View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Archivio istituzionale della ricerca - Politecnico di Milano

Case studies of landscape and environmental impact evaluation of roundabouts

Elisabetta Ginelli
Politecnico di Milano, BEST Departement,
Via Bonardi, 9 20133 MILANO,
tel. +39 02 23995182
fax +39 02 23995195
eginelli@polimi.it

Lorenzo Mussone*
Politecnico di Milano, BEST Departement,
Via Bonardi, 9 20133 MILANO,
tel. +39 02 23995182
fax +39 02 23995195
mussone@polimi.it

Gian Domenico Riva
Laboratory of Architecture, Via Galliari, 26 24047 TREVIGLIO
+39 0363 419088
riva@laboratoriodiarchitettura.net

Marco Trabucchi
Technical Society of Building Design, Via Paglia, 10 24122 BERGAMO
+39 035 221227
marco.trabucchi@archiworldpec.it

* corresponding author

This paper has been submitted to the Transportation Research Board (TRB) and presented at the 3rd International Conference on Roundabouts

Submission Date: June 1st, 2011

CASE STUDIES OF LANDSCAPE AND ENVIRONMENTAL IMPACT EVALUATION OF ROUNDABOUTS

ABSTRACT

This paper is a follow-up to a previous one that presented a new method for evaluating the landscape and environmental impact of roundabouts borrowed from building technology and based on the needs, requirements and performance expected from an object rather than on prescriptions for and descriptions of its dimensions and quality.

The proposed method aims at defining criteria to set up an information structure based on a need and performance approach capable of evaluating impacts on the landscape and environmental integration. After a brief résumé of the above-mentioned principles, two applications are presented in order to highlight two practical developments.

The roundabouts on which the applications are focused are located in an urban and in a rural environment respectively in the Northern part of Italy. Obviously their analysis cannot be considered comprehensive of all possible cases but it covers a large proportion of them.

Differences between the two roundabouts are many and they concern, besides the landscape and environment, geometrical dimensions, type of flow, presence of weekday users (pedestrians and bikers).

The final evaluation sheets are presented and through them it is relatively easy to single out the problems and drawbacks of the roundabouts from the landscape point of view.

KEY WORDS: Roundabout, Landscape and Environmental evaluation, Needs and Performance approach

1. INTRODUCTION

A previous paper of the same authors (Ginelli et al., 2010b, Ginelli et al., 2011) proposed a method based on needs and performance approach for evaluating the landscape and environmental insertion of level non signalized intersections.

In order to face a problem using an approach based on needs and performance implies, by and large, the assumption that the quality of a generic object depends on the fulfillment of certain needs, either implicit or explicit, established by those who have to use it (Becker, 2008; Szigeti, F. and Davis G., 2005).

A specific object must always face questions related to different scales (from the particular to the general) besides giving answers to precise requirements.

In the architectonic and building field the three components of needs, requirements and performance become the cornerstones of the method and the technical specifics become the quantifiable determiners of a valuable quality.

As a first conclusion of the research activities focused on the application of this method to the particular case of roundabouts (as road infrastructures) the guide- lines for roundabout landscape and environmental evaluation were prepared for the Italian Ministry of Universities and Research (Ginelli et al., 2010a) and they present all the theoretical references and operative steps for the evaluation.

In this paper the evaluations of two case studies according to the developed method are presented. These two case studies refer to two roundabouts with different characteristics both as regards their form and urban context in such a way as to represent a significant though not comprehensive sample of possible roundabout building:

- The first one, case study A, is in the municipality of Curno (BG, Italy) and is in an urban context;
- The second one, , case study B, is in the municipality of Ponte San Pietro (BG, Italy) and is in a rural context characterized by an environmental landscape of significant importance.

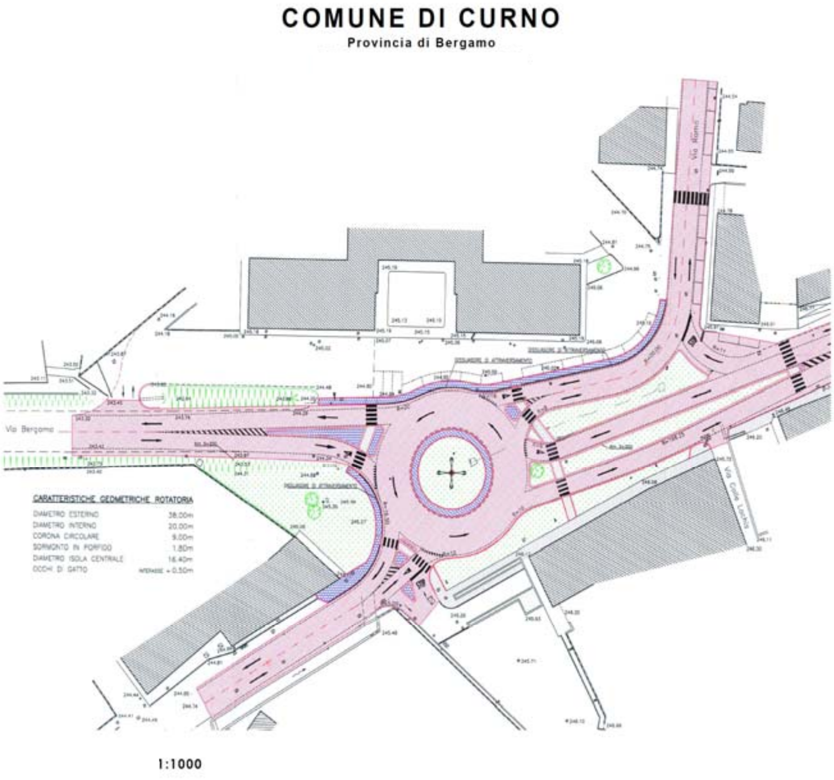

FIGURE 1 Layout of the roundabout of case study A (Curno).

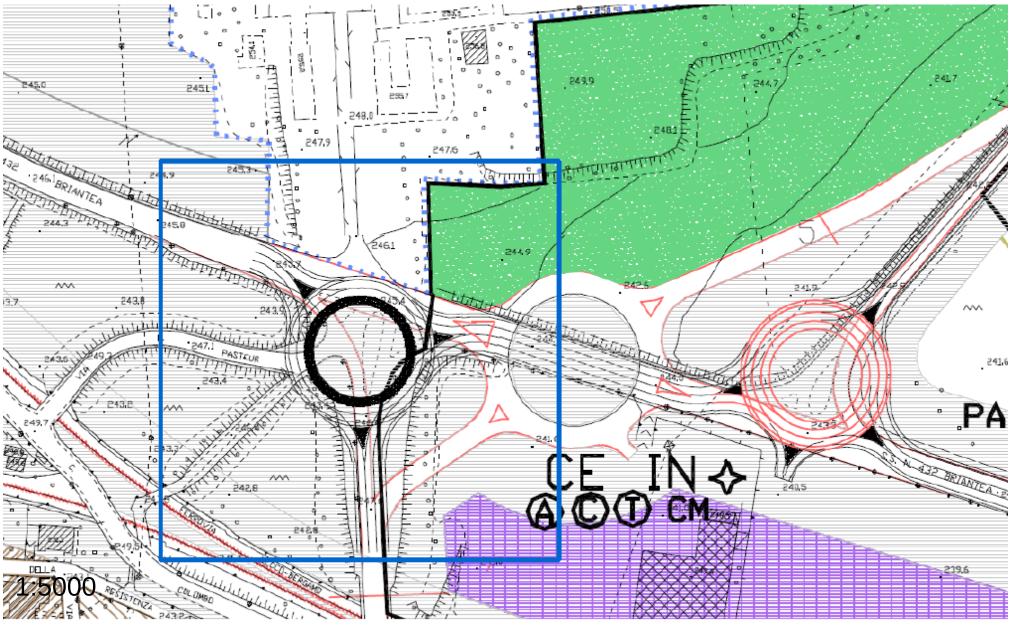

FIGURE 2 **Layout of the roundabout of case study B (Ponte San Pietro).**

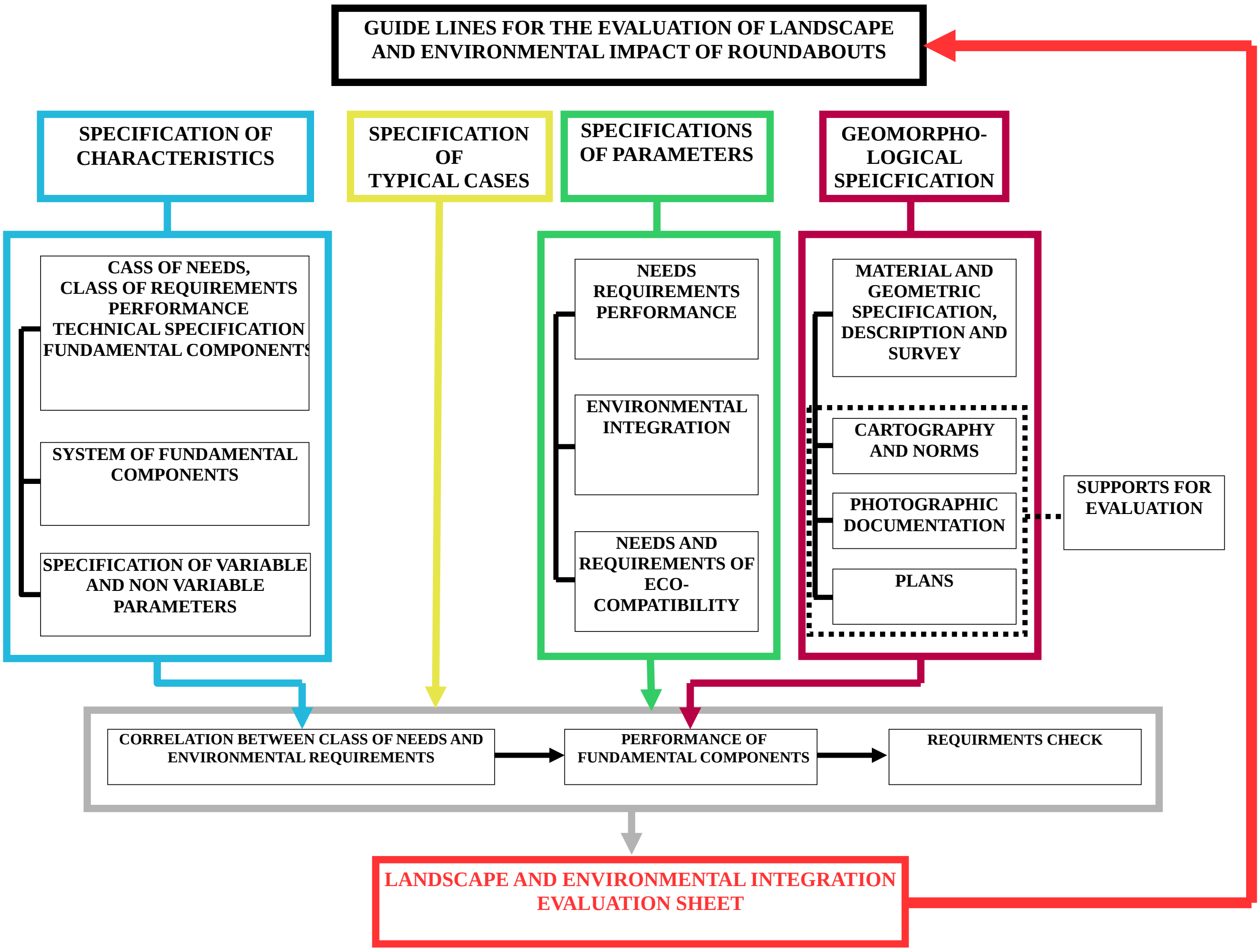

FIGURE 3 **Flow chart of the methodological steps in order to build the evaluation sheet.**

2. METHOD

The method used to define the final evaluation sheet (as described in greater detail in the Guide Lines (Ginelli et al., 2010a)) is shown in figure 3. It is made up of four main phases each concerning the analyses and specifications of roundabout characteristics the results of which are the input for the evaluation of correlation between the classes of needs, of performance, of fundamental components and lastly of requirement verification.

The first phase concerns the definition of characteristics of the elements of the "functional island" (as the roundabout is renamed, given its functional complexity); the fundamental components (figure 4); the classes of needs and related requirements; environmental requirements; performance; technical specifications. A parallel work (Mussone and Marescotti, 2010) investigated the characteristics and performance of roundabouts and also on the basis of this experience the fundamental components are singled out and described in their functional details; finally variable parameters related to the context, of landscape and traffic, and non variable parameters related to roundabout elements and norms are defined.

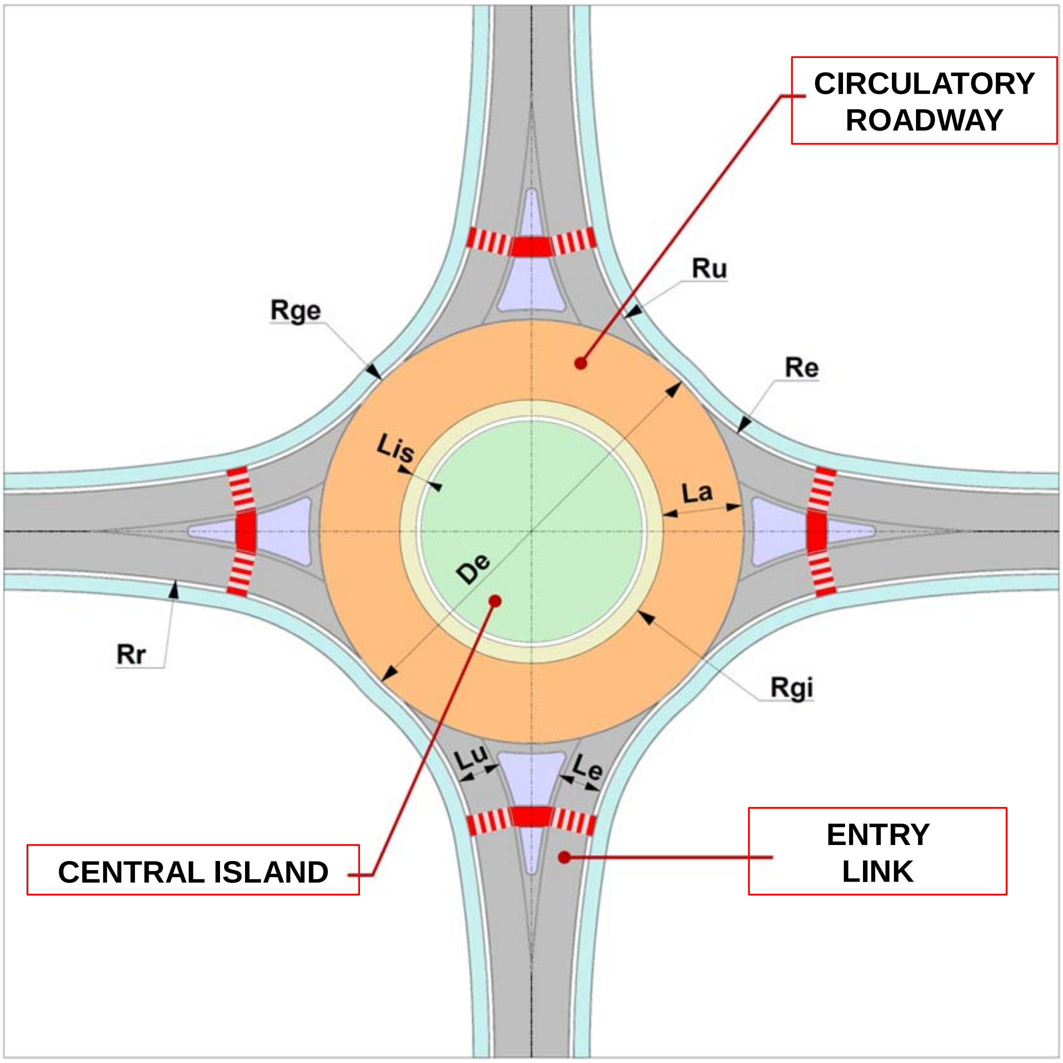

FIGURE 4 The three basic components of a "functional island".

Class of needs and environmental requirements		
USE ADEQUACY - FR	GEOMETRICAL **FR-GE**	FR-GE 1
		FR-GE 2
		FR-GE 3
		FR-GE 4
	MATERIALS **FR-MA**	FR-MA 1
SAFETY - SI	GEOMETRICAL **SI-GE**	SI-GE 1
	TO ATMOSPHERIC AGENTS **SI-AA**	SI-AA 1
		SI-AA 2
	MECHANICAL **SI-ME**	SI-ME 1
		SI-ME 2
	AGAINST FIRE **SI-AF**	SI-AF 1
	HYGIENIC **SI-IG**	SI-IG 1
		SI-IG 2
APPEARANCE - AS	MORPHOLOGICAL-GEOMETRIC **AS-MG**	AS-MG 1
	CHROMATIC **AS-CR**	AS-CR 1
		AS-CR 2
	MATERIALS **AS-MA**	AS-MA 1
INTEGRATION – IN		IN 1
		IN 2
MANAGEMENT – GE		GE 1
		GE 2
		GE 3
COMFORT - BE	ANTHROPOLOGICAL-DYNAMIC **BE-AN**	BE-AN 1
	ACOUSTIC **BE-AC**	BE-AC 1
		BE-AC 2
	OPTICAL LUMINOUS **BE-OL**	BE-OL 1
		BE-OL 2
	VISUAL **BE-VI**	BE-VI 1
	AIR BE-AE	BE-AE 1
ENVIRONMENTAL PROTECTION-SA	GROUND **SA-SU**	SA-SU 1
	SUBSOIL **SA-SO**	SA-SO 1
	AIR **SA-AR**	SA-AR 1
		SA-AR 2
	WATERS SURFACE **SA-AS**	SA-AS 1
	HYDRO-GEOMORPHOLOGICAL STRUCTURE **SA-AI**	SA-AI 1
	NATURE AND BIODIVERSITY **SA-NB**	SA-NB 1
		SA-NB 2
	LANDSCAPE **SA-PA**	SA-PA 1
		SA-PA 2
		SA-PA 3
	CULTURAL HERITAGE **SA-BC**	SA-BC 1
		SA-BC 2
	SPATIAL PLANNING **SA-AT**	SA-AT 1
		SA-AT 2
EFFICIENT USE OF RESOURCES - UR	GROUND **UR-SU**	UR-SU 1
	Water **UR-AC**	UR-AC 1
	ENERGY **UR-EN**	UR-EN 1
		UR-EN 2
	MATERIALS **UR-MA**	UR-MA 1

FIGURE 5 List of class of needs used for the case studies and relative environmental requirements.

To support this methodological approach the following parameters are singled out with their subsets:

- the class of needs uses: adequacy, safety, landscape and environmental qualifications, management, rational use of resources;
- environmental requirements, each for a class of needs;
- evaluation parameters of the “functional island “: needs, requirements and performance;
- criteria for environmental integration;
- needs and requirements for eco-compatibility.

The parameters of evaluation are borrowed initially from experience in building technology and are then precisely adapted to the specific application of roundabout evaluation.

After the class of needs is defined the corresponding environmental requirements are linked to them.

The parameters were verified during the review of a sample of roundabouts significant both from a landscape and an environmental point of view.

The research has systematically analyzed many roundabouts built in Europe starting from the first examples carried out in the UK to the extensive installations in France; to the innovative installations in Germany and Spain and to those built in Holland and Switzerland where particular care has been dedicated to bicycle paths in roundabouts. The survey was concluded by analyzing the Italian context where the insertion of new roundabout solutions in the road network is a continuing process.

The analysis of parameters of evaluation allows us to pinpoint the correlation between classes of needs and environmental requirements by means of a dual matrix which, for each class of needs, highlights these relationships.

The phase of collection of all possible elements supporting a correct evaluation of environmental and landscape insertion of the “functional island” includes necessarily the definition of all elements useful for the geo-morphological specification of the roundabout as a whole (location and context) and of each fundamental element (planimetric and altimetric shape, dimensions, position, surface and materials).

Other information may be found in urban plans, relevant for land and landscape placement of the area of the roundabout (cartography and norms); in photographic documentation; in technical plans (especially if the roundabout has still to be built).

Integration of landscape and environmental elements is therefore evaluated on the basis of the fulfillment of requirements for all defined correlations between classes of needs and environmental requirements.

In figure 5 the scheme with all the classes of needs and related environmental requirements used for the evaluation of the two case studies has been drawn up.

After the data on the objects and functions of a roundabout have been surveyed (by using instructions and tools prepared and described in the guidelines) and after an in-depth knowledge of the field is acquired, the filling-in of the final evaluation sheet allows us to determine the level of fidelity to the set of requirements for a correct environmental insertion.

To improve the understanding of the evaluation a figure made up in part of the photographic documentation is prepared and in each photo the negative results for one item is shown by its evaluation code.

TABLE 1 Evaluation sheet for the case studies A and B in a reduced form including only negative items

Class of needs and environmental requirements		**Performance of Fundamental components (Central island, circulatory roadway, entry links)**
USE ADEQUACY FR The set of conditions in which users (drivers and pedestrians) can use the “Functional Island” properly	**GEOMETRICAL** FR-GE	
	Accessibility (capacity of central islands and outer spaces, if used by the public, of being easily reachable and usable) FR-GE 1	Designs must insert outer spaces for others uses (such as buffer areas, panoramic views, pedestrian and cyclist paths) in order to improve, from the user point of view, the relation between the “Functional Island” and the surrounding landscape, with specific attention to the presence of natural or architectural landscape and environmental elements FR-GE 1.3
SAFETY SI Set of requirements for the safety of users, and prevention of damage depending on accidental factors, during work	GEOMETRICAL SI-GE	
	Safe use of road traffic spaces: of vehicles, motorcycles, bicycles, pedestrians (presence of signs, no barriers, connection of height differences, presence of vertical misalignment and changes of pavements, reduction of the longitudinal gradients of entry links to avoid glare by headlights) SI-GE 1	In order to provide safety barriers and retaining systems, preference should be given to an arrangement of safety areas with supplies and forms integrated into the surrounding landscape SI-GE 1.1
		Lighting elements, necessary to guarantee an adequate view of the different spaces, should be designed according to the dimensions necessary for effective lighting, and with forms, materials, and colors in harmony with the surrounding landscape SI-GE 1.2
		Signs and lighting elements should not represent an obstacle to landscape perception because of their size and number SI-GE 1.3
	MECHANICAL SI-ME	
	Safe use of road spaces (stability and resistance of structural elements that make and demarcate the road space; crash strength of protective structures) SI-ME 1	Design prospective works intended to increase the safety of users (anti-glare barriers, windbreak barriers, safety barriers and split islands) by introducing vegetation SI-ME 1.2
APPEARANCE AS Set of conditions regarding the perceived use: for the reciprocal relations between the “functional island" and the landscape	MORPHOLOGICAL-GEOMETRIC AS-MG	
	Control of geometric forms of spaces and supplies AS-MG 1	Natural and/or artificial features (trees, waterways, street furniture, lighting, posters, safety barriers, etc.) should be introduced with a view to respecting or improving optical visuals and cones as far as the existing landscape is concerned AS-MG 1.3
		The morphologic unity of the artifacts should be sought through the type of elements and recurring motifs (curbs, retaining walls, safety and sound-proof barriers) AS-MG 1.5
COMFORT BE Set of conditions relating to states of the 'functional island" as appropriate to the needs, use, integrity and health of users	OPTICAL LUMINOUS BE-OL	
	Limitation to the contribution of light pollution BE-OL 1	Soften the impact of light pollution (glare) by proposing plans that use lights integrated with naturalistic engineering technical solutions and with elements of street furniture opting for limited dimensions that do not affect the visual plane or the optical cones BE-OL 1.1
	Control of day and night-time light (no glare condition) BE-OL 2	Lighting signs and nighttime lighting control should be introduced using lights and their supporting poles that in number, size, colors and light intensity do not modify the perception of the “functional island”, of the surrounding areas or of the sky BE-OL 2.1
		With the aim of improving user visibility and safety, particularly by highlighting sensitive spots (pedestrian and cyclist crossings), lighting systems should be functionally adapted to the needs of the visual quality of the environment in question and of the existing elements of landscape and environmental value BE-OL 2.2
	VISUAL BE-VI	
	No visual obstructions along the route BE-VI 1	Lighting signs, in size and number, should not limit the visual field by obstructing perception of the environment BE-VI 1.1

3. APPLICATION TO THE TWO CASE STUDIES

In order to develop the evaluation a set of information about territorial planning, conditions of things, roundabout design is necessary. Documentation collected for the analyses is the following:

- Territorial landscape regional plan;
- Territorial plan of provincial coordination;
- General town plan and aero-photogrammetric maps;
- Photographic documentation of conditions of things;
- Executive design (only for case study A).

The analysis firstly aims at selecting from the complete evaluation sheet present in the guide lines
(Ginelli et al., 2010b) the only items with a negative result for which an intervention should be necessary. The results of this task is reported in table 1 and then on the photographic documentation as described in the following paragraphs.

It must be underlined that, in general, other specific users (such as blind pedestrians) or other traffic conditions (and therefore atmospheric and acoustic pollution) can be considered if necessary, this implies simply the definition of further needs and requirements.

3.1 Case Study A (Urban Environment)

In figure 6 requirements not met for this case study are listed. The critical points are, in fact, more since the same requirement is not met more than once as can be seen in figure 7. In this figure the specific spot and object that does not meet some requirement is shown by a red arrow together with the requirement code.

Obviously it is possible to show all the requirements, whether they are met or not, in order to verify immediately the evaluation process.

Class of needs and environmental requirements for case study A		
USE ADEQUACY FR	**GEOMETRICAL FR-GE**	FR-GE 1.3
SAFETY SI	**GEOMETRICAL SI-GE**	SI-GE 1.1 SI-GE 1.2 SI-GE 1.3
	MECHANICAL SI-ME	SI-ME 1.2
APPEARANCE AS	**MORPHOLOGICAL-GEOMETRIC AS-MG**	AS-MG 1.3 AS-MG 1.5
COMFORT BE	**VISUAL BE-VI**	BE-VI 1.1
	OPTICAL LUMINOUS BE-OL	BE-OL 1.1 BE-OL 2.1 BE-OL 2.2
ENVIRONMENTAL PROTECTION SA	**GROUND SA-SU**	SA-SU 1.1 SA-SU 1.2 SA-SU 1.4

FIGURE 6 List of requirements that are not met for case study A.

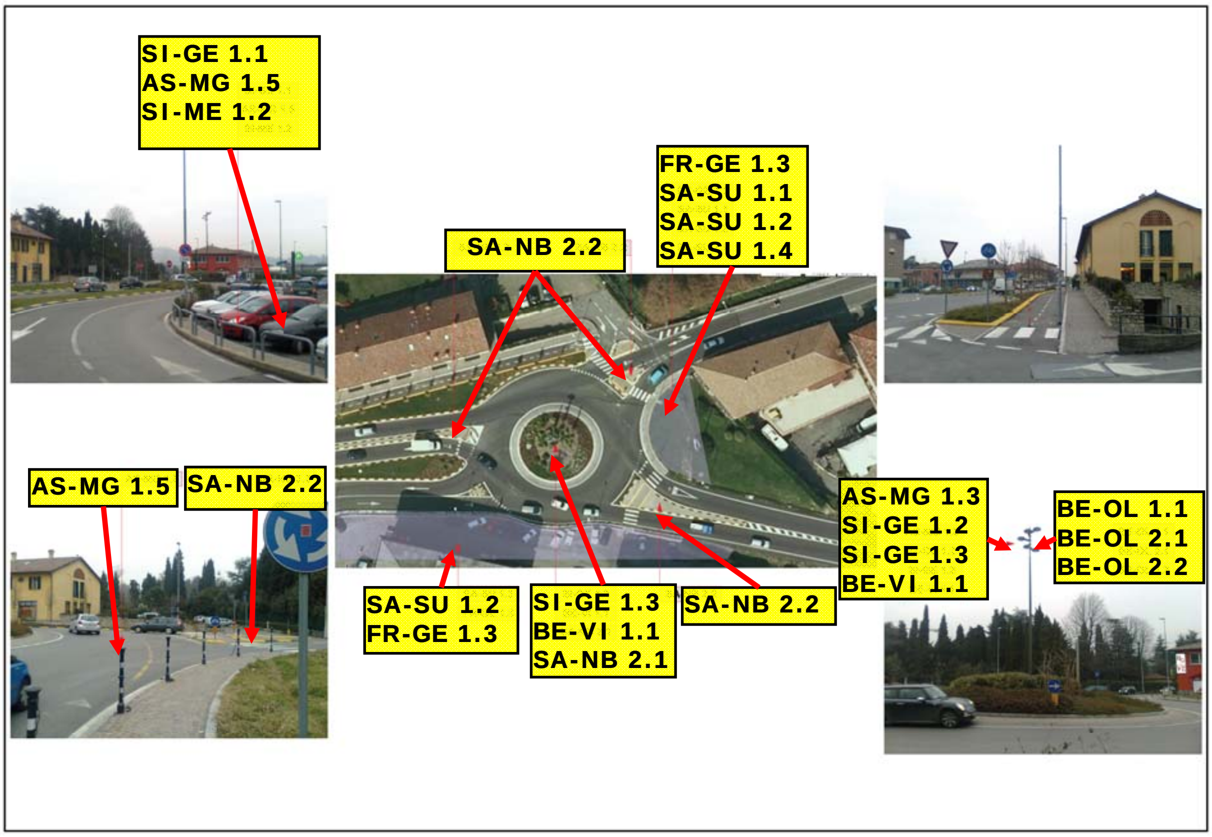

FIGURE 7 Map of critical points (relating to requirements that are not met) for case study A.

3.2 Case Study B (Rural Environment)

In figure 8 requirements that are not met for this case study are listed. As the previous case study the critical points are, in fact, more since the same requirement is not met more than once as it can be seen in figure 9. In this figure too the specific spot and object that does not fulfill some requirement is shown by a red arrow together with the requirement code

Classes of needs and environmental requirements for case study B		
USE ADEQUACY FR	**GEOMETRICAL FR-GE**	FR-GE 1.3
SAFETY SI	**GEOMETRICAL SI-GE**	SI-GE 1.1 SI-GE 1.2
	MECHANICAL SI-ME	SI-ME 1.2
APPEARANCE AS	**MORPHOLOGICAL-GEOMETRIC AS-MG**	AS-MG 1.3
COMFORT BE	**VISUAL BE-VI**	BE-VI 1.1
	OPTICAL LUMINOUS BE-OL	BE-OL 1.1 BE-OL 2.1 BE-OL 2.2
ENVIRONMENTAL PROTECTION SA	**GROUND SA-SU**	SA-SU 1.1 SA-SU 1.2 SA-SU 1.4
	NATURE AND BIODIVERSITY SA-NB	SA-NB 2.1 SA-NB 2.2
	LANDSCAPE SA-PA	SA-PA 1.2 SA-PA 2.2 SA-PA 3.2 SA-PA 3.3 SA-PA 3.4 SA-PA 3.5

FIGURE 8 List of requirements that are not met for case study B.

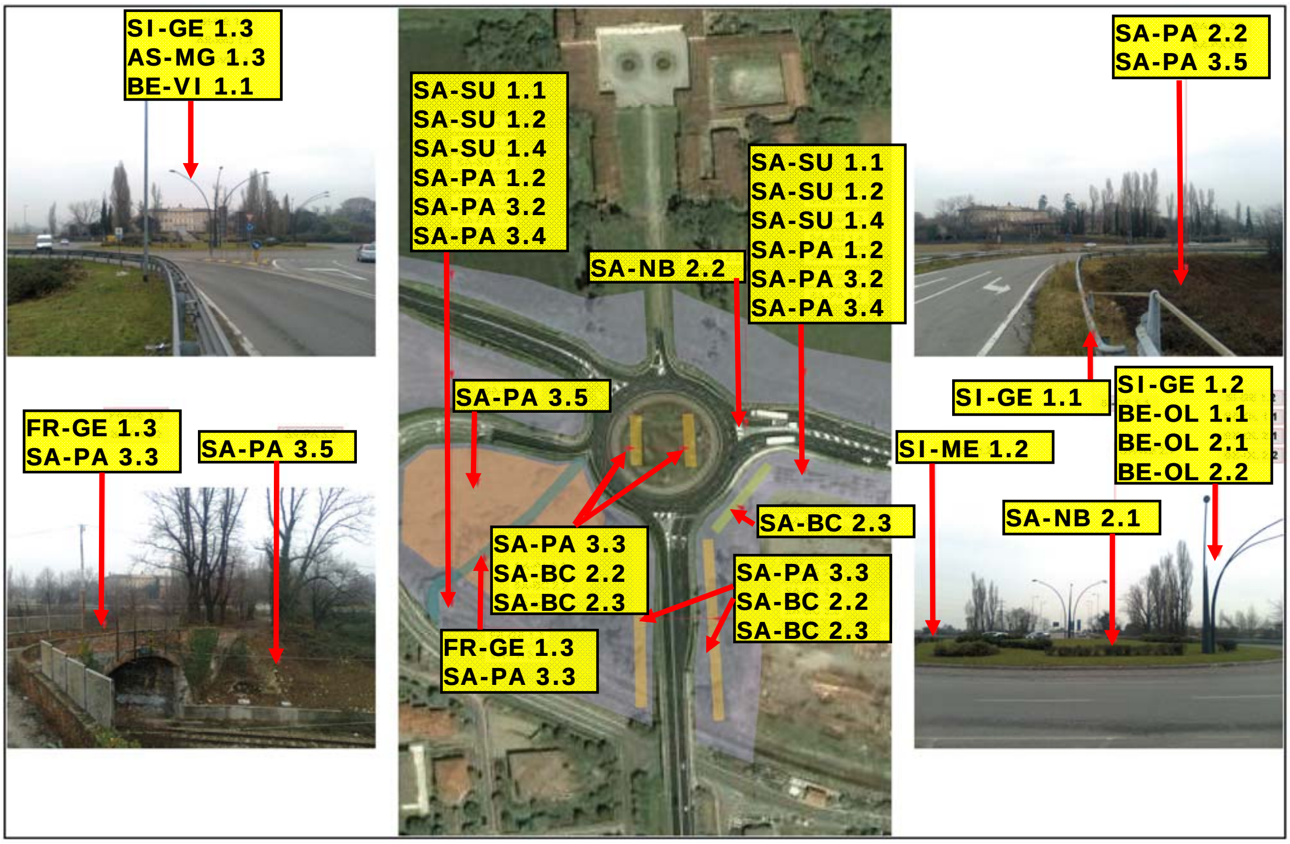

FIGURE 9 Map of critical points (related to requirements that are not met) for the case study B.

3.3 Design Proposals

The crucial elements the analysis has identified are further worked out so that planning suggestions can be proposed.

The proposed interventions for overcoming criticalities are the following (table 2 lists them briefly):

- FR-GE 1.3 Adjacent spaces could be used for other purposes such as: qualitative compliance areas (furnished green and parking areas safe for bikers), panoramic views, pedestrian routes, cycle lanes;
- SI-GE 1.1 crash barriers and other retaining elements could be substituted with areas, adapted for and integrated with the context;
- SI-GE 1.2 The possibility of reducing lighting bodies to dimensions that are strictly necessary to the efficacy the planned lighting should be evaluated;
- SI-GE 1.3 The reduction of the number of lighting bodies;
- SI-ME 1.2 Metal crash barriers could be replace by vegetal ones;
- AS-MG 1.3 Safeguard the existing landscape by preserving visuals and optical cones, possibly by reducing lighting bodies;
- AS-MG 1.5 Consider the opportunity of making crash barriers uniform from a morphological point of view through the clustering of elements;
- BE-OL 1.1 Consider the possibility of integrating lighting bodies as street furniture by favoring small dimensions that do not affect visuals and optical cones;
- BE-OL 2.1 Lighting bodies and respective poles could be reduced in dimension and number in order not to modify the perception of “functional island” areas, of adjacent areas and the sky;
- BE-OL 2.2 Plan the possibility of highlighting sensitive spots with a view to improving the

visual quality of pre-existing landscape-environmental values;

- BE-VI 1.1 Consider the possibility of reducing signs and lighting bodies in size and number;
- SA-SU 1.1 Consider the possibility of integrating the adjacent areas into the process in conformity with urban planning;
- SA-SU 1.2 - SA-SU 1.4 Adjacent areas not included in the roundabout could be integrated by providing them with natural elements;
- SA-NB 2.1 Consider the possibility of inserting vegetation in a lay-out that is consistent with the morphology of the adjacent environment;
- SA-NB 2.2 Splitter islands could be made large enough to allow the insertion of greenery;
- SA-PA 1.2 Consider the possibility of mitigating or compensating the alterations produced in adjacent areas by means of the insertion of natural elements;
- SA-PA 2.2 Consider the possibility of connecting the difference in height between the "functional island" and the surrounding context by using banks with a shape as similar as possible to the natural profile of the terrain, by using rounded forms that allow for planting; stabilizing the terrain using naturalist engineering techniques; making use of local plants and shrubs and arranging them so as to integrate them into the landscape context in which they are located;
- SA-PA 3.2 Plan landscape requalification of adjacent areas;
- SA-PA 3.3 Reassemble the pre-existing historical road network in order to use it as cycle lanes;
- SA-PA 3.4 Consider the possibility of inserting organic vegetation into the naturalistic grids;
- SA-PA 3.5 Residual areas at risk of degradation could be included in the appurtenant areas of the roundabouts, making them more qualitatively acceptable;
- SA-BC 2.2 Consider the possibility of creating, through the insertion of plants, visual cones that pinpoint significantly the preexisting landscape values;
- SA-BC 2.3 Consider the possibility of inserting arboreal, shrubby and herbaceous flora to enhance places of interest, to make particular points of view more perceptible and to hide degraded areas.

TABLE 2 Proposed interventions for improving the fundamental components for the case studies A and B

Class of needs and environmental requirements		Suggested alternatives / changes
USE ADEQUACY FR	GEOMETRICAL FR-GE 1.3	Arrange contiguous areas
SAFETY SI	GEOMETRICAL SI-GE 1.1	Insert protection elements more integrated with the context
	GEOMETRICAL SI-GE 1.2	Reduce the size of lighting bodies
	GEOMETRICAL SI-GE 1.3	Reduce the number of lighting bodies
	MECHANICAL SI-ME 1.2	Substitute metal crash barriers with more natural ones
APPEARANCE AS	MORPHOLOGICAL-GEOMETRIC AS-MG 1.3	Preserve views and optical cones
	MORPHOLOGICAL-GEOMETRIC AS-MG 1.3	Make the elements uniform
COMFORT BE	OPTICAL LUMINOUS BE-OL 1.1	Integrate lighting bodies and street furniture
	OPTICAL LUMINOUS BE-OL 2.1	Reduce the number and size of the poles of lighting bodies
	OPTICAL LUMINOUS BE-OL 2.2	Emphasize the sensitive spots of pre-existing environmental areas
	VISUAL BE-VI 1.1	Reduce the number and size of signs and lighting bodies
ENVIRONMENTAL PROTECTION SA	GROUND SA-SU 1.1	Integrate into the project adjacent areas to be enhanced
	GROUND SA-SU 1.2 e SA-SU 1.4	Insert natural elements into areas adjacent to the roundabout
	NATURE AND BIODIVERSITY SA-NB 2.1	Insert indigenous vegetation
	NATURE AND BIODIVERSITY SA-NB 2.2	Consider the insertion of greenery in splitter islands
	LANDSCAPE SA-PA 1.2	Mitigate or compensate effect on adjacent areas
	LANDSCAPE SA-PA 2.2	Connect differences in altitude between “functional island” and context
	LANDSCAPE SA-PA 3.2	Anticipate the landscape requalification of adjacent degraded areas
	LANDSCAPE SA-PA 3.3	Reassemble the pre-existing historical road network
	LANDSCAPE SA-PA 3.4	Insert greenery that is integrated into the context
	LANDSCAPE SA-PA 3.5	Insert residual areas at risk of degradation into the appurtenant areas of the roundabout
	CULTURAL HERITAGE SA-BC 2.2	Insert arboreal flora to enhance important pre-existing landscape
	CULTURAL HERITAGE SA-BC 2.3	Insert arboreal, shrubby and herbaceous flora to enhance areas of intrinsic value

4. CONCLUSIONS

In general, in order to face the problem of the environmental and landscape insertion of roundabouts, they, like any other artifact, must be considered from the point of view of the definitions laid down by the European Council on landscape, ratified in Florence, Italy in 2000 (Council of Europe, 2000), about the meaning of landscape, landscape policy, landscape quality, safeguard, management, planning, that are reported in Annex 1 of the Guidelines (Ginelli et al., 2010a).

The present discussion of the environment makes a series of considerations that are designed to give an effective answer to the above mentioned problem: the extension of the landscape, eco-compatibility and the necessity of reducing non-renewable energy consumption, the reduced availability of natural resources, the demand for a constant verification of the quality of the landscape.

The multi-disciplinary capacity necessary to face the global environmental question (for new different situations, needs and problems) can be, unlike other approaches to specific problems (related to urban planning), easily achieved by using an integrated technological approach.

The technical-scientific analysis represents a method that is capable of facing the complexity deriving from the new landscape concept.

A dynamic planning, following the evolution of land transformation, must be based on a willingness to consider as part of a single system all the problems to be faced. It requires a tool that takes into account quality, based on the correlation between needs, requirements and performance.

The concept of needs, requirements and performance is inevitable in a method where quality is achieved independently of the materials and techniques used. The components of the triad needs-requirements-performance become the cornerstones of the method and the technical specifics become the quantifiable determiners of quality.

An environmental planning aimed at a constant quality of the landscape, for all its many characteristics (valuable landscapes, degraded areas, anthropic or natural lands, and so on), requires an approach that is capable of conforming to a constantly changing realty, such as that defined by a needs-performance set.

This approach has been applied in two case studies, in examples of existing roundabouts, one located in an urban context, the other in a rural one. These examples cannot be considered comprehensive of the proposed method since there are many types of roundabouts in the Italian scenario but they are certainly emblematic.

The real landscape and environmental insertion has been checked according to their compliance or otherwise to the requirements previously set out for the many correlations between environmental classes of needs and requirements.

The final evaluation sheet allows us to check the compliance or otherwise to the defined requirements and no compensation between items is considered; but it is obvious that the evaluation could be dealt with by a multi-criteria approach where the criteria set is simply the requirements set. Indeed, this could be a possible development of this research.

It should be understood that this method requires the survey not only of all information about all elements of the roundabout but also an in-depth knowledge of the territory where the roundabout is located in order to determine the level of fidelity to the defined requirements for the environmental insertion. This implies a level of knowledge generally greater than that necessary for the roundabout design and in this sense the method is more expensive; two considerations should be held in mind, however:

- a roundabout is often preferred (at least in Italy) for its greater appeal in landscape insertion especially in an urban context; therefore it must fit into the landscape;
- the method forces us to analyze the roundabout (as well as the adjacent environment) from a different point of view (needs and requirements) in respect of norms and design

rules; this requires the designer to consider accurately all possible users and their needs and improve the quality of the design itself accordingly.

Besides this, the proposed tool, though it has been used in this research for the evaluation of a specific structure such as a roundabout, is flexible and versatile enough to be applied during the planning phase too or to be the evaluation tool for landscape and environmental insertion of other types of road structures.

ACKNOWLEDGMENTS

This research was supported by the Italian Ministry of Universities and Research (MIUR-PRIN07, according to the contract no. MO08RIST01.

REFERENCES

Becker, R. Fundamentals of Performance-Based Building Design, Faculty of Civil and Environmental Engineering Technion – Israel Institute of Technology, Haifa, November 2008.

Council of Europe (2000). European Landscape Convention. Florence, 20.X.2000

Ginelli E., Mussone L, Riva G.D. and Trabucchi M. (2010a) Guidelines for landscape and environmental impact evaluation for roundabouts, in M. Di Gangi, L. Mussone, Guide lines for level non signalized intersection design, Maggioli, Italy.

Ginelli E., Mussone L., Riva G.D. and Trabucchi M. (2010b). Intersezioni a Rotatoria: valutazione dell'impatto paesaggistico e ambientale. Strade & Autostrade. vol. 4, pp. 200-205, ISSN 1723-2155.

Ginelli E., Mussone L, Riva G.D. and Trabucchi M. (2011) A method for landscape and environmental impact evaluation of roundabouts, presented at the 90th TRB annual meeting, January 2011, Washington DC.

Mussone L., L. Marescotti (2010) Guide lines for roundabout design. in M. Di Gangi, L. Mussone, in M. Di Gangi, L. Mussone, Guide lines for level non signalized intersection design, Maggioli, Italy.

Szigeti, F. and Davis G. (2005). Performance-Based Building: Conceptual Framework. PeBBu Final Report, CIBdf, Rotterdam, October 2005.