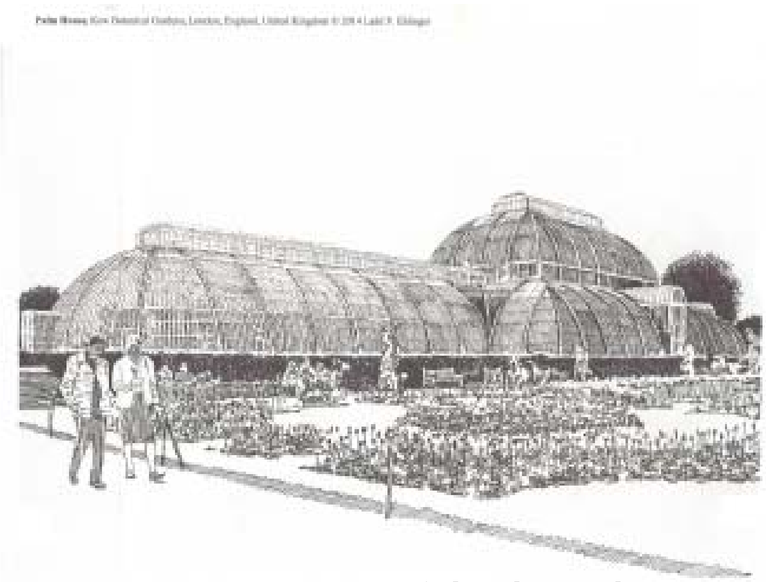
ARCHITECTURE

EHLINGER & ASSOCIATES **SECOND QUARTER 2014**



PALM HOUSE, Kew Botanical Gardens, London

The Palm House in Kew Botanical Gardens, London, is this edition's limited edition print of a sketch by Ladd P. Ehlinger. This building is an archetype of the skeleton frame of metal (cast and wrought iron) with glass infill that was beginning to be experimented with at the dawn of the Industrial Revolution. Palm House was built in 1844-48, and was a collaboration between Decimus Burton, Architect and Richard Turner, an iron founder and Engineer. It is based upon the glass house design principles developed contemporaneously by John Claudius Loudon and Joseph Paxton, and as such is a seminal work of Architecture. This was the first large scale structure to use wrought iron. It is considered the world's most important surviving Victorian age glass and iron structure.

The only predecessor to Palm House was the Conservatory at Chatsworth (1836-40) which was done by Joseph Paxton. Its appearance was of a "ridge & furrow" on the skin, a sort of "Vee" shaped surface, whereas the Palm House has a remarkably smooth contiguous surface finish. The "ridge & furrow" system in essence is a series of valley gutters formed by the glass running in the direction of the roof slope - very prone to severe leakage.

This was the age of experimental metal structures, first of cast and wrought iron, then of steel as the technology advanced learning how to make the iron less brittle and more ductile, eventually leading to the development of steel (iron with carbon and other metals in alloy). This age also developed the mathematics and knowledge of the engineering mechanics of what made buildings stand up (and fall down): forces, stresses, strains, how to calculate them, and the engineering properties of materials that enabled rational manipulation of this environment.

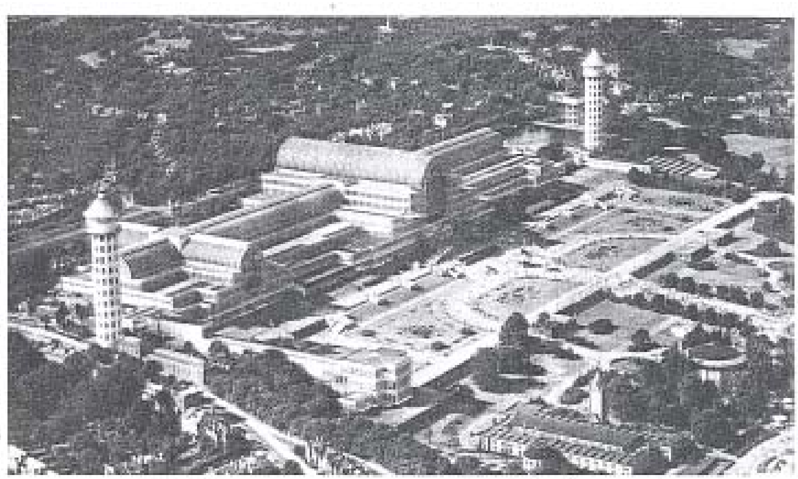
Consequently, there was a paring down of superfluous elements in buildings that had little, if anything to do with the work of enveloping the space, and a more spare use of ornament, which now was begun to be thought of as a means to express these aspects of how the building stood up.

Palm House is a space frame barrel vault of wrought iron arches, two story tall in the central nave 19 M high, with a viewing gallery at the second level 9 M high, so viewers could see into the crowns of the palm trees on display. The arches were held together at their base and at right angles by cables within tubes to tension the building together, and support the glass panes that were originally hand blown and tinted green with copper oxide to reduce the solar heat gain.

Kew Gardens originated in the exotic garden at Kew Park formed by Lord Capel John of Tewkesbury. It was enlarged and extended by Augusta, Dowager Princess of Wales, the widow of Frederick, Prince of Wales, for whom Sir William Chambers built several garden structures. One of these, the lofty Chinese pagoda built in 1761 still remains. George III enriched the gardens, aided by William Aiton and Sir Joseph Banks.

The Crystal Palace designed by Joseph Paxton was built in 1850-51 for the for the Great Exhibition (World's Fair) of 1851 in Hyde Park, London. It was subsequently disassembled and re-erected after being revised, in Sydenham, London. It was destroyed by fire in 1936.

The Crystal Palace was much larger than the Palm House, had the "ridge & furrow" method of glazing developed by Paxton at Chatsworth, and garnered a great deal more publicity because of the importance of the Great Exhibition of 1851, though the Palm House is probably the better of the three seminal buildings architecturally.



Revised structure, erected (1852–4) at Sydenham, London

The Crystal Palace, London.

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The Plastic Number

by R. Perrin Ehlinger

E&A has occasionally written about the Golden Ratio, Phi. While I was researching another article to discuss Phi, I stumbled across something interesting to share, but it requires a quick re-introduction to Phi to explain:

Even outside of the fields of architecture, arts, and mathematics, many people are familiar with the constant Phi, also known as the Golden Ratio. Phi is an irrational number, which is derived from solving the equation: $x^2=x+1$. This equation is derived from the well known Fibonacci Sequence:

0, 1, 1, 2, 3, 5, 8, 13, 21, 34 ,55, etc..

Which is created by each number being the sum of the previous two numbers, starting with 0 and 1. When you take the limit of the ratio of the Fibonacci Sequence, you get the irrational number 1.618..., which is the solution of $x^2=x+1$. It's also the solution of $x^1=x-1$, which is to say, 1/Phi = Phi-1.

1/1.618... = 0.618... = 1-1.618...

The Golden Ratio is well known to appear frequently in nature, because Phi is also the most efficient ratio in which to pack growth of subsequent elements. Example: the seeds on a sunflower. So the Golden Ratio has been studied and used intentionally in the arts and architecture as a method of bringing natural harmony into man made works, for a long, long time. It is a useful tool for rationally proportioning elements that people will find pleasing, because it conforms to the proportions we are used to seeing in nature.

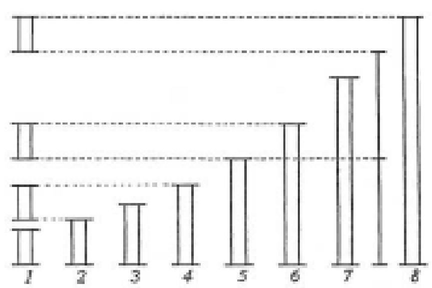
For a comprehensive, if perhaps fanatical, examination of phi, visit: www.goldennumber.net

What most people don't know is that Phi has a brother number. This companion wasn't discovered until 1924, and it wasn't until 2002 that it was proven that Phi only had one brother, and no more. What am I talking about? Well, mathematically, there is only one other real number that solves a similar set of equations simultaneously, as Phi does. If we look for any numbers that solve both $x^n = x+1$ that simultaneously solves $x^{-m} = x-1$, we find that only one other number will, and it solves $x^3 = x+1$, and $x^{-4} = x-1$. This number, 1.3247..., is called the Plastic Number.

It was discovered and studied by French mathematician, Gerard Cordonnier, who called it the Radiant Number. Cordonnier spent a great deal of the rest of his life writing a book about it, which he never finished. If he had, he might be better known as the discoverer of the Plastic Number, and we might call it the Radiant Number.

Instead, Cordonnier corresponded with a Dutch Benedictine monk and architect named dom Hans van der Laan. Cordonnier introducing Hans van der Laan to the Plastic Number, hoping to inspire him to use the number as a proportion architecturally, since it was so closely related to the Golden Number, mathematically. Because the Plastic Number is the solution of a cubic formula, they supposed that the Plastic Number is thus intended for proportioning three-dimensional grouping of elements.

Hans van der Laan took the idea and ran with it, developing a system of proportions and sizes for architecture and design based on the Plastic Number, and then published a book about it: ***Architectonic Space***.



Hans van der Laan's System of scaling.
(Richard Padovan, "Dom Hans Van Der Laan and the Plastic Number")

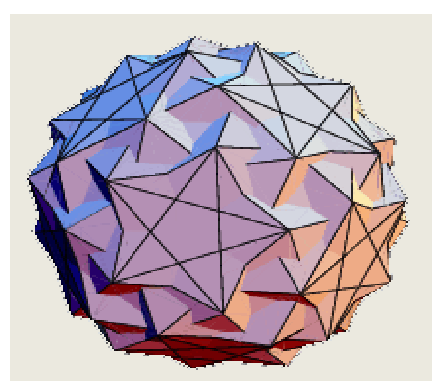
As the innovative implementer of the Plastic Number into the creative design world, Hans van der Laan is often mistakenly credited with the discovery of the Plastic Number, but really it's just the name that bears his mark. Hans van der Laan termed it "Plastic" because of its applicability and versatility to be used in three dimensional ratios (using his system, of course). Personally, I prefer Cordonnier's term Radiant, but it seems Plastic has taken root (bad math pun intended).

Does the Plastic Number make for better, more natural or perfect art and architecture? I don't know - some find his few works a little eerie and rarefied, but they do have a simple, formulaic beauty that can easily be appreciated and enjoyed. The proportions, though clearly consistent, seem... not necessarily forced, but perhaps unfamiliar.

Hans Van der Laan, Abbey in Vaals
photo by Frans de la Cuisine.
Van der Laan foundation
http://www.vanderlaanstichting.nl/en/

Good or not, I do not necessarily believe that just because the Plastic Number is derived from a cubic formula that this means the number is intrinsically related to three dimensions, or endowed with any particular special purpose. Supposedly both van der Laan and Cordonnier found examples of this ratio in nature, but in my research, the only relations (outside of Cordonnier and van der Laan's claims) that I could find regarding the Plastic Number to anything else is that it's the smallest Pisot number (a very esoteric mathematical subset of numbers), and that it's integral to the radii formula of a Snub Icosidodecadodecahe-dron. Not exactly a widespread, intrensic connection to natural forms.

Still, it is a very interesting way to derive a consistent set of proportions for design, and in design, consistency is a critical element. It's also a method that has gained its own subset of followers among European designers.



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