Quality In Road Design

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SYNOPSIS

Today we live in a world in motion, therefore designers have to understand and make pleasant the driving experience with good quality roads which are not just static elements of the landscape, but also sequences of observation points for the environment dynamic use.
Studying the road technical, physical and perceptive characteristics, the object of this research is to develop a road design method based on visual perception and on environmental psychology to obtain good quality roads, so that travels are not only more pleasant but also safer.
It has been necessary to understand how users judge the road quality, the role played by context and the way in which road users perceive and represent the environment.
In particular we have identified the aspects of *ecological road systems* which have a visual impact on the road user and physiologically and psychologically condition driving of the average motorist. We have divided these aspects into *environmental preference predictors* and *environmental preference detractors*.
So we have identified the fundamental *design elements* for the implementation of this research: the *marginal and accessorial pavement elements*, *road furniture*, *road equipment* and *traffic calming measures*.
Subsequently, a method was developed to design or manage urban and rural infrastructures.
The method is applicable in the following steps:

1. perceptive monitoring: it locates the visual area of intervention;
2. images examination: it locates *environmental preference predictors* or *detractors*;
3. identification of the possible design solutions removing the *environmental preference detractors* and combining the *environmental preference predictors*;
4. iterative representation of the intervention using computer analysis (photographic retouch or rendering) to simulate the road course or its insertion in a particular context, predicting the user's environmental preference and safety.

From the method application it has been possible to identify useful multidisciplinary design indications, divided according to the *environmental preference predictors* and *detractors*, suggestions to use of the aforementioned *design elements* and sound for road design and for requalification of an existing one, in urban and rural area.
To demonstrate their effectiveness, the results obtained have been applied, for the landscape and housing strong implications, to the existing main road no. 195, which should be requalified as a tourist and urban itinerary.
Finally, the results obtained allow us to assert that, with indepth study of this investigation area, we can optimize the technical instruments necessary to obtain quality roads; roads which suitably connected to places enchanted to reach, can produce a multiplicity of advantages, among which the reduction of atmospheric, noise and visual pollution and the social and economic development of the crossed areas.

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INTRODUCTION

The quality of a product, intended as “the performance response level to requirements which brought about its conception, design, realization and which continue to motivate its existence”, is a *relative value*, function of the comparison between the provided performance and the user demand. In particular, with reference to the “road” product, the user needs to travel in safe and pleasant conditions.
We can evaluate the road quality under three aspects: a) *technical - transport* which has to satisfy safety requirements and levels of service; b) *technical – structural* which also regards stability and maintenance of bridges and other structures; and c) *physical – perceptive* relating to those characteristics which are first noticed by road users and can condition them *physiologically* and *psychologically*. Road design can therefore take advantage of the psychological effects of certain visual elements and can be studied in another way, which goes beyond the observance of the norms and which has already been outlined by Frederick Steiner and Kevin Lynch.
Steiner has often maintained that design has to be *ecological* (Steiner F.; 1991), that is based on the relationship between human beings and between them and their habitat. These relations occur through our senses and can lead to psychological conditioning: all that we perceive, and above all see, makes us perform actions and this has to be taken into account in the design process to avoid irreversible transformations or unwanted side effects, so that road users behave like designers want. From the perception of environmental trails, intended as signs left by those who have used a particular space, we obtain information about the people surrounding use and this allows us to forecast and so direct the design of new areas (Baroni M.R.; 1998); for example short-cuts in green fields indicate that the originally designed ways were too long and that nothing has been done to make these ways used by people: this allows us to adopt adequate countermeasures or to learn from these experiences. So it is possible to speak about *ecological road systems*, intended as the whole included street, human beings gravitated on area and the physical, cultural, social and natural context in which the road is inserted, integrated with the different relations among these components.
Also Lynch’s theory, even if criticised, inspires reflections for the importance given to images. Given that the surrounding form conditions human behaviour, he uses the reactions and the emotions produced by sensations to define the quality form: this has to be possessed of *imageability*, understood as a visual quality being composed of that disposition or colour which most probably produces captivating images, and *legibility* visual quality understood as a facility in which the elements are found and structured (Lynch K.; 1960). If for Lynch, quality acts on the senses, it becomes important to study perception and to use it to obtain form of quality.
In particular, perception is studied in psychology, because *the sensorial experience is the foundation of conscious perception* (Farneti P., Grossi E.; 1995); in this case, environmental psychology studies the perception of the socio-physical environment starting from the stimuli produced and investigates how these stimuli mark human behaviour: we note that in the choice between itineraries, we prefer to cross a public garden or to pass through an aesthetically interesting street, or to pass near to a house of someone well-known (Baroni M.R.; 1998). So to know the relationship between behaviour, emotions and a cognitive map of an environment is useful to transform negatively perceived environments and to design, also in road engineering.

ROAD DESIGN

Roadways And The Visual Experience

The driver lives a travel experience between empty spaces and fixed objects along the road, between expositions and closed spaces, between constriction and relief; between lights and lines, space and movement; the complexity attracts the eyes causing an adequate concentration of the mind. Travelling by car, in fact, the sense most involved is sight, more than hearing and the sense of smell; touch gives instead a secondary contribution through the response transmitted to hands and feet (Appleyard D., Lynch K., Myer J.R.; 1966).
If a motorist closes his eyes he doesn’t realize the movement, unless sudden speed or direction change is caused by something: so our sense of movement and speed depends on sight, because this sense interprets the apparent movement of the context as the result of the car progression (Appleyard D., Lynch K., Myer J.R.; 1966).
A route is therefore the set of the points from which our surroundings can be seen, having a great effect on our emotions and on the representation of the function and the nature of the area. In particular, we must remember that the highlighted components vary in relation to the subject: the tourist concentrates on a few

elements useful for orientation (road signs, flyovers, tunnels), the resident instead on surrounding newness; the driver concentrates on events, on road limits, especially at high speeds, and on decision points (intersections), while the passenger is much freer in his behaviour and reactions (Appleyard D., Lynch K., Myer J.R.; 1966).
Vision, also, is a view sequence where the cumulative effect is important, because observers remember the contrasts: the relief after a restriction, tangents, that add to a drop in attention, followed by gradient and turn stretches, which provoke excitement and seem to introduce something promising but hidden (Lynch K.; 1971). When we are driving along bends in the roads, we experience tactile and inertial sensations, but vision predominates (Lynch K.; 1960) and this can be emotionally accentuated with opportune expedients, in such a way as to have a safe and pleasant driving experience.
This objective can also be reached by constructing curvilinear routes, organizing the overall context, significantly increasing or decreasing the height levels, because tangents and monotonous countryside, despite the fact that they facilitate orientation, can induce sleepiness or speeding due to the apparent objective unreachability, because the initial image, received with a glance, soon fades.
We can also deduce important design suggestions from environmental psychology and from its recent branch of research, the “place-attachment”, connected to a *wellbeing sense* descending from staying freely in a place equipped with resources in harmony with the individual needs, and connected to a *sense of loss* when we are forced to abandon it, despite having recognized in it the capacity to form an attachment relationship. When our attachment to a place ends we speak about an environment crisis, due, for example, to the discomfort which we experience when the territory is subject to development and use models not coherent with local inclination, to the lack of strong institutional buildings (schools, social structures) and to depopulation. To avoid situations like these, it is necessary to plan the territory use so that populations can manifest attachment and therefore preference for the places with which they interact.
With this objective in mind, some psychologists have proposed human behaviour models, with the objective to point out the *environmental preference predictors*, which are factors which a designer should use to make populations really feel own the work done on the environment and to try to predict the preference given by a population to an environment. The lack of any of these elements evidently introduces the same amount of *environmental preference detractors* and indicators of environmental deterioration.
For example, according to the psychologists Kaplan, once a person knows an environment, he tends to attribute an identity and a significance to it and to deepen his knowledge, because he needs to identify the structure of an area to orientate himself, to act and avoid stress; therefore an environment has to be *legible*, *rich in perceptive stimuli and in elements coherent* between them or with human rhythms. It also has to be *mysterious*, able to produce the sensation that, if you enter into it, the need of new knowledge will be satisfied (Baroni M.R.; 1998). Instead, according to Purcell, there exists an *optimum level of discrepancy* from the scheme that stimulates cogitative activity; therefore an excessive similarity or discrepancy cause disappointment (Baroni M.R.; 1998).
Applying some ideas of environmental psychology compatible with road design, it emerges therefore that an *ecological road system* has to be *spacious and comfortable*. It has to be *vital*, functional for safety and health of the environment and of those who travel along or live near it; it has to inhibit the *stress* sources and its crucial dimensions (duration) combining natural resources with *road furniture* (Baroni M.R.; 1998).
A road also has to *make accessible special landscapes* for their beauty and significance and *other people activities*, because listening to and seeing what other people do is also an amusement; it has to allow us to reach some *pleasant places* which we can escape to either alone or with a few close friends, satisfying our need of privacy, so that the wait for reaching these oases makes our journey a pleasant one; it has to highlight the *old appearance* of some traditional or cultural elements.
Finally, a road also has to be *correctly integrated with the landscape*, using local materials to define the structure that accompanies the road, avoiding a too decisive impact on the observer.

Design Elements

Located the road in the most ideal place from the landscape-cultural point of view, all the indications given can be implemented through the *marginal and accessorial pavement elements* (pavement edges, gutters, escarpments, lay-bys, footpaths), *road furniture*, *road equipment* and *traffic calming measures*, in the urban and rural area. Obviously these *design elements* have to be combined in a way in which the designers can obtain both a pleasant and a safe driving experience.
Road furniture includes those design *elements* which form an integral part of the road and complete its legibility and aspect, also having the obligation of satisfying some functional requirements. So we can include in such denomination not only the road accessories and ornamentation, but also those elements which allow us to highlight the route course or the singularity of eventual interesting background figures, and to define the vision field, the space and movement awareness, the visual sequences, the attention rhythm, accessibility and privacy, the pre-eminence of one part, the presence of key points of the road or particular points, continuity, directional differentiation and modulation. *Road furniture*, then, includes ornaments, pavements, kerbs, lighting, road signs, facilities (benches, bins, kiosks, phone boxes, newsagents, public

conveniences, installations, bus shelters, barriers, flower-pots, cycle stands) and green areas with the relative facilities (fencing, basins).
By *road equipment* we mean those elements not necessary to the road, but additional to satisfy particular needs: to define the views sequences and the relationship with the context, to highlight or to hide some particular element of the background or of the immediate context, to highlight road key points and the itinerary identity, to guarantee privacy or accessibility to activities which take place along the route and to introduce road service areas. In this category we can include the tree scenes which mask structures unsuited to the landscape: nothing is added to the street in itself, but to understand the route in certain ways requires intervention *with particular equipment* on the parts in context conditioning the driving experience.
Traffic calming measures are combinations of active and self-conditioning measures, physical and psychological, which change driving behaviour and road configuration favouring users who don't use cars. We can remember *traffic volume control measures* such as the half or full street closures and intersection diagonal obstructions, and *speed control measures* such as speed humps, raised intersections, textured pavements, forced turn islands, roundabouts, chicanes, realigned intersections and street narrowings. Such elements have to be combined with *road furniture* and *road equipment* to obtain a care sensation which often these technical road elements don't produce (Ewing R.H.; 1999).

The Design Method

The application of the above-mentioned *design elements*, with the aim of a pleasant and safe driving experience, can be regulated in a methodical way both in road design and in requalification of an existing one, in urban and rural area.
In particular, being sight the most involved sense during the driving experience along a route, to obtain a pleasant and safe driving experience, we need to begin with the sceneries and visual sequences breaking-up into elements to work on.
This operation of *examination* is certainly conditioned by the point of view under which we look about a place, because in this way different image characteristics are pointed out; it is however possible to locate some standard view components: the landscape and the road which is the object of interest (table 3, cell b).
The landscape, taken as the combination of elements which make up the interface between social and environmental processes (Steiner F.; 1991), is divisible in a background and in an immediate visual context. The first is the most distant part of the visual field and therefore it is seen in a distant and ill-defined way; the second is the best perceivable component in its form and in its elements.
The road, instead, in general occupies a central or foreground position in the image and is strictly connected to the immediate visual context through elements of *road equipment*, or underlined by *road furniture*, *marginal and accessorial pavement elements* and *traffic calming measures*.
Once the examination phase has been completed, with the aim of constructing visual experiences which can be perceived by the user in movement or stationary on the road, it is necessary to identify the possible design solutions: we need to place the road in the landscape in the most suitable and correct way possible, also taking into account the impact this can produce in the managing phase.
We also need to take advantage of the possibilities offered by the *visual context* and by the *environmental preference predictors* or, if necessary, treat with *road furniture* or *road equipment* the part of the landscape or the road itself which are degradation indicators or *environmental preference detractors*.
Contemporaneously we need to pay attention *to the road in itself*, to perception of its aspects and its identity by using, in an opportune way, the complementary elements available to the designer to reach aesthetic and safety aims.
Modern computer design methods applicable both to the road design and to the requalification of an existing one, permit us, finally, to simulate and iteratively correct the result obtainable with different intervention options, evaluating their efficacy.
This study, so, has created a design method applicable both to the road design and to the requalification of an existing one, in urban and rural area, a method which needs the following fundamental steps:

1. perceptive monitoring: it locates the visual area of intervention (table 3, cell a);
2. images examination: it locates *environmental preference predictors* or *detractors* (table 3, cell b);
3. identification of the possible design solutions removing the *environmental preference detractors* and combining the *environmental preference predictors* (table 3, cell d);
4. iterative representation of the intervention using computer analysis (photographic retouch or rendering) to simulate the road course or its insertion in a particular context, predicting the user's environmental preference and safety (table 3, cell e).

From the method application it has been possible to identify *different multi-disciplinary design indications* based on the *design elements* mentioned before, divided according to *environmental preference predictors* and *environmental preference detractors*, and sound for the road design and for the requalification of an existing one in urban and rural area. In particular, the tables proposed distinguish the suggestions regarding the landscape visual enjoyment (Table 1) from those relating to roads (Table 2), pointed out in both cases some *environmental preference predictors* such as *imageability*, *legibility* and *safety*.

Among these *environmental preference predictors* evidently exist some relations: for example it is necessary to opportunely combine imageability and legibility, as it could be considered superfluous, in some cases, to give legibility to an environment or a road not imageable; besides it is evident that the road legibility affects its safety and its imageability.

Table 1 The landscape visual enjoyment.

	A	B	C
1	Environmental preference predictor	Environmental preference detractor or indicator of environmental deterioration	Design indications
2	Imageability	Absence of colours and forms exciting emotions and attracting attention; anonymous landscape.	To attract attention on the road with *the design elements* and opportune visual sequences (table 4, cell b): • to highlight contrapositions or progression of elements, contrast expositions and restrictions; • to avoid long visual obstacles.
3		Lack of underlining of colours and forms exciting emotions and attracting attention; lack of special scenery and architecture.	To underline them with: • the landscape frame technique; to separate terraces with a view from parking areas with *design elements*; • to elevate roads and points of vision; • to use explanatory signs of the crossed area; • at high speeds to take advantage of larger scenery and more dominating elements.
4		No vital and no comfortable environment: too bright, too narrow, too dirty, too rich or with insufficient information, too hot, too cold, too noisy.	To limit dust, sounds, erosion caused by water, wind, sun with vegetation. To use sufficient and uniform lighting. To reduce noise giving a correct priority to positive provocative noise stimuli. To contrast “hot” colours (red, orange, yellow, brown) and “cold” colours (green and blue). To use *traffic calming*. Cleaning of the landscape.
		Abandoned destination.	To create nice areas coherent with human needs.
5		Elements which disturb in a visual context: industry, decay, electricity distribution substations, deserted areas, pronounced buildings, rubbish (table 5, cell a).	To constitute optimum discrepancy levels of the elements compared to the scheme: • correct environmental road insertion using local materials; • to hide troubled elements with *road furniture* and *road equipment* (table 5, cell b); • to place underground the technological network cables.
6		Incorrect environmental road insertion.	To position the route without damage to the environment or to protected sites. To use examples such as parkways, with road sections partially paved and immersed in the nature. To relieve the impact using local flora, including evergreen species; to uproot plants growing around abandoned buildings, to respect the area hydrology; to model and to stabilize the escarpments using vegetation; to expropriate the necessary areas.
7	Legibility	Absence of colours and forms exciting emotions and attracting attention; anonymous landscape.	To see cell C.2.

8		Lack of underlining of colours and forms exciting emotions and attracting attention; lack of special scenery and architecture.	To see cell C.3.
9		Incomprehension of the territory human use.	Reciprocal visibility of activities or visibility of activities from the street. To highlight the activity symbols; to use explanatory signs. To highlight the possibility of privacy with *road furniture* and *road equipment*, identifying human presence only with car parks.

Table 2 The visual enjoyment of a road.

	D	E	F
1	Environmental preference predictor	Environmental preference detractor or indicator of environmental deterioration	Design indications
2	Imageability	Route or long tangent monotony and hazard.	To realize opportune visual sequences with the *design elements*: • to organize the route with elements coherent between themselves and with man, contrasted or in slow and continuous progression to exalt speed and movement and to attract attention; • to contrast expositions and restrictions; • to avoid long visual obstacles. To highlight routes and key-roads with *road furniture*, *road equipment*, activities, appropriate road wide sections, facades, visibility from the city or from the road (bridges). To insert bends conforming with the three-dimensional alignment. To arrange serially *road furniture* or *road equipment* exalting movement and emotive reactions, and which are points of reference after the bends. To make clear the movement: the road rises on something if it has a hump, it is forced to go down under something if it has a depression, it goes around a pivot or is deviated by an object if it bends, it is divided by something if it diverges (Appleyard D., Lynch K., Myer J.R.; 1966). To exalt the intimacy sense with dense vegetation, closures given by buildings and visions of sky parts. To exalt the expositions with open spaces and visions of large sky parts. To use slopes to make crowded areas more spacious (Appleyard D., Lynch K., Myer J.R.; 1966). To make advantage of: the equipment and sign driving-effect, the *road furniture* and *road equipment* position to emphasize movement where it is necessary to slow down; the fact that objects placed ahead are better perceived than those laterally, those in apparent movement and near are better perceived than those stable and far away. To take advantage of a better perception of the objects on a side, above all the right hand side, noting the fact that oblique objects are better perceived than those perpendicular to the movement. To avoid long tunnels. To avoid anonymous landscape playing on the rhythm attention: a rapid rhythm of the elements focuses on near objects producing straining, a slow one focuses on distant objects (Appleyard D., Lynch K., Myer J.R.; 1966). To highlight singularities avoiding a gigantic effect, which produces a shock sense, and avoiding reductions, which induce a preciousness or insignificance sense.

3		Rubbish in gutters and escarpments.	To clean gutters and escarpments, to place containers for rubbish.
4		Neglected *design elements.*	To take care of such elements (table 3, cell e).
5		Spontaneous vegetation but not cared for, monotonous, episodic and unorganized.	To create formal or contrasting effects, contrasting forms or texture; to avoid to damage the architecture. Uniformity gives order but not rigidity, variety doesn't produce a composite pattern. The choice of vegetation is a function of climate, colour, existing green, maintenance, the land and buildings forms.
6		Inadequate guard-rails or guard-rails at eye level.	To use resistant guard-rails which act as barriers and visible warning signs; to make them in laminated timber with the framework in stainless steel in the areas under protection. To allow vision without neglecting safety.
7		Casual, illegible or not heterogeneous signals and signs.	To use clear and legible signals and signs, or writing on paving. To adopt a homogeneous language. Advertisements should give vitality but not distract the driver.
8		Congested roads.	To adopt sufficient road sections, to forbid access to heavy vehicles. To separate the highway from pedestrian areas or cycle lanes with *design elements*. To avoid intersections with overpasses (figure 6).
9	<u>Legibility</u>	Monotonous and dangerous tangent which immediately exhaust the image.	To see cell F.2.
10		Insufficient user or tourist orientation.	To guarantee continuity of paving, road width, vegetation, facades. To use the surrounding equipment and signal driving-effect. To create a road code with paving: cobbled paving is ideal for parking, stone pavements for walking. To realize a directional use of adjectives with regular changes or in progression of attributes (increase in trees near a park, of signs near the market), because a road is a thing going toward something. To create an oriented progression with strong key points. To use the climax to create suspense so that a key point, which has disappeared, reappears more intense or with a new face; you can see one key point immediately after the other (Appleyard D., Lynch K., Myer J.R.; 1966). Progression should be measurable with *the design elements* to highlight the objective reaching. To highlight the route direction using bends of about 90° and gentle bends, otherwise the mind is disconcerted. To use positively a clear and legible signaling system, written on pavements and explanatory signs of the crossed habitat.

11		Insufficient underlining of entrances and exits from particular areas.	To underline the beginning and end of a road with *the design elements*. To use positively a clear and legible signaling system, written on pavements and explanatory signs of the crossed habitat. To highlight the entrance to protected areas with road restrictions or with trees and houses on the route sides.
12		Intersections difficult to read.	To construct intuitive intersections. To signal the turns to avoid disorientation, to underline them with *the design elements*. To avoid loop ramps, because the turn comes after the intersection.
13		One way roads.	To reduce their presence because they are structural complications.
14		Incorrect lighting.	To underline routes, intersections, residential areas and tunnels with sufficient and uniform light. To use lamp posts and lighting equipment in proportion to the context, avoiding a gigantic effect, sense of preciousness or of insignificance.
15	Safety	Monotonous and dangerous tangents.	To see cell F.2.
16		Humps with low visibility.	To modify the vertical alignment.
17		Excessively large road sections.	To use opportune road sections and *traffic calming elements*.
18		Congested roads.	To see cell F.8.
19		Dangerous bends.	To insert bends conforming with the three-dimensional alignment. To arrange serially *road furniture* or *road equipment* exalting movement and emotive reactions, and which are reference points after the bends.
20		Dangerous intersections.	To see cell F.12.
21		Bus parking on traffic lanes or on turn lanes. Unpaved lay-bys for emergency parking, used as a parking area, or their absence: the parking is on the road.	To construct paved lay-bys, signaled, well-dimensioned and well-distributed.

Application

To demonstrate the validity of the obtained results, they are applied to the coastal main road no. 195, a road which runs along the southern coast of Sardinia.

Above all, we must underline that particular housing and environmental problems exist on this route: the decentralization provided for in the *Provincial town planning programme*, the *International Convention of Ramsar* and the "*Life-Natura*" project on the adjacent Santa Gilla lagoon, the erosion of the parallel Giorgino-La Plaia beach, the necessary canals connecting lagoon and sea and functional for the fish survival in the lagoon, and the vegetation existing along the road. This vegetation is dominated by *atriplex halimius L.*, a bush belonging to the most resistant species among those which could naturally grow in such environment full of rubbish, rubble and pieces of wreckage.

It is also necessary highlight the necessity of constructing a new main road no. 195, due to various reasons which have by now produced a traffic volume near to the road capacity, with obvious problems connected to safety and the trip time.

The main road is actually crossed by different vehicle flows: the summer tourist flow which goes towards Pula and Chia, situated west of Cagliari, those going towards the city from residential areas which have been constructed in the last ten years on the coast as a result of the concentration of industries in the Cagliari area, and the traffic flow directed towards the capital's port from the industrial area of Macchiareddu-Sarroch.

With the new main road constructing, the existing route, in the context of investment for tourism, begun on the island southern coast, should be requalified as a tourist and urban itinerary, even if, in emergency situations, it should however be suitable for the transit of industrial vehicles coming from Macchiareddu.

The intervention objective is to allow a smooth circulation between the different coastal residential areas, the requalification and a pleasant fruition of the coastal area and of the Santa Gilla lagoon, and the surrounding area socio-economic development.

Figure 1 The red line indicates the main road no. 195.

The first step for the application of the proposed methodology consists in perceptive monitoring, which has highlighted the presence on the route of two homogeneous parts: a rural one between the intersection for Giorgino and La Maddalena beach, and an urban one connecting some areas of the municipality of Capoterra.

Such parts, for what we have previously highlighted, cannot be considered quality routes, because, in the course of time, the environmental placing, *road furniture* and *road equipment*, *the marginal and accessorial pavement elements* and legibility have been neglected.

In particular, some degradation indicators can been perceived. These included some *elements of disturbance* not hidden by *road furniture* or *road equipment*, or not realized with natural materials (wood and stone): the remains of a demolished petrol station, a jetty of Enichem, tanks and pipelines not filled in at the jetty, electricity distribution substations covered with advertisements, the prolonged closure of the view because of a fuel depot wall, unpaved routes which intersect with the road without warning and which extend onto the by now degraded beach, and finally the neglected buildings and the agricultural companies.

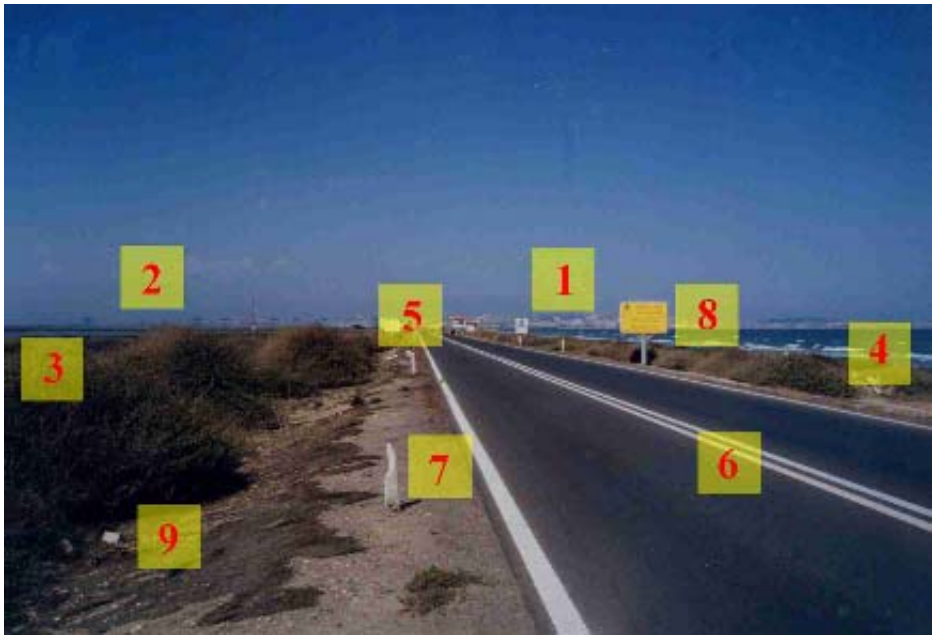
Instead, there appears an *environmental preference predictor:* the enjoyment of some special landscapes from the bridges on the canals connecting lagoon and sea, above all in the part of the "*Life-Natura*" project in the Capoterra salt-works.

Vegetation, which should be a primary material for *road furniture* and *road equipment*, is neglected. It isn't present on all the route. It has no aim of creating any formal effect or of highlighting axis roads or landscapes, or of concealing certain *environmental preference detractors*. However, in general, are present plants untypical of the area such as oleanders, or palms placed near the jetty.
In the urban stretch of road, residents on their own initiative have had to create tree filters against the dust and noise which comes from the road and also for privacy; besides cared for green areas are present at some junctions.
Guard-rails are often inadequate, made of grey metal, a colour which doesn't correspond with the surrounding landscape and generally their height blocks the view.
Advertising placards are cold and chaotic contributing, when are not covered by vegetation, to the creation of a cold peripheral rural atmosphere.
In order to have context *legibility*, in the rural route there aren't lay-bys for flamingo sighting and key points of particular aesthetic interest which allow us to give a pleasant identity to the route, to modulate it, to identify the direction of the route, and so to orientate the drivers: for example the passers-by take the jetty of Enichem as a reference point for the route direction, but it isn't well-inserted in the context and so appears also as a disturbance element.
The sensations at bends aren't exalting particularly with metallic guard-rails or plants; coming out of the bends there are no references indicating the main road development.
Besides, having considered an intermediate stretch of road, we can't locate an origin or a destination of the route.
Nevertheless, it has to be emphasised that a factory crane, the silo of a concrete mixing centre and the visibility of swimmers on the beach guarantee *legibility* of the Capoterra context; also the road section largeness *continuity* and the absence of important deviations allow the tourist orientation.
As far as regards the *safety* of the road, the rural part, immersed in an anonymous landscape, is made up of long tangents which make attention drop or increase the speed.
Also there are crossing bridges of canals between lagoon and sea which impede good visibility. In the urban road stretches, instead, the section is excessively wide and stimulates a speed increase.
Then, the intersections present problems of entrance into the principal traffic flow, also because night lighting is insufficient. The imposition of a 50 kph speed limit on all the road is not respected in order to make up the time lost travelling behind heavy vehicles or at traffic lights at the Capoterra junction.
Emergency *lay-bys*, often reduced, are used in the rural area as swimmer parking, while in the residential areas they are not paved; besides, where they don't exist, the swimmers park on the unpaved pavement margins.
Finally, bus stops of regularly travelling busses are situated in traffic or turn lanes.
For the application of the methodology remaining points, when opportune visual areas have been located for the intervention, and broken down into their elements to identify the *environmental preference predictors and detractors*, some multidisciplinary intervention have been proposed and are outlined as follows.
In the so called *urban road stretch*, given the predictable saturation of adjoining space, it is necessary to realize an *arterial road* with speed limits of 50 kph: the sense of spaciousness is reduced with two lanes of 3 metres, benches of 0.50 metres and footpaths of 4 metres.
Private vegetation has been maintained as an element of *road equipment* to guarantee privacy and hide greenhouses or abandoned buildings; artificial lighting has been used.
Given the visual monotony of long road stretches, provoked by tree filters and by oleanders, we have provided to put the *greenery* on the sides of the carriageway with a rapid rhythm, every 10 metres, under the form of regular form shrubs, belonging to low hill area species and characterized by different colour flowers: tamarisks, brooms, and in some parts oleanders. In such way, we realize the ecosystem respect, the passers-by attention towards the street, the impression, because of reduced distance between the shrubs, of an excessive speed which provokes slowing down, and the legibility of tangents and bends through the contrast with the background.
We proceed to cover the *electricity distribution substations* in stone, to remove the carriageway delineators and *advertising billboards*, substitute the *lay-bys* with parking areas within the residential areas, set the bus stops within the residential areas or, in particularly difficult cases, in adequate lay-bys, make visible the *signs of adjacent commercial places* and use *signs describing the crossed area* or the local tradition structures.
Roundabouts have been provided for in the residential area accesses, to guarantee greater safety conditions at the intersections, to deviate vehicles from their trajectories and to impose a speed reduction in correspondence with critical points, but also to allow vehicles to make u-turns and give legibility to the route, and creating points of visual reference for road users, above all for tourists, also through the greenery which characterize them (Ewing R.H.; 1999).
With the exception of the Capoterra roundabout, which has two lanes because of the greater traffic volume, the others have only one lane. All roundabouts present a truck apron, that is an area that can be crossed by busses or by heavy vehicles.

The urban road stretch *finishes* at the La Maddalena roundabout, which identifies a discontinuity point in the road section width and in the immediate visual context, because users pass from an area predominantly made up of housing, to another predominantly tourist. This fact is underlined with the visibility of the contrast between the natural landscape (the lagoon and the sea) and that which is a built up area, using a low vegetation which allows us to understand the surrounding human use.
In the *rural road stretch*, predicting a modest traffic volume, the transversal section has been reduced to one of a B C.N.R. type with a speed limit of 40 kph with two lanes of 2.75 metres and benches of 0.75 metres, making space for *road furniture* and parking areas at the carriageway side.
This road stretch is situated in a quite delicate area, between the coast and the humid zone, constituting a barrier between the two sites also as far as concerns the offshore bar dynamics; besides, human pressure and the refuse accumulation has produced, among other consequences, the *atriplex halimius L* proliferation.
Given its location, the road has an obvious tourist role, with the object of developing the coastal area and the humid zone, which is the site of the project "*Life-Natura*".
But for the development of this attitude, is necessary a plan of reclamation and environmental requalification of the two sites, which evidently has to be founded on a careful analysis of the existing equilibrium and of its historic evolution.
Evidently the intervention could be of very different types, but the results are unpredictable, as a result of the ecological system reaction, and, besides, can only be seen in the long term.
A preliminary intervention consists in minimizing the barrier-effect reducing the earth embankment heights where possible, cleaning the beach and the humid area of rubbish, *maintaining the existing vegetation* to reduce coastal erosion, regularizing the bush form in a way that limits the neglection sensation and guarantees to swimmers privacy and protection from dust.
Only when the visual context becomes an attraction source for passers-by, the road can realize its vocation as a tourist itinerary. To obtain this we need to act not only on the coast and on the lagoon, but also on the immediate visual context and on its elements which create a disturbance, and then on the road.
We need to use *shrubs* belonging to appropriate species adapted to marine or coastal areas, such as artemisias, tamarisks, brooms and oleanders and to situate them along the road with a rapid rhythm, every 10 or 20 metres in a way which concentrates the attention on the route and on the landscape respectively. Shrubs with flowers of different colours have been chosen to activate the passers-by attention and highlight the route direction.
We thought of covering the *Enichem jetty* in stone, hiding tubes and bridge abutments using trees (table 5, cell b), diverting the road axis at the jetty, inserting a roundabout with two lanes which includes greenery, and situating a bar and a paved parking area, lighted and with trees, for the the nearby "*Life-Natura"* fruition.
On the *beach*, we proceed to remove ruins and tanks unused, bury or mask some tubes with footbridges, create luminous parking areas on packed earth, which are reachable from the main street, and opportunely defined to prevent cars from gaining access to the foreshores. Also we need to highlight through stone paving the paths which lead from parking areas to the beach.
Proceeding towards Cagliari, the *wall of the petrolium depot* has been masked with a stone covering and with dense vegetation. Vegetation is also present on the other side of the street to give a closure sensation in contrast with the spaciousness which one feels before and after this road stretch.
The space occupied by the *demolished petrol station* has been requalified with an lighted square, separated from the road by dense vegetation and equipped with a kiosk, fountains, wooden benches facing towards the sea, stone pavements and tree barriers for protection along the coast. We have thought of encouraging the view from the bridges on the canals between lagoon and sea, removing every obstruction (signs and barriers which are too high) and substituting the metal guard-rails with those in laminated timber and of such a height that they don't obstruct vision.
The carriageway delineators have been substituted with *cat's eyes* positioned on the lines which limit the road, a *green coloured road paving* has been used, and the continuous double lines have been maintained in the carriageway centre.
Also some *bird-watching lay-bys* have been designed (table 4, cell b). These lay-bys are separated from the road by a dense vegetation, paved in stone and equipped with wooden benches, tree barriers for protection along the lagoon and telescopes.
In the area of the Capoterra salt-works we have designed a *surfer pier*, parking for cars and busses and *advertisement billboards* have been removed.
With the aim of visual context *legibility*, the road has been equipped with an adequate artificial lighting system at key points which need to be underlined also during a night journey along the road (for example the square), and of a sufficient number of *explanatory signs* about the crossed environment and about the different opportunities offered to passers-by.

Table 3 Example of method application.

a) Identification of the intervention visual area.



b) Image examination:

1) the background: Cagliari; 2) the background: the Porto-Canale; 3) the immediate visual context: the S. Gilla lagoon; 4) the immediate visual context: the beach; 5) the immediate visual context: the **demolished petrol station**; 6) the carriageway; 7) *the road furniture*: the carriageway delineators; 8) *the road equipment*: the advertising billboards; 9) *the marginal and accessorial pavement elements*: the escarpments.

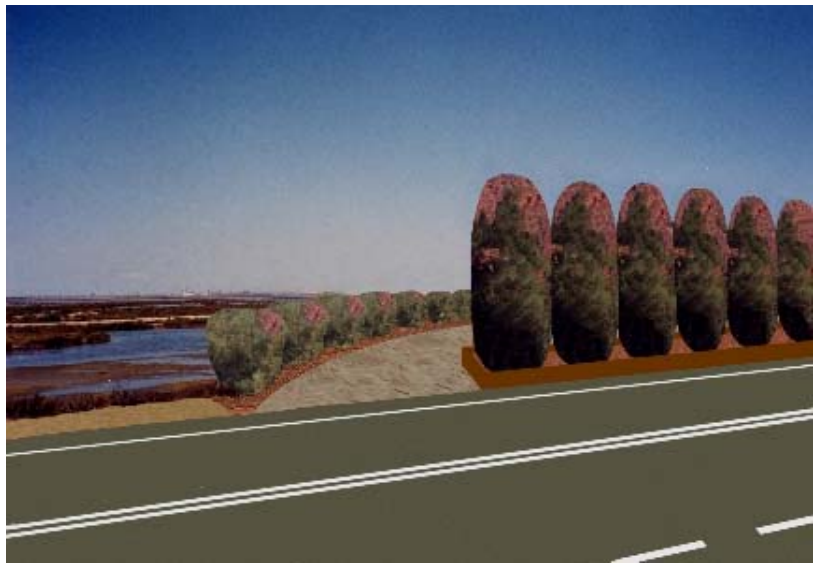
c) The particular intervention visual area: the demolished petrol station.

d) *Environmental preference detractors* removal.

e) The proposed intervention simulation for the particular visual area: a square on the seafront.

Table 4 Other interventions.

a) Identification of the intervention visual area: the special landscapes of the Santa Gilla lagoon.



b) The proposed intervention simulation for the particular visual area: to maintain the special landscape visibility or to realize lay-bys for bird-watching.

Table 5 Other interventions.

a) Identification of the intervention visual area: the intersection at the Enichem jetty.

b) The proposed intervention simulation for the particular visual area: to insert a roundabout and to mask the jetty.

Existing Examples

Similar design examples are historically represented by the American parkways, which seem to have anticipated many considerations made in this research.

In fact a parkway is a panoramic itinerary inserted in the uncontaminated nature, a connecting road between city parks or between the periphery and the city (riverside parkways), a ring park to admire from the window (figure 2, figure 3). It unites the advantages of the freeway and tourist roads, because it allows a fast and safe traffic circulation, it presents panoramic and recreational areas; it is precluded to heavy vehicles and the paved part only represents a small part of its total width, which sometimes reaches a few hundred metres; on park stretches the neighbouring border inhabitants don't have access or view right (Zapatka C.; 1995).

Figure 2 Parkway at Fort Indipendence, Castle Island, Massachusetts.

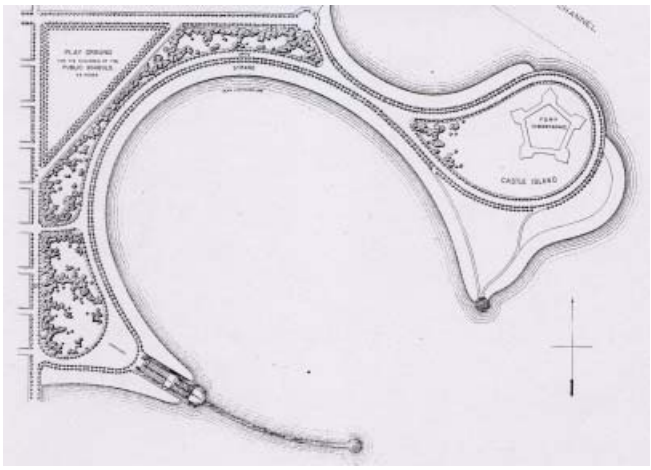


Figure 3 Plan of the Fort Indipendence parkway, Castle Island, Massachusetts.

The national parkways have continuously changing panoramas and take advantage of functional furniture adapted to recreational activities but dissimulated in the context with local material (wood and stone, figure 6): *road furniture*, footpaths separated from the lanes by trees, service stations, bathing areas, camping and fishing areas, walking or cycling areas, terraces with views, overpasses. Their elements are coherent between them and with man; many perceptive stimuli are present: mystery, spaciousness and a pleasant discrepancy compared to traditional roads. They give us access to other people, recreational activities, special landscapes and privacy areas. Trees or other *road furniture* underline bends and key lines (figure 4, figure 5); continuity is obtained through greenery (figure 7) and through the interference removal with overpasses (figure 6); nevertheless the greenery is often too homogeneous.

Figure 4 Blue Ridge Parkway, North Carolina.

Figure 5 The Daytona - St. Augustine road, Florida.

Figure 6 Wantagh State Parkway, Long Island, New Jersey.

Figure 7 Bronx River Parkway, New Jersey.

CONCLUSIONS

Roads are important elements of environmental design for the territory resource accessibility and fruition, not only from a simply functional point of view, but also, and above all, from a visual point of view. Being the background of our car journey, in the course of this study, we wanted to demonstrate the importance to evaluate the visual impact of an *ecological road system* on a driver. Consequently a design method has been proposed, based on the careful consideration of the principal technical and physical-perceptive aspects which, acting on the user's senses and psyche, could permit the raising of a route quality, so that is possible to obtain a more pleasant and safer driving experience.
In particular, the proposed methodology is potentially applicable both in the design of a new road and in the requalification of an existing one; it seems quite simple and it is equipped with some design suggestions deriving from the research made, above all in the environmental psychology field.
With a constant application in the road design, the method could be improved and so could allow us to obtain a collection of valid examples for designers; in fact after a sufficient number of projects carried out, the obtained indications could be included in the Technical Regulations for Public Works so guaranteeing that satisfactory products are obtained not only from a technical-executive point of view but also from a perceptive point of view, both for the road users and for the outside observers.
So this methodology heralds notable developments taking account of the computer-graphics instruments, which allow us to simulate the road route or its insertion in a particular context, and so to predict the environmental user preference of a route.
With the object of improving the results, it is evident that it is not enough to have sufficient computer-graphics instruments so that the method is fully feasible, but it is also necessary to have a multi-disciplinary collaboration between different professional men (town-planners, landscape architects, transport engineers, psychologists, sociologists, zoologists, socio-phytologists) so that every design aspect is opportunely considered, given the complexity of the *ecological road system*, and that the experts suggest the correct intervention in every sector, as we have tried to do in the application to the coastal road between Capoterra and Giorgino: territorial planners, transport engineers, socio-phytologists and psychologists were consulted.
All this cannot be contained in a norm or a law, but has to derive from a new design philosophy, which uses manuals, recommendations, new project collections which put the user and his way of interacting with the world at the attention centre.
From this point of view, a first interesting example is historically represented by the American parkways, which seem to have anticipated many considerations made in this research.
In conclusion we can affirm that examining this investigation area we can optimize the technical instruments necessary to obtain quality roads, pleasant and safe to travel on, roads which opportunely connected with places enchanted to reach, can produce a multiplicity of advantages, taking advantage of the fact that the most loved places are those capable of provoking emotions. We have to consider that greater attention towards the user environmental preference can certainly reduce the road construction visual impact, inducing a renewed interest towards the surrounding environment by the passers-by, who will not be inclined to quickly leave the road, but will travel along it with emotional participation, reducing the speed, and so the acoustic and atmospheric pollution. It becomes important, besides, to use various plant types connected with the different infrastructural typologies, in a way to maintain a certain perceptive interest during all the seasons and to interrupt the perceptive monotony. In this way we can also obtain a reduction in the crossed area visual pollution.
Also, linking roads and destinations of quality pushes the traveller, if necessary, to stop in the lay-bys without any hesitation or bother, producing economic and social advantages for the residents; in this way it acts on the tourist psyche convincing them to return to the places where they stayed as visitors, because visitors, in general, look for the travel comfort and temporary stops.
Also, we must make clear the fact that tourism allows the cultural development of the resident population and the territory requalification, with evident repercussions on the inhabitant physical and mental health.
Therefore, improving accessibility to places means to make easy, safe, pleasant, rapid and economic the journey towards such areas, so producing an inseparable link between accessibility and life quality.

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