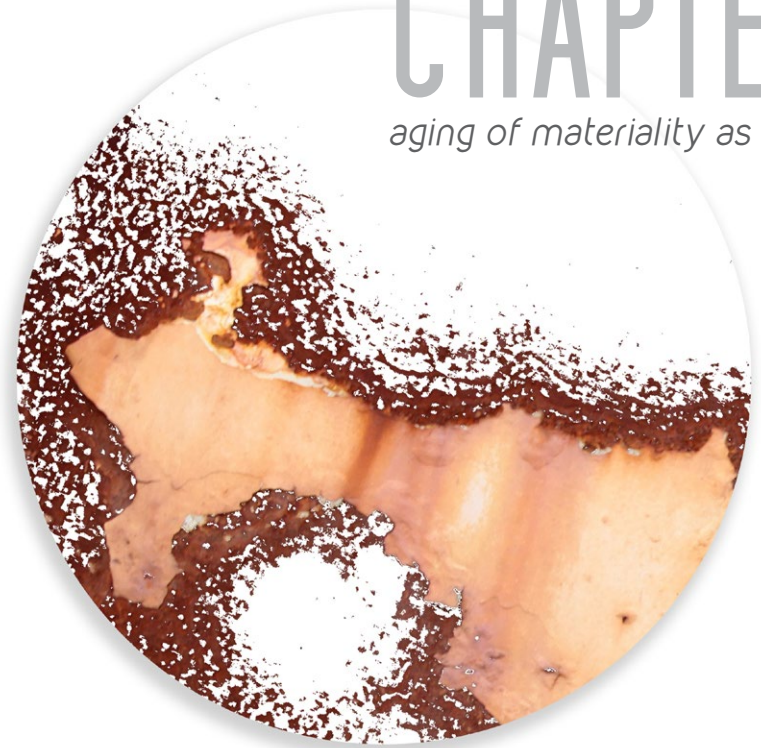


# 3

## CHAPTER

*aging of materiality as layer*



As the spatial and structural formation of vessels primarily rely on steel and the construction of a dock on concrete, this chapter will probe these materials theoretically in standings of their vulnerability to degradation. These proposed avenues of material investigation (corrosion protection, historic decay preservation and intentional oxidation) wish to conceivably ground potential design implementations that follow.



Figure 3.1. Layers of Time (Yume, 2010)

# MATERIALITY AS PALIMPSEST

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*"The land, so heavily charged with traces and with past readings,  
seems very similar to a palimpsest."*

André Corboz. 1983

Any surface where writing has been erased in order to accommodate new text is referred to as a palimpsest. When applied metaphorically, these actions can consequence into an architectural manifestation, which by extension, encourage the adaptive reuse of an existing structure. Similar to the act of erasing, a hint of what was will always remain as the past can never be fully erased. A palimpsest can be construed to have at least three connotations: the prior meaning, the new meaning, and the hybrid creation when reading the prior with the new. Ke Leng Tran (2011:7) continues by stating that "as past remnants appear partially through the new, the new work becomes an overlay of the old, making a simultaneous reading of both the old and new work. Hence, a palimpsest can be viewed in two ways; on the one hand, it is an entity that makes room for reuse and on the other, it represents a vessel for meaning." Subsequently, reinterpretation and rediscovery is created through the disclosing nature of a palimpsest, which reveals a state where layers of preceding work can be perceived. In addition to reinterpretation, this manifestation serves as an historic platform against which present amendments can be made, allowing for an entity that appears cohesive and seamless when comprehended in the future (Tran 2011:8).

When proposing the addition of another layer onto the existing fabric, it is vital to note that there are indeed **dissimilarities between renovation and reuse**. As the history and memory of a structure must be maintained in order to govern new appendages, it is essential that the proposed location be regarded as a ruin, "something in process, belonging to the past, present and future"(Scott 2008:96), and not as a historic landscape in need of preservation. Moreover, Fredd Scott (2008:7) stated that other than a work of art that is to be **preserved and remain untouched**, design decisions may allow for the **demolition or addition** to historical structures provided that **judgment is informed and unprejudiced**. He continues to challenge this believe by questioning whether further spatial amendment might not increase value, as the initial process of ruination produced such

a valuable result to begin with (Scott, 2008:58). Aside from this notion, Robbert Verheij (2015:30) cautions this form of romanticism by stating that design should not be tempted by mere images of ruin decay, but rather be used as a theme that informs the design process and entails an experience of bare materiality. In agreement with Verheij's standing, this study will focus on **the potential of material temporality and failures as a potential layer enabler**. Henceforth, when considering materiality as a form of palimpsest, the **quality of natural materials** that age characteristically should be ruminated (Verheij, 2015:120).

Likewise to the ghostly reminder of previous layers on a palimpsest, additions to a ruin allow for a structure to speak (Kahn, 1973:n.p.). Having analysed the language and layers of history embedded within the proposed **host and habitant**, how to move forward design wise will prove to be the main design discourse of this study. As opposed to the mere institution of a heritage approach, the **appendage of a new layer** is proposed that will **allow for past recollection and future addition thereon**. In order to assure that the metamorphosis of **philosophy and ideology** between the **past and present** become immediately apparent, the **investigation of steel and concrete corrosion as a tool of beautification** is required that will practically accentuate the process of layering.

The act of corrosion has been witnessed throughout the course of history. As **corrosion** can broadly be defined as the **degradation of a material's properties due to its chemical reaction with its environment**, the rate and level in which this fatigue occurs differ from one material to the other. Whilst primarily being associated with metallic materials, **all material types are susceptible to degradation**. Correspondingly to the formation of **patina** on bronze and rust on iron, timber can rot and concrete weather (Marcus and Maurice, 2011:100). In order to ground this investigation theory wise, the definite exploration of the main material associated with **a ship (the habitant) and dock (the host)** will be researched in this chapter - thus the corrosion of steel and concrete.

In nature, nearly all metals are unearthed in their stable **oxidised condition** either as oxides, carbonates, sulphides, sulphates or chlorides. In order for metal to be extracted from the applicable mineral, a reduction process is required during which a great deal of energy is engrossed. The resulting consequence of this hefty energy input converts the pure metal into a high energy condition labouring to return to its former oxidised, low energy and stable state as rapidly as environmental conditions will allow (Roberge, 2000:6). It is this distinct energy differentiation that occurs between the pure metal and its oxidised state which inaugurates the force for corrosion. Moreover, in order for metal to corrode (refer to figure 3.2), the establishment of a corrosion cell is indispensable. This cell is comprised out of an anode, a cathode, an electrolyte and a metallic path (Ahmad, 2006:9). Once established, the process of corrosion commences when a material is introduced to a corrosive medium. An electrochemical reaction occurs on the surface of a metal due to its energy rich base properties recovered through chemical reactions from naturally low energy minerals, inclined to transform back to its original form. Based on this process, two natures of corrosion reactions are distinguished: chemical corrosion, corrosion excluding electrochemical

reaction, and electrochemical corrosion, corrosion including at least one anodic and one cathodic reaction (Maab, 2011:2). For the purpose of this study, **corrosion is considered holistically as the process of universal material degradation. Steel corrosion is recognised as oxidation (rust), whereas concrete corrosion as weathering.**

Based on both the morphology of the attack and the situated environment, corrosion is traditionally classified into **nine divergent categories** as illustrated in figure 3.3 (Fontana & Green, 1967:34). The most prevalent type of corrosion is classified as **general or uniform corrosion** and is found widely. From rusting steel bridges to the tarnishing nature of silver, most unprotected steel left outside will show signs of uniform corrosion, which can definitely be delimited due to its predictable nature. One method of protection against uniform corrosion allows for the application of a sacrificial zinc layer that protects the underlying steel. This sacrificial form of oxidation permits another form of deterioration in the form of **galvanic or bimetallic corrosion** (Kelly & Shaw, 2006:24). As opposed to uniform corrosion, **pitting and crevice corrosion** occurs on certain areas of a materials' surface due to defective coating or underlying metals resisting deterioration through the formation of a native oxide. Contrasting surface deterioration, **intergranular corrosion** occurs when solidified metals, comprised out of once homogenize alloys, crystallises due to a chemical imbalance. This form of corrosion validities the mechanical strength of metals can often result into perfunctory fracture. In addition to this form of corrosion, **environmentally induced fracture** is generated when a material is exposed to a chemically reactive environment, such as an aqueous solution or organic solvent, which propagates the formation of cracks. The final form of corrosion, **dealloying**, transpires when one element in an alloy is selectively removed from the surface of a metal. Though limited to surface quality, in severe circumstances this selective leaching can cultivate into the solid structure of a material and prompt mechanical failure (Ricker et al, 1995:669).

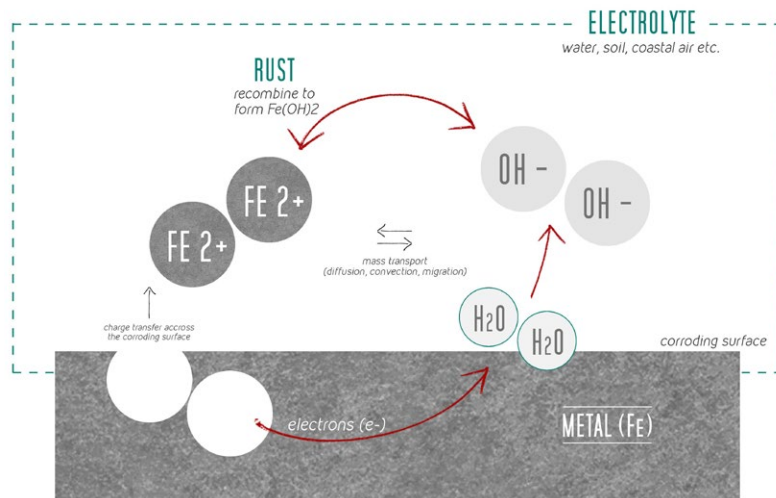


Figure 3.2. Process of Corrosion (Author, 2016)

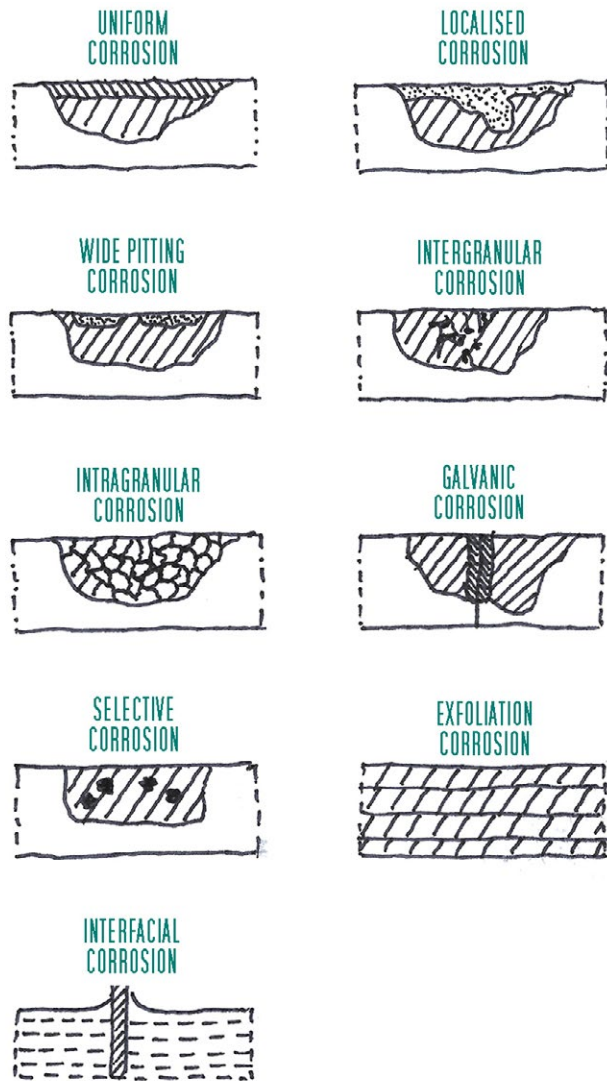


Figure 3.3. Types of Corrosion (Author, 2016)

Similarly to the deterioration of metals in the form of oxidation, the **weathering of concrete** is inevitable. Assumed as being the most widely used material of construction worldwide, the deterioration of concrete has assumed alarming proportion in harsh climatic conditions, such as sea-coastal areas, under recent studies. As illustrated in figure 3.4, concrete can be defined as the artificial stone produced when **cement** (usually Portland cement) is mixed with a **fine aggregate** (sand), a **coarse aggregate** (gravel or crushed stones) and **water**, the combination and quantity thereof is dictated by its intended implementation (van der Merwe, 2011:10). Being a very durable material in itself, the addition of steel embedded within concrete functions as an exceedingly effectual method of reinforcement. The minimisation of steel oxidation is reduced by the protective concretes' alkaline that environs the reinforcement. However, under certain environmental conditions, concrete may undergo degradation and reinforcing steel may also corrode. Dynamics that contribute towards the dilapidation of concrete is prevalent during the time of production. Good production practices demand adhering to lower temperature (5°C) and upper temperature (32°C) limits with the deviation thereof possibly leading to decreased durability. In addition to inferior practice, environmental factors can also affect the durability of hardened concrete. Freeze-thaw cycling, drying and carbonation shrinkage, humidity, sulfate attack and seawater are all ecological aspects contributing towards the corrosion of concrete (Ahmad, 2006:614).



Figure 3.4. Components of Concrete (Author, 2016)

As noted fleetingly overhead, the conditions of a coastal surrounding influence the rapid deterioration of both metal and concrete. Being that the location of the most prominent materials' of both the investigated host and habitat is prevalent by its nautical contact, further investigation in terms of **corrosion protection**, **historic decay preservation** and **intentional oxidation** is required in order to ground possible design implementations.

## 3.1 CORROSION PROTECTION

The protection of corrosive materials can be defined as the process, measure or procedure aimed at the minimisation, temporary delay and/or avoidance of corrosion by method of modification to a system vulnerable of degradation (Maab, 2011:9). Asserting the detail that properly manufactured concrete do not require conventional protection, but rather its steel reinforcement agent, responsiveness will be directed towards steel in this section.

**Active corrosion protection** aims to sway the reaction which ensues throughout corrosion. As opposed to only altering the material and corrosive agent, active protection influences the reaction itself in order to avoid corrosion. The addition of inhibitors to the aggressive medium and the development of corrosion-resistant alloys are examples thereof. **Passive corrosion protection** is used when mechanical isolation from the aggressive corrosive agent is required. The appendage of a protective layer in the form of a film or a coating is applied to prevent wear. Permanent corrosion protection provides perpetual defense against biotic, climatic and chemical hindrances relative to its place of use, by the addition of **a permanent chemical veneer**. These include **tin plating, galvanisation, enamel coating and copper plating**. **Temporary corrosion protection** aims to prevent stresses from occurring during handling, transport and storage and is easily removable upon utilisation or installation. For the purpose of this research, the elaboration of **passive protection methods** against corrosion will be investigated. As the main materials in need of protection are fixed and previously manufactured, other methods are deemed redundant. Furthermore, all newly introduced materials, both utilised externally and internally, will have to be passively protected or comprise out of an embedded active corrosion agent due to its maritime surroundings (Schweitzer, 2010:111).

In order to ensure that the correct method of protection associated with an unambiguous material is applied, it is essential that all environmental factors that might contribute towards possible corrosion

be investigated as illustrated in figure 3.5. As atmospheric corrosion is defined by geographic location and local weather conditions, the exact whereabouts of potential material utilisation need be admitted. The Southern Africa Stainless Steel Development Association (SASSDA) fashioned a corrosion map of South Africa that postulates the atmospheric corrosion rate of every region (refer to figure 3.6). Based on these findings, the International Organization for Standardisation (ISO) allowed for distinct categorisation which dictates suitable material selection and the protection thereof.



Figure 3.5. Environmental Factors of Corrosion (Author, 2016)

Apart from the existing materiality of both the host and habitant, the introduction of new materials will **require adequate protection**. In the instance where the actual process of corrosion cannot be chemically manipulated, passive protection methods are employed. As previously mentioned, passive corrosion protection either **prevents or decelerates corrosion** by method of the introduction of a protective layer that keeps corrosive substances away from the steel surface. The applied corrosion-resistant coating either serves as a **sacrificial anode that when scratched** is protected by the remaining deposit until entirely removed, or **protects its base metal by corroding first**. As a result, this composite exhibits properties not generally achievable when disjointed. Whilst

the coating merely provides a durable, **corrosion-resistant surface**, the actual core material remains the only entity able to **provide load-bearing aptitudes**. For a protective agent to be deemed apt, certain technical preconditions exist. In addition to its strict regulatory specifications, these protective layers "should be completely pore-free, resistant to external mechanical stress, provide ductility and firmly adhere to the base material onto which it will be passively adjoined" (Maab, 2011:9). This 'finish' can be defined as any final operation applied to the surface of a metal article that alters its surface properties in terms of appearance, abrasion and corrosion resistance, adhesion qualities and general adaptability (Roberge, 2000:782). Archetypally, this finishing layer is appended upon the completion of a materials physical manipulation and can primarily be classified as either being a **metallic or organic coating**, depending on the appraised resistance against corrosion needed in a specific environment (C1 – C5 classification).

## METALLIC COATINGS

As with all coatings, metallic passive coatings supplement a layer that **alters the surface properties** of the metal on which it is essentially applied (figure 3.7). Indifferent to organic and inorganic coatings, metal coatings are applied by hot dipping, electroplating, spraying, cementation, and diffusion. The selection of a coating process for a specific application depends on several factors, including the corrosion resistance that is required, the anticipated lifetime of the coated material, the number of parts being produced, the production rate that is required, and environmental considerations (Revie & Uhlig, 2008:269). For the purpose of this study, galvanised coatings in the form of dipping and electroplating will be investigated, as these methods are deemed environmentally appropriate within the identified marine context.

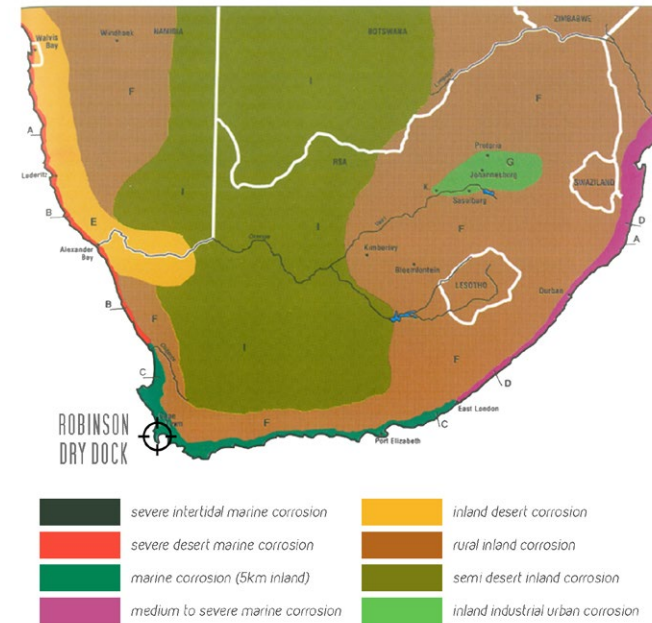


Figure 3.6. Composition of Metallic Coated Metal (ArcelorMittal, 2006)

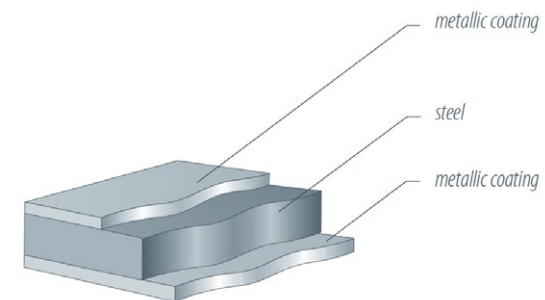


Figure 3.7. Composition of Metallic Coated Metal (ArcelorMittal, 2006)

## - HOT DIP METAL COATINGS -

Hot dipping is carried out by immersing the metal on which the coating is to be applied, usually steel, in a bath of the molten metal that is to constitute the coating, most commonly zinc, but also aluminum and aluminum-zinc alloys. Utilised either in a continuous (steel sheeting) or batch process (fabricated parts), this simplistic nature of galvanising allow for great protection and high popularity (Langill, 2003:801). As illustrated in figure 3.8, the layout of a continuous galvanising line consists of three main sections: entry, central section (annealing, metallic coating application and surface treatments) and exit. During the first entry section, a continuous loop of produced steel coils are mounted onto a decoiler that feeds the reel into an alkaline degreasing tank in order to remove any residual lubrication before annealing

can commence. In order to maintain the same processing speed in the annealing furnace and the bath of molten metal, two accumulators separate the three sections. In the central section, annealing allows for heat treatment that recovers mechanical properties needed in order to render material suitable for intended application. Once cooled, the uncoated steel is submerged in a bath of molten metal, leaving a thick residue upon reveal. Based on predetermined requirements, the weigh thereof ( $\mu\text{m}$ ) is adjusted and allowed to cool down to room temperature in a cooling tower. Additional surface treatments can be applied thereafter, followed by the final exit phase in production that permits skin-passing (flattening) and quality control (Arcelor, 2006:17).

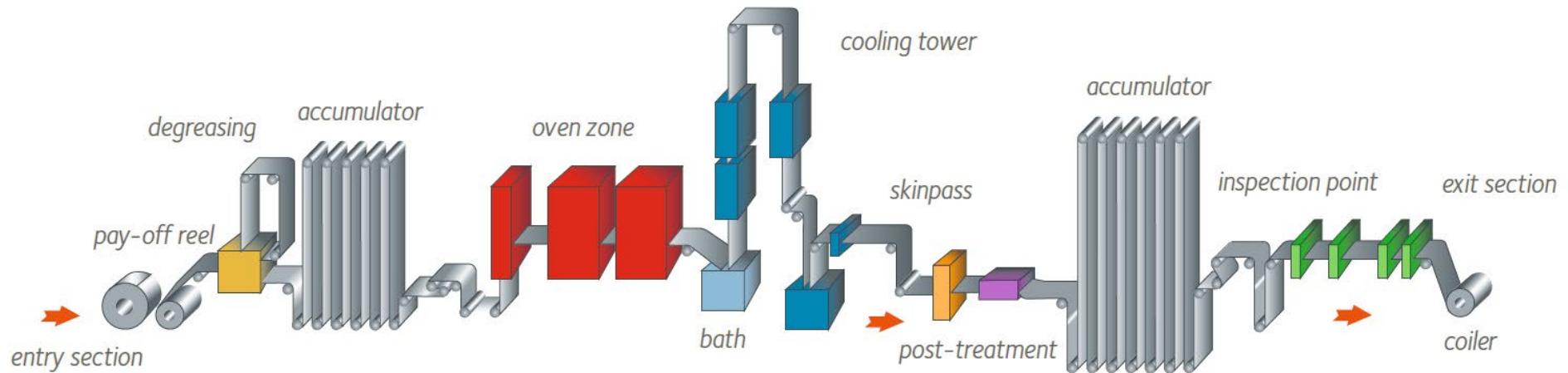


Figure 3.8. Hot Dip Coating Process (ArcelorMittal, 2006)



Figure 3.9. Surface Quality of Hot Dipped Metals (ArcelorMittal, 2006)



## - ELECTROPLATED METAL COATINGS -

The conversion of a metal into a cathode, by method of engrassing it into an aqueous electrolyte, is known as **electroplating**. Although primarily used to enhance resistance towards corrosion, this process can also be employed **decoratively**. Electroplating is the electroplating of zinc on either iron or steel with coatings ranging in thickness between 4 to 14  $\mu\text{m}$  (Revie & Uhlig, 2008:270). Similar to hot-dipping and as illustrated in figure 3.10, a continuous electroplating line consists of three main sections: entry, central section (surface preparation and coating) and exit. During the initial entry stage, a continuous loop of annealed steel coils is mounted onto a decoiler that permits elongation through suppression

of the yielding point. Once elongated, all oil present is removed in the hot electrolytic alkaline degreasing tank, followed by dip-pickling in bath of hydrochloric (or sulphuric) acid. Once rinsed, the steel strip passes through several electrolytic cells successively where the electric current flows through a zinc solution (the electrolyte) from an anode to a cathode. Before additional surface treatments can be appended, the strip is to be rinsed repeatedly in de-ionised water followed by severe air drying. Furthermore, this process is finalised through surface inspection, oiling and trimming if narrow width tolerances are required (Arcelor, 2006:18).

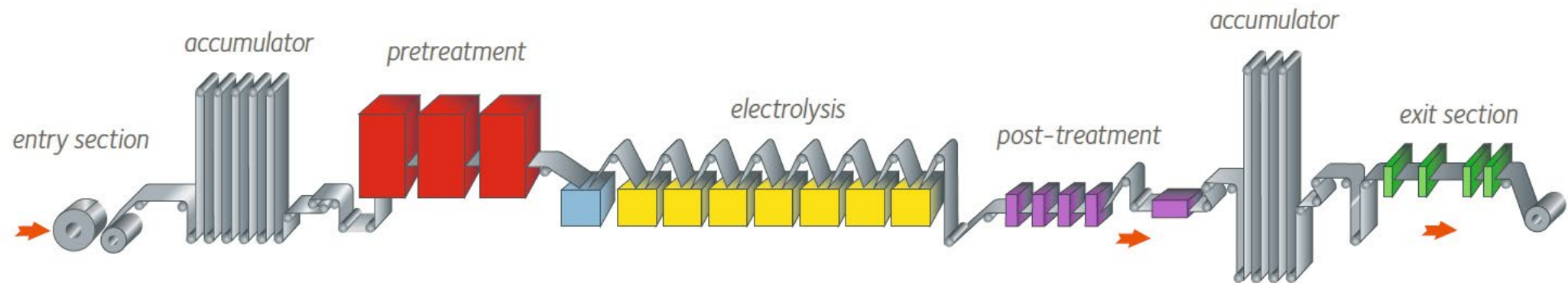


Figure 3.10. Electroplated Metal Coating Process (ArcelorMittal, 2006)



Figure 3.11. Surface Quality of Electroplated Metals (ArcelorMittal, 2006)

Having clearly distinguished between the above mentioned processes, it is essential to note that galvanising, in either the form of hot-dipping or electroplating, protects the underlying core material momentarily. Although galvanising will inhibit attack of the underlying steel, rusting will be inevitable. This eventual corrosion is determined by the amount of zinc present in the protective layer and the acidic conditions it is exposed to. As summarised in figure 3.12, initially zinc hydroxide is fashioned in a galvanised coating. Based on its poor conductivity, zinc hydroxide will slow down the corrosion process whilst dehydrating to form zinc oxide. As zinc oxide is a semi-conductor, a less effective barrier is constituted which may accelerate oxidation – thus not being desired in coastal surroundings. “In addition to the zinc oxides and hydroxides, zinc carbonates are the most abundant corrosion products of zinc when exposed to the atmosphere in an urban environment. Depending on the environment, zinc hydrochlorides (marine environment) or zinc hydroxysulphates (industrial urban environment) may also be formed (Arcelor, 2006:21).” Plainly put, **higher zinc content coatings** allows for the **slower formation of zinc hydrochloride** and thus permits **less maintenance**.

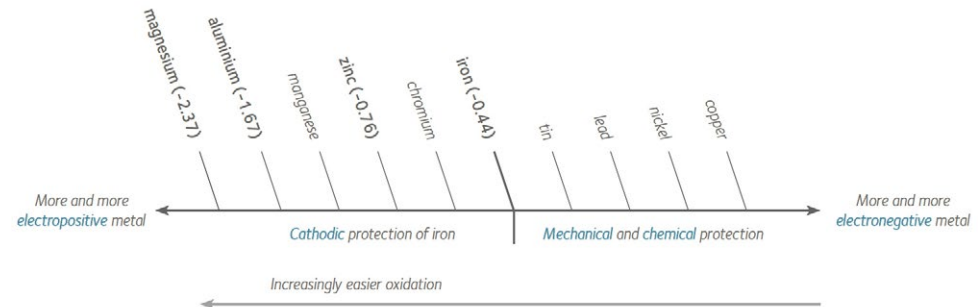


Figure 3.12. Oxidation Scale (Author, 2016)

## ORGANIC COATINGS

As an alternative to the mechanical enhancements of materials metallically, organic coatings provide and **ecological other in terms of its applicability as a passive protection technique** (refer to figure 3.13). Paints, veneers, and high-performance organic coatings were developed to protect equipment from environmental damage. Other than the actual differentiation in composition between metal and organic coatings, their lifetime expectancy differs in terms of application. Where metallic coatings can only be applied mechanically during production, the application of organic coatings on steel can either be automated or manually augmented upon installation. This manual application permits continuous maintenance on site, as opposed to challenging upkeep away from the principle area of activity. Governed by the regulatory standards of protective coatings technology, The Steel Structures Painting Council (SSPC) aims to advance and “standardise the use of protective organic coatings to preserve industrial, commercial and maritime structure components and substrates” (Roberge, 2000:818).

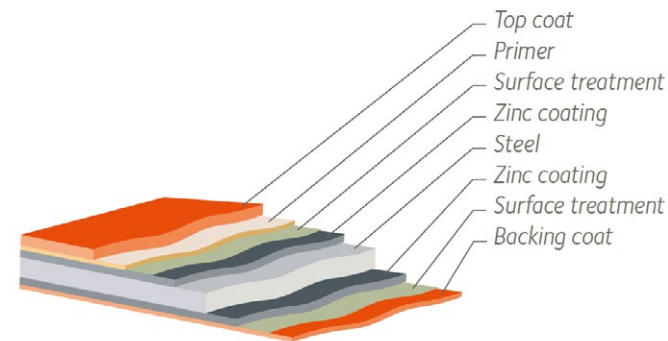


Figure 3.13. Composition of Organic Coated Metal (ArcelorMittal, 2006)

## - COATING SYSTEM APPROACH -

Many organic coatings comprise out of a wide array of constituents added to suit predetermined utilities. The existence of certain variables is used to design specific coatings that attest cathodically protective pigments, impermeability and inhibition. Moreover, the existence of a universal coating has yet to be developed, thus directly influencing the metal substrate on the processing performance and corrosion resistance of the organic coated product (Arcelor, 2014:14). As specified by the SSPC, the protection of a steel substrate, either cold rolled or with a zinc-based metallic coating, should adhere to the coating system approach that permit all core material to be covered with a primer, intermediate coat, and topcoat (Munger, 1999:n.p).

The composition thereof (refer to figure 3.14 - 3.15) will be briefly conversed in order to determine plausible utilisation likelihoods: The primer, regarded as the universal component of all anticorrosive coatings, is considered to be the most significant element in a protective system. This initial layer is applied directly onto the prepared steel surface in order to wet and provide sufficient adhesion thereon for all subsequently applied coats to follow. If duplex application on already metallic coated materials is not required, the provision of corrosion inhibition in either the form of primers pigmented with metallic elements anodic to steel (zinc-rich primers) or primers relying on the high adhesion and chemical-resistance properties of the binder (zinc phosphate) will be required (Hendy & Iles, 2015:306). The intermediate coat acts as a building agent that alters the

overall protective and structural integrity of the complete system. Generally, a thicker coating provides a longer life expectancy and thus dramatically lowers maintenance. Aside from overall protection enhancement, when highly pigmented, permeability of oxygen and water is decreased. High pigmentation, either in the form of micaceous iron oxide (MIO) or glass flakes acts as laminar pigmentation which reduces or delays moisture penetration in coastal regions. As this is the innermost layer, it is essential that it remains compatible with both primer and topcoat in order to avoid loss of corrosive integrity (Hendy & Iles, 2015:306).

The topmost layer is reserved for the finishing coat and provides external surface characteristics such as the final appearance (colour, texture, gloss, finish etc.), hardness and resistance to abrasion and ultraviolet radiation. In addition to its outward contribution, this layer serves as a resinous seal over the two preceding layers. Based on its applicability, either a single or double layer can be applied on one or both sides of the protected sheet. Furthermore, being that these coats are formulated with a lower pigment-to-solvent ratio, they are generally denser. "The topcoats commonly used include air-drying paints and oil-based varnishes which harden by oxidation; acrylics and other lacquers, which dry by solvent evaporation; and polyurethane and epoxy paints, which dry by cold curing chemical reactions" (Roberge, 2000:830). Subsequently, accompanying curing and stoving techniques can be employed to produce an even hardened finish, advancing higher corrosion resistance whilst testing removal possibilities.

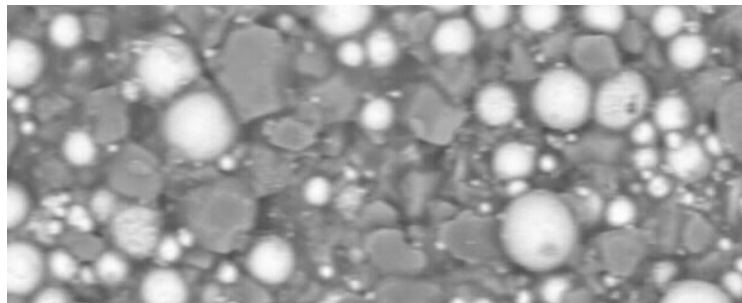


Figure 3.14. Surface Micrograph of Coating System Approach (ArcelorMittal, 2006)

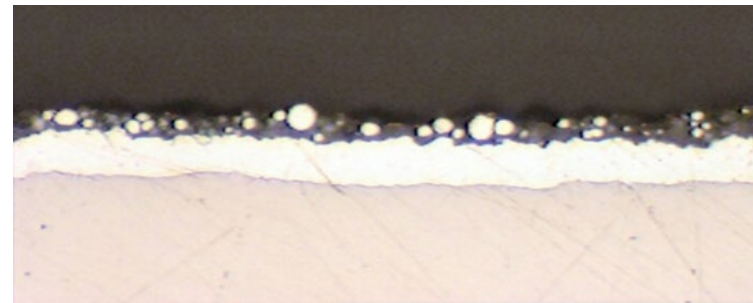


Figure 3.15. Cross Section Micrograph of Coating System Approach (ArcelorMittal, 2006)

- THE COATING LINE -

Likewise to the production of metallic coatings, organic coated steel can also be produced mechanically as illustrated in figure 3.16. Additionally, this coating line also permits three phases (entry, central and exit section) that allows for an automated coated system approach. During the initial entry stage, a continuous loop of annealed steel coils is mounted onto a decoiler which is pretreated in order to allow for preliminary coating. As the sheets enter the secondary section, coating heads apply liquid paint primer to the top and

the underside of the core material, before entering an oven for curing. This process is repeated with the intermediate and topcoat following successively. Once the final finishing layer is cooled, the strip passes through an inspection section. Here the overall thickness is controlled, the peak metal temperature (PMT) is measured continuously, along with the colour and ultimate surface quality. Once approved, the convolute weight is adjusted as per specifications and the final product is coiled (figure 3.17).

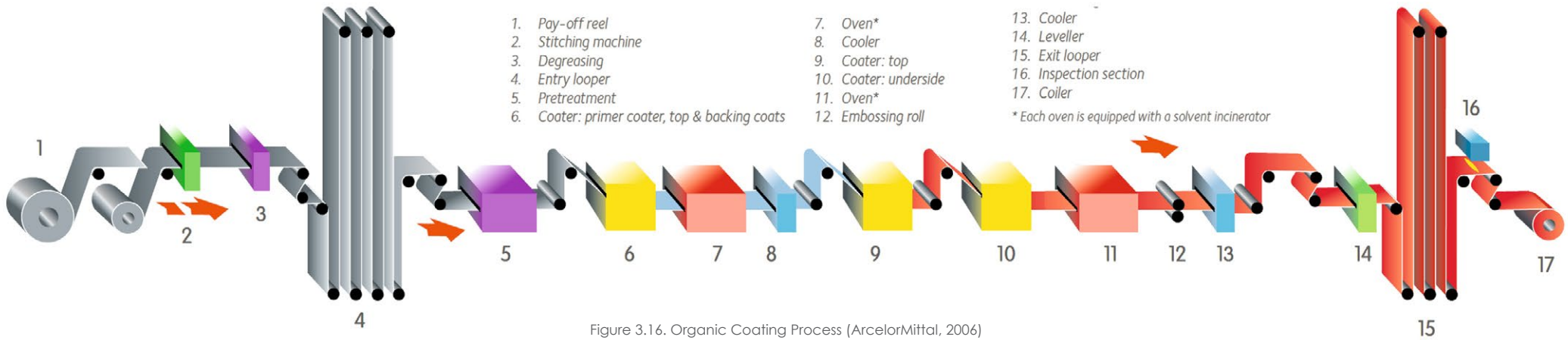


Figure 3.16. Organic Coating Process (ArcelorMittal, 2006)

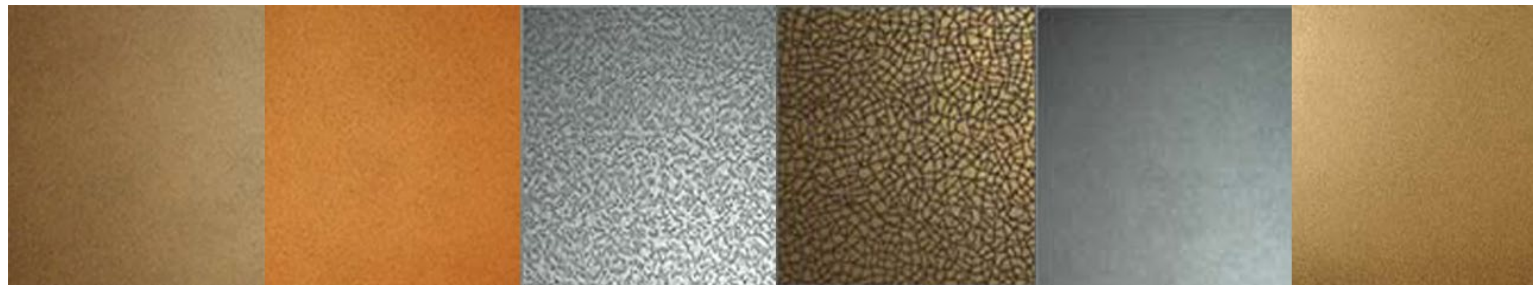


Figure 3.17. Surface Quality of Organically Coated Metals (ArcelorMittal, 2006)

## INTERIOR APPLICATION OF COATED METALS

The utilisation of steel has uniquely achieved a distinction in architecture and interior design - more so, the utilisation of coated steel due to its ability to provide prolonged existence. In addition to its enduring nature, the ever increasing ability of coated steel to meet architectural requirements esthetically warrants the use thereof whenever the opportunity arises. Aside from the vast array of exterior applications, coated metals have seen an upsurge in deployment internally (Axolotl, 2015:n.p.).

Apart from esthetic reasons, due to the reduced consumption of materials and the conservation of natural resources, the internal weight of the structure is reduced. The added thermal efficiency of organic coated steel reduces energy consumption in services and provides supplementary internal comfort, whilst offering excellent acoustics due to its high insulation merits. In order to accommodate adaptability and timely prospect, long spans and extension **quality create versatile spaces capable of changing overtime in terms of function, appearance and pertinence**. Furthermore, based on its composition, additional longevity and robustness allows for versatile application.

If enamelled, steel acquires added modern criteria that uphold hygiene, whilst respecting nature. As the applications thereof can either be **structural** (refer to precedent investigation 3.1) or **decorative** (refer to precedent investigation 3.2), its appliance can vary from wall and floor coverings, to false ceilings casing or partition entities. When used architecturally within a building, it can act as an easy-to-clean material with high moisture resistance and anti-bacteriological properties. With a merely unrestricted assortment of colours, screen-printing possibilities and surface textures, most design necessities are fulfilled. In addition to its imperial warranty to never loose colour or gloss, enamelled steel offers admirable resistance to corrosion, abrasion, pollution and fire, offering virtually an **unlimited scope of architectural employment** (refer to figure 3.18).

As one of South Africa's leading manufacturer in galvanised steel sheeting, ArcelorMittal has devoted their international existence to the development of ecological materials that prolong eventual corrosion. In order to concisely establish an appropriate material, zinc and alloyed-based metallic or organic coatings suitable for architectural use will be investigated.

<p><b>WALLING</b></p> <p>Coated metal is a perfect choice for interior and exterior wall panels. Metal wall panels are available in a large number of differing profiles in ribbed, insulated (foamed), composite, and architectural shallow flat styles.</p>	<p><b>SOFFIT &amp; FACIA</b></p> <p>Soffit, facia, and an assortment of other building trim parts are produced out of coated metal helping a home or business streamline its looks while protecting the underlying structure.</p>
<p><b>DOORS</b></p> <p>Coated metal's ability to be stamped into deeply drawn and detailed shapes, resistance to weathering, economical benefits &amp; environmental advantages makes it a perfect fit for door manufacturers.</p>	<p><b>CLADDING</b></p> <p>The metal itself is the major focus of the design. Ceiling tiles, back splashes, ceiling grids, wall panels, wainscoting, and column surrounds are some of the uses of coated metal for interiors.</p>
<p><b>FURNITURE</b></p> <p>Coated metal's ability to be formed into almost any contortion of shapes imaginable make it a popular choice for manufacturing furniture, as well as a wide assortment of parts needed for its installations.</p>	<p><b>FLOORING</b></p> <p>Due to the durable and tough nature of coated metals, its application as accent floor coverage and raised platforms is becoming more popular where life cycle cost is to be low.</p>

Figure 3.18. Interior Application (Author, 2016)



Figure 3.19. General Interiority of Block Office (Kawata, 2012)

## PROJECT SYNOPSIS

Slotted into a narrow gap between two existing building, the galvanised metal block office has a similarly corresponding interior than its exterior appearance. Designed for an interior construction company, special emphasis was directed towards the interior architecture. In addition to an industrial palette, the overall finish was to be bare, simplistic and low-maintenance - thus utilising coated metals which appeared unfinished in nature. "When I considered that they undertake precision construction, I believed that the exposed structure without apparent finishing was most appropriate" (Imazu, 2015). Apart from exterior elements, such as the metallic shutters and steel frame that boasts structural support, a variety of components which necessitates **structural reliability** is present internally. The introduction of a suspended feature staircase, purely constructed out of hot-dipped coated metals, is employed to allow vertical circulation. Furthermore, metal cladding, steel partitioning and the exposed galvanised frame permits **aesthetical, yet structural sustenance** (Dezeen, 2016).

## PROJECT OBJECTIVES

- Construct an interior that is **functional, low-maintenance, highly durable** and evoke **material honesty** and **good aesthetics**.
- Utilisation of metallically coated materials which permits **light reflectivity** in areas with low levels of natural light (hallways and lounges), yet limits glare in areas where light is ample and tasks are to be performed (desk space and meeting rooms).

## IMPLEMENTATION STRATEGIES

- Utilise coated metals in the design of both the outer and inner interior where some **structural veracity** is required, along with clean and **honest aesthetics, finish and application**.
- Employ similar materials where the materiality should **correspond with the existing fabric**.
- Use **material reflectivity** as a method to **enhance light distribution** in areas where natural light is limited.

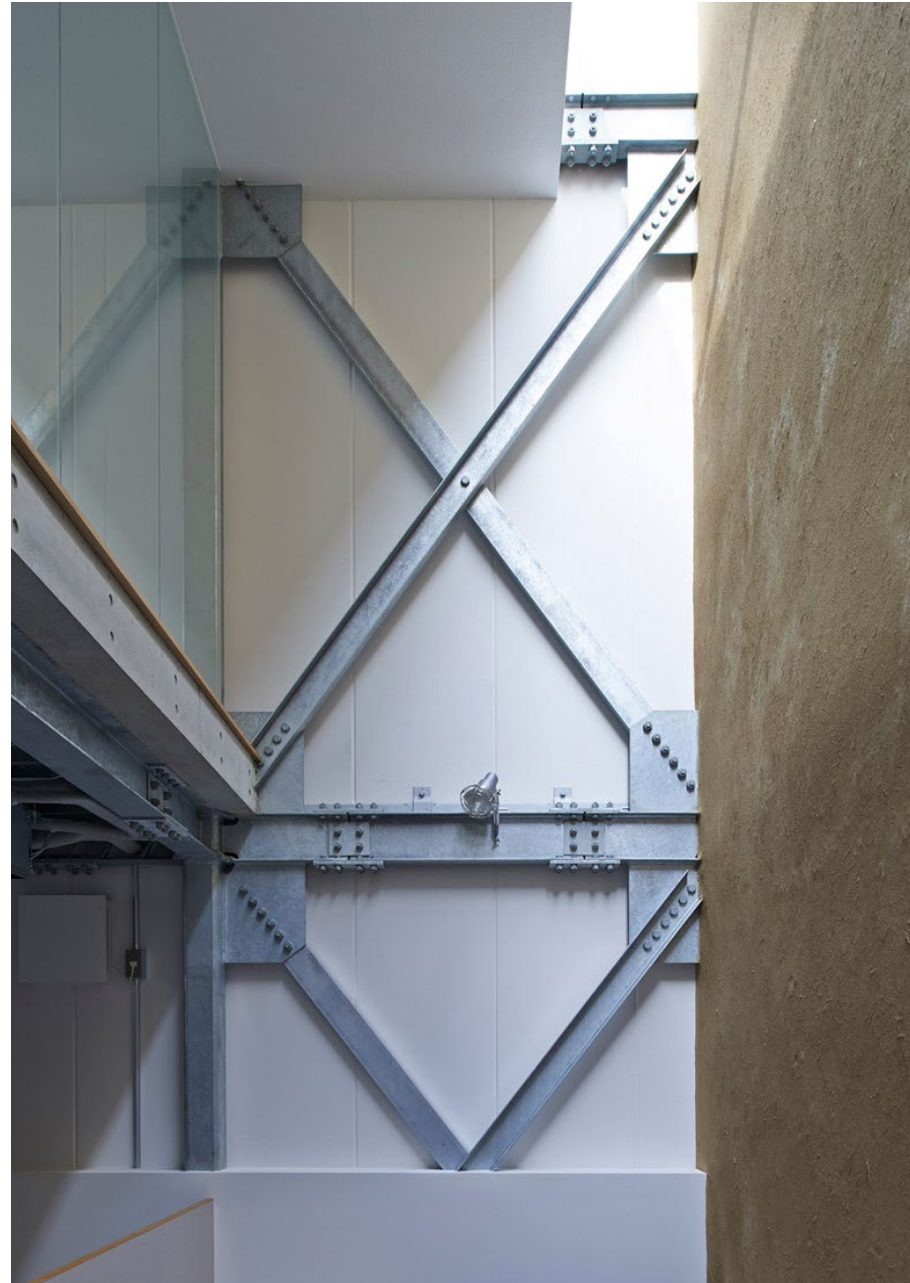


Figure 3.20. Exposed Interior Frame (Kawata, 2012)

## precedent investigation

3.1

NAME OF PROJECT  
BLOCK OFFICE

LOCATION OF PROJECT  
TOKYO, JAPAN

CHIEF ARCHITECT  
NINKIPEN!

DATE OF COMPLETION  
2015



theory



materiality



design



programme



Figure 3.21. Rouse Hill Food Court (Jack, 2012)



## PROJECT SYNOPSIS

The Rouse Hill Town Centre features all the facilities of a small town, including streets and a town square, providing patrons with everything they need in one location. There is a dedicated retail and commercial precinct, with added recreational and educational spaces intertwined. The design of the food court was conceptualised by Allen Jack and is enclosed by a feature floral screen that romanticises the notion of unity through the prominent utilisation of the surrounding vegetation as muse. The entire **screen-like canopy** is manufactured using **organically coated steel**. This selection of material provides durability and buoyancy, whilst its manufacturing process corresponds with the sustainable ethos of the centre. The same utilisation of pattern and material is echoed through the implementation of built-in planters, partitioning and counter space. As opposed to the previous precedent investigation, the utilisation of **coated steel** is employed here for **mere decorative purposes**. Supporting constructions coated in a similar finish acts a structural mediator (Allen Jack, 2012).

## PROJECT OBJECTIVES

- Find equilibrium between its concurrent roles of meeting place, marketplace and traffic way, all while maintaining links with nature.
- Additional design considerations attend to the community's needs, its imminent expansion and climatic environment.

## IMPLEMENTATION STRATEGIES

- Utilise **coated steel decoratively** in applications where only **visual interest is desired and no structural support** is required. Given the robust nature of coated metals, it can be utilised in the **inner and outer interior** on both horizontal and vertical platforms.
- Employ similar materials where the **materiality should correspond with the existing fabric**.



Figure 3.22. Food Court Screen Detail (Jack, 2012)

## precedent investigation

3.2

NAME OF PROJECT  
ROUSE HILL TOWN CENTRE

LOCATION OF PROJECT  
SYDNEY, AUSTRALIA

CHIEF ARCHITECT  
ALLAN JACK

DATE OF COMPLETION  
2012



theory



materiality



design



programme

## 3.2

# HISTORIC DECAY PRESERVATION

By way of the previous section serving as a **protection strategy manifesto of sorts for all newly proposed materials**, this section will alternatively highlight **preservation approaches for already corroding materials that exist on site**. The definite exploration of this chapter sieves the consideration of the safeguarding of the main material associated with the host (Robinson Dock) and habitant (SS Nomadic). "Conservation does not have its own universally defined preservation standards and generally works towards goals generated to satisfy prevailing situations" (Watkinson, 2010:3308). As both the SS Nomadic and Robinson dry-dock each require different approaches in terms of preservation, it is essential that these needs be clearly identified. In previous chapters it was founded that the SS Nomadic underwent complete restoration during 2012, thus merely requiring protection against future degradation. As for the dock, since undergoing structural upgrades in 1980, and being declared as a dock of concern in 2010, not much has been done in terms of upkeep. With most docking requirements currently being fulfilled by neighbouring docks, Robinson dry-dock stands desolated and **in need of preservation and intercession**.

Artifacts of cultural importance contribute greatly to the economy of nations via employment and tourism. As these objects and structures authenticate development, they provide gateways to the past and statute significant symbols of cultures, religion and individual identity. In order to assure the future contribution thereof, these objects need be actively preserved (Watkinson, 2010:3308). Historical objects are often imperiled by decay and corrosion due to timely use, origin and age. Prone to further deterioration, the diversity of contexts from

which heritage materials originate presents a significant preservation challenge. In addition to this challenge, the preservation of an object should permit minimal change in order to retain cultural context and evidence of integrity - thus **retaining layers of time**. As there is a fine line between preservation and restoration, general conservation aims to establish a concise balance. Traditionally, the conservation of materials can either be classified as being interventive or preventive. Interventive methods involve the **removal or addition** of something to an object in order to preserve it, whereas the latter aims to prevent corrosion by **controlling the environment** (Caple, 2000:np.). Essentially, both scenarios allow for eventual change in an object or **structure's appearance, functionality and/or configuration**.

Whilst restoration seeks to re-establish the integrity of what once was, it neglects to address chance and the need of progression or the addition of another layer thereon (Scott, 2008:48). Furthermore, Scott (2008:95) asserts that the process of traditional preservation, which seeks to retain a building's condition as it stands to avert future decay, must be prevented as it goes against the natural lifespan of a building's existence. Instead thereof, the decaying nature of materials should be embraced - thus acknowledging a building's failure to provide for a current need and proposing alteration as a form of preservation. This form of alteration aspires to act as mediator by method of stabilising current corrosion, whilst allowing for future layering to commence thereon. Serving as a clear normative stance on preservation, innovative methods such as **decay stabilisation and rust transformation for steel** and **resin infill for concrete**, will be researched in order to act as tools of design during spatial implementation.

## DECAY STABILISATION

---

The eventual conservation objective of indefinite preservation has compelled conservation rationale for numerous years. The frequent use of stabilisation as a method of upkeep requires careful reassessment in terms of its procedure, prerequisites and context. Given that both the **steel of the SS Nomadic and concrete of the dock had either been restored or altered in previous years**, one can assume that abundant structural integrity permits direct stabilisation. If this was not the case, pre-stabilisation procedures would have been required in order to alleviate prior degradation. Due to the fact that only a few materials are inherently stable in ambient conditions, the prevention of continuous corrosion for concrete and metal alloys **necessitates some grade of environmental control** (Ashley-Smith, 1999:15). Beneficial to the sufficient identification of the associated environmental needs of concrete and metal, qualitative and quantitative research conducted on ecological parameters will underpin the concept of preventive conservation. Regardless of this form of control, the associated materials remain unstable and these conditions merely prevented or decreased corrosion. **Stabilisation does not provide interventive treatment which fundamentally prohibits alteration** – hence linking it back to the principles Scott detest. Instead, this minimalist approach actively acts as an inhibitor that **removes, limits or controls corrosion accelerators - thus allowing alteration to occur** (Watkinson, 2010:3309).

Conventionally, environmental control was only employed once restoration was complete in order to enhance the physical and chemical stability of corrosion accelerators. This investigation supports the notion that prior interventive treatments should only be conducted if the stability and lifespan of an object, without contravening ethical guidelines, can be achieved. Various stabilisation procedures currently exist and ideally should support the role and function of the object in a society (Cagle, 2000:n.p.). As the most prevalent procedures, such as deoxygenation and ion removal, involve the limitation of public associability in terms of controlled oxygen, light, and heat, these are rendered unpractical as the whole purpose of the envisioned design is to allow complete

public accessibility. As an alternative, desiccation will be investigated for possible implementation by way of decay stabilisation for the steel hull of the SS Nomadic.

The prevention of electrolytic corrosion, by method of controlling the agencies needed for this process to commence, is a common strategy employed when aiming to preserve cultural metals. Similarly to deoxygenation, the removal of moisture that causes corrosion can be achieved through desiccation, which is far simpler, inexpensive, and more user-friendly. Dictated by the corrosion mechanism associated with a particular metal, the degree of desiccation necessary to prevent corrosion differs (Watkinson, 2010:3314). As this form of preservation is still relatively novel in terms of actual implementation, only chloride infested iron has been extensively researched. Fortunately, the SS Nomadic's hull corresponds to the researched material, making it possible to identify the relative humidity (RH) no-corrosion thresholds for reactions within its corrosion mechanism. Within corroded metals, ambient humidity can supply moisture to solvate ions which in return create electrolytes. When endeavouring to conserve metals, it is for this exact reason that as opposed to absolute humidity, the function of relative humidity be examined (Scott, 2002:np.).

Reputable research has shown that deliquescent and hygroscopic salts, such as sodium chloride, can lower the relative humidity threshold for corrosion to occur. Moreover, where the formation of electrolytes begins during relative humidity is referred to as the threshold corrosion value. Subsequently, desiccation outlaws the fall of relative humidity and lowers the threshold value, thus controlling the rate of decay (Selwyn, 2004:n.p.). Humidity control either employs passive desiccation (silica-like solvents) or active dehumidification (mechanical plant) in fixed display or storage areas (Ashley-Smith, 1999:21). In order to illustrate the actual implementation of desiccation, the referral to the SS Great Britain (precedent study 3.3 - page 98) will prove vital, as various similarities between this intervention and that of what is envisioned exist.



Figure 2.23. The SS Great Britain's Bow (Watkinson, 2005)

## PROJECT SYNOPSIS

Relating the increasing relative humidity to the corrosion rate provides the opportunity for pragmatic management. Based on resource availability and accessibility requirements, the degree of corrosion control for the SS Great Britain (refer to figure 2.23) was implemented in order **to reduce, but not prevent corrosion**. This logic thereof was applied to act as the corrosion regulator of Brunel's famous 1843 wrought iron steamship, whose chloride-ridden lower hull is preserved in a mechanically desiccated dry dock maintained at 20% relative humidity with a goal of retaining its structural integrity, whilst allowing regulatory aging (Watkinson, 2005:77). As illustrated in figure 2.24, the mechanical desiccation system is fastened on either sides of the hull, following its distinct profile which assures even levels of humidity. Telemetric sensors monitor the relative humidity, ensuring that moisture remains below the corrosion threshold value (Watkinson, 2010:3315). This form of stabilisation allows public availability, which heightens its role as a cultural artifact through exposure, as opposed to mere prior degradation (ArchDaily, 2009).

## PROJECT OBJECTIVES

- **Stabilise corrosive nature** by slowing down degradation of metal (through desiccation preferably) in order to **preserve** the hull.
- Preservation technique must **permit public accessibility, preserve current oxidation and be visually discreet**.

## IMPLEMENTATION STRATEGIES

- As the hull of the SS Nomadic has been completely restored and adequate measures have been employed to protect the steel hull, **atmospheric corrosion** is bound to eventually take its toll. The employment of an identical desiccation system will **decrease the process**, and allow its **sluggish integration** into the existing surrounding as an **additional layer of time**.
- Furthermore, this form of stabilisation will **permit accessibility** and is not in need of **complete enclosure**.

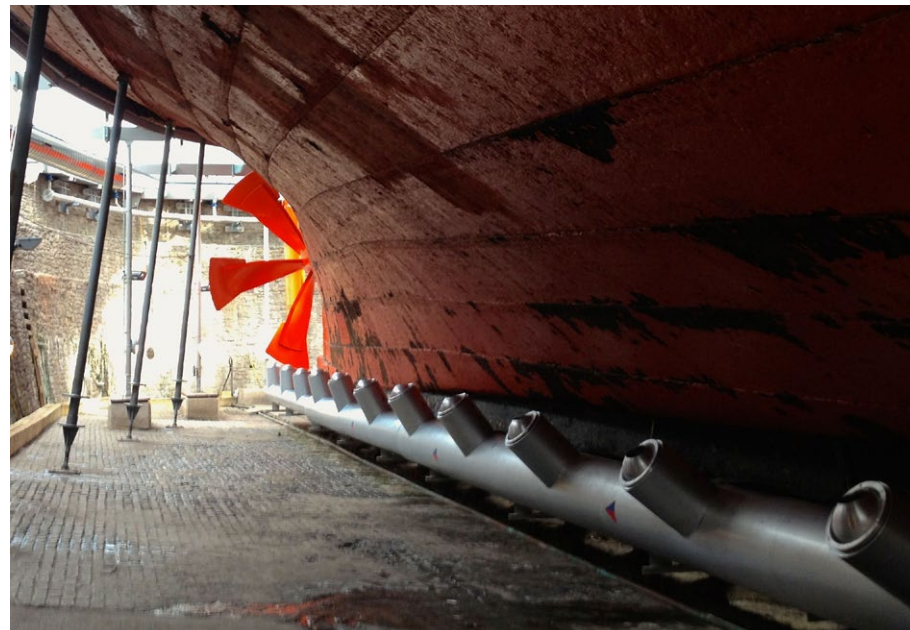


Figure 2.24. Great SS Britain Restored (Watkinson, 2005)

## precedent investigation

3.3

NAME OF PROJECT  
SS GREAT BRITAIN

LOCATION OF PROJECT  
GREAT WESTERN DOCKYARD, UK

CHIEF ARCHITECT  
FENTON HOLLOWAY

DATE OF COMPLETION  
2006



theory



materiality



design



programme

## RUST TRANSFORMATION

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As opposed to the discipline orientated practice of desiccation, the transferal of rust in the form of **printing and dyeing** allows for a more tentative form of corrosion stabilisation. In recent times, literal and figurative expression has been found in concepts such as decay, impermanence and the fleeting nature of conservation. In the production of artifacts that use pigments obtained from rusted metals exposed to ageing conditions such as heat, acid and weather, the process of mark-marking consents corrosion preservation (Feldberg, 2015:33). If looked beyond the most prevalent nuisances associated with oxidation, the ability of rust to provide permanent colour to an object presents perfect properties for a unique design technique. The formation of iron oxides appears once unprotected metal is exposed to air and moisture, resulting in the formation of a reddish-brown layer embedded on the metal's surface. As opposed to the chemical or organic removal thereof, rust dyeing allows for the transferal of iron oxides onto suitable materials, creating a permanent print as rust is absorbed. Furthermore, rust can be **absorbed from objects intentionally subjected** to corrosion, or historic artifacts **exposed to degradation**. As ions are absorbed from the host metal, the actual removal of corrosion occurs in a layering manner. Oxidation can either completely be removed if continuous dyeing occurs, or partially in order to stabilise the core material (Ross, 2015:n.p.).

The process of rust dyeing is rather simple in character and requires little resource availability, rendering it highly feasible. Initially, as a suitable piece of material is immersed into an acidic liquid before being placed over the corroded object. This acidic liquid can range in power of hydrogen (pH level), depending on the ion deposition

required. Plainly put, the higher the pH level, the darker the transferred rust colour will be. This acidic liquid acts as an electrolyte that relocates iron oxides from a corroded element thereon. Allow the fabric to stay in contact with the rust until you are satisfied with the pattern and intensity of colour that it takes - the longer you leave the fabric in contact with the rust, the deeper the colour becomes. Once the desired amount of oxidation has been transferred, the fabric must be neutralised. **Neutralisation** can be achieved by method of soaking the finished fabric in a light saline (salty) solution - therefore stabilising oxidation and permanently embossing the conveyed surface with rust indentation (Fox, 2015:56).

Renowned British eco printmaker, Alice Fox, specialises in the creation of natural textiles. Rust dyeing is one of several processes in Fox's mark-making repertoire, chosen to convey a personal message about time and a sense of place. Being vastly influenced by the coastal landscape, her textile creation turned to the recouping of rusted objects washed upon shore. Apart from their interesting mark-making potential, these found objects behold the **capacity to convey an authentic sense of place**, which once added to material, creates an historic layer. As part of a national exhibition, Fox's work was exhibited in 2012 in an old lighthouse near the coast of Spurn, England, which happened to be the exact location from which all rusted objects were salvaged. As part of this exhibition, various wall and floor coverings were exhibited (figure 3.25 left), along with a sculptural tapestry, consisting of a number of rust dyed sheets stitched together (figure 3.25 middle), that acts as area divider and acoustic insulator (figure 3.25 right).



Figure 3.25. Exhibited Work of Alice Fox (Fox, 2013)

### - RUST DYEING EXPERIMENTATION -

By means of actual experimentation, credibility was achieved and potential design opportunities realised. Expending Alice Fox as precedent, a similar technique was employed where the transformation of rust onto an auxiliary surface occurred. Different methods of application on a variety of mediums were exercised in order to determine the most optimal practice of rust conversion. Ultimately it was concluded that the complete submersion of uncoated paper (natural fiber) into an acidic liquid, before being brought into direct contact with an oxidised object, produced the best opportunity for proper rust dyeing.

As illustrated in figure 3.26 - 3.34, trialing with various acidic liquids produced different levels of rust transformation. It was concluded that the greater the pH level of the liquescent, the darker and more prominent the transferred oxidised pattern was.

The eventual outcomes provided interesting patterns, which will be utilised for print-making purposes in the spatial intervention that follows. This form of design will serve as educational décor that tangibly illustrates the process of rust stabilisation.

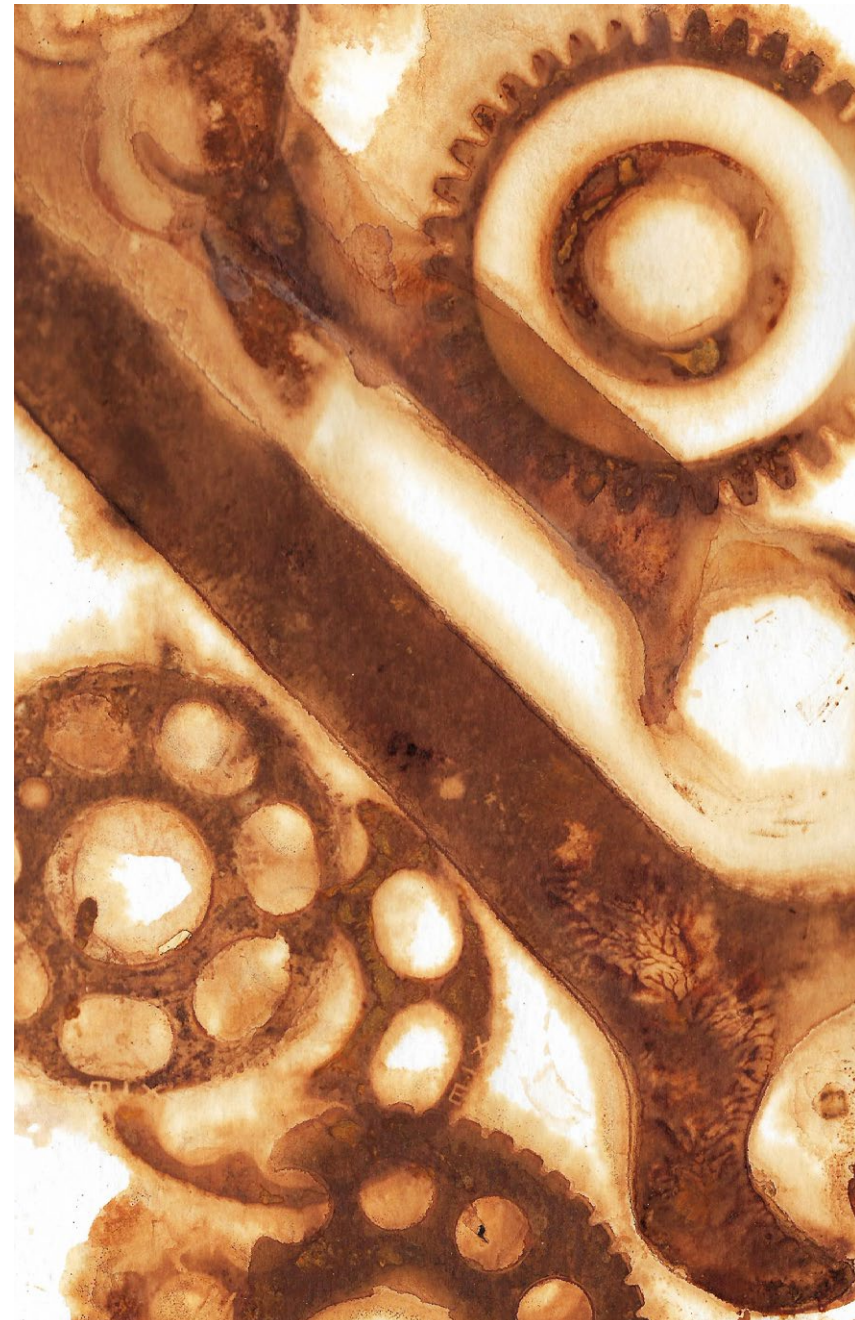


Figure 3.26. Rust Printing and Dyeing Experimentation (Author, 2016)





Figure 3.27. Printing with 100% Vinegar (Author, 2016)



Figure 3.28. Printing with 50% Vinegar (Author, 2016)

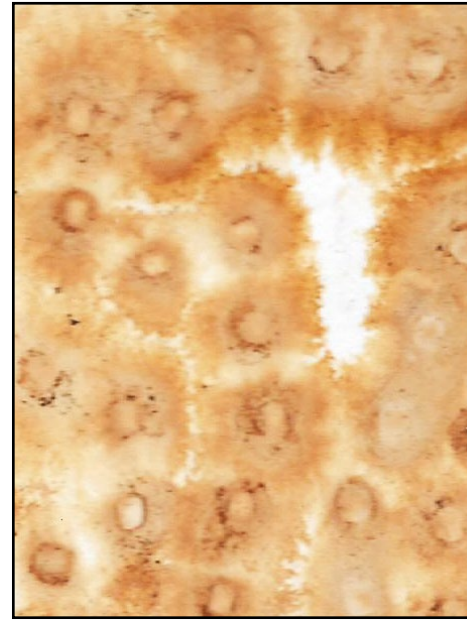


Figure 3.29. Printing with Saltwater (Author, 2016)



Figure 3.30. Printing with Orange Juice (Author, 2016)

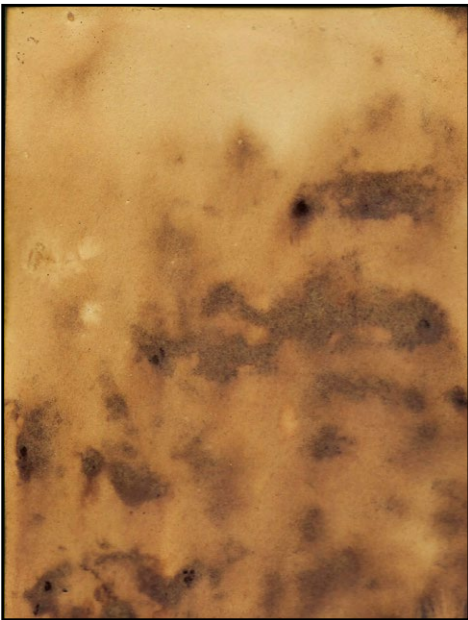


Figure 3.31. Printing with Full Cream Milk (Author, 2016)

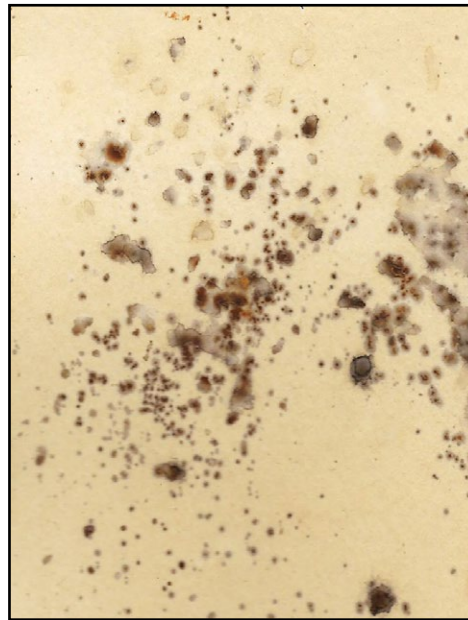


Figure 3.32. Printing with Rooibos Tea (Author, 2016)

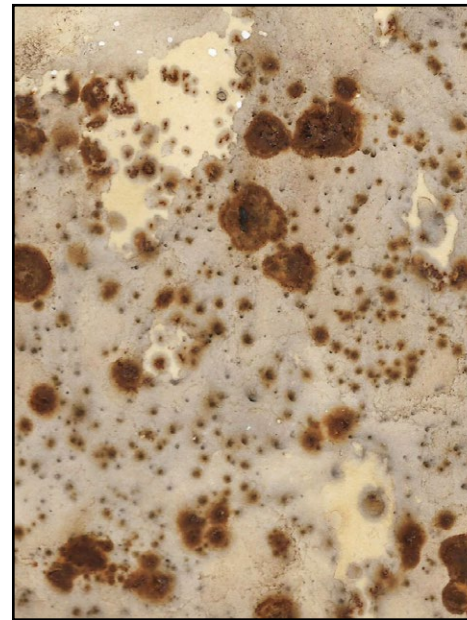


Figure 3.33. Printing with Instant Coffee (Author, 2016)



Figure 3.34. Printing with White Wine (Author, 2016)

## RESIN INFILL

Regarded as being one of the Building Industry's most versatile and durable material, the structural distress of concrete can be associated with three distinct occurrences; **cracking, joint deterioration and punchouts** (CCAA, 2009:5). The process of concrete crack stabilisation encompasses the unwanted halting of unwanted conditions such as cracking or settlement (Soudki, 2001:2). The structural impurity of cracks can be established through the investigation of the fractures anatomy (refer to figure 3.26). **Structural cracks** are those which extend either **longitudinal or transverse through the depth of the concrete** and will require extensive repair. **Artificial cracks** however occur on **surface level and are less significant in terms of safety** and are mostly considered due to **aesthetics** (Mehndi, 2014:29).

Conventional methods of repair include **caulking and pressure injection**, as illustrated in figure 3.27. Depending on the desired aesthetics, materiality, surface quality and function, the selected sealant might differ. Most conventional repairs utilise Shotcrete or Guniting epoxy **mortar or cement mortar injection** which, when completely cured, provide a leveled and visually analogous finish. These are normally employed when wanting to stabilise the existing concrete and have it **appear unblemished** (Khan, 2010:440). Conversely, when the preservation is to be noted, novel interventions exist that highlight the stabilisation process and acknowledges the **infill as an additional layer of visual interest** (refer to precedent investigation 3.4). Similarly to mortar instillation, resin injections provide related cosmetic preservation, whilst acting as a medium to **differentiate between the existing and the proposed**.

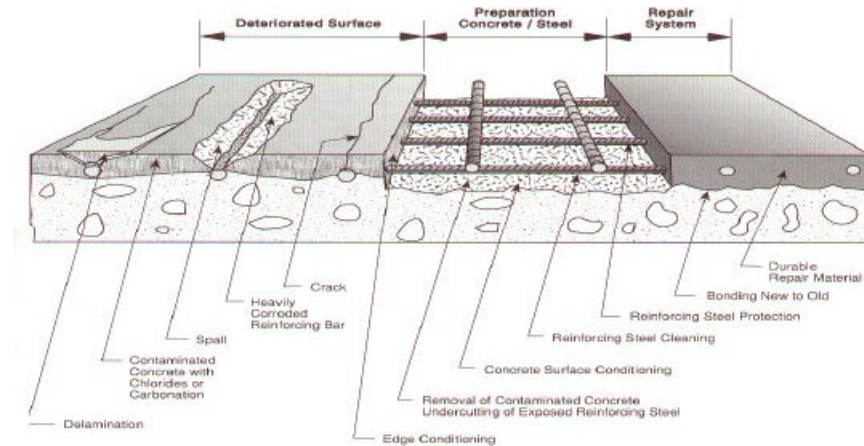


Figure 3.35. Anatomy of Concrete Cracks (Emmons & Vaysburd, 1995)



Figure 3.36. Caulking Repair of Concrete Crack (East Ronavtions, 2015)

## PROJECT SYNOPSIS

As a way to avert additional fracture to an existing cracked concrete floor, Naritake Fukumoto infused **conventional methods** of repair with a **traditional technique** which involved the caulking of a golden-hued resin into a surface crack. The method used to create this effect is called Kintsugi, which means to “repair with gold”. Traditionally used for repairing broken pottery, this art involves in filling cracks using lacquer mixed with powdered gold. As opposed to conservative methods that wish to provide an **unblemished and perfected finish**, this form of preservation alternatively **enhances and accentuates** the screed floor infill. Through the combination of **honest and contrasting techniques**, the transformation of what was considered imperfect is now the subject of beauty. In addition to this specific infill, several other lacquers have been developed that will provide a related effect in environments coveting to celebrate the **auxiliary layer of material preservation** (Dezeen, 2016).



NAME OF PROJECT  
X-CHANGE APARTMENT

LOCATION OF PROJECT  
KYOTO, JAPAN

CHIEF ARCHITECT  
TANK ARCHITECTS

DATE OF COMPLETION  
2016

## PROJECT OBJECTIVES

- As opposed to conventional methods of concrete repair that wish to cover up the effect of time, the utilisation of a traditional method is to be employed which **celebrates imperfection** and regards the **residue of preservation** as an additional attribute of visual interest.
- **Stabilise** the current nature of weathered materiality through **simple, cosmetic techniques**.

## IMPLEMENTATION STRATEGIES

- Employ this form of **stabilisation** to weathered areas which will be subjected to high amount of physical interaction, possibly the existing cracks on the altars of the dock which will act as walkway.
- **Accentuate the beauty of imperfection** through the addition of a contrasting infill layer that clearly **differentiates** between the **old and the new**.



theory



materiality



design



programme

Figure 3.37. Gold Resin Infilled Concrete Cracks (Hasegawa, 2016)

### 3.3

## INTENTIONAL OXIDATION

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As opposed to the protection and preservation of materials to corrosion, in some instances the act of oxidation might be a design prerequisite. When a material, particularly metal, is purposefully exposed to environments conducive to deterioration in order to corrode, the act thereof is referred to intentional oxidation. Where protection strategies wish to avoid decay and preservation wish to control decomposition, intentional oxidation sees weathering as a form of beautification - thus **embracing and not dreading age**. This practice shows extreme favourism in areas where materiality must be seamlessly incorporated into the adjoining landscapes or a periodic appearance is desired. Furthermore, in designs where lifecycle cost and upkeep must be low, materials protected or prone to benefit from corrosion is desired. Nonetheless, it remains vital that the continuous rate of the applied corrosion be alleviated, monitored and controlled in order to ensure structural integrity and no endangerment to public health. It is therefore advised that certified materials designed for this purpose be utilised, as opposed to conventional materials that will simply rust if left unprotected. Utilising this form of oxidation as a **layering tool, chemically altered metals (weathering steels) and physical approaches (faux oxidation)** will be reconnoitered. Furthermore, **biological concrete** will also be investigated as a potential contrivance to calculatedly create weathered concrete.

## WEATHERING METALS

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Apart from the practical values of weathering steel, the aesthetic value of this textured and worn material makes its application particularly useful where **ease of fabrication, strength and appearance are of paramount importance**. If left unprotected, **atmospheric corrosion** will encourage the formation of **patina - a sable protective layer** consisting out of a self-generated oxide deposit. Structures made of these steels **need no anticorrosive protective coating**, subsequently **boosting economic and ecological benefit** (Žáček et al, 2009:1).

As this material will be subjected to **continuous change**, the appearance thereof will perceptibly also show forms of variation, as **oxidation never completely stops**. Successively, the primary layer of patina appears within a few weeks of exposure, with the final coloration only achieved within one to two years and lasting, without maintenance, for at least 80 years depending on product specifications. Furthermore, copper alloys at concentrations up to 0.55%, tolerates the production of a homogeneous, regenerative and **protective surface layer**, which **decelerates corrosion and safeguards the structural integrity** of the **underlying steel**. Henceforth, the investigation of popular weathered metals will be investigated in order to assist possible architectural solicitation (Arcelor, 2013:2).

## - STAINLESS STEEL -

Classified as being an actively protected material, the addition of at least 11% of chromium to steel creates an iron-based alloy commonly referred to as stainless steel. Possessing mechanical qualities that limit corrosion, provide chemical resistance and prevent scaling at high temperatures, stainless steel provides universal convenience (Outokumpu, 2013:9). Once compared to carbon steel, the usage thereof is fairly lower due to unfamiliar practice within the field of architecture. As shown in figure 3.29, usage is dominated by areas related to consumerism and equipment, with the building and general construction sector merely accounting for 5% (Leffler, 2011:4). Recent statistics has shown an upsurge in utilisation due to gain in familiarity, product affordability and lifecycle costs justification. Before the suitability of stainless steel as a material ideal for intentional oxidation is conveyed, the distinct classification thereof in terms of composition and topographical implementation will be declared.

Theoretically, stainless steel is divided into five classes. However, as local sourcing will be advantageous, only the three classifications of stainless steel, as recognised by SASSDA, will be mentioned. Apart from their differentiation in production, ferritic, austenitic and duplex stainless steel differs greatly in chemical composition. As mentioned previously, stainless steel must contain a minimum chromium content of 11%. The increase thereof, in addition with supplementary elements such as Molybdenum (Mo) and Nickel (Ni), allows for distinct categorisation (refer to figure 3.30). Austenitic stainless steels are primarily employed architecturally due to a higher composition of chromium and nickel. However, when proposed usage is in close proximity to the coast, duplex stainless steels are advised, as the high levels of molybdenum content renders it resistant to saline corrosion (Revie & Uhlig, 2008:341).

Evidently, it is essential that the intended location of proposed implementation be acknowledged in order to select a compatible grade of stainless steel. In addition to the previously mentioned corrosion map of South Africa (fig 3.6), the different calibers of stainless steel have been arranged according to their resistance to atmospheric corrosion.

Contrary to the popular belief of mere place and structure, this selection is more so governed by budgetary constraints and visual prerequisites. If a material is required that must remain rust-free in appearance, it is advised that a type of stainless steel be selected that fall within the

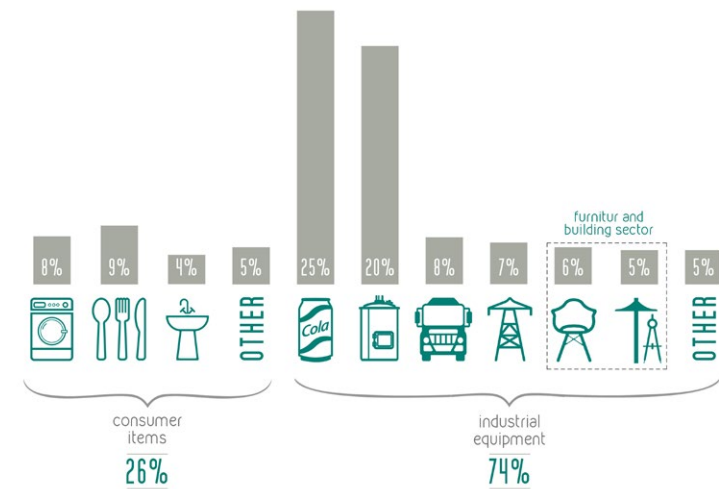


Figure 3.38. Consumer and Industrial Utilisation (Author, 2016)

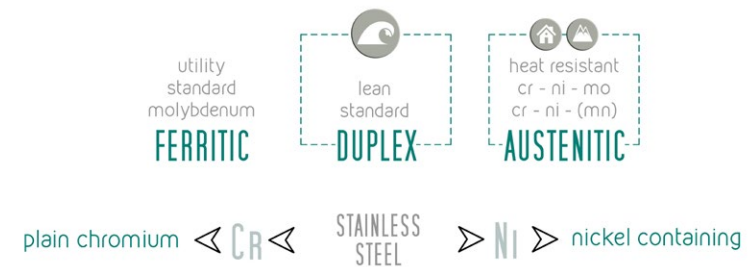


Figure 3.39. Categorisation of Stainless Steel (Author, 2016)

governed region. As per example, if finances allow high cost and the material is required to remain rust-free in appearance in a severe marine environment, the selection of a stainless steel that falls in Class IV must be utilised. However, if the appearance quality is not of vital importance, lower grades of steel can be selected, as only aesthetic modification (addition of patina), and no structural alteration, will occur - similarly to that of conventional weathering metal.

## - COR-TEN AND INDATEN STEEL -

As one of the building industry's oldest atmospheric corrosion-resistant steel material, COR-TEN has efficaciously overcome oxidation by capitalising on its unique "rust cures rust" function. Benefitting from its abilities to be implemented without any finish, since the encouraged formation of rust creates a protective layer which suppresses the rate of corrosion, this material nullified the common belief that all steel should be covered with paint. However, should painting be a visual requirement, the service life thereof will be prolonged quite extensively once compared to coatings applied onto ordinary steel. From the time of initial establishment, COR-TEN has been used in practically any field where steel is required. Raging from engineering structures such as bridges and railways, to architectural application on both and internal and external level, the abilities of COR-TEN to reduce lifecycle costs (LCC) and lower environmental burdens will warrant emergent usage (NSSMC, 2014:3).

When exposed to the elements, similarly to any weathered steel, an initial layer of oxidation develops which gradually converts to fine-textured rust. As exemplified in figure 3.31, the initial colour during application appears yellowish, followed by a gradual shift in colour within two years of installation. Thereafter, the materials stabilises due to sulphates of the alloying elements which produce insoluble compounds that clogs the pores of the rust/steel interface, resulting into no clear change other than a darker hue of brown. Moreover, if the patina does not stabilise, penetration might occur, which under continuous wet or buried conditions may result into similar corrosion rates as carbon steel, therefore not recommending such implementation. In marine environments stable oxide films may form on the steel, provided that harmful levels of chloride be washed off if regular contact with direct seawater is permitted (Arcelor, 2013:1). As an alternative to COR-TEN, Indaten steel can also be used as its properties and functionalities are merely identical. Variation in availability and price renders COR-TEN preferable.



Figure 3.40. COR-TEN Secular Changes in Rust Appearance (Hasegawa, 2016)

## PROJECT SYNOPSIS

Through the coverage of arch beams clad with COR-TEN steel, which **conceals** the rougher surfaces of the walls behind, a former desolated railway tunnel was converted into an enclosed pedestrian passageway. As a **method of rehabilitation** that had to adhere to **strict environmental constraints**, the area was transformed into a striking promenade. Connecting two northern Italian towns (Albisola and Celle Ligure), the focal idea was to design a structure which **accentuated natural** pathways, overhangs and viewpoints. In order to **govern reversibility** of the intervention, **temporarily materials were used and sensitive joining methods employed**. In addition to being a covered walkway, temporary exhibitions can take place inside the tunnel. As one exits the eastern end, the passageway unifies onto the seafront, where stepped decking creates an informal seating area (ArchDaily, 2012).

## PROJECT OBJECTIVES

- The intervention was not allowed to alter the existing identity of the historic fabric, **permitting semi-reversibility** if deemed necessary.
- The function of the pathways was to provide the continuity of pedestrian pathways and the usability of all surrounding coastlines and amenities.
- Materiality was to be of **low maintenance and have little environmental/visual impact**.
- In addition to serving as a connecting promenade, the restoration of the railway tunnel must function as a container for visionary art exhibitions and artistic installations.

## IMPLEMENTATION STRATEGIES

- Employ the selection of COR-TEN steel in a similar, seamless fashion that **sybiotically merges the new** (spatial intervention) **with the old** (existing host and habitant).
- Engagement alterations that can be **semi-revisable and respect its current setting**.



## precedent investigation

3.5

NAME OF PROJECT  
ALBISOLA PUBLIC PROMENADE

LOCATION OF PROJECT  
SAVONA, ITALY

CHIEF ARCHITECT  
3S STUDIO ARCHITECTS

DATE OF COMPLETION  
2011



theory



materiality



design



programme

Figure 3.41. Albisola Promenade (Voarino, 2011)



Figure 3.42. MONA's Central Staircase (MONA, 2012)



NAME OF PROJECT  
MUSEUM OF OLD AND NEW ART

LOCATION OF PROJECT  
MOORILLA, AUSTRALIA

CHIEF ARCHITECT  
NONDA KATSALIDIS

DATE OF COMPLETION  
2012

## PROJECT SYNOPSIS

As one of Australia's largest privately owned museums, the Museum of Old and New Art (MONA) was designed by architect Nonda Katsalidis to evoke the essence of time. Inspired by the antique Greek strongholds, the structure stretches over 6500 square meters and extends to three levels above ground. With the distinct feature of having no apparent windows on the outer envelope of the structure, a sense of danger is engendered in order to **enliven the experience** of the artistic works. As opposed to traditional light and signage, audio and **materiality** is used to guide all visitors - thus **heightening the theory of time and place**. Utilising the concept of Palais de Tokyo in Paris, this museum boasts various platforms where aspiring artists can exhibit work and use the space as a personal studio. This form of active collaboration acts as **supplementary layer** to the exhibited work permanent on display. The selection of materials used in the interior was carefully selected with the **concept of fragility and timeliness** as primary criterion - thus using an assortment of materials which appears to have been exposed to time and harsh conditions. In addition to COR-TEN-like materials, a combination of **unblemished and discoloured** stainless steel is employed in order to **contrast and outline past, present and future** occurrences (Trend Vision, 2012).

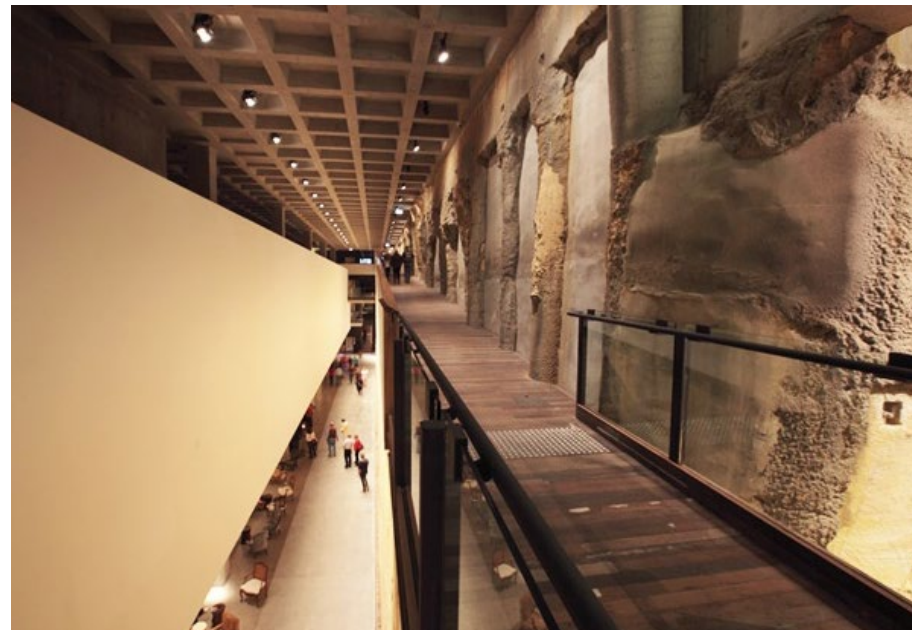


## PROJECT OBJECTIVES

- Create an **enticing environment** that aspires to encourage collaboration through the appreciation of art and design in an **alluring space**.
- Design an interior that is highly versatile in programme, atmosphere, display and materiality.
- Establish a prominent **link between the old and the new** through the art on display and **selection of appropriate materials**.

## IMPLEMENTATION STRATEGIES

- Employ the selection of materials in a similar, seamless fashion that symbiotically **merge the new** (spatial intervention) **with the old** (existing host and habitant).
- Utilisation of stainless steel un tarnished, and if underspecified, permit discolouration and appears **intentionally corroded**.



theory



materiality



design



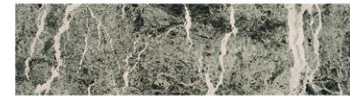
programme

Figure 3.43. MONA's Exhibition Space and Materiality (MONA, 2012)

## FAUX OXIDATION

If the chemical alteration of materials intentionally are deemed unfeasible, physical approaches exist that promote similar results visually. Faux finishing is the decorative process during which the appearance of materials, such as marble, stone and wood, is artificially replicated (Shekhar, 2005:110). Observed for centuries, this form of decorative art began with plaster and stucco in Mesopotamia. By way of shortage in resources and capabilities, the development of alternative forms of adornment was endorsed. Subjected by time and product availability, two essential grades of faux production remain - the positive or negative categorisation. All positive methods govern direct application of paint onto the surface to be decorated. The surface is essentially either covered with a base colour, followed by the application of patterns onto the wet base-coloured surface, or alternatively, colours are layered onto a dry surface and induced to mix with a spattering of mineral spirits. The latter mentioned negative methods permit the removal of material from the decorated surface by method of surface shellacking or paint chipping (O'Neil, 1971:9).

A number of faux finishes exist, as shown in figure 3.35, that can be employed when the devastating effect of age to certain materials is desired. Apart from stylistic advantages and temporality, structural integrity of the underlying object is certified due to the superficial nature of this application. Faux oxidation utilises a positive approach, which through layering, creates artificial patina. In conclusion, the appearance is enhanced three dimensionally and its protection against corrosion prolonged when a final layer of translucent glaze is applied.



### MARBLEISING

*used to make walls and furniture look like real marble, this can be done using either plaster or glaze techniques.*



### FRESCO

*simple technique, mixtures of tint and joint compound to add mottled colour and subtle texture to plain walls.*



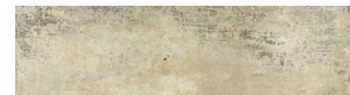
### FAUX BOIS

*french for "fake wood" is often used to imitate exotic or hard-to-find wood grain varieties.*



### TROMPE L'OEIL

*realistic painting technique often used in murals to create architectural details as well as depth and 3 dimensionality.*



### VENETIAN PLASTER

*smooth and often reflective plaster design that appears textured, but is smooth to the touch - concrete.*



### COLOUR WASH

*free-form finish that creates subtle variations of colour using multiple hues of glaze blended together.*



### STRIÉ

*glazing technique that creates soft thin streaks of colour using a paint brush - linen and denim.*



### SPONGING

*free-form finish achieved by applying glaze to the wall by dabbing a sea sponge.*



### OXIDISING

*free-form finish that creates subtle variations of colour using multiple hues of glaze blended together - rust.*

Figure 3.44. Positive Faux Methods (Author, 2016)

## PROJECT SYNOPSIS

Situated within the world renowned uShaka Marine World Theme Park, the Phantom Ship is regarded as being one of the key attractions on site. Located on the strip of land between the beachfront and the harbour, uShaka Sea World is the fifth largest aquarium in the world. As a central feature, the Phantom Ship acts as entrance to the aquariums situated underground, which is designed around five infamous shipwrecks. In addition to being a point of admission, the Phantom Ship hosts various restaurants, souvenir shops and ablution facilities. As **opposed to the adaptive reuse of a decommissioned vessel**, the exterior of the ship was newly-built, aspiring to **replicate** an old, stranded steamer. Various artificial methods of **intentional corrosion** were used to **replicate the passing of time**, both on an exterior and interior level. In addition to **weathered steel, faux oxidation techniques** were employed to create a rustic interior, as all elements were in actual fact new. Due to the cost associated with a vessel in such a severe state being too high, the **replication** of a stranded ship was deemed more feasible. Furthermore, a lack of decommissioned vessels resembling the desired **aesthetics supported the notion of imitation** (Tourisms SA, 2004).

## PROJECT OBJECTIVES

- Design a central gathering space that will permit admission to aquariums, restaurants, conference venues and souvenir attractions.
- Provide a structure that **correlates with its surrounding theme and location**.
- Imitate the **passing of time** through the selection of durable, cost-effective and artificial techniques that would not hinder safety, nor lessen structural integrity.

## IMPLEMENTATION STRATEGIES

- Employ the **replicating technique** of faux oxidation in a similar, seamless fashion that **sympiotically merges the new** (spatial intervention) **with the old** (existing host and habitant).
- Utilise this form of **intentional artificial corrosion** on elements where **materiality cannot be replaced** or be **endangered by possible structural loss**.



## precedent investigation

3.7

NAME OF PROJECT  
PHANTOM SHIP

LOCATION OF PROJECT  
DURBAN, SOUTH AFRICA

CHIEF ARCHITECT  
TNGG

DATE OF COMPLETION  
2004



theory



materiality



design



programme

Figure 3.45. Phantom Ship's Cargo Hold Restaurant (Unknown, 2005)

## BIOLOGICAL CONCRETE

In addition to the actual degradation of concrete due to **corroded reinforcement, severe load, or inferior composition**, weathering can occur when concrete is exposed to **natural pigmentation**. In addition to atmospheric stress created by water and salinity in coastal surroundings, the growth of microalgae, fungi, lichens and/or mosses can ensue on concrete when subjected to continuous humidified environments. These photoautotrophic organisms are able to obtain different elements for their metabolism (e.g. iron, aluminum, calcium, silicon etc.) through biosolubilisation. Such biosolubilisation involves the production of organic acids, which is the best known biogeochemical mechanism of concrete decay (Jayakumar & Saravanane, 2010:352). As opposed to **actual decay**, the Structural Technology Group has developed a type of biological concrete that **endorse the natural, augmented evolution** of pigmented organisms. In addition to aesthetic advantages, when applied to façades of buildings, **thermal comfort is improved** and atmospheric CO<sub>2</sub> levels reduced (UPC, 2012: np.).

In addition to sufficient pH levels, material properties which influence bio-receptivity, such as surface roughness and porosity, were amended in order to produce biological concrete. This resulted into the formation of a **multilayered** panel, which in addition to a structural deposit, consists out of three distinct layers. As illustrated in figure 3.37, the first layer that is situated on top of the structural layer is reserved for waterproofing. This ensures protection against possible damage caused by water. The second sheet, referred to as the biological layer, warrants colonisation and consents water accumulation. Acting as the internal microstructure which

facilitates the actual development of the biological organisms, this layer expels moisture and supplements retention though the capacity of rainwater encapsulation. The top layer is reserved for a discontinuous coat that permits the entry of rainwater, but prevents discharging. This reverse waterproofing layer directs the outflow towards where biological growth is desired (UPC, 2012: np.).

Since the onset of its introduction to industry in 2011, research was directed towards the process of growth and ability of the grown organisms to evolve with time, screening deviations of colour according to the time of year and the predominant families of organisms. This form of **intentional weathering** provides **revolutionary options** within the field of design.

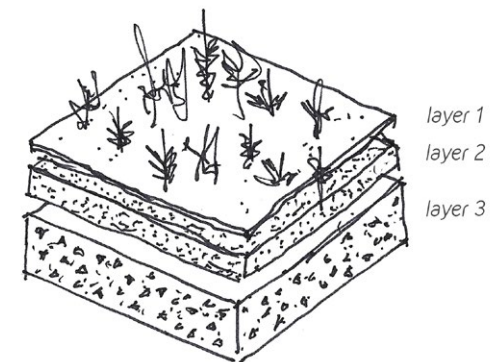


Figure 3.46. Composition of Biological Concrete (Author, 2016)

## PROJECT SYNOPSIS

The Aeronautical Cultural Centre is located on a wide stretch of land situated alongside industrial buildings all connected to the Barcelona Airport's terminal. Constructed to showcase, repair and host aircrafts dating back to World War II, the design followed similar construction systems employed by ancient aircraft and hangers. With an outer continuous skin constructed out of concrete, the overall skeleton steel structure was designed to support the weight of suspended aircrafts. The deliberate combination of ancient and current construction techniques contrasts the past with the present, the old with the new. Wanting to imitate a departing plane, the facade is elevated, allowing ample light to flood into the interior. Similarly to the **fragile nature** of corroded aircrafts, the process of **corrosion was intentionally replicated** on the outer envelope. As opposed to the steel of a plane that rusts, the concrete of the actual **building weathers**. The utilisation of biological concrete governs this concept and allows the building to **merge into its surrounding environment with the passing of time** (Dezeen, 2012).

## PROJECT OBJECTIVES

- The design of ample space that permits **multi-functionality and adaptability**.
- Combine ancient aircraft construction methods with current architectural trends in order to **contrast the past with the present**. This is applicable to the selection of materials as well.
- Construct a building that permits **migration** into its current setting. As the surrounding buildings and hosted aircrafts decay, the building should undergo evolution as well. This should however be of an **artificial kind** and **not compromise the structural integrity** of the steel skeleton.

## IMPLEMENTATION STRATEGIES

- Utilise biological concrete in a similar fashion where **intentional weathering of concrete** is desired. Seeing that the introduced design will make use of great quantities of new concrete, the proposed should be **evidently contrasted against the existing**, yet permit gradual and controlled visual migration with the passing of time.
- Furthermore, this form of material application will **tangibly** illustrate the **process of layering**.



## precedent investigation

3.8

NAME OF PROJECT  
AERONAUTICAL CULTURAL CENTRE

LOCATION OF PROJECT  
BARCELONA AIRPORT, SPAIN

CHIEF ARCHITECT  
SERGI GODIA

DATE OF COMPLETION  
2009



theory



materiality



design



programme

Figure 3.47. Centre Facade and Biological Concrete Panel (Unknown, 2011)

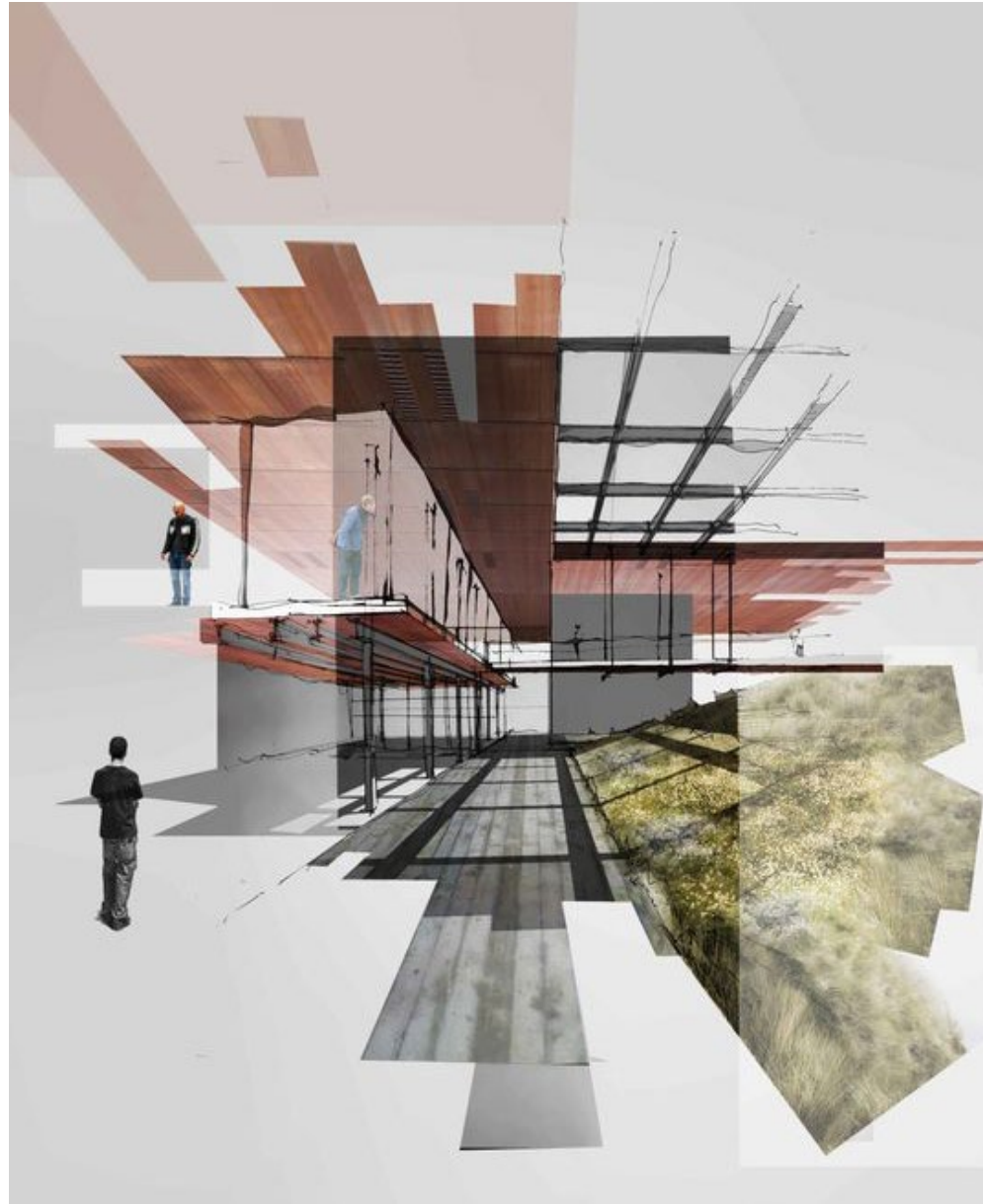


Figure 3.48. Layered Ink, Markers and Watercolour (Chahine, 2016)

## CORROSION OF MATERIALS

main material associated with a dock (host) and a ship (habitant)

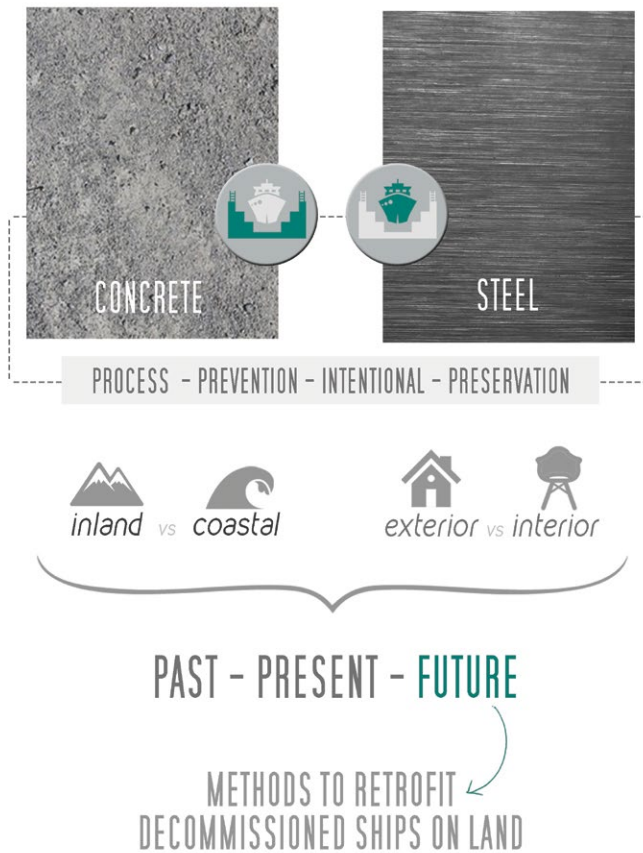


Figure 3.49. Approach to Materiality (Author, 2016)

In conclusion, this chapter served as theoretical premises that illustrated **corrosion as a tangible form of layering** which, if associated with materiality, generates an **architectural palimpsest**. As opposed to the mere institution of a conventional approach to heritage (refer to illustration 3.39), the **appendage of a new layer** is proposed that will allow for **past recollection and future addition thereon**. As a way to substantiate the aforesaid belief, **three material methodologies** that gradually acknowledges the conceivable introduction of **corrosion as a form of beautification**, were investigated.

The initial approach, **corrosion protection**, employs coated metals specifically engineered to **withstand the progression of oxidation** through complete fortification. The complete elimination of possible degradation permits the distinct introduction of new materiality that aspires to remain prominent. The second methodology, **historic decay preservation**, completely acknowledges the fact that all materials are **prone to complete deterioration** and thus wish to **stabilise the process in order to prolong material migration**. As opposed to the initial approach that is solitary reserved for all things new, the latter is only applicable to elements of historic importance. The concluding slant, **intentional degradation**, can be applied to both proposed and existing materiality and encourages a **mediated prominence through superficial degradation**.

In summary, design should be comprehended with the **clear realisation that materiality can act as a definite form of palimpsest**, which can either **migrate or overrule existing fabric** with the passing of time. As contended by Fred Scot (2008:96), the deed of alteration should not merely embolden absolute restoration or inattentive demolition practices, but methods of preservation that revel in the remembrance of what once was. Possessing a clear understanding of these fundamentals, the actual implementation thereof in the form of a spatial intervention can be promoted.