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Identification and conservation in Alvar Aalto's industrial sites: The case of Toppila Pulp Mill

Fransesca Piccolo

Ph.D student
Oulu School of Architecture
Virkakatu 3, F 132, 90570 OULU, Finland, +358 44 92 39 460
Francesca.Piccolo@student.oulu.fi

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Industrial sites as recent product of restoration

During the first industrial revolution, factories were not a place for architects. Plants were born as product of engineering and business: they were supposed to be efficient and lucrative. Manufacturing processes, location of machines, installations design had nothing to do with design. Plants aimed at developing technologies looking constantly looking towards. On the contrary, architecture aspired to stop time. Indeed, the architects themselves saw the industrial assignments as a sterile task, due to limitations of creativity.
In the 1900s, architecture was looking for new references: the disappointment gained from the 19th century values, the advanced use of materials and technologies, the new building typologies and the "demand for morality" (Giedion 1967) drew attention to the industrial phenomena.
Consequently, architecture transformed its features but also its substance. The use of iron, concrete, glass was totally reinvented and new construction methods were developed. Prefabricated elements and dry assembly made the building process more similar to the industrial one. Indeed, standardization put in contact engineering and architecture, distancing the latter one from art. Modernism wanted to be a breakpoint: buildings were not consider as artistic artefacts, but rather efficient machines. Therefore, if architecture learned technology from factories, industrial buildings got nearer to social matters. This mutual exchange favoured a synergy between architects and engineers which gave rise to a different outcome. It was till an extraordinary product, but it carried other kinds of values.

For this reason, restoration subject took its first steps slowly in the conservation of industrial sites. Indeed, factories were not even contemplated in restoration about fifty years ago. The Venice Charter was just related to historical monuments and Cesare Brandi[1] in his *Teoria del Restauro* (Brandi 2000, 3) even distinguished between two separate categories of interventions - industrial products and art works- outlining different weights between functional aspects and artistic ones.
Industrial buildings were too close to engineering and not enough artistic to be seen as an extraordinary product in need for specific cares.
Over the years, temporal distance has favoured to create not only historical value but also deeper awareness [2]: industrial sites, factories, machineries, workers' houses bear witness to mankind´s history and its civilization. Nowadays specific international guidelines promote the conservation of such heritage[3], but this subject is still evolving and waiting for fresh answers.

An essential role is played by the material form. As Brandi argued, restoration has to focus on the material form, because the art work takes place on such surface. (Brandi 2000, 6) The outstanding value of the original substance is highlighted by The Venice Charter as well: "Replacements of missing parts must integrate harmoniously with the whole, but at the same time must be distinguishable from the original so that restoration does not falsify the artistic or historic evidence" (1964)
Consequently, the original material form is a guarantee of authenticity.

The case of functionalist factories is extremely interesting concerning the original substance, distinguishable interventions and authenticity. They consist of reproducible materials: cheap and efficient constructions, standardized elements, but particularly emphasize the use of reinforced concrete . Furthermore, these plants were a perfect merging between architecture and engineering, making it hard to identify the architects' contribution in the industrial design.
Indeed, the conservation of many of factories faces two essential matters: the identification outstanding

values, the restoration of reinforced concrete and the reuse.

Toppila Pulp Mill in Oulu is an example of this complexity. It was the first proper industrial assignment of Alvar Aalto. Although the experience turned out to controversial because of the restrictions gained by the client, the industrial processes and the tight budget, the collaboration was a new starting point for his career and for the development of new ideas and goals.

The research aims at interpreting Aalto's contribution as part of a synergy between architecture and engineering. The review of the historical events is seen as the first step of the conservation process: the identification of key points sets the parameters for the restoration action.
A special attention is paid to phenomena about the degradation of the reinforce concrete, in particular in the wood chip container, since it stands out both its intangible and tangible values.

The involvement of the architects in industrial buildings design: Aalto and Toppila Pulp Mill
At the end of 1920s, in Oulu, Toppila cellulose factory was seen as a proper symbol of rebirth because of the local economic situation. The board manager of Toppila Oy Gösta Serlachius understood the significance of the plant, playing a role as patron of art: he insisted on getting an architectural contribution in the industrial design, even though the project had already started by the engineers Nyrop and Mattas in 1927. The emergent Alvar Aalto was chosen to solve such task. The architect was making a name for himself abroad, introducing Finnish culture to European countries. Because of that, he was a perfect candidate for the assignment: he could be the perfect interpreter of the values the factory wanted to convey.
To tell the truth, these values did not correspond with Aalto's own. He was exactly turning his vocabulary into the modernist principles, when he was involved in the design process in the 1930. Indeed, Toppila pulp mill is included among the *Turun Sanomat*, Paimio Sanatorium and Vyborg library drawings on a time scale.

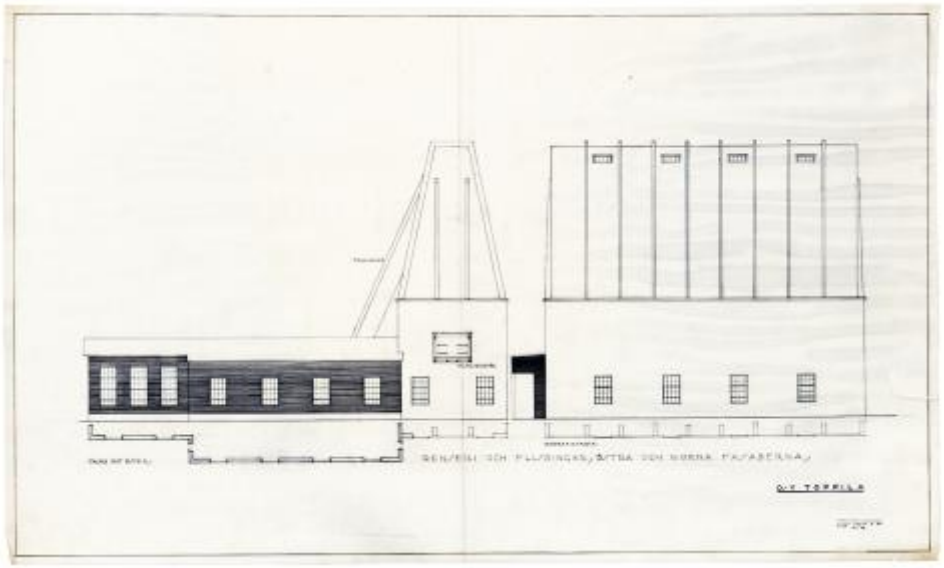
On the other hand, Serlachius still belonged to a generation of traditionalist Finns who saw Finnish industry as a nationalistic matter. The same position itself of the manager was the result of a national protectionist policy with entered into force in 1919[4].
The director of Toppila factory needed Aalto to embellish the outward appearance of the buildings. Materials, colors, façade details and some activities were the main tasks of the architect. Additionally, a fundamental aspect of the matter was related to the economic situation. The assignment included a really tight budget because of the recession, weighing heavy on the stylistic choices.

The cellulose factory was a proper challenge, but despite everything, the designer did not back off. This experience turned out like an ancient *gymnasium* for the young architect: he got in touch with many professionals, some of whom would continue to work with Aalto later (Arkkitehti 10/1938), but also different industrialists. He proved himself in this collaboration, where anything could not be create from the scratch but simply transformed from construction into architecture, showing that creativity is also being able to deal with the constraints.
For the first time, the activities to design were unusual (the water tower, pumping station, boiler room, digester, acid tower, steam power plant), they presented specific needs and requirements such as efficiency, which was a necessary parameter to allow the factory to carry out its function. But most likely these conditions offered new detailed considerations of form and function. In spite of the limitations, Aalto tried to put into action the CIAM criteria through the use of color and the smooth shapes in order to enhance the atmosphere of the place: it was a chance to test his own approach to Modernism and machine aesthetic, as a matter of fact his interpretation of the new architecture was never

conventional. According to Göran Schildt several details in Toppila industrial complex highlight a tendency to organic architecture: “from the unschematic grouping of the buildings to the freespan roof of the drying room, reminiscent of Maillart’s bridge constructions, and from the cathedral ceiling of the chip container to the soft joints of the conveyor belt.” (Schildt 1994, 147)

Actually this short description points some key points in Aalto’s work in Toppila plant. More precisely, they form the basis of his “industrial vocabulary” and the result of what he learned from this unusual collaboration. This lesson taught to the architect how to achieve an arrangement between architecture and engineering. He was able to combine site plan and circulation, machinery and functional solutions, industrial processes and atmosphere, source of forms, self-supporting concrete constructions and bricks surfaces. He made a dialogue possible between innovation and tradition, the place and the buildings.

The development of such industrial vocabulary is supported by the tracks left in the successive industrial assignment. For this reason, it is interesting to compare the project for Toppila Sunila: they are two extreme cases (strict design restrictions versus wide creative freedom) but are also temporally related, since there are only about 5 years apart. These conditions give the chance to identify the common key points and to follow their development over time.
Indeed, Toppila Pulp Mill design task and Sunila´s were not so far from each other as it looks. Aalto gained more freedom in the Gullichsen’s assignment, but this flexibility resulted also from the chance to plan various buildings not involved in the manufacturing process. Indeed, once again, the plant itself was designed by the engineers. They played a key role in designing the preliminary plans, location of machinery and structures. Also in Sunila assignment, the architect was asked to take care of the outward aspect of the plant and to draw the details of each building. (Hipeli 2004, 35) Actually, even though they praised different ideals, there were some similarities about the architectural criteria. The main reasons are related to some important aspects: both mills produced cellulose pulp, shared manufacturing matters and so the same industrial processes; the construction engineer Nyrop was involved in the engineering team (Korvenmaa 2004,14); financial circumstances imposed some critical restrictions about materials and masses, sometimes reducing architectural design just to essential features.



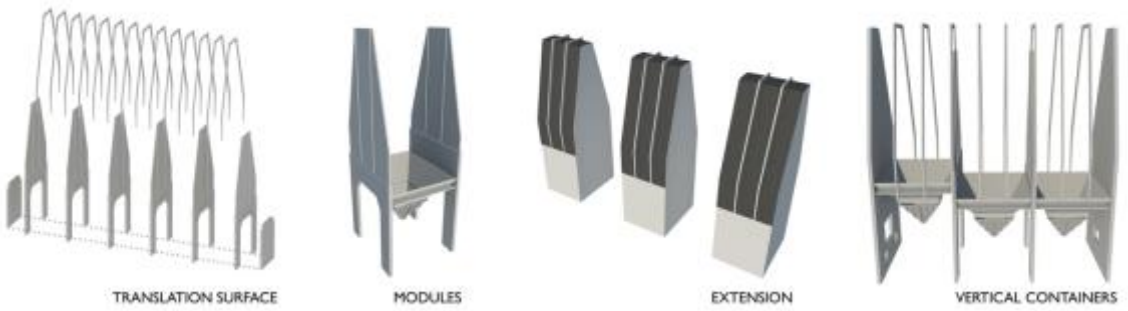
1. Sources of form – 70/58, “Alvar Aalto Oulun Horisontissa" exhibition material, Oulu University School of arch. Hist. Of architecture and Restoration studies archive, 1998

Furthermore, the materials were similar. The constructions of both mills are in cast reinforced concrete and completed with red bricks. About the coating, Toppila was characterized by limewashed surfaces while in Sunila the internal walls were whitewashed. (Hipeli 2004, 35-99) Lime wash and white wash are from different reactions, but present similar results. In Oulu Aalto focused much on surfaces because he gained more freedom in their design. Moreover, the architect used the colors to unify all the buildings in one single composition.
About the source of forms, Serlachius did not allow functionalist features in Toppila area, but Aalto found a way of introducing them in the small details such as *soft joints*. In Sunila mill, the architect was free to choose an organic design for the warehouses (glauber salt warehouse, sulphate warehouse). Storage buildings included no industrial processes, giving less restrictions to the their architectural task. This is the reason why storages are entirely different from the other factory buildings both in Toppila plant and in Sunila one. They became a sort of landmarks. It is interesting to underline that the glauber salt warehouse in Kotka shares some common aspects with the chip container in Oulu.

A key reading of this subject is about "functionalist" engineering. An important tip has been suggested by Schildt about Maillart's work. It was not a coincidence that also Sigfried Giedion paid a particular attention to the bridges in *Space, Time and Architecture*. The Swiss engineer and the French one Freyssinet caused a turning point in the history of construction and a support base for the *new* architecture, because their design of the structures brought a radical change of view about the use of reinforced concrete. The innovation concerned the method of building: each nonfunctional element was removed or turned into a loadbearing one, obtaining self-supporting structures which were made only from active components. So far, beams and columns worked like the model of timber construction where the framework was loadbearing and the slab was placed passively on the structure (one-dimensional support), but in engineering design, reinforced concrete takes its first steps into the second dimension.
Mushroom columns, beamless self-supporting slab, eggshell thin surface, form-resistant structures are some of the main recurrent elements belonging to this method of building and so to numerous industrial buildings. Indeed, they were often used in warehouses or more generally factories. (Giedion 1967, 450) This reason enlightens the value tied to Aalto's plants constructions. Of course, the engineering team, which Nyrop was involved with, was the main responsible for structures, but it is should be underlined the architect's laboratory itself was not stranger to these elements at all. As a matter of fact, mushroom pillars appeared already in the *Turun Sanomat* (1928) printing room or the famous *Armchair 42* (1932) where these criteria were applied to furniture design, using some sheets of plywood as eggshell surface. (Giedion 1967, 465)

Therefore, constructions played a central role both for engineering matters and also for architectural ones in the abovementioned industrial complexes. A special attention has to be paid to the warehouses since they can be defined as a leitmotif. Indeed, the ceiling of the chip container in Toppila and that one of glauber salt warehouse in Sunila plant follows the same structural criteria: they are both eggshell thin surfaces which collaborate actively with the ferroconcrete ribs. The shape of the storages results from geometries which are form-resistant structures. The main difference concerns the shape itself: the glauber salt warehouse is made up by concrete vaulting, resulting in considerably softer design.
The basic form of the chip container in Toppila was sharpened, but extremely efficient. The original building consists of two ferroconcrete silos which were connected to a brick buildings on the southern side. Each storehouse was conceived to be an independent box like a proper module. The underlying idea of this construction was to create an expandable building if needed. Indeed, in the 1950s, a third silo was added to the previous ones. This architecture is characterized by self-supporting surfaces in ferroconcrete: the loadbearing walls, the "slabs", the eggshell thin roof, the ribs and they collaborate all

together.
The shape of the silos results from a geometry which is a form-resistant structure. It is repeated like in a translation, generating the main walls and ribs that work on the vertical dimension. This solution made easier and to build a new standardized module. The “slabs” form is really specific, in order to carry out its double task: it is an open box which assembles the vertical surfaces and to sustain the metal hoppers, participating in collecting the wood chips to be kept. The eggshell thin roof joining all them, making the structure a self-supporting single unit.



2. Silo key points– Image: Francesca Paola Piccolo

Aalto dealt with the construction as starting point of his own design. In spite of the economic limitation, the result was not just efficient. He comprehended the potential of the construction and its geometry, emphasizing the vertical orientations Indeed, the extensions of ribs aimed at ‘draining’ the rainwater more adequately, but made the overall view harmonious and ascending at the same time. Such rising perception turned a warehouse into an eloquent building. Aalto interacted with the atmosphere of the place, but also with the landscape creating landmark for collective memory.

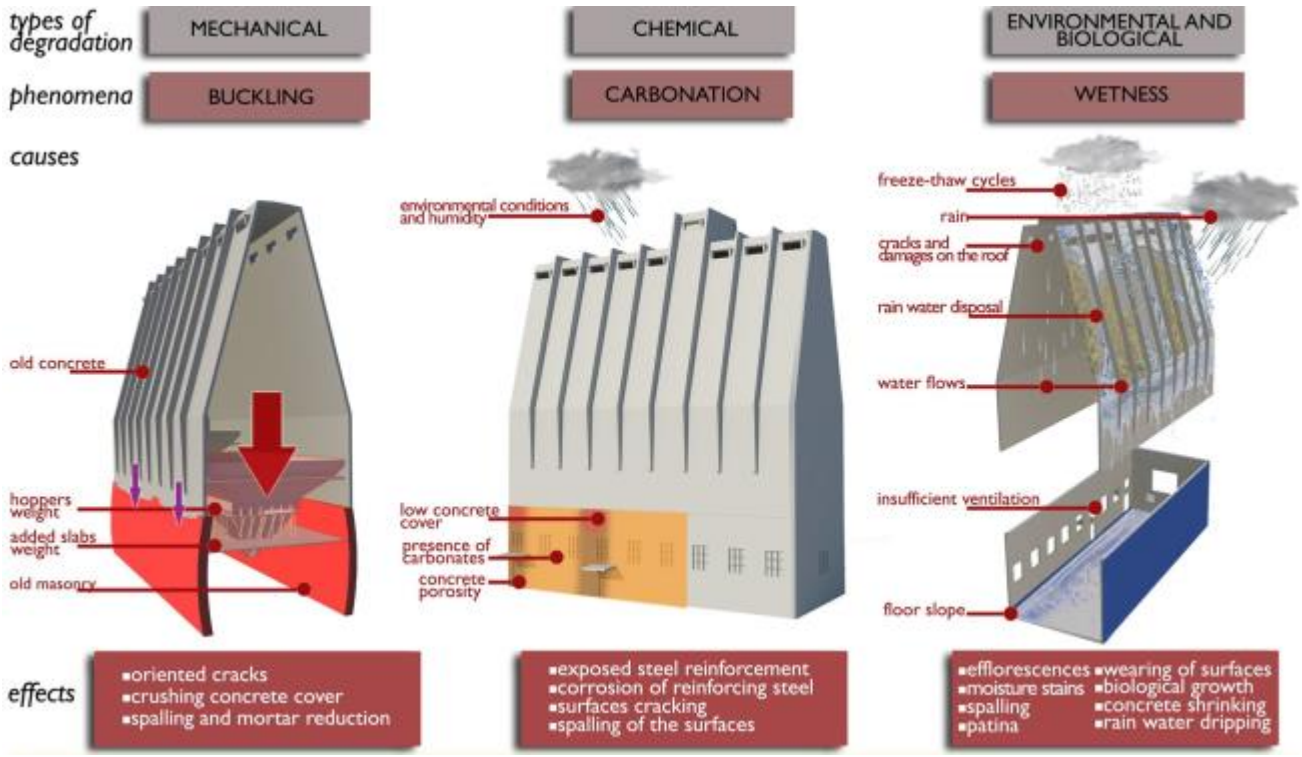
From the material form to a compatible reuse

Nowadays, the area is part of the inventory RKY 2009 and it is preserved by the urban plan tool. Indeed, the buildings of the ex-factory complex are labelled with different levels of protection: the silo is the most protected since it belongs to the category “sr-1”. The category demands respect of the original architecture as much as possible in order to carry out properly its message. It means that restoration has to find solutions to combine both the conveyance of tangible and intangible values.

Tangible values are related to the material form: they are what is possible to see and touch, it is possible to walk and experience. Moreover, they represent an urgency, because this is where intangible values take on their shapes. The degradation of the building sets the main parameters of the restoration action, because to support what is left is the first step of a respectful intervention.
Therefore, the study of the damages plays a vital role in this process. An accurate degradation survey, which involves a multidisciplinary team and an appropriate equipment, leads to a deeper awareness: it can suggest a meaningful and compatible direction for the design phase.

The damages report: causes-effects-solutions

As mentioned above, assessing the current state of the building is a fundamental stage for gaining basic information to the stage of restoration design. The research has been carried out through the use of basic survey tools: pictures, infrared thermometer and videos by drone[5]. The material gained on the site has been fundamental to outline essential hypothesis concerning the degradation phenomena. The study of cracks, the surfaces stains[6] and temperature suggested three main categories of degradation types. Then, these classes have been divided into phenomena, causes and effects. The decay issues are obviously connected each other, but a basic step is to understand the reasons: taking care only of the “effects” can produce just temporary solutions without solving any problem.

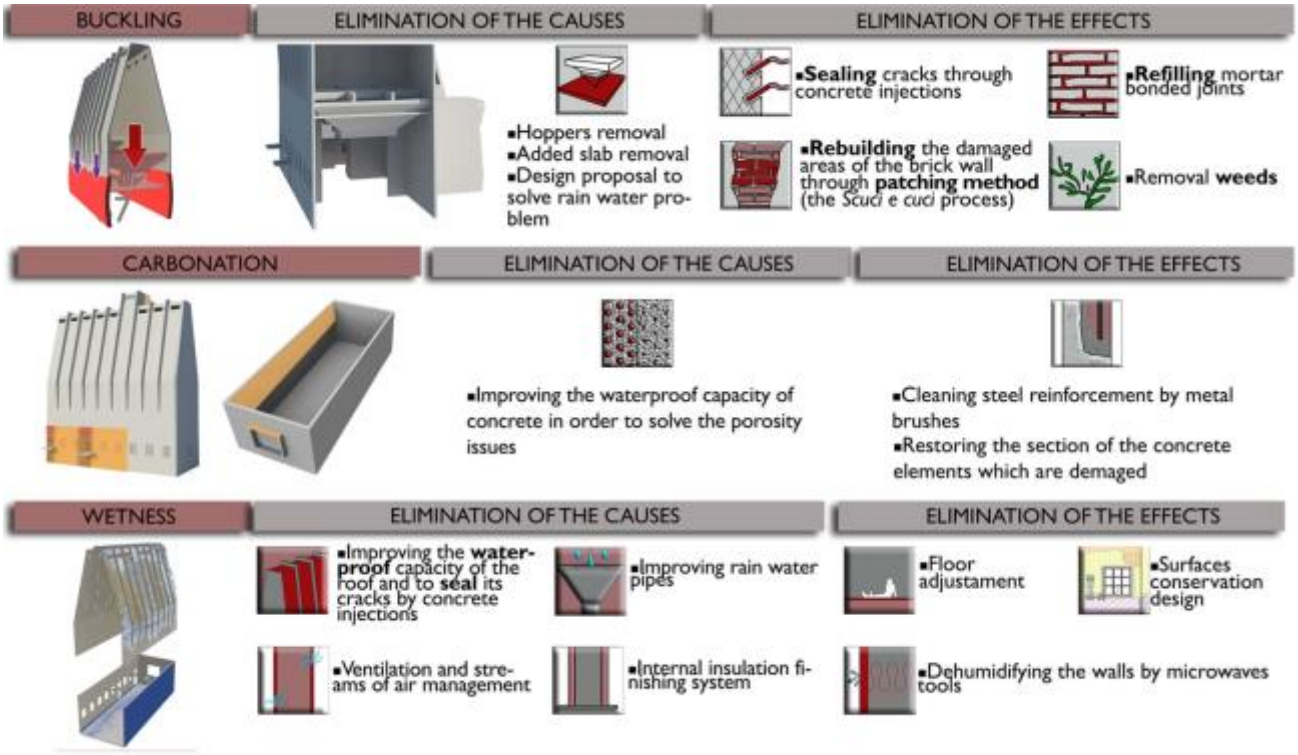


3. Hypotheses of the degradation issues – Image: Francesca Paola Piccolo

Especially in the case of industrial buildings, the weight of machineries and processes can create difficulties over the years. For example, the cracks on the eastern façade follow the borders of the infill wall: for long a time that surface supported the weight of the conveyor belt. The closure of the factory put automatically an end to that degradation cause, making sufficient to seal the cracks only. Indeed, the metal hoppers (also the successive addition of wooden slabs) add further weight on the structure or the problems of ventilation derives of the function of warehouse which was not designed to host human activities. All these matters affect the building substantially and should be taken into account for survey purposes.

Therefore, the damage report aims at identifying what and how to fix as matter of urgency.

In the summer 2016, the silo showed mainly issues of wetness. The ceiling was particularly damaged with holes, cracks and lacks in the bituminous cover surface, creating a proper water flow indoors. Outdoors the bricks and the concrete surfaces presented a loss of material because of the environmental and run-off rain water. These problems caused carbonation phenomena and the infiltration made the condition of wetness even worse. The lack of ventilation has generated significant cases of efflorescence and moisture. The intervention can be summed up by this procedure: cleaning the surfaces, restoring the sections/sealing the crack, skimming coating and improving the waterproof capacity of the materials. Furthermore, the research suggested the removal of the metallic hoppers and the wooden slabs in order to unload the structure and improve the regulation of airflow.



4. Scheme of technical interventions proposed – image: Francesca Paola Piccolo

The matter of the material form: the restoration of reinforce concrete silo

Reinforced concrete is a material of modern era and deserves a special attention in the restoration process. For these reason, the silo in Toppila is deeply meaningful: its industrial nature and its history make it a special case. The reinforced concrete construction was shaped to be just a wood chip container in its functional and structural honesty. Therefore, to take care of the structure adequately would be of paramount importance in a restoration project in the ex-factory, because it is a valuable element.

Indeed, an important difference between the modern heritage and the ancient one is related to the collection of quantitative data. Time is one of the few objective values, because it is measurable in numbers, but also offers a wide range of achievements and mistakes which is possible to learn from. In the case of functionalism the circumstances are totally different and still in study phase. Many modern buildings consist of reinforced concrete constructions, especially in the case of factories.

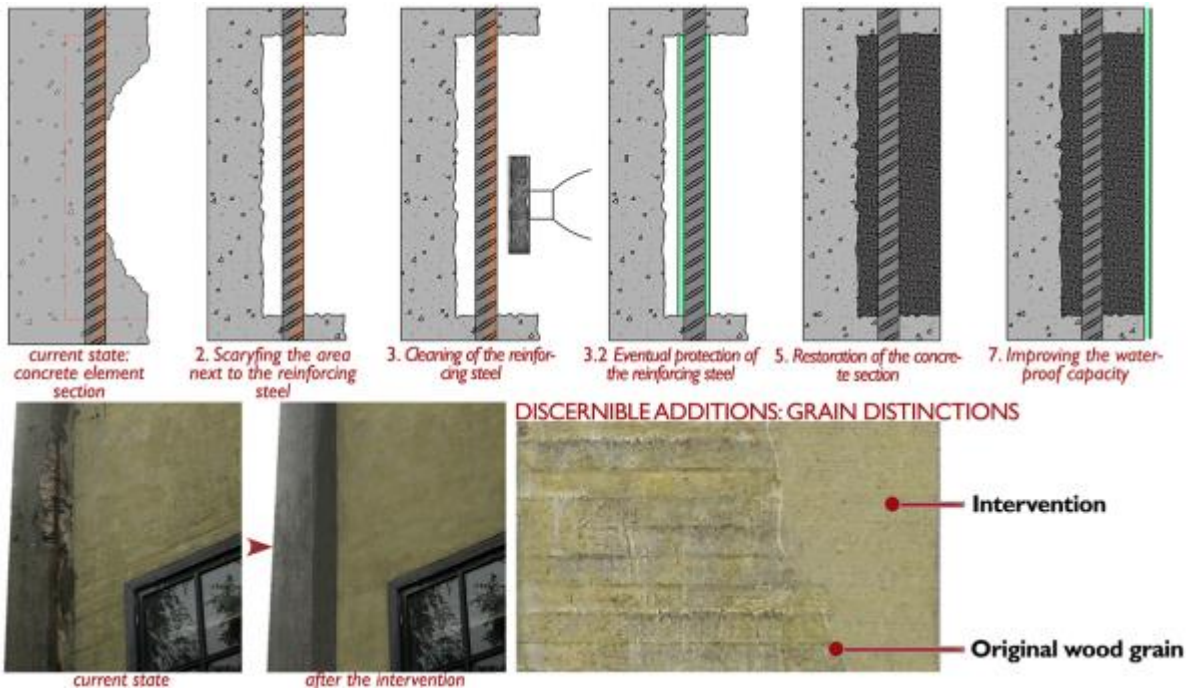
Cheapness, mechanical resistance and plasticity made this technique a perfect response to the industrial process needs because it was convenient and efficient, but also it seemed to be eternal, because of its own mechanical properties.

In fact, at the beginning of its use, reinforced concrete showed all of its potential. Only time revealed its vulnerability: cracks are physiological and appear on the surface even when they are not dangerous; porosity makes it extremely exposed to atmospheric agents and consequently, to moisture and mold; carbonation is recurring phenomenon which defaces the regular section of an element, compromising its mechanics and aesthetic. In less than one century, concrete has showed its own lacks about durability, leaving restoration theory and technique unprepared. For example, the plasticity which made this material so versatile makes the interventions problematic: reproducibility changes the concept of

authenticity, monolithic feature requires to scarify even the sane original portions to operate correctly on the damaged ones, material fluidity erases the patina and does not permit to distinguish the additions, failing to fulfil the article n. 12 of Venice Charter about this matter.

The concrete structure of the silo is no exception. The carbonation phenomenon affects many parts of the structure, leaving the steel reinforcement exposed and subjected to further degradation. Nowadays, this case the only solution available is to scarify the damaged area, to clean the rusty bars by wire brushes and then to restore the section of the element. An important phase is the addition of a waterproof layer: it cannot be too permeable or too resistant, because the goal is to prevent the water infiltration but at the same time not to block the airflow and to cause moisture.

Moreover, the concrete surfaces of the silo are characterized by timber grain from the concrete formworks. This original detail asks new questions about its conservation: should the intervention be discernible? As Brandi argued, the restoration aims at reestablishing the potential unity of an art work: an artwork cannot be divided in different parts, it has to be conceived as an entity. But at the same time the *lacuna* can be filled up in similar way to the original material to guarantee a correct visual perception in its entirety and assuring an easy identification between original and additional layer. (Brandi, 13-18) So, the wood grain surface may definitely be a strategy to conserve the authenticity of the original material form.



5. Practical and theoretical issues about the restoration of reinforced concrete

A reinterpretation of an industrial work

Apparently, to keep the factory as an industrial complex seems to be the most respectful choice, especially concerning to Aalto's organic approach and his overall view about architecture. Unfortunately, this solution may not be suitable with the context anymore, it would be a too rigid solution. Moreover, Toppila area is developing as a wide residential area and is in need for different facilities. Because of that, the use of different levels of protection can be an efficient strategy of conservation. Indeed, the ex-factory can serve the community in order to create new values and to offer

compatible answers for people needs, meeting Aalto's humanism somehow.
Consequently, a good solution on larger scale is planning joined functions according to the protection levels: the buildings with less restrictions can support the others both for activity or technical solutions.

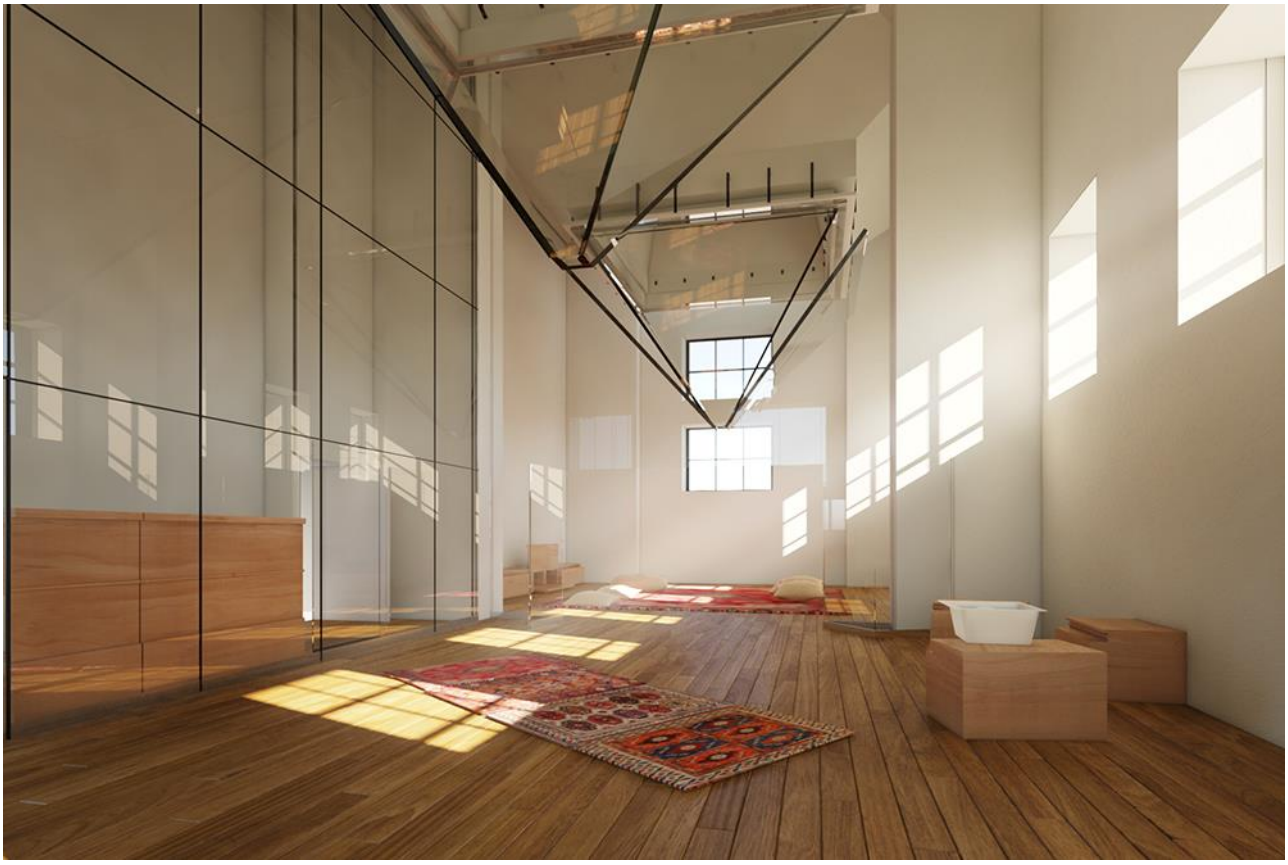
6. Silo, current state of the south façade (Summer 2016) - Image: Francesca Paola Piccolo

As mentioned, the silo is particularly valuable according to the urban plan: it carries landscape, architectural and engineering values. At the same time, the reuse appears limited by its complex structure: mixed constructions, three ferroconcrete boxes covered by a lengthened eggshell roof where windows are only at the base and at the top. So the building should be subjected to substantial changes to be functional, but such plan would not respect the criteria of the minimum intervention. If form follows the function, is there any compatible activity with spatial quality? The reading of Aalto's work and the previous analysis on the specific feature provide for an answer: the interpretation of the architectural type. The mark left in the collect memory, the landscape, the ascendant orientation and

the sharped lines remind of places tied to solemnity. The silo retraces the type of the civil or religious buildings regardless of belief or origin, because it is an archetypal form. But the container presents a restricted surface area and cannot provide for all the facilities.
The ex-dryer unit building could assist it: the unit belongs to a lower protection category and presents opposite features: a strong horizontal direction and a wide surface area. Indeed, this type evokes covered public spaces. For this reason a joined function turns out to be efficient, because it can supply functional and energetic lacks of the main building – the silo.

7. Design proposal for the dryer unit: a Multi-cultural center – image: Francesca Paola Piccolo
The structure is not covered to be appreciated. It is emphasized by the red sliding boxed in the “aisles”. The horizontal direction is underlined by a terracing construction, eventually removable.

If reuse creates new values in the respect of the original architecture, the interventions aim at conveying the intrinsic ones. Actually, the needs of the buildings themselves are the most important guideline: a technical issue can stimulate innovative solutions in design beyond to support the authenticity of the place. Like most of the modern buildings in reinforced concrete, Toppila Pulp Mill presents a shorter lifespan of his materials. Furthermore, the arctic climate and the manufacturing activity played an important role in the degradation phenomena. Furthermore, the lack of windows and so ventilation is significant and moisture is the main degradation issue of the building.
Examining the qualitative data of the building (modularity, single boxes, verticality etc.), a ventilation channel can become a creative solution which combines technical needs and design. Obviously, dry assembly is always preferable to respect the criteria of reversibility, distinguishable addition and minimum intervention.



8.Design proposal for the ex-chip container: a Multi-faith space – image: Francesca Paola Piccolo
The original hoppers has been removed to ease the ventilation and to unload the structure. The new ones are light, transparent, openable and removable: they aim at keeping the same spatial quality. Dry assembly solutions for the internal insulation finishing system and radiant floor panels.

9.-10.Design proposal for the ex-chip container: a Multi-faith space – images: Francesca Paola Piccolo
The modules are divided by flexible glazed surfaces. Each module can works independently or together, creating different functional combinations.
The hoppers are connected to cones and hide the controlled mechanical ventilation. The cones are “stretch ceilings” with lighting diffusers .

Conclusions

Aalto´s functionalism was as complex as a weave, where is possible to recognize various fibers of the same fabric, working as a one. In his work, all features were designed in detail to collaborate efficiently as parts of a unique entity, performing "as a natural solution" (Schildt 2007, 245). In his industrial works, this pragmatism is even more evident and made possible to merge architecture and engineering in one single entity. All the questions about the division of labor are fundamental and deserve appropriate answers but they cannot be the only way of interpreting the work, for it would narrow down the perspective leaving something important out. Indeed, it is fundamental to empathize with architecture and its parts: to comprehend that the artifact guarantees a better interpretation of the quantitative data. Therefore, the case of Toppila Pulp Mill shows the importance of evaluating Aalto's industrial work in an enlarged background in order not to leave anything to chance. Moreover, the research about the ex-chip container highlights some of the most intricate questions in restoration of modern architecture like concrete decay and functional purposes, trying to offer a different reading and answers for such matters.

Notes

1. Cesare Brandi's theories played a vital role in drafting the Venice Charter
2. In 1979, Australia ICOMOS drafted "the Burra Charter" . The document is inspired by the Venice Charter, but introduced the concept of "place", including "industrial plant".
3. the Nara document on authenticity, the Madrid Document for the conservation of the 20th architectural heritage and the Nizhny Tagil Charter for the Industrial Heritage.
4. After 1919, the foreign companies had to include Finnish citizens in the board of directors in order to continue their business.
5. In the summer 2016, the silo showed significant issues of wetness from the ceiling, but the upper part of the building was inaccessible. A drone has been used to check the roof out in order to take notes of cracks and stains on the surface.
6.The reference manual for the damage report has been: Coppola, Luigi (2015) Il restauro dell'architettura moderna in cemento armato : alterazione e dissesto delle strutture in c.a., diagnostica, interventi di manutenzione e adeguamento antisismico, materiali, tecniche e cantieristica, Editore Ulrico Hoepli, Milano

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