POLYTECHNIC OF TORINO
FACULTY OF ARCHITECTURE
Degree in Architecture
Honors theses

Proportions and mathematical relations in Greek architecture. The secret of Harmony

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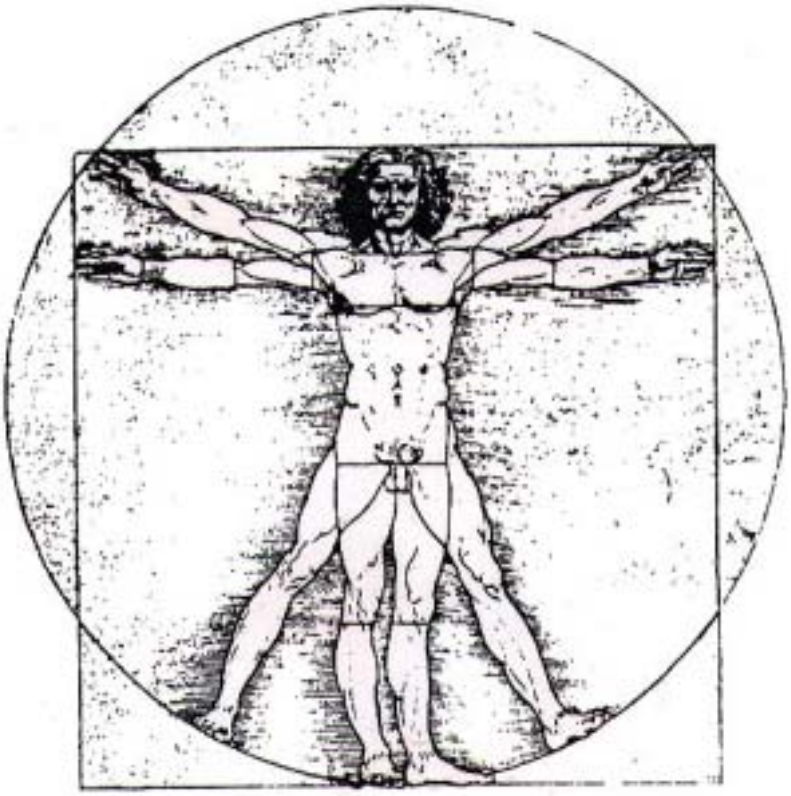
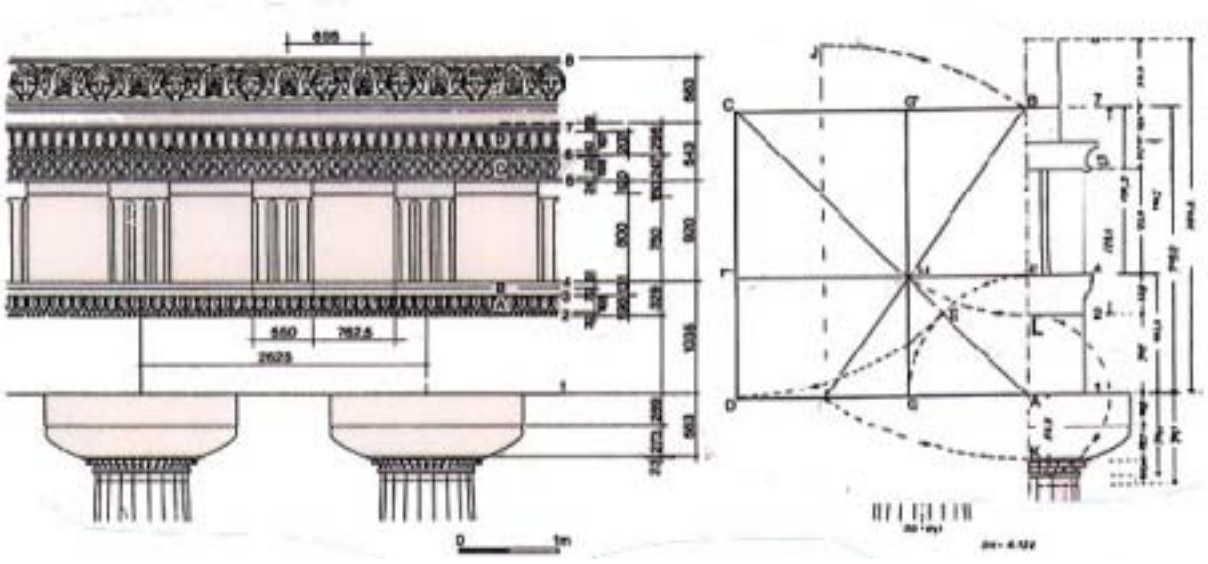
The remains of the ancient classical temples still evoque a sense of balance, harmony and perfection, that enchants us with the rythm of their proportions. It is the result of an organic aesthetic conception that inspired every artistic expression of the Hellenic people, in music, in sculpture, in painting and in architecture.
Unfortunately, despite the quantity of works that have survived, some of them in perfect condition, we know very little of the aesthetic theory that lies behind them, due to the lack of clear graphic or literary evidence, and to an often superficial reading of Vitruvius' *De Architectura*, the only treatise on architecture that has been handed down to us by the ancients.
The research becomes yet very interesting if we expand the analysis to the whole cultural background and if we remember that the concept of "proportion" (analogia in greek) was created in the context of the mathematical doctrine, introduced in Greece by Pythagoras of Samos.
From the study of the numeric laws that regulated musical harmony, the Pythagorean school discovered some general morphological principles, which soon became the

composition principles of every kind of art, above all the one dedicated to construct sacred buildings. This is what can be deduced by the proportional analysis of works such as Iktinos' Parthenon, or Polikleitos' Diadumenos, that have a common mathematical inspiration.
The research has been organized, to allow an easier reading, in four chapters:
1.The essence of the Number
Our knowledge of the aesthetic theory lying behind the mathematical philosophy is very poor, in part because of the esoteric nature of the pythagorean doctrine, which used a symbolic language in order to protect its secrets from the "profanes".
My reconstruction, based on the study of written evidence from the philosophical tradition (especially the work of the Presocratics and of Plato), moves from the idea of Number as the universal cosmological principle, in order to define the concepts of Harmony and Proportion, through the study of the Pythagorean symbols, the golden section and the main musical chords.
2.Harmony in nature and in the arts
If we follow the aesthetic principles elaborated by the pythagorean school, we can notice a profound correlation between the artistic and the reflective activities. The correlation is most clear when we compare the cosmological conception described by Plato with the sculptural canons of Polikleitos and Vitruvius, or with what remains of the treatises on music, painting, medicine and oratory.
By studying the proportions, painters, potters and sculptors were able to give to their work an 'absolute' beauty, but it was undoubtedly in the greek temple (that had, thanks to its shape, materials and dimensions, a character of eternity and perfection) that the pythagorean idea of Harmony reached its highest realization.
3.Harmony in Greek architecture
By analizing the planning technique and the aesthetic meaning of the sacred buildings, and by reading the Vitruvian treatise through the Pythagorean doctrine, we are able to find some clear indications on the theory of proportions that characterized Greek architecture until the Hellenistic period.
Ancient architects had to realize the *Symmetria* ('measure accordance') by repeating certain special proportional relations, that would produce *Euritmia* ('harmony') between lengths, areas and volumes of the building, both in its whole and in its parts. The planning technique was supposed to be that of the proportional schemes, which were refined geometrical constructions that started out from a *square*, in order to find, with simple projections, all the main lines of the building, in the plan and in the faces. The purpose was always to reach the universal Harmony, intended as "Unification of the molteplicity and accordance of the discordant" (Philolaos, *Fr.* B10 DK), meaning the perfect balance between opposite principles.
4.The harmonic planning
Finally, I have collected and arranged a few recent studies, very rare and isolated, that deal with the relation between the histories of philosophy, mathematics and architecture, among which the works of G.Jouven, J.Bousquet e L.Frey on the Parthenon, the Treasure of Cyrene at Delphi and the Temple of Athena at Paestum.



Picture 1. Vitruvius'man drawn by Leonardo



Picture 2. The temple of Athena at Paestum: the harmonic partition of the entablature (by L.Frey)

The proportions of this temple, built between 510 and 500 B.C., are clearly inspired by the Pithagorean doctrine. The dimensions of the parts of the entablature, for example, were determined according to the *harmonic* proportion (one of the three main proportions discovered by the Pythagorean school, together with the *arithmetic* proportion and the *geometric* one), that can be obtained graphically starting from the ABCD square.

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