LANDSCAPE COMPATIBILITY OF FACTORIES: FROM PRACTICES TO TACTICS

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ABSTRACT
Industrial facilities are responsible for several detrimental effects on the landscape. Impact occurs in terms of both interference in the main ecosystem's physical matrices and intense perceptual-aesthetic contrasts with the landscape. As a result, the social sphere also is affected and corporate identity is threatened. Agri-food companies are particularly touched by the issue due to the high environmental impact of their processes, their recurring proximity to the rural landscape, and the strong link between corporate image and environmental attitude. Since the Eighties, literature and regulations have proved harmonisation between industry and landscape is a crucial element of companies' social awareness. In this framework, some tools have been developed to analyse the impacts, but their main focus is on environmental issues. Nowadays there is no unitary vision capable of balancing manufacturing requirements with effective measures to mitigate the impact of factories on the landscape at all different levels. Our research therefore aims to define a methodology to analyse how agri-food facilities interfere with the landscape and to develop a set of measures suitable to promote less conflictual relationships. This can be achieved by combining the natural, perceptual-aesthetic and social/cultural dimensions of landscape. The goal is to develop a design support tool to analyse impacts and prioritise weaknesses, thereby helping companies to define case-specific mitigation strategies. In particular, the paper presents real life case studies noteworthy for the adoption of mitigation practices, from which a set of general tactics was devised. Over 50 exemplary facilities have been analysed, 200 good practices identified, and more than 100 general mitigation tactics formulated. Furthermore, the study has identified recurrent patterns in the architecture of factories, which generally confirm trends found in literature.
Keywords: environmental impact, landscape harmony, factories, corporate identity, mitigation tactics.

1 INTRODUCTION

Decades of shallow practices in the design of factory now call for a deep reflection on the relationship between industrial sites and the everyday landscape. Over the last forty years academics, policymakers, companies and consumers have become increasingly interested in the topic, and several design support tools have been developed with the aim of reducing the impact of industrial facilities on the landscape. However, a unitary and consistent approach to cope with the manifold dimensions of the problem is still lacking.

The paper presents some outcomes of a research project which aims to define a methodology to analyse and ideally enhance the landscape compatibility of factories by dealing with their environmental impact, aesthetic-perceptual interference and the related socio-economic aspects. An overview of the general assumptions and approaches adopted in the study is presented and the main findings of the first research stages are described. Specifically, the article discusses the structured analysis of selected case studies, which led to the identification of mitigation practices, and the extraction of an inventory of impact reduction tactics.

2 IMPACT OF FACTORIES ON THE LANDSCAPE

Industrial facilities significantly interfere with the landscape. In this framework, a clear definition of the terms and boundaries is needed, as landscape is a broad and multifaceted concept which has often been confused with environment [1]. This research assumes the

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definition of landscape given by the European Landscape Convention (ELC) [2]: an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors. Accordingly, the landscape components set by the Landscape Character Assessment [3] have been adopted (Fig. 1). Thus, the impact of industrial facilities on the landscape is not limited to its natural dimension, but the perceptual-aesthetic and cultural/social components also need to be considered.

Firstly, factories affect the natural component of the landscape. Industrial facilities, in fact, often compromise the quality and balance of the urban or rural ecosystems that host them. This is due to their high energy consumption, intense use of natural resources and harmful emissions on the main environmental physical matrices [4], [5], typically caused by manufacturing processes, facility construction and operations, and heavy traffic flows.

Secondly, beyond their physical impact, they also create perceptual-aesthetic disturbances, disrupting the quality of the everyday landscape. An analysis performed in the Mediterranean regions [6] shows that in general factories are scattered in a disorderly manner throughout the territory due to ineffective planning rules or mere company attitudes. In addition, the study highlights that attention to the aesthetic quality of productive facilities is usually scarce. As a matter of fact, industrial buildings often lack spatial associations with the context, figurative identity and design quality [7], [8]. Since factories are rarely harmoniously integrated into their surroundings, they are rather perceived as landscape detractors [9].

Lastly, the social sphere also is affected: since the ELC recognises the landscape as a ground for collective memories and natural, cultural and symbolic associations [6], [10], its quality plays a key role in the well-being of individuals and society [11], [12]. Consequently, spatial proximity to a badly designed factory can affect the nearby communities, engendering negative psychophysical effects. Although not factory-related, recent studies on the visual impact of man-made objects in the landscape demonstrate that the kind of disturbances perceived by those living nearby are often associated with a disruption to the sense of place [13], [14]. However, it is worth noting that correlation between the proximity and degree of acceptance of an intervention does not always exist: there is evidence of an "inverse NIMBY syndrome" when the man-made object has some positive environmental implications [15].

Figure 1: Landscape components [3].

2.1 The agri-food industry

In the industrial context, the agri-food sector – which refers to the processing of agricultural, forestry and fishing products into edible food and drink for human beings or animals [16] – is specifically affected by the issue.

Firstly, because it often involves high energy and resource-consuming processes, as well as practices that compromise the quality of the ecosystem (e.g. the thermal pollution of rivers through wastewater) [17].

In addition, as there is a close relationship between the processing of edible goods and the quality of the environment from which they originate, the production site and location play an important role in company image [18]. This is particularly true for typical products in certain cultivated landscapes [19] and evidenced by the increasing number of wineries investing in sophisticated and sustainable production buildings [20]–[22].

Lastly, the vast majority of agri-food facilities are scattered throughout the country in or near rural areas, often within territories designated as high-quality landscapes. Therefore, they heavily interfere with the perceptual-aesthetic quality of such sensitive sites.

2.2 Impact of factories on the landscape: between theory and practice

Growing awareness of global environmental problems has raised the interest of academics, policymakers and practitioners in this issue [5], [23].

On the one hand, literature and regulations have pushed the manufacturing sector towards more sustainable behaviours. Governmental measures to lessen the environmental impact have been implemented, such as penalties for lack of compliance, tax benefits and economic incentives [5]. Gradually, some planning, morphological and landscape aspects have also been addressed [17], [24], [25], mainly through guidelines. An increasing number of studies prove that the perceptual-aesthetic harmonisation of facilities into the landscape is important: many articles refer to renewable energy source projects [24], [26]–[28], energy infrastructures [13], and rural buildings [6], [20], [24], whereas industrial assets are still given little consideration.

On the other hand, there is evidence that firms now recognise their own impacts more clearly [29] and are trying to mitigate the effects. The rise in energy costs in recent years has driven companies to pay great attention to energy efficiency as a competitive factor, along with resource efficiency and pollution prevention [23], [30]. Besides, stakeholders' and consumers' more acute sensitivity to ethical and environmental issues is progressively influencing the attitude of businesses, which have turned sustainability into a long-term element of competitiveness [5], [31], [32].

Although still limited, some exemplary cases highlight that more effort has been put into designing buildings that are sympathetic to their surroundings by combining the three landscape components together. Furthermore, as some authors suggest that the communication of sustainable behaviour is as important for business as the attitude itself, Corporate Social Responsibility has spread [32] and design quality, traditionally devoted to company headquarters, has gradually also been applied to manufacturing sites [33]. However, several examples have shown that using factory architecture as a communication tool means – if it is not effectively combined with environmentally-friendly practices – running the risk of "Disneyfying" the work space or engaging in trivial "greenwashing" [32].

Although some positive trends regarding both theory and practice, they still tend to focus mainly on the environmental impact of factories; while the social/cultural and perceptual-aesthetic aspects are often neglected or managed separately despite being closely interrelated.

3 LANDSCAPE COMPATIBILITY OF FACTORIES

The research deals with the landscape compatibility of factories and attempts to combine its multiple connotations into a consistent framework.

The basic assumption is that a deep reflection on harmonisation between production sites and the landscape is necessary not only to protect the environment and the closest communities, but also to promote the competitiveness of companies which act in a sustainable/conscious way. Thus, the objective is to define a system to analyse and promote the landscape compatibility of industrial buildings, considering the environmental, perceptual-aesthetic and social/cultural dimensions together. The aim is to help companies to mitigate their impact on the landscape by providing them with a design support tool.

To do this, the method we came up with breaks the process down into three steps:

1. Identification of a comprehensive list of impacts generated on the landscape by industrial facilities, occurring at site, building and process levels, followed by the development of a set of indicators to measure individual impacts and their weighted effects as a basis to identify intervention priorities.
2. Construction of a best practices catalogue to obtain an inventory of general mitigation tactics.
3. Development of a design support tool by combining the set of indicators (step 1) with the collection of best practices (step 2). The tool will be tested on an Italian agri-food company by analysing the major weaknesses and issues and then developing some mitigation scenarios for different kinds of facilities within the site.

The first two phases were undertaken in parallel and informed each other, while the third has yet to begin. The paper, however, focuses on the best practices catalogue (step 2).

3.1 Method

The second step of the research involves the study of exemplary facilities that have succeeded in reducing their impact on the landscape, thus increasing their level of compatibility.

The aim of the case studies collection is twofold: in addition to providing a catalogue of practices – which are useful as references when designing/renovating an industrial facility – it also allows the inductive formulation of mitigation tactics which can be combined and applied to other projects.

To do this, remarkable case studies were analysed using a structured methodology. Given the novelty of the topic, the cases were found not only in academic publications but also taken from trade literature (corporate websites), design competitions and awards (e.g. Green Company Award Industria e Paesaggio; GBE Factory; Brand & Landscape Award) and guidelines. As the purpose was to obtain a broad and general overview of the actual scenario, only secondary sources were consulted.

In order to select the cases, a functional classification was adopted: since the research focuses on agri-food many food factories were selected. In addition, other kinds of facilities were studied for the relevance of some adopted practices and their replicability in the agri-food industry. In fact, the cases were selected based on the strategies applied to achieve at least one of the following purposes:

- reduce environmental impacts at site, building and process level;
- lessen perceptual-aesthetic disturbances at site and building level;
- implement good practices regarding workers and neighbours.

Table 1: Extract from the collection of case studies.

Case study	Country	Intervention	Year
Food industry (Ateco C10)			
Melinda	IT	RD and E	2014
Bio Pastificio IRIS	IT	NC	2015
Almazara Olisur Olive Oil Factory	CL	NC	2009
Stabilimento Maina	IT	NC	2015
Grandi Salumifici Italiani	IT	RD	2013
Solare Manufaktur Peter Backwaren	DE	NC	2012
Pastificio Felicetti	IT	NC	2014
Amadori	IT	RD	2016
Beverage industry (Ateco C11)			
UC Davis Wine and Food Facility	CA	NC	2013
Cantina Pizzolato	IT	RD and E	2016
Cantina Antinori	IT	NC	2013
Macallan distillery	UK	NC	ongoing
Carlsberg	FR	NC	2014
Energy facilities			
Centrale di cogenerazione Mozart	IT	NC	2009
Amager Bakke	DK	NC	ongoing
C.O.V.A. - Centro oli Val D'Agri	IT	RD	2015
Warehouses (Ateco H52)			
Celle ipogee Melinda	IT	NC	2004
Pedrali	IT	NC	2016
C.O.CE.A.	IT	E	2015
Iron and steel industry (Ateco C24)			
Thyssen Krupp AG Industries	DE	RD	2000
Deacero GMM	MX	NC	2010
Mechanical industry (Ateco C27-C29)			
Drexel und Weiss	AT	RD	2005
Stabilimento Omes	IT	NC	2004
Various			
Technogym Village	IT	NC	2012
Vitsoe	UK	NC	2017
Salewa	IT	NC	2011

Among others, new constructions (NC), redevelopment (RD) and the expansion (E) of the beverage industry, wineries, warehouses, the mechanical industry and energy facilities were considered (Table 1).

3.1.1 Two progressive levels of analysis

The selected cases were examined using the system of credits developed in the first stage of the research, which established an assessment protocol based on the U.S. GBC LEED Rating System. Despite being usually applied to quantitative aspects, the multi-criteria approach of sustainability Rating Systems was adopted as it provides a framework within which impacts of different nature and they synergies can be managed. Since some authors suggest that the

subjective perception of aesthetic characters largely depends on cultural codes [34], [35], less strict limit between quantitative and non-quantitative gauges have been surmised. Therefore, some semi-quantitative indicators of aesthetic-perceptual attributes were found and applied in parallel with the quantitative parameters typical of the environmental impact assessments. In particular, *LEED v4 for BD+C: Warehouses and Distribution Centers* was chosen and extended by adding a new evaluation area referred to perceptual-aesthetic aspects. Like all the LEED assessment areas, this new one includes a set of indicators to measure each impact and the rules to combine them in order to calculate the corresponding credits.

The credit scheme used as an observation lens consists of 51 credits: Integrated Process (1); Location and Transportation (7 credits); Sustainable site (6); Water efficiency (5); Energy and Atmosphere (7); Materials and resources (5); Indoor environmental quality (10); Innovation (2); Perceptual-aesthetic aspects (8);

Hence, the case studies analysis was performed in two subsequent increasingly in-depth steps: an initial "horizontal" investigation followed by a "vertical" examination.

The first analysis level (horizontal) consists of a quick glance at the case study in order to ascertain whether it fits the protocol scheme and whether it is worth expanding on. Next, the project work credits are identified and reported in a table. The table, where the thematic areas and corresponding credits are arranged on the x-axis and the case studies on the y-axis, is filled in according to a binary code (on/off). Cases that had less than 2 credits "on" have been removed. Fig. 2 shows an extract of the dynamic table: the credits have been incorporated into the thematic areas column, which presents the number of "on" credits out of the total number of credits per area.

The next stage is the second level of analysis (vertical), which expands on the previous one. Each case study is described over two pages where the data is organised into six sections (Fig. 3): the first sheet contains basic information and builds the "identikit" of the project; the second provides an in-depth description of the adopted good practices. The collection of all these data sheets constitutes the best practices catalogue.

In particular, Section 4 provides a short but comprehensive summary of the project, which can help readers to choose whether the case is worth reading according to their needs. In Section 5 the good practices are extensively described within their context, hence reciprocal

Food industry (Ateco C10)	Integrated process	Location and Transportation +	Sustainable site +	Water efficiency +	Energy and Atmosphere +	Materials and resources +	Indoor environmental quality +	Innovation +	Perceptual-aesthetic aspects -	Morphological Harmonisation	Colour and Material Harmonisation	Noise Pollution	Smell Pollution	Site Accessibility and Receptiveness	Work Space and Leisure Area Design	Consideration of Symbolic Character	Corporate Image	
1 Melinda	☐	1/7	2/6	0	2/7	1/5	5/10	1/2	3/8	☐	■	☐	☐	☐	■	☐	■	15/51
2 Bio Pastificio IRIS	☐	0	3/6	2/5	3/7	2/5	1/10	1/2	3/8	☐	☐	☐	☐	■	■	☐	■	15/51
3 Almazara Olisur Olive Oil Factory	☐	0	0	0	2/7	1/5	2/10	0	3/8	■	■	☐	☐	☐	☐	■	☐	8/51
4 Grandi Salumifici Italiani	☐	0	0	0	1/7	0	0	0	1/8	☐	☐	☐	☐	☐	☐	☐	■	2/51
5 Solare Manufaktur Peter Backwaren	■	1/7	0	0	2/7	2/5	1/10	0	1/8	☐	☐	☐	☐	☐	☐	☐	■	8/51
6 Kerrygold	☐	1/7	0	0	3/7	0	1/10	0	0	☐	☐	☐	☐	☐	☐	☐	☐	5/51

Figure 2: Horizontal analysis: a black box means the credit is "on".

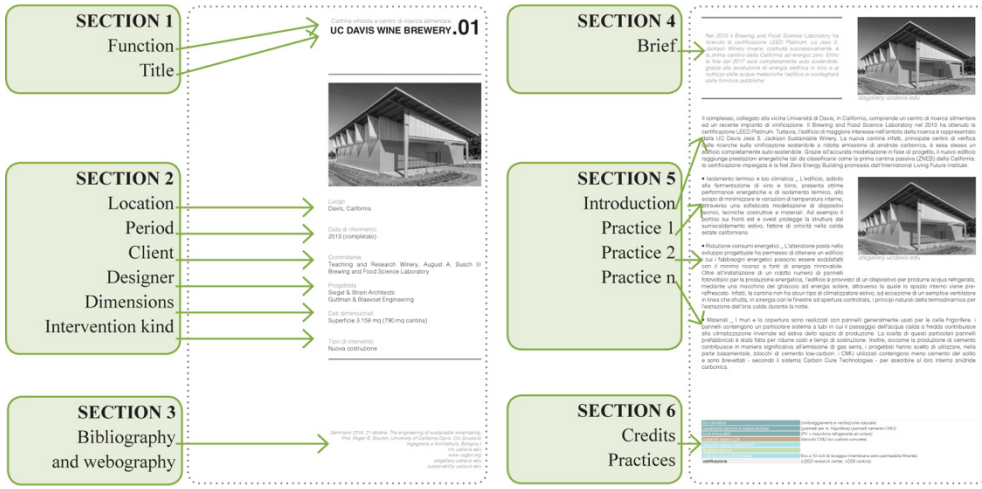

Figure 3: Vertical analysis.

Figure 4: From practices to tactics.

connections between practices are reported. Lastly, Section 6 summarises the practices using keywords and referring to credits, laying the foundations for the process of devising tactics. At the end of this procedure, the horizontal analysis is updated.

3.1.2 From practice to tactics

In parallel, the practices are collected in an Excel file where they are grouped by thematic area and linked to the corresponding credit. When two or more practices have a common denominator, a general tactic is inductively formulated (Fig. 4). For example, “green hill” to hide the height of the building and “land depression” to reduce the visibility of the complex are two practices which work with landform. Hence, “landform” is derived as a tactic. In addition, when the same practice recurs in at least two cases, it is considered common enough to become a general tactic.

3.2 Results and discussion

Thus far, 52 case studies have been “horizontally” analysed and 40 of them have also been “vertically” studied. A total of 234 practices were found in the collection and 112 general tactics were obtained.

Table 2: Tactics and number of corresponding practices for the Perceptual-Aesthetic area.

Credit	Tactic	Practices
Morphological harmonisation	screen	7
	predominance of horizontal dimension	1
	landform	4
	underground building	2
	shape of local constructions	1
	shape of landscape features	2
	volume division into minors	1
	consistent layout	3
Colour and material harmonisation	colour from context	6
	texture from context	3
	green roof	2
	materials from context	2
	colour/graphic design	2
Noise pollution	screen with landform	1
	technological screen	2
Smell pollution	-	-
Site accessibility and receptiveness	multifunctionality	6
	social responsibility and territory promotion	1
	public park	1
Work space and leisure area design	workspace customisation	1
	workers participation in designing	1
	services and leisure spaces for workers	5
	workspace ergonomic	3
	environmental psychology for workspace	1
	non-hierarchical spaces	1
	space flexibility	1
Consideration of symbolic character	symbolical remind of local constructions	1
	preservation of iconic quality of the context	2
Corporate image	reference to the product	8
	consistency with company values	5
	certification	1
	industry 4.0 (openness)	3
	dynamic perception	3
	exhibition of the process outward	4
	awareness raising project	1

Although it is not complete, the catalogue of best practices can be already consulted by practitioners, professionals and companies who can find inspiration in some exemplary projects suited to their specific case. In fact, its division into sections makes it easy to find information for specific tactic/credit/thematic areas.

Furthermore, the first level of analysis facilitates both a direct comparison among case studies and statistical analysis by sector.

Figure 5: From top left, clockwise: Thyssen Krupp (D); Cantina Antinori (I); Melinda (I); Amager Bakke (DK); Technogym (I); UCS Davis Winery (USA).

Lastly, the collection of case studies led to the recognition of several recurrent patterns which characterise some sectors or heterogeneous groups of case studies. The more significant ones are (Fig. 5):

1. Existing buildings, the visual impact of which is often mitigated by colour design (deconstruction, dematerialisation, camouflage, etc.)
2. Wineries, which emphasise the relationship between architecture and territorial identity, harmonising iconic design with the landscape where possible.
3. Food industries, which often use underground buildings as a strategy both to mitigate the visual impact and take advantage of ground thermal inertia.
4. Energy facilities that, with the association of leisure and production activities, are turned into multifunctional buildings and equipped with collective spaces.
5. Industries along highways, which experiment with dynamic perception leaving a rapid but memorable and effective impression of the building and creating an actual landmark in the landscape.
6. Zero emission factories, which often show(-off) technological devices as design elements.
7. Conclusions.

Although the research is in progress, the second stage described above provides some useful insights concerning the landscape compatibility of factories.

- The literature review points out that there is still a lack of integration between different aspects of the same topic: environmental impacts are often addressed both in research and practice, while social/cultural and perceptual-aesthetic disturbances are still rarely considered. However, this authors review of exemplary factories shows that several companies are heading in the right direction.
- Interestingly, the study highlighted that the more successful cases – in terms of prizes won or public acceptance – are those where the three areas of impact are addressed simultaneously. This is in line with Tandy's statement: "As the public becomes better informed, they are less likely to be satisfied with a mere cosmetic or "beautification' treatment" [17].

- According to the evaluating framework developed in the first research stage, the second phase shows that the higher the number of "on" credits, the better landscape compatibility the factory has.
- In addition, a first list of tactics is made available and can guide practitioners or companies through the catalogue of case studies in search of exemplary corresponding practices to use as design references.

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