

Title:

Of Quotidian Proportions: The Everyday Determinants of Great Modern Architecture.

Author:

Steven Fleming, The University of Newcastle

Introduction

Historically, the architecture of all continents has been regulated by symbolic mathematics. The Mandala of India, the Ying Zao Fa Shi of China, and the Pythagorean proportions of the Western tradition, all testify to an iron grip of mathematics on architectural production. Be it Bramanical, Imperial or transcendent, Mathematics in architecture symbolises authority.

In the case of twentieth century architecture — though it is rarely applied in a self-conscious manner — it could be argued that mathematics symbolises the cultural authority of nothing more than everyday instrumentalism, the overwhelming imperative to produce buildings on time and on budget for profit orientated clients. A structural engineer can determine the width of an auditorium according to the maximum span of a commonly available steel section. A services engineer can reduce the overall height of an office block simply by specifying slimmer ductwork for its ceilings. The height of a concert hall can flow from an acoustics calculation. Architects make a virtue of standard sized products, thus producing symbols of industrial modes of production. Architects today don't calculate proportions so often as they calculate Floor Space Ratios, or fire egress limits, or the number of toilets required in a certain sized cinema. The proportions of buildings are subservient to, and symbolic of, a plethora of apparently mundane concerns.

Can this be said of all modern buildings though? Perhaps, among a rarefied minority of great works of architecture, there are cases in which the noble tradition has been kept alive, by architects dedicated to the art of architecture. To answer this question, the

present paper examines the most revered building of the celebrated Modern master, Louis I. Kahn, whose name is often invoked as a synonym for devotion to the art, rather than the business, of architecture. If any twentieth-century architect had resisted the quotidian obstacles that fetter most architects' symbolic geometrizing, it was Kahn. The paper will focus on the The Kimbell Art Museum in Fort Worth, Texas (1966-72), and approach the topic from a number of angles. Firstly, Kahn's public statements concerning proportion will be considered. Secondly, geometrical analyses of the plans and sections of The Kimbell are presented, showing where precise and approximate proportions actually exist. Analytical mathematical and geometrical findings are then reconciled with the archival records for this project, to determine the extent to which existing proportions reflect deliberate architectural intensions, or are the result of chance.

The paper highlights a complex interplay of forces, and draws few general conclusions. For Kahn, the incorporation of harmonic proportions (that is, proportions based on musical ratios) is a stated aim, but it is not an overriding concern. His genius lay in his ability to frame correspondence with his client and specialist consultants in terms that would make music based proportions a likely outcome of their dialogue. In particular, Kahn couched queries and suggestions regarding dimensions in terms of whole feet dimensions. When dealing with major dimensions, he errs away from prime numbers, preferring numbers with factors that could be shared with related dimensions. In this way, he is able to appease others' instrumentalist and quotidian agendas while leaving himself greater scope for establishing music based ratios.

The complex and tentative nature of this paper's findings reflects the disparate backgrounds of this paper's author and a key consultant on this project, Mark Reynolds. Reynolds is a geometer whose past publications in this field are specifically concerned with finding geometrical relationships. He has generously contributed to this work by analysing plans of the Kimbell, and by highlighting the significance of that building's sectional ratios. Steven Fleming is an architectural historian, who has published texts challenging geometrical analyses, showing their inconsistency with archival records.

Their unusual collaboration reflects a desire to reach balanced conclusions regarding the role of proportion in Modern architecture.

Kahn's Stated Views Regarding Proportion

A sense of Kahn's attitude towards proportion must be sifted from seemingly conflicting public statements. These can be better understood in the context of his central theoretical statement, which is an article titled "Form and Design." According to Tim Vreeland from Kahn's office, this article embodies Kahn's thinking better than any previous text,¹ and Kahn would not produce such a painstakingly considered text at any later time. David De Long claims that those inquiring about Kahn's theory would be routinely sent a copy of this article.² In it, Kahn argues that particular buildings of the same type share an archetypal essence, or "form," which is transcendent. He speaks of architects having mystical revelations of ideal "forms", then translating these into terrestrial buildings through a process he refers to as "design". According to Kahn's favourite illustration of his thesis,

in the differentiation of a spoon from spoon, spoon characterizes a form having two inseparable parts, the handle and the bowl. A spoon implies a specific design made of silver or wood, big or little, shallow or deep. Form is "what." Design is "how."³

Kahn's terms "form" and "design" openly acknowledge the tension between the timeless aspects of architecture and the quotidian processes that frame the design and construction of particular buildings.

Although it is undated, Kahn's earliest documentation of this thesis is most likely a hand written draft within his personal notebook.⁴ The first recorded public expression of this precise thesis is contained within a public address delivered at the Cooper Union entitled "The Scope of Architecture" on 20 January 1960.⁵ Kahn's preoccupation with the thesis dominated his theorising throughout 1960, leading to a Voice of America broadcast on 21 November 1960,⁶ the revised transcript of which would be published in April 1961 as "Form and Design" in *Architectural Design*⁷ and reprinted in the 1962 book entitled

Louis I. Kahn by Vincent Scully.⁸ Kahn's distinction between universal "forms" and the circumstantial outcomes of the "design" process, provides a basic framework by which to appreciate his statements regarding proportion.

Where proportion has traditionally been thought of as the terrestrial adumbration of an unseen realm, Kahn does not appear to associate proportions with the universal realm of "form". Rather, he associates proportions with the circumstantial, or quotidian "design" process. In the same year that he published "Form and Design", Kahn stated that, "[d]esign is a material thing. It makes dimensions. It makes sizes".⁹ "Form", on the other hand, "is not design, not a shape, not a dimension. It is not a material thing".¹⁰ By associating dimensions with the idiosyncratic "design" phase, Kahn appears to be saying that dimensions, and therefore proportions, are simply a matter of personal preference, and are subject to everyday concerns, such as cost or construction systems. If architects would like to establish mathematical relationships between key proportions, then they are free to, but in doing so they would not be adumbrating the universal realm of "form".

While proportions may not point to anything higher than an architect's own taste, this does not mean that they could not be a vital aspect of Kahn's own sensibility. Unfortunately though, Kahn's theoretical pronouncements provide no clear sense for his personal preference. On one occasion, Kahn specifically states his preference for buildings *without* mathematical proportions. He states that

to make a thing deliberately beautiful is a dastardly act; it is an act of mesmerism which beclouds the entire issue. I do not believe that beauty can be created overnight. It must start with the archaic first. The archaic begins like Paestum. Paestum is beautiful to me because it is less beautiful than the Parthenon. It is because from it the Parthenon came. Paestum is dumpy — it has unsure, scared proportions. But it is infinitely more beautiful to me because to me it represents the beginning of architecture. It is a time when the walls parted and the columns became and when music entered architecture. It was a beautiful time and we are still living on it.¹¹

In the context of this quotation, the phrase “to make a thing deliberately beautiful” refers to the application of sophisticated proportional systems to architectural compositions, since what differentiates the temples at Paestum from the Parthenon are their “unsure, scared proportions.” Whilst not rejecting the use of proportions outright, Kahn subordinates this device to a sense of the “archaic.” The temples at Paestum are championed for their chronological and, in a sense, their ontological proximity to architecture’s mythical beginnings as a poetic discipline.

While the above statement highlights Kahn’s fascination with the origins of building types and institutions generally, it does not give a complete picture of his ruminations on the topic of proportion. For a more complete appreciation of Kahn’s attitude, a number of statements regarding music must be taken into consideration.

For Kahn, the principles guiding architectural production apply equally to musical composition. This is made clear in a statement he makes in 1964, in which the relationship which he purports to exist between particular “designs” and their corresponding “forms” is extended to particular pieces of music and their underlying structures. “If I were a musician,” Kahn argues,

and I were the first person to invent the waltz,
the waltz doesn’t belong to me at all,
because anyone can write a waltz —
once I say there is a nature of musical environment
which is based on three-four time.
Does that mean I own the waltz?
I don’t own the waltz
any more than the man who found oxygen owns oxygen.¹²

Kahn’s feigned modesty in this quotation belies the fact that he was actually a talented musician. In his youth, and without the benefit of formal training, Kahn had helped support his family by playing the piano at a local cinema.¹³ There is also evidence to suggest that he may have taken an interest in the traditional relationship between architecture and music. In February of 1956, during a period of profound transition in Kahn’s work, the architectural theorist Colin Rowe wrote to Kahn to thank him for an

evening of intense discussion which they had spent together¹⁴ and to inform Kahn that he would be sending him a copy of Rudolf Wittkower's book, *Architectural Principles in the Age of Humanism*.¹⁵ A major portion of Wittkower's book discusses the musical consonants that regulate the proportions of Palladio's Villas, a fact that Rowe may have considered when informing Kahn that in Wittkower's book, "I think that you will discover attitudes with which you are profoundly in sympathy".¹⁶

Keeping in mind that Kahn's theoretical pronouncements are often oblique (as though he were avoiding any binding contracts with himself), two of his statements do seem to echo Wittkower's analysis of Palladio. In the following statement, Kahn imagines a space having the character of a sound.

I imagine myself composing a space lofty, vaulted, or under a dome, attributing to it a sound character alternating with the tones of the space, narrow and high, with graduating silver, light to darkness.¹⁷

In his aforementioned article titled "Form and Design", Kahn also writes that

[t]o the musician a sheet of music is seeing from what he hears. A plan of a building should read like a harmony of spaces in light.¹⁸

Kahn's conception of space in aural terms recalls the connection made by architects of the Neoplatonic tradition between spatial proportions and musical consonants, as described in Wittkower's book.¹⁹ Indicative of one who boasts that he only tends to read the first few pages of books, Kahn appears to appropriate a simplified version of Wittkower's thesis into his own theory, by attributing a sound character to space. Notably, in the introductory pages to *Architectural Principles*, Wittkower discusses Alberti's belief that "in music the very same harmonies are audible which inform the geometry of the building".²⁰

At this point and despite Kahn's references to music, it is important not to overstate his interest in proportional systems. Kahn's "Form and Design" thesis confers a higher status to the inseparable combination of fundamental elements that constitute a type, while relegating dimensions to the so-called "design" process. In this sense, the act of

inscribing proportions sits on par with quotidian tasks, like meeting a client's budget, or adhering to building regulations.

Yet there is another statement of Kahn's that leaves open the possibility that proportions might perform a higher, or numinous role in his architecture. In "Form and Design," Kahn argues that a great building "must begin with the unmeasurable, must go through measurable means when it is being designed and in the end must be unmeasurable".²¹

One paragraph later, he reiterates this view, arguing that

a building has to start in the unmeasurable aura and go through the measurable to be accomplished. It is the only way you can build, the only way you can get it into being is through the measurable. You must follow the laws but in the end when the building becomes part of living it evokes unmeasurable qualities. The design involving quantities of brick, method of construction, engineering is over and the spirit of its existence takes over.²²

Precisely how a building can evoke "unmeasurable" qualities is never spelled out. Other scholars have argued that Kahn does this through his control of light²³. Yet there is no reason to exclude mathematical proportions from Kahn's repertoire of numinous devices.

From Kahn's complex, oblique and at times contradictory pronouncements, one plausible interpretation emerges, which — as will be seen shortly — seems to recon with the mathematics of The Kimbell Art Museum. Firstly, it must be recognised that Kahn is more interested in fundamental spatial arrangements, and so the inscription of proportions is not so much an imperative, as it is a matter of personal preference. Also, as something that would occur during Kahn's "design" phase, the process of making dimensions would at times be determined by the client's budget, or other everyday factors, rather than the desire to achieve harmonious proportions. Having said this, there is evidence to suggest that Kahn might welcome the presence of music based proportions, where they can be achieved in conference with competing circumstantial factors. Their presence could even evoke what Kahn calls "unmeasurable" qualities. Finally, in the light of Kahn's remarks about the Parthenon, we can assume that he would be more interested in relatively simple ratios, and would be unlikely to delight in complex or overly sophisticated proportions.

The Proportions of The Kimbell

Those who are familiar with recent publications about Kahn, would be aware of Klaus-Peter Gast's 1998 book, *Louis I. Kahn: The Idea of Order*.²⁴ In it, Gast argues that Kahn continues the Neoplatonic tradition by consciously inscribing his buildings with a hidden geometry.²⁵ However, with regards to The Kimbell, Gast's analysis is by no means exhaustive, and it may even be erroneous. The most obvious limitation to Gast's work is that he only analyses plans, where, in the case of The Kimbell, the viewer would be more likely to recognise sectional proportions. Also, Gast's Kimbell analysis is of the building as a whole, and does not acknowledge the fact that the Eastern most vaults are partitioned off from the viewer, being used for office space, file storage and an auditorium.

The greatest problem with Gast's analysis of the Kimbell, is that it may be inaccurate. According to Gast, the distance by which the rectangular plan of the Kimbell Art Museum falls short of being a double square, determines the width of the gallery's many bays. This claim simply does not tally with Kahn's working drawings, according to which the Kimbell is 318' wide (measuring from north to south) and 174' deep (measuring from east to west).²⁶ To be a double square, the building would need to be 348' wide, that is, twice as wide as its depth of 174'. The difference between its actual width and the width it would be were it a double square is 30' and this is the distance Gast refers to in his analysis as x , which should also be the width of the gallery's bays. However, the bays are not 30' wide. They are 20' wide — or 22' when measuring from the centres of the supporting columns. This represents a discrepancy of between 8' and 10' (or 40% to 50% of 20').

Whether Gast's claims should be heeded or approached with caution, the Kimbell features a number of mentionable mathematical relationships that his analysis overlooks. In this paper, where the emphasis is on a textural analysis of Kahn's theory and archival records, only the most obvious of the Kimbell's ratios will be considered. The present

author is currently preparing a more exhaustive analysis of the Kimbell's geometry for future publication.

The most apparent of the Kimbell's mathematical ratios are those which determine the proportions of its two major parts, those being the Southern and Northern groups of 5 bays (excluding the porches). Each group of five bays form rectangles of approximately root two proportions. They have internal dimensions of one hundred feet by 142 feet, yielding a ratio of 1: 1.42. This falls very close to a root two rectangle, of 1:1.414. The fact that the Eastern most vaults are partitioned off from the gallery, making these ratios imperceptible to the viewer, suggests that the presence of these ratios could be a matter of coincidence. Were these ratios precise to a number of decimal points, then it would also be easier to argue that they are intentional. This is, after all, a building made using reinforced concrete technology, that could easily accommodate precise dimensions.

However, there is one very good reason why we should not expect to find precise ratios incorporating irrational numbers in the Kimbell, and that is that The Kimbell contains a multitude of ratios involving small rational numbers. In plan, the internal proportions of the bays are 5 to 1. In section, the internal proportions of each bay are 5 to 3 (measuring to the springing point of the cycloid shells), while the internal proportions of the interstitial spaces linking each vaulted bay (or "servant" spaces as Kahn called them), are 1 to 2.

Such elementary proportions are made possible through a relentless adherence to an imperial module, the foot. Lengths measurable in whole feet are to be found everywhere in the Kimbell. For example, 1" x 1' pieces of parquetry sit beside 6' x 2' travertine floor tiles, which align with the 2' square columns. The obsessive rule even governs the mosaic tiles in the toilet cubicles, which are 1" inch and cover the walls in multiples of 12.

Further to his use of an imperial module, Kahn tends to use dimensions with common factors. The 5 to 1 planar proportion of the vaults reflects the simplest of measurements — 100' x 20'. The sectional proportions of 5 to 3 reflect simple dimensions again, 20' x 12', while the 12' high "servant" spaces are simply 6' wide. Similar combinations of

whole feet dimensions, featuring numerical values with many factors, are to be found everywhere in the Kimbell.

Kahn's adherence to a module, the resultant commensurability of dimensions in the Kimbell, and the corresponding lack of precise proportions resulting from geometrical constructions, makes perfect sense when seen in relation to Wittkower's thesis regarding the architecture of the Italian Renaissance. In *Architectural Principles*, Wittkower states that the central issue of Renaissance architecture is the commensurability of ratios, and that recent scholars obscure this fact "by insisting on the theoretical and practical advocacy of incommensurable, i.e., geometrical proportions by Renaissance architects."²⁷ "It seems almost self evident" he argues,

that irrational proportions would have confronted Renaissance artists with a perplexing dilemma, for the Renaissance attitude toward proportion [...] was aimed at demonstrating that everything was related to everything by number.²⁸

Since Kahn owned a copy of Wittkower's book, and since Wittkower's thesis is almost as valid for the Kimbell as it is for a Palladian villa, it would be reasonable to conclude that Wittkower's book had some influence over the Kimbell's dimensions. The fact that Renaissance architects believed harmonic proportions adumbrated a Platonic realm, in much the same way as Kahn thought buildings could evoke the "unmeasurable", adds further weight to this interpretation.

However, one major obstacle stands in the way of this analysis, and that is the office correspondence for the Kimbell, which contains compelling evidence that the client, and not the architect, made crucial decisions regarding dimensions.

For a comprehensive account of the Kimbell's design and construction, based on archival records and interviews, the reader is referred to Patricia Cummings Loud's text, *The Art Museums of Louis I. Kahn*²⁹. Loud outlines an iterative and protracted process, which typifies Kahn's working method. The present paper will only refer to a small number of key documents which relate specifically to dimensions.

The office correspondence reveals no record of a conscious attempt to establish harmonic consonants. On the contrary, it shows that many dimensions were established in conference with the client, the gallery director Richard Brown, who regarded himself as Kahn's "sparring partner,"³⁰ and who persistently pressured Kahn to reduce the overall size of the gallery. His disposition can be summarised in a letter he wrote to Kahn on 12 July 1967 regarding a design iteration that was to be 400' square.

Within that big square you wind up with an awful lot of cubic space that must be heated, air-conditioned, illuminated, etc.; and acres of floor and wall surface that must be cleaned, waxed, mopped, resurfaced upon occasion, etc.; all of which costs money and labor to do, and I want as much money as possible saved from maintenance so I can buy more and more art as the years roll by, not just keeping up the house.³¹

In the same letter, Brown raised what he calls the issue of scale, writing that "The Grand Canyon is vast and its scale is exactly right [...]; size and scale are in balance."³² He contrasts it with a small Rococo church, that helps the user "feel as secure and intimate with God and the universe as does a warm bath behind a door bolted against any possible intrusion."³³ The letter goes on to state that the Kimbells' paintings "are very 'gentile', 'polite' representations of fair ladies, tender little children and singularly pure young men."³⁴ These arguments form a lengthy preamble to a list of size-paring instructions, including a suggestion that the gallery walls be lowered from 15' to 12', and that the overall height of the vaults be lowered from 30'. Subsequent iterations of the design feature 12' high walls as requested, and a much lower vault, based on a cycloid.

In a hand-written letter and sketch, from 11 May 1968, Brown noted that the design at that date was as long as the Dallas International Airport terminal, a building "notable for its affect of huge scale!!!"³⁵ Effacing himself and his aversion to monumentality, Brown signed the letter "Richard The Chicken Hearted." In subsequent iterations, the gallery bays are reduced from 120' to 100'. (At a more quotidian level, it can also be observed that 100' happened to have been the maximum distance that concrete walls or vaults could be produced without requiring expansion control joints). Under similar pressure from his client, Kahn reduced the width of the bays from 30' to 20'. There is no evidence

that Kahn chose this dimension for its 5:3 relationship to the 12' wall height, or its 1:5 relationship with the length of the bays, though the fact that 20 is a factor of 100, and has the number 4 as a factor in common with 12, may have influenced his choice. This distance also reflects Kahn's belief — based on an assertion by the American architect Clarence Stein (1882–1975) — that 20' is a minimum width for any space containing artworks. According to his wife, Kahn had not allowed artworks to be hung in their home because it was not 20' wide.

While there is no direct archival evidence to suggest that Kahn consciously sought harmonic proportions, the office files do testify to his commitment to the imperial module. The day to day negotiations and directions between Kahn, other members of the design team, and Richard Brown, were conducted and documented via written correspondence, and it would have been a matter of convenience that sizes be expressed in terms of whole feet. Unlike other kinds of communication, including the transfer of electronic drawing files, or the exchange of plans, letters are a poor means of communicating fussy dimensions. To reduce the likelihood of error, Kahn fostered a kind of written discourse in which dimensions were exclusively expressed in whole feet, and where, by implication, plans and sections would adhere to an invisible foot-square grid.

A few examples of this rule have been seen in Brown's letters to Kahn, but other examples abound. A raft of major dimensional changes were negotiated in various letters between Kahn's associate Marshall Meyers and the partnering architects in Texas.³⁶ Smaller dimensions are discussed in another letter in which Meyers is asked to nominate which columns need to be 3' by 2' for structural reasons, as opposed to the 2' square column used generally in the project.³⁷ Columns measuring 2' 6" are not considered, though they are likely to have been adequate structurally. In another letter, the partnering architects mentioned that the suspended floor slab could be 10" thick, with sheer heads at the top of each column.³⁸ Wishing to maintain the imperial module in section (and wishing to keep cleaner lines), Kahn opted for a thicker slab, 1' in depth.

Conclusions

With The Kimbell Art Museum, Kahn managed to reconcile a number of competing demands. First and foremost, this is a building in which technological ambition comes head to head with fiscal constraint. The building's roof is made from post-tensioned curved concrete beams, spanning an incredible 100'. Within that complex roof structure, a sophisticated network of ducts and electrical services is carefully integrated, and remains virtually imperceptible to the viewer. The building meets a number of other demanding criteria related to security, egress, access, catering, archiving, the preservation of precious artworks, and, most significantly, a limited budget. Clearly, many of these criteria would not have been of so great a concern to architects of the Neoplatonic tradition, during, for example, the Italian Renaissance. Yet, despite the burdens of modern practice, Kahn was able to accommodate traditional design parameters into his own work. He did this, albeit with limited success, by limiting the way in which dimensions were communicated on a day to day basis in written correspondence. For architects, exchanging letters with clients and a broader design team is an everyday occurrence, whereas plans are exchanged far less frequently. In the case of the Kimbell Art Museum, one limitation of letters — that they cannot easily communicate fractional dimensions — contributed to that building's geometrical strength, by giving it a foot square grid, which locks in an array of harmonic proportions.

Were it not for his client's fiscal constraints, Kahn would surely have made the Kimbell a much larger gallery. It may have had bolder proportions, such as a square section, but circumstances led to less striking proportions, based on harmonic proportions. The fact that any proportions resulted from the complex interplay of client's, consultants' and architect's input, can be attributed to Kahn's subtle manipulation of day to day correspondence. In this sense, quotidian measures have been enlisted for a timeless purpose.

¹Letter, Vreeland to Pidgeon, 11 January 1961 "Master File, November 1 through December 30, 1960," Box L.I.K. 9, Louis I. Kahn Collection, University of Pennsylvania

and Pennsylvania Historical and Museum Commission (hereafter cited as Kahn Collection).

²David De Long “The mind opens to realizations: Conceiving a new architecture, 1951-61,” in David Brownlee & David DeLong (eds.), *Louis I. Kahn: In the Realm of Architecture*. See p. 71.

³Louis Kahn, “Form and Design”, in *Architectural Design* 31, No. 4 (April 1961): 145-154.

⁴Louis Kahn, “Louis I. Kahn notebook,” [undated, circa 1959], Box K12.22, Kahn Collection.

⁵Cassette recording, “The Scope of Architecture at The Cooper Union Hall, 1-20-60,” Kahn Collection.

⁶Louis Kahn, *Structure and Form*, Voice of America Forum Lectures, Architecture Series, no. 6. Washington D.C.: Voice of America, 1961.

⁷Louis I. Kahn, “Form and Design,” in *Architectural Design* 31, No. 4 (April 1961):145-154.

⁸Louis I. Kahn, “Form and Design,” in Vincent Scully, *Louis I. Kahn*, New York: Brazillier, 1962, pp. 114-121.

⁹Louis I. Kahn, “The nature of nature”, in Alessandra Latour (ed.), *Louis I. Kahn: Writings, Lectures, Interviews*, New York: Rizzoli International Publications Inc., 1991, pp.141-144. See p. 141.

¹⁰Kahn, “The nature of nature”, p. 141.

¹¹Louis I. Kahn, “Wanting to be: The Philadelphia school,” in Richard Saul Wurman ,ed., *What Will Be Has Always Been: The Words of Louis I. Kahn*, (New York: Access Press Ltd. and Rizzoli, 1986), pp. 89-92. See p. 91.

¹²Louis I. Kahn, “Talks with students”, in Alessandra Latour (ed.), *Louis I. Kahn: Writings, Lectures, Interviews*, New York: Rizzoli International Publications Inc., 1991, pp. 154-190, see: p. 177.

¹³Alexandra Tyng, *Beginnings: Louis I. Kahn’s Philosophy of Architecture*, New York: Wiley Interscience Publications, 1984.

¹⁴Letter, Colin Rowe to Louis I. Kahn, 7 February 1956, file labelled, “Correspondence from Universities and Colleges”, L.I.K. Box 65, Kahn Collection.

¹⁵Rudolf Wittkower, *Architectural Principles in the Age of Humanism*, 2nd. edn., London: Tiranti, 1952.

¹⁶Letter, Colin Rowe to Louis I. Kahn, 7 February 1956, file labelled, “Correspondence from Universities and Colleges”, L.I.K. Box 65, Kahn Collection.

¹⁷Louis Kahn, cited in: Duncan Robinson, *The Yale Centre for British Art: A Tribute to the Genius of Louis I. Kahn*, New Haven: Yale University Press, 1997, p. 12.

¹⁸ Kahn, “Form and Design”, p. 149.

¹⁹ Inspired by figures including Pythagoras, Plato and Saint Augustine, architects of the Neoplatonic tradition applied to buildings the same proportions that underpin musical harmony, in the belief that those proportions are of transcendent origins and order the cosmos.

²⁰Wittkower, *Architectural Principles in the Age of Humanism*, p. 9.

²¹Kahn, “Form and Design”, p. 149.

²²Kahn, “Form and Design”, p. 149.

²³ At least two scholars state that Kahn’s control of sunlight has a numinous, or transcendent effect, See: Sherri Geldin, “Prologue, Louis I. Kahn: Compositions in a fundamental timbre”, in David Brownlee & David DeLong (eds.), *Louis I. Kahn: In the Realm of Architecture*, pp.15-17, p. 17. Also see: Andrea O. Dean, “A legacy of light”, in *AIA Journal*, Vol. 67, No. 6 (1978): [80]-[89], p. 87.

²⁴Klaus-Peter Gast, *Louis I. Kahn: The Idea of Order*, trans. Michael Robinson, Berlin: Birkhäuser, 1998.

²⁵Gast, *Louis I. Kahn: The Idea of Order*. This book has been reviewed by the present author. See: Steven Fleming, “Klaus-Peter Gast, Louis I. Kahn: The idea of order [book review]”, in *Architectural Theory Review*, Vol. 4, No. 2 (1999): pp. 116-117.

²⁶See the drawing titled: “A4: Upper Level Floor Plan”, Kahn Collection.

²⁷ Rudolf Wittkower, *Architectural Principles in the Age of Humanism*, New York: W. W. Norton and Company, 1971, p. 158.

²⁸ Rudolf Wittkower, *Architectural Principles in the Age of Humanism*, p. 158.

²⁹ Patricia Cummings Loud, *The Art Museums of Louis I. Kahn*, Durham: Duke University Press, 1989.

³⁰ Letter, Brown to Kahn, 29 July 1968, L.I.K. Box 37, “Dr. R. Brown – Correspondence 1.3.66 — 12.70,” Kahn Collection.

³¹ Letter, Brown to Kahn, 12 July 1967, L.I.K. Box 37, “Dr. R. Brown – Correspondence 1.3.66 — 12.70,” Kahn Collection.

³² Letter, Brown to Kahn, 12 July 1967, L.I.K. Box 37, “Dr. R. Brown – Correspondence I, 3.66 — 12.70,” Kahn Collection.

³³ Letter, Brown to Kahn, 12 July 1967.

³⁴ Letter, Brown to Kahn, 12 July 1967.

³⁵ Letter, Brown to Kahn, 11 May 1968, L.I.K. Box 37, “Dr. R. Brown – Correspondence 1.3.66 — 12.70,” Kahn Collection.

³⁶ For example, see: Letter, Marshall D. Meyers to Mr. Thad Harden, 20 May 1969, L.I.K. Box 37, “Preston M. Gerin – Correspondence 11.11.66 — 7.21.69,” Kahn Collection. Also see: Letter, Marshall D. Meyers to Mr. Preston M. Gerin, 21 December

1967, L.I.K. Box 37, "Preston M. Gerin – Correspondence 11.11.66 — 7.21.69," Kahn Collection.

³⁷ Letter, T.E. Harden, Jr. to Marshall D. Meyers, 20 June, 1969, L.I.K. Box 37, "Preston M. Gerin – Correspondence 11.11.66 — 7.21.69," Kahn Collection.

³⁸ Letter, Preston M. Gerin to Marshall D. Meyers, 26 March, 1969, L.I.K. Box 37, "Preston M. Gerin – Correspondence 11.11.66 — 7.21.69," Kahn Collection.