Velocity of Body Movement:

Generating Architectural Space by Musical Paces

ZHANG Yu, PhD candidate
School of Architecture, Tianjin University, Tianjin, China
e-mail: yzhangarch@hotmail.com

REN Sijie
School of Architecture, Tianjin University, Tianjin, China
e-mail: ren_sijie@yahoo.com.cn

Abstract:

While the generative ideas largely broaden our horizon for creating in architecture, music, and other art fields, it could be noticed that, little attention has been paid on the potential possibilities of bonding architecture and music together. Don't we experience the linear sequences that are common both in space and music? In this regard, why not generate architectural spaces by a certain musical, temporal code?

By reinterpreting some early Chinese written accounts (dating from 3rd century BC) on the experience of ritual motion, this paper seeks to explore the ancient sensibilities in a new key, with three strategies weaved into the text.

(1) examining the ancient Chinese attitudes towards the reciprocal relationship between architecture, music, and motion, and taking them in new directions. The velocity of body movement is reconstructed to be central to the perception of architectural space.

(2) contextualizing Chinese literatures with Western sources. For example, the Greek myth as well as a tale narrated by Goethe could contribute to a broader understanding of architectural as "frozen music".

(3) generating architectural spaces by presenting different ways of rhythmic body movement in/through the buildings, where the pace/tempo is shown to be the basic measurement unit in both architecture and music.

1. Introduction

It is well-known that Goethe called architecture "frozen music" and he further told a tale to support his remark. "Imagine Orpheus," said Goethe in 1827, "when he was assigned a great desolate building site, shrewdly settling at the most appropriate spot and forming a large market place all around him by the life-giving music of his lyre."[1] Well, doesn't such a description transmit to us a modern sense, to some extent, of the generative process? An open ground, then a core space to start

working, where "an artistic and craftsman-like structure" is automatically shaped in a kind of algorithm composed by certain musical rules. Still, the tale was empty on what those particular rules are. So it remains to seek ways for turning Goethe's poetic saying such as "the friendly enticement of music" into the algorithm in practice.

One approach is to look at the linear perception that is common both in space and music. In this regard, the *pace* rises to attract attention. A pace could either be a measure of space (as indeed used in different areas of the world), or play a vital role for music, dance and other time arts in the sense of "tempo". However, it occurred possibly in ancient China that the term "pace" merged the two meanings into one; hence opens up our horizon. The specific methods to generate architecture by music may thus emerge.

2. A Set of Definitions

2.1 original terms

Let us examine some vocabulary entries recorded in *Erya* (Near Correctness), the oldest extant Chinese dictionary (3rd century BC) [2]. A set of definitions that are enormously concerned with pacing could be found in Chapter 5, "*Shigong* (Glosses on Buildings)" (*fig. 1*):
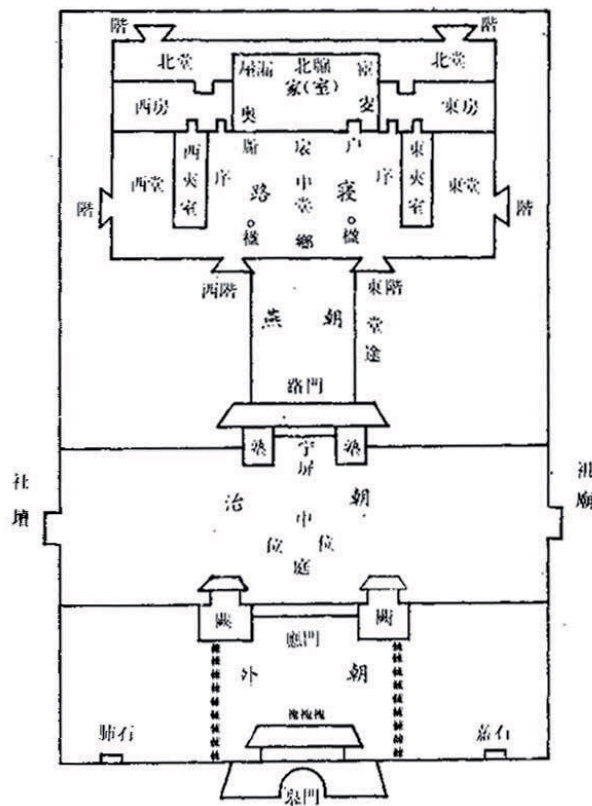

fig. 1 Court plan based on Shigong, Erya, sketched by JIAO Xun (1763-1820), Qunjing Gongshi Tu (Building Illustration of Classics)

1. inside a chamber is called *shi* (a walk but barely move);
2. on a hall in called *xing* (a slow walk);
3. besides a hall is called *bu* (a moderate walk);
4. outside a gate is called *qu* (a brisk walk);
5. in the courtyard is called *zou* (a run);
6. on an avenue is called *ben* (a quick run).

Specifically treating the body movements that occurred in different architectural settings, the above terms seem readily assimilable to our modern understanding, despite of its laconic lexicographical style. However, to make a deeper and better understanding, we'll look into some fundamental conceptions of Chinese architecture.

2.2 An understanding within the context of Chinese architecture

According to Sir Joseph Needham, who had a deep insight into "the spirit of Chinese architecture" [3], the horizontal spaces were the keynote of Chinese buildings. Its fundamental conceptions suggested by him could be summarized here as the following five points:

1. The ground-plan was composed by one or more rectangular courtyards; enlargement is by continual duplication of existing units, and growth in breadth or preferably depth.
2. Each courtyard was rounded by formal grouping of buildings with a marked attention to axis; the courtyard was made a part of the building, and not something additional and separate.
3. In a typical building group, the main hall as the chief building was placed on the rear of the axis, with open galleries on its two sides, and a gate as the entrance to the courtyard.
4. The main hall was based upon a platform; it might occasionally be of two storeys.
5. The circuit started from the gate, passed either across the courtyard or through the connected side galleries, reached the platform and ended in the hall and the chambers inside.

To give these conceptions some historical proofs, a few passages in the earliest existing collection of Chinese poems, the *Shi jing* (Book of Odes, ca. 1100BC-500BC) are worth quoting [4]:

Crowds brought the earth in baskets
They threw it with shouts into the frames;
They beat it with responsive blows;
They pared the walls repeatedly, and they sounded strong.
Five thousand cubits of them arose together,
So that the roll of the great drum did not overpower.
They set up the gate of the enceinte;
And the gate of the enceinte stood high.
They set up the court gate;
And the court gate stood grand.
They reared the great altar,

From which all great movements should proceed.

The above lines recount how people constructed a large composition: the walls around, the gate of the enceinte, the court gate, and the altar (the platform) on the rear. Bearing in mind such a scene, together with the five-point conceptions, we will realize that the before-mentioned six entries concerning the body movements and architectural settings are basically follow a space sequence from the chamber, via the hall, the court and the gate, finally to the avenue – in one word, from the deepest inner to outer places.

2.3 An understanding within the context of ritual music

Another noteworthy point indicated from the above poem is the image of "the great drum". What is its function while such a musical instrument being fixed on the building site? Taking Needham's commentary [5] as one reasonable answer, it was the drummers who were setting the rhythm of the working process. If this was indeed true, we may infer a step further: since the music rhythm might accompany the builders' activities, why not the rhythm itself to act as a generator of the whole structure? [6]
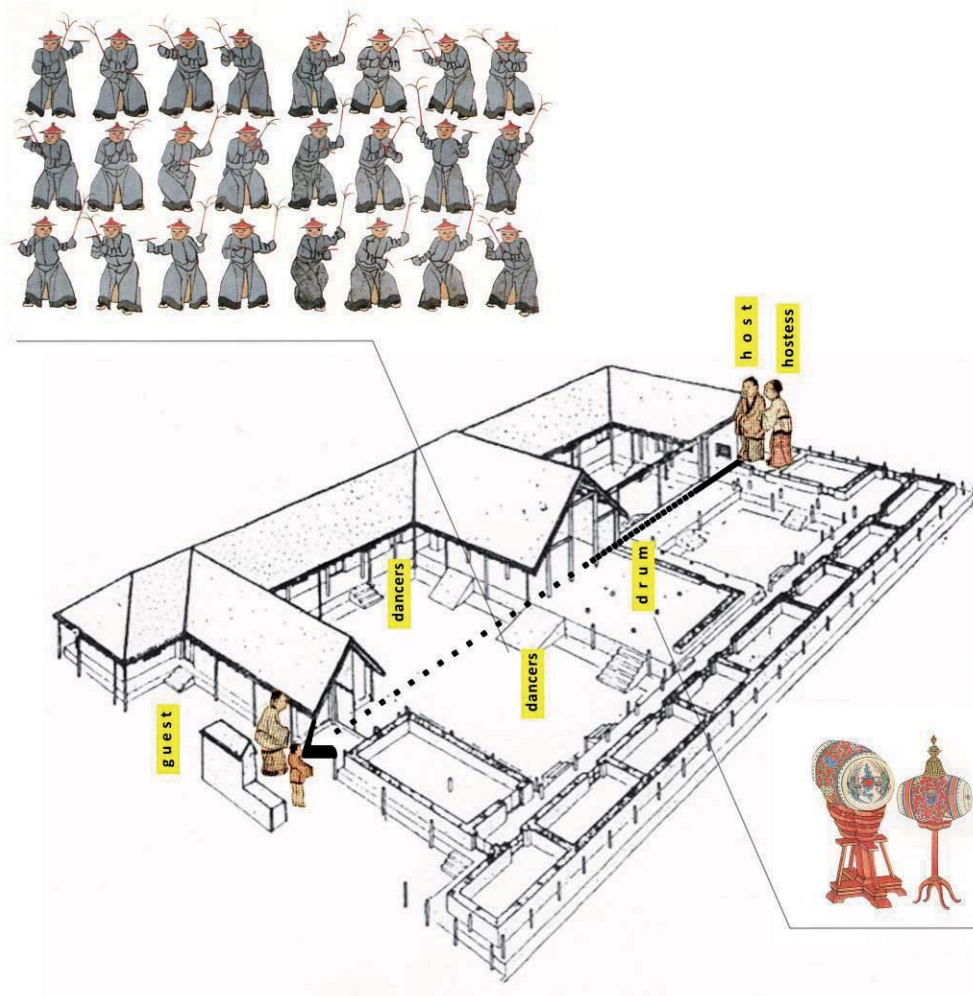

fig. 2 A typical dwelling life for ancient Chinese. The perspective is based on a conceptual restoration draft upon a ruin site dated from ca. 1095 BC

In fact, music played an indispensable role in the ancient Chinese's dwelling life (*fig 2*), yet the issue might be out of the discussion here; simply exploring the six entries about pacing will discover a closely-related musical context. Owning to the traditional textual annotations on the *Erya* and on other early Chinese classics, we may conclude that each entry actually described a kind of velocity of body movement accompanied by a certain tempo, altogether counting quite a few in the architectural settings. As shown in *Table I.*

Table I

architectural setting	subject	pace	tempo
chamber	host & guest	*shi* (a walk but barely move)	*largo*
hall	host & guest	*xing* (a slow walk)	*adagio*
	band	-	-
court	host & guest	*bu* (a moderate walk)	*andante*
	dancers	-	-
	attendant (on vehicle)	*zou* (a run)	*allegro**
outside the court gate	host & guest	*qu* (a brisk walk)	*allegretto*
	attendant (on vehicle)	*ben* (a quick run)	*presto**
outside the enceinte	guest & attendant (on vehicle)	*ben* (a quick run)	*presto**

* The tempos of allegro and presto were made by the small bells tied to the vehicle in motion.

Here we correspond each of the original Chinese pacing terms with a tempo marking much more familiar to nowadays musicians. Now, it's ready for us to put forward the generative method that adapt well from the ancient set of definitions.

3. The Generative Method

3.1 Building Developing Steps

Taking music as the generator, the whole building group could be developed from its core space to its periphery. The basic steps operate as below:

(1) Set where the host stands as the core space and hence build a platform.

(2) The plan size of the platform depends on the arrays of the band and the dancers.

(3) The band locates at the centre of the platform, while the dancers respectively flank or proceed with them. Since the arrays of the band mark the ground-plan of the hall, the different array patterns of dancers suggest two variations of the plan composition (*fig. 3*).

When everything is in order, the music begins to perform.

(4) The host steps out by a half circle in the velocity of a *largo*, which trait marks the first half plan of the chambers.

(5) The host walks along the court axis in the velocity from an *andante* till an *allegretto*, and thus determine the length of axis from the hall to the enceinte wall.

(6) At the node where the host's velocity shifts between *andante* and *allegretto* sets the court gate.

As mentioned before, the courtyard was made a part of the building, so it's this gate that demarcates the "interior" and the "exterior", as in the *Erya* one of the entries was named "outside a gate".

(7) The host turns back with the guest, thus reaffirming the length of the axis.

(8) In the meantime, it's the attendant driving vehicle who determines the periphery of the enceinte wall in the velocity of a *presto*; and that of the court in an *allegro*.

(9) The guest arriving on the hall steps in by another circle in the velocity of a *largo*, which trait marks the rest half plan of the chambers.
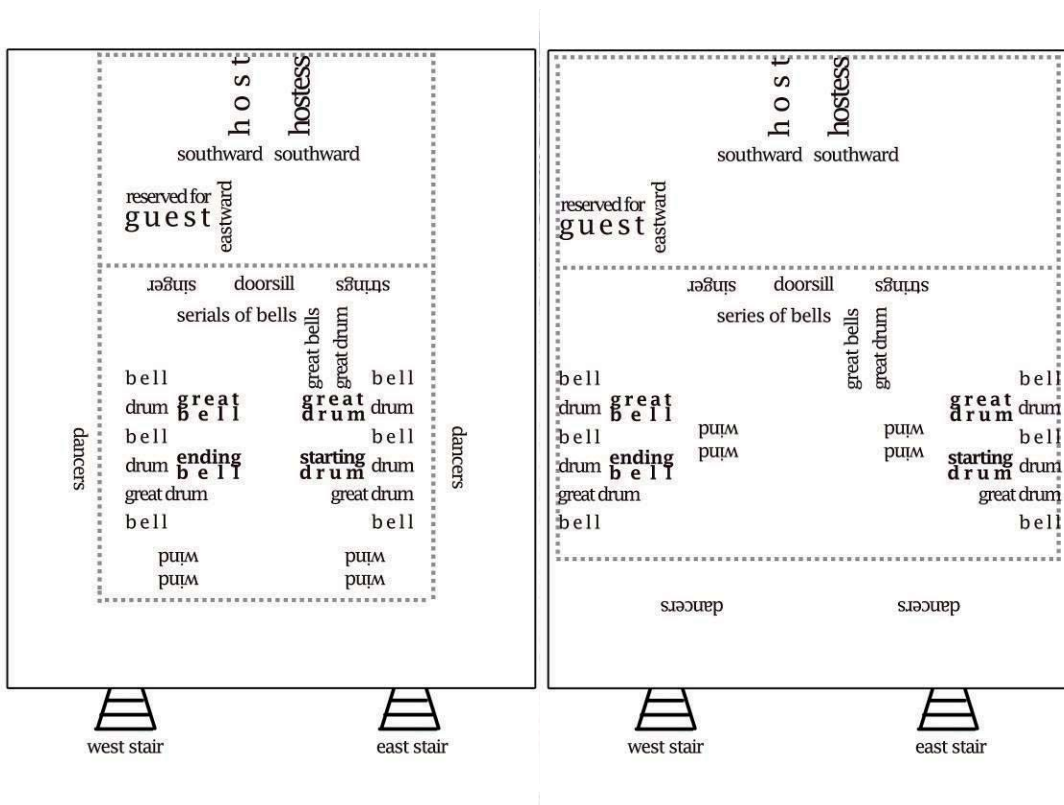
fig. 3 Two variations of plan composition of the hall, chamber, and platform

3. 2 Discussions on Two Variable Parameters

(1) As concerning the performing music, in most occasions, several independent passages may be linked seamlessly, thus sounding like a single one. In this case, we may say that the single continual passage is composed by different "density zones" – with higher or lower number of pace/ tempo per unit of time.

Moreover, due to the characteristics of the traditional Chinese musical notation (*fig. 4*), the music is always played in somewhat undetermined, even "improvisational" tempos. More precisely speaking, the moment when an *andante* shifts to an *allegretto* (from 76-108 bpm to 112-124 bpm) differs in each performance and might be treated totally dissimilar by another performer. Consequently, the location of the court gate, and hence the depth of the court vary in each generative process.
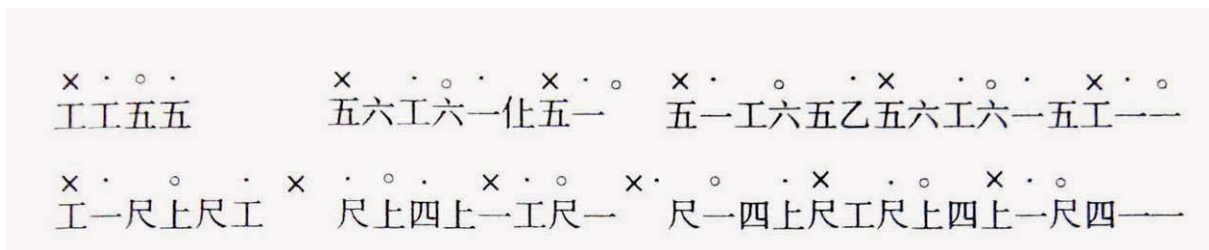

fig.4 A piece of traditional Chinese musical notation, in which the icon "x", "." and "o" act as the tempo markings

(2) There are two discrete sound sources in action simultaneously: the band on the hall, and the small bells tied to the vehicle in motion. The host and guest pace the length of axis from the hall to the court gate, while in the meantime the vehicle measures the perimeter of the court; the length of axis from the court gate to the enceinte gate, as well as the perimeter of the enceinte, are determined in a similar way.

It could be further concluded that, the breadth to depth ratio is variable when determining the court or the enceinte, because the velocity ratios between the pedestrian and the vehicle are unfixed.

3.3 Other Potential Parameters

By far, some parameters existing in the ancient ritual music are still out of our vision. Just to name a few. For one thing, the music melody may repeat two or three times during the ceremony or the meeting, which we may use for generating a main hall of two or three storey (*fig. 5*). For another, the dancers performed with rhythmic postures, and each posture was designate to a certain meaning corresponding with the lyric of the ritual hymn. So we might further designate one posture with one attribute of a certain architectural element.
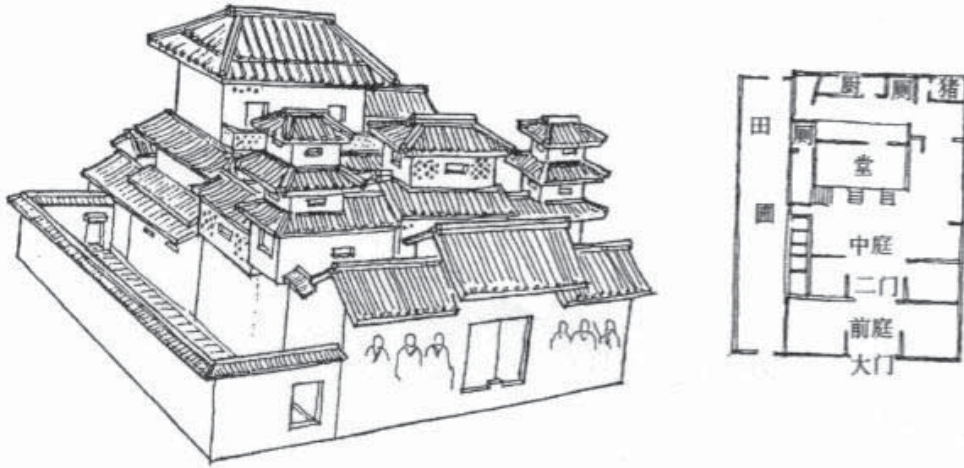
fig. 5 Pottery miniature of a castle with courtyard, 2nd century CE

4. Conclusion

As we have seen, the architectural space could derive from a series of body movements that fit exactly the musical paces. In some sense, the dwelling experience of the ancient Chinese has successfully grafted onto Goethe's tale of Orpheus.

On the generative level, our approach was not really self-contained for machine learning however, the translation method from paces to space remaining mostly qualitative. Since the music pieces, especially those kinds without modern musical notations might hardly make quantitative analysis, thus bringing enormous difficulties for our generative efforts. Anyhow, the study contributes a better understanding to certain architecture and certain music, and how they could benefit from each other. Moreover, the study emphasizes the central role of our bodies on perceiving in both space and time. A further study plan would focus on the collaboration with the computer graphics and the application of the real-time rendering.

References

[1] Johann Wolfgang von Goethe; trans. by Elisabeth Stopp, Peter Hutchinson, *Maxims and reflections* (1998, London: Penguin Classics): pp.143-144. No. 1133.
[2] Bernhard Karlgren concluded that "the major part of its glosses must reasonably date from" the 3rd century BC. Bernhard Karlgren. *"The Early History of the Chou Li and Tzo Chuan Texts". Bulletin of the Museum of Far Eastern Antiquities* 3, 1931: 49.
[3] Sir Joseph Needham. *Science and Civilisation in China*, Vol. 4, Physics and Physical Technology, Part III, Civil Engineering and Nautics (d) Building Technology, Cambridge University Press, 1965: 60-66.
[4] The poem "*Mian*" on the growth of the House of Zhou, *Shijing* III. 1. (No. 237); see James Legge, The Chinese Classics v.4, *The She King* [Shijing]. Hong Kong: Hong Kong University Press, 1960: 439-440.

[5] Needham: 124.
[6] It reminds us the founding myth of the city of Thebes: Amphion and Zethus, the twin sons of Zeus, the former was a great singer and the latter a strong hunter. When they constructed the city's walls, Zethus struggled to carry his stones, while Amphion played his lyre and his stones followed after him and gently glided into place. Edward Tripp. *Crowell's Handbook of Classical Mythology*. New York: Thomas Crowell Company, 1970: 44.