PhD in Architecture XXXV cycle
Architecture: Theory and Design

ABSTRACT ITA

La ricerca, al netto dell'analisi e della classificazione geometrico-semantica dei fari del Mediterraneo, indaga la creazione di una metodologia replicabile di valorizzazione e di studio - in ambiente BIM e in ambito ontologico - applicata al patrimonio storico "caratterizzato", nello specifico i fari, ossia architetture contraddistinte da forme e geometrie ricorrenti.
In ambito parametrico, l'obiettivo è quello di creare un "modello di progetto dei fari Italiani" attraverso il quale modellare una volumetria parametrica proporzionata e geometricamente coerente al faro esistente. Ad affiancare la modellazione parametrica troviamo le scienze ontologiche che, attraverso l'inserimento delle informazioni geometriche, funzionali e compositive, risultano essere capaci di rispondere in maniera automatizzata, mediante "grafi della conoscenza", a molteplici interrogazioni poste da parte dell'utente, rendendo la conoscenza più inclusiva e fruibile.
L'uso di una specifica terminologia e di una tassonomia comune rende infine possibile la commistione di queste due scienze, verso la creazione di un software onto-parametrico inclusivo e personalizzato.

ABSTRACT ENG

The research, net of the analysis and the geometric-semantic classification of the Mediterranean lighthouses, investigates the creation of a replicable methodology of enhancement and study - in the BIM environment and in the ontological field - applied to the "characterized" historical heritage, specifically the lighthouses, that is architectures characterized by recurring shapes and geometries.
In the parametric field, the goal is to create a "design model of Italian lighthouses" through which to model a proportionate and geometrically consistent parametric volume to the existing lighthouse. Alongside the parametric modeling we find the ontological sciences which, through the insertion of geometric, functional and compositional information, are able to respond in an automated way, with "knowledge graphs", to multiple queries posed by the user, making the most inclusive and usable knowledge.
The use of specific terminology and a common taxonomy makes it possible to mix these two sciences, towards the creation of an inclusive and personalized onto-parametric software.

Sonia Mollica

The Knowledge of cultural heritage: parametric modeling, between semantics and ontology. The network of Mediterranean lighthouses

PhD in Architecture

Sonia Mollica

THE KNOWLEDGE OF CULTURAL HERITAGE: PARAMETRIC MODELING BETWEEN SEMANTICS AND ONTOLOGY

The network of Mediterranean lighthouses

Scuola di Dottorato – Università Mediterranea di Reggio Calabria · PAU · dArTe

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On the cover
Marraffa, A., 2022, Visions and coastal admixtures.

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PHD
Architecture
Architecture: Theory and Design

S.S.D. ICAR/17
XXXV CYCLE

THE KNOWLEDGE OF CULTURAL HERITAGE: PARAMETRIC MODELING BETWEEN SEMANTICS AND ONTOLOGY

The network of Mediterranean lighthouses

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Sonia Mollica

THE KNOWLEDGE OF CULTURAL HERITAGE: PARAMETRIC MODELING BETWEEN SEMANTICS AND ONTOLOGY

The network of Mediterranean lighthouses

Index

Abstract

The research, net of the analysis, the classification and the geometric-semantic cataloging of Mediterranean lighthouses, investigates the creation of a possible replicable methodology for the enhancement and study of the "characterized" historical heritage in the BIM environment and in the ontological field. The choice of this type of tools associated with the peculiar coastal architectures is a consequence of the identification in the compositional system of the lighthouse of recurring shapes and geometries, an aspect with enormous potential, through which to reconnect data and create adaptive parametric models.
In the parametric field, the goal is to create a "design model of Italian lighthouses" through which to model a proportionate and geometrically consistent parametric volume to the existing lighthouse. In this sense, the model that is generated is configured as sufficiently performing, as it is characterized by a metric error between the parametric model and real geometry equal on average to 0.5%, useful for the dissemination of cultural heritage in digital applications.
Alongside the parametric modeling we find the ontological sciences which - through the insertion of geometric, functional and compositional information - are able to respond in an automated way, through "knowledge graphs", to multiple queries posed by the user, making the most inclusive and usable knowledge.
The ultimate goal, through the use of specific terminology and a common taxonomy, is to enhance the knowledge and connection of lighthouses by creating a replicable parametric-ontological methodology, to be channeled towards the design of a unique software addressed to four different users - adults, children and disabled, blind and experts - assuming a totally personalized and inclusive learning experience.

Key words:
Mediterranean, methodology, lighthouses, semantics, BIM, ontology.

Introduction

Along the coasts that separate the urban space from the terrestrial one - that is the surface and coastal limit theater of centuries-old conflicts, myths and hope for a prosperous future - lie those architectures called 'amphibians', consisting of foundations firmly on the ground but with the gaze fixed on the horizon. Their construction dates back to very distant times and their transformation goes hand in hand with the progress of navigation technologies. Despite the succession of increasingly innovative systems, lighthouses have represented and still represent the main navigation tools, constituting a huge architectural example in the field of cultural heritage.
Today it appears evident how the technological evolution of optics is configured as the main cause of the abandonment of these architectures which, while maintaining the high symbolic and identity value , are the protagonists of a sudden and inexorable transformation of the architectural organism into relict of history, a piece of memory now past. In this sense, in fact, the maintenance of the lighthouse is today exclusively reserved to the apparatus containing the luminous optics, as well as to the relative support structure, causing what appears to be the extreme aesthetic contrast symbol of technological progress.
In the field of cultural heritage, in which the lighthouses are configured as an integral but often forgotten part, it is now known that the issues relating to the protection of the same are today the subject of various researches aimed not only at maintenance but also at enhancement and dissemination of architectural heritage through digital devices such as BIM, AI, augmented reality, virtual reality, etc.
Preliminary to the explanation of the analysis process through which to expose the reasons for the research and the application developments of the same, we want here to give the reader a summary picture of the aspects linked to the exaltation and dissemination of cultural heritage. As mentioned, the theme of cultural enhancement appears today as an extremely discussed issue, through which to protect and rediscover known or still unknown architectural values. Similarly, national and international policies aim at an ever more extensive and intensive analysis, dissemination and digitization of cultural heritage, as demonstrated by the numerous strategies implemented in favor of their protection and rediscovery. The research therefore fits, by virtue of the relative association and mixture of cultural heritage and digitization, in the context of numerous and different programs, among which we recall: the 2030 Agenda, the ERC sectors, the Smart Specialization Strategy , the Horizon 2021-2027 program and the PNRR.
The 2030 Agenda, with goal 11 "Sustainable cities and communities", recognizes as a priority, in point 11.4, the enhancement and protection of the world's cultural and natural heritage[1]. Similarly, the Horizon 2021-2027 program, aimed at research and innovation, in

the cluster "Culture, Creativity and Inclusive Society", intends to direct innovation towards cultural and creative industries in the field of cultural heritage, oriented towards digitization and dissemination 2.0[2]. Smart Specialization Strategy , pertaining to the regions of Calabria and Sicily, protect, on the one hand, with the "Smart Communities" cluster, the enhancement of cultural heritage[3] and, on the other, in the "Energy and environment" cluster, the marine areas and the related architectural pertinences[4].
As with the international and regional plans, also at the national level, attention is focused on safeguarding the architectural heritage and its digitization. This is the case of the National Recovery and Resilience Plan (PNRR), as part of Mission 1 "Digitization, innovation, competitiveness, culture and tourism", component 3 "Tourism and Culture 4.0", through which to restructure the key assets of the heritage cultural heritage, favoring the birth of new services, accessibility and regeneration[5]. The European Sectors Research Finally, the Council (ERC) directs the research fields, coherently with the topics covered by this doctoral research, towards three fundamental points: the SH5 Cultures and Cultural Production: Literature, philology, cultural studies, anthropology, study of the arts, philosophy; the SH5_8 Cultural studies, cultural identities and memories, cultural heritage; the SH5_13 Computational Modeling and Digitization in the Cultural Sphere. Ultimately, it is clear that all the programs and strategies, whether they are short-range or wide-ranging, consider the protection of cultural heritage as an emergency which must not be overlooked.
In line with what is configured as the rediscovery of value-utility addressed to the enhancement of the historical heritage, in the same way, the lighthouses today rediscover a new landscape, architectural and cultural value, thanks to the great evocative sense they exert on our memory and on the landscape. The coastal heritage of the Mediterranean lighthouses, the 'birthplace' of these architectures composed of fires that lit up the nights from the top of the hills and indicated the way to sailors, is an architectural category extremely present along the entire Mediterranean coastline, constituting an apparatus of about a thousand architectural artifacts.
The entire series of lighthouses of the Mediterranean is therefore defined as a system of networks of high artistic, cultural and landscape value, in which the Italian territory is inserted as a virtuous example of a prosperous and flourishing country of these coastal architectures. Italy, in fact, holds the primacy in terms of quantity and artistic value of coastal artifacts: one hundred and seventy-four lighthouses made up of 80% architecture with a high architectural, landscape and compositional value. Although the Italian lighthouses are in absolute numbers lower than in countries such as, for example, Greece and Croatia, it is the historical-architectural value that determines the actual keystone in the context of cultural enhancement, distinguishing itself from the more Mediterranean architectural organisms. recurrently simple and composed solely of the tower element. Italy therefore wins the title of Mediterranean country with the highest number of lighthouses of architectural and landscape value (fig. 1).
As dealt with in the area of programming, it is immediately evident that all the strategies aimed at safeguarding and enhancing cultural heritage appear to be oriented towards the digital transposition of the asset itself and the creation of digital processes capable of optimizing cataloging, knowledge and dissemination of cultural heritage. In line with all those that have been configured as the premises of the research, focused on the importance of safeguarding the cultural heritage and on the relative emergency concerning the conservation and enhancement of the Mediterranean lighthouses - as confirmed during the numerous conferences followed, the participation a summer schools , among which we recall the "After the Damages" project[6], the scientific contributions consulted and the numerous contributions published - at this point we want to briefly explain the scope of application of doctoral research and how the latter has been extremely influenced by the architectural-spatial configuration of the lighthouse itself.

In this sense, in fact, as treated for the entire second part of the thesis, the lighthouses, in addition to 'connecting' the entire coastal territory through tangible and intangible networks, are themselves connected by endogenous, functional and stylistic relationships and factors that define its geometry and compositional style. These architectures, in fact, are characterized by simple but extremely recurring geometries, through which to define a specific architectural semantics, found in all the lighthouses present in the Mediterranean basin.
Having identified the extreme interest addressed to the coastal military heritage and the effective existence of common languages, through the wings implement intelligent and adaptive processes towards the enhancement of these architectures. At this point it is possible to break down the main architectural system into three basic macro elements - the building, the tower and the lantern - containing the micro variants, i.e. the most characteristic and specific elements of each macro element pertaining to the architectural system, which can be summarized in the following peculiarities: the ashlar, the openings, the moldings, the shelves and the balustrades. The compositional knowledge of the entire series of Mediterranean lighthouses therefore makes it possible to identify a generic lighthouse system to be characterized according to a database of constituent elements extrapolated from each single case study, a methodological process in which semantics and taxonomy are configured as fundamental for the systematization, cataloging and connection between the elements. It is precisely through semantics and taxonomy that the methodology finds its application foundations, through the use of two of the best performing digital systems in the field of cataloging, connection and interoperability: BIM and ontology[7].
BIM applied to cultural heritage appears to be a widely debated topic in recent years, a topic accompanied by numerous points of view, research and analysis relating to new possible methods of use and application of parametric software on built heritage. Despite the excessive rigidity of BIM for buildings, today the parametric sciences can be said to be sufficiently performing in the classification and cataloging by parts, in which the theoretical semantic subdivision of the elements is configured as one of the most current and complex challenges, as needing to study numerous case studies. In this sense, it is through

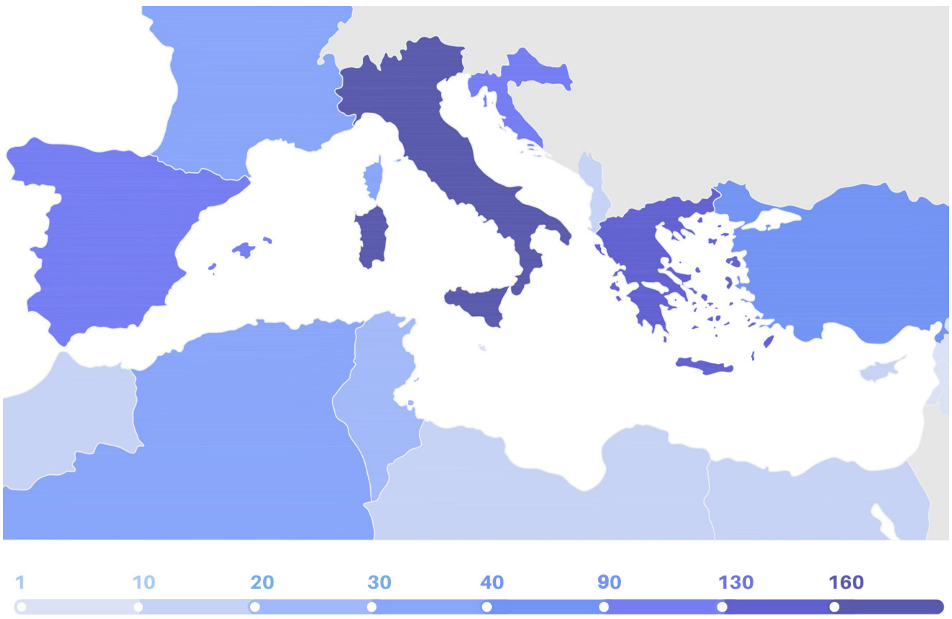


Fig. 1. Number of lighthouses with architectural value in the Mediterranean area.

the semantic decomposition that it is possible to create a "project model of Italian lighthouses", that is a library based on semantic elements composed of macro and micro variables, through which to model specific case studies and obtain a more or less consistent with real consistency, depending on the metric data in our possession.
Ontology, unlike BIM, turns out to be a topic extensively treated in the past in its philosophical meaning, rediscovered only in recent years in the field of artificial intelligence (AI). This science, in fact, is configured as fundamental and extremely performing in the context of data connection, an essential action to guarantee understanding and interoperability between elements, a key feature belonging to the enhancement of cultural heritage. In this sense, if on the one hand the BIM is configured as a tool with a high technical-practical value but not very performing in the context of the connection between data, the Protégé ontological software is defined as the solution to the complete decomposition and semantic connection of data belonging to the lighthouses of the Mediterranean.
The possible union between these two sciences, an argument dealt with during the doctoral period carried out abroad at the CNRS laboratory in Paris[8], makes it possible to increase the potential of parametric and ontological software, through which to facilitate connection processes, create cultural oriented models and making knowledge more inclusive and opensource .
Ultimately, within the research guidelines relating to national and international programs, there is therefore a strong interest in the field of digitization and the consequent enhancement of cultural heritage, an objective towards which research, through the use of semantics applied to parametric and ontological sciences, intends to address itself through an adaptive and performing approach from a scientific-technological and social-humanistic point of view , themes in line with the scientific disciplinary sector ICAR17 in which the thesis is inserted.

Notes

1. For further information: https://www.eda.admin.ch/agenda2030/it/home/agenda-2030/die-17-ziele-fuer-eine-nachhaltige-entwicklung/ziel-11-staedte-und-siedlungen -inklusiv-sicher.html.

2. As underlined by the point "Innovative Research on the European Cultural Heritage and the Cultural and Creative Industries ". For further information: https://horizoneurope.apre.it/struttura-e-programmi/global-challenges-european-industrial-competitiveness/cluster-2/.

3. For further information: https://calabriaeuropa.regione.calabria.it/wp-content/uploads/2021/12/Scheda-Cluster-Smart-Communities.pdf.

4. For further information: https://www.regione.sicilia.it/istituzioni/regione/struttura-reginali/assessorato-attivita-produttive/dipartamento-attivita-produttive/strategia-s3-sicilia.

5. For further information: https://pnrr.cultura.gov.it/.

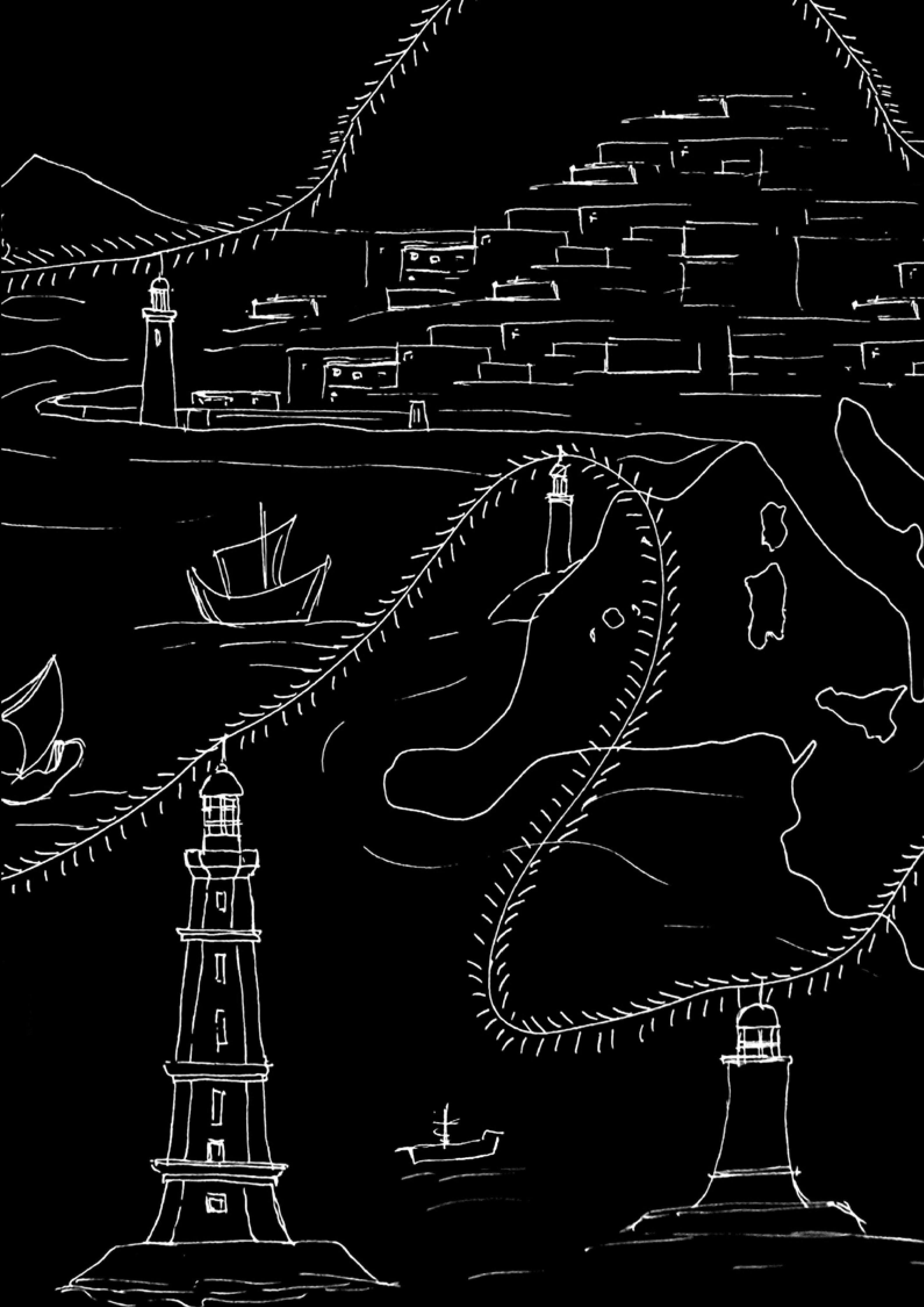
6. For further information: https://www.afterthedamages.com/.

7. It should be emphasized that the use of BIM and ontology is configured as the product of a research process, aimed at identifying the best performing sciences in the field of data modeling and connection, a step subsequent to the actual theorization of a common semantics of lighthouses.

8. For further information: https://www.maacc.archi.fr/.

Part I
The Mediterranean lighthouses

The first part of the research, based on the explanation of the geo-morphological characteristics of the entire Mediterranean area and the evolution of lighthouses from an architectural and technological point of view, has a transversal character and develops the state of the art on which the research focuses its premises and its foundations.
The Mediterranean area is therefore treated and analyzed in its double dichotomy, from terrestrial space to the marine landscape, identifying its characteristics, myths and peculiarities. It is in this context that the lighthouses of the Mediterranean are inserted, narrated starting from the first fires that rose from the heights to today's modern technology: a landscape, technological and compositional *excursus* aimed at directing the reader towards a clearer understanding of the subsequent parts of the analytical-experimental research.
In summary, the objectives of the first part are: the definition of the fundamental historical stages relating to the mutations of the Mediterranean basin, from its landscape component to that of the land; the description of the coastline in relation to the evolution of navigation systems and the consequent implementation of a network of lighthouses on a Mediterranean scale; the definition of the importance inherent in the creation of tangible and intangible connections in the coastal area; the identification, through the illustration of strategic plans and initiatives, of the potentials related to the development and increase of coastal networks connected to culture and the economy; the narration of the history of Mediterranean lighthouses from a technological and compositional point of view, through which to understand the compositional evolution of these architectures; the discussion of the function of the lighthouse in the contemporary context, towards the introduction to new strategies and analyzes.



Chapter 1

The Mediterranean

"Che cos'è il Mediterraneo? Mille cose insieme. Non un paesaggio, ma innumerevoli paesaggi.
Non un mare, ma un susseguirsi di mari.
Non una civiltà, ma una serie di civiltà accatastate le une sulle altre"
[Braudel, 2017, p. 5].

The objective of the following chapter is to identify the concept and essence of the 'Mediterranean' through the consideration of some key elements that compose it, namely the gluing characteristics of the surroundings, of the peoples and of the materiality of the place, as well as the presupposition through which to argue from an aesthetic-material point of view: on the one hand, from a strategic-normative point of view, on the other, the aspects linked to the actual existence of a cultural and architectural-coastal network.
The Mediterranean area is then treated and analyzed in its double dichotomy, from the terrestrial space to the marine landscape, through which to identify the characteristics, myths and peculiarities of this territory. This process is configured as fundamental in order to identify and describe the presence of a network of Mediterranean lighthouses, the lifeblood of material and immaterial coastal connections.
In this 'dreamlike' discussion, however, today's national and international strategies are not overlooked, through which to understand the processes of economic, architectural and cultural growth and development of the coastal space.

On the cover. The Mediterranean: lighthouses and networks.
Fig. 1. Oliva, F., 1650, Portolano of the Mediterranean.

Introduction

Dealing with the vast Mediterranean territory means traveling, encountering the Roman world in Lebanon, prehistory in Sardinia, the Greek cities in Sicily, the Arab presence in Spain and Turkish Islam in Yugoslavia (Braudel , 2017) (figs. 2-5). It means encountering the superimposition of ancient stories alongside ultramodern knowledge: city walls next to contemporary buildings, historic cities alongside industrial centers, small fishing boats escorted by flows of enormous oil tankers[1]. This is because the Mediterranean is an ancient crossroads of exports, goods, ships, ideas, cultures and vegetation (figs. 6, 7), a space that is therefore configured as a place of contamination and interaction between cities, traditions, cultures and society.

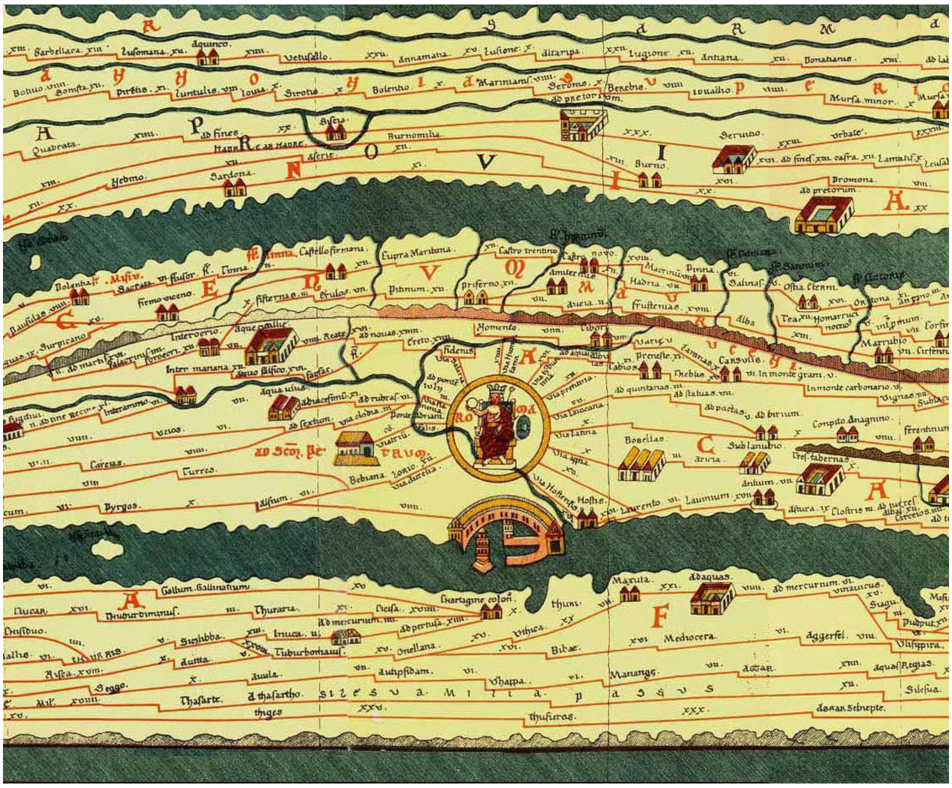
The context is particularly important and significant for understanding the developments and interactions between cities, territories and port systems, events that are certainly representative of the technological and compositional evolution of lighthouses, border architectures between land and sea, which have always been identity symbol of places[2] (Cerret et al., 2014). But how to effectively explain such a territory, made up of agglomerations of which it is often difficult to grasp the beginning and the end, that is, a system fused and reassembled into an original unit?[3] Trying to reconstitute this organism, it is possible to identify three macro-groups, through which to compose a magnificent overall design: the terrestrial system, the maritime system and the sky. The earth is the internal feature of places, the theater of stories and myths. Together with the sky, it composes the landscape, the definitive and indelible result of every change that has occurred in the social context, in the ways of producing and in the lifestyle of the territories (Turri, 2014).

On a geographical map, the Mediterranean is nothing more than a fissure in the earth's crust, a territory that stretches from the isthmus of the Suez Canal to Gibraltar. The territories that compose it are numerous as are the morphological attributes that characterize it: the mountains give the boundless space a structure and draw its skyline; the hills, home to numerous flora and fauna riches, determine its mild and welcoming climate; a very long coastline, finally, draws the boundary between land and sea. It is precisely this line that is a spectator of the infinite complexity and potential of the 'border' which, in its industriousness, is configured as a very intricate design of sea and land routes, masterfully organized and directed by the lighthouses of the Mediterranean, through which to connect every typology of cities, be they metropolises or residential agglomerations of modest dimensions, as long as they are distinguished by the coastline that defines and emphasizes their identity, space and belonging . The so-called "space-movement"[4] is therefore determined, in which the 'movement' given by coastal connections is superimposed on the terrestrial and material space, thanks to which the wealth, values and possessions of the three continents that compose it are generated and multiplied, balanced by changing equilibria[5] (Braudel , 2017).

The land is therefore contrasted by the sea, an intricate network of coastal connections, a generator of myths and a tourist catalyst, as well as a portal to global connections and material and immaterial flows. This space - in the past an insurmountable limit, full of pitfalls and the scene of numerous tragedies and defeats - finds the origin of its networks in the appearance of the first Phoenician boats and in the need of the populations to go to other territories, in search of resources for survival of the people: the 'tamed' sea, in addition to connecting places, itself manages to be a fundamental resource for the community.

Finally, the sky, a spectacular scenography, characterized by innumerable colors and contrasts, by glows and shadows, is reflected in the windows of the buildings, lights up the plaster of the houses and floods the territory with a strange and surreal magic. Sailors owe their salvation in the night to its constellations, the only source of direction from ancient times, today a catalyst of glances and hopes, as well as a connecting element in an ever-changing and mutating terrestrial environment.

Fig. 2. Parracciani, A. (2007). Representation of the Mediterranean, acrylic on canvas, 50x40 cm.
Fig. 3. Picasso, P. (1952). Mediterranean landscape, oil on panel, 81x125 cm.



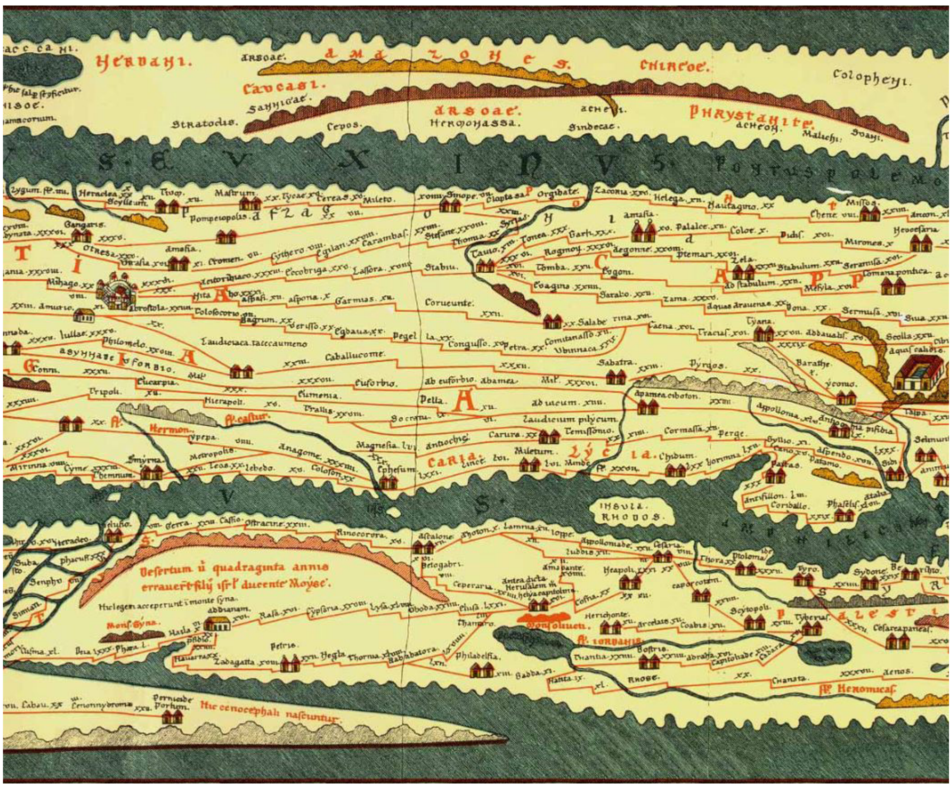
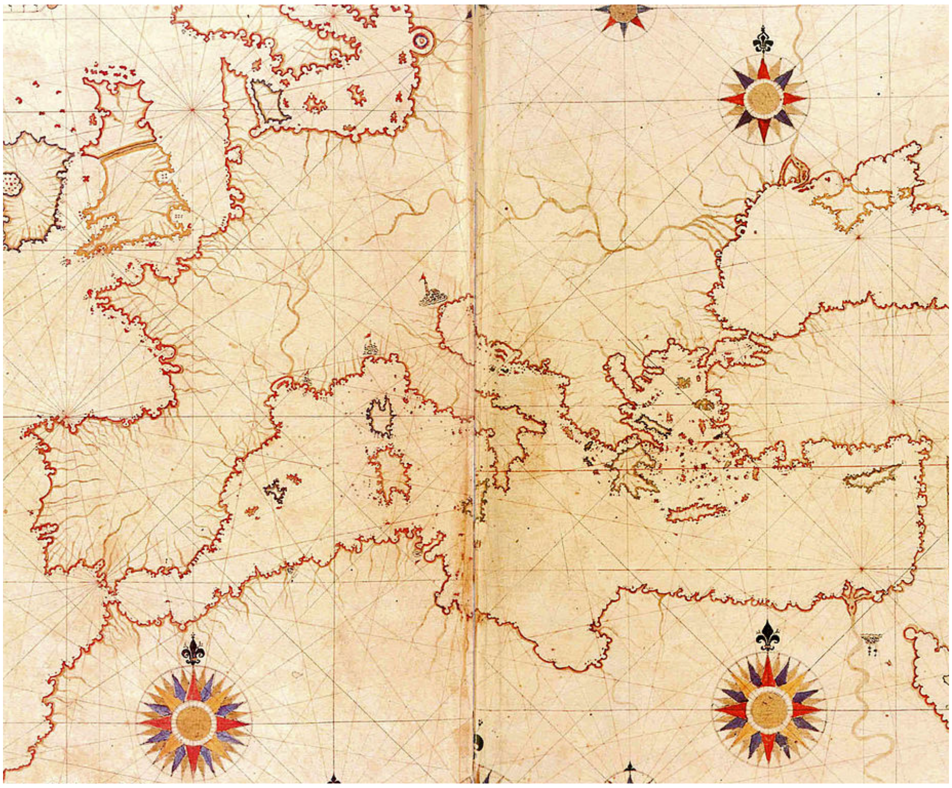


Fig. 4. Peutinger, K., Fragment of the Roman itinerary-map called 'Peutingeriana', 3rd-4th century, canvas 680x33cm.
Fig. 5. Peutinger, K., Fragment of the Roman itinerary-map called 'Peutingeriana', 3rd-4th century, canvas 680x33cm.



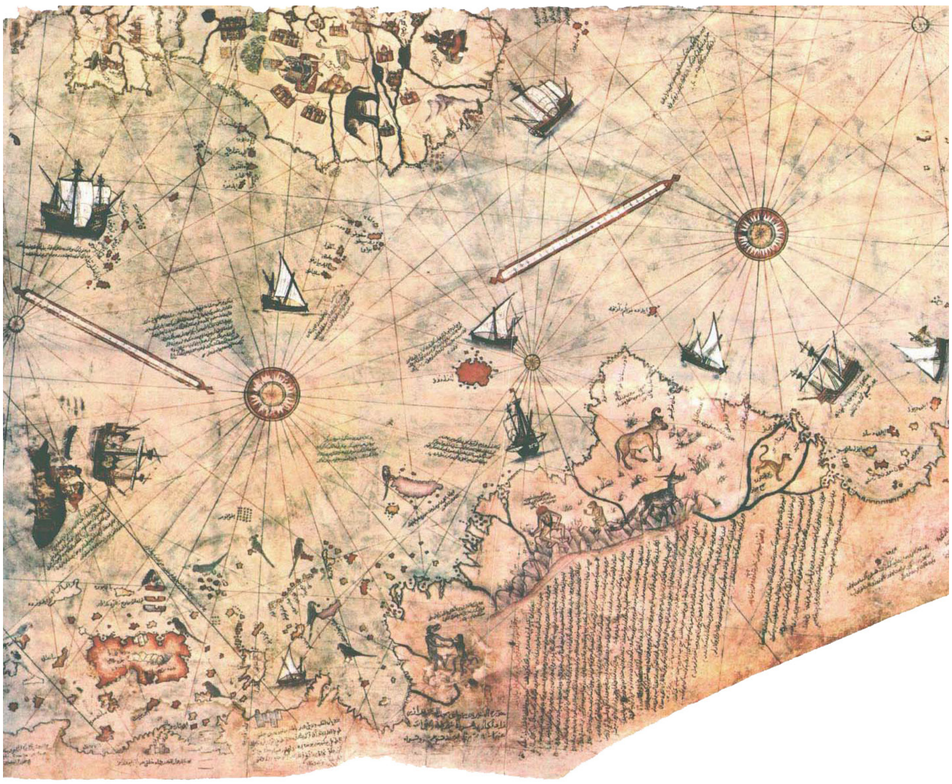
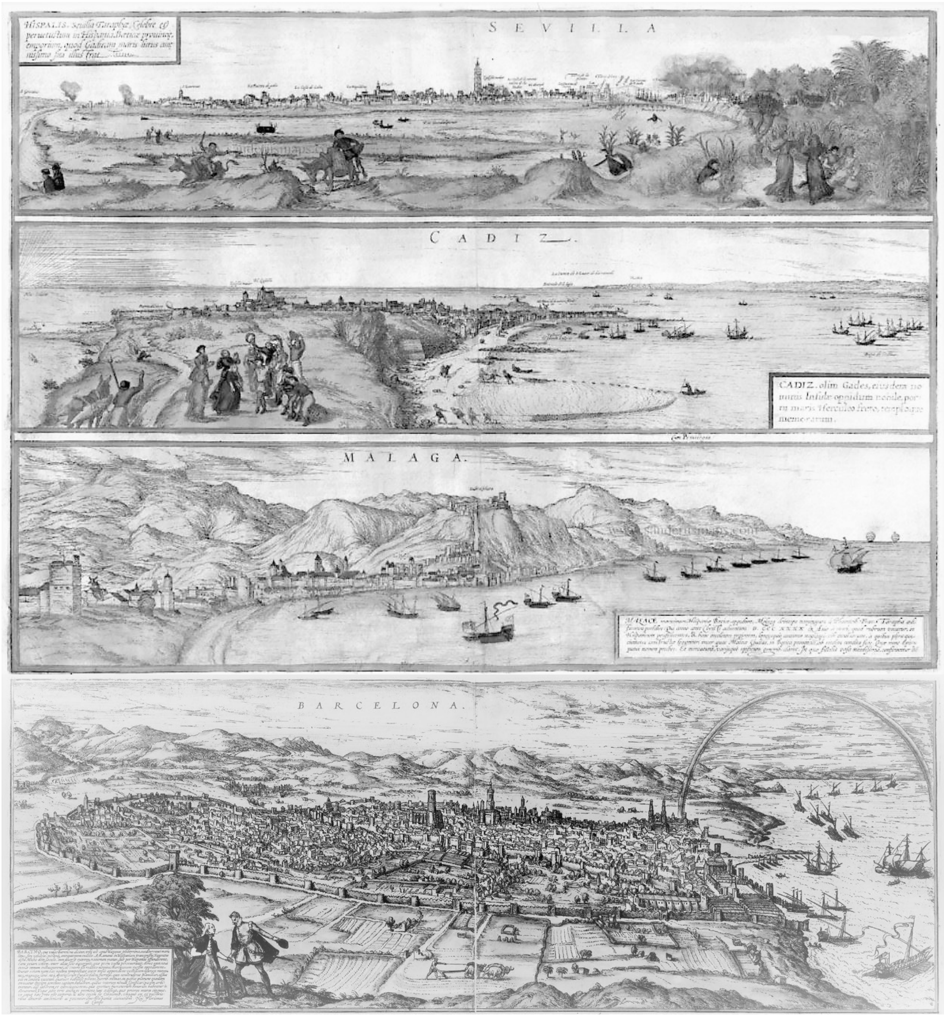


Fig. 6. Piri Reis, Map of Europe and the Mediterranean. 16th century copy of the Kitab-ı Bahriye navigation book.
Fig. 7. Piri Rei (1531). Map depicting part of the Atlantic Ocean, together with the European and East African coasts.

Below we want, therefore, to clarify the relationships that bind these three elements, through which to understand the reasons and the generating connections of a Mediterranean identity, the birthplace - and for this reason inextricably linked to it - of amphibious architectures. object of this research, connected and united by common languages and codes.

1.1 Terrestrial space and Mediterranean character

The internal territory, as just stated, is defined as an agglomeration of cultures, spaces, cities and landscapes: open spaces, cracks, fractures and jagged reliefs characterize the territory in which the land and the sea are mutually scenography, between more or less prominent and more or less characterizing heights.
In the Mediterranean terrestrial space, it is the volcanoes - often asleep, but always ready for a sudden and perhaps dramatic awakening - that dominate the landscapes of these territories, recognized in the past by sailors as points of identity, guiding sparks in the nights illuminated by darkness. This is the case of the Stromboli volcano, recognized as the most active volcano in the world, located in the middle of the sea off the homonymous island and for this reason defined in antiquity as the oldest 'lighthouse'. As for the volcano of Stromboli, also Vesuvius, in the Gulf of Naples, and Etna, always seething in the province of Catania, are defined as structures soaring along the horizon and for this reason, for a long time, points of identity and guide for the sailors. Finally, the mountains, together with the volcanoes, contribute to the construction of the skyline of the cities and the landscape, defining further points of reference and perfect locations to ignite the sparks of light: this is the case of the Alps, the Apennines, the Taurus, the chains of the Spain, the Pyrenees, the Balkans, the Atlas and Lebanon (figs. 8, 9). These, like a stone skeleton, pierce the skin of the Mediterranean territory (Braudel , 2017), defining its borders and structure, as well as the conspicuous points through which to connect and mend the land border.
The set of soaring elements therefore make up the connection system of this unitary territory, even if the Mediterranean identity territory is not only made up of stone and ash walls ready to welcome sparkling fires[6].
It is to the migration towards the coasts, together with the now increasingly pressing technologies in the field of light emission, that we owe the creation of a dense network of relationships and relationships along the entire Mediterranean basin, managing to unify, as we will see in the next paragraph, the terrestrial space to the terrestrial space, changing its relationships and relationships: what is previously defined as the only possible duality, composed of the alternation between the hill and the mountain, is today the dichotomy between the terrestrial space and the sea to define the Mediterranean area[7].
Before analyzing the connections and networks associated with the relationship between sea and land, it should be emphasized that, on a cultural and structural level, it is people who are configured as the real essence of the Mediterranean space, linked by common identities and cultures. There is, in fact, a Mediterranean lifestyle, a Mediterranean character which includes in its terminological etymology a design of religions and destinies of civilization, diets and foods, cultures and arts, mythologies and physical-somatic characters[8]. In this sense, Mediterranean unity, understood as a relationship between populations, began its journey in 1995, when in the meeting held in Barcelona[9], which later became the Declaration, 27 European and Mediterranean countries accepted the commitment to start a partnership for rapprochement. and understanding between peoples, improving their mutual perception[10]. This unity subsequently also becomes territorial thanks to the geographers Fische and Philippson , creators of a broad cultural project aimed at union on a geographical basis and aimed at defining well-defined limits and borders (Prontera, 2014). The mending given by the coastal architectures - hereinafter referred to as the ma-



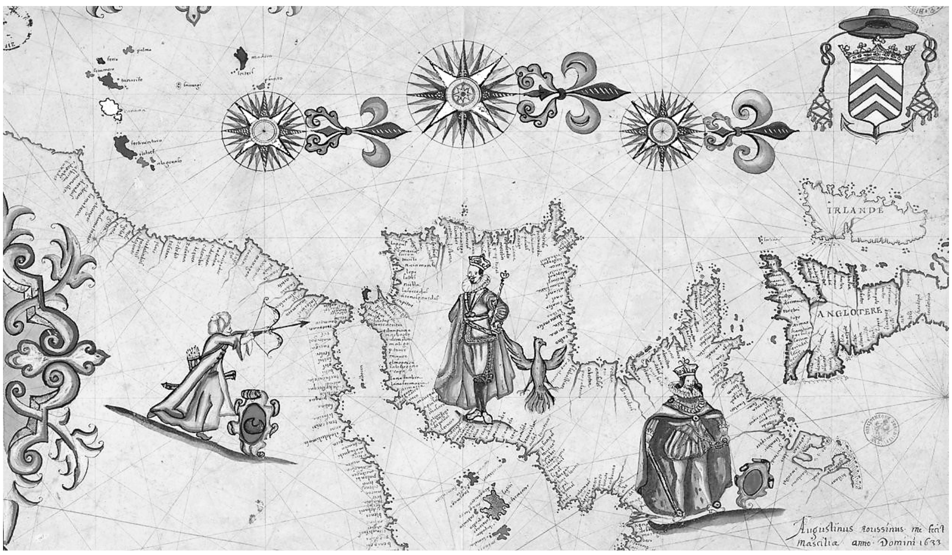


Fig. 8. Braun, G., Hogenberg, H.(1572). Seville, Cadiz and Malaga in *Civitates orbis terrarum*.
Fig. 9. Roussin, A. (1633). France, Spain and North Africa in the Provencal Atlas of the Mediterranean.

terial and immaterial network of the Mediterranean lighthouses - is therefore the consequence of a preliminary cultural connection and consequently structural and territorial of the Mediterranean space.
As part of the Mediterranean lighthouse network, if on the one hand all those coastal and terrestrial connection systems of an infrastructural type are already a reality, through which to physically connect the territories, on the other hand, the construction of 'intangible infrastructural' networks they define themselves as capable of producing territorial cohesion, favoring the attractiveness, identity and enhancement of places. It is, in fact, now known that the potential of intangible network systems are defined as the presupposition through which the value of the network and of the specific intangible consistency can be intertwined, incorporated and linked to the consistency of the material asset, defining an added value (Gambardella, 2005).
Therefore, the imaginative construction of material and immaterial networks, made up of objective and imaginary connections, makes it possible to create a system through which the territory and the related identity architectures can be recognized. In this context, the lighthouses are configured as architectures distinguishable on a functional and aesthetic level, as well as united by an architectural language and a common landscape, through which to connect the three Mediterranean elements: the earth, the sea and the sky.

1.2 The sea line and coastal development

The line of the sea represents the border of the 'domestic' environment, the place where rules and visions changes. Today the marine space, in contrast to the terrestrial space, translates into a material and immaterial architectural unity of which it is easy to perceive the myths and the stories (Giovannini, 2005) (fig. 10). Since the past, the sea, despite its boundless and not entirely known space, has been considered a great unitary design, a concept soon destroyed as a result of the numerous conflicts that have occurred over time between peoples. The distancing between the two shores begins to develop mainly after the First World War, when we witness the economic hegemony of the Arab countries, especially by France and Great Britain. Subsequently, relations worsened further during the Second World War, fragmenting the *Mare Nostrum* more and more, leading to the creation of borders that were no longer physical but mental, transforming it from a crossroads of great cultural exchanges into a place that was the scene of bitter conflicts, above all religious and ethical (Petracca, 2017).
The Mediterranean, a succession of different seas, is thus divided into autonomous surfaces with finite horizons: a particularly suitable context for the men of the past, but not for the contemporary ones. In this sense, in fact, the sea was seen in the past as a barrier without a horizon, as an immense and obsessive expanse of water in which the imposition of limits and boundaries is transformed into peaceful security. It is the growing need for the exchange of goods[11] that increasingly shortens geographical distances, adding to these needs the possibility of an abundant supply from a material and food point of view (Braudel, 2017). Therefore, a past made up of discomforts of navigation in a unitary context is contrasted with the now total familiarity in riding the waves in a fragmentary context as a whole.
In the past, in fact, the streets of the Mediterranean consisted of two spaces, one the sounding board of the other, which define its identity: the first is the inland sea - the one closest to the city, theater of small exchanges, of the relationship between the neighborhood, of domestic knowledge - incorporated by the Mediterranean understood as a vast area, which envelops it and determines its geographical relationships. On the contrary, the perspectives aimed at the enhancement of the Mediterranean area increasingly

Fig. 10. Gafurri, C., Semi-precious stone salesman depicting the port of Livorno, 17th century. Florence: Uffizi Gallery.

envisage a return to the great overall design, to be combined with contemporary knowledge, towards a unitary empowerment that can only be implemented through the social, cultural, architectural and geographical reconnection of places.

The only geometric and material 'limit' allowed in the enhancement of the coastal environment is represented by the *finis terrae* defined by the coastal landscapes, unique spaces not only for the geometric-spatial relationship they maintain between the built city and the sea, but also fundamental for regarding the birth and development of intangible cultural heritage (Bozzato & Bandiera, 2019). In this sense, in fact, each waterfront must be considered as a multipolar node in which individual lives and cities intersect with community social spaces and with the neighboring shores, in order to reconnect the territory through bonds and networks: this is because waterfronts are the places par excellence where, as mentioned, the cultures, economies and characteristics of coastal settlements are manifested (Vallega, 2003).

In cities such as Venice, Genoa, Naples, Istanbul and Marseille (figs. 11-15) the waterfront is defined as a structuring element and as a place of identity to be considered as a catalysing factor for the reconnection of cultures and cultural assets (Governa, 1999; Ostrom, 2006), in the constant ambition to open up to the new, through which to transform coastal places into landscape, as recognized in the transformation processes (Settis, 2010; Quaini, 2008). Established that the sea-land interface is not only a geographical condition but rather a portal of connection of material and immaterial flows, the new city-ports are configured as economic transformers of global networks, with a broader interaction and a more clear, capable of generating new urban forms and a new landscape, capable of feeding the networks of culture and knowledge. The interaction between landscape and architecture generates coastal cities, associated by Bauman with "liquid cities", transporting us towards

a new strategic attitude centered on the economy addressed to culture (Charter, 2012). In this sense, it is no coincidence that the liquid city is associated with coastal cities and their economy: this is because in the years in which Bauman proposed his concept of 'liquid', Sloterdijk[12] also envisaged a "new liquid world" as an element engine of modernity. The waterfronts are therefore proposed as territories capable of intercepting the material and immaterial characteristics of a place and making them travel along the networks of economic development and cohesion[13] (Charter, 2012), an area in which coastal architectural structures are configured as the perfect intersection point between culture and economy, between history and function, between material and immaterial.
If to deepen the question regarding intangible connections, refer to sub-paragraph 4.1.3., At a strategic-procedural and material level there are numerous European projects focused on the enhancement of port and coastal contexts present in the Mediterranean context. This is the case of the Mediterranean Strategy for Sustainable Development[14] and the National Strategies for Sustainable Development[15] , taking into account the objectives assigned by the Commission for Sustainable Development of the United Nations, whose

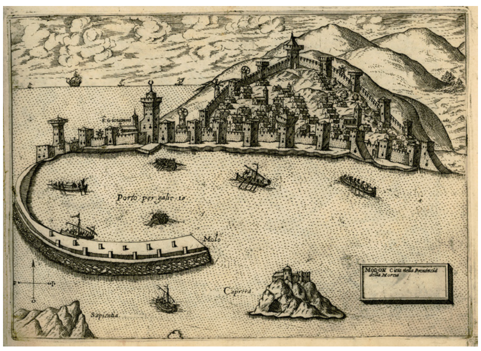
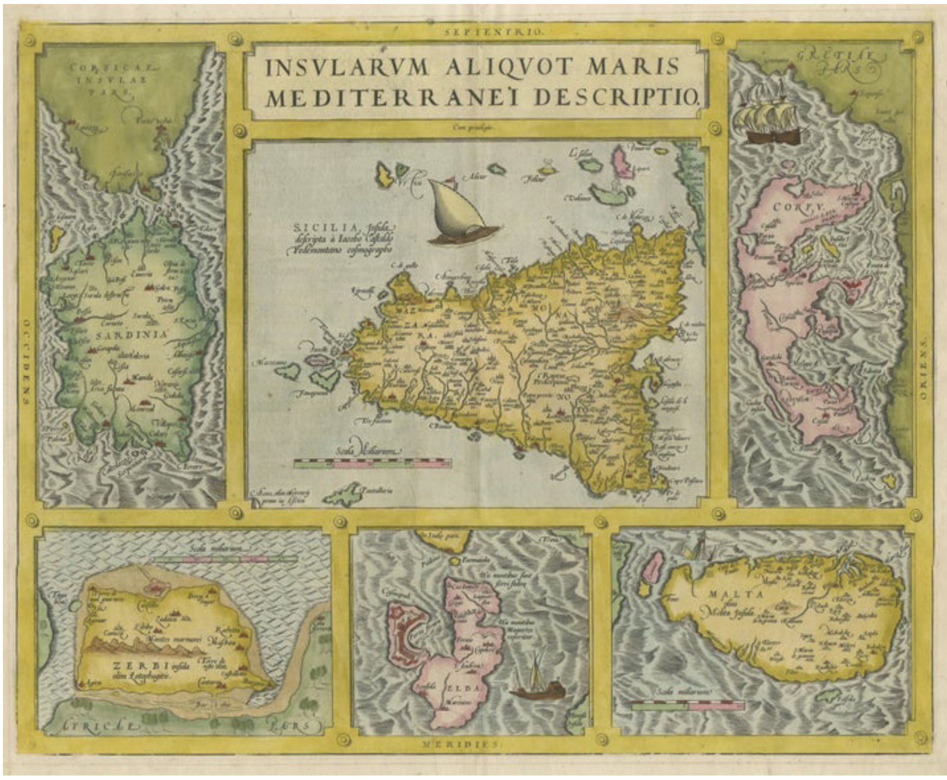


Fig. 11. Braun, G., Hogenberg, H., Naples in *Civitates orbis terrarum*.
Fig. 12. Coronelli, V. M., The wharf of Modone in the Morea, Venice, 17th century.
Fig. 13. Braun, G., Hogenberg, H., Marseilles in *Civitates orbis terrarum*.



Figs. 14, 15. Abraham, O., (1601). Islands of the *Theatrum terrarum*, Amsterdam, late 16th century.

objectives are to promote the use and redevelopment of coasts and waterfronts on the basis of sustainability. It is in these development and mending strategies of the coastal territory that the lighthouses of the entire Mediterranean basin are inserted, an extensive heritage that marks the coasts, characterizes their identity and proposes their reconnection towards the increase of culture, of the identity and knowledge of the coastal heritage.

1.3 The Mediterranean lighthouse network

Among the architectural-landscape resources that have unified over time the three dimensions of the Mediterranean territory - land, water, sky - attributing a significant value to Mediterranean places, those buildings connected to the coast, born from the need of the populations to take advantage of elements that could act as a sighting or, on the contrary, as a signaling: these are the lighthouses, towers and defensive forts (Magnani & Pistocchi, 2019) (fig. 16).
The presence of the lighthouse - as well as constituting a fundamental functional element for the safeguarding and safe navigation of sailors - is configured as an identifying element of the places, whose presence in the Mediterranean is probably as old as the history of navigation of which the origins: coasts illuminated by the glare present on the hill by lighting fires on braziers (Simonetti, 2009). Thanks to their location and their height - soaring from the beaches closest to the sea, from the mountains and cliffs that overlook it - they often represent the territorial landmark that puts an end to the earth, the *finis terrae*, from which the sea begins: a sort placeholder represented by towers plastered in white, red, black and white stripes, etc.
The idea of historical identity rooted in the architecture of the lighthouse is strong in Mediterranean culture: it is for this reason that the enhancement of lighthouses, as for all cultural heritage, is today a privileged resource for sustainable development and innovation. of the national and international system (Pollice & Rinaldi, 2012). In this sense, in line with the indications promoted by the European community, the culture-oriented development models aim to generate, activate and increase the value of the cultural asset in its patrimonial, historical, civil, symbolic and social development function, through a network system aimed at promoting connection systems capable of connecting communities through culture and knowledge, simultaneously redesigning the relationships between local and global, tradition and innovation, public and private (Lupo, 2013).
It is in this context that the lighthouse, in order to promote cultural-based initiatives, is often traced back and connected to tourist, cultural but also religious paths, capable of recognizing and re-establishing a new value-identity: an example of this is drawn in Galicia[16], in the Camino de Santiago, and in Brittany[17]. In this context, Italy is a step below the numerous possible initiatives to be undertaken in order to enhance the attractiveness of the territory, by virtue of the great Italian coastal heritage in our possession. However, there are some initiatives, albeit timid, aimed at promoting the visit of these monuments/architectures: this is the case of the South Cultural Route[18], in Puglia, in which 8 other historical and cultural routes are connected to the path of the lighthouse.
At the same time, in a purely strategic and guiding line, there are two projects that aim at the enhancement and networking of the Mediterranean lighthouses. In the European context, we recall the MED-PHARES[19] project , in partnership with the ENPI CBC MED "Mediterranean Basin" 2007-2013, aimed at the recovery and enhancement of lighthouses and traffic light stations throughout the Mediterranean basin through the cataloging and the study of coastal sites in the Mediterranean, with the consequent identification of pilot sites located in France, Tunisia, Lebanon and Italy[20]. In a purely Italian context, the Agenzia del Demanio[21] proposes on the market a network centered on lighthouses, towers and coastal buildings, assets in this case described as "buildings located in contexts of absolute beauty and full of suggestion"[22].

In order to give a new life to coastal structures, the Agenzia del Demanio, through the project called "Valore-Paese FARI", offers[25] coastal structures ready to welcome tourist, accommodation and/or social and sports initiatives. and cultural on sustainable and innovative business projects.

There are therefore numerous experiences of enhancement and connection put in place by many countries 23 in which the creation of methodologies, processes and projects are configured as fundamental assets in the rediscovery of coastal totems. In this sense, a passage contained in the Baltic document is underlined below Lights, aimed at enhancing and promoting lighthouses for tourism purposes: "in geography, it means the re-naturalization of a derelict and shattered space: in the case of lighthouses, it is often a question of using them as museums, restaurants and cafes, conference centers or stalking for naturalistic observation, activities that also contribute to covering management costs"[24]. The document outlines, by points, the future of these architectures, identifying in them "the guarantee of a safe landsca-

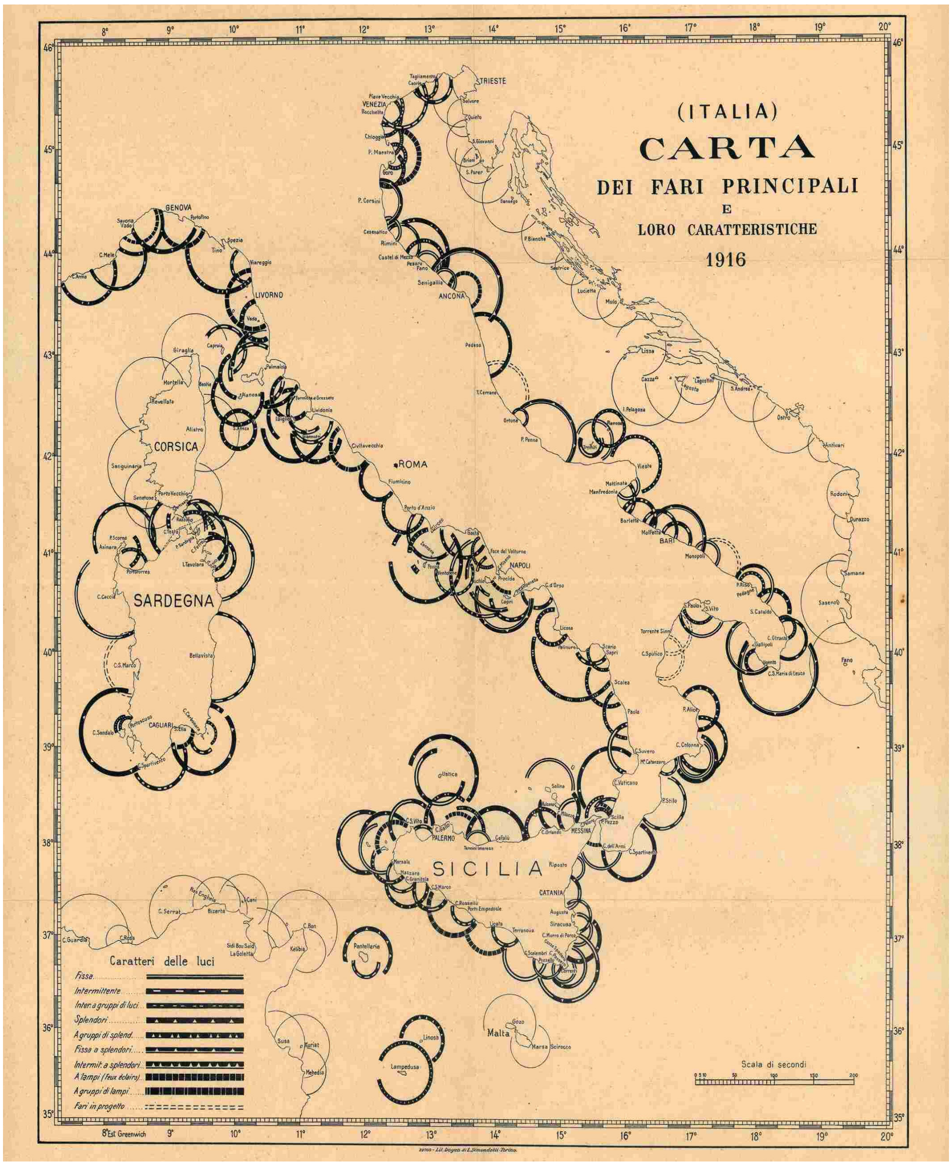


Fig. 16. Map of the lighthouses and lanterns present on the Italian coasts in 1916.

pe; advanced technological systems; the landmarks of the coastal landscape; historical monuments; distinctive buildings; source of cultural history; tourism; study and research center; holidays"[25] .

Moreover, as claimed by Dr. Sanna[26], the theme of the lighthouse, now partially eviscerated from its role and intended solely as an aid to navigation, now needs a re-evaluation, avoiding its alienation through re-functionalization[27], analysis and compositional study, making it possible to understand of languages and connections unpublished to date. In this sense, the construction of material and immaterial networks of knowledge is configured as a functional strategy for the enhancement and rediscovery of these architectures, constituting the case study of this doctoral research. This is because , the ever growing interest in these architectures, together with their peculiar 'characterized' composition, is configured as the basis through which to implement processes based on semantics and addressed to modeling, knowledge and dissemination of heritage cultural. In addition, the 'domestic' and 'closed' context that distinguishes the Mediterranean space makes it possible to intercept a specific territorial area by its very nature connected, the natural delimitation of a fertile field of action in the context of the reconnection between coastal architecture, territories and landscapes.

It is therefore in this context that the lighthouses of the Mediterranean arise, a context with a very high research potential as it contains all the prerequisites for a semantic 'experimentation' aimed at enhancement: a delimited field, of recurring characteristics, of already existing cultural relations and architecture with a high landscape value. In this sense, the introduction of modern navigation systems has relativized the usefulness of the lighthouse, causing the sudden abandonment of the building intended for residential use by the guardian, destined to undergo, with the passage of time, an inexorable deterioration, in a critical state and at the mercy of strong weather events (Sanna , 2016). But the importance of the lighthouse and light still exists. It is, in fact, to be remembered how the cult of light has always marked the passage of man and civilizations overlooking the Mediterranean, for which light is understood as life, as a means of knowledge and as an instrument of a double orientation: the real and ima-

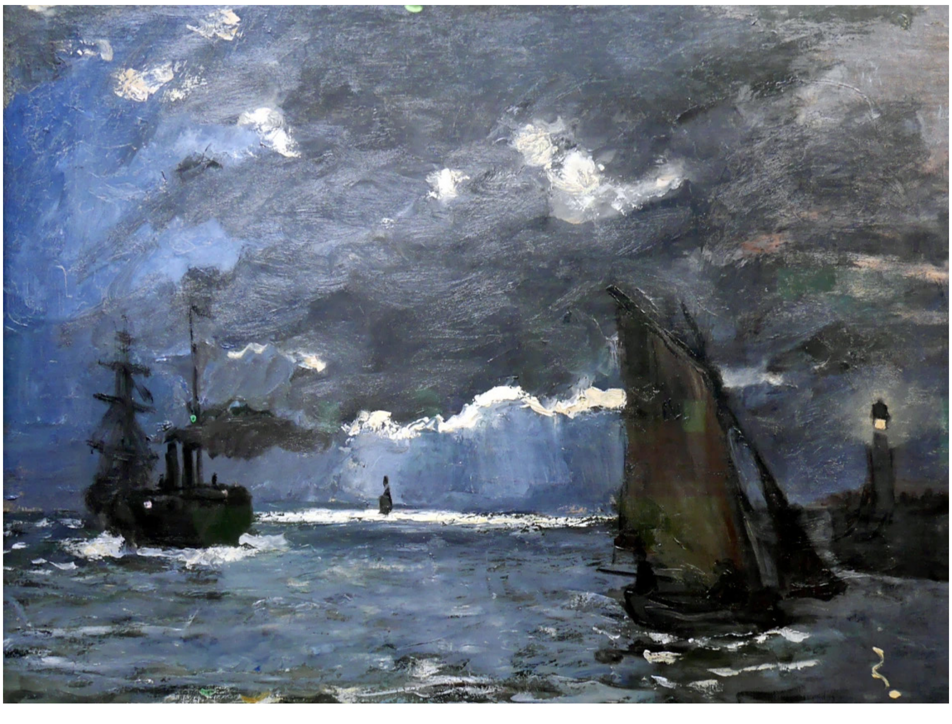


Fig. 17. Monet, M., Marina, boats in the moonlight, 1864, 60x70cm.

gined, bi- directionally linking myth and function. The light beam emitted by the lighthouses thus becomes the pivotal propagation tool of networks, flows, connections and similarities. For this reason, the theme of the lighthouse has always and continues to be, throughout the Mediterranean territory and beyond, an object of great interest for the purposes of reuse, enhancement and analysis. The coastal buildings, albeit in a state of neglect and of strong criticality linked to technological evolution, continue to maintain their high evocative power and recognition of places: this is confirmed by the widespread use of lighthouses by the great artists of the past, exceptional location of stories and tales, among which we remember the book written by Virginia Woolf entitled "To the lighthouse" (Woolf, 2007), the poem "Les Phares" by Baudelaire (2014), the book by Jules Verne "The lighthouse at the end of the world", the evocative paintings by Monet, Picasso, Hopper and De Chirico (figs. 17-20) and, finally, the numerous films set in lighthouses perched on the sea and on isolated rocks[28].

Fig. 18. De Chirico, G., oil on canvas, 1914, 38.5 x 41 cm.
Fig. 19. Hopper, E., Lighthouse Hill, oil on canvas, 1927, Dallas museum of art, excerpt.

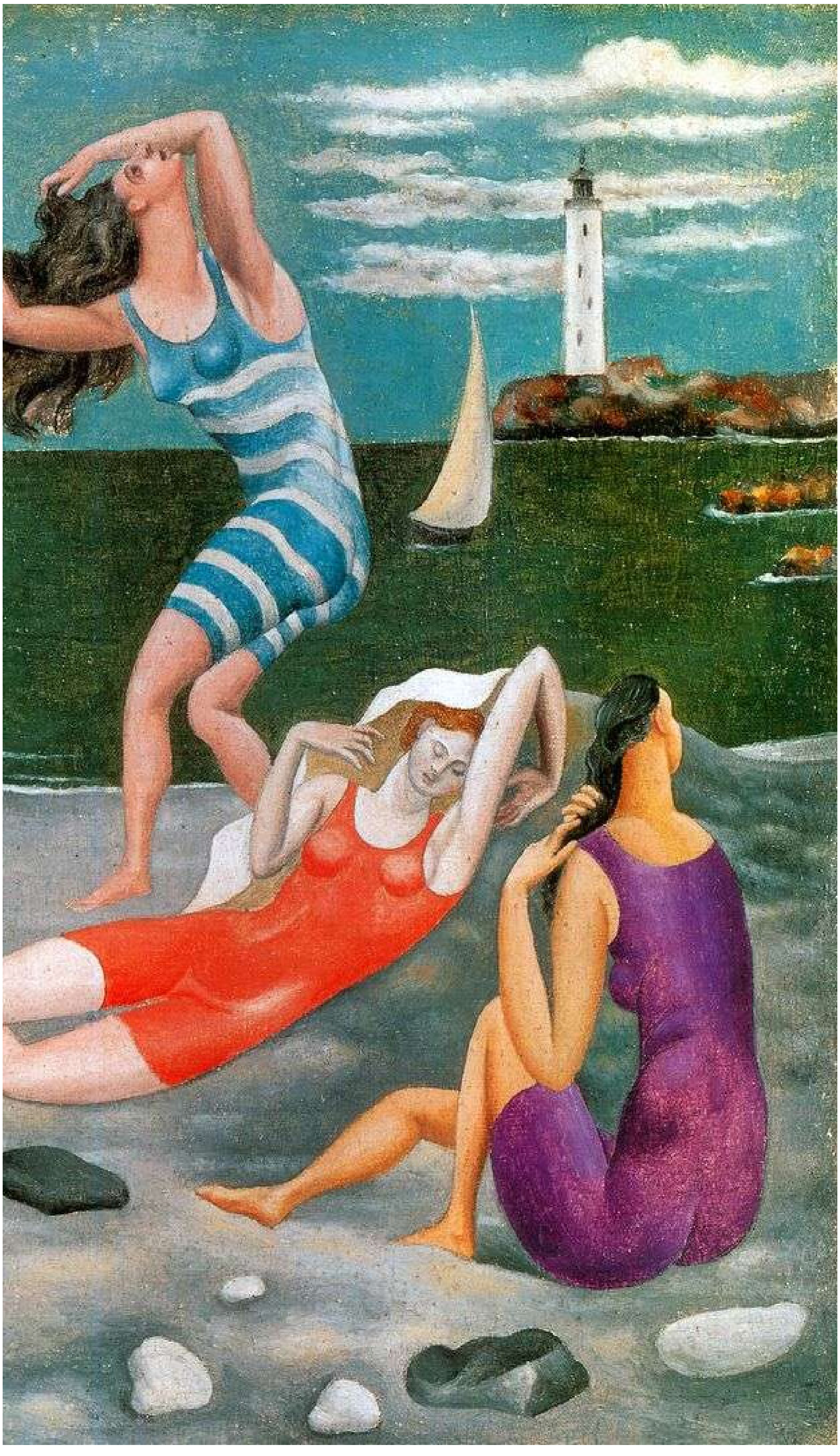


Fig. 20. Picasso, P., The bathers, 1933, oil on canvas.

Notes

1. "What exactly do we mean when we talk about the Mediterranean? Certainly not the same thing, depending on whether you look at Beirut, Marseille, Tunis, Athens, Cairo, Barcelona, Istanbul... Each language has a word to designate this liquid continent; but behind the words there are different visions. Place by place, the representations of the Mediterranean are built on a different historical and cultural stratification, and also largely influenced by the political context and relations, now conflicting now peaceful, that are established between the two shores "(Fabre, T., 2000) .

2. The analysis of the link between the lighthouse and the Mediterranean area will subsequently be discussed in the course of paragraph "1.3 The Mediterranean lighthouse network".

3. The modern idea of the Mediterranean can be traced back to Wickellmann who, by means of his humanistic knowledge, supports the doubt of a Greek matrix of the classical Mediterranean, juxtaposed with a more enigmatic Egyptian culture (Winckelmann, 1832).

4. "The gifts of movement add up to the contribution of the surrounding space, terrestrial or marine, which is the basis of his daily life. The more this accelerates, the more these gifts multiply, manifesting themselves in visible consequences" (Braudel, 2017, p. 55).

5. "For the three continents (which overlook it) the Mediterranean Sea is a unifying factor and the center of world history. Here is Greece, the bright spot in history. In Syria, Jerusalem is also the center of Judaism and Christianity, to the southwest are Mecca and Medina, the original seat of the Muslim faith. Towards the west there are Delphi, Athens, even more to the west Rome; moreover Alexandria and Carthage lie on the Mediterranean . The Mediterranean Sea is, therefore, the heart of the Old World, it is its necessary condition and its life. Without it it would be impossible to represent history, it would be like imagining Ancient Rome or Athens without the forum, where everyone gathered"(Hegel, 1998).

6. As Braudel recalls (2017, p. 13): "Already on the northern coast there are some interruptions, such as the Languedoc coast , up to the Rhone delta, or the low Venetian coast, on the Adriatic. The main exception to the rule, however, is constituted, in the south, by the long, unusually flat, almost blind coastline, which stretches for thousands of kilometers from the Tunisian Sahel to the Nile delta and the mountains of Lebanon".

7. The expansion of coastal cities - thanks to industrialization, the opening of the Suez Canal and colonial expansion , generator of large international metropolises (Troin , JF, 1997) - is contrasted by the current internal Mediterranean space, nourished by large portion of wild vegetation.

8. To learn more: https://www.ansa.it/documents/1267724972796_progettocittadelmediterraneo.pdf, p. 2, accessed on 05/05/2021.

9. The EU, with this declaration, directs the relations of the Mediterranean countries towards a relationship of solidarity and respect for the specificities of each participant. Furthermore, it aims to favor the birth of a common space of peace and stability. To learn more: https://eur-lex.europa.eu/legal-content/IT/TXT/?uri=LEGISSUM%3Ar15001,accessed on 05/05/2021.

10. For further information: https://web.archive.org/web/20070221102458/http://www.esteri.it/doc_dossier/dossier_euromed/mediterraneo_en.pdf, accessed on 05/05/2021.

11. The technological developments of boats have favored the exchanges of the past. In the first instance, to open new routes, were the sailing ships of the Cyclades equipped with sails and oars; in the sixteenth century the evolution of ships made it possible to move from the Balearics to Sardinia and Sicily. With increasing frequency, then, routes have also been undertaken in the open sea, expanding the basin of exchanges and discoveries, making the Mediterranean territory a unique and unitary space (Braudel , 2017).

12. He analyzes the concepts of world and earth from antiquity to the modern age. In it it recognizes that globalization represents the victory of the ideal, in a world in which geographers and sailors are the ones who have the decisive task of providing an image of the world (Sloterdijk, 2002).

13. As is known from the recent City 600 report of the McKinsey Global Institute concerning cities contributing to total global GDP, megacities are destined to produce only 10% of global growth, compared to 50% of the propulsion produced by medium-sized cities in theme of culture and creativity for the attraction of the population. In this sense, according to the Better Life Index , in the next 10 years culture is the determining factor in the growth of the economy, outclassing the automobile, ship and steel sectors: no longer debit-driven cities but increasingly smart oriented (Carta, 2012).

14. In short MSSD, established in 2005 with the aim of providing a starting line for the sustainable development of coastal countries, identifies four priority objectives, nine challenges and 34 sub-objectives. The objectives are placed side by side with the main assets of the 2030 Agency , among which the objectives relating to the 14th point of the Agenda can be distinguished: "Ensuring sustainable development in marine and coastal areas". To learn more: https://www.unep.org/unepmap/what-we-do/mediterranean-strategy-sustainable-development-mssd#:~:text=The%20Mediterranean%20Strategy%20for%20Sustainable,-national%20and % 20local% 20levels% 20in, accessed on 05/09/2021.

15. In short NSSD, adopted by twenty Mediterranean countries.

16. The Way of the lighthouses, or Camiño dos Faros , is a path that connects 200 kilometers of the Costa da Morte from Malpica to Finisterre: a path in which the sea stands out and whose protagonists are the lighthouses of this coast, divided into nine stages. The route starts from Muxia and arrives in Finisterre, the two final destinations after the arrival in Santiago de Compostela. On this path, the lighthouse joins the splendor of the beaches, rivers, rocks and forests, in a riot of smells and colors. The stages are: Malpica - Niñóns; Niñóns - Ponteceso ; Ponteceso - Laxe; Laxe - Arou; Arou - Camariñas ; Camariñas - Playa do Lago; Playa do Lago - Muxía; Muxía - Nemiña; Nemiña - Finisterre. To learn more: https://www.camminatorianonyms.com/2018/07/04/il-cammino-dei-fari-o-camino-dos-faros/#:~:text=Il%20Cammino%20dei%20Fari% 20% C3% A8,% C3% A8% 20 divided% 20 into% 20 nine% 20taps, accessed on 10/05/21.

17. The Road of Lighthouses o Route des Phares , is a 90 km long itinerary that runs along the north-west coast

of Brittany. The tour starts from the beaches of Brignogan to finally arrive in Brest. Along the way we touch the small island of Ouessant, renowned for one of the most legendary lighthouses in the Breton territory. On this same island there is the Stiff lighthouse , the most ancient Breton lighthouse still in operation. To learn more: https://www.ehabitat.it/2020/03/05/strada-dei-fari/, accessed on 10/05/21.

18. South Cultural Routes is part of the two strategic plans of Tourism "Puglia365" and Culture "PiiiLCulturainPuglia", which aim at the seasonal adjustment of tourist flows, promoting cultural and experiential products legal for slow mobility, which are able to involve both coasts than the internal areas. To learn more: the website: https://madeinmurgia.org/2019/05/28/la-puglia-dei-cammini-e-degli-itinerari-turistici.html, accessed on 10/05/21.

19. It is a multilateral cross-border cooperation initiative financed by the European Neighborhood and Partnership Instrument which allows to promote and generate historical and cultural processes for the development of Mediterranean areas. To learn more: https://www.mediterraneaonline.eu/med-phares-nuova-vita-ai-fari-del-mediterraneo/, consulted on 10/05/21.

20. In Italy we remember as pilot sites: the lighthouse and the traffic light station of Sant'Elia, the lighthouse and the traffic light station of Punta Scorno and the traffic light station of Capo Sperone in Sant'Antioco. The final conference was held in Cagliari on 10 November 2016. To learn more: http://www.sardegnaambiente.it/index.php?xsl=1824&s=254525&v=2&c=9424&idsito=23, accessed on 10/05/21 .

21. For further information: https://www.agenziademanio.it/opencms/it/, accessed on 12/05/21.

22. For further information: https://www.agenziademanio.it/opencms/it/progetti/fari/, accessed on 12/05/21.

23. Such as Australia, Canada, Portugal, Croatia, France, the United States, the Baltics and Greece.

24. Cultural Heritege Co-operation in the Baltic Sea States, p. 9, Report 3, 1st September 2003. To learn more: http://www.diva-portal.org/smash/get/diva2:1294847/FULLTEXT01.pdf, accessed on 12/05/21.

25. Cultural Heritege Co-operation in the Baltic Sea States, *ibidem*, p. 25.

26. Officer responsible for the monumental and landscape protection of the metropolitan city of Cagliari and for the provinces of Oristano, Medio Campidano, Carbonia-Iglesias and Ogliastra.

27. The MiBACT , by means of articles 54 et seq. of the general code of inalienability of cultural state property, in fact authorizes the sale, concession and change of intended use.

28. Examples are Taylor Hackford 's 'Officer and a Gentleman', Martin Scorsese's ' Shutter Island' and Kristoffer 's ' The Vanishing Lighthouse' Nyholm .

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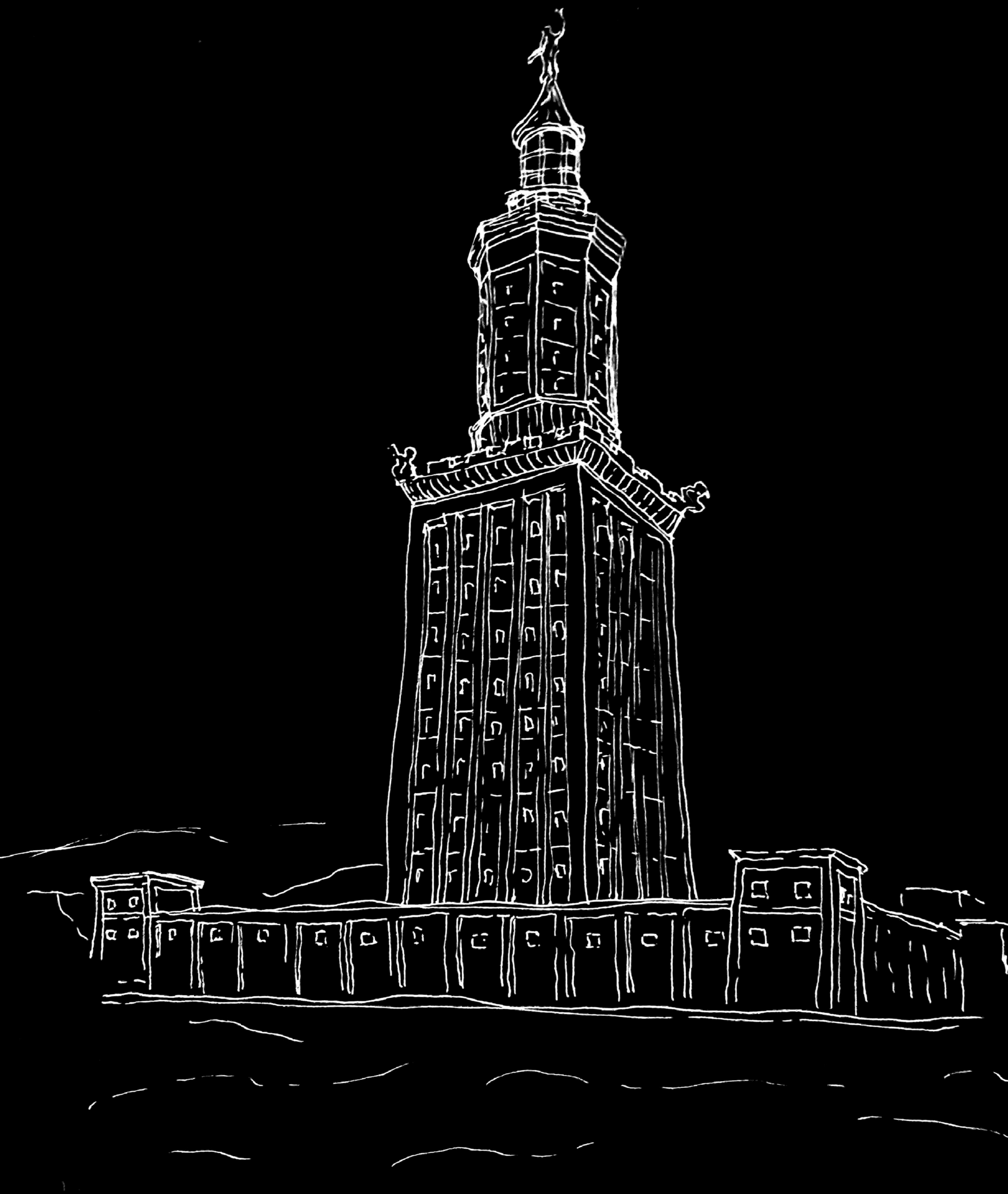


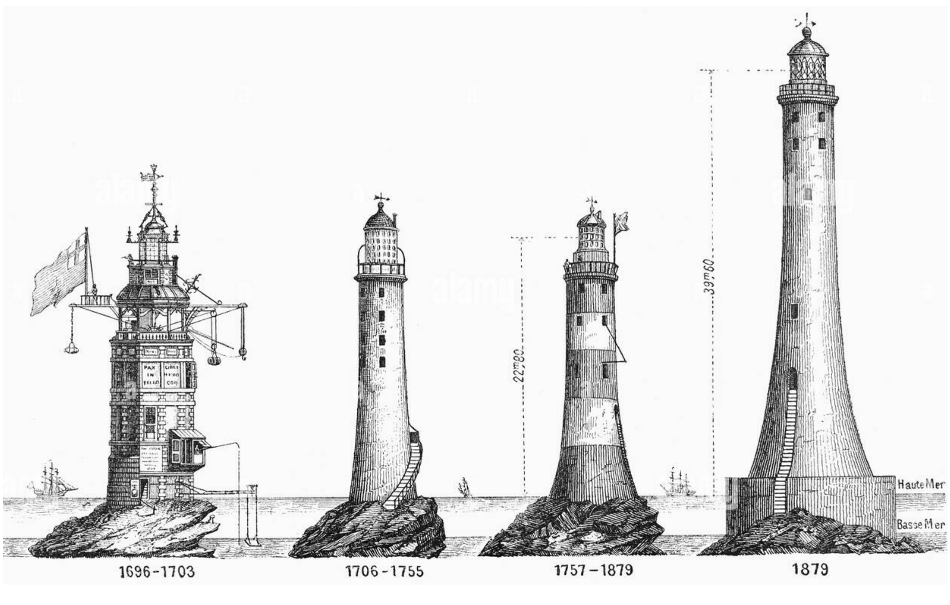
Chapter 2

A brief history of lighthouses

"Il faro era allora una torre argentea, nebulosa, con un occhio giallo
che si apriva all'improvviso e dolcemente la sera"
[Woolf, 2007].

"I fari sono simili ai templi del Mediterraneo [...]. È bene prendere altresì in considerazione
la maniera in cui il mare li circonda, di quale specie è il loro isolamento o il distacco [...].
E da ultimo a chi fanno luce e su quale percorsi"
[Matvejević, 2006].

The following chapter summarizes the history and the modifications of the light beam that for a long time reassured the sailors of the night: an *excursus* between the innovations and the story of the inexorable and unstoppable ruin of these architectures, victims of the passage of time.
We therefore want to first tackle the origins of the architecture of the lighthouse and of the relative light source, subsequently covering all those stages that have marked the technological evolution of the lighting apparatus, innovations directly connected to the historical, cultural, economic and politician of the time. The architectural and technological evolution of lighthouses, in fact, goes hand in hand with what are the glories of a people, the desire to enhance coastal flows and the intention to show nearby and conspicuous peoples the effective economic power of a territory. The ancient glories will then suddenly turn into the decline of coastal signaling architectures.



On the cover. The lighthouse of Alexandria in Egypt.
Fig. 1. Development of the Eddystone Rocks lighthouse in the English Channel, from 1696 wooden structure to 1879, wood engraving.

Introduction

To talk about the lighthouses in their composition/placement today it is necessary to start from the genesis of their creation and from the reasons that prompted the people to create flames that could indicate the way: to warn the sailors of yesterday about the earth, but also, in a new dress, to signal the sea to the 'terricolous' of today, as claimed by Vincent Guigueno[1], Breton historian, curator of the Phares exhibition at the Musée National de Marine in Paris (Guigueno, 2012).

The sea, one of the three components previously traced in the Mediterranean space, is the material that is sighted and which often acts as a reflecting mirror to these architectures. Without it, the lighthouse would have no *raison d'etre*, although there are lighthouses, such as that of Verzenay[2], erected far from the sea, for advertising purposes and as a tourist attraction. Initially, before becoming a link and connection between different territories, the sea has always been considered an obstacle, a source of fears and fears caused by its unknown and boundless dimension.

With the progress of navigation techniques, starting from the second half of the third millennium with the Egyptian crossings in Biblio and in the second millennium with the sailing ships of the Cyclades, the sea begins to be a place of movement, albeit prudent and cautious (Braudel, 2017). In fact, we tended to go towards points not far from each other: the route followed the coast line and we ventured into the sea only during the day. In the sixteenth century sea journeys multiplied and trade between the inland and the North sea made routes to the open sea more common, both day and night. It is in the nocturnal condition that the traditional navigation system needs to be accompanied by signals and lights that can indicate the way and any obstacles to be circumvented.

In the beginning, the stars guide sailors on nights lit only by the moon. It is the brightest star in the constellation of Boote, the star Arctūrus, near the Big Dipper. In book V of the Odyssey she is described as the Diva[3], or Calypso, who gives instructions to Ulysses when he agrees to his departure from Ogygia, the unidentified island where he is staying for seven years due to falling in love by a nymph. For centuries the sailors of the past plowed the sea guided by the sparkling light of the stars, led by the Ursa Maggiore (Boscolo, 2014), and then gave way - before the fires were lit on the hills - to the volcanoes, present both in the Pacific and in Sicily. Here, among the various volcanoes present in the Mediterranean area, lies one of the oldest 'natural lighthouses' of all time, the Stromboli volcano, already mentioned in the course of the discussion of the Mediterranean, continuously active and bright by virtue of the eruptions fairly regular, as well as one of the last active volcanoes in this territory[4]. Later in time, the volcanoes give way to the first lights lit in the hills, flaming bonfires that rise from the hills or from the rocks, as Victor Hugo imagines them (fig. 2), later located on the top of towers, ie the actual ancestors of the lighthouse understood in today's architectural meaning.

Having described the relationship between the Mediterranean and these architectures, in the course of the following paragraphs we want to outline in a precise, albeit concise, the history of the lighthouses - from the first fuel lights to contemporary systems - as well as the succession of methodologies and techniques that have led them to constitute, in a solid and still present way, the reference points and limits of the terrestrial territory. This base, in fact, will subsequently be preparatory and necessary in order not only to understand the relationship between the history and the current configuration of the lighthouse but also to carry out a geometric and compositional examination of today's lighthouses, through which to understand the style and language, characteristics fundamental in the creation of a semantic methodology associated with the architectural and functional peculiarities of these structures.

Fig. 2. Hugo, V. (1866). Casquets Lighthouse, pen and ink on paper.

2.1 Origin of lighthouses: between myth and history

The genesis of the word lighthouse has remote origins, traceable in antiquity and in myth, which has always been the origin of the glow that reassures those who travel by sea, extinguishing their fears. The word "lighthouse", in fact, is the name of the helmsman of the ship that brings Menelaus and Helen back to Sparta, after the Trojan War, who, during the voyage, was bitten by the snake on the island of the same name, that is *Pharos* . But the concept of lighthouse in the modern sense, from the Greek pháros , was born only in the third century BC, with the construction of one of the most monumental lighthouses of all time: the lighthouse of Alexandria in Egypt, which is one of the most ancient and majestic constructions of the past, recognized as one of the seven wonders of the world (fig. 3).
By virtue of its ancient origins, the figure of the lighthouse has always intrigued the collective imagination. The birth of these architectures dates back to very distant times and their transformation goes hand in hand with the progress of navigation technologies - first purely coastal and daytime, after night and wide-ranging - consequently to the need for ever more massive exchanges. The history of the intensification of maritime traffic, in fact, coherently follows the constitutive process of the Mediterranean lights, first based on a few signaling points placed at the service of sailors[5] and then configured as a real network covering the entire coastal territory.
Regarding their origins, Homer in the nineteenth book of the Iliad already compares the shimmer of Achilles' shield[6] to one of those fires that rise from the heights and make the way safe for sailors. Aeschylus, on the other hand, describes them as a sort of luminous relay, whose flame crosses the sea from Troy to Argos (Aeschylus, 2014), alluding to the "sentinel who lights the fire", therefore to the ritual of nourishing and treating the flame on the of the evening. As mentioned, it was only in 300 BC that the concept of lighthouse was born as we understand it today, attributable to two of the largest structures, similar to monumental lighthouses, among the most important of all time: the lighthouse of Alexandria in Egypt, built on the islet of Pharos and erected by Sostrato di Cnido, and the Colossus of Rhodes, represented by classical iconography as an anthropomorphic figure, the god Elios, holding a brazier in one hand[7] (fig. 4).
Of the ancient lighthouses, after years of research in underwater archeology, only some of the fragments of these historic architectures have re-emerged from the sea, today faded into myth. The only sources to remember them are the verses of the ancient texts that narrate the composition, together with the numerous representations that attest to their importance through their representation on high reliefs, coins and mosaics (fig. 5). This is the case of the Roman mosaic[8] in which one of the first 'lanterns' appears, that is a fire lit on a column, probably fueled by wood. The representation of the light also recurs in the mosaic of the Basilica of San Marco, in Venice, which narrates the sighting of the lighthouse in Alexandria in Egypt[9] by San Marco during one of his apostolic journeys (fig. 6). This representation is also shown in a high marble relief on the Tower of Pisa, representing a tower with a fire surrounded by Pisan ships, dating back to the 12th century (Simonetti , 2009) (fig. 7), and in a front plate of a sarcophagus depicting the port of Ostia and its lighthouse (fig. 8).
The importance of the lighthouse of Alexandria in Egypt[10] (fig. 9) is therefore unquestionable, the most significant and ancient construction prior to the fires on columns and the *fani*[11](Giorgetti , 1977), whose light signal, powered by wood and oil at the top, projected into the sea, is attested to be, on the basis of historical transcriptions, capable of reaching a distance of over 30 miles at sea, by means of a system of mirrors designed by Archimedes. As claimed by Edrisi , an Arab philosopher of the twelfth century, it is thought that the lighthouse of Alexandria in Egypt was one hundred stature of men, about 71 meters of base, composed of a narrower octagonal tower of 34 meters, surmounted

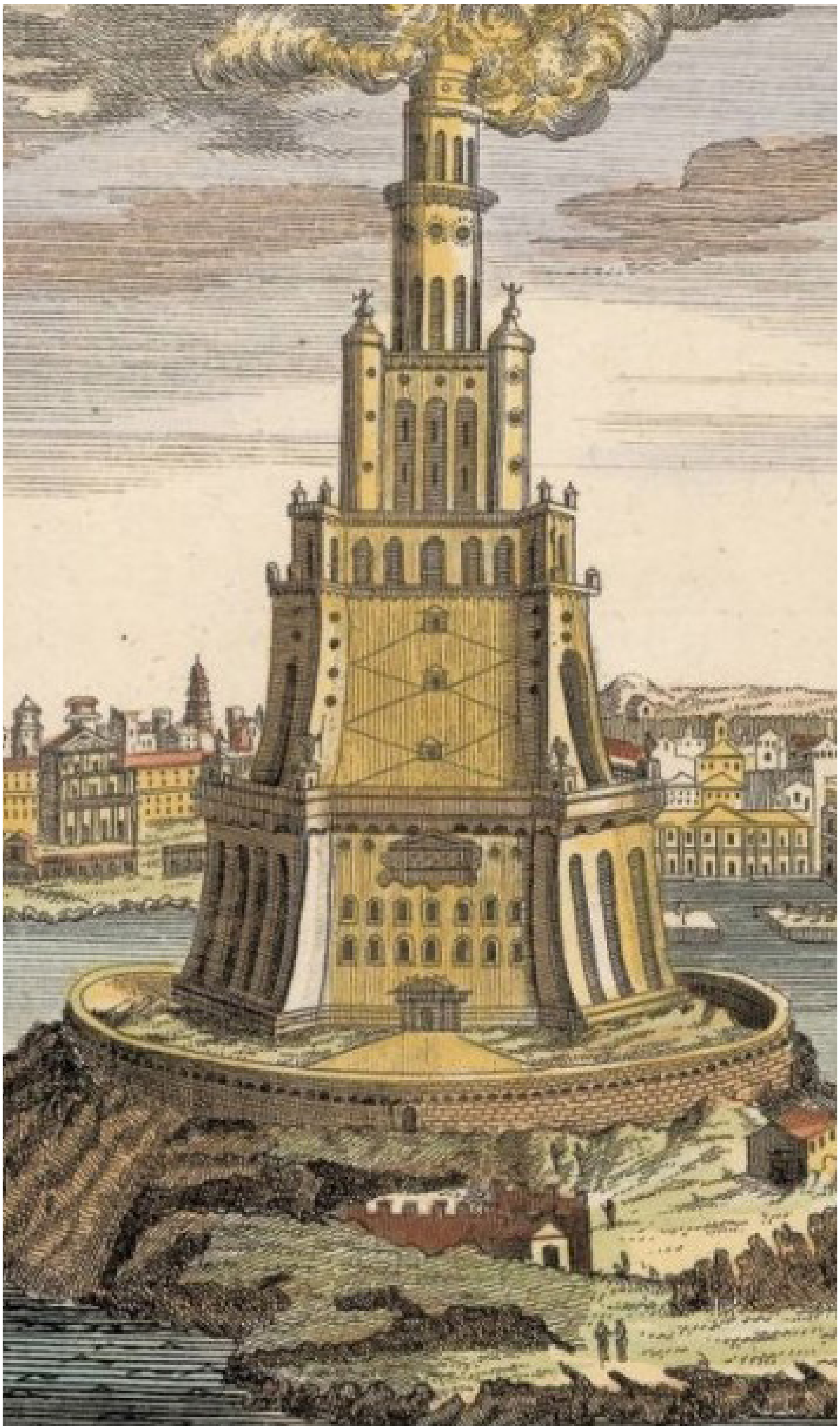


Fig. 3. Fischer von Erlach, J. B. (1720). The lighthouse of Alexandria in Egypt.

Fig. 4. Balthasar Probst, G. (1700). The Colossus of Rhodes.
Fig. 5. Rostral altar with a sailing ship and a lighthouse.
Fig. 6. Mosaic of the vault of the chapel of San Leone in the church of San Marco in Venice.
Fig. 7. Marble relief of the Tower of Pisa depicting the lighthouse of Alexandria in Egypt
Fig. 8. Front plate of a sarcophagus depicting the port of Ostia and its lighthouse.

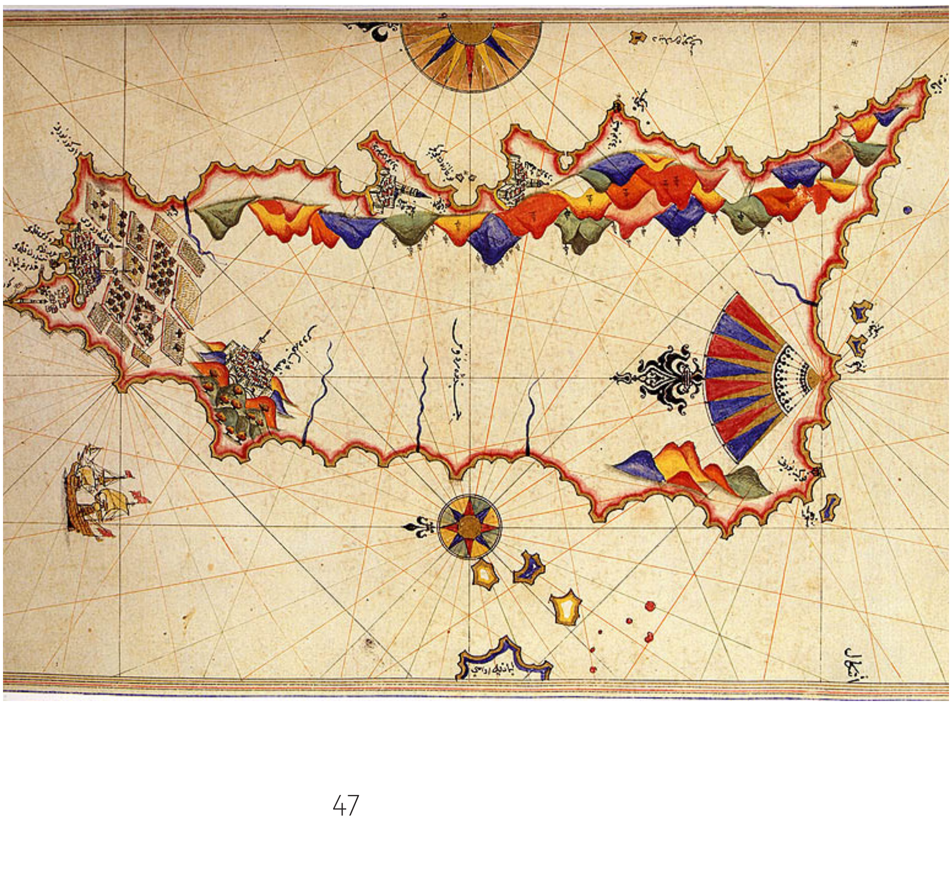


Fig. 9. Piri Reis, 1523.
Map of Alexandria in Egypt.
Fig. 10. Piri Reis, 1521.
Island of Rhodes.

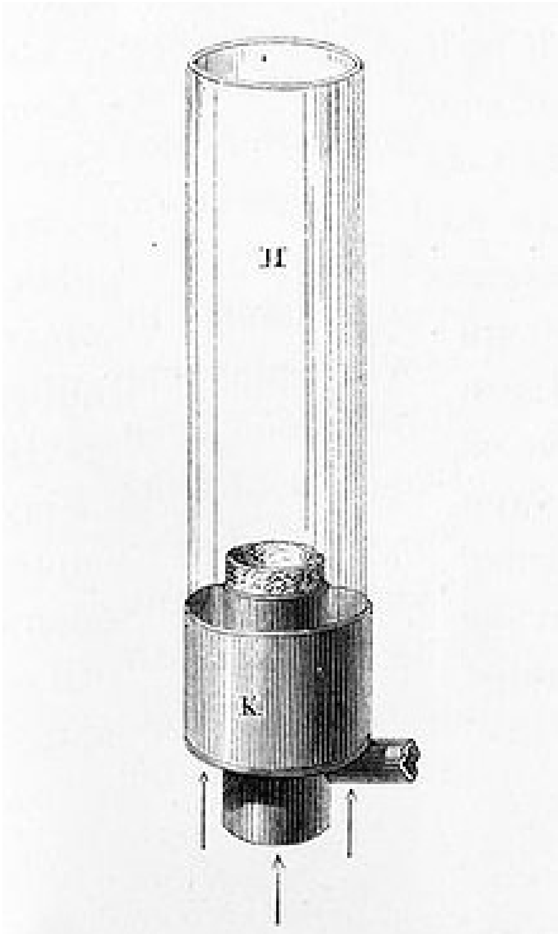
by a statue of Zeus or Poseidon, as represented in the many representations, in part already mentioned, concerning him (Fatta, 2002). Its importance is proven and described by many stories and documents, among which the epigram of Posidippus dating back to the 2nd century BC, published in 1879 by the archaeologist Weil (1879), during which the usefulness and function of alert and sighting by the lantern is praised. It should be emphasized, however, that the lighthouse of Alexandria in Egypt, although considered as the oldest and most monumental lighthouse in history, is certainly not the only one in Egypt. In fact, it is Strabo, in his Geography, who reports the presence of further towers placed on the coast, at the entrance to the port of Alexandria[12].
Among the lighthouses present in the oldest network belonging to the Mediterranean area is undoubtedly the 'lighthouse' erected in Rhodes (fig. 10): it is the Colossus of Rhodes, the one that should have and perhaps could have been a lighthouse. According to the studies of archaeologists and researchers, the Colossus dedicated to the god Helios must have been an anthropomorphic figure with legs apart, placed between the two piers of the port of Mandraki in Rhodes, through which it would have been possible to pass an ancient ship, to sails unfolded (fig. 11). This lighthouse, unlike the one in Alexandria in Egypt, has left no evidence of itself: despite the quotations from Pliny and other artists, its composition is still doubtful, even if it is believed to be 70 cubits high, or 32- 33 meters. In this sense, the only certain information we have received is related to its destruction, which took place in 227-226 BC, the remains of which were transported by Arab caravans in the 8th century AD, subsequently used for other uses. However, to date, the iconography relating to its physical consistency remains unchanged: his head graduated with rays or laurel, holding a torch, has, in the past and still today, been very popular for the representation on coins, perhaps inspiring of the very current Statue of Liberty, on Liberty Island (Boscolo, 2014).
The imposing fame of these two lighthouses has certainly obscured the coastal architectures that have developed where the navigation systems were more advanced. Greeks, Romans and Egyptians, in fact, had already built towers with the top lit at the mouth of the Ellesponto and on the Bosphorus, as well as in the East in the ports of Laodicea, Smyrna and Byzantium. Although having left no trace of their composition, the existence of an ancient network of lighthouses confirms the actual usefulness and historical-cultural recognition of these architectures.
In more recent times, albeit still ancient, in Italy the lighthouses can boast an echoing fame, by virtue of the news and researches received by scholars: this is the case of the Messina lighthouse, called San Rainieri, and the Ostia lighthouse, built in the first century BC by the emperor Claudius (Simonetti, 2009) (fig. 12a, b, c), that is lighthouses of great strategic, historical and architectural importance. In this sense, the history of lighthouses, after a period of stagnation following the construction of the lighthouse in Alexandria in Egypt, resumes its course only with the Romans who, overlooking the conquered coasts, build about thirty towers used as lighthouses, from the Canal of the Channel to the coasts of the Mediterranean. Examples are the square tower in Ravenna, the Civitavecchia lighthouse, the Capri lighthouse, the Porto Cassis lighthouse and, among the most important, the La Coruña[13] lighthouse, called Torre d'Ercole, located in ancient Brigantium, in Galicia.
From the Middle Ages to the modern age, with the fall of the Western Roman Empire, the construction of lighthouses was interrupted and the navigation flows stopped due to the barbarian invasions, dissuading navigation on the open sea and preferring, on the contrary, a coastal and diurnal type of displacement. This 'change of course' thus becomes the cause of the fall into ruin of many of the thirty Roman towers aimed at creating an initial networking of the coastal signaling system, encouraging the return to previous wood ignition systems (Mariotti, 2005). Subsequently, with the resumption of trade and

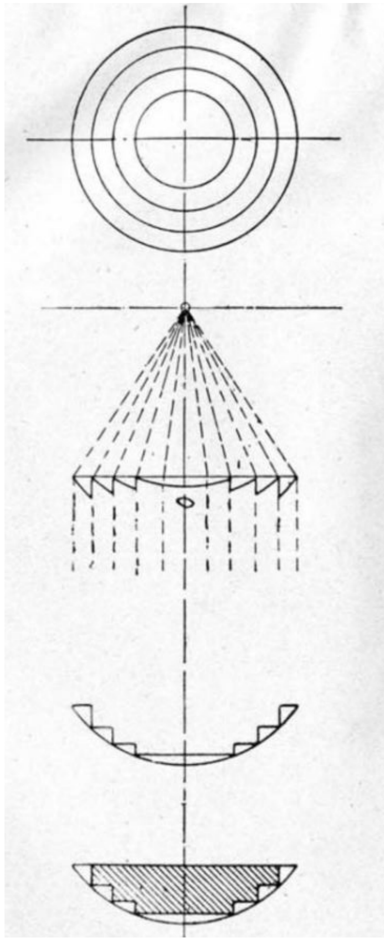
Fig. 11. Heermskerck, M., Colossus of Rhodes, 16th century, engraving.
Fig. 12. a) Sextus Pompey's silver denarius depicting the lighthouse of Messina, 40-42 BC
b) Commodus bronze medal depicting the lighthouse of Porto, near Ostia, 180-192 AD.
c) Hadrian's bronze hemidrachma depicting the lighthouse of Alexandria in Egypt, 117-138 AD.

the birth of the maritime republics from the twelfth century onwards, the construction of towers and lighthouses in Italy returned to life[14], while maintaining the same lighting techniques, i.e. using wood and mineral oils, and the same compositional characteristics, therefore formed by high stone towers with simple and essential volumes.
It is during the Renaissance and the Baroque age that the lighthouse takes on a new compositional style, by virtue of the new historical as well as functional value attributed to these architectures, reaching particular architectural and constructive prestige in countries such as France and England. In this period, in fact, it became common belief that the lighthouse should, in addition to fulfilling its signaling function, be a sign of admiration and prestige on a par with the monuments[15], becoming a perfect architectural element by virtue of their location, extremely visible from land and by sea, through which to represent the pomp and political hegemony of the countries. Therefore, the construction of a long series of lighthouses focused mostly on aesthetics and not on stability and functionality: the consequent result is their destruction and ruin due to the strong weather generated by the oceans, determining their cyclical reconstruction[16]. Over time, costs become excessively high, making it necessary, in conjunction with an increasingly intense request for the construction of a signaling network, to return to simple geometries, with the exception of some ancient lighthouses or particularly identifying places.
But the most important stage that actually marks the transition from modern to 'contemporary' lighthouses is certainly to be identified in the technological evolutions and inventions in terms of lighting, technologies that have radically changed the construction methods, geometries, performance and presence. more or less intense of these architectures in the coasts of the Mediterranean area.

2.2 Lighting techniques and technologies

As just mentioned, the history of lighthouses, in addition to being strongly linked to the history of navigation and therefore to the geographical place in which these architectures are located, is also inextricably intertwined with the evolution of technology and techniques of propagation of light emission.
As for navigation, it is almost impossible to attribute a chronological beginning to these systems, although the first source of light can be traced back to the firewood stacked at the highest points of the coast, on rocks and promontories, through which to drive, to signal the imminent danger represented by the shallow seabed or by rocky outcrops and directing the sailors towards a safe landing place. If until the seventeenth century the technology of the lighthouse remained unchanged - giving way to debates focused on their monumentality and, only in some cases, stability - it is only from the end of the eighteenth century that the functioning of the lantern was totally upset: by the use of the resulting fire from the combustion of wood placed on platforms we move on to the design of lighting and propagation systems, still in use today.
In this sense, in fact, the initial methods of lighting, using wood, that is expensive and impractical systems, made the lighting of the lighthouse a great waste of energy and resources, as demonstrated by some documents of the time. The lighting of the Chassiron lighthouse, in the French Oléron, for example, required 700 kg of wood per night, making prolonged lighting of the lighthouse unsustainable. However, this ignition system remained in force and widely used for a long time until the installation of the first oil lamp equipped with a reflector, on the Sète lighthouse, produced by the Tourville-Sangrain company (Boscolo , 2014). Oil lamps, although capable of overcoming the problem of extinguishing fires fueled by coal or wood - also thanks to the protection against atmospheric agents adopted since the 18th century - are configured as not very powerful systems. Nevertheless, this technique, considering





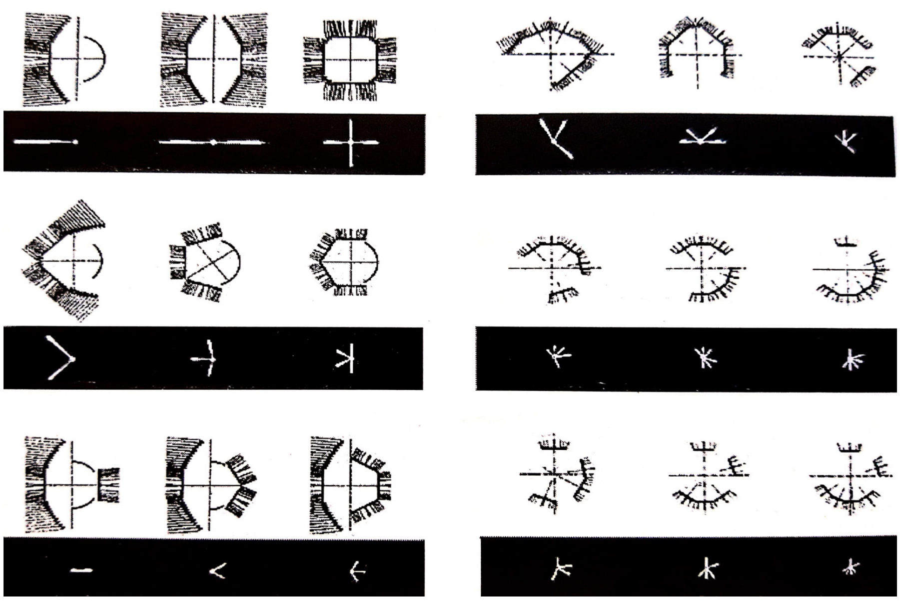
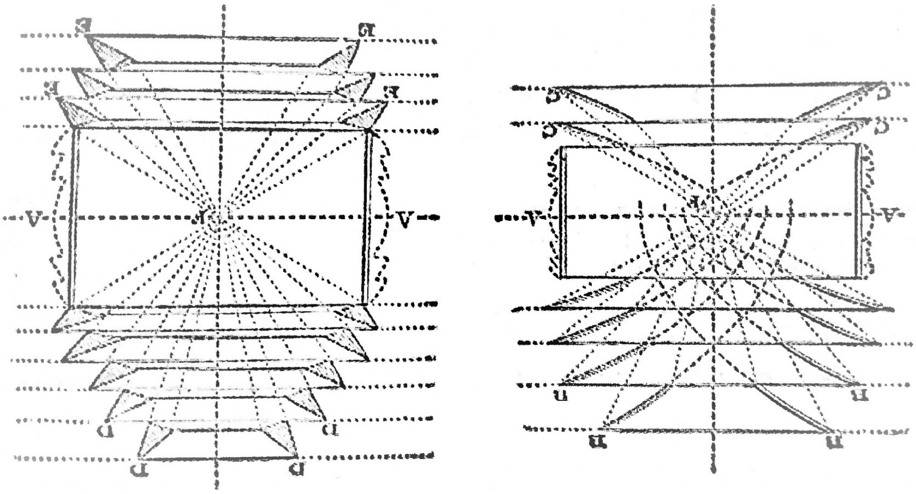
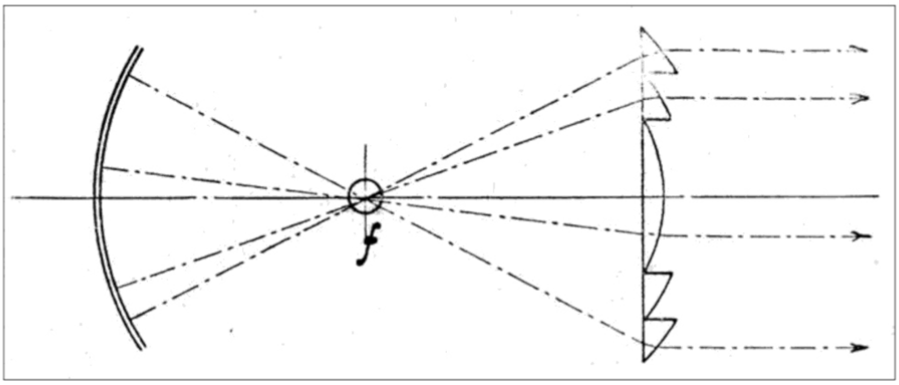


Fig. 13. Figuer, L., Illustration of the Argand lamp, in the book Les meirelles de la science, 1867.
Fig. 14. Dioptric drum and Fresnel profile.
Fig. 15. Main combinations of rotating optics.

the abundance of raw materials and the need to have a coastal light source always in service, is adopted in all the lighthouses present in the Mediterranean basin[17], starting to constitute what will later be identified as' the lighthouse network of the Mediterranean '.
It is then the turn of attempts aimed at enhancing their range by increasing the quantity of fuses[18] and modifying their geometric conformation[19], transforming the lighting system into circular and hollow (fig. 13). It was only with the Industrial Revolution that new gas lighting systems were used in headlights, thanks to the discovery and diffusion of butane and propane gases, already tested for the road systems of large European cities. The main advantage of this system lay in the very low consumption of material and, secondly, in the possibility of its use even in the absence of personnel in charge[20]. But the actual turning point in the lighting panorama of the lighthouse, and of light in general, only became a reality at the end of the nineteenth century, with Edison's experiments for the first incandescent lamp with carbon filaments, then replaced with tungsten filaments. and titanium[21]. With this innovation, flanked by the use of Siemens lamps, the headlights find new life, capable of projecting their beam of light in a more sustainable and effective way.
However, what is identified as the keystone in the use of the light source of the lighthouse is undoubtedly the optical propagation system, fundamental to making possible the concentration of light in a small portion of space, capable of reaching significant distances and far greater than previous lighting systems. In this sense, the light source alone, with undirected and controlled light beams, would in no way be capable of reaching such distances without encountering important and wasteful energy dissipations (Petino , 2002). This is how Augustin-Jean Fresnel[22] - following in the footsteps of the American physicist Benjamin Thompson Earl of Rumford , the watchmaker Bertrand Guillaume Carcel and an engineer unknown to date - hypothesizes the improvement of the propagation power of lightning by means of concentric lenses powered by oil. under pressure[23]. Nonetheless, the creation and supply of 'smooth' lenses, although capable of improving visibility at greater distances than previous light emission methods, are still not sufficient to cover the needs of a coastal network aimed at being increasingly dense and efficient. In fact, simple lenses, albeit of large diameter, cannot be able to cover large focal distances, without considering the excessive weight of the lens itself to be borne by the turreted system. For this reason, the lenses are therefore equipped with 'steps', capable of optimizing the propagation of the light emission, subsequently used with great success all over the world under the name of " Fresnel lenses " (figs. 14-18) (Boscolo , 2014).
The first theorization of Fresnel lenses provided for a typological classification equal to six different types of lenses for the headlights, of different size and focal length, depending on the nominal range to be achieved. This differentiation is then transferred, as we will see in the next chapter, in the drafting and partly implementation of the first program for the construction of an Italian lighthouse network, classified according to six 'orders': from the first, the largest and most powerful, to the sixth order[24]. The passage of time brings with it the innovation and enhancement of lenses and orders: therefore even more powerful lenses of the first order[25] are created , called meso-radial and hyper-radiant , inserted in the seventh and eighth order[26], in addition to the creation of the 3⁄1 order, placed between the third and fourth orders.
Ultimately, as just discussed, the evolution of the system and operation of the lighthouse appears to be the consequence not only of the progression in the context of navigation systems but also of the theoretical and practical innovation implemented in the field of lighting and the consequent propagation light, fundamental concepts for the correct functioning of these structures, by their nature classified and managed by virtue of their focal range. Hand in hand with the theorization of new technologies and lighting techniques, the usefulness and the historical-functional importance of these architectures grows dramatically, creating a real field of analysis and study: "farology"[27], specifically addressed to the study of lighthouses intended as an architectural structure and as a source of coastal lighting.





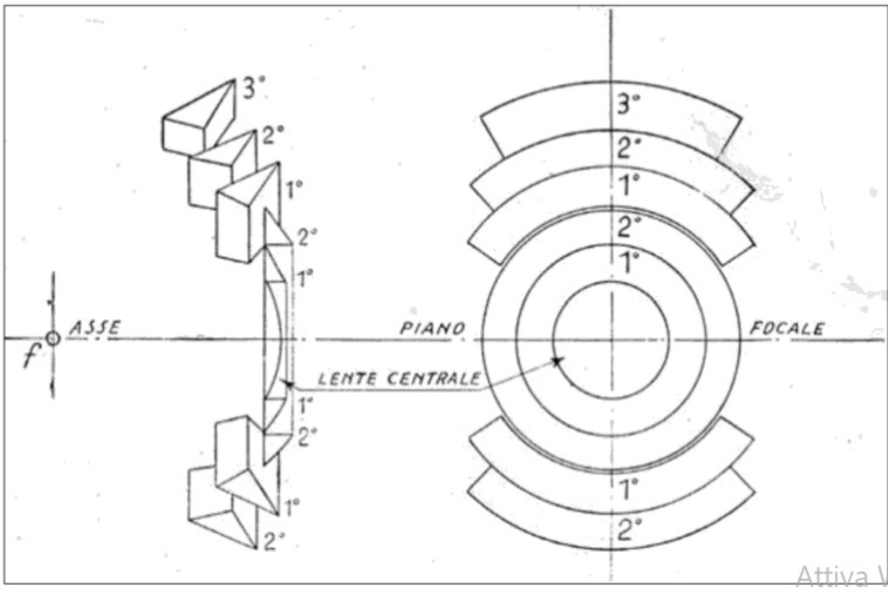


Fig. 16. Retro-reflective system and re-tro-reflective system.
Fig. 17. Focal point of directional apparatus with concave mirror and Fresnel profile lens.
Fig. 18. Complete lenticular panel.

Attiva W

2. 3 From the birth of farology to the present day

In fact, with the advancement of naval hegemony by England, the nineteenth century became the period of birth and flowering of farology, spectator of technological and engineering miracles, especially along the coasts of England, Scotland and of Ireland. As already mentioned in the previous chapter, it is the Eddystone[28] lighthouse (fig. 19), a 46-meter high offshore structure with a range of 22 miles, that sets off a series of engineering miracles[29]. The vast production of light towers of significant architectural and engineering interest can be traced back to the considerations made from the late 1800s and early 1900s regarding the stability and constructive principles of these architectures[30], capable of resisting the strength of wind and waves. On a constructive level, therefore, the 'contemporary lighthouses' are for the most part solid masonry structures, to be accompanied by useful precautions to guarantee their stability: the use of similar and compatible materials, the use of not too resistant materials and the adoption of structural types suitable for the construction site (Santini, 2006). The use of materials together with the place of location and the 'new' theories on stability are configured as the generating assumptions of today's geometric configuration of these architectures, an argument subsequently dealt with in the third chapter, in favor of increasingly simpler constructions and geometrically symmetrical, certainly more robust in case of wind or other atmospheric phenomena (Amoruso, 2005).
In terms of wind and oscillation, salient features in the stability of the lighthouse, it is France, in particular Paris, to experiment with new methods of analysis and control: the oscillograph built by the Jules Richard company, installed in seven French lighthouses of different structure and height, made it possible to sense and record the vibrations of the light towers[31]. It was an easy to transport but incomplete device as it was not sufficient to collect all the data necessary for an exhaustive study aimed at determining the stresses caused by the wind. However, it is thanks to this first experience that, subsequently, it is possible to understand the elements necessary for a good oscillograph, necessarily characterized by: automatic and continuous operation; an anemometer for measuring wind direction and speed and a chronograph. As there was no device capable of enclosing all these functions in a limited space, it was decided to position the individual instruments, individually connected to each other[32]. The oscillometer, although being tested, was very successful for the analysis of towers characterized by precarious stability: in fact, it was in September 1913 that the Ministry of the Navy, together with the Inspectorate of Lighthouses and Maritime Signaling, draws the attention of the Ministry of Public Works to the lighthouse of Fiumara Grande, at the mouth of the Tiber, due to the strong fluctuations caused by the wind. The Permanent Commission for Lighting is in favor of the adoption of this type of systems and their related studies, conducted by the Royal Office of the Civil Engineers of Rome, identifying in the theme of structural reliability the main topic of pharological innovation of the nineteenth century, a period of real revolutions in terms of structural stability and compositional harmony.
In the same years, in fact, to accompany the interest aimed at strengthening the load-bearing structure of the lighthouses, there is an increasingly strong interest in the establishment of a real architectural identity of the lighthouse, made possible by the creation of a network of lighthouses, characterized by functional and compositional characteristics common to the entire network. Already equipped with a network of lighthouses organized by the Kingdom of the Two Sicilies (fig. 20) (Raddogna , 1982), it was in 1860, with the unification of Italy, that the Italian State armed itself with all the tools to organize systematic a lighting structure along the 8,000 kilometers of Italian coast, passing from the 50 lighthouses and maritime signals present in 1861 to the 512 existing in 1916. This modernization strategy is documented in the first Italian publication dedicated to the

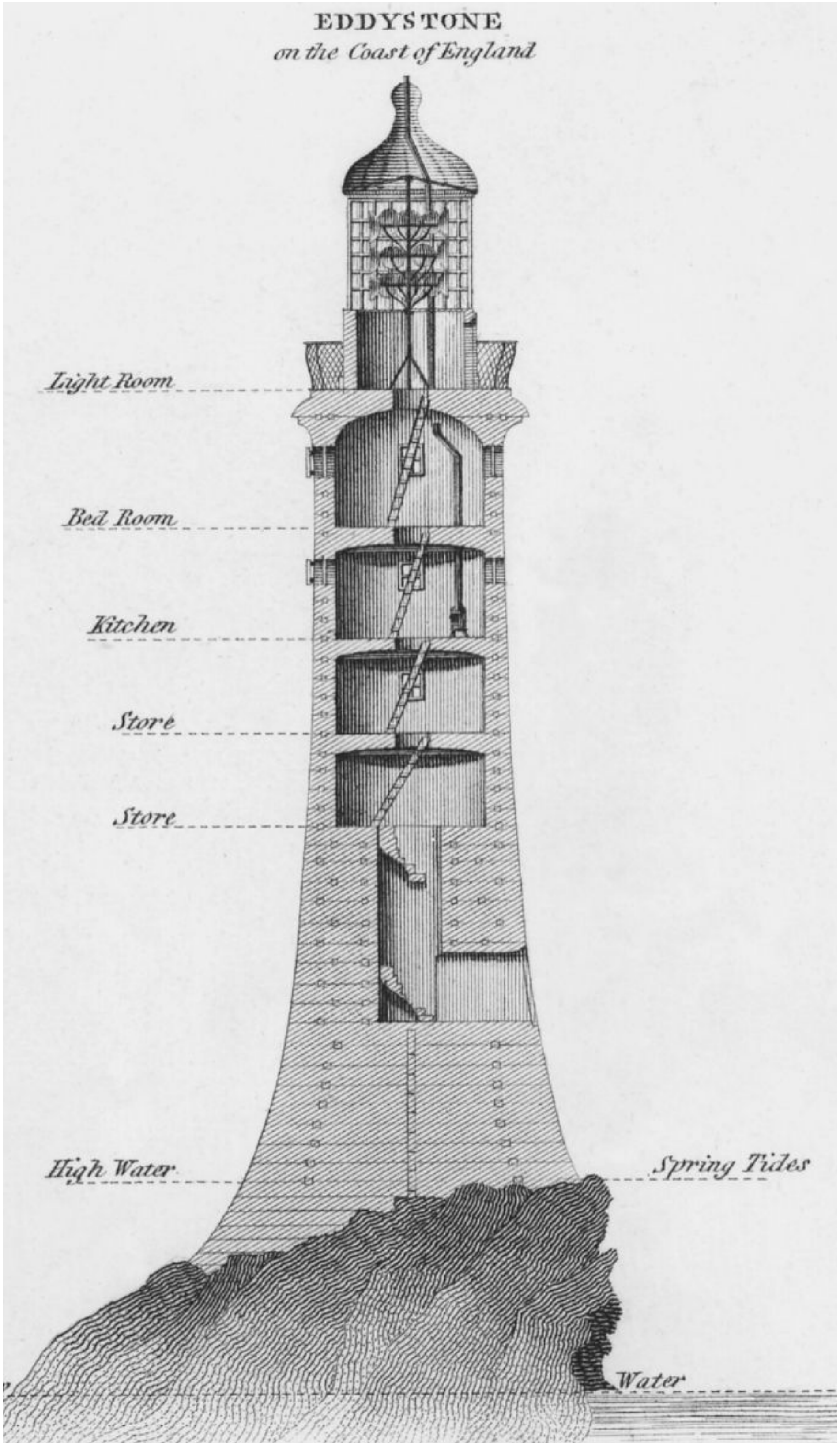


Fig. 19. Smeaton, J. (1759). The Eddystone Lighthouse.

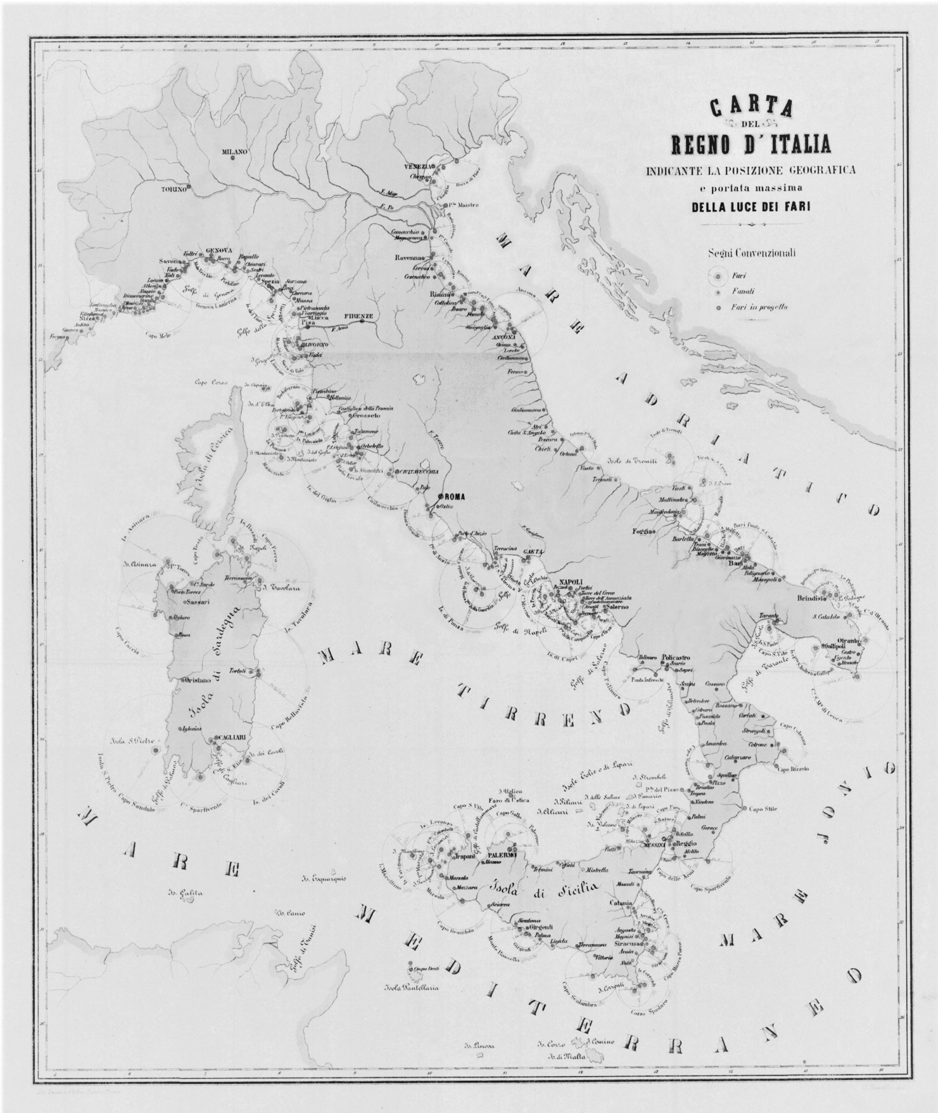


Fig. 20. Main lights of the Italian network in the aftermath of the Kingdom of Italy.

governance of lighthouses from the constructive point of view and maintenance, in order to create a single signaling network that could unite the entire Italian coast. The project takes shape with the formalization by the Ministry of Public Works of the *Album dei Fari illustrato dalle notizie intorno ai loro caratteri e posizione non che da quelle intorno alle spese di costruzione e impianto e di annuo mantenimento ed illuminazione*[33] (fig. 21), still available today in the National Libraries and in some State Archives.

If until that moment the function of the lighthouse had been fulfilled and incorporated by the towers, bastions, fortresses and defensive towers, with this program a new era of modern and technologically advanced structures and to know the increase and the progress brought in this service after the constitution of the Kingdom[34]. In this sense, from the unification of Italy onwards, the interest addressed to lighthouses and their construction becomes so high as to outclass any type of coastal work, including ports (Curti, 2022), probably because , as reported in the same Album, in the lighthouses are identified the "monuments of general interest and undoubted pledges of the civilization of a people".

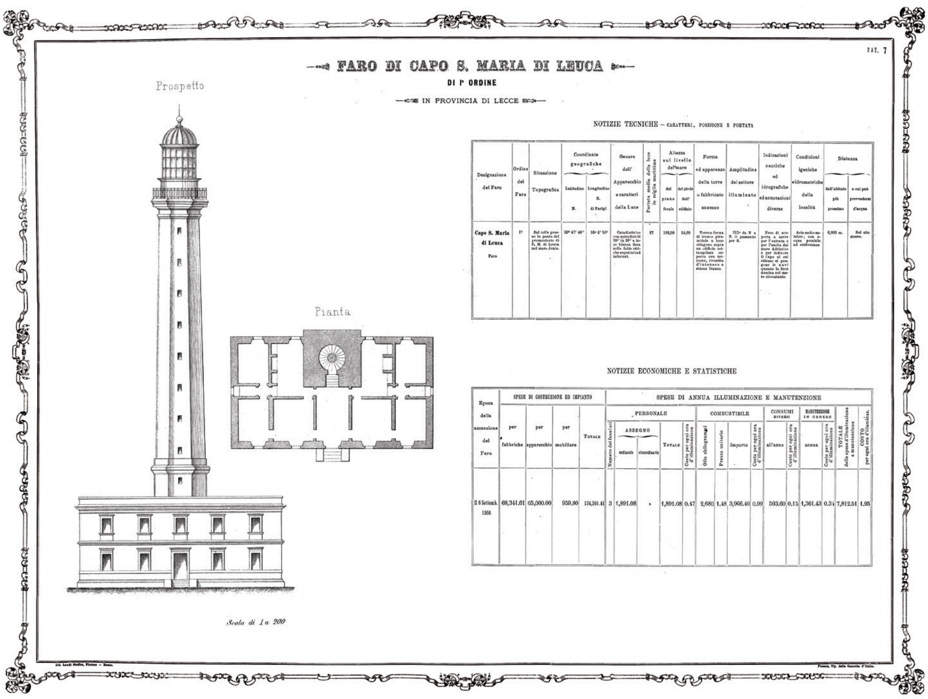


Fig. 21. Cover of the *Album dei Fari illustrato dalle notizie intorno ai loro caratteri e posizione non che da quelle intorno alle spese di costruzione e impianto e di annuo mantenimento ed illuminazione*.
Fig. 22. Table of the lighthouse of Santa Maria di Leuca (LE) present in the *Album dei fari*.

More specifically, the *Album dei fari* is configured as a collection of drawings depicting the design of numerous lighthouses (fig. 22), in plan and elevation, accompanied by the technical characteristics of the systems, maintenance costs and the necessary economic plan. to their construction and management. The geometric-architectural setting of most of the projects featured in the Album follows recurring and very precise geometries - alternating with sporadic neoclassical style lights with local materials and unique features such as cornices and columns - still partly existing and in use today. In this sense, despite the accuracy of the projects, the construction program was never completed, only to be subsequently partially carried out in subsequent periods, with more or less evident changes compared to the original project. Nonetheless, the publication makes it clear that Italy is actually willing to invest in technology and in this type of identity buildings, through which to express the degree of civilization achieved.
If until now the interest addressed to the construction of ever new lighthouses is configured as a Gaussian in continuous growth, it is with the technological evolution - until now the source of an ever renewed interest in these architectures - that start to the inexorable and disarming decline of coastal architecture. In this sense, in fact, it was in the early twentieth century that, thanks to the Swedish inventor Gustaf Dahlén, we are witnessing the electrification of the lighthouses, a process that lasted for many years and ended only with the updating of the electrical system in the headlights located on the high seas, through the use of electric generators or through solar or wind energy[35].
Technology, which has always been a process aimed at increasing the architectural-functional value of coastal architecture, becomes the cause of the definitive Gaussian decrease in interest. To contribute to the definitive decay is, together with the electrification of the lighting system, the birth of new technologies and systems for navigation: from GPS to NAVTEX[36], from radar to depth sounders, from autopilots to digital cartography, to conclude with the creation of multiple smartphone applications capable of helping the navigator in the crossing and in predicting weather trends (Boscolo , 2014).
This is how the figure of the lighthouse, although still active thanks to automated systems, partially abandons its function, alienating itself from the context, turning into a relic of history, a fragment of memory. At the same time, the architectural apparatus of the lighthouse is still configured today as a building with enormous architectural-tourist potential for the entire Mediterranean territory, as well as constituting a fundamental historical testimony for the identity of places and memory. It is no coincidence that some of the lighthouses present in the Mediterranean are protected by the European Commission[37], demonstrating the great symbolic, architectural and landscape value of these architectures for the entire Mediterranean and therefore Italian territory.
Ultimately, the architecture of the lighthouse now needs a new interpretation and re-reading in order to direct the population towards new interpretations, through which to generate processes of recognition and identification of their value-utility. In order to renew the interest in these architectures it is possible - through the decomposition and 'recomposition' of the archetypal architecture of the lighthouse - to generate methodologies, events, products and processes of analysis and enhancement aimed at the construction of a material and immaterial network, towards a common language based on knowledge, tourist dissemination and safeguarding.
It is on these assumptions that the constitutive foundations of the second part of the doctoral thesis are laid, towards the analysis and breakdown of the structural and qualifying elements of the lighthouse, in its double interpretation - from the diurnal language, characterized by geometry, form, color and landscape, to nocturnal language, made up of luminous networks and radar communication systems - through which to guide the reader towards the theorization and formalization of the parametric and ontological methodology.

Notes

1. Author of several books on maritime reports, consultant for French Maritime Affairs.

2. It is located 17 km south-east of Reims, surrounded by 420 hectares of vineyards, erected in 1909 by Joseph Goulet, founder of Goulet-Turpin and wine merchant. It was to serve as an advertising advertisement, illuminated at night: at the foot of it there was a tavern and a restaurant. After the First World War the structure was abandoned, it was then purchased in 1987 by the municipality of Verzenay to reuse it as an ecomuseum of wine (Boscolo , 2014).

3. "Nor did sleep fall on his eyelids while the Pleiades was watching and the late sunset Boote and the Bear which is also called the Chariot, and there he turns, always looking at Orion, and alone and in the liquid Ocean disdains wash. The Bear that Ulysses, sailing to miss, had to leave, as the Diva ordered "(Homer, 1822, p. 141).

4. Less than a mile to the north-east of the island today lies a real lighthouse, consisting of a circular white tower, located on a rock that has tapered over the years.

5. Over time, despite the barbarian invasions and pirate raids, these architectures have always served all peoples without discrimination, as Aldo Mazzacane recalls: "They belong to a principle of coexistence".

6. "And then the shield took, great, massive; and from this moonlike brightness it spread far away. As when the flame of a burning fire appears to sailors on the sea, burning high in the mountains, in a solitary hut; and the storms unwillingly take them to the sea full of fish far from their friends: thus from the shield of Achilles radiance reached the sky, with a beautiful shield, artistically worked" (Homer, 2013, vv . 373).

7. To learn more: https://www.ilmondodeifari.com/page_20.html, accessed on 15/05/21.

8. Preserved in the museum at the Palazzo Colonna Barberini in Rome.

9. This is the mosaic in the Zen Chapel depicting the journey of St. Mark to Alexandria, the healer of Aniano . The mosaic dates back to 1200 and at the moment the last representation of the lighthouse is chronologically.

10. "Its construction in the time of Ptolemy I was, as expected, pharaonic. His disappearance in a Dantesque tsunami. His resurrection, spectacular" (Paolini, 2007).

11. By *fani*, or *fana*, we mean the small turrets whose only function was to protect the fires themselves. In the case of the existence of the artifact, this did not have any signaling or defensive function (Nucifora, 2007).

12. Some traces have been found in Abu Sir, 50 kilometers from Alexandria, of which an upright part still remains, where the ancient Taposiris Magna once stood. At the compositional level it is a small replica of the lighthouse in Alexandria in Egypt: the first level with a square base, the second on an octagonal base and the third on a circular base, exactly like the lighthouse that inspired it (Simonetti, 2009) .

13. Outside the Mediterranean, on the Atlantic Ocean, we find one of the most important and ancient lighthouses, dating back to the 2nd century AD: the La Coruña lighthouse , still in excellent condition. It was consecrated to the god of war, consequently to its primary sighting function: the building has a square plan, 18 meters wide on each side, with an original overall height of 36 meters, compared to the current 48. The tower, divided into three floors , followed the same compositional scheme as the lighthouse in Alexandria in Egypt, consisting of four communicating rooms and an external staircase. In the Middle Ages it was converted to a simple fortification (Mariotti , 2005).

14. Examples are the Genoa Lantern, the Porto Pisano light in Livorno, the Capo Peloro tower and the Meloria shoal tower .

15. An example of this is the lighthouse of Cordouan in France, built in the seventeenth century and located in the open sea off the Gironde. Wanted by the king of France and adorned like a palace, with monumental stairways and a chapel with sculptures, stained glass windows and marble slabs, it is a miracle for the dogmas of stability. In fact, it is built on a sand bank which disappears underwater at high tide. After more than four hundred years later, however, this lighthouse is still in service, constituting the exception of all those lighthouses destroyed by endogenous and exogenous conditions (Mariotti, 2005).

16. This is the case of the Eddystone lighthouse , built in 1698, consisting of loggias, cornices, friezes and loading masts, erected on rocks, it represents the symbol of the struggle between man and nature, between architecture and science. As described by Victor Hugo: "This construction took the storm from all sides, like those generals who, for being too braided and decorated, attract blows in battle" (Hugo, 2000).

17. The importance of the functioning of the lighthouses was at the time so recognized that it prevented the abuse of the products for their lighting - that is the various oils of rapeseed, olive, etc. - also through their adulteration to avoid their trade or use, as established by the edict of Cosimo de Medici for the Livorno lighthouse.

18. In this sense, Joseph Teulère at the suggestion of Borda, in 1782, endowed the Cordouan lighthouse with 84 fuses.

19. To adopt this solution, in 1784, is the Swiss chemist Aimè Argand.

20. This system was adopted for the first time for the Trieste lighthouse, and then found wide use throughout Europe, particularly in the Irish lighthouses.

21. In fact, however, gas systems have never been totally abandoned, constituting a valid system in the event of a power failure.

22. He is in Augustin-Jean Fresnel , born in Broglie in 1788, who, together with the theorization of the lenses of the same name, is responsible for the formulation of the " Fresnel integrals", ie special transcendent functions introduced to explain the diffraction phenomena.

23. He uses lenses instead of mirrors as they are able to concentrate more light.

24. It is after the drafting of the construction program aimed at creating a network of Italian lighthouses that an intermediate order between the third and fourth order is added, bringing the classification of the lighthouses to seven types of orders.

25. In this context, the idea of using lenses larger than those of the first order was first proposed in 1869 by the British engineer Thomas Stevenson, depending on the ability of gas burners to propagate the lights of the headlights over distances more and more and even in the event of fog, causing, at the same time, overheating problems in the first order lenses. The meso-radial and hyper-radiant lenses are therefore mounted on 31 headlights - still present today in the Manora Point lighthouse in Pakistan, in the Santa Maria a Laguna lighthouse in Brazil and in the Punta Makapuu lighthouse in Hawaii - and removed in most of cases starting from the 20s of the twentieth century, by virtue of new lighting technologies. To learn more: https://uslhs.org/hyper-radial-lenses, accessed on 17/05/21.

27. The term " farology " appears for the first time in the Transactions of the Royal Society of Arts of London which, in 1847, credits its coinage as "introduced for the first time by the late Mr. Purdy ". For further information: http://www.worldwidewords.org/weirdwords/ww-pha1.htm.

28. For further information: https://uslhs.org/fresnel-lens-orders-sizes-weights-quantities-and-costs, accessed on 17/05/21.

29. Further examples are the Longships and Bishop Rock Lighthouse in Cornwall, the Skerryvore Lighthouse in Scotland and the Fastnet Lighthouse in Ireland.

30. "The study of the stability of the equilibrium of a structure has its origin in a gradually increasing load and may present a sudden change in the characteristics of its deformation. This change does not depend on failure or on modifications of the mechanical properties of the constituent material, but on the circumstance that, under a certain load value, the configuration of the initial equilibrium ceases to be stable and becomes unstable: the structure then undergoes a heeling, a following which it abandons the configuration in question and seeks, if possible, another location" (Mezzina & Sollazzo, 1993). From this moment on, the design of the towers takes into consideration the theory of bending, that is, considering the lighthouses as bodies embedded in their foundations.

31. In the early 1900s the theme of wind and oscillation was carefully studied by virtue of the sudden collapse of the bell tower of San Marco in Venice.

32. The wind represents a concrete danger for these architectures, as too rapid oscillations can cause cracks perpendicular to the direction of the vertical movement, if the masonry has not been correctly executed by a sufficiently resistant and homogeneous monolith (Santini, 2006).

33. Thus reads the introduction of the Album: "If there is a country where lighthouses can be said to be indispensable more than elsewhere, it is certainly Italy, not so much for its topographical position, but for the development of its so rugged coast" (Kingdom of Italy/Ministry of Public Works, 1873).

34. Of a different nature, however, are the projects and surveys of the Historic American Buildings Survey (HABS) and the Historic American Engineering Record (HAER), which document the successes achieved not only in the farological field , but in the entire architectural sector of the United States (Amoruso, 2005).

35. At the same time, the potentially explosive bulbs used for lighting are being replaced by today's 1000 Watt halogen bulbs. Today, it is only in some cases that we are witnessing the adoption of fixed pulsed light by means of LED light panels (Massariolo & Zanelli, 2008).

36. Or "NAVigational TEXt messages", is an automatic international service on medium frequencies, for sending navigation warnings and weather reports.

37. In particular, there are five Mediterranean lighthouses protected by the Commission, among which we find the Italian Punta Palascìa , commonly called Capo d'Otranto, with its white stone tower rising 32 meters from the ground and 92 meters above sea level. , together with the La Mortella lighthouse in Corsica, the Tourlítis lighthouse in Greece, the Tiro lighthouse in Lebanon and the Palagruža lighthouse in Croatia.

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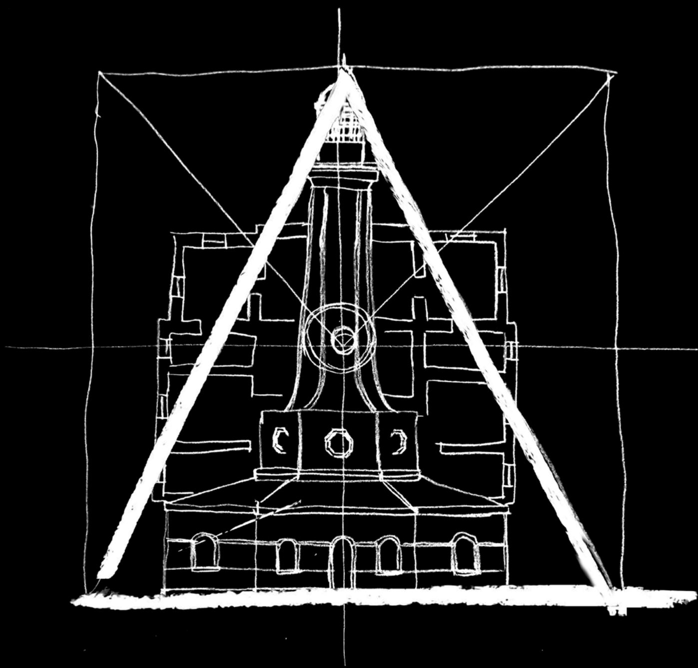
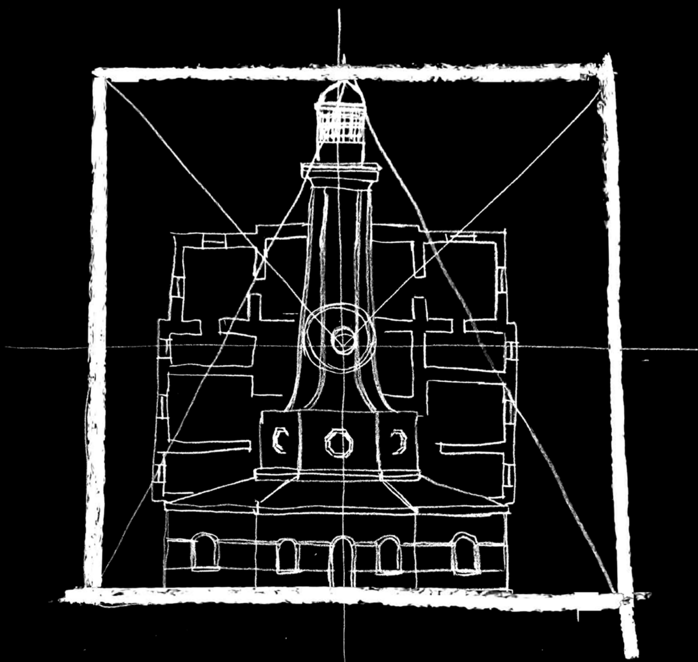
Part II

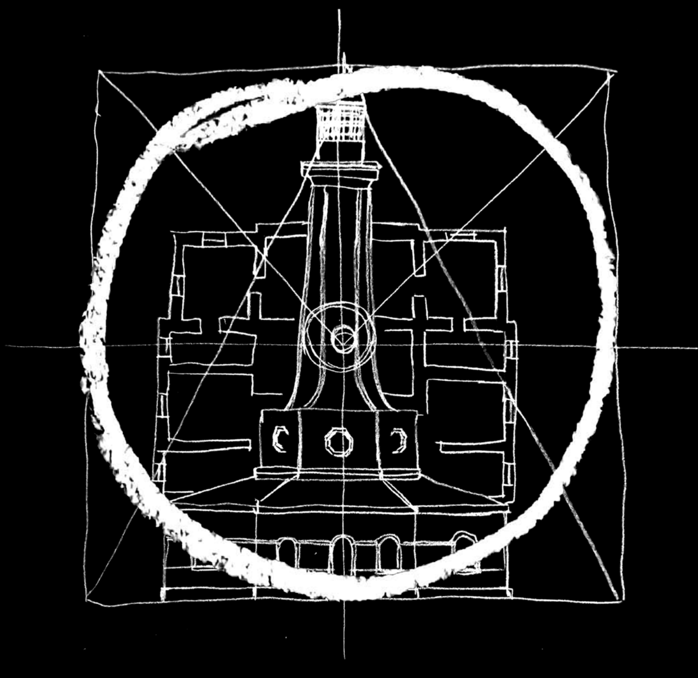
The lighthouse: from the day language, color and shape, to the nocturnal language, lights and eclipses

The second part, of a theoretical-analytical nature, has the function of connecting the first part, purely theoretical, to the third part, almost entirely experimental and applicative, thus configuring itself as the basis through which to undertake the development of a replicable methodology in BIM environment and in the ontology field. The ultimate goal is to create a theoretical-representative-experimental 'path' that identifies its origin in the history and geometric composition of the lighthouses, up to their enhancement through digital technologies.

The objectives of the second part can be summarized according to the following points: theoretical and analytical identification of the geometries of the lighthouses through which to study and identify the geometric and semantic recurrences; classify the lighthouses in a descriptive and figurative way by building types - tower, block, fortress, etc. - through which to carry out an initial examination of the variables of the lighthouse, preparatory for an architectural/ semantic analysis of the architectural structure; identify in a precise, theoretical and graphic manner the variables of the lighthouses - namely the 'lantern', the 'tower', the 'building' - through which to undertake the first considerations and hypotheses regarding the theorization of a methodology of enhancement and knowledge; briefly outline the invariable lighthouses - composed of the coastline, the beam of light and the landscape - in order to understand the importance and mutual influence implemented between the landscape and coastal architecture; briefly analyze the figure of the lighthouse in relation to the colors/patterns that constitute it and how these can be read according to the landscape on which they lie, in order to convey to the reader the primary importance of the lighthouse in the context of the characterization and definition of the landscape itself; describe today's technological operation, thanks to which to obtain a complete picture of the state of the art of the lighthouses, not only from an aesthetic and geometric point of view but also from a technological point of view.





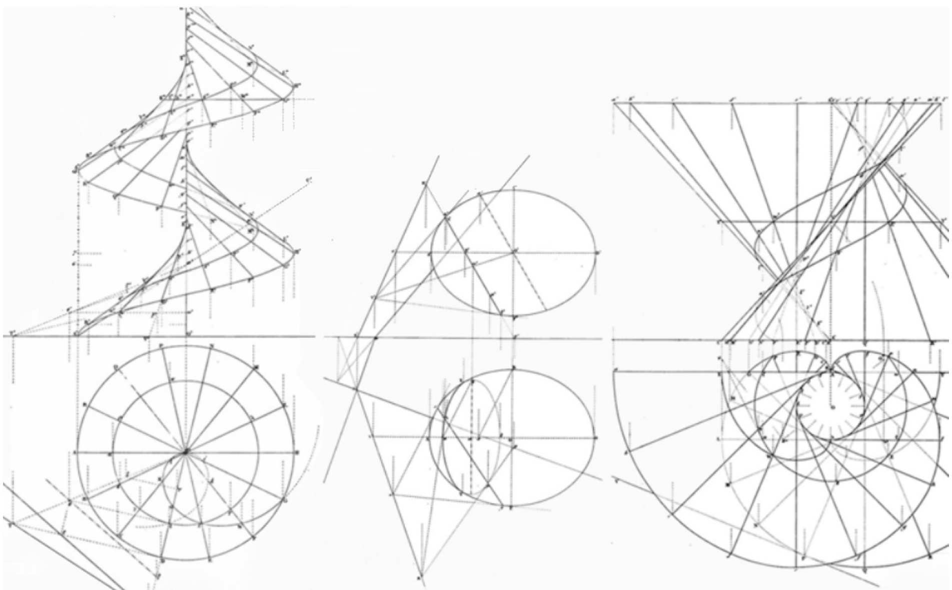


Chapter 3

Geometry and shape

"L'unità è pensata come punto avente posizione ed estensione: tanto il numero pari che il numero dispari. I numeri pari sono costituiti infatti da unità che si rappresentano in quantità uguali da una parte e dall'altra di un'altra unità o punto. Le unità giustapposte formano dei campi (χωrv α) che rappresentano i numeri e le proprietà di questi numeri sono a loro volta determinate dalle figure cui essi danno origine.Queste figure possono essere a una, due o tre dimensioni e si hanno così i numeri in genere (lineari), i numeri "piani", "i numeri solidi". Euclide non ignora questa tradizione e definisce il numero piano come prodotto di due numeri e numero solido il prodotto di tre numeri. I numeri piani, poi, a seconda delle differenti proprietà delle figure sorte dalla disposizione delle loro unità si definiscono ulteriormente come numeri triangolari, numeri quadrati, numeri gnomoni, numeri oblunghi [...]"
[Baraii, 1952].

The study of the history of lighthouses allows us to understand their evolution not only from a technical and technological point of view but also from an architectural-compositional point of view. If, on the one hand, the first and second chapters of the thesis turn out to be purely aimed at the historical and technological explanation of the Mediterranean lighthouses, at this point we want to deal with these architectures according to a new interpretation, a point of view projected directly towards the architectural dimension of the artifact. In the course of the following chapter, therefore, we want to introduce the reader to the geometric world of coastal architecture, first identifying the pure geometries, up to the typological and semantic decomposition. This last type of breakdown represents the basis through which to undertake the experimentation of the research methodology.

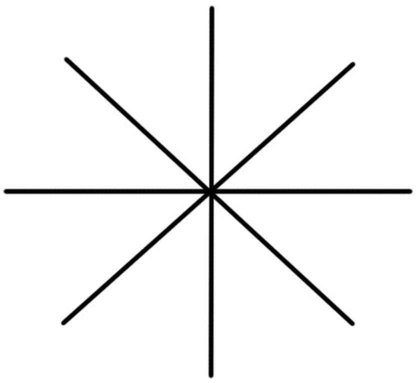


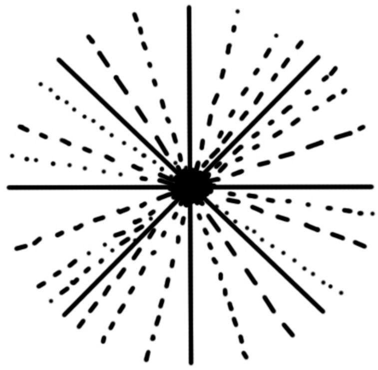
On the cover. The Cozzo Spadaro lighthouse: square, triangle, circle.
Fig. 1. Leroy, C. F. A., Traité de Géométrie descriptive, 1834.

Introduction

The study of the history of lighthouses allows us to understand their evolution not only from a technical and technological point of view but also from an architectural-compositional point of view. If, on the one hand, the first chapter of the thesis turns out to be purely addressed to the historical and technological explanation of the lighthouses of the Mediterranean[1], on the other hand, the second chapter is configured as the necessary continuum of what is intended to be a comprehensive treatment of the state of the art of lighthouses, towards the creation of a methodology for the study, analysis and enhancement of the 'characterized' heritage.
Having established what is the final 'generic' objective of the methodology, it is essential to deepen the subsequent preparatory steps for the geometric, architectural and functional understanding of these architectures. In this sense, we recall how: "architecture can be understood as the three-dimensional physical projection of an optical - tactile nature, which can be inhabited, of the overall multi-dimensional space. But the real space of architecture changes with the historical - evolutionary one because what has three dimensions, which can be measured and which is habitable, varies with the variation of the culture that produces it precisely because a spatial complexity is projected into the three dimensions. -dimensional (historical, social, economic, political, ...) that we could define as 'cultural' "(Fatta, 2018). It therefore appears evident that the geometric composition of the lighthouse, as for all architectures, is the result of the historical, political, social and economic evolution of a territory.
If for an in-depth study of the historical, political and technological development of these architectures and these places, we refer to the previous two chapters, in this chapter we want to explain the geometric and compositional characteristics of the lighthouses, analyze their recurrence, establishing a classification through which to found the interpretation key and the parametric and ontological structure.
At this point it is preparatory to the exposition of the following paragraphs to define and explain what was previously understood by the term 'characterized architecture'. With this term, in fact, useful to make the methodology 'replicable' to different architectural typologies, we mean all those architectures characterized by recurring geometric and functional characteristics, among which some abbeys, basilicas, towers, etc. can be inserted.
The administration of the methodology to different architectural typologies is due to the methodological process adopted, based on the categorization and architectural breakdown into recurring macro and micro elements[2], a process explained in more detail in the course of paragraph "3.3 Replicable and non-replicable variables", through which create a model valid for all 'characterized' architectures. In this context, however, it should be emphasized that each architectural typology, although it can be assimilated to a set of specific recurring macro and micro elements, does not appear to be detached from the social and territorial context that surrounds it, requiring an ex novo study with respect to this research. The latter, in fact, is defined solely as a reference to the methodological process to be applied to different architectures, and not as a practical basis to be used as is.
In the case study of the lighthouses - from this moment on located only in Italy but whose decomposition turns out to be totally coherent and feasible to all the lighthouses of the Mediterranean - it is possible to identify recurring elements through which to compose a 'semantic abacus' , fundamental for obtaining a three-dimensional model and knowledge useful for the three-dimensional/cognitive representation of architecture aimed at the enhancement and dissemination of architecture and knowledge (Maldonado, 2015). This is because, as also asserted by Mario Docci (Docci & Mirri, 1989), it is the representation itself that is prey to the decomposition into constructive parts in order to understand

the relationships, corroborating the process of analysis and modeling of the architecture through subdivision of the architecture itself. In this sense, in fact, it is undeniable that for the construction of an analytical apparatus - whether it is addressed to restoration, dissemination or enhancement actions - the reorganization of the individual parts of the architecture, as well as of their relations of connection and connection, is configure as a necessary and validable process for all types of architecture (Galizia & Santagati, 2012).





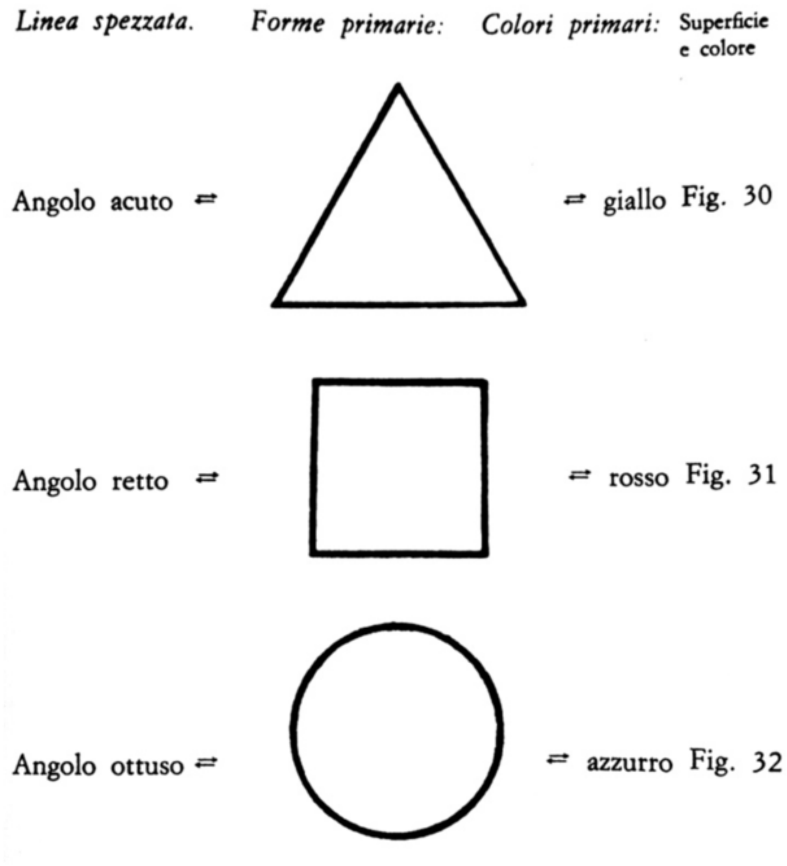


Fig. 2. Scheme of the fundamental types.
Fig. 3. Diagram of the temperature differences.
Fig. 4. Triangle circle square.

It should be emphasized, in fact, that the semantic decomposition of architectures is already a common and practiced methodology in the field of representation, study and modeling of cultural heritage, to be implemented through the use of different technological supports, in this research enhanced by codification, from the assimilation and interoperability of data provided by BIM and ontological supports. As previously stated, in order to proceed with the semantic cataloging of the specific case study and its technological application, it is therefore necessary to identify, first of all, the geometric characteristics present in the architectural typology considered and, subsequently, to categorize them into macro and micro architectural categories, through which to incorporate most of the cases present in the case study group.
The geometries of the architectural compositional apparatus of the lighthouse are therefore elaborated in the following paragraphs, from its reading in plan - of which we can distinguish structures with square, octagonal, cylindrical elevations, etc. - to the relative identification and three-dimensional characterization, by means of the distinction of tower, block and fortress lighthouses, to then subsequently intercept the variables and invariables of the lighthouse, the final key to the categorical-typological dissertation .
The semantic architectural decomposition goes hand in hand with those that are configured as the primitive geometries, composed of broken or curved lines, generating the form and compositional structure of each element. To give life to the entire geometric apparatus is therefore line[3], described by Kandinsky as an invisible entity, that is, a trace of the moving point, destruction of the point itself, constantly changing from static to dynamic[4]. It is Kandinsky himself who distinguishes three different types of straight lines: horizontal, vertical and diagonal. The horizontal line is the simplest and corresponds to the surface line on which the man stands and moves. The latter, in conjunction with the vertical line, forms a right angle, causing the flatness to change in height. Finally, the diagonal line breaks away from the previous ones forming an equal angle towards both, representing the union in equal measure (figs. 2, 3)[5]. The union and combination of these lines creates simple geometric figures, defining in turn colors and meanings addressed to the single elementary geometric representations. It should be remembered, in fact, how for Kandinsky each of the three fundamental geometries can be traced back to specific angles and colors: the triangle, formed by acute angles can be represented with yellow; the square, made up of four right angles, can be painted in red; the circle, or the union of innumerable obtuse angles, can be painted with the color blue (fig. 4).
The following geometric analysis of the lighthouse develops and partly continues all those theories that have developed mainly in the field of painting, architecture and drawing, in order to accurately analyze the single pure geometry and at the same time identify and intercept the variables that unite different lighthouses, in order to be able to reach, through the semantic decomposition, a geometric apparatus composed of different categories of geometric-architectural variables .
In general, at a geometric and representative level, the architecture of the lighthouse, even before being broken down into different pure geometries and architectural categories, can be traced back and analyzed according to its entire and total architectural consistency. We want to underline, in fact, how all the lighthouses attract vertical axes of symmetry to themselves, a symbol of a harmonious, identifying and recognizable architecture compared to all the other geometries that make up the territorial skyline. It is precisely this harmony that makes the composition of the lighthouse so fascinating in the eyes of those who admire it. In this sense, the elevation, and therefore the lantern-light system visible from this point of view, represents the perfect synthesis of architecture, geometry and man, themes with a high analytical potential, discussed below as preparatory to the precise and analytical explanation of the constitutive geometric variables.

3.1 The geometry and the lighthouses

The word geometry - from the Latin geometrĭa and from the Greek *γεωμετρία* - appears to be composed of the prefix 'geo', which refers to the word *γή* or 'earth', and from *μετρία*, or 'metry' and therefore 'measure'. It is literally "the measurement of the earth", that is the branch of mathematics that deals with space in the plane and its relations, indicating an ancient discipline that can be traced back to the Egyptians. Herodotus, in fact, tells how, due to the erosion caused by the floods of the Nile, the surface of the Egyptian land properties constantly underwent variations from year to year, making it impossible to calculate for tax purposes, thus giving rise to the need to experiment with effective techniques for the measurement of the earth, from which the meaning derives[6].

Geometry, in addition to being an ancient discipline, is one of the most studied and researched philosophical systems, capable of interpreting the world we inhabit and perceive, today branched out into numerous sub-sectors with multiple research themes and as many open problems: a subject through which to develop continuous scientific advances and theories.

Geometric study and science do not find their only *raison d'etre* in mathematical problems and scientific description. In fact, the problems that lie at the base of the geometric rules are the prerequisite through which to undertake study and analysis paths in many fields, such as that of architecture, art, landscape, urban planning, music, etc. Many will perhaps agree that art - be it pictorial, musical or architectural - is totally in contrast with mathematics, cold and rational. To confirm this link, however, is the perfect combination of art and mathematics practiced in the Renaissance by masters such as Leonardo da Vinci, Michelangelo and Albrecht Dürer, both mathematicians and artists.

What unites these two sciences is undoubtedly symmetry, structuring regularity and order between the parts. Through the construction of simple geometries - such as the square, the circle and the triangle - it is possible to analyze on a mathematical basis all the artistic manifestations present in nature, in search of perfectly harmonious proportions and relationships[7]. As described by Le Corbusier , in fact, "Cubes, cones, spheres, cylinders or pyramids are the great primary forms that light enhances; the image appears clear and tangible to us, without any ambiguity. This is why they are beautiful forms, the most beautiful forms"(-Le Corbusier, 2003, p. 16). In this sense, it is through the treatment of pure geometries that we want to analyze the harmonic and characterizing characteristics of the lighthouses below, associating a specific element of the architectural system of the lighthouse to each primary geometric figure. It will then be the whole of the reflections put in place in the field of pure geometries and of the formal compositional categorizations of the lighthouses to constitute the basis through which to proceed with the definition of the architectural variables, and therefore 'materials', founders of the parametric and ontological.

If on the one hand geometry is the scientific presupposition for the treatment and material decomposition of the lighthouse, it also turns out to be the unit of measurement through which to perimeter and define the mental and intangible places, represented by non-places[8], capable of relating the architecture of the lighthouse with a thousand stories, sciences and ways of thinking. In this sense, it is Albert Einstein himself who clarifies how, if only tangible spaces of space were to be investigated, geometry would cease to be an "axiomatic-deductive" science and become natural science. It is in this sense that, in the course of discussing the composition of the lighthouses, the geometries are not treated only as relationships and relations of existing physical units, but also as 'visual' and 'visionary' geometric connections, through which to associate architecture of the lighthouse to intangible geometries of gaze, light and form.

Exceeding only for the moment the concept of intangible geometry, subsequently the subject of discussion in the course of the fourth chapter "Color and landscape", we can as-

sert how, in the context of material geometry, every harmonious architecture can be traced back to the reconfiguration and imagination of itself by means of geometrical-figurative apposition and analysis. In fact, it is now known that more or less complex geometric models represent a fundamental process for the creation of regular and recognizable architectures, through which to generate a geometric regularity, fundamental principles of the classical Greek aesthetic theory of the 5th century. BC, characterized by symmetry and proportion. In this sense, it is Vitruvius who, in the second chapter of the first book of De Architectura, defines the proportion as "eurythmy", or "that pleasant effect, which results from the ease one feels in embracing the appearance of an entire building and its parts. Such an effect takes place when the parts of the work are in relation to each other, that is, the height with the width, the width with the length, and that all correspond to the whole of the symmetry, or general proportion". Finally, it should be emphasized that with the concept of eurythmy it is not configured as a mere equation of symmetrical parity of the architectural complex, but rather as an agreement between the relationships and proportions of the building (fig. 5).
By virtue of these premises, the architecture of the lighthouse understood in its entirety lends itself optimally to an analysis and a geometric decomposition capable of explaining the sense of harmony and charm emanating in the eyes of those who admire it, inserting itself in perfect symbiosis between architecture, man and landscape. In this sense, the architectural composition of the lighthouse, in fact, can easily be assimilated to the three pure forms that unite architecture to the human figure: the circle, the triangle and the square (fig. 6-9). The Vitruvian Man is configured as the emblem of this symbiosis, capable of welcoming the harmonies of the universe - in a perfect mathematical correspondence between macrocosm and microcosm - towards the perfect correspondence between geometry, architecture and symmetry[9]. In this sense, the Colossus of Rhodes, one of the seven wonders of the world and one of the first existing lighthouses together with the lighthouse of Alexandria in Egypt, is configured as the lighthouse-anthropomorphic architecture through which to perceive the ancient identification and association of these architectures with respect to the multiple geometric, human and landscape configurations, in a perfect relationship between man and architecture. Given these premises, the lighthouse, be it anthropomorphic in ancient times or purely geometric and of contemporary construction, today represents the perfect subject in the context of the study and analysis of geometry, history, art and architecture.
In the course of the following subparagraphs, therefore, all those reflections relating to pure geometry related not only to the aesthetic-philosophical aspects, but more to the composition of the lighthouse itself as a function of the intrinsic compositional harmony and the relationship with the landscape that surrounds it, find space. As Max Bill argues, in fact, "form is what we encounter in space. Shape is all we can see. But when we hear the word form or reflect on the concept of form, it means more to us than something that exists by chance. From the beginning we associate the concept of form with a quality" (Maldonado, 2008).
It is therefore precisely the elementary forms that establish relationships between multiple expressive capacities, capable of communicating and interpreting the morphology of the territory, the structure and the architecture[10], in search of a complex and harmonious whole[11]. In this sense, with the decomposition and treatment of the lighthouse system according to simple semantic geometries - albeit a representation of the whole[12]- we do not want to diminish what is the compositional structure of the building understood as an architectural organism and as a landscape totem, the more to look for a recurrence between the parties through which to develop information processes for the digital creation and information connection of the artifacts, topics covered in the course of the following chapters and in the third part of this research.

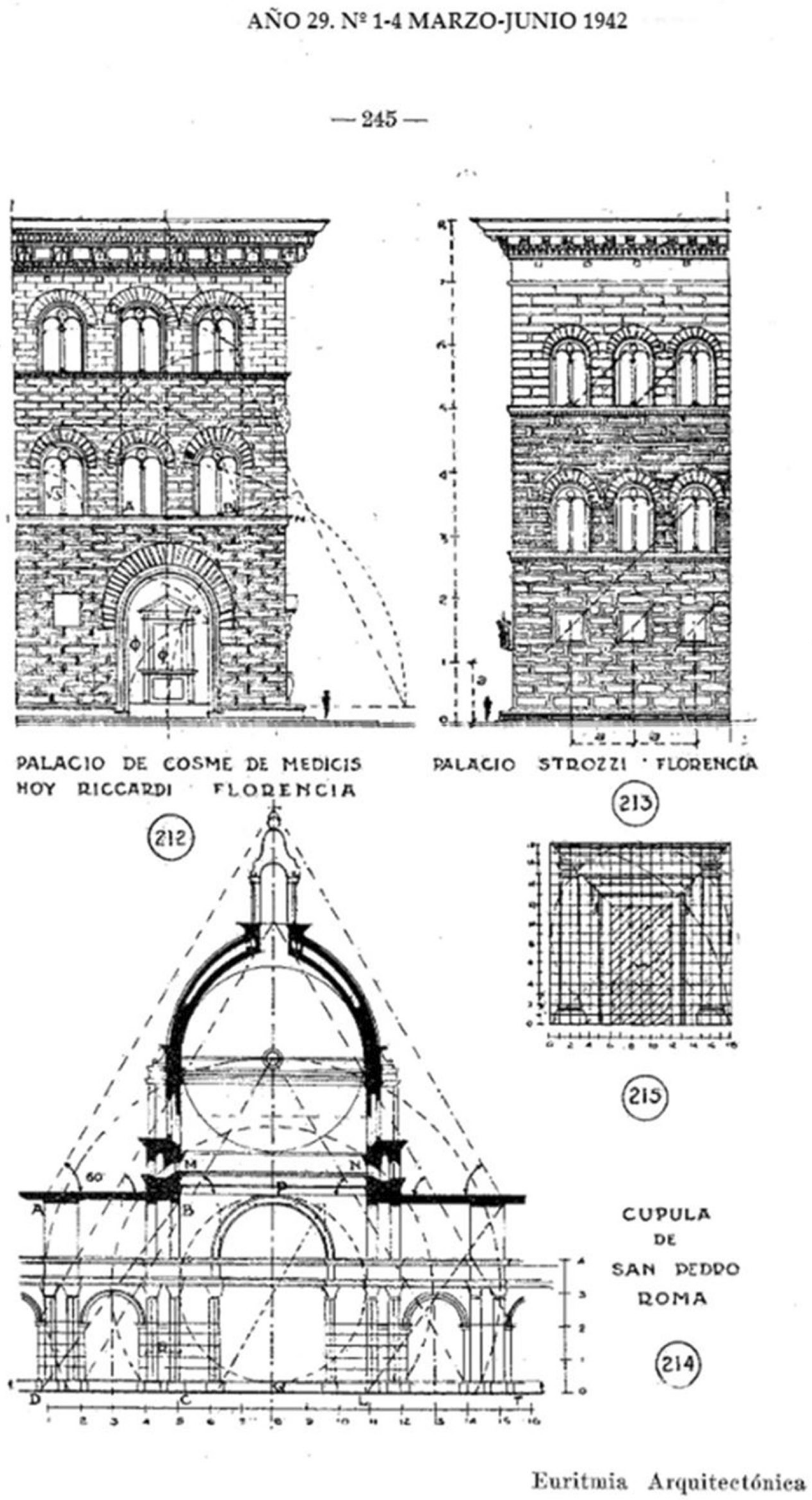
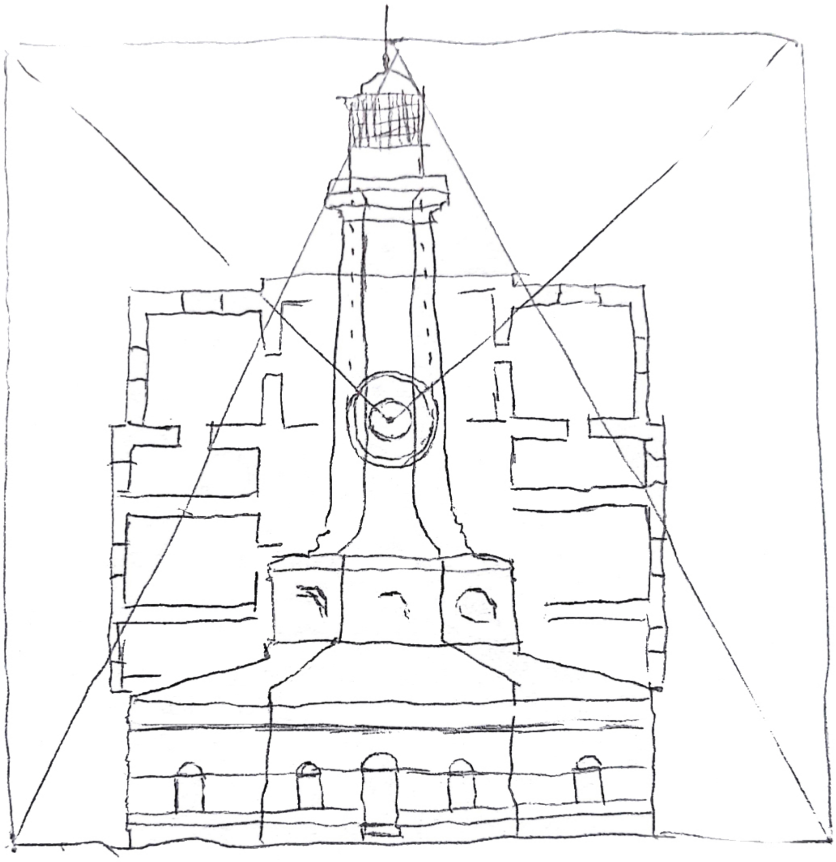


Fig. 5. Lo Celso, A. T. (1942). Euritmia Arquitectonica.



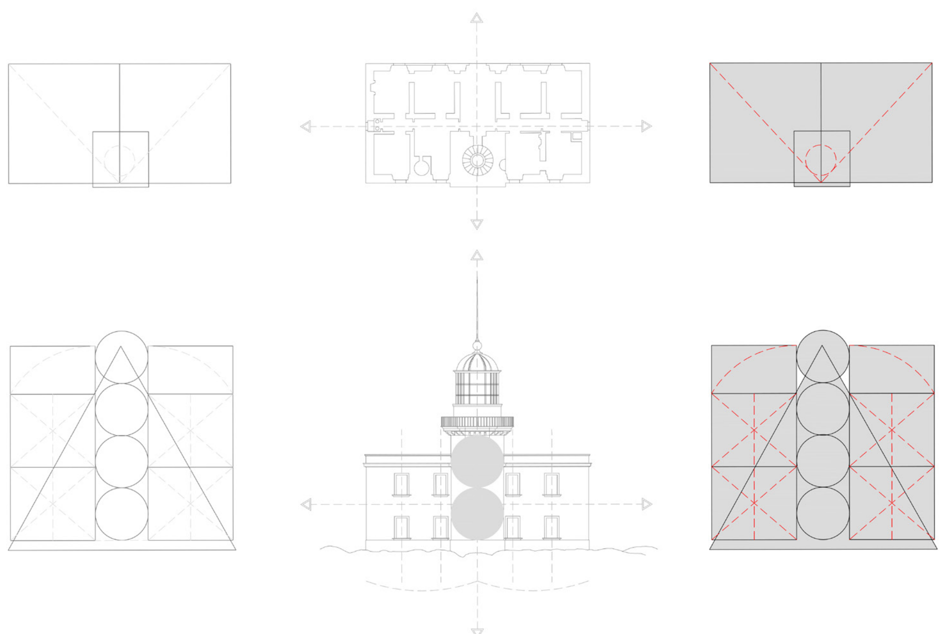
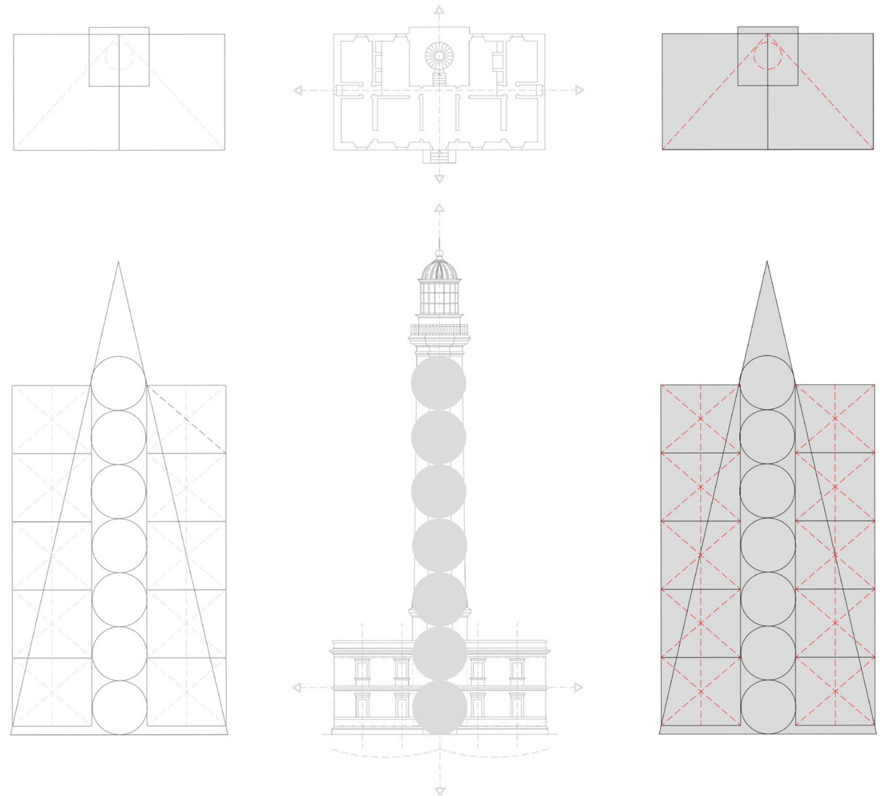


Fig. 6. The lighthouse: square, circle and triangle.
Fig. 7. Geometric analysis. Capo Palinuro lighthouse.



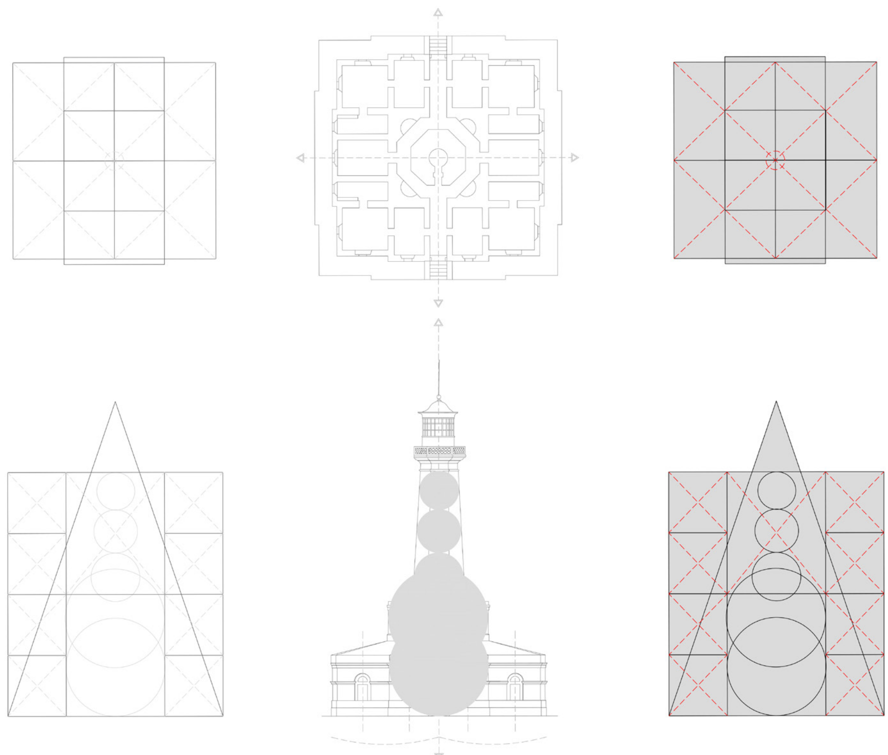


Fig. 8. Geometric analysis. Lighthouse of Santa Maria di Leuca.
Fig. 9. Geometric analysis. Cozzo Spadaro lighthouse.

3.1.1 The square

The square, together with the circle and the triangle, is configured as one of the main geometries constituting the theory of the composition of form. This figure, due to its geometric regularity, is defined as the basis through which to establish formal procedures of creation, decomposition and analysis, thanks to the four angles of ninety degrees and the four axes of symmetry, generators of stagnation, stabilization, i.e. a static and stopping sense of movement (Fonatti & Martinez, 2021). If in its usual conformation of form resting on one side it transmits a sense of stillness, resting on an edge immediately transmits a sense of dynamic movement, of instability.

Symbol of the earth - as the number four represents the earthly consistency - the square is par excellence the form that 'contains', from which everything arises. As tall and wide as a man with open arms, the square represents the idea of a fence, a house, a village.

It is thanks to its symmetrical and coherent geometry that it is defined as a 'right' shape, so much so that it is used by the Pythagoreans as a symbol of justice[13]. It also becomes right in the compositional process of creation associated with the architectures and cities of every era and every style[14] filtered by a harmonic skeleton through which the artistic construction can be restarted (Munari, 2005). In painting, the quadratic form, formed by four equal right angles, can be traced back to the red color, composed of horizontal and vertical lines, which make it a monolithic and at the same time dynamic figure: on the one hand the horizontal line, stable on the ground, on the other, the vertical line, imposing in the elevation (fig. 10).

In the field of geometry applied to lighthouses, the square represents the shape that most stands out in the plans of these architectures. Enigmatic even in its simplicity, it can generate a series of figures - from harmonic rectangles to the golden section - organized by mathematical relationships able to establish and distribute destinations of use and configurations that are always different and harmonious.

In the context of coastal architecture, the composition according to primary geometries is configured, as well as a structure generating an extreme harmony of the parts, as a distinctive feature of each case study, to be distinguished even at a considerable distance from the coast line. In this sense, in fact, the structural stability only partially conditions the shape of the turreted structure of the lighthouse, as the primary function connected to the geometry is mainly to be attributed to the recognizability of the architecture itself by sailors.

Nevertheless, this aspect still affects the static essence of the building, and in particular of the tower of these architectures. In this sense, in fact, for tall towers octagonal or circular sections are preferred, often tapered at the top[15], for towers of modest height and of more recent construction[16] the square section is instead used as it is not possible to implement the tapering of the structure, of fundamental importance for static purposes as well as for construction reasons.

In addition to the structural level, the square is configured as a form with a thousand compositional potential as it can be divided into submodules, i.e. an effective compositional methodology to be applied to the design of the lighthouse-building, seat of the office but also of the lighthouse's home[17], still formed today by modules capable of defining the structure on double axes of symmetry, making the division of the surface easier, especially in the case of coexistence of two or more lighthouses. The square plan therefore manages to ensure harmony and spatial functionality, guaranteeing internal and external symmetry and aesthetics, through which to obtain terrestrial glimpses always similar and similar from all vanishing points.

The quadratic form therefore represents one of the fundamental keys to interpreting the diurnal geometry of these architectures by sea sailors, characterized by monolithic turreted forms with a square base, easily visible in the distance in all weather conditions, and by harmonious 'quadratic' buildings and perfectly functional.

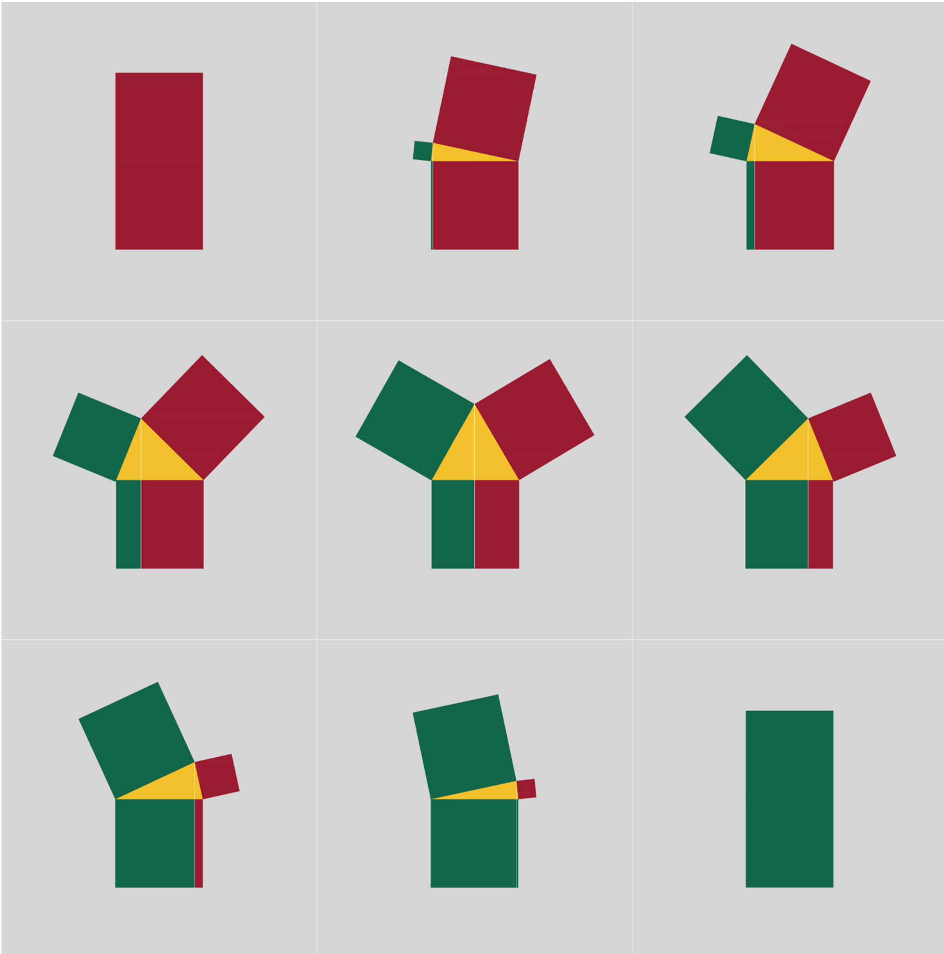


Fig. 10. The transformation of the square.

3.1.2 The triangle

The triangle represents the most stable form symbolizing in the Pythagorean tradition - in which it manifests itself as *Tetraktys* - the ascent from the multiple to the One. It can be understood and imagined in its multiple geometric representations, although the equilateral triangle is in any case the triangle par excellence, immutable and immobile in its shape.
Considered in its pure tetrahedral essence, the triangle is configured as an essential symbol, with the least number of angles, present in all traditions as a return to unity and to the primordial (Munari, 2007). In this sense, in the patriarchal culture, the triangle pointing upwards represents fire, the ascent to divine transcendence, as opposed to the triangle pointing downwards, symbol of the human and nature (Fonatti & Martinuz, 2021). According to the alchemical interpretation, in the order of closed figures, the triangle is inserted halfway between the square and the circle, therefore an intermediate entity between abstract substance and matter.
To characterize this type of geometric figure there are undoubtedly the nodes, the points in which the line changes direction, forming the main geometric combination. The nodes, and therefore the intertwining, are relationships capable of binding or untying the elements in order to join, connect and fit two or more elements.

In the case of the lighthouses, the ‘node’, or main point, that distinguishes these architectures can be identified in the lantern, to be traced back to a triangle with the point upwards, a night guide for sailors and, as previously mentioned, ‘symbol of the fire’. The lantern, in fact, represents the culmination in the elevation of these architectures, through which to connect the territories according to beams of light and circular rays to protect the coastline: in this connection the relationship between the line and the ray is therefore close, between the light and its propagation, between the triangle and the circle.
In this sense, the geometric figure of the triangle turns out to be nothing more than the result of the representation of circles with variable radius, linked by a directly proportional geometric relationship (fig. 11). In the same way, different rays of light propagation can be associated with the triangle present in the prospectus of the headlights, depending on the height of the culmination point of the ‘triangle’.
The geometric figure with acute angles such as the triangle is flanked by those geometries with multiple facets - decagon, octagon, dodecagon, etc. - geometric shapes that distinguish the lighthouse tower in plan, characterizing the volume in the elevation. In fact, if in the previous subsection we saw how the quadratic form can be inserted both in plan and in elevation, in the same way the triangle can be traced in the lighthouse figure with respect to the two different reading planes. It is, in fact, in the plan section of the tower that complex geometries recur, with multiple acute angles, which give life to the

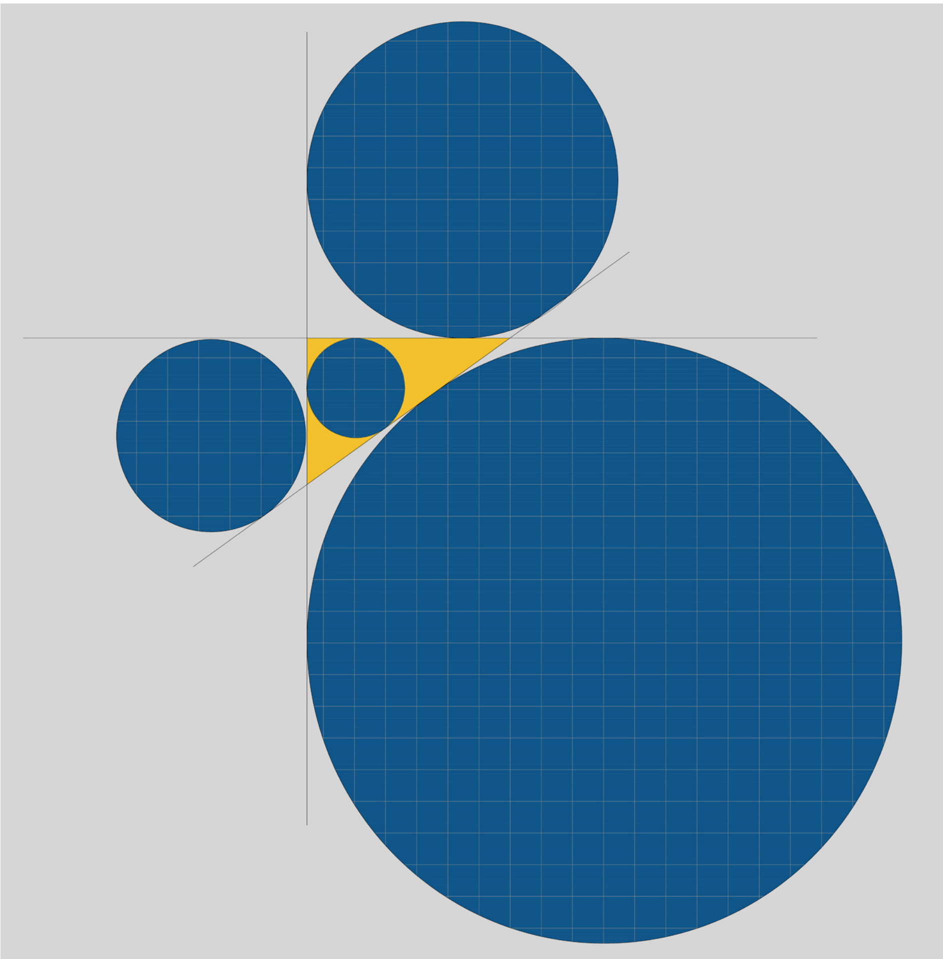
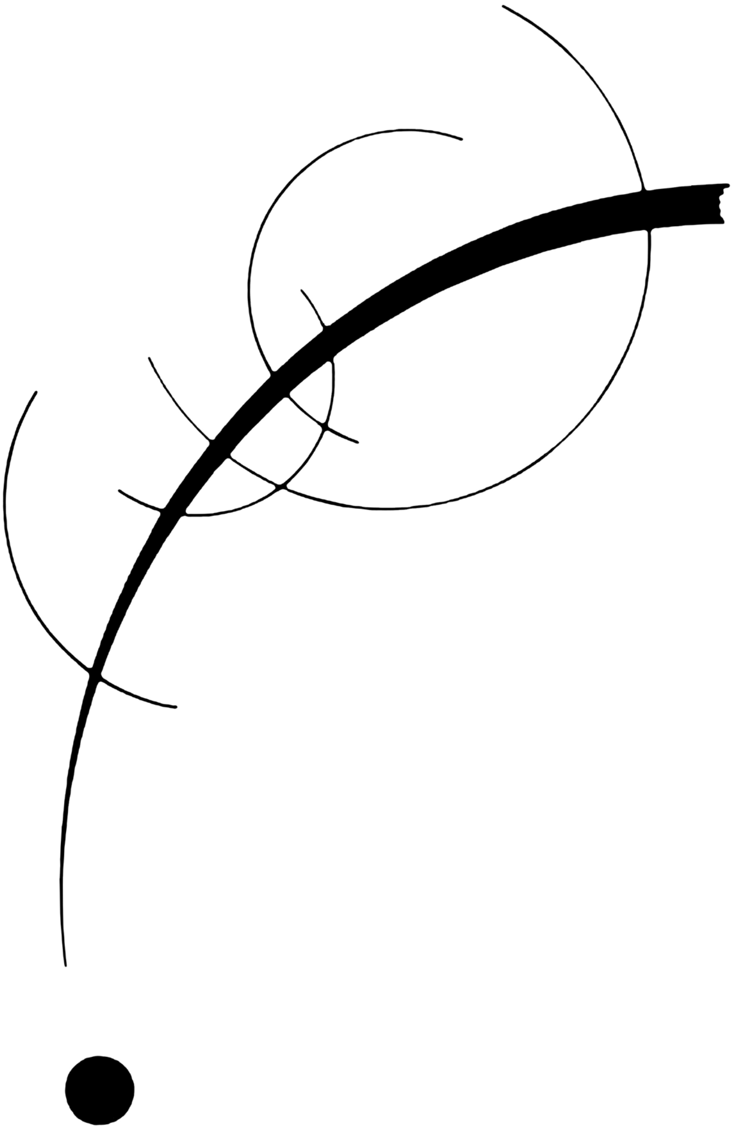


Fig. 11. Creation of a triangle using circles.

countless identifying totems of the coast, extremely recognizable even from long distances. The tower, in fact, with its extruded geometries, simple or complex, manages to capture the attention of sailors, representing a reference point through which to distinguish different lighthouses and landscapes.

3.1.3 The circle

But if the square is linked to man and the triangle to the ascent towards the One, the circle instead has divine relations: it represents, in fact, even today, eternity, contemplating neither a beginning nor an end (Munari, 2016). Given the absence of edges or corners, this geometric figure represents the harmony and equality of principles, a symbol of uniformity, of eternity, as well as of immutable substance, associated with the cyclical nature of time, that is an invariable and continuous succession of identical seconds between them (Fonatti & Martinuz, 2021). The circle can also be traced back to the point, an 'invisible' and 'immaterial' entity, with abstract characteristics and variable dimensions over time. When an external force is applied in any direction, the point changes into a straight line, defined therefore by a direction and a tension (fig. 12): it is when the latter thicken that a 'star' is created, always denser, the intersections of which form an increasingly dense center, in which the material point is configured and grows (figs. 13, 14) (Kandinsky, 2021).
If the representation of the point, in its millimeter composition, can be traced back to the art of writing, the circle and its material point find one of its most fascinating developments and representations in the architecture of lighthouses. In this sense, in fact, as already described in the discussion of the square and the triangle, the circle can be traced in the plans of these architectures, as well as in the large-scale plan, placing the lighthouse, the landscape and the lighthouses in a close neighboring relationship. If in plan the circle represents one of the most common sections belonging to the turreted geometry of the lighthouse, in the plan this geometric representation changes its meaning, changing its unit of measurement and scale from the architectural dimension to the visual-luminous one.
Visual-luminous correlation belonging to the set of lighthouses located in the same coastline is, in fact, extremely connected to the philosophical themes linked to the representation of the centers of force and unions. In this sense, each lighthouse can be assimilated to a monad[18], that is, according to the Pythagorean philosophy, to a simple and indivisible entity characterized by centers of force constituting the universe (fig. 15). It is the same monad which, in physics, appears to be constituted by the union of the numerous molecules that make up a more complex system, thus changing the consistency of the single element and the respective connection of similar elements to each other.
In the same way, the lighthouse-monad communicates with the surrounding territory through the intersection of rays and lines in which the fulcrum always converges with the lantern and with the center of the lighthouse, understood as architecture and the beating heart of the circle and of the related lines. connection. The light emission of the lighthouse lantern therefore emits a sparkling ray capable of covering and protecting the entire surface of the Mediterranean coasts (fig. 16), according to different ranges and systems of lightning and eclipses. In association with the architecture there is the territory, that is the coast which, through the use of the circle as a light module, is therefore unfolded until the straight lines joining the segments that unite the different lighthouses in a single horizontal line are rectified, through which to establish circular modules (fig. 17), that is to say the 'structural step' existing between one light and another. Ultimately, the analysis and study of the geometric line applied to the lighthouses is configured as the tool through which to propose a partially abstract and partially real interpretation, to be associated with the different 'canonical' compositional typologies dealt with in detail below, characterized in any case by relationships of harmony, symmetry, recognizability and stability.



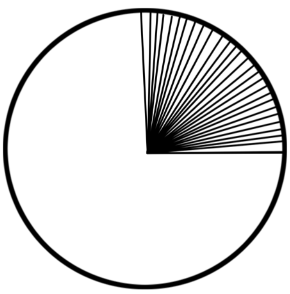
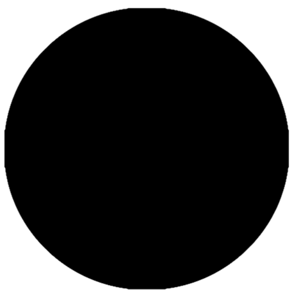
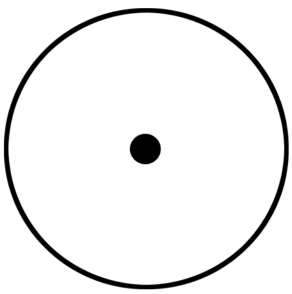
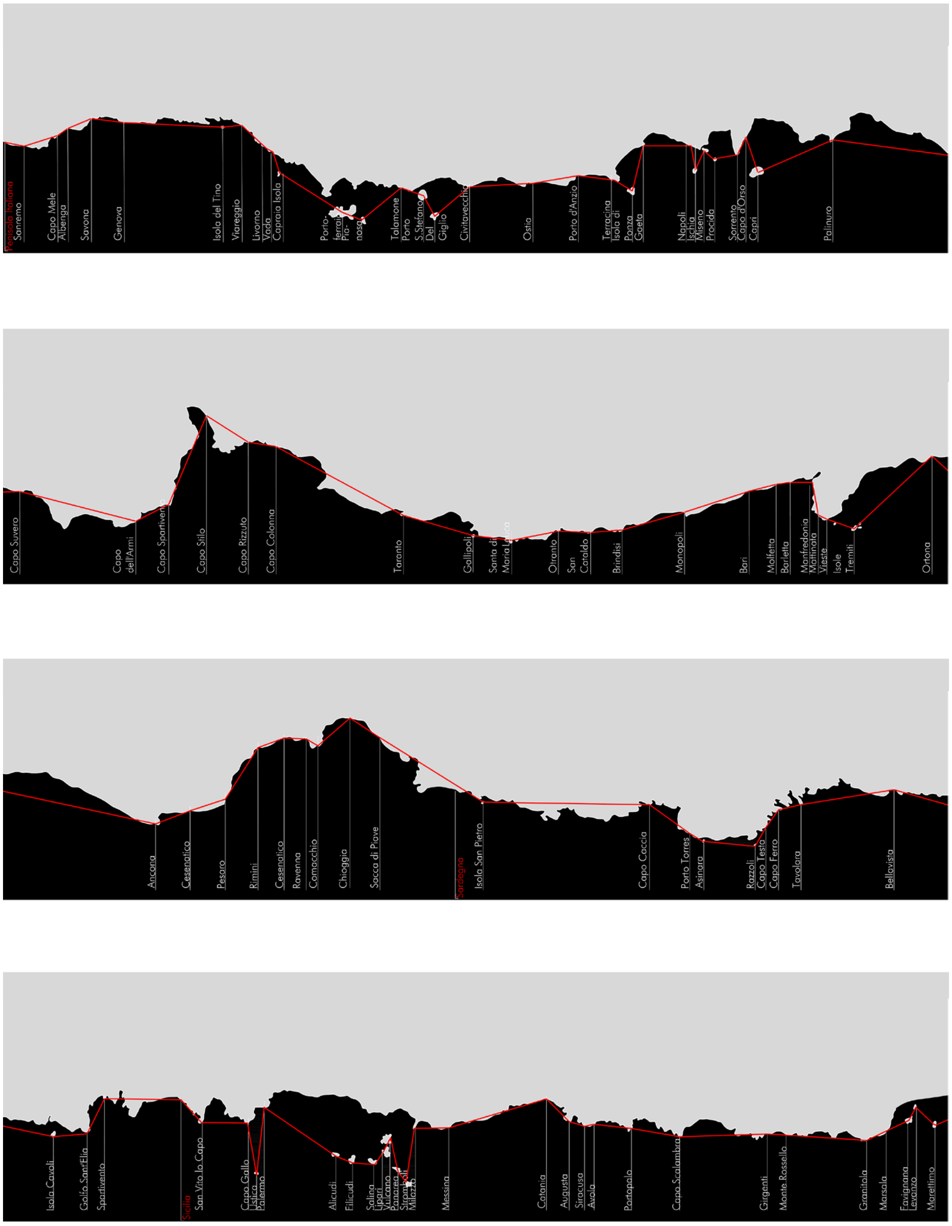
  

Fig. 12. Free curved line towards the point.
Fig. 13. Thickening of lines on a circle.
Fig. 14. Result of the densification of straight lines.
Fig. 15. The Monad.



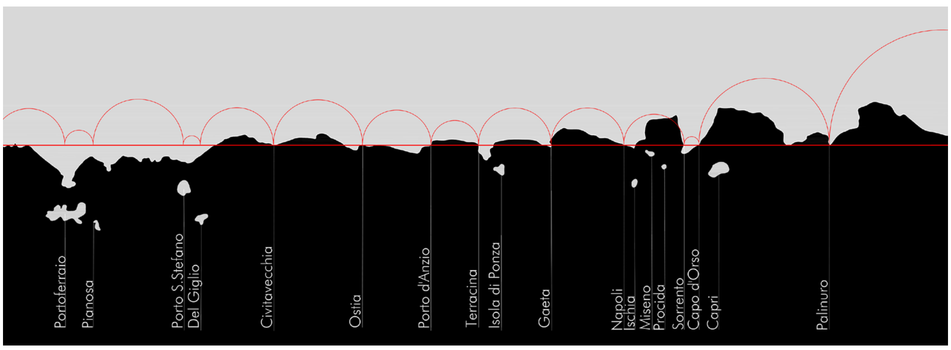


Fig. 16. Unrolling of the Italian coast through remarkable points.
Fig. 17. Final straightening of the coast: lines and modules.

3.2 Typological classification of lighthouses

The formal study of the essential plane figures implemented in the previous paragraph represents the prerequisite through which to develop a path of knowledge aimed at the geometric understanding and subsequent semantic classification of the lighthouses present in the Mediterranean area. If in the previous paragraph it was analyzed how pure geometries can be associated with the unitary composition of the lighthouse, at the same time, it can be classified according to compositional and formal categorizations, a preparatory action in the proposition of a subsequent and new 'grounded' classification on semantics.
The 'canonical' compositional cases of the lighthouses are many, among these we remember: low block building; medium block building; high block building; low tower; medium tower; high tower; on fortress and lattice. More specifically, it is evident that the architectural apparatus is extremely influenced by the landscape that surrounds it and by the residential and functional function to which it must fulfill, as well as by the related issues related to the stability of the structure. If the height of the tower depends exclusively on the coastal altitude in which the turreted structure is located - a low tower corresponds to a high height above sea level, while a high tower corresponds to a low height above sea level - the height of the building does not depend on external sighting factors, but rather on the use of the lighthouse by the guardians. As is known, in fact, in the past these architectures have always been inhabited by the figure of the lighthouse keeper who, together with the family, maintained and supervised the correct functioning of the light source.
Taking up the concept of compositional categorization, it is now established that the masonry structures making up the building and the tower constitute a vast, albeit well-defined compositional typological apparatus of the lighthouses built before the 1970s. From this moment on, in fact, thanks to the new automation technologies[19], the construction plan of the lighthouses undergoes a sharp halt, giving way to the creation of lighthouses on metal trusses, with lower economic expenditure and simpler maintenance, at the expense of compositional aesthetics.
This setback is therefore configured as an opportunity for the definition of a specific and defined time frame through which to propose an architectural categorization that is always valid in the context of studies, analyzes and researches.
The following compositional classification, together with the consequent and subsequent architectural breakdown of an 'unpublished' type, therefore represents the premise through which to carry out a weighted semantic categorization, identifying the macro and micro variables of these architectures, the creative fulcrum of the proposed onto-parametric methodology, described in the third part of the research.

3.2.1 The tower lights

The tower-system of the lighthouse architecture represents the fundamental component through which to guarantee the correct propagation of the light emission. In fact, it supports the lantern, that is the cage in which the optical device responsible for the propagation of the light beam is housed, as well as one of the three semantic macro variables making up the system-lighthouse, better defined in the next chapters. As a support system for the lighting system, the turreted structure represents a component that is always present in the lighthouses, whether they are in masonry or steel, in some cases supported at the base by the building used as a house and/or office of the lighthouse keeper or totally autonomous. The latter type is often configured as a recurring variable in the case of lighthouses built from the 1970s onwards, as a consequence of the abandonment of the regencies by the lighthouse keepers.

Fig. 18. Tower lights.

As for the turreted structures attached to the building, the 'autonomous' tower lighthouse (fig. 19) is generally built in reinforced concrete or stone masonry, very common materials and used for all types and coastal construction categories. The section of the isolated tower is almost always circular with a trochoconical section[20], distinguished on the outside by a white or red and white striped facing, useful for signaling the presence of any dangers and to facilitate sighting[21].
Access to the lantern is in almost all cases via helical stairs - although there are stairs in line as in the case of the Genoa lantern - in masonry or reinforced concrete, in which the number of treads and risers depend on the height of the tower, to be distinguished in low, medium and high tower. Finally, as for all lighthouses, access to the lighting system takes place via internal metal ladders.
If the towers interpenetrated in the body of the building are often used in the case of architectures placed near the city settlements, on the contrary, the lighthouses characterized by autonomous/isolated towers are often located on peninsulas, rocks and islets from which they rise towards variable heights, based on the classification of the turreted structure just proposed: less than 20 meters for low towers; between 20 and 30 meters for the medium towers; over 30 meters for the tall towers (Bartolomei, 2005).
In the Mediterranean area, territories such as Albania, Cyprus, Greece, Malta, Morocco, Tunisia, Turkey and Croatia welcome numerous low-type isolated tower constructions, finding in Italy few and rare examples belonging to this category, among the which we remember the lighthouses of: Strombolicchio (SR), Porto Maurizio (IM); Punta Vagno (GE); Shoals of Meloria (LI); Scoglio d'Africa (LI) and Licosa (SA). The isolated towers of medium height, on the other hand, make up a large part of the lighthouses of all Mediterranean countries, specifically of France, Libya, Spain and Italy, among which we remember the lighthouses of: San Vincenzo (NA); Barletta (BA); Molfetta (BA); Scoglio Porcelli (TP). Finally, the high isolated tower lighthouses represent only a constructive exception as they are more costly and less stable, to be built solely according to the geographical location of the structure, the range of the lighthouse, the sighting point and the earth's curvature. Nonetheless, they are defined as a type particularly used in Croatia, albeit also present in countries such as Egypt, France, Spain and Italy, the latter characterized by considerably towers such as the lighthouses of: Murano (VE); della Vittoria (TS); Lantern of Genoa (GE); Viareggio (LU); Livorno (LI), Capo San Vito (TA); S. Andrea di Gallipoli (LE); Capo S. Maria di Leuca (LE); Torre Canne (BR); San Cataldo (BA); Punta Penna (CH); San Benedetto del Tronto (AP); Ravenna (RA); Punta della Maestra (RO); Piave Vecchia and San Giacomo (LI)[22].

3.2.2. Block with tower light

If in the previous sub-paragraph the cases belonging to the lighthouses composed solely of the isolated tower were eviscerated, in this sub-paragraph we want to analyze the composition and the recurrence in the Mediterranean area of the lighthouses constituted not only by the tower but also by the building, represented by the compositional system 'block lighthouse with tower' (fig. 19), that is a construction type widely used in lighthouses present throughout the Mediterranean area.
The peculiarity of this typology lies in the presence of a service block with one, two or more floors, often interpenetrated by the tower, the latter positioned on the axis of symmetry, at an angle, on the side or totally detached from the building. The size of the building is not conditioned by the height of the tower or by the location of the lighthouse itself as it depends exclusively on the needs of regency and maintenance. Nevertheless, in order to maintain a compositional harmony and proportion, a low tower is very often associated with a one-level building, a medium or high tower, on the other hand, is frequently pla-

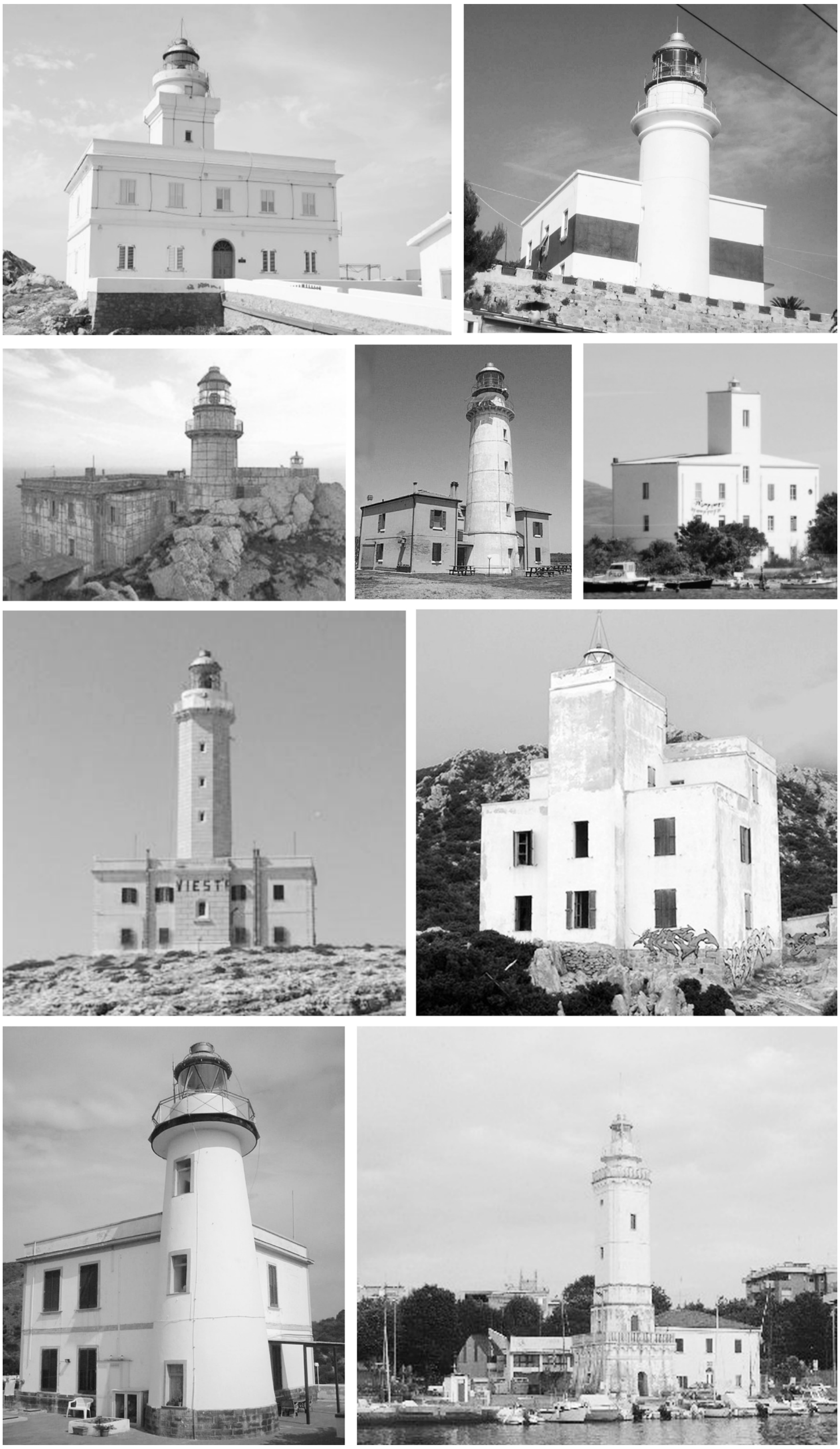


Fig. 19. The block lights with tower.

ced on buildings with two or more levels, albeit the latter. are very rare: among these we remember the historic Italian lighthouse of Porto Corsini (RA). In fact, we recall how the assets of Italian lighthouses are made up of 36% of single-level buildings, 56% of two-level buildings and 8% of three-level buildings[23].
The building materials of the regencies, as for the towers, are strongly influenced by the local availability of the materials themselves, although they are often built in stone masonry or reinforced concrete, painted on the outside mostly white, with white stripes and red, with black and white stripes or totally red. The entrance to the lantern, as mentioned, takes place along the spiral staircase located inside the turreted structure, in this case interpenetrated with the building itself, composed of stone elements, as in the case of isolated turreted structures.
It is precisely the stone elements that characterize the static balance of the structure, made up of steps made up of a single block of stone[24] and embedded in the pillar placed at the center of the vertical distribution system (fig. 20). Still in the static field, it should be specified that for constructive and stability reasons, in the case of interpenetration with the building, the tower is often built projecting with respect to the wall facing of the building or, on the contrary, in a position set back from it.
Although the building represents a structure of fundamental importance for carrying out the maintenance functions of the tower, due to its small size it often fails to impose itself in the landscape as much as the turreted structure, a true coastal landmark. The positioning of the tower with respect to the building therefore represents one of the fundamental aspects for the architectural compositional analysis, defining not only the surrounding landscape but also all the relationships of symmetry and harmony present in the building.
In this sense, the tower located along the symmetry axis of the building corresponds to a very common case study belonging to the Italian and Mediterranean lighthouses, designed to be monolithic, external to the building or incorporated into it[25]. The location of the turreted structure represents a fundamental choice not only at a static level but also, as previously mentioned, according to the correct internal layout of the building, through which, through the positioning of the tower along an axis of symmetry, to guarantee a scheme

Fig. 20. Detail of the staircase in the tower of the San Vito Lo Capo lighthouse.

symmetrical, linear and rational distributive. A little used solution is instead the positioning of the tower along the two axes of symmetry of the building, therefore placed exactly in the center with respect to the architectural body, capable of guaranteeing the creation of two perfectly mirror-like dwellings.
The tower placed laterally, unlike the solution along the axis of symmetry, is certainly a less common setting as it is strongly binding with respect to the distribution of the rooms inside the building. This solution derives from the need to design a building with smaller dimensions, often a consequence of a limited or impervious construction site size. As in the case of the tower arranged along the axis of symmetry, the tower placed on its side can be incorporated into the structure, totally detached / independent or partially connected to it through external stairs. An example of this is the Italian lighthouses of: Marina di Carrara, Capo Miseno and Portofino (Bartolomei & Amoruso, 2006).
Finally, the tower located on its side is the least frequent solution and difficult architectural distribution, albeit necessary for strictly functional reasons. In this sense, in fact, it is in some cases necessary to place the tower laterally with respect to the building due to the orography of the territory or even in the case in which it is necessary to raise the source of the light emission with respect to an already existing tower, thus resorting to a new structure to be placed next to the building[26]. Unlike the lighthouses with a tower arranged along the axis of symmetry and with an angular tower, the side tower is presented exclusively as an independent structure, whose height can in any case be categorized into low, medium or high, in relation to the sighting point to reach. For this type of device we remember the Italian lighthouses of: Capo Rossello; Pantelleria; Sciara Biscari; Marsala; West Pier; Islet Forica; Capo Faro; Punta Omo Morto; Capo Milazzo; Brucoli; Marina di Ragusa[27].
Ultimately, the block lighthouse with tower is configured as a typology characterized by a recurring and performing pattern both from a functional and aesthetic point of view. As for the isolated tower, this 'canonical' compositional typology often hosts, with a few exceptions called 'not replicable'[28] below , common and recurring characteristics that can be traced in almost all the Italian and Mediterranean lighthouses, a key to reading the following methodology: this is the case of the replicable variables of the lighthouse system, that is a new type of decomposition, an argument treated in the course of the following paragraphs.

3.2.3. Lighthouse on fortress or watchtower

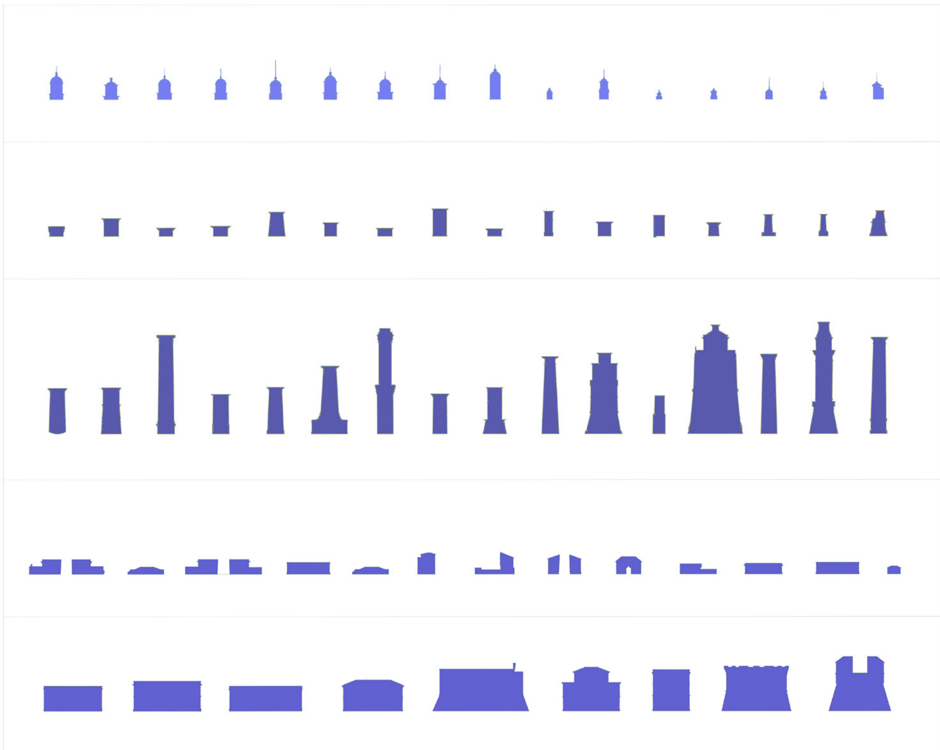
The lighthouses on fortresses or watchtowers are configured as structures with a high cultural value as they are associated with ancient historical structures and often of very high compositional and monumental value. In these constructions, the lighthouses contribute to the continuous maintenance of the building-monument, preserving the original structures and minimizing the modifications necessary for the fulfillment of the new use, as in the case of the lighthouses of: Forte Stella on the Island of Elba; Fort La Rocca; Alfonsino Castle in Brindisi; Punta San Raineri; San Venerio at the Tino Island; Capo Focardo on the island of Elba; Talamone; Castle on the Island of Ischia; Torre del Soffio.
But what is the reason for the intense presence of these towers and why does the decision to use these architectures as a lighthouse represent a functional and coherent decision? As is known, following the fall of Constantinople in 1453, in order to counter the advance of the Ottoman conquest of the West, numerous defensive structures were built along much of the coast of Central and Southern Italy. The ultimate aim is to create a sighting network capable of covering the entire territory from attacks, organizing a timely line of defense. In order to guarantee an effective and extensive network throughout the territory, the Spanish Government therefore has towers built along the entire Adriatic and Tyrrhenian coasts,

useful for the sighting of suspicious ships both day and night[29]. With the passage of time, the sighting structures become devoid of function and utility, with the consequent deterioration of the structures, albeit of high artistic value. Hand in hand with the architectural decline of these architectures, it is in the 9th century AD that, due to technological development, we witness the corresponding decay of the lighthouse and its architectural value: the result is the installation of lanterns on the sighting devices or on fortresses, unintentionally reuniting history with functionality as well as recreating what has always been the coastal sighting and defense network (Stucchi, 1994).
The lantern of the lighthouse is therefore affixed to the ancient watchtower or fortress, that is a full masonry structure of variable thickness from 2 to 4 meters, with a square or truncated pyramidal base of size 10x10 meters for a height of up to 20 meters, with battlements that can reach 2.5 meters. The internal layout is spread over a single environment of one or more levels, closed by a vaulted roof, called 'armament', essential to guaranteeing the issue of signals addressed to the sighting of enemy boats. Access to the tower is via an external vertical system supported by an arch with one or more spans, positioned on the front facing the mountain side (Faglia, 1974; Faglia, 1978). As for the lighthouses, the watchtowers are designed and located according to very precise modules/radii of action: they can be more than 30 kilometers apart in the case of rocky coasts and without inlets while, in the case of indented coast, the interval may reduce up to 10 kilometers[30].
This type of lighthouse does not have all or part of the characteristics that make up simple tower or block with tower lights, thus constituting a 'non-replicable' compositional structure. In this sense, the architectural features such as battlements, decorations, external vertical connections with arches and everything that can be definitive as a single element present only in a given architecture do not allow the study and identification of recurring geometries that can unite two or more lighthouses as extremely personalized, peculiar and characterizing elements. As 'non-replicable', these characteristics cannot therefore be integral parts of the methodology addressed to modeling, although in this research we become aware of these elements, in any case identified and cataloged.
It is precisely with regard to the distinction between 'replicable' and 'non-replicable' elements that the following paragraph is based, through which to clarify and define the methodological assumptions and semantic categories necessary for the correct explanation of the research and of the parametric and ontological methodology.

3.3 Replicable and non-replicable variables

Since their first birth, in a succession of functional and constructive technologies, in the continuous though not constant construction on more or less soaring points belonging to the coastal cities, it is possible to observe the thunderous sparkle generated by the lighthouses. As just mentioned, this type of architecture, dating back to a not very distant period and present along the Mediterranean coasts, contains specific compositional and structural characteristics, a topic previously dealt with through the geometric metamorphosis of the lighthouse - from pure form to composition complex - towards a consequent harmony of the parts associated with compositional categories[31].
During the chapter the topic was therefore introduced with the treatment and analysis of pure geometries, strictly connected to these architectures according to tangible and intangible, real and visionary associations. It was therefore the turn of a first compositional classification of the lighthouse architecture, mainly according to the distributive, functional and landscape characteristics to be fulfilled, a basis through which to trace the recurring macro elements of the lighthouse. With the following paragraph we therefore want to define and categorize in a precise manner all those competing characteristics to the

composition of the 'lighthouse system', through which to proceed with the creation of a process useful for modeling and architectural, functional and historical knowledge of the entire coastal architectural apparatus.
As can be seen from the previous paragraphs and subparagraphs, the lighthouse system welcomes recurring components that alternate and change in the different coastal architectures present in the Mediterranean area, an observation made possible by the reconnaissance of the data and the detailed study of coastal architectures, through which to define and classify the structure according to structural and ornamental variables.
The three 'macro-variables' belonging to the lighthouse system therefore contribute to the definition of the structural breakdown, i.e. the parts holding the main functions of the



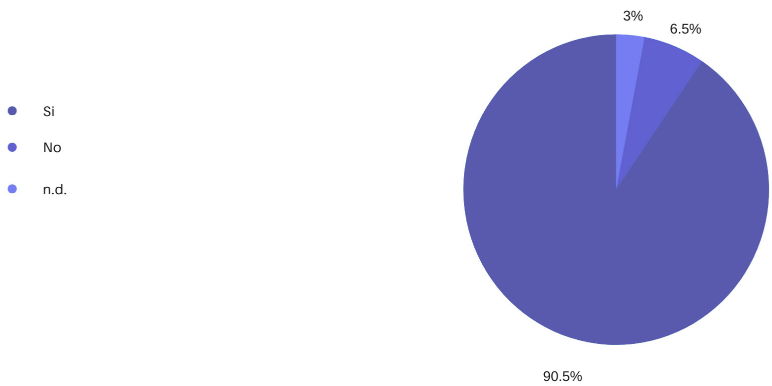


Fig. 21. Division into variables of some Italian lighthouses.
Fig. 22. Percentage of replicability of the variables of Italian lighthouses.

structure itself, present in most coastal constructions, distinguished by: the 'lantern', the 'tower' and the 'building' (fig. 21). To accompany these structural attributes, it is possible to trace further recurring ornamental variables, hereinafter defined as 'micro-variables', to be identified in characteristics such as: the openings, the shelves, the ashlar, the balustrade, etc. The entire compositional-structural apparatus of the lighthouse system, made up of macro-variables and micro-variables, can be further subdivided and defined in two macro-groups: the replicable and non-replicable elements. This is because, although the aforementioned categorization is defined as exhaustive in the case of 90.5% of the lighthouses present in Italy[32], there are still some exceptions that characterize the building and distinguish it in an absolute way from the others, thus defining a 'non-replicable' apparatus (fig. 22).
In the context of macro-variables, if the lantern is always configured as a replicable model as it is founded on a structure that has remained unchanged over time and in its aesthetic composition, as well as a purely functional element, the tower and the building are not present in all coastal architectures, as they do not always appear to be associated with replicable elements, as in the case of lighthouses built on watchtowers or fortresses. The tower, therefore, while not configuring itself as the element that can always be replicated and present in every lighthouse, can be defined according to characteristics common to all turreted systems, which can be summarized in four main sections: octagon, circle, square and mixed. The 'building' element, understood as the only housing structure of the lighthouse keeper and/or office of the same, on the other hand, unlike the tower and the lantern, in addition to being an element that is not always present, looks like a geometry, albeit in its simplicity not always categorized by shape, although in most cases it can be traced back to a parallelepiped. In the following subparagraphs the three main macro-variables of the lighthouse are therefore extensively explained - whose importance, characteristics and constitutive typologies are analyzed - and the related micro-variables, for a complete semantic treatment of the lighthouse system, towards the establishment of a replicable methodology.

3.3.1 Macro-variables: the lantern

The lantern represents the most important macro-variable of the lighthouse system as it is the seat of the optical device capable of emitting the light beam that illuminates the sea and indicates the way to sailors. The accompanying structures, namely the tower and the building, are configured as parts totally designed and structured according to the lantern itself, through which the luminous structure can be raised, making maintenance possible.
Constituting one of the three macro-variables of the lighthouse system, the lantern is always present in these structures and always replicable, as it is characterized by totally catalogable and classifiable elements, which can be summarized in certain characteristics belonging to the micro-variables of the element itself.
At the compositional level, the lantern looks like a transparent shell with a polygonal section - in most cases almost circular as a consequence of the number of polygons that form the shell, inside which the optic resides (fig. 23) - a conditioned characteristic from two main factors: from the specificity/technology of the optics it contains and from the construction period of the lighthouse itself[33] (Amoruso & Bartolomei, 2010).
The entrance to the lantern takes place along the internal stairs of the turreted structure, accessible from the inside or outside of the regency building, passing through the clock room, so called because it houses the light emission control equipment. Finally, the optic can be reached by taking a last very small metal ladder, from which to admire

the optic supported and raised about two meters by a cast iron structure. With regard to the structure, the optic is placed inside a limited space which, based on the size of the lighthouse and the tower, is around 3-6 meters in diameter, composed of uprights and metal rings of thin copper with vertical and diagonal or crossing. The composition of the uprights represents a fundamental choice especially from a functional point of view as the crossing uprights are able to hide a smaller amount of light. The environment is finally closed by a hemispherical or conical steel cover, coated in copper and zinc, almost always accompanied at the top by an additional perforated sphere[34] useful for the ventilation of the environment, necessary to avoid the formation of condensation, or a phenomenon that could affect the correct propagation of light. On top of it we find, in most cases, a ring and a lightning rod pinnacle in bronze with a platinum tip, useful as a lightning rod.
From a spatial and material point of view, the lantern appears to be accompanied by a gallery projecting about 1 meter from the glazed structure of the lantern - a fundamental element not only for maintenance but also for cleaning the external windows - surrounded by a 1 meter high parapet. and a half in masonry, with vertical, horizontal or X metal currents.

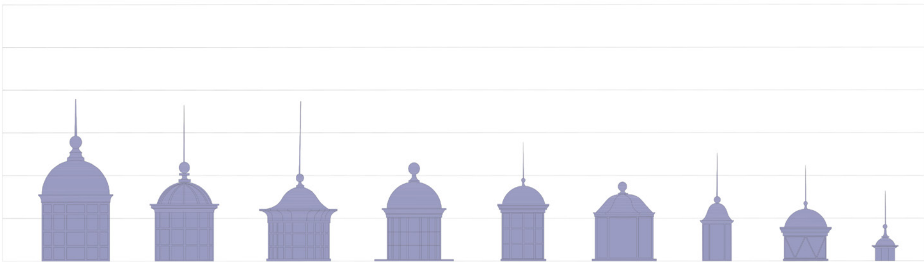
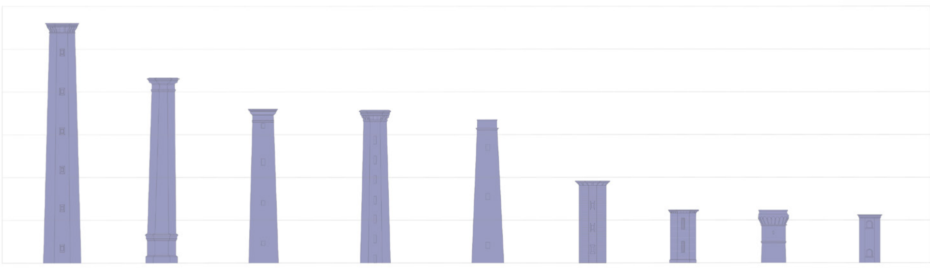


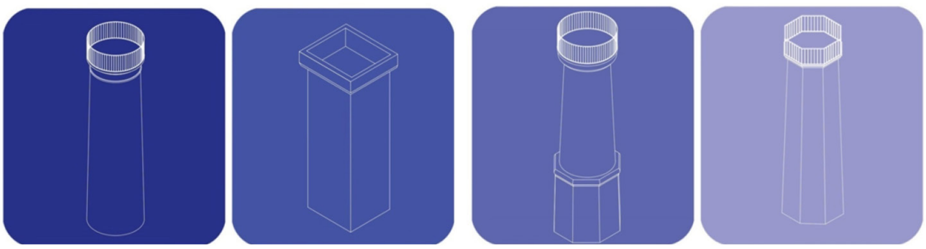
Fig. 23. Some lanterns belonging to Italian lighthouses.

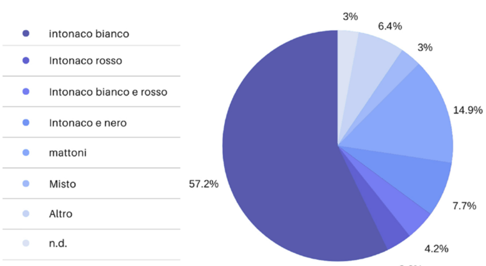
3.3.2 Macro-variables: the tower

The tower represents the soaring element of the architecture, support of the light source and therefore a necessary and fundamental presence for almost every lighthouse, with the exception of the towers placed on fortresses and watch towers. It is configured not only as a support for the lantern but, moreover, as a daytime reference point, often painted with colored bands or a bright but not blinding white plaster[35]. In addition to color, it is the shape and height that characterize the specificity of the light towers located in a specific territory, in close connection with the geographical scope, understood as the relationship between the height of the light emission and the point of view of the observer[36].
The sectional and elevated shape of the tower, like the entire structure of the lighthouse, is characterized by elementary geometries tapered at the top, able to withstand the horizontal forces of the wind, thanks to their linear conformation and without points of discontinuity. In this sense, the plan section does not seem to be linked to the passage of ages and time, as the only guideline to follow is the ability to distinguish a specific lighthouse from neighboring coastal structures, as well as ensuring adequate static resistance, an area in which pure geometries are configured as the most performing.
As partially treated in the course of the introduction to the variables, the turreted geometry can be traced back to very precise compositional schemes, present in all the lighthouses of the Mediterranean, which can be summarized in: octagonal/hexagonal plan, circular plan, square plan and system plan mixed (figs. 24, 25). These compositional schematizations are

the result of the study, cataloging and categorization of the characteristics of each single 'macro-variable', through which to reach a few categories to be associated with almost all the 'replicable' coastal architectural systems. In this case, as shown by the graphs (figs. 26, 27), by virtue of the characteristics identified for the macro-variable 'tower', the data collected in the context of the Italian lighthouses demonstrate how the circular section towers are configured as the most used structures, followed by the hexagonal/octagonal and square section, painted mostly by white plaster. This recurrence is mostly associated with static reasons due to a simpler tapering, although, as already discussed above, the recognizability and architectural harmony are configured as fundamental points for the construction of these architectures.
Once the characteristic typologies connected to the macro-variable 'tower' have been identified, various ' micro-variables ' are therefore associated and incorporated to it, dealt with in a timely manner in the following sub-paragraphs, among which we recall: the openings, the shelves and the moldings. In this sense, the windows are configured as openings of reduced size, mostly rectangular or circular in shape, composed only of the aluminum structure or a frame flush with the wall face. The crowning of the turreted structure, a portion connecting and supporting the lantern, is instead characterized by more or less complex moldings, sometimes accompanied by support brackets, which characterize the tower and define its limits (fig. 28).







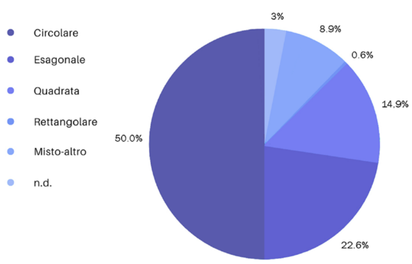


Fig. 24. Some towers belonging to Italian lighthouses.
Fig. 25. Representation of the average calculated with respect to the four main types of tower of Italian lighthouses.
Fig. 26. Recurrence percentages of Italian lighthouse coatings.
Fig. 27. Recurrence percentages of the typologies of Italian lighthouses.

Fig. 28. Axonometry of some towers belonging to the Italian lighthouses.

3.3.3 Macro-variables: the building

The building represents the last of the three macro-variables of the lighthouse system as well as of the methodology proposed here. Although not present in all the Italian and Mediterranean lighthouses, the building, where present, is configured as the regency of the lighthouse and the lighthouse accommodation, a fundamental figure in a past in which the optical mechanisms are configured as not always performing, susceptible to continuous checks and maintenance. With the advent of new technologies and remote control, a topic later dealt with in the fifth chapter, communication systems become increasingly functional and independent from human interactions, triggering the inexorable abandonment of buildings. If the macro-variable 'building' turns out to be a source of neglect and degradation in existing lighthouses, new buildings often do not present this element, leaving only the tower and the lantern way, in order to guarantee an effective propagation of the beam light emission.
Considering, therefore, the constructions prior to 1950, in which the macro-variable 'building' is often present, we want to extrapolate common and reproducible geometries and characteristics, to be used in the context of parametric modeling and ontological classification. In this sense, unlike the classification carried out for the macro-variables 'lantern' and 'tower', for the macro-variable 'building' it is not possible to identify a recurring geometric pattern. In fact, although it provides a compositional geometry for most cases pure and simple, very often assimilable in plan to the rectangular shape, it cannot contemplate a geometric differentiation that does not include right angles, such as circular or irregular-shaped buildings, possibly configuring as a 'non-replicable' building, as it is difficult to parameterize without the presence of a relief.
During the categorization and classification, therefore, only the lighthouses attributable in plan to the rectangular / square geometry are considered, founding and splitting the cognitive apparatus of the element into: one-level, two-level and three-level buildings (fig. 29). These, as in the case of the macro-variable 'tower', appear to be associated with various 'micro-variables', dealt with in detail in the following sub-paragraphs, among which we recall: the openings, the ashlar and the moldings.

Fig. 29. Some buildings belonging to Italian lighthouses.

3.3.4 Microvariables : moldings, ashlar, openings and ornaments

Having defined those that are configured as the macro-variables of the lighthouse system, it is possible at this point to outline what are the 'minor' characteristics of the building, equally traceable and classifiable in a recurrent manner in the Mediterranean and Italian areas, hereinafter referred to as 'micro-variables', consisting of: moldings, ashlar and openings.

The compositional rules of the micro-variable 'molding', variable present both in the macro-variable 'building' and in the macro-variable 'tower', can be traced back to the classic construction rules, confirming the will of the Navy and the King of promoting their prestige and power through the creation of buildings that, despite their simplicity, could accommodate the dogmas of beauty of the classical order and proportionality. Moreover, as claimed by Vignola: "How admirable are the productions of the beautiful ancient Greek and Roman architecture for the elegance, variety and simplicity of the moldings!" (Barozzi & Gianni, 1914, p. 3).
For their classification and categorization in the area of lighthouses, we therefore refer to the classic order belonging to smooth moldings, divided into: flat, round and mixed. Of the flat profiles we remember: the strip, the continuous tooth and the band. The round profiles are characterized by: the rod, with a convex semicircle profile; the bull, with the same profile as the rod but larger in size; Scotland, with a semicircular profile; the smooth ovolo, with a convex arc-shaped profile; the cable, with a concave quarter-circle profile. Finally, the mixed profiles, among which we can distinguish: the straight throat, with an oblique S profile and concave curve in the protruding part; the inverted groove, with an oblique S profile and a convex curve in the protruding part; the owl's beak, with a convex profile and made up of circular arcs of different radius (Ginouvès & Martin, 1985).
Another micro-variable, belonging only to the building system, is instead the ashlar, or a covering placed at an angle or over the entire surface of the elevation, characterized by bosses[37], in this case relating to two specific types: rustic, if the bosses are just roughly hewn, and flat, with more roughly hewn stones to obtain an almost smooth surface (Carpo, 1993). As in the case of the moldings, and as confirmed by Antoine Chrystome Quatremère de Quincy in his Historical Dictionary of Architecture, ashlar is configured as a coating capable of giving prestige and value to the building[38], giving coastal architecture a high representative value, clearly visible to all.
Finally, the openings constitute the last micro-variable of the lighthouse system, an almost totally replicable category, categorized geometrically and formally in: rectangular/square openings, single or double-leaf, with or without vaults or circular, accompanied by wire and shutters, elements present in different percentages in all Italian and Mediterranean lighthouses.
The entire apparatus of 'micro-variables', as in the case of 'macro-variables', can therefore be divided into 'replicable' and 'non-replicable', depending on the particular occurrence of the element itself with respect to the different lighthouses. In this sense, in fact, although the micro-variables turn out to be almost always replicable, there are however totally unique characteristics, consisting of the ornaments, or all those extremely peculiar characteristics of the structure - such as sculptures, vaulted structures, capitals, etc. - defined as elements in any case 'not replicable', ie elements that do not allow the identification

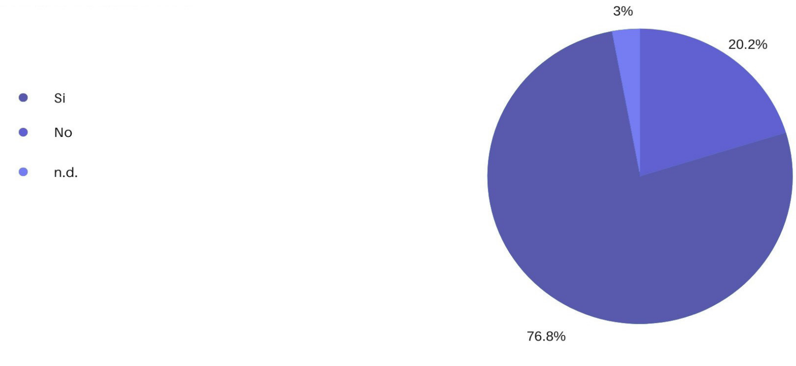


Fig. 30. Percentages relating to the presence of micro-variables in Italian lighthouses.

of recurring characteristics that can unite two or more lighthouses. Finally, it should be emphasized that in the presence of replicable micro-variables associated with non-replicable macro-variables, it is in any case impossible to proceed with the application of the data modeling and reconnection methodology as they cannot be cataloged according to common categories.

Although the identification of the non-replicable micro and macro-variables may initially be a weak point of the proposed methodology, it is nevertheless configured as a strong point of the methodology itself. It is in fact essential to analyze the exceptions in the architectural composition of the lighthouse in order to quantify the effective non replicability of the methodology created, through which to validate and quantify its relative feasibility. In this sense, as shown by the graph in the figure (fig. 30), the presence of replicable micro-variables in coastal buildings is around 76.8%, followed by a percentage of 20.2% belonging to buildings that they have replicable macro-variables but at least one non-replicable micro-variable . The most significant figure, however, is constituted by the percentage equal to 3% for Italian lighthouses that do not have any type of replicable characteristics, confirming the correct semantic classification / hierarchization and the effective reproducibility of the methodology[39].

Notes

1. The Mediterranean context, although apparently far from purely geometric considerations, is narrated and told precisely through the study of geometry by Jacques Guillerme: «[...] the world, in every moment, resides in the universe of its figures; the world of representations is the world itself». The Mediterranean apparatus is therefore closely linked to the architectural concept of the lighthouse and to Euclidean geometry (Guillerme , 1981).

2. It should be emphasized that the semanticization by parts must not be understood as an alienation of the elements aimed at the creation of self-sufficient objects, but rather as a detailed study of the same, aimed at the knowledge of the relationships and recurring characteristics.

3. "The line is a line, thought is a line, action is a line. Everything is line. The line connects two points. The point is an instant, the line begins and ends in two instants" (Brusantin, 1993).

4. In this sense, in fact, Kandinsky argues that "the point brings to itself only a tension and cannot have any direction, the line necessarily participates both in the tension and in the direction" (Kandinsky, 2021, p. 59).

5. The straight lines just mentioned are in turn defined and classified according to well-defined temperatures: the representation of the horizontal line subtends a cold representation. On the contrary, the warmth is reflected in the depiction of the vertical line. It is therefore the diagonal line that assimilates the perfect synthesis between hot and cold (Kandinsky, 2021, pp. 59-61).

6. It should be remembered, in fact, that the Egyptians and Babylonians were already able to use non-rudimentary geometric concepts, as demonstrated by a clay tablet of the Paleo-Babylonian period 1800-1600 BC in which a square with side 30 and its diagonals. It is only with the Greeks, however, that it is possible to find a principle of knowledge, albeit not yet well defined, of the axioms or postulates (Andreatta, 2019).

7. "A mathematician sees the expression a2 + b2 and immediately thinks of the Pythagorean theorem, with its image of a right triangle surrounded by squares built on three sides. However, this expression does not appear only in geometry; it occurs in almost all areas of mathematics, from number theory and algebra to calculus and analysis; it becomes a pattern, a paradigm. Similarly, when an artist looks at the decoration of a wallpaper, the regular occurrence of a basic motif that seems to repeat itself over and over remains etched in his mind. The search for regularity is really the common thread that links mathematics to art" (Maor & Jost , 2020).

8. In this sense, lighthouses represent one of the non-places par excellence. As for the other spaces defined by Foucalt as "non-places", inside the lighthouse the fascinating lives of the lighthouses who lived there follow one another, in an epic of emotions spent in the darkness of the night facing the sea. As stated by Foucalt: "There are therefore countries without a place and histories without chronology; cities, planets, continents, universes, of which it would certainly be impossible to find traces in some geographical map or in some sky, simply because they do not belong to any space. Probably these cities, these continents, these planets were born, as they say, in the heads of men or, to tell the truth, in the depth of their stories or even in the place without a place of their dreams. However, I believe that there are utopias that have a precise and real place" (Foucault, 1998, p. 13).

9. As described in the first chapter of the third book of De Architectura of Vitruvius: "Thus, the center of the body is naturally the navel; in fact, if a man were placed on his back with his hands and feet open and if the center of the compass were placed in the navel, one would have tangentially touched the fingers and toes. But it is not enough, in addition to the scheme of the circle, the figure of the square will also be found in the body. In fact, if you measure from the plane of the feet to the vertex of the head, and then carry this measurement to the outstretched hands, you will find a length equal to the height, as happens in the square pulled as a square" (Vitruvio Pollone Marco, 1836) .

10. Morphology, in fact, derives from the Greek, *morphé*, meaning 'form', and logos , meaning 'speech'.

11. As claimed by the Gestalt: "Knowledge cannot be broken down into simple elements. The whole is more than the sum of the single parts", that is, the totality of the perceived is defined not by the sum of the single parts but more by the sensory activations that arouse the single parts side by side, in a complex totality (Zerbetto , 1998).

12. With the representation of the circle, the triangle and the square, in fact, it refers to the elements of the universe, in an infinity that has no form. The human conception defines a dichotomous view of existence, dividing what has a form and what does not (Ori, 1979).

13. The Pythagoreans made tetraktys and also the square of four, that is sixteen, the basis of their doctrine, that is a form that has always been a manifestation of universal perfection, derived from the quaternary division of the circle by means of the formula 1 + 2 + 3 + 4 = 10 and its inverse 10 = 1 + 2 + 3 + 4. It therefore represents the hermetic problem of squaring the circle conceivable as the highest human perfection.

14. Examples are Babylon, the Parthenon, the arch of Septimius Severus, the Palazzo Farnese, the spans of Brunelleschi's Portico degli Innocenti, etc.

15. The turreted structure of the lighthouses, regardless of their section in plan, requires an adequate analysis for what are defined as the oscillations of the structure mainly due to the action of the wind. In this sense, it is recalled that since the beginning of the twentieth century oscillographs - called 'Richard' - were adopted in the highest towers and then perfected to guarantee an exhaustive stress calculation (Santini, 2006).

16. The particularly soaring lighthouses designed after the unification of Italy, in fact, as demonstrated by the Album dei fari , are almost always characterized by circular and octagonal towers, unlike a few exceptions with a low height such as the lighthouses of: Tavolara; Po di Goro; Ponza; Capo Spartivento; Ancona (Ministry of Public Works, 1873).

17. It should be emphasized that the lighthouse building is configured as an architectural element that still exists today albeit often in a state of neglect, with the exception of the buildings still used as homes by the lighthouse keepers.

18. The term monad is used by various philosophers to designate indivisible centers of force, but, as a rule, these units do not have the power of representation or perception, which is the hallmark of the Leibniz monad . Renouvier is an exception who, in his "Nouvelle monadologie", argues that the monad has not only internal activity but also the power of perception (Leibniz , 2001).

19. As discussed in part during the second chapter and subsequently in the next chapter concerning the type of light emission today, it is from the 1900s that there has been a continuous and incessant innovation regarding the power of the light emission (Boscolo, 2014).

20. The truncated cone section, in fact, allows greater stability to the turreted structure, allowing it to resist the forces caused by the wind (Santini, 2006).

21. The red color in boating, in fact, has always communicated a dangerous situation to sailors. This is the case of the flags provided for by the International Code of Maritime Signals in which the flags painted in whole or in part in red - such as Bravo; Echo ; Oscar; Tango; Uniform - signal situations for which attention must be paid. It is also the case of the red and black banded beacons, defined by the international danger signaling system (IALA), with which we intend to warn sailors about an imminent punctual danger such as, for example, an outcropping wreck. or a rock. Finally, the red color is configured as the chromatic characteristic of the light emission of some headlights and lamps, through which to signal any shoals or outcropping rocks. To learn more: http://www.iala-aism.org/iala/index.php

22. To learn more about the height of all the towers in the Mediterranean, reference is made to the Atlas of the Mediterranean lighthouses which can be consulted in the appendix.

23. Data extrapolated from the survey of all data relating to Italian lighthouses, available in the appendix.

24. In the case of imposing structures, the central vertical distribution pillar is made up of a hollow cylinder, that is a sort of central shaft to the stair body.

25. In the Italian context, the following lighthouses represent: Capo Colonna; Chief of the Weapon; Chief of Arms; Capo Mele; Capo S. Elia; Capo Cefalù; Capo Circeo; Capo D'Anzio; Capo d'Orso; Capo Palinuro; Capo San Marco Cabras; Capo Sandalo; Capo Spartivento; Ischia Castle; Cozzo Spadaro; Fenaio; Po di Goro; Pianosa Island; Capel Rosso; Capo Bellavista; Cesenatico; Fano; Giannutri; Lividonia; Punta Lingua; Scario; Pianosa; Porto Garibaldi; Punta Alice; Punta Beppe Tuccio; Punta Carena; Punta dei Porci; Punta Libeccio; Punta Polveraia; Punta Secca; Punta Spadillo; Punta Tagliamento; San Cataldo; San Domino; San Vito Lo Capo; Santa Croce; Santa Maria di Leuca; Scoglio Palumbo; Torre Cane; Vieste. In this sense, the cases of Capo d'Anzio, Capo Sandalo and Cozzo Spadaro are emblematic, with the tower placed on the second double axis of symmetry, a feature not dependent on the structural shape of the tower.

26. This is the case of the Capo Suvero lighthouse (CZ), from which a new tower rises 25 meters high, on the 12 meters already existing.

27. To deepen the entire cognitive apparatus of architectural-geometric-historical cognitive apparatus, see the sixth chapter of this thesis, together with the list in the appendix.

28. In this sense we recall the peculiar towers of the Vittoria lighthouse, of Cozzo Spadaro, of the Lantern of Genoa, etc.

29. The sighting of enemy ships occurs during the day through the creation of columns of smoke and, in the evening, through the lighting of torches.

30. It should be emphasized, however, that there are turreted structures or fortresses that do not belong to past eras but, on the contrary, are extremely recent. This is the case of the buildings of San Andrea Missipezza , Punta Fortino, Scoglietto on the island of Elba, Sapri , Torre Preposti and San Giovanni a Ugento , or buildings inspired by the military architectural spirit of sighting although built respectively in 1932, 1923, 1910, 1915, 1937 and 1932.

31. To deepen the subject, refer to paragraph 3.1, concerning the geometry of the lighthouses, and to paragraph 3.2, concerning the typological classification of the headlights.

32. It should be emphasized that for the data inherent to geometry we refer to the case studies of Italian and no longer Mediterranean lighthouses, as they constitute too large an audience of analysis and study, although the study methodology and workflow can be implemented by genesis to the conclusion, for all the case studies present in this area.

33. It is, in fact, since the discovery of the Fresnel lens , which took place in 1850, that we witness the mutation of the envelope too small for its containment, changing its shape from prismatic to cylindrical.

34. In some cases, in fact, it is possible to find a cylindrical conical in its place.

35. According to the studies carried out by the author as part of the research, the use of white plaster appears to be present in more than 50% of Italian lighthouses, followed by the pattern of black and white and red and white stripes.

36. To learn more about the luminous and visual characteristics of the lighthouse, see chapter 5 "Light and eclipse".

37. The term 'boss' derives from the Old French 'buigne', a term indicating something that protrudes from a plane.

38. "The ashlar is a means of clarifying, and increasingly highlighting the merit of the construction, due to the importance and difficulty of transport, the placement of materials, and the related work" (Leoni, 2018).

39. The data cited represent the result of the detailed analysis carried out by the author in the context of Italian lighthouses. To learn more, refer to the database dedicated to Italian lighthouses placed in the appendix.

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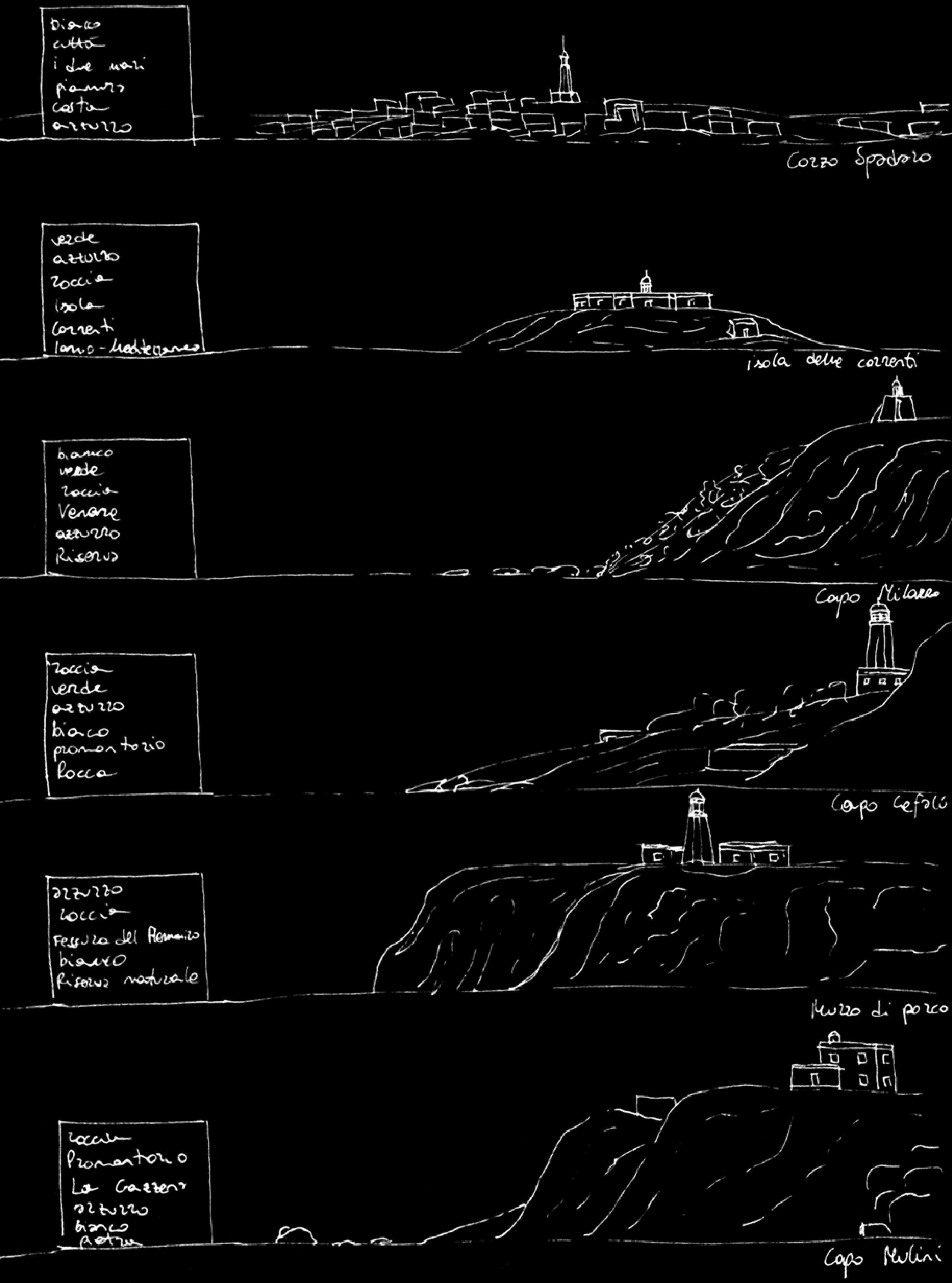
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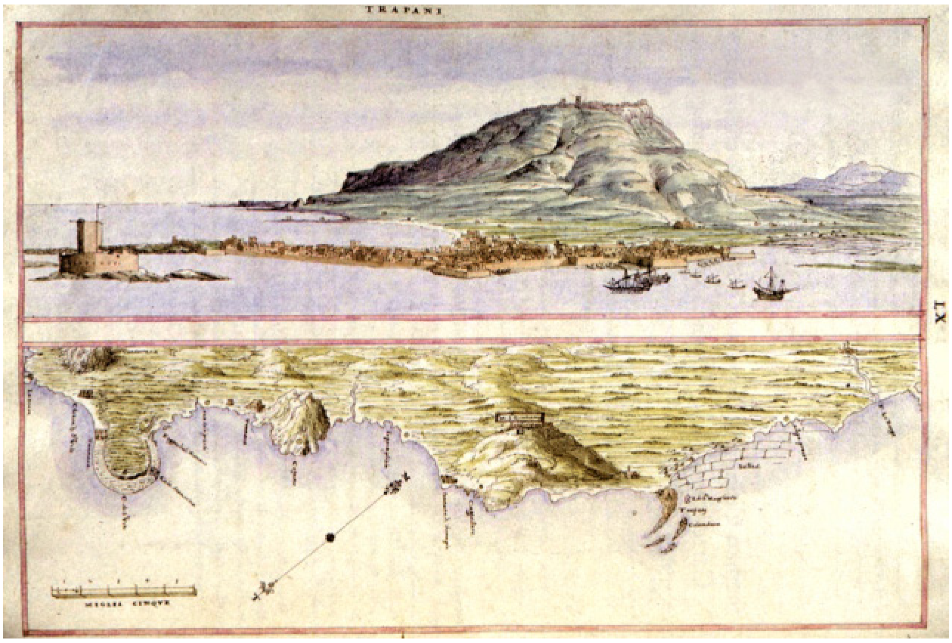
bianco
promontorio
Rocca
Capo Cefalù
azzurro
roccia
Fessura del Promontorio
bianco
Riserva naturale
Muzzo di porco
roccia
Promontorio
La Gazzena
azzurro
bianco
pietra
Capo Mulini

Chapter 4

Color and landscape

"Descrivere, rappresentare, raccontare un paesaggio, un organismo architettonico complesso, conduce a esprimersi accettando di vederlo sia attraverso quel piano di sensazioni poetiche e di messaggi provenienti dal patrimonio collettivo, sia esploradone proprietà naturali e artificiali che rendono il luogo, nel nostro caso la costa, sistema di terra, mare, sole, organismo architettonico, lavoro, nell'equilibrio delle sue parti" [De Simone, 1986].

If the previous chapter, dedicated to the geometry and shape of the lighthouse, sees a discussion deeply rooted in the endogenous constitutive characteristics of the lighthouse itself, in the fourth chapter we want to highlight and eviscerate all those exogenous and immaterial materials, formal and structural peculiarities, which envelop and characterize the coastal architecture of the lighthouse.
Here the exogenous characteristics are schematized through the treatment of three specific elements - the coast, the light beam and the landscape - necessary treatment in order to guarantee an all-round analysis of the lighthouses, which are extremely dependent on the landscape, colors, shapes and textures.



On the cover. The coastal landscape: pantoni. Fig. 1. Spannocchi, T., XVI century, view of the port of Trapani.

Introduction

Having concluded the discussion of the geometries belonging to the lighthouse, directly connected to the compositional structure of the lighthouse itself, it is at this point necessary to propose a brief transversal dissertation to the parametric and ontological methodology, analyzing what surrounds the coastal architecture, as it is strictly influenced by the landscapes, an essential argument for the correct examination of this type of architecture. In order to analyze these relationships, reference is therefore made to what are configured as the classical rules and dogmas addressed to analysis, valid both for the study of architecture and for the territory. In this sense, if on the one hand the lighthouse is configured as an architecture capable of accommodating the infinite potential of the line as an analysis - composed of the set of rules that generate the flat geometries - on the other, also the two-dimensional coastline, real or represented by nautical charts, deserves an in-depth analysis, through which to identify the meanings and connections between the land line and the coastal architectures. The geometric study of the lighthouses is therefore intended to be accompanied by the study relating to the relationships between the lighthouse and the territory, of which it constitutes a dense network and through which to ideally mend the territory, through the comparison of different cultures, knowledge and traditions.
To accompany this vision 'in plan', all those horizontal lines and colors that define the perspective surroundings of these architectures contribute: the horizon, the landscape and the color. The term 'horizon' refers to relationships, connections, limits, geography, astrology, mathematics, geology and theater, areas in which the proportion of things and the delimitation/definition of the horizon veer towards infinity meanings. In this sense, the horizon and the landscape appear to be fundamental and characterizing aspects in the context of the design of coastal architecture (Jacob, 2005) as an integral part of the creation of a landscape and a horizon seen from the other side of the urban space or from the point of view of sailors, by the 'citizens of the sea' (fig. 2).
The lighthouses therefore outline the horizon and the landscape seen by sailors, defining the proportions of the gaze and of the territory of which they constitute a precise landmark, that is, identifying points of the coastal horizon, of which it is possible to trace figurative images, architectural relationships and literary connections, that is 'delimitations-horizons' of thought.
If in elevation the lighthouse and the coast are configured as real and frontal visions, on nautical charts they are transformed into virtual visions: we pass from the three-dimensional geometric view to the flat linear one. In the same way, if the simplicity of the lighthouse system provides us with a totally understandable analytical and conceptual reinterpretation, the sinuous and zigzagging line of the coast detaches itself from the classical rules in favor of a clear complexity or, better still, chaoticity , understandable only by moving away from the laws of geometry and its meanings (Nucifora, 2007).
In a zenith view, it is through the light beam of the lighthouses, i.e. straight lines that intersect each other, generating geometric, semantic and cultural connections, that it is possible to ideally establish a reconnection of places and gaze, shortening distances and defining the so-called 'network territory': a dense luminous mesh, an intertwining of constantly evolving contaminations. It is through this dense network made up of lines that it is possible to analyze, transfer and systematize the values rooted in one's own territory: material and intangible values placed at the basis of economic and social development.
Therefore we want to explain all those characteristics that surround the lighthouse and characterize it in a permanent and unchanging way according to perspective or zenith views: these are precisely the 'invariable' of the lighthouse - consisting of the beam of light, the coastline and of the landscape - that is, characteristics independent of the co-

astal architecture but extremely identifying in the relationship between the architecture itself and its surroundings. In this context, the lighthouses, in turn, distinguish the surrounding landscape with colors and patterns, in perfect harmony between architecture, color and landscape.
The color, together with the texture and the patterns, is therefore configured as the last feature of this journey along the geometric and perceptive architectural paths of the lighthouse, i.e. essential features from a functional, aesthetic and landscape point of view, as fundamental for recognition of the lighthouse by sailors as an identity point in the perceptive landscape context.

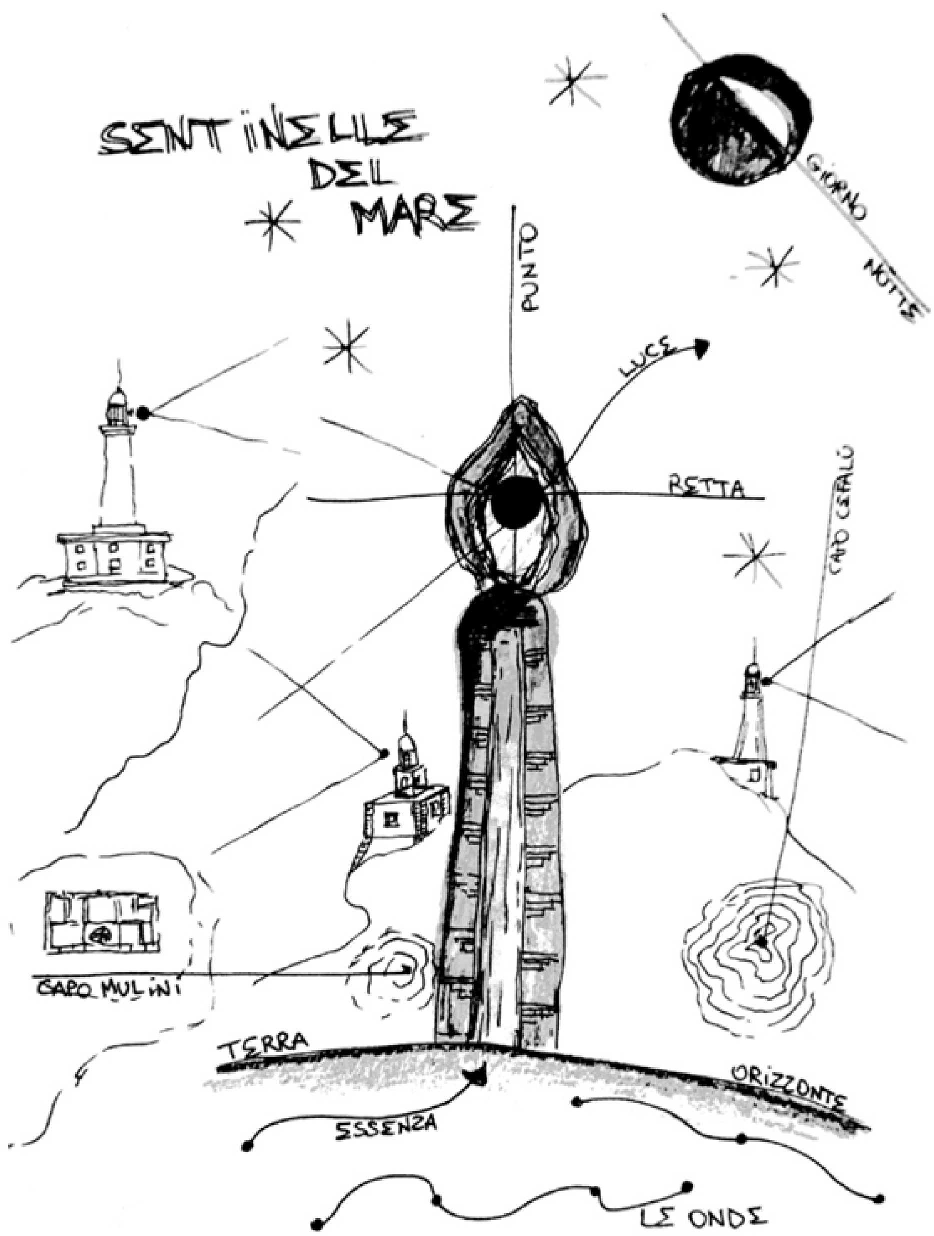


Fig. 2. The lighthouse: abstraction and sentinel.

4.1 The invariables

It is part of our daily experience: distinguishing and cataloging objects according to their function and/or formal composition, systematically defining and dividing the elements from the essential to the accessory part. These actions are configured as the basis through which to catalog a compositional system - lines, shapes, geometries - defined by the 'internal image' that everyone has of it, a mobile source of knowledge that is always active, capable of perceptually revising the characteristic features of the countless similar objects in the world in order to implement a 'semantic indeterminacy', i.e. the recognition and classification of the object through innumerable meanings, whether they are changeable or even contradictory (Garroni, 2015).
The line, on a perceptual and constructive level, allows us to rearrange all the elements that reveal themselves to our sight, known or unknown, through schemes, axes of symmetry and modules: it is through this way of 'observing' that from a first fragmentation of the element we are moving towards the unification of the real. The set of lines generates simple and complex figures, shapes, barriers and geometries, through which to create and analyze architectures of all types and of all periods. Therefore, it is always the lines, curves or straight lines that are, in their various combinations and configurations, that define and circumscribe the totality of the objects present in the world, towards an infinite variety of forms, forcing us to a necessary cataloging and semantization of the elements (Hogarth, 2001).
If already, during the third chapter "Geometry and shape", the line has been configured as the means through which to carry out categorization and semantization actions of the coastal architectural elements, also in this paragraph the line finds great use on a more large scale, capable of intercepting all those elements that make up the coastal territorial area, in which the line changes its meaning and direction, linking knowledge, traditions and cultures of the places. If on the one hand, therefore, the architecture of the lighthouse is made up of a defined geometric architectural apparatus, on the other hand, it is the architecture itself that is the fulcrum of wide-ranging territorial connections, intangible bonds that can be assimilated to the lines of the eye.
The landscape, the coastline and the beam of light - elements common to all coastal architectures and with a language that is always consistent with itself - are configured as invariable elements that condition the relationship between man and coastal architecture, capable of change meanings and perceptions.
The decision to produce a treatment linked to these characteristics is the result of a profound analysis of the artefact, in its material and immaterial essence. In this sense, if on the one hand the geometric examination of the lighthouse turns out to be a necessary starting point for the creation of a methodology that can be replicated in a parametric and ontological environment, on the other hand, in order to carry out a cataloging and a complete treatment of the characteristics of the architecture, we cannot neglect all those elements that define architecture in its context, equally catalogable and analysable, albeit 'invariable'. As 'invariable', the treatment of the following characteristics takes place according to different aspects compared to those put in place in the field of cataloging and analysis of architectural geometry, 'limiting' itself to the simple intangible exposition of the relationship between these attributes - three-dimensional and two-dimensional, perspective and zenith - and the lighthouse itself.

4.1.1 The inland line

If on the one hand the line as an analysis applied to coastal architecture is configured as essential to establish and design a compositional harmony, on the other hand, it is in the territorial context that the line is expressed as a connection with multiple and different

meanings, through the which to establish relationships from the double reading: on the vertical plane the analysis of the lighthouse, on the horizontal one the study of the land system and the border line. In this sense, in fact, the analysis of amphibious architectures cannot be reduced to the mere study of the building and its geometries as an end in itself as it has always been connected to the surrounding territory, constituting a fundamental reference point for maps and nautical charts.
The imposition of two different interpretations - vertical and horizontal - places us in front of two types of analysis which, in addition to converging towards two different points of view, require two dissimilar treatments. In this sense, if the vertical reading is based not only on lines, but also on geometric shapes and Euclidean objects, that is linear and clear concepts, previously already treated in the third chapter, the horizontal analysis, on the other hand, refers to the chaos theory and fractal geometry - past participle of frangere or 'to break' - that is non-linear science as it is not Euclidean (Nucifora, 2007).
In the horizontal configuration, the light beams generated by the lighthouses create a dense network along the entire coastline, for which the Von Koch curve defines as a performing tool, through which to analyze and rectify the land line on the horizontal plane[1]. It is defined by Bruno Giorgini as "[...] the intertwining of life, universe and geometry" (Giorgini, 1999) and, as Cesarò states "[...] it would not be possible to annihilate it without suppressing it at the first stroke, because otherwise it would be incessantly reborn from the depths of its triangles, like the life of the universe [...]"(Cesarò, 1964). The Von

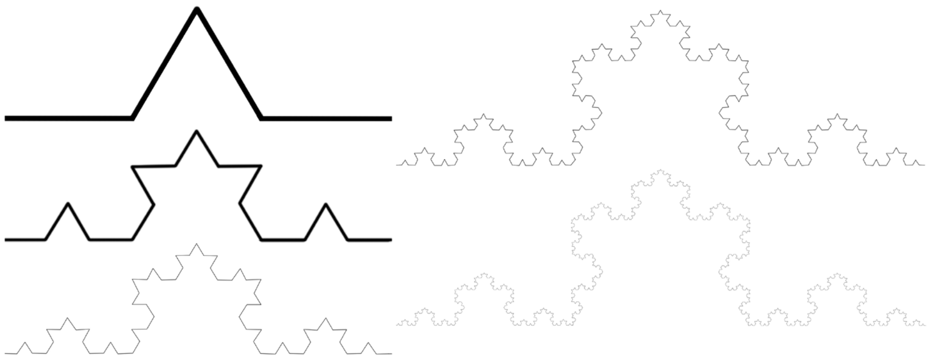


Fig. 3. Construction of the Koch curve.
Fig. 4. Construction of the Koch curve: successive interactions.
Fig. 5. Approximation of the coast of Great Britain with polygonals.

Koch curve is therefore configured as a curve parameterized by a continuous function on the interval [0,1], generating a continuous curve of infinite length, self -similar and non-derivable, i.e. without limit as it is increasingly amplified by a quantity equal to 4/3 of its previous length (figs. 3, 4).
These issues appear to be particularly similar with regard to the analysis applied to the coastline in its flat dimension. In this sense, in fact, it is the mathematician Benoît Mandelbrot, in his book *The Fractal Geometry of Nature*, to propose the Koch curve as a schematic model for the coastal approximation of Great Britain by means of a polygon (fig. 5). Using a very rough approximation, made up of polygons of 200km each, for a coastline of 2400 km, we therefore pass to polygons of 100 km and a coastline of 2800 km. Proceeding with the same methodology, the shortening of the polygons leads to the continuous and progressive growth of the coastal length, in accordance with the 'infinite' curve included in a finite area (Mandelbrot, 1982).
Similarly, the lighthouses represent the notable points of the polygonal line, through which to analyze and rectify the coastline, configuring itself as the most performing methodology aimed at the knowledge of the horizontal two-dimensional space applied to the land line, in order to understand the architectural relationships, landscape and functional (Fatta et al., 2020).

4.1.2 The beam of light

Halfway between the coastline and the landscape, all those beams of light emitted by the coastal totems are inserted, characterized by a specific luminous code and visible only at sunset: a different landscape than the one we are used to, consisting of signs in code of address not only to the inhabitants of the sea but also to the locals.
If, on the one hand, the invariable associated with the coastline markedly defines the territory, conditioning the architectural/urban development, on the other hand, the beam of light is configured as a partially immaterial invariable which, on the contrary, is adapted to the territory, managing to create an 'ideal' and 'idealized' connection between the landscape, the gaze and the architecture in an intangible way through straight lines which, intersecting and joining each other, ideally create connections of a geometric, semantic and cultural type.
This type of light beams, in addition to connecting the territories according to unprecedented points of view, manages to create a partly 'material' design throughout the territory, designing a network composed of several colors and different flashes, depending on the message to be communicated.
At a two-dimensional and zenith level, the beam of light can be traced back to all effects to the concept of a map, as a connector, encoder and clarifier of the territory. The term 'map'[2], in fact, appears to be connected to a very large number of meanings and representations belonging to a vast array of fields and applications. In all cases, the ultimate purpose of 'mapping', and therefore of connecting through beams of light, is to represent in a definite way the links between two relationships: strips of land and territories. It is therefore the clarification of the data and territories that up to that moment seemed 'random' and/or 'messy'. To compose and impose an order in the structure of the boundless space, triangles, circles and lines intervene, in favor of one of the primary needs of the human intellect: to impose a classification and a relationship to the infinite spatiality, only apparently without limit, of the known world (Khanna, 1216).
In this context, the coastline, previously mentioned as further 'invariable', turns out to be the starting point for the numerous light beams, networks, maps and relationships. It is precisely this line that is a spectator of the infinite complexity and potential of the

'border' which, in its industriousness, is configured as a very intricate design of maritime and terrestrial streets and lights, capable of connecting cities of all sizes and types, defining the so-called, 'space-movement'[3], in which the terrestrial and material space overlaps the 'movement', generating and multiplying the wealth and possessions of the three continents that compose it[4]. The Mediterranean area thus changes from "territory-area" to "territory-network", making it necessary to create a dense mesh, an intertwining of continuously evolving light contaminations (fig. 6).
In conclusion, the networking of territories through tangible and intangible, cultural and landscape, ideal and idealized networks, represents the shared action that can glue all the Mediterranean countries, in order to recover a primitive condition of identity and recognizability, a fundamental tool for the material and immaterial connection of places. In this sense, the material and immaterial mending of territories makes use of mapping and networking, in order to make reconnection a universal tool, to be used as a foundation for the re-construction of the landscape, architecture and culture.
This is because mapping according to beams of light, an 'invariable' characteristic of coastal landscapes and architectures, means thinking about the surroundings in the perspective of an enhancement and construction, through which to connect places in a material and intangible/digital way (Fornasari, 2012), which is why this discussion was considered essential and necessary for a conscious explanation of these architectures, in their simple complexity.

Fig. 6. The Mediterranean lighthouse network.

4.1.3 The landscape

The study of coastal artifacts, and in particular of lighthouses, welcomes an important reflection on the great evocative sense that these exert on the memory of each of us. Each coastal identity, in fact, welcomes legends, myths, ancient stories, the charm of an unknown reality. The reconnection of myths corresponds to the reconnection of places, to the creation of a dense plot that links history to landscape, based on what is visibility, temporality and narration (Venturi Ferriolo, 2009). The eye investigates the surrounding environment in depth, to reveal the relationships and plots of the future, that is, the intertwining of events that have taken place in a site, therefore, the facts that have determined it (Turri, 2011). The succession of events creates ever new scenarios and landscapes to be codified[5]: imaginative projections, historical knowledge, literary and figurative suggestions. This is what, according to Morin, with his *homme imaginaire*[6], nourishes dualities, strengthens connections, stimulates the union between real and imaginary, between landscape and lightning.
The narrative function of a territory and its landscape is inextricably linked and correlated to the exercise of its interpretation, in a virtuous circle from which the way of thinking about that territory and living it derives (Pollice, 2015). The narration of the landscape becomes and takes the form of a process of reinterpretation of reality through the narration of oral, written and visual stories transcribed according to the art of representation (figs. 7-9).
The network of the landscape thus becomes an intricate living organism composed of infinite arteries, vessels and capillaries, through which coasts, cities and the sea can be re-connected. But coastal landscapes are not configured solely as the geometric relationship between the built city and the sea, but play a fundamental role in the birth and development of the tangible and intangible cultural heritage of these landscapes (Bozzato & Bandiera, 2019).
Each waterfront must be considered, in fact, as a multipolar node in which individual lives and cities intersect with community social spaces and with neighboring shores, in order to reconnect the territory through intangible ties: this is because waterfronts are the places for excellence in which the cultures, economies and characteristics of coastal settlements are manifested (Vallega, 2003). In cities such as Venice, Genoa, Naples and Marseille it is the landscape-waterfront that is configured as a structuring element and a place of identity, to be considered as a catalysing factor for the reconnection of cultures and cultural heritage, in the constant ambition to open up towards the new (Governa, 1999). Finally, it is the community that generates the multiple pieces of a puzzle, ready to be inserted in a territory that becomes a landscape as soon as it is recognized in the processes of economic, social and cultural transformation of the populations (Ostrom, 2006).
But as mentioned in the course of the discussion of the invariables associated with the coast line and the beam of light, the coastal multipolar node where by definition the links intersect and the geometries are clarified are precisely the lighthouses, the main fulcrum through which to analyze the lines coastal areas, reconnect the territories and, therefore, generate known or unpublished, real or imagined landscapes.
In the context of unpublished and 'imagined' landscapes, it should in fact be emphasized that today the understanding of lighthouses and related landscapes underlies the consideration of different scenographies, therefore means entering and identifying oneself in a heterotopy (Foucault, 1998). In this context, the lighthouse becomes a closed casket, in which stories and myths take shape to be interpreted through the understanding of their internal and external landscape, guaranteeing their reconnection and enhancement. Here, the sea, the landscape and the coastal architectures - associated respectively with the invariable 'coastal linear', the 'landscape' and the 'beams of light' - are configured as elements united by an indissoluble bond, in a relationship of closeness and proximity of places.

Figs. 7-9. Cipolla, M. A., The narration of the Capo Zafferano lighthouse (PA). Reinterpretation of reality.

Since the past the Bourbons, in fact, looking towards the coasts of Sicily used to refer to the lands - in this case island - with the words "beyond the lighthouse". This is because the lighthouse represents and has always represented a universe in its own right, a pivotal and cardinal reference point through which to point up the overcoming of a horizon line that divides the known space from the mysterious one, and of a zenith line that highlights the relationship of proportion and connection (Nucifora, 2010).
The coast line, the light and the landscape still remain today the three key elements that make up the recognition of coastal architecture and the electrocution of a glimpse and a horizon, or elements that act as the glue of the surroundings and of the peoples, towards the duplicity of image and being, connected in a close link between the essence of the lighthouse-architecture and the landscape-horizon.

4.2 Color: between landscape and architecture

Color, accompanied by motifs and textures, is the last feature of this journey along the geometric and perceptive architectural paths of the lighthouse. This 'characteristic' cannot be defined, and has therefore not been included, as one of the invariable elements, as it is totally intrinsic to architecture, much less variable, as it does not constitute an architectural three-dimensional element.
In this sense, if in the course of the previous paragraphs it was the relationship between the lighthouse and the surrounding environment - summarized in three 'invariable' characteristics such as the coastline, the beam of light and the landscape - in this paragraph we wants to analyze the presence of color[7] as an aesthetic and perceptive/functional interpretation key of the lighthouse and the landscape, totally detached from the variables and invariable ones of the lighthouse, that is a subject with a vast discussion and enormous importance from an architectural, functional and landscaped. Here color does not therefore become an exclusively objective fact of the manifestation of a chromatic nuance on an element, but rather as a relationship between the color itself and the observer at an aesthetic/perceptive and functional level[8].
In general, in the perceptual field, as claimed by Goethe, no color can be detected if it is not surrounded by darkness or by a lower brightness, identifying precisely in the dark an active role in perception[9]. The quantity of light/dark present in the environment is configured as a first fundamental characteristic of perception, strictly connected to the perceptual duality identified by the chapter. In this sense, if on the one hand the daytime aspect makes it possible to perceive and underline the chromatic contrasts of the lighthouse plasters, on the other hand the night darkness underlines and makes the chromatic light emitted by the lighthouse[10] extremely visible.
In the nocturnal context, perception goes hand in hand with the communication of signals and useful information to sailors, in which both languages become fundamental as well as closely connected (Piana, 1966). On a purely explanatory and non-exhaustive level, the colors and lights visible in the darkness become the formal alphabet of the lighthouses best known for the transmission of information: green and red represent the colors of entry into ports[11]; red and black convey the presence of an isolated danger; the red light of the lighthouse warns of the presence of a shoal; the yellow color of the buoys communicates the existence of submarine cables, etc. The diffusion of color therefore goes extremely hand in hand with the functionality of the 'luminous' data, effectively transmitting a non-verbal language to sailors.
But if on the one hand the transmission and irradiation of one or more colors represents the communication of useful information to skirt dangers or to maintain safe navigation, on the other hand the use of the same colors undoubtedly represents the transmission of an aesthetic and of a communicative symbolism traceable both in the architectural organism and in the landscape (fig. 10).

Fig. 10. Landscape abstractions.

More specifically, in its diurnal configuration, the introduction of color on the plasters of these architectures is probably due to a random event, and then, over time, it becomes part of the laws that regulate the hierarchy and communication of maritime signals. In this context, the perception of the color of the lighthouses, and of the related landscape, must not be understood exclusively as a mere representation of the single body made up of a color, but rather as a perception of the surrounding spatiality, in which it becomes "the fundamental framework for the constitution of the whole thing"(Husserl, 1965).

With regard to perception, we recall how since the Middle Ages colors have played a fundamental role in the representation of symbols and virtues, favoring colors such as white, red, green and black. Specifically, the combination of white and red colors, in medieval aesthetics, is configured as a symbol of compassion, black, which in the fifteenth century, thanks to Johan Huizinga (1924), loses its negative connotation and is inserted among the full colors used by the Pre-Raphaelites, together with blue, green, red, yellow and white, towards a depth of tone and closeness to nature. Color, therefore, has always taken on very specific meanings and uses throughout history, identifying in them a non-verbal language at the service of all.

It is with this very brief dissertation addressed to color between landscape and architecture that we want to sow a seed with respect to the themes addressed to the study and analysis of color as a landscape-coastal language . In this sense, in fact, if on the one hand the color of the lighthouses connected to the nocturnal language is configured as a clear and defined communication, on the other hand, it is undeniable how the daytime language of the lighthouses is closely linked to a non-verbal communication linked to the landscape, that is an argument so vast that it needs a separate treatment, in order to properly investigate all aspects related to language, visuality and the transmission of emotions.

4.3 Motifs and patterns

The motifs and patterns present in the Mediterranean lighthouses, together with the architectural and landscape color, are configured as fundamental characteristics for the recognition of the architecture by seafarers and for the understanding of the relationship between perception and the motif itself. The term tessitura, or texture, with the contributions of Gibson and Julesz, can be made to refer, starting from the 1950s and 1960s, not only to the materiality of the element as much as to the perception we have of it (Giora, 2011). In this sense, for Gibson the perception of the surrounding visual space is nothing more than the perception of the totality of the surrounding surfaces through which to define the orientation, distance and size of objects (Gibson, 1950). On the contrary, Julesz defines the vision of motifs/textures as an activity of isolation of the same in the context of the visualization of a totality, by virtue of the studies carried out in the field of sensitivity by the human visual system with respect to specific images (Julesz, 1965). Regardless of the sensitivity and visual perception addressed to the visualization of the patterns, the image is always configured as a form of communication, the most primitive and immediate that man has ever used.

In the context of maritime sighting, the extreme importance associated with the immediate and correct visualization of the coastal totem is evident. In this sense, it is precisely the Gestalt that underlines how we cannot perceive everything from an image, as the human eye is created to organize and process information as quickly as possible. Through a series of rapid involuntary movements, the eye is able to capture a first summary view of the landscape and the horizon, entering only subsequently into the merits of

detail (Kanizsa, 1977). The display of bright colors, clear color combinations and a very distinct geometry are the key to an immediate visualization of the lighthouse, together with motifs, textures and patterns that are easily recognizable and distinguishable in the landscape and quickly decoded by the human eye.
In this sense, the patterns constituting the Italian and Mediterranean lighthouses appear to be multiple, albeit characterized by a remarkable simplicity: from white and red stripes, passing from optical white plasters, or even ashlar and bold decorations[12] (fig. 11), that is a very specific and recurring casuistry relating to the colors/patterns that define the landscape. The treatment of the unitary color is therefore combined with all those combinations between colors and textures (figs. 12, 13) capable of making the lighthouse unique and immediately recognizable in the eyes of the observer, painted with pure colors that are linked to the landscape and become constitutive identity.

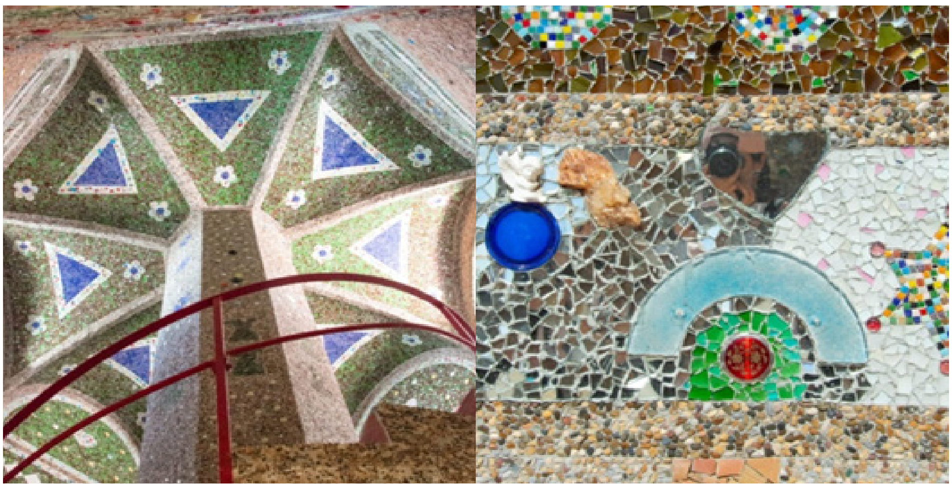


Fig. 11. The Capo Gallo lighthouse.

Fig. 12. The pattern of the headlights: black and white stripes, red and white stripes.

Fig. 13. Colors and textures of Italian lighthouses

Notes

1. The Von Koch curve appears for the first time in 1904 on a document entitled "Sur une courbe continue sans tangente, obtenue par une construction géometrique élémentiare".

2. The origin of maps is very ancient, dating back to around the sixth century BC, bearing the need on the part of men to rearrange boundless spaces and/or data through the design of geometric shapes and travel notes (Brotton, 2013) .

3. "The gifts of movement are added to the contribution of the surrounding space, terrestrial or marine, which is the basis of his daily life. The more this accelerates, the more these gifts multiply, manifesting themselves in visible consequences" (Braudel, 2017, p. 54).

4. "For the three continents (which overlook it) the Mediterranean Sea is a unifying factor and the center of world history. Here is Greece, the bright spot in history. In Syria, Jerusalem is also the center of Judaism and Christianity, in the southwest are Mecca and Medina, the original seat of the Muslim faith. Towards the west there are Delphi, Athens, even more to the west Rome; also Alexandria and Carthage lie on the Mediterranean . The Mediterranean Sea is, therefore, the heart of the Old World, it is its necessary condition and its life. Without it it would be impossible to represent history, it would be like imagining Ancient Rome or Athens without the forum, where everyone gathered" (Hegel, 1998, p. 219).

5. In "*Il paesaggio come teatro. Dal territorio vissuto al territorio rappresentato*", Turri places the actor-spectator as a mediator between knowledge and sense of memory, of protection and safeguarding, of being able to grasp the meaning that landscapes emanate.

6. That is the half real and half imaginary individual.

7. It is now known how color, together with the shape of the elements, is configured as a fundamental characteristic regarding the weight of a composition, of an architecture, etc. The light color, as a whole, has more weight than dark colors, as well as cold colors have less weight than warm colors. In this context, it is not the single color that defines the reading hierarchy of an element but rather the examination of the hierarchical totality of the elements (Klee, 2009).

8. As Plotinus argued , the eye exists and is created to be precisely a function of light. It is therefore pointless to study light and color in an objective sense without taking into consideration the subjective vision of the eye (Plotino, 2000).

9. "Color is the interaction between light and darkness: each color is always is lighter than complete darkness. Color is the 'value of shadow' with respect to light and it is light with respect to darkness" (Goethe, 2014).

10. In this sense we remember how the light emitted by the headlights does not appear as an exclusively white chromatic emission: in fact, colors such as green, red and yellow should be remembered.

11. In the IALA system the positioning of the colors is different compared to the two portions of the world: in system A - that is Europe, Africa, Australia and continental Asia - the green light is placed on the right in the entrance of the ports, while the red light on the left ; vice versa in system B - including the Americas , Korea and the Philippines - the green light is placed on the left while the red light on the right. To learn more: https://www.iala-aism.org/, accessed on 09/09/2021.

12. In this context, we remember the Capo Gallo lighthouse - nicknamed "God's lighthouse" - which, although not functioning, represents the perfect example of the coexistence between redevelopment and proximity to Mediterranean aesthetic motifs. The lighthouse, built in the Bourbon period, appears to be embellished with mosaics made by the artist "Israel" through the use of glass fragments, bottles and shells, towards the aesthetic composition as well as as a homage addressed to God and his creation. To learn more: https://www.spaghettievaligie.it/il-semaforo-delleremita-trekking-nella-riserva-naturale-di-capo-gallo/, accessed on 09/09/2021.

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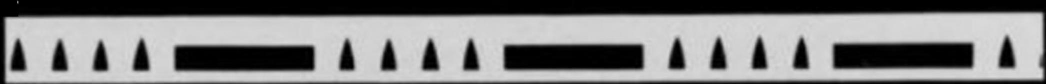
INTERMITTENTE BIANCA A GRUPPI DI LUCI

A SPLENDORI BIANCHI O A LAMPI

A GRUPPI DI SPLENDORI BIANCHI O A GRUPPI DI LAMPI

FISSA BIANCA A SPLENDORI BIANCHI

INTERMITTENTE BIANCA A SPLENDORI O A GRUPPI DI SPLENDORI

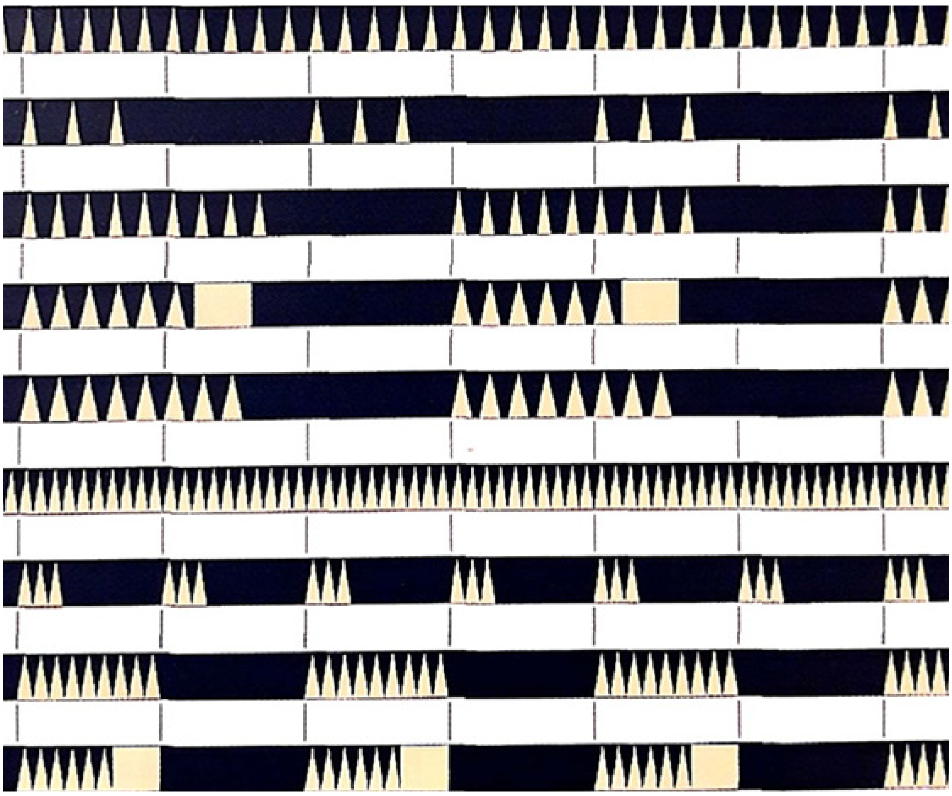


Chapter 5

Light and eclipse

"Solo da adulto, ho capito perché mi affascinano tanto queste magnifiche torri.
Sono sempre stato rapito dal fascio di luce brillante del faro, e dal suo scopo:
guidare le navi e i suoi equipaggi in acque sicure. Pioggia o nebbia, tempesta o foschia,
la luce è sempre là, dietro la lente di cristallo, una sorta di muro trasparente
posto innanzi alla fonte luminosa per amplificarne la forza"
[Bambarén, 2002].

Having dealt with what is the exogenous relationship of the lighthouse with the territory, at this point we want to discuss, in the course of this chapter, an analysis regarding the function and type of emission of lighthouses in contemporary times. This assumption, in fact, is configured as the current state of the art of the methodology of propagation of light around the world, through which to guide sailors towards a path free of dangers. However, technological innovations in the area of light diffusion leave an indelible mark on the architecture of the lighthouse, now in a total state of ruin and neglect.



On the cover. Periods and flashes.
Fig. 1. Flashes and eclipses of the headlights, excerpt.

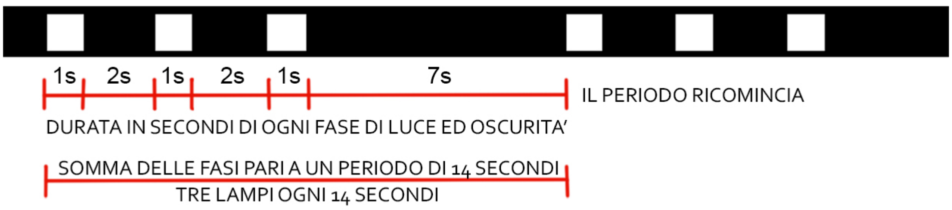
Introduction

If the daytime compositional reading of the lighthouse and the landscape takes place according to colors, shapes and textures, it is in the nocturnal environment that the relationship with the outside changes, changing its visible through the light emission propagated by the lantern, the only fundamental element aimed at recognition of the coast.
It is precisely for the intensification of the light beam generated by the lantern that men have always worked over the centuries in order to make it increasingly visible and defined (Faraone, 2005). In this sense, if for the evolution of light emission we refer to the second chapter of this thesis, the following treatment is specifically addressed to the explanation of the function and type of light emission in contemporary times, although it is now known how the operation of the lighthouse has been almost completely supplanted by modern navigation systems, in any case a source of signaling and reference. In this sense, in fact, it is the light emission that represents the actual communicative language in the nocturnal context, a necessary source in case of failures of the electronic systems, as well as useful for navigation for the visual recognition and aesthetic shock of the coasts. In fact, it is undeniable how the light emission, in addition to still partially supporting a functional type of action, is configured as the light that acts as a stage/scenography for the nocturnal landscape, otherwise not recognizable and visible.
Ultimately, the principle of operation and utility-value of lighthouses is based today on the possibility of being located by sailors during the day and night: the shape, the color, the geometry, positioning and ability to generate an intense light beam (Petino, 2002). If for the discussion of geometry and color we refer to the previous chapters, the following therefore aims at explaining the methodologies aimed at the operation of the optics present in today's lighthouses, in order to understand their functioning and night language.

5.1 The light signal: flashes and periods

Taking a very short step back, in order to be able to connect history to the present, the Fresnel lens is configured as the latest innovation in optics in the context of coastal signaling. Accompanying this innovation is immediately the problem addressed to the definition of a common language of lights, colors and intermittences, tracing a suitable solution in the Fresnel lens, by virtue of the possibility of being connected to a rotating motor, through which to communicate different meanings in a function of the variation of the rotation speed of the optic and, therefore, of the light emission.
Starting from this assumption, we recall how this technology has made available three different optical systems to be applied to the light emission of the lighthouses: the rotating optics, the dioptric drums and the fixed optics. Dioptric drums are composed of Fresnel lenses with a toroidal dioptric surface and are mainly used for headlights. The fixed optics, on the other hand, are composed of a dioptric part and two reflex reflectors. Finally, the dioptric system consists of the sum of lenses and prisms which, in front of a light source, refract the light rays.
Regarding the type of light propagation, in the fixed optics, the crystal lenses concentrate the light emission only along the vertical plane, illuminating the marine space uniformly according to the azimuth directions. The rotating optics, on the other hand, are composed of dioptric and retro-reflecting panels which, rotating around the light emission, divide the light into different portions, in an alternation of lights and eclipses, composing the phases and therefore the rhythm, fundamental for the recognition of the light source by sailors (Faraone, 2005).

The rhythmic fires can therefore be distinguished according to the alternation of glow and shadow, defining a universal communication language, through intermittent, constant, flashing lights, etc. The intermittent light signals appear to be constituted by a constant rhythm and of longer duration than the eclipse time. Flashing lights are also characterized by a constant rhythm but, unlike the intermittent type, they are characterized by a longer period of light than that of eclipse.
Signaling can also be defined in groups of eclipses if these groups are separated by an interval of light greater than that inside the groups themselves, or sparkling, i.e. isophase, if the alternation of light and eclipse is always constant, varying from 60 to 120 flashes per minute (Petino, 2002) (fig. 2). The type of light emission, in a purely technical and nautical annotation field, can therefore be divided into: fixed light (F); flashes with eclipses greater than the times of light (Fl); intermittent with eclipse less than the times of light (Oc); sparkling with 50-80 flashes per minute (Q); rapid sparkling with more than 80 flashes per minute (VQ); isophase with eclipse times equal to the times of light (Iso) and fixed with continuous flashes (F Fl) (figs. 3, 4).
The method of classification and luminous evaluation of the ligthouses, in addition to depending on the rhythm and speed of their emission, is also conditioned by the power of the light source itself: the greater the distance between the lamp and the lens system. In this sense, the headlights are classified into six orders[1], divided according to the distance between the lamp and the lens system, expressed in millimeters: 1st order 1000 mm; 2nd order 700 mm; 3rd order 500-350 mm; 4th order 300-250 mm; 5th 187.5 mm; 6th order 150 mm.



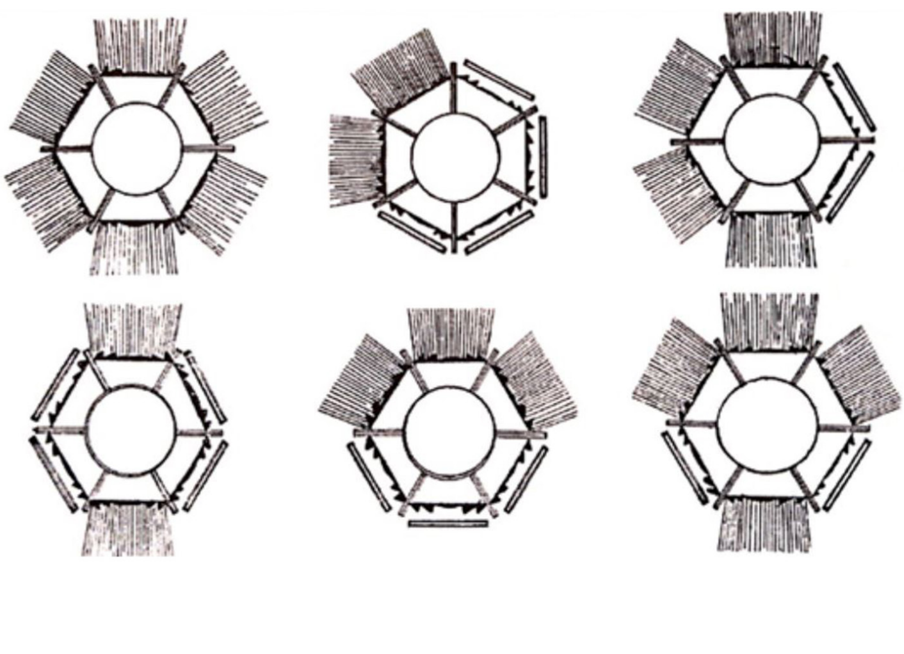


Fig. 2. Light emission: the period.
Fig. 3. Different luminous characteristics of a lighthouse: flashes, group of two/three or four flashes.

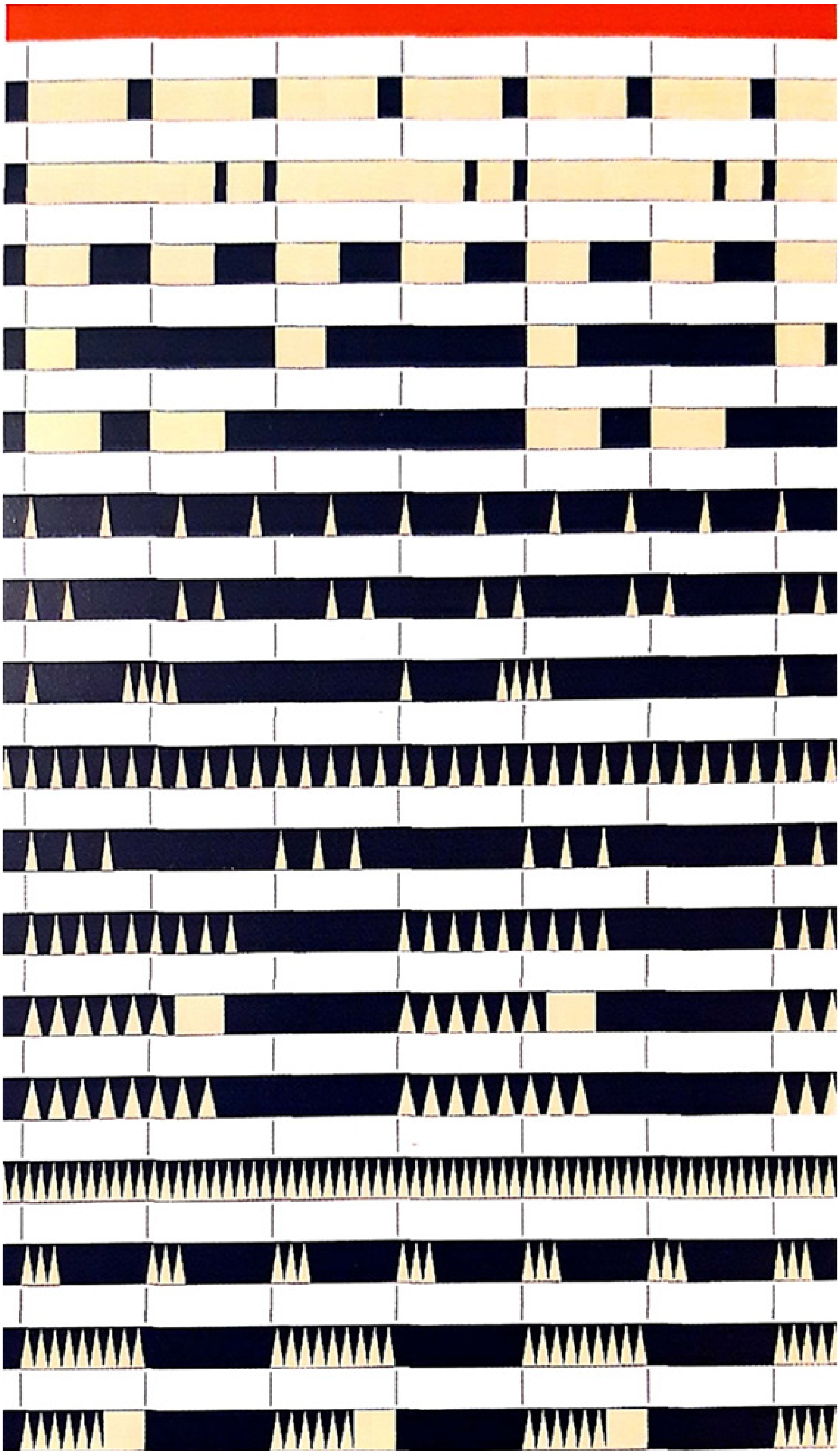
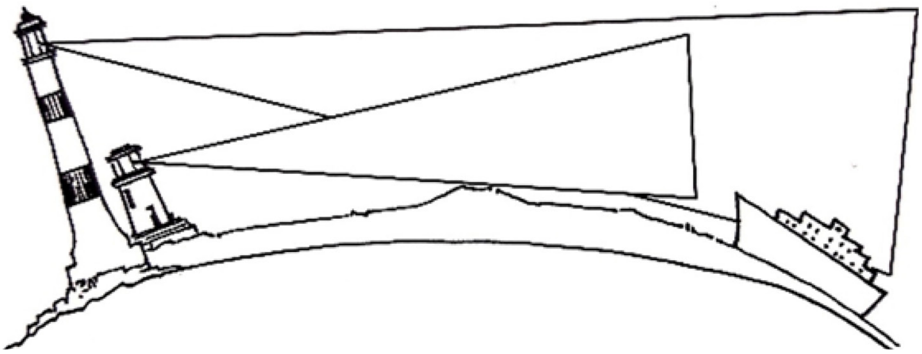
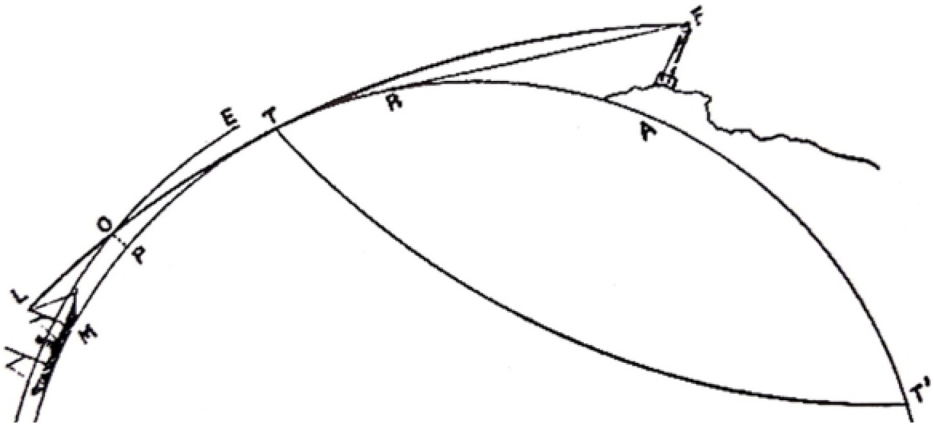


Fig. 4. Flashes and eclipses of the lighthouses.





Intermittente	**Int. ...**	**int. ...**	Occ.	Occ.	... Occ. Clign. ...	o. ...	Ubr. ...	Ubr. ...
A lampi	Lam. ...	lam. ...	Fl.	Fl.	Éclats ...	é. ...	Blz. ...	Blz. ...
A gruppi di *n* lampi	**Grp. *n* lam. ...**	lam. ...	Gp. Fl. (*n*)	Gp. Fl. (*n*)	Gr. *n* Éclats	*n* é.	Blz. Grp. (*n*) ...	Blz. Grp. (*n*) ...
A splendori	Spl. ...	spl. ...	Fl.	Fl.	Éclats ...	é. ...	Blk. ...	Blk. ...
A gruppi di *n* splendori	**Grp. *n* spl. ...**	spl. ...	Gp. Fl. *n*)	Gp. Fl. (*n*)	Gr. *n* Éclats	*n* é.	Blk. Grp. (*n*) ...	Blk. Grp. (*n*)
Scintillante	Scint.	sc.	Occ. (Fl.)	Occ. (Fl.)	Scint.	sc.	Ubr. (Blz.)	Ubr. (Blz.)
Intermittente a gruppi di *n* ecclissi	**Int. ... grp. *n* eccl.**	int. ...	Gp. Occ. (*n*)	Gp. Occ. (*n*)	... Gr. *n* Occ.	*n* o. ...	Ubr. Grp. (*n*)	Ubr. Grp. (*n*)
Intermittente a gruppi di *n* luci	**Int. ... grp. *n* lu.**	int. ...	Gp. Fl. (*n*)	Gp. Fl. (*n*)	Gr. *n* Clign. ...	*n* é.	Blz. (Blk) Grp. (*n*)...	Blz. (Blk) Grp. (*n*) ...
Intermittente a splendori	**Int. ... spl.**	int. ... spl.	F. Fl.	F. Fl.	Alt. Fixe ... Éclats ...	... é. ...	Mi.	Mi.
Intermittente a gruppi di *n* splendori	**Int. ... grp. *n* spl.**	int. ... spl.	F. Gp. Fl. (*n*)	F. Gp. Fl. (*n*)	Fixe, Gr. (*n*) éclats...	... *n* é.	Mi.	Mi.
Fissa a lampi	Fissa ... lam.	f. ... lam.	F. Fl.	F. Fl.	Fixe ... Éclats	f. ... é. ...	F. m. Blz.	F. m. Blz.
Fissa a splendori	Fissa ... spl.	f. ... spl.	F. Fl.	F. Fl.	Fixe ... Éclats	f. ... é	F. m. Blk.	F. m. Blk.

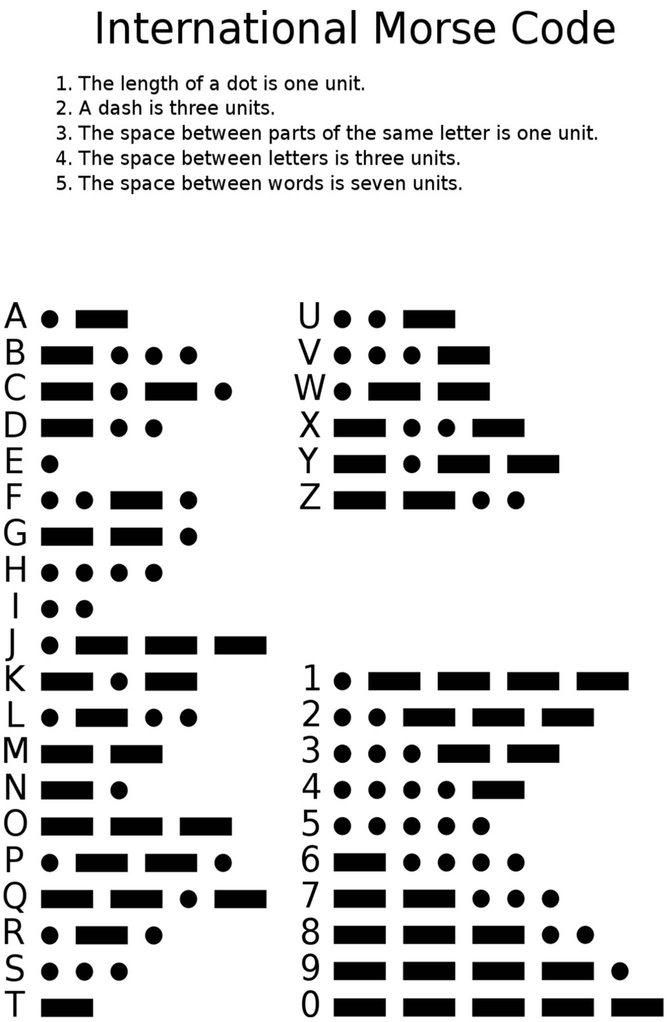
Fig. 5. Explanatory diagram of the geographical range as a function of the height of the observer.
Fig. 6. Explanatory diagram of the geographical range as a function of the height of the observer.
Fig. 7. Type of light emission of six Italian lighthouses.

Other classification factors of the light output are the luminous range, the nominal range and the geographical range. The first is defined as the maximum distance from which the light emission can be perceived, after the interposition of an opaque object between the light source and the human eye. It naturally depends on the intensity of the light itself, as well as on the meteorological visibility and the position of the observer. The geographical range depends directly on the elevation of the lighthouse and on that of the observer, bringing into question the earth's curvature[2] (figs. 5, 6). The nominal range, on the other hand, is independent of atmospheric conditions and is defined as "the luminous range that the lighthouse would have in standard conditions, with a meteorological visibility of at least 10 miles"[3] (fig. 7).
Finally, together with the characteristics linked to the period and the eclipse of the light emission, we recall a last system useful for the distinction at sea of the luminous signals produced by the headlights: the color. Color, a subject already partially treated, represents the third so-called 'characteristic of the lighthouse', obtained by affixing to the lighting system yellow, green or red colored glass or plastic filters. This type of filters are therefore placed in front of the lamps after strengthening the lighting system itself, as it is partially reduced by the application of the filter itself, although, in general, these colored filters are often present on fixed optics, making these lights greater, distinguishable in the nocturnal landscape context. According to the nautical technical annotation, the characteristic of these lights is reported, together with the explanation of the type, by means of the letters: R; G; Y; W[4]. It should be remembered that this type of characteristics refer to "Region A" defined by the IALA signaling system[5] , through which the organism conventionally divides the world into two "Regions"[6].
In conclusion, all the characteristics listed up to this moment allow to distinguish and constitute the technical and technological classification of the "characteristics of the lighthouse" in its nocturnal configuration. It is, in fact, essential that these characteristics are as well known, clear and recognizable as possible, especially in the case of light emissions close to each other, or again, in the case of adverse climatic conditions, taking the form of a real coastal common language, composed of beams of light, through which to put the entire coastal system into a tangible and intangible network. Today, in fact, this type of communication is increasingly directed towards new meanings linked, in addition to the functional aspect, to the ability to develop narratives aimed at the architectural-coastal enhancement of places. A necessary rereading of the utility-value of these architectures is therefore put in place, incorporating their validity in contemporary ways of life (Montella, 2009), a consequence of an increasingly current and present technology, from telegraphic signals to GPS.

5.2 Communication systems: from radio-telegraph to GPS

If in the past light has always represented the only source for a safe landing, between the nineteenth and twentieth centuries there was a revolution in the context of coastal navigation, reaching considerable levels of safety through the use of the electric telegraph (Cavina, 2008). It is in this context that, in 1836, the American painter and inventor Samuel FB Morse[7] created an alphabet composed of lines and points through an intermittent coded signal (figs. 8, 9), capable of sending a message in a short time, even at great distances. Thus, during the twentieth century, the technological development applied to navigation progressed towards an increasingly safe and precise navigation, in which the figure of the lighthouse began to constitute itself as an orientation signal and verification of the routes traced, a point of reference, a guiding light. From this moment on, technological development continues to bring about ever new in-

novations: in 1895 Guglielmo Marconi invents a new system for communication. This is the radio that will lead him, starting from 1901, to the first transatlantic radio-telegraphic link and the relative official introduction, in 1920, of the maritime radio-beacon (Petino, 2002). This type of communication systems are based on the principle of transmitting radiotelegraphic signals to ships, in order to prevent maritime accidents along the coasts that present dangerous conditions, totally detaching themselves from the concept of light as a guide (fig. 10). These technological researches then continued with the Englishman Watson and the subsequent invention, in 1935, of the radio-locator, commonly known as "radar": man was thus able to look into the night with ever greater safety. Subsequently, in order to enhance transmission, the seas are equipped with luminous coastal signals consisting of buoys and beacons[8], equipped with special reflectors called "Racon", ie active radar reflectors capable of transmitting the radar signal received in Morse code.
But the definitive leap in quality in the field of communication comes with the advent of GPS[9] systems, consisting of a dense network of 31 NAVSTAR satellites arranged on six or-



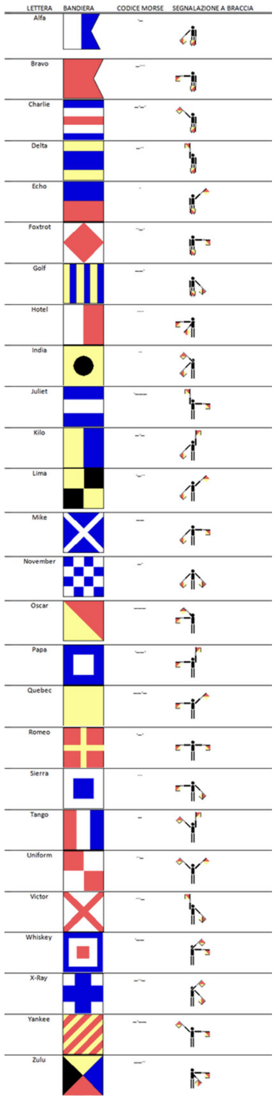


Fig. 9. Morse code table.
Fig. 10. Comparison between clamp systems and flags.

bital planes with an inclination of 55° on the equatorial plane, following a almost circular orbit with maximum tolerated eccentricity of 0.03 and radius of about 26,560 km[10]. The satellites, provided there are at least four, by means of some atomic clocks on board and a receiver, allow the identification of the exact position in terms of distance and altitude, with a margin of error of 5 meters, both on land and at sea, making navigation, previously reserved only for the military, officially safe and available to anyone with equipment capable of receiving the signals. However, it should be emphasized that, although new information technologies make navigation extremely safe, how the latter can be the subject of failure or conflicts at any time

Fig. 11. Map of maritime accidents occurring in Italy between 1891 and 1900.

with the consequent deactivation of satellite technologies, making the lighthouse regain the primacy of sole source. guide, always present for sailors. Ultimately, the lighthouses light is now outlined as an additional system compared to today's systems and equipment, albeit fundamental in the event of breakdowns or malfunctions. For this reason, it is useful to rethink the value-utility of these architectures and their light as a source of enhancement, a light that can rekindle interest in coastal culture and architecture.
In this sense, as stated by Anna Petino: "If the sea has not lost its charm anyway, the hope is that all the patrimony of the collective imagination also built around the architectures of the lighthouses, characterizing the coastline of the whole world , can find memory of the re-use of these structures, rather than oblivion and contempt associated with visions of decay and abandonment" (Petino, 2002, p. 65).
Confirming the high functional, historical and cultural value, there are already actions and programs, at national and international level, aimed at enhancing coastal architecture: this is the case of ResCult[11], MEDPHARES[12] and VALORE Paese-Fari[13], projects and initiatives symbolizing the real and current need aimed at the creation of databases, interoperable protocols/methodologies and enhancement strategies, through which to recover the structures that are now in the grip of deterioration by atmospheric events and time, in favor of the protection of the coastal heritage and the recognition of the heritage itself by citizens.
With the clarification of the just exposed communicative double language, as announced by the title of the second part "From daytime language, color and shape, to nocturnal language, lights and eclipses", we therefore wanted to define a propaedeutic geometric-perceptual apparatus to the creation of a replicable methodology based on the categorization, semantics and geometry of the lighthouse, the latter understood not only as a relationship between measures and proportions but more as an aesthetic, historical and functional explanation and cataloging of forms that characterize architecture and therefore the landscape, through the use of digital, IT and virtual.

Notes

1. The subdivision into orders of the lighthouses is already in place in the drafting of the *Album dei Fari illustrato dalle notizie intorno ai loro caratteri e posizione non che da quelle intorno alle spese di costruzione e impianto e di annuo mantenimento ed illuminazione*, dating back to the unification of Italy, that is a project of modernization and creation of a dense coastal network that could make navigation safer and at the same time demonstrate the Italian political-economic power. The latter appears to have already been studied in depth in the previous discussions, in particular in the course of paragraph 2.3 "From the birth of farology to the present day".

2. It should be remembered that up to the distance of ten miles the earth's curvature can be considered as absent (Petino, 2002).

3. To learn more: https://www.nauticando.net/lezioni-di-nautica/segnalamenti-ottici-marittimi/#:~:text=La%20portata%20nominale%2C%20invece%2C%20%C3% A8, meteorological% 20of% 20at least% 2010% 20Miles, accessed on 02 March 2022.

4. The letters refer respectively to the colors red, green, yellow and white. No filter is applied to the light source for the propagation of white light.

5. The signaling system adopts the AISM IALA standard, acronym of "International Association of Lighthouse Authorities".

6. Region A, of which the Mediterranean is part, is characterized by red side markings to port and green to starboard. Region B, on the other hand, provides for the side markings green on the left and red on starboard.

7. It was then officially built by the technician Alfred Vai, his collaborator since September 1873.

8. The buoys are configured as daytime optical signals, with lights visible up to a distance of ten miles, characterized by rounded and floating structures, anchored to the seabed. Beacons, like buoys, are defined as optical daytime signals, with lights visible up to a distance of ten miles. They differ from the buoys by their elongated structure, which is also anchored to the seabed.

9. Acronym for Global Positioning System in turn abbreviation of NAVSTAR GPS, acronym for NAVigation Satellite Timing And Ranging Global Positioning System or NAVigation Signal Timing And Ranging Global Position System, is a term that can be translated into Italian with "global positioning system" as it provides data relating to the latitude, longitude and altitude of a given point on the Earth. To learn more: https://web.archive.org/web/20130303214202/http://history.nasa.gov/sp4801-chapter17.pdf, accessed on 02 March 2022.

10 For further information: https://web.archive.org/web/20110721061422/http://www.pnt.gov/public/docs/2008/spsps2008.pdf, accessed on 02 March 2022.

11. ResCult (Increasing Resilience of Cultural Heritage) has as its general objective the improvement of the ability of the Civil Protection to prevent and mitigate the impacts of disasters on the sites of Cultural Heritage. This will be done through the creation of an integrated interoperable European database (EID) for cultural heritage, designed to provide a single framework for civil protection, national ministries of cultural heritage, the European Union and local authorities. Specifically, ResCult is working on the following three general objectives: improvement of the disaster risk reduction strategy (for prevention and resilience); increased cooperation and interoperability between EU Member States to protect cultural heritage (information sharing, interoperable protocols, dissemination of best practices, alignment with EU policies/standards); strengthening the capacity of civil society protection organizations to understand/prevent/mitigate the impacts of disasters on cultural heritage. To learn more: https://www.rescult-project.eu/project/, accessed on 05 March 2022.

12. MED-PHARES aims to start the recovery and enhancement of the Mediterranean lighthouses: an immense coastal heritage which, once made accessible and usable again by the local population and tourists, could represent an important development factor for the area. For further information: https://www.mediterraneaonline.eu/med-phares-nuova-vita-ai-fari-del-mediterraneo/, accessed on 05 March 2022.

13. The network project, promoted since 2015, aims at the recovery and reuse of lighthouses and coastal buildings for tourism, cultural and social purposes, in line with the principles of sustainability linked to the culture of the sea. With the last three editions, 19 structures have been given in concession to private individuals who can take care of the redevelopment.

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Part III
Methodological workflow

The third part, of a practical and experimental nature, examines in detail all the main technical phases of the research methodological pipeline, based on the themes of knowledge of heritage and the consequent enhancement through the use and mixing of parametric and ontological sciences. In this sense, in the parametric field, the final product is the creation of a "project model of Italian lighthouses", through which to model a proportionate and geometrically coherent parametric volume to the existing lighthouse, to be used in a digital context addressed to knowledge and the dissemination of coastal heritage. Alongside parametric modeling we find ontological sciences, capable of responding in an automated manner, through "knowledge graphs", to multiple questions posed by the user, making knowledge more inclusive, connected and usable. Finally, through the commission of these two sciences, we want to hypothesize the creation of an ontoparametric software through which a more inclusive and open source experience and knowledge.
Ultimately, the objectives of the third part are therefore: to create an analysis methodology applicable to all the 'characterized' heritage, that is, the heritage that welcomes specific semantic recurrences in its compositional characteristics; encourage the enhancement of coastal assets through their semantic reinterpretation; create a coastal database through which to undertake redevelopment and enhancement actions; identify an architectural matrix useful for modeling coastal towers in a BIM environment; make the methodology and data usable for other future studies and, at the same time, enhance the asset through initiatives dedicated to the use of the heritage in question; lay the foundations for the creation of onto-parametric software through which to hypothesize a totally personalized and inclusive cognitive experience.

Numero	LOCALITÀ — Anno di attivazione e dell'ultima modifica	POSIZIONE	Lat. N — Long. E	CARATTERISTICHE — Potenza luminosa in c. d.	Altezza in metri sul livello medio del mare	Portata in miglia
1	2	3	4	5	6	7
			° ′ ″			
725	**Peloro,** *capo.* 1909 1929	**Estremità N E del capo, a dritta entrando da N nello stretto di Messina.**	**38 16 02** **15 39 13**	**Int. b. sett. r.** Periodo 4s b. 706 r. 140	25.7	b. **15** r. **7**
726		*Punta Mazzone, ad W N W del faro.*	*38 16 20* *15 38 35*	*Fissa v.* *2*	*11*	*2*
727	**Rasocolmo,** *capo.*	Sul capo.	38 17 40 15 31 18	Lam. b. Periodo 3s	87.2	15.5
728	**Milazzo,** *capo e porto.* 1853 1932	**Estremità N della penisola di Milazzo.**	**38 16 09** **15 13 57**	**Lam. b.** Periodo 5s 1050	89.7	**16**
729	1891 1930	Testata del molo.	38 13 01 15 14 55	Int. v. Periodo 5s 35	7.2	6
730	**Vulcano,** *isola.* 1887 1916	**Punta denominata Praia dei Porci, parte S dell'isola.**	**38 22 02** **14 59 45**	**Spl. b.** Periodo 20s 37100	45	**18** *26*
731	**Lipari,** *isola.* 1867 1930	Ancoraggio del *Pignataro*, al N della città di *Lipari*.	38 28 40 14 57 48	Int. b. grp. 3 la. Periodo 11s 180	38.2	10.5
732	1930	Testata del molo nell'ancoraggio del *Pignataro*.	....	Fissa v. 40	11	6
733	1919 1929	Punta *Scaliddi*, a S dell'ancoraggio del *Monastero*.	38 28 05 14 57 20	Int. r. Periodo 6s 80	14	8

Chapter 6

Identification/knowledge
Representation/model

"Uno dei modi migliori per far rivivere il pensiero di un uomo è ricostruire la sua biblioteca [...].
Qualunque cosa si faccia, si ricostruisce sempre il monumento a proprio modo;
ma è già molto adoperare pietre autentiche"
(Yourcenar, 2014).

The third part is preparing to be the conclusion of a thesis aimed at cultural enhancement, knowledge and tourism development, all based on new digital reinterpretations and visualizations in which the collection of data and the creation of a database are configured as actions preparatory to the subsequent development of the thesis in BIM and ontology. In this context, the sixth chapter is based on in-depth knowledge and cataloging of lighthouses, as well as on the explanations of the reasons that led to the collection of specific types of data, that is, fundamental and preparatory actions for the analysis of any architecture. All the geographical, functional, architectural and geometric data of the Mediterranean and/or Italian lighthouses have therefore been identified, through which to proceed with the transposition of the data in the parametric and ontological field.

3208 E2008	- Diga Foranea -- **Sul gomito**	38 07.6 13 22.6	**Fl(4) W 15s**	15	**15**	Tci bianca 11	**1** - 1 - **1** - 1 - **1** - 1 - **1** - 8	19.37 2019
								(Scheda 1281/2019)
3242	- ROCCELLA DI PALERMO -- *Boa d'ormeggio*	38 06.4 13 24.6	*Fl Y 3s*	3	4	*Gialla* *2*	**0.5** - 2.5 Segnala il terminale oleodotto AGIP **P**	11.26 2019
								(Scheda 686/2019)
3243.3	- ACQUA DEI CORSARI -- *Boa*	38 05.9 13 26.4	*Fl Y 5s*	2	3	*Ci segnale speciale*	**1** - 4 Segnala terminale oleodotto ESSO **P**	11.26 2019
								(Scheda 686/2019)
	PORTICELLO SANTA FLAVIA							
3249 E2024	- Scoglio Formica	38 05.4 13 33.6	Fl(2) W 6s	2	3	ME di pericolo isolato	**1** - 1 - **1** - 3 **P**	18.35 2020
								(Scheda 1649/2020)
3250 E2025	- Molo foraneo, a 10m dall'estr	38 05.1 13 32.6	Fl G 3s	6	5	Pil.ne/Ca 4	**1** - 2 **P** **(T)**: Spento 2018-07	15.38 2018
								(Scheda 1002/2018)
3252 E2026	- Molo sottoflutto, a 25m dall'estr	38 05.1 13 32.5	Fl R 3s	10	4	Tr-Ris rossi 6	**1** - 2 **DS 35m** **P** **(T)**: Spento 2018-07	15.38 2018

n the cover. List of lighthouses and fog signals, excerpt.
Fig. 1. List of lighthouses and fog signals, excerpt.

Introduction

Knowledge and cataloging are outlined as fundamental and preparatory actions for the analysis of any architecture (Becattini, 1989). While the first part of this thesis was intended to catapult the reader into an almost dreamlike dimension of the history of lighthouses and the Mediterranean, in the second part the shapes and all those real and 'virtual' geometries that characterize and identify the buildings come to life, up to the third part, i.e. the conclusion of a thesis aimed at cultural enhancement, knowledge and tourism development, all based on new digital reinterpretations and visualizations in which the collection of data and the creation of a database are configured such as the preparatory actions for the subsequent development of the thesis in the BIM and ontological fields.
In this sense, the digital is able to totally transform the ways of transmission, use and sharing of knowledge and, consequently, the way in which the human being interacts with it. The dissemination of cultural heritage through the use of digitization is an increasingly widespread strategy for what concerns the methods and techniques addressed to all classes of the social and cultural levels of the communities, with a consequent democratization of knowledge and knowledge never experienced before, capable of making the citizen a privileged actor involved in the sustainable development of a global smart society , based on co-creation (Barbuti et al., 2020)[1]. In this sense, in fact, the first and fundamental challenge lies precisely in the urgency of building and consolidating a network for the enhancement of cultural heritage, to be associated with digital cataloging, in order to make knowledge more democratic, homogeneous and within everyone's reach, through which to protect the memory and value of every society (Barbuti, 2016).
On the other hand, the issues of inclusive accessibility, promotion and technological innovation aimed at protection, conservation and enhancement are fundamental assets in the dialogue between European and non-European countries, actions shared by the Council of Europe and promoted by Code of cultural heritage and landscape. It is precisely the Council of Europe which, in the Framework Convention presented at the Ministerial Conference held in Faro (Greece) on 20 October 2005, addresses the issues addressed to the enhancement of cultural heritage to be assigned to the new Directorate General for Technological Innovation and Promotion[2]. The ultimate aim is to support and encourage the development of information technologies aimed at enhancing initiatives capable of empowering the quality of content aimed at knowledge and, at the same time, disseminating accessible knowledge, in order to guarantee the right to information, addresses also shared by the Directorate General for Technological Innovation (Branchesi, 2006).
In the field of programming as well as research, there is therefore a strong interest in digitization and the consequent enhancement of cultural heritage. As is well known, when we talk about 'digital' data we are referring to immaterial data, information and connections associated with ethereal and intangible spaces called 'software'. Despite their immateriality, the collected data nevertheless represent the basis through which to undertake any type of study and research aimed at digital and material enhancement on digital data support.
More specifically, the promotion of cultural heritage through digitization systems (Digital Cultural Heritage - DCH) can be distinguished according to different levels of management of 'intangible' material: the Digital FOR Cultural Heritage, in which digital methods and processes are finalized to the reproduction of analogical-material and intangible-immaterial cultural contents (as in the case of digital libraries , virtual museums, databases, etc.); and the Digital AS Cultural Heritage, in which the processes and methods of safeguarding cultural entities of a material and immaterial type are derived from analog data (Barbuti et al., 2016). In any case, it is a laborious challenge of digitization and systemisation of data that concerns everyone and which identifies as the ultimate goal, in line with the research thesis, the safeguarding of the immense tangible and intangible cultural heritage, and therefore of the Mediterranean lighthouses.

6.1 The Atlas of Mediterranean lighthouses

As just stated, the collection of data according to a scientific methodology and the consequent creation of a database, be it paper and/or digital, represent the first fundamental action to be taken for the development of any strategy aimed at the enhancement, knowledge and recovery. In this sense, the creation of a methodological workflow aimed at enhancing the cultural heritage, in this case of a coastal type, regardless of the tool used for dissemination, is undoubtedly based on the collection of data and on the cataloging and management of the same. The cognitive phase therefore represents the first operational prerequisite for the creation of a replicable methodology applied to lighthouses, in which the sources and the scientific nature of the material are the key elements for a reliable, validable and expandable research.
It should be emphasized that, although the creation of a database represents a fundamental step for the management of projects and/or processes, it is at the same time preparatory to choose the type of data to be collected, since it is able to influence the development

Italia

ID*	Name and location		Coordinates	Date	LH	TH	R	D
ID* (EF-)	Nome e località	Mare	Coordinate	Data	Al	At	P	D
1474	Faro di Capo dell'Arma	Mar ligure	43°49'00.0"N 07°49'09.0"E	1912	50	15	24	Fl (2) W 15s
1514	Faro di Porto Vado	Mar ligure	44°15'05.0"N 08°27'02.0"E	1883	43	34	14	Fl (4) W 15s
1478	Faro di Porto Maurizio	Mar ligure	43°52'5.00"N 08°10'00.0"E	1882	11	11	16	Iso W 5s
1506	Faro di Capo Mele	Mar ligure	43°57'03.0"N 08°10'04.0"E	1856	n.d.	25	25	Fl (3) W 15s
1569	Torre della Lanterna	Mar ligure	44°24'16.2"N 08°54'16.2"E	1128	117	77	26	Fl (2) W 20s
1575	Faro di Punta Vagno	Mar ligure	44°23'31.2"N 08°57'09.9"E	1931	26	9	18	L Fl (3) W 15s
1675	Faro di Punta di Portofino	Mar ligure	44°17'09.0"N 09°13'01.0"E	1870	40	12	16	Fl W 5s
1708	Faro di San Venerio	Mar ligure	44°01'06.0"N 09°51'00.0"E	1839	99	24	25	Fl (3) W 15s
1765	Pegazzano	Mar Ligure	44°06'10.2"N 09°48'18.6"E	1915	48	13	16	Iso W 4s
1671	Camogli	Mar Ligure	44°21'06.4"N 09°08'57.0"E	1950	13	7	9	Fl W 3s
1846	Faro di Marina di Carrara	Mar ligure	44°02'11.0"N 10°02'13.0"E	1956	22	22	17	Fl W 3s
1868	Faro della Diga Foranea	Mar ligure	43°51'29.0"N 10°14'14.0"E	'900	30	33	24	Fl W 5s
1884	Faro settentrionale della Meloria	Mar ligure	43°35'24.0"N 10°12'42.0"E	1950	18	20	10	Fl (2) W 10s
1888	Faro meridionale della Meloria	Mar ligure	43°32'47.0"N 10°13'08.0"E	1950	18	20	10	VQ (6) W 15s
1896	Fanale di Livorno	Mar ligure	43°32'38.0"N 10°17'40.0"E	1303-1305	52	52	24	Fl (4) W 20s
1911	Faro della Diga Curvilinea	Mar ligure	43°32'35.0"N 10°17'22.0"E	1857	22	20	16	Fl WR 3s
1975	Faro delle Secche di Vada	Mar ligure	43°19'13.0"N 10°21'49.0"E	1867	18	18	12	Fl (2) W 10s

Fig. 2. The Atlas of Mediterranean lighthouses, example page.

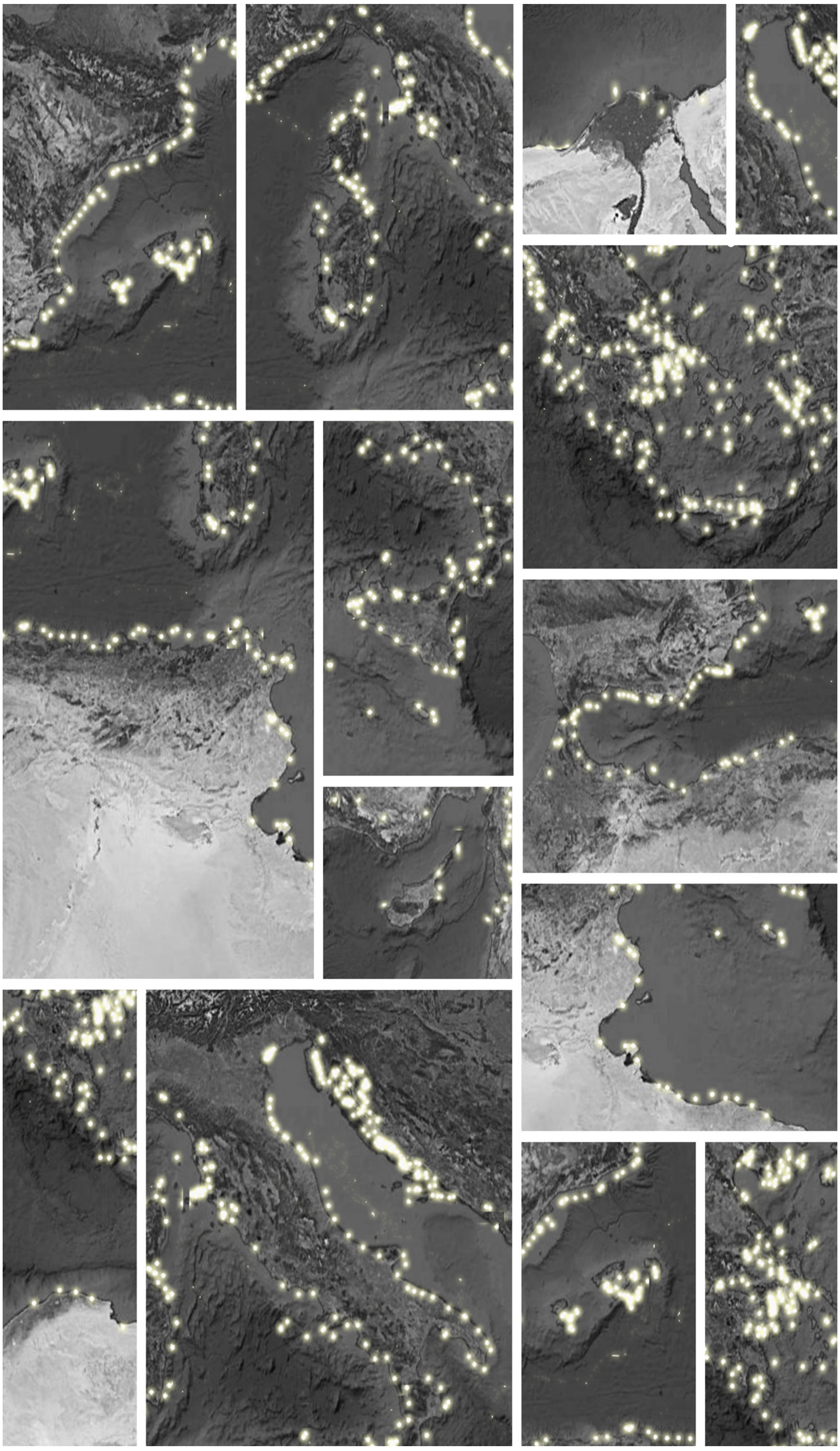

Fig. 3. The lights of the Mediterranean lighthouses.

and the use of the data itself, constituting a key point in the cut to be donated to research or study. In this sense, the historical, functional and geometric data and characteristics treated in the previous chapters are configured as the basis through which to identify the type of data to be cataloged in the different collection databases: on the one hand the Atlas of the Mediterranean lighthouses, aimed at the collection of mostly technical/historical data and, on the other hand, the Semantic Atlas of Italian lighthouses, a collection aimed, in addition to functional and historical aspects, at the semantic and geometric focus. The Mediterranean lighthouses, in fact, being composed of about a thousand case studies, a range for obvious reasons too extensive to provide data concerning all the aspects of the artifact, made it necessary to make a basic typological choice, to be subsequently expanded in the case study of the Italian lighthouses. In fact, it should be emphasized that the ontological and parametric methodology was developed solely for the Italian lighthouses, even if this research is still valid and can be extended also for the other Mediterranean countries.
Technical-historical-morphological data were therefore collected for the Mediterranean lighthouses: identification code of the afferent country (ID); name; sea; coordinates of the place of construction; date of construction; light height above sea level; tower height; range of light emission and typological and chromatic description of the light beam (fig. 2). This type of data makes it possible to create a first catalog of lighthouses, capable of tracing all the notable points and relationships of the Mediterranean area in a timely manner (fig. 3). In this sense, in fact, through the clarification of the identification code, the name of the lighthouse and the relative coordinates it is possible, on the one hand, to identify the recurrence and location of these architectures on the coastline and, on the other, to provide a basis implementation of the methodological process[3], through which to undertake an increasingly detailed path aimed at the knowledge and connection of lighthouses on a gradually narrower scale.
With regard to the cataloging of coastal data, it is important to underline, finally, that the aforementioned data are the result of an in-depth research undertaken, for most of the countries, on official sites belonging to military bodies belonging to the different countries[4]. This relatively long process is the consequence of often fragmented and inhomogeneous coastal data, making the study of these artefacts impractical in a research context. At the same time, their official role as guides for sailors makes the data, on the one hand, difficult to find but, on the other hand, totally accessible in an open source manner.
The Mediterranean cataloging, which can be consulted in its entirety in the appendix, therefore stands as the genesis of an increasingly in-depth examination of coastal architecture, on the one hand of a technical/historical type, for the Mediterranean context, on the other of a geometric/semantic type, in the Italian context.

6.2 The semantic atlas of the lighthouses of Italy

If, as previously analyzed, the Atlas of the Mediterranean lighthouses is configured as an in-depth examination from the historical / functional point of view of the coastal heritage present in the Mediterranean countries, at the same time, the Atlas of the semantic lighthouses of the Italian lighthouses - available in appendix to this thesis - is defined as a preparatory database for the development and application of the heart of the methodology in the parametric and ontological field[5].
Entering into the merits of the specific content of the Atlas of Italian lighthouses, consisting of 178 case studies corresponding to the lighthouses with concrete and/or brick structure[6], it is outlined as the identification and systemization of all those characteristics that define the geometry and semantic composition of the lighthouse. In paragraph 3.3 "Replicable and non-replicable variables", the semantization of the coastal architectural elements appears

to be an action already put in place, albeit in a theoretical way, through the identification of three macro-variables fundamental to the composition of the lighthouse: building, tower and lantern. In this sense, it is important to remember how the semantic decomposition is the result of a process of analysis and study aimed at identifying the categories that can be associated with most of the coastal architectures of these places, identifying in them the basic organisms and accessory elements. The preparatory breakdown is therefore reported in the Semantic Atlas of Italian lighthouses[7], that is the basis through which to create the parametric models and order the data according to semantic relationships (fig. 4).
If the historical sources applied to all the Mediterranean lighthouses were obtained through bibliographic/didactic research, the geometric and semantic characteristics of the Italian lighthouses were searched and categorized through the bibliographic collection together with the photographic and documentary one, from use as a support for the identification and verification of all micro-variables. In this sense, unlike the first atlas on a Mediterranean scale, the atlas of Italian lighthouses is the result of an extremely fragmentary and inhomogeneous data collection compared to the previous one as it is specifically addressed to the architectural apparatus of the lighthouse, as well as constituting a type of documentation never collected before as it is adapted and performing to the methodological process proposed below.
It should be emphasized, in fact, how the choice of the data to be researched was carried out in parallel with a first experimentation in a digital environment of these architectures, as it was deemed necessary to question oneself in advance not only on the level of in-depth analysis of the architecture, but, at the same time, on how to adapt the parametric software to the modeling and creation of geometric data in the most efficient way possible. The two types of cataloging are therefore the basis through which to undertake a path aimed at decomposition and semantic application on digital and knowledge models, through which to generate a replicable modeling and enhancement protocol.

Edificio (Building)

Name (ID-)	Livelli edificio				B	Finestra tipo						Modanature											
	0	1	2	3		1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11	12
Faro di Capo dell'Arma (1474)			X			X																	
Faro di Porto Vado (1514)				X	X		X					X											
Faro di Porto Maurizio (1478)																							
Faro di Capo Mele (1506)				X			X										X						
Torre della Lanterna (1569)			X			X																	
Faro di Punta Vagno (1575)																							
Faro di Punta di Portofino (1675)			X				X						X										
Pegazzano	X																						
Camogli	X																						
Faro di Marina di Carrara (1846)				X		X																	
Faro della Diga Foranea (1868)	X																						
Faro settentrionale	X																						

Fig. 4. The Semantic Atlas of Italian lighthouses, example page.

6.3 Surveys and representations

Once the knowledge process applied to the existing architecture is concluded, it is at this point necessary to question ourselves about the issues relating to the development and application of the data just collected, i.e. the discussion of which elements to transfer to the knowledge and three-dimensional models and how to proceed with the transfer and the creation of the elements themselves. In this sense, just before getting to the heart of the experimental research methodology, we want to propose a brief examination of the processes related to the survey and representation of data and the model, towards a comparison between the traditional approach and the research processes. In this sense, it is in the digital field that, starting from the middle of the last century, there has been a rapid change, in the time span of just over fifty years, of the disciplines of representation, modifying their approaches, methodologies, methods of representation and approaches to survey. If, on the one hand, in traditional drawing a two-way relationship is established between sign and reality (fig. 5) - as well as between signifier and signified (Garagnani, 2012) - on the other, it is also digital, despite the evident modifications of the operational context, to confirm itself as a valid tool in the process of interpreting knowledge of the world through the construction of models through which to express meanings, concepts and theories.
The birth of representation in the digital world is due to the creation of the first single-user computer, around the second half of the twentieth century, thanks to the project of John Lentz, creator of the IBM 610 (Lentz, 2018), together with the first software aimed at crea-

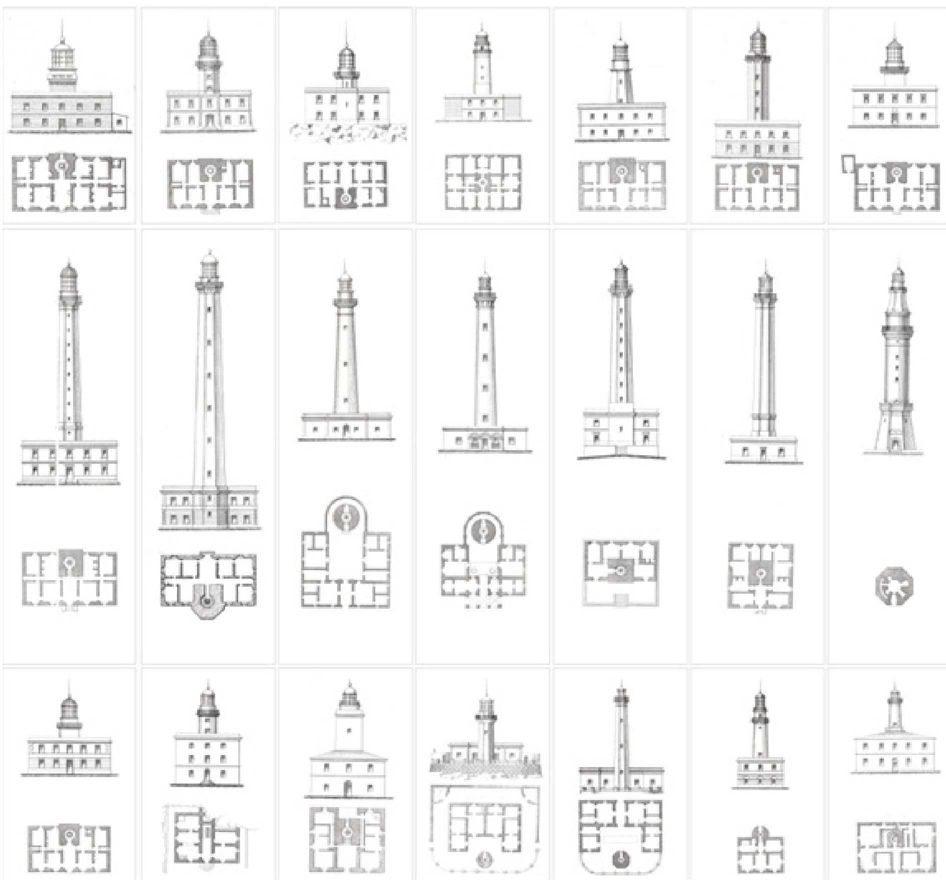

Fig. 5. The *Album dei fari*.

ting computer drawings called Sketchpad, that is the ancestor of what will later become the much better known Autocad. The transition from paper to digital design (Computer Aided Design - CAD) has, in the first instance, transposed only the modalities of traditional drawing to digital representation, without modifying the theoretical approach in which the relationship between reality and representation resides (Bianchini et al ., 2016). The technological/ graphic language is therefore configured as a method of representation through which to reproduce geometric figures, lines of different thicknesses, two-dimensional backgrounds, that is a universally understandable graphic language.
The concept of digital representation is however revolutionized when, starting from the 70s, together with the innovations in the two-dimensional field with the creation of edges, complex curves and splines[8], we arrive at the conception of a methodology capable of creating three-dimensional models, thus introducing the concept of 'volume', with the consequent modification of the ways of creating forms. The final will, however, remains unique, that is to give rise to a representation as much as possible in conformity with the real vision, in its meanings and spatial articulations, even if the line has lost, as asserted by Vito Cardone (2000), "that decisive character, that absolute importance that it has had in all graphic representation, technical and otherwise, up to now. It also seems that there is a prevalence of models that [...] are proposed to the view 'as if they were' the real object".
Today, together with digital three-dimensional representation techniques aimed at the reproduction of real space, today's technologies aim not only at the creation of an 'ideal' and 'idealized' digital twin but also at the direct transposition of reality into the digital space. This is what happens with indirect surveying, in which data acquisition takes place in a reality - based manner and through which a model almost equal to reality is transposed to the digital space by means of point clouds (figs. 6-8), i.e. a nourished number of points independent from each other and corresponding to a given position, surface and color in RGB (Remondino , 2011).
If up to this moment the digital representation had been the conceptualization of elements or the creation of a digital cast, it is starting from the 1960s that the possible creation of a model consisting of interconnected lists of data, characterizations and typologies is gaining ground. These are BIM processes, characterized by the union between classical representation and three-dimensional solid modeling of an interactive and parametric type. As stated by Sdegno (2017): "On the one hand, representation by contours (Boundary Representation, B-rep) was the method that allowed to visualize the surfaces in order to create a solid with a defined shape. On the other, Constructive Solid Geometry (CSG) associated relative equations and textual commands to three-dimensional models, which did not provide for the creation of boundary surfaces in the visualization. While the first sampled the results as a sum of operations, the second recorded the algebraic formula of the morphology, with the possibility of varying the results of the modeling in a more interactive way. The union of these two activities allowed to start the solid modeling which, acquiring the interactivity of the parameterization, made it possible to tackle the issues of Building Information Modeling".
The processes attributed to BIM representation therefore differ from the methods of reality based to move towards an object-oriented parametric modeling , in which the properties of the object become the cornerstone through which modeling and representation can be made explicit.
Ultimately, it is immediately clear that each type of representation corresponds to a specific type of model, equipped with specific characterizations, attributes and levels of detail. For this reason, the definition of the type of representation to be adopted turns out to be a preparatory and fundamental choice, through which to optimize the potential of knowledge, data and the chosen methodology. This is because, as will be discussed during the parametric modeling process, the preliminary choice of typological representation and the level of detail of the model represent fundamental actions in order to guarantee the optimization of work times and data collection.

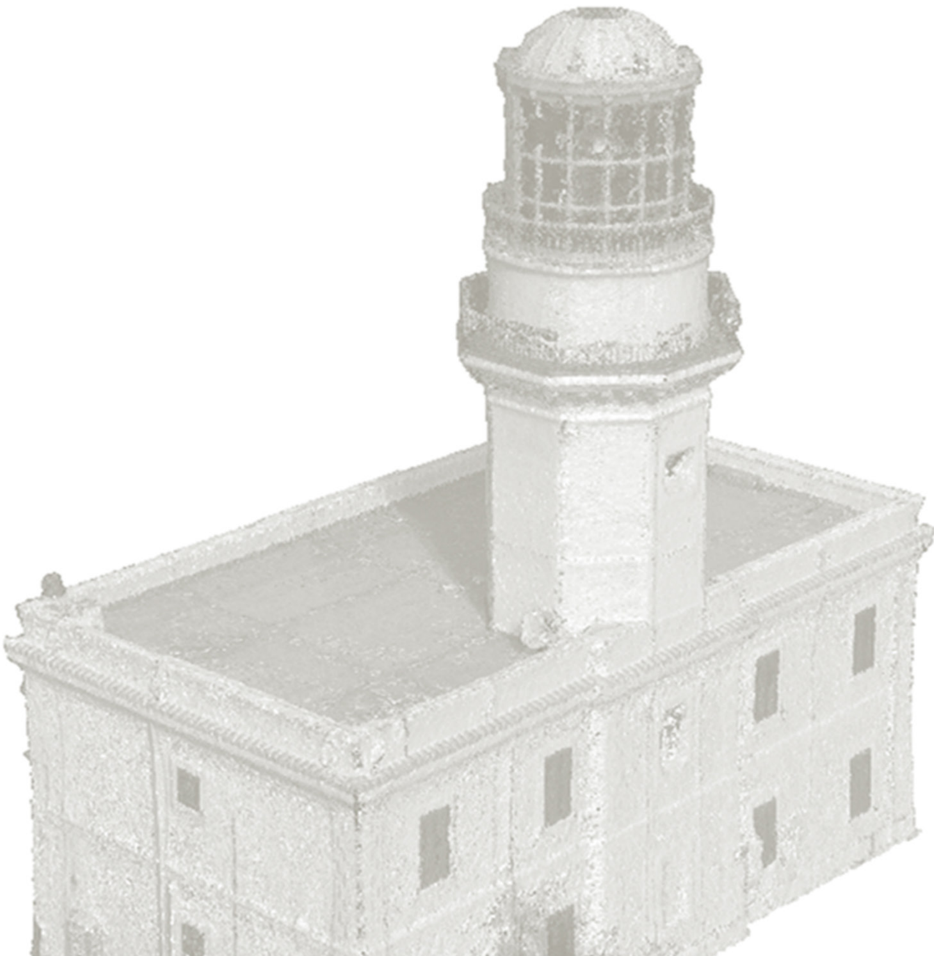

Fig. 6. The Capo Colonna lighthouse: the point cloud.

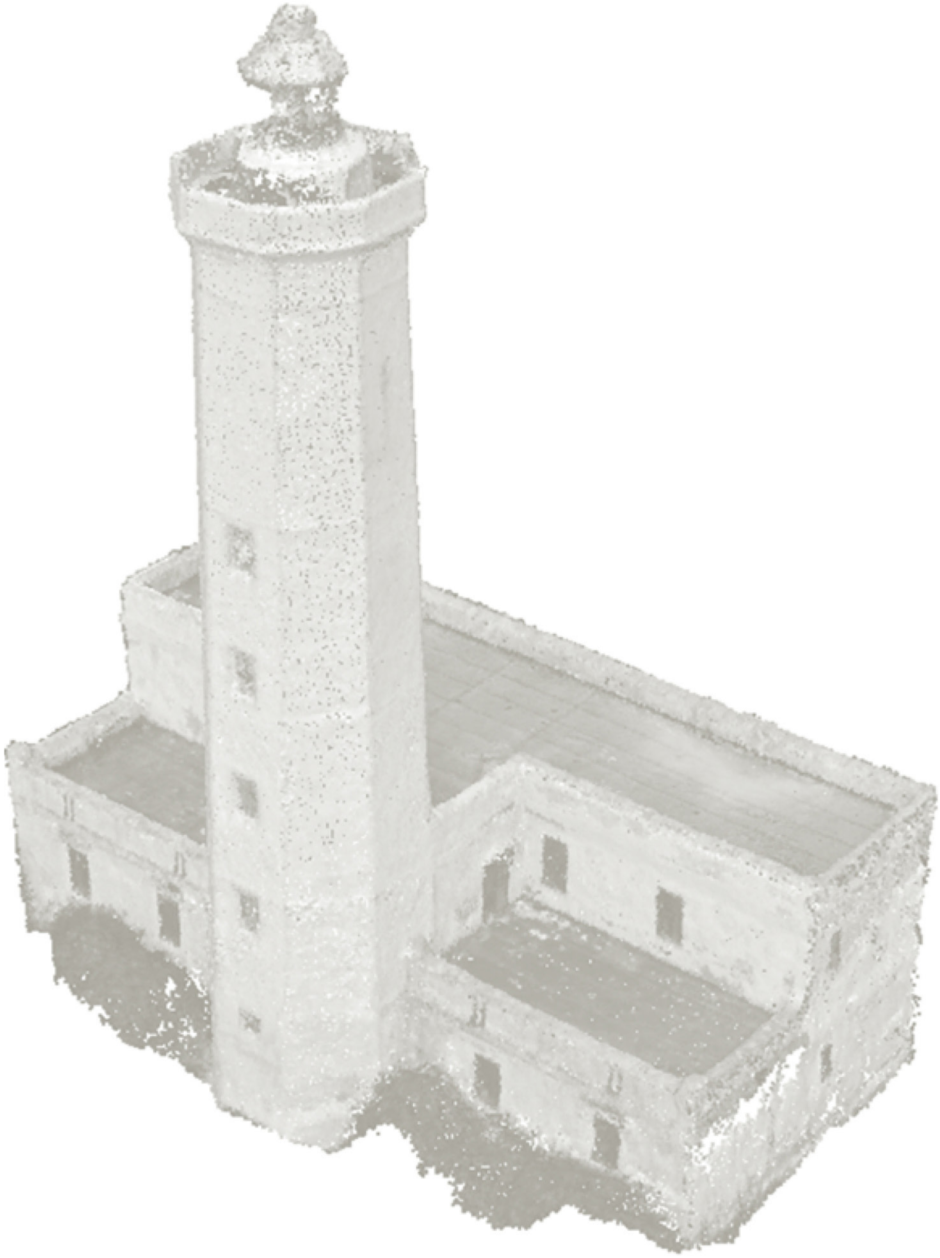

Fig. 7. The Punta Alice lighthouse: the point cloud.

Fig. 8. The San Vito Lo Capo lighthouse: the point cloud.

6.4 The function of the model

In general, the term 'model' refers to a schematic conceptualization of the representation of the architecture and/or system under examination, through which to understand and highlight precise stylistic, compositional and figurative aspects (Mandelli & Velo, 2010). In this context, the history of the typological characterization of models is to be understood as the development of a method that finds its origins in environments that are first of all material and then later lead to immateriality, which is itself material through actions such as, for example, three-dimensional printing and the *maquette*.
It is starting from the second half of the twentieth century, however, that, the result of an increasingly intense innovation in the field of architectural-digital information technology, the development of Computer Graphic leads in a few decades to numerous possibilities and paths aimed at the creation of multiple types of three-dimensional digital models, different in structure, functionality, purpose, representation, etc. In this sense, in fact, today there are numerous software aimed at the creation of the most disparate models: it is precisely these representations that change their meaning today, requiring a profound analysis in the context of the purpose according to what you want to represent in the real world (Docci, 2009). Representation thus becomes the means through which to depict a specific reality according to different interpretations, capable of "covering in a single system of representation, the totality of possible 'vision' mechanisms: on the one hand, they provide the same performance as iconic models, on the other of the non-iconic ones (diagrammatic and mathematical models)" (Gaiani , 2004).
The model therefore represents the purpose and ultimate expression of digital representation, through which to disseminate theories, information, concepts and projects. As it is addressed to different purposes, the level of detail to which it is subjected turns out to be extremely variable, depending on the message to be communicated, in addition to an obvious and preparatory choice as regards the scale of representation of the model itself (Empler, 2017).
Taking up the notions concerning the relationship between traditional and digital drawing in the context of the model, if, on the one hand, the representative 'model' obtained through the techniques of traditional drawing is mostly configured as an 'abstract' interpretation by the on the other hand, the creation of the digital model aims to be constituted solely by the objectivity of reality. In this sense, geometric models created on software such as AutoCAD [9] are configured as objective representations if preceded by appropriate surveys but, at the same time, 'isolated' as models composed of elements not connected to each other and not characterized by specific material characteristics, archives, rules or logic (fig. 9). The concept of representation inserted in the context of Building Information Modeling, on the other hand, represents a real revolution in the context of the representation of the building on universally recognized models, shifting the attention from the pure graphic sign to the univocal essence in the field of codification and semantization of a real object (Scandurra, 2020).
BIM modeling, therefore, through two-way associations between the alphanumeric data and the graphic data - unlike the previous models based on symbolic graphic primitives such as points, lines and arcs - becomes the object of the acquisition of a series of inhomogeneous data but connected by logic and syntaxes common to architecture such as walls, windows, floors, etc. This type of models, therefore, appear to be characterized by an 'intelligent' behavior, an attitude to be attributed not only to the ability to implement the data but also to the relationships that can be generated in relation to the elements created (Osello , 2015). We therefore define a modeling extremely aimed at objectivity, adaptability and the relationship between the elements considered, opening the software to numerous directions aimed at innovation and experimentation, as developed in the course of the next chapter.

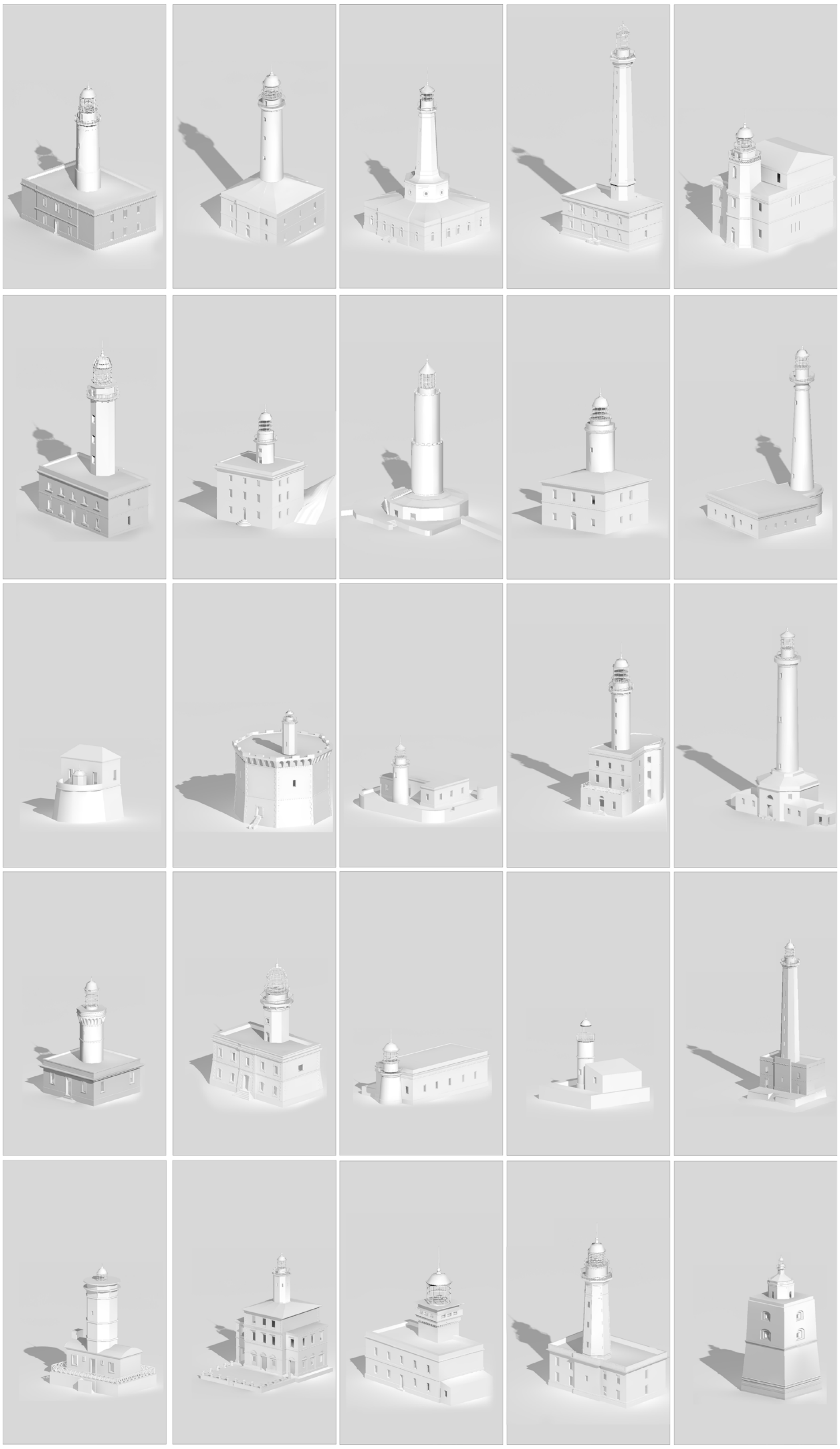

Fig. 9. Three-dimensional models of some Italian lighthouses.

Notes

1. To deepen the concept of co-creation , refer to the School on the Net project for Digital Training Cultal Heritage, Arts And Humanities - DiCultHer , available at the website: https://www.diculther.it/rete-diculther/, accessed on 09 March 2022.

2. For further information, please refer to the website: https://www.lavoro.gov.it/ministro-e-ministero/Il-ministero/Organizzazione/Pagine/DG-Sistemi-informativi-in Tecnologia-tecnologica-monitoraggio-dati-e -comunicazione.aspx, accessed on 09 March 2022.

3. As described in the first part of the thesis "The lighthouses of the Mediterranean", it is in fact possible to trace a solid unitary identity of these territories, made up of cultures, colors, climates and languages. Together with this type of characteristics, as we will see in chapter 7 "Parametric semantic modeling", it is possible to outline a 'Mediterranean language' capable of characterizing not only cultures and climates but also coastal architectures, towards the construction of an architectural alphabet- semantic. In this sense, it is emphasized that a compositional language and a recurring architectural semantics are actually present in this type of architecture, through which the methodology can be extended to different countries, here defined as 'replicable'.

4. For some of them, such as for example Albania, it was necessary to carry out a more in-depth bibliographic search, by consulting military pilot books or websites.

5. As previously stated, in fact, although the thesis is based on the treatment of a unitary coastal system such as that of the Mediterranean, it is clear that the time variant plays a fundamental role in the collection of data and in the development of the data on technological supports.

6. In this sense, it should be specified that the steel structures, that is the pylons and lanterns placed at the entrance to the ports with red or green light, do not represent a suitable sample for the proposed classification as they constitute systems that are not suitable for decomposition and to the semantic analysis carried out in the experimental phase.

7. Having defined and identified the basic elements, we then proceeded to classify the accessory elements, relating to each single 'macro-variable'. For the macro-variable 'building' the following have been identified: the levels that make up the building; the possible presence of angular ashlar; the type of moldings and the type of openings. For the macro-variant 'tower' the following have been identified: the plan section of the tower; the possible presence of tapering of the geometry in elevation; the type of moldings; the type of openings and the possible presence of shelves under the tunnel. Finally, for the macro-variable 'lantern' the following were identified: the type of balustrade in the gallery and the type of shell that protects the lens and, therefore, the light emission.

8 The complex curves are the result of numerous studies carried out by SA Coons, regarding the algorithms aimed at the creation of a double-curved surface, and to Pier Bézier, who understood the importance of managing not only the contours but also of all the surface created. Finally, it is Bézier together with KJ Vesprille who formalized the creation of a B-Spline for CAD systems, that is the union of several 'Bézier curves' (Ushakov , 2011).

9. A computer-aided design (CAD) software that architects, engineers and construction professionals rely on to create accurate 2D and 3D drawings, created in 1982 by the US software house Autodesk. For more information: https://www.autodesk.it/products/autocad/overview?term=1-YEAR&tab=subscription, accessed on March 16, 2022.

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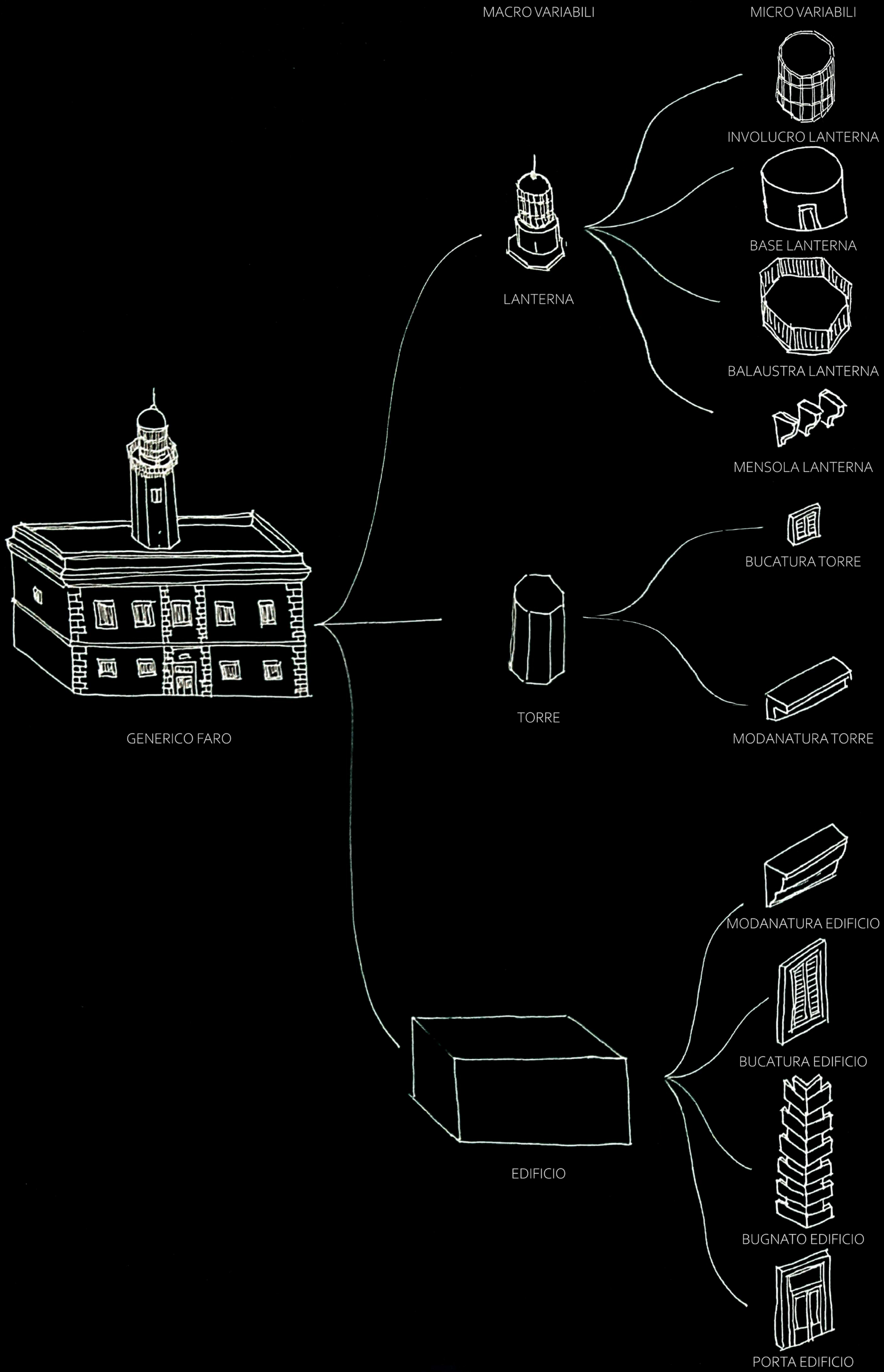

MACRO VARIABILI
MICRO VARIABILI
INVOLUCRO LANTERNA
BASE LANTERNA
LANTERNA
BALAUSTRA LANTERNA
MENSOLA LANTERNA
BUCATURA TORRE
TORRE
GENERICO FARO
MODANATURA TORRE
MODANATURA EDIFICIO
BUCATURA EDIFICIO
EDIFICIO
BUGNATO EDIFICIO
PORTA EDIFICIO

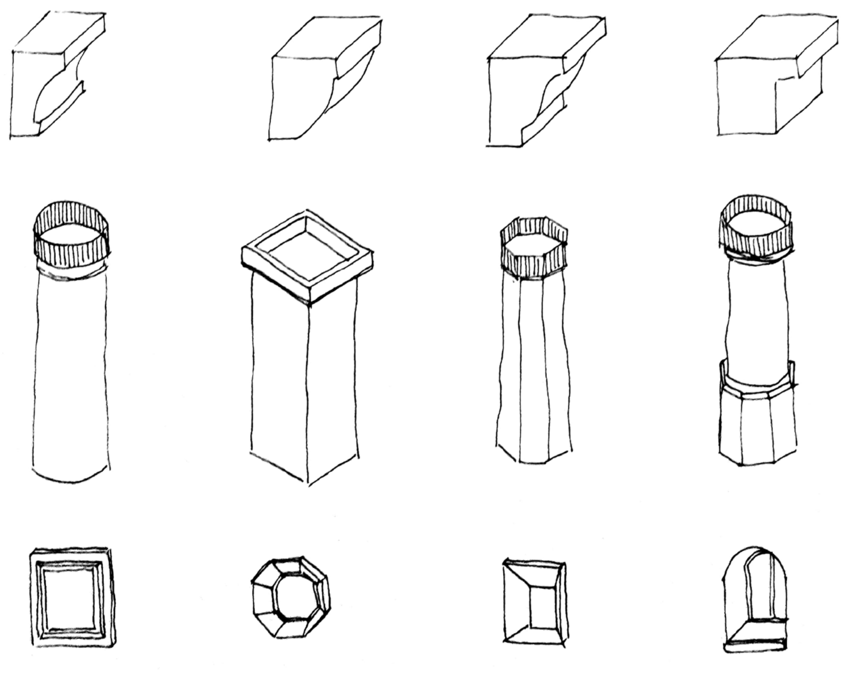
Chapter 7

Semantic parametric modeling

"Solo ponendo tanta attenzione agli elementi anche di minor scala potremo cercare di addentrarci in quella particolare atmosfera che caratterizza e costruisce l'immagine che ogni luogo possiede ed emana, così pienamente descritta dal *genius loci* di Norberg Schulz"

[Puma, 2004, p. 82][1].

The seventh chapter is configured as the theoretical and applicative treatment of the parametric methodology, towards the creation of a "project model of Italian lighthouses" capable of optimizing the modeling times of Italian lighthouses. Through the identification and collection of data, in this case architectural, it is possible to 'impose' a semantics on coastal architectures, which is essential for the creation of the parametric families to be included in the project model. Once the creation of the model was completed, the methodology itself was then tested with respect to three different case studies, through which it was possible to identify a metric error of the model equal to 0.5%.



On the cover. The semantics of the 'generic lighthouse'.
Fig. 1. The semantics of lighthouses: towers, openings and moldings of lighthouses.

Introduction

This chapter is configured as the continuation as well as the fulcrum of the discussion aimed at the theoretical and practical development of the research methodological workflow, as well as the experimental part of the same. If the first part of the thesis is based on the definition of a purely historical state of the art - addressed to the historical-technological-spatial configuration of the Mediterranean and of the lighthouses that fall into this cleft of earth - the second part sees the necessary continuation of what wants to be a methodology based on the definition and geometric classification of lighthouses, that is a transition chapter through which to define and establish the fundamental geometries, languages and relationships maintained between the lighthouses. The third part, of which this chapter is part, is finally constituted as the explication of an experimental methodology, which identifies in the process of cataloging and classification of the Mediterranean lighthouses the methodological input through which to digitally model and connect data of the entire coastal architectural apparatus.
If for the 'technical-applicative' explanation of the methodology, please refer to the reading from paragraph 7.3 "Development of a parametric methodology: the semantic decomposition" onwards, in this brief introduction and in the course of the following paragraphs we want to deepen the question linked to development of the methodological process and of how this process is configured as conditioned by the parametric processes of the software and by the type of digital model to be obtained.
In this sense, the methodology addressed to lighthouses can be partly traced back to what is defined by Andrea Tiveron (2020) as a "reverse method", that is, a management system capable of allowing the implementation of organizational processes on the basis of clear and defined actions to be taken, in order to allow a sure 'achievement of objectives', by creating an automated methodology[2].
Tiveron 's "reverse method", in which the "management" is implemented through the decoding of the architectural-informative language of coastal buildings, up to "reaching the objectives" through the their application 'recomposition' according to specific case studies. In fact, as for the "reverse method" the starting point is defined by the classification of objectives, in the same way, the methodology draws its basis in the cataloging of the data up to the explication of the single case study, that is 'the' objective 'obtained according to a top-down[3] approach in which the data are identified and explained with ever greater detail, i.e. a breakdown by parts already in place in the context of data cataloging, the latter available in appendix.
In the following chapter we therefore want to illustrate the theoretical-applicative developments of the research methodology aimed at optimizing the parametric modeling processes of the coastal heritage, through the creation of a "project model of Italian lighthouses". In this sense, in order to reduce modeling times, the "project model" is therefore structured according to the three main volumes of the lighthouses previously identified - namely the building, the tower and the lantern - and the related architectural features inserted in them, in order to create a 'parametric semantic database' based on loadable and system families, through which to more easily generate a three-dimensional model of each case study belonging to Italian lighthouses, as well as an information base associated with architectural characteristics.
Therefore, if the aim of the previous chapters is to make the reader understand the geometric characterization of these architectures - in addition to their ability to generate networks and cultural flows - the ultimate aim of the current chapter is to explain a methodology aimed at modeling and to the connection of coastal heritage data, ultimately projected towards the themes of artificial intelligence, a science with a high potential as it can be branched to different uses and disseminations.

7.1 BIM & HBIM

Before going into the merits of methodological experimentation, it is necessary to make a brief introduction regarding the birth of BIM and its development in the context of new constructions and existing buildings. It was around the 1960s that DC Engelbart began to work on the hypothesis of models of digital objects endowed with autonomy, capable of facilitating the design path of a building (Engelbart, 1962), theorising the possible creation of architectural elements through modification of specific basic parameters connected to each other through a managed database system. This type of data management takes shape as early as 1969, thanks to the ESRI[4] foundation, with the birth of systems now called GIS - Geographical Information System - in which cartographic representation is integrated into the documentation and territorial analysis systems in the context of memorization of the data, still allowing the possibility of documenting a territory on a large scale (Brusaporci & Centofanti, 2008). It was only in 1971, in Pittsburgh, that Carles M. Eastman (1974) coined the term BDS - Building Description System - that is the father of what was later formalized and defined in 2002 by J.Laiserin with the acronym of BIM (Eastman et al., 2008).
BIM, in common with what previously theorized by Engelbart in 1962, attracts the possibility of structuring the data in interconnected lists, in order to facilitate the work of construction operators, configuring itself up to that moment as a tool purely addressed to the world of new buildings. In this context, the intent is to be able to give life to the automatic composition of architectural drawings through the systematization of specific algorithms aimed at automation (Scandurra, 2020), proposed a few years later by Eastman himself. At the same time, J. Souder and W. Clark conceived the Computer Aided Planning CoPlanner system, aimed at the graphic and statistical control of functional subdivisions in the hospital environment, thus experimenting with new frontiers of this methodology (Sdegno, 2016).
However, for the start of the BIM processes, conceived as we understand them today, it was necessary to wait several years, during which a unique modeling protocol was defined, far removed from the modeling processes of traditional software. As discussed in paragraphs 6.3 and 6.4, in fact, the real revolution in the field of parametric modeling is to be identified precisely in the concept of representation, modeling and transposition of reality with respect to a digital three-dimensional model inserted in an archival context of information, based on defined rules and logic for managing categories and classes. The change attributed to methodological processes is confirmed by how, in reality, the term 'modeling' can no longer be coherently associated with this process as modeling is defined in itself as an approach aimed mostly at reproduction and representation of reality, lacking transparency and rigor, characteristics inherent in the BIM process (Cresti, 2016).
In this sense, in fact, the construction of volumes is not limited to being a mere independent geometric schematization but, on the contrary, it is the volumes themselves that aim at the connection between them. The evolution in modeling is clearly defined by Pavan (Pavan et al., 2017) through the analysis of the representation of a wall: in a hand drawing the wall will be represented by two parallel lines at a defined distance; on CAD the representation will be the same with the only difference that the represented lines are read by the computer which recognizes them as simple lines and not as walls; in BIM the wall is created exactly as an object corresponding to reality on a geometric and material level.
The three-dimensional representation therefore becomes coherent with the information to be transmitted as well as a visual means of data that are no longer ambiguous, able to be synchronized with the different actors involved in the design, completely re-

volutionizing the relationship between reality and modeling, opening the road to infinite alternative research paths[5]. Building Information Modeling, therefore, is configured today as a tool with a high experimental and innovative value in the field not only of new buildings but also of the management and enhancement of the historical heritage built[6], characterized by different parametric approaches.
In this sense, if for new constructions full control of all phases of the design and life of the building is guaranteed, on the other, for the built, the debate regarding the most effective processes for their modeling and construction is still open, through which to develop archiving and management technologies and methodologies (Centofanti et al., 2016). The importance and topicality of these issues is now clear and undeniable, as evidenced by the interest on the part of UNESCO, specifically, with regard to the relationship between architectural heritage and its digitization[7]. This is because the representation of the built heritage today changes in both analog and digital form and representation, towards an immersive and cognitive vision of the architecture (El-Hakim et al., 2004).
The modeling of built heritage - a process defined by Murphy with the term HBIM (Murphy et al., 2013) - traces its first essence in the creation of a 'virtual replica' almost completely conforming to the real, the result of numerous measurements and surveys, in order to obtain a useful model on an executive scale and, therefore, through which to undertake actions aimed at restoration, consolidation, etc. (Xiuncheng, 2018). At the same time, the creation of models based on historical documentation, images and paintings - that is all documentary sources not directly attributable to a direct/indirect survey by the operator - make it possible to create three-dimensional models very close to the existing architectural reality or past, through which to undertake paths of enhancement and dissemination of a visual, interactive and cognitive type (Talaba et al., 2010; Girbarcia et al., 2013).
This type of methodology addressed to the built heritage is still today subject to numerous difficulties in the parametric modeling phase, as a consequence of a rigid predisposition of the program towards the creation of parametric elements identified and enclosed in 'libraries' of excessively standardized digital objects, therefore not very adaptable to the vast characterization and uniqueness of the elements making up the existing cultural heritage. Despite the objective difficulty reserved for the modeling of the built heritage in a BIM environment, today there is a need for increasingly adaptive three-dimensional models, capable of accepting and integrating data continuously.
The traditional HBIM approach involves the acquisition of historical, documentary data and a point cloud through which to describe the actual state of the object under examination according to its geometric, chromatic and material essence. This is the Scan-to-BIM process in which the real conditions of the structure are acquired by surveying and reported in the BIM systems for the relative parametric transposition. The result is a model not suitable for the parametric context as the acquired point cloud is configured as a mere surface, a cast on which to model the three-dimensional parametric elements, making the Scan-to-BIM process composed of a predominant manual modeling as it consists of unique elements, that is, distant from the pre-existing families in the modeling software.
Today there are numerous ongoing researches aimed at optimizing the modeling processes of built heritage, in which countries such as Italy, Canada, Great Britain and Ireland define themselves as pivotal territories in the field of parametric innovation. According to an examination of the scientific contributions consulted[8], it is possible to intercept the key points towards which the national and international scientific system is moving in the field of modeling historical heritage in the parametric field[9]: more adequate procedures and methodologies addressed to semantic modeling of BIM objects;

creation of specific libraries in order to optimize the modeling processes of the historical heritage; organization of data for the facility managment ; processing of data, objects and uncertain relationships in the context of knowledge of the historical heritage. It is precisely on the first two points that the research methodology proposed here is based, drawing its strength in the actual and just exposed lack of adaptive models and processes aimed at built heritage, characterized by unique elements albeit, in some architectural categories, often 'recurring'.
The identification of the constituent elements of coastal architecture - i.e. the cognitive phase[10], undertaken during the creation of the Atlas of Mediterranean lighthouses and the Semantic Atlas of Italian lighthouses - therefore appears to be the first step to be initiated in the context of creation of a methodology aimed at modeling a specific category of cultural heritage, the lighthouses, characterized by peculiarities which, although different, can be traced back to common variables. It is precisely the semantic subdivision into micro and macro variables that is defined as the cognitive foundation of the entire treatment and methodological experimentation, first parametric and then ontological.

7.2 Knowledge management: the project model

The use of the BIM methodology applied to buildings includes, as just discussed, a necessary acquisition of data, both material and immaterial, that is, a challenge that is still current today in the field of information extraction, analysis and related aggregation in the model, for which the ontological and semantic sciences are characterized as effective actions to ensure the interoperability and reproducibility of research and data (Simeone et al., 2014). In this sense, the choice of the elaboration of a methodology applied to the existing heritage therefore confronts us with a first problem related to this type of architecture: information. It is in fact known how the initial information of the building, fundamental for the understanding of the architecture, often turns out to be heterogeneous from each other. The researcher's ability lies precisely in the ability to intercept the correct information to be entered and to identify the relationships and classification of the same in a tailor-made methodology (Del Giudice, 2015).
Once the archival, historical and geometric data of the artefact to be modeled have been collected, it is therefore necessary to understand how to manage and to unify the modeling process in the parametric software. In fact, once the phase addressed to the in-depth knowledge of the data of the artefact, whose connection is delegated to the ontological software, it is possible to take two paths, depending on the parametric modeling strategy to be adopted: use a default model provided automatically from programs such as Revit, making the modeling work slower and more unique or create your own model file, called template, by modifying the structure of the database and the data entered and adapting them to your own purposes.
Revit software gives the possibility to use different file extensions with different functions and characteristics, among which we remember: the loadable and system families (.Rfa); project files (.rvt) and project template files (.rfe). The latter are model files preloaded as part of the creation of a new Revit project, containing the fixed settings created and the families already inserted, facilitating the modeling process of elements in series or relating to common characteristics.
In order to obtain a model aimed at the modeling of several case studies - a particularly valid and recommended model in the context of parametric modeling applied to historical buildings (Del Giudice, 2015a) - it is necessary to define in detail the purpose of the parametric model and, consequence, of what you want to model, in order to obtain a

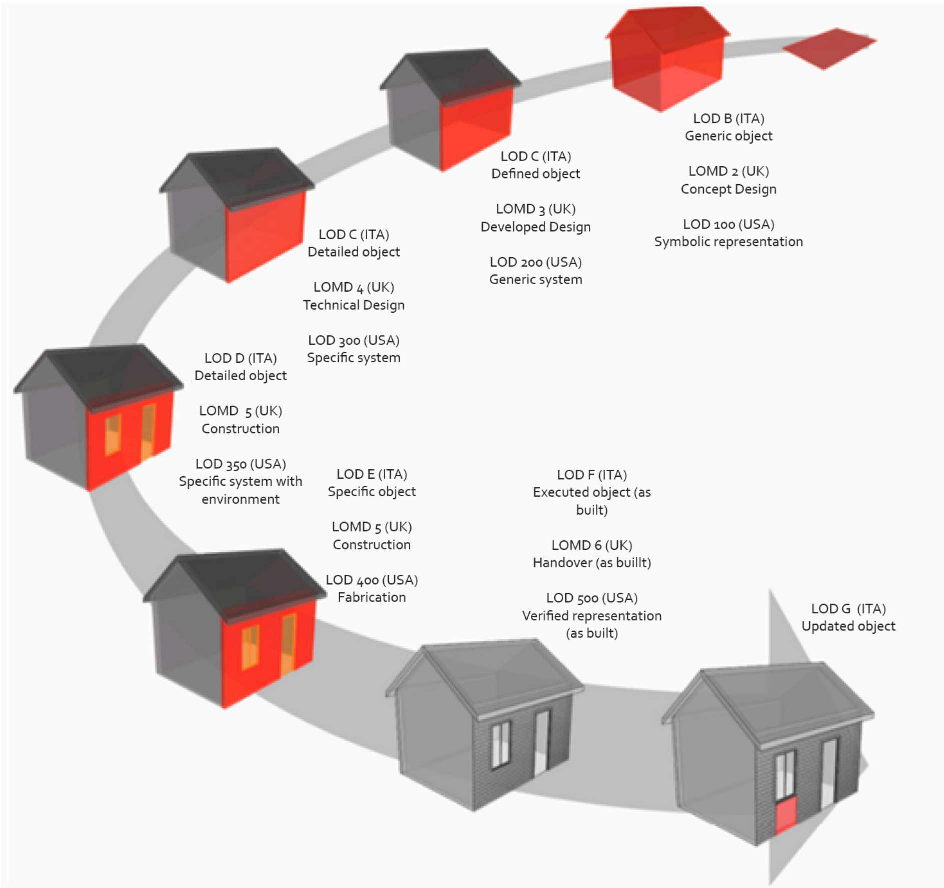
systematic organization of the elements, avoiding creating an excessively rigid structure that could hinder the modeling processes. The creation of a 'project model' file therefore universally facilitates the professional in the field of modeling and parametric management of elements or recurring settings, avoiding to continuously set not only the interface but above all the libraries present in the model. It is precisely the latter that is considered as the salient point of the thesis, aimed at creating a project model capable of hosting all those families belonging to a specific architectural category[11], to be used in the course of modeling different coastal case studies.
Ultimately, this type of process turns out to be particularly relevant in the context of a semantic study based precisely on the recurrence and classification of the elements, constituting a solid basis through which to develop the research methodology. In this sense, the creation of a basic project model in which to collect all the semantic types by means of loadable or system families, better explained in the next paragraphs, makes it possible to model more expeditiously and adaptively to different case studies and of different purposes of use.
In the next paragraph we want to explain the semantic classification at the base of the methodological process: from the use and transposition of the first semantic theories modeled in Dynamo to the creation of the "project model of Italian lighthouses".

7.3 Development of a parametric methodology: semantic decomposition

The creation of a methodological workflow aimed at enhancing the coastal heritage is based, as discussed several times, on the collection of data and on the cataloging and management of the same, constituting the first prerequisite for the creation of a replicable methodology in which the sources and the scientific of the material appear to be the fundamental elements for a reliable, validable and expandable study. The data collection just mentioned, which can be consulted in the appendix, finds its genesis in the interception of two research macro-groups: technical/historical and geometric/semantic. If on the one hand a documentation has been collected aimed at the theoretical knowledge of the artefact, on the other, the geometric/semantic cataloging turns out to be the basis through which to develop reasoning in the field of design, semantic relationships and representation, key elements of entire methodology addressed to parametric modeling and ontological knowledge.
Before going into what is the precise choice in the context of the semantic classification of Mediterranean lighthouses and the relative definition of the levels of detail, it is necessary to carry out a brief examination in the field of semantics and the classification of elements relating to cultural heritage, including strengths and weaknesses. In this sense, the first criticality to underline undoubtedly relates to the heterogeneity of the architectural elements. When we talk about historical heritage, in fact, we almost always have to do with an artifact composed of different characteristics and irregular shapes, difficult to be traced back to standard solutions, together with often fragmentary data documentation[12]. In the case of the Mediterranean lighthouses, the characterization of the coastal architectures makes it possible to almost completely overcome the obstacle of the uniqueness of the elements as these architectures are almost entirely made up of a recurring and homogeneous geometric apparatus[13], that is an architecture 'characterized'[14], although not free from elements of uniqueness.
In this sense, as claimed by Brusaporci (2017): "The specificity, heterogeneity and multiplicity of information require the creation of adequate databases, capable of recording, managing, analyzing and correlating more complex information than those traditionally offered by BIM on the market". Furthermore, as has been repeatedly asserted, the

precise identification of the elements making up the architecture is not to be thought of as a process aimed at isolating them but, on the contrary, at the precise analysis of the elements in relation to their entirety, rediscovering the connection between form and meaning present in the historical construction: "The central problem is therefore that of tracing complexity back to a system, no longer of signs, but of ontologically concluded elements, whose definition is a function of cognitive objectives. Modeling for objects is in fact based on a different way of approaching the architectural project and the study of the existing, preparing multidimensional models that can be shared with other professionals, also on the basis of interoperability between software" (Di Luggo & Scandurra , 2016). In the approach to semantics, attention is therefore paid not only to the shape of the elements but also to the meaning[15], a relationship capable of making each part uniquely recognizable in the terminological-architectural context.
In the context of the identification and cataloging of architectural elements, there are already some actions aimed at making the elements capable of hierarchization and identification through unique codes[16]. One example is the Getty's Art & Architecture Thesaurus (AAT) Research Institute[17], that is a structured vocabulary according to unique identifying elements recognized at international level for the hierarchization of the elements and their respective relationships in the field of architecture and art. The ICOM CIDOC CRM[18], acronym for Conceptual , also works in the same research sector, that is a theoretical and practical tool aimed at integrating information in the context of cultural heritage. The ultimate aim is to promote a shared understanding of information in the existing building framework, providing a semantic framework that can always be integrated with additional information[19]. Finally, in the Italian context, we recall the ICCD[20], that is the Central Institute for Cataloging and Documentation, which provides the user with a series of terminological tools in order to guarantee a shared vocabulary in the field of scientific research, guaranteeing correct consultation and use of the same[21].
The semantic terminology is also outlined for the present research as a fundamental characteristic for the success of the methodology since, the imposition of ontologically and semantically recognized terms, allows to generate in the first place a universal knowledge and, secondly, to connect knowledge according to different fields of study. The composition of a coherent terminology, reported in appendix under the heading "Ontological Glossary"[22], therefore appears to be an integral part in the choice and definition of the semantic elements of the building, even if not fully performing within the universality of the name. This is because, in the semantic definition of coastal architecture, in addition to partially intercepting the universally recognized elements, it must also adapt to the peculiar composition of the architecture, towards an optimal, personalized and unprecedented semanticization.
A further preliminary aspect to the elaboration of the semantic decomposition of the lights is undoubtedly the level of detail identified for the modeling of the elements. The creation of a geometric-semantic classification, in fact, attracts to itself the need to pursue preliminary choices to modeling, questioning about the purpose of modeling and its uses. If, as previously stated, the acquisition of the point cloud and the consequent modeling of the same in the BIM environment allows the creation of a model that is extremely similar to the real one, it is clear that this level of detail is not always the most suitable for all needs. In fact, if on the one hand this type of survey and modeling is configured as an extremely performing address in the case of restorations and detailed projects, on the other, such a level of accuracy turns out to be redundant in the case of models aimed at cultural tourism enhancement, for augmented reality and for didactic projections, for which the creation of a model of lower detail would allow to optimize the production times of the model itself (Girbarcia et al., 2013).

The preliminary choice of the objective for which the model is being created is therefore a prerequisite for defining the accuracy and detail of the model and its elements (Del Giudice, 2015). As Anna Osello (2015) recalls, in fact, the data must be defined case by case starting from specific questions, among which we recall and mention: "which/how much information should be used?; which format is the correct one for each type of information?; what is the level of detail that must be achieved for each type of information?; what information should be omitted?".
In the BIM field, in fact, the 'Level of detail' and the 'Level of Development'[23] (LOD) have the task of accurately providing the level of depth of the information contained within the model, as well as constituting a 'universally accepted' and defined degree of definition, albeit addressed in a different way by the various regulations. In the United Kingdom, the BIM PAS 1192-2 standard represents the reference standard for the exchange of parametric information, defining, from 2013 onwards, some Levels Of Model Definition (LOMD) addressed to the description of the graphic content of the definitive models from a double track: geometric and informative. In the American context[24], the American Institute of Architects (AIA) has published a specific protocol addressed to LODs entitled 'AIA G202-2013', in which five different LODs are distinguished: one passes from LOD 100, in which "the element is represented in a generic way or with a symbol", At LOD 500, in which "the element faithfully reflects reality, and is a representation verified on site in terms of size, shape, position, quantity and orientation". These levels can be conceptually defined as follows: LOD 100; conceptual; LOD 200; approximate geometry; LOD 300; precise geometry; LOD 400; constructive; LOD 500; As-built. In the Italian context, the legislation that refers to the LODs is UNI 11337-4: 2017 25, which is an indication to be observed voluntarily and not compulsory, as established by the BIM Decree (DM 560/2017). Specifically, the Italian legislation is divided into LOD[26] ordered alphabetically, providing five levels for the modeling of the elements and two other levels: the LOD F and the LOD G[27] (figs. 2, 3).
Having concluded the brief examination in the context of the definition of LODs at national and international level, it is therefore essential to understand in advance the LOD to be achieved in the process of defining a working methodology aimed at modeling coastal architectures. In this context, it is important to underline that the modeling process applied to any type of historical heritage necessarily requires a certain degree of approximation and simplification as an excessive degree of detail could be considered inappropriate and useless. For this reason, the concept of LOD (Level of Detail[28]) does not only apply to geometry but also to the reliability, accuracy and transparency of the element (Brusaporci et al., 2019), as well as representing, as already mentioned, a fundamental choice for the optimization of modeling times according to the outputs of these models (Maiezza, 2019).
At this point it is possible to carry out the definitive identification of the constituent elements of the ' lighthouse system'[29] and of how these can be represented in the parametric context. For the architectural typology of the lighthouse, be it located in Italy or in a different Mediterranean country, specific categories have therefore been identified that are present in almost all of the case studies: this is the case of macro variables and related mic variables, already discussed previously. during paragraph 3.3 "Replicable and non-replicable variables". In this sense, it is recalled that for the macro variables of the lighting system, elements such as the building, the tower and the lantern were traced (fig. 4), i.e. elements present in almost all of the case studies for the 'building' element. 'and always present as regards the' tower 'and' lantern 'elements. The latter, in turn, welcome and incorporate further peculiar characteristics, defined as 'micro variables' (fig. 5) and classified according to the macro variable that hosts them. For the building element we remember as micro variables: the number of levels, the type of molding,



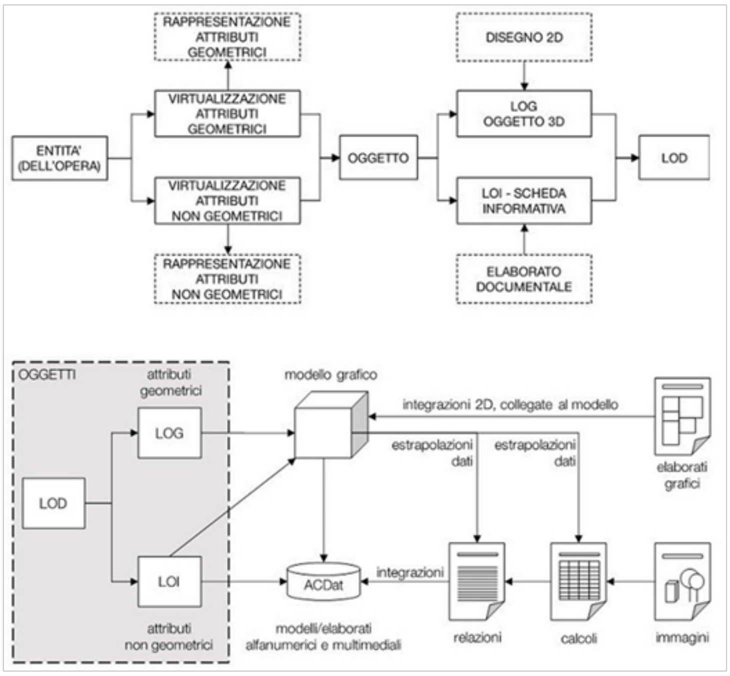


Fig. 2. Relationship between LOD and Italian, American and English legislation.
Fig. 3. Example scheme of structuring of the LOD present in the Italian standard UNI National Standard 11337-4: 217.

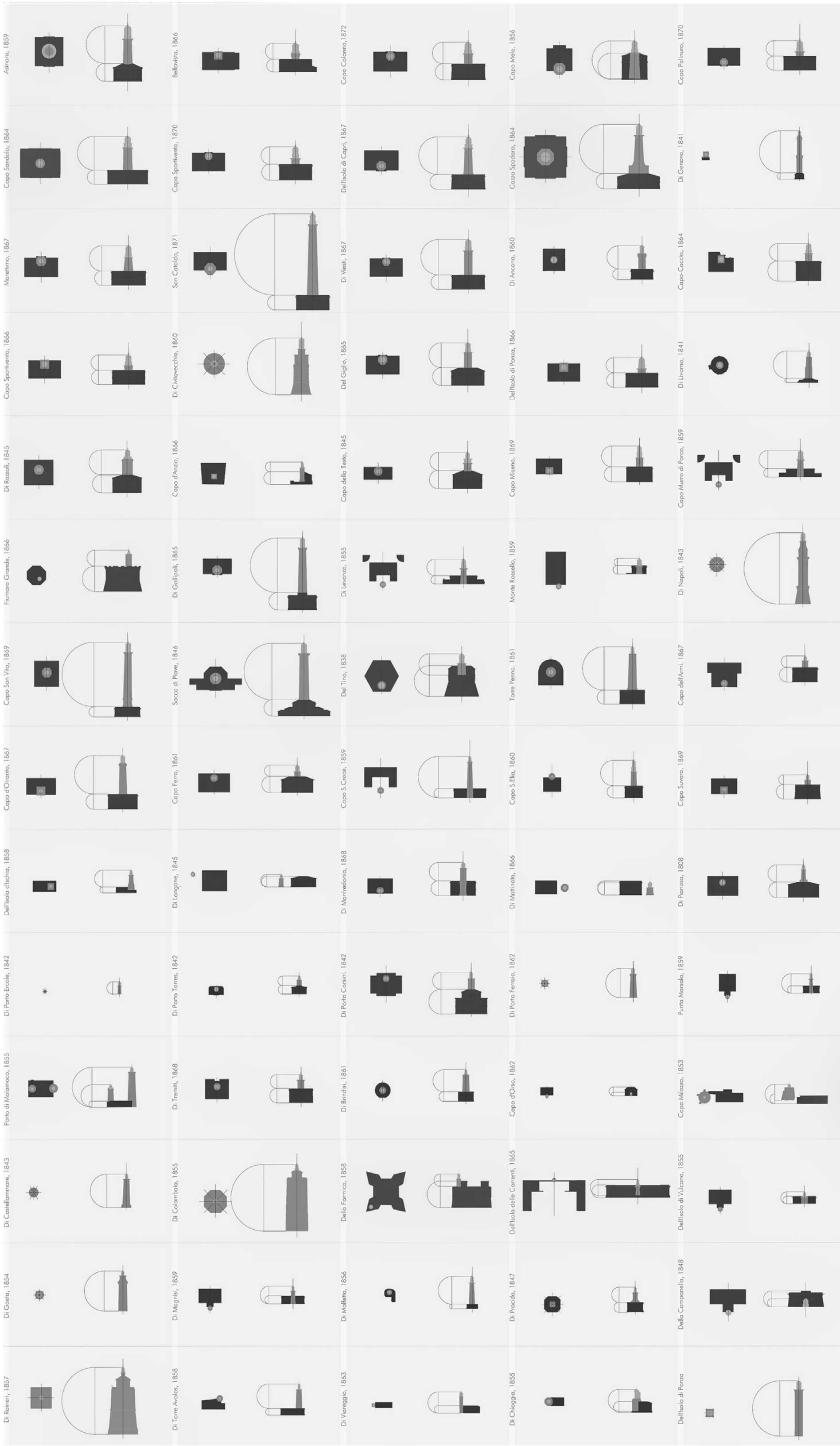


Fig. 4. The macro variables of lighthouses.

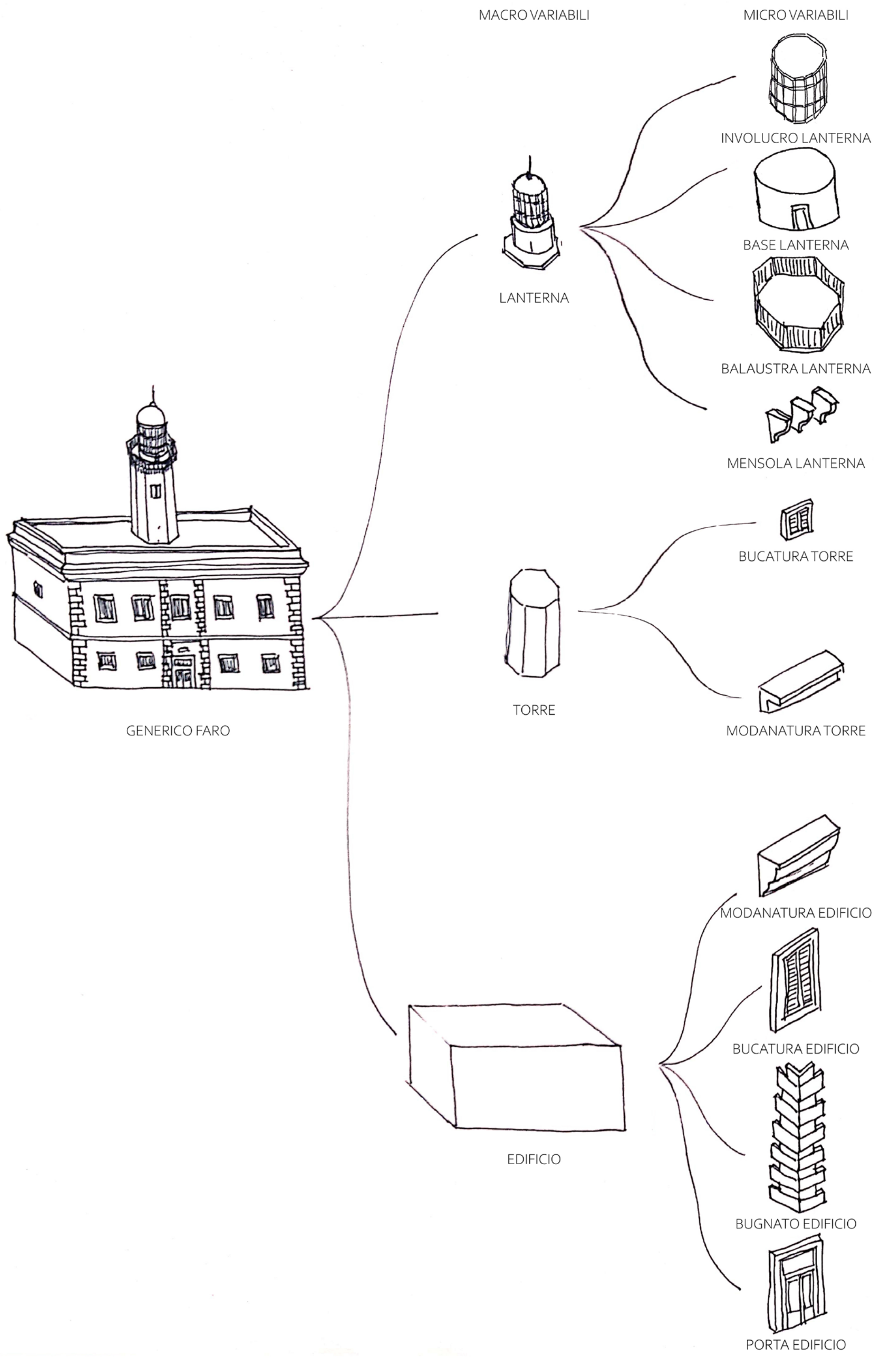


Fig. 5. Semantic decomposition of the generic lighthouse.

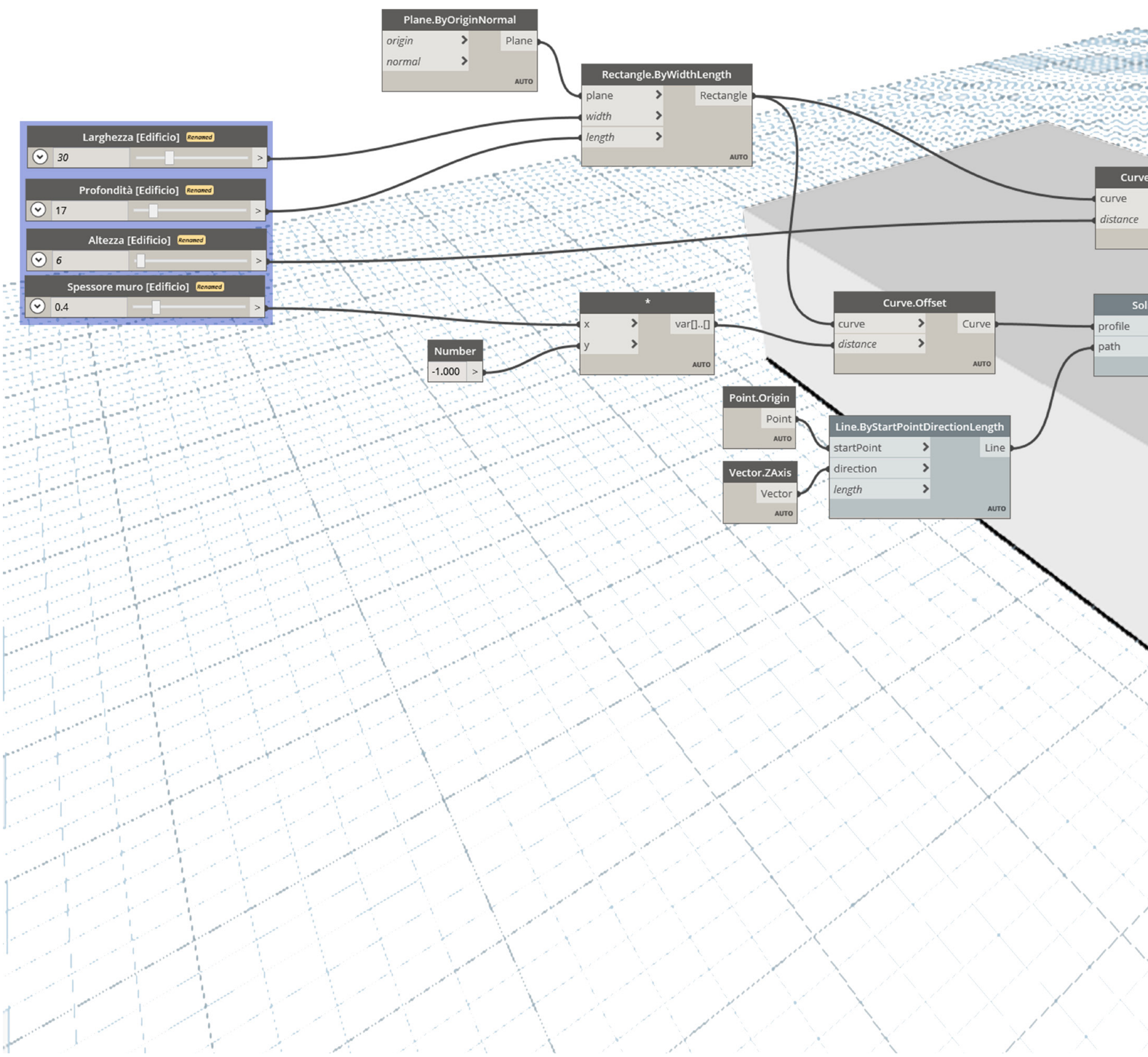
the type of hole, the possible presence of ashlar. For the tower element we remember: the section in plan; the possible presence of a shelf; the presence of tapering; the type of molding; the type of punching. Finally, for the lantern element, we recall: the type of balustrade and the section in plan. This type of subdivision obviously represents the set of cases united and characterized by a reproducibility of the elements, that is, associated by a 'genericity'. Having identified the generic variables, we immediately questioned the level of parametric detail to be obtained, an argument just discussed, as well as the best performing methodology to be adopted for the modeling of the elements.
The theorization of the modeling process proposed below is the direct consequence of the compositional apparatus of the lighthouse system and of the relative semantics connected to it. As stated by Paolo Salonia, in fact: "the semantic evaluation must be carried out before the measurement project, it must therefore be inspiring", this is because in the context of measurements, semantics is identified as a 'qualitative' measure. Citing again: "because in the measure - and in the subsequent representation - full meaning is given to the measured quantities and qualities, the semantic evaluation of the object-document to be measured should be carried out before the action of the measure and indeed this should be addressed by that" . As mentioned, therefore, the identification of semantics is configured as an obligatory step in the modeling and classification process, the actual starting point of the process of creating an adaptive methodology based on a 'basic model' containing the entire apparatus of macros and micro variables of the lighthouse system, to be adapted adaptively according to the measures relating to the specific case study to be modeled.
We therefore asked ourselves what was the optimal process to be used in the creation of this methodology. After various tests, Dynamo was therefore identified as the most performing programming system, through which the three macro variables of the lighthouses, namely the building, the tower and the lantern, were created in a semi-automatic manner. We therefore proceeded with the importation of the elements into the "project model of the Italian lighthouses" built in Revit, complete with all the loadable and system families belonging to the micro variables of the lighthouse system.
The use of this methodology, explained in the following paragraphs, makes it possible to create models close to a LOD 200, according to the American classification, and to a LOD C according to Italian legislation, defining themselves as the most effective levels in the time/detail ratio, in as custodians of the main volumes and of the fundamental detail elements, i.e. optimal level in the context of the enhancement and dissemination of cultural heritage through virtual reality, augmented reality and, therefore, in general, to the tactile and visual didactic/cognitive experiences[30].

7.3.1 Dynamo

The Dynamo[31] plug-in is in fact configured as the formal and practical beginning of the methodology proposed here. The Dynamo program can be defined as a visual programming interface[32] through which to customize the workflow related to building information. Specifically, through the aforementioned workflow, Dynamo is able to amplify the parametric capabilities that characterize Revit, through the development of data and logic through the modification of graphic algorithms (Kensek, 2014). The design is therefore configured as a 'project in code', used by specialized users with the aim of maximizing the personalization of the elements (Sandzhiev et al., 2018).
As part of the built heritage it is used, as well as for the creation of customized algorithms aimed at automating the process of creating complex and irregular geometries starting from meshes or from models based on point clouds (Barazzetti et al., 2015),

for the following purposes: support for the creation of conventional geometries, for the closure of meshes and for their transfer in Revit IFC formats; modification of Revit elements through embedded nodes that benefit from the reduction of human involvement; integration between the geometric elements of Revit and the semantic description of the ontology/database (Quattrini et al., 2017); analysis of the HBIM model such as, for example, the characteristics of the materials (Pocobelli et al., 2018).
In the parametric methodology proposed here, Dynamo is configured as the optimal tool for the adaptive representation of simple geometries to be included in increasingly specific modeling processes. In this sense, a workflow was created aimed at creating the three macro variables belonging to the 'lighthouse system'[33] - building, tower and lantern - to be modified in an 'automated' way through the numbers slider and to be imported into the Revit context net of the metric changes pertaining to a specific case study.
It is with the 'building' element that the creation of the workflow begins, although it is possible to proceed in an unrelated manner with respect to the relationship between the element and the support base. The creation of the graphic algorithm belonging to the building element is mainly based on the precise identification of the corners belonging to the rectangular geometry and of the relative offset, in order to create a parallelepiped that can be modified in width, length, height and thickness of the wall offset, through i number sliders[34, 35] (fig. 6). For the creation of the visual algorithm belonging to the tower element, the concept of representation changes. In this sense, in fact, the algorithm was first based on the creation of a circle and the relative wall offset, to then be connected to a box capable of creating different regular polygons with origin belonging to the circle itself. As with the building element, the tower element can be modified using numbers sliders associated with: radius, number of polygons, thickness of the wall, height and height of the element from the origin (fig. 7). Finally, the creation of the script belonging to the lantern element developed in the same way as the creation of the tower element as it is geometrically similar to it (figs. 8, 9).
It should be emphasized that the dome element, placed above the lantern and for obvious reasons always present in the structure of these architectures, is not assimilated either as a macro variable or, consequently, as an element to be modeled in the visual programming process. This is because the dome cannot be understood as a 'variable', as it only includes variations in the sectional curvature of the element itself. At the same time, although it is not included in the macro variables of the lighthouse, it undeniably represents a structure attached to the lantern element as a closure of the same, thus posing the necessary doubt whether to include it in the context of visual programming. In this sense, its creation on Dynamo would make it necessary to create a hemisphere composed of mesh and therefore difficult to manage even for expert users (fig. 10). The dome will therefore be subsequently built through the creation of a generic family in the 'project model of Italian lighthouses', generated through "extrusion on revolution of the specific profile".
Having created the algorithms, and therefore the geometries, relating to the macro variables of the 'system-lighthouse', it is now possible to save the elements in extension .sat, through which to proceed with importing the modified elements into Revit according to your needs. As part of the 'project model of Italian lighthouses', these elements are already imported (fig. 11). In fact, once the geometric characteristics of the elements have been modified, the user will simply have to proceed with the "Reload" of the file, present in the Revit interface under the heading "CAD formats" in "Manage links". Proceeding with the 'reload' of the model .sat, depending on the new geometric attributes assigned, the latter will consequently be modified and already present in the Revit workspace, ready to be used as a basis for inserting the semantic families proposed below.

Following pages:
Fig. 6. Dynamo script for building construction.
Fig. 7. Dynamo script for the construction of the tower.
Fig. 8. Dynamo script for the construction of the lantern.
Fig. 9. Dynamo script of the entire 'macro-variable' apparatus of the generic lighthouse.
Fig. 10. Creating a mesh hemisphere on Dynamo. model .sat.
Fig. 11. Refill model .sat.



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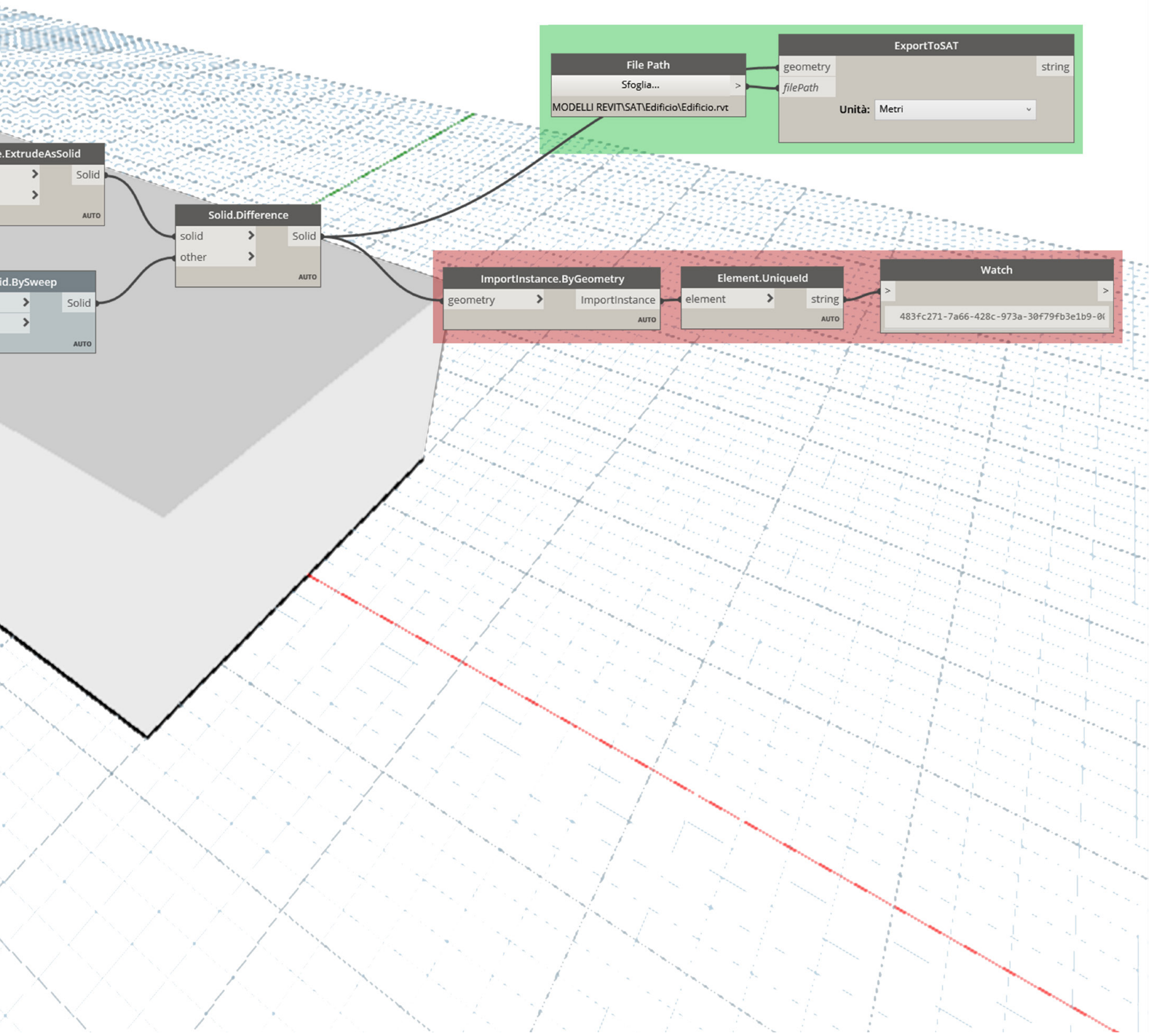

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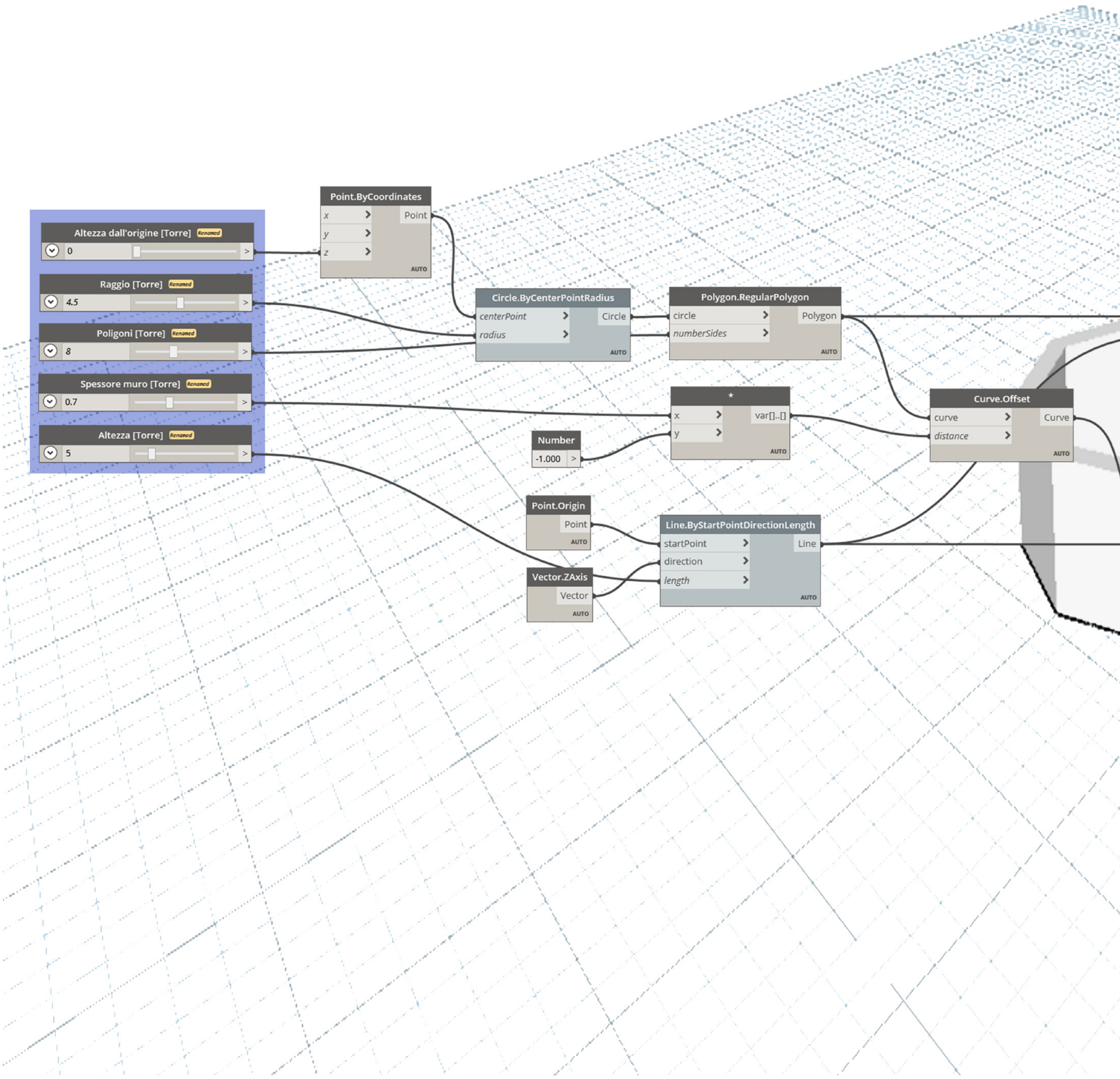

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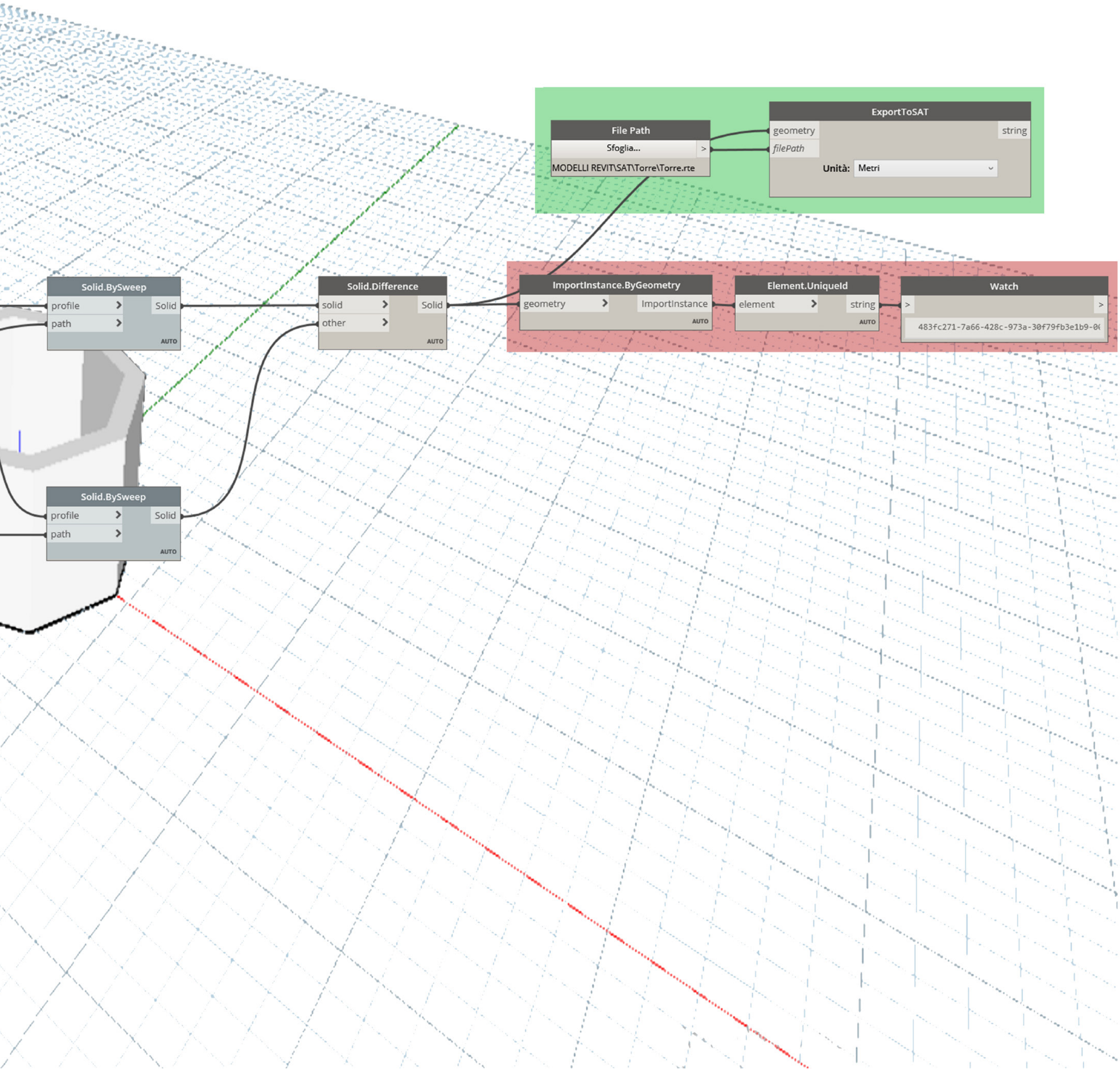
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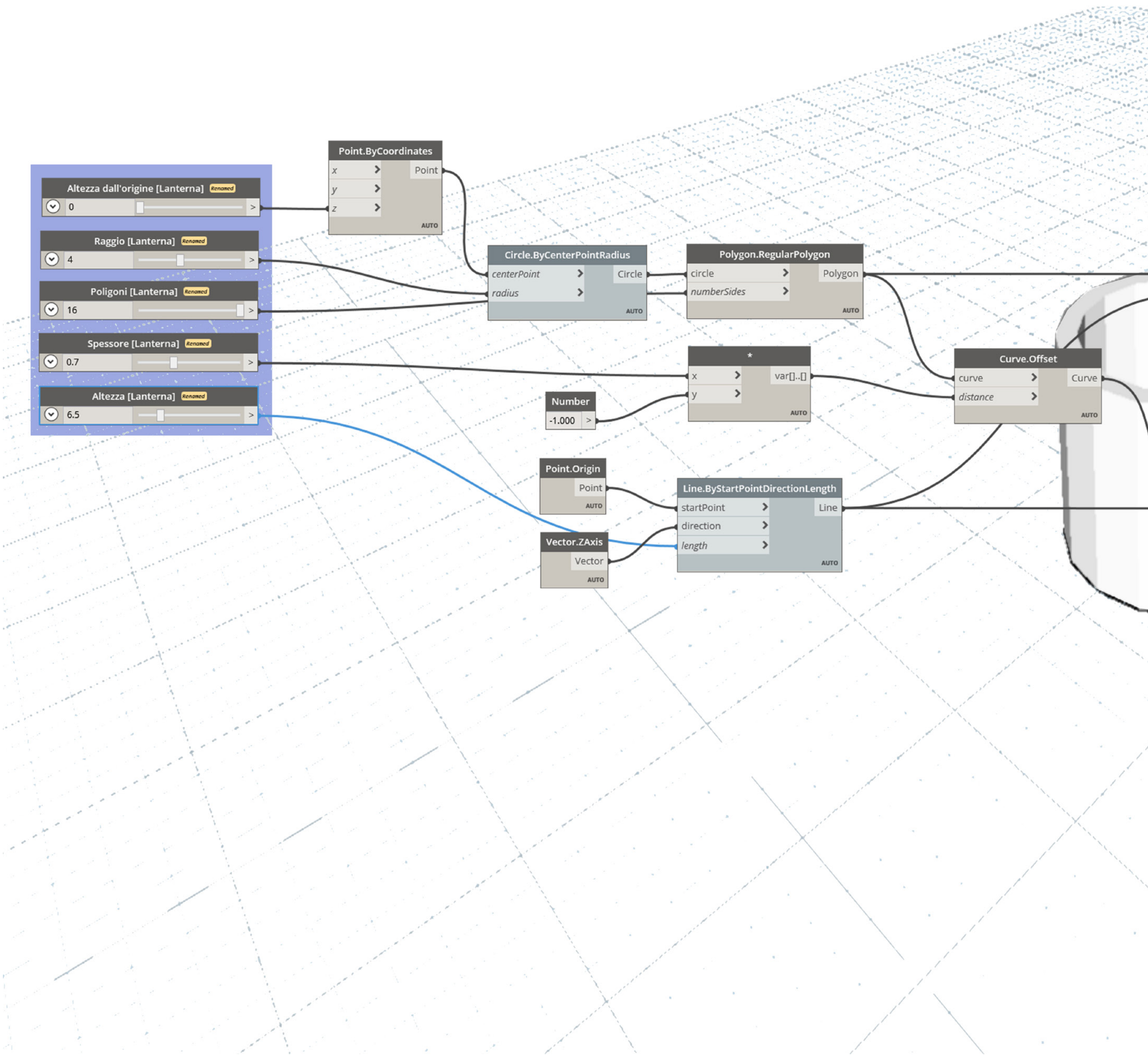

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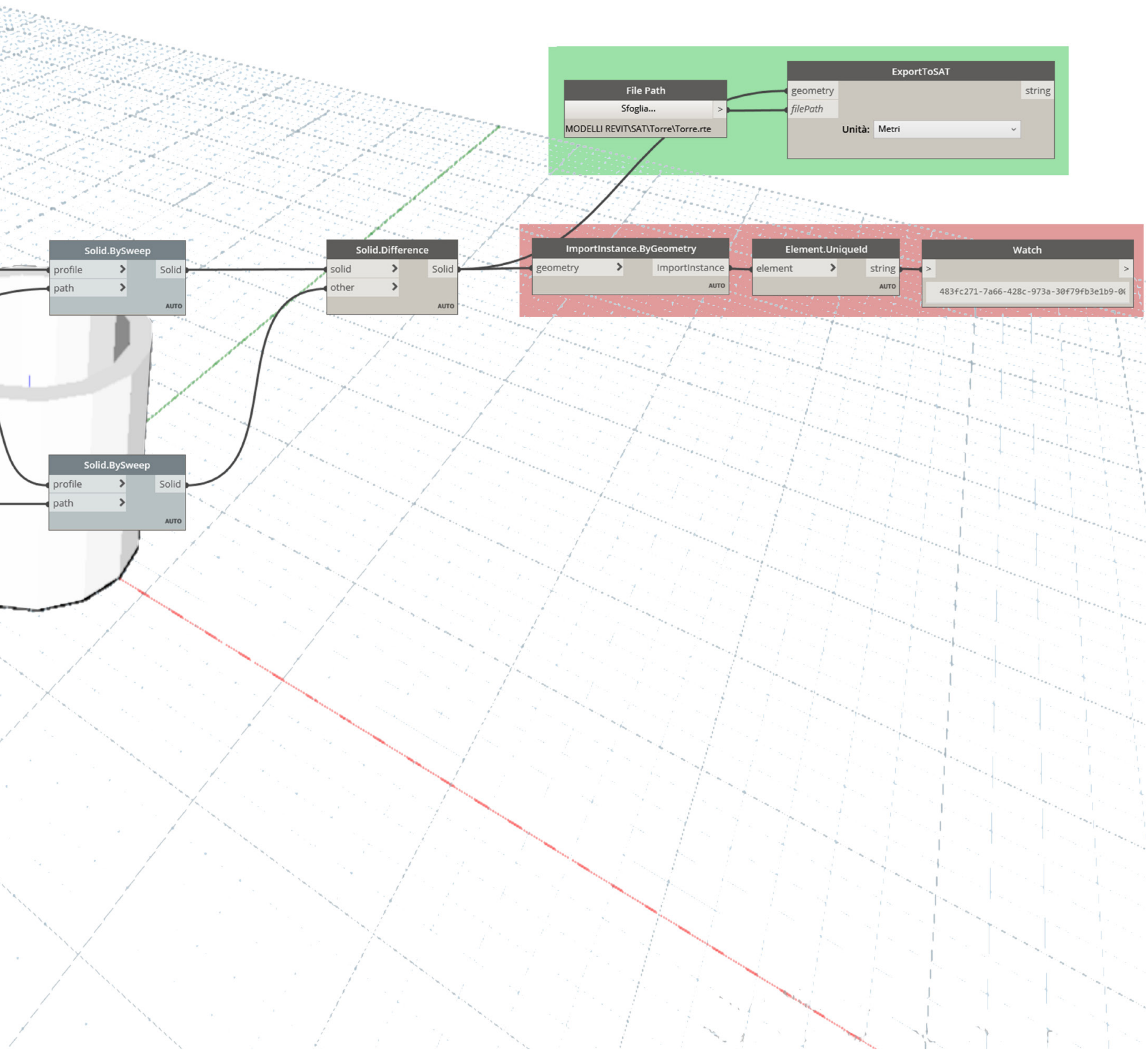
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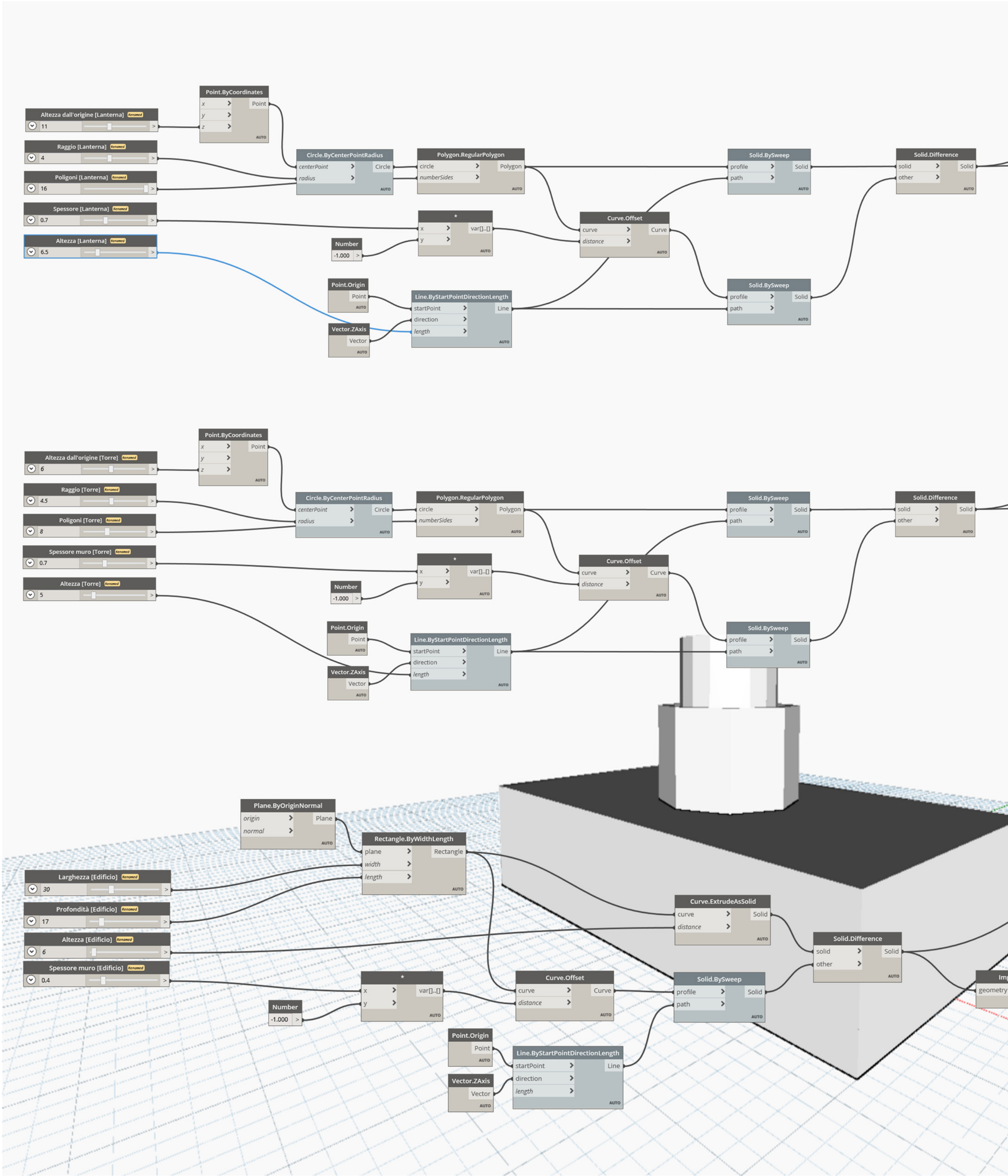
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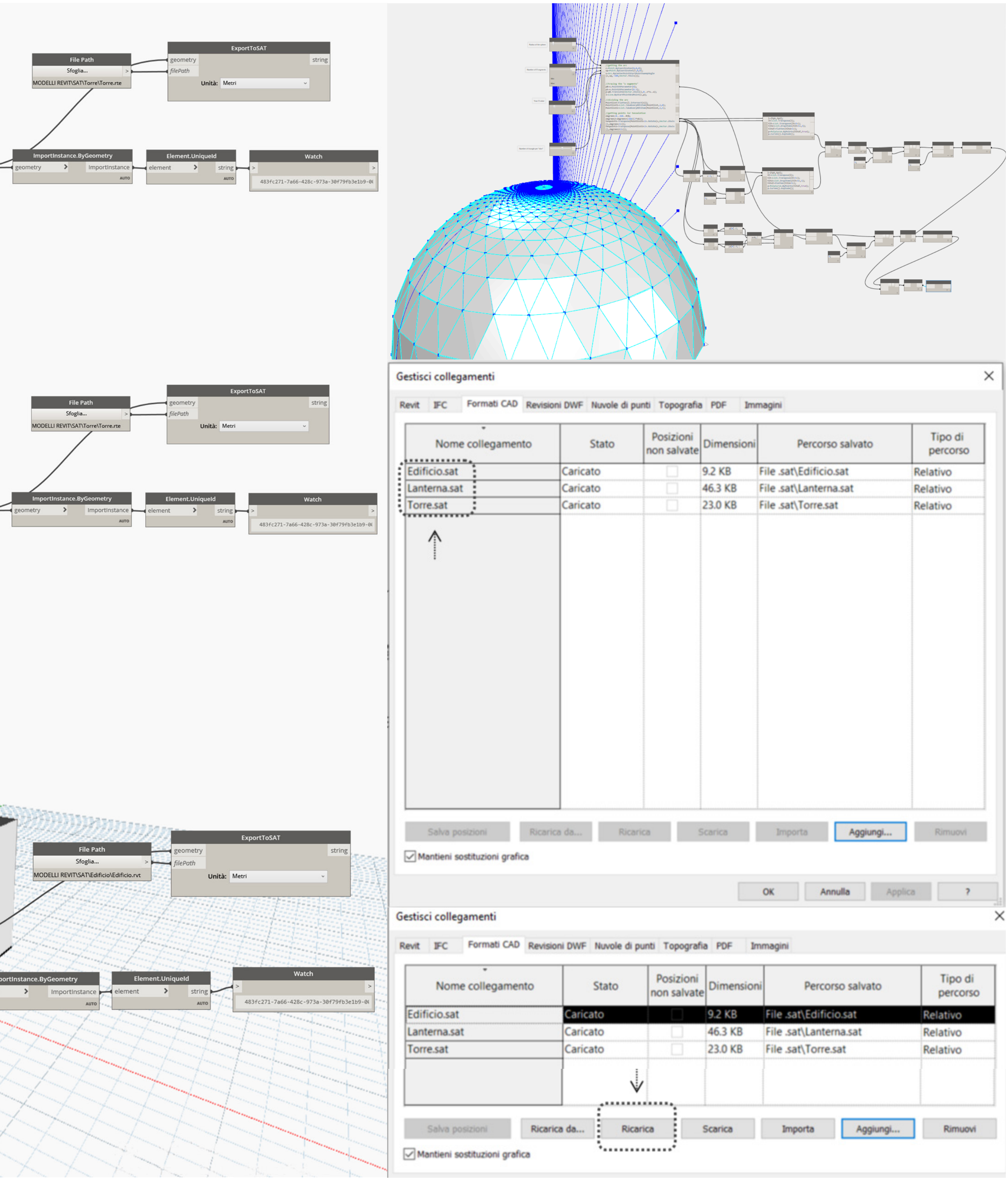
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7.3.2 Parametric modeling: typology of families

Having concluded the treatment and the relative modeling of the macro variables of the 'generic lighthouse', it is now necessary to introduce the concept of family in the parametric software, in order to proceed with the practical treatment relating to the creation of the families themselves. This is because the choice of the type of family to be used for the modeling of the micro variables on Revit is a fundamental and preparatory aspect, in order to guarantee a simple and immediate use of the architectural element. Nevertheless, it is important to specify how, regardless of the correct choice of the family, the BIM process is always configured as a software characterized by roofs, walls, floors, doors and windows, i.e. standardized elements, albeit entirely modifiable (Bonazza et al., 2010).
Families are parametric components of Autodesk Revit and allow the creation of various types of elements associated with each other from geometric, material, systemic and contextual behavior information (Garagnani & Cinti Luciani, 2011). Each element to be created in Revit must be modeled starting from a family, choosing the most suitable among them, in order to facilitate the modeling process and to guarantee correct management and cataloging of the element.
Parametric families can be divided into three types: system families, in place families, that is 'local' and standard components. System families are predefined families within the program and constitute the basic elements of a building, such as walls, doors, floors, windows, etc. It is not possible to load them from external files but through the use of these families it is possible to reach a customized element starting from the basic elements. Local families, on the other hand, are families created specifically for a model and are created and loaded into projects as needed and, as they cannot be inserted in any other context, they are defined here as 'non-replicable' elements. This type of family is created in external extension files. rfa and subsequently imported or loaded from time to time in the projects. Finally, standard or loadable components are by far the most common families and can be inserted into projects and project models by establishing a basic library from which to draw on in the processes of each type of modeling. This type of family is often modeled outside the final project but always within the Revit program , or in general BIM, often hosted by 36 system families . The elements created as standard components are therefore constituted as elements not created specifically for a project and can therefore be inserted several times in different models, configuring themselves as the most used families in the creation of the "project model of Italian lighthouses".
It should be emphasized and remembered that families - whether they are loadable, local or system - are classified in the parametric software by category, thus allowing the grouping of the elements created into Content Libraries or in the Project Browser, through which to modify the type properties and the instances of the families themselves. Changing the type properties will change all the information applied to all type instances of the selected family. The instance properties, on the other hand, contain information relating to a specific element of the inserted family and, therefore, the modifications of the information will be made only to a specific instance belonging to a specific family.

7.3.3 Semantics: identification of geometric attributes

As just described, the detailed discussion of the characteristics pertaining to the different families is configured as a necessary examination to understand the choices addressed to the modeling of the specific semantic components connected to the coastal architectural modeling methodology. Continuing with the discussion of the methodological

flow, and remembering how the three macro variables of the lighthouse system have already been included in the 'project model of Italian lighthouses', it is at this point necessary to proceed with the creation of semantic families, whether they are system or loadable[37], through which to create a specific library relevant to the spotlights. Entering into the heart of what is the methodology, we want to make explicit, in the course of the following subparagraphs, the precise choice of the families associated with the different semantic components of the 'lighthouse-system'.
In order to proceed with the choice of the most suitable families to host the semantic elements, please note below, only as a summary, what is identified in the course of paragraph "6.2 The semantic atlas of Italian lighthouses": "For the part 'building' the following have been identified: the levels that make up the building; the possible presence of angular ashlar; the type of moldings and the type of openings. For the macro-variant 'tower' the following have been identified: the plan section of the tower; the possible presence of tapering of the geometry in elevation; the type of moldings; the type of openings and the possible presence of shelves under the tunnel. Finally, for the macro-variable 'lantern' the following were identified: the type of balustrade in the gallery and the type of shell that protects the lens and, therefore, the light emission" (figs. 12-14). If the macro variables are elements already modeled on Dynamo and subsequently imported into Revit, the semantic characteristics belonging to the micro variables - such as moldings, openings, ashlar, balustrades, etc. - are still elements to be defined in a geometric and parametric context.

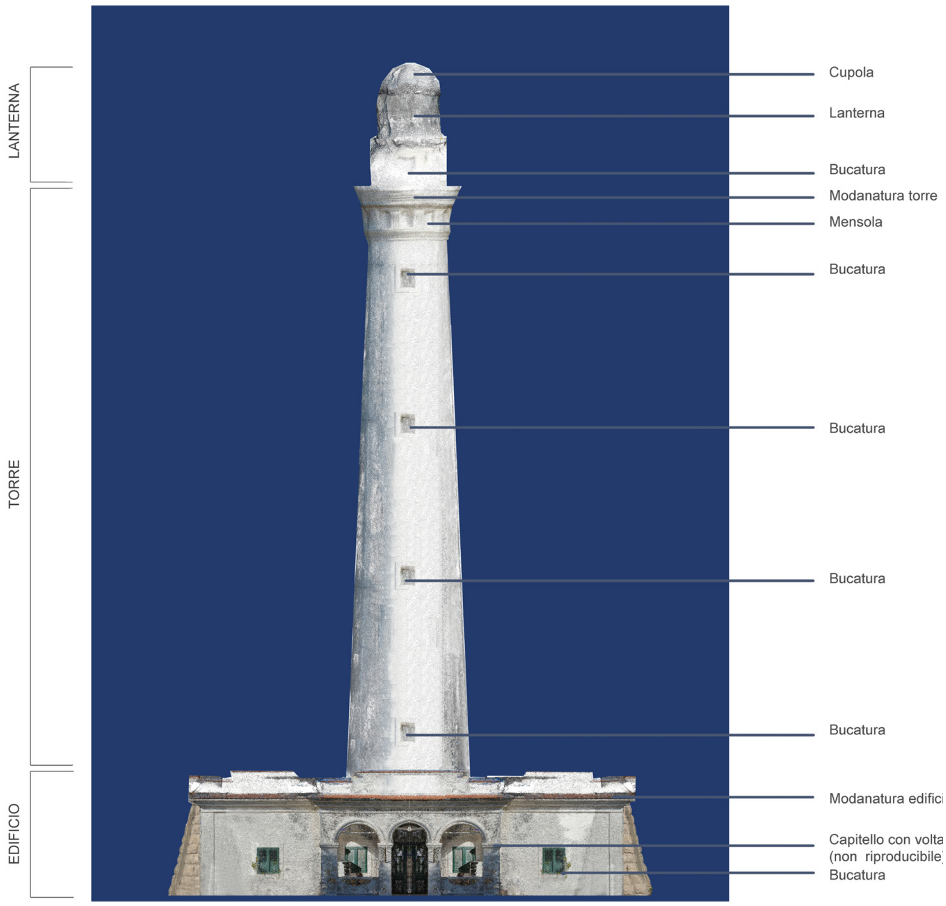
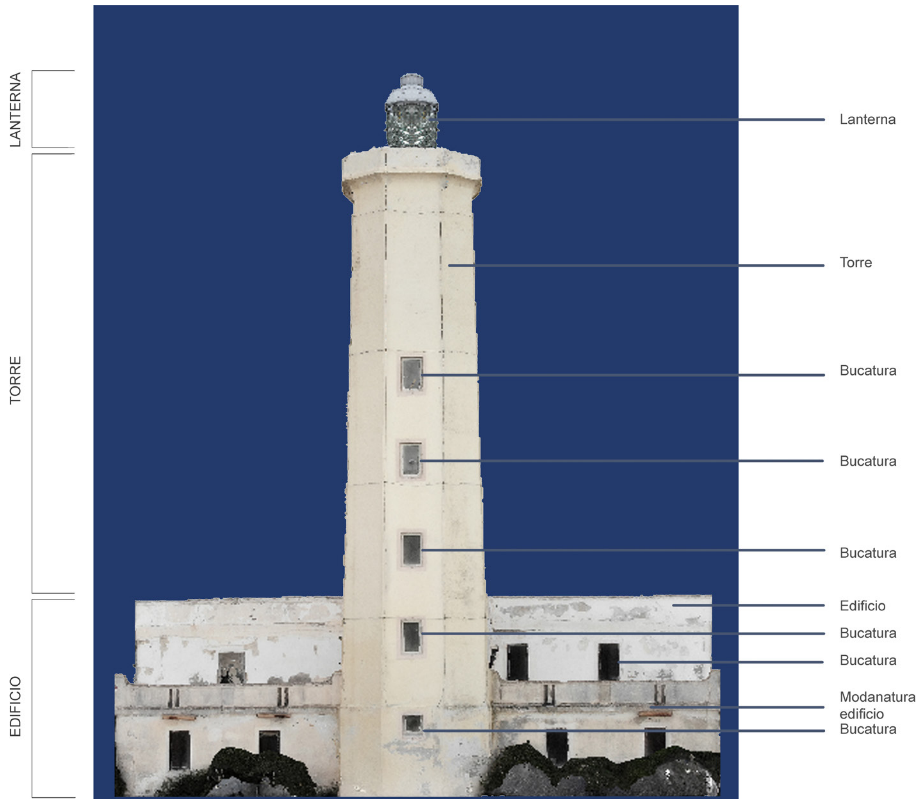


Fig. 12. The Capo Colonna lighthouse: decomposition into macro and micro variables.



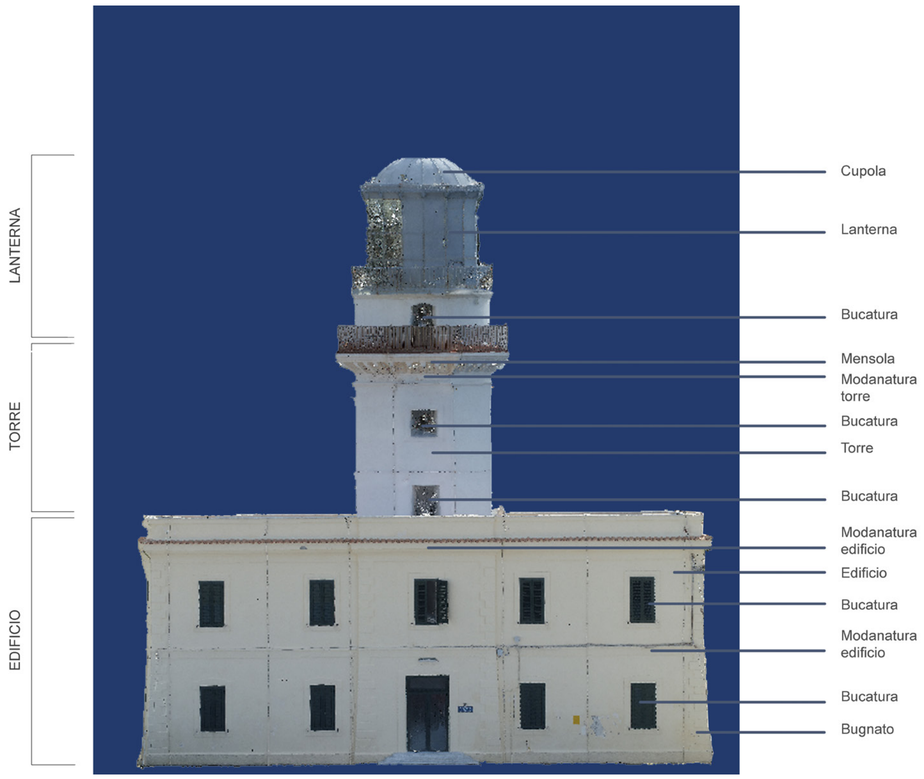
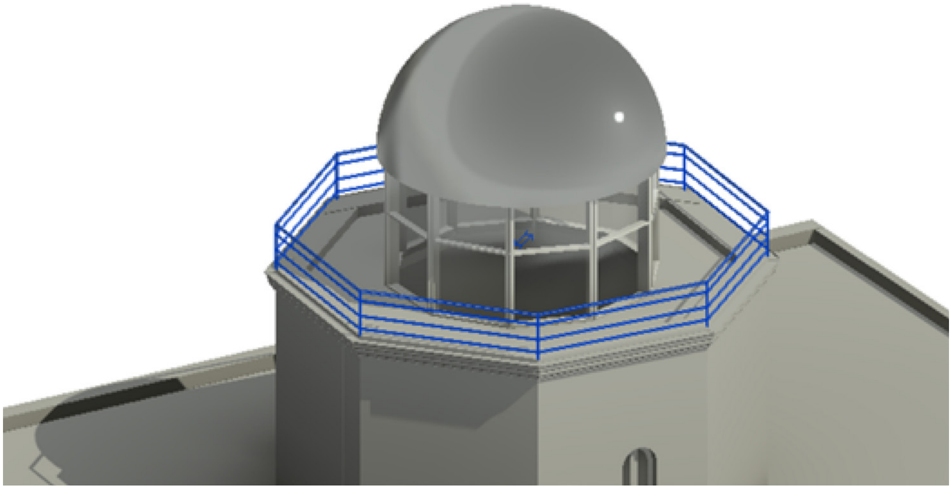


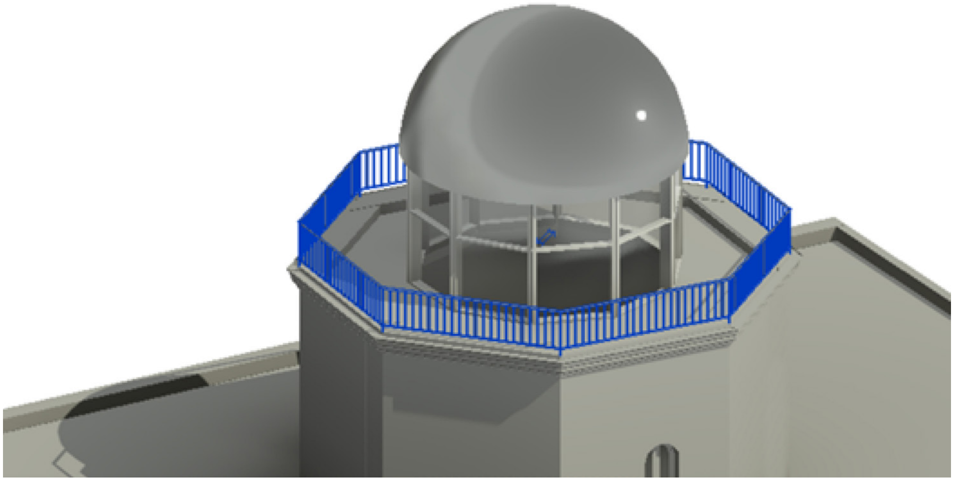
Fig. 13. The Capo Colonna lighthouse: decomposition into macro and micro variables.
Fig. 14. The Punta Alice lighthouse: decomposition into macro and micro variables.

As regards the associations made between the types of families and the semantic elements to be modeled, for the micro variables 'molding' - whether it belongs to the 'building' system or to the 'tower' system - and 'window' has become more efficient the use of a loadable family of the 'metric profile' and 'metric window' type respectively. For the micro variable belonging to the 'balustrades' category, the system families were used, modifying the families already existing in the parametric software. Finally, for the micro variable relating to the 'ashlar' category, a loadable family of the 'generic metric based on wall' type was used , as it is directly hosted by the wall element.
This list is configured only as a summary and non-exhaustive framework of what will be, in the course of the following subparagraphs, the treatment and actual creation of the families to be included in the 'project model of Italian lighthouses', during which they will also be exposed the reasons for the choices and semantic classifications of the elements.

7.3.3a Replicable semantic modeling: system and loadable families

With this paragraph, the discussion and practical creation of the methodology begins, during which the families used for the elements to be modeled will first be identified and, subsequently, the compositional processes of the family itself will be developed, in this case exclusively of type 'system' and 'loadable'. The system families, as previously mentioned, are configured as families already inserted in the parametric software, mainly addressed to the creation of the basic elements of a building, they cannot be inserted from external files but, instead, they can be customized in geometry and size through type modification. In this thesis, in order to proceed with the modeling of the semantic elements of Italian lighthouses, we have chosen to use this type of families only for the balustrades, i.e. elements already existing in the parametric software interface under the heading 'railing', making it less complex the creation of the template and, on the other hand, the more expeditious use of semantic elements in the modeling process of a specific case study.
It should also be emphasized that the use of balustrades already present in the system is configured as an optimal choice in relation to the detail scale used for the elements. As has been said several times, in fact, the modeling obtained by this methodology, which does not include a photogrammetric survey, makes it possible to create 'approximate' geometric shapes, a scale of detail, therefore, for which the creation of specific families can be loaded with type 'metric railing' would have proved not legitimate with respect to the relationship between the level of detail and the laboriousness of creation and insertion in the project model.
The types of balustrades - present in the macro variables 'building' and 'lantern' - can therefore be divided into four types, including: 'vertical currents', 'horizontal currents', 'cross currents at x' and in concrete (figs. 15-17). Once the replicable typologies belonging to the Italian lighthouses were identified, they were therefore built and created in the parametric field. As a system family, it was not necessary to identify parameters and constraints aimed at modifying the parametric structure of the balustrade element, since , as visible in the type properties panel of the railing element (fig. 18), it is possible, defined the host and the explication trajectory, easily model the structure using the labels already present in the system.
Loadable families, on the other hand, are configured as the most used families in the parametric field, aimed at creating libraries from which to draw during the modeling process of different case studies - as they can be easily modified through labels linked to each other - and for this reason more used during the methodological flow aimed at





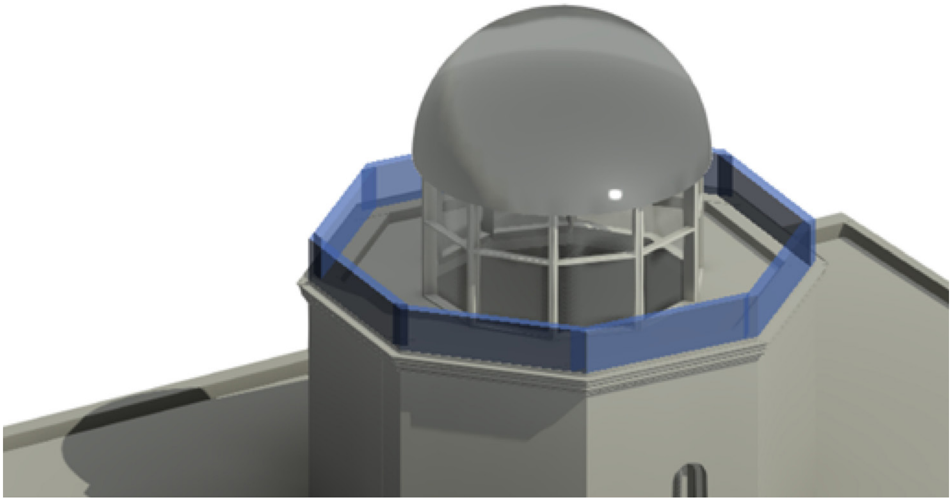


Fig. 15. Generic lighthouse: steel handrail with horizontal currents.
Fig. 16. Generic lighthouse: steel handrail with vertical currents.
Fig. 17. Generic lighthouse: concrete handrail.

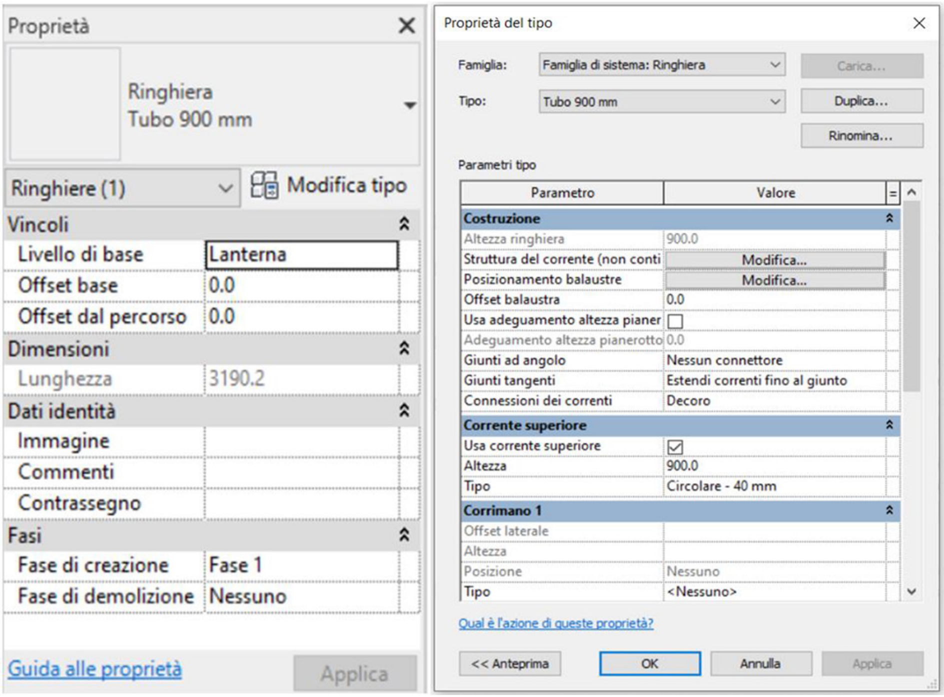
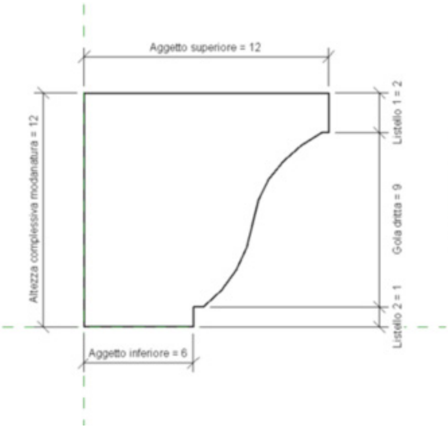


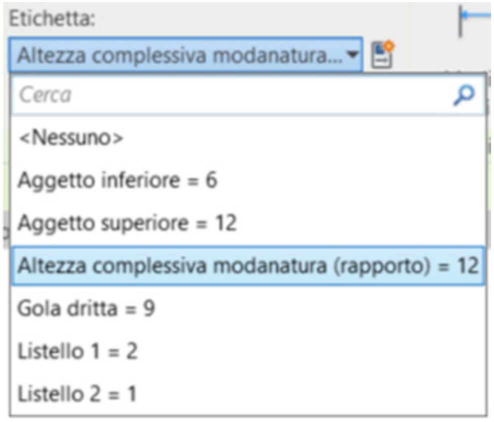
Fig. 18. Railing system family: type properties.

the creation and insertion of the micro variables belonging to the Italian lighthouses. This type of family is therefore defined as extremely performing for the modeling of the micro variants shown below, which we remember to be: the 'dome', the 'ashlar' and the 'moldings'[38].

For the micro variable 'molding', present in the macro-variables 'building' and 'tower', thirteen types were found for the building element and seventeen types for the tower element, some of which coincide. Therefore, having identified the types of moldings identified for Italian lighthouses - i.e. classifications resulting from the precise cataloging of the characteristics of the lighthouses, which can be consulted in the appendix - we proceeded with the construction and creation of the same in the parametric field. The creation of a specific molding, aimed at composing the entire parametric apparatus of the "Italian lighthouse model", takes place with the opening of a new loadable family of metric type, a more performing type through which to guarantee a direct import into the model, that is, along the entire profile of the architectural geometry. In this context, the relationships between the modules and the totality of the geometric composition are more important than the specific measurements of the geometry. This is because the intent of the methodology is not to build a molding aimed at a specific lighthouse, but a basic model to be used and subsequently adapted with respect to certain case studies. Once the geometric-stylistic design of the molding has been completed, we proceed with the insertion of the dimensions and labels (figs. 19, 20), through which to adaptively modify the measurements of the molding without distorting its profile. In fact, labeled dimensions are configured as editable parameters for families, whose values can be changed using the 'family type' dialog in the family editor. When the family is loaded into the project, it is possible to modify its instance parameters directly from the properties palette.

By opening the basic project model, in which the main wall geometries specific to the case study to be modeled have already been reloaded, it is therefore possible to insert





Parametro	Valore	Formula	Blocca
Dimensioni			
Aggetto inferiore	5.50	=	☐
Aggetto superiore	12.30	=	☐
Altezza complessiva modanat	12.00	=	
Gola dritta	9.00	=	☐
Listello 1	2.00	=	☐
Listello 2	1.00	=	☐
Dati identità			

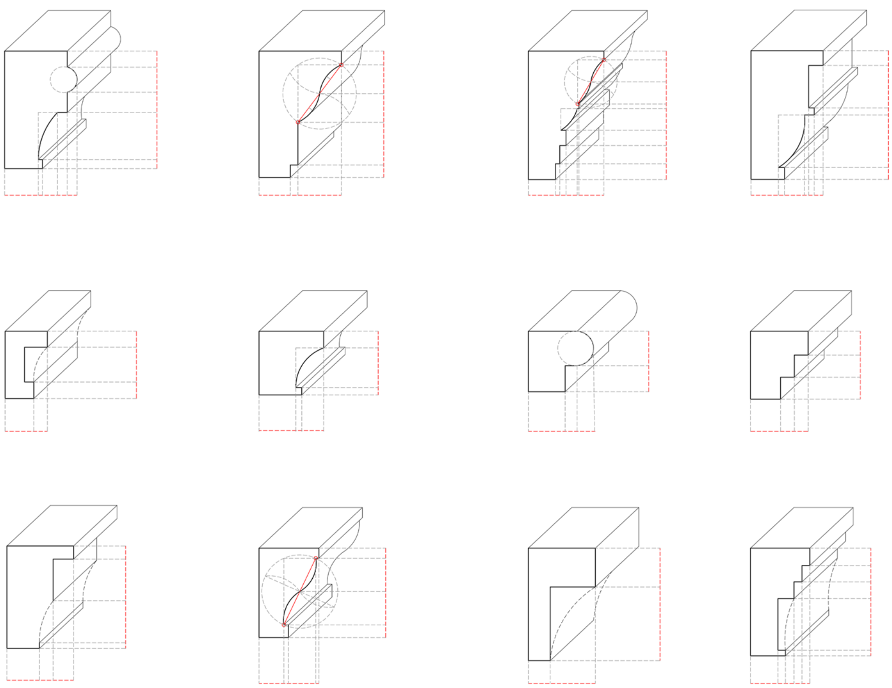
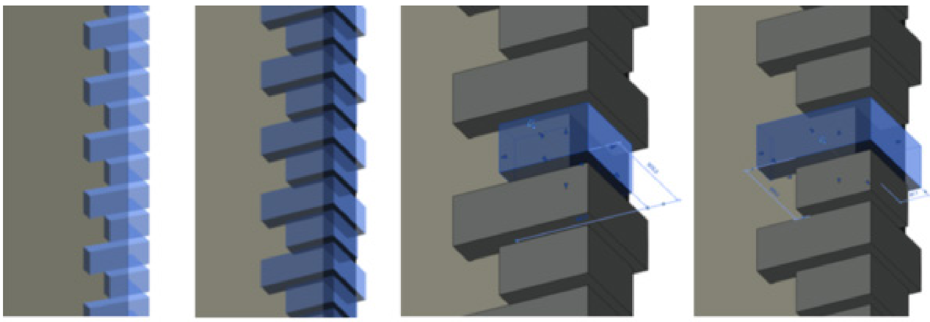


Fig. 19. Inserting labels and relative modification of the reports.
Fig. 20. Type of family: dimensional parameters of the inserted labels.
Fig. 21. Moldings identified for the tower element.

one or more moldings created by drawing from the list of profiles already present in the 'project model of Italian lighthouses' (fig. 21). The process of inserting the "wall: extrusion" element makes it possible to directly create the "decoration" profile associated with the molding along the entire perimeter of the architecture, of which, in the "constraints" section, it is possible to change the height of the insertion of the molding itself, according to the reference levels created in the basic project model[39]. In the "change type" section, however, it is possible to select the type of profile to be inserted as molding, both for the 'building' element and for the 'tower' element, while still guaranteeing the possibility of changing the individual measures for each type molding inserted in the model.
Working in the basic model, in fact, as already mentioned several times, it is possible to draw from different families constituting a 'library of elements' capable, on the one hand, of speeding up the modeling process and, on the other, of creating a library of elements useful for permanent and intangible knowledge of the history and architecture of the lighthouse.
As far as the creation of the angular ashlar is concerned, it was decided to use a loadable family generated by a 'generic metric model based on a wall', i.e. a type of model 'hosted' by the wall element present in project[40]. For the creation of the loadable family



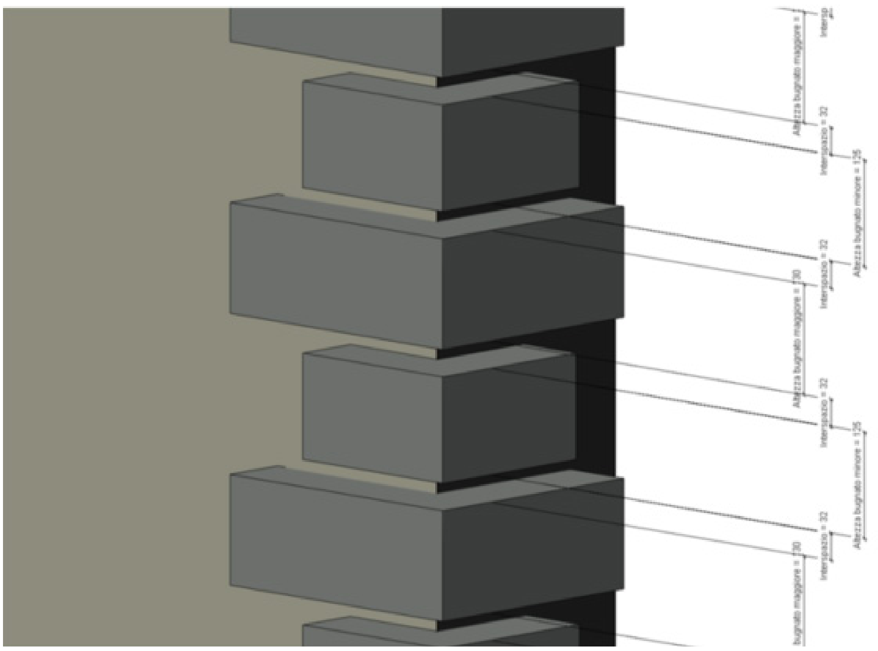


Fig. 22. Construction of ashlar elements on host wall.
Fig. 23. Inserting labels on ashlar.

belonging to the ashlar we therefore proceeded with the modeling of the three-dimensional elements useful for the configuration of the angular ashlar, without paying specific attention to the measures of the elements. As in the case of the moldings, also for the ashlar, only their geometry was taken into account and not the specific size since (figs. 22, 23), as already stated, the intent of the methodology is not to build an ashlar - and in general an element - addressed to a specific lighthouse, but a basic model to be used and adapted subsequently with respect to specific case studies. In this sense, in fact, the sizes of the individual elements that make up the ashlar can be subsequently modified by the modeler directly from the project model, in an almost completely automated manner[41].
Once the design of the three-dimensional elements that make up the ashlar has been completed, the dimensions and the consequent labels are inserted, through which the measures of the elements can be adapted adaptively without changing their geometric setting and the host connection with respect to the wall element. The insertion of the dimensions is therefore associated with labels relating to all the measures - width, thickness, elevation - of the single element concurring the composition of the angular ashlar. Finally, in the 'family types' section it is possible to consult and modify the measures relating to the individual labels[42] (fig. 24), thus making it possible to adapt the 'basic' model to the final element to be created, addressed to a specific case study. Once the labels have been set, it is now possible to transfer the loadable family relating to the ashlar to the 'project model of Italian lighthouses', that is to say an action to be carried out once, upon creation of the project model itself[43].

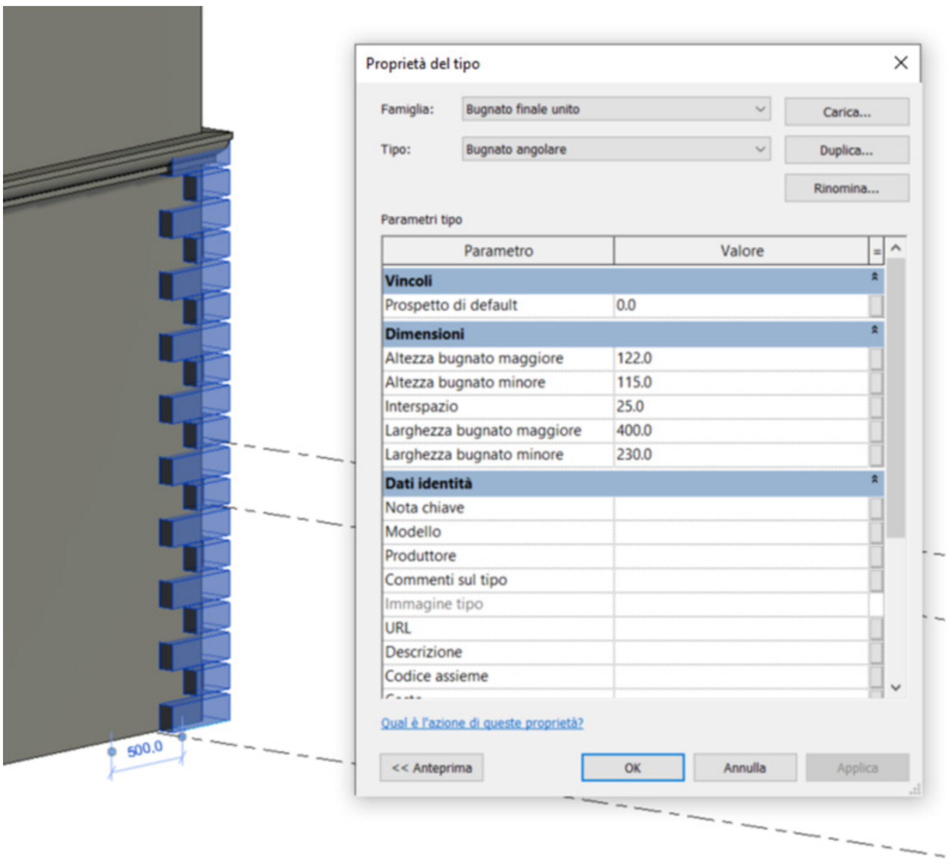
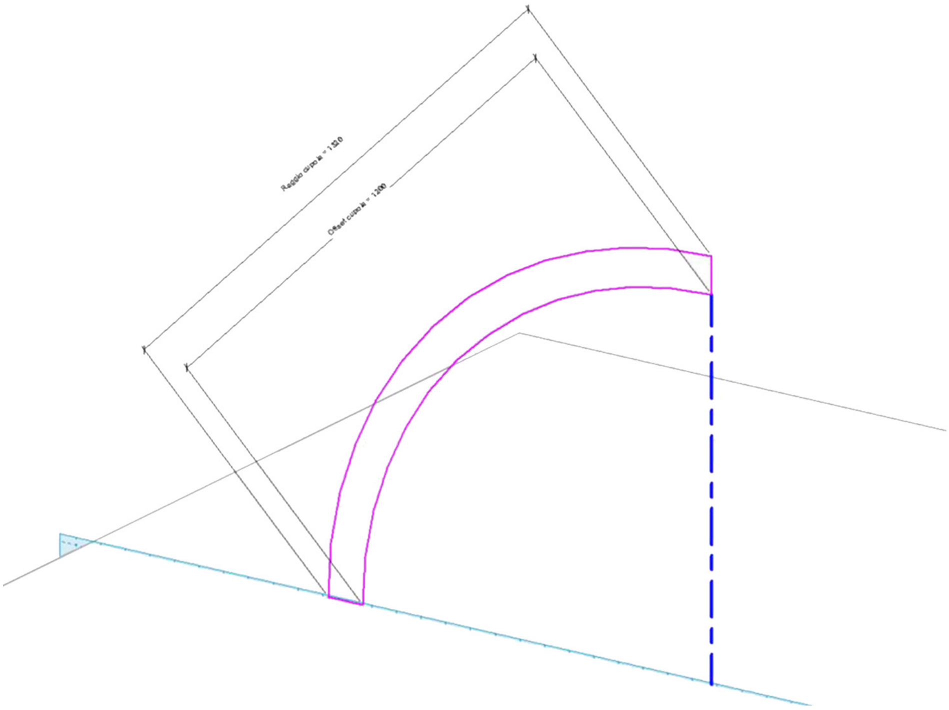
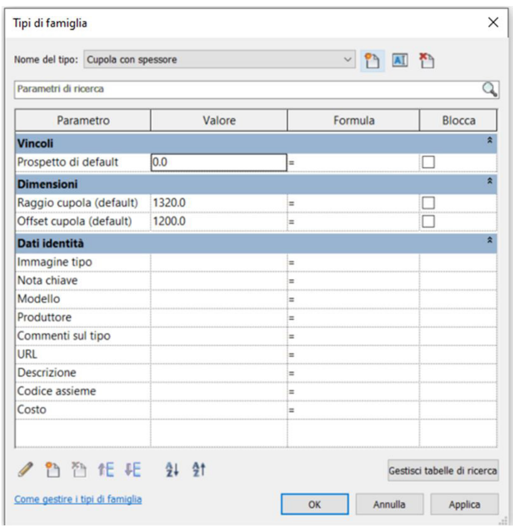


Fig. 24. Adaptation of the generic ashlar to the case study.

Once the discussion concerning the creation of the elements that make up the angular ashlar and the moldings is concluded, it is possible to introduce the creation and the parametric definition of the element placed above the lantern: the dome, that is a hemispherical or conical steel cover, covered in copper and zinc. As previously underlined, the dome element, although an integral part of the lantern macro variable, for obvious reasons always present in the structure of these architectures, is not assimilated either as a macro variable or, consequently, as an element to be modeled through the use of programming visual since, being characterized by a single radius of curvature, the use





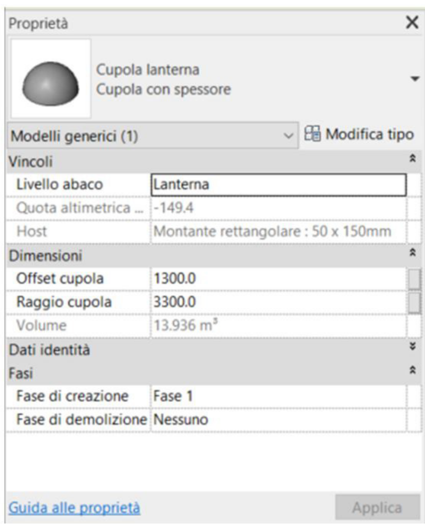


Fig. 25. Creation and labeling of the dome.
Fig. 26. Dome labels.
Fig. 27. Type properties of the dome element.

of a loadable family is configured as more congruous and simple, through which to modify the section of the same in an easier way. As previously described, in fact, the creation of the section editable dome element on Dynamo would have made it necessary to create a hemisphere composed of mesh and therefore difficult to manage even for expert users. For the parametric creation of the dome, it was therefore decided to use a loadable family of the "generic surface-based metric model" type, making it possible not only to define several types - in this case with single curvature and double curvature - but also the insertion of labels through which, as implemented during the creation of the other generated families, modify the metric apparatus in an adaptive way. We therefore proceed with the opening of a new family and with the creation of a 'shape by revolution', tracing the section lines useful for the construction of the dome and its axis line (fig. 25). Finally, the labels are inserted (fig. 26), making the drawing dimensionally constrained and ready to be modified according to one's needs through the 'family types' window (fig. 27).
By opening the basic project model, in which the main wall geometries specific to the case study to be modeled and the relative lantern have already been created, it is therefore possible to insert one of the two types already present in the model: single curvature and double curvature, modifying the type and instance parameters directly from the project browser. The process of inserting the dome element is configured to be easy as the family associated with the dome, i.e. 'generic metric model based on a surface', appears to be hosted by a surface and therefore, upon its insertion, it will be possible to constrain it directly to the surface, on the top of the lantern (fig. 28).

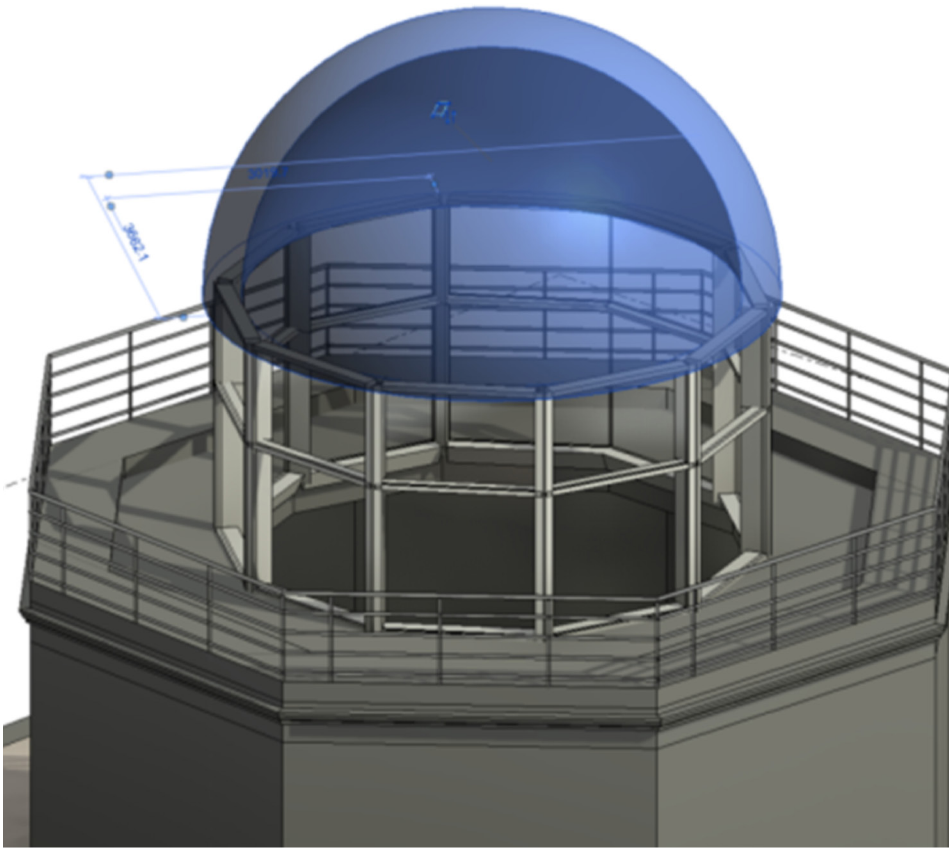
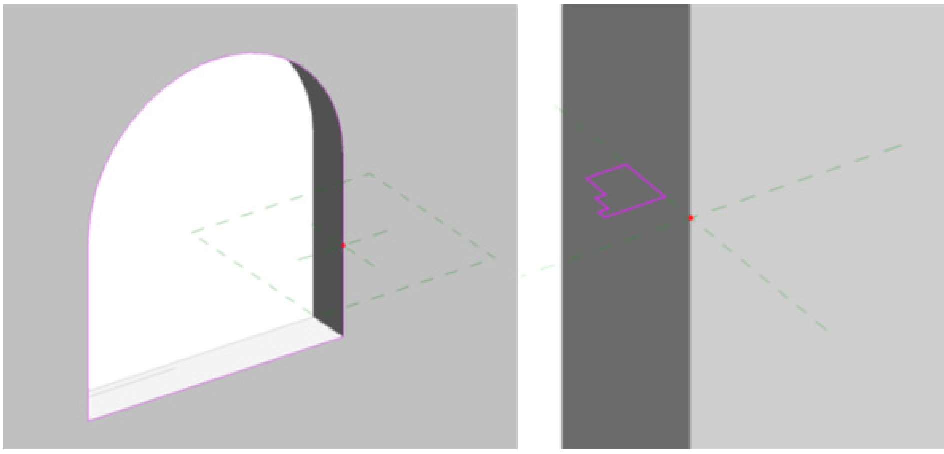


Fig. 28. Insertion of elements created on a generic lighthouse.

Finally, we proceeded to the production of the last semantic category created through the use of loadable families: the windows. As for the moldings, the process of identifying the openings was carried out through the analysis and classification of six specific recurring typologies for the 'building' element and eight typologies for the 'tower' element, typologies almost entirely coinciding with each other, different only in size. For this reason, since the parametric model can be modified through the type properties, it was therefore considered sufficient to proceed with the creation of eight main window-type parametric families, that is: vertical with single leaf; vertical double leaf; vertical double leaf with vault; double hinged horizontal; vertical single-leaf with vault; horizontal with single leaf; square; circular.
For the production of the individual families, a new 'window family' is created, hosted by the wall element, to be inserted in the library of the 'project model of Italian lighthouses'. The methodological process for the creation of the single typologies is the same as the one previously adopting, therefore, for this reason, we have chosen below to illustrate only the modeling of the 'vertical double leaf with vault' typology.
Unlike the process put in place for the creation of the moldings, this type of modeling includes preparatory actions to be implemented with respect to the insertion of the final height and width labels of the finished element. The first element to be created, in fact, is the fixed frame using the 'extrude on path' command, first defining the extrusion path and then the section to be extruded (fig. 29). Constrained the fixed frame to the host masonry and affixed the dimensional labels of height and width, it is possible to model the remaining structure composed of the mobile frame and the glass. Following the same modeling methodology, we proceed to the creation of the mobile frame, the glass and the threshold, taking care to bind the elements created to the connecting elements each time. In this way, a set of constraints and parameterized dimensions will be created which, net of the variation of one of the generic dimensional values - such as height and width of the window, thickness and width of the threshold, etc. - will allow to obtain a model proportionally modified according to our needs in all its parts (fig. 30).
Once the creation of the entire apparatus associated with the openings has been completed, proceed with importing them, as if to complete the modeling of each semantic element of the lighthouse, on the 'project model of the Italian lighthouses', through which to proceed with the final modeling of the specific case study.
In the course of the studies aimed at the cataloging of Italian lighthouses, in relation to the identification of the typologies of windows, a characteristic often present within this semantic category was found, to be considered together with the type: the shutters. This type of element, in fact, is configured as an element in addition to the type of punching and independent from it. In this sense, the differentiation between single and double sash does not exist as this type of elements is used exclusively for double sash windows, whether they are vaulted or not. For the modeling of the shutter element we therefore proceeded with the creation of a loadable family of the 'window' type to host the wall element by using hinges, corresponding to the type of window chosen. As for the openings, we proceed with the creation of the frame and the relative slats, taking care to affix the relative parametric constraints, in order to make it possible to modify the height and width of the shutter in an adaptive way, obtaining a model proportionally modified according to of the case study to be modeled. After the modification of the family, of which material parameters have also been defined (fig. 31), it can be inserted in the 'project model of Italian lighthouses' and subsequently in the case study to be modeled.
In conclusion, we want to underline how the identification and clarification of the methodological process of creating the parametric families is not intended to be a user manual but rather a clarification aimed at the compositional illustration of the 'project



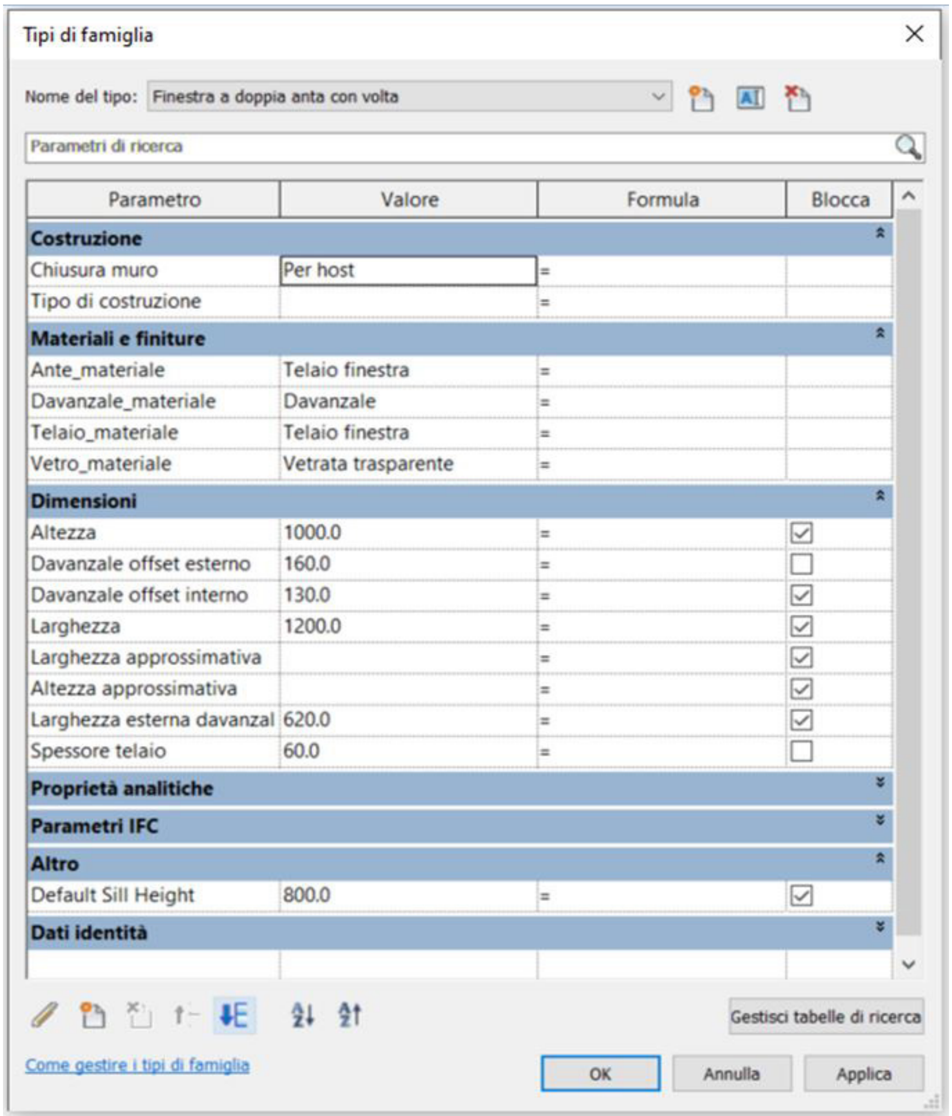


Fig. 29. Punch creation: extrusion on path.
Fig. 30. 'Double-leaf window with vault' type properties.

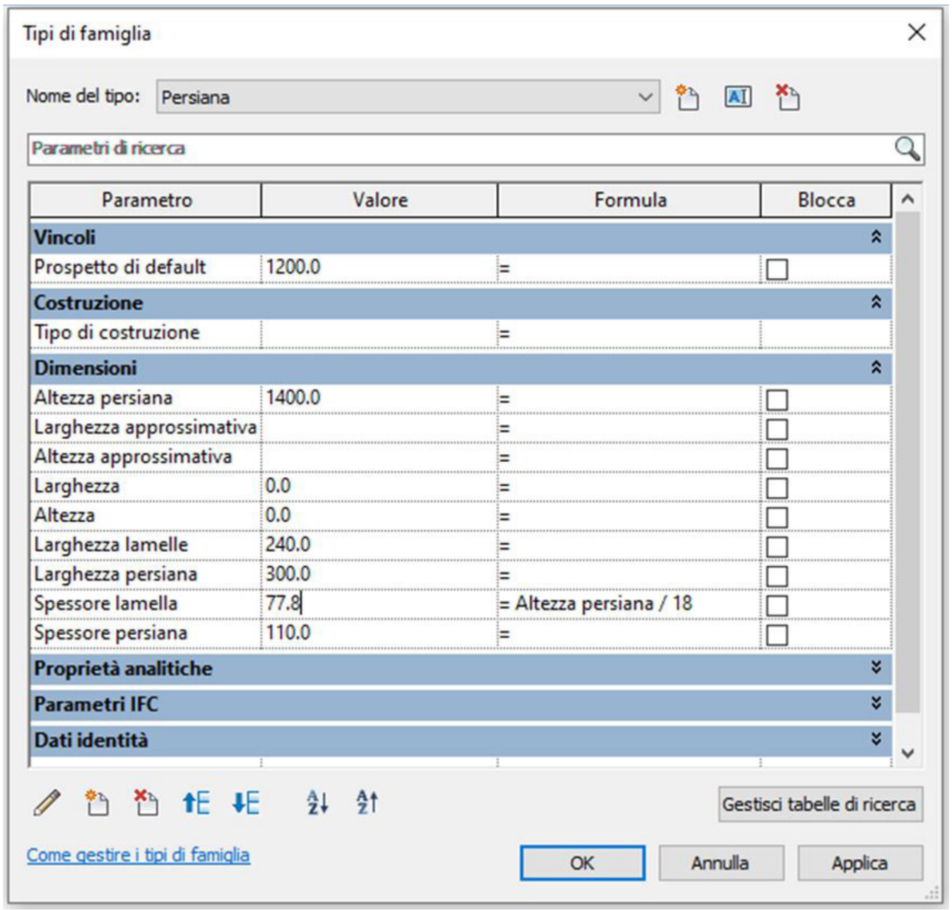


Fig. 31. Shutter: type of family and labels.

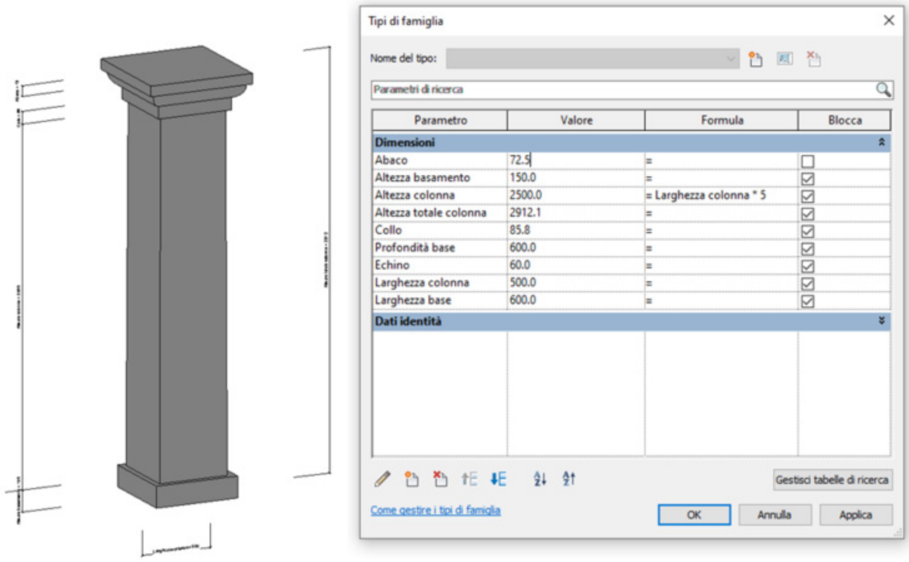
model of the Italian lighthouses'. With this chapter we wanted to narrate and explain the applicative and procedural reasons of the model development, that is the reasons for which a specific modeling process was chosen and how this process is configured as the most performing for obtaining one of the partial objectives of the research: the creation of a 'project model of Italian lighthouses' to be used in the modeling processes relating to specific case studies of coastal architectures. This is because, as mentioned several times, the parametric modeling process proposed here is based on the creation of 'generic' semantic elements to be adapted according to the specific geometric characteristics of the individual architectures. This methodology is particularly similar to the processes implemented during the different scientific contributions consulted and addressed to the built heritage. In this sense, in fact, the conception of an 'artisanal' methodology - composed of the most performing families and suitable for the insertion of the semantic element in an adaptive and almost completely 'automated' way - turns out to be fundamental in the modeling process aimed at creating three-dimensional of a specific existing cultural asset. It is therefore the approach from the general to the particular that is the key to the interpretation necessary for the functioning of an 'artisan methodology in reverse' .
In this context, it is important to underline, finally, how the 'artisanal' modeling process just described is applicable exclusively to all those architectures united by a high degree of seriality and recurrence of the elements, made up of all that architectural apparatus defined up to this moment as 'replicable'.

7.3.3b Semantic modeling: non-replicable elements

As mentioned and defined in the previous paragraph, the architecture of the lighthouse is undeniably based on serial architectural matrices, of which it is possible to trace specific occurrences made of similarities and geometries. In the course of the text, this type of compositional apparatus was therefore defined as 'replicable' in order to identify all those elements present in multiple lighthouse architectures, albeit partially dissimilar to each other in size and proportion. In the modeling field, the geometric difference between different elements making up the same semantic category is configured to be, as we have just seen, the expedient genesis of the entire methodological process. In this sense, in fact, this 'obstacle' is therefore configured as the keystone for the creation of a semantic parametric database through which, lying to the architectural and aesthetic setting of the elements, to modify the dimensions and proportions of the element itself.
As described in the previous chapters dedicated to the definition of the geometry of the lighthouses and the consequent examination of the concept of geometric 'replicability' and 'non - replicability' of the same, it is in fact to be remembered that there are certain architectural-aesthetic characteristics of the lighthouse that are totally unique, defined from the beginning as 'not replicable'.
This concept is flanked by two architectural typologies: the lighthouses composed in their entirety of unique elements, and for this reason not modelable through this methodology, and the lighthouses comprising both recurring semantic elements and unique elements, signs of characterization and distinction, for this reason partially 'not replicable' and therefore partially modelable by the methodology. In this sense, architectural features such as battlements, columns, arches, etc., do not allow the definition of an architectural category and therefore the creation and development of adaptive parametric families to be included in the project model, as they are configured as highly customized systems. and peculiar.
A further limitation to 'non-replicable' parametric modeling lies in the interception of the geometric data to be developed. This is because, as mentioned, the proposed methodological modeling process is not based on point clouds from which to extrapolate the metric measurements, thus making it impossible to effectively model such specific and characteristic elements. Nevertheless, the modeling of a specific case study is still feasible, consisting of a single 'non-replicable' part and therefore 'partially modelable' by the methodology.
Proceeding with the practical modeling of the element, the local families are defined as the most used families for the creation of this type of elements as they are specifically addressed to the creation of solids to be modeled and inserted in a specific project. Nevertheless, the possible afference of the element to be created with respect to an already existing loadable family turns out to be a more immediate and agile choice. We therefore proceed with the modeling of the 'non-replicable' element present in the San Vito LoCapo lighthouse[44] (figs. 32, 33), that is one of the three case studies subsequently chosen for the experimentation and practical application of the methodology itself.
The non-replicable elements are inevitably connected to specific compositional and aesthetic considerations, as they are closely linked to the ornamental characteristics of the building of which they constitute an identifying element. The columns present in the San Vito Lo Capo lighthouse, in fact, appear to be a clear reference to the Doric order, albeit consisting of a base and a square-shaped shaft, therefore devoid of entasis. As in classical capitals, however, the capitals placed at the entrance to the lighthouse appear to be composed of an abacus, an echinus and a neck connecting the shaft, connecting elements placed to support two barrel-vaulted spans. For the construction of the column we proceeded in a similar way with respect to the creation of the replicable elements proposed

for the construction of the semantic database of the lighthouse, through the use of a loadable metric family based on a 'column' - as a category already present in the apparatus constitutive of the loadable families - and the creation of labels useful for changing the dimensions, to be reused for any further architectural projects, coastal or otherwise. For obvious reasons, the setting of labels on non-reproducible elements is configured as an action that is not strictly necessary for the purpose of a subsequent modification of the element (figs. 34, 35). We proceed in the same way with the creation of the barrel vaults, in order to fully create the part relating to the 'non-replicable' system of the lighthouse, to be imported into the 'partially replicable' case study created in the 'project model of Italian lighthouses'.
Finally, for the completion of the 'replicable' modeling process put in place for the San Vito Lo Capo lighthouse, see paragraph 7.4 "Applications: from the basic project model to the case studies", concerning the application of the methodology described up to now with respect to to three specific case studies: the lighthouse of San Vito Lo Capo, the lighthouse of Punta Alice and the lighthouse of Capo Colonna.

Fig. 32. The lighthouse of San Vito Lo Capo: the entrance and non-replicable elements.
Fig. 33. The lighthouse of San Vito Lo Capo: the entrance and non-replicable elements.



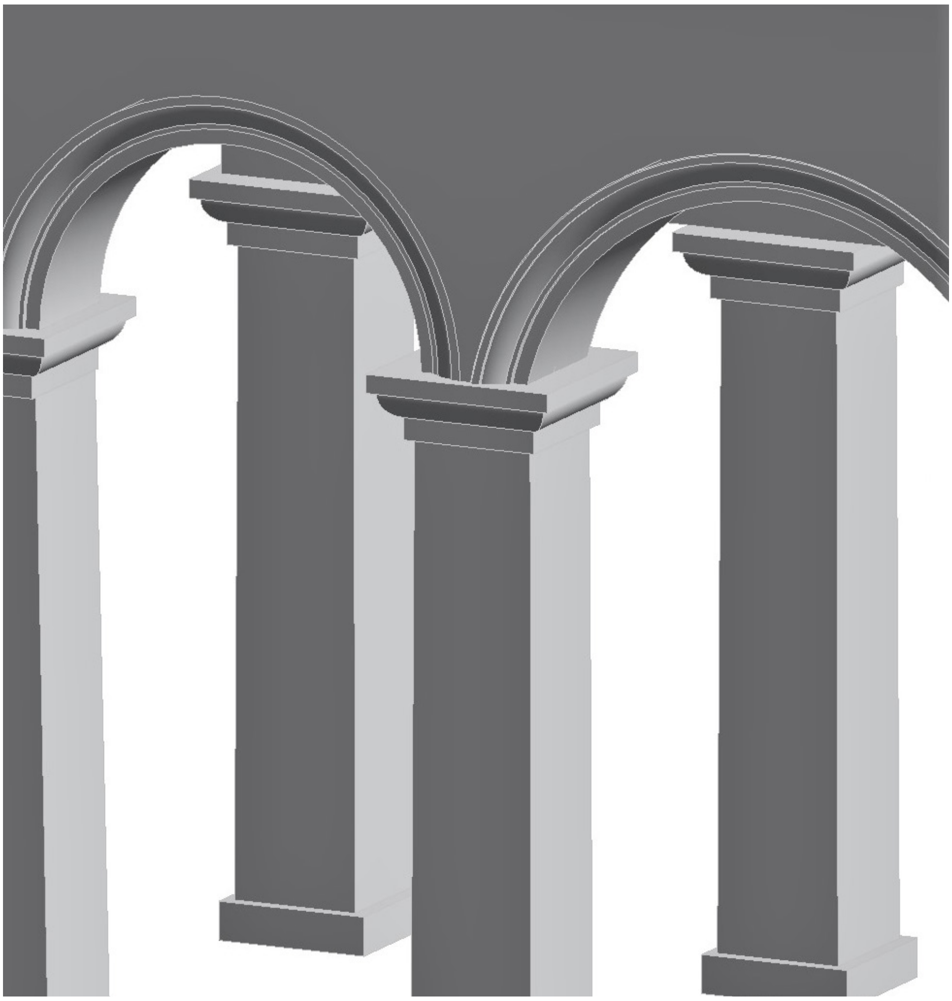


Fig. 34. The lighthouse of San Vito Lo Capo. Column and family type.
Fig. 35. The lighthouse of San Vito Lo Capo: model of the entrance colonnade.

7.3.4 The design model of the Italian lighthouses

The 'project model of Italian lighthouses' is defined as the final parametric product, albeit 'inconclusive'[45], of the methodology proposed by the research, as it was later addressed to ontological sciences and artificial intelligence, key arguments of the eighth chapter, during which we will again deal with semantic cataloging and classifications.
With regard to the creation of the model, the parametric elements - entirely inserted in the semantic database, whose classification was developed through the precise geometric and functional cataloging of all Italian lighthouses - are configured as families to host with respect to the basic elements, namely the 'macro variables', inserted in the project model through the Dynamo plug-in. Once the three main elements of the lighthouse have been loaded within the project model of the Italian lighthouses, it is possible to insert in the modeling environment one or more loadable or system families present in the project browser of the model itself, in order to proceed with the modeling of a specific case study. In fact, in the project browser, in addition to all the views, schedules, tables, groups, links - all the families included in the project model, divided into architectural categories/family groups, are displayed. By expanding and collapsing the individual groups, it is possible to view the different elements placed at the lower levels.
The semantic parametric elements to be included in the modeling project can be selected according to two strategies: by carrying out a manual search in the elements placed within the different types of family or by using the 'search' tool. In this sense, it is in fact possible to search for the family to be inserted following the name/terminology of the element, that is a fundamental argument developed during the identification and semantic classification of the lighthouses, as well as a cornerstone and connection point of the ontology addressed to lighthouses.
In the 'project model of Italian lighthouses', in the project browser panel, it is therefore possible to insert in the model the different families associated with the semantic categories. More specifically, the category 'generic models' includes the parameterized loadable families afferent to the angular ashlar, hosted by the wall element, and to the dome, hosted by the upper surface of the lantern (fig. 36). In the 'windows' category we find all the ten types attributable to the tower and building macro-variables, hosted by the wall element and

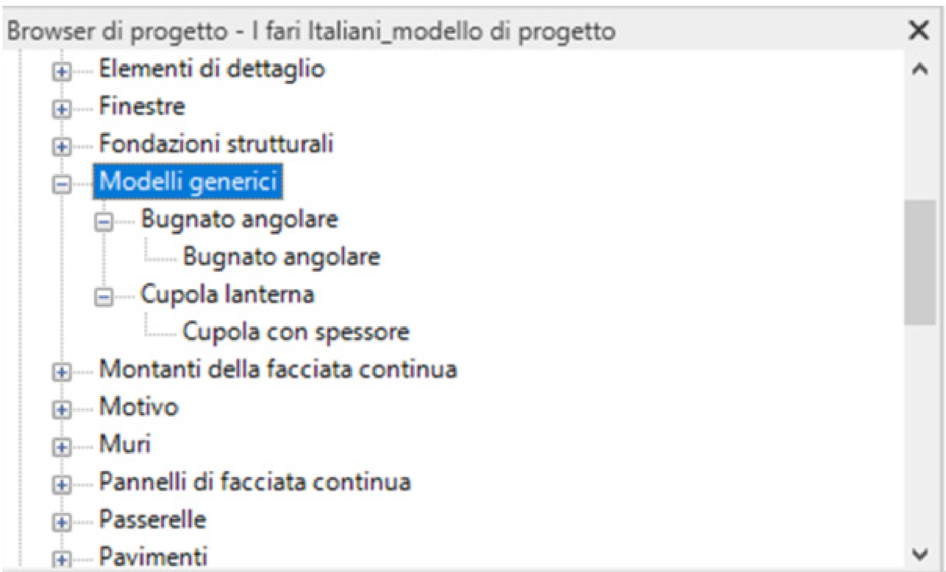


Fig. 36. Project browser. Generic models category (with host): angular ashlar and lantern dome.

created in all their variants. Finally, within the 'profiles' category we find all the twenty-one loadable families belonging to the semantic category of moldings, hosted by the wall element as extrusion, whether it belongs to the macro variable tower or to the macro variable building (fig. 37). A parametric library is therefore created from which to draw in the course of modeling specific coastal case studies, i.e. the object of the next paragraph, through the appropriate modification of the dimensional and material parametric labels, belonging to the entire series of 'replicable' Italians lighthouses.

Fig. 37. Project browser. Profiles category: moldings.

7.4 Applications: from the 'Italian lighthouse project model' to case studies

This paragraph is configured as the implementation and 'validation' of the parametric methodological process through the modeling, on the basis of the 'project model of Italian lighthouses', of three specific case studies: the lighthouse of San Vito Lo Capo, the lighthouse of Punta Alice and the lighthouse of Capo Colonna.
Before dealing with the precise manner of the modeling process, it is however necessary to clarify some preparatory considerations regarding the model, methodology, measurements and use. As mentioned in paragraph "6.4 The function of the model": "the model represents the ultimate explication of digital representation and transposition, through which to express and disseminate theories, information, concepts and projects. As it is addressed to different purposes, the level of detail to which it is subject is extremely variable and depends almost exclusively on the project and on the information to be communicated". In this sense, the proposed methodology, in fact, is aimed at a level of detail from low to medium-high level, depending on the data available to us and the type of use of the model itself.
The flexibility of the degree of detail is such as the loadable and system families included in the 'project model of Italian lighthouses' are configured, on the one hand, as objects with basic details but, on the other, as totally modifiable parametric elements in size and, in part, composition. The methodology therefore manages to adapt to the level of detail chosen by the user, depending on the use of the asset and the quantity and quality of the known measures of the building to be modeled. In this sense, in fact, from the first applicative approach to the methodology, it was realized how much the preparatory choice of the purposes, an argument further treated in the course of the ninth chapter, was necessary to build a process aimed at modeling.
With regard to the modeling process, through a partial manual survey - combined with the use of programs for the photo straightening of digital images, by taking some measurements according to the x and y axis - it is possible to intercept in a significantly precise manner - although not comparable to common indirect survey systems using cameras or laser scanners - the measurements of the flat facades of the building. Through these measurements it is therefore possible to return a proportionate and geometrically coherent model with respect to the existing building, in which the parametric methodology proposed here is configured as suitable for a more expeditious modeling - with modeling times equal to half compared to standard processes - through which to obtain a performing model for its insertion in digital applications useful for the knowledge and dissemination of this type of historical heritage[46].
Despite the optimization of the modeling times, some limits still appear evident, which can be managed according to an integrated approach. In this sense, in fact, if addressed to a medium-high detail model, the methodology proposed here is sufficient for the creation of generic replicable elements - such as windows, moldings, ashlar, shelves, railings, etc. - but not sufficiently detailed to the digital transposition of any degradation and specific details of the elements just mentioned. It is therefore necessary to integrate the methodology with the traditional Scan-to-BIM systems for a higher accuracy of the model, in which the methodology is inserted as a guideline and, in part, a three-dimensional basis. In the course of the ninth chapter, indicators of adequacy will be theorized through which to evaluate and strengthen the methodology according to the uses and actions to be undertaken.
In the course of this paragraph, however, we want to focus on the process of building models with average detail of three specific case studies, different in geometry, composition and dimensional relationships. The first building modeled is the Capo Colonna lighthouse (figs. 38, 39), that is a lighthouse of imposing importance, not only from the point of view of signaling but also as a function of the architectural aesthetics and the context on which it lies. In fact, in the modeling process aimed at digital use, it is always necessary to analyze

Fig. 38. Capo Colonna: aerial image.
Fig. 39. Point cloud of the Capo Colonna lighthouse.

the context in which the architecture is located since, especially in the case of lighthouses, as explained in chapter 4 entitled "Color and landscape", the context appears to be the characterizing and characterized background of the building.
The Capo Colonna lighthouse, built in 1873 and located on the homonymous promontory, is in fact surrounded by a very important archaeological site - of which we remember the remains of Heraion Lakinion, building B guardian of the votive objects of the Treasury of Hera, temple A, building K and building H - thus defining itself as a lighthouse with enormous tourist and cultural potential. The modeling of the lighthouse, at any level of detail and use, is configured, in fact, as an essential action for the rediscovery not only of the architecture itself but also of the surrounding area.

Fig. 40. Parametric model of the Capo Colonna lighthouse created using the design model of the Italian lighthouses.

In this context, given the peculiar conformation and characterization of the territory, we want to underline that the methodology proposed here is not defined as a pretentious modeling strategy in which the building is eviscerated from its essence and mechanically assembled by parts. On the contrary, the specific characteristics of the lighthouse and the relationship between the architecture and the surrounding environment have always been recalled and analyzed - as per the appendix in the context of the identification of the Mediterranean lighthouses - and the geometric importance of the analysis of architectural elements.

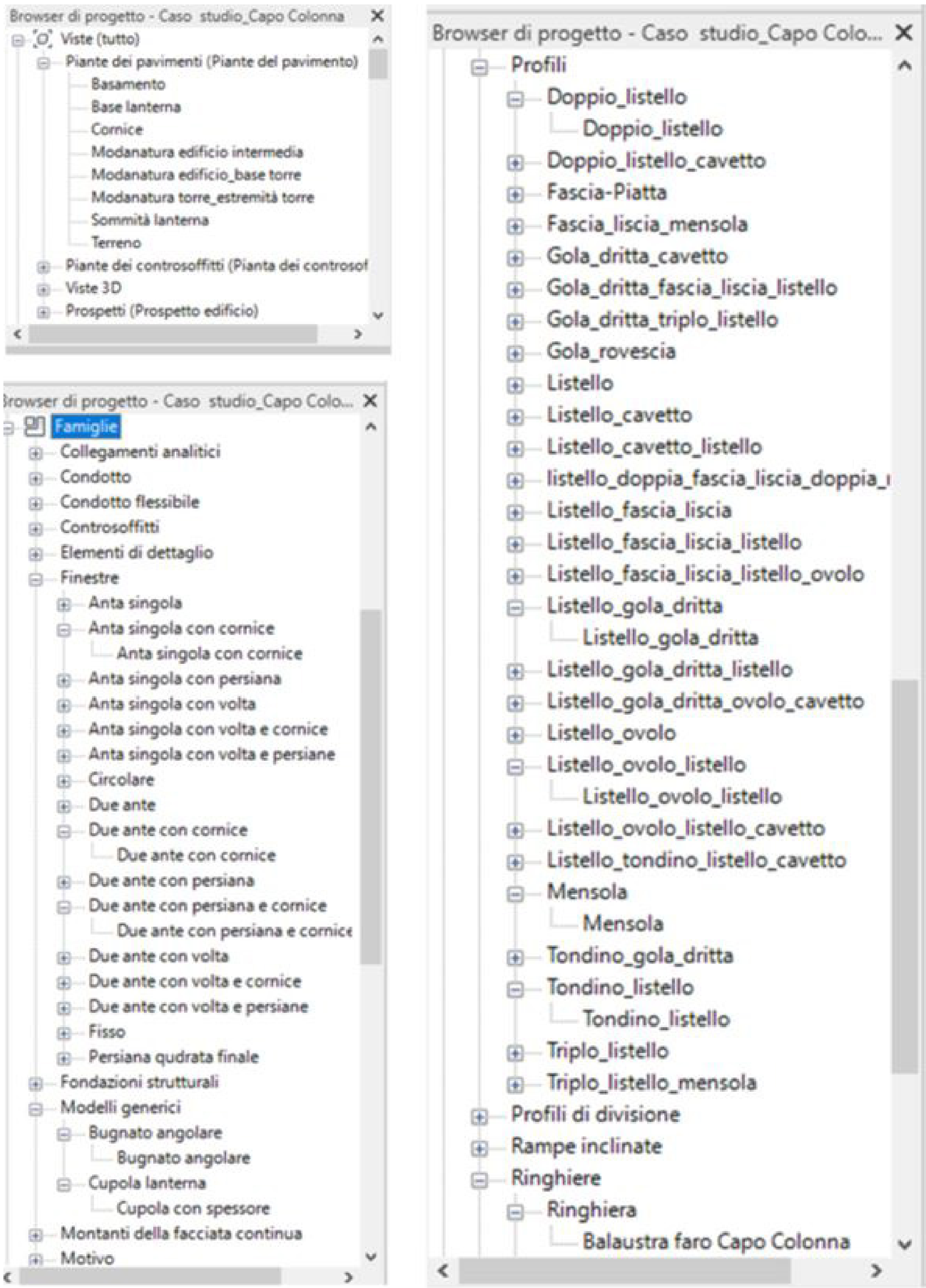


Fig. 41. The Capo Colonna lighthouse: project browser. Families and levels used.

With regard to the application process of the methodology on the Capo Colonna lighthouse, we therefore proceeded, net of taking the measurements using the photo straightening method, with the transposition of the same with respect to the three macro variables of the lighthouse in the three customized Dynamo scripts and inserted in the project model.
In this sense, it is important to underline that, even if direct measurements and straightened photos were used for the modeling based on the research methodology, we have at the same time available the cloud of points of the same building, through which subsequently relates the accuracy of the measurements of the model built through the use of the methodology with the same point cloud. Returning to Dynamo, net of the definition of the measures relating to the three macro variables, we proceed with the reloading of the files, through which to build the main geometries of the building. With the support of the rectified images and some measures useful for scaling the rectified image, the entire compositional apparatus was then built through the use of the families already loaded in the project model, duly modified according to the measures necessary for the reproduction of elements[47, 48].
In the specific case of the Capo Colonna lighthouse, the elements created on Dynamo are: a two-level building with a rectangular plan, an octagonal tower and a tetradecagonal lantern. As regards the semantic elements attributable to loadable families, present in the project model and in the lighthouse, we recall: double-leaf window with frame and shutter for the building, double-leaf window with frame for the building, single-leaf window with frame for the building, angular ashlar for the building, double-leaf window with frame for the tower, double-batten and batten-ovolo-batten molding for the building, molding with rod-batten and straight groove-batten for tower. To the loadable families composed of different types are added the elements created by system families and loadable families such as: shelves placed below the gallery, the balustrades of the tower and the antenna placed above the dome of the lantern (figs. 40, 41).
Similarly, the modeling of the Punta Alice lighthouse (figs. 42, 43) was developed through the implementation of the same methodology put in place for the Capo Colonna lighthouse, thus adapting the necessary parametric elements present in the basic project of the Italian lighthouses' according to the geometric characteristics of the lighthouse.
As previously mentioned, if the geometric semantics of the lighthouse is defined as the determination of the recurring elements, the same consideration cannot be traced back to the landscape and aesthetic context of these architectures. In fact, even in this case it is not possible to dwell on the vast considerations addressed to the magnificence of the places that surround them, although it is only right to make a brief mention of them.
In this sense, the lighthouse of Punta Alice, located in Cirò Marina and built at the end of the nineteenth century, by virtue of its cultural and touristic importance, is one of the lighthouses included in the "LIGHTS, TOWERS AND COASTAL BUILDINGS" project, within of the broader initiative called "Valore Paese - DIMORE", which aims at the rehabilitation and restoration of these architectures, according to Presidential Decree 380/2001 art. 3 let. c[49]. The interest in this architecture therefore derives not only from the powerful evocative value that it causes in the eyes of the beholder but also by virtue of the high tourist, cultural, architectural and landscape value of the places: we remember the extreme proximity of the lighthouse to the markets Saracens and the temple of Apollo Aleo .
In the parametric field, the lighthouse at Punta Alice was therefore modeled using the following elements created on Dynamo: one and two-level rectangular building, octagonal tower and octagonal lantern with inclined uprights. As regards the semantic elements attributable to the loadable families, present in the project model and in the lighthouse, we recall: double-leaf window with shutter for the building, single-leaf window with frame for the building, single-leaf window with frame for the tower, molding with battens and double battens for the building (figs. 44, 45).

Fig. 42. The Punta Alice lighthouse: aerial image.
Fig. 43. Point cloud of the Punta Alice lighthouse.

The application process of the parametric methodology therefore finds its conclusion in the modeling of the third and last case study: the lighthouse of San Vito Lo Capo (figs. 46, 47). The construction of this lighthouse, built in 1854, is due to the Bourbon Kingdom which, in the same years, built numerous fires along all the coasts of the Kingdom of the Two Sicilies, in order to make both offshore and coastal navigation safer. Mentioned not only in portolans but also in literature - "if the ship were in a position to survey the Cape for Mezzogiorno-Scirocco, the lighthouse would be seen between two towers, the one towards libeccio is called d'Agra, the one towards Greek is Sereno" (Persano, 1880) - the lighthouse of San Vito Lo Capo, with its 40 meters high tower, stands out on the coastline of the town of the same name, characterized by a conspicuous seasonal tourist flow. The seaside

Fig. 44. Parametric model of the Punta Alice lighthouse created using the design model of the Italian lighthouses.

attraction is joined by important cultural and landscape catalysts: the usher's tower, the tonnara del Secco, Mount Cofano, the Cavalli cave and the nearby Scopello. It is therefore defined as a lighthouse with enormous tourist and cultural potential, whose modeling, at any level of detail and use, is configured as an essential action for the rediscovery not only of the architecture itself but also of the surrounding area.
Overcoming what may be the multiple considerations regarding the dissemination of a cognitive, historical and cultural type of this architecture, that is to say the themes dealt with in the course of the ninth chapter, we therefore want to dwell on the geometric aspect of the same. The lighthouse of San Vito Lo Capo, in fact, unlike the previous modeled lighthouses, is characterized, on the one hand, by a turreted structure and a 'replicable' type lantern and, on the other, by an entrance colonnade to the 'non-replicable' building, an argument already dealt with in the course of the sub-paragraph "7.3.3b Semantic modeling:

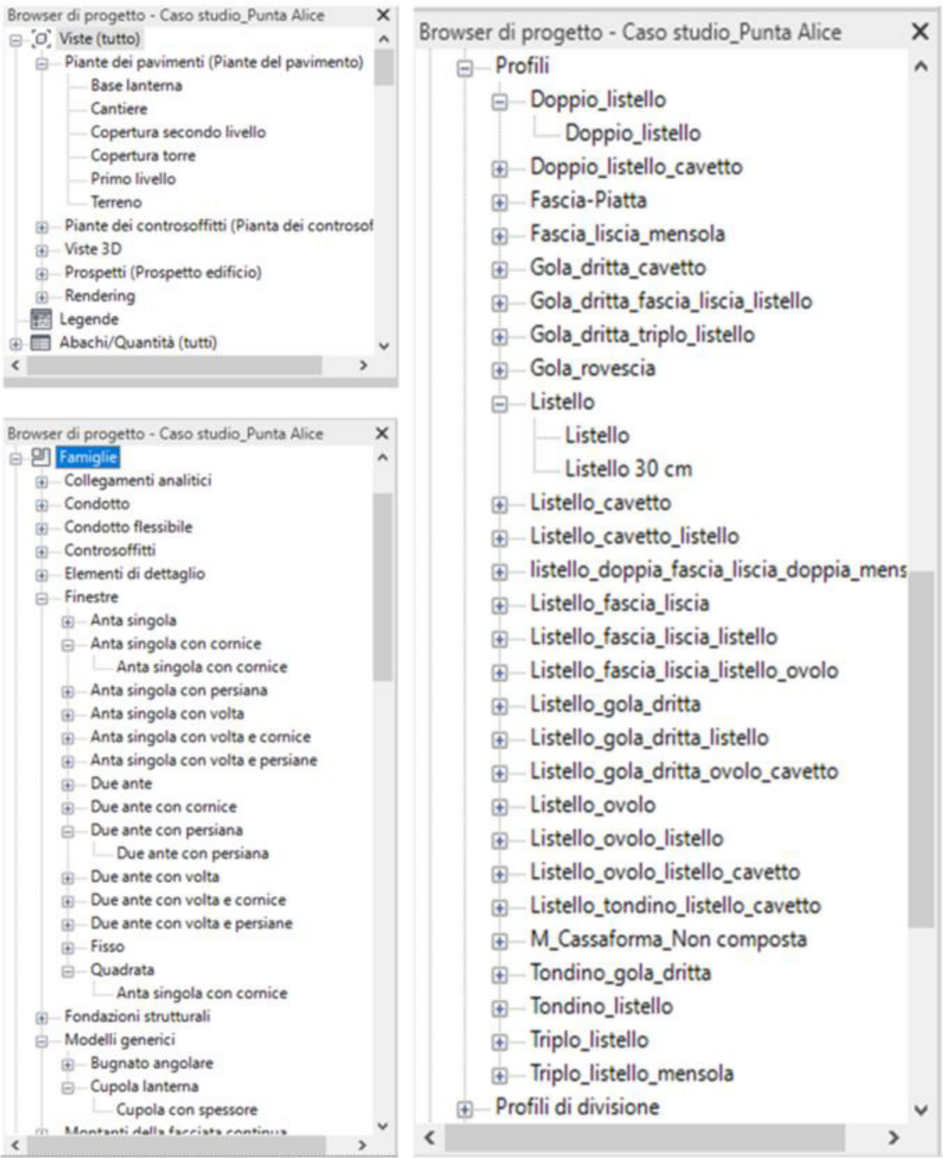


Fig. 45. The Punta Alice lighthouse: project browser. Families and levels used.

Fig. 46. The lighthouse of San Vito Lo Capo: aerial image.
Fig. 47. Point cloud of the San Vito Lo Capo lighthouse.

non-replicable elements". In this last chapter, in fact, we proceeded with the modeling of the colonnade, during which it was demonstrated how the methodology can still be feasible and effective even in the case of lighthouses composed in part of 'non-replicable' elements, as long as this the latter do not identify themselves as outstanding elements with respect to the basic architecture.
Regarding the modeling of the replicable elements of the San Vito Lo Capo lighthouse, specifically those created on Dynamo, they are characterized by: a single-level building with a rectangular plan with a courtyard, a circular tower and a dodecagonal lantern. As regards the semantic elements attributable to loadable families, already present in the project model and inserted at the same time during the lighthouse modeling process, we recall: double-leaf window with frame and shutter for the building, single-leaf window with frame for the tower, strip-ovolo-strip-cable molding for the building, straight groove-triple strip molding for the tower. To the loadable families are added the elements created by system families such as: shelves placed below the gallery, balustrades of the tower and

Fig. 48 Parametric model of the San Vito Lo Capo lighthouse created using the design model of the Italian lighthouses.

antenna placed above the dome of the lantern. Having created the model composed of the replicable elements, the non-replicable component was finally added to it, and therefore not present in the 'basic project model of the Italian lighthouses', composed of the entrance porch, modeled through the use of a 'generic model' (figs. 48, 49).
In conclusion, net of the application process of the methodology proposed up to now, it is possible to present considerations regarding the potential and limits of the methodology itself, identifying criticalities and strengths between the results obtained and those obtainable through the modeling process canonical, i.e. according to the Scan-to-BIM process[50].
It is clear that there is no correct and univocal methodology to be applied to every type of historical heritage, since, as already discussed in the introduction, it is the process itself that must adapt to the needs relating to the purpose of the model and the type of 'architectural apparatus: the system is shaped according to the detail class chosen by the user, the type of use of the asset and the quantity/quality of the data in our possession of the building to be modeled. With the research methodology, through the archival collection and a partial direct survey[51] - possibly combined with the use of programs for the photo strai-

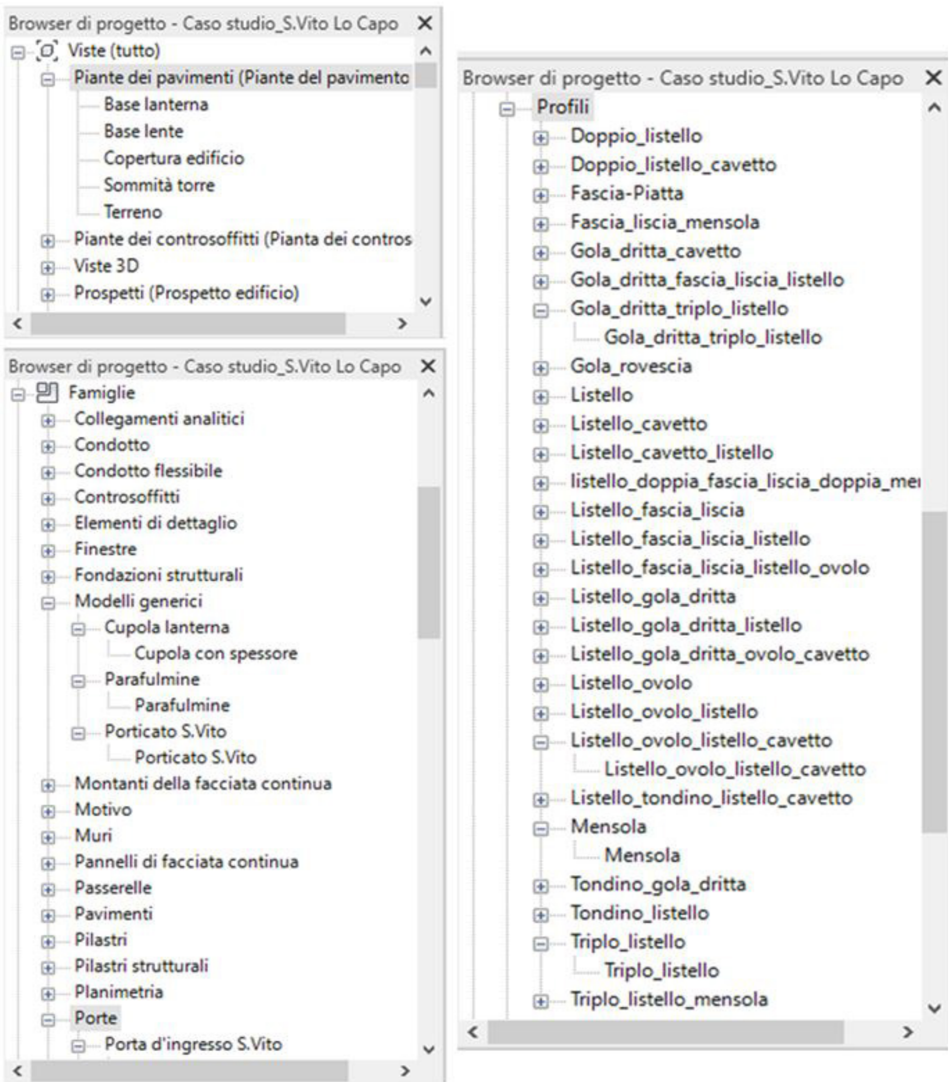


Fig. 49. The San Vito Lo Capo lighthouse: project browser. Families and levels used.

ghtening of digital images - it is possible to return a proportionate and geometrically coherent model of the existing building, in which the methodology is configured as suitable for a more expeditious modeling, net of the knowledge of some geometric and architectural data.
The model that is generated is therefore configured as sufficiently performing for its use in digital applications[52] useful for the knowledge and dissemination of the historical heritage, significantly encouraging the cataloging of the heritage, the creation of models as well as the interest in these architectures. This type of methodology - in which the estimated modeling time is less than half compared to the time taken to model the same architecture on the basis of the point cloud - is configured as useful for ensuring a more extensive acquisition of models over time, guaranteeing the conservation of the state of affairs and architectural knowledge, that is a fundamental action in the context of the protection of the historical heritage in the eventual occurrence of natural and anthropogenic disasters.
In order to evaluate the accuracy of the model obtained on the basis of the methodology, through the use of the 'project model of the Italian lighthouses', we therefore proceeded with the comparison and the overlap between the model and the point cloud of the architecture, through which it is possible to demonstrate a remarkable correspondence as regards the ratios and the volumetric geometries (figs. 50, 51). A metric comparison was also carried out for the case study of the Capo Colonna lighthouse, in order to be able to quantify the difference between the two models and estimate the adequacy of the model with respect to different dissemination areas, obtaining an error gap equal to 0.5%, which is an acceptable discrepancy in the case of cataloging aimed at cultural dissemination, cultural events and the safeguarding of the historical architectural heritage by means of an intensive and non-invasive methodology (fig. 52).

7.5 Architectural vocabulary and element IDs

The identification of specific IDs (Identification Detail) of the elements pertaining to the semantics identified and modeled in the BIM environment represents the definitive systematization and cataloging of the parametric objects associated with the semantics of Italian lighthouses, although this identification cannot be defined as the actual conclusion of the methodology itself. This is because, if on the one hand the identification of the ID elements is defined as the apparent conclusion of the methodology in the parametric field, on the other hand, the identification of the same ID elements represents the prerequisite through which to undertake a path of knowledge and cataloging in an ontological environment, as well as a starting point through which to hypothesize the mixture of these two sciences through the creation of a third onto-parametric software[53].
By examining specifically the argument inherent to the ID elements, we therefore want to outline a general framework aimed at explaining their uses, their identification and the different types of IDs. These identification attributes can in fact be divided into four basic categories: ID element, unique ID element, DwfGuid and IfcGuid, the latter two corresponding to elements connected to the .NET format, encoded according to the IFC[54] rules created in the 1990s and not shareable by Revit. On the contrary, the use of the ID element and the unique ID element make it possible to directly search for a specific element in Revit, through the 'Manage' panel, under the 'Selection ID' item, if you want to view the ID of a specific element, or 'Select by ID' if you want to highlight the elements belonging to a specific ID in the model. In this sense, in fact, each element created in the Revit parametric environment has an element ID and a unique ID element.
At this point it is necessary to specify and differentiate the concept of 'ID element' and 'unique ID element', albeit conceptually connected to each other as the latter is partly constituted by the encoded ID element, composed by adding the eight digits corresponding to the 'Unique ID of the elements'. More specifically, the GUID is made up of different codes corresponding to

Fig. 50. Relationship between the semantic model and the point cloud: the lighthouse of Punta Alice.

Fig. 51. Relationship between the semantic model and the point cloud: the Capo Colonna lighthouse.

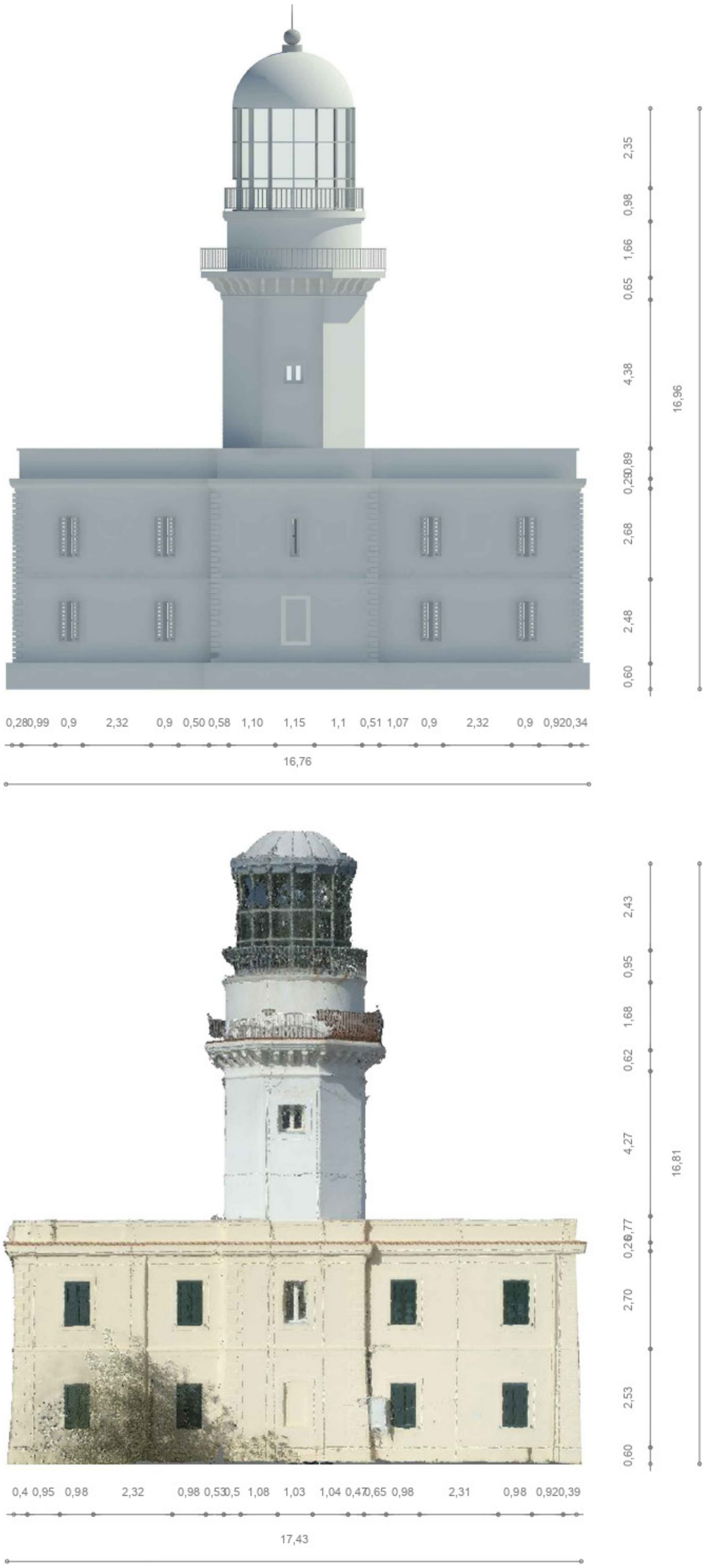


Fig. 52. Metric relationship between the semantic model and the point cloud: the Capo Colonna lighthouse.

groups of 8-4-4-4-12 hexadecimal characters, unlike the single ID element, made up of a group of 8-4-4-4-12- 8 hexadecimal characters, i.e. with 8 additional characters placed at the end, corresponding to the association of the unique ID element present in Revit[55].

With regard to the identification of the ID element of a solid, if the latter can be consulted and traced directly from the Revit interface, to identify the unique ID element it is necessary to use Dynamo, a visual programming tool previously used for the modeling of the macro variables of the lighthouses. By creating a script, in fact, it is possible to select the element for which we want to know the code - under 'Select Model Element', connected to two outputs of type 'Element.Id' and 'Element.UniqueId' (fig. 52) - and know the codes of the element and of the unique element.

The classification of the elements according to an identification code wants to be, as in part previously stated, the partial conclusion of the semantic cataloging belonging to BIM and the principle of connection between parametric modeling and ontological science, towards the construction of an increasingly interoperable and manageable knowledge. In this sense, if the identification of the IDs in the parametric field is configured as a mere action of searching for the elements in the model, their connection in the ontological field opens the door to an unprecedented knowledge-connection of the parametric and ontological elements, with respect to the relative semantic characteristics.

However, it should be emphasized that the 'ID elements' and the 'unique ID elements' in the parametric context are exclusively conditioned by their spatial positioning, regardless of the modification of the shape and size values. Therefore, the cataloging of the identification codes belonging to the elements took place in the context of the 'family' of the element, as it is precisely the 'basic' families of the elements that form the semantic database of Italian lighthouses and not the creation of the different instances in a specific project.

Net of the precise identification of the identification codes associated with each semantic element, corresponding to the families included in the 'project model of Italian lighthouses', it is therefore possible to 'associate' these codes in the Protégé ontological software, through which to lay the foundations of a first connection between semantic elements and different types of management, visualization and use, making the management and connection of semantics and knowledge increasingly feasible in the creation of 'basic' semantic models relating to specific architectural typologies.

In this context, the definitive mix between the two sciences, towards the creation of a parametric and ontological application, turns out to be a road with extreme potential (Iadanza et al., 2019) in the field of interoperable knowledge and dissemination of 'characterized' heritage, as illustrated in the course of the ninth chapter.

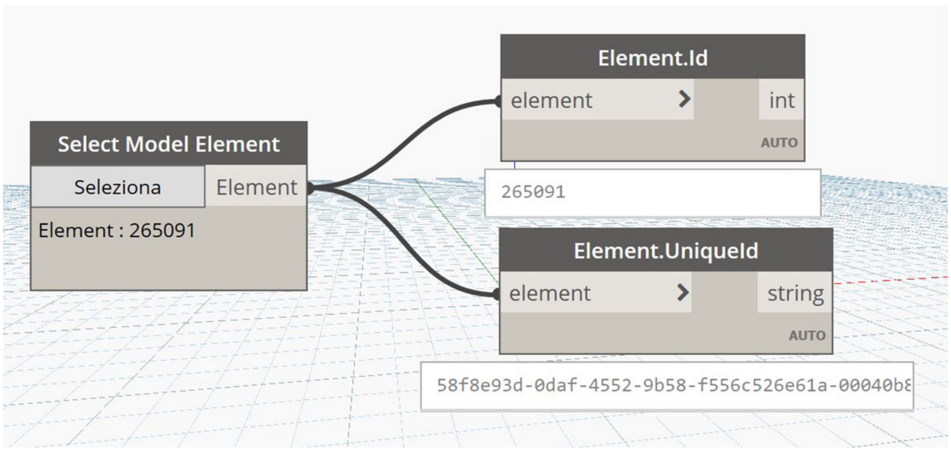


Fig. 52. Dynamo script ID elements. 'Double leaf element with frame and shutter'.

Notes

1. To deepen the theme of the Genius loci, see the text: Norberg, S. (1991). *Genius loci*. Milan: Electa.

2. As argued by Tiveron (2020, p. 268): "The basic idea was to reverse the point of view 'from action to result' to 'from result to action'. This is why I have called this methodology the 'reverse method', because the methodology starts from the definition of the organizational objectives to arrive, proceeding backwards, to the single task to be implemented".

3. The top-down approach, together with the bottom-up one, is configured as a strategy for the processing and management of information data of knowledge, whether they are intended in the field of computer science, humanities or systems theory (Gadomski, 1993).

4. Foundation born thanks to I. McHarg and J. Dangermond.

5. For a discussion of the information content and related legislation, please refer to paragraph 7.3 "Development of a parametric methodology: the semantic breakdown" as issues strictly connected to the motivations and choices made during the research methodology.

6. When talking about intervention models aimed at the maintenance of a new building, it is appropriate to use the term BIM as-built (as built) as the information relating to the construction is already defined in the design context of the building itself. In the case of restoration or maintenance addressed to the existing heritage, we refer instead to BIM as-is models (as is) (Osello, 2015).

7. For further information, please refer to the Charter on the Preservation of Digital Heritage, 2003. Url: https://en.unesco.org/themes/information-preservation/digital-heritage, accessed on 20 March 2022.

8. As absolutely new and ongoing topics, scientific production on the subject can be limited mostly to the production of articles in online journals or conference proceedings, guaranteeing research an extremely current character.

9. "Results show scarce BIM implementation in existing buildings yet, due to challenges of (1) high modeling/conversion effort from captured building data into semantic BIM objects, (2) updating of information in BIM and (3) handling of uncertain data, objects and relations in BIM occurring in existing buildings" (Volk et al., 2014).

10. "The history of the arts proceeds from the known to the unknown, precedes direct, meticulous, analytical observation to the systematic synthesis of data [...]. But the observation must in turn lead back to the system. Once the parts are well known both in themselves and in their mutual relations, the whole must follow, that is, the whole which is the universal verification, otherwise our efforts would be in vain" (Quatremère de Quincy , 1815).

11. Please note that the micro variables previously identified in the architecture of the lighthouse are divided into: moldings, openings, ashlar, balustrade, etc. Each micro variable can be traced back to one or more macro variable elements - that is the building, the tower and the lantern - of which they are an integral part.

12. Problem in part negligible as the lighthouses constitute a common patrimony managed by public bodies, therefore from archival data often almost entirely opensource.

13. However, it should be specified that there are exceptions made up of totally univocal architectural elements that are impossible to trace back to a semantic group, as also foreseen in the analysis of sets.

14. Let us recall how by 'characterized' architecture we mean all those architectures composed of more or less simple geometries that can be easily broken down into recurring architectural elements, as in the case of lighthouses, some abbeys, some churches, etc.

15. The relationship between form and meaning is already the subject of discussion in paragraph 6.3 "Reliefs and representations", in particular in the context of drawing and the consequent relationship between sign and reality.

16. In the course of the research we will deal with cataloging using univocal codes, even if this strategy is not ultimately configured as optimal in the case of the methodology applied to lighthouses.

17. For further information: http://www.getty.edu/research/tools/vocabularies/aat/, accessed on 23 March 2022.

18. For further information: https://cidoc-crm.org/, accessed on 23 March 2022.

19. Since December 2016, the CIDOC CRM has been recognized as an official ISO standard, a status which was then renewed in 2014 in the context of ISO 21127: 2014.

20. For further information, please refer to the official website: http://www.iccd.beniculturali.it/it/strumenti-terminologici, accessed on 23 March 2022.

21. Specifically, the words created are divided into closed or open: the former are predefined lists of terms, which prevent the cataloger from adding new terminologies. Open words, on the other hand, can be increased by inserting new terms during the drafting of a form. The catalog of terms is available at the link: https://github.com/ICCD-MiBACT/Standard-catalografici/tree/master/strumenti-terminologici/beni%20architettonici%20e%20paesaggistici, accessed on 23 March 2022.

22. The creation of an ontological glossary, even if not preparatory in the field of parametric sciences, will then be fundamental and preparatory in the course of the creation of a formal ontology applied to Italian lighthouses. This is because, firstly, the different terms can have multiple meanings and, secondly, because the definition of a specific terminology allows to connect the ontology towards other IT and valorisation processes.

23. The 'Level of Detail' and the 'Level of Development' are configured as integral parts of the LOD in which the detail level can be defined as the input of the element, while the development level defines the reliability of the output.

24. The BIM legislation in the field of modeling and the definition of parametric detail can count on four different organizations: the Ameri can Institute of Architects (AIA); the US chapter of buildingSMART Interna-

tional (BIMforum); the National Institute of Building Sciences - buildingSMARTalliance - (NIBS); the US ArmyCorps of Engineers (USACE). We also remember the BIMforumLOD specification. To learn more about the latter, see: https://bimforum.org/lod/, accessed on March 24, 2022.

25. See: http://store.uni.com/catalogo/uni-11337-4-2017?josso_back_to=http://store.uni.com/josso-security-check.php&josso_cmd=login_optional&josso_partnerapp_host=store.uni. com, accessed March 17, 2022.

26. The legislation Italiana divides the Level of Detail (LOD) into Level of Geometry (LOG) and Level of Information (LOI).

27. Both additional levels refer to an existing building (as-built) and define maintenance, management and repair operations throughout the life span.

28. In the present research the Level of Detail (LOD) is configured as the main feature treated as a tool for defining the detail of the elements.

29. We are therefore not referring to the single study/architecture case but to the totality of the architectures related to this building typology, in which the identification of generic geometries is configured as the result of a careful study carried out for all Italian and, albeit partially, Mediterranee.

30. This type of models can be adapted to different addresses requiring a more detailed degree of study, to be implemented therefore with information to be identified case by case. The theme inherent to the different outcomes and disseminations of the methodology will be the subject of study in the course of the ninth chapter, through the identification of different "indicators" that can guide the user and the methodology towards different actions to be strengthened or reduced, depending on the final use.

31. See: https://knowledge.autodesk.com/it/support/revit/learn-explore/caas/CloudHelp/cloudhelp/2018/ITA/Revit-Customize/files/GUID-F45641B0-830B-4FF8-A75C- 693846E3513B-htm.html #: ~: text = Dynamo% 20% C3% A8% 20 an interface% 20 of, installed% 20 under% 20 of% 20, accessed March 25, 2022.

32. Specifically, the visual programming language (VPL) allows, unlike the classic explicit writing of a computer code, the graphic manipulation of elements. Dynamo logic can in fact be defined as "boxes and arrow", in which each node (box) is defined as a specific programmed instruction that the user can form according to customized sequences directly through connection bridges (arrows).

33. That is, a lighthouse that does not really exist and is 'unknown', attributable to the concept of 'typical lighthouse' in which the 'macro' elements to be inserted - the building, the tower and the lantern - are modeled, but not the dimensional data that constitute, precisely, 'unknowns'.

34. Whose name has been appropriately changed to "width [Building]", "Depth [Building]", "Height [Building]" and "Wall thickness [Building]" in order to make geometry modification easier and more intuitive constituting the building element.

35. We remember how the measures in the number boxes sliders are expressed in meters.

36. At the end of the typological definition of parametric families, nested families are mentioned, ie elements created with one or more families together, through which the relative parameters can be controlled simultaneously.

37. It should be emphasized, in fact, that in the process of creating the 'project model of the Italian lighthouses' the local families will not be used as, as previously illustrated, they are configured as specifically used for the creation of 'unique', therefore addressed to the modeling of a specific case study, to be created in 'real time' in the modeling context.

38. The precise identification of the moldings was produced through the use of archival elements, photographic documentation and some surveys.

39. In fact, all the reference levels useful for the association between the level and the different components belonging to the micro variables have been included in the basic project model.

40. All loadable families appear to be 'hosted' by a wall, floor, ceiling, level, surface, etc. By 'host', in fact, we mean a family specifically associated with a specific host element, as in this case a wall. To learn more: https://mgtuts.com/it/housing-planning/what-is-hosted-family-in-revit.html.

41. A further label which has been taken into account is represented by the height of the host element, ie the wall, provisionally set at three meters, in order to provide the modeler with a reference in relation to the architectural scale of the building.

42. By modifying the measure of a single label, all the elements pertaining to that specific label will be modified: these are identified by including alternating elements according to the 'major' and 'minor' nomenclature.

43. By loading the family in the 'project model of Italian lighthouses' and clicking on 'Properties' it is possible to view and choose between different types of ashlar, in this case all based on the same arrangement of the elements, dissimilar to each other only as regards the interspace between the solids.

44. This element was chosen because the San Vito Lo Capo lighthouse, in addition to being a replicable lighthouse containing a single non-replicable architectural element inside, turns out to be a lighthouse that has already been personally detected.

45. The methodology is intended as 'not conclusive' as it is based on the collection of semantic data from the Italian lighthouses present at this time in our territory, as well as being defined as an expandable database for all the lighthouses in the Mediterranean.

46. The parametric methodology is therefore defined as malleable in the accuracy of detail as the elements created and inserted in the design model are sufficiently detailed and parameterized in their geometric and typological component, including all the 'replicable' variables similar to Italian lighthouses.

47. In the Semantic Atlas of Italian lighthouses, which can be consulted in the appendix, it is possible to view the correspondence between the Italian lighthouses and the semantic categories present in the single case study.

48. The metric modification of the parametric semantic elements follows an accuracy that is directly pro-

portional and connected to the type of measurement collection. In the case of the modeling proposed below, it was decided to follow the measurements collected through the photo straightening of the facades, while having a cloud of points available for each lighthouse-case study. Through this choice we want to understand and analyze the degree of accuracy of the 'average' type model created using photos and a few direct measurements, while underlining how the accuracy of the model depends exclusively on the use of the model itself, a topic dealt with in the course of the ninth chapter in the context of the identification of indicators.

49. It is the same project that identifies for the entire surface of the lighthouse, with the exception of the government space, a change of intended use of a "tourist-accommodation type, with the possibility of initiatives of high cultural value linked, for example, to scientific and/or environmental and/or didactic research, especially in relation to the historical-landscape context". To learn more: https://www.investinitalyrealestate.com/it/property/faro-punta-alice/#tab-analytic-description.

50. As previously stated, the Scan-to-BIM methodology is configured as an optimal methodology for the creation of models consistent with the real consistency of the building, although not free from management problems and a significant waste of time. This occurs as a consequence of the program's rigid predisposition towards the creation of parametric elements identified and enclosed in 'libraries' of standardized digital objects - a problem partly overcome through the creation of the semantic library of lighthouses - therefore not very adaptable to the vast characterization and uniqueness of the elements constituting the existing cultural heritage.

51. In the context of data collection, the complex laboriousness of the documentation and creation of a common and recurrent language of the architecture in question must be taken into consideration.

52. In the course of the ninth chapter, the possible further exits of the methodology are illustrated by means of indicators through the refinement of some areas of development. Regardless of further developments, the methodology nevertheless becomes effective in the development of an application addressed to four types of users, capable of combining the parametric and ontological sciences, an argument developed in the same chapter.

53. In this sense, in fact, it should be remembered that the identification of a common element ID code in the parametric and ontological field represents only the presupposition and the starting point through which to develop a hypothetical application aimed at the use and dissemination of data, object of study during the ninth chapter of the thesis, in which methodology and dissemination are compared by means of usability indicators.

54. Industry Foundation Classes (IFC) aims to describe data within the construction and building industry. It consists of a neutral and open, object-based file with a data model developed by buildingSMART (International Alliance for Interperabilit, IAI) to encourage interoperability between building disciplines. This format is used in a BIM environment, recognized and registered by ISO as the international standard ISO 16739: 2013. In the architectural field, the IFC model is based on the entity-relationship model made up of several hundred construction elements such as, for example: IfcWall, IfcExtrudedAreaSolid, IfcCartesianPoint. To learn more: https://www.ibimi.it/ifc-cose-e-come-e-fatto/.

55. For explanatory purposes, the transposition of the 'DwfGuid' and 'unique ID element' associated with the wall element is proposed below:
Id = 130315; Class = Wall; Category = Wall; Name = Generic - 200mm;
UniqueId = 60f91daf-3dd7-4283-a86d-24137b73f3da-0001fd0b
Dwf Guid = 60f91daf-3dd7-4283-a86d-24137b720ed1.

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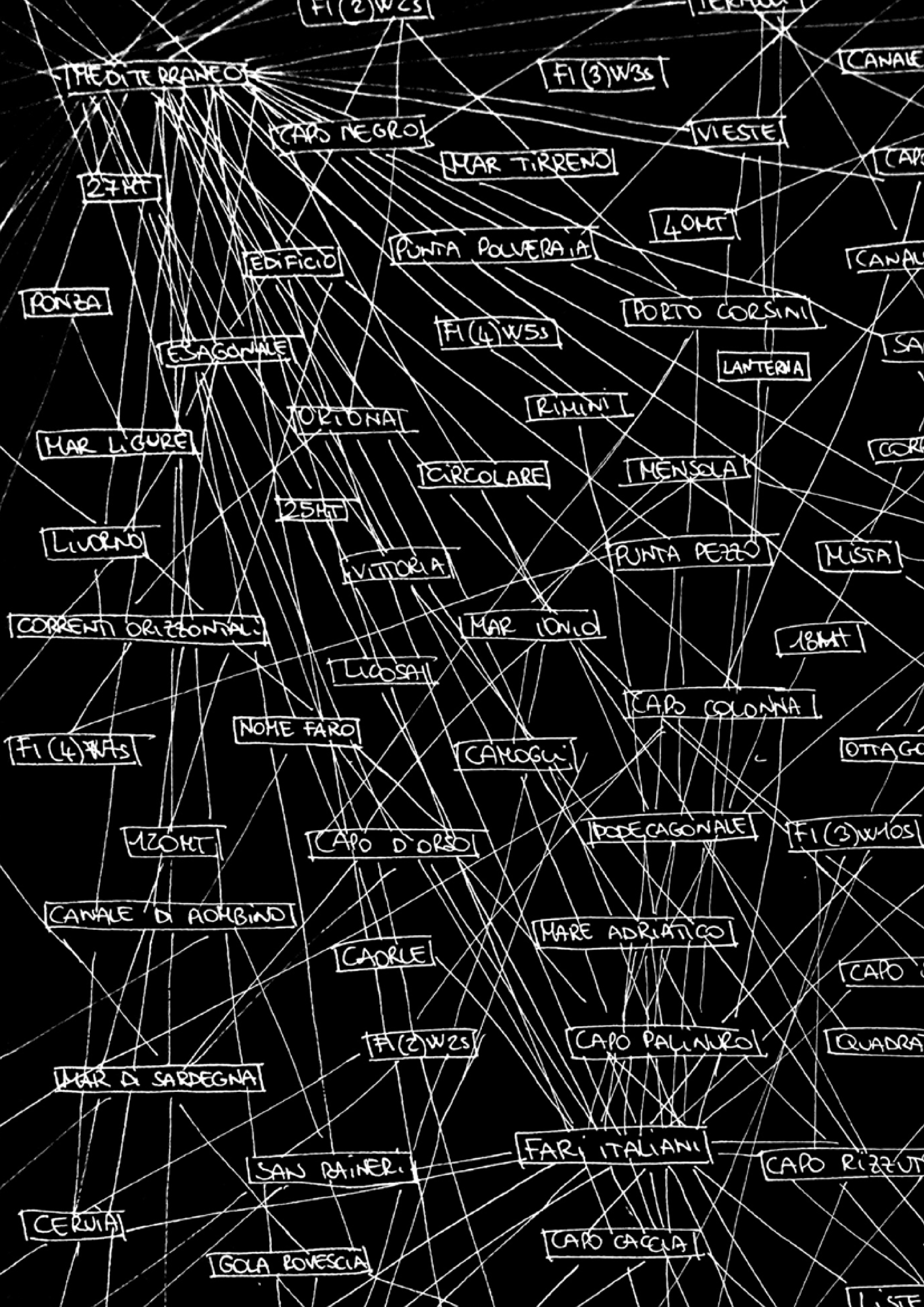
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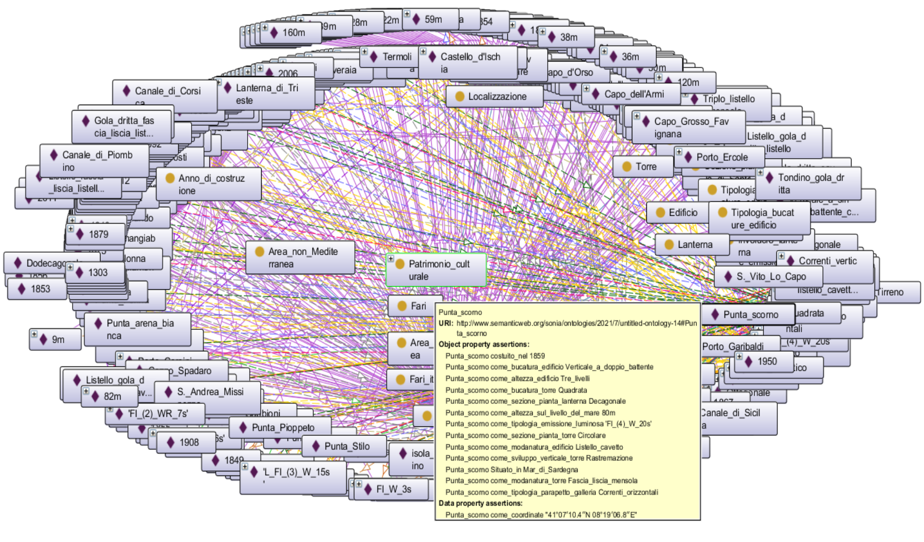
SAN RAINERI
CERVIA
CAPO CACCIA
GOLA ROVESCIA

Chapter 8

Ontology as a form of knowledge, connection and sharing of data

> "Una conoscenza è valida solo se riguarda l'aspetto sostanziale,
> mentre del particolare non si dà scienza"
> [Aristotele, 1064, p.7].

If in the course of the previous chapter the conduct of a semantic methodology aimed at the creation of parametric models having as object the Italian lighthouses was explained, in the course of the eighth chapter we want to narrate another type of knowledge management belonging to coastal buildings, through the use of a science with an enormous connective and cognitive potential: ontology.
This chapter therefore has as its object the creation of an ontological model of Italian lighthouses through which, with the use of the Protégé software, obtain the total reconnection of lighthouse data according to the dogmas of artificial intelligence. It is a process of sharing and knowledge of data that is radically different from the parametric field as it is based on the connection of textual data through specific relationships and taxonomies, capable of making 'theoretical' knowledge totally interoperable and 'infinite'. With the use of ontology, it is therefore possible to reconnect the lighthouses not only from an architectural point of view but also from an historical, landscape and functional point of view.



On the cover. The Italian lighthouses: knowledge networks. Fig. 1. The network: ontology of Italian lighthouses.

Introduction

The explication and use of ontology can be traced back to two specific areas: on the one hand philosophy and on the other computer science (Corcho et al., 2007).
In the philosophical field, Ontology refers to "the essence of things through changes", a concept on which philosophers such as Parmenides of Elea, Aristotle and, in the 18th century, even Kant work, according to whom ontology is that system of concepts and principles that allow us to go back to the data of experience, that is, from the sensitive to the supersensible[1]. In the more recent past, ontology has attracted new meanings to itself in the field of information technology, therefore aimed at document archiving, i.e. an orientation of enormous interest on the part of institutions, towards which to allocate investments and research oriented towards semantic organization[2]. The purpose of these guidelines can be summarized in three well-defined points: rational use of data; increase in the exchange and sharing of data; retention of information for a longer period (Felicetti, 2009).
It is immediately evident that the conservation and representation of historical heritage cannot be exempt from the production of classifications, in which archival sources are configured as fundamental for a correct explanation of historical identity (Grasso, 2011). In this sense, the archive and digital classification represent a fundamental imprint for the memory of history and the past, as well as constituting the basis through which to guarantee knowledge that is increasingly accessible to all types of users[3], multiplying exponentially the attention to all architectural typologies.
The birth of special systems for cataloging in fact involves indisputable benefits for the knowledge linked to the places and their history, while often generating in turn an excessive fragmentation and dispersion of data (Tonicello, 2014), as well as the dissemination of archives of incomplete architecture: 'silent' fragments awaiting their recognition as examples of the succession of architectural history over time (Albisinni & De Carlo, 2011). Nonetheless, the last few years have seen the intertwining of increasingly innovative and pressing dynamics aimed at the cataloging and enhancement of cultural heritage, often subject to sudden changes in the field of use and dissemination.
In this sense, cultural institutions can use ICT (Empler, 2017), which is a valid tool for digitization and the connection between hard science and soft science, fundamental in the connection between knowledge, in order to improve accessibility, communication and understanding of data and architectural heritage (Mollica, 2022). Ultimately, the organization and connection of digital information is becoming increasingly necessary today, a field in which the ontological sciences, based therefore on 'intelligent' behaviors to be implemented by breaking down into sub-problems, are configured as extremely performing. and high potential.
But why is ontology specifically configured as the perfect method for cataloging cultural heritage? This is because, in fact, ontology improves the management/understanding and access to the complexity of data, as well as improving its implementation and interoperability, areas in which semantics is configured as the most effective cataloging tool, to be profitably associate with this type of science (Acierno et al., 2017; Celani et al., 2015). In this sense, the use of an ontology is extremely efficient for: sharing information between people and software; to clarify hypotheses about a specific domain; to broaden knowledge of a domain, to analyze and create new knowledge of a domain (Noy & McGuinness, 2001).
In a purely applicative field, ontology represents a shared conceptualization of a certain domain and is based on the definition of the concepts and relationships that characterize the knowledge of the chosen domain, making it possible on the one hand to intelligently organize information already known and on the other hand, to establish new deductible

assertions, or new knowledge (Drap et al., 2015). Before explaining the process of creating the ontology aimed at reconnecting both 'known' and 'unedited' data associated with Italian lighthouses, it is however necessary to briefly clarify what an ontology is, the structure that defines it and the relationships that make up.

8.1 Theory and use of ontology

If in the past ontology is defined by Aristotle as 'the study of being as being', that is to say a discipline closely linked to philosophy, this science today changes meaning and use, moving towards digital communication and information, that is, an optimal process useful for facilitating sharing (Berners-Lee , 1998). There are several definitions associated with ontology that have followed one another in modern times: from the philosophical point of view it is a "systematic explanation of being"; from the IT point of view Gruber (1995) defines it as an "explicit specification of a conceptualization"; Borst (1997) defines it as a formal specification of a shared conceptualization while according to Guarino (2000) "ontology defines a logical theory that gives an explicit and partial justification of a conceptualization". But the definition that best matches the content of this thesis is undoubtedly the one asserted by Swartout in 1997: "an ontology is a structured set of terms that describe a domain and that can be used as a skeleton for the creation of a base of knowledge" (Swartout et al., 1997).
At a purely formal and structuring level, ontology falls within the realm of artificial intelligence and the representation of knowledge, configuring itself as a first-order theory, split into two well-defined parts: syntax and semantics.Semantics is configured as the representation of an ontology using web languages, through which to guarantee the correct exchange and correct reading of data by the machine: this is the case of the syntax of XML and RDF[4]. The Web Ontology is anchored on them Language (OWL), an extension of RDF, i.e. a markup language[5] to represent and explicit the semantics and meaning of specific terms in relation to each other. The final aim is to build not only knowledge bases but also the creation of new deductions, as well as overcoming the frequent problems of homonymy in the context of web research[6]. The syntax, on the other hand, is nothing more than a language based on the XML standard, through which the data can be organized into categories defined according to imposed relationships. This classification makes it possible to interpret, understand and understand the knowledge also exposed to humans and not only to machines.
Ultimately, ontological semantics brings about the analysis and a common understanding of the architecture associated with its meaning, towards a shared and interoperable knowledge of data, key issues also in the field of parametric modeling[7]. In fact, it already appears to be based on data management through simultaneous processes, during which, however, all textual data relating to the history of the building, functional characteristics[8], etc., are neglected, highlighting a gap between architectural interoperability and the 360° knowledge of the modeled building. In the ontological context of the Italian lighthouses, this aspect, together with the treatment of the semantics and terminology of the building, turns out to be a fundamental reading key in order to reconnect the material and the immaterial, aesthetics with function.
In this sense, before going into the process of practical creation of the ontology applied to Italian lighthouses - as a function of 'classes', 'relations' and 'domains' - it is necessary to make a first consideration regarding the extreme importance of terminology associated with the domain we want to refer to. This is because the different terms can have multiple meanings, based on the field of study and the language to which we refer, as well as representing the means through which to connect and connect the ontology to IT, modeling and enhancement processes[9], i.e. a extremely fertile field in the context of studies between 1995 and 2008[10].

The terminist logic can be traced back to the English William of Ockham who, with the article entitled "Terminologie et ontologie" published in the thirteenth century, initiates the theory based on the properties of terminology and its connection with reality. This logic is followed by the analytical influences of logical positivism, based on Wüster's theories, thanks to which ontology fits fully into the disciplines connected to terminology, together with logic, epistemology, applied linguistics, linguistics and, above all, computer science. Finally, Rastier, in the article "ontologies (s)", specifies how the ontological study is indissolubly associated with semantic linguistics, a recurring typology of classification in the present thesis and for this reason chosen in the analysis process aimed at the connection of knowledge.
With regard to the relationship between ontology and terminology, we cannot fail to mention, moreover, the thought of Roche (2005; 2007), who defines ontology as "*une conceptualisation d'un domaine*", underlining how terminology should be considered as practical as science, as well as key you promise for the construction and definitive representation of knowledge. Finally, among the keywords that describe the key points towards which the research is directed, we can underline "*la cartographie des savoirs*", in which Cristopher Tricot (2006) defines ontology as the information space addressed to the management of knowledge, to be organized according to: method, process, criteria, descriptive formalism and language. The method must respond to concrete needs, the process constitutes the relationship between information and operations in ontological creation, the descriptive formalism (called SNDF, Semantic Network Description Formalism) describes the knowledge in a specific field and, finally, the criteria structure the ontology of a specific domain. At this point it appears evident how the terminology used for the explication of a domain is fundamental in the creation of new or existing knowledge. In this sense, as already mentioned in the context of web research, the possible objective misunderstanding of the words with respect to the domain to which we are referring should be highlighted. Words such as 'lighthouse', 'lantern', 'gallery' appear to attract obvious homonymy problems in which the terminological indication is fundamental in the research context proposed here (fig. 2)[11].
We also recall how, in the context of problems connected with terminology, polysemic words are also characterized according to the language to which they refer. The word 'lighthouse', in fact, presents this type of problem in the case of the Italian and French languages but not for languages such as English and Spanish. Terminology, therefore, represents a fundamental aspect in the definition of an ontology, in which the prior definition of the language and the relative meaning of the terms becomes necessary. In this sense, in fact, the research approaches the meaning of words relating to the Italian language, of which specific categorizations and meanings have been defined, which can be consulted in the last part of this thesis.
In order to be able to develop and correctly express an ontology, together with the definition of a correct terminological apparatus, it is necessary to make explicit the formal mechanisms that occurred in conceptual languages of the OWL type. Having therefore defined the importance of terminology, at this point we want to analyze the composition of an ontology composed on the one hand of the hierarchy of classes, that is, the taxonomy and, on the other, of their relations, properties and instances (fig. 3).
The classes are configured as a set of 'individuals' organized hierarchically according to 'over- classes' and 'sub-classes', the latter comprising all the relational properties of the elements[12]. The properties are binary relationships on the individuals category, that is instances inserted in the classes, divided into two types: object properties and datatype properties . The first is defined as a relationship that binds different individuals, the second is nothing more than the bond of a specific individual to specific datatype values . Finally, the restrictions, that is the links between individuals, grouped according to three

categories: quantity restrictions, cardinality restrictions and hasValue restrictions , consisting of properties, a quantifier and a filler.
In summary, we can therefore state that for the design of an ontology the following elements are required: determination of the domain and purpose for which the ontology is created; organization of classes through a hierarchy according to classes and subclasses; definition of the attributes of relationship or relationship between concepts; definition of instances of classes and subclasses. By satisfying these elements, ontological science is therefore configured as a methodology through which to facilitate cooperation through: the exchange and aggregation of information; the illustration of the connections between concepts, semantics or case studies; the categorization of data and information; the exploration of different cognitive assertions, whether they are known or new (Wang et al., 2013); the infinite extension of knowledge.
Before explaining the ontology of Italian lighthouses in a practical and systematic way, we want to propose a final but necessary clarification regarding the ontological approach. Citing the concepts expressed in the course of the introduction to the seventh chapter

Term	Definition	Source
Lighthouse	Light signaling instrument, consisting of a projector of white or red or green light, with a range of 10 to 40 miles, usually implanted in a solid tower construction or in another suitable building, on the most visible points of the coast (ends of the piers, promontories, rocks), to serve as a fixed point of reference for night navigation; it is said characteristic of a f. the type of light emission (continuous or intermittent) and its range. In some cases it is mounted on a float (light boat, light ship). [...]	Treccani dictionary Url: https://www.treccani.it/vocabolario/faro/
Nominal range of the light source	The range of the headlights can be divided into nominal, geographical and luminous range. The nominal range, on the other hand, is independent of atmospheric conditions and is defined as the light range that the lighthouse would have under standard conditions, with a meteorological visibility of at least 10 miles. The nominal range of a lighthouse is from 10 miles to 40 miles.	Sites specialized in boating; lessons for the acquisition of a nautical license. Url: https://www.nauticando.net/lezioni-di-nautica/segnalamenti-ottici-marittimi/; https://www.mkonsulting.it/joomla/images/Navigazione/fari%20e%20segnali%20da%20nebbia.pdf.
Lantern	Part of the architectural complex of the lighthouse, the lantern is the glass structure that contains and protects the lamp and the optics. Generally circular in shape, but also polygonal, the lantern is made with special technical devices to be as transparent as possible to the light signal emitted by the optic [...]. Finally, on the tower there are one or more hanging galleries (the "terrace" or "gallery"), outside the service room and the lantern, the latter mainly to allow cleaning of the external surface of the lantern windows.	Sites specialized in boating and officers. Url: https://www.nps.gov/maritime/; https://www.mkonsulting.it/joomla/images/Navigazione/fari%20e%20segnali%20da%20nebbia.pdf. Libro: L'architettura dei fari italiani

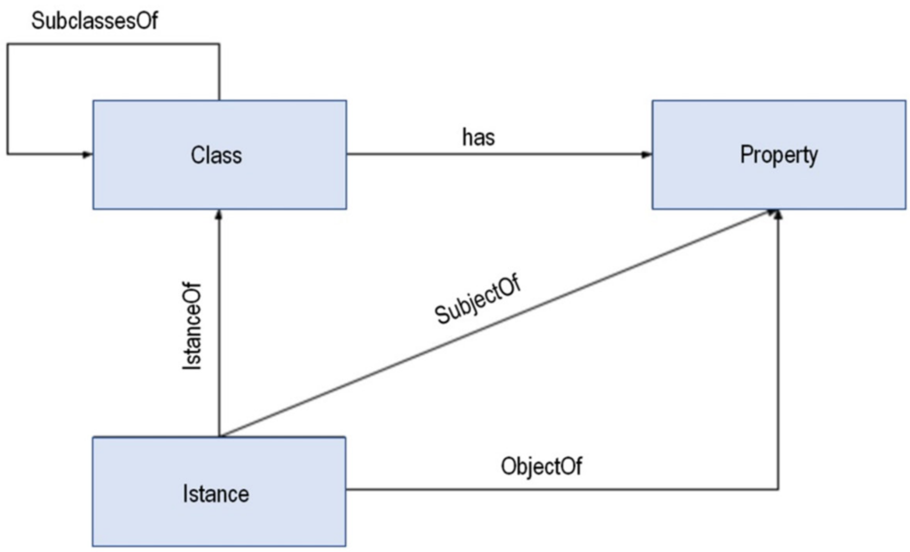


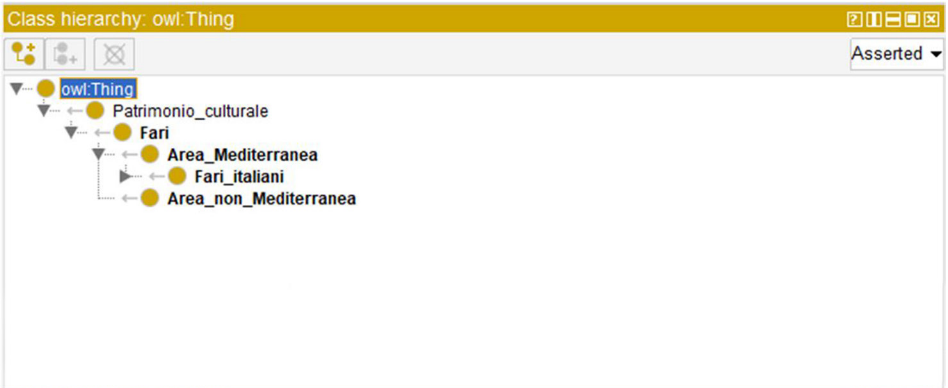
Fig. 2. Terminology and definition of ontological terms.
Fig. 3. Classes, connections and ontological relations.

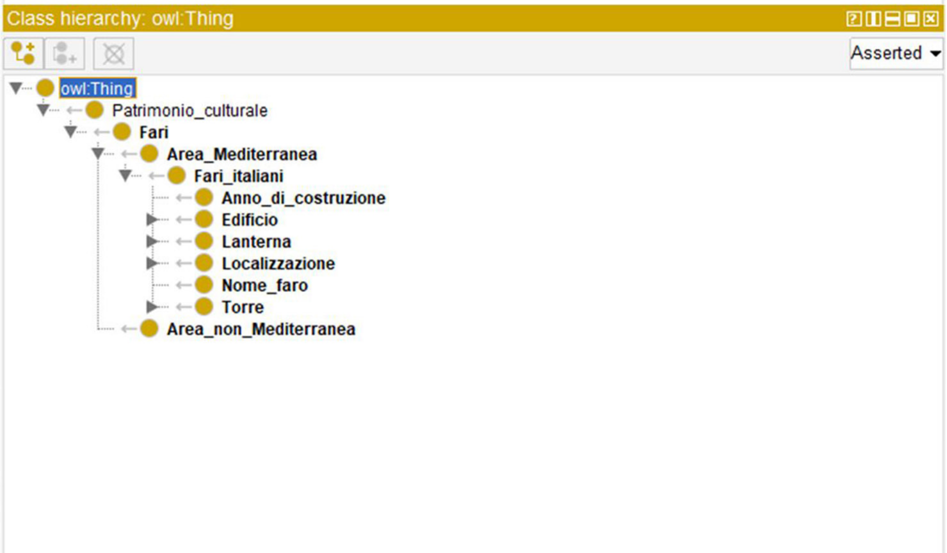
"Parametric semantic modeling", addressed to the methodological creation of the parametric type: "The methodology proposed here partly takes up the concepts expressed by the 'reverse method' of Tiveron , in which the 'management' is implemented through the decoding of the architectural-informative language of coastal buildings, up to 'achieving the objectives' through their application 'recomposition' according to specific case studies. In fact, as for the 'reverse method' the starting point is defined by the classification of objectives, in the same way, the methodology draws its basis in the cataloging of the data up to the explication of the single case study, that is the objective obtained according to a top-down approach in which the data are identified and explained with ever greater detail, that is to say a breakdown by parts already in place in the context of data cataloging". Similarly, the ontological management of Italian lighthouses, like the parametric one, is configured as a "decoding of the architectural-informative language of coastal buildings", through which to reconnect knowledge and reach the informative and modeling completeness of specific case studies. Therefore, consistently with the logic followed for the parametric methodology, the ontological methodology of the Italian lighthouses is directed towards the same top-down process, based on the constitution of generic aspects, supported by further specific sub-topics: a first level ontology described according to reports and subtopics. In this sense, the issue relating to the creation of relationships and sub-topics is configured as extremely connected to the decomposition process implemented for the Italian lighthouses, composed of macro and micro variables, each related to the higher group that contains it, an extremely performing methodology in scope of the hierarchical construction of an ontology.
Finally, it should be emphasized that, in any case, each ontology represents the knowledge that 'we' want to represent, that is, a personal interpretation and analysis of reality, albeit based on scientific and objective concepts and terms.

8.2 For an ontology of Italian lighthouses: motivations and taxonomy

Having defined what is the ontological theory and its use, it is at this point possible to explain the ontology created in the context of this doctoral thesis, aimed at the knowledge and dissemination of the historical heritage of Italian lighthouses, through which to view the characteristics belonging to to different coastal architectures and to carry out analyzes and studies of reconnection between stylistic typologies, geometric shapes, three-dimensional parametric elements and functional characteristics.
The Protégé open source software was used to create a map of the knowledge of Italian lighthouses, that is an ontological editor capable of creating and managing ontologies of various formats: RDF (S), OWL and XML Schema. The platform allows to use two modalities for the creation of ontologies: Protégé-Frames editor and Protégé-OWL editor. The first allows you to build ontologies based on "frames", the second, that is the type used for research, allows you to build ontologies addressed to the Semantic Web, specifically the OWL language, including the description of classes, properties and instances, included in the generic 'owl: Thing' supra-class . It is in the latter that Protégé , consistent with the creation of an OWL ontology, Protégé allows us to define a hierarchy of classes (taxonomy) and a set of properties, corresponding to the relations.
The first action to be implemented in the context of ontological creation is precisely the identification of a domain and the identification of the purpose for which the ontology is created[13]. In this sense, the research domain included in the ontology corresponds and refers to the semantic architectural elements, as well as to the functional elements associated with them, corresponding to the Italian lighthouses, even if they can be implemented in the whole Mediterranean context.

Accompanying this answer are further questions to be asked and to which an answer must be given, namely: what is the constituent domain of the ontology? What do you want to use the ontology for? What types of questions and information do we want to answer? Who is the user of the ontology? (Noy & McGuinness, 2001), that is questions that can change during the creation of an ontology, but in any case necessary in the initial processes in order to delimit the field of study and data of the ontology itself.
Regarding the answer to these questions, if the research domain has just been illustrated, we can affirm that the proposed ontology aims to create a knowledge connection apparatus, through which to expand the parametric semantization and generate new analytics knowledge in the field of the study of lighthouses. Through the hierarchization and the mixing of the architectural-coastal data, it is in fact possible to analyze any stylistic-architectural recurrences according to the geographical areas, possible common areas of action in relation to the coastline, any processes of strengthening the coastal signaling in the course of one specific space-time, as well as reconnecting knowledge that is fragmented for the moment.
The questions and information to be answered are varied, a natural consequence of a number of extensive and heterogeneous data and information, on which the entire sub-paragraph 8.2.2 "Competency questions: the creation of an ontological map for reconnection" is based. Finally, a further fundamental point in the treatment of an ontology concerns the users of the ontology itself, an area strictly connected to the complexity and typology of the data processed. Through the construction and connection of the data of the Italian lighthouses, it is possible to extrapolate different levels of knowledge and use, making it necessary to identify different users , that is an action taken during the sub-paragraph "Competency questions: the creation of an ontological map for reconnection", as well as in the course of the ninth chapter, depending on the mode of use in relation to possible new 'onto-parametric' developments.
Entering into the heart of the ontological creation of the Italian lighthouses, we therefore proceeded to create the taxonomic structure with the supra-class called *Patrimonio Culturale*, in which the *Fari* are placed as a sub-class, divided according to the *Area Mediterranea* and the *Area non Mediterranea* (fig. 4). In this sense, it should be emphasized that the hierarchy and taxonomy have been built exclusively for the *Fari Italiani*, i.e. subclass of the *Fari dell'Area Mediterranea*, since, as previously stated, the ontological knowledge is infinitely expandable and, at the same time, excessively complex compared to the vast number of elements to be treated in the whole of the Mediterranean area during the three years of research[14].
For the taxonomic identification of the ontological classes, the same structuring and decomposition proposed for the parametric modeling was followed, through the creation of three subclasses referring to the three macro-variables of the lighthouses: *Edificio*, *Torre* and *Lanterna*. Together with the creation of the previous subclasses, it was necessary to create three further subclasses of the superclass *Fari Italiani*, as they are not connected to the single macro variable but, on the contrary, to the entire structure. These subclasses, in fact, are associated with the functional and localization characteristics of the lighthouse, as well as constituting the category associated with the name of the specific lighthouses: *Anno di costruzione, Localizzazione* and *Nome faro* (fig. 5). If no further subclass has been identified for the *Anno di costruzione* and *Nome faro* classes, as they constitute a specific category of information to be included in the Instances context, it was necessary to create useful subclasses for the *Localizzazione*, *Edificio*, *Lanterna* and *Torre* classes, for a more specific supra-class[15]. In this sense, for the over-class *Localizzazione* the subclasses *Altezza sul livello del mare* and *Nome mare* have been identified, ie categories extremely based on the relationship between the lighthouse and its surroundings, as well as constituting elements previously identified in the knowledge database addressed to the Mediterranean





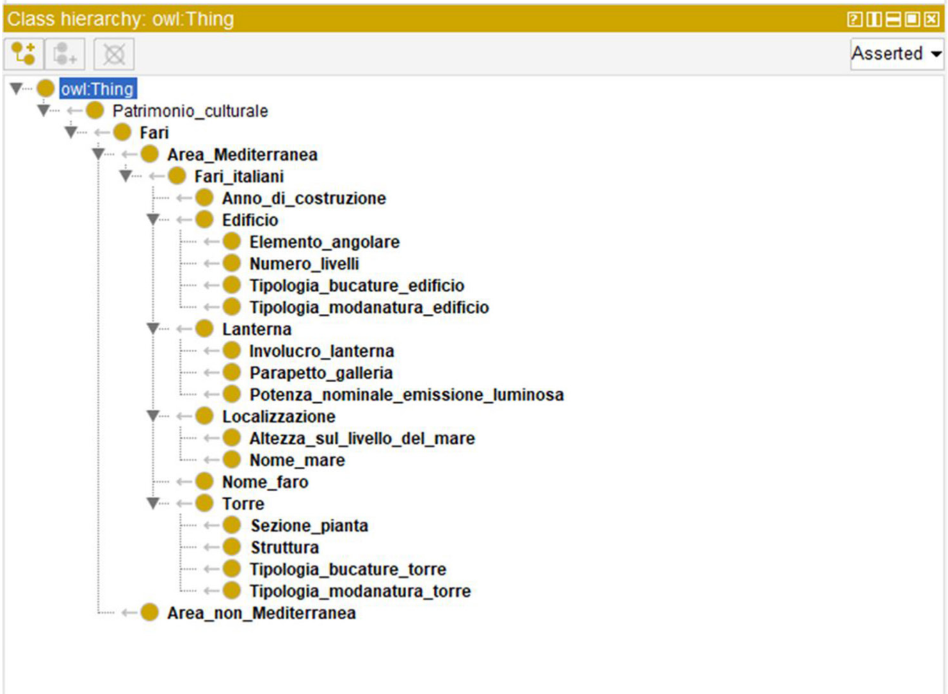
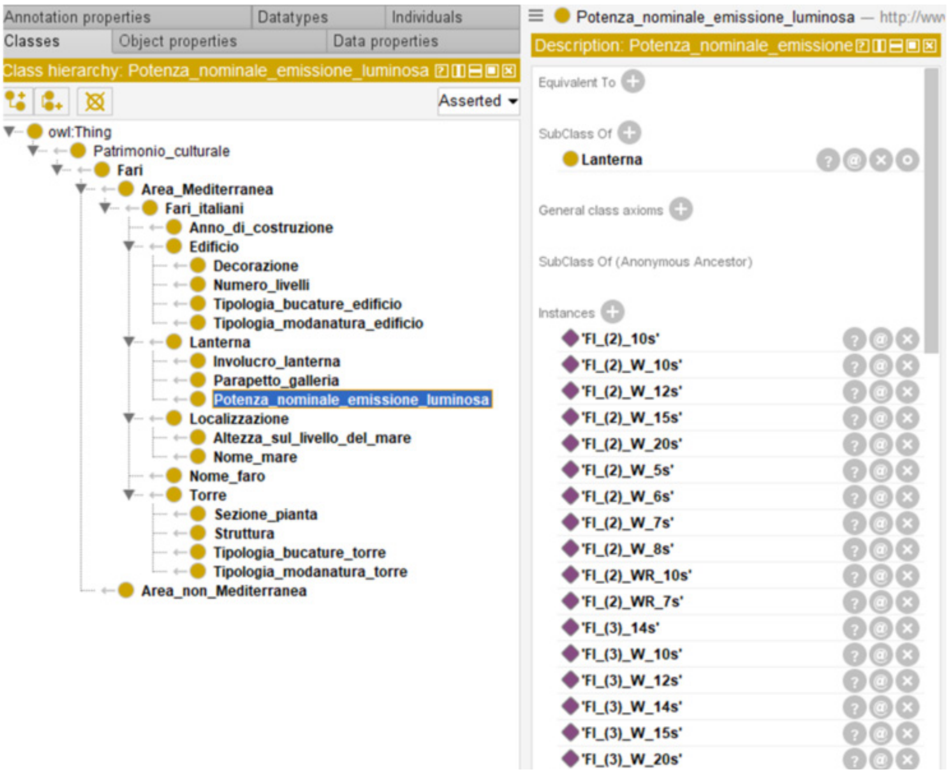


Fig. 4. Construction process of the ontological taxonomy of Italian lighthouses: over-classes.
Fig. 5. Construction process of the ontological taxonomy of Italian lighthouses: structural elements.
Fig. 6. Construction process of the ontological taxonomy of Italian lighthouses: qualifying elements.

lighthouses. For the subclasses of the overclasses *Edificio*, *Lanterna* and *Torre*, have identified the same semantic categories used for parametric modeling as they are suitable to be used for the cognitive decomposition of the architecture of the lighthouse and, at the same time, capable of being connected in the parametric context. In particular, for the over-class *Edificio* the sub-categories have been identified: *Elemento angolare*, *Numero livelli*, *Tipologia bucatura edificio* and *Tipologia modanatura edificio*. The subclasses have been identified for the *Torre* overclass: *Sezione pianta*, *Struttura*, *Tipologia bucatura torre* and

Fig. 7. *Individuals* of the ontology of Italian lighthouses.



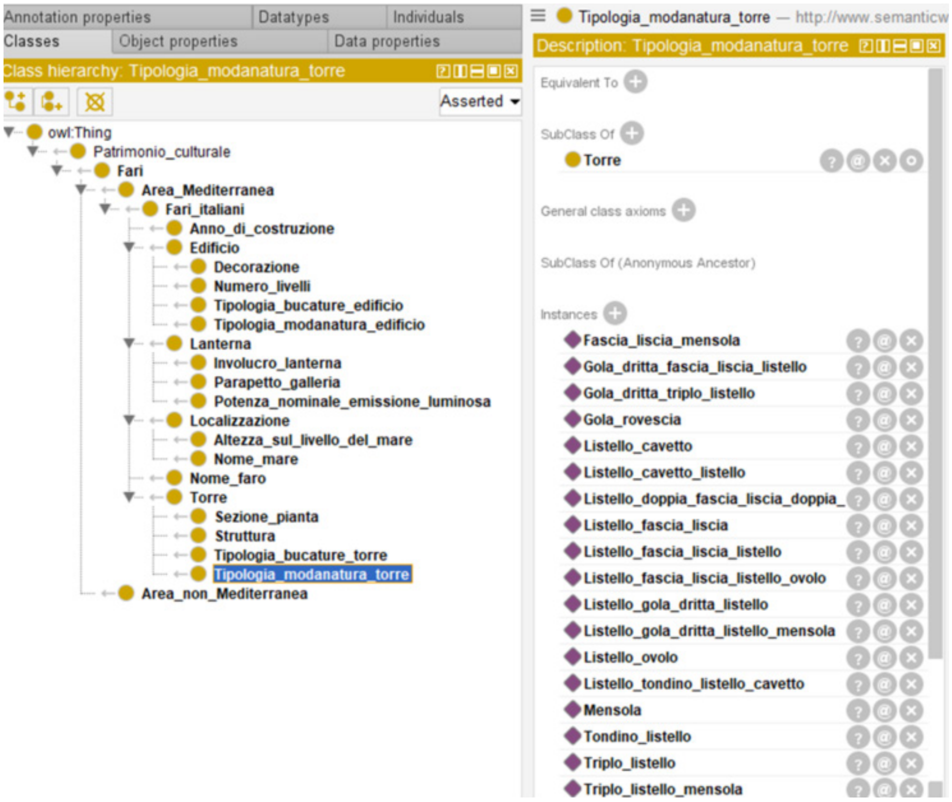
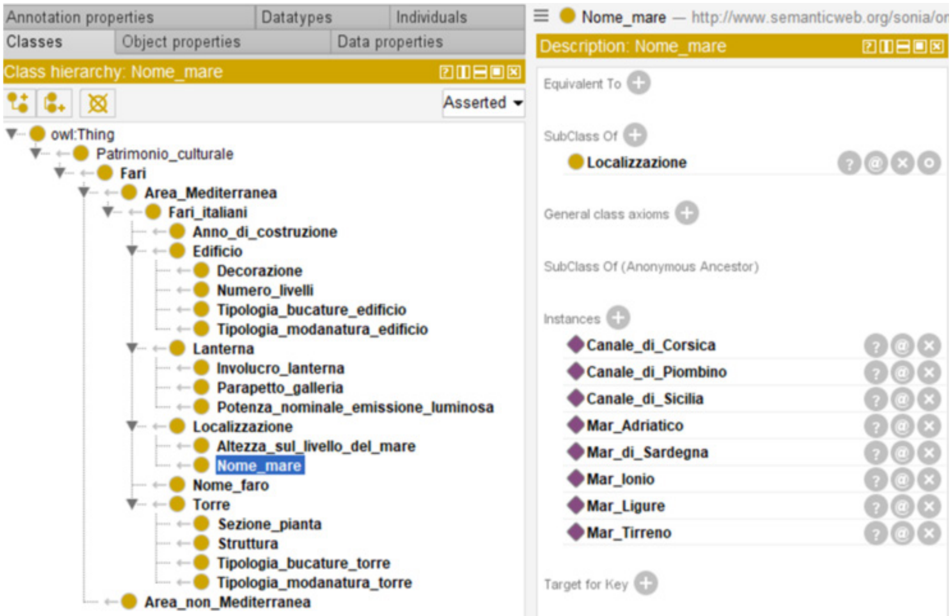


Fig. 8. Ontology of Italian lighthouses: Instances belonging to the nominal power of the light emission.
Fig. 9. Ontology of Italian lighthouses: Instances belonging to the types of moldings of the tower element.

Tipologia modanatura torre. Finally, for the *Lanterna* over-class, the following sub-classes have been identified: *Involucro lanterna*, *Parapetto galleria* and *Potenza nominale emissione luminosa* (fig. 6).
Finally, the next step useful for the composition of an ontology, through which it is possible to proceed with the definition of the properties and related relations, is undoubtedly



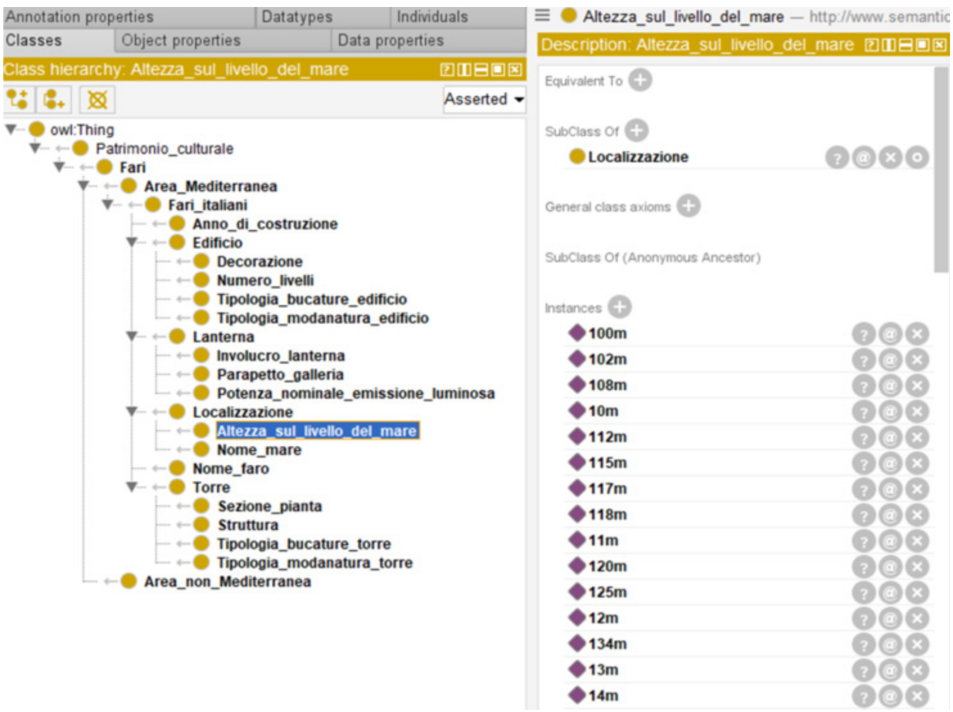


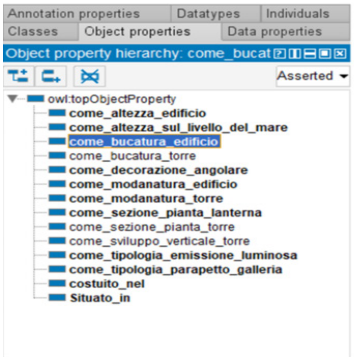
Fig. 10. Ontology of Italian lighthouses: Instances belonging to the marine localization.
Fig. 11. Ontology of Italian lighthouses: Instances belonging to the height above sea level of Italian lighthouses.

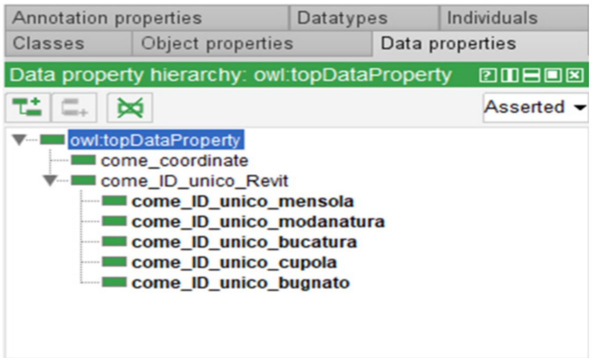
the creation of the Individuals belonging to the various classes of the hierarchy under the name of 'instance'. In this sense, the logics of description make use of three types of entities: concepts, roles and individual names. Concepts define the set of individuals, roles represent the relationships between individuals and individual names define the individuals of the domain. In the context of first-order logic, the previous three entities can be associated with unary predicates, binary predicates, and constant predicates.
If those just treated can be associated with the concepts that make up a specific domain, below we want to explain the names that contribute to the identification of the individual names that define the domain. Individuals are therefore configured as the characterization of a specific class described according to physical objects and numbers, defined as concepts belonging to the classes and connected to each other through relationships, in this case including all the semantic characteristics found in the context of parametric modeling and defined previously like the 'micro variables' of Italian lighthouses.
In the ontology of Italian lighthouses, therefore, all the proper names of Italian lighthouses have been transcribed (fig. 7), together with all the instances belonging to the different subclasses, corresponding to the micro variables and functional characteristics of the architecture. Examples are the technical nomenclatures of the luminous range of the lantern (fig. 8), the geometry of the section in the plan of the tower, the types of windows in the building element and the tower element, the types of molding of the building element and of the tower element (fig. 9), the number of levels of the building element, the sea overlooked by the lighthouse (fig. 10) and the height above sea level (fig. 11). In conclusion, once the taxonomy of the classes and instances has been set, it is therefore possible to proceed with the explication of the relative Objects property assertions and Data property assertions, i.e. indispensable actions for knowledge and the relationship between data, towards complete connection and interoperability.

8.2.1 Relationships: object properties and data properties

The taxonomy, as just explained, is not sufficient to provide the information suitable for determining the specific purpose of the ontology, as described in the course of the previous paragraph. In this sense, once the taxonomy has been defined, it is necessary to describe the internal structure of concepts by relating, through the properties of data and objects, individuals to specific characteristics, providing a restriction and at the same time a connection.
As stated previously, in fact, the logics of description make use of three types of entities: concepts, roles and individual names. Concepts define the set of individuals, roles represent the relationships between individuals and individual names define the individuals of the domain. At this point we want to define the roles, that is the relationships between individuals, through which to connect data and ontological instances, towards the final production of the ontology of Italian lighthouses.
Regarding the practical construction of relationships, the "Object property" it is used to map and relate the ER model with respect to two properties of the ontological object OWL, through which to connect an individual/class to another individual/class present in domain[16]. Therefore, we proceed to create the specific object properties for Italian lighthouses, inserting as object properties all those relationships of connection between the lighthouse and a specific semantic, historical and functional characteristic. Through an object property such *come_bucatura_edificio*, a specific lighthouse is therefore related to a specific type of window present in the building, such as the opening belonging to the type *Verticale_a_doppio_battente_con_volta*, *Verticale_a_singolo_battente*, *Circolare*,

Quadrata, etc. (fig. 12). Or again, using the object property as_section_plan_tower it is possible to define the section geometry of the tower of a specific lighthouse belonging to the Individuals such as the *Circolare*, *Mista*, *Ottagonale* and *Quadrata* plant.
Finally, it is necessary to insert and develop the "Data properties", that is the affirmations of connection capable of relating an Individual to a textual description, through which to uniquely identify a specific case study with respect to a specific data, often numerical. Data properties, in fact, are often associated with unique codes and numerical descriptions, frequently composed of identification codes, production numbers and localization codes, i.e. characteristics present only in a specific Individuals. In this sense, it was therefore considered appropriate to relate the characteristics pertaining to the specific geographical location and the ID element code of the semantic parametric mo-





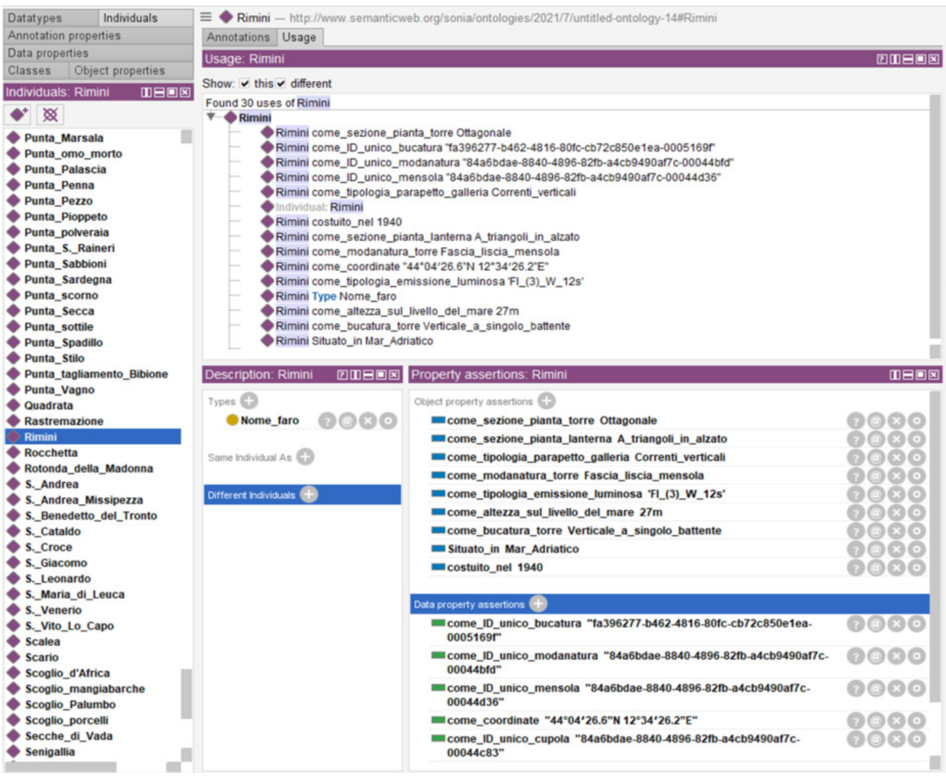


Fig. 12. Object properties: relationship "*come_bucatura_edificio*".
Fig. 13. Data Properties belonging to the ontological model of Italian lighthouses.
Fig. 14. Ontological information panel of the Rimini lighthouse.

dels through the Data properties. The relations associated with the data property have therefore been created, named *come_coordinate* and *come_ID_unico_Revit*, the latter in turn made up of all the parameterized semantic elements such as: *come_ID_unico_bugnato*; *come_ID_unico_cupola*; *come_ID_unico_bucatura*; *come_ID_unico_modanatura*; *come_ID_unico_mensola* (fig. 13). The connection therefore becomes total upon consultation of the Data properties assertions, as they are connected to the element IDs of the semantic families created in Revit, through which the semantics, knowledge and data are recomposed and reconnected[17] .
The semantic, functional and historical data are therefore reconnected to a specific case study, bringing back the whole of the "broken down" semantics, already fragmented during the schematization and parametric modeling, towards the recomposition and relocation in specific lighthouses (fig. 14). This recomposition makes possible not only the creation of an interactive ontological knowledge, linking specific semantic and functional characteristics to different case studies, but also the possible union between three-dimensional parametric modeling and textual ontological knowledge, an argument subsequently studied in the course of the ninth chapter.

8.2.2 Competency questions: creating an ontological map for reconnection

One of the ways in which the purpose of an ontology can be determined is undoubtedly by defining a list of basic questions that the ontology should be able to answer, in order to generate a data connection and a new knowledge: this is the case of "competencies questions", formally defined as the questions we want to answer with the created ontology (Gruninger & Fox, 1995). These questions, posed in preparation for the creation of the ontology itself, are outlined as useful guidelines for determining the field of investigation and defining the taxonomy. The same questions are also formulated net of the ontological conclusion, defined as the litmus test through which to verify the correct and consistent transposition of the data (Noy & Hafner, 1997).
In order to be able to answer these questions, the ontology must therefore be composed of axioms sufficient to answer certain questions, depending on the knowledge to

Competency Questions	Risposta
Quanti sono i fari sono presenti in Italia?	198
Quanti fari sono stati costruiti nel 1867?	6
Quanti fari sono presenti nel Canale di Sicilia?	10
Numero tipologia potenza nominale dei fari Italiani?	55
Quanti fari con tipologia luminosa Fl (3) W 15s?	22
Quanti fari hanno sezione ottagonale della torre?	142
Quanti fari hanno un edificio a due livelli?	57
Quanti fari presentano un bugnato angolare?	15
Quanti fari sono presenti nel Mar Ionio?	16
Quanti fari sono presenti nel Mar Tirreno?	85
Quanti fari sono presenti nel Mar Adriatico?	41
Quanti fari hanno una torre a struttura rastremata?	76
Quante torri del faro hanno un triplo listello come modanatura?	4
Quanti fari sono situati a 12 metri sul livello del mare?	6
...	...

Fig. 15. Some *Competency Questions* of the ontology of Italian lighthouses.

be transmitted (Gruninger & Fox, 2005). In this context, it should be specified how the proposal, administration and verification of competency question is still a task carried out manually by a specialist, configuring itself as a process not yet automated in the opensource environment, albeit fundamental in the field of innovation and ontological validation[18].

Not having available an automated verification tool, in order to validate the newly created ontology of the Italian lighthouses, the same model/questionnaire was administered in a non-automated manner, through which it was possible to verify the response of the software with respect to to certain questions shown in the figure (fig. 15). The competency questions therefore allow us to respond in a partially automated way, using graphs or descriptive codes, to questions relating to the historical, functional and compositional sphere of the domain for which the ontology was created, as well as to connect the answer with all case studies including the required feature.

The ontology of Italian lighthouses ultimately manages to relate and identify the common aspects shared by different case studies, generating ever new and comprehensible maps of knowledge for all types of users[19] (figs. 16-18). By means of the ontology of Italian lighthouses, we therefore want to reconnect all the data sought and schematized on the Atlas of Mediterranean lighthouses and the Semantic Atlas of Italian lighthouses, in order to make these data accessible to all types of public and above all, renewable and expandable.

Regarding the use of ontological data, the creation of a platform capable of simultaneously and adaptively hosting parametric data and semantic data is today a challenge not yet practiced in the field of research oriented towards knowledge and tourism. In the course of the next paragraph we therefore want to clarify the hypothesis addressed to the creation of a software with four user interfaces - adult, disabled, child and expert - through which to guide the user towards knowledge and understanding of data.

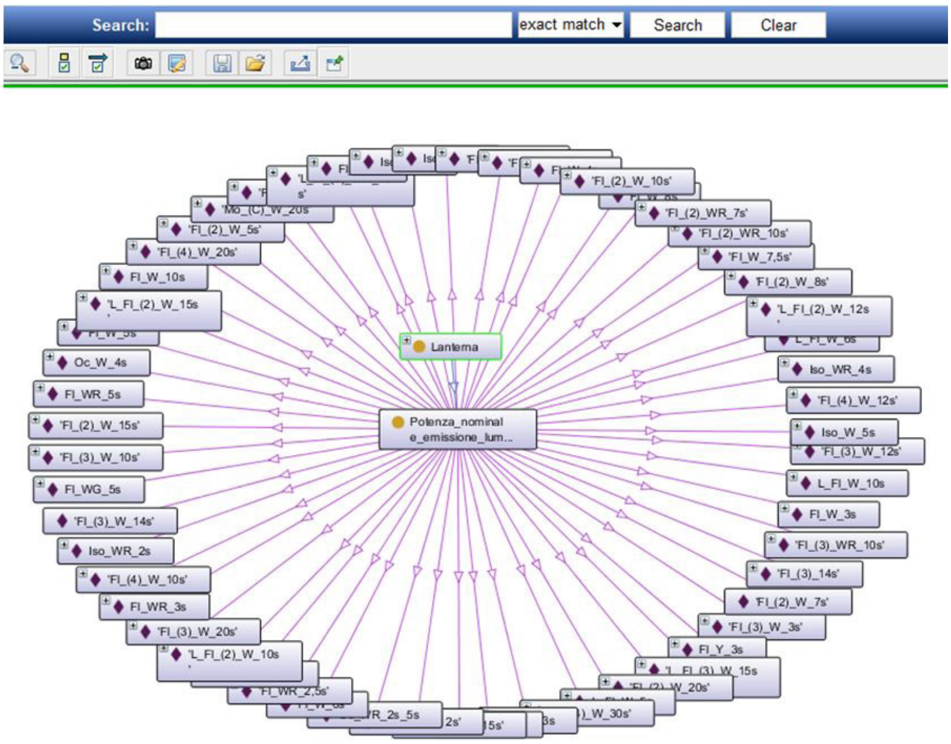
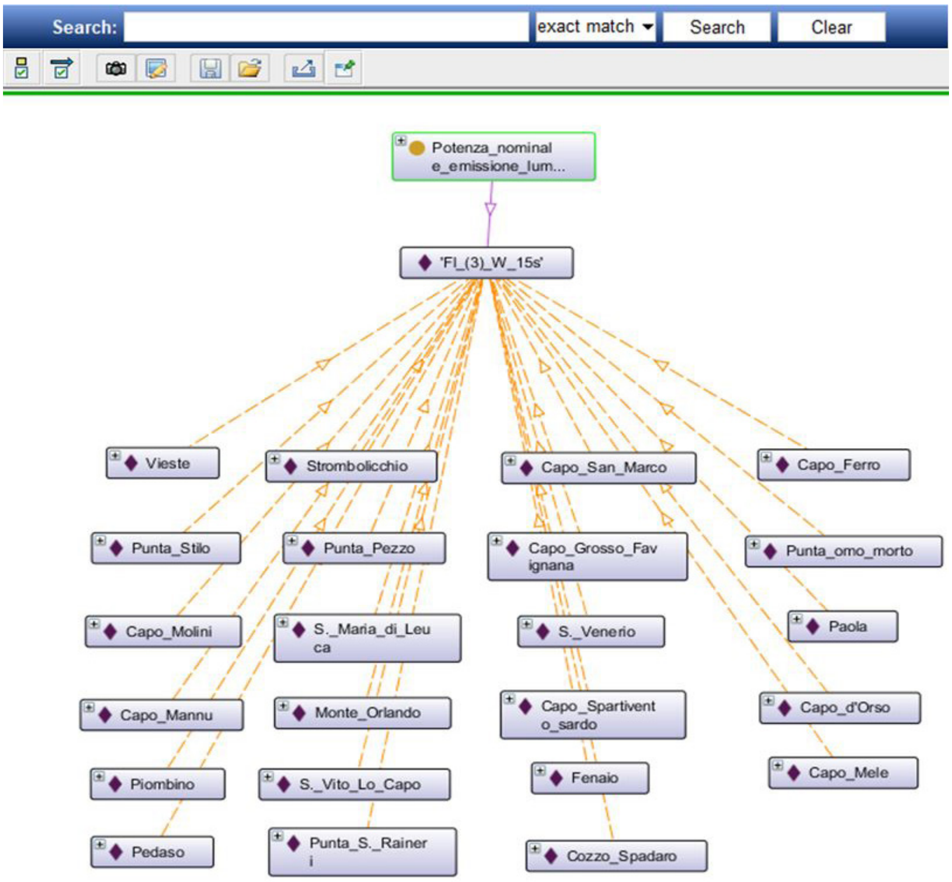


Fig. 16. Ontograph of Italian lighthouses: nominal power of the light emission.



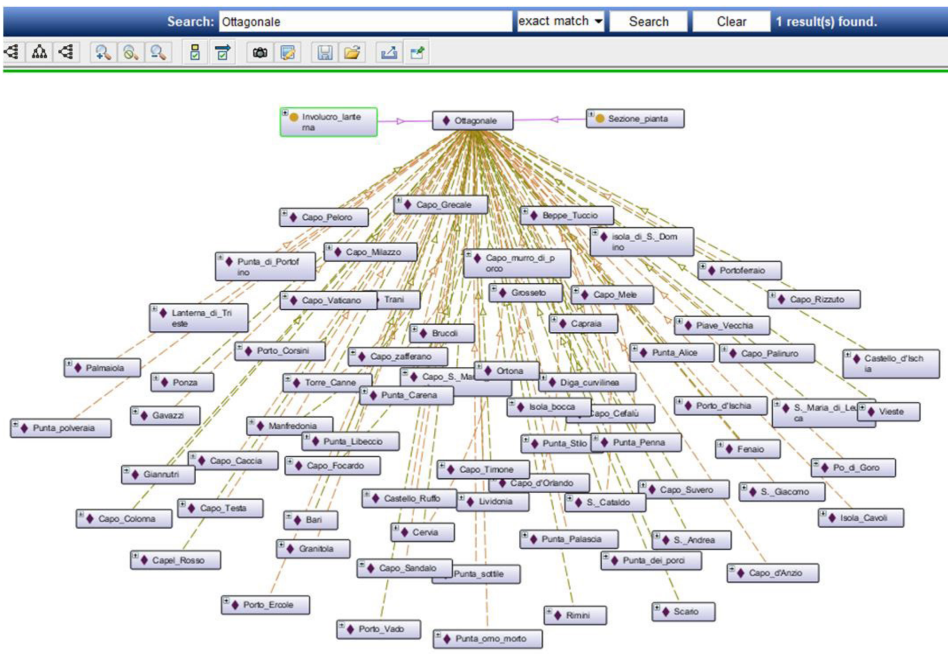


Fig. 17. Ontograph of Italian lighthouses: nominal light emission power, type Fl (3) W 15s.
Fig. 18. Ontograph of Italian lighthouses: plan section, octagonal tower.

Notes

1. For further information: https://www.treccani.it/encyclopedia/ontologia_%28Encyclopedia-del-Novecento%29/#:~:text=Kant%2C%20Gesammelte%20 Schriften%2C%20Akademie%20Ausgabe,%2C % 20from% 20sensitive% 2C% 20to% 20suprasensitive, accessed on May 30, 2022.

2. An example is the "Inception" project, aimed at methods and tools translated into "3D models easily accessible to all user groups and interoperable for use by different hardware and software. It develops an open standard semantic Web platform for the construction of information models for cultural heritage (HBIM) to be implemented in easy-to-use augmented reality (VR and AR) operable on mobile devices". Among the main objectives, extremely connected in the context of this research, we highlight "objective 3: to develop an open standard semantic Web platform for accessing, processing and sharing interoperable digital models resulting from 3D surveys and acquisition of data". To learn more: https://www.inception-project.eu/en/project, accessed on May 30, 2022.

3. It should be emphasized that the enhancement of the archive, in addition to its use, depends on the critical interpretation of the documentation, allowing the forward projection of one's past towards a present future, through digital transposition techniques that can develop a renewed interest of architecture inextricably linked to history (Culotta & Sciascia, 2008).

4. Acronym for 'Resource Description Framework', is the W3C (World Wide Web Consortium) coding tool for the use and exchange of metadata, through which semantic interoperability is guaranteed.

5. Or also 'markup language', that is a set of rules designed to describe the mechanisms of representation of a text through the use of standard conventions.

6. In this sense, the actual and evident problems encountered during the development of this thesis should be emphasized. In this sense, words such as 'lighthouse', 'lantern', 'gallery' appear to attract evident problems of homonymy in which the terminological indication, as well as the language of expression, is fundamental in the research context. It was therefore considered necessary to draw up an 'ontological glossary', which can be consulted in the appendix, through which to explain the meaning attributed to each semantic term.

7. The semantics of the programming language can be divided into: algebraic semantics, axiomatic semantics, operational semantics, denotational semantics and translation semantics. Algebraic semantics interprets the program by defining an algebra. Axiomatic semantics determines the meaning of a program by constructing assertions about an association that they hold at every point in the program's execution (ie implicitly). The operational semantics compares the languages to the abstract machine and the program is then evaluated as a sequence of state transitions. The denotational semantics expresses the meaning of the program in the form of a set of functions that operate on the state of the program. Translational semantics focuses on the methods used to translate a program into another language.
For the present research it is clear how an axiomatic semantics was used as it is based on assertions addressed to the connection of data according to relationships. For further information: https://vitolavecchia.altervista.org/differenza-tra-sintassi-e-semantica-in-informatica/, accessed on May 30, 2022.

8. For this reason, in the course of the ninth chapter a hypothesis will be put in place regarding the creation of a software that can connect the ontological data to the parametric ones.

9. In this sense, in fact, the use of specific terminologies makes it possible to connect computer knowledge with different digital environments such as, for example, parametric modeling.

10. In particular, it is France that is configured as a context in which ontology, and therefore the terminology connected to it, represents an absolute virtuous example of development and research. In this sense, in fact, the doctoral period spent in Paris, in the MAP-MAACC laboratory affiliated to the CNRS, was configured as essential for the deepening and knowledge of these issues.

11. The use of correct terminology also makes the research itself expandable towards an 'infinite' knowledge. This is because ontological knowledge can be extended to infinity, using inference rules. The difference between the database and the ontology lies precisely in this characteristic: the database is configured as a list, while in the ontology there is the assumption of an open world.

12. To each class, moreover, can belong to the 'conditions', that is to say asserted conditions, "necessary" or "necessary and sufficient" to belong to that class.

13. As seen in the parametric field, the choice of the purpose of a given methodology is a preparatory step for the creation of any type of action.

14. In this context, the data collected for the Mediterranean lighthouses appear to be mostly related to the relationship between the lighthouse and the surrounding area, that is, elements that are not partially complete with respect to the semantics identified for the Italian lighthouses. It was therefore considered appropriate not to report this material, in favor of the creation of a complete ontology of Italian lighthouses.

15. In any case, all the subclasses can be associated with the semantic and functional characteristics reported in the appendix and in the parametric process.

16. The relationship in OWL is described in binary form, divided into the following groups: one-to-one relationship (1: 1); relationship one to many and many to one (1:N or N:1); many-to-many relationship (M: N) (Chujai et al., 2014).

17. It should be emphasized that the connection of the element IDs is not sufficient to mechanically connect the parametric and ontological software as the file extension is configured as extremely different and unmanageable. In this sense, it is useful to think of a third platform that can connect the two different data extensions in order to be able to use both information at the same time. This is how the seventh and eighth chapters merge towards the hypothesis of an onto-parametric software, an argument treated in the course of the ninth chapter.

18. In this context, during the international conference on Web Intelligence, a tool called CQChecker was hypothesized, to support the evaluation of an ontology in relation to competencies questions. This support, suitable for understanding a text written according to natural language, considers not only the

requests but also the terminology adopted. During this study, attempts were made to automate the competency response processes questions through a CQChecker Module (Bezerra et al., 2013).

19. The use of ontological maps by blind users could be implemented through the audio transposition of ontological information manageable by voice search commands. It should be emphasized, however, that the overcoming of architectural barriers by ontological software is not yet a practiced reality, although there are some studies on the matter. This is the case of a thesis in biomedical engineering entitled "Smart Hospital Assistant: study and implementation of a hospital voice assistant using semantic technologies", in which both the patient and the doctor can use the voice assistant to obtain information on a ontological, on the one hand, on the contacts to call and, on the other, on the medical records. To deepen the themes of the thesis: https://amslaurea.unibo.it/24006/1/DiTuccio_Gianluca_SmartHospitalAssistant_Tesi.pdf, accessed on May 30, 2022.

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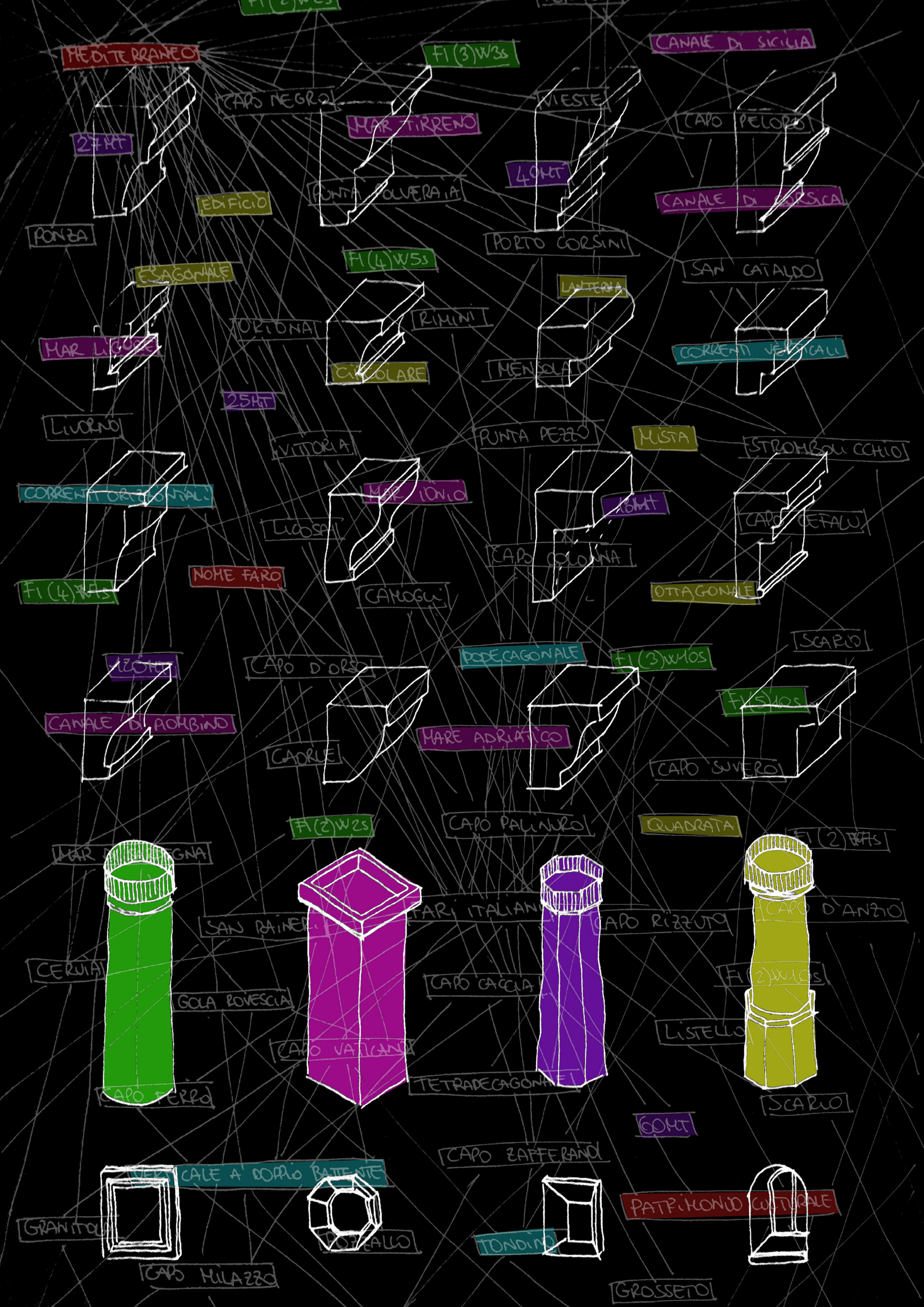
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SAN CATALDO
ESAGONALE
LANTERNA
ORTONA
RIMINI
MENSOLA
25MT
LIVORNO
VITTORIA
PUNTA PEZZO
MISTA
STROMBOLICCHIO
MAR IONIO
LICOSA
CAPO CEFALU
CAPO COLONNA
NOME FARO
CAMOGLI
OTTAGONALE
SCARIO
CAPO D'ORSO
DODECAGONALE
FI(3)W10s
CANALE DI PIOMBINO
MARE ADRIATICO
CAORLE
CAPO SUVERO
FI(2)W2s
CAPO PALINURO
QUADRATA
FARI ITALIANI
SAN RAINERI
CAPO RIZZUTO
CAPO D'ANZIO
CERVIA
CAPO CACCIA
FI(2)W10s
GOLA ROVESCIA
LISTELLO
CAPO VATICANO
CAPO FERRO
TETRADECAGONALE
SCARIO
60MT
CAPO ZAFFERANO
CALE A DOPPIO BATTENTE
PATRIMONIO CULTURALE
GRANITOLA
TONDINO
CAPO MILAZZO
GROSSETO

Chapter 9

Conclusions: for dissemination of results and further research developments

"Valutazione: attività complessa connessa al metodo della programmazione, attraverso la quale si verificano i benefici raggiunti, rispetto alle risorse impiegate e agli obiettivi posti, nonché l'adeguatezza delle strategie attuate per il raggiungimento dei risultati attesi. Può fare riferimento a standards, scale qualitative e oggettive"
[Ministero dell'Interno, 1994, p. 23].

With this chapter we want to analyze all those immediate or potential outputs of the research, towards a dissemination[1] addressed to different fields of investigation and users. In this sense, it is now known how the enhancement and dissemination to the expert and less experienced public of methodologies and programs is configured as a fundamental step in the validation of a product/process, as they are based precisely on the principle of use and inclusiveness. In fact, even if the methodology is already configured as a validated product of the research, this output cannot be defined as completely sufficient for the inclusive dissemination of the same as it is exclusively addressed to an expert audience. As part of the dissemination of results, the creation of a replicable methodology in a parametric and ontological environment welcomes a possible and immediate development, albeit not yet implemented, in the context of the use of knowledge and of the methodology itself, through which guarantee the principle of inclusiveness. We therefore want to clarify the possible creation of a software capable of combining parametric and ontological data in a direct connection, to be addressed to four different types of users: adults, children and/or disabled, blind and experts. The latter is accompanied by the assessment of the adequacy of the methodology through indicators associated with possible developments of the methodology itself.

SKIL-L
Semantic knowledge of Italian lighthouses

On the cover. Italian lighthouses: parametric modeling, between semantics and ontology.
Fig. 1. Onto-parametric software logo: SKIL-L.

Introduction

Net of the discussion and the hypothesis of creation of the onto-parametric software, we therefore want to analyze the possible developments of the research, through the use of some useful indicators to evaluate the effective adequacy of the methodology with respect to specific development directions. In this sense, as claimed by Orazio Carpenzano: "To date, the products of scientific research in architecture enter with difficulty in an evaluation grid commensurate with the bibliometric disciplinary sectors. For an architectural project, which by its nature deals with mainly contextual methodological and thematic issues, characterized as it is by elements of an expressive-poetic nature, it is even more difficult to formulate an assessment based on objective and commensurable criteria" (Carpenzano et al., 2020, p. 37).
Through the indicators we therefore want to try to conduct research towards different types of dissemination, enhancing aspects such as: the survey of data; computerization; knowledge, computer equipment and graphic software. These actions will be the parameters through which to evaluate the adequacy of the proposed research methodology with respect to four different types of dissemination: restoration; documentation; AR/ VR and Machine Learning. A score from one to ten is therefore attributed to the intersection between action and modality, through which to understand the assets to be enhanced within the created methodology, in order to pursue a specific result.
But before going into the field of dissemination and its further possible developments, we want to assess the validity and effectiveness of the methodology itself, intended as the final product of doctoral research. Self-assessment, in fact, undoubtedly appears as a complex but necessary assessment process as it is a prerequisite for the final considerations regarding the growth of knowledge in the chosen field of study.
In this sense, as argued by Luigi Arcopinto and Francesco Calabretti: "Evaluating the architectural project, on the basis of explicit categories derived from a self-evaluation process, is of fundamental importance to understand how it can be considered the research product" (Arcopinto & Calabretto, 2020, p. 65). For this reason we used the evaluation table[2], contained in the previous bibliographic reference, in order to evaluate the methodological product at the basis of the subsequent disseminations (figs. 2, 3).
Analyzing what is the self- evaluation table of the final methodological product, it appears evident that it is particularly characterized by 'technology' and 'tools', in which 'spatiality' is totally lacking. This is because it is understood as the physical composition of the product/project, a component totally absent in the methodology, albeit extremely connected to what is the theme of material and architecture. On the other hand, 'technology' and 'tools' appear as categories with high 'potential' as well as high 'value' and 'innovation', this is because the issues associated with parameterization and knowledge are configured today as extremely current and from the enormous 'potential' in the field of cultural heritage enhancement.
These processes go hand in hand with what is the context and therefore the 'place' in which the methodology is placed which, although it is configured as a methodology that can be replicated in different geographical contexts, is in this case imbued and united with a high evocative meaning and immaterial of Mediterranean places.
The categories associated with the 'method' and the 'language' appear particularly fitting with the parameters of the 'validity' of the methodology, as they are closely related to the classification and semantization of the elements on a taxonomic and terminological basis, that is, partially objective arguments, with clear and defined boundaries and categories. Finally, we find 'interdisciplinarity', an element strictly connected to the state of the art of the research methodology as well as to possible future developments.

	Innovazione	Validità	Impatto	Potenzialità
Luogo	○	○	○	○
Programma	○	○	○	○
Metodo	○	○	○	○
Tecnologia	○	○	○	○
Strumenti	○	○	○	○
Interdisciplinarità	○	○	○	○
Linguaggio	○	○	○	○
Spazialità	○	○	○	○

	Innovazione	Validità	Impatto	Potenzialità
Luogo	○	○	●	●
Programma	○	○	○	●
Metodo	●	●	○	○
Tecnologia	●	○	●	●
Strumenti	●	○	●	●
Interdisciplinarità	○	○	○	●
Linguaggio	○	●	○	○
Spazialità	○	○	○	○

Fig. 2. Evaluation form format
Fig. 3. Self-evaluation form of the research project "Knowledge of cultural heritage: parametric modeling, between semantics and ontology. The network of Mediterranean lighthouses".

9.1 BIM and ontology: hypothesis of an onto-parametric software

If in the course of the previous text the principles and the effective validity of the as is, then we want to analyze the dissemination of the same by creating a software that can combine the parametric methodology with the ontological one. In this sense, as discussed in chapters eight and nine, the two processes appear to be unofficially placed in common through the identification of the element IDs, a relationship that is not actually sufficient to trigger an effective practical connection of the data. This is not possible as the identification codes of the parametric elements associated as Data property in the ontological software refer only to the 'family' context of the element in Revit, in addition to being configured as incompatible elements by virtue of their computer extension of the file, that is, objects that are not actually readable by the ontological software itself and vice versa.
On the contrary, the objective of this paragraph is defined as the possible creation of an unpublished software, capable of uniting the parametric sciences with the ontological ones, reconnecting data and facilitating their dissemination. In this sense, the parametric-ontological connection is outlined as a winning strategy in sharing and disseminating data, even if their interchange is still difficult to use. In fact, if on the one hand, the extension of the data is still not associable, on the other hand, the introduction of ontological data in the BIM environment, and vice versa, would allow better management of the project in a historical environment, as it would constitute an important source of historical, semantic and geometric knowledge (Iadanza et al., 2019), in addition to the linking of different buildings, in order to facilitate the use of databases for the buildings, facilitating their management and knowledge.
In order to proceed with the study and creation of a possible onto-parametric software , it is therefore necessary to analyze the type of data provided by the two different software and the possible related connections. The first hurdle is data extension: Owl data on the one hand, and .Rfa, .Rte and .Dyn data on the other hand. For the creation of a possible software,

it was decided to keep the same type of data extension, without therefore creating a different extension for onto-parametric data, as it was considered appropriate to guarantee its own IT specificity for each type of data. This is because the data belonging to the methodology already appear informally 'connected' and associable by a terminological apparatus donated to the parametric and ontological elements, that is an action of particular deepening during the whole thesis, as well as the subject of a specific glossary connected to it. This decision is also confirmed by the parametric and ontological structural classification of the elements themselves, divided in both cases into structural elements and qualifying elements (figs. 4,5). Having clarified, albeit in a very summary way, the processing of computer data, it is possible to explain the composition and configuration of the software itself. The platform, to be used in museums or near lighthouses, to be downloaded on electronic devices under the acronym "SKIL-L" (Semantic Knowledge of Italian Lighthouses) (fig. 6), appears to be the basis through which to undertake a path of dissemination and creation of knowledge addressed to four different users: adults, children and/or disabled, blind and experts (figs. 7, 8). For each type of user, therefore, the creation of four different interfaces, discussed below, has been hypothesized, which can meet the needs of the viewer, with the aim of increasing knowledge and interest in these architectures.

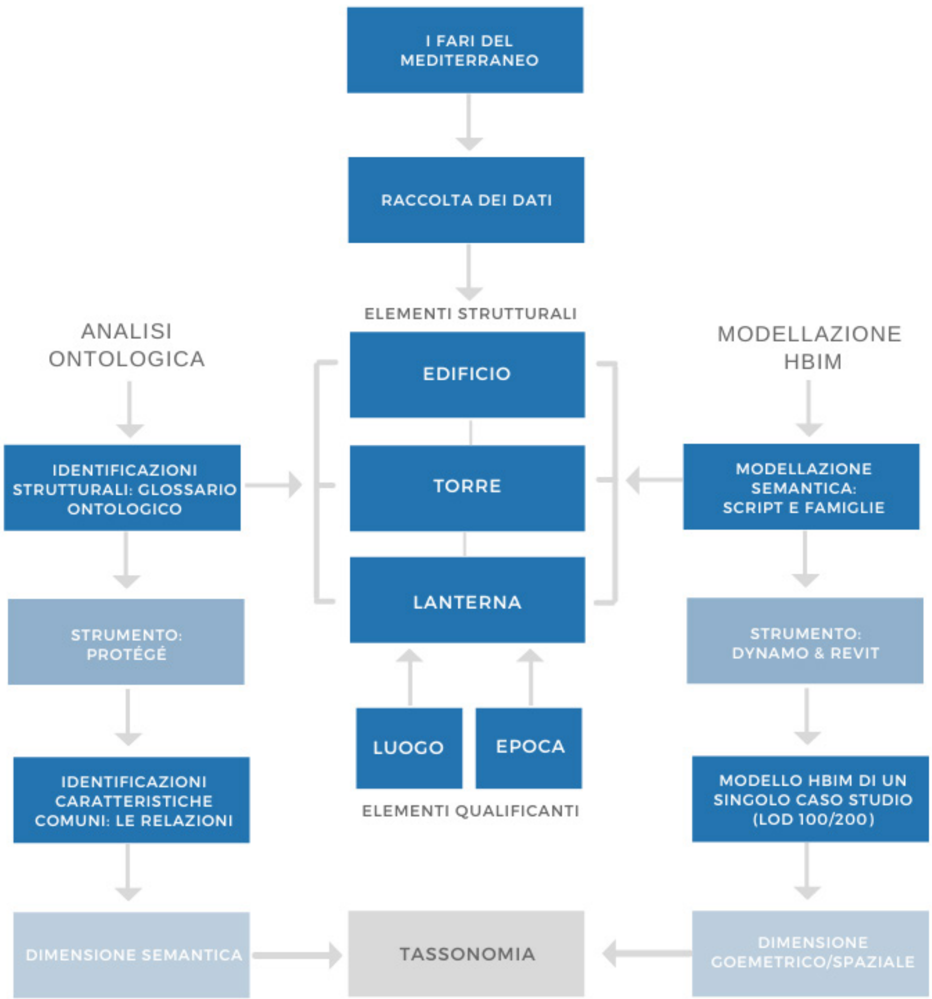
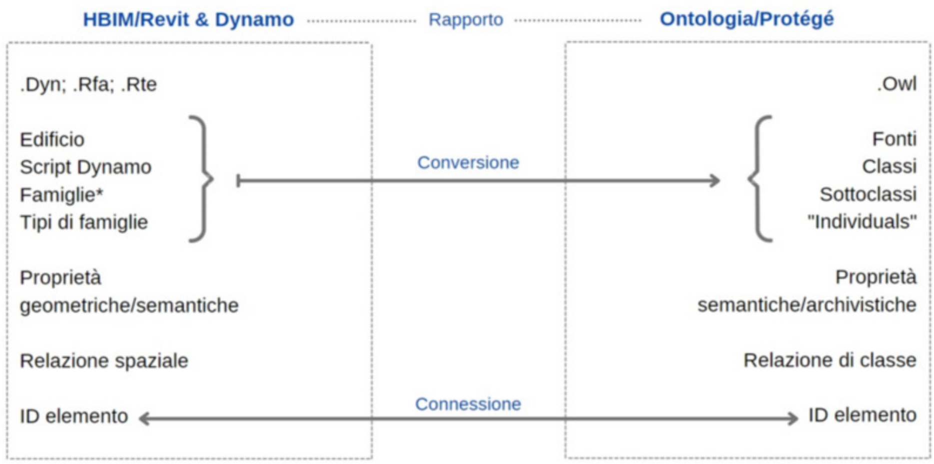


Fig. 4. Semantic decomposition process applied to Mediterranean lighthouses: the relationship between HBIM and ontology.

The "adult" interface (fig. 9) is characterized by two upper bars through which, using the competency questions[3], it is possible to query the system about the data present, asking questions about the composition of the lighthouse, its operation and the characteristics common to several lighthouses. In the figure, the question "how many lighthouses are there present in the Ligurian Sea", whose answer is shown in the bar next to it. Accompanying this response is the presence of an interactive map, placed in the left quadrant of the screen, depicting the Italian coast line, on which all the lighthouses present in this area are identified through identification codes. Depending on the question asked, the lighthouses in question will be highlighted by a different color compared to the other coastal architectures, also giving the user the possibility to select a specific lighthouse and view the fact sheet of the same.
In the central quadrant, it is possible to consult the knowledge graph associated with the question posed by the user, with the possibility of selecting a specific lighthouse and knowing the data already present in the interactive map on a graphic support. Finally, in the



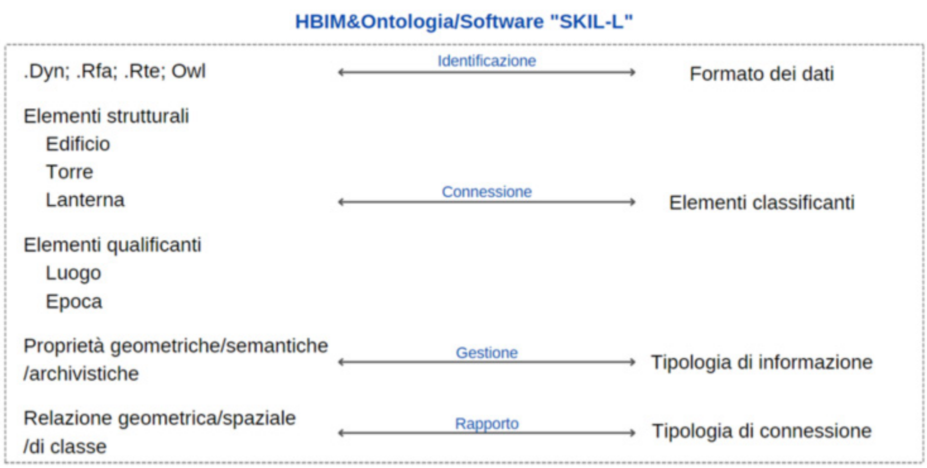


Fig. 5. Relations between parametric software and ontological software.
Fig. 6. Onto-parametric relationships and connections in the "SKIL-L" software.

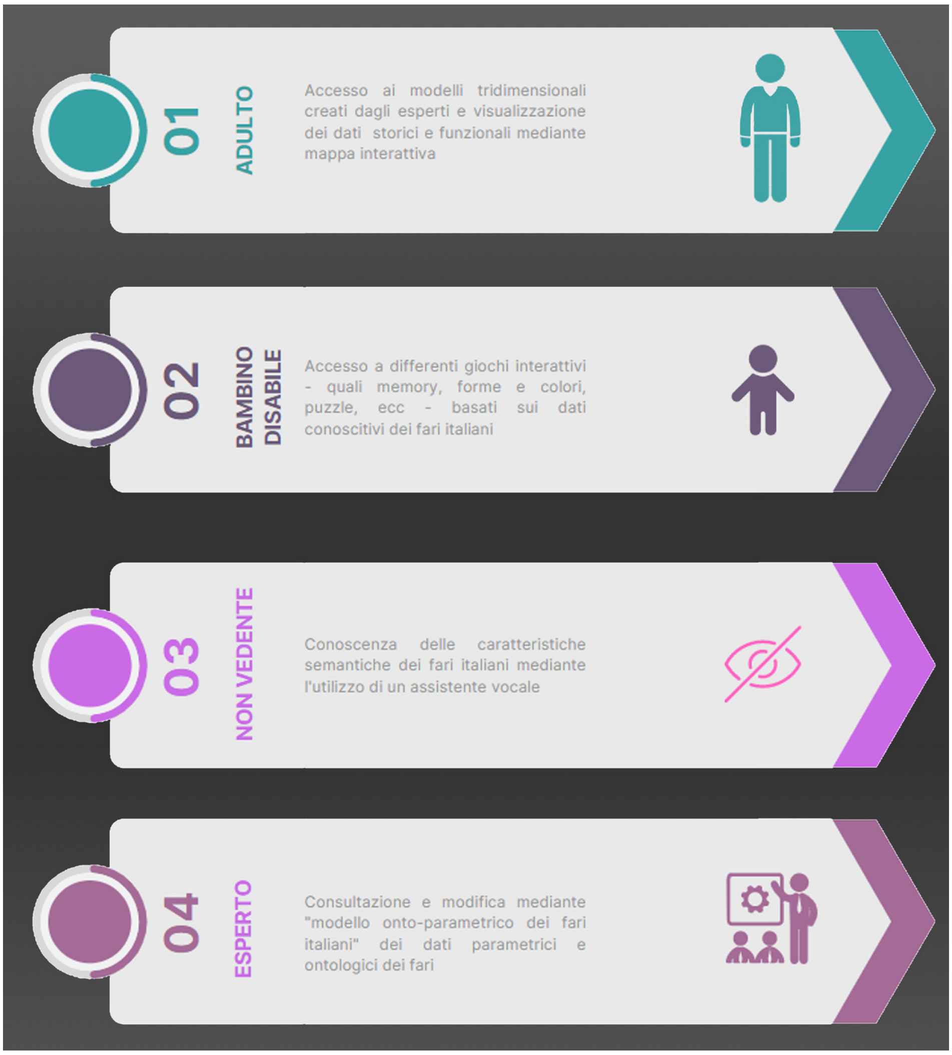
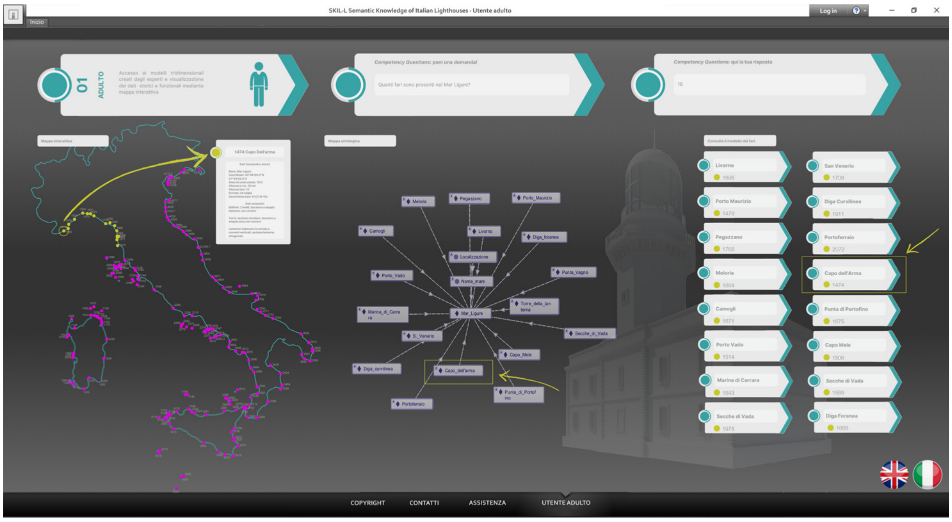
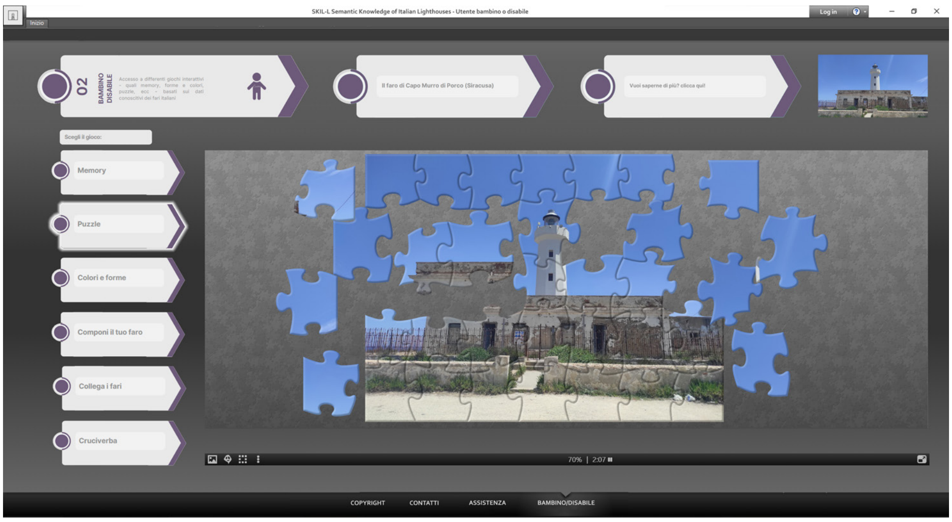


Fig. 7. SKIL-L software: user choice.
Fig. 8. SKIL-L software: user choice, detail of users.





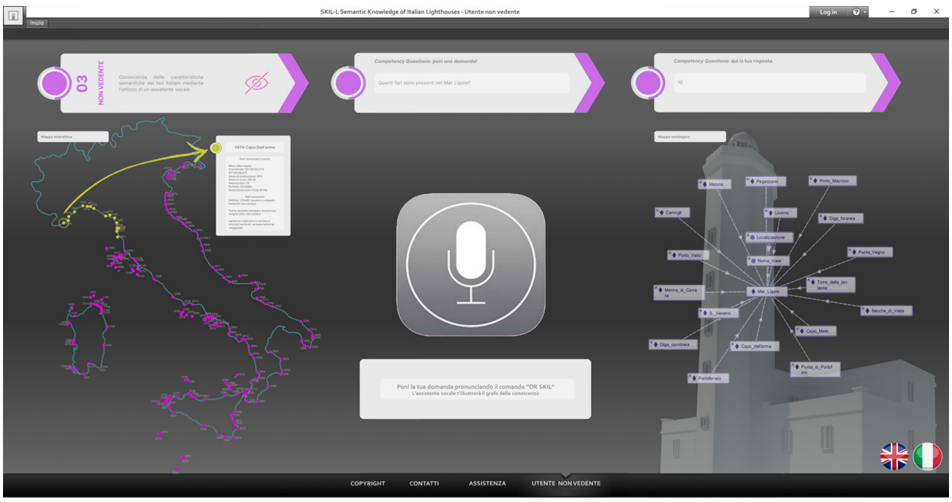
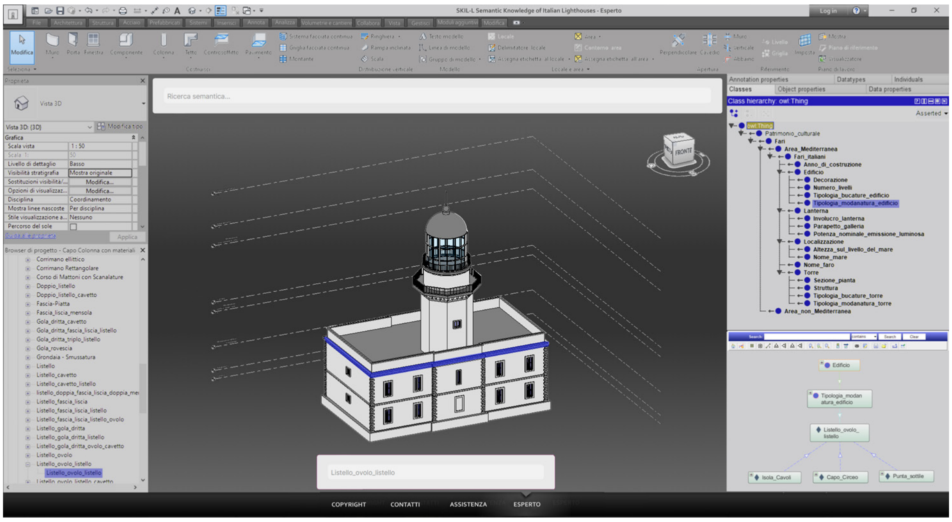
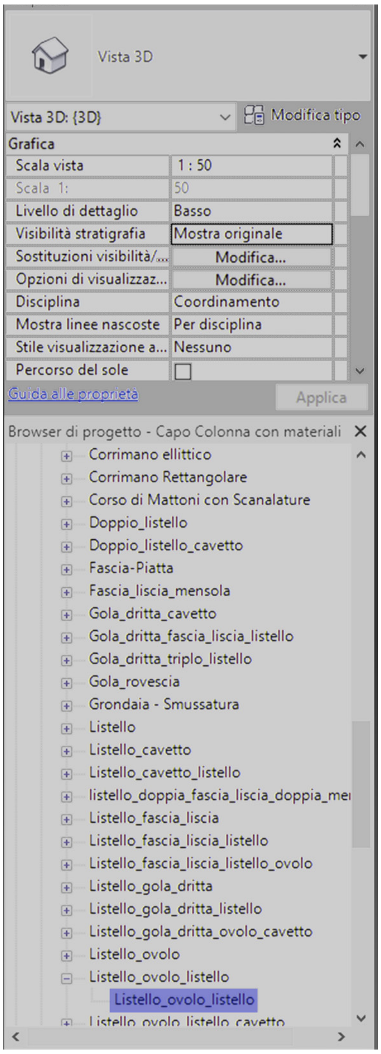


Fig. 9. SKIL-L user interface: adult user.
Fig. 10. SKIL-L user interface: child and/or disabled user.
Fig. 11. SKIL-L user interface: blind user.

quadrant on the right, again according to the question asked, the list of three-dimensional models of the lighthouses belonging to the requested category appears, giving the user the possibility to consult them but not to modify them.
The configuration of the child and/or disabled user interface (fig. 10) is configured as an application mainly addressed to edutainment and play, associating knowledge of the heritage of lighthouses with six simple games: memory; puzzle; colors and shapes; compose your lighthouse; connect the lighthouses; crossword puzzle. With the 'memory' game we want to associate the development of memory with the image of some semantic characteristics of lighthouses. The puzzle uses the classic process of recomposing the image through pieces, obtaining a photo of one of the Italian lighthouses. With the game 'colors and shapes' we want to undertake the beginning of a path of knowledge towards the semantic association with respect to a specific color, together with 'Compose your lighthouse', through which to choose and arbitrarily position the different semantic components of the lighthouse. 'Connect the lighthouses' can be traced back to the classic 'connect the points' in which the lighthouses correspond to the points to be reconnected, through which to build the coastline. Finally, the 'Crossword' consists of inserting words in a grid, derived from definitions, inherent in the world of boating and lighthouses, while maintaining a low degree of difficulty.
The configuration for the blind user (fig. 11) is consistent with the 'adult' interface but with the possibility of using a voice assistant to whom the competencies can be set questions, through which to receive answers regarding historical, functional and semantic data. In this sense, as stated in a previous note, the overcoming of architectural barriers by ontological software is not yet a sufficiently practiced reality, although there are already some studies on the subject, in which voice assistants are configured as an extremely performing tool.
Finally, it is the turn of the 'expert' user interface (figs. 12-14), the real connector of the two softwares and therefore a much more complex product than those just exposed, through which to guarantee the use of the platform in its double configuration: ontographic and parametric. This could be possible by exploiting the keywords that have guided the research thesis since the beginning: taxonomy, terminology and semantics. In fact, they are configured as keys of interpretation and identification that were immediately common to both sciences, as well as representing the structure used for the classification and architectural decomposition of the lighthouse system.
If the semantic identification in the ontological field turns out to be a methodology that is already feasible since the system is already able to recognize and converge the data according to keywords, the Revit software, although based on the classification of the elements, does not make it possible to search based on words. The final system therefore assumes the union of software by searching for keywords associated with semantics and terminology, to be identified simultaneously in both the parametric and ontological databases. It will therefore be possible to view and identify the semantic family associated with the parametric library and the three-dimensional model, where present in the model itself, as well as being able to consult the ontological knowledge graph associated with it. The expert interface therefore provides for the simultaneous use of the two sciences, making it possible to view the parametric project browser and the ontological taxonomy at the same time, creating an immediate and profound knowledge of the individual elements, capable of guiding the expert user towards a more speed of existing or imagined lighthouses. Through the union between BIM and ontology in the same platform, it is therefore possible, on the one hand, to model the elements according to the canonical parametric methodologies by taking advantage of the 'project model of Italian lighthouses' and, on the other, to know the semantic elements to be insert for modeling a specific lighthouse.





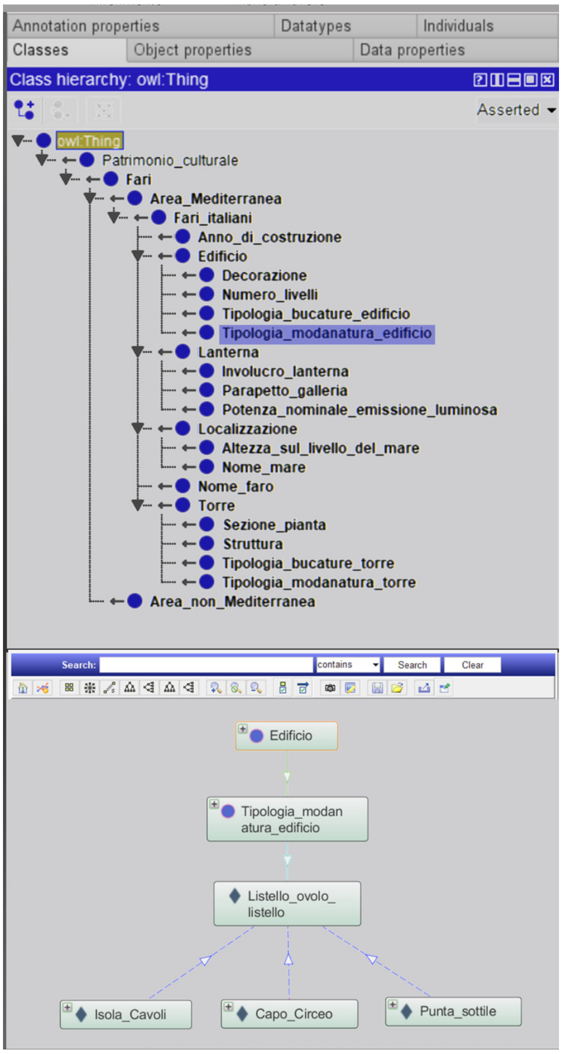


Fig. 12. SKIL-L user interface: expert user.
Fig. 13. SKIL-L user interface: expert user, parametric properties panel.
Fig. 14. SKIL-L user interface: expert user, ontological panel.

9.2 The usability of the methodology: the adequacy indicators

Having built what we wanted to define as the hypothesis of an "onto-parametric" software, that is to say the most visionary but at the same time more 'immediate' application output of the research, it is now possible to investigate possible future outputs of the thesis itself, partially distant from the arguments proposed up to this moment.
In order to assess the actual congruence between the proposed methodology and possible future releases, some adequacy indicators were therefore used, through which to identify the categories or actions to be strengthened in order to make the methodology fully performing. In this context, as partially explained in the introduction to this chapter, it should be emphasized that the creation of adequacy indicators appears as a fundamental evaluation strategy in the relationship between methodology and possible disseminations. In fact, as argued by FiorinoTessaro (2012, p. 110): "the finalized realization consists in the ability to face a problem from scratch, to diagnose and analyze the problem in the given situation, to plan the solution strategies and to implement them concretely and unpredictability of the action. It is the indicator that defines the standard of acceptability (and qualification) of the competence". As also underlined by Palumbo (2016, p. 10), one of the strategies to be implemented in the construction of the indicators: "[...] instead, it starts from the available (or easily detectable) data to define only secondarily which elaborations can be considered valid indicators of the concept to be measured. In any case, different paths can be defined between the following steps: data (available or detectable); information (data structured

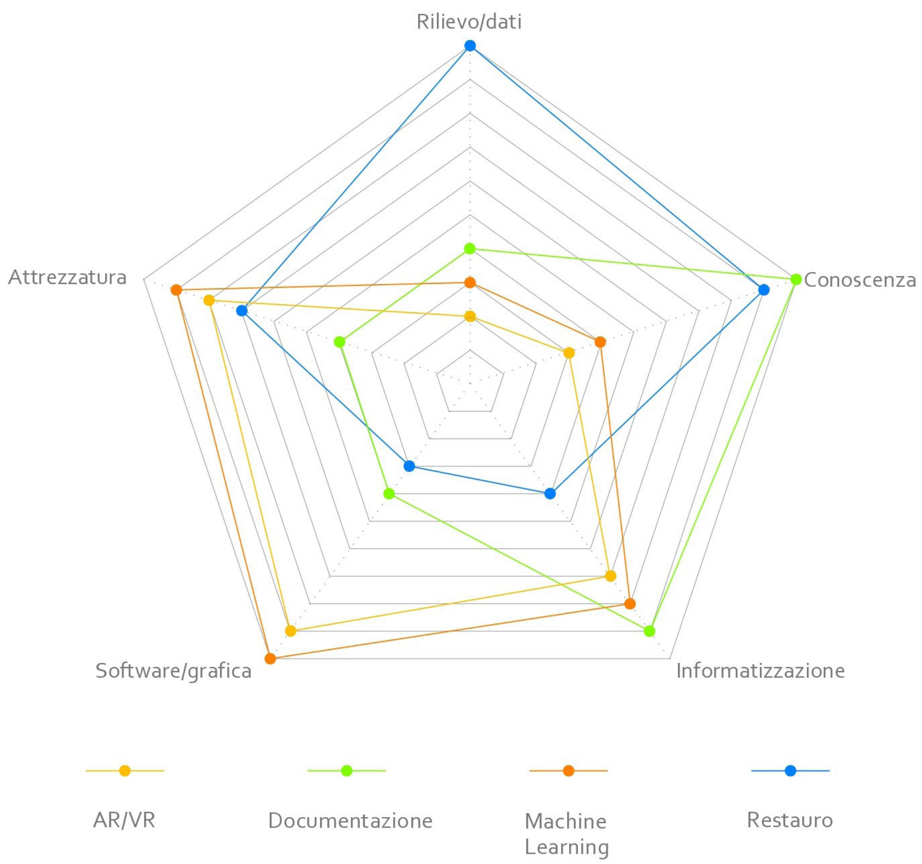


Fig. 15. Indicators of adequacy: documentation, restoration, AR&VR and Machine Learning.

according to criteria); indicators (information structured and possibly elaborated according to criteria); concepts (to which the indicators refer)".
The imposition of adequacy indicators is therefore the necessary action useful to establish the competence of the research methodology according to the outputs to be measured, here divided into two macro-groups: the AR/VR and the Machine Learning; documentation and restoration (fig. 15). Augmented reality and virtual reality together with the Machine Learning are configured as the macro-group addressed to tourist and cognitive/visual areas of the architectural heritage of lighthouses, in which the parametric model obtained by the methodology is configured as sufficient for action but lacking in the application-IT field.
The macro-group relating to documentation and restoration actions, on the other hand, is based on the knowledge and historical safeguarding of the material and intangible historical heritage, for which the methodology is suitable in the field of equipment and graphics but lacking in the field of geometric data and the survey of the data themselves.

9.2.1 The usability of the methodology: restoration and documentation

With this sub-paragraph we want to define how this methodological product can be strengthened in order to ensure the achievement of different and further types of dissemination, in this case subsection addressed to restoration and documentation[4].

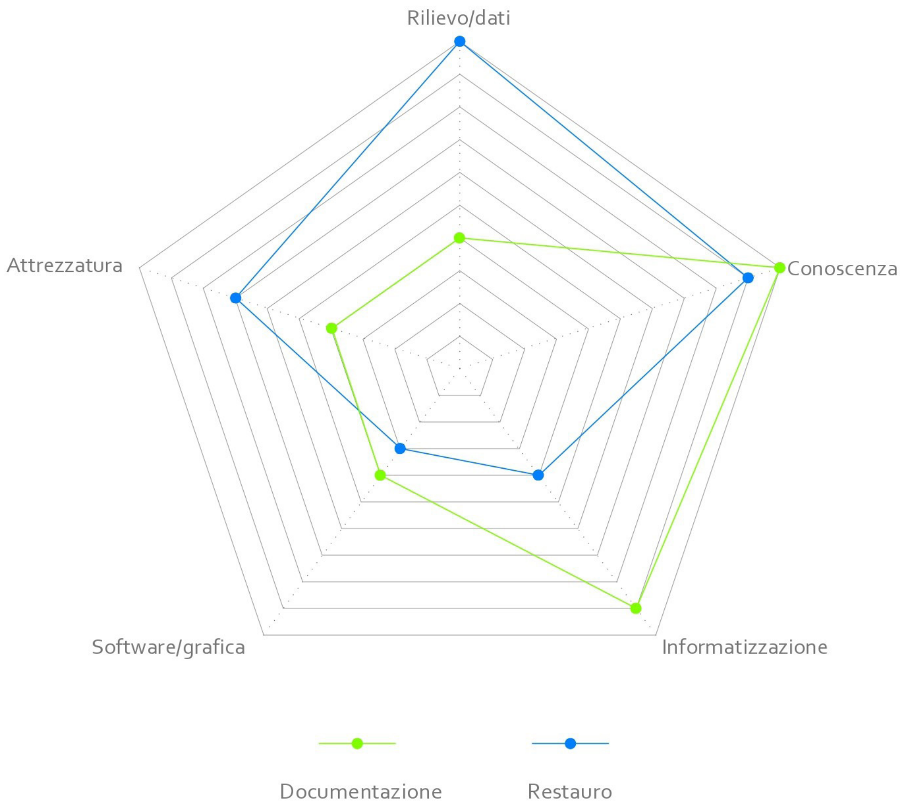


Fig. 16. Indicators of adequacy: documentation and restoration.

In the restoration, the graphic documentation is defined as "that particular collection of information relating to an artifact and its historical-conservation events carried out through a symbolic representation and a legend" (Sacco, 2006). The documentation as an end in itself, consists instead in the collection of data with respect to the architecture that is going to be documented: not only historical, constructive and geometric data but also social e cultural, i.e. the analysis of the relationship between architecture and the local.
In order to evaluate the adaptability of the methodology created with respect to restoration and documentation actions, the effectiveness of some aspects to be strengthened was analyzed, as previously anticipated, assigning a score from one to ten: the survey of the data; knowledge; the equipment; computerization and software/graphics (fig. 16).
In the context of restoration, the actions to be strengthened with respect to the methodology being researched are undoubtedly the aspects relating to the equipment intended as a means for collecting data and metric information, as well as the knowledge and computerization of the survey itself.
This is because, as previously specified, the created methodology is capable of producing an approximate parametric model, with a metric error of approximately 0.5%. This difference, although acceptable in the case of the production of videos and three-dimensional prints for tourist use, is not suitable for the production of models aimed at the restoration of a specific case study. Nevertheless, the methodology can be equally defined as the basis through which to identify the asset to be restored, to intercept in advance the characteristics that compose it and to adapt the parametric design model according to the measures to be included. On the ontological level, the already existing knowledge of lighthouses can be unlimitedly expanded, making it possible to insert any further relevant data directly into the existing ontology of Italian lighthouses. In this sense, the area of restoration applied to coastal construction is configured as an action with enormous potential as well as of great national and international interest.
In the context of documentation, the action that is most identified as lacking in the methodological process is undoubtedly constituted by the knowledge of the data and the relative computerization of the same. This is because, in the course of the methodology adopted, the data collected were mainly defined with regard to the existing geometric and functional characteristics, as well as partially identifying historical data such as, for example, the year of construction. The documentation process, instead, incorporates and catalogs all the data that have brought architecture to today's conformation, investigating the construction processes, the materials and the relationship with the territory. Even in this case, the methodology created still represents a solid basis through which to integrate ontological data and make knowledge interoperable.

9.2.2 The usability of the methodology: AR/VR and Machine Learning

If in the previous sub-paragraph the potentialities of the methodology applied in the field of restoration and documentation were analyzed, in this sub-paragraph we want to analyze the usability of the same to be addressed to two specific macro-sectors: AR/VR and Machine learning. As for the analysis of the methodological usability aimed at restoration and documentation, the effectiveness of some aspects to be strengthened in future applications is analyzed below, through the attribution of a score from one to ten: the survey of the data; knowledge; the equipment; computerization and software/graphics (fig. 17).

As far as augmented reality and virtual reality are concerned, it is immediately evident that the lack of software, and of the consequent application IT processes, is configured as the main obstacle between the methodological application and the use of models and semantics in virtual environments. Although these models are adequate to establish processes of knowledge of the territory and architecture through cognitive and educational videos (figs. 18, 19), this type of use does not appear to be sufficient in any case to establish and configure new realities as it is lacking in the point of view of the instruments, while defining itself as the basis through which to undertake a path of 'increased' knowledge both in the compositional and cognitive fields.
Through the creation of intuitive applications and/or through the use of semantic recognition according to colors, it is possible to use augmented reality and virtual reality as tools of knowledge and interaction with the public. In this sense, in the context of augmented reality, an application could be hypothesized, to be used via QR-Code, through which it is possible to view the different semantic classifications on smartphones - directing the camera of the digital instrument towards the existing architecture - as well as to access the ontological map connected to it (figs. 20, 21). This aspect has already been partially investigated in the context of research dissemination through the hypothesis of an onto-parametric software in which the semantic visualization is defined as similar but different, depending on the user.
We recall how, in the field of augmented reality, the technique of videomapping also falls, that is a multimedia technology through which to illustrate, through the use of

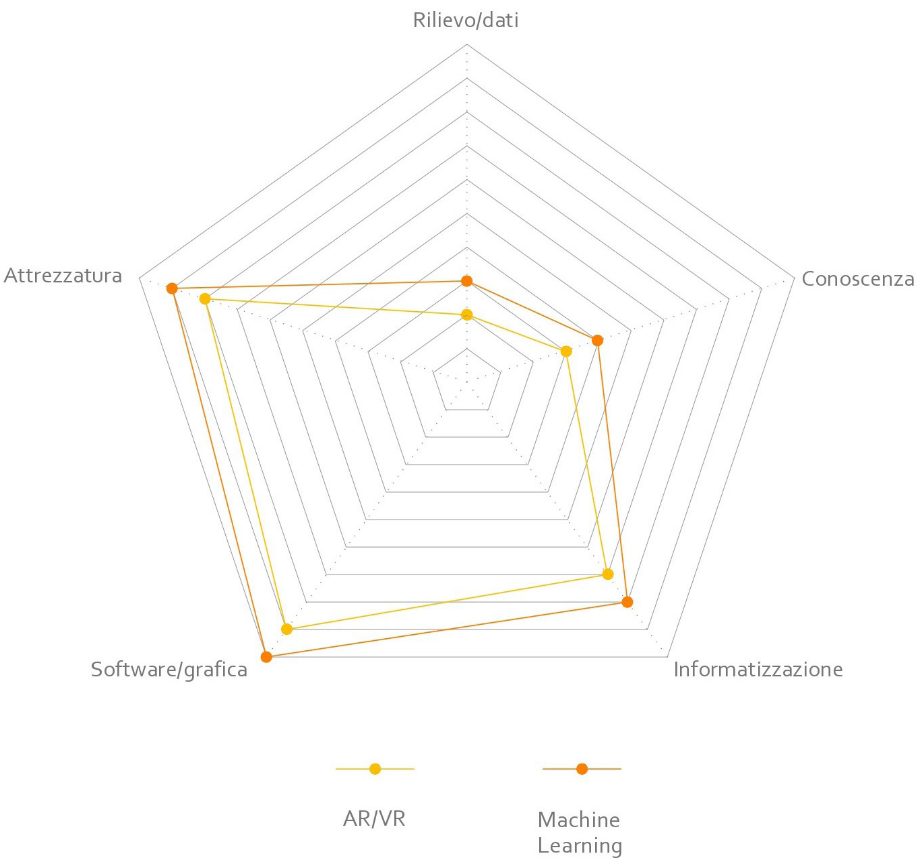


Fig. 17. Adequacy indicators: AR&VR and Machine Learning.

light beams, virtual worlds on more or less complex objects (Ivona & Privitera, 2019). Through the radiated light, often accompanied by sounds and music, it is possible to transform any real object into a dynamic display on which to project imaginary stories, landscapes and tales, obtaining a synergistic blend of real and virtual. In this context, through the mixture of methodology and videomapping, it is possible to narrate knowledge, painting the real architecture of a virtual vision, giving the viewer, in a direct and immediate way, the semantic and ontological knowledge of these architectures (figs. 22 -24).

As regards virtual reality, however, it is possible to hypothesize access to compositional, semantic and ontological knowledge through the use of viewers through which to access the three-dimensional model, rotate around it, observe its compositional details from every angle and view the semantic characterizations identified by the different colors of the model. Wearing a common VR viewer it is therefore possible to immerse

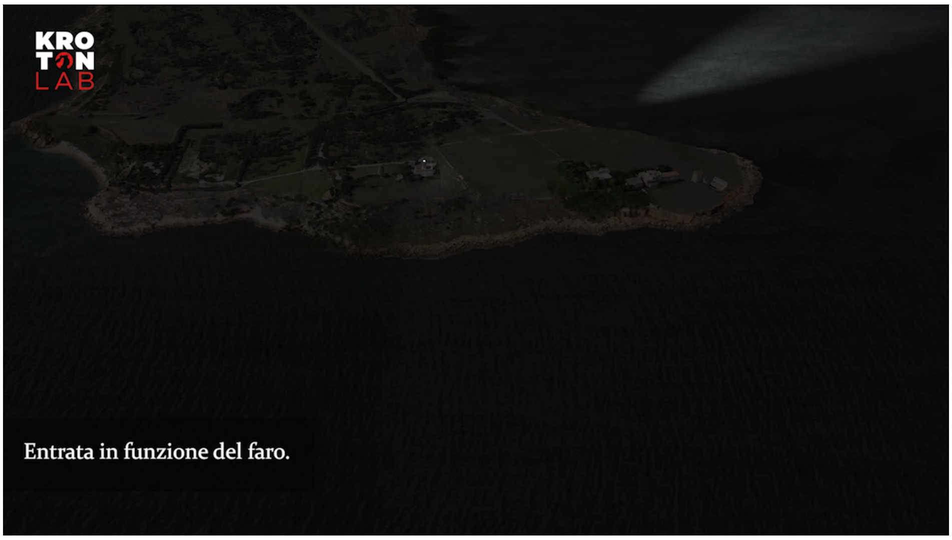


Fig. 18. Video for cultural dissemination: the use of the model. Kroton-Lab, Naos s.r.l.
Fig. 19. Video for cultural dissemination: the use of the model. KrotonLab, Naos s.r.l.

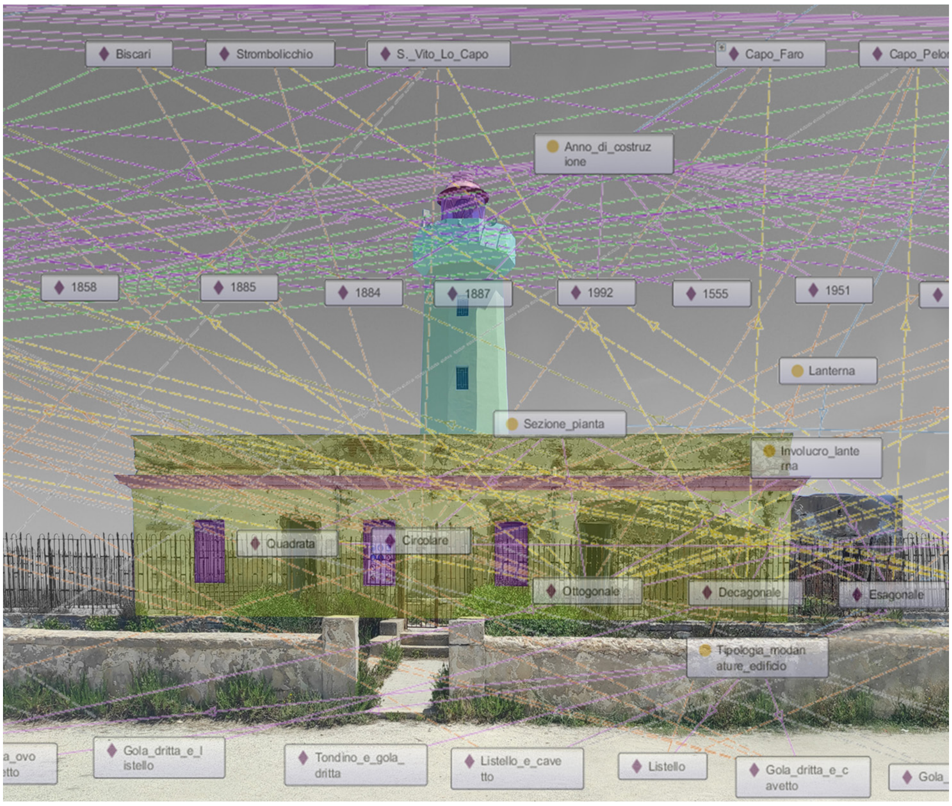
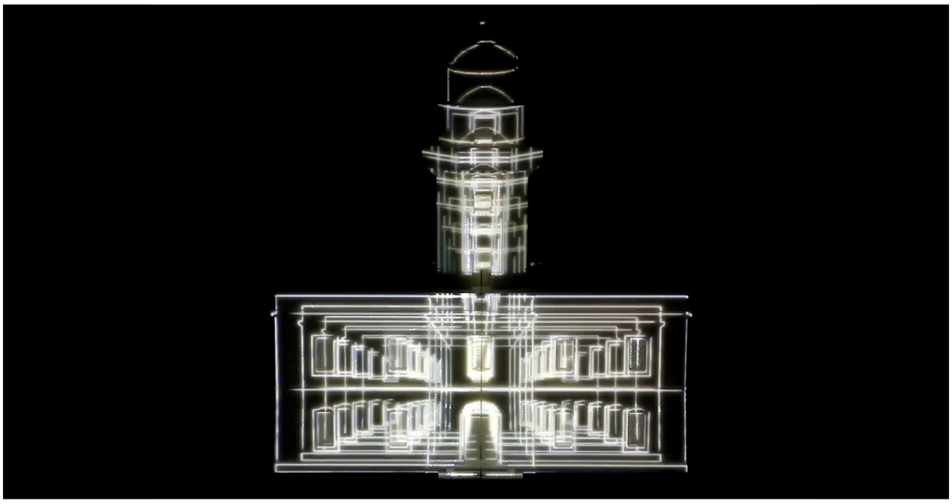
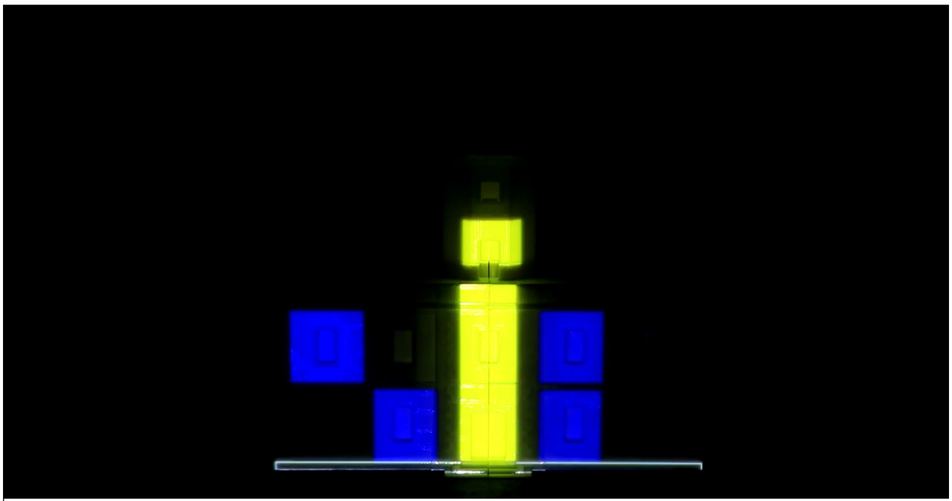
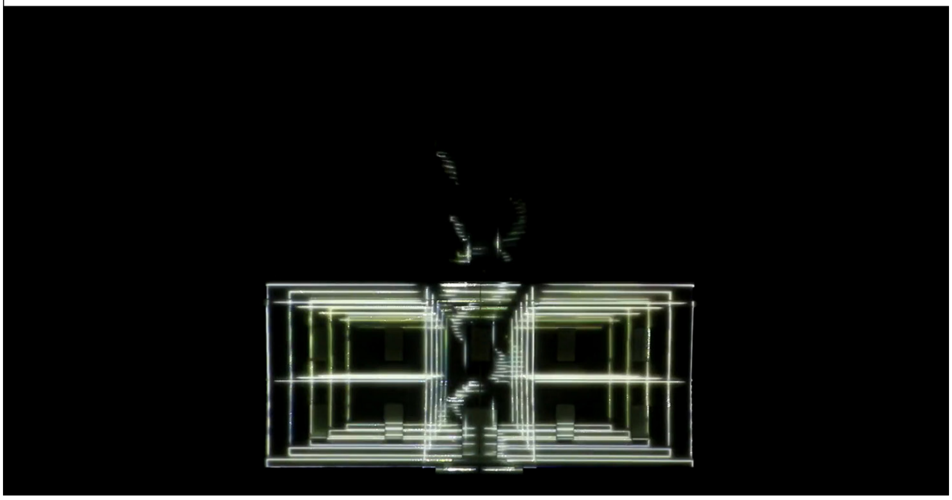


Fig. 20. Virtual reality applied to the model.
Fig. 21. Augmented reality applied to the model.







Figs. 22-24. Augmented reality applied to the model: videomapping of the Capo Colonna lighthouse.

yourself in an interactive space of knowledge through which to view not only the architecture, arranged according to the geographical position, but also to know its semantics and history (fig. 25).
As part of the methodological application in the field of Machine Learning, as in the case of augmented reality and virtual reality, it is necessary to enhance the aspects relating to software and the consequent application IT processes. More specifically, the Machine Learning is configured as a subset of artificial intelligence (AI), in which the methodology is the semantic, cognitive and three-dimensional basis through which to propose a more immediate and advanced reconnection of data, through the automatic association of the three-dimensional semantic model compared to the full model. This process is ensured through the use of random automatic matching, that is an automatic association between the single semantic component and the whole, through which to guarantee the automated production of a complete model.

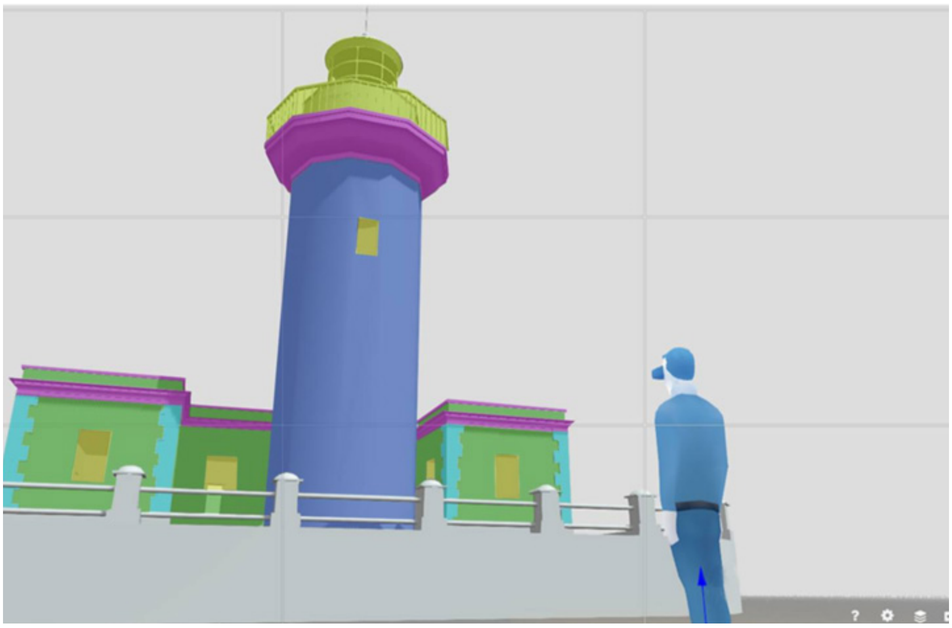


Fig. 25. Virtual reality applied to the model.

9.3 Conclusions and final remarks

The research presented is defined as the study and analysis of the architecture of the lighthouse, towards the creation of a methodology that can be not only replicable but also hypothetically open to new and future challenges. The structure of the thesis, although apparently too broad and verbose, represents the obligatory path to undertake for a complete discussion of the history, places, innovation and coastal architecture. If for the reasons of the research we refer to the abstract and the introduction of the thesis, with this conclusion we want to deepen the key concepts of the research, as well as some considerations relating to the processes and to parametric and ontological objectives.
We can affirm how 'semantics' has been defined as the unique and constant keyword of research, fundamental in the context of the cataloging of cultural heritage and, therefore, of coastal heritage. In fact, semantics makes it possible to aggregate the elements that make up any structured set of objects (Scandurra, 2020), through which a concrete meaning can

be given to the geometric data of architecture (Manuel et al., 2019). As demonstrated during the research, as well as by the numerous studies analyzed[5], semantics also represents the basis through which to undertake a path of enrichment in the context of three-dimensional digitization, offering the possibility of automating the process of identifying the element itself (Croce et al., 2021), once cataloged and 'filed'. This type of classification, together with the terminology of the elements identified, was therefore configured as the guideline of the entire parametric and ontological methodology.
With regard to the parametric field, we want first of all to focus on the increasingly growing demand for innovation in the field of parametric processes applied to built heritage, a real asset towards which the entire academic research, together with this thesis, has moved and it's still moving. It is precisely academic research that raises one of the critical points in the context of HBIM: a methodology that is still disadvantageous or unsuitable today, although it is configured as a process with a high compositional and technological potential. In this context, it should be emphasized that the use of parametric technologies, today perhaps excessively used, must not be implemented through excessive forcing of the system: the creation of new and unprecedented software processes must not in fact override the original use of the latter[6] but, on the contrary, try to exploit the potential by assuming plug-ins or methodologies adaptable to the software. Trying to limit an excessive distortion in the original use of parametric software, a new top-down methodology was therefore created, based on the simplification and architectural semantization of the coastal built heritage[7].
By placing the simplification of the architecture, and the relative definition of a new project state as is, as a process with a high potential, we questioned the effective usability of geometric simplification aimed at optimizing processes. In this context, the semantic classification was configured as a suitable strategy to guarantee the simplification and optimization of modeling times, through the creation of a semantic database capable of bringing together all the architectural characteristics of Italian lighthouses[8].
All this is possible only by virtue of the simplification and interpretation of the data, which is a fundamental action to be able to migrate real architecture to the virtual world (Attenni, 2019). The conclusion of this parametric process therefore draws its strength in the investigation of new methodologies applied to the characterized historical heritage, through which to rediscover geometries, history and forms.
Alongside the parametric world we find the ontological sciences, a field with deeper meanings, capable of joining data in a dense interoperable connection, through the definition of a domain, classes, subclasses and relationships. The ontological creation makes possible the connection, through the decomposition and the 'semantic simplification', that is an action already used in the parametric field, of the different elements of the building in question, creating not only an intelligent and interactive relationship system, but also a process of in-depth knowledge of the building itself. This process, in addition to being configured in itself as a methodology with a high value and potential, becomes highly validable if associated with parametric modeling, improving knowledge and data management through *competency questions*, useful for understanding the connections between the specific case study, the semantic classification and the rest of the architectures present in the chosen domain.
Finally, the union between ontology and parametric modeling can be hypothetically validated through the creation of an onto-parametric software, through which the consultation and simultaneous modification of parametric and semantic data can be used, towards a process of knowledge depth of the building, of its relationship with the territory and with the similar historical architectural heritage. This hypothesis is configured as an aspect with a high potential as it perfectly performs to the principles of reproducibility, expandability and interoperability of data (Simeone et al., 2014), characteri-

stics which are today fundamental to guarantee a correct transmission of information towards a heritage. still extremely endangered today.
The hypothesized process is therefore configured as a valid and reproducible methodology in the context of the semantically characterized built heritage - that is, architectures that can be broken down into well-defined and 'characterized' parts - to be applied in its original configuration or to be examined and deepened through the proposed future developments, in order to arrive at an ever better and effective final product. It is in the context of possible new uses that the methodology is directed towards tourism-type applications, through which to guarantee all the objectives proposed by the guidelines of cultural development based on *edutainment* (McLuhan , 1964).

Notes

1. It should be emphasized that, regardless of the dissemination of the methodology, it is configured in itself as the final and tangible product of the research, as a process totally conceived and validated in the context of the development of adaptive models in the context of coastal architectures.

2. To facilitate the evaluative reading, what is described on p. 66 with reference to the categories and parameters described and which best represent belonging to the methodology. As regards the categories: the place is the theme within which the argument of the research is applied; the program is the set of principles and objectives pursued; the method is the theoretical structure through which to solve design problems; technology represents solutions to optimize procedures; the tools are the scientific and technical means that assist the research activity; interdisciplinarity is the complementarity of different competing disciplines towards the same goal; language pertains to the expressive value attributed to signs; the spatiality of the work concerns the physical composition of the project and, therefore, cannot be applied. As for the parameters: innovation represents the introduction of new features pertaining to the avant-garde; validity is the parameter inherent in the correctness of the scope examined with respect to certain procedures; the impact is the resonance parameter that the project/methodology has; finally, the potential measures the possibility of developing future projects according to the project/method created.

3. That is, the interrogation of the system with respect to information entered in a parametric and ontological environment. Ultimately, the questions we can answer through ontological data.

4. These actions are configured as apparently connected to each other, but in this case interpreted according to different types of dissemination of data.

5. This is the case of some research aimed at the analysis and documentation of cultural heritage through semantics, including:

Apollonio, FI, Basilissi , V., Callieri , M., Dellepiane , M., Gaiani, M., Ponchio, F., Rizzo, F., Rubino, A. R., Scopigno, R., & Sobra, G. (2018). A 3d-centered information system for the documentation of a complex restoration intervention. Journal of Cultural Heritage, vol. 29, pp. 89-99; Havemann , S., Settgast , V., Berndt, R., Eide, O., & Fellner, D. W. (2008). The Arrigo Showcase Reloaded - towards a sustainable link between 3D and semantics. VAST: International Symposium on Virtual Reality, Archeology and Intelligent Cultural Heritage, (JOCCH), 2 (1), 1-13; Robbiano, F., Attene, M., Spagnuolo, M., & Falcidieno, B. (2007). Partbased annotation of virtual 3d shapes. Proceedings of the 2007 International Conference on Cyberworlds, ser. CW '07. Washington, DC, USA: IEEE Computer Society, pp. 427-436; Soler, F., Melero, FJ, & Luzón, M. V. (2017). A complete 3d information system for cultural heritage documentation. Journal of Cultural Heritage, vol. 23, pp. 49-57.

6. This is because parametric modeling offers the possibility of creating recurring standardized products and adaptive modification of the parameters that make up the elements. For this reason, the modeling of non-reusable and/or excessively complex architectures in the ornamental field, for which a management program is not envisaged, often turns out to be a 'forcing' of the system.

7. As recommended in all parametric processes addressed to built heritage, simplification appears as a necessary action, through which the shapes can be brought back to regular geometries. In this sense, the existing building is considered as 'like new', in which the modeling of the existing becomes the definition of a project status, that is the as is model .

8. It should be remembered that the semantic decomposition was carried out by examining the entire case history of Italian lighthouses, through the cataloging and semantization of the elements into recurring and characterizing objects.

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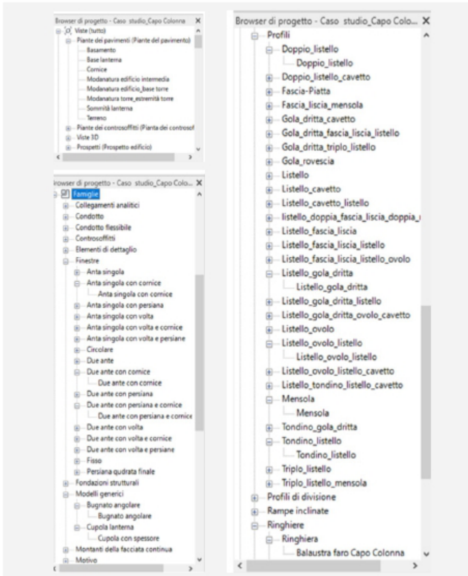
Part IV
Appendices and glossaries

Appendix: Modeled Case Study Cards

DIGITAL OBJECT: Capo Colonna Lighthouse	DIGITAL LIBRARY



BIM AND SEMANTICS

Semantic group: macro and micro variables

Macro variables: Edificio, Torre, Lanterna

Micro variables:
- Edificio_Bugnato
- Edificio_Due livelli
- Edificio_Modanatura: gola dritta-cavetto
- Edificio_Bucatura: doppia anta con cornice e persiana
- Edificio_Bucatura: anta singola con cornice
- Torre_Sezione in pianta: ottagonale
- Torre_Bucatura: anta singola con cornice
- Torre_Modanatura: fascia liscia con mensola
- Lanterna_sezione: dodecagonale
- Lanterna_balaustra: acciaio_correnti verticali

Parametric families used

Macro variables_Edificio, Torre, Lanterna: Dynamo

Micro variables:
- Edificio_Bugnato: famiglia caricabile, modello metrico generico basato su muro
- Edificio_Modanatura: famiglia caricabile, profilo metrico
- Edificio_Bucatura: famiglia di sistema personalizzata
- Torre_Bucatura: famiglia di sistema personalizzata
- Torre_Modanatura: famiglia caricabile, profilo metrico
- Lanterna_balaustra: famiglia di sistema

ONTOLOGY AND ANALYSIS

Reuse of the macro variables of the model

Edificio_Due livelli: 38,96%
Torre_Sezione in pianta_ottagonale: 29,87%
Lanterna_Sezione in pianta_dodecagonale:17,53%

% Reuse of model micro variables

Edificio_Bugnato: 12,34%
Edificio_Modanatura: 4,55%
Edificio_Bucatura_doppia anta: 19,48%
Edificio_Bucatura_anta singola: 14,29%
Torre_Bucatura: 48,08%
Torre_Modanatura: 19,48%
Lanterna_Balaustra: 36,36%

EVALUATIONS

% Metric error	Suitability for dissemination processes*	
	Restoration and doc.	AR/VR and ML
0,5%	3	5

DIGITAL SUITABILITY = 3

Scoring

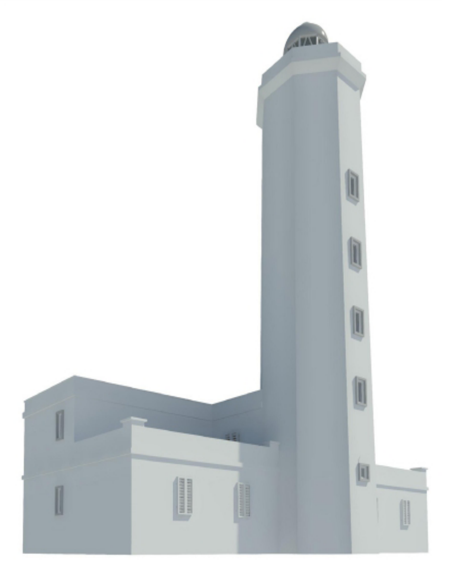
Modeling time by methodology:
1= oltre 40 minuti
2= da 40 a 30 minuti
3= meno di 30 minuti

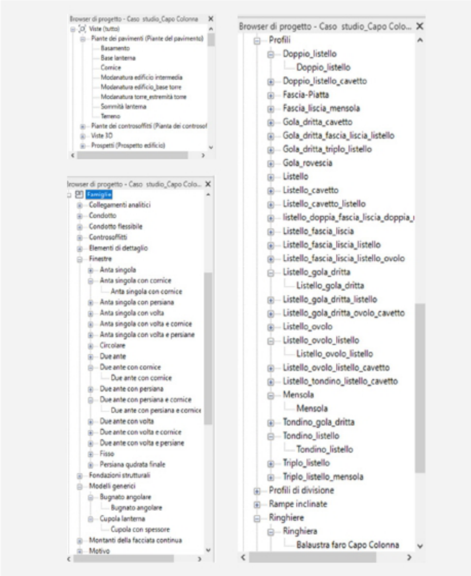
Modeling time by survey and point cloud
1= oltre 40 minuti
2= da 40 a 30 minuti
3= meno di 30 minuti

$$\text{DIGITAL ADEQUACY} = \frac{\text{METHODOLOGY}}{\text{POINT CLOUD}}$$

*Adequacy assigned according to values from 1 to 5

DIGITAL OBJECT: Punta Alice Lighthouse	DIGITAL LIBRARY





BIM AND SEMANTICS

Semantic group: macro and micro variables	Parametric families used
Macro variables: Edificio, Torre, Lanterna	Macro variables_Edificio, Torre, Lanterna: Dynamo
Micro variables: Edificio_Due livelli Edificio_Modanatura:listello Edificio_Bucatura: doppia anta con cornice e persiana Edificio_Bucatura: anta singola con cornice Torre_Sezione in pianta: ottagonale Torre_Bucatura: anta singola con cornice Torre_Modanatura: listello-gola dritta Lanterna_sezione: ottagonale Lanterna_balaustra: cemento	Micro variables: Edificio_Modanatura: famiglia caricabile, profilo metrico Edificio_Bucatura: famiglia di sistema personalizzata Torre_Bucatura: famiglia di sistema personalizzata Torre_Modanatura: famiglia caricabile, profilo metrico Lanterna_balaustra: famiglia di sistema

ONTOLOGY AND ANALYSIS

Reuse of the macro variables of the model	% Reuse of model micro variables
Edificio_Due livelli: 38,96% Torre_Sezione in pianta_ottagonale: 29,87% Lanterna_Sezione in pianta_ottagonale: 34,32%	Edificio_Modanatura: 14,29% Edificio_Bucatura_doppia anta: 19,48% Edificio_Bucatura_anta singola: 14,29% Torre_Bucatura: 48,08% Torre_Modanatura: 3,25% Lanterna_Balaustra: 25,97%

EVALUATIONS

% Metric error	Suitability for dissemination processes*	
	Restoration and doc.	AR/VR and ML
0,3%	4	5

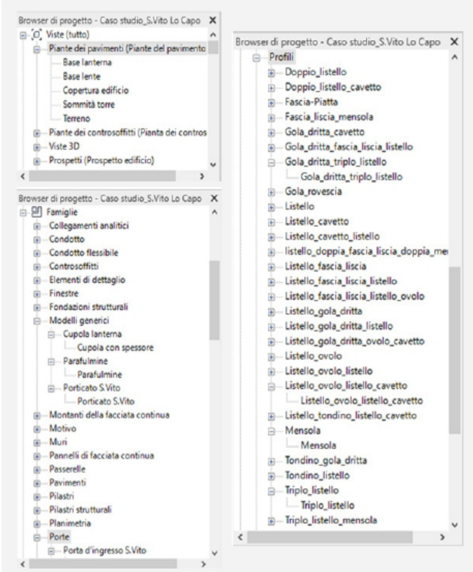
DIGITAL SUITABILITY = 3

Scoring

Modeling time by methodology:	Modeling time by survey and point cloud	
1= oltre 40 minuti 2= da 40 a 30 minuti 3= meno di 30 minuti	1= oltre 40 minuti 2= da 40 a 30 minuti 3= meno di 30 minuti	$\text{DIGITAL ADEQUACY} = \frac{\text{METHODOLOGY}}{\text{POINT CLOUD}}$

*Adequacy assigned according to values from 1 to 5

DIGITAL OBJECT: S. Vito Lo Capo Lighthouse	DIGITAL LIBRARY



BIM AND SEMANTICS

Semantic group: macro and micro variables

Macro variables: Edificio, Torre, Lanterna, Porticato

Micro variables:
- Edificio_Un livello
- Edificio_Modanatura: listello-ovolo-listello-cavetto
- Edificio_Bucatura: doppia anta con cornice e persiana
- Torre_Sezione in pianta: circolare
- Torre_Bucatura: anta singola con cornice
- Torre_Modanatura: triplo listello con mensola
- Lanterna_sezione: decagonale
- Lanterna_balaustra: acciaio, correnti verticali

Parametric families used

Macro variables_Edificio, Torre, Lanterna: Dynamo

Micro variables:
- Edificio_Modanatura: famiglia caricabile, profilo metrico
- Edificio_Bucatura: famiglia di sistema personalizzata
- Torre_Bucatura: famiglia di sistema personalizzata
- Torre_Modanatura: famiglia caricabile, profilo metrico
- Lanterna_balaustra: famiglia di sistema

ONTOLOGY AND ANALYSIS

Reuse of the macro variables of the model

Edificio_Un livello: 25,97%
Torre_Sezione in pianta_circolare: 51,30%
Lanterna_Sezione in pianta_decagonale: 12,99%
Porticato d'ingresso_ 0,00%

% Reuse of model micro variables

Edificio_Modanatura: 2,60%
Edificio_Bucatura_doppia anta: 19,48%
Torre_Bucatura: 48,08%
Torre_Modanatura: 2,60%
Lanterna_Balaustra: 36,36%

EVALUATIONS

% Metric error	Suitability for dissemination processes*	
	Restoration and doc.	AR/VR and ML
0,5%	2	4

DIGITAL SUITABILITY = 2

Scoring

Modeling time by methodology:

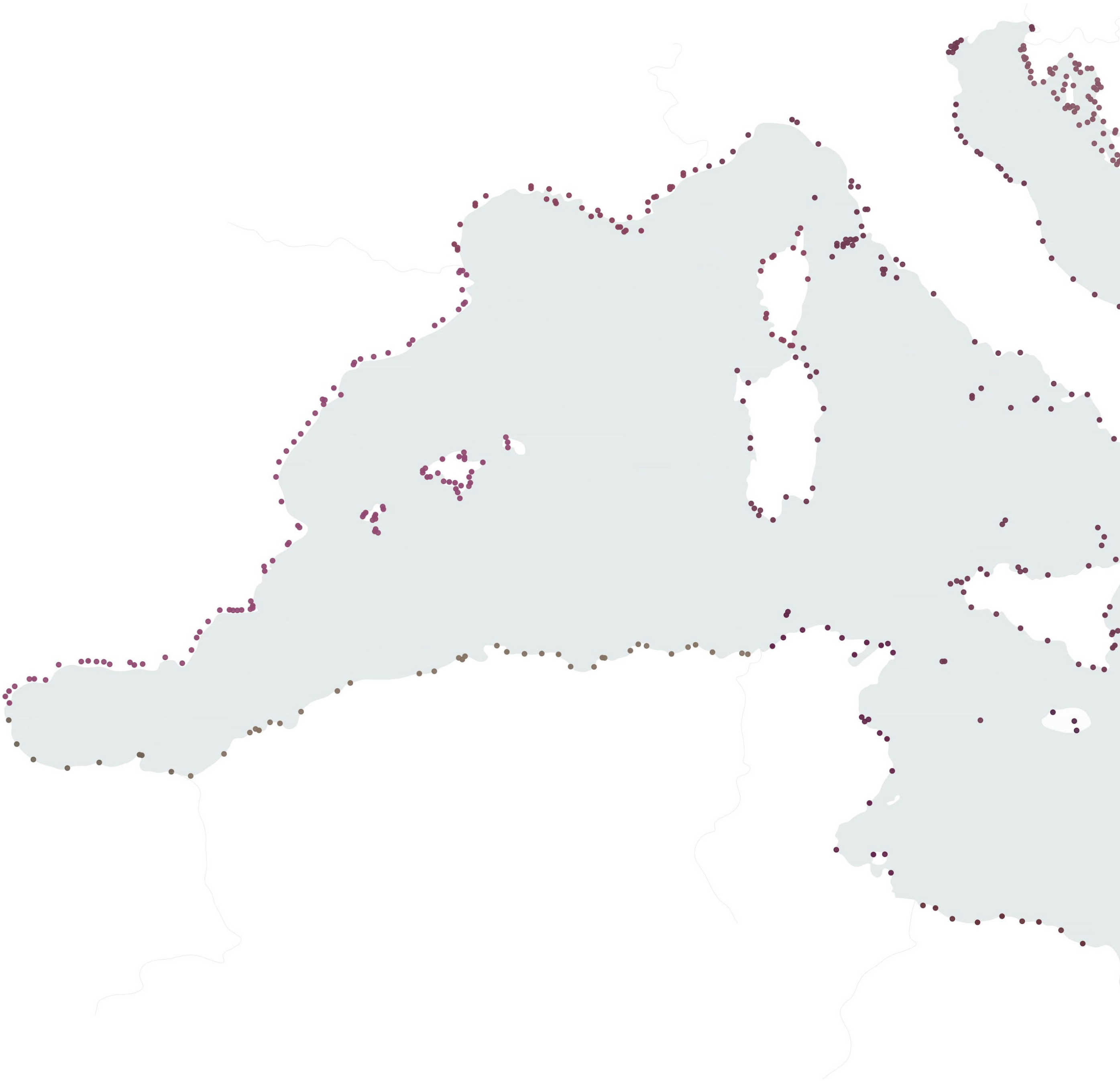
1= oltre 40 minuti
2= da 40 a 30 minuti
3= meno di 30 minuti

Modeling time by survey and point cloud

1= oltre 40 minuti
2= da 40 a 30 minuti
3= meno di 30 minuti

$$\text{DIGITAL ADEQUACY} = \frac{\text{METHODOLOGY}}{\text{POINT CLOUD}}$$

*Adequacy assigned according to values from 1 to 5



The Atlas of the Mediterranean lighthouses

Albania

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
155,91875	Sarandë	Mare Adriatico	39°51'50.6"N 20°01'35.5"E	2010	215	8	20	Fl (3) W 30s
155,87847	Kepi i Feruc	Mare Adriatico	39°52'09.2"N 20°00'11.3"E	2019	6	4	n.d.	Fl W 3s
3741	Kep i Qefalit	Mare Adriatico	39°54'28.4"N 19°54'50.5"E	n.d.	155	12	20	Inattivo
3734	Kep i Palermos	Mare Adriatico	40°03'00.4"N 19°47'38.8"E	n.d.	113	10	n.d.	Fl W 8s
155,54722	Himare Bay	Mare Adriatico	40°04'18.8"N 19°46'43.0"E	2019	32	12	6	Fl W 3s
155,50347	Kep i Gjuhezes	Mare Adriatico	40°25'19.3"N 19°17'29.2"E	n.d.	58	8	11	Fl W 6s
3732	Sqepi i Sevasinit	Mare Adriatico	40°22'33.7"N 19°24'16.2"E	n.d.	75	6	8	Fl (3) W 8s
3731	Gji Dukatit	Mare Adriatico	40°19'39.8"N 19°25'11.4"E	n.d.	21	8	8	Fl (2) W 5s
155,37847	Kep i Kalaja	Mare Adriatico	40°24'48.6"N 19°28'55.8"E	1864	44	6	10	L Fl W 10s
3727	Kep i Treportet	Mare Adriatico	40°30'43.8"N 19°23'45.7"E	n.d.	18	10	9	FL W 5s
ALB-004	Ishull i Sazanit	Mare Adriatico	40°30'14.6"N 19°16'00.8"E	1871	n.d.	12	n.d.	Inattivo
3723	Ishull i Sazanit	Mare Adriatico	40°30'40.0"N 19°16'11.0"E	1871	157	5	12	Fl W 15s
155,25347	Kep i Jugor	Mare Adriatico	40°28'26.8"N 19°17'09.4"E	n.d.	18	8	n.d.	Fl W 6s
3719	Faro di Selina	Mare Adriatico	41°08'46.8"N 19°26'19.8"E	n.d.	71	8	11	Inattivo
3711	Kep i Durresit	Mare Adriatico	41°18'56.2"N 19°26'06.8"E	1864	126	14	n.d.	Fl (2) W 10s
3708	Kep i Pali	Mare Adriatico	41°24'48.0"N 19°23'30.6"E	n.d.	32	14	10	Fl W 10s
3705	Kep i Rodonit	Mare Adriatico	41°35'14.9"N 19°26'40.0"E	2007	40	3	9	Fl (2) W 10s
3704	Talej	Mare Adriatico	41°42'36.1"N 19°35'10.9"E	n.d.	10	9	6	Fl W 6s
3702	Mali Renzit	Mare Adriatico	41°48'38.2"N 19°34'58.6"E	n.d.	46	16	12	Fl W 5s

Algeria

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
6592	Cap Bengut	Mar Mediterraneo	36°55'19.4"N 03°53'34.0"E	2010	63	29	30	Fl (4) W 15s
6580	Cap Corbelin	Mar Mediterraneo	36°54'34.7"N 04°25'22.1"E	1905	42	15	22	Fl (3) WR 15s
6578	Cap Sigli	Mar Mediterraneo	36°53'39.7"N 04°45'32.2"E	1906	57	25	17	FL W 5s
6572	Cap Carbon	Mar Mediterraneo	36°46'29.8"N 05°06'24.2"E	1851	220	10	28	Fl (3) W 20s

6572	Cap Carbon	Mar Mediterraneo	36°46'29.8"N 05°06'24.2"E	1851	220	10	28	Fl (3) W 20s
6566	Bejala	Mar Mediterraneo	36°45'09.4"N 05°06'05.8"E	1901	16	15	n.d.	Fl W 4s
6562	Ile Mansouria	Mar Mediterraneo	36°40'45.8"N 05°28'45.9"E	n.d.	21	6	n.d.	Fl W 2,5s
6550	Jijel Jetée Nord	Mar Mediterraneo	36°49'38.4"N 05°46'48.6"E	1841	62	12	n.d.	Fl (3) WR 12s
6544	Ra's el Maghreb	Mar Mediterraneo	37°01'19.2"N 06°15'43.8"E	1871	30	15	n.d.	Fl W 4s
6542	Cap Bougaroun	Mar Mediterraneo	37°05'15.3"N 06°28'02.1"E	1911	91	10	29	Fl (2) W 10s
6530	Ilot des Singes	Mar Mediterraneo	36°54'18.3"N 06°53'00.7"E	1847	17	9	n.d.	F W
6522	Skikda	Mar Mediterraneo	37°04'47.5"N 07°10'16.7"E	1913	21	14	n.d.	Fl WR 6s
651	Cap de Fer	Mar Mediterraneo	37°04’47.0’’N 07°10’17.0’’E	1859	65	17	19	Fl (3) W 15s
6510	Chetaibi	Mar Mediterraneo	37°04'34.5"N 07°23'27.0"E	1881	128	16	n.d.	Fl WR 4s
6508	Roche Akcine	Mar Mediterraneo	37°03'04.3"N 07°30'37.4"E	n.d.	16	16	n.d.	Fl (2) W 6s
6506	Cap de Garde	Mar Mediterraneo	36°58'02.3"N 07°47'00.1"E	1884	143	14	30	Fl W 5s
6504	Fort Genois	Mar Mediterraneo	36°56'58.5"N 07°46'32.6"E	1841	61	8	n.d.	Fl (2) W 6s
6484	Cap Rosa	Mar Mediterraneo	36°56’47.0’’N 08°14’13.0’’E	1906	132,3	15,3	19	Fl (2) W 6s
ALG-38	Ghazaouet	Mar Mediterraneo	35°05'52.6"N 01°52'23.6"E	1868	92	15	26	Fl (3) W 15s
6718	Ile Rachgoun	Mar Mediterraneo	35°19’26.0’’N 01°28’47.0’’E	1870	81	15	16	Fl (2) R 10s
6714	Iles Habibas	Mar Mediterraneo	35°43’14.0’’N 01°08’00.0’’E	1879	112	12	26	Fl W 5s
6712	Ile Plane	Mar Mediterraneo	35°46'14.8"N 00°54'08.2"E	n.d.	24	6	n.d.	Fl (2) W 6s
6708	Cap Falcon	Mar Mediterraneo	35°46’16.0’’N 00°48’03.0’’E	1868	104	27	29	Fl (4) W 25s
6678	Oran Jetèe gu Large	Mar Mediterraneo	35°43’11.0’’N 00°37’39.0’’E	1905	21	15	22	Fl (3) W 15s
6674	Cap de l’Aiuguille	Mar Mediterraneo	35°52’33.0’’N 00°29’19.0’’E	1906	62	10	26	FL (2) W 10s
6672	Ilot d’Arzew	Mar Mediterraneo	35°52’26.0’’N 00°17’23.0’’E	1848	19	12	16	Fl R 5s
6670	Arzew Jetèe du Large	Mar Mediterraneo	35°50'53.6"N 00°17'27.0"E	n.d.	15	14	n.d.	Fl (4) W 6s
6660	Mostagane	Mar Mediterraneo	35°55'60.0"N 00°04'06.7"E	1902	17	10	n.d.	Fl (4) W 15s
6658	Cap Ivi	Mar Mediterraneo	36°06’46.0’’N 00°13’46.0’’E	1898	118	18	31	Fl W 5s
6656	Pointe Colombi	Mar Mediterraneo	36°26’35.0’’N 00°56’20.0’’E	1954	62,9	32	22	Fl (3) W 15s
6646	Cap Ténès	Mar Mediterraneo	36°32’59.0’’N 01°20’26.0’’E	1865	89	31	31	Fl (2) W 10s
E6644	Ilot Tokikt	Mar Mediterraneo	36°35'36.1"N 01°50'43.6"E	n.d.	12	6	n.d.	Fl W 6s
6636	Fort Joinville	Mar Mediterraneo	36°36’42.0’’N 02°11’17.0’’E	1855	37	26	21	Fl (3) W 15s
6637	Grand Hammam	Mar Mediterraneo	36°36'49.0"N 02°11'32.3"E	n.d.	13	12	n.d.	Q W
6630	Ra’s el Kalia	Mar Mediterraneo	36°35’50.0’’N	1869	34,08	13,58	18	Fl W 4s

6624	Sidi Fredj	Mar Mediterraneo	36°45'48.9"N 02°50'58.7"E	1970	42	24	17	Fl (3) W 12s
6621	Cap Caxine	Mar Mediterraneo	36°48'46.0''N 02°57'15.0''E	1868	64	33	30	Fl W 5s
ALG- 024	Alger	Mar Mediterraneo	36°47'14.0"N 03°04'06.8"E	1834	n.d.	16	n.d.	Inattivo
6602	Alger Jetée Kheireddine	Mar Mediterraneo	36°46'37.7"N 03°04'40.5"E	n.d.	23	17	n.d.	Fl W 3s
6594	Cap Matifou	Mar Mediterraneo	36°48'42.0''N 03°14'43.0''E	1868	74	6	23	Fl (3) W 15s

Cyprus

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
5908	Paphos Point	Mar Mediterraneo	34°45'37.8''N 32°24'22.6''E	1888	36	20	17	L Fl W 15s
5888	Faro di Cape Greco	Mar Mediterraneo	34°57'25.9''N 34°05'06.3''E	1892	16	15	12	Fl W 15 s
5882	Faro di Cape Kiti	Mar Mediterraneo	34°49'01.4''N 33°36'11.0''E	1864	20	8	13	Fl (3) W 15 s
5900	Faro di Capo Andreas	Mar Mediterraneo	35°42'36.9''N 34° 36'22.2''E	1991	20	10	14	Fl (4) W 20s
5890	Faro di Capo Elea	Mar Mediterraneo	35°19'29.7''N 34°02'50.3''E	2002	31	11	5	Fl W 10s
5904	Faro di Cape Kormakitis	Mar Mediterraneo	35° 24'11.8''N 32°55'14.9''E	1991	30	20	15	Fl (2) W 20s
5892	Faro di Famagusta	Mar Mediterraneo	35°08'31.4''N 33°55'35.1''E	1906	18	11	W 15 R 11	Fl WR 7s
5892	Famagusta	Mar Mediterraneo	35°07'23.0''N 33°56'51.7''E	1972	23	11	16	Fl (2) W 15s
n.d.	Vecchio faro di Kyrenia	Mar Mediterraneo	35°20'36.2''N 33°19'11.5''E	1907	7	n.d.	n.d.	Inattivo
5876	Faro di Cape Gata	Mar Mediterraneo	34°33'50.2''N 33°01'28.0''E	1864	58	n.d.	15	Fl W 5s

Croatia

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
3180	Faro di Babac	Mar Adriatico	43°47'24.2''N 15°23'41.4'' E	1874	7	6	10	Fl (2) W 5s
3595	Bezdanj	Mar Adriatico	42°39'40.6"N 18°01'12.2"E	n.d.	18	6	n.d.	Fl (2) W 8s

3522	Blanca	Mar Adriatico	42°55'29.6"N 17°31'06.9"E	1885	10	10	n.d.	Inattivo
3093	Bonaster	Mar Adriatico	44°11′55.7′′N 14°50′19.7′′E	n.d.	12	6	n.d.	Fl W 2s
3344	Bijaca	Mar Adriatico	43°19′49.4′′N 16°26′04.9′′E	1881	8	7	n.d.	Fl R 3s
3226	Faro di Blitvenica	Mar Adriatico	43°37′30.6′′N 15°34′28.1′′E	1872	38	21	24	Fl (3) W 30s
3614.5	Cavtat	Mar Adriatico	42°35'09.4"N 18°12'16.4"E	n.d.	8	8	n.d.	Fl (2) W 10s
2782	Faro di Crna Punta	Mar Adriatico	44°57′25.5′′N 14°08′44.1′′E	1873	15	9	10	Inattivo
3600	Daksa	Mar Adriatico	42°40'12.9"N 18°03'21.2"E	1876	7	13	n.d.	Inattivo
2896	Ertak	Mar Adriatico	45°13'09.9"N 14°36'37.0"E	1875	9	5	n.d.	Fl W 2s
2744	Galiola	Mar Adriatico	44°43'42.0"N 14°10'29.4"E	1890	21	18	n.d.	Fl W 5s
3116.4	Galijolica	Mar Adriatico	43°52'37.9"N 15°22'12.9"E	n.d.	11	8	n.d.	Fl (2) R 10s
3406	Galisnik	Mar Adriatico	43°09'56.3"N 16°26'15.3"E	1913	11	9	n.d.	FL G 6s
3554	Faro di Glavat	Mar Adriatico	42°45′56.4′′N 17°08′45.1′′E	1884	45	19	22	Fl (5) W 30s
3598	Faro di Grebeni	Mar Adriatico	42°39′5.5′′N 18°2′52.3′′E	1872	27	13	10	Fl (3) W 10s
3044	Faro di Grujica	Mar Adriatico	44°24′34.2′′N 14°34′08.3′′E	1873	17	15	10	Fl (3) W 15s
3445	Hirid Lukavci	Mar Adriatico	43°04'58.2"N 16°34'52.7"E	n.d.	14	8	n.d.	Fl R 3s
3034	Hrid Silo	Mar Adriatico	44°33'30.6"N 14°20'37.4"E	n.d.	11	9	n.d.	Fl R 5s
n.d.	Loviste	Mar Adriatico	43°02'46.2"N 17°00'10.6"E	1920	n.d.	n.d.	n.d.	Inattivo
6488	Loviste	Mar Adriatico	43°02'49.8"N 17°00'04.0"E	1874	10	9	n.d.	Fl (3) W 10s
3560	Lirica	Mar Adriatico	42°52'24.7"N 17°25'34.9"E	1911	34	14	n.d.	Fl W 2s
3338	Livka	Mar Adriatico	43°19'49.4"N 16°23'56.3"E	n.d.	11	10	n.d.	Fl W 5s
3436	Viska Luka	Mar Adriatico	43°04′34.7′′N 16°12′16.7′′E	1873	21	11	8	Fl W 4s
2822	Mlaka	Mar Adriatico	45°20'01.3"N 14°25'12.8"E	1878	39	38	n.d.	Fl W 10s
3440	Mali Barjak	Mar Adriatico	43°03'09.5"N 16°02'22.8"E	n.d.	13	8	n.d.	Fl W 3s
2750	Faro di Marlera	Mar Adriatico	44°48′12.4′′N 14°00′6.50′′E	1883	21	9	9	Fl W 9s
2822	Faro di Mlaka	Mar Adriatico	45°20′01.1′′N 14°25′12.6′′E	1920	39	38	15	Fl W 10s
3064	Morovnik	Mar Adriatico	44°25'56.3"N 14°43'56.2"E	1930	8	8	n.d.	Fl G 5s
3286	Faro di Mulo	Mar Adriatico	43°30′25.2′′N 15°55′07.1′′E	1873	23	18	21	Fl W 5s
3022	Murtar	Mar Adriatico	44°33'00.1"N 14°25'16.6"E	1867	9	7	n.d.	Inattivo
3340	Mrduja	Mar Adriatico	43°20'19.8"N 16°24'34.6"E	n.d.	14	6	n.d.	Fl G 3s
2884	Negrit	Mar Adriatico	44°58'46.5"N 14°37'02.6"E	1874	14	5	n.d.	Inattivo

3561	Olipa	Mar Adriatico	42°45′30.1′′N 17°46′36.6′′E	1878	31	11	n.d.	Fl (3) W 10s
3431.5	Otok Vodnjak Veli	Mar Adriatico	43°10'08.5"N 16°18'39.3"E	n.d.	31	8	n.d.	Fl W 6s
3486.5	Osicac	Mar Adriatico	43°00'36.9"N 17°00'18.0"E	n.d.	9	8	n.d.	FL W 3s
3134	Faro di Ostri Rat	Mar Adriatico	44°07′48.1′′N 15°12′15.4′′E	1869	14	14	15	Fl (3) W 10s
E3024	Koludarac	Mar Adriatico	44°33'27.3"N 14°25'48.3"E	1876	10	7	n.d.	FL G 3s
E2784	Kovacine	Mar Adriatico	44°57'34.9"N 14°23'27.0"E	1871	9	6	n.d.	Fl (2) W 6s
E2854.1	Faro di Ostro Kraijevica	Mar Adriatico	45°16′23.0′′N 14°33′36.7′′E	1872	15	15	8	Iso W 2s
2792	Krizice	Mar Adriatico	44°57'19.7"N 14°23'31.0"E	1888	9	6	n.d.	Fl G 3s
3548	Kremene	Mar Adriatico	42°45'14.7"N 16°48'49.0"E	n.d.	18	8	n.d.	Fl WR 5s
3282	Kremik	Mar Adriatico	43°34'27.7"N 15°54'59.5"E	1899	10	8	n.d.	Fl W 3s
3224	Kukuljari	Mar Adriatico	43°45'36.0"N 15°38'03.0"E	1895	11	5	n.d.	Inattivo
3032	Kurila	Mar Adriatico	44°33'44.8"N 14°22'06.7"E	n.d.	11	8	n.d.	Fl WR 5s
3180	Otocic Babac	Mar Adriatico	43°57'23.7"N 15°23'43.1"E	1874	7	6	n.d.	FL (2) W 5s
2886	Otocic Galun	Mar Adriatico	44°56'26.9"N 14°40'38.0"E	n.d.	12	8	n.d.	Fl (3) W 10s
2761	Otocic Visoki	Mar Adriatico	44°46'34.5"N 14°20'51.8"E	n.d.	13	8	n.d.	Fl W 3s
2950	Kristofor	Mar Adriatico	44°28'36.2"N 15°04'43.9"E	1911	62	6	n.d.	Fl W 5s
2994	Juraj	Mar Adriatico	44°45'05.6"N 14°45'56.3"E	1894	14	7	n.d.	FL G 2s
2944	Jurisnica	Mar Adriatico	44°34'26.6"N 14°59'17.9"E	1920	10	7	n.d.	Fl (3) W 12s
3220	Otocic Maslinjak	Mar Adriatico	43°46'03.7"N 15°40'46.5"E	1913	17	7	n.d.	Fl G 3s
3086	Otocic Misjak	Mar Adriatico	44°18'11.5"N 15°11'07.4"E	n.d.	8	8	n.d.	Fl G 3s
3229.2	Otocic Ravan	Mar Adriatico	43°39'32.9"N 15°44'12.7"E	1895	12	10	n.d.	Fl W 5s
3452	Otocic Proizd	Mar Adriatico	42°58'59.8"N 16°36'25.8"E	n.d.	11	8	n.d.	FL W 3s
3482	Otocic Sestrice Vela	Mar Adriatico	42°57'44.7"N 17°12'29.2"E	1871	18	12	n.d.	Fl (4) W 5s
3551	Otocic Tajan	Mar Adriatico	42°48'57.3"N 16°59'27.3"E	n.d.	20	7	n.d.	Fl W 5s
3426	Otocic Zecevo	Mar Adriatico	43°11'25.9"N 16°41'49.9"E	n.d.	11	6	n.d.	Fl W 5s
3586	Faro di Palagruza	Mar Adriatico	42°23′33.5′′N 16°15′20.3′′E	1875	110	23	26	Fl W 17,5s
3295	Pasika	Mar Adriatico	43°27'19.7"N 16°04'19.4"E	n.d.	11	10	n.d.	Fl (4) W 15s
3404	Pelegrin	Mar Adriatico	43°11'43.1"N 16°22'00.8"E	1909	21	8,5	n.d.	Fl (3) W 10s
2710	Faro di Peneda	Mar Adriatico	44°53′17.0′′N 13°45′11.3′′E	1877	20	15	11	Iso W 2s
2872	Plavnik	Mar Adriatico	44°58'53.6"N 14°29'07.6"E	1890	20	12	n.d.	Fl W 6s
2742	Plicina Albanez	Mar Adriatico	44°44'05.3"N 13°54'09.4"E	1910	15	15	n.d.	Fl WR 8s
3450	Faro di Plocica	Mar Adriatico	43°01′50.0′′N 16°48′59.1′′E	1887	25	13	10	Fl (2) W 10s

3446	Podscedro	Mar Adriatico	43°05'07.3"N 16°39'57.5"E	n.d.	21	n.d.	n.d.	Fl WR 6s
3410	Faro di Pokonji Dol	Mar Adriatico	43°09'24.0''N 16°27'10.0''E	1872	20	15	10	Fl W 4s
3348.2	Faro di Pomorac	Mar Adriatico	43°30'02.7''N 16°26'35.0''E	1958	54	38	10	Fl (2) W 6s
2738	Faro di Porer	Mar Adriatico	44°45'29.2''N 13°53'27.3''E	1833	35	31	25	Fl (3) W 15s
3370	Postira	Mar Adriatico	43°22'41.7"N 16°37'37.2"E	1885	7	6	n.d.	FL R 2s
2802	Faro di Prestinice	Mar Adriatico	45°07'12.6''N 14°16'22.3''E	1872	17	13	10	FL W 8s
3202	Faro di Prisnjak	Mar Adriatico	43°49'31.6''N 15°33'32.1''E	1886	19	15	9	Fl (3) W 10s
3392	Rascatna	Mar Adriatico	43°18'50.7"N 16°53'57.7"E	n.d.	12,5	8	n.d.	Fl (4) W 15s
3212	Rat	Mar Adriatico	43°49'24.4"N 15°36'55.2"E	1909	10	9	n.d.	Fl W 5s
3342	Fro di Razanjic	Mar Adriatico	43°19'11.7''N 16°24'31.1''E	1875	17	14	13	Fl W 15s
2680	Rovinj	Mar Adriatico	45°05'02.8"N 13°37'46.6"E	1903	19	7	n.d.	Fl W 4s
2776	Rtac	Mar Adriatico	45°00'11.4"N 14°03'18.1"E	n.d.	9	6	n.d.	Fl G 2s
2642	Faro di Savudrija	Mar Adriatico	45°29'23.8''N 13°29'27.4''E	1818	36	29	30	FL (3) W 15s
2922	Senj	Mar Adriatico	44°59'23.9"N 14°53'49.1"E	1880	10	9	n.d.	Fl (3) W 10s
3482	Faro di Sestrica vela	Mar Adriatico	42°57'45.0''N 17°12'28.1''E	1871	18	15	11	Fl (4) W 15s
3134	Faro di Sestrica vela	Mar Adriatico	43°51'11.0''N 15°12'19.0''E	1876	47	26	20	Fl W 8s
2901	Silo	Mar Adriatico	45°09'23.5"N 14°40'08.9"E	1909	14	9	n.d.	Fl W 3s
3072	Skrda	Mar Adriatico	44°28'50.6"N 14°50'54.4"E	1890	15	12	n.d.	Fl (3) W 15s
3537	Sobra	Mar Adriatico	42°44'41.8"N 17°36'38.2"E	1885	14	10	n.d.	Fl W 3s
2976	Sorinj	Mar Adriatico	44°50'40.5"N 14°40'43.3"E	1920	10	7	n.d.	Fl (3) W 12s
2995.6	Stara	Mar Adriatico	44°36'16.0"N 14°52'12.4"E	n.d.	9	8	n.d.	Fl (3) W 5s
3432	Faro di Stoncica	Mar Adriatico	43°04'20.3''N 16°15'15.8''E	1866	38	28	30	Fl W 15s
2938	Stokic	Mar Adriatico	44°42'31.5"N 14°53'33.1"E	1920	50	6	n.d.	Inattivo
2887	Faro di Strazica	Mar Adriatico	44°55'59.5''N 14°46'05.5''E	1875	21	5	9	Fl W 6s
3544	Faro di Struga	Mar Adriatico	42°43'26.7''N 16°53'04.9''E	1839	105	23	27	Fl W 10s
3443	Stupisce	Mar Adriatico	43°00'22.3"N 16°04'01.7"E	n.d.	18	8	n.d.	Fl (3) W 12s
3490	Faro di Sucuraj	Mar Adriatico	43°07'29.9''N 17°11'47.2''E	1912	14	14	11	Iso W 2s
3396	Sumartin	Mar Adriatico	43°16'50.6"N 16°52'25.0"E	1881	8	6	n.d.	Fl W 3s
3538	Faro di Susac	Mar Adriatico	42°45'00.6''N 16°29'23.4''E	1878	94	17	24	Fl (2) W 15s
3034	Faro di Susak	Mar Adriatico	44°30'51.89''N 14°18'6.27''E	1881	100	12	19	Fl R 5s

2794	Faro di Sveti Andrija	Mar Adriatico	42°38′47.4′′N 17°57′04.6′′E	1873	69	17	24	Fl (3) W 8s
2690	Faro di Sveti Ivan na Pucini	Mar Adriatico	45°2′34.6′′N 13°36′51.2′′E	1853	23	15	24	Fl (2) W 10s
2772	Sveti Mikula	Mar Adriatico	44°58'40.8"N 14°04'35.3"E	n.d.	9	6	n.d.	Fl R 2s
CRO-166	Faro di Sveti Nikola	Mar Adriatico	43°21′42.4′′N 16°44′07.1′′E	1403	23	15	8	Inattivo
3388	Faro di Sveti Petar	Mar Adriatico	43°17′ 41.4′′N 17°00′30.9′′E	1884	16	14	11	Fl W 5s
2961	Tanka Nozica	Mar Adriatico	44°19'55.7"N 15°15'57.5"E	n.d.	8	6	n.d.	Fl W 3s
2910	Tokal	Mar Adriatico	45°08'18.0"N 14°44'24.5"E	1920	20	7	n.d.	Fl W 6s
3106	Faro di Tri Sestrice	Mar Adriatico	44°10′19.7′′N 15°00′42.9′′E	1899	16	16	8	FL (2) W 5s
3002	Faro di Trstenik	Mar Adriatico	44°40′7.4′′N 14°34′41.3′′E	1873	26	12	11	Fl WR 8s
2768	Ubac	Mar Adriatico	44°56'43.4"N 14°03'55.1"E	n.d.	16	5	n.d.	Fl W 4s
3098	Faro di Veli Rat	Mar Adriatico	44°09′07.3′′N 14°49′12.8′′E	1849	41	36	22	Fl (2) W 20s
3461	Velo dance	Mar Adriatico	42°55'32.6"N 16°38'20.0"E	n.d.	12	6	n.d.	Fl (3) W 10s
3081	Faro di Vir	Mar Adriatico	44°18′11.7′′N 15°01′34.02′′E	1881	21	11	21	Fl W 10s
2894	Faro di Voscica	Mar Adriatico	45°14′19.7′′N 14°35′23.9′′E	1875	12	8	3	FL R 3s
2752	Faro di Vnetak	Mar Adriatico	44°37′09.6′′N 14°14′08.5′′E	1873	17	13	10	FL (3) W 10s
3044	Vranac	Mar Adriatico	44°24'34.4"N 14°34'09.0"E	1872	17	15	n.d.	FL (3) W 15s
2764	Faro di Zaglav	Mar Adriatico	44°55′16.2′′N 14°17′18.3′′E	1876	20	15	10	FL (3) W 15s
2658	Faro di Zub	Mar Adriatico	45°17′53.2′′N 13°34′08.4′′E	1872	11	7	9	FL (3) W 10s

Egypt

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
6162	Borolus	Mar Mediterraneo	31°36′00.0′′N 31°04′48.0′′E	1992	47	39	20	FL (3) W 20s
6156	Damietta	Mar Mediterraneo	31°31′23.8′′N 03°50′53.8′′E	1992	47	39	20	Lato est: FL (2) W 30 s Lato ovest: FL G 10s
6173.50	El Ajami	Mar Mediterraneo	31°08′53.8′′N 29°47′12.1′′E	n.d.	17	14	15	FL (2) W 15s
5973	Arish	Mar Mediterraneo	31°08′42.0′′N 33°48′54.0′′E	1997	39	20	18	FL W 5s

5978.60	Torre El Bahar	Mar Mediterraneo	31°18′06.1″N 32°21′36.0″E	2008	42	42	15	Iso W 1s
6191.10	El Dikheila Range Rear	Mar Mediterraneo	31°07′59.8″N 29°48′42.1″E	n.d.	31	27	17	Iso W 1s
6174	Great Pass	Mar Mediterraneo	31°10′00.1″N 29°48′29.8″E	1899	21	21	16	Fl W 4s
5978	Faro di Port Said	Mar Mediterraneo	31°16′18.1″N 32°17′35.8″E	1997	47	39	20	Fl (4) W 15s
6193	Ra's SHakik	Mar Mediterraneo	30°57′18.0″N 28°49′41.8″E	1987	47	15	20	Fl (4) W 10s
6173	Ras el-Tin	Mar Mediterraneo	31°11′42.0″N 29°51′42.1″E	1848	55	52	21	FL (2+1) W 30s
6166	Ra'schid	Mar Mediterraneo	31°26′35.8″N 30°25′48.0″E	1991	47	15	20	Fl (4) W 20s

France

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
1282	Phare du Cap Béar	Mar Tirreno	42°30′56.5″N 03°08′11.7″E	1905	29	27	30	Fl (3) W 20s
0498	Port-Vendres	Mar Tirreno	42°31′16.5″N 03°06′49.3″E	1700	30,7	29	9	Oc G 3s
1293	Cap Leucate	Mar Tirreno	42°55′3.06″N 03°03′35.7″E	1949	66	19	20	Fl (2) W 10s
FR-708	Cap d'Agde	Mar Tirreno	43°15′47.0″N 03°30′07.0″E	1836	22	n.d.	13	Inattivo
1300	Mont Saint-Clair	Mar Tirreno	43°23′44.0″N 03°41′23.4″E	1903	93	23	29	Fl W 5s
1301	Mole Saint-Louis	Mar Tirreno	43°17′53.9″N 03°30′10.7″E	1948	34	31	27	Fl (4) WR 15s
1321	l'Espiguette	Mar Tirreno	43°29′15.5″N 04°08′30.1″E	1869	27	27	24	Fl (3) W 15s
FR-308	Grau du Roi (Gard)	Mar Tirreno	43°32′11.2″N 04°08′04.2″E	1829	20	19	19	Inattivo
FR-512	Aigues-Mortes	Mar Tirreno	43°34′06.7″N	1246	n.d.	33	n.d.	Inattivo
NGA 6241	Pointe du Barrou	Mar Tirreno	43°25′30.8″N 03°40′27.2″E	n.d.	6	6	n.d.	L Fl W 5s
1324	Gacholle	Mar Tirreno	43°27′17.3″N 04°34′13.1″E	1884	17	16	12,5	Fl WRG 4s
1325	Beauduc	Mar Tirreno	43°21′52.5″N 04°35′04.2″E	1903	27,2	27	17	Inattivo
1328	Faraman	Mar Tirreno	43°21′16.5″N 04°41′13.7″E	1892	41	43	27,5	Fl (2) W 10s
1351	Saint-Gervais	Mar Tirreno	43°25′42.5″N	1980	45	45	25	Fl (7) WRG 12s
1385	Cap Couronne	Mar Tirreno	43°19′31.9″N 05°03′11.0″E	1959	34	31	18,5	Iso R 3s
1415	La Planier	Mar Tirreno	43°11′54.6″N 05°13′50.4″E	1959	68	66	23	luce bianca ogni 5s
1431	Grand Rouveau	Mar Tirreno	43°04′48.8″N 05°46′03.2″E	1863	45	17	n.d.	Fl W 6s
1434	Cap Cépet	Mar Tirreno	43°04′02.9″N 05°56′39.7″E	1992	76	14	20	Fl (3) W 15s
1459	Grand-Ribaud	Mar Tirreno	43°00′59.4″N 06°08′38.5″E	1953	35	16	15	Fl (4) W 15s
1462	Cap d'Arme, Porquerolles	Mar Tirreno	42°59′0.30″N 06°12′22.7″E	1837	80	20	29	Fl (2) W 10s
0764	Cap Bénat	Mar Tirreno	43°05′18.6″N 06°21′46.3″E	1895	60	16	21	Fl R 5s

1479	Titan	Mar Tirreno	43°02'47.5''N 06°30'37.4''E	1893	70	10	28	Fl W 5s
1481	Cap Camarat	Mar Tirreno	43°12'03.2''N 06°40'28.3''N	1836	130	25	27	Fl (4) W 15s
1490	Agay	Mar Tirreno	43°25'33.4''N 06°52'14.8''E	1884	28	16	15	Oc WR 3s
FR-082	Saint-Tropez	Mar TIrreno	43°16'21.7"N 6°37'57.1"E	2001	15	16	n.d.	Fl WR 6s
1494	Vallauris	Mar Tirreno	43°34'05.4''N 07°3'41.6''E	1927	167	19	15	Fl (2) WRG 4s
1498	La Garoupe	Mar Tirreno	43°33'52,0''N 07°07'59.4''E	1948	104	29	28	Fl (2) W 10s
1508	Cap Ferrat	Mar Tirreno	43°40'30.5''N 07°19'36.7''E	1952	69	32	21	Fl W 3s
852	Cap Corse	Mar Tirreno	43°01'35,8''N 09°24'19.9''E	1848	85	26	22,2	Fl W 5s
864	Alistro	Mar Tirreno	42°15'37.3''N 09°32'25.8''E	1864	93	27	23	Fl W 10s
NGA 8148	Chiappa	Mar Tirreno	41°35'42.6''N 09°21'55.8'' E	1845	64,5	21	23	Fl (4) W 15s
NGA 7948	Lavezzi	Mar Tirreno	41°20'04.6''N 09°15'32.5''E	1874	27,5	12	15	Fl WR 6s
NGA 7952	Ecueil Lavezzi	Mar Tirreno	41°19'01.8"N 9°15'13.7"E	1904	18	22	n.d.	Fl (2) W 6s
876	Pertusato	Mar Tirreno	41°22'03.2''N 09° 11'04.0''E	1844	100	17	25	Fl (2) W 10s
0894	Senetosa	Mar Tirreno	41°33'30.9''N 08°47'39.1''E	1892	54,3	15	22	Fl W 5s
0902	Sanguinaires	Mar Tirreno	41°52'43.3''N 08°35'39.9''E	1844	98,5	18	24	Fl (3) W 10s
0918	Punta Revellata	Mar Tirreno	42°34'59.0''N 08°43'27.80''E	1844	97	19	21	Fl (2) W 10s
0926	Pietra	Mar Tirreno	42°38'40.0''N 08°55'56.0''E	1857	64	13	n.d.	Fl (3) W 12s

Greece

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
20584	Strogili Megisti	Mar Egeo	36°06'34.8"N 29°37'56.9"E	1917	107	7	17	Fl W 5s
20416	Agios Nikolaos	Mar Egeo	36°27'04.3"N 28°13'41.0"E	1863	24	6	11	L Fl W 12s
20388	Prasonisi	Mar Egeo	35°52'42.7"N 27°45'03.6"E	1890	61	14	17	Fl (4) W 30s
20292	Kandeloussa	Mar Egeo	36°29'53.8"N 26°57'41.3"E	1890	55	10	17	Fl W 10s
20196	Pserimos	Mar Egeo	36°55'15.3"N 27°10'34.0"E	n.d.	43	4	n.d.	Fl (2) WR 10s
20180	Kalolimnos	Mar Egeo	37°03'30.5"N 27°06'23.4"E	1864	29	6	7	Inattivo
20068	Akra Pappas	Mar Egeo	37°30'41.0"N 25°58'43.6"E	1890	75	11	n.d.	L Fl W 20s
20080	Akra Armenistis	Mar Egeo	37°38'08.8"N 26°04'59.5"E	n.d.	29	4	n.d.	Fl (3) W 12s
19924	Nisida Venetiko	Mar Egeo	38°07'32.7"N 26°00'54.2"E	n.d.	76	5	11	Fl (2) W 15s
19900	Agios Georgios	Mar Egeo	38°32'12.4"N 25°36'33.7"E	n.d.	78	9	17	Fl W 10s

19946	Vrachonisida Strovilo	Mar Egeo	38°33'09.6"N 26°09'49.3"E	n.d.	73	4	n.d.	Fl W 5s
19952	Vrachonisida Prasonisia	Mar Egeo	38°31'28.6"N 26°11'00.8"E	n.d.	17	4	n.d.	Fl (2) W 10s
19968	Pasas	Mar Egeo	38°30'01.9"N 26°17'35.0"E	1885	69	8	11	Fl (2) W 20s
19756	Mitilini	Mar Egeo	39°06'11.4"N 26°33'32.5"E	2007	20	6	n.d.	Fl (3) W 14s
19732	Megalonisi	Mar Egeo	39°12'45.8"N 25°49'58.0"E	1947	53	15	21	Fl (2) W 15s
19740	Akra Molyvos	Mar Egeo	39°22'44.3"N 26°11'02.6"E	n.d.	27	4	W 12 G 8	Fl WG 7,5s
19752	Korakas	Mar Egeo	39°23′22.8′′N 26°20′29.0′′E	n.d.	13	6	n.d.	Fl W 5s
16924	Vrachonisida	Mar Egeo	39°33'55.2"N 25°00'12.3"E	n.d.	34	8	n.d.	Fl W 5s
16920	Plaka	Mar Egeo	40°02'06.1"N 25°26'43.8"E	1912	55	18	22	Fl (3) W 30s
15655	Gavrio	Mar Egeo	37°52'31.2"N 24°43'37.0"E	n.d.	68	11	8	Fl W 6s
15672	Fasa	Mar Egeo	37°57'48.7"N 24°42'09.1"E	1856	201	20	22	Fl W 10s
15676	Gria	Mar Egeo	37°53'55.1"N 24°57'18.3"E	1914	86	10	25	Fl W 10s
15680	Tourlitis	Mar Egeo	37°50'35.1"N 24°56'47.5"E	1887	19	7	6	Fl (2) W 15s
15744	Livada	Mar Egeo	37°36'38.0"N 25°15'12.0"E	1910	41	10	7	L Fl W 15s
15738	Planitis	Mar Egeo	37°39'34.8"N 25°04'01.4"E	1886	80	8	n.d.	Fl (2) W 14s
15736	Disvato	Mar Egeo	37°40'21.4"N 24°58'01.4"E	1903	33	9	16	Fl W 10s
15804	Armenistis	Mar Egeo	37°29'22.8"N 25°18'52.4"E	1891	184	19	22	Fl W 10s
15704	Akra Trimenson	Mar Egeo	37°30'49.5"N 24°53'01.6"E	n.d.	62	5	n.d.	Fl (2) W 14s
15708	Gaiduroisi	Mar Egeo	37°25'37.4"N 24°58'19.3"E	1834	68	29	N/A	Fl W 6s
15608	Makronisos	Mar Egeo	37°38'45.0"N 24°06'22.2"E	n.d.	32	6	12	Fl (2) W 14s
15624	Tamelos	Mar Egeo	37°31'20.7"N 24°16'36.0"E	1893	60	7,5	17	Fl (2) W 15s
15644	Akra Mericha	Mar Egeo	37°23'52.0"N 24°23'24.7"E	n.d.	60	7	n.d.	FL WR 5s
15764	Spathi	Mar Egeo	37°06'45.3"N 24°30'18.6"E	1901	67	10	19	Fl (3) W 30s
15888	Nisida Paximadi	Mar Egeo	36°37'54.3"N 24°19'04.1"E	n.d.	29	4	n.d.	Fl (2) W 15s
15900	Akradhia	Mar Egeo	36°46'49.4"N 24°23'24.6"E	1892	88	7	10	Fl W 8s
15904	Ormos Milou	Mar Egeo	36°43'13.5"N 24°26'06.1"E	n.d.	36	5	n.d.	Fl W 5s
15920	Polyaigos	Mar Egeo	36°46'24.1"N 24°39'39.7"E	1898	138	9	n.d.	Fl W 5s
15824	Agios Fokas	Mar Egeo	37°05'25.7"N 25°07'56.1"E	n.d.	11	6	6	Fl W 4s
15836	Korakas	Mar Egeo	37°09'15.8"N 25°13'29.0"E	1887	60	10	14	L Fl W 12s
15884	Akra Kaloterousa	Mar Egeo	37°08'06.2"N 25°49'44.3"E	n.d.	147	4,5	n.d.	Fl (3) W 15s
15988	Katapola	Mar Egeo	36°50'10.2"N 25°50'21.7"E	1882	46	7	n.d.	Fl (2) W 10s
15932	Aspropunta	Mar Egeo	36°37'56.2"N 24°51'36.4"E	1919	70	11	17	Fl (3) W 30s
15944	Ios	Mar Egeo	36°42'53.5"N 25°15'33.6"E	1892	33	9	9	Inattivo
15952	Akrotiri	Mar Egeo	36°21'27.8"N 25°21'25.5"E	1892	100	10	24	Fl W 10s
16208	Tripiti	Mar Mediterraneo	34°48'07.2"N 24°07'15.2"E	1990	37	6	n.d.	Fl (2) W 16s

16196	Nisida Megalonisi	Mar Mediterraneo	34°55'23.6"N 24°48'02.7"E	n.d.	67	6	21	Fl (3) W 20s
16224	Elefonisi	Mar Mediterraneo	35°16'06.7"N 23°31'27.0"E	n.d.	43	15	12	Fl (3) W 24s
16008	Gramvousa	Mar Egeo	35°38'51.6"N 23°34'35.3"E	1874	108	4	n.d.	Fl R 10s
16012	Chania	Mar Egeo	35°31'10.3"N 24°01'00.4"E	1864	26	18	7	FL R 2,5s
16024	Akra Maleka	Mar Egeo	35°35'11.1"N 24°10'27.6"E	n.d.	48	6	n.d.	Fl (2) W 12s
16040	Nisisi Soudhas	Mar Egeo	35°29'38.4"N 24°09'10.4"E	1864	20	5	n.d.	Fl G 4,8s
16036	Drepano	Mar Egeo	35°28'23.8"N 24°14'25.4"E	1948	56	7	20	Fl (3) W 30s
16064	Rethymno North Mole	Mar Egeo	35°22'24.3"N 24°29'03.1"E	n.d.	10	8	10	Fl G 3s
16068	Rethymno South Mole	Mar Egeo	35°22'16.1"N 24°28'57.9"E	n.d.	12	7	10	Fl R 4s
16076	Khondros Kavos	Mar Egeo	35°25'36.3"N 24°41'59.9"E	n.d.	57	4,5	n.d.	Fl W 6s
16100	Breakwater	Mar Egeo	35°21'07.5"N 25°09'21.8"E	n.d.	14	12	n.d.	Fl G 4s
16104	Heraklion Pier 6	Mar Egeo	35°20'54.3"N 25°09'09.9"E	n.d.	13	10	9	Fl R 4s
16128	Agioi Pandes	Mar Egeo	35°12'11.9"N 25°43'54.4"E	n.d.	24	7	n.d.	Fl W 3s
16132	Molo Agios Nikolaos	Mar Egeo	35°11'36.9"N 25°43'13.1"E	n.d.	10	8	n.d.	Fl R 3s
16140	Akra Vamvakia	Mar Egeo	35°13'28.6"N 26°06'59.3"E	1892	24	5	n.d.	Fl (3) W 18s
16160	Cape Sidero	Mar Egeo	35°18'57.0"N 26°18'39.0"E	1948	45	15	18	Fl W 10s
16184	Ierapetra	Mar Mediterraneo	35°00'12.7"N 25°44'19.5"E	1948	45	15	n.d.	Fl W 10s
14900	Strofades	Mar Ionio	37°14'47.7"N 21°00'12.4"E	1829	39	11	17	Fl (2) W 15s
14724	Skinari	Mar Ionio	37°55'51.5"N 20°42'07.7"E	1897	66	9	20	Fl W 5s
14728	Akra Kryoneri	Mar Ionio	37°48'16.4"N 20°54'16.0"E	1869	21	8	n.d.	Fl (2) W 16s
14737	Zakynthos	Mar Ionio	37°46'52.4"N 20°54'19.7"E	n.d.	11	9	n.d.	Fl G 1,5s
14740	Keri	Mar Ionio	37°39'16.7"N 20°48'29.9"E	1925	194	7	17	Fl W 10s
14684	Dhik Halia	Mar Ionio	38°16'50.9"N 20°40'33.4"E	1910	17	5,5	5	Fl (2) R 8s
14708	Argostoli	Mar Ionio	38°11'29.0"N 20°28'04.2"E	1960	11	9	n.d.	Fl W 3s
14704	Vardiani	Mar Ionio	38°07'59.1"N 20°25'36.5"E	n.d.	58	13	n.d.	Inattivo
14720	Gerogompos	Mar Ionio	38°10'48.6"N 20°20'29.6"E	1947	58	13	24	Fl W 3s
14672	Fiskardo	Mar Ionio	38°27'39.8"N 20°34'55.1"E	1892	28	14	7	Fl W 6s
14640	Oxia	Mar Ionio	38°17'00.2"N 21°05'58.9"E	1899	70	8	17	Fl (2) W 15s
14644	Akra Far' Aetos	Mar Ionio	38°21'45.0"N 20°39'57.7"E	n.d.	19	4	n.d.	Fl W 5s
14572	Akra Dukato	Mar Ionio	38°33'48.7"N 20°32'33.8"E	1890	70	15	20	Fl W 10s
14496	Antipaxos	Mar Ionio	39°08'26.2"N 20°14'54.5"E	1906	41	12	W 20 R 15	Fl WR 4,5s
14488	Panagia	Mar Ionio	39°12'16.3"N 20°11'40.5"E	1825	26	11	n.d.	Fl W 5s
14484	Laka	Mar Ionio	39°14'08.2"N 20°07'40.9"E	1919	64	9	20	Fl (3) W 24s
14392	Peristeres	Mar Ionio	39°47'33.1"N 19°57'32.4"E	1872	23	10	8	Fl R 5s

14398	Yfalos Serpa	Mar Ionio	39°46'15.2"N 19°57'21.7"E	n.d.	12	12	n.d.	Fl W 5s
14430	Sidero	Mar Ionio	39°37'23.5"N 19°55'45.2"E	1828	78	8	13	Fl (2) W 6s
14436	Levkimnis	Mar Ionio	39°27'34.8"N 20°04'20.4"E	1874	8	5	n.d.	Fl W 6s
14380	Kastri	Mar Ionio	39°51'53.6"N 19°25'45.1"E	1872	103	13	18	Fl W 10s
16836	Alexandroupoli	Mar Egeo	40°50'36.9"N 25°52'30.2"E	1880	31	27	24	Fl (3) W 15s
16796	Akra Fanari	Mar Egeo	40°57'28.3"N 25°07'48.5"E	n.d.	40	5	n.d.	Fl W 6,5s
16736	Akra Kara Orman	Mar Egeo	40°55'48.3"N 24°24'50.3"E	n.d.	33	4	n.d.	Fl W 5s
16744	Kavala	Mar Egeo	40°55'58.0"N 24°24'23.1"E	n.d.	11	11	15	Fl R 2s
16640	Kassandra	Mar Egeo	39°57'35.3"N 23°21'44.7"E	1864	19	18	24	Fl (2) W 12s
16576	Megalo Emvolon	Mar Egeo	40°30'06.6"N 22°49'02.1"E	1864	30	10,5	15	Fl WR 10s
16628	Ufficio del Porto	Mar Egeo	40°37'54.1"N 22°56'05.6"E	n.d.	18	14	n.d.	Fl G 2,5s
16584	Axio	Mar Egeo	40°30'39.7"N 22°44'51.4"E	1960	9	8	16	Fl (2) WRG 12s
16572	Akra Atheridha	Mar Egeo	40°21'45.5"N 22°39'39.4"E	n.d.	12	9	n.d.	Fl W 5s
16464	Psathoura	Mar Egeo	39°30'11.6"N 24°10'51.1"E	1895	40	25	17	Fl W 10s
16472	Akra Teleio	Mar Egeo	39°08'22.2"N 23°49'46.8"E	n.d.	21	4	n.d.	Fl (3) W 12s
16480	Akra Gourouni	Mar Egeo	39°12'27.2"N 23°35'36.0"E	1884	70	14	n.d.	Fl (3) W 30s
16496	Repi	Mar Egeo	39°08'49.4"N 23°31'44.5"E	1914	42	15	12	Fl (2) W 10s
16520	Akra Sepia	Mar Egeo	39°11'13.2"N 23°20'59.4"E	n.d.	105	4	n.d.	Fl W 8s
16528	Trikeri	Mar Egeo	39°05'47.6"N 23°03'02.8"E	1864	22	14	20	Fl (3) W 20s
16420	Argironisos	Mar Egeo	39°00'34.8"N 23°04'32.6"E	1899	32	7	16	Fl W 5s
16388	Anteros	Mar Egeo	38°51'04.8"N 22°41'47.1"E	1890	10	8	10	Fl (3) W 15s
16360	Arkitsa	Mar Egeo	38°45'18.2"N 23°02'03.0"E	1908	15	15	19	Fl (2) W 5s
16352	Aralanti	Mar Egeo	38°41'00.8"N 23°05'26.3"E	n.d.	10	5	n.d.	Fl W 1,5s
16328	Kakokefali	Mar Egeo	38°28'35.8"N 23°36'13.7"E	1886	21	12	12	Fl (2) R 18s
16380	Strongili	Mar Egeo	38°48'30.0"N 22°49'15.6"E	1870	41	9	17	Fl (2) W 10s
16408	Vasilina	Mar Egeo	38°52'14.3''N 22°51'02.7''E	1892	9	10	W 14 G 11	Fl WG 5s
16516	Pontikonisi	Mar Egeo	39°02'57.7"N 23°20'18.8"E	1907	62	19	15	FL W 15s
16432	Prasouda	Mar Egeo	38°39'52.0"N 24°15'00.9"E	1897	42	18	16	Fl W 5s
16444	Lithari	Mar Egeo	38°46'29.0"N 24°40'53.1"E	1894	96	12	16	Fl (3) W 30s
16228	Mandili	Mar Egeo	37°56'00.8"N 24°31'31.2"E	1925	83	10	15	Fl (3) W 20s
16308	Avlida	Mar Egeo	38°24'34.5"N 23°37'56.5"E	1880	9	9	6	Fl (2) W 12s
14833	Antikyra	Mar Egeo (Golfo di Corinto)	38°22'33.6"N 22°37'59.8"E	2003	10	10	n.d.	Fl G 4s
14816	Apsifia	Mar Egeo (Golfo di Corinto)	38°22'41.2"N 22°24'09.4"E	n.d.	13	5	n.d.	Fl W 7s
14804	Psaromyta	Mar Egeo (Golfo di Corinto)	38°19'18.1''N 22°11'03.6''E	1894	65	9	21	Fl (2) W 15s

14792	Nafpaktos	Mar Ionio	38°23'30.7"N 21°49'44.3"E	1909	13	6	3	Fl G 2s
14784	Antirrio	Mar ionio	38°19'37.5"N 21°45'56.9"E	1880	16	9	10	Fl (2) W 10s
14756	Agios Sostis	Mar Ionio	38°19'16.1"N 21°22'29.8"E	1859	12	11	W 17 R 14	Fl WR 15s
14584	Volios	Mar Ionio	38°47'41.1"N 20°43'42.1"E	1913	8	4,5	5	L Fl W 1,5s
14560	Lefkada	Mar Ionio	38°50'43.4"N 20°43'11.2"E	1861	17	6	20	Fl (2) WR 12s
14504	Aktio	Mar Ionio	38°56'39.8"N 20°45'40.5"E	1928	5	4	7	Q Y
14536	Koprenas	Mar Ionio (Golfo di Ambracian)	39°01'47.4"N 21°04'32.2"E	1893	9	9	5	Fl (2) W 16s
14476	Murtos	Mar Ionio (Golfo di Ambracian)	39°24'17.5"N 20°12'35.8"E	1884	87	14	12	Fl (3) W 20s
16296	Ormos Oropou	Mar Ionio	38°19'40.5"N 23°48'26.3"E	n.d.	6	4	n.d.	Fl W 4s
16280	Vrachonisida Ligeia	Mar Ionio	38°11'01.6"N 24°06'10.8"E	n.d.	10	5,5	n.d.	Fl (2) W 16s
16252	Nisida Raftis	Mar Egeo (Golfo di Petalion)	37°52'57.3"N 24°02'40.4"E	n.d.	100	7	n.d.	Fl W 5s
15620	Vrisaki	Mar Egeo (Golfo di Petalion)	37°44'39.7"N 24°04'51.2"E	1892	23	7	16	Fl W 5s
15224	Agios Georgios	Mar Egeo	37°27'43.6"N 23°56'20.9"E	1901	135	10	n.d.	Fl (2) W 15s
15524	Pireo Molos Themistokleus	Mar Egeo	37°56'11.9"N 23°37'16.4"E	n.d.	14	10	n.d.	Fl G 4s
15528	Pireo Molos Vasileus	Mar Egeo	37°56'19.1"N 23°37'19.5"E	n.d.	14	10	n.d.	FL R 4s
15384	Akra Keos Molos	Mar Egeo	37°56'56.0"N 23°35'52.5"E	n.d.	14	11	n.d.	Fl (2) G 10s
1856	Psitalia	Mar Egeo	37°56'26.5"N 23°35'23.5"E	1856	47	14	25	Fl (2) W 15s
15476	Fylatouri	Mar Egeo (Golfo di Elefsina)	37°58'47.7"N 23°33'07.5"E	n.d.	13	10	n.d.	Fl (2) W 14s
15324	Koghi	Mar Egeo (Golfo Saronico)	37°52'25.7"N 23°26'56.6"E	1901	33	12	9	Fl W 4s
15252	Plakakia	Mar Egeo	37°45'42.2"N 23°25'03.9"E	1881	11	6	7	Fl (2) W 15s
15228	Dana	Mar Egeo	37°31'38.6"N 23°25'33.1"E	1870	31	9	8	Fl W 4s
15236	Akra Stavros	Mar Egeo	37°29'37.0"N 23°27'45.6"E	n.d.	7	7	n.d.	Fl WRG 3s
15216	Zourvas	Mar Egeo	37°21'51.6"N 23°34'42.2"E	1946	36	9	17	Fl (3) W 20s
14196	Dokos	Mar Egeo	37°19'52.0"N 23°21'22.3"E	1923	23	9	6	Fl (2) W 2s
15176	Spetses	Mar Egeo	37°15'48.0"N 23°10'02.1"E	1885	27	10	18	Fl W 5s
15088	Velopoula	Mar Egeo	36°55'38.8"N 23°27'10.7"E	1884	112	10	22	Fl (2) W 20s
15084	Falkonera	Mar Egeo	36°50'36.9''N 23°53'23.2''E	n.d.	136	4	n.d.	FL W 5s
15076	Apolitare	Mar Egeo	35°49'24.6"N 23°19'28.8"E	1926	40	23	n.d.	Fl (2) W 15s
15052	kapsali	Mar Egeo	36°08'33.3"N 23°00'00.5"E	1853	24	8	10	Fl W 3s
15048	Moudari	Mar Egeo	36°22'52.3"N 22°57'00.4"E	1901	114	25	20	Fl (3) W 30s
14868	Likoporia	Mar Egeo (Golfo di Corinto)	38°08'09.2"N 22°29'27.0"E	n.d.	17	15	10	Fl (2) W 16s
14844	Melagavi	Mar Egeo (Golfo di Corinto)	38°01'42.5"N 22°51'00.5"E	1897	58	13	19	Fl W 10s

15320	Susaki	Mar Egeo (Golfo di Corinto)	37°54'44.5"N 23°03'25.4"E	1894	10	7,5	12	Fl G 10s
15092	Monemvasia	Mar Egeo	36°41'22.1"N 23°03'31.6"E	1896	20	10	n.d.	Fl W 5s
15044	Maleas	Mar Egeo	36°27'01.1"N 23°12'05.9"E	1883	40	15	17	Fl W 10s
15040	Zovollo	Mar Egeo	36°25'43.5"N 23°07'51.3"E	n.d.	13	4	n.d.	Fl W 7s
15008	Kramai	Mar Egeo	36°45'15.6"N 22°34'32.7"E	1873	23	23	n.d.	Fl (3) W 18s
14992	Akra Tainero	Mar Ionio	36°23'09.8"N 22°28'58.6"E	1882	41	16	n.d.	Fl (2) W 20s
14980	Limeni	Mar Ionio	36°40'49.3"N 22°22'13.5"E	1898	14	6	6	Fl W 1,5s
14968	Kitries	Mar Ionio	36°54'53.2"N 22°07'33.9"E	1892	32	11	7	Fl (2) W 12s
14932	Sapienza	Mar Ionio	36°44'30.3"N 21°41'48.8"E	1885	116	9,5	18	Fl (3) W 20s
14908	Sfaktiria	Mar Ionio	36°54'19.6"N 21°40'23.1"E	1873	36	9	9	Fl (2) W 10s
14892	Katakolon	Mar Ionio	37°38'16.3"N 21°18'50.7"E	1865	49	9	15	Fl W 4s
14880	Kafkalida	Mar Ionio	37°56'24.4''N 21°07'14.9''E	1906	21	15	W 12 R 9	FL WR 15s
14876	Drepano	Mar Egeo (Golfo di Corinto)	38°20'20.3"N 21°50'57.8"E	1880	10	9	10	Fl W 10s

Italy

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
1474	Faro di Capo dell'Arma	Mar ligure	43°49'00.0"N 07°49'09.0"E	1912	50	15	24	Fl (2) W 15s
1514	Faro di Porto Vado	Mar ligure	44°15'05.0"N 08°27'02.0"E	1883	43	34	14	Fl (4) W 15s
1478	Faro di Porto Maurizio	Mar ligure	43°52'5.00"N 08°10'00.0"E	1882	11	11	16	Iso W 5s
1506	Faro di Capo Mele	Mar ligure	43°57'03.0"N 08°10'04.0"E	1856	n.d.	25	25	Fl (3) W 15s
1569	Torre della Lanterna	Mar ligure	44°24'16.2"N 08°54'16.2"E	1128	117	77	26	Fl (2) W 20s
1575	Faro di Punta Vagno	Mar ligure	44°23'31.2"N 08°57'09.9"E	1931	26	9	18	L Fl (3) W 15s
1675	Faro di Punta di Portofino	Mar ligure	44°17'09.0"N 09°13'01.0"E	1870	40	12	16	Fl W 5s
1708	Faro di San Venerio	Mar ligure	44°01'06.0"N 09°51'00.0"E	1839	99	24	25	Fl (3) W 15s
1765	Pegazzano	Mar Ligure	44°06'10.2"N 09°48'18.6"E	1915	48	13	16	Iso W 4s
1671	Camogli	Mar Ligure	44°21'06.4''N 09°08'57.0''E	1950	13	7	9	Fl W 3s
1846	Faro di Marina di Carrara	Mar ligure	44°02'11.0"N 10°02'13.0"E	1956	22	22	17	Fl W 3s
1868	Faro della Diga Foranea	Mar ligure	43°51'29.0"N 10°14'14.0"E	'900	30	33	24	Fl W 5s
1884	Faro settentrionale della Meloria	Mar ligure	43°35'24.0"N 10°12'42.0"E	1950-1960	18	20	10	Fl (2) W 10s

1888	Faro meridionale della Meloria	Mar ligure	43°32'47.0"N 10°13'08.0"E	1950	18	20	10	VQ (6) W 15s
1896	Fanale di Livorno	Mar ligure	43°32'38.0"N 10°17'40.0"E	1303-1305	52	52	24	Fl (4) W 20s
1911	Faro della Diga Curvilinea	Mar ligure	43°32'35.0"N 10°17'22.0"E	1857	22	20	16	Fl WR 3s
1975	Faro delle Secche di Vada	Mar ligure	43°19'13.0"N 10°21'49.0"E	1867	18	18	12	Fl (2) W 10s
1996	Faro di Capraia	Canale di Corsica	43°03'04.0"N 09°50'40.0"E	1868	30	12	16	Fl W 5s
2016	Faro di Palmaiola	Canale di Piombino	42°51'54.0"N 10°28'30.0"E	1844	52	14	10	Fl (2) W 10s
2040	Faro di Capo Focardo	Canale di Piombino	42°45'16.2"N 10°24'35.4"E	1863	32	13	16	Fl (3) W 3s
2054	Faro di Monte Poro	Mar Tirreno	42°43'40.2"N 10°14'14.3"E	inizio '900	160	7	16	Fl W 5s
2056	Faro di Marina di Campo	Mar Tirreno	42°44'30.2"N 10°14'17.3"E	1901	34	n.d.	10	Fl W 3s
2060	Faro di Punta Polverata	Canale di Corsica	42°47'40.4"N 10°06'37.6"E	1909	52	10	16	L Fl (3) W 15
2072	Faro di Portoferraio	Mar Ligure	42°48'59.0"N 10°20'03.0"E	1788-1789	63	25	16	Fl (3) 14s
2088	Faro di Pianosa	Mar Tirreno	42°35'01.0"N 10°05'08.0"E	1864	42	19	16	Fl (2) 10s
2096	Faro dello Scoglio d'Africa	Mar Tirreno	42°21'30.0"N 10°03'51.0"E	1868	19	16	12	Fl W 5s
2098	Faro di Piombino	Canale di Piombino	42°55'12.0"N 10°31'31.0"E	1920	18	5	11	Fl (3) W 15s
2136	Faro delle Formiche di Grosseto	Mar Tirreno	42°34'41.0"N 10°52'50.0"E	1901	23	12	11	Fl W 6s
2140	Faro di Talamone	Mar Tirreno	42°33'06.0"N 11°08'01.0"E	1865	30	18	15	Fl (2) W 10s
2144	Faro di Lividonia	Mar Tirreno	42°26'47.0"N 11°06'15.0"E	1893	47	12	16	FL W 5s
2156	Faro del Fenaio	Mar Tirreno	42°23'18.0"N 10°52'52.0"E	1883	39	10	16	Fl (3) W 15s
2168	Faro di Capel Rosso	Mar Tirreno	42°19'15.0"N 10°55'11.0"E	1883	90	20	23	Fl (4) W 30s
2172	Faro di Porto Ercole	Mar Tirreno	42°23'24.0"N 11°12'46.0"E	1862	91	19	16	Oc WR 2s 5s
2184	Faro di Giannutri	Mar Tirreno	42°14'22.0"N 11°06'29.0"E	1883	61	8	13	Fl W 5s
2258	Faro di Capo Circeo	Mar Tirreno	41°13'20.7"N 13°04'07.5"E	1866	38	18	23	Fl W 5s
2315	Faro di Monte Orlando	Mar Tirreno	41°12'04.0"N 13°34'07.0"E	1954	185	14	23	Fl (3) W 15s
2672	Faro di Scario	Mar Tirreno	40°02'55.1"N 15°29'24.9"E	1883	24	12	n.d.	Fl (4) W 12s
2664	Isolotto Licosa	Mar Tirreno	40°15'04.9"N 14°54'01.0"E	1951	13	10	11	Fl (2) W 10s
2616	Isolotti Li Galli	Mar Tirreno	40°34'58.6"N 14°26'01.4"E	n.d.	67	12	n.d.	Fl W 5s
2286	Ventotene	Mar Tirreno	40°47'48.7"N 13°26'04.6"E	1891	21	16	15	Fl W 5s
2274	Porto di Ponza	Mar Tirreno	40°53'44.0"N 12°57'52.8"E	1918	12	12	9	FL Y 3s
2266	Rotonda della Madonna	Mar Tirreno	40°53'42.9"N 12°58'13.1"E	1959	61	18	15	FL (4) W 15s
2278	Punta della Guardia	Mar Tirreno	40°52'40.2"N 12°57'09.1"E	1886	112	18	24	Fl (3) W 30s
2262	Capo Negro	Mar Tirreno	40°58'24.1"N 13°03'17.7"E	1884	37	13	12	Fl (3) W 10s
2258	Capo Circeo	Mar Tirreno	41°13'20.4"N 13°04'06.6"E	1866	38	18	23	Fl W 5s
2246	Capo d'Anzio	Mar Tirreno	41°26'45.0"N 12°37'18.5"E	1870	37	21	22	Fl (2) W 10s

1508	Civitavecchia	Mar Tirreno	42°05′54.3″N 11°49′00.6″E	1951	125	30	24	Fl (2) W 10s
2547	Portici	Mar Tirreno	40°48'36.6"N 14°20'00.1"E	1889	16	14	n.d.	Fl W 3s
2668	Faro di Capo Palinuro	Mar Tirreno	40°01′28.5″N 15°16′26.7″E	1870	206	10	25	Fl (2) W 10s
2374	Porto d'Ischia	Mar Tirreno	40°44'53.3"N 13°56'32.6"E	1868	13	11	n.d.	Fl W 3s
2612	Faro di Punta Carena	Mar Tirreno	40°32′10.1″N 14°11′55.9″E	1867	73	n.d.	25	Fl W 3s
2660	Faro di Punta Fortino	Mar Tirreno	40°21′17.8″N 14°59′13.2″E	1923	42	n.d.	16	Fl (2) W 6s
2672	Faro di Scario	Mar Tirreno	40°02′55.0″N 15°29′25.1″E	1883	24	n.d.	15	Fl (4) W 12s
2358	Faro di Punta Pioppeto	Mar Tirreno	40°46′13.4″N 14°01′00.6″E	1849	21	11	11	Fl (3) W 10s
2402	Faro di Capo Miseno	Mar Tirreno	40°46′42.0″N 14°05′20.1″E	1869	80	12	16	Fl (2) W 10s
2593.3	Faro di Punta Campanella	Mar Tirreno	40°34′10.1″N 14°19′29.7″E	1872	65	n.d.	10	Fl W 5s
2628	Faro di Capo d'Orso	Mar Tirreno	40°37′59.5″N 14°40′50.9″E	1882	66	n.d.	16	Fl (3) W 15s
2424	Faro di Molo San Vincenzo	Mar Tirreno	40°49′58.3″N 14°06′35.3″E	1916	25	24	22	Fl (3) W 10s
2370	Faro di Castello d'Ischia	Mar Tirreno	40°43′55.7″N 13°57′56.5″E	1913	82	n.d.	16	Fl W 6s
2374	Faro d'Ischia	Mar Tirreno	40°44′53.3!N 13°56′32.7″E	1868	13	n.d.	15	FL WR 3s
2672	Scario	Mar Tirreno	40°02′55.0″N 15°29′25.1″E	1883	24	12	15	Fl (4) W 12s
2612	Faro Punta Carena	Mar Tirreno	40°32′10.4″N 14°11′55.5″E	1867	73	28	25	FL W 3s
2676	Punta del Fortino	Mar Tirreno	40°04′08.6″N 15°37′06.6″E	1915	13	n.d.	7	FL (2) W 7s
2406	Fortino Tenaglia	Mar Tirreno	40°48′43.6″N 14°04′56.4″E	1950	13	8	8	Iso WR 2s
2680	Scalea	Mar Tirreno	39°49′09.2″N 15°47′17.8″E	1922	92	13	25	Fl W 5s
2684	Capo Bonifati	Mar Tirreno	39°32′41.4″N 15°52′59.8″E	1929	63	7	15	Fl (2) W 10s
2688	Paola	Mar Tirreno	39°21′44.6″N 16°01′53.3″E	1929	53	17	15	Fl (3) W 15s
2692	Capo Suvero	Mar Tirreno	38°57′07.8″N 16°09′27.8″E	1984	58	25	15	Fl (2) W 10s
2597	Faro Calata Buccarelli	Mar Tirreno	38°43′27.6″N 16°07′42.6″E	1952	17	15	15	Fl WG 5s
2708	Capo Vaticano	Mar Tirreno	38°37′09.8″N 15°49′43.3″E	1885	108	8	24	Fl (4) W 20s
2712	Castello Ruffo	Mar Tirreno	38°15′22.0″N 15°42′52.4″E	1255	72	6	22	Fl W 5s
2720	Faro di Punta Pezzo	Mar Tirreno	38°13′51.9″N 15°38′11.5″E	1953	26	23	15	Fl (3) R 15s
3380	Capo dell'Armi	Mar Ionio	37°57′15.5″N 15°40′44.6″E	1867	83	12	22	Fl (2) W 10s
3384	Faro di Capo Spartivento	Mar Ionio	37°55′32.6″N 16°03′38.4″E	1867	63	16	22	Fl W 8s
3388	Punta Stilo	Mar Ionio	38°26′51.2″N 16°34′39.0″E	1887	54	16	22	Fl (3) W 15s
3396	Faro di Capo Rizzuto	Mar Ionio	38°53′42.7″N 17°05′34.3″E	1906	37	17	26	L Fl (2) WR 10s
3404	Faro di Capo Colonna	Mar Ionio	39°01′32.4″N 17°12′16.2″E	1873	40	22	24	Fl W 5s

3424	Punta Alice	Mar Ionio	39°23'5.9"N 17°09'12.7"E	1895	31	27	16	Fl (2) W 10s
3428	Capo Trionto	Mar Ionio	39°37'18.2"N 16°46'06.6"E	1923	n.d.	18	n.d.	Inattivo
3752	Faro di Molfetta	Mar Adriatico	41°12'30"N 16°35'39"E	1853	18	19	17	Iso W 6s
3706	Faro di Bari	Mar Adriatico	41°08'21.0"N 16°50'42.2"E	1869	66	62	24	Fl (3) W 20s
3562	Faro di Sant'Andrea	Mar Ionio	40°03'40.7"N 17°58'59.6"E	1850	12	43	20	Fl (2) W 10s
3832	Faro dell'Isola Pianosa	Mar Adriatico	42°13'31.7"N 15°44'41.2"E	1914	25	24	12	Fl W 10s
3844	Isola di San Domino	Mar Adriatico	42°06'23.5"N 15°28'38.5"E	1905	48	9	11	Inattivo
3812	Torre Preposti	Mar Adriatico	41°46'57.0"N 16°11'32.2"E	1946	62	22	15	Fl W 10s
3796	Faro di Manfredonia	Mar Adriatico	41°37'43.5N 15°55'24.0"E	1868	20	18	23	Fl W 5s
3590	Faro di Santa Maria di Leuca	Mar Ionio	39°47'45.4"N 18°22'06.7"E	1864	102	48	24	Fl (3) W 15s
3626	Castello Alfonsino	Mar Adriatico	40°39'19.4"N 17°58'03.3"E	2003	28	12	10	Fl (4) W 20s
3771	Faro di Trani	Mar Adriatico	41°16'57.9"N 16°25'19.6"E	1885	9	5	14	Fl W 5s
3612	Faro di San Cataldo	Mar Adriatico	40°23'24.0"N 18°18'07.0"E	1895	25	23,5	16	L Fl W 5s
3816	Faro di Vieste	Mar Adriatico	41°53'21.0"N 16°11'03.0"E	1867	40	27	25	Fl (3) W 15s
3780	Faro di Barletta	Mar Adriatico	41°19'28.7"N 16°17'06.1"E	1959	36	28	17	L Fl (2) W 12s
3596	Punta Palascia	Mar Adriatico	41°53'21.0"N 16°11'03.0"E	1865	92	32	18	Fl W 5s
3584	Faro di Torre San Giovanni	Mar Ionio	39°53'25.0"N 18°06'45.0"E	1932	24	n.d.	15	Iso WR 4s
3608	Sant'Andrea Missipezza	Mar Adriatico	40°15'18.0"N 18°26'42.0"E	1936	24	16	15	Fl (2) WR 7s
3846	Faro di Termoli	Mar Adriatico	42°00'20.3"N 14°59'48.6"E	1963	41	17	15	Fl (2) W 10s
3856	Faro di Punta Penna	Mar Adriatico	42°10'15.9"N 14°42'52.5"E	1948	84	n.d.	25	Fl W 5s
3864	Faro di Ortona	Mar Adriatico	42°21'32.8"N 14°24'30.7"E	1937	23	n.d.	15	Fl (2) W 6s
3871	Faro di Pescara	Mar Adriatico	42°27'59.4"N 14°25'25.7"E	2006	9	n.d.	17	Fl (3) W 20s
3898	San Benedetto del Tronto	Mar Adriatico	42°57'09.5"N 13°53'10.1"E	1957	31	31	22	Fl (2) W 10s
3904	Pedaso	Mar Adriatico	43°05'28.3"N 13°50'42.5"E	1950	51	21	16	Fl (3) W 15s
E2336.7	Chiesa del Cristo Re	Mar Adriatico	43°18'38.5"N 13°43'40.9"E	1967	42	n.d.	11	Mo (C) W 20s
3930	Colle Cappuccini	Mar Adriatico	43°37'22.2"N 13°30'56.7"E	1965	118	15	25	Fl (4) W 30s
3954	Faro di Senigallia	Mar Adriatico	43°43'11.8"N 13°13'15.1"E	1950	17	17	13	L Fl (2) W 15s
3966	Faro di Fano	Mar Adriatico	43°51'03.7"N 13°00'55.8"E	1903	21	20	14	Fl W 5s
3986	Monte San Bartolo	Mar Adriatico	43°55'23.1"N 12°52'24.7"E	1952	175	25	30	Fl (2) W 15s
3996	Faro di Cattolica	Mar Adriatico	43°58'08.3"N 12°45'04.1"E	1868	10	17	15	Fl G 3s
4005	Faro di Rimini	Mar Adriatico	44°04'26.6"N 12°34'26.2"E	1940	27	25	15	Fl (3) W 12s
4028	Faro di Cesenatico	Mar Adriatico	44°12'22.0"N 12°24'05.8"E	1892	18	17	15	Fl (2) W 6s
E2411	Faro di Cervia	Mar Adriatico	44°15'594"N 12°21'17.3"E	1875	16	16	11	Iso W 2s
4056	Faro di Porto Corsini	Mar Adriatico	44°29'31.1"N 12°17'03.2"E	1863	35	33	20	Fl W 5s

4264	Faro di Piave Vecchia	Mar Adriatico	45°28'42.9"N 12°34'59.8"E	1950	48	48	18	Fl (4) W 10s
4132	Faro Rocchetta	Mar Adriatico	45°20'21.6"N 12°18'40.2"E	1879	25	24	16	Fl (3) W 12s
4152	Punta Sabbioni	Mar Adriatico	45°25'21.7"N 12°26'12.3"E	1908	26	25	15	Iso W 6s
4138	Porto di Malamocco	Mar Adriatico	45°20'02.1"N 12°20'35.1"E	1874	18	19	n.d.	FL G 5s
4177.01	Faro di Murano	Mar Adriatico	45°27'10.0"N 12°21'16.5"E	1934	35	35	17	Oc W 4s
4272	Faro di Caorle	Mar Adriatico	45°36'00.6"N 12°53'34.87"E	1917	20	12,5	14	Fl (2) W 6s
4288	Punta Tagliamento Bibione	Mar Adriatico	45°38'10.0"N 13°05'51.0"E	1913	25	21	15	Fl (4) W 10s
n.d.	Spignon	Mar Adriatico	45°20'33.9"N 12°17'44.0"E	n.d.	n.d.	n.d.	n.d.	Inattivo
4376	Faro della Vittoria	Mar Adriatico	45°40'32.2"N 13°45'25.3"E	1927	115	68	31	Fl (2) W 10s
n.d.	Lanterna di Trieste	Mar Adriatico	45°38'57.0"N 13°45'21.9"E	1831	n.d.	31	n.d.	Inattivo dal 1969
2796	Faro Biscari	Mar Ionio	37°29'20.4"N 15°05'06.7"E	1951	31	28	22	Fl W 5s
2954	Faro San Giacomo	Canale di Sicilia	37°05'46.7"N 13°56'27.5"E	1895	37,5	37,5	21	Fl W 5s
3170	Faro di San Vito Lo Capo	Mar Tirreno	38°11'18.7"N 12°43'59.8"E	1859	43	40	25	Fl (3) W 15s
2942	Faro di Punta Secca	Canale di Sicilia	36°47'14.0"N 14°29'39.0"E	1853	35	34,5	16	Fl (2) W 8s
3261	Faro di Capo Cefalù	Mar Tirreno	38°02'23.2"N 14°01'46.0"E	1913	80	26	25	Fl W 5s
3010	Faro di Torretta Granitola	Canale di Sicilia	37°33'57.5"N 12°39'43.7"E	1862	38	35	23	L Fl W 10s
3264	Faro di Capo d'Orlando	Mar Tirreno	38°09'53.1"N 14°44'48.9"E	1904	27	11	16	L Fl (2) W 12s
3296	Capo Faro	Mar Tirreno	38°34'49.7"N 14°52'17.2"E	1884	56	12	18	L Fl W 6s
3268	Faro di Capo Milazzo	Mar Tirreno	38°16'13.7"N 15°13'51.8"E	1891	90	10	16	L Fl W 6s
2736	Faro di Capo Peloro	Mar Tirreno	38°16'05.6"N 15°39'02.5"E	1909	37	22	19	Fl (2) W 10s
2752	Punta San Raineri	Mar Tirreno	38°11'36.7"N 15°34'27.2"E	1555	41	42	22	Fl (3) W 15s
3276	Faro di Capo Rasocolmo	Mar Tirreno	38°17'44.6"N 15°31'08.5"E	n.d.	85	13	15	Fl (3) W 10s
3280	Faro di Punta dei Porci	Mar Tirreno	38°22'01.5"N 14°59'30.3"E	1887	35	31	16	Fl (4) W 20s
3284	Faro di Marina Corta	Mar Tirreno	38°27'53.2"N 14°57'27.7"E	1916	10	8	14	Fl (3) W 15s
3300	Faro di Punta Lingua	Mar Tirreno	38°32'13.9"N 14°52'16.4"E	1920	13	12	11	Fl W 3s
2788	Faro di Capo Molini	Mar Ionio	37°34'36.8"N 15°10'34.2"E	1919	42	20	22	Fl (3) W 15s
2815	Faro di Brucoli	Mar Ionio	37°17'09.0"N 15°11'10.7"E	1912	13	13	11	Fl W 5s
2820	Faro di Santa Croce	Mar Ionio	37°14'36.3"N 15°15'22.8"E	1859	39	27	16	L Fl (2) W 12s
2910	Faro Capo Murro di Porco	Mar ionio	37°00'11.3"N 15°20'06.2"E	1959	34	20	17	Fl W 5s
2918	Faro di Cozzo Spadaro	Mar Ionio	36°41'10.7"N 15°07'53.9"E	1864	82	37	24	Fl (3) W 15s
2934	Faro di Pozzallo	Canale di Sicilia	36°42'34.5"N 14°49'52.7"E	2011	18	15	15	Fl (4) W 12s
3194	Punta Gavazzi	Mar Tirreno	38°41'39.0"N 13°09'17.6"E	1885	40	28	16	Fl (4) W 12s
3186	Punta Omo Morto	Mar Tirreno	38°42'45.2"N 13°11'54.9"E	1884	100	10	25	Fl (3) W 15s
3244	Faro di Capo Zafferano	Mar Tirreno	38°06'43.7"N 13°32'15.1"E	1884	34	11	16	Fl (3) WR 10s
3208	Faro sulla Diga foranea	Mar Tirreno	38°07'35.2"N 13°22'30.7"E	1982	15	11	15	Fl (4) W 15s

3198	Faro di Capo Gallo	Mar Tirreno	38°13'24.6"N 13°19'00.1"E	1854	40	8	16	L Fl (2) W 15s
3138	Scoglio Palumbo	Mar Tirreno	38°00'45.4"N 12°29'19.0"E	1881	16	13	11	Fl W 5s
3128	Isolotto Formica	Mar Tirreno	37°59'21.1"N 12°25'32.1"E	1858	28	20	11	Fl W 4s
3120	Faro di Capo Grosso Favignana	Mar Tirreno	38°01'13.3"N 12°20'00.3"E	1858	68	12	11	Fl (3) W 15s
3132	Scoglio Porcelli	Mar Tirreno	38°02'38.0"N 12°26'22.0"E	1903	25	23	11	Fl (2) W 10s
3112	Punta Libeccio	Mar Tirreno	37°57'24.2"N 12°03'00.3"E	1867	73	24	24	Fl (2) W 15s
3104	Faro di Punta Sottile	Mar Tirreno	37°56'06.2"N 12°16'20.4"E	1860	43	38	25	Fl W 8s
3100	Punta Marsala	Mar Tirreno	37°54'24.3"N 12°21'55.3"E	1859	20	15	15	Fl (4) W 15s
3080	Faro di Marsala	Mar Tirreno	37°47'14.9"N 12°26'21.7"E	1885	19	19	15	Fl (2) W 10s
3010	Faro di Capo Granitola	Mar Tirreno	37°33'57.5"N 12°39'43.5"E	1865	37	35	18	L Fl W 10s
3310	Strombolicchio	Mar Tirreno	38°49'02.2"N 15°15'07.6"E	1905	58	13	11	Fl (3) W 15s
3038	Faro di Capo Grecale	Canale di Sicilia	35°31'03.5"N 12°37'55.6"E	1855	82	19	22	Fl (2) W 5s
3054	Punta Beppe Tuccio	Canale di Sicilia	35°52'19.9"N 12°52'43.0"E	1891	32	17	16	Fl (4) W 20s
3058	Punta Arena Bianca	Canale di Sicilia	35°51'23.5"N 12°51'31.2"E	n.d.	9	6	9	Fl W 5s
3006	Faro di Capo San Marco	Canale di Sicilia	37°29'45.3"N 13°01'15.4"E	1992	25	15	18	Fl (3) W 15s
3018	Faro di San Leonardo	Canale di Sicilia	36°50'07.1"N 11°56'40.2"E	1988	21	n.d.	15	Fl W 3s
3014	Faro di Punta Spadillo	Canale di Sicilia	36°49'27.2"N 12°00'44.6"E	1884	50	21	24	Fl (2) W 10s
1418	Faro di Capo Caccia	Mar di Sardegna	40°33'38.8"N 08°09'46.4"E	1864	186	24	34	Fl W 5s
1270	Faro di Capo S. Elia	Mar Tirreno	39°11'03.4"N 09°08'50.5"E	1860	70	21	21	Fl (2) W 10s
1014	Faro di Capo Testa	Mar di Sardegna	41°14'37.5"N 09°08'39.1"E	1845	67	23	17	Fl (2) W 12s
1258	Faro di Capo Carbonara	Mar Tirreno	39°06'12.8"N 09°30'50.2"E	1917	120	5	23	Fl W 7,5s
1146	Faro di Capo Ferro	Mar Tirreno	41°09'17.7"N 09°31'23.7"E	1858	2	16	24	Fl (3) W 15s
1390	Capo San Marco Cabras	Mar di Sardegna	39°51'36.3"N 08°26'03.5"E	1924	57	15	22	Fl (2) W 10s
1384	Faro di Capo Sandalo	Mar Tirreno	39°08'50.8"N 08°13'25.4"E	1864	134	30	24	Fl (4) W 20s
1262	Faro di Isola dei Cavoli	Mar Tirreno	39°05'19.1"N 09°32'00.1"E	1858	74	37	11	Fl (2) WR 10s
1138	Faro di Porto Torres	Mar di Sardegna	40°50'09.8"N 08°23'50.2"E	1966	45	20	16	L Fl (2) W 10s
1426	Faro di Punta Scorno	Mar di Sardegna	41°07'10.4"N 08°19'06.8"E	1859	80	35	16	Fl (4) W 20s
1422	Faro di Porto Conte	Mar di Sardegna	40°35'37.6"N 08°12'14.7"E	1859	17	n.d.	10	Fl W 3s
1246	Faro di Capo Bellavista	Mar Tirreno	39°55'48.6"N 09°42'48.4"E	1866	165	19	26	Fl (2) W 10s
1310	Faro di Capo Spartivento	Mar Tirreno	38°52'40.1"N 08°50'43.8"E	1866	81	19	22	Fl (3) W 15s
1315	Porto Ponte Romano	Mar di Sardegna	39°03'29.6"N 08°28'25.9"E	1924	23	22	15	Fl W 5s
1346	Scoglio Mangiabarche	Mar di Sardegna	39°04'35.4"N 08°20'43.6"E	1935	12	11	11	Fl W 6s
1404	Faro di Capo Mannu	Mar di Sardegna	40°02'06.3"N 08°22'40.7"E	1960	59	11	15	Fl (3) W 15s
1230	Faro di Capo Comino	Mar Tirreno	40°31'42.4"N 9°49'40.0"E	1925	26	20	15	Fl W 5s
1226	Faro di Capo Timone	Mar Tirreno	40°55'34.1"N 09°44'09.3"E	1922	72	7	15	L Fl (2) W 10s

1170	Faro di Isola Bocca	Mar Tirreno	40°55′13.9″N 09°34′00.7″E	1887	24	22	15	L Fl W 5s
1162	Isolotto Figarolo	Mar Tirreno	40°58′44.0″N 09°38′40.3″E	1915	71	6	11	Fl W 5s
1142	Isolotto Monaci	Mar Tirreno	31°12′57.7″N 09°31′00.7″E	1936	24	16	11	Fl WR 5s
1030	Punta Sardegna	Mar Tirreno	41°12′24.7″N 09°21′46.6″E	1913	38	13	11	Fl W 5s
1125	Faro di Capo d'Orso (Isola di Santo Stefano)	Mar Tirreno	41°10′39.5″N 09°25′23.4″E	1924	12	10	10	Fl W 3s
1000	Faro di Isola Razzoli	Mar Tirreno	41°18′25.8″N 09°20′23.8″E	1924	77	10	19	Fl WR 2,5s
1010	Faro di Barrettinelli	Mar Tirreno	41°18′05.8″N 09°24′03.1″E	1936	22	6	11	Fl (2) W 10s

Lebanon

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
003	Sur	Mar Mediterraneo	33°16′33.6″N 35°11′36.1″E	1912	15	6	12	Fl (3) W 12s
002	Beirut	Mar Mediterraneo	33°54′00.3″N 35°28′11.5″E	2003	52	50	22	Fl (2) W 10s
E5926	Jazirat Ramkin	Mar Mediterraneo	34°29′49.4″N 35°45′39.0″E	1864	22	n.d.	18	Fl W 3,3s
E5940	Az Zirah	Mar Mediterraneo	33°34′23.9″N 35°22′03.2″E	1930	10	n.d.	6	Fl R 3s

Libya

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
21636	Faro di Al Khoms	Mar Mediterraneo	32°39′25.2″N 14°16′07.8″E	1881	26	19	12	Fl (2) W 10s
21432	Faro di Bardia	Mar Mediterraneo	31°45′15.6″N 25°06′15.7″E	n.d.	98	12	12	Fl W 5s
21508	Faro di Benghazi	Mar Mediterraneo	32°07′29.6″N 20°03′49.0″E	1922	41	22	17	Fl W 3s
21472	Faro di Derna	Mar Mediterraneo	32°44′52.8″N 22 41′04.7″E	1880	60	10	20	Fl (4) W 20s
21728	Faro di Farwah	Mar Mediterraneo	33°06′25.3″N 11°44′36.4″E	1920	17	12	12	Fl W 3s
21640	Faro di Ra's Hallab	Mar Mediterraneo	32°48′06.9″N 13°48′08.6″E	n.d.	35	22	12	Fl (3) W 15s
21612	Faro di Ra's Lanuf	Mar Mediterraneo	30°30′42.1″N 18°32′17.8″E	n.d.	52	50	15	Fl (2) W 5s
21644	Faro di Ra's Tajura	Mar Mediterraneo	32°53′42.0″N 13°23′12.1″E	n.d.	34	17	14	Fl W 5s Temp. Inattivo
21500	Faro di Sidi Suwaykir	Mar Mediterraneo	32°19′59.8″N 20°17′17.8″E	n.d.	21	15	13	Fl (4) W 15s

21624	Faro di Sirte	Mar Mediterraneo	31°12'29.8"N 16°35'35.8"E	n.d.	35	30	15	Fl W 5s
21452	Faro di Tobruq	Mar Mediterraneo	32°05'17.8"N 23°59'24.0"E	n.d.	53	8	15	Fl (3) W 15s
21496	Faro di Tolmeita	Mar Mediterraneo	32°54'18.0"N 13°10'41.8"E	1913	21	16	12	Fl (3) W 10s
21652	Faro di Tripoli	Mar Mediterraneo	32°54'18.0"N 13°10'41.8"E	1880	60	26	12	Fl (2) W 10s
21716	Faro di Zuwarah	Mar Mediterraneo	32°55'30.0"N 12°07'12.0"E	1930	15	12	12	Fl W 5s

Malta

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
003	Ġurdan	Mar Mediterraneo	36°04'19.9"N 14°13'06.2"E	1853	161	22	38	Fl W 7,5s
E2051	Mġarr Main Breakwater	Mar Mediterraneo	36°01'29.6"N 14°18'06.8"E	1970	8	5	n.d.	Fl R 4s
n.d.	Portomaso Marina	Mar Mediterraneo	35°55'17.5"N 14°29'41.3"E	1990	8	6	n.d.	Iso R 4s
007	Valletta	Mar Mediterraneo	35°54'07.0"N 14°31'07.0"E	2013	49	10	n.d.	Fl (3) W 15s
200	St. Elmo	Mar Mediterraneo	35°54'09.4"N 14°31'31.6"E	1908	16	14	n.d.	Q G
004	Ricasoli	Mar Mediterraneo	35°53'57.7"N 14°31'22.8"E	1908	11	9	n.d.	Fl R 6s
001	Delimara Point	Mar Mediterraneo	35°49'19.4"N 14°33'31.4"E	1855	35	22	n.d.	Fl (2) W 12s

Morocco

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
MOR-047	Ras Ciress	Mare di Alboran	35°54'24.6"N 05°28'53.9"E	n.d.	44	8	n.d.	Fl W 12s
D2495	Ilot du Nord	Mare di Alboran	35°54'36.8"N 05°28'53.6"E	n.d.	20	15	n.d.	Fl (3) W 10s
MOR-032	Malabata	Mare di Alboran	35°49'00.3"N 05°44'56.9"E	n.d.	76	18	n.d.	Fl W 5s
MOR-024	Le Charf	Mare di Alboran	35°45'59.1"N 05°47'20.2"E	n.d.	88	7	n.d.	Fl WRG 12s
MOR-032	Cap Spartel	Mare di Alboran	35°47'27.6"N 05°55'25.7"E	1864	95	24	n.d.	Fl (4) W 20s
6842	Ra's El Aswad	Mare di Alboran	35°41'05.5"N 05°16'29.1"E	n.d.	135	13	n.d.	Fl W 4s
6789.5	Oued Laou	Mare di Alboran	35°28'25.7"N 05°06'32.4"E	n.d.	150	n.d.	n.d.	Fl W 6s
6789	El Jebha	Mare di Alboran	35°12'41.6"N 04°39'42.6"E	n.d.	38	4	n.d.	Fl (2) W 10s
6786	Sidi Abed	Mare di Alboran	35°15'41.5"N 03°55'45.8"E	n.d.	151	16	n.d.	Fl (2) W 10s

6784	Cap Quilates	Mare di Alboran	35°16'57.9"N 03°40'50.6"E	n.d.	62	32	n.d.	Fl (3) W 12s
6780	Anse Tramontana	Mare di Alboran	35°24'05.1"N 03°00'33.0"E	n.d.	49	4	n.d.	Fl W 12s
6778	Cap des Trois Fourches	Mare di Alboran	35°26'17.8"N 02°57'47.8"E	1909	112	18	n.d.	Fl (4) W 20s
6776	Los Farallones	Mare di Alboran	35°25'40.0"N 02°56'25.9"E	1928	21	5	n.d.	Fl W 4s
6757	Ra's el Ma	Mare di Alboran	35°08'48.5"N 02°25'31.3"E	n.d.	42	8	n.d.	Fl (2) W 6s
6757.1	Ra's Kebdana Directional	Mare di Alboran	35°08'50.1"N 02°25'16.6"E	n.d.	16	15	n.d.	Fl WR 5s

Palestine

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
n.d.	Faro di Gaza	Mar Mediterraneo	31°31'25.6"N 34°25'57.1"E	2016	16	14	n.d.	F W
n.d.	Ristorante Lighthouse	Mar Mediterraneo	31°30'29.3"N 34°25'14.5"E	n.d.	17	13	n.d.	F W

Syria

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
5921.04	Faro di El Burj	Mar Mediterraneo	35°30'51.7"N 35°46'07.2"E	1864	22	5	10	Fl (2) W 9s
N5923.5	Faro di Baniyas	Mar Mediterraneo	35'08'49.0"N 35°55'16.7"E	n.d.	98	11	W 16 R 12	Fl (3) WR 17s
N5924	Jazirat Arwad	Mar Mediterraneo	34°51'24.5"N 35°51'26.0" E	1864	24	8	12	Fl W 5s
E5919	Faro di Ra's al-Basit	Mar Mediterraneo	35° 51'01.1"N 35°48'36.2"E	n.d.	75	12	14	Fl W 4s
E5919.4	Faro di Ra's al Fasuri	Mar Mediterraneo	35°40'21.8"N 35° 46'17.6"E	n.d.	74	n.d.	5	Q (3) W 5s
E5920	Faro di Ra's Ibn Hani	Mar Mediterraneo	35°35'08.7"N 35°43'02.1"E	1864	18	17	12	Fl W 5s

Spain

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
2408	Faro de Barbate	Oceano Atlantico - Mar Mediterraneo	36°11'13.0"N 05°55'24.0"E	1980	23	18	n.d.	Fl(2)WR 7s

2411.5	Faro de Camarinal	Oceano Atlantico - Mar Mediterraneo	36°05'24.0"N 05°48'38.0"E	1989	75	20	13	Oc(2)W 5s
2414	Faro de Isla de Tarifa	Oceano Atlantico - Mar Mediterraneo	36°00'04.0"N 05°36'35.0"E	1854	41	33	n.d.	Fl(3)WR 10 s
2420	Punta Carnero Faro	Oceano Atlantico - Mar Mediterraneo	36°04'37.0"N 05°25'34.0"E	1874	42	19	n.d.	Fl(4) WR 20s
2438	Faro di Torre Victoria	Oceano Atlantico - Mar Mediterraneo	36°06'57.9"N 05°20'69.0"E	n.d.	49	19	18	IsoW 10 s
0088	Faro de Adra	Mar Mediterraneo	36°44'53.0"N 03°01'52.0"E	1883	49	26	16	Oc(3)W 10,5s
0114	Aguilas	Mar Mediterraneo	37°24'06.0"N 01°34'41.0"E	1860-1973	30	23	13	Fl (2) W 2s
0173.6	Albir	Mar Mediterraneo	38°33'49.0"N 00°03'00.0"E	1863	112	8	15	Fl (4) W 30s
0086	Faro Alboran	Mar de Alboran	35°56'17.0"N 03°02'07.0"E	1876	40	20	10	Fl (4)W 20s
n.d.	Almeria	Mar Mediterraneo	36°49'42.0"N 02°29'32.0"E	1976	77	7	19	n.d.
0216	Cabo Canet	Mar Mediterraneo	39°40'28.0"N 00°12'28.0"E	1904	33	30	20	Fl (2) W 10s
0106	Cabo de Gata	Mar Mediterraneo	36°43'18.0"N 02°11'34.0"E	1863	55	19	24	Fl WR 4s
0166	Cabo de la Huerta	Mar Mediterraneo	38°21'11.0"N 00°24'18.0"E	1856	38	9	14	Fl (5) W 19s
0176	Cabo de la Nao	Mar Mediterraneo	38°43'58.0"N 00°13'48.0"E	1928	122	20	23	Fl W 4s
0136	Cabo de Palos	Mar Mediterraneo	37°38'05.0"N 00°41'25.0"E	1865	81	51	23	Fl (2) W 10s
0180	Cabo de San Antonio	Mar Mediterraneo	38°48'11.0"N 00°11'51.0"E	1855	175	17	26	Fl (4) W 20s
0152	Cabo de Santa Pola	Mar Mediterraneo	38°12'34.0"N 00°30'49.0"E	1858	152	15	16	Fl (3) W 20s
0080	Cabo Sacratif	Mar Mediterraneo	36°41'40.0"N 03°28'06.0"E	1863	98	17	25	Fl (2) W 10s
0124	Capo Tinoso	Mar Mediterraneo	37°32'08.0"N 01°06'29.0"E	1859	146	10	24	Fl (4) W 20s
0377	Cabo Tortosa	Mar Mediterraneo	40°42'56.0"N 00°55'42.0"E	1864	18	18	14	Fl WR 6s
n.d.	Cala Nans	Mar Mediterraneo	42°16'15.0"N 03°17'12.0"E	1864	33	7	8	n.d.
0058	Calaburras	Mar Mediterraneo	36°30'27.0"N 04°38'23.0"E	1863	46	25	18	Fl W 5s
0448	Calella	Mar Mediterraneo	41°36'29.0"N 02°38'47.0"E	1859	50	10	18	Fl (3+2) W 20s
0486	Cap de Creus	Mar Mediterraneo	42°19'08.0"N 03°18'57.0"E	1853	87	11	20	Fl W 10s
0012	Carbonera	Mar Mediterraneo	36°14'40.0"N 05°18'05.0"E	1990	39	14	14	Oc W 4s
0226	Faro de Castellon	Mar Mediterraneo	39°58'07.0"N 00°01'40.0"E	1867-1971	32	28	15	FlW 8 s

0226	Faro de Castellon	Mar Mediterraneo	39°58′07.0″N 00°01′40.0″E	1867-1971	32	28	15	FlW 8 s
0232	Castillo del Papa Luna	Mar Mediterraneo	40°21′31.6″N 00°24′28.8″E	1899	56	11	23	Fl(2+1)W 15s
0093	Castillo de San Telmo	Mar Mediterraneo	36 49,709 N 02 29,533 W	n.d.	77	7	19	Fl(2)W 12s
0222	Columbretes	Mar Mediterraneo	39°53′59.0″N 00°41′11.0″E	1859	85	20	21	Fl (4) W 2,2s
0198	Cullera	Mar Mediterraneo	39°11′11.0″N 00°13′01.0″E	1858	28	16	19	Fl (3) W 20s
0062	Dique del Este faro	Mar Mediterraneo	36 42,849 N 04 24,866 W	n.d.	38	37	25	Fl(3+1)W 20s
0126	Escombreras	Mar Mediterraneo	37°33′33.0″N 00°58′08.0″E	1864	65	8	17	Fl W 5s
0140	Estacio	Mar Mediterraneo	37°44′45.0″N 00°43′33.0″E	1862	32	29	14	Fl (4) W 20s
0380	Faro de Fangar	Mar Mediterraneo	40°47′26.0″N 00°46′06.0″E	1864	20	18	12	Fl(2+1)W 12s
0110	Faro de Garrucha	Mar Mediterraneo	37°10′24.0″N 01°49′26.0″E	1881	19	10	13	Oc (4) W 13s
0472	Illes Medes	Mar Mediterraneo	42°02′53.0″N 03°13′18.0″E	1868	87	11	14	Fl (4) W 24s
0231.6	Irta	Mar Mediterraneo	40°15′36.0″N 00°18′14.0″E	1990	33	28	14	Fl (4) W 18s
n.d.	Isla de Isabel	Mar Mediterraneo	35°11′01.0″N 02°25′51.0″E	1899	52	18	8	n.d.
n.d.	Isla Hormiga	Mar Mediterraneo	37°39′19.0″N 00°38′57.0″E	1862	24	12	8	n.d.
0388	La Banya	Mar Mediterraneo	40°33′38.0″N 00°39′41.0″E	1864	27	18	1	OcW 3s
0398	Llobregat	Mar Mediterraneo	41°19′30.0″N 02°09′08.0″E	1852	32	31	23	Fl W 5s
0062	Malaga	Mar Mediterraneo	36°42′51.0″N 04°24′52.0″E	1817	38	33	25	Fl (4) W 20s
056	Faro de Marbella	Mar Mediterraneo	36°30′26.0″N 04°53′24.0″E	1864-1974	35	29	22	Fl(2)W 14,5 s
0120	Faro de Mazarron	Mar Mediterraneo	37°33′38.0″N 01°15′16.0″E	1862-1974	65	11	15	Oc(1+2)W 13,5s
6758	Melilla	Mar Mediterraneo	35°17′40.0″N 02°55′57.0″E	1888-1918	40	12	14	Fl (2) W 6s
0108	Faro Mesa del Roldan	Mar Mediterraneo	36°56′30.0″N 01°54′24.0″E	1863	222	18	23	Fl(4)W 20s
0462	Palamos	Mar Mediterraneo	41°50'29.5"N 03°07'44.7"E	1865	22	8	18	Oc(1+4)W 18s
0400	Montjuic	Mar Mediterraneo	41°21′40.0″N 02°09′57.0″E	1906-1925	108	13	26	Fl (2) W 15s
0218	Faro de Nules	Mar Mediterraneo	39°49′36.0″N 00°06′37.0″E	1992	38	36	14	Oc(2)W 11s
0230	Oropesa del Mar	Mar Mediterraneo	40°05′00.0″N 00°08′48.0″E	1857-1891	24	13	21	Fl (3) W 15s
0232	Peniscola	Mar Mediterraneo	40°21′30.0″N 00°24′30.0″E	1898	56	11	23	Fl (3) W 15s
06788	Penon de Velez de la Gomera	Mar Mediterraneo	35°10′22.0″N 04°18′03.0″E	1899	47	6	12	Fl (3) W 20s

0134	Portman	Mar Mediterraneo	37°34'45.0"N 00°50'32.0"E	1861	49	8	13	Fl W 4s
2482	Punta Almina	Mar Mediterraneo	35°53'54.0"N 05°16'51.0"E	1855	148	16	22	Fl (2) W 10s
2420	Punta Carnero	Mar Mediterraneo	36°04'37.0"N 05°25'34.0"E	1874	42	19	16	FL (4) WR 20s
n.d.	Punta de la Mona	Mar Mediterraneo	36°43'25.0"N 03°43'55.0"E	1992	140	14	15	n.d.
0107.7	Punta de la Polacra	Mar Mediterraneo	36°50'27.0"N 02°00'11.0"E	1991	281	14	14	Fl (3) W 14s
0089.5	Punta de los Banos	Mar Mediterraneo	36°41'45.0"N 02°50'51.0"E	1992	22	18	11	Fl (4) W 11s
n.d.	Punta del Melonar	Mar Mediterraneo	36°43'03.0"N 03°22'07.0"E	1992	237	12	14	n.d.
20	Punta Doncella	Mar Mediterraneo	36°25'01.0"N 05°09'17.0"E	1863	31	21	18	Fl (3) W 15s
0488	Punta s'Arenella	Mar Mediterraneo	42°21'05.0"N 03°11'13.0"E	1913	22	13	13	Fl W 5s
n.d.	Roquetas de Mar	Mar Mediterraneo	36°45'12.0"N 02°36'23.0"E	1863	n.d.	12	n.d.	n.d.
0476	Roses	Mar Mediterraneo	42°14'45.0"N 03°10'59.0"E	1864	24	11	12	Fl (4) W 15s
0090	Sabinal	Mar Mediterraneo	36°41'13.0"N 02°42'05.0"E	1863	34	32	16	Fl (3) W 10s
0386	Salou	Mar Mediterraneo	41°03'21.0"N 01°10'19.0"E	1858	43	11	23	Fl (4) W 20s
n.d.	Saint Cristofol	Mar Mediterraneo	41°13'01.0"N 01°44'14.0"E	1866	27	21	19	n.d.
0470	San Sebastià	Mar Mediterraneo	41°53'16.0"N 03°12'09.0"E	1857	167	13	32	FL W 5s
0148	Faro de Tabarca	Mar Mediterraneo	38°09'51.0"N 00°28'16.0"E	1854	29	14	15	L Fl W 8s
0072	Torre del Mar	Mar Mediterraneo	36°44'06.0"N 04°05'46.0"E	1964	30	28	13	Fl (3) W 10s
0393.7	Faro de Torredembarra	Mar Mediterraneo	41°07'56.0"N 01°23'42.0"E	2000	58	38	17	Fl (5) W 30s
0074	Torrox	Mar Mediterraneo	36°43'36.0"N 03°57'26.0"E	1864	29	23	20	Fl (4) W 15s
0453	Tossa del Mar	Mar Mediterraneo	41°42'56.0"N 02°56'02.0"E	1919	60	12	21	Fl (4) W 20s
0200	Valencia	Mar Mediterraneo	39°26'57.0"N 00°8'08.0"E	1909	30	22	20	Fl (5) W 20s
n.d.	Alcanada	Mar Mediterraneo	39°50'07.0"N 03°10'16.0"E	1861	22	15	11	n.d.
0276	Bleda Plana	Mar Mediterraneo	38°58'47.0"N 01°09'32.0"E	1972	28	8	10	Fl (3) W 15s
0264	Botafoch (Ibiza)	Mar Mediterraneo	38°54'15.0"N 01°27'14.0"E	1861	31	16	14	Fl WR 7s
0330	Cala Figuera	Mar Mediterraneo	39°27'27.0"N 02°31'21.0"E	1860	45	24	22	Fl (4) W 20s
0316	Cabo Blanco	Mar Mediterraneo	39°21'49.0"N 02°47'16.0"E	1863	95	12	15	Fl W 10s
0342	Cap d'Artrutx	Mar Mediterraneo	39°55'21.0"N 03°49'27.0"E	1895	45	34	19	Fl (3) W 10s

0342	Cap d'Artrutx	Mar Mediterraneo	39°55'21.0"N 03°49'27.0"E	1895	45	34	19	Fl (3) W 10s
0251	Cap de Barbaria	Mar Mediterraneo	38°38'28.0"N 01°23'22.0"E	1972	78	19	20	Fl (2) W 15s
0289	Punta Grossa	Mar Mediterraneo	39°47'50.0"N 02°40'54.0"E	1859	120	22	19	Fl (3) W 15s
0314	Cap Salinas	Mar Mediterraneo	39°15'55.0"N 03°03'12.0"E	1863	17	17	11	Fl (3) W 20s
0308	Capdepera	Mar Mediterraneo	39°42'56.0"N 03°28'39.0"E	1861	76	18	20	Fl (5) W 30s
0350	Caballeria	Mar Mediterraneo	40°05'21.0"N 04°05'32.0"E	1857	94	15	26	Fl (2) W 10s
0344	Ciutadella	Mar Mediterraneo	39°59'46.0"N 03°49'22.0"E	1863	21	13	14	Fl W 6s
0274	Isla Conejera	Mar Mediterraneo	38°59'37.0"N 01°12'45.0"E	1857	85	18	18	Fl (4) W 20s
0254	D'en Pou	Mar Mediterraneo	38°47'56.0"N 01°25'18.0"E	1864	28	25	10	Fl (4) W 20s
0352	Favaritx	Mar Mediterraneo	39°59'50.0"N 04°16'01.0"E	1922	47	28	21	Fl (3) W 15s
0296	Formentor	Mar Mediterraneo	39°57'41.0"N 03°12'46.0"E	1863	210	21	24	Fl (4) W 20s
0366	Isla del'Aire	Mar Mediterraneo	39°47'58.0"N 04°17'35.0"E	1860	53	38	18	Fl W 5s
n.d.	Illa des Penjats	Mar Mediterraneo	38°48'52.0"N 01°24'42.0"E	1861	27	17	10	n.d.
0486	La Creus	Mar Mediterraneo	39°47'49.0"N 02°41'22.0"E	1964-1945	35	13	10	Fl (2) W 10s
0334	Sa Mola	Mar Mediterraneo	38°39'48.0"N 01°35'03.0"E	1861	142	22	23	Fl (4) W 12s
0282	Llebeig	Mar Mediterraneo	39°34'27.0"N 02°18'17.0"E	1910	130	15	21	Fl W 8s
n.d.	Na Foradada	Mar Mediterraneo	39°12'26.0"N 02°58'43.0"E	1926	42	13	10	n.d.
n.d.	Na Popia	Mar Mediterraneo	39°35'11.0"N 02°19'02.0"E	1852	363	12	n.d.	inattivo
0338	Punta Anciola	Mar Mediterraneo	39°07'45.0"N 02°55'17.0"E	1870	121	21	20	Fl (3) W 15s
0310	Porto Colom	Mar Mediterraneo	39°24'50.0"N 03°16'14.0"E	1861	42	25	20	Fl (2) W 10s
0318.8	Porto Pì	Mar Mediterraneo	39°32'55.0"N 02°37'25.0"E	1617	41	38	18	Fl (2) W 15s
n.d.	Punta de l'Avancada	Mar Mediterraneo	39°53'59.0"N 03°06'38.0"E	1905	29	18	15	n.d.
0270	Punta Moscarter	Mar Mediterraneo	39°07'03.0"N 01°31'59.0"E	1978	93	52	18	Fl W 5s
0348	Punta Nati	Mar Mediterraneo	40°03'01.0"N 03°49'25.0"E	1913	42	19	18	FL (4) W 20s
0268	Tagomago	Mar Mediterraneo	39°01'57.0"N 01°38'57.0"E	1914	86	23	21	Fl (3) W 30s
0312.6	Torre d'en Beu	Mar Mediterraneo	39°19'47.0"N 03°10'37.0"E	n.d.	32	6	10	Fl W 3s

Tunisia

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
016	Phare de l'Île Galiton	Mar Mediterraneo	37°29'52.9"N 08°52'27.5"E	1920	168	14	24	Fl (4) W 20s
017	Tabarka	Mar Mediterraneo	36°57'55.3"N 08°45'31.1"E	1906	72	14	17	Fl W 2,5s
015	Cap Serrat	Mar Mediterraneo	37°13'54.1"N 09°12°36.0"E	1890	199	13	24	Fl (2) W 10s
026	Ras Enghela	Mar Mediterraneo	37°20'42.0"N 09°44'18.0"E	1898	38	15	28	Fl W 2,5s
004	Phare de l'Île Cani	Mar Mediterraneo	37°21'24.0"N 10°07'24.0"E	1860	39	21	19	Fl (2) W 10s
0024	Phare de l'Île Plane	Mar Mediterraneo	37°10'54.0"N 10°19'42.0"E	1888	20	12	15	Fl (2) W 10s
025	Pointe de Sebra	Mar Mediterraneo	37°15'30.6"N 09°51'33.4"E	1895	16	15	n.d.	Iso W 5s
012	Sidi Bou Said	Mar Mediterraneo	36°52'18.0"N 10°20'54.0"E	1840	146	12	22	Fl W 4s
028	Îlot Zembretta	Mar Mediterraneo	37°06'24.0"N 10°52'22.6"E	1906	59	n.d.	n.d.	Inattivo
029	Hammamet	Mar Mediterraneo	36°23'42.0"N 10*36'54.0"E	1912	17	14	15	Fl (2) W 6s
006	Cap Bon	Mar Mediterraneo	37°04'42.0"N 11°02'42.0"E	1875	126	20	30	Fl (3) W 20s
001	Qulaybiyah	Mar Mediterraneo	36°50'17.0"N 11°06'59.1"E	1895	82	18	23	Fl (4) W 20s
019	Sousse	Mar Mediterraneo	35°49'24.0"N 10°38'18.0"E	1890	70	22	22	Fl W 4s
002	Phare de l'Île Kuriat	Mar Mediterraneo	35°47'54.0"N 11°02'00.0"E	1894	30	26	18	Fl WR 5s
031	Monastir	Mar Mediterraneo	35°45'06.0"E 10°51'03.0"E	1888	26	6	18	Fl (2) R 3s
013	Mahdia	Mar Mediterraneo	35°30'30.0"N 11°04'54.0"E	1890	26	15	17	Fl R 5s
E6368	Ra's kaboudia	Mar Mediterraneo	35°14'00.0"N 11°09'24.0"E	1890	27	18	19	Fl (2) WR 6s
E6396	La Goulette	Mar Mediterraneo	36°48'23.7"N 10°18'31.5"E	1850	13	10	n.d.	Fl W 6s
E6362	Sfax Port	Mar Mediterraneo	34°43'50.4"N 10°46'06.9"E	n.d.	18	17	n.d.	Fl W 8s
E6330.2	Arghir	Mar Mediterraneo	33°45'13.0"N 11°00'44.7"E	n.d.	7	7	n.d.	Fl W 4,5s
E6389.1	Port Yasmine	Mar Mediterraneo	36°22'17.7"N 10°32'47.3"E	2009	17	n.d.	n.d.	Fl W 15s
009	Ra's Thyna	Mar Mediterraneo	34°39'00.0"N 10°41'06.0"E	1895	55	44	24	Fl W 5s
018	Gabes	Mar Mediterraneo	33°53'36.0"N 10°06'48.0"E	1894	13	11	20	Fl (2) W 6s
010	Ra's Taguerness	Mar Mediterraneo	33°49'18.0"N 11°02'42.0"E	1895	64	49	24	Fl W 5s

E6366.6	Ra's Djlija	Mar Mediterraneo	34°49'47.0"N 11°14'50.4"E	n.d.	10	9	n.d.	Fl (2) W 10s
020	Zarzis	Mar Mediterraneo	33°29'49.8"N 11°07'10.9"E	1894	15	14	n.d.	Fl W 12s

Turkey

ID	Name and location	Sea	Coordinates	Date	LH	TH	R	D
1732	Fenerbahce	Mar di Marmara	40°58'05.2"N 29°01'55.4"E	1856	20	25	15	L Fl (2) W 12s
n.d.	Pendik South BW	Mar di Marmara	40°51'33.3"N 29°15'09.3"E	n.d.	11	n.d.	8	Fl G 5s
n.d.	Yelkenkaya	Mar di Marmara	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
n.d.	Dilburnu	Mar di Marmara	40°44'24.7"N 29°30'53.6"E	n.d.	14	n.d.	7	Fl W 3s
n.d.	Bozburun	Mar di Marmara	40°32'02.7"N 28°46'55.1"E	n.d.	76	n.d.	10	Fl W 5s
17092	Degirmen Burnu	Mar di Marmara	40°57'39.2"N 28°37'13.7"E	n.d.	20	8	n.d.	Fl W 5s
n.d.	Fener Adasi	Mar di Marmara	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
n.d.	Kapsule	Mar di Marmara	40°28'37.7"N 28°02'02.1"E	n.d.	20	n.d.	5	Fl (2) W 10s
n.d.	Balyos	Mar di Marmara	40°29'38.7"N 27°40'58.1"E	n.d.	38	n.d.	10	Fl (2) R 10s
n.d.	Asmali	Mar di Marmara	40°37'58.4"N 27°45'31.4"E	n.d.	40	n.d.	10	Fl (3) W 15s
n.d.	Ekinlik	Mar di Marmara	40°30'50.7"N 27°28'41.1"E	n.d.	18	n.d.	10	Fl W 5s
n.d.	Karaburun	Mar di Marmara	40°28'28.7"N 27°17'07.6"E	n.d.	50	n.d.	10	Fl (3) W 10s
17104	Yesilkoy	Mar di Marmara	40°57'29.8"N 28°50'20.6"E	1856	23	16	15	Fl W 10s
17072	Marmara Ereglisi	Mar di Marmara	40°58'00.6"N 27°57'42.2"E	1861	53	8	8	Fl W 10s
17060	Hoskoy	Mar di Marmara	40°42'10.8"N 27°18'24.4"E	1861	50	22	n.d.	Fl (2) W 10s
17056	Inceburun	Mar di Marmara	40°33'23.4"N 26°59'44.2"E	1953	32	10	10	Fl (3) W 10s
n.d.	Eceabat Range Front	Mar di Marmara	40°11'03.4"N 26°21'44.3"E	n.d.	7	n.d.	5	Fl G 5s
n.d.	Eceabat Range Rear	Mar di Marmara	40°11'03.3"N 26°21'37.3"E	n.d.	7	n.d.	5	Fl R 5s
n.d.	Cimenlik	Mar di Marmara	40°08'49.1"N 26°23'53.7"E	n.d.	16	n.d.	7	Fl RG 5s
17048	Gelibolu	Mar Egeo	40°24'35.0"N 26°40'54.0"E	1856	34	9	5	Fl W 5s
17036	Karakova	Mar Egeo	40°19'11.2"N 26°35'13.7"E	1858	10	n.d.	5	Fl R 6s
n.d.	Kepez	Mar di Marmara	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
16956	Mehmetcik	Mar di Marmara	40°02'38.9"N 26°10'28.6"E	1919	50	25	n.d.	Fl WR 5s
n.d.	Polente	Mar Egeo	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
16932	Kalekoy	Mar Egeo	40°14'04.4"N 25°53'46.7"E	1960	49	9	n.d.	Fl W 3s
n.d.	Batiburnu	Mar Egeo	n.d.	n.d.	n.d.		n.d.	n.d.
17028	Uzun Burnu	Mar Egeo	40°16'04.4"N 26°29'31.3"E	n.d.	11	10	n.d.	Fl R 10s
n.d.	Babakale	Mar Egeo	39°28'46.8"N 26°03'50.3"E	n.d.	32	n.d.	n.d.	Fl (4) W 20s

n.d.	Sivrice	Mar Egeo	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
n.d.	Karaburun	Mar Egeo	40°28'28.7"N 27°17'07.7"E	n.d.	50	n.d.	10	Fl (3) W 10s
n.d.	Bozburun	Mar Egeo	39°26'16.1"N 26°48'45.0"E	n.d.	35	n.d.	10	Fl W 5s
n.d.	Gunesadasi	Mar Egeo	39°19'34.9"N 26°32'22.1"E	n.d.	66	n.d.	10	Fl W 3s
n.d.	Ilicaburnu	Mar Egeo	38°49'24.2"N 26°53'40.0"E	n.d.	50	n.d.	10	Fl W 5s
n.d.	Oglakadasi	Mar Egeo	38°49'25.3"N 26°53'40.4"E	n.d.	25	n.d.	10	Fl W 5s
n.d.	Guzelbahce	Mar Egeo	38°22'31.2"N 26°51'58.2"E	n.d.	14	n.d.	18	Fl (2) W 10s
n.d.	Karaburun	Mar Egeo	38°39'30.3"N 26°21'45.2"E	n.d.	97	n.d.	10	Fl (4) W 20s
n.d.	Sungukaya	Mar Egeo	38°17'34.4"N 26°11'42.4"E	n.d.	42	n.d.	40	Fl WR 5s
n.d.	Kusadasi	Mar Egeo	37°51'50.2"N 27°14'49.3"E	n.d.	20	n.d.	10	Fl (2) W 10s
n.d.	Tekagac	Mar Egeo	37°21'13.8"N 27°11'32.4"E	n.d.	15	n.d.	10	Fl W 15s
n.d.	Turgutreis	Mar Egeo	n.d	n.d.	n.d	n.d.	n.d	n.d
n.d.	Huseyinburnu	Mar Egeo	36°57'53.5"N 27°15'50.9"E	1964	15	9	14	Fl (2) W 15s
n.d.	Bodrum West BW	Mar Egeo	37°01'56.3"N 27°25'29.2"E	n.d.	9	n.d.	7	Fl R 5s
n.d.	Deveboynu	Mar Egeo	36°41'12.8"N 27°21'48.5"E	n.d.	50	n.d.	3	Fl (2) W 10s
n.d.	Kadirgaburnu	Mar Egeo	36°43'49.2"N 28°18'09.2"E	n.d.	39	n.d.	10	Fl (3) W 15s
n.d.	Keciadasi	Mar Egeo	36°47'53.7"N 28°15'33.9"E	n.d.	30	n.d.	7	Fl W 2s
n.d.	Peksimetadasi	Mar Mediterraneo	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
20536	Kizilada	Mar Mediterraneo	36°39'10.7"N 29°02'38.7"E	1910	32	13	15	Fi W 5s
n.d.	Patara	Mar Mediterraneo	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
n.d.	Finike	Mar Mediterraneo	36°16'32.5"N 30°09'02.4"E	n.d.	30	n.d.	10	Fl (2) W 7s
n.d.	Taslikburnu	Mar Mediterraneo	36°13'08.9"N 30°24'34.8"E	n.d.	36	n.d.	5	Fl R 5s
n.d.	Cavus	Mar Mediterraneo	36°17'54.6"N 30°29'16.3"E	n.d.	45	n.d.	10	Fl W 15s
n.d.	Bababurnu	Mar Mediterraneo	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
n.d.	Side	Mar Mediterraneo	36°45'58.2"N 31°23'02.5"E	n.d.	14	n.d.	10	Fl W 3s
n.d.	Alanya	Mar Mediterraneo	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
n.d.	Anamur	Mar Mediterraneo	36°01'03.3"N 32°48'10.0"E	n.d.	68	10	20	Fl (2) W 10s
n.d.	Bolukada	Mar Mediterraneo	36°08'03.8"N 33°41'00.8"E	n.d.	43	n.d.	18	Fl (2) W 6s
20708	Mersin	Mar Mediterraneo	36°47'04.7"N 34°37'07.3"E	1865	16	15	15	Fl (3) W 10s
n.d.	Deliburun	Mar Mediterraneo	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
n.d.	Karatas	Mar Mediterraneo	36°33'23.2"N 35°23'19.8"E	n.d.	8	n.d.	7	Fl (2) R 10s
n.d.	Iskenderun Harbor	Mar Mediterraneo	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
n.d.	Iskenderun	Mar Mediterraneo	36°32'05.9"N 36°02'34.8"E	n.d.	45	n.d.	20	Fl W 10s
n.d.	Akinci Burnu	Mar Mediterraneo	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

LH= height above sea level; TH= tower height; R=range; D= description

The Semantic Atlas of Italian Lighthouses

Edificio (Building)

Name (ID-)	Livelli edificio				B	Finestra tipo						Modanature											
	0	1	2	3		1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11	12
Faro di Capo dell'Arma (1474)			X			X																	
Faro di Porto Vado (1514)				X	X		X					X											
Faro di Porto Maurizio (1478)																							
Faro di Capo Mele (1506)				X			X										X						
Torre della Lanterna (1569)			X			X																	
Faro di Punta Vagno (1575)																							
Faro di Punta di Portofino (1675)			X				X						X										
Pegazzano	X																						
Camogli	X																						
Faro di Marina di Carrara (1846)				X		X																	
Faro della Diga Foranea (1868)	X																						
Faro settentrionale della Meloria (1884)	X																						
Fanale di Livorno (1896)	X																						
Faro della Diga Curvilinea (1911)		X												X									
Faro delle Secche di Vada (1975)	X																						
Faro di Capraia (1996)			X			X	X																
Faro di Palmaiola (2016)			X			X	X																
Faro di Capo Focardo (2040)		X				X																	
Faro di Monte Poro (2054)	X																						
Faro di Punta Polveraia (2060)		X						X							X								
Faro di Portoferraio (2072)	X																						
Faro di Pianosa (2088)			X				X								X								
Faro dello Scoglio d'Africa (2088)	X																						
Faro delle Formiche di Grosseto (2096)		X					X						X										
Faro di Talamone (2140)				X		X			X					X									
Faro di Lividonia (2144)			X				X	X						X									
Faro del Fenaio (2156)			X			X																	
Faro di Capel Rosso (2168)			X				X																
Faro di Porto Ercole (2172)	X																						
Faro di Giannutri (2184)		X				X																	

Faro di Capo Circeo (2258)			X			X										X						
Faro di Monte Orlando (2315)		X				X						X										
Faro di Scario (2672)			X		X	X											X					
Isolotto Licosa (2664)	X																					
Ventotene (2286)		X					X								X							
Porto di Ponza (2278)			X				X							X								
Rotonda della Madonna (2266)	X																					
Capo Negro (2262)		X				X																
Capo d'Anzio (2246)		X				X	X											X				
Faro di Capo Palinuro (2668)			X		X		X								X							
Porto d'Ischia (2374)	X																					
Faro di Punta Carena (2612)			X				X						X									
Faro di Scario (2672)		X			X		X								X							
Faro di Punta Pioppeto (2358)		X																				
Faro di Capo Miseno (2402)			X				X														X	
Faro di Capo d'Orso (2628)			X		X		X															
Faro di Molo San Vincenzo (2424)	X																					
Faro di Castello d'Ischia (2370)			X					X														
Faro d'Ischia (2374)	X																					
Fortino Tenaglia (2406)	X																					
Capo Suvero (2692)		X					X										X					
Capo Vaticano (2708)		X			X		X															
Castello Ruffo (2712)	X																					
Faro di Punta Pezzo (2720)		X					X														X	
Capo dell'Armi (3380)		X				X									X							
Faro di Capo Spartivento (3384)		X				X						X										
Punta Stilo (3388)	X																					
Faro di Capo Rizzuto (3396)		X					X							X								
Faro di Capo Colonna (3404)			X		X		X															X
Punta Alice (3424)			X				X														X	
Capo Trionto (3428)	X																					
Faro di Molfetta (3752)	X																					
Faro di Bari (3706)			X		X		X												X			
Faro di Sant'Andrea (3562)			X				X														X	
Faro dell'Isola Pianosa (3832)			X				X									X						
Isola di San Domino (3844)		X				X						X										
Torre Preposti (3812)			X				X															

Faro di Manfredonia (3796)			X		X		X													X			
Faro di Santa Maria di Leuca (3590)			X				X										X						
Castello Alfonsino (3626)	X																						
Faro di Torre Canne (3688)			X		X				X													X	
Faro di Trani (3771)	X																						
Faro di San Cataldo (3612)		X				X											X						
Faro di Vieste (3816)			X				X														X		
Faro di Barletta (3780)			X				X														X		
Punta Palascia (3596)			X				X														X		
Faro di Punta Penna (3856)			X		X		X												X				
Faro di Ortona (3864)			X				X																
San Benedetto del Tronto (3898)			X							X													
Colle Cappuccini (3930)		X																					
Faro di Senigallia (3954)			X				X																
Faro di Fano (3966)			X				X																
Monte San Bartolo (3986)		X																			X		
Faro di Rimini (4005)	X																						
Faro di Cesenatico (4028)			X				X															X	
Faro di Cervia (E2411)	X																						
Faro di Porto Corsini (4056)			X					X											X				
Porto Garibaldi (4062)		X					X																
Faro del Po di Goro (4072)			X				X																
Faro di Piave Vecchia (4264)	X																						
Faro Rocchetta (4132)		X					X					X											
Faro di Murano (4177.1)	X																						
Punta Tagliamento Bibione (4288)			X				X																X
Lanterna di Trieste			X								X										X		
Faro Biscari (2796)	X																						
Faro San Giacomo (2954)	X																						
Faro di San Vito Lo Capo (3170)		X			X		X						X										
Faro di Punta Secca (2942)	X																						
Faro di Capo Cefalù (3261)			X			X													X				
Faro di Torretta Granitola (3010)		X					X																
Faro di Capo d'Orlando (3264)		X			X			X												X			
Capo Faro (3296)	X																						

Faro di Capo Milazzo (3268)		X					X															
Faro di Capo Peloro (2736)			X				X														X	
Faro di Capo Rasocolmo (3276)			X				X														X	
Faro di Punta dei Porci (3280)			X		X		X															
Faro di Marina Corta (3284)	X																					
Faro di Punta Lingua (3300)		X					X														X	
Faro di Capo Molini (2788)			X				X														X	
Faro di Brucoli (2815)	X																					
Faro di Santa Croce (2820)		X					X															X
Faro Capo Murro di Porco (2910)		X					X													X		
Faro di Pozzallo (2934)	X																					
Punta Gavazzi (3194)		X					X															
Punta Omo Morto (3186)		X					X					X										
Faro di Capo Zafferano (3244)		X					X															
Faro sulla Diga foranea (3208)	X																					
Scoglio Palumbo (3138)		X				X															X	
Isolotto Formica (3128)		X					X															X
Faro di Capo Grosso Favignana (3120)		X					X															
Scoglio Porcelli (3132)	X																					
Punta Libeccio (3112)			X		X		X														X	
Faro di Punta Sottile (3104)		X			X		X									X						
Punta Marsala (3100)			X				X														X	
Strombolicchio (3310)	X																					
Faro di Capo Grecale (3038)		X					X														X	
Punta Beppe Tuccio (3054)		X					X															
Faro di Capo San Marco (3006)		X					X														X	
Faro di Punta Spadillo (3014)			X				X														X	
Faro di Capo Caccia (1418)			X				X															
Faro di Capo S. Elia (1270)			X		X		X														X	
Faro di Capo Testa (1014)			X				X													X		
Faro di Capo Carbonara (1258)	X																					
Faro di Capo Ferro (1146)			X				X															
Capo San Marco Cabras (1390)			X		X		X															X
Faro di Capo Sandalo (1384)			X				X					X										
Faro di Isola dei Cavoli (1262)				X			X							X		X						

Faro di Punta Scorno (1426)				X			X								X								
Faro di Porto Conte (1422)	X																						
Faro di Capo Bellavista (1246)			X			X	X								X								
Faro di Capo Spartivento (1310)			X		X	X																X	
Porto Ponte Romano (1315)				X			X																
Scoglio Mangiabarche (1346)	X																						
Faro di Capo Mannu (1404)			X																				
Faro di Capo Comino (1230)				X			X														X		
Faro di Capo Timone (1226)	X																						
Faro di Isola Bocca (1170)			X					X															X
Isolotto Figarolo (1162)	X																						
Isolotto Monaci (1142)	X																						
Punta Sardegna (1030)			X				X												X				
Faro di Capo d'Orso (1125)	X																						
Faro di Isola Razzoli (1000)				X			X																X
Faro di Barrettinelli (1010)	X																						

"Building" element legend

B= bugnato

Modanatura
1= doppio listello
2= listello ovolo, listello, cavett
3= doppio listello cavetto
4=listello, cavetto
5=listello, ovolo, listello
6= listello, gola dritta
7= listello, gola dritta, ovolo, cavetto
8= gola dritta, ovolo, cavetto
9= tondino, gola dritta
10= listello
11= gola dritta, cavetto
12= listello, gola dritta, listello

Finestra tipo
1= a singolo battente
2= a doppio battente
3= a doppio battente con volta
4=a singolo battene cno volta
5= circolare
6= quadrata

N.B. The semantic elements have not been translated as they are fundamental for the understanding of the ontological and parametric structure

Torre (Tower)

Name (ID-)	Sezione pianta				Finestra						Modanature														
	C	O	O	M	1	2	3	4	5	6	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Faro di Capo dell'Arma (1474)	X				X																				
Faro di Porto Vado (1514)		X			X							X													
Faro di Porto Maurizio (1478)		X			X							X													
Faro di Capo Mele (1506)		X				X	X							X											
Torre della Lanterna (1569)			X												X										
Faro di Punta Vagno (1575)				X	X																				
Faro di Punta di Portofino (1675)				X	X																				
Pegazzano (1765)		X				X	X																		
Camogli (1671)	X																								
Faro di Marina di Carrara (1846)			X																						
Faro della Diga Foranea (1868)	X				X																				
Faro settentrionale della Meloria (1884)																									
Fanale di Livorno (1896)	X																								
Faro della Diga Curvilinea (1911)		X						X								X									
Faro delle Secche di Vada (1975)	X				X																				
Faro di Capraia (1996)			X		X																				
Faro di Palmaiola (2016)			X		X																				
Faro di Capo Focardo (2040)		X												X											
Faro di Monte Poro (2054)																									
Faro di Punta Polveraia (2060)	X							X						X											
Faro di Portoferraio (2072)	X				X																				
Faro di Pianosa (2088)			X		X												X								
Faro dello Scoglio d'Africa (2088)	X																								
Faro delle Formiche di Grosseto (2096)	X				X													X							
Faro di Talamone (2140)	X																X								
Faro di Lividonia (2144)		X			X	X		X						X											
Faro del Fenaio (2156)		X			X																				
Faro di Capel Rosso (2168)		X			X												X								
Faro di Porto Ercole (2172)	X																								
Faro di Giannutri		X			X																				

Faro di Capo Circeo (2258)				X				X									X
Faro di Monte Orlando (2315)			X		X												
Faro di Scario (2672)		X			X												
Isolotto Licosa (2664)	X																
Ventotene (2286)	X								X								
Porto di Ponza (2278)		X														X	
Rotonda della Madonna (2266)	X																
Capo Negro (2262)			X		X												
Capo d'Anzio (2246)	X																
Faro di Capo Palinuro (2668)		X			X								X				
Porto d'Ischia (2374)	X																
Faro di Punta Carena (2612)		X			X												
Faro di Scario (2672)		X			X												
Faro di Punta Pioppeto (2358)			X														
Faro di Capo Miseno (2402)	X				X												
Faro di Capo d'Orso (2628)				X		X											
Faro di Molo San Vincenzo (2424)	X						X										
Faro di Castello d'Ischia (2370)		X						X									
Faro d'Ischia (2374)	X																
Fortino Tenaglia (2406)	X																
Capo Suvero (2692)		X			X												
Capo Vaticano (2708)	X				X												
Castello Ruffo (2712)	X																
Faro di Punta Pezzo (2720)	X				X												
Capo dell'Armi (3380)																	
Faro di Capo Spartivento (3384)			X							X							
Punta Stilo (3388)	X				X												
Faro di Capo Rizzuto (3396)		X															
Faro di Capo Colonna (3404)		X								X							
Punta Alice (3424)		X						X									
Capo Trionto (3428)	X																
Faro di Molfetta (3752)				X													
Faro di Bari (3706)		X			X												

Faro di Manfredonia (3796)		X					X							X
Faro di Santa Maria di Leuca (3590)		X										X		
Castello Alfonsino (3626)														
Faro di Torre Canne (3688)		X			X									
Faro di Trani (3771)														
Faro di San Cataldo (3612)		X			X		X							
Faro di Vieste (3816)		X			X									
Faro di Barletta (3780)				X	X									
Punta Palascia (3596)	X													
Faro di Punta Penna (3856)		X			X									
Faro di Ortona (3864)		X			X			X						
San Benedetto del Tronto (3898)	X				X									
Colle Cappuccini (3930)	X													
Faro di Senigallia (3954)			X				X							
Faro di Fano (3966)			X		X									
Monte San Bartolo (3986)	X													
Faro di Rimini (4005)		X			X									
Faro di Cesenatico (4028)	X				X									
Faro di Cervia (E2411)		X			X								X	
Faro di Porto Corsini (4056)		X			X									
Porto Garibaldi (4062)	X				X									
Faro del Po di Goro (4072)	X				X									
Faro di Piave Vecchia (4264)	X													
Faro Rocchetta (4132)	X				X									
Faro di Murano (4177.1)	X				X									
Punta Tagliamento Bibione (4288)	X				X					X				
Lanterna di Trieste	X				X					X				
Faro Biscari (2796)	X				X									
Faro San Giacomo (2954)	X				X						X			
Faro di San Vito Lo Capo (3170)	X				X				X					
Faro di Punta Secca (2942)	X				X								X	
Faro di Capo Cefalù (3261)		X			X							X		
Faro di Torretta Granitola (3010)	X				X							X		
Faro di Capo d'Orlando (3264)		X				X						X		

Capo Faro (3296)	X			X							
Faro di Capo Milazzo (3268)	X			X							
Faro di Capo Peloro (2736)		X		X			X				
Faro di Capo Rasocolmo (3276)			X	X							
Faro di Punta dei Porci (3280)		X			X						
Faro di Marina Corta (3284)	X										
Faro di Punta Lingua (3300)	X										
Faro di Capo Molini (2788)			X								
Faro di Brucoli (2815)		X									
Faro di Santa Croce (2820)	X			X						X	
Faro Capo Murro di Porco (2910)		X		X						X	
Faro di Pozzallo (2934)	X										
Punta Gavazzi (3194)	X										
Punta Omo Morto (3186)	X										
Faro di Capo Zafferano (3244)		X		X		X					
Faro sulla Diga foranea (3208)	X										
Scoglio Palumbo (3138)	X										
Isolotto Formica (3128)	X										X
Faro di Capo Grosso Favignana (3120)	X										
Scoglio Porcelli (3132)	X										
Punta Libeccio (3112)		X		X							
Faro di Punta Sottile (3104)	X			X							
Punta Marsala (3100)	X			X							
Strombolicchio (3310)	X										
Faro di Capo Grecale (3038)		X		X				X			
Punta Beppe Tuccio (3054)	X			X						X	
Faro di Capo San Marco (3006)	X										
Faro di Punta Spadillo (3014)	X			X							
Faro di Capo Caccia (1418)	X										
Faro di Capo S. Elia (1270)	X			X							
Faro di Capo Testa (1014)			X	X					X		
Faro di Capo Carbonara (1258)	X										
Faro di Capo Ferro (1146)	X								X		
Capo San Marco Cabras (1390)		X		X					X		
Faro di Capo Sandalo (1384)	X			X							
Faro di Isola dei	X			X							

Cavoli (1262)							
Faro di Punta Scorno (1426)	X				X		
Faro di Porto Conte (1422)	X						
Faro di Capo Bellavista (1246)			X				
Faro di Capo Spartivento (1310)			X	X			
Porto Ponte Romano (1315)			X		X		
Scoglio Mangiabarche (1346)	X					X	X
Faro di Capo Mannu (1404)			X		X		
Faro di Capo Comino (1230)			X		X		
Faro di Capo Timone (1226)		X					
Faro di Isola Bocca (1170)		X					X
Isolotto Figarolo (1162)			X				
Isolotto Monaci (1142)	X						
Punta Sardegna (1030)			X		X		
Faro di Capo d'Orso (1125)	X						
Faro di Isola Razzoli (1000)	X						
Faro di Barrettinelli (1010)	X						

"Tower" element legend

C= Circolare
O= Ottagonale
Q= Quadrata
M= Mista

Modanatura
1= listello, tondino, listello, cavetto
2= listello, doppia fascia liscia, doppia mensola,
3= listello, fascia liscia, listello
4=cavetto
5= gola dritta, triplo listello
6= triplo listello, mensola
7= fascia liscia, mensola
8= listello, fascia liscia
9= listello, fascia liscia, listello, ovolo
10= gola dritta,fascia liscia, listello
11= tondino, cavetto
12= listello, gola dritta, listello
13= gola rovescia
14= listello, ovolo
15= triplo listello

Finestra tipo
1= a singolo battente
2= a doppio battente
3= a doppio battente con volta
4=a singolo battene con volta
5= quadrata
6= circolare

N.B. The semantic elements have not been translated as they are fundamental for the understanding of the ontological and parametric structure

Lanterna (Lantern)

Name (ID-)	Balaustra				Chiusura struttura		
	Acciaio a X	Acciaio verticale	Acciaio orizzontale	Cemento	A V	Fino 8	Da 8
Faro di Capo dell'Arma (1474)		X					X
Faro di Porto Vado (1514)		X					X
Faro di Porto Maurizio (1478)		X			X		
Faro di Capo Mele (1506)			X				X
Torre della Lanterna (1569)				X			X
Faro di Punta Vagno (1575)			X		X		
Faro di Punta di Portofino (1675)			X			X	
Pegazzano (1765)	X						
Camogli (1671)			X		X		
Faro di Marina di Carrara (1846)			X		X		
Faro della Diga Foranea (1868)				X	X		
Faro settentrionale della Meloria (1884)				X	X		
Fanale di Livorno (1896)				X			X
Faro della Diga Curvilinea (1911)		X				X	
Faro delle Secche di Vada (1975)					X		
Faro di Capraia (1996)						X	
Faro di Palmaiola (2016)			X			X	
Faro di Capo Focardo (2040)		X				X	
Faro di Monte Poro (2054)					X		
Faro di Punta Polveraia (2060)		X				X	
Faro di Portoferraio (2072)				X		X	
Faro di Pianosa (2088)		X			X		
Faro dello Scoglio d'Africa (2088)					X		
Faro delle Formiche di Grosseto (2096)				X		X	
Faro di Talamone (2140)		X			X		
Faro di Lividonia (2144)			X		X		
Faro del Fenaio (2156)		X			X		
Faro di Capel Rosso (2168)		X					X
Faro di Porto Ercole (2172)				X		X	
Faro di Giannutri (2184)		X			X		
Faro di Capo Circeo (2258)		X			X		
Faro di Monte Orlando (2315)			X		X		
Faro di Scario (2672)		X				X	
Isolotto Licosa (2664)			X		X		
Ventotene (2286)		X	X		X		
Porto di Ponza (2278)			X				X
Rotonda della Madonna (2266)			X		X		
Capo Negro (2262)			X		X		
Capo d'Anzio (2246)		X				X	
Faro di Capo Palinuro (2668)		X					X
Porto d'Ischia (2374)		X				X	
Faro di Punta Carena (2612)		X				X	
Faro di Scario (2672)		X				X	
Faro di Punta Pioppeto (2358)			X		X		
Faro di Capo Miseno (2402)	X				X		
Faro di Capo d'Orso (2628)				X	X		
Faro di Molo San Vincenzo (2424)	X				X		
Faro di Castello d'Ischia (2370)							X
Faro d'Ischia (2374)		X				X	
Fortino Tenaglia (2406)		X			X		
Capo Suvero (2692)		X			X		
Capo Vaticano (2708)		X					X
Castello Ruffo (2712)		X					X
Faro di Punta Pezzo (2720)					X		
Capo dell'Armi (3380)			X		X		
Faro di Capo Spartivento (3384)		X					X
Punta Stilo (3388)		X				X	
Faro di Capo Rizzuto (3396)				X	X		
Faro di Capo Colonna (3404)		X					X

Capo Trionto (3428)		X				X	
Faro di Molfetta (3752)	X				X		
Faro di Bari (3706)		X					X
Faro di Sant'Andrea (3562)				X			X
Faro dell'Isola Pianosa (3832)		X			X		
Isola di San Domino (3844)				X	X		
Torre Preposti (3812)				X	X		
Faro di Manfredonia (3796)		X				X	
Faro di Santa Maria di Leuca (3590)				X			X
Castello Alfonsino (3626)					X	X	
Faro di Torre Canne (3688)		X				X	
Faro di Trani (3771)		X				X	
Faro di San Cataldo (3612)		X				X	
Faro di Vieste (3816)		X					X
Faro di Barletta (3780)			X			X	
Punta Palascia (3596)				X		X	
Faro di Punta Penna (3856)			X			8	
Faro di Ortona (3864)			X		X		
San Benedetto del Tronto (3898)		X			X		
Colle Cappuccini (3930)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Faro di Senigallia (3954)				X	X		
Faro di Fano (3966)			X		X		
Monte San Bartolo (3986)		X					X
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Faro di Cervia (E2411)		X				X	
Faro di Porto Corsini (4056)				X	X		
Porto Garibaldi (4062)				X			X
Faro del Po di Goro (4072)			X			X	
Faro di Piave Vecchia (4264)				X		X	
Faro Rocchetta (4132)		X				X	
Faro di Murano (4177.1)		X				X	
Punta Tagliamento Bibione (4288)			X			X	
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Faro San Giacomo (2954)							
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Capo San Marco Cabras (1390)		X			X	
Faro di Capo Sandalo (1384)				X		X
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Faro di Capo Timone (1226)				X	X	
Faro di Isola Bocca (1170)		X			X	
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Chapter 8_ Ontology as a form of knowledge, connection and sharing of data

Glossary and list of abbreviations

As built
Digital and extremely detailed reconstruction of an existing building on a geometric level, from the literal translation of "as done". Combine new project data with existing geometric and non-geometric data of the built building. The process of an As built model, unlike the design from scratch, always begins with a geometric survey of the building and with the collection of information to be included in the model.

As is
Compared to the As Built digital model , the As Is model is configured as more exhaustive and detailed in terms of quality and quantity of attributes. This level of detail, which can be translated from English into "as it is", lends itself to management, maintenance and restoration interventions.

CIDOC CRM
The CIDOC (ConceptualReference Model) CRM is an ontology developed by the International Committee for Documentation of the International Council of Museums (ICOM) which provide definitions and a formal structure in order to describe concepts and relationships used in the documentation of cultural heritage. Consistently with the use of formal ontology, it is aimed at simplifying the integration and exchange of heterogeneous information in the context of cultural heritage, guaranteeing their interoperability.

Competency questions
The competency questions , or questions of competence, are defined as the questions we want to answer through the created ontology (Gruninger & Fox, 1995). These questions, already posed before the creation of the ontology itself, useful as guidelines for determining the field of investigation, are subsequently posed net of the ontological conclusion, defined as the litmus test through which to verify the correct and consistent transposition of the data. In order to be able to answer these questions, the ontology must therefore be composed of axioms sufficient to answer certain questions, depending on the knowledge to be transmitted.

Database
It is an archive of data and information structured in such a way as to allow the management and cataloging of the data. The data contained in the most common databases are defined and ordered according to rows and columns contained in a series of tables through which to catalog the data and make their modification, management, updating and control easier. Unlike ontology, the data in the database are not connected to each other through relationships.

Deep Learning
It represents a research field belonging to machine learning and artificial intelligence. It is based on hierarchies and concepts or again, according to the definition of the Artificial Observatory Inteligence of the PoliMI, on artificial neural networks organized on several layers, where each layer calculates the values of the next layer in such a way as to obtain more and more complete information. Evolution of the Machine Learning, the Deep Learning becomes accessible only in recent years, thanks to the exponential improvement in the performance of GPU processors.

Domain
In computer science, a domain is "a collection of computers that share a database of network resources and that are administered as a unit with common rules and procedures".

In the context of knowledge representation, the domain constitutes the object category of knowledge, to be divided into two sub-categories: specific categories and general categories. In the Protégé software these categories are hierarchized by structuring classes and subclasses.

ID element

It is the numerical form of a Revit element. You can interact with this element directly using the 'Select by ID' command in Revit.

Unique ID element

It is a stable unique identifier for an element within the Revit document . It is configured as a concatenation of a standard UUID for Revit EpisodeId (session-based), along with the Revit Id element. Similar to the standard GUID format, it has 8 additional characters at the end of the latter. These 8 additional hexadecimal characters are large enough to store, either 4 bytes or a 32-bit number, which is the size of a Revit element ID.

Families

It is defined as the collection of all the elements that can be hosted and inserted within a BIM project. They contain the geometric definition of the elements and the relative parameters used, controlling and defining the instances of the elements themselves. The BIM platforms predispose the creation of different types of families grouped and ordered in the Content Libraries and in the Project Browser.
Each family has variable attributes, expressed as types or as instances, to be modified according to your needs. Specifically, families can be divided into loadable, system or local. System families are families modeled throughout the project and related to basic elements such as windows, walls, doors, floors, etc. Loadable families are families created specifically for a project or set of projects with elements in common. Often hosted by system family, loadable families can be inserted in any type of project and modified through the inserted metric labels. Finally, local families are configured as extremely personalized elements and therefore used for the creation of unique geometries.

IFC

The IFC (Industry Foundation Classes) is an open data format aimed at facilitating interoperability between different operators, allowing the interchange of an information model without the loss or distortion of information and data. Through the IFC it is possible to process all the information of the building during the entire life cycle, from planning to construction and maintenance.
The IFC architecture is based on: semantics, relationships and properties. Each element is designed to describe the components of the entire building, among which we mention: the systems, spaces, areas, furnishings, structural elements, etc. By means of this subdivision it is possible to associate characteristics such as shape, cost, position, physical characteristics, etc. to each element.
These data are encoded using the three available extensions: .ifc, default file format based on the ISO-STEP standard; .ifcxml, based on XML language; .ifczip; possibly containing additional files such as pdf and/or images.

Artificial intelligence

In general, artificial intelligence (AI) refers to any human-like behavior that a machine or system engages in. It allows systems to understand their environment, to relate to what it perceives and to solve problems, acting towards a specific goal. Problem solving is tackled by scientists by breaking it down into sub-problems, each for a specific field of research:

strong and weak artificial intelligence; education, reasoning and problem solving; knowledge representation; planning; learning, natural language processing; movement and manipulation. It is precisely the sub-problem "representation of knowledge" to understand the ontological sciences, focusing on what kind of knowledge is needed within an intelligent system and on how to represent it.

Interoperability

It is configured as the possibility of exchanging data and contents of a design model created by different platforms, software and/or applications, facilitating the interaction, exchange and reuse of information between non-homogeneous systems. Interoperability is determined as a fundamental characteristic as a function of the ever increasing variety of global systems, towards a by now consolidated tendency towards the convergence of some advanced technologies: through interoperability it is therefore possible to offer new services and/or functionalities.
In the field of telecommunications, interoperability contains two different meanings: technical interoperability, referring to the compatibility between different software; conceptual interoperability, relating to the relationships at the semantic level between, for example, different databases.

OWL language

The Web Ontology Language (OWL) is a markup language, or also a 'markup language', that is a set of rules designed to describe mechanisms of representation of a text through the use of standard conventions, to explicitly represent a meaning and semantics of terms through vocabularies and relationships. This language consists of a formal semantics built by the W3C consortium on the basis of the XML standard, called RDF.
The ultimate goal is to build not only knowledge bases but also the creation of new deductions, as well as overcoming the frequent homonymy problems in web research. Formal semantics is nothing more than the constituent language of the syntax, in this case based on the XML standard. Ontological semantics manages to organize data into defined categories through imposed relationships: the classification of information therefore allows humans, and not just machines, to read and understand the knowledge exposed.

LOD

The Level or Development has the task of precisely defining the level of depth of the information contained within the model, thus representing the level of definition or development of the objects present in the BIM model. The LODs contain both the information attributes (LOI) and the geometric attributes (LOG), and is therefore directly proportional to the degree of definition of the project.

LOd

The Level of Detail describes the level of geometric detail of the element modeled in BIM.

LOG

The Level of Geometry represents and defines the geometric attributes of a specific parametric element according to its LOD. The LOd is applied to the LOG, which is the level of graphic definition of the element.

LOI

The Level of Information defines the information attributes of a specific parametric element as a function of its LOD.

LOR
The Level of Reliability defines the degree of objective reliability of the modeled element as a function of parameters such as geometric characteristics, surveys, survey data, etc. In the text the Level of Reliability is defined as fundamental in the context of the conclusions and results relating to the methodology presented.

Machine Learning
It is configured as one of the basic techniques of artificial intelligence, in which algorithms use mathematical-computational methods to learn information directly from data, improving performance in an 'adaptive' way by imitating the learning system of human beings. In the context of the Deep Learning, the Machine Learning describes how neural networks can improve their performance over time by 'learning' through experience. In this sense, in fact, the main objective is to allow the computer to learn autonomously without human assistance or interaction, acting accordingly.

Template
A model is a three-dimensional mathematical representation afferent to a real or imaginary object. It consists of a set of structured data files containing the properties of the geometric primitives making up the modeled object.
Being composed of a set of data and points in space, three-dimensional models can be made by hand according to a physical essence, algorithmically through procedural modeling, or scanned from reality. The former can be referred to the scale model or maquette, the latter to the parametric modeling and the latter to the scanning by 3D scanner, photogrammetry or structured light of a real object.

Parametric model
The parameterization process is defined as the creation of a series of variables and relationships whose modification is capable of altering the final result of the system, allowing the coordination and management of changes related to shape and geometry. The relations can already exist in the software or can be created directly by the user according to the desired geometry. Through the relationships it is possible to structure and create models linked by a series of modifications, automating the process with each modification of the parameter.
The adjective parametric or algorithmic refers to the fact that parametric modeling software uses mathematical algorithms to describe actions and processes translated into three-dimensional models.

Number slider
A number slider, or numeric slider, corresponds to the assignment of a certain number score relevant to a specific question or input. In visual programming, the number slider corresponds to the automated modification of the geometry created.

Ontology
In the past defined as one of the fundamental branches of philosophy, associated with being as such, as well as with its fundamental categories, today it is rediscovering a new application and meaning in the computer field. In this sense, in fact, computer ontology is defined as a shared and explicit formal representation of a conceptualization with respect to a specific domain of interest. More specifically, it is configured as an axionomic theory of the first order, or calculus of predicates, expressible through a descriptive logic, used to represent knowledge in the domain of application.
At a formal level, ontology today falls within the field of artificial intelligence and the representation of knowledge, dealing with defining the symbolisms and languages that allow the

formalization of knowledge, in order to describe the way in which the different schemes are combined in a structuring containing the relevant entities and related relationships in a given domain.

Augmented reality
Augmented reality (AR) allows you to superimpose multimedia information on what you are observing through the use of a display or a wearable device. The cardinal principle, in fact, is that of the overlay, that is the creation of a new level of knowledge superimposed on tangible knowledge. An example is the reading by a camera of an object recognized in the frame through which to activate a new level of communication to be superimposed on the existing, perfectly integrating the virtual with reality.

Virtual reality
Virtual reality (VR) is an exclusively digital space that simulates tangible and/or intangible reality conveyed to our senses through devices such as consoles, viewers, headsets, cybertutes, etc., which allow real-time interaction with everything that is reproduced in the virtual world.

Semantics
Also called science of meanings, semantics refers to that part of linguistics that studies the meaning of words through which to define notions and syntactic relationships. In mathematical logic and philosophy of language, semantics is the discipline that studies the relationship between linguistic expressions and what they refer to.
Semantics is therefore configured as the tool through which to understand things and interpret information systems. The affixing of a specific meaning allows information systems to interface more efficiently, ensuring correct interoperability of the data. This is because through semantics it is possible to organize data into well-defined categories with precise relationships, obtaining a classification of information and knowledge that is easy to understand and read by machines.

VPL
The visual programming language (Visual Programming Language) is defined as a language through which to program the elements through graphic manipulation without the use of written syntax. Based on "boxes and arrows", or rather on 'box' functions connected to each other by means of 'arrows', visual programming allows you to program models and programs that can be viewed in real time using "visual expressions".
With the Dynamo program, a program for the visual programming used as a plug in Revit Architecture, it is possible to create and modify all the geometries at the same time through the creation of algorithms, that is the logical sequences necessary to achieve the result, connected by a series of nodes.
The most popular language for representing the virtual world is VRML (Virtual Reality Modeling Language) through which to construct three-dimensional vertices and polygons, set information about color, opacity, surface brightness, etc.

Ontologic glossary

Altezza sul livello del mare
We consider the standard measurement in meters of the elevation of a place or, as in this case, of an architecture, in relation to the historical average of the sea level. It is determined through the Global Positioning System (GPS), altimeters, aerial photogrammetry and surveying.
Source:https://it.wikipedia.org/wiki/Metri_sul_livello_del_mare#:~:text=Metri%20 sul%20livello%20del%20mare%20(abbreviato%20m%20s.l.m.)%20%C3%A8%20 una,fattori%20e%20cambiano%20nel%20tempo.

Area Mediterranea
It is a geographic area underlying the states bordering the Mediterranean Sea, namely: Albania, Algeria; Bosnia and Herzegovina; Cyprus; Croatia; Egypt; France; Gibraltar; Greece; Israel; Italy; Lebanon; Libya; Malta; Morocco; Monk; Montenegro; Palestine (Gaza Strip); United Kingdom (Akrotiri and Dhekelia); Syria; Slovenia; Spain; Tunisia and Turkey.
Source: Attenborough, D. (1987). The First Eden: The Mediterranean World and Man. Boston: Little Brown and Company.

Balaustra galleria
By balustrade or parapet we mean the protective element designed to prevent people or objects from falling into the void in any place where there are differences in height, in this case in the tower gallery.
Source: https://it.wikipedia.org/wiki/Parapetto.

Bucatura
Opening made in a surface for aero-illuminating purpose.
Source: https://www.teknoring.com/wikitecnica/progettazione-architettonica/bucatura/.

Caratteristiche dell'emissione luminosa
A different propagation of the light source makes it possible to distinguish a light signal from another place in the vicinity.
The characteristics of the emission are divided into: color, type, period, eclipse and phase. The color can be: white, red, green, yellow (abbreviated to W, R, G, Y).
The type is divided into fixed light (F), flashes with eclipse greater than the times of light (Fl), intermittent with eclipse less than the times of light (Oc), sparkling with 50-80 flashes per minute (Q), rapid sparkling with more than 80 flashes per minute (VQ), isophase with eclipse times equal to the times of light (Iso) and fixed with continuous flashes (F Fl).
The period is the total duration of seconds of the complete cycle of lights and eclipses.
The eclipse is the interval of darkness between one light and another.
The phase is the duration of each single light and each single eclipse.
Source: Sites specialized in boating; lessons for the acquisition of the nautical license.
Url: https://www.nauticando.net/lezioni-di-nautica/segnalamenti-ottici-marittimi/; https://www.mkonsulting.it/joomla/images/Navigazione/fari%20e%20segnali%20da%20 nebbia.pdf.

Edificio
Part of the architectural complex of the lighthouse, the building constitutes the architectural apparatus that rests on the ground, almost always the support of the tower and, therefore, of the lantern. At one time this architectural volume, usually composed of 1 to 3 floors, permanently housed the life of the lighthouse keeper, or the person in charge of operating the lighthouse.
Source: personal processing.

Faro
a) Luminous signaling device, placed on special buildings in particular locations (along the coasts or on outcropping rocks, at the entrance to ports, near airports, etc.) to guide navigation at night or in conditions of poor visibility.
b) Light signaling instrument, consisting of a projector of white or red or green light, with a range from 10 to 40 miles, usually installed in a solid tower construction or in another suitable building, on the most visible points of the coast (ends of piers, promontories, rocks), to serve as a fixed point of reference for night navigation; it is said characteristic of a f. the type of light emission (continuous or intermittent) and its range. In some cases it is mounted on a float (light-boat, light-ship).
Source: a) Garzanti Dictionary. Url: https://www.garzantilinguistica.it/ricerca/?q=faro;
b) Treccani Dictionary. Url: https://www.treccani.it/vocabolario/faro/.

Galleria
The gallery is the external and uncovered part of the lantern, present in many lighthouses, in order to maintain the external structure of the lantern.
Source: Bartolomei, C., & Amoruso, G. (2006). L'architettura dei fari italiani. The architecture of Italian lighthouses. Vol. 2: Mar Ligure e Mar Tirreno. Firenze: Alinea.

Lanterna
Part of the architectural complex of the lighthouse, the lantern is the glass structure that contains and protects the lamp and the optics. Generally circular in shape, but also polygonal, the lantern is made with special technical measures to be as transparent as possible to the light signal emitted by the optic, and with sufficiently robust crystals to withstand the force of the wind and the fury of the sea, as well as the birds attracted to light. On the roof of the lantern there is a ventilation system in order to evacuate the fumes and the heat produced by the lamp. A lightning rod and a grounding system for the metal dome that makes up the roof of the lantern secure the building in the event of lightning strikes. Finally, on the tower there are one or more hanging galleries (the "terrace" or "gallery"), outside the service room and the lantern, the latter mainly to allow cleaning of the external surface of the lantern windows.
Source: Bartolomei, C., & Amoruso, G. (2006). L'architettura dei fari italiani. The architecture of Italian lighthouses. Vol. 2: Mar Ligure e Mar Tirreno. Firenze: Alinea.

Modanatura
It is a band shaped according to a geometric profile, continuous along the entire length, placed on the architectural volume with the function of emphasizing the subdivision into parts of the object through decoration. Depending on the profile, the moldings are named with specific nomenclatures and can be divided into three basic groups: straight profile; simple curvilinear profile; complex curvilinear profile.
Source: https://it.wikipedia.org/wiki/Modanatura;https://www.treccani.it/vocabolario/modanatura/.

Livello
By level we mean the number of elevations of a building, in this case intended solely for the 'building' element.
Source: personal processing.

Patrimonio culturale
By cultural heritage we mean the set of tangible and intangible, artificial and natural assets that constitute wealth for a place and its population, having particular interests at an arti-

stic, historical, archival or anthropological level. It includes works of art, monuments, the landscape, but also the set of traditions, uses and customs of a people.
Source: https://www.raicultura.it/raicultura/articoli/2020/10/Che-cose-il-patrimonio-3c1eb0bd-ec7d-4fee-9f89-e5c52bc31e3b.html

Portata nominale della sorgente luminosa
The range of the lighthouses can be divided into nominal, geographical and luminous range. The geographic range depends directly on the elevation of the lighthouse and that of the observer, bringing into question the curvature of the Earth. The light range depends not only on the power of the lamp but also on the weather conditions. The nominal range, on the other hand, is independent of atmospheric conditions and is defined as the light range that the lighthouse would have under standard conditions, with a meteorological visibility of at least 10 miles. The nominal range of a lighthouse is from 10 miles to 40 miles.
Source: Sites specialized in boating; lessons for the acquisition of the nautical license.
Url: https://www.nauticando.net/lezioni-di-nautica/segnalamenti-ottici-marittimi/; https://www.mkonsulting.it/joomla/images/Navigazione/fari%20e%20segnali%20da%20nebbia.pdf.

Rastremazione
In architectural language, the reduction in diameter that in some styles the column undergoes passing from the base section (imoscapo) to the top section (sommoscapo), or even a similar more complex trend (for which see entasis). More generally, the reduction of the transversal dimensions that the vertical bearing structures (piers, pillars, walls) undergo in the transition from the lower to the upper extremity: this variation is usually commensurate with the different magnitude of the stresses in the different parts of the structure, and it often constitutes a valid means of formal expression.
Source: Treccani Dictionary.
Url: https://www.treccani.it/vocabolario/rastremazione/.

Sottogalleria (mensola)
By sottogallera we mean the union between the shelf and the undershelf, where the shelf is constituted in this case by the gallery of the lighthouse tower, the undershelf is instead made up of the decorative part placed below and 'supporting' the shelf. This element, in the case of lighthouses, can be understood as a single element or as a connection between two different moldings.
Source: personal processing.

Torre
Part of the architectural complex of the lighthouse, the tower represents the vertical support of the lantern - often placed on the roof of the lighthouse building / accommodation and less frequently isolated from the latter - it is capable of raising the light source at different heights on the level of the lighthouse. sea, in relation to the night sighting needs. It also has a diurnal sighting function, thanks to its clear and immediate recognition in the territorial context.
Source: Nautical and official sites.
Url: https://www.mkonsulting.it/joomla/images/Navigazione/fari%20e%20segnali%20da%20nebbia.pdf.

N.B. The nomenclatures have not been translated as they correspond to the ontological structure

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