

## **Bridge building and bridge conservation in agreement with the genius loci**

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**Abstract.** Bridges ideally stand for the convergence of engineering landmarks and aesthetical attractions. But what's even more: bridges can be signs that reveal their meaning only by means of a skilful integration to their surrounding landscape or urban context. The appreciation of the spirit of place where bridge building happens is a substantial part for successful bridge design. The paper includes case studies of significant bridges and analyses essential observations on their formal and structural design along with their environmental adaptation, regarding the perception, reflection and incorporation of the "Genius Loci". It suggests some rules how to reach, to conserve or even increase interaction and harmony between form, function and integration: the everlasting challenge for bridge planners. A plea is made for the valuation, protection and conservation of bridges within their environment, defending their unique charm.

The "genius loci" as a notion refers -not only since, but all the time more- to the famous publication of Christian Norberg-Schulz (1926-2000) (Norberg-Schulz 1982). The concept introduced by Norberg-Schulz is applied usually to high-rise buildings, embedded into their natural or built environment. If we apply this concept to bridge-building we have to face some more difficulties in common architectural, urban and landscape planning. Let's assume first that the bridge, a generally linear construction, is not creating a considerable space by its own, but it exerts an enormous influence on the space where it is inserted. Furthermore there is to consider that there are a lot more technical rules and limitations -which at the same time can be as well possibilities- than for any other building. This may also be the reason why we often forget to consider the so important not technical, but

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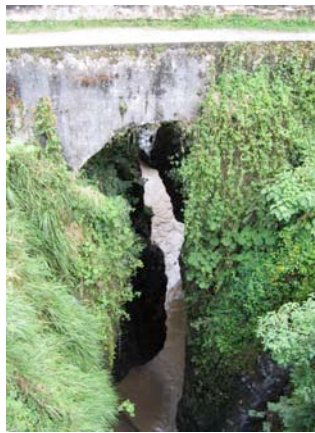
“existential” implications which are so fundamental for our well-being. Furthermore bridges have to be part of certain, pre-established traffic routes in order to serve their purpose. Unfortunately this is a condition that frequently is not considered as a problem or even a chance to be solved by empathetic urban or traffic planning, but is often abused as an argument in the sense of an inherent necessity by the management, trying to save efforts or money, or just due to a lack of imagination. Of course a bridge can also be considered only as the straightest connection between two points, a just indispensable construction, planned as an extremely efficient and remarkably well calculated structure under most advantageous economic circumstances. But on the other hand the consideration of the “genius loci” may stand in bridge building for a constructive attitude towards a design, not detached from the natural or urban context, including items like human perceptivity and the human right for -at least- a basic quality of life, along with the creation and conservation of cultural achievements or the “homestead” brought up by Norberg-Schulz.

Particularly in the perception of bridges have to be recognized different categories which depend, to begin with, on factors like the period of awareness, the previous technical knowledge of the observer and his personal relationship to the surrounding and specific place. But also psychological peculiarities and anxieties may play a role in how a bridge will be perceived. But since a bridge connects initially not more than two points of a route, impossible or at least difficult to be connected without this structural support, the first perception is of course a quite practical one, usually quite short-termed, causing no further identification than just the only use of the bridge. A technically prepared person will probably still make an impulsive and superficial analysis of the structure: a professional habit. Starting from this initial and archaic perception and depending on the previous knowledge of a person, who actually represents rather an observer than just a user, there are different levels of perception to be acknowledged: definitively, there should to be observed an emotional one, linked intimately to the visual and aesthetical quality of the construction and its tangibility. But there are also the structural and, more than anything else, the historical perceptions, generating at last the impression of identity. Only this bundle of perceptions, together with the awareness and knowledge about their origin, will after all be able to create the aura enclosing the bridge, a phenomenon quite intimately related to the spirit of place. This aura, comprising

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both, knowledge and sensation, analysed and thus made aware leads to understand the spirit of a place. Depending on their presentation, bridges are capable to communicate powerful signs and to increase the manner of their perception in a positive way. Some examples of their formal possibilities may illustrate this idea.

An exciting prototype for the hidden expressivity of bridges is a small passage over a gorge in the Mexican State of Puebla (*Figure 1*) with a span not larger than two or three meters, a sportsman



*Figure 1* A quite short bridge helps to get over this deep gorge.

would be able to jump easily over it, so that the gap seems insignificant so far; but arriving in the middle of the modest structure the user finds out, that the gap is unexpectedly about 30 meters deep! The unexpected authentic hazard the user is exposed to reveals the significance and reliability of the support that represents this helpful bridge. Other bridges create a special ambience only by their indescribable dimensions performing an unbelievable tenderness of their structure within a rough or majestic nature. They are able to represent beauty and empathy, conferring a new, man made personality to the landscape. In a general way and additionally the legibility of the structure and its concordance not only with its surroundings but also with its shape and the building material employed make up the individuality of a structure in the very place where it is built. With a smart presentation arises another important factor at this point of analysis: changing and unexpected views for observation during the approach to the bridge, sometimes inviting to a

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rest, may reveal hidden connotations of the structure and help to enhance the spirit of place and thus making it tangible.

Besides these more spectacular effects, which apply to both urban and natural places, the addition of decorative elements to the structure may improve or even create another attraction to the place. There are, for instance, gateways at the entry and exit of a bridge like towers, large pedestals with representative sculptures or just the impressive monumentality of pylons. These means are meant to emphasise as determinant signs the change of attitude and posture of the user at a point where the obstruction of the “safe” way occurs and the structural crossing over the “dangerous” gap begins and ends. Additional identifying elements on the passage may be observation platforms, a remarkable design of the railing or the positioning of sculptures.

### **Examples**

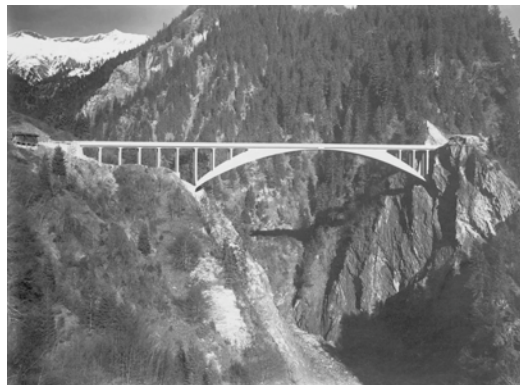
Case studies of significant bridges and analysis of essential observations of their formal and structural design along with their environmental adaptation regarding their perception will help the reflection, handling and incorporation of the “genius loci”. Furthermore, not only structural and formal, but probably even more ideological, historical, imaginary or symbolic reasons can produce an influence on the meaning and perception of a bridge.

If we can learn a lesson from history it would be the one about the co-action between technique and aesthetics in the early concrete bridges (for instance in Germany), because their manifestations are the result of exhaustive discussions about the new technical possibilities in bridge building and the demands of traditional aesthetics. The introduction of new building material to bridge construction occurred step by step (Bühler 2007, 2). Concrete was used just for the foundations since around 1880, already ten years later it was the material of the choice to make the deck and at last, around 1900 it was employed to build the most difficult structural parts, such as arches. In the steps as the use of concrete advanced, stone and bricks were substituted slowly until they disappeared definitively from the building sites. But these bridges made of rammed or armoured concrete still had to fulfil the stylistic requirements of their time. Many of these first concrete bridges are still riveted by decoratively arranged stone slabs producing the appearance of the traditional stone

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built prototype. This impression was frequently reinforced by cornices and other traditional forming elements until practices appeared which permitted to convey a structured aesthetic surface even made of concrete to the visible parts of the bridge. In the first 20 years of the past century special exteriors have been prepared out of concrete, used as a kind of precast plaster inside the formwork. This surface was finished by an artisan after retracting the formwork. The general structure of stone bridges with round arches develops slowly to shallower, segmental and finally flat arches. Beam bridges made of concrete only appear with the improvement of armoured concrete. A common property of these early concrete bridges is the intention of their makers to find a structurally acceptable and at the same time legible form, together with a modern surface finishing and the best possible integration into the landscape.

Let's have a look at a bridge, built soon after these first concrete-experiments in the 1930ies, looking so unique, so impressing and finally constituting even an essential part of the landscape: The Salginatobel-Bridge in Graubünden/Switzerland (Billington 2000) (*Figure 2*). Structurally the bridge is considered as a box girder with a



*Figure 2* The Salginatobel-Bridge

very slim profile in the upper part, supported in the lower part by a segmental arch, whose profile shores up visibly, almost tangibly on the two sides of the gorge. The resultant triangles on each side of the bridge connect the arch and the slab by a row of columns, showing the perfect distribution of forces, of pressure and tension. These qualities of the bridge, the unpretending evidence of the structure and the unsophisticated sincerity of this bridge make it look not only as an integral part of the nature, but even as an accentuation of it, because

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the depth, the cliffy and savage profile of the steep borders of the gorge with its depth of 80 meters only become conscious by the intrepidity of the light and nearly airborne construction that connects them. Besides that we admire, as in all bridges designed by Robert Maillart (1872-1940) the application of entirely appropriate details and an enormous harmony of all parts, that makes the bridge look like an entity of its own. But the values of this bridge are a lot more than that: beyond these aesthetic values there is another most important one: Maillart won that competition not because of the artistic virtues of his design, but because his proposition was the less expensive out of 19 other offers. Therefore this bridge stands not only for its visual properties that are path breaking for future concrete constructions but also for economic reasons, a fact, that shows that well designed bridges not necessarily have to be the most expensive ones. Consequently in 1991 the Salginatobel-Bridge was quoted formally a “Milestone of International Historic Civil Engineering” by the American Society of Civil Engineers and the “Schweizer Ingenieur- und Architektenverein”, but the monument still awaits an official national and international protection.

The wooden Kintai-Kyo-Bridge in Iwakuni (*Figure 3*) is another outstanding and suggestive example for the study of the spirit of a place and furthermore for the obligation to conserve an intangible



*Figure 3* The Kintai-Kyo-Bridge

heritage. In order to understand the importance of this bridge a look back to history is required: Some years after the famous battle of Sekigahara, in 1600 the defining moment in Japanese history, the Iwakuni-Castle was built in 1608 by Hiroie Kikkawa (1561-1625).

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But just a few years later the castle had to be destroyed by order of the Tokugawa-Emperors who wanted to reduce the number of castles to one per province, leaving this one without landmark. So Hiroyoshi Kikkawa (1621-1679) ordered to build the Kintai-Kyo-Bridge in 1673, which should connect the city of Iwakuni on one side of Nishi-River with the settlement of his Samurai and his own palace on the other side. In addition to these practical and military benefits, the bridge should achieve another meaning as a sign: Since the site didn't dispose of a representative building after the destruction of the castle, this bridge was meant to stand for the presence and power of the Daimy\_ and his prosperous city. Based on this political reflection an extraordinarily sophisticated, technically challenging structure was built. Five flat, wide-spanned timber arches, intricately assembled by specialized craftsmen, are constructed over four stone piers, founded in midst of the wild river. The bridge since then became famous enough, so Japanese artists liked to present it frequently in their drawings, prints and paintings as an ideal type of bridge. Unfortunately due to the torrents of the river the bridge suffered damages and destructions on several occasions during its lifetime. But as a landmark and symbol for the place, the bridge has been reconstructed every time in the original way, using the traditional techniques and even materials. These reconstructions have been documented accurately in the archives of the city. So, if we want to understand the spirit of this very place we have to be aware of the historical and symbolic background and to consider the building and re-building process; this helps the people to conserve not only the bridge itself but also their traditional construction techniques, tools and skills: finally the intangible part of their heritage.

Similar examples for the preservation of an intangible heritage in addition to the spirit of place are the suspension bridges in the Andean Mountains of Peru crossing deep incised rivers like the Apurimac. These bridges are witnesses of the ancient Peruvian street-system which connected the Inca Empire since the 13<sup>th</sup> Century A.D. over thousands of miles from North to South. Since these times, the bridges are made usually of organic material and thus subject to a permanent and unavoidable natural deterioration. In ever lasting cycles these catenary bridges were rebuilt with natural fibres in the same traditional manner. But in this special case it is not just the permanence of historic routes, traditional building materials and techniques but also the conservation of the social structures and rituals

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of the Indios which ensure and permit the management of the recurring reconstruction.

Compared to the preceding examples, which all refer to bridges integrated into their -mainly conserved- natural landscapes, urban bridges are much more subject to alteration, destruction and changes of their environment. One of the most striking examples for the deterioration of an urban bridge is the case of the “Stone Bridge” in Lima (Peru) (Bühler 2007, 1) (*Figurs 4-5*).



*Figures 4 and 5* The Bridge in Lima in the 19<sup>th</sup> Century (left) and today (right)

This bridge was built in 1613 as one of the first durable stone bridges in Peru and hence has been admired by the Indians and the Spaniards. Chronicles praise the stone bridges as a real progress compared to the bridges made of natural fibres during the Inca-Empire. The city-council of Lima, the capital of the vice-royalty of Peru, wanted this stone bridge to be built over the Rimac-River with the best technologies available in the Americas, and in order to make it a real landmark a triumphal arch was erected at the entry to the bridge, which later should be the place where the first public clock was mounted. In front of the access a small open place was created and the riverside-walk permitted attractive, always changing and sometimes unexpected panoramas of the bridge. Artists presented this bridge always as an urban landmark in city-plans, paintings and engravings until the beginning of the 20<sup>th</sup> century. The decline of the bridge began slowly with the installation of the railway on the city's side of the river, when the first arch of the bridge had to be replaced by a rigid steel structure. As a previous measure to this change the demolition of the entry's arch was unavoidable and probably also politically wanted because times and taste had changed. Some decades later, another part of the bridge was sacrificed: when the bridge-deck, due to increasing traffic, had to be broadened, the additional spaces for a rest were covered by a new plane concrete slab, leaving the



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bridge completely bald and finally without mayor attraction. Today the bridge connects the historic centre with a poorer sector of the city and hence the small place is observed by the Peruvian Army positioned at a control post and protected by a tank.

### **Suggestions and conclusions**

By observing some simple rules it will be possible to reach, to conserve or even increase interaction and harmony between form, function and integration: the everlasting challenge for bridge planners. A plea is made for the valuation, protection and conservation of bridges within their environment, defending their unique charm. Since man is capable to understand, to interpret, to feel, even to improve nature, we should be conscious that daring to build a bridge is not just a structural challenge but also a challenge for the visual design and integration. There are two levels of analysis: the urban space and the landscape. Therefore the planner should first think about the role of the topography and the kind of vegetation as the limits of natural space and about the volumes, layout, colours and composition of the boundaries of built spaces. At the same time, political, social, historical and economic spaces, present in all surroundings, have to be kept in mind. In addition adequate traffic solutions can only be found by an analysis of the actual landscape or urban shape, being aware of these places as spaces that have developed under particular historic conditions and that they are a result of their history. So the nature or buildings around, the place-making, the colours, the volumes and layout, the shape of the surrounding areas should define the first design solutions. The planner could, for instance, emphasize on the rivers to go beyond as crossings of water and land playing with volumes and lines of the –as we have seen- mostly linear construction. There are more items for an appropriate design, e.g.: (1) the playing with the heights and width of the building without breaking dimensions and proportions, (2) the –even if limited- space below and above the bridge, (3) its surface treatment and colour as a possibility to integrate, to make disappear or to emphasise the bridge in its context, (4) its physical form, (5) its building materials, (6) its course which may be straight or bended, movable or fixed and (7) the superior guidelines for the routes, creating not only functional but also visual references to other ways and buildings.

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An important feature should also be to imagine the approach of the user/observer to the bridge building and the speeds of approach, access and passage: if he hurries away by car, just superficially seeing what's around him or if he walks slowly and can observe and experience every detail of the building and its surroundings. In any case the human being and its necessities should be in the centre of the planners' attention again, but these necessities cannot be only seen as functional and technical ones but also as the very human desires of identification, social and historical association, protection and the care about the human scale; all these are desires that finally might be subsumed as the creation of the famous "homestead", the presence of a protecting genius.

These propositions should help to support the analysis and appreciation of the engineering heritage, bridges in this case, in order to promote the awareness and consciousness for their values that make them valid and valuable for further conservation. But this preservation cannot be reduced to the pure structure only: Even more than in many other cases, the protection has to include the environment that embeds these structures and creates the possible points of their observation, because they often cannot be appreciated from a shorter distance.

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