

A Study on the Definition of the Term “Tectonics” in Architecture

Ran Soo Kim

Ph.D. of Architecture, Georgia Institute of Technology, Atlanta, U.S.A.

Abstract

This paper attempts to identify the term “tectonics” comprehensively by collecting and categorizing existing definitions of tectonics within the architectural area rather than to stress the concept of tectonics of each specific theorist. Although no consensus of opinion on the concept of tectonics exists, architectural tectonics was closely related to the following terms in three categories: 1. *techné*, technique, and technology; 2. construction and structure; and 3. stereotomics. Based on its etymology, system, and material construct, the notion of tectonics common in these three categories signifies “the art of framing construction,” in which linear elements are connected with joints and clad or infilled with lightweight material. Thus, the art of framing construction, as a common concept of tectonics, reveals the following characteristics: First, tectonics is based on framing construction in contrast to piling-up construction as the etymology of tectonics signifies the art of carpentry. Then, the term tectonics, dealing as it does with a higher level of construction rather than the mechanical level of structure, incorporates the poetic aspect of *techné* as well as the rational aspect of technology. Third, Owing to the organic, double system of tectonic frame and incrusting or infilling materials, the tectonic body becomes both the ornament and the structure simultaneously. As the art of framing construction is based on material construction rather than structural or ornamental form, this paper proposes that one can view tectonics as a term that conveys the meaning of the actual material effect on space.

Keywords : Tectonics, Stereotomics, Techné, Structure, the Art of Framing Construction

1. INTRODUCTION

This paper attempts to define the term “tectonics.” Within the scope of architectural theories, no consensus of opinion exists on the concept of tectonics although its adjective form, “tectonic,” basically signifies “of or relating to construction or building.” While vaguely agreeing that tectonics is related to construction, architectural theorists have formed their own definitions. In order to suggest a logical interpretation of a certain building, critics have frequently reduced the meaning of tectonics to structural form by treating tectonics as similar to the visual expression of dynamic forces. In order to comprehensively identify the term tectonics, this study collects existing definitions of the term and categorizes them. The term tectonics within the architectural area is closely related to the following terms in the three categories below:

1. *Techne*, technique, and technology
2. Construction and structure
3. Stereotomics

The definition of tectonics will be stated in terms of its etymology in the first category, in terms of building system in the second, and in terms of Gottfried Semper’s material construct in the third. This categorization is useful, as one can understand any critic who raises the issue of tectonics and interpret its meaning in each context of discussion by comparing tectonics with the terms above. In terms of its etymology, system, and material construct, this study will identify the notion of tectonics common in these three categories.

2. TECHNÉ, TECHNIQUE, TECHNOLOGY, AND TECTONICS

2.1 Techné

One may illuminate the concept of tectonics in the light of etymology by comparing it with such terms as *techné*, technique, and technology. According to Demetri Porphyrrios, the Greeks used the same term *techné* for both art and craft, as they did not distinguish artists from craftsmen, generally calling them *technites*. In Greek, *techné* does not simply refer to practical dexterity on the basis of execution but implies a kind of knowledge; it signifies man’s intelligence as reflected in the construction of products in carpentry, sculpture, music, poetry, medicine, agriculture, and architecture. Porphyrrios states that *techné* is frequently used as a concept opposite to nature (*physis*). The organized knowledge for production can be formulated in order to transform raw material into a useful utensil, which reveals the way in which it was made in contrast to natural things.

Martin Heidegger, going beyond the superficial meaning of *techné*, most authentically defined the Greek term *techné*:

However usual and convincing the reference may be to the Greek practice of naming craft and art by the same name, *techné*, it nevertheless remains oblique and superficial; for *techné* signifies neither craft nor art, and not at all the technical in our present-day sense; it never means a kind of practical performance. The word *techné* denotes rather a mode of knowing (Heidegger, 1971).

According to Heidegger, to know implies to apprehend what is present, so *techne* as knowledge “brings forth present beings as such beings out of concealedness and specifically into the unconcealedness of their appearance.” Therefore, Heidegger argued that *techne* did not signify an action of making but a mode of knowing. From his point of view, building is not an art or a technique of construction but dwelling. As the German word of building *Bauen* signifies “to stay in a place,” the objective of building is to dwell. By letting dwell and making a space a place based on a site, in which four primal beings—earth, sky, divinities and mortals—belong together in one, building accomplishes its nature. He called the oneness of the four the fourfold. A building can gather the fourfold and bring the fourfold into a thing, that is, an existential being. Heidegger, arguing that letting dwell rather than construction is the nature of building, explained that the essence of architectural tectonics originated from *techne*, which signifies making something appear:

The Greeks conceive *techne*, producing, in terms of letting appear. *Techne* thus conceived has been concealed in the tectonics of architecture since ancient times. Of late it still remains concealed, and more resolutely, in the technology of power machinery. But the nature of the erecting of buildings cannot be understood adequately in terms either of architecture or of engineering construction, nor in terms of a mere combination of the two (Heidegger, 1971).

For Heidegger, *techne* meant the poetic revealing of things on the basis of his accounts below:

Techne belongs to bringing-forth, to *poiesis*; it is something poetic. . . . Thus what is decisive in *techne* does not lie at all in making and manipulating nor in the using of means, but in the afore-mentioned revealing (Heidegger, 1977).

Christian Norberg-Schulz, who borrowed the meaning of *techne* from Heidegger, explained *techne* using a phenomenological approach in which the ontological purpose of a building is to make a site a place, that is, to potentially uncover the meanings present in a given environment. According to Norberg-Schulz, a building embodies its meaning by standing forth in the open as a concrete identity. “By standing there” (Norberg-Schulz emphasized the importance of the expression as Heidegger repeated it four times), a building reveals the properties of everything surrounding it. For Norberg-Schulz, the definition of *techne* implies the poetic embodiment of a place through plastic forms rather than the scientific abstraction of a space (Norberg-Schulz, 2002). Kenneth Frampton, following Martin Heidegger’s definition, also argued that *techne* includes the meaning of revealing, which he signified as both knowing and making by explaining that “*techne* reveals the ontological status of a thing through the disclosure of its epistemic value” (Frampton, 1995).

2.2 Technique and Technology

The terms technique and technology are derivatives of the same root *techne*: technique originates from Greek *techne*, technology from Greek *techne* and -logy (science or theory) from Greek *logos* (word). According to Marc M. Angelil, who applied these terms to architecture, technique implies the architectural ability to execute particular skills and at the same time, the body of the specialized procedures and methods for architectural production. On the other hand, technology, although having evolved from the word technique, emphasizes a system more rationally intertwined with the development of modern science.

Gevork Hartoonian explained the replacement of the word *techne* with technique or technology historically. According to Hartoonian, Vitruvius and Palladio used *techne* to signify the logos of making, which emphasizes the ontological bond between art and science. However, from the end of the seventeenth century, *techne*, in its classical sense, was replaced by technique as artists and artisans focused on technical quality rather than on ontological importance to the solve problems. Due to the invention of tools that measured the natural world and Cartesian logic, people began to be concerned with the inner structure of architecture beyond the outer appearance. Hartoonian argued that “a major consequence of the seventeenth-century break with classical thought was a shift from interests in ‘what’ to ‘how’—that is, from object to process” (Hartoonian, 1994). As the idea of process became a focal issue in architecture, technology replaced *techne*. Accordingly, Hartoonian insisted that the shift from *techne* to technique and technology took place in the seventeenth century.

In contrast to Hartoonian, who believed that such terms as technique and technology were generalized during the same period, Angelil argued that technique as a skill was subordinated to technology as the structure of scientific thought with the transition from the Middle Ages through the Renaissance to the Age of Reason. According to Angelil, technique maintained both its magical and material aspects. With the transition from magic to science, magical technique, which focused on visual imagination, was discouraged whereas material technique was developed into the idea of technology that focused on conceptual know-how and objective operation. In his conclusion, Angelil argued that technology must re-address the poetic component of technical matters, which reminds one of the meanings of *techne*.

2.3 Tectonics

Although architectural critics define technique and technology in slightly different ways, they agree that while the Greeks used *techne* in architecture as a term connoting the poetic revelation of construction as the organized body of knowledge, modern architectural theorists considered the term technology deficient because it signified the structural utilization of construction on the basis of scientific and objective analysis, and thus did not have a

higher metaphysical level of architectural theory. In the nineteenth century, when modern structural materials and constructional methods were invented, a plausible term that covered the theoretical explanation of the phenomena of technological construction was needed. In this context, Mitchell Schwarzer explained the background of flourishing discussions on tectonics as follows:

New iron structures and scientific analyses of living habits revolutionized building construction and appearance. . . architectural theorists sought to coordinate the observable world of building and the inner consciousness of art. Their efforts led to discourse on tectonics . . . (Schwarzer, 1995).

Kenneth Frampton also argued that the term tectonic cannot be divorced from the technological, by identifying three distinct conditions:

1) the *technological object* that arises directly out of meeting an instrumental need, 2) the *scenographic object* that may be used equally to allude to an absent or hidden element, and 3), the *tectonic object* that appears in two modes. We may refer to these modes as the ontological and representational *tectonic* (Frampton, 1990).

The term, tectonic derives from the Greek term *tekton*, signifying carpenter, and the term tectonics matches the Greek *tekonike* that implies the knowledge of carpentry, that is, "the *techne* of carpentry" (Porphyrios, 2002). According to Frampton, the term, tectonic, as the adjective form of tectonics, has been used in the glossary of English since 1656, implying "belong to building," and it was initially and elaborately discussed as a modern architectural meaning in Karl Bötticher's *The Tectonic of the Hellenes* of 1843-52 and in Gottfried Semper's *The Four Elements of Architecture* of 1851.

In summary, the term tectonics etymologically refers to the art of construction, as Kenneth Frampton described it (Frampton, 1995). While *techne* in terms of etymology refers to the poetic revealing of all fields in which craft and knowledge are needed, tectonics implies the art of carpentry, which mainly indicates the art of architectural construction. From the materially constructional point of view, carpentry signifies a framing constructional type in which lightweight linear elements are connected with joints in contrast to a massive constructional type in which solid mass is piled up. To satisfy the requirements of modern construction, wood, as the main material of carpentry, is substituted by more intensified materials such as steel and concrete. This presumptive interpretation of tectonic materials may be persuasive in that tectonics has been animatedly used with the theoretical progress of architectural technology. Technology in architecture refers to a rational system that the term *techne* does not cover. On the other hand, technology in architecture does not maintain the meaning of the poetic knowledge of architecture. Tectonics is revived by the need to express a higher level of construction.

3. CONSTRUCTION, STRUCTURE, AND TECTONICS

Tectonics may be defined by comparing it with such terms as construction and structure, as all three terms define the meaning of a system. In the article "Structure, Construction, and Tectonics," Eduard F. Sekler, regarding these three words as closely related yet distinct, from one another, defined construction as the concrete realization of a principle or system based on material selection and handling, and structure as the more general and abstract concept referring to a system or principle based on the arrangement of forces. Sekler claimed that another term that means certain expressive qualities in the relationship with the play of forces cannot yet be described in terms of construction and structure alone. The term he was referring to was "tectonics."

On the other hand, Adrian Forty defined construction as the everyday practice of building, comparing it with structure, which he divided into three meanings according to historical architectural discourses. Until the middle of the nineteenth century, structure signified "any building in its entirety" in English; in the second half of the nineteenth century, it implied "the abstract system of support of a building independent of actual building and keeps the assumed notions of 'stability' distinguished from its other elements, such as its decoration, cladding, or services" (Forty, 2000); in the twentieth century, structure implied an invisible and intelligible schema that was usually identified through the arrangement of tectonic parts. According to Forty, modernists who used the term, structure confused the second meaning (the support system of a building) with the third meaning (the intelligible schema of the relationship between parts). Although Sekler also regarded structure as the combination of the second and the third definitions of Forty, both Sekler and Forty considered construction based on material facts while regarding the term tectonic differently. The former regarded tectonic as the representational qualities of forces and the arrangement of parts beyond the idea of a technical system while the latter simply considered it a synonym for mechanical. He identified tectonic structure as mechanical structure, which signifies "the system of support independent of material substance."

The example above shows that architectural theorists have their own unique definitions of tectonic or tectonics. The variation in the definition is so wide that the term cannot be assigned one unified meaning but instead classified into three categories in relation to the concepts of structure and construction.

3.1 A Mechanically Structural Form

In the first category, the term tectonic relates to the meaning of a technical or mechanically structural form excluded from subjective sensibility, which conforms to Forty's definition. Stanford Anderson, before defining

tectonic, introduced the following writing of Le Corbusier: “We may then affirm that the airplane mobilized invention, intelligence, and daring: *imagination* and *cold reason*. It is the same spirit that built the Parthenon. . . . not a bird or a dragonfly, but a machine for flying; the lesson of the airplane lies in the logic which governed the enunciation of the problem and which led to its successful realization” (Le Corbusier, 1946).

Anderson, emphasizing the importance of objective logic rather than *a priori* personal sensibility in making architectural form, defined the term tectonic as “a complex and evolving concept that attempted to establish a relationship between form and technical considerations” (Anderson, 1980). Anderson, connecting the term tectonic to utilitarian design for mass-production, focused on the issue of a technique free from subjective expression.

While Anderson identified the term tectonic with the concept of technical form, Anne-Marie Sankovitch understood it as related to mechanical statics far from subjective sensibility: “the tectonic principle by which load, support, and thrust are accommodated” (Sankovitch, 1998). Sankovitch, regarding the concept of structure as more comprehensive than that of tectonic, argued that “structure includes the system of statics indicated by the more strictly tectonic meaning of the word, and it also encompasses the building’s ornament” (Sankovitch, 1998). Sankovitch’s definition of structure is based on the original Latin meanings of *structura*, denoting the complete work of architecture itself, which corresponds to Forty’s first definition, any building in its entirety. Sankovitch’s definition of tectonic is also similar to Forty’s. Both associate it with mechanical statics, which constitutes the part of the mentally abstract concept of structure, which is far from a subjective representation.

3.2 Structural and Representational Forms

In contrast to the first category, in which tectonic is defined as relating to a mechanically structural form devoid of artistic sensibility, in the second, it is stated to be a term possessing the dichotomous meanings of construction: structural and representational forms. As Sekler insisted, the idea of tectonics involves more than technically structural qualities. Mitchell Schwarzer also argued as follows:

The importance of considering tectonics as a discourse lies precisely in the need to rewrite chapters in the history of architecture that have been understood too much through the uniform ascendance of concepts like functionalism and structural realism (Schwarzer, 1995).

Regarding tectonic qualities beyond the mechanical structure, Gevork Hartoonian believed in the higher level of constructional aspects of the tectonic, interpreting tectonic as “the logos of making” and distinguishing it from mere construction based on mathematics and mechanics and simply responding to gravity. Hartoonian argued that “in the tectonic, column, wall beam, and roof

surpass their structural rationality and reveal meaning” (Hartoonian, 1994). According to him, the tectonic responds to structural forces by analogy and makes them palpable with the help of ornamentation. In this context, ornament is a necessity for the tectonic. On the same basis of such concepts as *techne* and construction, as Hartoonian interpreted the tectonic, Kenneth Frampton argued that the term not only signifies a structural and material integrity but also a poetic construction. In tectonic theory, Frampton regarded “the structural unit as the irreducible essence of architectural form” (Frampton, 1990), and at the same time, focused on the poetic representation of it beyond the technical and mechanical logics of structure.

3.3 A Material Construct Creating a Spatial Effect

While the second definition of tectonics focuses on visual forms expressing both structural logic and representational art, the third definition of tectonics is defined as a material construct that creates a spatial effect based on an order. To distinguish between the second and the third categories, one should distinguish the concept of order to that of structural logics: order signifies systematic rules that combine architectural elements. As these rules are organized by tradition, region, the construction industry, materiality, comfort, architectural style, structural calculation, and other such factors, they are not explained by reasons relating to supportive force only.

The definition of tectonics described by Carles Vallhonrat falls within the purview of the third category: “Tectonics depends upon a very few fundamental aspects of the physical world. One, of course, is gravity and the physics that goes with it. Gravity affects what we build and the ground beneath it. Another aspect is the structure of the materials we have, or make, and a third is the way we put those materials together. How and why we do it affects the way they appear as the surfaces that bound space” (Vallhonrat, 1988). As the final constituent condition of tectonics, Vallhonrat was concerned with the surface effect on space rather than the representation of inner structure. This point of view, which considers the spatial effect of surface as the object of tectonics, may be based on that of Gottfried Semper, who considered structure as secondary, arguing that “wall dressings,” rather than structural frame itself, play the main role in making livable space. He wrote as follows:

The use of the crude weaving that started with the pen—as a means to make the “home,” the *inner life* separated from the *outer life*, and as the formal creation of the idea of space—undoubtedly preceded the wall, even the most primitive one constructed out of stone or any other material (Semper, 1989).

For Semper, the *dressings* and the *mask* are as old as civilization, but “masking does not help, however, when behind the mask the thing is false or the mask is no good.” Wanting to draw attention to “the principle of dressing and incrustation” (Semper, 1989) that veiled inner structure, Semper emphasized the mastery of material and its

techniques, only through which architects can upgrade raw material into the spiritualized form. He regarded this spiritualized fashion as "structural-symbolic rather than structural-technical" (Semper, 2004). Semper argued, "only by complete technical perfection, by judicious and proper treatment of the material according to its properties, and by taking these properties into consideration while creating form can the material be forgotten, [and] can the artistic creation be completely freed from it, and can even a simple landscape painting be raised to a high work of art" (Semper, 1989).

3.4 Karl Bötticher's Core-form and Art-form

In contrast to the third category, which focuses on the spatial effect created from the material, the second, which may have originated from Karl Bötticher's core-form and art-form, emphasizes that tradition defines tectonics with a dichotomy between structural core and meaningful representation. Mitchell Schwarzer claimed that Bötticher defined architectural tectonics simply as "the activity of forming a building" (Schwarzer, 1993); however, in *Die Tektonik der Hellenen*, Bötticher suggested two elements of *tektonik*, the core-form (*kernform* or *werkform*) and the art-form (*kunstform*) as the essential issues of tectonics. One may conclude that Bötticher defined tectonics as the activity of forming a building composed of the core form and the art form. Bötticher explained these two terms: "The core-form of each part is the mechanically necessary and statically functional structure; the art-form, on the other hand, is only the characterization by which the mechanical-statical function is made apparent" (Herrmann, 1984).

According to Mitchell Schwarzer, Bötticher's writings on architectural tectonics during the 1840s suggested a new direction in architectural theory because his tectonics illuminated architecture in terms of the constructional process revealing social and physical forces and his "association of structure and ornament with ontology and representation was new to architectural thinking." Schwarzer argued that the dual concepts of ontology and representation allowed Bötticher to prospect for "the cognitive space to advance a radical proposal for technological innovation in iron. Without this split and its embodiment of tradition and history in the moderating *Kunstform*, the modern metaphysics of structural realism might have taken a different course" (Schwarzer, 1993).

Bötticher stated that "no longer can stone alone form a new structural system of a higher stage of development" (Herrmann, 1992), so a new material and structural system should be adopted in order to "permit wider spans, with less weight and greater reliability" than stone alone. He continued, saying that "a minimal quality of material should be needed for the walls, thus rendering the bulky and ponderous buttresses of the *Spitzbodenstil* [Gothic arcuated system] completely superfluous." Bötticher argued that iron would become a new "basis for the covering system" and that iron structures would "come to

be as superior to the Hellenic and medieval systems as the arcuated medieval system was to the monolithic trabeated system of antiquity." Bötticher interpreted the history of constructional systems in terms of structural progress. In his view, the iron tectonic system was superior to the existing stereotomic system, and the tectonically trabeated system of stone was inferior to the stereotomically arched medieval system; stereotomy implied cutting stones into complex forms such as vaults, helical stairways, and arches. In contrast to Semper, Bötticher seemed to give little attention to material sensibility, which distinguished tectonic tensility from stereotomic compressibility; rather, his major interest was in structural progress that enabled quantitatively voluminous space.

Despite the spatial possibilities of iron, Bötticher still believed, in 1846, that the new iron structure should be covered by a historical style. Otherwise, he commented that "architecture could never be elevated to an object of history." According to Schwarzer, the conflict between technological innovation and the pursuit for eternal beauty demanded that Bötticher provide "separate trajectories and identities for *Kunstform* and *Werkform*."

Bötticher defined the art form as a simple covering and a symbolic attribute of the part-decoration, *κοσμος* (Herrmann, 1984). Frampton also interpreted the core form (*Kernform*) as the essence of the constructional nucleus and the art form (*Kunstform*) as cladding or ornament (Frampton, 2002). Bötticher explained that, unlike natural form by life force, tectonics, by creating its form from dead material, is unable to express the process "in any other way than in semblance to the natural unfolding, which here seems as if applied and added to it from the outside" (Herrmann, 1984). According to Wolfgang Herrmann, Semper remarked that he could not agree with Bötticher, noting, "I admit that decorative symbols have no real static function, but it is wrong to conclude that they are applied and added from the outside."

3.5 Gottfried Semper's Material Construct

Semper suggested another opinion of ornament by illustrating the bindings of wire in the following:

With rigid materials, like metal wire, it is the best to bind many wires into one. This system of cords is capable of the richest ornamental development and almost elegance. . . It is likely that through this agency the plait became one of the earliest and the most useful symbols of the technical arts that architecture borrowed (Semper, 1989).

Semper implied that ornaments are not added afterwards and cannot be separated from the structure of the material because the body becomes the ornament and the structure at the same time. He argued that "the parts of an architectural work of art can be explained as material parts of a construction not only by their real or symbolic significance." For Semper, the artistic or ideal aspect of tectonics was neither added from the outside nor confined to independently ornamental objects.

Schwarzer identified Semper's tectonics in terms of a collective sense of material creation that overcame the dichotomy between rational reason and subjective imagination:

He [Semper] recommended that, rather than beginning with the mind's rational or imaginative faculties, historians of the visual arts take into account man's handling of the physical world. To a large degree, Semper located the unity of culture in the ways that people satisfied both their spiritual and material drives in the act of making artistic and/or useful things (Schwarzer, 1995).

Semper's tectonics is distinguished from Bötticher's, in that Semper clarified in his views on the significance of material. Herrmann wrote their different points of view regarding material use: "The material employed, its properties, and its negative or positive effect on form and shape were of decisive importance for Semper. To Bötticher it mattered only that the function was clearly expressed, and it was therefore of no consequence to him" (Herrmann, 1984). Bötticher did not explain *Tektonik* in terms of construction that meets both material and spiritual needs, but rather in terms of "the activity that raises this construction to an art form." Semper objected to Bötticher's expression that the core-form is conceived, noting that it was "not conceived but arises out of necessity." As Schwarzer insisted, Bötticher seemed to agree with Schinkel that "architectonic relations are based on general static laws," providing a comprehensive tectonic theory covering modern innovative space and realizing the objectivity of art by introducing structural realism to the existing artistic subjectivism of architecture. However, this study argues that Bötticher bequeathed a fixed tradition that separated ornament from structure, beauty from truth, and art from science in discourse on tectonics. (One can easily find an ambiguous dichotomy between art and science in the dictionary definitions of architectural tectonics, which have not yet reached a consensus. The *Oxford Dictionary* defines tectonics as "the art and process of producing practical and aesthetically pleasing buildings," while *WordNet* defines it as "the science of architecture.")

The terms of Bötticher, core form and art form, are based on the concept of form rather than of material, detail, or a constructional whole. Since architectural tectonics implies the premise of building and construction rather than form-oriented concepts, the tradition of dividing the definitions of tectonic into logical reading and artistic meaning needed to be revised or extended to a more comprehensive concept that met the needs of architecture. About 150 years has passed after Bötticher's *Die Tektonik der Hellenen* was published in 1852. Akos Moravansky argues that we should more directly appreciate the sensuality of material surfaces rather than load architecture buildings with meanings because today we no longer recognize such meanings. Semper's theory of tectonics, although it was almost as old as Bötticher's, provided another insight into tectonic thinking, the details of which are described in the

next chapter. Semper's dual concepts of tectonics and stereotomics suggest the importance of the material effect on space beyond structural expression and form the basis of another interpretation of tectonics.

4. STEREOTOMICS AND TECTONICS

4.1 Semper's Stereotomics and Tectonics

One can define tectonics by contrasting it with stereotomics. Both terms are derived from the technical arts and the material approach of Semper, but in a broader sense, Semper identifies tectonics as all artistic skill revealing cosmic order by molding the material in his following statement:

Tectonics deals with the product of human artistic skill, not with its utilitarian aspect but solely with that part that reveals a conscious attempt by the artisan to express cosmic laws and cosmic order when molding the material (Herrmann, 1984).

According to Wolfgang Herrmann, before Semper read Bötticher's *Die Tektonik*, he never used the term tectonics, simply defining the process of building as "joining material into an organized form." When Semper became aware of the term in Bötticher's *Die Tektonik*, where it was defined as "any activity having to do with building and furnishing," he reacted by extending its meaning to encompass all technical arts. Some time later, when revising the text of his book, the subtitle of which was "The Technical Arts," Semper is said to have replaced the word tectonics with the term fine arts or simply arts or artistic skill whenever he used it in the broader sense.

On the other hand, enumerating the four basic technical skills of ceramics (afterwards metalwork), masonry, timberwork and weaving, Semper referred to timberwork, or carpentry, as tectonics, adding to this description "in the narrower sense of the word." Accordingly, under the influence of Bötticher's *Die Tektonik*, Semper used tectonics in a broader meaning comprised of all artistic skills dealing with material and then formulated his own concept of tectonics by confining the use of it to carpentry within the boundary of architecture. Despite his adoption of the term tectonics from Bötticher, Semper's tectonics differs from Bötticher's, in that it more concretely develops the material approach of architecture on the basis of artistic skill by contrasting tectonics with stereotomics.

Stereotomics denotes the knowledge or quality of stereotomy, defined in a dictionary as "the science or art of cutting solids into certain figures or sections, as arches, and the like; especially, the art of stonecutting." That is, as the Greek etymology of stereotomy is composed of two roots, *stereos*, solid, and *tomia*, to cut, stereotomy simply signifies the art or technique of cutting solids. While its dictionary definition and etymology as well as the history of stereotomy emphasize the importance of the cutting technique, Semper's concept of stereotomy focuses more on massive materiality and the constructional process rather than on the stonecutting itself. According to

Cornelis van de Ven, "with stereotomic Semper meant, above all, a constructive method of assembling mass in such a manner that the total plasticity was moulded in one undivided dynamic unity" (Van de Ven, 1978). Stanford Anderson summarized Semper's term *Tektonik* as "constructs of articulated elements (elastic skeletal structures, e.g., timber or metal frames)" and the term *Stereotomie* as "comparatively inert assemblies (intractile masses, e.g., masonry walls)."

Semper's term, *tektonik* and *stereotomie* are not only based on the properties of the materials related to the two technical skills of carpentry and masonry but also derived from the components of Semper's four elements that suggest four built types. According to Semper, the four elements that composed ancient architecture were the hearth (the sacred focus), the mound (the earthen platform), the roof on columns (supporting system), and finally the enclosure as a textile hanging. At the same time, technical skills match these elements, as Semper described as follows:

Ceramics and afterwards metal works around the hearth, water and masonry works around the mound, carpentry around the roof and its accessories. But what primitive technique evolved from the enclosure? None other than the art of the wall fitter (Wandbereiter), that is, the weaver of mats and carpets (Semper, 1989).

On the basis of this pragmatic anthropological taxonomy of Semper, Kenneth Frampton interpreted *tectonics* and *stereotomics* as follows: "the *tectonics* of the frame, in which lightweight, linear components are assembled so as to encompass a spatial matrix, and the *stereotomics* of the earthwork, wherein mass and volume are conjointly formed through the repetitious piling up of heavyweight elements" (Frampton, 1995). Frampton actively applied tectonics to the modern constructional situation by focusing on the issue of the spatial matrix of the structural frame, while he expanded stereotomics in terms of the constructional process by describing "the repetitious piling up" of load-bearing masonry.

4.2 Semper's Tectonic Wall

In contrast to the explanation above, in which each material property and constructional process clearly correspond to either tectonics or stereotomics, one cannot make one-to-one matches between the interpretations of the walls of Semper and George Edmund Street, who introduced two types of Gothic wall, walls veneered with thin layers of marble and substantial marble walls:

In my notes upon the buildings as they were passed in my journeys, I have described two modes in which this kind of work was treated; the first was that practised in Venice- the veneering of brick walls with thin layers or coats of marble; the other, that practised at Bergamo, Cremona, and Como, in which the marble formed portion of the substance of the wall. These two modes led, as would naturally be expected, to two

entirely different styles and modes of architecture (Street, 1855).

If one applies Street's veneering wall and substantial wall to Semper's tectonic and stereotomic walls, one may view the construction of the monolithic wall as conforming to Semper's stereotomic wall, but not his tectonic wall. Semper regards the tectonic wall as a combined type, that is, the frame with the filling, which Frampton, in modern sense, referred to as the framework and the lightweight enclosing membrane, respectively. Although Semper's theory on original tectonics was based on carpentry as the frame or the support, the spatially enclosing function was more important than the structurally supporting one in Semper's tectonic wall. As Semper considered the intrinsic function of the wall as a spatial enclosure by stressing that in all Germanic languages, the word *Wand* (wall) has the same root and basic meaning as *Gewand* (dress), the tectonic wall of Semper is spatially and materially focused. For Semper, structure was veiled by material dressing and needed to provide itself as the frame or the support of the enclosing membrane.

Frampton also asserted that this "tectonic/stereotomic distinction was reinforced in German by that language's differentiation between two classes of wall: the *die Wand*, indicating a screen-like partition such as the type we find in wattle and daub infill construction, and *die Mauer*, signifying massive fortification" (Frampton, 1995). Although Frampton stressed the importance of the structure by regarding "the structural unit as the irreducible essence of architectural form" (Frampton, 1990) in his tectonic theory, he appeared to say that the screenlike infilling was also an essential part of the tectonic wall. Jesús María Aparicio Guisado also argued that tectonics comprised both the structure and the covering: "In German, the word for tectonic is *Wand*, which comes from *Gewand*, to dress. In this way, the tectonic is connected with dressing, with covering and therefore, also with skeleton, with structure."

Another description similar to the Semperian concepts of the tectonic wall applied to modern built types is that of Adolf Max Vogt, who referred to Joseph Paxton's distinction between "table and tablecloth." Paxton compared the support structure to the table and the glass skin to the tablecloth in his description of the innovative features of the Great Exhibition hall, the so-called Crystal Palace of 1851, as the characteristic of the improved building method that adapted to modern changing conditions. According to Vogt, it was marvelous that Semper's theory of the Caribbean Hut was exhibited in the Crystal Palace at that time. The wall of this primitive house, Semper argued, was not made of stone but of textiles hung on a frame analogous to the relationship between the table and tablecloth in the Crystal Palace. Vogt said that "the germ of primal form, the seed for the Crystal Palace, was exhibited within its own structure." (However, Semper did not seem to notice the connection.) Robert Dell Vuyosevich pointed out that the glass curtain

wall as a modern constructional method still retained the word curtain, the essential motif of the Semperian wall, so Vuyosevich expected that this “would amuse Semper.” Rosemaie Hagg Bletter also reiterated that Semper gave as an example the German terms *mauer* and *wand*. Although both terms generally imply wall, the second meaning of *Mauer* is battlement, and *Wand* has also the meaning of screen. For Semper, walls indicate the lightweight enclosures, such as screen and curtain.

In brief, Semper newly defined tectonics and stereotomics from his anthropological point of view, which was based on the collective sensibility of the material properties and the technical skills of ancient buildings. Frampton and Guisado further expanded these concepts so that they were more concrete and adaptable to modern architecture. In particular, Vogt’s comparison between the Caribbean Hut and the Crystal Palace provided a connection between Semper’s textile wall and modern curtain wall in terms of tectonics. The most important contribution of Semper’s tectonics may be that it raised the issue of space with regard to structure as secondary to spatial enclosure in architectural construction. Cornelis van de Ven described the contribution of Semper in terms of material space as follows:

For the first time in the history of architectural theory, existential forces innate in man related to the human artifacts and its space enclosing functions. Both tectonic and stereotomic form are no longer seen a planar treatment of ornament, but as a direct response to the spatial direction of man, with respect to the technique and nature of the materials used (Van de Ven, 1978).

The insight of Semper differed from that of Bötticher, whose tectonics gave rise to the relationship between the core form and the art form, and thus, encouraged the proliferation of structural theories in tectonic debates. While Bötticher’s tectonics concerned the ontology and the representation of spatial structure, Semper’s tectonics suggested a materially spatial approach, the object of which was a high level of spatial effect beyond simply material techniques. On the basis of Semper’s point of view, expanded as it was by Frampton and Guisado, his tectonics may be defined as knowledge dealing with the spatial construct composed of clearly jointed framing elements clad or infilled with lightweight material compared with stereotomics, which is concerned with a monolithic construct with the massive continuum of solid material. The new definition of Semper’s stereotomics and tectonics may be universal in the classification of modern built types, if one refers to the following Carles Vallhonrat description: “One can imagine the entire repertoire of construction materials organized along that grand counterpoint between mass or masonry materials and that other group that comes out of point loads, and the notion of frame and infill panels” (Vallhonrat, 1988).

In the *Der Stil*, Semper argued that the Greek temple, although revealing the highest form, was based on stone

tectonics which implies a heterogeneous combination of tectonic form with stereotomic material. Stereotomic pieces, which are identical or similar to one another, act monotonously as members of resisting compression, while the size and the shape of tectonic members are various in their action following each of their positions in the frame. Semper regards the tectonic members of Greek stone temples as “organic forms” (Semper, 2004), which, by means of art, could be brought to life like organisms. In contrast to this organic quality of tectonic members, stereotomic mass was felt to be lifeless due to the constructed totalities of a eurythmic character, which Semper considered as a regular, closed form. Semper described Greek architecture as a body that maintained organic forces by striving against mass and weight and by encrusting the structure with decoration “so intimately bound together by this influence of the principle of surface dressing that an isolated look at either is impossible” (Semper, 1989).

Although Semper approved of the organic life of Greek architecture, which united tectonic structure with stereotomic incrustation, in contrast to barbaric architecture, in which the elements of structure and decoration come together mechanically or inorganically, he believed the theory that the Greek temple had been originally conceived in stone was untenable. Semper argued that, despite of their barbarous organization of architectural elements, the Assyrian, the Medes, and the Babylonians influenced Greek architecture. Based on his anthropological research, Semper maintained that material was subject to replacement, so its forms were transferred to another material, and that this process, having begun in the early period, still remained:

The timber style must have been modified by a prior change in material and could have evolved from this change to the stone style only through the meditation of a second change in material (Semper, 2004).

In contrast to Semper, Bötticher insisted that the Hellenes maintained from the beginning a higher intellectual creativity that enabled them to reveal the innermost character of stone buildings. According to Bötticher, Hellenic architecture was originally invented for stone-building, and the existing view that stone buildings imitated timber ones is untenable. Regarding the origin of the Greek temple, one still cannot judge who was most accurate in debates among those who favored material logic or classical styles; however, in terms of materially constructional types, Bötticher’s argument was ambiguous as to the innermost character of stone and the relationship of his structural principle to this material characteristic. A structural system of the post-and-lintel type made of stone seemed inefficient, as stone could not resist bending moments. In that point, Semper’s theory was persuasive, as it created the material concepts of tectonics and stereotomics in constructional theory and synthesized tectonics with the idea of organic incrustation.

5. CONCLUSION: THE DEFINITION OF TECTONICS

The objective of this paper is to identify the term "tectonics" in a more comprehensive sense by collecting and categorizing different positions on tectonics. It is proposed that tectonics is defined as the "art of framing construction," in which linear elements are put together with joints and clad or infilled with lightweight material. The "art of framing construction" reveals a common concept of tectonics in three categories: in terms of its etymology in the first, building system in the second, and in terms of Gottfried Semper's material construct in the third. First, tectonics is based on framing construction in contrast to stereotomics that is piling-up construction, as the etymology of tectonics signifies the art of carpentry. Second, this definition of tectonics is beyond the idea pertaining to a mechanically structural element devoid of artistic sensibility. Thus, the term tectonics, dealing as it does with a higher level of construction rather than the mechanical level of structure, incorporates the poetic aspect of *techne* as well as the rational aspect of technology. Third, Owing to the organic, double system of tectonic frame and incrusting or infilling materials, the tectonic body becomes both the ornament and the structure simultaneously. This dual characteristic of the tectonic body suggests a more comprehensive view which overcomes the existing concept of tectonics that focuses on structurally supportive forms. In that sense, this definition avoids the tradition of dividing tectonics into logical structure and artistic ornament, which may have originated from Bötticher's core form and art form. As the "art of framing construction" is based on material construction rather than structural or ornamental form, this paper proposes that one can view tectonics as a term that conveys the meaning of the actual material effect on space.

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- (Data of Submission : 2006. 5.2)