and regional authorities in the EU context, as well as "improving access to safe, sustainable and affordable energy"[32]. This objective aims to join relations of public / private energy management, potentially allowing to establish agreements in order to define micro smart grids. This is possible involving the managers of the motorways in the agreement round table. The relationship between motorway and suburban ecotopes becomes peer-to-peer in energy production and management.

2_Design & Technology. In this case the Conduit Urbanism project of the Megaregions of the great northern lakes is the best example to mention. The project suggests to work on peri-urban systems as catalysts of existing highway corridors combined with emerging renewable energy distribution and transport systems. The project works on the construction of real urban hubs, which in addition to being energy collectors and strategic systems, it works on the community and sociality as poles attractive to a more complex system that sees infrastructure and city working together.





Regulating Service.
If the potential and the need to create a regulating service is found, the applicable actions are: to protect and / or to improve this relationship between motorway and suburban area. The regulating service in this case is represented by mitigating the impact that is recorded on production systems, flora, fauna and man present in suburban areas.

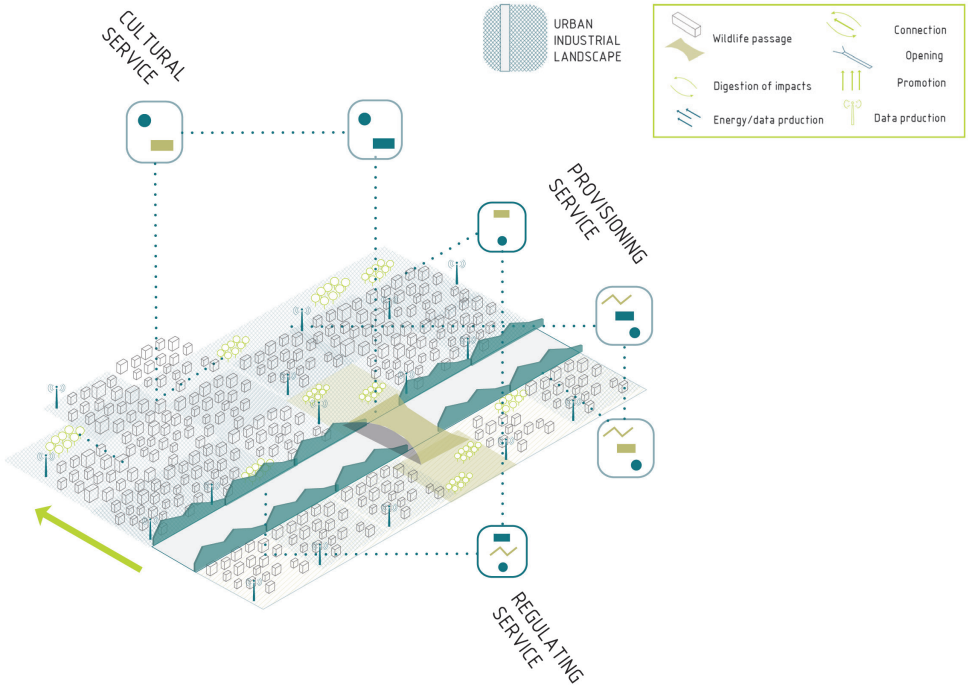
1_Regulation & control. According to the Covenant of mayors, in terms of regulation and control strategies, action plans can be drawn up with the direct involvement of infrastructure managers in the decision round tables. In this way, compensation strategies, such as setting up 25,000 square meters of

forest[33], can also include the use of areas close to the motorway, as punctual and strategic parts of the action plan.

2_Design & Technology. Also in this case, as for the rural ecotopes, taking into account the type of pollution, functional elements can be designed to mitigate and to compensate the effects produced by the motorway. This has been suggested previously for regulating services (agricultural and semi-natural). The main reference of the toolbox to follow is the integral Noise Barrier seen in the third chapter (3.2.1).

Urban-Industrial Landscape

In order to plan the three types of technoecosystemic service, the strategies to be adopted in this session are similar to those already described for suburban landscapes. Through the interview with Susannah Drake of the DLand studio in Brooklyn NY, the BQGreen project will be described. Due to its characteristics, this project can be considered a paradigm of the technoecosystemic project that arises from the relationship between infrastructure and urban ecotopes, relating to the expressway connecting the Queen and Brooklyn municipalities.



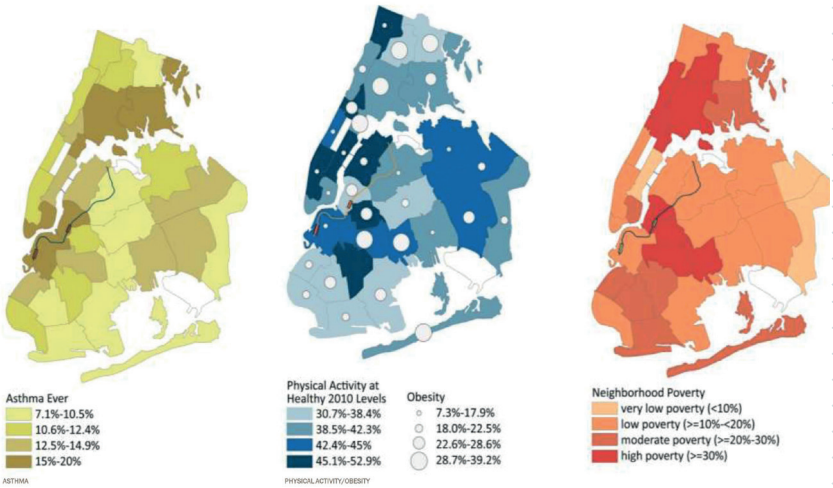
BQGreen: healing a wounded neighborhood

"The world-class surface transportation system passed on by previous generations of Americans has reached the age of obsolescence and now needs to be rebuilt." James L. Oberstar, chairman of the House Transportation and Infrastructure Committee.

The Brooklyn Queens Expressway (BQE) was proposed to mitigate the traffic congestion by Robert Moses in 1930s. "He spent a lot of time looking down at it, watching the cranes and derricks and earth moving machines that looked like toys far below him moving about in the giant trench being cut through mile after mile of densely packed houses, a big black figure against the sunset in the late afternoon, like a giant gazing down on the giant road he was molding"[34]. The expectation does not responds to reality.
The described image of the project of R. Moses definitely does not have the same appearance as what BQE is today. If the infrastructure had the goal of connecting the municipalities of New York City with each other, at the end the result was a caesura of 6 lanes in the urban settlement in addition to pollution impacts, for over 70 years.
In the predominantly Latin district of Los Sures, in the south of Williamsburg, the infrastructure has catalyzed a process of loss of value of the area, due to the consequent increase in social impacts.
But this condition could not be neglected for a long. Thanks to the DLand Studio[35], a process of recognition of the problems of the areas near the BQE started. " I applied for and received a grant from the New York State Council on the Arts and did initial theoretical studies of the BQE. That design work and research caught the attention of City Council Woman Diana Reyna who created and RFP (Request For Proposal) that we won to explore the feasibility of capping the trench in Los Sures. DLANDstudio was commissioned to develop a feasibility study for creating a new park on deck over the highway."[36]
The feasibility study of DLand focused on the geometry and components of the expressway and also investigated the social impacts found along the infrastructural route. It is not a coincidence that, according to the analysis reported by Susannah Drake during the conference "Transform or tear down?"[37] , all the problems such as poverty, criminality and asthma have been widely identified close to the BQE.
From this framework, emerges the need to respond through an organic project, to the three main values: community, equity and health[38].
In order to increase park space in an underserved neighborhood in Brooklyn; to have environmental justice (balance public resource allocation); to reduce air and water pollution, high asthma rates in the neighborhood; to address gang violence; to eliminate territorial landmarks; to improve pedestrian safety (safe routes to schools), alternative transportation (safe bike routes); to enhance local economy construction jobs; to increase retail and real estate value, the general strategy of the project was to cap the road with a park [39].
"The program was 100% community driven. We developed a lot of materials to help demonstrate some of the issues such as distance to active recreation, danger of pedestrian routes to school, and amount of particulate matter in

the air but they told us what they wanted. Program includes ball fields, community gardens, places for kids of all ages to play, passive park space and a new recreation center where kids can learn to swim. Now they are fighting for their park."[40] (Image 7)

Image 3|Poverty, criminality and asthma analysis of New York City©D-LandStudio



The park is a cogent requirement that balances and mitigates the social and environmental impact created by the infrastructure. 9 tonnes of pollutants per 110 thousand vehicles on average per day, on a section of infrastructure less than 60 km long, are impressive estimated data for an urban section of infrastructure[41]. To understand the dimension of the problem, the A22 motorway in the busiest section, Verona-Brennero of 224 km, produces almost the same values, intercepting a different variety of landscape ecotopes[42]. According to estimations of DLand Studio, " in one year 350 trees will generate $250,000 oxygen, provide $490,000 pollution control recycle $297,000 of water contribute $3.9 million in shade value...in 10 years gain of $50 million"[43]. This makes the project more attractive not only for its functional impact, but also for the future development of the area.
The goal of the project is to guarantee the following results:
- 30% increase in park space in neighborhood
- 250% increased tree coverage - annual benefit of over $50K
- potential 25% reduction in asthma rates
- saving of $1 million with reduced asthma related hospitalizations
- at least 200% increase in permeable surfaces
- potential annual capture of over 11 million gallons of storm water
- 200+ construction jobs during construction
- $245 million in NYC economic activity during construction
- $5 million annual gain in local retail sales
- $16 million gain in value of existing real estate

Taking into account the benefits, the awareness campaigns and fundraising

by the community, at this point the question is: why have not the works started yet?

"Politics is the biggest issue. First Vito Lopez sold out the neighborhood, down zoning it and up-zoning the waterfront. Then Bloomberg pushed waterfront development presumably to strengthen the NYC economy. DeBlasio

Image 4|BQGreen project ©DLandStudio

talks a lot about helping under served communities but is hiding behind ridiculous cost estimates so that he can support real estate developers in other areas that support his political career. Need a mayor who truly cares about under-served communities, open space, public health and the environment, rather than using rhetoric as a stepping stone to national office."[44]

The process is similar to the High Line one, but in this case there is a lack of continuity in taking seriously the proposed planning.

Apparently the blockade is economic, although it has been widely demonstrated that the investment has been overestimated by the administration De Blasio, currently head of the municipalities of New York City. " City Council can support. The Borough President has committed millions. The project needs public infrastructure funding to rebuild the bridges. Extending the bridges to make the park could happen through a combination of public and private funding sources. Federal funds for infrastructure are channeled through the states and NY is a big state with a lot of infrastructure improvement needs, Its not simple."[45]

There are precedents that demonstrate the feasibility of the process, such as the Wooldall Rogers Freeway project - Klyde Warren Park Dallas[46], which is considered an example to follow.

In the meantime, considering the range of time, the Friends of BQGreen[47] continue their awareness campaigns following the process of the previous case of infrastructural obsolescence of the High Line.

Although the path of BQGreen has not yet been completed, what emerges

from the interview and from the blog of the Friends of BQGreen, is the ambitious resul of a real project of a technoecosystemic infrastructure, both in the process and in the final hoped outcome. In addition to be a complete representation of how the project can become a tool for mitigating and for compensating the impacts caused by the expressway, the proposed design proves to respond to the principles of cultural service seen in the previous paragraphs.

Image 5|Environmental justice campaign ©BQ-Green Blog

The work of the communities, through the regulating, cultural and provisioning services, allows a technoecosystemic expressway to enter into a relationship with the urban system in which it is inserted. This example shows the possibility to make converge within a single project, all the services necessary, responding also to the real wishes of the involved community. The social planning of American culture, brings out that American inclination to spontaneously join in group in order to fight and achieve a common goal. This trend gradually also in Europe is becoming widespread practice, even though it has many difficulties[48]. As base of a social and cultural value that we want to achieve through a technoecosystemic project there is what claimed Jane Jacobs "Cities have the capability of providing something for everybody, only because, and only when, they are created by everybody "[49]. Years later, it seems that the main opponent of Robert Moses' projects has taken her revenge, ironically through an infrastructural project.

Image 6|Environmental justice campaign ©BQ-Green Blog

Positions

Joshua D. Eldridge
GreatEcology Studio

Hillary Brown
Professor CCNY

Donna Walcavage
LA Stantec, NYC

Olga Gorbunova
Engineer Stantec, NYC

Carlo Costa
Technical Director A22

Susanna Drake
LA DLand studio, NYC

Vanessa Keith
StudioTEKA Design, NYC

Francesca Moraci
ANAS S.p.a.

Maurizio Carta
Professor UNiPA

Paolo Pileri
Fouder of "VENTO" project

Mosè Ricci
Scientific supervisor InfrA22Lab

5.2 Positions. Comparison of ideas and experiences.

In the previous chapters and in the last paragraph are reported some positions recollected during the period of research in three specific moment:

- FUTURINFRASTRUCTURE International Summer school held in Trento, in July 2017;

- Transform or tear down?. Conference under Urban Design Forum, Maintaining, at Arup NYC on October 18th;

- Adventures in Urbanism, presentation of books held on November 6th at The Bernard and Anne Spitzer School of Architectur at CCNY.

The last two were held during the foreign period of research in New York City at The Bernard and Anne Spitzer School of Architectur at CCNY.
Starting from the topics developed into these moments, there was the opportunity to have conversations with practitioners, academic researchers and people involved in the infrastructure field.

The figures met are: Hillary Brown professor at CCNY, Donna Walcavage and Olga Gorbunova of Stantec firm, Joshua D. Eldridge of Great Ecology firm, Vanessa Keith of StudioTEKA, Susanna Drake of DLand Studio, Francesca Moraci CDA of Anas S.p.a., Paolo Pileri professor at Polimi, Maurzio Carta professor at Unipa, Carlo Costa CDA Autostrada del Brennero S.p.a. and Mosè Ricci professor at Unitn.

The objectives of the conversation were fundamentally two:
- to have an internal control process for the definition of the method previously seen;
- to collect positions about the future of infrastructure, looking at different field of research.

One of the goals of these meetings was to find people from different field, in order to have a complete overview on the theme, from different point of views and backgrounds. Among the interviewed people there are: architects, landscape architects both researchers and practitioners; ecologists, engineers and also people involved in the management of infrastructure.
The process used to be the same for each interview:
- presentation of thesis and hypothesis of research, with the description of the prototype of the noise barrier and the service area as good practices of ThechnoEcoSystemic approach;
- discussion on the presentation of the thesis;
- interview on the theme of their field of work.

This sequence of steps allowed us to collect opinions of individual experts on the theme, starting from the research. At the end, the results of the conversa-

tions are a comparison between this doctoral research and the interlocutor's work area.

The general considerations that can be made on the overall outcomes of these meetings can be summarized in the following points.

1_Interdisciplinarity. This is a theme that emerged in all conversations. Starting from the projects on the A22, the attention moved on this aspect as the fundamental. In the presentation, the focus was on the multidisciplinary nature of the parties involved, which gave a further value to the projects presented in chapter 3 and 4. From the conversation with Donna Walcavage and Olga Gorbunova of Stantec, it is clear that in their group, hybrid work is the norm, because every day Landscape Architect and Civil Engineer collaborate together. This allows them to start a "Context Sensitive Design" approach in the starting point of the project. "You have to understand your surroundings, you have to understand the needs...So the design approach is really identified by a Context Sensitive Solution and understanding the needs of the communities, understanding the needs of the clients, understanding the needs in terms of what the current design concept and progressive solutions are...and try to kind of marry those. You have to take all those things into consideration, when you design. What we do well is working together... it is very collaborative. The process is very fluid."[50] The results of this fluid process are excellences in the design of infrastructures, such as for example in the project Route 9A Reconstruction in urban area, which was the key for the reconstruction of the entire viability of Down Town after 9/11. Interdisciplinarity has not only been seen as an opportunity to enrich the project, but also to be transgressive to the usual process procedures. As emerged from the conversation with Joshua D. Eldridge, ecologist of Great Ecology, the borderline position between disciplines starts change, making it richer in meaning, it is on the limits that the innovation comes. So the one to which we aspire is an interdisciplinarity that crosses the disciplinary boundaries horizontally and which, if it reasons holistically, also exceeds the space-time limits, reasoning on the processes and the hybrid dynamics of the various fields[51].
According with this, the interdisciplinary nature of the InfrA22 research, in addition to have a broad consensus in the process, has had the ability to be comprehensible to everybody in its general objectives, being borderline among the disciplines.

2_Nature vs Man. Another theme emerged is the difficulty of overcoming the idea that the project can only cause impact. When we talk about big projects, it automatically starts a conservative position against the project to preserve nature(1.5). We must force and break the man / nature dichotomy that was created. In the definition of motorway as a system that works in its processes as a natural system, the description says: a technological system which supports the ecological dynamics that surround it. The project (if necessary as seen in the Toolbox) will have the possibility to catalyze some processes, entering into the dynamism and evolution of natural ecosystems.

We should be aware that "man vs nature is the struggle. Men is trying to make improvement but not always works. Understanding the natural science and how there is working. Making sure that the way we are working with the landscape, because it is dynamic, is flexible and so the resilience of the system should be so."[52] However, the originality and innovation of the thesis emerged, which completely breaks a rigid division between gray and green infrastructure[53], reasoning on the system in general and on its processes that are translated only if necessary in the project.

3_ Hybrid use of design. The third theme emerged is the hybrid and flexible use of the project, especially if it is infrastructural. This is linked to the obsolescence of what we create. One of the problems that emerged from the conversation with the Stantec studio is the necessity of maintenance on big construction, because of both to frequent use and to unused. The inactivity or the precarious use of the infrastructure, leads us to reflect on future scenarios that transform or tear down it. But what emerges from the conversations is to change the use, mostly to make it hybrid in its functionality. "So if we have less space and we have to be more careful with it, it is not longer make sense to do something that is doing in one thing. Like a road, where the only purpose is to carry cars, so you can do more than that. Maybe the space can be used in a smarter way, surfaces can be used in a smarter way, they can be engineer to be habitat for animals or slice for technologies."[54] The zero consumption of soil leads to incentive creativity, not only in reuse, but in the hybrid use of the objects we design. It is an overlapping of uses, which make motorway conduits and ecological machines functional for the territory. This is the answer to obsolescence process. According with this point in their answers are: Vanessa Keith, Paolo Pileri, Francesca Moraci, Maurizio Carta and Hillary Brown. "Design for multipurpose use is one key principles, designing for low impact, design to incorporate passive, natural processes wherever possible. We have to design for zero carbon and for climate instability. And finally we need to be not only considerate but beneficial to communities that host an infrastructure facility"[55]. Therefore the infrastructure from "road of communication" can become "road of energy"[56] or something more. The goal is to think that "these corridors stop to be corridors and become armors, connectors, interfaces ... maybe in some cases even slow down the flows ... because slowing down allow the streams to feed the local systems"[57].

The interviews are reported in their original languages into the following paragraph:

Hillary Brown professor at CCNY(entire in 1.6), Donna Walcavage and Olga Gorbunova of Stantec (cited in 5.2), Joshua D. Eldridge of Great Ecology (cited in 5.2), Vanessa Keith of StudioTEKA(cited in 5.2), Susanna Drake of DLand Studio (cited in 5.1), Francesca Moraci CDA of Anas S.p.a.(entire in 2.2.2), Paolo Pileri full professor at Polimi (entire in 2.2.1), Maurzio Carta full professor at Unipa (cited 5.2), Carlo Costa CDA Autostrada del Brennero S.p.a. (entire in 3.2.2) and Mosè Ricci full professor at Unitn (entire in 3.2.2).

Note

1. Rèpublique Française. (2005). Circulaire du 31 mars 2005 relative à la politique du "1% paysage et développement"sur le réseau routier national.
2. Naveh, Z. (2000). What is holistic landscape ecology? A conceptual introduction. Landscape and Urban Planning, 50(1-3), 7-26.
3. Taking into account the THE scenario of Naveh and Lieberman in Landscape Ecology, the energy systems are two: fossil fuel and solar energy. Towards a scenario 4.0, however, we should consider an energy framework in transition. Instead of talking of Solar energy, we shoul consider the set of renewable resources that allow natural and antophic systems to relate to each other. These are: solar, wind, geothermal, biomass, etc.
4. The control and information processes both in the Landscape Ecology vision and in a transition scenario take into consideration both natural biophysical and cultural processes.
5. Naveh, Z. (2000). What is holistic landscape ecology? A conceptual introduction. Landscape and Urban Planning, 50(1-3), 7-26.
6. Poli, D. (2013). Perchè l'agricoltura tradizionale era naturalmente paesaggistica? In Agricoltura paesaggistica: Visioni, metodi, esperienze. Firenze: Firenze University Press.
7. It refers to a type of agriculture that uses chemical pesticides to preserve the quality of agricultural production.
8. Lyle, J. T. (1994). Regenerative design for sustainable development. New York, NY (u.a.: Wiley).
9. It refers to the refuse and impact in the balance of systems: pollution, waste, etc. (Naveh, 2000)
10. Principles: Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows; Optimise resource yields by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles; Foster system effectiveness by revealing and designing out negative externalities. (Definition of Ellen MacArthur Foundation: What is a Circular Economy? | Ellen MacArthur Foundation. (2017). Retrieved from https://www.ellenmacarthurfoundation.org/circular-economy)
11. The existence of a motorway near a natural landscape, makes it immediately semi-natural.
12. In the south the Amazon forest decreased because of the effect of the highway, related to the IIRSA project (Integration of Regional Infrastructure in South America).
13. Picchi, P. (2013). Il paesaggio nei progetti originari di A22,l'esperienza di Pietro Porcinai. In P. Scaglione & M. Ricci (Eds.), A22, nuove ecologie per infrastrutture osmotiche =: A22, new ecologies for osmotic infrastructures.
14. Rural Development Program in Normandy, measure 122. Here, the development of the Perron pond site is a successful operation for restoring a sensitive protected environment. (Direction Dépatementale des territoires de l'Orne. (2004). Bilan de la politique du 1% Paysage et Développement de l'A28. dossier aidé par le 1% A28).
15. Jakob, M. (2009). Il paesaggio. Bologna: Il Mulino.
16. Rather than talking about localized regulations, the reference goes to the European policies to reduce CO2 emissions. One of the consequences of this policy can be found in the reduction of vehicles emissions (such as euro 1,2,3,4,5,6,7) which provide for the registration of cars with particle filters (PM10).
17. The saline concentration (of sodium chlorides) in the land close to the motorways is one of the causes of damage to the vegetation near the roads. The use of drained asphalts helps the water to be disposed during rains, but it diffuses more easily in soils close to the motorways with such as particles on the asphalt and salts contained in antifreeze compounds. (Fay, Shi, 2012).
18. In particular, They are measurement systems combined with vehicles or monitoring stations, already with the main air quality analyzers. In addition, these systems can measure the concentrations of the main gases in open environments with good accuracy, acquiring fundamental data on air quality.
19. Cost341_Handbook, details in 5.4.3 and 5.5 paragraph.
20. Ibidem.
21. It mainly refers to the Italian state of art, where the topic of ecological fragmentation, seems to be faced only recently in some Italian regions through the Landscape and Territorial Plans. As reported in the 2008 ISPRA documents (Protection of ecological connectivity and linear structures) and 2011 (Territorial fragmentation from linear infrastructures) we need a more detailed manual in which, in addition to a specific analysis of the Italian motorway system, we refer to a list of case studies transferable in method to the Italian territory.
22. Thanks to APA (Air Pollution Abatement), the company has been awarded by the European Commission as a project of excellence in the Horizon 2020 program. The project provides the installation of a structure that filter the air in a radius of 25/28 m through three different chemical-physical-mechanical processes, breaking down most of the pollutants in the atmosphere, such as Pm, NOx, SOx, CO, O3, CH4, benzene, alcohol, acetylene, Gpl. All using a power of 560 W. (Breath your life | Iscleanair. (2017). Retrieved from http://www.iscleanair.com)
23. It refers to: flood unloaders combined with overflow capacity; grating systems, sedimentation and separation of oils and fats; sand filters; detention basins; filtration and biofiltration systems; infiltration systems; refinement systems: phytodepuration and lagooning. (Papiri, Todeschini, 2008)
24. Picchi, P. (2013). Il paesaggio nei progetti originari di A22,l'esperienza di Pietro Porcinai. In P. Scaglione & M.

Ricci (Eds.), A22, nuove ecologie per infrastrutture osmotiche =: A22, new ecologies for osmotic infrastructures.
25. Cost341_Handbook, more information are in the chapter 7.
26. Article 185, paragraph 1) of Legislative Decreto 152/06, Testo Unico Ambiente, Bosetti & Gatti.
27. Comune di Varna. (2017). Impianto di teleriscaldamento. (Retrieved from http://www.gemeinde.vahrn.bz.it)
28. "The atmospheric deposition on the ground takes place both in dry weather and during the rain.The second occurs through two successive phases: the incorporation of substances in the water droplets into the cloud (rainout) and atmospheric washout (washout), this water still needs to be cleaned even if it does not come into contact with polluted surfaces. (Papiri, Todeschini, 2008)
29. It refers to the surveys of temperature peaks and to the measurement of the localized pressure, different from the average measurements of the nearest meteorological station.
30. As already mentioned in the fourth chapter, Adopt an Highway is a type of policy of the United States, which makes it possible for anyone interested (single or in community) to adopt a mile of highway, paying the maintenance costs of the same to obtain advertising.
31. Born as a bottom-up movement in 2008, supported by the European Union, the Covenant of Mayors establishes a transition to clean energy against climate change. The municipality signatories of the agreement, currently 7676 throughout Europe, promote action and monitoring plans, whose general objective is to reduce CO2 emissions by 40% by 2030. The proposals planned ranging from the inclusion of car sharing systems in cities to the inclusion of trees and / or shrubs for large areas, able to absorb CO2. (Energy-cities.eu. (2017). Patto dei Sindaci. Retrieved from http://www.pattodeisindaci.eu)
32. Ibidem.
33. As in the project "New Green Urban Areas Planting" for the municipality of Caronno Pertusella, which is a project among the excellence examples of the Covenant of Mayors project.
34. Caro, R. A. (2015). The power broker: Robert Moses and the fall of New York (p. 846).
35. DLANDstudio is an interdisciplinary design firm founded in 2005 by Susannah C. Drake, based in Brooklyn, NYC.
36. Answer to the question:" How did the BQGreen project start? And how DLand Studio was involved?" Extract from the interview with Susannah Drake, 20/11/17, NYC.
37. Transform or tear down? Conference with Elena Conte, Susannah Drake, Margaret Newman, Jennifer Pehr and Nicholas Pettinati to hear original proposals for re-thinking New York City's arterial roadways. Conference under Urban Design Forum, Maintaining, Arup, NYC, on October 18, 2017. (Transform or Tear Down? Retrieved from http://urbandesignforum.org/events/transform-or-tear-down/)
38. The three values emerge from the blog Friends of BQGreen on the project proposed by the DLand studio. The communities belonging to this place are mainly families and children who use the few park areas and the dangerous overpass near the infrastructure to reach the school services. The equity is related to the disparity between north and south in the Williamsburg neighborhood (Southside has less benefits in terms of space and recreational services). The lack of health is highlighted by the high rate of asthma, detected in the South Williamsburg area. (The Friends of BQGreen - BQGreen. (2017). (Retrieved from http://bqgreen.org/)
39. Cap the BQE with Green, intervention of Susannah Drake in 'Transform or tear down?' Conference under Urban Design Forum, Maintaining, Arup, NYC, on October 18, 2017. (Transform or Tear Down? Retrieved from http://urbandesignforum.org/events/transform-or-tear-down/)
40. Answer to the question: "What was/is the role of the communities in the design process?" Extract from the interview with Susannah Drake, 20/11/17, NYC.
41. The New School's Tischman Environment and Design Center, GLD's Environmental Justice and Open Space team, youth and mothers serving as volunteers to recollect data interviewed park users, conducted air monitoring and counted truck traffic.
42. AISCAT data for the last six months of 2016. Average daily vehicles in the Verona-Brenner section of the A22 is equal to 120 thousand vehicles average per day.
43. Data provided by U.S. Forest Service in '*Cap the BQE with Green*', Susannah Drake in Transform or tear down? Conference under Urban Design Forum, Maintaining, Arup, NYC, on October 18, 2017. (Transform or Tear Down? Retrieved from http://urbandesignforum.org/events/transform-or-tear-down/)
44. Answer to the question: " What is the biggest problem to realize the project? What is the state of the project now?" Extract from the interview with Susannah Drake, 20/11/17, NYC.
45. Answer to the question: "What are the policy that are you adopt as group of stakeholders to finance the project?" Extract from the interview with Susannah Drake, 20/11/17, NYC.
46. Data for the contruction: $ 17 Million Federal Funding, $ 20 Million City of Dallas, $ 20 Million Texas State DOT, $ 53 Million Private, $ 110 Million Total construction cost. (Drake, 2017)
47. The Friends of BQGreen work in partnership with a number of community organizations based on the Southside of Williamsburg and partner organizations in Brooklyn and the rest of New York City. They are composed of local community organizations dedicated to the development of BQGreen, including: The Brooklyn Arbor

School, Churches United for Fair Housing (CUFFH), El Puente, El Puente Academy for Peace and Justice, Mothers Out Front, Los Sures, New Yorkers for Parks, Nuestros Niños, Open Space Alliance for North Brooklyn (OSA), St. Nick's Alliance. They are involved in: run volunteer and membership programs, raise private and institutional funds to supplement public funds, act as a champion for the BQGreen project. Until the park is built, help maintain and activate Marcy Green and Rodney Park, which are part of the site of the future park. (The Friends of BQGreen - BQGreen. Retrieved from http://bqgreen.org)

48. Venturini, L. (2004). URBANISTICA E COMUNITÀ Politiche e piani per la rigenerazione urbana a New York (Doctoral dissertation in Politiche Territoriali e Progetto Locale XVI Ciclo DipSU - Dipartimento di Studi Urbani Dottorato di Ricerca in Politiche Territoriali e Progetto Locale - XVI Ciclo).

49. Jacobs, J., & Recorded Books, Inc. (2016). The death and life of great American cities. New York: Vintage Books.

50. Answer to the question: " During the preliminary step of project, what is the first thing that are you looking at?" Extract from the interview with Olga Gorbunova, Civil Engineer in Stantec. 06/11/17, NYC.

51. "It means that we have to get out our "silos" (fragmentation of our disciplinary thinking) and start to think horizontally across boundaries. Not just our professional boundaries but thinking across the boundaries of time and space" Answer to the question n.1 Chapter 1.6. Extract from the interview with Prof. Hillary Brown, CCNY. 16/11/17, NYC.

52. Extract from the interview with Joshua D. Eldridge, Great Ecology, 15/11/17, NY.

53. Conversation with Prof. Mosè Ricci, chapter 3.2.

54. Extract from the interview with Vanessa Keith, StudioTEKA, 17/11/17, NY.

55. Extract from the interview with Hillay Brown, CCNY, 15/11/17, NY. The entire interview is reported in the first chapter (1.6).

56. Definition reported in the interview with Francesca Moraci, Anas, 18/07/17, Futurinfrastructure, Trento. The entire interview is reported in the second chapter (2.2.2).

57. Extract from the interview with Maurizio Carta, Unipa, 19/07/17, Futurinfrastructure, Trento.

Epilogue

The main objective of this research can be summarized in the idea that it is necessary to enlarge and to overcome the boundaries both in the concept of a physical space and in research fields. The survey of small part helps us to deepen the problem, but not to understand its broad-spectrum consequences. We know very well that in systems theory, every little variation changes a balance that manifests itself in the long term[58]. For this reason we are inclined to consider every human action an impact, which consequently implies an implicit judgment in respect to any planning on the landscape and on the natural environment. Ineptitude or an incorrect approach to the project, which responds to contingent needs, leads us to be superficial in the design action, both to lack of time and money. In the creative process we lose a clear link between cause and effect, made visible only by an approach that says of "thinking in larger systems and looking at the formal / informal, visible / invisible reactions between natural systems and constructed systems"[59]. Putting the relationship with nature at the center of the project[60], we can see how the dichotomy between man and nature exists only when it is read as such. Ecology studies the relationship between living sphere and its environment[61]. Man is also part of this. If we think of the roads or more specifically the motorways, used as an experimental field in this research, we realize how "the interactions between roads and the ecosystems and watersheds in which they reside fundamentally shape of the flows and movements across the land, in effect determining how landscape works"[62].
For this reason, in the landscape project we can not overlook an overview that highlights the possible dynamics of the relationship between anthropic and natural systems. Starting from this goal, through a holistic view of the system, the research "Future motorway. Design strategies for next generation infrastructure", in its path, deals with doubly important and urgent issue: the need to consider mobility infrastructures as landscape devices and the definition of a new paradigm for the motorways of the future.

In an initial phase of historical assessment of the problem, emerged the need to redefine the infrastructures in a systemic point of view that saw them not be "on hold", but active. This is possible through strategies of compensation, mitigation and proactive planning towards change, applied in a preliminary stage of design in a transition framework to technological, ecological and cultural changes in which infrastructure is inevitably involved.
The motorways are protagonists and examples of gray territorial infrastructures that deal with the theme of change through three different points of view: cultural, technological and ecological. From the initial analysis emerges the need for a change in the infrastructures, which from impact become systems related to the environment in a phase of transition to a stage 4.0. This change tries to overcome the paradox of the future through the definition of TechnoEcoSystem and the thesis elaboration: TechnoEcoSystem as design strategy for resilient motorway (1.0).

With this statement, the technological, ecological and systemic motorway, through the design of osmotic devices, such as service areas to support tran-

sit, transects and noise barriers, becomes TechnoEcoSystemic, switching the logic of an eco-environmental culture. The motorway assumes the role of a system within a holistic view of the landscape ecology that recognizes the anthropic systems as part of the whole. In this framework, the motorway, like many other infrastructural systems, instead of being impact, becomes a system and an instrument of balance between natural and anthropic systems. This is possible in an energy transition scenario with an increasingly reduced use of non-renewable resources and an increase in natural ones. After the transition, the motorway should prove to be resilient to change, and this through strategies that increasingly see it as a machine for the landscape. Through case studies (Theory, Trend & Action), these strategies are collected in a classification in terms of services to demonstrate the second hypothesis: TechnoEcoSystem from descriptive concept of processes, to an active strategy. So the motorway becomes a support for the systems, aiming at a balance of the ecosphere, through design strategies that produce cultural, provisioning and regulating technoecosystemic services for the landscape (2.0).

Following the premises, which emerged also during the research "Reinventing A22"[63], both theoretical and design aspects related to the concept of osmotic infrastructure and thecnoecosystemic motorway have been investigated through projects. The design part of the research has allowed the group to translate the ThechnoEcoSystem concept into application, through specific osmotic devices: service areas and noise barriers. Both have been reworked in a perspective of conceptual and experimental innovation (3.0).

More attention both in the more theoretical and in the application part of research has been placed on the service areas, going to elaborate the second hypothesis: Service areas as prototype of TechnoEcoSystem. Having always been central to the processes of cultural change, service area is used as an experimental prototype of the concept. In a 4.0 scenario of the TechnoEcoSystem motorway, the service area becomes a techno Ecotone, which overcomes its non-place[64] condition, deleting out the equality between the 'here' and the 'elsewhere'. It intercepts the crossed territories, and enriches the (motorway and non-motorway) environments with which interaction occur.
The service area will assume a characterization both for the type of morphology it will have in each territory and above all for the technoecosystemic services that it is able to provide for the environments, in which it is a direct or indirect interface (4.0). This becomes clear with the detailed study done on the Plose East case study reported in chapter 4.

The whole path with theoretical / analytical investigation and design experimentation combined in a systemic logic, is summarized in a methodological path for the design process. The methodological proposal aims, through a closed process structure, to have a complete opening on the contents. Through the recognition of values and impacts outcome to the relationship between motorway and different types of landscape, the methodological tool allows the design process to identify the potentials and the services that are

able to produce together two systems in apparent opposition. The functional interface between the two systems allows us to work on balancing the relationship between anthropic and non-human environments, also in order to keep aware to the possible loss of functionality of one of the two (5.0).
This method proves the initial thesis by defining an approach for the infrastructural project in a 4.0 scenario that defines the infrastructures, specifically the motorways as: osmotic, resilient and systemic.

As a whole, the work combines theoretical and experimental aspects, within a path of design process that through qualitative and quantitative observations, defines the 4.0 motorway through a holistic view of the system. Through the method emerged some aspect to be applied at future projects, such as: it is necessary to immediately clarify the roles of the subjects involved; we must look for ever broader support, not limiting it to the initial one; it is never too late to decide to change something that already exists whose design is not recognized; we must experiment to learn which they are the right solutions to adopt and we have to read everything in an interdisciplinary and system-based way. An architect, a landscape architect, an ecologist...all these people have a piece of the puzzle, but none of them are connecting across all of those different disciplines. We are working in silos and we are missing a lot of potential solutions that we have. So each disciplines has a tiny piece of the solution and what we really need to do is link and then connect[65]. This research tries to do that, marring the aspects of nature and man-made systems.
What we need to do is try to keep a balance between the systems, making sure that you are not creating another problem by trying to do too much. The technoecosystemic goals are ambitious and the design gives a lot of benefits that should be calibrated. We are interested in this type of infrastructure, if we really think it should be more intelligent, it must be: more porous, more relational, more interactive and capable of generating other dynamics in the territory[66]. A gray infrastructure that almost becomes a green infrastructure. This completely changes a division that until today had been rigid, subverting the relationship between landscape and infrastructure or environment and infrastructure. The infrastructure to be rigid and passive becomes in the technoecosystemic scenario, an environmental infrastructure at the service of the territories[67]. Within a complex vision of the environment, the innovation of the research is in recognizing the motorway behavior as systemic, which thanks to a 4.0 scenario of technological innovation combined with ecological objectives reveals its ability to produce cultural, ecological and energetic services through the sensible design approach. The motorway, therefore, to be an element of impact and disequilibrium, becomes a useful tool to balance the biogeochemical exchange processes that take place within the geosphere. This crosses a border representing an absolutely new point of view, on which research must continue to work.
The thesis takes shape through a resilient method to changes that can be implemented over time. The future perspectives that can be developed starting from this reflection on the future of infrastructures are the following:

1_Implementing the toolbox with innovative solutions with the applicability of new technologies to systems to produce technoecosystemic services.
2_Appling the method to other contexts different from Autobrennero and specifically, on other devices than the service area (for example the motorway exits, hubs of interchange between different dynamics of living space). This would allow us to have an almost complete vision of the idea of the motorway system in all its parts.
3_Quantifing economically the services produced in the specific experimental cases, in order to have a shared reading of the results in terms of value, including monetary value, which is decisive in the action of the projects.
4_Producing an operational tool that puts the method seen in chapter 5 into the system with the idea of a future-oriented technoecosystemic infrastructure. The tool must be free from temporal and instrumental constraints. As the toolbox, it should be able to be resilient to the needs that both in time and in respect to context the project needs.

Image 7|Poster Futurinfrastructure. "Let's make osmotic what is already there".

At the end, the Future Motorway in a 4.0 scenario is what we already have. We do not need new infrastructures, but we need to work on the existent elements, connecting the technologies with nature, in a process of dynamic relationship between systems, in order to avoid the obsolescence of our actions on the landscape.

Note
58. The butterfly effect, concept of the Chaos theory.
59. Extract from the interview with Hillay Brown, CCNY, 15/11/17, NY. The entire interview is reported in the first chapter (1.6).
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63. The results were published in the book "New Ecologies for Infra / Osmotic Structures". Scaglione, P., & Ricci, M. (2013). A22, nuove ecologie per infrastrutture osmotiche =: A22, new ecologies for osmotic infrastructures. Rovereto: List
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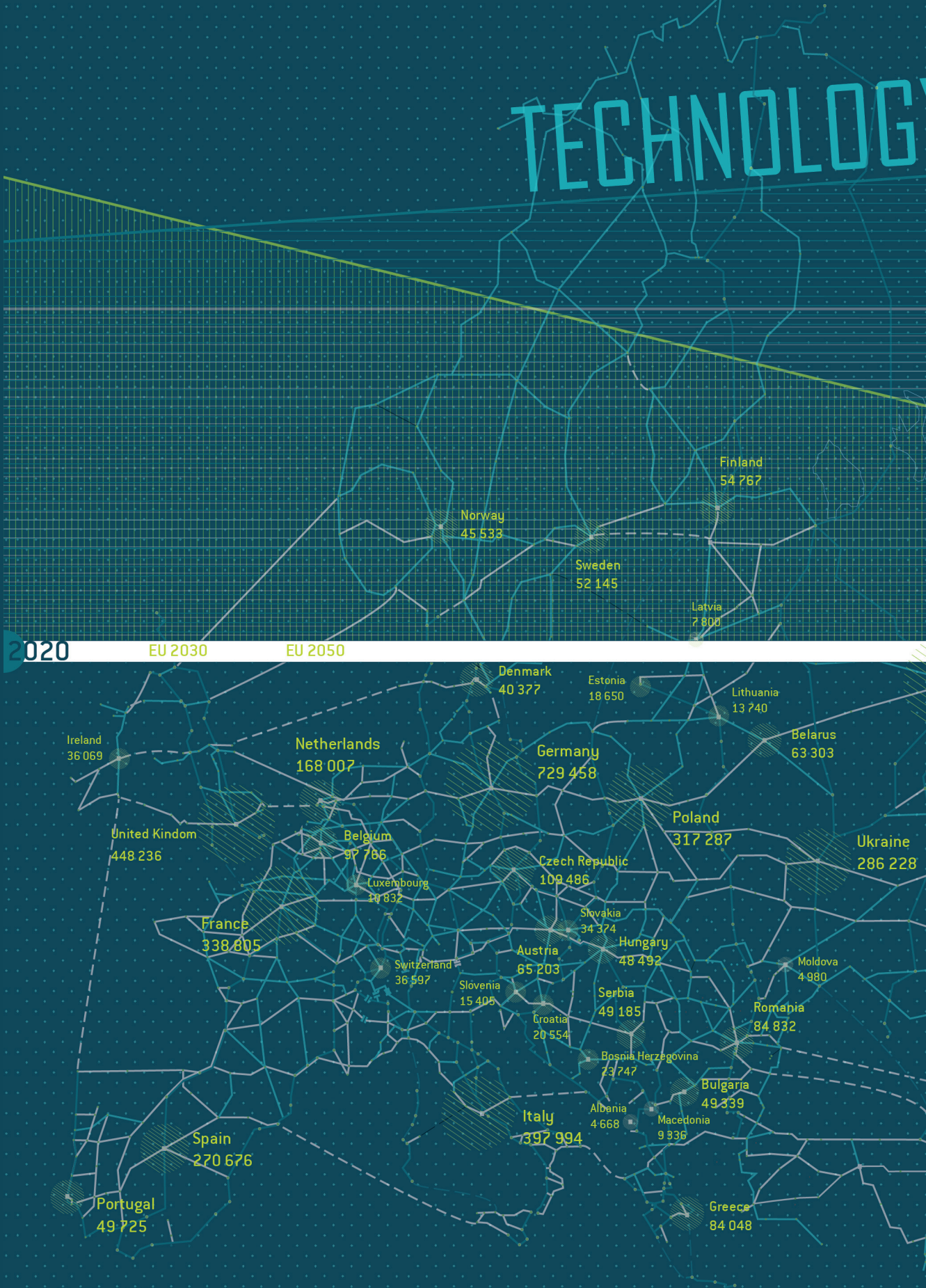
65. Extract from the interview with Vanessa Keith, StudioTEKA, 17/11/17, NY.
66. Extract from the interview with Maurizio Carta, Unipa, 19/07/17, Futurinfrastructure, Trento
67. Interview with Prof. Mosè Ricci, chapter 3.2.



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Images

Chapter 1

Image1| Motorway A4. Autogrill bridge. Soave(VR). Ph: Gaia Sgaramella

Image 2| Cover Le vie d'Italia. From high left: Società Italo-Americana Pel Petrolio (8/1928), Bassi (3/1933), Bernazzoli (3/1934), Angoletta-Puricelli, Italstrade s.a. (2/1941), Angoletta-Puricelli, Italstrade s.a. (6/1941), Duse-Puricelli, Italstrade s.a. (8/1941), Duse-Puricelli, Italstrade s.a. (2/1942), Duse-Puricelli, Italstrade s.a. (6/1942), Di Massa-Puricelli, Italstrade s.a. (8/1943). Source: www.gbreda.it, in Touring Club Section

All schemes of the chapter are designed by Gaia Sgaramella

Chapter 2

Image 1| A22 osmotic concept. Research "reinventing A22". Designed by Pino Scaglione. Source: Scaglione, P., & Ricci, M. (2013). A22, nuove ecologie per infrastrutture osmotiche =: A22, new ecologies for osmotic infrastructures. Rovereto: List

Image 2| Osmotic devices. Research "reinventing A22". Source: Scaglione, P., & Ricci, M. (2013). A22, nuove ecologie per infrastrutture osmotiche =: A22, new ecologies for osmotic infrastructures. Rovereto: List

Image 3| Total Human Ecosystem. Landscape Ecology. Naveh, Z., & Lieberman, A. S. (1994). Landscape ecology: Theory and application. New York: Springer. Designed by Gaia Sgaramella.

Image 4| Total Human Ecosystem Ecosphere. Actual prevalence situation. "What is holistic landscape ecology? A conceptual introduction". Zev Naveh. Designed by Gaia Sgaramella.

Image 5| Total Human Ecosystem. Transition towards a 4.0 scenario. Designed by Gaia Sgaramella.

Image 6| Total Human Ecosystem. Transition towards a 4.0 scenario. Role of the motorway in the Technoecosphere. Designed by Gaia Sgaramella

Image 7| Total Human Ecosystem 4.0 scenario. Complete passage to renewable energy. Designed by Gaia Sgaramella

Image 8| Total Human Ecosystem 4.0 scenario. Balance between natural sphere and technosphere. Designed by Gaia Sgaramella

Image 9| Motorway as a TechnoEcoSystem. Relation with landscape systems. Designed by Gaia Sgaramella

Image 10| Systemic services. Adige Valley. Designed by Gaia Sgaramella

Image 11| UniAmo il territorio. Render of the project. Designed by Francesca Dusini, Veronica Foretta, Veronica Tolotti.

Image 12|Visual analysis of the area. (Ferrari,2017)

Image 13|Winner project details. UniAMO il territorio. (Ferrari, 2017). Designed by F. Dusini, V. Floretta, V. Tolotti.

Image 14|Features of the project: frammenti di ricchezza (Ferrari,2017). Designed by G. Codroico e E. Menin.

Image 15|Road Effect Zone. Designed by Gaia Sgaramella.

Image 16|COST design solutions for wildlife overpasses and underpasses. Designed by Chiara Rizzi (Rizzi, 2016)

Chapter 3

Image 1| Functional options. InfraA22 Lab. Designed by Vincenzo Cribari.

Image 2| Smart Barrier. InfraA22 Lab. Designed by Vincenzo Cribari.

Image 3| Technological section. InfraA22 Lab. Designed by Vincenzo Cribari.

Image 4| Conceptual diagrams. InfraA22 Lab. Designed by Vincenzo Cribari.

All images related to the smart barrier are designed by Vincenzo Cribari.
All images on the service area are designed by Gaia Sgaramella.

Image 5| Plessi Museum. © Oskar-Da-Riz, Archivio Autostrada del Brennero S.p.A.

Chapter 4

Images 1|Survey on the service station Plose East. All the images rappresent the relationship with the landscape of the valley. Basically, there is a wall between the infrastructure and the beauty of the valley. ©Gaia Sgaramella.

Image 2| Forest type. From the peculiarities of vegetation emerges the split in two part of the mixed forest of oaks and chestnuts around the service space. Data: WebGis Bolzano Province. ©Gaia Sgaramella.

Image 3|The functionality and distribution of the spaces into the area, with parking areas and double typology of fluxes, both for car and truck. ©Gaia Sgaramella.

Image 4|Daily Sound Pollution near along the motorway. Here it is clear the effect of the noice on the differente type of landscape: Semi natural Landscape, Agricultural landscape, Suburbs and Rural landscape. Data: WebGis Bolzano Province. ©Gaia Sgaramella.

Image 5| Night Sound Pollution near along the motorway and on Plose East. Here it is clear the effect of the noice on the differente type of landscape: Semi natural Landscape, Agricultural landscape, Suburbs and Rural landscape. Data: WebGis Bolzano Province. ©Gaia Sgaramella.

Image 6| Strategies that aim to reduce noise pollution, to connect the two side of the motorway with an ecological crossing passage for animal and people and to improve the landscape cultural value of the Plose valley. All these goals could be reached also through the management of the functionality of the service area. ©Gaia Sgaramella.

Image 7| Project of the service area through the idea of an Ecotonal space. ©Gaia Sgaramella.

Image 8| The idea of the service area is an interface, interconnected with the other systems of the geosphere. In order to change also the usual distribution of the fluxes, to increase the parking spaces and to invert the fluxes. The result is this, a conceptual vision of a park space along the motorway. ©Gaia Sgaramella.

Image 9| The building disappears and the valley landscape is the protagonist of the scene. ©Gaia Sgaramella.

Image 10| Abstract concept of the building that is the principal entrance. ©Gaia Sgaramella.

Image 11| The section shows a different relationship with the context. ©Gaia Sgaramella.

Image 12| Functional distribution of the building, based on a Design fo All approach. ©Gaia Sgaramella.

Chapter 5

Image 1| The methodology has a double process of knowledge, before and after the selection of the type of service. The action is into an open tool box of options, classified into three macro categories, where the risk is controlled by the use of alternative possibilities. ©Gaia Sgaramella.

Image 2| Each kind of landscape, in relationship with motorway have different actions and possibilities to control and balance the relationship between systems. ©Gaia Sgaramella.

Images Stategies|©Gaia Sgaramella.

Image 3|Poverty, criminality and asthma analysis of New York City©DLandStudio. Source: Presentation of Cap the BQE with Green, intervention of Susannah Drake in 'Transform or tear down?' Conference under Urban Design Forum, Maintaining, Arup, NYC, on October 18, 2017.

Image 4|BQGreen project ©DLandStudio. Source: Presentation of Cap the BQE with Green, intervention of Susannah Drake in 'Transform or tear down?' Conference under Urban Design Forum, Maintaining, Arup, NYC, on October 18, 2017.

Image 5|Environmental justice campaign ©BQGreen Blog. Source: http://bqgreen.org/en/friends-of-bqgreen/

Image 6|Environmental justice campaign ©BQGreen Blog. Courtesy of DLand Studio

Image 7|Poster Futurinfrastructure. "Let's make osmotic what is already there". ©Gaia Sgaramella

The research “Future motorway. Design strategies for next generation infrastructure”, in its path, deals with a double important and urgent issue: the need to consider mobility infrastructures as landscape devices and the definition of a new paradigm for the motorways of the future.

The main objective of the thesis is the definition of a planning strategy for the infrastructures of the future, starting from the TechnoEcoSystem concept.
It is based around a double hypothesis: one theoretical, the other experimental.
The first observes the definition of TechnoEcoSystem (Naveh, Lieberman,1990) from the ecology of the landscape and transfers it to the project/transformation process of the motorways.
The second one identifies one of the prototypes of the Motorway TechnoEcoSystem into the service areas. As a whole, the work combines theoretical and experimental aspects, within a path of design process that through qualitative and quantitative observations, defines the 4.0 motorway through a holistic view of the system.

Gaia Sgaramella, is a PhD candidate in architecture and landscape planning at University of Trento, where she received her master’s degree in Architecture and Building Engineering. She is a distinguished scholar at CUNY, Bernard & Anne Spitzer School of Architecture, City College of New York.