

Being and Architecture: An Historical Study

by

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(ABSTRACT)

The establishment of a comprehensive world-view enables a person to orient himself both physically and metaphysically within his context. Since the time of Plato, the development of these world-views has been increasingly determined by the physical sciences and their accompanying modes of thought. What have some of the major tenets of these world-views been and how have they been developed? How have they influenced the concept of *being* and how is that concept of *being* expressed in Architecture?

Acknowledgements

This work is dedicated to my parents who made all of this possible with their enduring love and patience.

I also wish to thank that Cleveland Browns fan who helped me to see that which was truly important.

To see a world in a grain of sand
And a heaven in a wild flower
Hold infinity in the palm of your hand
And eternity in every hour.

-William Blake

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Preface

We fasten stones together in such a way that they speak, and from this arises Architecture. To truly accept that assembly of stones, that work of Architecture must speak of something which one holds to be true.

I search for an impetus for bringing a work of Architecture into being. This thesis is part of that search. I have, no doubt, made errors along the way and have stumbled over some areas but I sense that the search is a valid one and the path that I find myself on is in the general direction of where I want to go. As a section of a search, this thesis does not necessarily provide any answers to the questions of Architecture. It simply addresses some of the questions which I have asked in the pursuit of Architecture. What do I hold to be true? To what end do I bring a work of Architecture into being?

Introduction

*"What was God doing before He created the world?"
"He was busy preparing Hell for those who ask foolish questions."
- old joke*

The historian, Thomas Kuhn, presents the evolution of the history of the physical sciences as a series of paradigms, each containing new information which apparently conflicts with the old way of viewing things. Eventually someone challenges the accepted view of things by asking, what some would consider, foolish questions. The previously accepted view is eventually overturned and a new world-view is established and assimilated. The establishment of a comprehensive world-view enables a person to orient himself both physically and metaphysically within the scheme of things, thus enabling him to find meaning to his existence and enabling him to *dwell* in the world.

This thesis is a selective historical account of how Western man has often viewed the concept of *being* in relation to his world-view and how that concept of *being* has been expressed in Architecture. The objective of this thesis is to make the architect aware that the current conventions of "design" which we, as the architectural community, believe to be true and valid may not be so. Another objective of this thesis, sought after in abbreviated form, is to find if the concept of *being* has a place in Architecture. Is the concept of *being* a "vapor and a fallacy" as Neitzche once wrote or does it, as Heidegger said, "*hold within it the spiritual destiny of the West*"? This thesis is also intended to make the architect somewhat aware of the evolving modern world-view which I believe most architects are unfamiliar with. A comprehensive overview of that new world-view, however, is beyond the immediate scope of this thesis and as such it excludes topics which other readers would deem necessary for "completion".

The Art of Dwelling

"Architects are full of commonsense, and look at the results all around us." - Bruno Zevi¹

Marcus Vitruvius Pollio once wrote that Architecture is the "Art of Building". That definition is certainly debatable for it seems to confuse the cause of Architecture with the effect. Architecture can mean so much more than the Art of Building. Although Architecture need not serve as a reconciliation between man and his context, it has that potential if one chooses to use it as such. In such a case, Architecture can help man orient himself within his context and assist him in his attempt to *dwell*. Christian Norberg-Schulz, in his book Genius Loci, defined **dwelling** as: "*when man can orient himself within and identify with an environment.*"² If man is to *dwell* in this sense, his Architecture can become part of that reconciliation and help give meaning to man's existence. If one does seek an understanding of life, it becomes part of human nature to extend this understanding to the expressive arts and artifacts of that particular culture. In the realm of Architecture this may appear to be difficult due to the functional aspects involved in the field. We don't "need" Architecture, we "need" only shelter, but there is a distinct difference between a work of Architecture and shelter. Architecture is that intangible quality that transcends the immediate structure and speaks of something. It may speak of any number of things and it may do so in a variety of ways but in the end, Architecture must speak. Obviously one does not need Architecture. The Greeks didn't need the Parthenon, nor did the French need the cathedral of Notre Dame. We didn't need Fallingwater. But as cultures which preceded ours' discovered, we wanted a meaningful work of Architecture enough to bring it into being because it enriches our lives by helping us to remember the existential as well as the physical bond between ourselves and our context. It enables us to *dwell* in the world.

The main thrust of this thesis is the historical study of various discoveries within the physical sciences which have altered man's world-view. The view of the relation between man and his context has undergone a radical change in this field over the past century that has gone virtually unnoticed within the field of Architecture. Part of that reason may be that the implications of those changes are difficult to understand. Another reason, perhaps more responsible, is that Architecture, as a whole, has ceased to be a reconciliation between man and his physical context, rather, it has become, to a great extent, a commentary on man and his relation to society, or an introspective examination which leads to a figurative Architecture. In any case it is obvious that the language of Architecture today still reflects a belief in a materialistic universe in an absolute space and absolute time which is filled with a collection of objects. This "*naive realism*", often associated with the Rationalist movement in Architecture, reflects either a profound ignorance of a modern world-view or the establishment of a set of priorities which discounts that view.

What the Rationalist movement in Architecture fails to understand or discounts is the present world-view which contains the concepts of a probabilistic and dualistic space-time continuum which is relative to each individual. Too many architects, following "*naive realism*", view Architecture as a synthesis of objects. There will be those who will continue to believe the Rationalist vision and they will have their disciples, but as time goes on their vision will be seen for what it is; a discredited view of our world. We can no longer *dwell* with

¹ Bruno Zevi on Modern Architecture p.51

² Genius Loci p.5

the Rationalist vision for it can no longer be substantiated. As a new world-view is assimilated by the Architectural community the adherents of Rationalism will simply die out.

I still shake my head and laugh at Historic Post-Modernism and those who take it seriously. They seem to find the ultimate potential for Architecture to be a rehashing of forms and symbols generated by cultures which no longer exist. Oswald Spengler (1880-1936) once pointed out that "*There is not one sculpture, one painting, one mathematics, one physics, but many....*"³ We, too, should have our own. Spengler went on to add:

*"All art is mortal, not merely the individual artifacts but the arts themselves. One day the last portrait of Rembrandt and the last bar of Mozart will have ceased to be - though possibly a colored canvas and a sheet of notes may remain - because the last eye and the last ear accessible to their message will have gone. Every thought, faith and science dies as soon as the spirits in whose 'external truths' were true and necessary are extinguished."*⁴

The *forms* of Historic Post-Modernism are no longer accessible to many of us, they have ceased to be. It would seem that one cannot *dwell* in the world with forms that contain no inherent meaning regarding ones' life. If our Architecture is to help us to *dwell* in the world then our Architecture must speak of us. It must enable us to orient ourselves within both the physical and metaphysical environment. To this end we must learn to *dwell* anew in our time and we must utilize the **Art of Dwelling**.

³ Decline of the West p.21

⁴ Decline of the West p.168

Being: Part 1

Central to the question of Architecture is the concept of *being*. What is man's *being*? How is *being* expressed in a work of Architecture? What do we mean by *being* anyway?

The systematic study of *being* in the West began with the Greeks. For Plato, *being* was an expression of that which truly was. That which truly was, in turn, belonged to the "Kosmos"; a perfect world where nothing changed. All that was had always been and would always be. Only that which was immovable and immutable really existed; all *becoming* and passing away was mere appearance which was equivalent to that which is not.⁵ Plato had accepted *becoming* as a degenerate form of *being* based upon the notion, put forth by Pythagoras, of a world of true *being* consisting of an unchanging mathematical order underlying the illusory world of *becoming*. Within Plato's cosmology there were basically two distinct levels of *being*. The first level was the level of mutability which contains that which is immediately given to the senses. Everything at this level is merely a shadow of something else which belongs to a higher level.⁶ This view is illustrated in Plato's Republic:

Socrates: *"And now, let me show in a figure how far our nature is enlightened or unenlightened: - Behold! human beings living in an underground den, which has a mouth open towards the light and reaching all along the den; here they have been from childhood, and have their legs and necks chained so that they cannot move, and can only see before them, being prevented by the chains from turning round their heads. Above and behind them a fire is blazing at a distance, and between the fire and the prisoners there is a raised way: and you will see, if you look, a low wall built along the way, like the screen which marionette players have in front of them, over which they show the puppets."*

Glaucon: *"I see."*

Socrates: *"And do you see men passing along the wall carrying all sorts of vessels, and statues and figures of animals made of wood and stone and various materials, which appear over the wall? Some of them are talking and others silent."*

Glaucon: *"You have shown me a strange image, and they are strange prisoners."*

Socrates: *"Like ourselves; and they see only their own shadows, or the shadows of one another, which the fire throws on the opposite wall of the cave?"*

Glaucon: *"True; how could they see anything but the shadows if they were never allowed to move their heads?"*

Socrates: *"And of the objects which are being carried in like manner they would only see the shadows?"*

⁵ Hebrew Thought Compared With Greek p.51

⁶ Timaeus p.10

Glaucon: "Yes"

Socrates: "And if they were able to converse with one another, would they not suppose that they were naming what was actually before them?"

Glaucon: "Very true."

Socrates: "And suppose further that the prison had an echo which came from the other side, would they not be sure to fancy when one of the passers-by spoke that the voice which they heard came from the passing shadow?"

Glaucon: "No question."

Socrates: "To them, the truth would be nothing but the shadows of the images."

Glaucon: "That is certain."⁷

The second level is itself subdivided into two levels. The lower of these consists of the mathematical realities (number and geometry) while the upper level contains the *ideas* of those things which *truly are* and is the highest of all possible levels.⁸ The *idea* of man incorporates all men and personifies the *essence* of man, yet each man has his own sense of *being* and is seen as a term, complete unto himself.⁹ It is in this upper level of *ideas* that the *being* of man rests; yet his is not the only *being* present. All things have their own innate sense of *being* and they are all ordered in a hierarchical scheme in which the more original and spiritual a thing is, the higher the rank. God is the most original and spiritual *being* of all and is the highest in rank.¹⁰ Yet, since the kosmos was complete and perfect, this God was incapable of creating things, he simply presided over that which was. For Plato, all that truly was had already existed and would continue to exist forever.

"For *being* has to *becoming*," Plato remarked, "the same relation as truth to belief."¹¹ If truth (vs. Truth) be the relation of conformity between the strict object of a judgement and the *being* represented by it, then can we know truth or only our relation to the object due to our limited and prejudiced criteria? Can we only believe? Plato held that through the form of an object, we could know its *being*. Apart from its form, can we know the *essence* or *being* of anything?

If Architecture is to speak of that which is truly man, it should relate to his sense of *being* (if we accept that as his true reality). Can one resign the study of man's *being* to purely deductive reasoning? Can the understanding of his *being* be separated from the understanding of his relation to his context? To better understand these questions we can examine the historical development of their formulation during specific periods in time and the tools used in their development.

⁷ The Fourth Dimension p.8

⁸ Hebrew Thought Compared With Greek p.53

⁹ Decline of the West p.9

¹⁰ Hebrew Thought Compared With Greek p.54

¹¹ Timaeus p.42

Mathematics

"Bless us, divine number..." - Attributed to Pythagoras¹²

In the process of bringing a work of Architecture into being and in his attempt to understand his context, man has made wide use of the system of geometry. Within the field of Architecture, this use is almost always restricted to Euclidean geometry for two main reasons; the first being that architects tend to design with a network of planes. They make use of plans and elevations to a great extent and this fosters a network of two dimensional design relations. The second reason is that some architects retain the notion that geometrical relations and shapes embody meaning; that they express symbolism befitting a work of spatial art such as Architecture. But what is *geometry*? What is *number*? What is *mathematics*?

The term *mathematics* is derived from the Greek "*mathema*" which means "knowledge, cognition, or understanding."¹³ *Mathesis* is derived from this and refers to "the act of teaching and learning".¹⁴ The Greeks of the Platonic school believed that this specific type of learning was simply the taking cognizance of something one already knows. *Mathematics* then, becomes a specific branch of learning which deals with the taking cognizance of specific things; namely, *number* and *geometry*.

Number and Geometry

Mathematics, to borrow Descartes view, may be superficially divided into two areas; **number**, which can be considered the "*res cogita*" of mathematics, and **geometry**, which can be considered as the "*res extensia*". As a whole, mathematics may stand as the greatest language the human mind has ever developed, but it remains just that - a language.

Number itself can be subdivided into two parts - *cardinal* and *ordinal*. A cardinal number implies a simple correspondence, as in assigning an abstract symbol to represent an object which is either real or imagined.¹⁵ An ordinal number corresponds to the last number in a sequence, and as such it implies counting. The operations of mathematics are based upon the assumption that we can always pass from any number to its successor, and herein lies the essence of the ordinal number.¹⁶ Obviously one must be able to pass from a cardinal number to an ordinal number with relative ease to make counting useful. The human hand makes this simple with its fingers. Within the capacity of cardinal and ordinal usage, number has been viewed as **magnitude** in that it relates to a positive entity. It can also be viewed as **relation** when one accepts the existence of negative and imaginary numbers as well as the concept of "0" as representing something. This relational view makes algebra possible. Algebra is simply a set of relations between symbolic forms. It would not be possible with the purely "magnitude" view.

¹² Number, the Language of Science p.41

¹³ Mathematics and Optimal Form p.preface

¹⁴ Dictionary

¹⁵ Number, the Language of Science p.8

¹⁶ Number, the Language of Science p.9

Geometry, as its name implies, is the measuring of the Earth, or anything else for that matter. It is the extension realm of mathematics and implies that any object, or relation of objects, can be described by a system of numbers represented by points, lines, planes and other surfaces. To every geometrical shape or relation there corresponds a number or relation of numbers. The system of symbolic logic which is geometry and the axiomatic schema which defines it, may or may not correlate with the outside world we often refer to as *reality*. Within the axiomatic schema which defines Euclidean geometry, for example, a *point* is **dimensionless** and a *line* has no width or height, only length. These symbols have a specific meaning that is divorced from our multi-dimensional world. In Euclidean geometry, a line, as a series of dimensionless points, is able to be subdivided indefinitely. This condition leads to several paradoxes, including the paradox of **infinity**.

The Infinite

"There are some, King Gelon, who think that the number of the sands is infinite....." From Archimedes: The Sand Reckoner¹⁷

The infinite. Few concepts have created so much trouble for the human mind; a concept necessary for the language of mathematics yet a concept inaccessible to the human mind except in the abstract. Zeno, one of the Sophists of classical Greece, presented the dilemma of the infinite which has had an impact upon our thinking of space and time up to the present. Aristotle recorded the "Four Arguments of Zeno" in his Physica; they are:

Dichotomy: The first is the one on the non-existence of motion, on the ground that what moves must always attain the middle point sooner than the end point.

Achilles and the Tortoise: The second is the so-called Achilles. It consists in this, that the slower will never be overtaken in its course by the quicker, for the pursuer must always come first to the point from which the pursued has just departed, so the slower must necessarily be always still more or less in advance.

The Arrow: If everything, when it is behaving in a uniform manner, is continually either moving or at rest, but what is moving is always in the now, then the moving arrow is motionless.

The Stadium: The fourth is that concerning two rows, each row being composed of an equal number of bodies of equal size, passing each other on a race course, as they proceed with equal velocity in opposite directions; the one row originally occupying the space between the goal and the middle point of the course, and the other that between the middle point and the starting point. This, he thinks, involves the conclusion that half a given time is equal to double the time.¹⁸

The first argument: **Dichotomy**, presents the assumption that physical space is infinitely divisible. Any amount of space, be it matter or the void, was deemed infinitely divisible because

¹⁷ Number, the Language of Science p.62

¹⁸ Number, the Language of Science p.122

the mind was capable of dividing any rational amount in half, *ad infinitum*. For the Greeks, the absolute, Euclidean nature of space and matter assured them that regardless of one's motion or the motion of an object, the geometrical properties of that object would remain constant; they were considered to be part of its *being*.¹⁹ It was assumed that since both matter and geometry/number were commensurable (rationally divisible), then their correlation must be direct and exact. Any law, axiom or property accorded to geometry/number had to be accorded to matter as well. Since the human mind was capable of producing ideal situations in math, such as infinite divisibility, then those same ideal situations must also apply to physical matter; hence, space and matter are infinitely divisible.

The same basic reasoning applies to the concept of time as illustrated in Zeno's third argument, **The Arrow**. A universal time can be infinitely divided into smaller and smaller units of time. Time in this sense is considered *spatial* and is equivalent to motion. Once one reduces motion to an infinite number of motionless states, then one can consider each motionless state to be a state of rest. Motion would then be logically impossible. What Zeno does is to represent time as a line, thus duration in time is equal to extension in space.²⁰ Zeno, in a sense, geometricizes time. Any axiom that one attributes to geometry/number, in this case, must also be attributed to time as well as space. The dichotomy of time and the dichotomy of space go hand in hand for Zeno.²¹

The spatial thinking of the Greeks naturally led Zeno to represent time as a line. This view was essentially the same view of time for the West until Albert Einstein introduced his "*Special Theory of Relativity*" in 1905 in which he demonstrated that time is relative to the velocity of the observer. We often fail to recognize that the abstractive nature of the mind is removed from the direct experiential nature of our senses. The correlation must be suspect. The concept of infinity is not a logical or experiential necessity, only a mathematical one.²²

Since the Greeks held that the correlation between the properties of matter and the axioms of geometry/number was direct, it was reasoned that all space and any measurement of space had to be commensurable. With this notion, the Greeks reasoned that geometry was inherent in nature rather than a language we use in our relative description of nature. Pythagoras examined that view.

"*Number is the essence of all things.*"²³ Pythagoras and his followers were certain that only through number and form could man grasp the fundamental nature of the universe.²⁴ As long as nothing arose to upset the commensurable nature of geometry, the Pythagoreans were confident that they could, and would, achieve their goal of understanding the universe through number. The Pythagorean dream of nature ruled by number, however, was to end shortly after it had begun. What ended it was what the Pythagoreans called *alagons* (unutterables). We call them *irrationals*.²⁵ Suddenly the commensurable relation between geometry and physical reality was no longer ideal. The classic case of an irrational number is found in the geometrical exercise of squaring the circle. As one can see in this exercise, the critical feature of squaring the circle is the diagonal of the square, which is also the diameter of the circle. In order to

¹⁹ Timaeus (introd.) p.10

²⁰ Number, the Language of Science p.125

²¹ Number, the Language of Science p.125

²² Number, the Language of Science p.75

²³ Decline of the West p.62

²⁴ Number, the Language of Science p.43

²⁵ Number, the Language of Science p.101

square the circle one needs a rational solution to both the diagonal and the sides of the square. If one assumes a rational value for the diagonal, then the sides of the square are irrational. If on the other hand, one assumes a rational value for the sides, then the diagonal of the square is irrational. In either case, the diagonal of the square is incommensurable with the sides. The Pythagoreans never found a solution to this problem and, in fact, no solution exists. The proof of this was not determined until the end of the eighteenth century when Johann Lambert (1728-1777) showed that π could not be a rational number and Adrien Legendre (1752-1833) established that it could not be the root of a quadratic equation with rational coefficients.²⁶ This showed that the circumference of the circle had to be an irrational value. This ended the quest to square the circle and demonstrated that mathematics is not a completely commensurable concept.

Yet within Euclidean geometry the paradox of infinity seems insurmountable. The definition of the symbols within Euclidean geometry produce these inherent paradoxes. A symbols' meaning, however, changes when a new axiomatic schema is introduced. The meaning of *point*, *line* and so on, are determined by the theorems and propositions in which they occur.²⁷ In Euclidean geometry, we **define** a line as the shortest distance between two points. One cannot prove a definition, however. This was the great realization of those who discovered non-Euclidean geometry.

Non-Euclidean Geometry and the Finite

The discovery of non-Euclidean geometry was one of those odd occurrences in history as it was simultaneously discovered by two people in different parts of the world. In 1823, Janos Bolyai (1802-1860), a Hungarian, and Nikolay Lobachevsky (1793-1856), a Russian, both discovered the fundamental properties of non-Euclidean geometry.²⁸ How they managed to do so was by examining the axiomatic schema of Euclidean geometry and its postulates. Around 323 B.C., Euclid, expounding upon the work of Thales, wrote the 13 volumes of his Elements in which he established five postulates:

- 1) A straight line segment can be drawn joining any two points.
- 2) Any straight line segment can be extended indefinitely in a straight line.
- 3) Given any straight line segment, a circle can be drawn having the segment as radius and one end point as center.
- 4) All right angles are congruent.
- 5) If two lines are drawn which intersect a third in such a way that the sum of the inner angles on one side is less than two right angles, then the two lines inevitably must intersect each other on that side if extended far enough.²⁹

The fifth postulate cannot be rigorously proven. It can, in fact, be denied by denying an equivalent postulate; the parallel postulate, which reads as follows; "*Given any straight line, and a point not on it, there exists one, and only one, straight line which passes through that point and never intersects the first line, no matter how far they are extended.*" In this case, the

²⁶ Number, the Language of Science p.117

²⁷ Godel Escher Bach p.93

²⁸ Godel Escher Bach p.91

²⁹ Godel Escher Bach p.90

second line is considered to be parallel to the first line. What Bolyai and Lobachevsky did was to realize that in a **hyperbolic geometry** one could assert that at least two lines satisfied that postulate. Later, Bernhard Reimann (1826-1875) established that in an **elliptical geometry** at least two lines satisfied that postulate.³⁰

A separate geometry can be established by creating a new axiomatic schema. In this way a variety of geometries can be established, each one perfectly logical within its own axiomatic schema. The situation is analogous to M.C. Escher's drawing "*Relativity*" (Figure 1 on page 12), in which the individual parts are all logically consistent within themselves, but the totality of the drawing is a contradiction of our spatial intuition. Similarly, each separate geometry may be logically consistent within its own axiomatic schema, but the totality of all the geometries together is a logical contradiction in that they contain axioms that may contradict other axioms in another geometry. Yet, even the logical consistency of any axiomatic schema is unprovable. Mathematics is a deductive science and the method of deduction is based upon the principle of contradiction, and nothing else. A mathematical proposition is true only if it leads to no logical contradictions.³¹

Kurt Godel

In the first half of the twentieth century, Kurt Godel (1906-1978) showed that it is impossible to demonstrate the non-contradictoriness of a logical mathematical system using only the means offered by the system itself. Mathematics, according to Godel, is an incomplete formal system which cannot be used to critique itself.³² In such a case, the system must be transcended, but how does one transcend mathematics? What system does one use? The answer may not be known but the question is valid. Mathematics must eventually be transcended if its axioms and propositions which defines it are to be proven. One cannot *prove* that any geometrical system, including Euclidean geometry, is a logically consistent system. In regards to which geometry is correct, in that it corresponds to the real world, the answer is; none. The geometry of the universe is determined by matter and no one single geometry is intrinsic to space itself.³³ In his "*General Theory of Relativity*" (1915), Einstein, expounding upon the work of Gauss and Minkowski, used a type of non-Euclidean geometry called Reimannian geometry, in which the curvature constantly changes, not because it was "correct" but because it was the most useful in his descriptions. The new type of geometry proved to be more useful because, as Einstein said:

"The laws according to which solid bodies may be arranged in space do not completely accord with the spatial laws attributed to bodies by Euclidean geometry. This is what we mean when we talk of the 'curvature of space'. The fundamental concepts of the 'straight line', the 'plane', etc....., thereby lose their precise significance in physics. In the General Theory of Relativity the doctrine of space and time, or kinematics, no longer figure as a fundamental independent of the rest of physics. The geometrical behavior of bodies and the motion of clocks

³⁰ Godel Escher Bach p.93

³¹ Number, the Language of Science p.67

³² Godel Escher Bach p.17

³³ Godel Escher Bach p.100

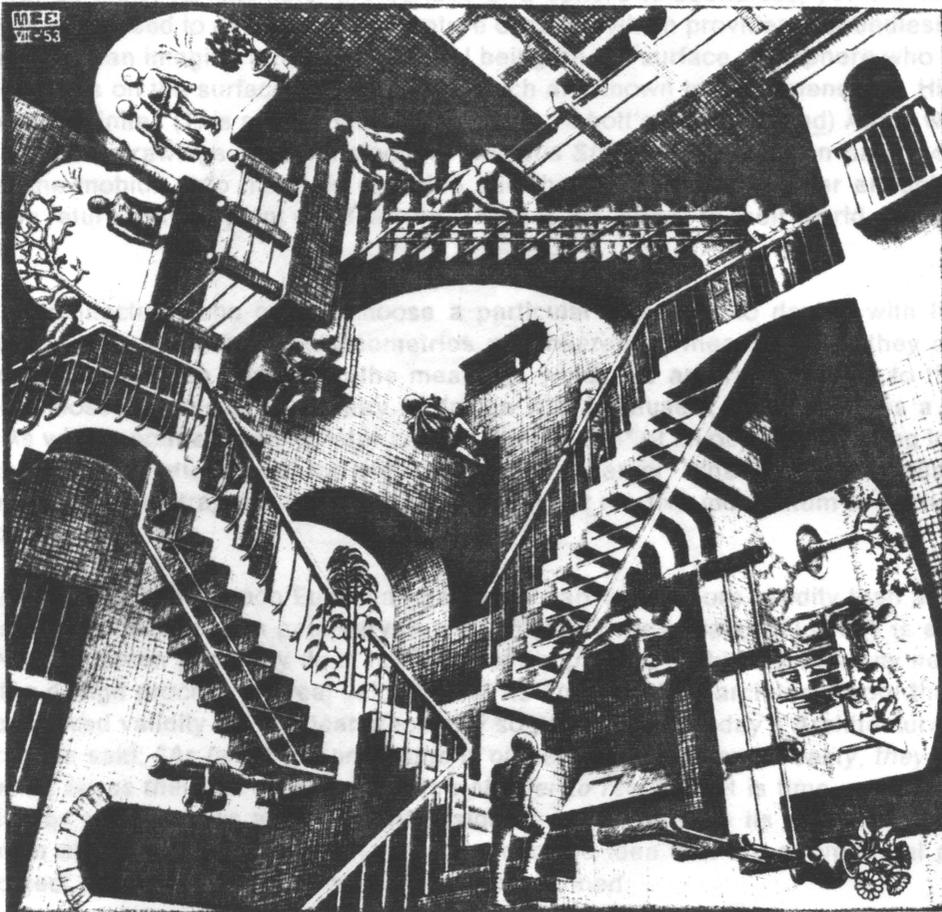


Figure 1. Relativity - M.C. Escher

* Ideal and Opinions p 231

* Ideal and Opinions p 231

rather depend on gravitational fields, which in their turn are produced by matter."³⁴

The development of non-Euclidean geometries, such as Riemannian geometry, enables us to make an important distinction between "infinite" space and "boundless" space. A boundless space can be finite; for example, the surface of a sphere is boundless, yet it is finite. This analogy is often used to describe the curvature of space which provides a boundless yet finite universe. One can imagine a two-dimensional being on the surface of a sphere who can travel in all directions on the surface of the sphere which are known to his dimensions. His world is boundless yet finite. (This case is illustrated in A.A. Abbott's book *Flatland*) Again we can use one of Escher's drawings as an analogy; in "*Mobius Strip II*" (Figure 2 on page 14), we can see that the mobius strip has only one side and that if the ants travel far enough they will eventually return to their point of departure. There is no "edge" to their world, it is boundless yet finite.

Within Architecture, one cannot choose a particular geometry to design with because it embodies certain "meaning" - all geometries are inherently "meaningless"; they contain no metaphysical dimension apart from the meanings which we arbitrarily assign to them. Nor can one choose a particular geometry to design with because it best describes a particular object. As will be pointed out in a later section, the "shape" of an object, according to Einstein, is relative to the momentum of the object or of the observer. What may be a square to you may be an elongated trapezoid to me depending on our relative momentum to each other and to the object.

An Architecture based upon Euclidean geometry carries no more validity than an Architecture based upon Riemannian geometry; it may, in fact, be less valid (if validity is even an issue). Non-Euclidean geometry does not necessarily provide architects with any new tools to use in the design process. Its real value lies in its ability to free architects from the confines of the perceived validity of Euclidean geometry so prominent in today's Architectural designs. Einstein once said; "*As far as the propositions of mathematics refer to reality, they are uncertain; and as far as they are certain, they do not refer to reality.*"³⁵ It is time we, as architects, reconsidered mathematics as a primary design tool and question its primary validity in the description of our context. We must also abandon the idea that the geometrical properties of any object are part of its *being* as Plato had envisioned.

Now that we have a better idea of what mathematics is, let us examine its use within Architecture during specific periods in time. Let us also examine how the tool of mathematics has been incorporated into a world-view, its impact upon the concept of *being*, and how and why it has been used within Architecture.

³⁴ Ideas and Opinions p.231

³⁵ Ideas and Opinions p.233

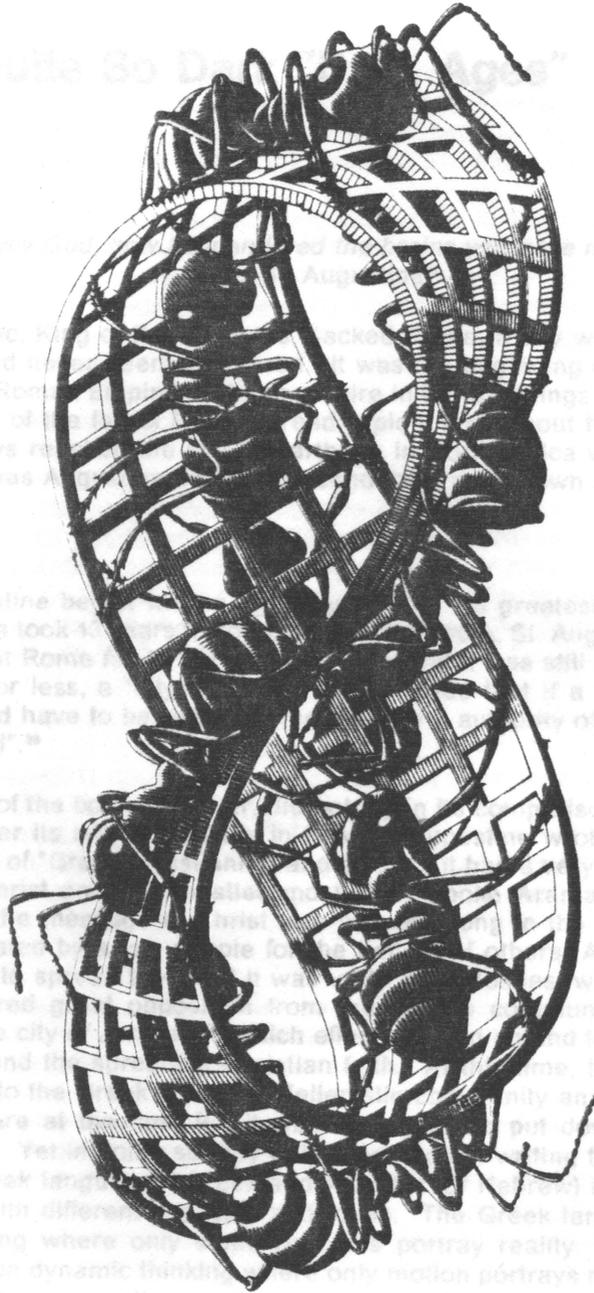


Figure 2. Möbius Strip II - M.C. Escher

The Not Quite So Dark "Dark Ages"

"Let me tell you, my God, how I squandered the brains you gave me on foolish delusions."
- St. Augustine³⁶

In 410 A.D., Alaric, King of the Visigoths, sacked Rome, a city which had stood for a thousand years and had never been conquered. It was the beginning of the end for the once all-powerful Western Roman Empire. With no empire in Europe things naturally began to fall into disarray and news of the fall of Rome spread rapidly throughout the remains of the Empire. Eventually the news reached the city of Carthage in North Africa where the Bishop of Hippo lived.³⁷ His name was Augustine, later to be canonized and known as St. Augustine (354-430).

St. Augustine

In 413, St. Augustine began writing The City of God, his greatest work, which consisted of 22 books and which took 13 years to complete.³⁸ In this work, St. Augustine explained his belief that the reason that Rome fell to the Visigoths was that it was still basically a pagan city and that it was, more or less, a "city of Satan". He believed that if a city were to survive such tribulations it would have to be built obeying the moral authority of the church, it would have to be a "city of God".³⁹

The real impact of the book, however, did not lay in its comparison of a "city of Satan" to a "city of God"; rather its real impact lay in how St. Augustine wrote it. The City of God was basically a product of "Greek Christianity" and as such it had a very specific impact upon later readers. Jesus Christ and his Apostles most likely spoke Aramaic, a language related to Hebrew. At first, the message of Christ was passed along in the same language, Aramaic, being orally translated by a few people for the benefit of others. After Christ was no longer physically present to spread the word it was up to the Apostles, who spread the word orally but who encountered great opposition from the Jewish community. Around 70 A.D. the Romans sacked the city of Jerusalem which effectively put an end to the Jewish resistance to both the Romans and the spreading Christian faith. At this time, the center of the Christian community shifted to the Greek speaking Hellenistic community and the Church that was being established there at the time felt it was necessary to put down in writing the life and teachings of Christ. Yet in doing so they only preserved in writing the word of Christ and the Apostles in the Greek language.⁴⁰ Greek and Aramaic (or Hebrew) are fundamentally two different languages with different concepts and ideas. The Greek language is based primarily upon spatial thinking where only static concepts portray reality. The Hebrew language is based primarily upon dynamic thinking where only motion portrays reality.⁴¹ These differences can be seen in the two respective number concepts. In Greek number theory, the concept of

³⁶ Confessions p.37

³⁷ The Day the Universe Changed p.20

³⁸ Confessions p.20

³⁹ The Day the Universe Changed p.20

⁴⁰ Hebrew Thought Compared With Greek p.17

⁴¹ Hebrew Thought Compared With Greek p.27

two represents an additional **object** whereas in Hebrew number theory, the concept of two represents a repeated **motion**.⁴² Greek tradition is *static*. Hebrew tradition is *organic*. Christianity molded the two together into a new, and somewhat self-contradictory, mind-set. The *New Testament* was assimilated into a predominantly Greek mind-set and consequently the late Hellenistic view became part of the evolving Christian view.

In writing his book, St. Augustine had synthesized the holy scriptures of the Bible with the philosophy of Plato, which he had learned through the writings of Plotinus.⁴³ As Platonism rejects the illusory world perceived by the senses and speaks of a hidden true reality behind it, Platonism was easily assimilated by the early Christians. It helped them in their acceptance of the suffering that they had to endure due to their faith and it seemed to fit reasonably well with the spiritual nature of the holy scriptures. Many of those accepting Christianity at that time wanted to expand it beyond what was found in the Bible, which led them to want to correlate it with a substantive philosophy; Plato was the obvious choice.

St. Augustine's work was to become a cornerstone in the philosophical development of the Catholic Church and although Christians may no longer have needed the psychological comfort Platonism provided (Christianity had been made the official religion of Rome in 326), it remained the central philosophy used by the Church.⁴⁴ This may have been in part due to the access of the Church to many of Plato's works. The works of Aristotle, on the other hand, were difficult to assemble and study after 641. In that year the great library at Alexandria was destroyed and many of its works went up in flames.⁴⁵

A Library Lost

The library at Alexandria was considered by many to have been one of the greatest libraries in existence. Over 300,000 scrolls containing copies of the finest achievements of Western civilization were housed within its walls.⁴⁶ The works of Plato and Aristotle, as well as countless others, were kept there. A separate school was established next to it to copy and translate the finest works on philosophy, law, medicine, biology, history and countless other subjects. People from all over the Mediterranean came to Alexandria to study; it was the heart of Western civilization.

In 640, the Muslim armies under Omar I besieged and captured the city of Alexandria with its magnificent library intact. It is not known how many of the precious scrolls were removed over the next year but in 641 the Arabs set fire to the library and destroyed the accompanying school. Whatever scrolls were left were destroyed in the ensuing fire.⁴⁷ The Byzantine fleet was unable to retake the city until 646, but by then it was too late to do anything about the library and the incalculable loss. Although remnants of the works of Aristotle and Plato, as well as others, had survived in various locations around the European continent, there was no longer any single concentration of the great works. It was virtually impossible for anyone to study the philosophers in depth and coordinate the various sciences, arts and humanities. It is generally considered that Western philosophy at this time began to enter into the Dark Ages.

⁴² Hebrew Thought Compared With Greek p.165

⁴³ The Day the Universe Changed p.20

⁴⁴ Hebrew Thought Compared With Greek p.53

⁴⁵ Timetables of History p.641

⁴⁶ Timetables of History p.641

⁴⁷ Timetables of History p.641

As Europe entered its Dark Ages, the Muslim Empire flourished. It stretched across regions of Asia, Africa, and parts of Europe. The Byzantine Empire, also known as the Eastern Roman Empire, was centered at the fortress city of Constantinople and held out until the fifteenth century. The Muslim armies simply bypassed parts of the Byzantine Empire and went on to conquer regions of Europe including most of what is today Spain. Throughout the Spanish region, the Arabs constructed an array of citadels including one at Cordoba where they built a library to house the great literary works kept in that region. The library contained over 400,000 titles including such works as Euclid's Elements, lost to the West at this time, and the Physics and Metaphysics of Aristotle, complete with commentaries by some of Arabia's finest philosophers.⁴⁸

In 1013, internal rifts within the Muslim Empire initiated a power struggle which resulted in the defeat of the ruling Ummayyad faction. In the course of the conflict, the great library at Cordoba was destroyed but the precious books were spared and distributed among the smaller libraries in the various minor citadels. The Physics and Metaphysics of Aristotle were sent to Toledo.⁴⁹ 72 years later, in 1085, the citadel of Toledo fell to a host of advancing Christian armies who captured the library intact.⁵⁰ Aristotle was now to be a major part of the philosophy of Western Europe.

The advancing Christian armies which conquered Toledo were part of a loose confederation of armies fighting the Muslim Empire. Between 1096 and 1291 at least 7 separate crusades were launched against the Muslims in the Middle East.⁵¹ These series of actions eventually led to a surge in the construction of ecclesiastical Architecture, including cathedrals, the like of which had never been seen before and remain, even today, as some of the greatest works of Architecture in the world as well as incredible feats of engineering.

The Gothic Age

The mastercraftsmen empowered to raise the great cathedrals of Europe sought to achieve a number of goals, one of the most primary of which was to build as high as possible while utilizing a minimum of masonry. The fortress-like enclosures of the Romanesque were no longer needed psychologically; Christianity had won its battle in Europe. What the mastercraftsmen lacked was a means to raise the structures to the desired new heights.

At this point the flow of information from the crusades began to arrive in Europe. The victorious crusaders brought back a wealth of information to be utilized in a variety of fields, including Architecture. One of the things they brought back was a new way of building things using a pointed arch to increase the structural capabilities of buildings. This was soon extrapolated into a network of pointed ribbed vaults which in turn necessitated the development of an advanced buttressing system.⁵² With this accomplished, the mastercraftsmen had what they needed and soon the cathedrals were under way.

Around 1163, one of these great structures, the Cathedral of Notre Dame, in Paris, was begun under Bishop Maurice de Sully and over the next century the structure rose and became

⁴⁸ The Day the Universe Changed p.38

⁴⁹ The Day the Universe Changed p.40

⁵⁰ The Day the Universe Changed p.36

⁵¹ Timetables of History p.1291

⁵² A History of Architecture p.626

part of a definitively new type of Architecture, later to be regarded as Gothic⁵³ (Figure 3 on page 19). The completed work was not only a testament to empirical engineering but it also manifested the mind-set of its creators in stone and glass which emphasized the view that the entire universe was seen as a theatre for the drama of man's fall and eventual redemption in Christ. On the purely physical level it was both a social center for the city as well as a teacher for the vast number of illiterate people. Its statues and stained glass windows became a "*biblia pauperum*", teaching the history of the Bible as well as the lives of the Saints, thus becoming, for most of them, the place where their faith was dominantly manifested.⁵⁴ The plan of the cathedral was a path leading from the nave to the alter, where God would be present during the service, signifying the path that one took in life to reach God. On the metaphysical level the construction of the cathedral portrayed the basically Platonic mind-set which the Church inherited from St. Augustine. The cathedral, as an expression of the Christian/Platonic world-view, helped to give meaning to the lives of the population thus helping them to *dwell* in the world. Although much of the structure was derived from past structural failures and accomplishments, the integration of the parts was also symbolic. Within Platos' hierarchical cosmology, hidden behind every object was an *idea* which was the objects only true reality.⁵⁵ These *ideas* were ordered according to a hierarchical scheme rather than being harmoniously equal. This hierarchical scheme is reflected in the overall structure of the cathedral; for example, the piers used in the work may have been well proportioned unto themselves, but they were not intended to be harmoniously proportional to the structure as a whole. ⁵⁶

All things within the medieval world were viewed in relation to God. Within the cathedral this can be seen easily in the aforementioned stained glass windows in which the Saints are pictured as being larger than the ordinary people. This is because the Saints were viewed as being closer to God; their *being* was more spiritual. There was no attempt to portray things as they were seen in relation to man because what man saw wasn't reality, but merely shadows of that which truly was. If man could only see the shadows of that which truly was, then he needed God's help in order to see the true reality of existence. The diaphanous skeleton of the masonry walls served to this end as they enabled the use of a mixture of colored light that softly filtered in through the stained glass windows and provided a "*lux mirabilis*" to the interior thus providing a physical analogy to the divine illumination which the people felt the cathedral provided. To understand that which truly was, man needed the direct presence of God. Without that direct presence no understanding was deemed possible. As such, man was incapable of possessing the true *being* of any object. Since the book-of-nature was inaccessible to man without God, the cathedrals role was to bring man closer to God so that he could understand that which truly was.⁵⁷

By 1300, most of the great cathedrals of Europe were nearing completion as a new mind-set began to be assimilated by the learned members of society and to eventually be passed down to the populace at large. Over the next century Western man began to change how he viewed the world and of his place in it.

⁵³ A History of Architecture p.594

⁵⁴ Meaning in Western Architecture p.111

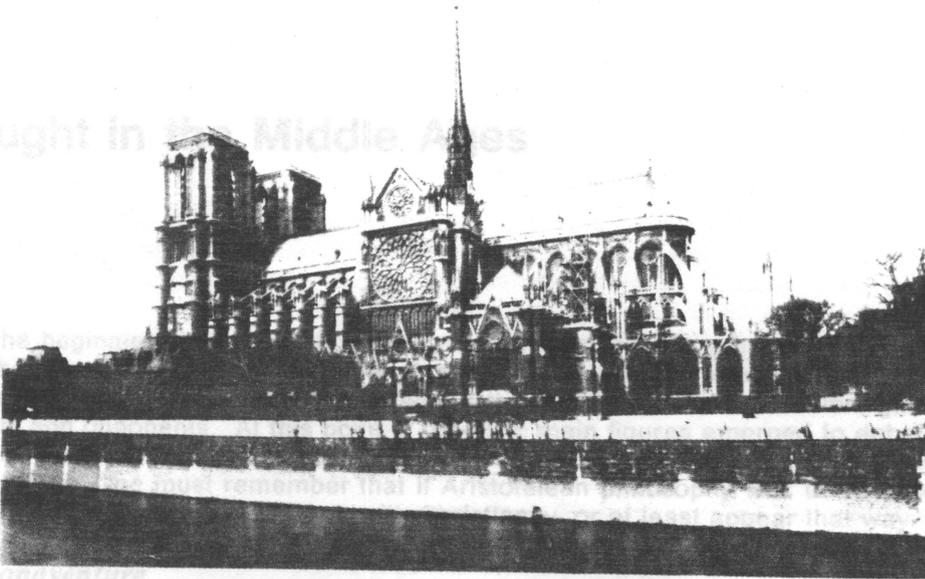
⁵⁵ The Day the Universe Changed p.28

⁵⁶ Architectural Principles in the Age of Humanism p.160

⁵⁷ Meaning in Western Architecture p.111

Caught in the Middle Ages

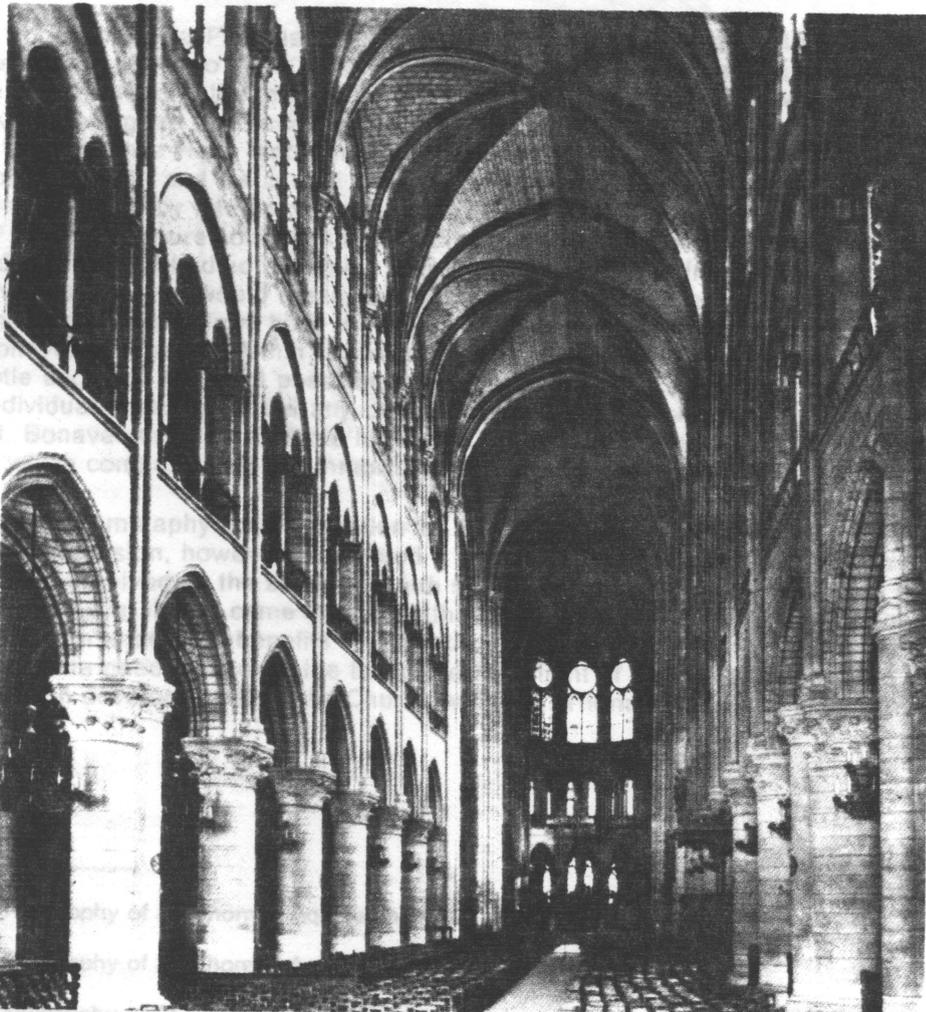
At the beginning of the Middle Ages, with the fall of the Roman Empire, began here philosophy in the 12th century. Church



was captured in Latin and being both adopted by the philosopher Thomas Aquinas noted by the Church

St. Bonaventure

St. Bonaventure's theory of knowledge is concerned with the individual. According to the Bonaventurian view, the individual is not an isolated entity, but is part of a larger whole. He cannot understand all things in isolation, but must see them in relation to the whole. This is the role of the philosopher, who is to help the individual understand the whole. St. Bonaventure's theory is based on Aristotle's theory of knowledge, but he adds a Christian perspective. For St. Bonaventure, knowledge is not just about the material world, but also about the spiritual world. He believes that the individual must understand the whole of creation, including the spiritual realm, in order to truly know God.



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Classical philosophy, which was based on the works of Aristotle, was the dominant philosophy of the Middle Ages. It was a philosophy that was based on the idea of a hierarchy of being, with God at the top and the material world at the bottom. This philosophy was based on the idea of a hierarchy of being, with God at the top and the material world at the bottom. This philosophy was based on the idea of a hierarchy of being, with God at the top and the material world at the bottom.

problem: his understanding of the world was limited to the material world, and he was unable to understand the spiritual world. This was a problem because the spiritual world was the more important part of the world, and it was the spiritual world that was the source of life and meaning. This was a problem because the spiritual world was the more important part of the world, and it was the spiritual world that was the source of life and meaning.

The philosophy of St. Thomas Aquinas was based on the idea of a hierarchy of being, with God at the top and the material world at the bottom. This philosophy was based on the idea of a hierarchy of being, with God at the top and the material world at the bottom. This philosophy was based on the idea of a hierarchy of being, with God at the top and the material world at the bottom.

Figure 3. Notre Dame

The Philosophy of St. Thomas Aquinas p 15
The Philosophy of St. Thomas Aquinas p 16

Caught in the Middle Ages

At the beginning of the twelfth century, the Physics and Metaphysics of Aristotle, captured with the fall of Toledo, along with their Arabian commentaries, were translated into Latin and began to circulate throughout Europe where they made a deep impression, gaining both adherents and opponents. At this point in time two main figures emerged to debate the philosophy of Aristotle and its relation to Christianity; St. Bonaventure and St. Thomas Aquinas (1225-1274).⁵⁸ One must remember that if Aristotelean philosophy was to be accepted by the Church, it had to be in accordance with Christianity, or at least appear that way.

St. Bonaventure

St. Bonaventure, a Platonist in the vein of St. Augustine, argued that Aristotle's theory of *concept*, as opposed to Plato's theory of *ideas*, was incompatible with Christianity. According to the *concept* theory, the intellect abstracts the universal contained within an individual.⁵⁹ St. Bonaventure argued that according to this theory, God did not possess, in Himself, the *ideas* of all things; hence He is ignorant of the particular. If He is ignorant of the particular, then He cannot know man and He cannot exercise providence over all things. This would mean that all things happen by fate or chance, but this could not be possible for it would rule out God's role.⁶⁰ St. Bonaventure continued that Aristotle never spoke of the world having any beginning or end. If the world had no beginning then there had to be an infinite number of human beings who have lived. This would mean one of three things; there are an infinite number of souls, the same soul passes from body to body over time, or everyone shares the same eternal soul. St. Bonaventure believed that the Arabian translations and commentaries had shown that Aristotle accepted the third possibility, that everyone shares the same soul. This would rule out individual immortality and any chance of eventual punishment or reward in the afterlife. For St. Bonaventure, the Platonic hierarchy of forms was superior to Aristotle's unity of all forms which compromised the immortality of the individual soul.⁶¹

Clearly the metaphysical dimension of Aristotle's work presented a major problem; his physical dimension, however, presented a complete and rational approach to understanding the world perceived by the senses.⁶² Faith seemed to dictate Plato but reason seemed to dictate Aristotle, yet if both came from God, then they could not be in conflict. As more and more people began to see the benefits of Aristotle view on the physical world, it became apparent that someone needed to examine these views in light of how they could serve Christianity. A chasm soon developed within the Church which St. Thomas sought to overcome.

⁵⁸ The Philosophy of St. Thomas Aquinas p.14

⁵⁹ The Philosophy of St. Thomas Aquinas p.12

⁶⁰ The Philosophy of St. Thomas Aquinas p.14

⁶¹ The Philosophy of St. Thomas Aquinas p.15

⁶² The Philosophy of St. Thomas Aquinas p.16

St. Thomas Aquinas

St. Thomas had read the Physics and found in it a world endowed with reason, reality, sensibility, stability and intelligibility.⁶³ Plato had offered a world where things only had the appearance of *being* and which denied real intelligibility. St. Thomas knew that in order to reject the teachings of Plato in favor of the teachings of Aristotle, he would have to reject much of the work of St. Augustine as well. This would not be easy for he would have to reject the *a priori* proofs of God, as explained by St. Augustine, as well as having to deny the need for special illumination of the intellect by divine ideas and deny the soul as existing independent of the body.⁶⁴ All of these were ideas that the church as a whole had come to accept. To overturn them would be a tremendous change in Christian theology. So be it. In 1255 St. Thomas, and others who supported his views, succeeded in convincing the Church to teach the Aristotelean corpus instead of Plato and thus set in motion the general acceptance and diffusion of Aristotle's work and theories.⁶⁵

What St. Thomas finally arrived at in his Summa Theologica (1273) was that the power of reason was capable of understanding some truths but that other truths were only given by revelation from God.⁶⁶ St. Thomas also elaborated upon the concept of *being* and its relation to God and Man. It is with St. Thomas that we find the concept of *being* changing from a Platonic form concept to an existential concept.⁶⁷ God, as pure *being*, is solely responsible for the presence of all other *beings* and brought all other *beings* into existence through the act of creation.⁶⁸ Man, as a created *being*, receives his *being* as a participation in the divine *being*. Man's *essence* is what defines man apart from the other *beings* and is what limits his participation in the divine *being*.⁶⁹ The true *essence* of man, according to St. Thomas, is his spirit and in this sense that which is truly man is considered to be a spiritual *being*. In a crude sense, a spiritual *being* is one which is capable of possessing the *being* of other entities while a material *being* is one which exists only unto itself. For example, man, as a spiritual *being*, is capable of possessing the *being* of tree, but tree, as a material *being*, is incapable of possessing the *being* of man. It is through his *essence* that man's *being* is knowable.⁷⁰ Yet *essence* does not confirm existence. Only *being* can confirm existence.⁷¹ Something may have an *essence* and not exist in actuality. As St. Thomas put it "*To be is the actuality of all acts and consequently the perfection of all perfections.*" To possess a *being* is the true supremacy over possessing only an *essence* for it is through *being* that all that exists in actuality exists.⁷²

⁶³ The Philosophy of St. Thomas Aquinas p.21

⁶⁴ The Philosophy of St. Thomas Aquinas p.22

⁶⁵ Timaeus (introd.) p.21

⁶⁶ The Philosophy of St. Thomas Aquinas p.41

⁶⁷ Being and Essence p.10

⁶⁸ Being and Essence p.23

⁶⁹ Being and Essence p.10

⁷⁰ Being and Essence p.34

⁷¹ Being and Essence p.21

⁷² Being and Essence p.10

Man, as a created *being*, is only capable of transforming and altering that which is part of his transient world; he cannot create. As a created *being*, man is of a different order than God and therefore cannot form an integral part of God, nor can he be added to Him, nor can he be subtracted from Him.⁷³ There can be no commensurability between two *beings* which do not belong to the same order.

Within the theology of St. Thomas, philosophy was given equal status with religion in explaining some of the workings of nature. The traditional approach of "*credo ut intelligam*" (understanding comes through belief) began to change to "*intelligo ut credam*" (belief comes through understanding).⁷⁴ The presence of this shift can be seen in the writings of Dante Alighieri.

Dante Alighieri

Dante Alighieri (1265-1321) was perhaps the most gifted author of his times. His greatest work, The Divine Comedy, is considered by many to be the greatest work of literature of the late Middle Ages. In it, Dante is taken on a tour of Hell, Purgatory, and Heaven in which he describes them all in the outlook common to his times. An example of this outlook is in canto #2, Paradiso (Heaven):

*"She to whom my inmost thoughts were known,
As blithe as she was fair, now turned and said:
'Direct thy mind with gratitude to God
Who has united us with heaven's first star.'
It seemed as though a cloud were covering us,
Solid and smooth and dense, and sparkling forth
As 'twere a diamond the sun had struck.
Within itself that everlasting pearl
Received us, though remaining undivided,
As water can receive a ray of light.
If I was body - though here we cannot think
That one dimension could enclose another,
Which must be so, if body enter body -
Then should desire should the more enkindle us
To stand before that essence where 'tis shown
How God and our own nature are united.
That will be seen there, which we hold by faith -
Not demonstrated, but self-evident,
Even as primal truth that man believes.
I answered: 'As devoutly as I can,
My lady, I now render thanks to Him
Who has removed me from the mortal world.
But tell me, what are those dark spots I see?
Are they those which, seen by men on earth,
Give rise to all the fables about Cain?'
She smiled a little ere she made reply:
'If mortals err in forming their opinion
Even when the eyes of sense do not unlock,
Surely no wonder should amaze thee now:*

⁷³ The Philosophy of St. Thomas Aquinas p.140

⁷⁴ The Day the Universe Changed p.53

*For thou canst see, I think, that reason flies
When following the senses on clipped wings."*

75

In this section Dante is taken to Heaven's first star (the moon) by his guide Beatrice where upon Dante notices that the surface of the moon is perfectly flat; "*Solid and smooth and dense, and sparkling forth as 'twere a diamond the sun had struck.*" From his former vantage point back on Earth the moon had appeared to have dark areas on its surface, leading Dante, as well as most others, to assume that its surface was not perfectly smooth, but rough, like the Earth's surface. So Dante addresses Beatrice; "*But tell me, what are those dark spots I see? Are they those which, seen by men on Earth, give rise to all the fables about Cain?*" Beatrice later tells Dante that the dark spots are souls of people and not surface imperfections.

The point Dante is trying to make in this section is that when reason and faith seem to be in conflict, faith must precede reason. Dante knew of the Ptolemaic system of astronomy and had based the structure of the heavens in The Divine Comedy upon it.⁷⁵ The Ptolemaic system teaches that the heavens are perfect; hence, the moon must be perfectly spherical and have a smooth surface, yet his senses showed him several dark areas on its surface; hence, it should be imperfect. Reason must fall to faith, as Beatrice tells him; "*If mortals err in forming their opinion even when the eyes of the senses do not unlock, surely no wonder should amaze thee now: for thou canst see, I think, that reason flies when following the senses on clipped wings.*" For Dante, as well as most people of his time, reason would always be flying upon "clipped wings".

St. Thomas Aquinas, about fifty years earlier, had put forth the case that certain truths about the book-of-nature must be accessible to reason and that other truths are only delivered by divine revelation. Dante, in his Divine Comedy, showed the chasm that was developing around the time the book was written (1307). It would only grow wider with the years.

⁷⁵ The Divine Comedy p.131

⁷⁶ Scientific American April 1986 p.76

A Somewhat Reasonable Age

Around the turn of the fourteenth century the **power** of reason began to take hold and "scientific experimentation", in a crude sense, was initiated as the new Aristotelean view began to be assimilated.⁷⁷ Objects were no longer seen as completely mysterious; the book-of-nature began to yield a few secrets. In general, the nature of an object was explained by its excellence in simply being what it was. This view was a small step away from all objects being just a shadow of something else but it was an important step. Man could now possess the true *being* of an entity. Nature, as understandable, was now becoming a valid subject of study. Although most of Europe refused to yield to Aristotelean authority and still clung to its Platonic heritage, by 1345 the new Aristotelean outlook and the acceptance of reason as a viable approach to knowledge had begun to infiltrate into society. A rise in the continental economy had the Europeans heading for a bright future by the summer of 1347; the summer that a merchant ship, returning from the Black Sea, entered the Sicilian port of Messina. On board was an extra passenger whom the Europeans came to call the **Black Death**.⁷⁸

The Black Death was a plague that struck its victims with an alarming swiftness; within 24 hours of infection, the victim died a very agonizing and gruesome death.⁷⁹ By 1351, just 4 years after its arrival, the plague was responsible for the deaths of 75 million people in Europe. In 1347 alone, one-third of England was killed.⁸⁰ Land went uncultivated, livestock perished, famine struck in the wake and eventually there weren't enough of the living willing to bury the dead in some regions. The period of economic growth and optimism had come to an abrupt end as a dreadful silence descended over Europe. To those unfortunate enough to experience the horror it must have seemed like the end of the world.

The Renaissance

The world did not come to an end but the fourteenth century did by which time the plague had run its course and the process of recovery had begun. Italy was the first to recover and quickly got its economy back on track as it was still the main trading country between the Far East and the rest of Europe. Those that had survived the plague along with their descendents found themselves as the inheritors of all that the dead had left. With a drop in the work force and more available money, workers found that they could demand a higher price for their labor. Within the decade the Italian economy took off like a shot.⁸¹ People were eager to spend their money in order to have a good time in an attempt to help them forget about the nightmare that they had lived through.⁸² With so much money floating around it eventually became more and more difficult to keep track of it all. If anyone could keep track of it and manage it so that it went to the right place at the right time, they could make a fortune.

⁷⁷ The Day the Universe Changed p.52

⁷⁸ The Day the Universe Changed p.55

⁷⁹ The Day the Universe Changed p.55

⁸⁰ Timetables of History p.1351

⁸¹ The Day the Universe Changed p.57

⁸² The Day the Universe Changed p.56

At the beginning of the fifteenth century, the Italians were ready to take advantage of two earlier events. The first event was the culmination of the work of Leonardo Fibbonacci (1180-1250) who had lived in North Africa under the rule of the Muslim Empire. It was there that Fibbonacci had learned of the advanced bookkeeping methods used by the Arab merchants and, being a master of mathematics himself, he had decided to make some improvements. What Fibbonacci finally arrived at was a form of double-entry bookkeeping which made it easier for people to keep track of their monetary situation.⁸³ The other event was in 1396, and occurred at a place called Nicopolis, on the edge of the Black Sea. It was here that the last great army that Western Europe could assemble met the advancing Turkish Armies to do battle. To make a long battle short, the Turks won. All that remained between the Turks and what remained of the Byzantine Empire was the fortress of Constantinople. The Emperor of that beleaguered citadel, Manuel II Palaeologos, decided that if they were to survive they were going to need help so he sent an entourage to Rome headed by an academic scholar named Chrysaloris. (With the impending fall of the Empire, many Greek scholars fled north to Italy where they introduced the Italians to many of the Byzantine ideas and concepts.) The Pope in Rome, not caring much for the rival church in the East, sent back the entourage empty-handed, minus one member. The Pope had asked Chrysaloris to stay in Italy for awhile and to accept a position at Florence University teaching Greek culture. Chrysaloris accepted and began a three year visit.⁸⁴

At about this time, Fibbonacci's double-entry bookkeeping system appeared in Florence after having gone through Genoa and Venice without anyone really paying much attention to it. Eventually a wealthy family in Florence noticed Fibbonacci's work and its potential use. This family, the Medici's, owned a great deal of wealth and were heavily involved in loaning money. Like everybody else, though, they had trouble keeping track of it all and maintaining their record books. Enter Fibbonacci's new system. It was this that was able to balance the Medici's books and to keep track of all the money that they had floating around. Double-entry bookkeeping became a type of secret weapon in the ensuing economic war.⁸⁵ With this secret the Medici's were able to tame and harness the great financial beast and they made a fortune with it. The more money the Medici's made, the more there was to loan around and the richer everybody got. Florence flourished.

Unlike the Medici's, many of the families who were becoming wealthy were coming into money for the first time. They became the *nouveaux riches*, or the new middle class; and what did this new middle class want more than anything else? Social status and recognition! But where does one go to get social status if you couldn't quite buy it outright? To Chrysaloris' Greek culture classes at Florence University.⁸⁶

As the new middle class began to study Greek culture many of them found that they wanted to have a look at it, so Chrysaloris suggested that they all accompany him back to Constantinople, the last great vestige of Greek culture and the capital of the beleaguered Byzantine Empire.⁸⁷ In 1400 they packed their bags and went. After an extensive tour of the city, some of the Florentines were disappointed but others were intrigued and wanted more. They began to long for the past and the glory that was once Rome which Constantinople reminded them of and they decided that they would make their beloved city of Florence the "New

⁸³ The Day the Universe Changed p.61

⁸⁴ The Day the Universe Changed p.67

⁸⁵ The Day the Universe Changed p.61

⁸⁶ The Day the Universe Changed p.67

⁸⁷ The Day the Universe Changed p.67

Rome". These particular Florentines decided to travel to Rome to see what they could learn about building an empire. When they got there they found the old city ruins and marveled at them, but they couldn't figure out how to duplicate them. The Romans had been extraordinary engineers and their feats were still beyond reach of the visiting Florentines. The Florentines, determined to find out how the Romans built their grand structures, gathered what they could and began a search through the old libraries and monasteries of Europe for literature on anything Greek or Roman. In 1414 they struck a gold mine; a book entitled The Ten Books of Architecture by Marcus Vitruvius Pollio who was a Roman architect and engineer.⁸⁸ In the same year the Medici's had amassed so much money that they became the bankers to the Papacy. Armed with Vitruvius' book and plenty of money of their own as well as the "Medici bank" the Florentines were ready to build their "New Rome".

Filippo Brunelleschi

At about this time, another learned individual arrived in Florence, or rather, returned to Florence. His name was Paolo del Pozzo Toscanelli and he was returning from Padua where he had recently obtained his medical education.⁸⁹ At some point around 1420, Toscanelli came across a man by the name of Filippo Brunelleschi (1377-1446) and he explained to his new friend some of the things which he had learned while in Padua. One of those things was a theory of light and how the eye sees things as explained by the great Muslim thinker Al Hazan.⁹⁰ The two men thought about trying out Al Hazan's theory with painting and what Brunelleschi discovered was what we call **scientific perspective**. That is, they discovered the geometrical properties inherent in such a view of things. It didn't take long for Brunelleschi to use this new technique on a work of Architecture and in 1423, the Church of San Lorenzo in Florence was built according to Brunelleschi's plans (Figure 4 on page 27). Brunelleschi had designed the interior of San Lorenzo so that the the "perspective" lines of the structure would lead the eye to the vanishing point which was the holy tabernacle on the alter.⁹¹

But it wasn't as innocent as that. What Brunelleschi had shown everybody was that the geometrical lines used in perspective enabled the entire world to be measured and related from man's vantage point. Things were no longer viewed only in relation to God, they were now seen in relation to man.⁹² This, coupled with the rise in social status that many of the Florentines felt, led them to view man as the measure of all things; and of mans' measure? That's where Vitruvius' book came in handy. It seems that Vitruvius had written that man was made in the image of God and that therefore the proportions of his body were produced by divine will.⁹³ Vitruvius had shown that an ideal man, with his arms outstretched, would touch the edge of a circle which had been circumscribed around his body with its center at the man's navel. Apparently Vitruvius was implying that there existed a hidden proportioning system in nature that determined the shapes of all things. The Florentines knew that they had to uncover this proportioning system, but where to look for it?

⁸⁸ The Revolution in Science p.7

⁸⁹ The Day the Universe Changed p.69

⁹⁰ The Day the Universe Changed p.70

⁹¹ The Day the Universe Changed p.77

⁹² The Day the Universe Changed p.77

⁹³ Architectural Principles in the Age of Humanism p.101

When Cosimo de Medici became the new ruler of Florence and it was under him that the Platonic Academy in Florence was established in 1440.¹⁶ It was here that the Florentines came to have the secret proportioning system that Vitruvius has alluded to. The Florentines realized that Plato, in his *Timaeus*, had a version of Pythagoras' view that there existed an unchanging mathematical order underlying the constant flux of experience.¹⁷ The Florentines then delved upon the known works of Pythagoras and searched for any others lying around in the monasteries. The Florentines upon examining Pythagoras' work, were convinced that they had uncovered the secret proportioning system that the ancients had known about and had used in their Architecture. The Pythagoreans, it seemed, practically worshipped the concept of number.



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did not share the Greek fear of irrationals. This unit, the diagonal of the square, remained the only noncommensurable value widely used throughout the Renaissance, but that wasn't because the Renaissance architect feared the irrational numbers as the Greeks did; rather, he was searching for lost knowledge, not necessarily new knowledge, so since Vitruvius had accepted the diagonal of the square, then so would they.¹⁸ This reliance upon basic geometric forms and the Pythagorean proportioning system was somewhat of a return to the Hellenic Greek view, expressed by Pappus that without geometry and mathematics, no perfect art could exist.¹⁹ The Florentines also began to pick up on the concepts used in Byzantine Architecture now that there was increased communication between the two cultures.

In 1468, Alberti was able to try out his new Architectural theory by enclosing the old structure of the Malatesta church in Rimini; was an envelope of classical forms utilizing Pythagoras' proportioning system.²⁰ (Figure 5 on page 30). Ten years later he was again commissioned

¹⁶ *Timetables of History* p. 1440
¹⁷ *Architectural Principles in the Age of Humanism* p. 104
¹⁸ *Number, the Language of Science* p. 41
¹⁹ *Architectural Principles in the Age of Humanism* p. 108
²⁰ *Architectural Principles in the Age of Humanism* p. 108

Figure 4. San Lorenzo

²¹ *Timetables of History* p. 350
²² *The Day the Universe Changed* p. 80

In 1434, Cosimo de Medici became the new ruler of Florence and it was under him that the Platonic Academy in Florence was established in 1440.⁹⁴ It was here that the Florentines came to find the secret proportioning system that Vitruvius has alluded to. The Florentines realized that Plato, in his *Timaeus*, had made use of Pythagoras' view that there existed an unchanging mathematical order underlying the constant flux of experience.⁹⁵ The Florentines then descended upon the known works of Pythagoras and searched for any others lying around in the monasteries. The Florentines, upon examining Pythagoras' work, were convinced that they had uncovered the secret proportioning system that the ancients had known about and had used in their Architecture. The Pythagoreans, it seemed, practically worshiped the concept of number, in fact they prayed to it;

"Bless us, divine number, thou who generatest gods and men! O holy, holy tetraktys, thou that containest the root and the source of the eternally flowing creation! For the divine number begins with the profound, pure entity until it comes to the holy four; then it begets the mother of all, the all-comprising, the all-bounding, the first born, the never-swerving, the never tiring holy ten, the key holder of all."⁹⁶

Leon Battista Alberti

The Florentines set out to combine this Platonic-Pythagorean view with Christianity and the desire to express their new secular power. In 1450, a friend of Brunelleschi's, a man named Leon Battista Alberti, published his own version of the new proportioning system to be used in Architecture. In all but one case, these proportions were all commensurable.⁹⁷ The one exception was the use of the diagonal of the square which Vitruvius himself had accepted. Vitruvius was a Roman, not a Greek, and as such he was more interested in modular design and how various proportional units could be integrated into a structurally sound design. He did not share the Greek fear of irrationals. This unit, the diagonal of the square, remained the only noncommensurable value widely used throughout the Renaissance, but that wasn't because the Renaissance architect feared the irrational numbers as the Greeks did, rather, he was searching for lost knowledge, not necessarily new knowledge, so since Vitruvius had accepted the diagonal of the square, then so would they.⁹⁸ This reliance upon basic geometric forms and the Pythagorean proportioning system was somewhat of a return to the Hellenic Greek view expressed by Pamphilus that without geometry and mathematics, no perfect art could exist.⁹⁹ The Florentines also began to pick up on the concepts used in Byzantine Architecture now that there was increased communication between the two cultures.

In 1446, Alberti was able to try out his new Architectural theory by enclosing the old structure of the Maltesta church in Rimini with an envelope of classical forms utilizing Pythagoras' proportioning system¹⁰⁰ (Figure 5 on page 30). Ten years later he was again commissioned

⁹⁴ Timetables of History p.1440

⁹⁵ Architectural Principles in the Age of Humanism p.104

⁹⁶ Number, the Language of Science p.41

⁹⁷ Architectural Principles in the Age of Humanism p.108

⁹⁸ Architectural Principles in the Age of Humanism p.108

⁹⁹ Timetables of History p.-350

¹⁰⁰ The Day the Universe Changed p.80

to execute a new facade for an old church; San Maria Novella in Florence (Figure 6 on page 31). The classical members are somewhat subdued in this work but the new proportioning system was used throughout yielding a well integrated design.¹⁰¹

The first entire structure known to be constructed with the new proportioning system was San Maria delle Carceri in Prato (Figure 7 on page 32). Most likely designed by Alberti, the Church was begun in 1485 by Giuliano da Sangallo. Here, a number of new techniques are executed in the design including a centralized plan built on the Greek cross instead of the traditional Latin cross. This was done to emphasize the harmonic ratios inherent in the design and was probably influenced by the Byzantine use of centralized space in churches.¹⁰² This was not, however, a simple imitation of Byzantine Architecture. The main cause for the similarity was that the Florentines were beginning to view things in a similar way to the Byzantines. They did, of course, have their differences which can easily be seen in the fact that Byzantine Architecture utilized a type of diaphanous approach to construction while the Florentines utilized a strongly spatial and concrete approach to construction. Classical members and elementary geometrical relations were also emphasized in the works of Architecture which followed and soon a new approach to Architectural design was begun.

A Changing Mathematics

The rise in Pythagorean research sparked a renewed interest, not only in numerical relations, but also in the *concept* of number. Up to this time (the end of the fifteenth century) number was viewed as *magnitude*. It represented something tangible, something real. As more and more people began to reevaluate the symbolism of various numerical relations they also began to reevaluate the purely *magnitude* view of number. In 1545 the concepts of *complex* and *imaginary* numbers were introduced to Europe.¹⁰³ *Imaginary* numbers? Mathematicians were wary of them but they proved to be useful in certain calculations so they remained. Four years later, in 1554, the concept of "0" entered Western math.¹⁰⁴ How could *nothing* exist? Numbers represented something tangible and *nothingness* was anything but tangible. Mathematicians, however, found "0" extremely useful so it, too, was retained. By 1591, the concept of *algebra* was introduced to the West via Arabia.¹⁰⁵ Within the algebraic system, letters were used to represent numbers; any symbol, in fact, could be used to represent a quantity or, more importantly, a numerical relation. The concept of number as *magnitude* began to give way to number as *relation*. In 1614 Napier introduced logarithms; a new way of considering numerical relations.¹⁰⁶ By 1630, the view of number as solely *magnitude* was all but over. Mathematicians had simply augmented the definition, and hence, the parameters, of number.

And of number's companion geometry? It may have been a bit behind in development but in 1637, Rene Descartes introduced *analytic geometry* which essentially set out to redefine the concept of geometry.¹⁰⁷ Architects may have been a little slow to catch on to all of this as they continued to utilize the Pythagorean proportioning system as a design tool and still considered it valid. Any system is viewed as valid when it relates to something true and when an alter-

¹⁰¹ The Day the Universe Changed p.82

¹⁰² The Day the Universe Changed p.81

¹⁰³ Number, the Language of Science p.182

¹⁰⁴ Decline of the West p.178

¹⁰⁵ Decline of the West p.71

¹⁰⁶ Einstein for Beginners p.133

¹⁰⁷ Decline of the West p.74

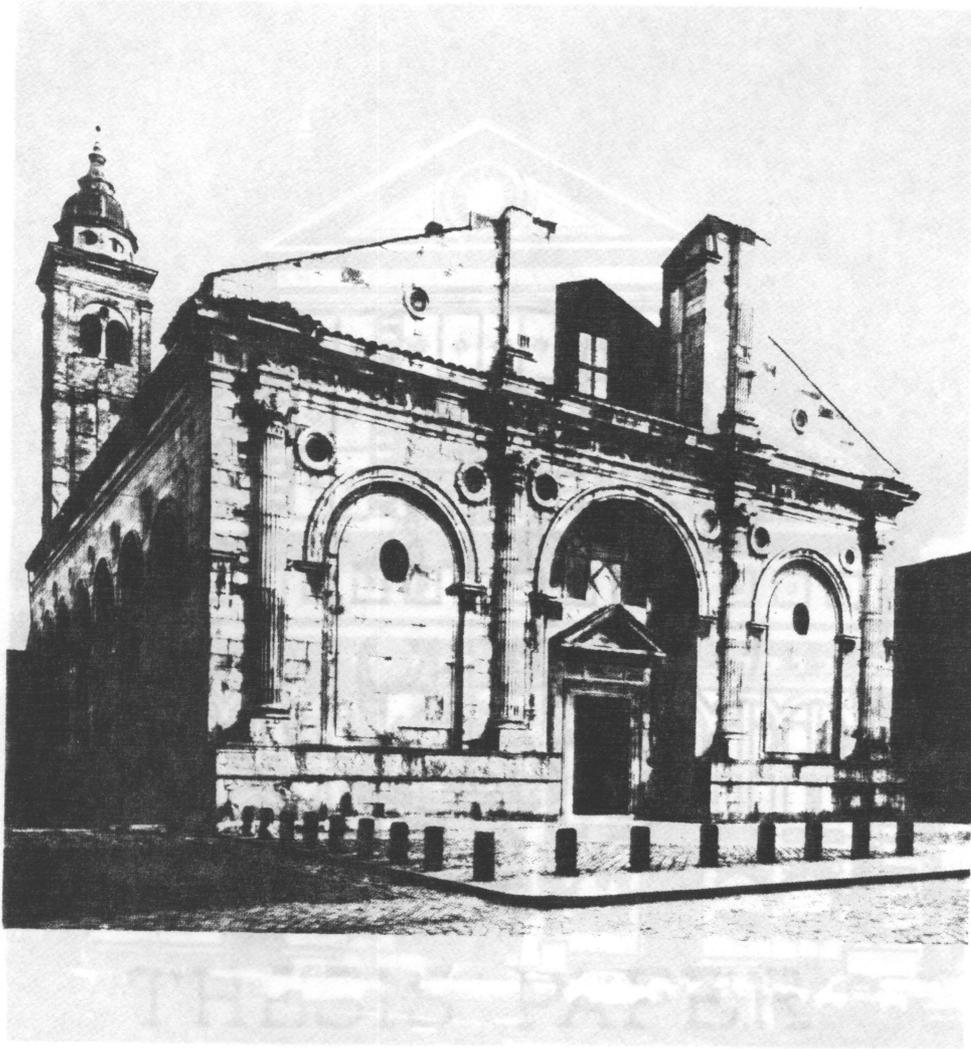


Figure 5. Maltesta Church

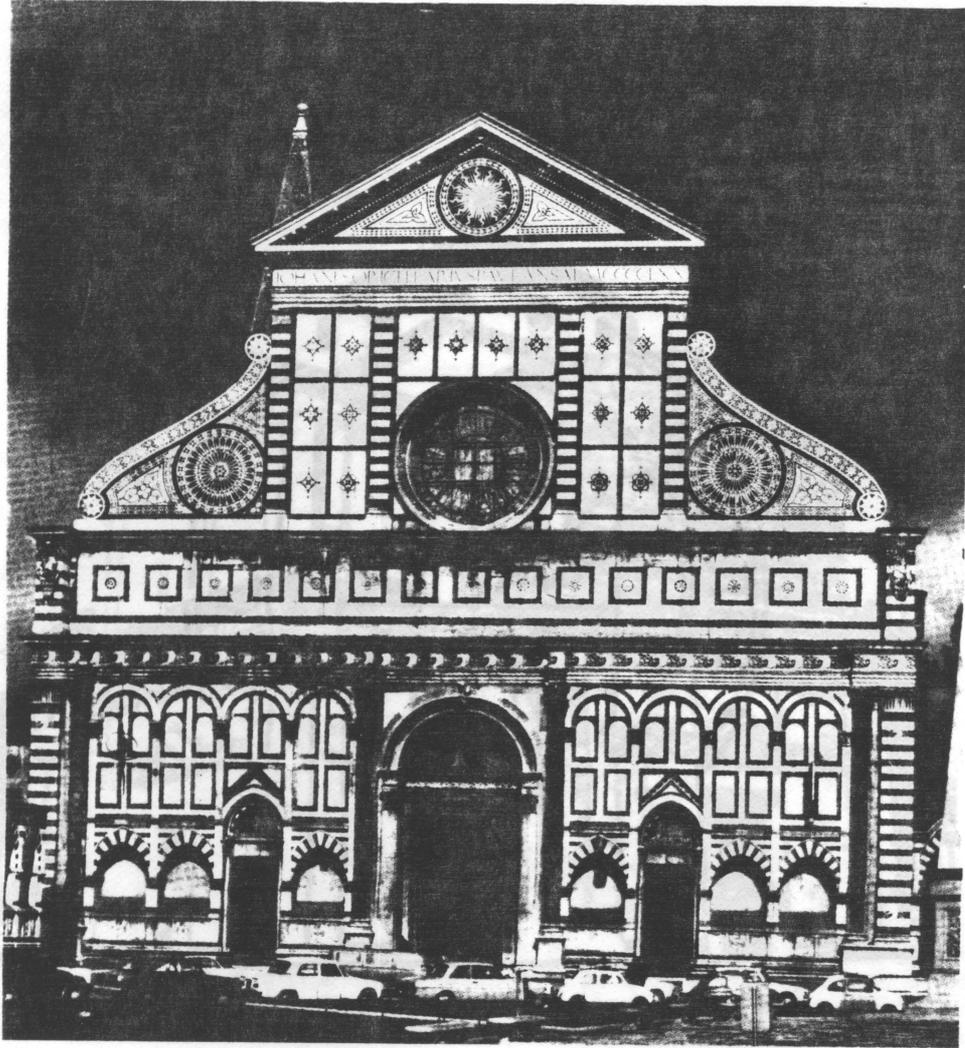


Figure 6. San Maria Novella artcuri

nate system has no such relation to what is true. There was, at this time, at least one musician who was tired of the perceived validity of the Pythagorean musical scale and who decided to create a new one. Johann Sabastian Bach (1685-1750) took Napier's logarithms and established a tempered scale according to the logarithmic series. In our own time, Schoenberg has introduced a 12 tone scale, thus opposing the octave. If one can simply change a scale to suit a different proportioning system, what becomes of the metaphysical validity of any proportioning system? What about Pythagoras' proportioning system? Was it no longer the key to the truth about nature? Had Bach or Schoenberg changed the lock to fit a new key? No. Bach's tempered scale and Schoenberg's 12 tone scale are no more valid than the Pythagorean scale. And of the Pythagorean proportioning system which architects were using? Was that valid? No. It could still be used as a design tool; many still use it as such, but it carries no more validity than any other proportioning system. Our view of what constitutes number and geometry has changed so much that we must be capable of understanding that no proportioning system is valid in an attempt to understand nature.

But what of the heavens? Did they not operate according to the divine nature of the mathematical harmonies? Were they, the heavens, not perfect? Not unless we want to redefine "perfection", as Gottfried Leibniz would later do. In 1604, Galileo observed and identified a radical change in the heavens; a supernova. The heavens were not perfect, at least not any more. Tycho Brahe had spotted a supernova earlier in 1572, but it remained an exception.¹⁰⁸ Kepler's observation of a second supernova confirmed it; the heavens were not perfect. Observation; that was the key. This new approach to knowledge, called empirical investigation, would eventually lead to a new view of the world.

Nicolas Copernicus

With the renewed interest in nature, people began studying the various sciences and began to amass a collection of other information that didn't fit well with the Aristotelean or Platonic/Pythagorean view of things. Although the mounting information discrediting the old view was serious, the real blow came in 1543 when Nicolas Copernicus (1473-1543) wrote a book claiming that the Earth revolved around the sun and not the other way around.¹⁰⁹ Copernicus' book De Revolutionibus Orbium Coelsetium (1543) undermined all of Aristotle's physics and, as a result, his metaphysics as well.

Copernicus had the book published while he was on his deathbed wishing to avoid the controversy which he knew would follow.¹¹⁰ Almost 100 years later, in 1642, Issac Newton was born. After Newton, few would challenge what Copernicus had set out to accomplish. The Aristotelean world-view was drawing to a close and with it the Platonic-Pythagorean world-view as well although numerous later scientists would hold either Platonic or Aristotelean leanings. The new view that arose set out to discover what the world was like empirically. Induction began to take the place of deduction in the search for knowledge of the ultimate truth.

¹⁰⁸ The Birth of a New Physics p.55

¹⁰⁹ The Revolution in Science p.40

¹¹⁰ Mathematics and Optimal Form p.42

An Absolute World

At the beginning of the nineteenth century, the mechanistic and deterministic theories which comprised the bulk of what is known as the Mechanical, or Rationalist, world-view were widely accepted by the scientific and learned communities of Western Europe, and the Rationalist view was at, or near, its zenith. A little more than 125 years later it was almost totally abandoned by the scientific community; yet for the majority of the nineteenth century it reigned supreme.

Issac Newton

The Rationalist view grew primarily out of the Italian Renaissance and upon the work of such men as Galileo, Descartes and Newton. In perhaps what could be considered its mature form the Rationalist view considered the universe to be akin to a giant watch, running smoothly in accordance with strict and universal laws set in motion by the divine will of a Creator. Hence, it was considered by some to be a perfect universe, as Gottfried Leibniz (1646-1716) had argued in his work Essays on Theodicy (1710).¹¹¹ This universe consisted of a three dimensional absolute space of height, depth and length, and a separate dimension of absolute time as defined by Issac Newton (1642-1727) in his work Mathematical Principles of Natural Philosophy (1687):

"Absolute space, in its own nature, without regard to anything external, remains always similar and immovable."¹¹² "Absolute, true and mathematical time, of itself and by its own nature, flows uniformly, without regard to anything external."¹¹³

Put another way, the space interval between objects, or of objects, was believed to be independent of the motion of the object or of the person measuring it. For example, if a man were to measure a rod and found it to be two feet in length, then that's how long the rod was, regardless of how fast either the rod or the person measuring it was moving. Similarly, the time interval between events was believed to be independent of the motion of an observer. For example, if a man were to measure the time which elapsed between the turning on of a lamp and the opening of a door and found it to be two seconds, then that was the duration between the two events, regardless of how fast the observer was moving relative to the two events.

Absolute space and absolute time were viewed as a giant stage set which the observer viewed from a distance confident that no matter what he did the stage set would remain constant. Within this absolute universe and upon this stage set existed objectively real and basically passive particles of matter. In his Opticks (1706) Newton explained these particles in the following way;

¹¹¹ Mathematics and Optimal Form p.17

¹¹² Philosophical Impact of Contemporary Physics p.7

¹¹³ Philosophical Impact of Contemporary Physics p.36

"It seems probable to me that God in the beginning formed matter in solid, massy, hard, impenetrable movable particles, of such sizes and figures, and with such other properties, and in such proportion to space, as most conducted to the end for which He formed them; and that these primitive particles being solids, are incomparably harder than any porous bodies compounded of them; even so very hard, as never to wear or break in pieces; no ordinary power being able to divide what God Himself made one in the first creation."¹¹⁴

These particles had specific properties which enabled them to be joined together like building blocks which formed larger substances, namely the matter that we sense around us. This view, called *materialism*, supported a reductionist philosophy towards matter, where in, all the attributes of an object could be explained as the simple addition of all of the attributes of its components; the whole equaled the sum of its parts. Today this view is referred to as *naive realism* where the universe is seen as a collection of objects.¹¹⁵ It is a result of the human tendency to reduce "reality" to simple, easily digestible images. The lumps of matter which comprised this universe "floated" in a "void" which was permeated by an ether - an absolutely stable medium.

Rene Descartes

These particles of matter were viewed as objectively real due mainly to the original atomic theory of Democritus as well as the philosophical work of Rene Descartes (1596-1650). Although Descartes did not accept the theory of *Atomism*, his philosophical writings led him and others to accept the objective reality of things. It was Descartes who formulated the *cartesian dualistic* view of the universe in which the human mind acted as a mirror of reality. Whatever a person sensed around him, existed in the state in which the person sensed it to be and would continue to exist in that state even if that person were removed. This was one of the outgrowths of Descartes' famous dictum: "*cogito ergo sum*" ("I think, therefore I am"), which he outlined in his work Discourse on Method (1637).¹¹⁶ Descartes wanted to know what knowledge he could be certain of and what knowledge was mistakenly believed to be true. His first rule of logic, as presented in Discourse on Method, was as follows:

"My first rule was to accept nothing as true which I did not clearly recognize to be so; to accept nothing more than what was presented to my mind so clearly and distinctly that I could have no occasion to doubt it."¹¹⁷

Descartes accepted that the only thing which he could not doubt as being true was the fact that he was doubting. Descartes reasoned that if he knew for certain that he was doubting, then he had to exist in order to doubt; hence: "I doubt, therefore I exist" (*dubito, ergo sum*). Put in a positive sense: "I think, therefore I am" (*cogito, ergo sum*). Since Descartes associated the *self* with the thought process and not with the sensory process, he reasoned that that which was truly man was expressed by his mind alone. After Descartes accepted his own existence as undoubtable, he accepted that anything which was obvious to him must also be true. After all, Descartes reasoned, God was a benevolent and perfect being and He would

¹¹⁴ The Science of Matter p.76

¹¹⁵ Superforce p.48

¹¹⁶ Rene Descartes: The Essential Writings p.134

¹¹⁷ Rene Descartes: The Essential Writings p.125

not want to purposefully deceive people; perfection cannot deceive.¹¹⁸ Therefore, logically, everything which Descartes sensed around him had to exist in the state in which he sensed it and his mind simply reflected what was "out there". Ergo, matter exists as "objectively real".

Since these particles of matter did not have a mind of their own, they had to be passive in nature. They were moved about and directed by natural forces, such as gravity. How this was done was explained primarily by Galileo Galilei (1564-1642) and Issac Newton. These two men formulated a number of theories and descriptions which demonstrated that these forces acted in a strictly deterministic fashion. One could reproduce experiments which demonstrated that, under identical circumstances, matter would act in the same way each time. Since the particles themselves were passive, then it had to be the *forces* which acted in a uniform and strictly deterministic fashion. An initial release of energy started a series of events which were all linked together by a simple cause and effect relationship right down to the level of the most basic particle. What provided this initial directed release of energy was unknown and was therefore assigned to the realm of God. Since God had simply set the universe in motion and had directed natural law to govern it, He was seen as unnecessary in the daily workings of the universe.

Man, the divine, rational creation, was still seen as central to the universe. It was man, and man alone, which was capable of investigating and comprehending the universe. The strict Rationalists, such as Descartes, believed that all truthful knowledge was implanted by God and reason alone would reveal this knowledge to man. Since that which was truly man was expressed by his mind, then God simply imparted knowledge directly into the mind. Others, such as Newton, believed that a certain amount of empirical knowledge, that is knowledge gained through observation, was necessary to reach the ultimate truth to universal laws. It was believed that if man continued long enough, asked the right questions and used the right equipment then his mind should be capable of comprehending the ultimate truth to the laws which govern the universe. In the use of empirical investigations this was a step beyond the traditional Platonic view of the human mind being able to grasp the fundamental laws which govern the universe; it's foundations, however, are Platonic. This view has also led to the acceptance, in the West, that the *being* of man is associated with his mind, not so much with his mind and body as a whole organism.

Pierre Simon LaPlace

The deterministic view of the universe later prompted the response by Pierre Simon LaPlace (1749-1827) in his work Mecanique Celeste, in which he stated:

"We may conceive the present state of the universe as the effect of its past and the cause of its future. An intellect who at any given instant knew all the forces that animate nature and the mutual position of the beings who compose it, were this Intellect but vast enough to submit his data to analysis, could condense into a single formula the movement of the greatest body in the universe and that of the lightest atom; to such an Intellect nothing would be uncertain, for the future, even as the past would be ever present before his eyes."¹¹⁹

¹¹⁸ The Revolution in Science p.196

¹¹⁹ Number, the Language of Science p.136

It is from this view that the classic law of causality is formed; in an isolated system, if the present state of the system is known in all particulars, then the future state of the system can be calculated.¹²⁰

Upon the review of *Mecanique Celeste*, Napoleon Bonapart was said to have commented to LaPlace: "*Monsieur LaPlace, they tell me you have written this large book on the system of the universe, and have never even mentioned its Creator.*" To which LaPlace supposedly responded: "*I had no need for that hypothesis.*"

Man, the measure of all things, had no need of God on Earth and yet in a deterministic and mechanistic universe he was slowly but surely being reduced to just another cogwheel in that giant watch. If God was unnecessary, then was man? Such was the Rationalist world-view.

Within the realm of Architecture, the harmonic perfection of a geometrical scheme represented an absolute value, independent of man's subjective and transitory perception. This approach can be seen in the work of a number of architects such as Claude-Nicolas Ledoux, Lucas Von Hildebrandt, Jules-Hardouin Mansart as well as the landscape architects Louis Levau and Andre LeNotre. An excellent example of the absolutist view in Architecture is the palace complex at Versailles (Figure 8 on page 38). Begun in 1661 the palace proper serves as the focal point for both the town and the gardens which surround it. Avenues of infinite perspective, interlaced with an orthogonal grid, radiate out from the palace proper while the dynamic extension of the plan and the highly symmetric planning of the buildings all serve to illustrate the absolute world where man was the focal point and where the monarch was the focal point of other men. The entire complex was viewed as a single, perfectly ordered mechanism which reflected the deterministic natural laws which governed the universe.

¹²⁰ Quantum Mechanics and Objectivity p.51

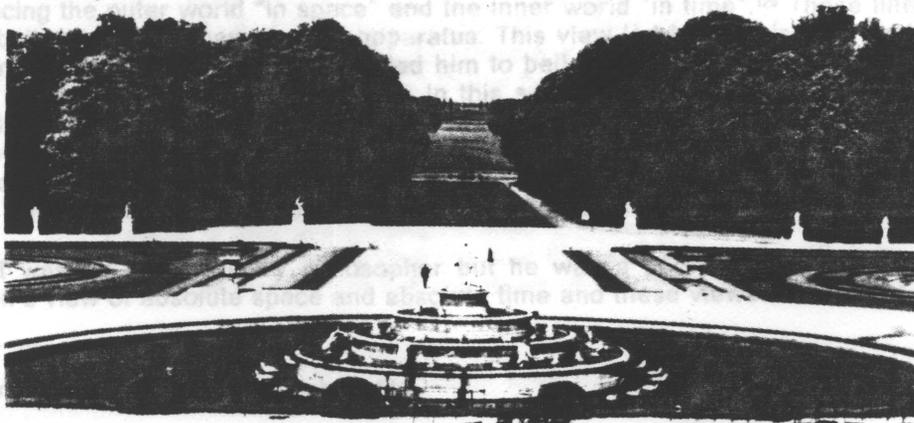
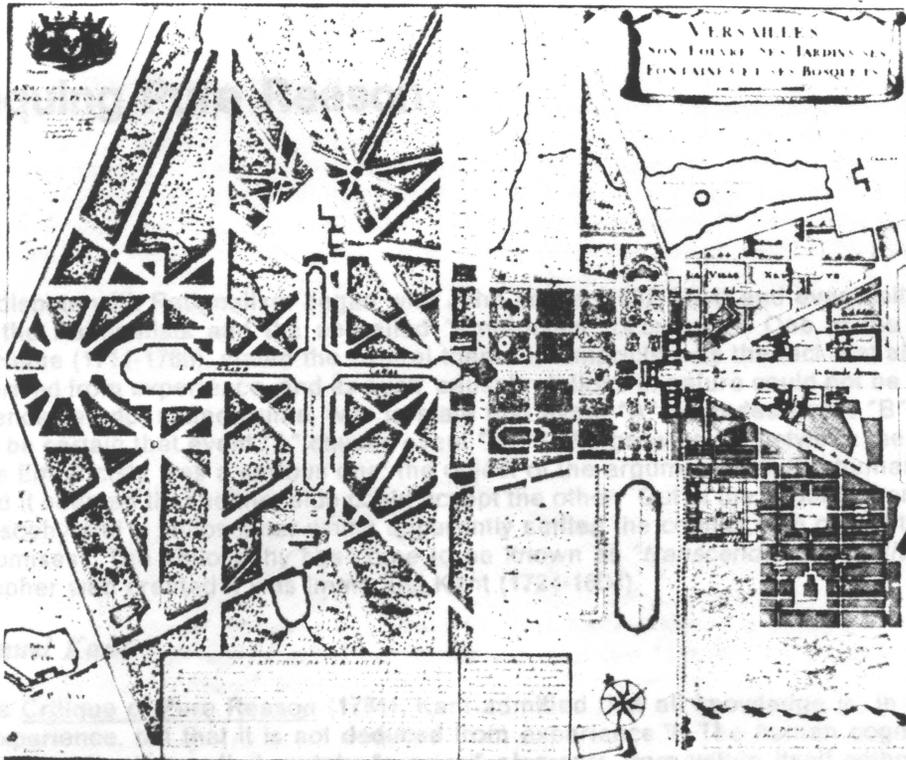


Figure 8. Versailles Palace

Critiquing Pure Reason

The dispute with Rationalism began with John Locke (1632-1704) and eventually a split between the Rationalists and the so called "Empiricists" occurred.¹²¹ One of the Empiricists, David Hume (1711-1766), stated the central theme to Empiricism as the fact that all knowledge was derived from experience, and as such, causal relations in nature could not be established. All science can do, stated Hume, was to state that event "A" **preceded** event "B" but that we cannot be certain that event "A" **caused** event "B".¹²² The growing rift between the Rationalists and the Empiricists was a serious one; the object of the argument was the human intellect itself and it seemed that neither side could accept the other. Out of the conflict eventually came a philosophy and a philosopher which apparently settled the conflict with one of those "grand compromises". The philosophy has come to be known as "*transcendental idealism*", and the philosopher who created it was Immanuel Kant (1724-1804).

Immanuel Kant

In his Critique of Pure Reason (1781), Kant admitted that all knowledge is, in fact, **derived** from experience, but that it is not **deduced** from experience.¹²³ The human cognitive faculty, according to Kant, supplied certain "*a priori*" elements from within itself without which no empirical knowledge would make any sense. Central to these elements were the concepts of space and time. Kant had studied Hume's position on Newton's cosmological scheme and came to accept the existence of absolute space and absolute time as necessary, "*a priori*" truths.¹²⁴ Kant believed that human beings do not abstract space and time from experience, rather, they are part of the way we inherently view things and as such, we cannot avoid experiencing the outer world "in space" and the inner world "in time".¹²⁵ These filters, for Kant, were built into the human sensing apparatus. This view led Kant to isolate spatial concepts from material concepts which in turn led him to believe that the human mind somehow **imposes** Euclidean geometry upon matter. In this sense, Euclidean geometry, for Kant, had to be universally valid throughout space.¹²⁶ After Einstein showed that matter acts on space, thereby curving it, and that space acts on matter, dictating its geometrical properties, Kant's isolation of spatial and material concepts must be declared in error.¹²⁷ The isolation of "*a priori*" knowledge must also be abandoned within modern physics.¹²⁸

Kant was an extraordinary philosopher but he was a poor scientist. He had accepted Newton's view of absolute space and absolute time and these views had a great impact upon

¹²¹ Cosmology, Physics and Philosophy p.444

¹²² Constructing the Universe p.10

¹²³ Constructing the Universe p.10

¹²⁴ Cosmology, Physics and Philosophy p.389

¹²⁵ Constructing the Universe p.10

¹²⁶ Mind and Matter p.158

¹²⁷ Cosmology, Physics and Philosophy p.386

¹²⁸ Physics and Philosophy p.82

Kant was an extraordinary philosopher but he was a poor scientist. He had accepted Newton's view of absolute space and absolute time and these views had a great impact upon his thinking. There were others, such as Leibniz and Hegel, who argued against it with alternate theories. Hegel defined time within, what he termed, an "*ecstatico-ontological*" system in which, "past", "present" and "future" are viewed as "*ecstasies*" and are defined as purely human experiences. This is the view that Martin Heidegger would later adopt in his "*phenomenological*" approach. Within Hegel's view, time is no longer seen as occurring along a coordinate axis but is solely existent in the human experience.¹²⁹ This view illustrates the "inward" trend in Western philosophy which is still occurring today. Philosophy has removed itself from trying to unify the various sciences, and has turned upon itself in an effort to understand both the nature of the thought process as well as the concept of "knowledge".¹³⁰ The dilemma which occurs is that the methods used and the knowledge that is gained within this search cannot be easily transferred to the other sciences. It degenerates into the Philosophy of Philosophy.

As Kant was placed upon the "sacramental alter" of philosophy other philosophers followed his lead and turned to studying the human mind and the logic and structure of language itself. The *Vienna Circle* eventually declared that all philosophy was nothing but a critique of language.¹³¹ The members of this group, such as Rudolf Carnap, wanted to find not so much the logic of language as a language of logic. Within this search they arrived at the conclusion that language was inadequate for its task; but in their studies they analyzed the words themselves and not the concepts which were supposed to exist behind them. If someone, like Carnap, analyzed the "symbol" *sein (being)* he would find that the "symbol" is meaningless, so he would dismiss the "concept" *being* as meaningless.¹³² A parallel argument might be drawn here between what Godel said of math and what Carnap did with language. Godel showed that one cannot use the language of math to critique math; in the same sense it would seem true that one cannot use language to critique language as Carnap did. I make the case for whatever it may be worth.

Martin Heidegger

Martin Heidegger (1889-1976), the father of modern existentialism, called language "*the house of being*". It was his belief that through the naming of an object we bring it into our world. As he put it: "*In the naming, things named are called into their thinging.*"¹³³ We make the unfamiliar familiar and in doing so the things become part of our personal world. Goethe had written that symbols (language is a system of symbols) made visible the invisible and express the inexpressible.¹³⁴ Yet in identifying a thing or a system we separate it from the other things. This tends to create *dualism* where the world is separated and compartmentalized into a collection of objects which in turn enhances the subject/object dichotomy. This, though, is natural for human beings. Our sensing apparatus creates a perceptual dualism which is easily and directly translated into a conceptual dualism. The struggle to overcome this dualism and reject the subject/object dichotomy is a difficult problem.

¹²⁹ *Cosmology, Physics and Philosophy* p.446

¹³⁰ *Cosmology, Physics and Philosophy* p.475

¹³¹ *Cosmology, Physics and Philosophy* p.475

¹³² *Hebrew Thought Compared With Greek* p.24

¹³³ *Concept of Dwelling* p.111

¹³⁴ *Architecture and the Crisis of Modern Science* p.323

other kinds of knowledge. Another avenue of knowledge is what is known as "*phenomenological analysis*" and is characterized by the studies of Heidegger and Christian Norberg-Schulz. Phenomenology is defined as "the letting of that which shows itself be seen from itself."¹³⁵ It entails a direct observation of the primary senses. Phenomenologists aren't inherently critical of the physical sciences as much as they are critical of the approach to knowledge that the physical sciences take.¹³⁶ At the end of the nineteenth and beginning of the twentieth century the main approach to scientific knowledge was the "positivistic" approach, in which, metaphysics is discarded and facts alone are considered the only tool capable of leading to the truth about reality. The phenomenologists argue that facts are of no value once they are divorced from the fundamental conception in which the phenomena is studied. In light of this, phenomenologists disagree that the physical sciences have the only true path to the truth about reality. They argue that they both search for a different aspect of the same reality. Within their view, the phenomenologists adhere to the view that space and time are solely personal experiences as illustrated by Heidegger's use of Hegel's view of time as personal "ecstasies".

The phenomenological approach does have its drawbacks however. Many of Heidegger's critics believe his work to be "mystical" and that the evolution of *being* into *Dasein*, which Heidegger makes, leads to several unnerving results. Within Heidegger's historically oriented approach it appears that although each individual man can have his own *being*, a separate and distinct group of people can have their own *Dasein* and their own destiny. As Heidegger said in his work Rektoratsrede :

*"The whole German people must demand and seek for its own historical-political Dasein, if, in general, this people wills to securely place its duration and its greatness and preserve its future."*¹³⁷

Do the German people have a different *Dasein* than the French? Do they have a unique destiny inherent in their own *Dasein*? Heidegger's *Dasein* and Nietzsche's *Will* seem to lead to the same end. Heidegger's approach to the question of *being* does have its pitfalls but this doesn't mean however, that other things which Heidegger wrote about are not of any value. This thesis will examine the concept of phenomenology in a later chapter.

¹³⁵ Being and Time p.51

¹³⁶ Heidegger and Science p.14

¹³⁷ Heidegger's Being and time and the Possibility of Political Philosophy p.215

Relatively Speaking

*"In the beginning, God created the heavens and the Earth....."*¹³⁸

The Rationalist view of a mechanistic and deterministic universe complete with its notions of absolute space and absolute time began to fall apart around the turn of the twentieth century. In its place rose a new world-view consisting of a probabilistic and dualistic universe with its notions of a relativistic space-time continuum. There no longer existed any absolute measure of an object nor any notion of a universal "now". The length of any object was relative to the motion of the object and the person measuring it; the faster the motion of the person measuring the object, the shorter the length of the object relative to a stationary person. Likewise, the time element involved in a sequence of events was relative to the motion of the observer; the faster the motion of the observer, the shorter the duration of the events relative to a stationary observer. Gravity was also shown to have an effect upon time. The stronger the gravitational field, the slower time "flows". As an example, time "flows" faster at the top of a building than in the basement, though the effect is too small for people to recognize without the aid of highly sophisticated measuring devices.

Another example of the properties of time, as given by the General Theory of Relativity, is illustrated by a "black hole". Stars convert hydrogen into helium. After the hydrogen is exhausted the helium begins to contract until it is ignited. Usually, the remains of the star will continue to collapse until it becomes pure iron. The iron core will normally then continue to collapse until its density is equivalent to the density of its atomic nucleus, at which point the star implodes triggering an explosion of the outer layers in a supernova. This doesn't always happen though. Sometimes the mass of the iron core is so great that it continues to collapse indefinitely under its own gravitational fields and eventually collapses into "nothing" - literally. It becomes a "black hole", a region of space where the gravitational fields are so intense that no signal, not even light, can escape and where our concepts of space and time no longer hold as valid.¹³⁹

If two people examined a black hole and person #1 entered into the region of the black hole, person #2, remaining "outside", would see person #1 approach the black hole at an ever decreasing rate, until person #1 reached what is known as the "event horizon". At this point person #2 would see person #1 come to a complete stop. Time would "stand still" at the event horizon and person #1 would "never" enter the black hole. From person #1's perspective, however, things would be quite different. As person #1 approached the event horizon he would not feel his own sense of time was slowing down, rather he would sense that everything outside the influence of the black hole's gravitational field was accelerating at an ever increasing rate. The closer he approached to the event horizon, the faster the acceleration of events "outside". When person #1 arrived at the event horizon, all of eternity would have passed by "outside" in an instant, from his perspective. Within this example it is easy to see that space and time become purely relative measurements in the description of the world of an observer. They are, in fact, inseparably combined into a hyperdimensional space-time continuum. One must recognize, however, that this is different from the "ecstatico-ontological" view of Hegel and Heidegger. Time, in Einstein's work, is defined by the simultaneity of events which can be effected by various physical phenomena outside the observation of man. The "ecstatico-

¹³⁸ Genesis 1:1

¹³⁹ Creating the Universe p.217

ontological" view is based solely upon human observation of a system. One view is empirical, the other phenomenological.

Within this relativistic universe particles of matter change into other particles and which at times behave like an electromagnetic wave. Matter is considered to be both a particle and a wave and in this sense the universe is considered to be dualistic in nature; it is both matter and energy **at the same time**. The energy equivalency of matter has been shown to be equal to its mass times the speed of light squared ($E=MC^2$).¹⁴⁰ Matter, in this capacity, is simply a different form of energy with the energy being in the "form" of an electromagnetic field. As Einstein described it:

"We may therefore regard matter as being constituted by the regions of space in which the field is extremely intense...There is no place in this new kind of physics both for the field and matter, for the field is the only reality."¹⁴¹"The victory over the concept of absolute space...became possible only because the concept of the material object was gradually replaced as the fundamental concept of physics by that of the field."¹⁴²

In this sense, materialism has to be abandoned; matter is simply an "extension" of the continuum. Einstein explained it this way:

"Space-time is not necessarily something to which one can ascribe a separate existence, independent of the actual objects of physical reality. Physical objects are not in space, but these objects are spatially extended. In this way the concept of 'empty space' loses its meaning."¹⁴³

Particles of matter are an "extension", or "condensation" of the field, in a way similar to raindrops being condensations of water vapor. A particle of matter has specific properties, such as mass and energy, but these properties must change as the energy imparted to the particle changes. For example, a particle at rest will have a specific mass but once accelerated, the mass of the particle will increase proportionally. The greater the acceleration, the greater the mass. In a modern particle accelerator, a wide variety of particles are accelerated to 99.9% the speed of light. That ultimate speed (186,000 mps) though is unattainable because as the particle approaches the speed of light its mass increases proportionally, making it more and more difficult to accelerate. The end result is that no particle, with any rest mass, can be accelerated to the speed of light. But what of photons, don't they travel at the speed of light? Photons are massless, that is, they have a zero rest mass.¹⁴⁴ But can something that has no mass physically exist? No. Having mass is part of the definition of any physical object. A photon only physically exists when it travels at the speed of light and it is already traveling at the speed of light when it is created. It cannot go any slower or any faster or else it would cease to exist. For a photon, only motion has any reality.

Special Relativity

¹⁴⁰ Einstein for Beginners p.165

¹⁴¹ The Philosophical Impact of Contemporary Physics p.319

¹⁴² Bruno Zevi on Modern Architecture p.191

¹⁴³ Bruno Zevi on Modern Architecture p.186

¹⁴⁴ Constructing the Universe p.237

The relativistic view of the universe began to take shape at the end of the nineteenth century. In 1887, two scientists, Albert Michelson (1852-1932) and Edward Morely (1838-1923), conducted an experiment which was designed to detect once and for all the ether that everyone was talking about and using in their theories but which no-one had been able to actually show existed.¹⁴⁵ The results of their experiment failed to detect any ether which led most scientists to state that the experiment had failed. A few, however, began to speculate that the reason Michelson and Morely had been unable to detect the ether was because it didn't exist. With no ether, how do particles and energy interact? "In" what do they exist? Clearly a problem existed and the answer required a new way of looking at things.

The new method of investigation which brought about the new world-view was modeled after the so called "*positivist*" philosophy founded by Auguste Comte (1798-1857) and elaborated upon by Ernst Mach (1838-1916).¹⁴⁶ This new "Machian positivistic" approach to physical theories advocated the abandoning of metaphysics. A physical theory was to be based solely upon primary sense perceptions and facts alone would lead to the truth about "reality". This new approach, as elaborated by Ernst Mach, had a tremendous impact on the scientific community in general and one of those taken by the new "*positivistic*" approach was Albert Einstein (1879-1955).

In the late 16th century, Galileo had proposed a theory by which all uniform motion involving mechanical systems was relative and therefore could not be detected by an observer without reference to an outside point.¹⁴⁷ This "*principle of relativity*" was to play a major role in a problem that Einstein was going over in his mind.

Around the turn of the century, Einstein had been concerned with a thought experiment which asked, "*What would happen if you traveled at the speed of light and tried to see your image in a handheld mirror?*"¹⁴⁸ According to classical mechanics, since you were traveling at the speed of light, (186,000 mps) the light traveling from your face to the mirror would have to travel at twice the speed of light (372,000 mps) in order for you to be able to see your image. If the light traveled at any speed less than that, it would be unable to catch-up to the mirror and your image would disappear. This, said Einstein, could not happen because then you would know how fast you were moving, thus upsetting the principle of relativity.¹⁴⁹

Based upon the electromagnetic experiments of James Maxwell (1831-1879) and Heinrich Hertz (1857-1894), Einstein deduced that there were no instantaneous interactions in nature.¹⁵⁰ This meant that there had to exist a maximum possible speed for all interactions. Einstein believed that this maximum possible speed was the speed of the electromagnetic interactions traveling through the electromagnetic field. Since light was an electromagnetic interaction, then the speed of light must be the maximum possible speed.¹⁵¹

So Einstein deduced that the speed of light was the maximum speed possible. According to the principle of relativity, when extended to electromagnetic phenomena, all observers must

¹⁴⁵ Constructing the Universe p.157

¹⁴⁶ Cosmology, Physics and Philosophy p.473

¹⁴⁷ Einstein for Beginners p.83

¹⁴⁸ Einstein for Beginners p.73

¹⁴⁹ Einstein for Beginners p.91

¹⁵⁰ Einstein for Beginners p.101

¹⁵¹ Einstein for Beginners p.102

observe the same speed of light regardless of their own speed, otherwise they could tell that they were moving by measuring the speed of light. A constant velocity of light for all observers, however, is irreconcilable with the notions of absolute space and absolute time which permit the adding of velocities *ad infinitum* until one reached an infinite velocity for light. Einstein realized that those notions had to be revised; and he was not alone.

Mach had doubted the notions of absolute space and time: *"No one is competent to predict things about absolute space and absolute motion; they are pure things of thought, pure mental constructions that cannot be produced in experience."*¹⁵² Henri Poincare had stated in a 1900 Paris address: *"There is no absolute time; to say that two durations are equal is an assertion which has by itself no meaning and which can acquire one only by convention."*¹⁵³ Einstein had not been the first to question these presuppositions.

Einstein decided to take what he considered to be a "positivistic" approach to the problem, that is, he chose to examine the notion of time by how one measures it; through observation. One judges time by the duration involved in a sequence of events. In one frame of reference that duration could be zero: the events could occur simultaneously for an observer. Einstein then argued that this did not necessarily mean that another observer had to view the same sequence of events as occurring simultaneously. The duration of the sequence of events depends upon the relative speed of the observer; the faster the observer passes by the events, the shorter the duration of the events relative to the observer. Two events could occur simultaneously for one observer but not necessarily for another observer. The duration of the sequence of events for the observers would depend upon their velocities relative to the sequence of events.

To illustrate this point, Einstein proposed a thought experiment involving two observers. If one remembers that speed = distance/time, then observer 1 could view a lightwave traveling a certain distance (d) in a certain time (t) to give the speed of light (c). Observer 2, traveling at a uniform velocity relative to observer 1, could view the propagation of the light wave, but over a different distance (d') in a different amount of time (t') to give the speed of light (c).¹⁵⁴ What this showed was that although the speed of light was constant the distance it traveled and the time it took for it to travel that distance could be shown, algebraically at least, to be relative to the speed of the observer. Again; what is simultaneous for one observer was not necessarily simultaneous for another.

Einstein proposed a visual analogy to the algebraically derived explanation of the simultaneity of events. Take two observers and place one in a moving train car. Place the other observer on an embankment which the train car will pass.

Within the train car, observer 1 has a lamp situated in the center of the car (Figure 9 on page 46). The car is equipped with a front and a back door, both of which are designed to open when struck by the light waves emitted by the lamp which is situated in the center of the car. Now, according to the principle of relativity, regardless of whether the train car is moving or at rest, observer 1, when he turns on the lamp, will see both the front and back doors open simultaneously. If he didn't, he would know that he was moving and this would violate the principle of relativity.

Observer 2, however, sees something different (Figure 10 on page 48). Once the lamp is switched on, observer 2 sees the light being emitted at point x_1 . Once the train car has moved forward, the light still propagates from point x_1 , not x_2 where the lamp is a moment later. Re-

¹⁵² Einstein for Beginners p.79

¹⁵³ Subtle is the Lord p.133

¹⁵⁴ Einstein for Beginners p.107

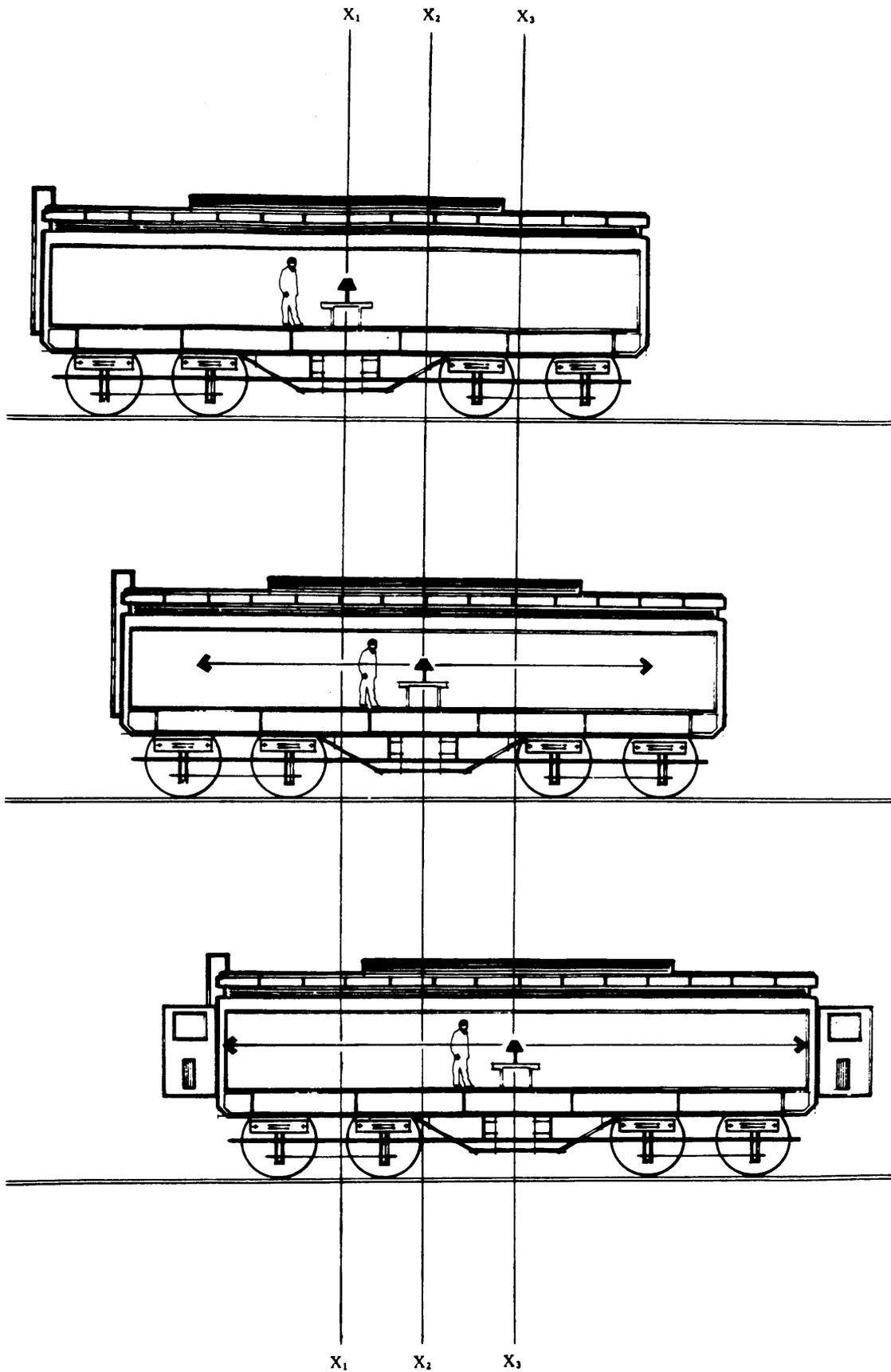


Figure 9. Observer #1

Observer 2, however, sees something different (Figure 10 on page 48). Once the lamp is switched on, observer 2 sees the light being emitted at point x_1 . Once the train car has moved forward, the light still propagates from point x_1 , not x_2 where the lamp is a moment later. Remember, the speed of light is independent of the speed of the source, it cannot partake of the speed of the train car. It's speed depends solely upon the electromagnetic field in which it travels. So observer 2 sees the rear of the train car "rush forward" to "meet" the light rays, while the front of the train car "recedes away" from the light rays. To observer 2, the rear door will open before the front door.

To observer 1, the time elapsed between the opening of the back door and the opening of the front door is zero; the events, for him, occurred simultaneously. For observer 2, the time elapsed between the opening of the back door and the opening of the front door is relative to the speed of the train car; the faster the speed of the train car, the longer the elapsed time. The simultaneity of events for observer 1 are not simultaneous for observer 2. As time is defined by the simultaneity of events, which is relative, then **time is relative**.

Erich Mendelsohn

There are several works of Architecture which seek to express the concepts behind the relativistic theories of Einstein, but the one that stands is Erich Mendelsohn's *Einsteinturm* in Potsdam, East Germany (Figure 11 on page 49). Mendelsohn knew of Einstein's theories and had a great interest in them. In 1917 Mendelsohn made the first sketches for the project in the trenches at the Russian front and three years later construction began.¹⁵⁵

The tower that rose at Potsdam was part of the growing Expressionist movement; a desire to portray emotions in dynamic plastic shapes. Although the *Einsteinturm* was actually built out of bricks for economical reasons, its shape and form expressed a monolithic construction. Bruno Zevi has described the work as:

"Earthy, telluric, incandescent matter, frozen at one instant of its growth, of its eruption - but not only matter. The inner and outer forces are spatial. Charged with energy to the point of spasm, they press on the boulder inwards and outwards, plasticize its contours and lacerate it in order to unite it. Doors and windows are not holes cut into the wall, but openings forced through by a dual stress, by a mighty drive of the landscape which strives to rush forth into the building and by an equal impetus of the architectural cavity which moves furiously to find its way through into the landscape."¹⁵⁶

In this work it is possible to see the liberation from the confines of Euclidean geometry and the sterile notions of the mechanistic view of the Rationalists. The tower, as Einstein had described it, was "organic".¹⁵⁷ It seemed to grow, to pulsate, to come alive in both space and time. It rejected the Rationalist vision and portrayed itself as a powerful object in the landscape; but there, perhaps, was its failing. Its mighty sculptural presence made it something to be viewed, not so much to be experienced. Its relation to its context was abstracted, it was not direct in the experiential sense. The language of the Expressionist movement was often a free flow of form and space and its grammar was often fluid, reinforced concrete. The total

¹⁵⁵ Bruno Zevi on Modern Architecture p.187

¹⁵⁶ Bruno Zevi on Modern Architecture p.187

¹⁵⁷ Bruno Zevi on Modern Architecture p.187

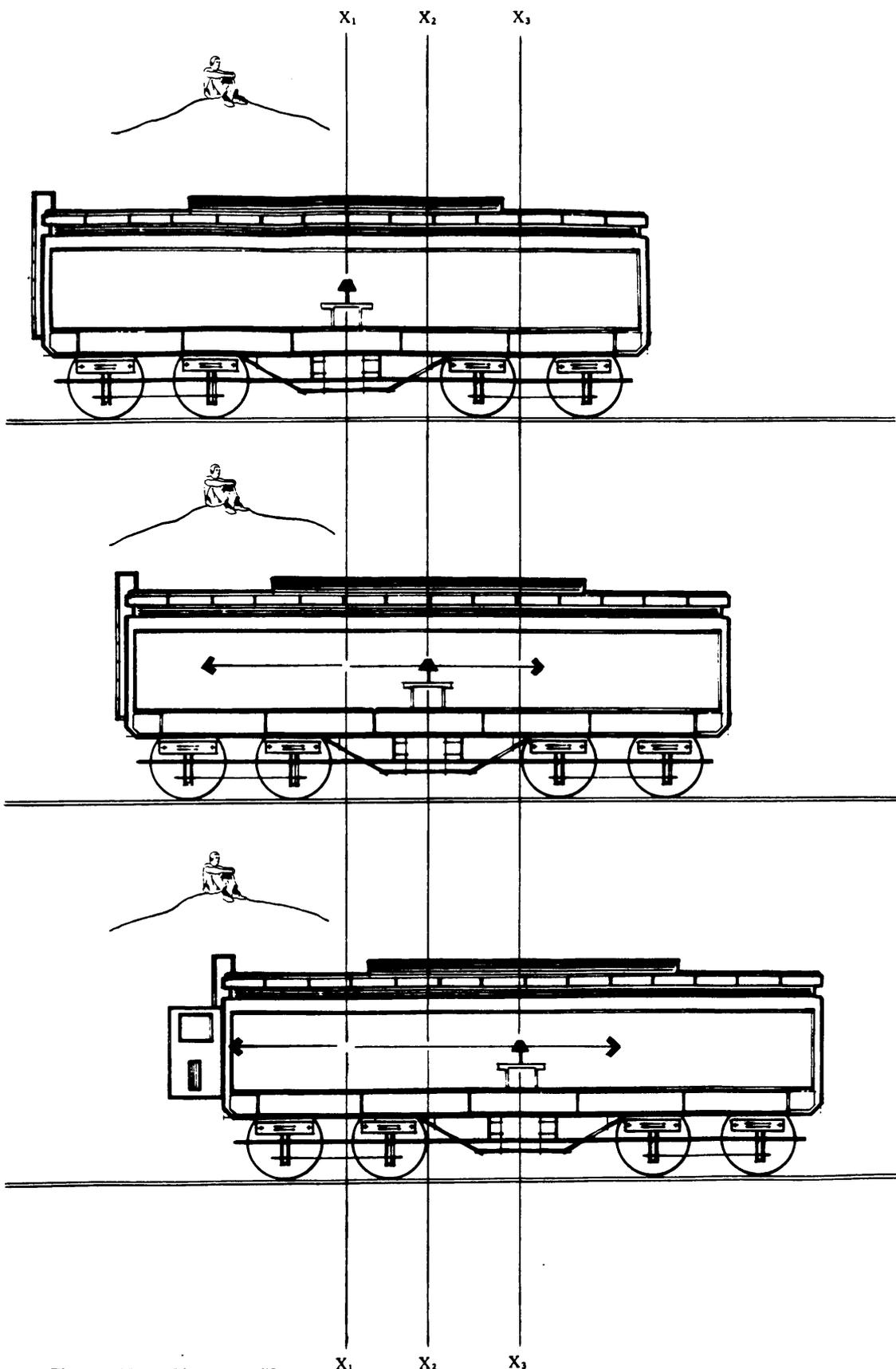


Figure 10. Observer #2

The inability of the Expressionist movement to convey itself in an easily understandable language hastened its demise and the odd consequences of Einstein's theories made them difficult to grasp. After the horror of the First World War, the populations of Europe did not want more problems in a strange world. They did not know what it meant to dwell in this new world. They wanted a calm, understandable and rational world where they could maintain a fragile sense of dwelling, yet knowing that their world could not be sustained for long. They received that fragile sense of dwelling in Architecture as the Rationalist movement dominated the profession and which offered a psychological sense of security. In science, however, especially in theoretical physics, things went from odd to bizarre.

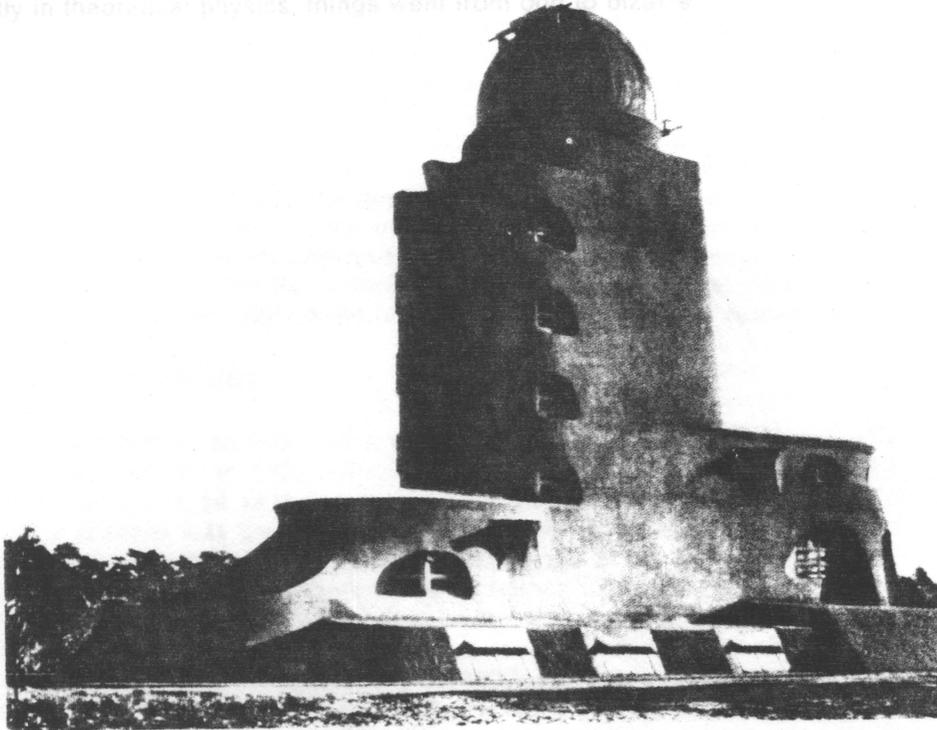


Figure 11. Einsteinturm

The inability of the Expressionist movement to convey itself in an easily understandable language hastened its demise and the odd consequences of Einstein's theories made them difficult to grasp. After the horror of the First World War, the populations of Europe did not want more problems in a strange world. They did not know what it meant to *dwell* in this new world. They wanted a calm, understandable and rational world where they could maintain a fragile sense of *dwelling*, yet knowing that their world could not be sustained for long. They received that fragile sense of *dwelling* in Architecture as the Rationalist movement dominated the profession and which offered a psychological sense of security. In science, however, especially in theoretical physics, things went from odd to bizarre.

Making Waves

"God does not play dice." - Einstein¹⁵⁸

In 1896, G. H. Becquerel accidentally discovered radioactivity and in so doing helped open a new level in atomic research - the subatomic level.¹⁵⁹ The radioactivity which was released by the unknown ("x") rays was soon explained as the result of atoms being split apart. The indivisible atom had come to an end and with it many of the theories formulated by Democritus over 2000 years ago. A divisible atom had to have "parts" and within the year Sir Joseph John Thomson (1856-1940) had discovered and isolated one of those "parts" - the electron.¹⁶⁰ By 1911, Ernst Rutherford had bombarded atoms with alpha particles from radioactive emissions and provided a model of this new atom complete with orbiting electrons. The new "*Rutherford atom*", however, was only a stop-gap measure. His reliance upon classical mechanics impeded Rutherford, for he knew that classical mechanics could not account for the stability of the atom yet he felt sure that his model was reasonably accurate.¹⁶¹

Particle/Wave Duality

As often happens, someone else was able to look at the puzzle from a different perspective and find a solution. In 1909, Einstein had published a paper in which he suggested that photons, known to be particles, could also be considered as waves.¹⁶² This particle/wave duality of photons was the key that unlocked a new door and a physicist by the name of Louis de Broglie was there to open it. De Broglie had read Einstein's paper on the particle/wave theory for photons and considered that if photons could be dualistic in nature, then perhaps all matter was dualistic in nature. This is just what de Broglie, in 1923, suggested.¹⁶³ He took Thomson's electrons and considered them, not as particles, but as waves. This would make the orbits of the electrons specific wavelengths. Upon investigation, the results were promising but puzzling. Of all the possible wavelengths which could be used to describe the electron orbits, only those wavelengths corresponding to whole integers fit the data. This meant that the electrons orbited the nucleus at regular and very specific intervals. In effect, an electron could orbit the nucleus in the orbits which corresponded to the wavelengths of 2, 3 or 4 for example, but not at 2.5, 2.9 or 3.6. The only problem with this was that physicists knew that when an atom became "excited" into a higher energy state (either absorbing or emitting energy), the electrons would jump orbits. For example, an electron "at rest" in orbit 2 would jump to orbit 3 then to orbit 4 and could be detected doing so but it was assumed that it was also going through the "intermediate" orbits of 2.1, 2.2, 2.3etc. The problem was that the electron "disappeared" from one orbit and "reappeared" in the next orbit - **instantaneously**. Something was wrong and it wasn't the experimental data, it was the clas-

¹⁵⁸ In Search of Schrodinger's Cat p.3

¹⁵⁹ National Geographic May 1985 p.642

¹⁶⁰ Subtle is the Lord p.85

¹⁶¹ Physics and Philosophy p.36

¹⁶² Subtle is the Lord p.403

¹⁶³ Subtle is the Lord p.436

sical theory which said that energy was infinitely divisible and so the electrons would have to go through the "intermediate" orbits. The solution to this puzzle lay in accepting a theory that stated energy was not infinitely divisible and was, in fact, distributed in small packets called "quanta". This view of *quantized* energy had been introduced by Max Planck (1858-1947) in 1900 and had been developed enough by Einstein and Niels Bohr to be introduced into the new model of the now quantized atom.¹⁶⁴

Probability Wave Theory

By 1925, the dualistic nature of matter had been assimilated by the majority of the scientific community working in subatomic physics. Bohr had developed a model of the new quantized atom though several of its properties could not easily be explained.¹⁶⁵ At this point two basic schools of thought emerged in the explanation of the new atomic structure of our world; they were **wave mechanics** and **matrix mechanics**. Wave mechanics was developed by Erwin Schrodinger (1887-1961) and took the position that matter could be explained solely as energy.¹⁶⁶ Werner Heisenberg (1901-1976) developed matrix mechanics which took the position that matter should still be explained as consisting of a matrix of particles. He maintained that the evidence of the electron orbits was too vague to substantiate an approach based upon matter being viewed solely as energy.¹⁶⁷ The problem was, both Schrodinger's wave mechanics and Heisenberg's matrix mechanics worked; that is, they both explained the basic properties of the atomic structure. If one wanted to study matter as a particle, then one looked for matter as a particle. If one wanted to study matter as a wave, then one looked for matter as a wave. Enter Max Born. It was Born that reconciled the two theories into a single theory known as the "*probability wave theory*".¹⁶⁸ Within this theory, electrons were viewed as being neither particles nor waves, instead, the initial state of a subatomic system was considered as a "probability wave function" which would "collapse" into a system of particles. Obviously the question of existence is raised in regards to this. Does a probability wave really exist if it has no definite location in either space or time. An even more bizarre dilemma, however, occurred when some of the physicists involved began to wonder if the "collapse of the wave packet", as it was called, was "influenced" by the act of observation or measurement. The theory stated that the observation of a system would cause the system to evolve one way; non-observation of the same system would cause it to evolve a different way. In order to measure or observe any subatomic phenomena, one must impart energy into that system. That additional energy is absorbed into the system causing it to behave differently. The discontinuous changes which were produced by the acts of observation or measurement were considered a physical, psychological and logical change. It was considered a physical change in that it changed the system with the interaction of energy quanta in the acts of observation and measurement. It was considered a psychological change in that it resulted in a discontinuous change in our knowledge of the system. It was considered a logical change in that it changed the mathematical representation of the physical process from a wave to a particle.¹⁶⁹

¹⁶⁴ In Search of Schrodinger's Cat p.57

¹⁶⁵ Physics and Philosophy p.37

¹⁶⁶ Quantum Mechanics and Objectivity p.34

¹⁶⁷ Quantum Mechanics and Objectivity p.35

¹⁶⁸ Physics and Philosophy p.42

¹⁶⁹ Quantum Mechanics and Objectivity p.50

Schrodingers' Cat

Herein lies a very difficult question. Do we *create* that which we term *reality* by our acts of observation. Our observation of a subatomic system will influence the collapse of the wave packet thus influencing the physical result of that system. This result is the basis of physical reality. This dilemma is what caused Schrodinger to introduce what is perhaps his most famous thought experiment. Place a live cat in a box, Schrodinger said, and in with it, place a flask of cyanide that is set up to be broken when struck by a hammer. Attach the hammer to a control box containing radioactive isotopes which decay at a random rate. Rig the control box so that when a sufficient number of isotopes decay, the hammer will have a 50% probability of striking the flask thus releasing the cyanide thus killing the cat. Now, says Schrodinger, without looking inside the box we cannot know if the cat is alive or dead. In fact, says Schrodinger, the cat is neither alive nor dead, but simply exists as a probability function.¹⁷⁰ The system that is the box and its contents can be considered as the initial state of a subatomic system. The cat neither lives nor dies until we open the box and look inside and observe the system, thus causing the wave packet to collapse. At the moment the wave packet collapses, and not any sooner, physical reality is manifested from the initial probability function. One can say that Schrodinger misuses a macroscopic phenomena to illustrate a microscopic phenomena and thus ignores other influences such as gravitational fields and electromagnetism. The problem arises when one tries to determine just how much of an influence the act of observation is. The answer to that seems to be an open question.

If one accepted the dichotomy of subject vs. object in the first place, then the union of subject and object in the subatomic system results in a condition which makes objective knowledge of the system no longer possible. There is no longer any "isolated" system to study; we are a part of it. The situation is analogous to Escher's drawing "Print Gallery" (Figure 12 on page 54). in which a young man is viewing a picture of a ship in a harbor. On the dock of the harbor is a series of apartments where a woman is looking out of one of the windows which in turn is part of the building in which the young man is viewing the picture. The subject and object are one in the same.

Niels Bohr described this situation when he characterized life as a drama where we are both a spectator and a participant.¹⁷¹ In our desire to make sense out of our world, we constructed the material world "out there" by removing our "self" from it. As Erwin Schrodinger put it:

"Mind has erected the objective outside world of the natural philosopher out of its own stuff. Mind could not cope with this gigantic task otherwise than by the simplifying device of excluding itself - withdrawing from its conceptual creation. Hence the later does not include its creator.¹⁷² Subject and object are only one. The barrier between them cannot be said to have broken down as a result of recent experience in the physical sciences, for this barrier does not exist."¹⁷³

¹⁷⁰ In Search of Schrodinger's Cat p.2

¹⁷¹ Quantum Mechanics and Objectivity p.131

¹⁷² Mind and Matter p.131

¹⁷³ Mind and Matter p.137

And of "objective reality"? Heisenberg had said that it has "evaporated".¹⁷⁴ At least our unquestioning faith in it has. This view certainly needed further study. Bohr, Schrodinger and Heisenberg joined Born in order to develop the theory further. One of the central problems in the investigation was obtaining the precise location and momentum of the electrons everybody was arguing about. Heisenberg suggested a thought experiment. If you want the position of an electron, he said, "shoot" a light wave at it. When the wave hits the particle, record the particles position. A good idea, but once the wave hits the particle you alter or lose precise knowledge of the particles' momentum. On the other hand, you could measure the particles momentum but since no-one could predict with certainty where the particle was coming from, you lost the trajectory. The nature of the electrons was such that no-one could accurately predict their actions, hence, their actions were deemed acausal. The inability to know both the electrons' momentum and position led Heisenberg to introduce his famous "uncertainty principle", which simply stated that one could not know both the location and velocity of any individual particle.¹⁷⁵ The "universal laws" of determinism did not seem to apply at the subatomic level. **Strict determinism had to be abandoned.**

Of course there were those who refused to accept this and who presented a variety of scenarios which challenged Heisenberg's "uncertainty principle" and whether or not "objective reality" is even open to question. Perhaps the most famous of these was the *Einstein-Podolsky-Rosen*, or *EPR* thought experiment. In an oversimplified sense, the *EPR* thought experiment presented this case: take two particles and collide them together. After the collision measure either the momentum or position of particle A and then measure either the momentum or position of particle B. Since the two particles would then be separated by a considerable distance, the observation of one of the particles should not affect the other particle. This should rule out any observational interference and provide both the position and momentum of one of the particles.¹⁷⁶

This thought experiment was considered to be the premier challenge to Heisenberg's "uncertainty principle". Experimental facilities, however, were not adequate at the time (1935) to carry out the experiment. In the summer of 1982, Alain Aspect finally conducted this experiment and demonstrated that, in the absence of observation, a particle still could not have both a precise location and momentum.¹⁷⁷ Heisenberg's "uncertainty principle" could not be bypassed. Commensurate physics, as well as "naive realism", were over.

Within the empirical context of the physical sciences, we have come to abandon materialism, strict determinism and the notions of absolute space and absolute time. We have come to accept a dualistic, indeterministic space-time continuum which is relative to each individual. We can no longer accept without reservation that we can view ourselves as a "subject" viewing the "outside" world as an "object". We accept that we are an integral part of that which we term "reality" and we have abandoned the search for "truth" within an empirical context. We leave so many unanswered questions but we can at least begin to reformulate what constitutes a meaningful question regarding ourselves and our context. We no longer formulate our questions in terms of what our context is as much as we now ask what is our relation to our context.

¹⁷⁴ Quantum Theory and the Schism in Physics p.9

¹⁷⁵ Physics and Philosophy p.33

¹⁷⁶ In Search of Schrodinger's Cat p.182

¹⁷⁷ Superforce p.106

Being: Part 2

Through the historical analysis provided in this thesis, I have tried to show how man's world-view has often been reflected in his Architecture. I have illustrated this point for two reasons. The first, is that I believe that man is more easily able to find meaning to his existence through the formulation of a world-view. It enables him to order what he perceives to be and to find his place within the scheme of things. Secondly, since man's world-view keeps changing, it becomes difficult to know if man will ever know, without a doubt, how things really are and of his place within the scheme of things. I am uncertain that man will ever know the answers to the questions which comprise a comprehensive world-view, but I feel that it is part of the essential nature of man to ask "why?"; it is part of his *being*. With this in mind, I find that Architecture can never express absolute truths. It is the nature of man not to know them. What Architecture can do, however, is to express those things which man does know and believes in. It is his beliefs that define man. In response to the question of man's *being* and of his relation to his context, what do I believe?

In our own time we have come to recognize, primarily through the work of Einstein, the relativistic nature of natural phenomena. We have also come to recognize, primarily through the work of Schrodinger, Born and Heisenberg, that we must readdress the subject/object dichotomy inherent in our Western view of the world. We must, I believe, in light of these changes in our way of thinking, reevaluate the concept of *being*. What is *being*? How is *being* known and what is its role in Architecture?

Being, in the course of this study, is no longer held to be the true reality of any specific object, nor is it, by necessity, a "shadow" of that which truly is in the Platonic sense. *Being* is simply that which *is*. Within the ontological realm this comprises all that the mind can be aware of. In this sense, it contains both the "real" and the "ideal"; it contains apples, unicorns, mathematical propositions and nothingness. The distinction made between the real and the ideal rests on the basis that there exists that which is revealed from within itself and that which is only revealed through an alternate means. An apple, as a phenomena, may make itself known through itself but a mathematical proposition can only be revealed through an alternate means; it must be demonstrated. The former group, the phenomena, comprises that which we loosely term the "real" and the latter comprises that which we loosely term the "ideal." Since quantum mechanics has forced us to question the subject/object dichotomy, we can no longer place confident faith in the assumption that there exists an "objective reality" in the sense that Descartes spoke of. Yet to ask if the phenomena is "really" out there or not does not address the issue of the distinction between the real and the ideal, it only addresses our relationship to the real and the ideal. Whether or not the phenomena constitutes reality, it is still revealed to us through our primary senses and we can not simply will it away. It is my belief that it is within the phenomenological realm that Architecture is realized. As such, Architecture should respond to our primary senses and not serve merely as an intellectual abstraction.

Phenomenology

A work of Architecture, as a phenomena, is capable of revealing that which it directly is. It may reveal those qualities and attributes which comprise the phenomena itself and which are directly accessible to the primary senses. It may also reveal additional qualities and attributes within the ontological realm not directly associated with the work. If a work were manifested within concrete, then that work would reveal grayness, coldness, and density within the phenomenological realm. The coldness that is revealed through the work may, in itself, reveal

defensiveness, isolation or even brutality. These later qualities and attributes, while being revealed by the work in the ontological sense, are not directly associated with the work in a phenomenological sense. As we can see through this example, the original phenomena is capable of "overflowing" with *being* in that it may reveal that which is not directly and immediately associated with the work from a phenomenological standpoint. Within a work of Architecture, the revelation of the *being* of any element within the ontological sense, must be controlled so that it reveals primarily that which we, as architects, want it to reveal.

It is important that one understand that, to an extent, the revelation of *being* within a work of Architecture will be unique to each individual who experiences the work. Each individual possesses certain "filters", such as a cultural or social filter, which will temper the revelation of *being*. We, as architects, must be aware of this condition if we choose to employ icons, in whatever sense, in the servitude of *being*. Whether these icons are derived from a figurative abstraction or through a type of *gestalt* imagery we must be aware that a certain filter, say a cultural filter, may make an intended revelation impossible for a specific individual. We must also recognize that an individual possesses experiential filters. One may recall the train car analogy used by Einstein in his Special Theory of Relativity in which the first observer is placed in the train car with the lamp. The phenomena which he experiences contains the two doors opening simultaneously. For the observer on the embankment, the phenomena which he experiences contains the two doors opening in succession. Both phenomena are real, that is, they both occur but only to the respective observer. While the opening of doors may not seem critical, the analogy illustrates the point rather well; the phenomena is relative to the individual. We, as architects, must reevaluate our tendencies to make "absolute" design decisions which ignore the relative nature of the relationship between the individual who experiences the work and the work itself. We should strive to make the work accessible to the individual on a personal, experiential level.

I find that these investigations have a particular relevance for how one arrives at a particular Architectural solution. If we ignore the personal relationship between the individual and the phenomena, then we arrive at an over-intellectualization of Architecture that tries to speak of absolute truths of which we cannot be certain. If, on the other hand, we respect the personal relationship between the individual and the phenomena, then we arrive at an Architecture which reveals itself through the direct experiencing of the work. It becomes critical how an opening in a wall is oriented, not for the sake of the idea of "window," but for the sake of how light enters a place. It becomes critical how an opening in the overhead structure is dealt with, not for the sake of the opening itself, but for the sake of how rain enters the place. It becomes critical how the floor is constructed, not for the sake of the floor, but for the sake of the sound that is made as one walks across it. Do we align walls to express some abstract geometrical relation that only exist in an ideal state, or do we align walls to orient a person towards a specific view or to invite them into a place or to tell them "this is a private place, respect it"? How we approach these issues, impacts how we order our Architecture. This, in turn, determines what is revealed through our Architecture.

It must be recognized, however, that these methods are only means to an end, not the end in themselves. For myself, a more difficult issue to resolve is the question of "to what end does a work reveal particular *beings* ." To what end do I, as the architect, make a person aware of one particular *being* but not another? Why reveal "open" and not "closed"? Why reveal "light" and not "dark"? The answer to this may reside in the *essence* of the work itself. But does a work of Architecture possess an *essence*? In other words does it contain essential *beings*? Is *essence* even a valid topic? It would seem so because all things possess essential *beings* to a degree. It is, for example, essential that a tree reveal "branching" but not "feathering." But what is *essence*? The most concise explanation of *essence*, which I have come across, is by Hegel who defined *essence* as the inner relation among *beings* which serve to define that which is as it is. Hence there is an *essence* to tree, an *essence* to grass and an *essence* to man which serve to distinguish them from each other. They may or may not reveal similar *beings* but their *essences* are distinct from one another. This *essence*, though, need

not be viewed as the phenomena's true reality. The phenomena is not necessarily a shadow of its *essence* in the Platonic sense, rather the *essence* of the phenomena is how man comes to understand that which is as it is. As to the phenomena of man, it is through his *essence* that man tries to find and understand that which he truly is; what he essentially is. The *essence* of any phenomena enables man to distinguish between the various forms within his world and place order among those things. Although all things within the physical world may, in the end, be of the same ultimate order, within the realm of *essences* there is a particular and distinct order which defines that which is as it is and not as something else. The world, as given to man, is not homogenous.

We as architects however, can not be content to simply view our world and to find a place to *dwell* within it without disturbing it. It is our position to alter and to rearrange our world in the search for existential space. To this end we must make use of what the world has to offer. A stone by itself, in the revelation of its *essence* may reveal a plethora of *being*. It may reveal hardness, smoothness, density, and solidity. It may, in the ontological sense, reveal by its presence that which is not part of its *essence* such as the absence of stone. The deliberate ordering of stones in the revelation of *being* brings that revelation to a new level for it is no longer what the stones in themselves reveal, but rather what their ordering reveals. Stones may be ordered to reveal "bridge." The ordering of stones in the revelation of bridge may seek to reveal the *essence* of bridge which would be found in its being crossed. A bridge, so constructed that it reveals that its fulfillment resides in its being crossed, may make that revelation all the more apparent.

Stones placed next to each other in the servitude of a work of Architecture may be ordered to reveal the *essence* of that work of Architecture. In the case of a residence, this *essence* may be *dwelling*. But how is *dwelling* revealed? To begin with, let us recall what is meant by *dwelling*. Christian Norberg-Schulz, in his analysis of existential space, defined *dwelling* as "when man can orient himself within and identify with an environment."¹⁷⁸ To illustrate how *dwelling*, in this sense, is realized within Architecture, let us examine Frank Lloyd Wright's *Fallingwater* (Figure 13 on page 59).

Fallingwater

Fallingwater, as conceived by Wright, is a complex system of spatial relations. We cannot view *Fallingwater* as simply the man-made portion of the site; the stone, glass and concrete. It is not an object in that sense. We must view the work and its context as one. Without the relationships to the site inherent in the design, *Fallingwater* would be meaningless. All that went into creating the structure and spatial relationships found in the work was geared towards establishing both a physical and metaphysical bond between the people who dwell within the work and the immediate natural surroundings. The work becomes part of the landscape and the life that it orients the inhabitants towards puts them in touch with nature in such a way that they perceive themselves to be part of nature. Gone are the static images of the man-made world and in their place is the artistry of organic change. Wright once said, "The law of organic change is the only thing that mankind can know as beneficent or as actual. We can only know that all things are in a process of flowing in some continuous state of becoming."¹⁷⁹ Through this continuous state of becoming, the inhabitants of *Fallingwater* no longer view nature as if it were a painting to be looked upon, rather *Fallingwater* enables them to overcome the subject/object dichotomy as they come to perceive no ultimate distinction between themselves as a subject and nature as an object. Both subject and object are one in the same. Through this oneness with nature, those who live there find meaning within the work and its location, in turn, enables them to find meaning within their existence as a whole.

¹⁷⁸ Genius Loci p.5

¹⁷⁹ Frank Lloyd Wright: Writings and Buildings p.278

In this sense they dwell in the world. By their ability to dwell there the inhabitants are able to sense that the essence of *Fallingwater* is that it is a dwelling in the true sense of the word. It offers them security, a sense of familiarity, a psychological comfort, a sense of permanence and a sense of orientation both within the physical and metaphysical environment. The process by which this yearning for essence is accomplished is through the revelation of very specific and well-defined things.

Any sense of continuity between inside and outside is not limited as the stone walls and columns continue out of the building as the system of stone steps and terraces continues into the nature it achieves. The work is physically articulated in a place heard in the mind by a series of steps that were there before the building in such a way as to make man made and nature made as a whole is the work. A sense of continuity as the scene is revealed. Through the steel and stone palette and the natural light and seasonal changes of *Fallingwater*.¹⁰⁵ "In all things we are settling."¹⁰⁶

Fallingwater is a dwelling that does not dwell in nature, does not dwell in the world, but it is a place where man might dwell there. It was Wright's view that man is not a being that dwells in a place of distinction with nature, but rather, in light of this, it is clear that *Fallingwater* is a success in what it attempts to accomplish. Perhaps what I seek is not only a place that enables man to dwell but one which recognizes that its fulfillment lies in its being dwell in. In this sense, its existence necessitates man. To explore this avenue of the act of dwelling let us examine Louis Kahn's Exeter library (Figure 14 on page 81).

Exeter Library

To begin with, we must value and search for the essence of "library." Kahn pursued this by asking the existential space of "library," what it wants to be. In the case of "library," it wants

¹⁰⁵ *Fallingwater*, p. 117

¹⁰⁶ *Fallingwater*, p. 91

Figure 13. Fallingwater

¹⁰⁷ *Fallingwater*, p. 111

¹⁰⁸ *Fallingwater*, p. 127

In this sense, they *dwell* in the world. By their ability to *dwell* there the inhabitants are able to sense that the *essence* of *Fallingwater* is that it is a **dwelling** in the true sense of the word. It offers them security, a sense of familiarity, a psychological comfort, a sense of permanence and a sense of orientation both within the physical and metaphysical environment. The process by which this understanding of *essence* is accomplished is through the revelation of very specific and well ordered *beings* .

Any sense of a demarcation between inside and outside at *Fallingwater* is inhibited as the stone walls are treated in the same way both inside and out and the polished stone floors continue out onto cantilevering terraces. Spatial composition replaces a collection of objects as the system of cantilevers act as an extension of the landscape. Edgar Kauffman Jr., the son of the clients who commissioned the work wrote that the integration of *Fallingwater* with nature is achieved through " *the continuity of space - inside and out are all one - and the parallel continuity of material elements - floors, walls, ceilings - whether inside or out.* "¹⁸⁰ The work is physically anchored into the site through several devices. The western terrace is anchored into and cantilevers out from a massive boulder that also serves a part of the fireplace hearth in the living room. The work as a whole is anchored into the rock ledges behind it by a series of slender, exposed beams, a few of which curve to accept the trees that were there before the work was. All of these cantilevering systems are integrated with each other in such a way as they serve to offset the stresses that each produces. The interplay of both man made and natural forces balance one another. Kauffman wrote: " *I see Fallingwater as an irregular web of forces skillfully balanced to create floating horizontal levels.* "¹⁸¹ The work as a whole is situated next to, and over, a well paced stream which seems to penetrate into the work. A system of stairs and balconies lead the inhabitants into contact with the stream as the sound of the water cascading over the falls penetrates the open spaces of the interior. Through this method, the stream becomes an "element" within the overall work similar to the steel and concrete. Wright uses natural elements, such as water and sunlight, within his palette as easily as he uses artificial elements. Again, Kauffman wrote, " *The variations of natural light and seasonal progressions in plants and atmosphere become the chief enliveners of Fallingwater.* "¹⁸² " *In all these ways Fallingwater responds to, and integrates with, the natural setting.* "¹⁸³

Fallingwater , as an extension of nature, can aid man in his search to *dwell* and yet I find there is a quality lacking about the work. Perhaps to be fulfilled, the work, as an extension of nature, does not need man. Although the spaces within the work are ordered so that man might *dwell* there, the work as a whole does not seem to necessitate his presence. Man, as far as *Fallingwater* is concerned, is just another part of nature. The work is fulfilled unto itself. It was Wright's view that man was simply another extension of nature and hence, occupied no real place of distinction within the order of the world. In light of this, it is clear that *Fallingwater* is a success in what it attempts to accomplish. Perhaps what I seek is not only a place that enables man to *dwell* but one which recognizes that its fulfillment lies in its being *dwelt* in. In this sense, its existence necessitates man. To explore this avenue of the act of *dwelling* let us examine Louis Kahn's *Exeter* library (Figure 14 on page 61).

Exeter Library

To begin with, we must value and search for the *essence* of "library." Kahn pursued this by asking the existential space of "library," what it wants to be. In the case of "library," it wants

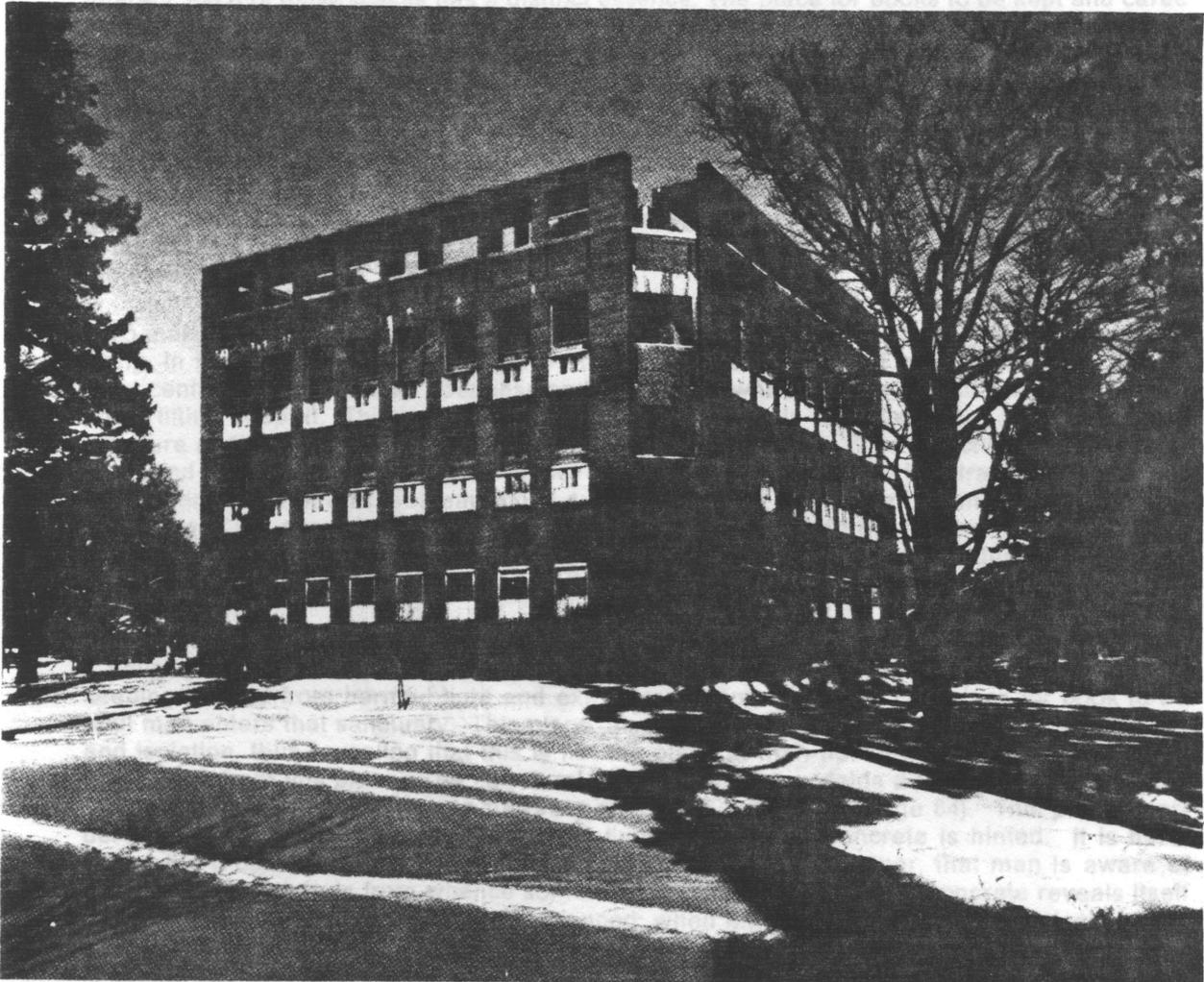
¹⁸⁰ *Fallingwater* p.117

¹⁸¹ *Fallingwater* p.90

¹⁸² *Fallingwater* p.117

¹⁸³ *Fallingwater* p.127

to be a place where books are kept and cared for not to their own ends but where they might be fulfilled in offering themselves to man. The library must then recognize a series of places within itself, a place for books to be kept and cared for, and a place where book and man can interact. Each of these places has a distinct essence. The place for books to be kept and cared



penetrates into other places. As concrete recedes, brick penetrates thus making the demarcation of places ambiguous enough that their transitions are experienced rather than clearly marked for the pleasure of the eyes. Man must leave this outer envelope place and enter the sanctuary of book but he cannot partake of book there. Man must return to his place where he sits in the light by a window, next to a wooden shutter which allows him to control the amount of light his place receives. It is here, in the solitude of man's place that he can shut out all that is around him and for that moment, only he and book exist and where man can receive that which book has to offer. Within the comfort of his place, man finds wood revealed where he comes into direct physical contact with the phenomena of library such as the shutter, the seat and the desk as a whole. His place, the reading booth, is ordered to reveal a warm, inviting essence where man feels at peace.

One may feel that the essence of library is fulfilled in such a place as Exeter and feel confident that the essence of library was revealed through the ordering of being, and yet, one can have doubts. How can we know when things are revealed to us in their true nature? How can we distinguish between the true being of anything and a false being? Can we know true being? Heidegger speaks of the Greek concept of "aletheia," the unconcealedness of being.

Figure 14. Exeter Library

to be a place where books are kept and cared for not to their own ends but where they might be fulfilled in offering themselves to man. The library must then recognize a series of places within itself; a place for books to be kept and cared for, and a place where book and man can interact. Each of these places has a distinct *essence*. The place for books to be kept and cared for must be dark to protect them from harmful sunlight and it must be a place which is not too damp or too dry. It should also be a solemn, quiet place where one respects that this is the sanctuary of book. The place where book and man interact must be a well lighted place where man can be comfortably seated in an environment that is well suited for man's environmental needs. This way he can take full advantage of that which book has to offer him. It must be a quiet place that portrays an optimism, a yearning for what is to come of the union of man and book. The revelation of *being* in the course of materials must be to this end. Materials must not only reveal that which they truly are but must also be ordered to reveal the *essence* of the existential space in which they are found. In the case of *Exeter*, they must all serve the *essence* of "library."

To make *essence* known within a work, the Architect must rely on the revelation of ordered *being*. In the case of *Exeter* this begins with the core of the work (Figure 15 on page 63). A giant central core reveals an openness and a lightness which, in turn, reveal a drawing inward and a lifting of spirit. This core, ordered in concrete, reveals that this place is where the true structure of "library" rests, both physically and metaphysically. The structure not only supports and braces the building as a whole, it also reveals that it is in the drawing inward and in the lifting of spirit that real learning is experienced. Yet Kahn offers, from within this place, a glimpse of the sanctuary of book. The massive circles formed from the ordering of concrete enables one to glimpse the sanctuary of book thus setting into motion the idea that after one draws inward and lifts the spirit, then one is ready to go to book and to find that which book has to offer him.

Enveloping the core is the sanctuary of book where darkened corridors care for book, keeping it away from harmful light and extremes in temperature. It is a place for book to be until man enters that sanctuary. This place, also ordered through concrete, reveals calmness and isolation, thus revealing that this is not the place of man nor of man to be except to remove book from this place. The structural ordering of *Exeter* yields a final envelope which is the place of man and where man partakes of book (Figure 16 on page 64). This place is ordered primarily through brick though a subdued presence of concrete is hinted. It is here, where there occurs a transition from one primary material to another, that man is aware of **boundary**. Boundary is from whence something begins its presencing. Concrete reveals itself most powerfully when it is directly experienced; when man comes into direct physical contact with it. Its nature reveals an ambiguity and a sense of withdrawal. Brick, on the other hand, is able to reveal itself from a more distant location; its boundary begins from afar and thus it penetrates into other places. As concrete recedes, brick penetrates thus making the demarcation of places ambiguous enough that their transitions are experienced rather than clearly marked for the pleasure of the eyes. Man must leave this outer envelope place and enter the sanctuary of book but he cannot partake of book there. Man must return to his place where he sits in the light by a window, next to a wooden shutter which allows him to control the amount of light his place receives. It is here, in the solitude of man's place that he can shut out all that is around him and for that moment, only he and book exist and where man can receive that which book has to offer. Within the comfort of his place, man finds wood revealed where he comes into direct physical contact with the phenomena of library, such as the shutter, the seat and the desk as a whole. His place, the reading booth, is ordered to reveal a warm, inviting *essence* where man feels at peace.

One may feel that the *essence* of library is fulfilled in such a place as *Exeter* and feel confident that the *true essence* of library was revealed through the ordering of *being*, and yet, one can have doubts. How can we know when things are revealed to us in their true nature? How can we distinguish between the true *being* of anything and a false *being*? Can we know true *being*? Heidegger speaks of the Greek concept of "alethia," the unconcealedness of *being*.

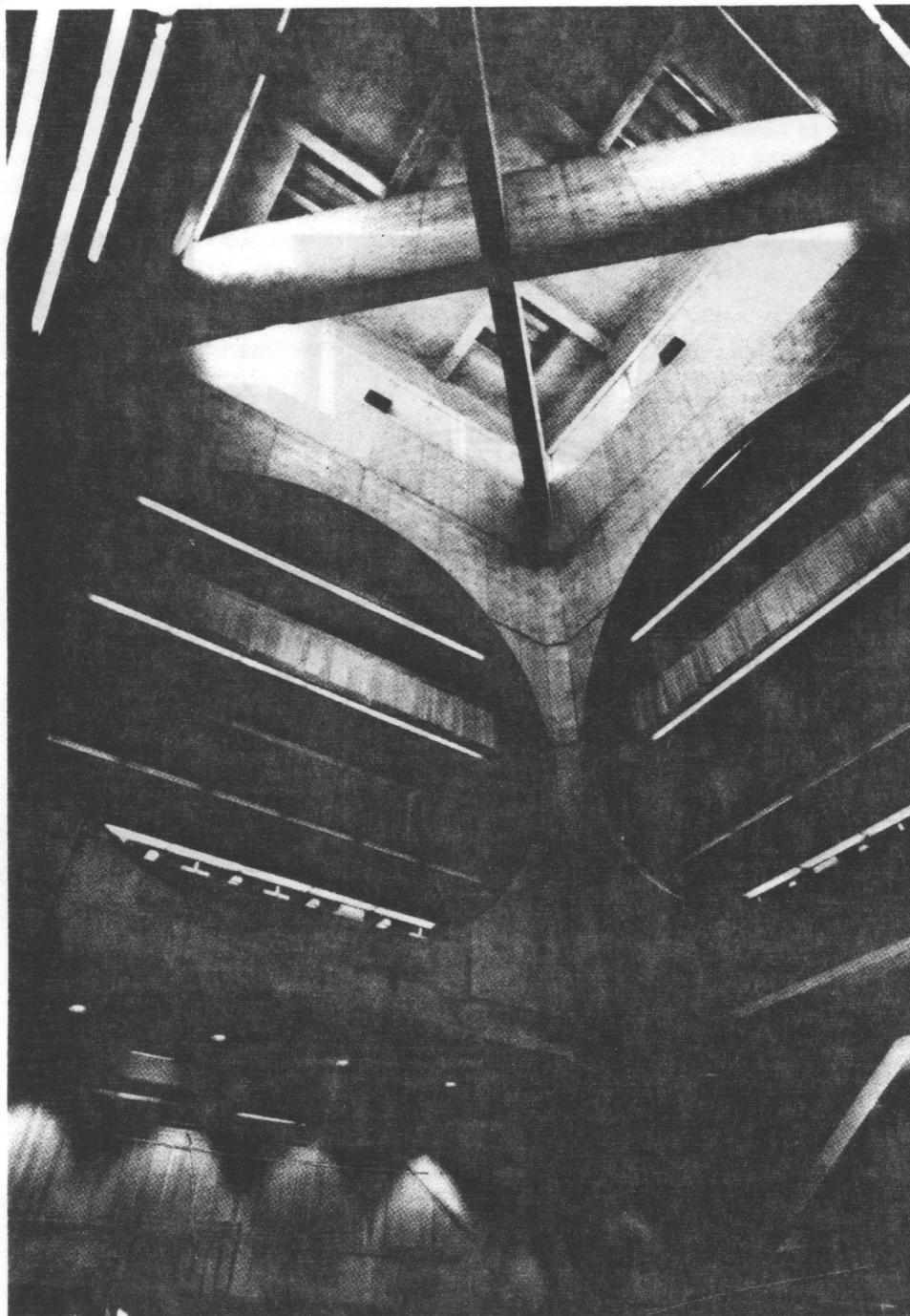


Figure 15. Exeter Library - Core

This is what constitutes true being. And of our recognition that what is revealed is, in fact, the unconcealed true being? The Greeks termed this recognition "anamnesis." It refers to the notion that the learning of eternal truths is really a type of remembering. It was always with us, the theory goes, but we failed to recognize it until it was revealed to us. But is this what we call knowledge? Or is it more closely allied with belief? The acceptance of anamnesis would seem to rest upon a foundation of faith. We must accept our belief.

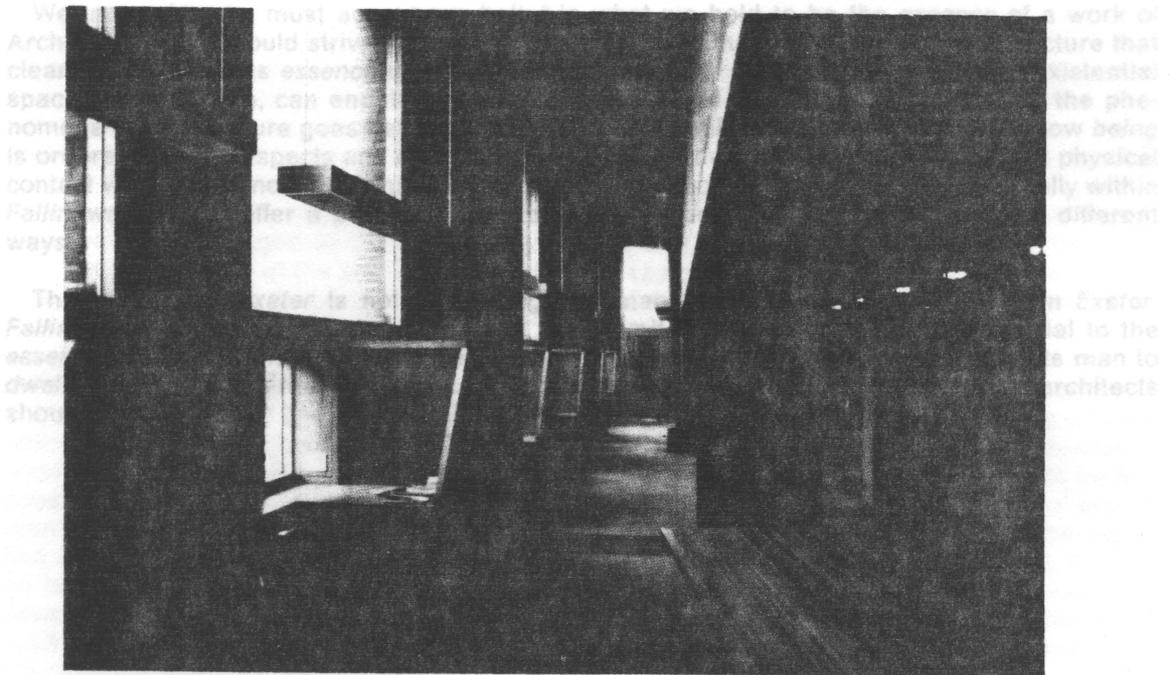


Figure 16. Exeter Library - Reading Desks

This is what constitutes true *being*. And of our recognition that what is revealed is, in fact, the unconcealed true *being*? The Greeks termed this recognition "anamnesis." It refers to the notion that the learning of eternal truths is really a type of remembering. It was always with us, the theory goes, but we failed to recognize it until it was revealed to us. But is this what we call knowledge? Or is it more closely allied with belief? The acceptance of anamnesis would seem to rest upon a foundation of faith. We must accept our belief.

We, as architects, must accept our belief in what we hold to be the *essence* of a work of Architecture and should strive to reveal ordered *being* to that end. A work of Architecture that clearly recognizes its *essence* enables us who partake of the work to experience existential space which, in turn, can enable us to *dwell* in our world. The place of man within the phenomena of Architecture goes beyond the question of "institution." It is a question of how *being* is ordered. *Exeter* respects and offers a place for man wherever he comes into direct physical contact with the phenomena. That quality seems to be lacking somewhat, but not totally within *Fallingwater*. Both offer a place for man, but they respect the presence of man in different ways.

The *essence* of *Exeter* is not a *dwelling*, yet man can *dwell* in the world within *Exeter*. *Fallingwater*, though it is a *dwelling*, does not permit man to feel that he is essential to the *essence* of the phenomena of Architecture. To bring into being a place which permits man to *dwell* and recognizes that its *essence* incorporates man is what, I believe, we as architects should strive for.

Epilogue

I had wanted to end my search for *being* in Architecture here, satisfied that I now began to understand how the Art of Dwelling is to be served within the phenomena of Architecture. And yet, there seemed to be a few questions which constantly demanded to be made known. Why does anything have the order that it does? Why do phenomena reveal certain things and not others? Why are there distinct phenomena? Why is man there to receive it? Is man's *essence* related to this? How is man's *essence* realized within his world-view? What constitutes man's world-view has changed so often and to such an extent that it is difficult to know if there are any "external truths" of the kind of which Spengler spoke. If there are any external truths, then I can offer none here that would convince anyone. I can only hold to those which I hold to be true and be content with that.

If the *essence* of man is expressed within that which is, then perhaps one should ask why is there that which is. The only answer to this which I am capable of rendering here is what philosophers call the principle of concretion; that there exists something which determines what is to be the way it is and not otherwise. With this recognized, there would seem to be two possibilities; that there is no reason for the principle of concretion or that there is a god. If man's *essence* resides in one of these two possibilities, then he is either an *essence* which has no reason for existence and is, in the words of Sartre, a useless passion, or he is what he is because God willed that it be so. But why would God will it to be so? If reason is an essential *being* of man, then through reason, as well as faith, I offer this: that God possesses such an unselfish love that He wills it for our benefit and that He loves the world so much that He gave His only son. Man's *essence*, in this case, resides in God.

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