The iron staircases: Light and inventive solution of historical architecture

Tiziana Campisi
Calogero Vinci

The iron staircases. Handicraft manufacture and industrial production, between the XVIII and XIX centuries

The diffusion of elegant metallic structures like the iron staircases, the penthouses, the greenhouses, the «winter-gardens», usually considered like furniture elements rather than like real complements of architecture, it contributed, in the second half of XIX century, to make familiar the new iron architectures. In many cases in fact, the custom with the full and soft forms of stone monuments, allowed that the linear geometries of iron structures weren’t appreciated, especially if these were applied to building types, for which constructive techniques and aesthetical canons were, by now, encoded from centuries of experience and constructive practice. For this reason, the iron use with structural function in the monuments and in the public buildings like the theaters was carefully dissimulated.

In the staircases, instead, the demand of that «apparent solidity», searched and recreated in an artificial way through structures that simulated, either in the volumes or in the decorations the masonry constructions, didn’t showed itself.

In Sicily, at the end of the XVIII century the iron use at sight was limited to the corbels and handrails of the balconies and to small staircases. These last, also if were characterized by reduced dimensions, when presented esteem characters, like particularly elaborate banisters, it could be considered an element that dignified the building. So, the presence of these structures was a characteristic of the «domus magna» (according to the coeval documents we have examined), as well as the engraved stone-frames, the balconies with stone corbels, stone-slab like flooring and the big windows. In the same period very steep iron staircases were realized diffusely, according to the type with ribs and rungs inside the defensive towers or bell-towers, and agile service staircases that allowed the access to the inside rooms or to little gardens and courts set to different altitude in many buildings that was interested by repeated configuration in all the XVIII century. (Figure 1)

Is this the case of the eighteen century Merendino-Costantino palace in Palermo, in which a similar staircase, placed in a small inside courtyard, connected the middle floor with the superior floor. (Figure 2)

This very steep staircase, similar to these that facilitated the inspection of the coeval «urns» located over the «water-distribution towers» (called also «water-towers», or «castelletti»), characterizing the historical urban tissue, was so realized: the main structure was constrained to wall through flat iron triangular corbels («righettone» flat, «a sguscio» corbel); the edge-flats, constituted by a double «righettone» flat (having dimensions of 4,5 x 1,5 cm), were constrained to these corbels through pins and nails, that were subsequently clinched. The handrail iron vertical rods were connected to these double iron flat and were
Figure 1
Iron staircase of the Trabia castle (Trabia, PA)

Figure 2
«Water-distribution towers», located in D’Ossuna square, in Palermo

performed with the same type of iron. The steps were realized also using a flat iron of small dimension («righetta» flat), as well as the inclined connections between the aforesaid iron vertical rod.

Because of the lacking mining resources, the transport difficulties and the elevated costs of the raw materials in Sicily, up to the first half of the XIX century, the foundries in Palermo were specialized only on handicraft production, inadequate to the melted-iron workmanship for building use.

Although in the second half of the nineteenth century the local building employment of this material was still limited to sporadic applications, structures designed on French or English models or directly imported from other Countries had notable success, also thanks to foreign specialized magazines that not only divulged new techniques, but above all proposed finished products. Not casually many of these structures were directly imported from France and then assembled «on site». The first panormitan foundries, the Oretea, founded in the 1841, the Gallo (1842), the Maggio (1850) and the Panzera foundries (1870) should compete with foreign Firms, like the French Izambert, privileged as regards the first not so much for a superior quality of the products, as for the
Francophile predilection fed from the diffusion of magazines and catalogues that supported the France myth, and particularly of Paris like capital of the good taste. In the tables that illustrate the numerous solutions and brevets of constructive systems for the iron and cast iron staircases, often, there wasn’t a specific reference to the plant, and this circumstance underlines that for any adopted form, whichever was the conformation of the staircase space, and the landings there were or not, it was possible, varying the combination and the assembling of the parts, to maintain the same structural warping. It was the applicative case of the staircases with rack-sides, shaped in a different way in function of the flight development. In this way, for any ordinary dimensions plant used for the eighteen century residences, cutting the sheet according to the plan dimensions, it was possible to realize a staircase in brief times, also intervening in a very limited way on the existing structures. (Figure 3)

In considerations of these advantages, an obstacle to the diffusion of this staircases type often was represented by the more elevated cost as regards the wood staircases, but the reduced expenses for the maintenance surely turned to advantage of the first type.

If the reduced dimensions of the metallic frame parts, the realization rapidity, the exceptional versatility of the industrial semi-worked product and the simple execution of the connections imposed the importation models, the local diffusion of the constructive techniques connected to the iron use, often revisited by the local planners talent and by the artisans mastery, contributed to the wish of the type creation and a critical adaptation to the local demands; this condition carried a new rush for the local production of original elements.

An example was represented by the symbiotic relationship established between industry and craftsmanship for the iron coverages realization of the two big panormitan eighteen century theaters, the Politeama Garibaldi designed by G. Damiani Almeyda and the Massimo Vittorio Emanuele designed by G. B. F. Basile, in which the iron workmanship was efficiently exploited for adapt elements industrially produced to the designers demands.

This industrial product awareness, like a raw material that should suffer some ulterior elaborations, continued for all the XIX century, also in the small iron works of the more inspired sicilian engineers and architects. So in 1898 the architect Ernesto Basile, in the amplification project of a rural residence in the Agrigento province, he characterized his intervention by the use of industrial production elements and through these he designed an elegant winding-staircase that represented a junction point between stylistic research, craftsmanship and industry. (Figure 4)

It seems evident that, till the iron would be employed like a stone or wood substitute, the distance between material and its expressive form would had perceived in an evident way. The same architect Damiani underlined that the architectural form should imposed itself to the mechanics and not this to that.
On the other hand, it was already clear to the contemporary that in the staircases and in many other small iron and cast iron structures, the slenderness and the mouldableness, that characterized these materials, were exasperated in an artificial and redundant way, making a misuse of ramificated beaten iron ornaments and printed or fused decorations. (Figure 5)

The contemporary also reproached to the metallic structures an useless complexity as regards the structure and the assemblage systems, resulting often superabundant, revealing a certain distrust, above all for the big structures, towards the mechanical characteristics of the not forged iron.

The advantages offered by the iron and cast iron staircases were fundamentally the lightness, the
adaptability to different planimetric fittings, the space economy, the solidity, the possibility to realize structures of a certain elegance and the incombustibility. The iron employment for the staircases construction remedy to the inconvenients deriving from the wood use, that often was adopted not perfectly seasoned; this condition made unfixed the connections, also provoking stability problems and made unsteady the staircases.

Also the incombustibility of the metallic structures was appreciated limitedly to the comparison with the wood staircases, that generally just those made with iron should replace them; in a first time, in fact, the iron was used, denying the own superior ownership and structural potentiality, like wood.

The presumed fire resistance of the iron staircases was much debated. It was evident that the notable deformations which these structures were subject, the surfaces that overheated and the possibility that the cast iron parts, of which the steps were constituted, could break because of the changes of temperature suffered at the moment of the extinction, all these conditions made these impracticable in case of fire.

Besides, the prerogative of the incombustibility imposed that the staircase cage was built with masonry and that in the cage weren’t openings at the floors pianos, if not those tightly necessary to guarantee the access. The skylights prevented that the staircase becomes impracticable because of the smoke.

After some disastrous fires, that showed the iron staircases ineffectiveness to guarantee the safety of those people that occupied the building, different systems were experimented for protect the metallic structures. Respect to the hollow structural elements, like the winding-staircases nucleuses or the columns that support the landings, it seemed useful to fill the hollow with cement or in a better way with clay or dries sands. Other systems, like the circulation of air or water in the inside of the hollow columns, showed themselves complexes in the realization and little effective. For avoid the breakage of the cast iron elements not protected, it was preferred to use those who were placed straight and not horizontally, for guarantee the material homogeneity in radial direction. For the iron structures, the main problem concerned not only the breakage, but above all the deformation that these suffered because of the differential retirement when, red-hot, were sprinkled with water in only a side.

In the United States the first fire-proof systems were experimented and had big diffusion; these systems foresaw the covering with uninfiammable and insulating materials, like stone or brick elements and above cement plasters.

The more diffused and convenient solution proved the covering with special brick pieces, solid or hollow, connected from steel little spanner and with external striped surface for allow a better plaster adherence.

For structural iron elements formally complexes, like the shaped sides or the staircases helices with a circular plant, it resulted more easy the covering with chalk or bastard mortar on a cement or hydraulic mortar floating coat. A double net layer, with a thin mesh in the inside and bigger in the outside, leave an empty interstice and guaranteed the plaster adherence. (Figure 3)

The fire damages revealed the not sufficient use of incombustible materials, or with a good fire resistance, but it was necessary that the same constructive system they constituted were really sure.

Besides, the iron and cast iron employ in the staircases construction allowed a reduction of the encumberance and more complex formal solutions with small expense. The refined cast iron components, produced in a semi-industrial way, didn’t require in fact ulterior decoration works, resulting therefore more convenient as regards the wood elements, that required entirely an handicraft workmanship. So, while the same cast iron elements, like the step tread and step elevation, characterized in a diffused way the small service staircases as well as the richer examples, the use of iron forged for model the staircases sides with a more articulated development and the iron beaten finishes employed in the more fanciful handrails were exclusive appanage of the last ones. These considerations underline like already to the half of XIX century, in a period of an industrial product exaltation, the handicrafts manufactured articles continue to be considered an «added value», above all for these small structures that were real furniture elements for the inside rooms, often characterizing also the buildings outside with their discreet or declared presence. (Figure 6,7)

The iron staircases success, above all in some contexts, it was favourite because these were presented by the sanitary engineering manuals and the hygiene treatises, that had wide diffusion
beginning from the second half of the XIX century, like structures also able to guarantee hygienic and salubriousness conditions. In fact these structures were often deprived of step elevation, allowed a better ventilation. Besides, the perfectly smooth and not porous surfaces facilitated a more deepened cleaning and didn’t allowed the micro organisms development and sprouting.

The step treads, despite result less hygienic, had often realized with wood or stone; the iron ones resulted in fact little sure because of their smooth for the use surfaces. It was preferable to employ cast iron perforated step treads or treads covered with materials easily washable like linoleum.

**CONSTRUCTIVE AND TECHNOLOGICAL CHARACTERS**

The constructive systems that characterized the first iron and cast iron staircases had often derived from those traditional systems of the stone or wood structures.

That explains why, still at the half of XIX century, in many cases for these materials has not matured neither an autonomous expressive form or, also having acquired an own structural affirmation, a connections system that didn’t require an ulterior definition during the construction.

We refer to the staircases in which the static operation of the stone monolitic steps was re-proposed with cast iron steps melted only in an element; this was, for example, the case of the «at neck» («a collo») winding staircases, or the case of the bound-staircases («scale a salzo») with a rectilinear development.(Figure 8)

Solutions of this type were soon abandoned for a decomposition in single portions of elevation, tread and sides, allowing as a more easy assemblage, simplifying the fusion operations of the elements, guaranteeing a better adaptability to the different planimetric schemes and facilitating the movement and the transport, fact surely not negligible in a period.
in which the metallic semi-worked elements represented an important export voice for Countries like England, Germany and above all France.

Examples of rectilinear cast iron staircases were very rare, either because they resulted excessively heavy, or because the very long rectilinear climbing elements were subjects to strong flexion solicitations to which the cast iron hardly could withstand.

The cast iron was used in prevalence for the realization of winding staircases with central mainmast, that could be constituted by the overlap of «glasses» jointly with the staircases, or that could present, in the case of soul constituted by an only piece, flanges, joint systems, rings or angle-iron applied, that they allowed a simple connection between staircases elevation and tread.

When the mainmast was represented by the «at cylinders» type with sleeve, (Figure 9) it was possible to insert inside it an iron bar, fixed to the foundation through a base plate, that arrived to the landing or that it could be prolonged up to the ceiling of the superior floor; for greater diameters it was possible to apply an oak upright. Also for avoid small mutual movements between the staircase parts, the «mainmast-iron bar» complex became solid by a cement-mortar throw, injected inside the soul.

The connection of the elements constituting the staircase had realized by the handrail upright that, spending through the two buttonholes to the external edges of two following treads and by the mediate sleeve jointly with the elevation, it made stable the whole structural complex. The connection between staircases elevation and tread had made still more rigid from the corbels insertion, that could be fixed by bolts connected with sweet-iron pins or through fused flanges. The iron corbels didn’t develop only a static function, but they often were the elements that mostly qualified aesthetically the «at sight» staircases.

The sweet-iron pins had used in a diffused way like connection system, because the cast iron brittleness didn’t allow the adoption of «at percussion» connections.

For circular plan of diameter better than 2mt, it was opted for «at empty spindle» («a fuso vuoto») winding staircases; in this case, the carrying elements, either that were the staircases treads or the elevations, they had inserted into the cage wall. An interesting example of this staircases type was represented by the staircase of the English Country House in Berlin. (Figure 10)

The cage diameter was equal to five times that of the spindle; the elevation, that constituted the carrying element, had thickened in correspondence of the inserted portion and acted from support for the tread. The two elements were connected by a squaring that contributed, with the big handrail batons, to the realization of an empty and very rigid spindle.

In this and in many other cases, the staircase was realized at completed building works, when straight the cage had stayed already plastered; that underlines the assemblage simplicity, effected simply with the use of a very sharp chisel that allowed to draw in the wall the buttonholes for the corbels placement. The assemblage facility (6 steps daily), the saving on the skilled workers job (they were sufficient a mason and a blacksmith) and the possibility of intervention in a not destructive way in existing buildings, favoured surely the diffusion of this type of structures.

For make lighter the cast iron staircases, in any cases, it was possible to not insert the elevations; the same staircase treads boring didn’t absolve only an aesthetical function but she also contributed to a notable weight reduction.

The exclusive cast iron use for the staircases realization, initially very diffused for the facility with
Figure 9
Cast iron staircase with assembled steps and sleeve-mainmast. (Pareto R., Sacheri G., vol.VI, p.1, p.1669)
which were strained elegant elements also with reduced costs, was soon limited to the small internal winding-staircases, or rectilinear secondary staircases on which elevated loads must not transit. The facility with which the cast iron elements broke theirselves because of bumps or changes of temperature, it made them in fact less reliable as regards those realized by forged or laminate iron that guaranteed, at parity of resistance, an own weight reduction and a better safety, also in the case of the external staircases, mostly subject to the temperature variations.

However, the use of the iron laminates was limited to the structural parts because the smooth and naked surfaces was considered less elegant, and the beaten iron had used limitedly to the accessories like handrails and decorative elements, because of the elevated costs.

For this reason, the metallic staircases that had a better diffusion, were those in which the iron and cast iron potentialities could be exploited.

At difference of the cases till now illustrated, that take back constructive schemes re-leded to the stone staircases, in the iron staircases the techniques of realization were inspired rather to the wood structures, because wood was a material similar to the iron for his good traction resistance.

The reference is evident in the so-called staircases with «at saddle» («a sella») steps, in which these last was supported by iron ribs («costole»), simple or double in horizontal or in vertical, in flat forged iron. The iron ribs, mails to the sides of the jaws («branche»), could be shape according to varied forms. Examples of staircases so conceived were the first one that located in the palace of the Alberto prince of Prussia in Berlin, in which the steps, melted in only a piece, were based both the extremities on two groins, and the second one that placed in German Cathedral always in Berlin; in this case the staircase tread had connected through iron squaring to a helicoidal groin. It was possible to realize either ramps of notable dimensions through some intermediary groins, or agile little staircases with iron steps or pegs. These last had realized inside or outside of towered buildings; for the easy construction and they for the reduced spaces that occupied, they were often used in the XIX century in the reconfiguration and splitting interventions of palaces and castles.

The ramps, constituted simply by flat irons, they were hooked to the intermediary landings that realized the walls connection by the means of an iron bar folded up to straight angle and inserted at the extremities. The stability was guaranteed besides by the presence of two corbels connected to the iron bar through brackets. In case of very long ramps, intermediary supports, constituted by wall-inserted corbels, were placed. (Figure 11)

These same staircases, for their lightness and for the structure slenderness that didn’t hinder the light passage, had positioned in a stable way on the big skylights and greenhouses, for their maintenance and cleaning.

The sides groins could be replaced from laminates that they constituted the staircases full-sides. These could be realized with steps inserted in the sides, for architectures examples remarkable as regards their dimensions and decorations, or with superimposed
stairs, for the more common house-building. The staircase sides could be also realized, in the case of inserted steps, with C, double T irons or plates, hems with flat or angular irons. If the steps had superimposed the plate presented itself «rack-shaped» and could be formed in an only piece or by some parts, equal to that of the steps, connected through flat spiked irons.

The stairs were connected to the sides through L irons that followed the elevations and treads course; these last could be realized with stone, wood or striped or grained floor-plates. When one of the staircase sides of the ramp was adjacent to a wall, it was realized a step support through flat shaped irons provided of fasteners.

If through the designers ability and the blacksmiths skill that realized these hand-manufactured works, was possible to realize iron forged staircases presenting the more complex forms, at the same time the decoration problem of the smooth-plates surfaces constituting them was left.

And still at the end of the XIX century the matter was so noticeable that one of the disadvantages attributed to the realization of this structures type was that, despite the staircase raw structure was expensive like a stone staircases, the exigence of superimpose to the naked iron a decorative apparatus made these ulteriorly onerous.

In the architectural manuals were intended models in which the ornamentation exigence had resolved with a proliferation of decorative irons, printed plates and of an endless variety of cast iron rosette, brindilles and rubans, what they rarely contributed to the staircase stability and thicker they instead constituted a notable load increase.

On the contrary, in the specialized magazines to the iron architectures was moved an only reproach, that they were uselessly complicated in the details and with forms too rich for the execution modalities employed. For these realizations was in fact evident that the iron demanded a better cleaning and clarity in the details, because some details, acceptable when hand-performed by stucco, stone or wood, they appeared heavy and artificial if reproduced using the cast iron. It was usually, however, already beginning from the second half of the XIX century, fluently and in a way just in that time defined like «commercial», the use of iron staircases cleverly assembled that resulted excellent examples for their structure, their disposition and economy, but in which rarely an adequate formal research could be founded. In the refusal for the undecorated surfaces we can realize as in that time the coeval were distant from formal solutions that could liberate theirselves by aesthetical
consolidated schemes and as any marginal realization of contemporary architects could result innovative, like these proposed also by Viollet-le-Duc.

In the 1876, at Chateau of Eu, he realized a staircase that for the forms study and the particular disposition represents an interesting case. (Figure 12)

The Viollet-le-Duc conviction that the employment of new materials like iron and a more rational vision of the structure and the distribution were the elements through which it would be expressed the XIX century architecture could also find its foundation in this small building work: no concession to decorative elements that they were not tightly functional, a very simple and clear structure conception, simple and visible details.

He built a staircase whose cage had arranged inside the old building walls, in which it was not possible insert the steps, besides the landings that allowed the access to the different floors didn’t correspond vertically the ones to the others. The architect, choosing the simpler solution and, like we would say today, «less-invaded», planned an independent from the perimetrical walls staircase, that presented an empty nucleus delimited by four upercuts and externally delimited from a plates spiral, connected to the masonry through iron corbels, inserted in correspondence of the vain angles. The four vertical supports had constituted from a square iron soul contained between four angular, and between these was inserted the rack-plates. In correspondence of the rack-plate prominences and along the inferior border, small angular permit to fix the staircase treads and the intrados wood tread-covering. The two handrails, interior and external, they presented different solutions; the first one was realized by a cut-plate with phitomorf motives, the second one, in beaten iron, had constituted by square upercuts and spiral motives.

In the same period in Palermo were realized iron and cast iron staircases that they could be defined semi-industrial and semi-handicraft for the components used, and for the skill with which they had adjusted to satisfy the designer exigences. We could consider two examples, the staircases with empty spindle in the Villa Whitaker-Malfitano veranda, designed By Ignazio and commissioned to the Izambert foundry in Paris in the 1882, and that of the Pignatelli Institute, located in the Colli plane. (Figure 13)
A technique development that was accompanied to a taste evolution could be individualized in the replacement of full plate sides with iron frameworks that, reducing at minimum the iron employ, they made apparent the structural line like a decorative element.

Often in the iron frameworks staircases the handrail collaborated with the carrying structure because the upright also assumed the function of rods, making in this way the staircases sides extremely resistant.

A particularly interesting example for the structural clarity and for the light skeleton without decorations, it was that of the Venetian Cotton-mill staircase in Venice designed by the engineer Mazzucchelli, in which the superior T current was rectilinear, the inferior was curved and the connection rods had realized simply with flat irons. (Figure 14)

The staircases with iron framework sides evolved in simpler forms, based on the connection of a maximum number of two or three elements. This was the case of the Joly, Wilk and Puls staircases. These, constituted by parts of reduced dimensions, presented the advantage of be transportable, easily assembling and aestetically pleasant. (Figure 15)

**NOTES**

(*) In this unitary study, it’s possible to ascribe the first paragraph to ing. Tiziana Campisi, and the second paragraph to ing. Calogero Vinci.
The iron staircases: Light and inventive solution of historical architecture

REFERENCE LIST


Figure 14
Staircase with iron framework sides, in the Venetian Cotton-mill. (Pareto R., Sacheri G., 1896)

Figure 15
Staircase with iron framework sides. (Donghi, 1925)