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a theoretical physics research facility

ABSTRACT

This thesis explores the conception of architecture as facilitator. A primary aspect of this exploration is how a framework can be established from the essential qualities found in a building's program and then utilized to inform the objective of the design. For architecture to act as a facilitator it has to promote an active participation of the inhabitants activities among themselves, throughout the building and to its surrounding natural landscape. I refer to this development as the architectural ritual, where the reiteration of events encouraged by the buildings spaces can promote a consequential experience.

This framework is developed in an attempt to create a building design that will facilitate a consequential experience for scientists in a theoretical physics research facility; because of the complex and paradoxical nature of their studies I turned to the Zen Buddhist monastery as the relevant paradigm. Borrowing from the Zen Buddhist monks disciplined actions of physical and mental exercise, I incorporated into the design, key aspects in their ability to develop ritual within their daily affairs throughout the monastery. The aspects I employed in the design of the facility dealt primarily with the interconnectedness of the natural surrounding to the function of the building, the separation of public and private activities and the patterns of movement created by these conditions.

facilitate

ritual

Zen

reiteration

event

program

framework

monastery

contemplation

sequence

consequence

physics

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INTRODUCTION

The primary intent of this Masters Design Project is to create a building design for a theoretical physics research facility; a building that not only possesses the required functional elements that are necessary for the study and teaching of this particular branch of science, but one that also acts to facilitate the cerebral skills necessary to comprehend its complex nature. For a phenomenological model I turn to the Zen Buddhist monastery. Quintessential aspects regarding exercises in contemplation, both active and passive, can be found in this Eastern philosophy, with particular regard paid to its ability in establishing a working discipline that undertakes the monumental task of achieving enlightenment. These essential components are best translated for an architectural intervention through ritual and the part that ritual is able to play in the events that transpires within the monastery complex. My interpretation of the architectural ritual, or the reiterated sequence of events that is defined by space, begins by establishing a fundamental understanding of the spatial framework required for these same events. The framework I established began with the program and its ability to inform the design process. I hoped to capture the elusive qualities that can render a ritual to existence. By understanding both the building's functional requirements and its principal goal (in this case the facilitation of a distinct thought process) at the introductory stage of program development, I will form the necessary spatial components that inspire the development of a ritual that in turn promotes the edification of this complex branch of science.

All attempts to adapt the theoretical foundation of physics to this (new type of) knowledge failed completely. It was as if the ground had been pulled out from under one, with no firm foundation to be seen anywhere, upon which one could have built.

Albert Einstein¹

The influence of modern physics goes beyond technology. It extends to the realm of thought and culture where it has led to a deep revision in our conception of the universe and our relation to it.

Fritjof Capra²

PARADOX & PARADIGM

There have been few advances in history that have caused as much in the way of change as the discoveries in the quantum world of physics. Beginning at the turn of the twentieth century with Einstein's *special theory of relativity* published in 1905, physics had found itself in a spiritual crisis. No longer could it simply rely on what was previously understood as fundamental truths and absolute frameworks established by *Newtonian physics* where basic concepts like matter, space, time, or even cause and effect were concrete realities. Instead, physics had to make a radical transformation from being a science that used scientific experimentation and mathematical formulation to describe observable reality to something resembling a philosophy that could only use these assets to translate the unobservable conditions occurring in the quantum universe. The most important difference that occurred within this transformation was the inability of physics to describe this unobservable reality in concepts that were not only rational and understandable, but reasonable and logical. Fritjof Capra in his book the Tao of Physics describes this condition by stating:

The mathematical framework of quantum theory has passed countless successful tests and is now universally accepted as a consistent interpretation, on the other hand - i.e. the metaphysics, of quantum theory - is on far less solid

¹ Albert Einstein in Fritjof Capra's, The Tao of Physics (London: Flamingo Press, 1986), p.61.

² Fritjof Capra, The Tao of Physics (London Flamingo Press, 1986), p.21.

ground. In fact, in more than forty years physicists have not been able to provide a clear metaphysical model.

Fritjof Capra³

In other words, there has not been, and may never be, a working model of the universe that can be understood within the conceptual framework of human perception.

Although the majority of the study of physics belongs in the coherent and conceivable world of human perception, the small branch of the quantum world that belongs to theoretical physics is firmly established on a paradoxical bed of knowledge: neither observable nor tangible. When Neils Bohr and Werner Heisenberg conceived the Copenhagen Interpretation in the 1920's, a model of the quantum world that understands and accepts the shortcomings of human perception and scientific experimentation, they ushered in a new development of theoretical physics that accepted the underlying 'uncertainty' that pervades any examination of the subatomic world. The theoretical branch of physics has had to concede that any new models that interpret the universe are just that: interpretations. The practice of following a scientific method and verifying theories with mathematical equations proves to be the mainstay of the discipline; however, the conceptual framework that supports it has accepted the fact that their theories, proven or not, can only be seen as a system that can be followed to allow for one such manner of interpretation.

Since the discipline has developed into what may be perceived as being closer to a philosophy rather than a science, the practice of studying it should also evolve to suit the task of interpreting the complex and often paradoxical framework found in modern theoretical physics. The general, but distinct, difference in the methodology found in theoretical physics over other branches in the scientific field is the change of order in the sequence followed in scientific research. The scientific method involves experimental evidence about a given phenomena, correlating that evidence with a mathematical formulation and then interpreting this information into a verbal model that describes, or predicts, the outcome of further experimentation; however, the process for theoretical physics

has to, at times, be reversed. In most cases the theoretical physicist generates a prediction, meaning that in order for any interpretation to occur a formal and precise question has to be asked, where logical constancy overrides consistent experimental fact. This sequence is found to exist in theoretical physics because there is no observable phenomena that supports the postulating of a question. At the sub-atomic level of physics all previous notions of unfaltering laws that govern the universe breaks down; whereas most forms of experimentation lead to a paradoxical condition that not only contradicts most classical laws but contradicts the experiment itself. There is a need for places where physicists can continue this line of work without the unnecessary baggage often associated with their profession. These physicists need to replace laboratories where they test and experiment their theories in relative seclusion with public arenas where they can share and collaborate their ideas with colleagues and visitors.

To find an appropriate model for a theoretical physics research facility, we must look to a discipline that expends the majority of its efforts on contemplating the unobservable realities that define our existence. One such paradigm can be found in the discipline practiced by the Zen Buddhist monks. For centuries now Zen Buddhist monks have established their entire existence in forming their environment, their rituals, and their way of thinking to accept the inequities of human perception and reason in the pursuance of enlightenment. They have established their entire discipline on creating an environment that enables them to concentrate exclusively on exercises that can lead to this goal. These pursuits have given the Eastern intellects a greater advantage over Western physicists when dealing with the paradoxical issues of nature where intuition overrides reason. This skill would prove a favorable asset for physicists who deal with theoretical formulations that are neither observable nor reasonable.

Capra explores the parallels between modern theoretical physics and Eastern mysticism in his book, describing one such parallel regarding the fundamental understanding of "the essential

interconnectedness of nature" and "the unity and mutual interrelation of all things"⁴. It is precisely because the existence of all matter departs from this paradox of uncertainties and probabilities that theoretical physicists should also practice the forms of acceptance and understanding long utilized by Zen Buddhists. Because they have established their entire principles of living and working on the notion of each and every action acting to facilitate their goal of enlightenment, Zen monks have established and honed these skills; accepting paradoxes, rather than questioning them. They believe that enlightenment does not mean withdrawal from the world; rather, they believe that it is often through the mundane participation in everyday affairs that one gains a higher perception.

I do not propose that a direct interpretation of the rituals and surroundings that define a Zen monastic experience would be a suitable response to the needs of theoretical physicists. Nor do I hold the position that for physicists to attain their aspirations they must leave the material trappings of the Western world for an isolated locale where they can meditate on mathematical theorems while repeating mantras of their favorite equations. Immersing the physicist in a Zen Buddhist lifestyle would be as effective as giving a monk a calculator to answer a koan riddle (an unanswerable question based on a paradox). Instead, architecture can attain the attributes found within the spaces of a Zen monastery and interpret them in the context suited to a theoretical physics research facility. The principal attribute that is evident within the monastic order is the ease in which the monks are able to incorporate exercises in contemplation within all aspects of their active role in the monastery. They have been able to develop rituals that define most aspects of their existence: from the performance of routine chores to the execution of exhausting meditative exercises. It is this active characterization between contemplation and action found in Zen Buddhism that makes it a more appropriate model over other Eastern philosophies that struggle with similar esoteric issues. The two positions, or schools of thought, found within Zen Buddhism rely heavily on the act of contemplation, both passive and active, respectively. The *Rinzai* school utilizes the koan riddle and approaches the subject of enlightenment as a sudden

What is the sound of one hand clapping?

Popular Zen koan

awakening during intense moments of thought. On the other hand, the gradual method of the *Soto* school aims for a progressive illumination through passive practices of quiet meditative thought or through the performance of ordinary activities. I hope to apply both the passive and active aspect of the thought process within the design of the theoretical physics facility. This design will demonstrate the unique manner in which the Zen Buddhist model of contemplation can facilitate the design of an appropriate place where physicists can follow these practices and where they can hopefully experience insights into the issues pervading their discipline. The Zen Buddhists view physical and mental discipline as one and the same method of training that is consequential to the attainment of their goal. They believe that capturing the essence of a physical gesture, as in a masterful brush stroke in calligraphy or executing the most obscure mental chores like understanding a koan riddle, are parallel paths of enlightenment.

It is precisely the definition of this building as a facility that allows for the architectural interpretation of the monastic qualities of Zen Buddhism. Although the practices, activities and rituals that are associated with the two building types vary greatly, it is their essential role in facilitating a way of thinking and studying that relates them so closely. Even as the physicists create and demand their own needs within the building, each action and interaction with the spaces provided should be in service to their intellectual pursuits. In a Zen Buddhist monastery each exercise, mental or physical, is contained within spaces that are removed of any distractions that may hinder the performance of that specific exercise. It achieves this primarily through a clear understanding of what is required in one's surroundings. This requirement is reduced to the most necessary of elements where even space and the formal definition of that space is utilized in its most minimal of states.



Figure 1, 2 & 3 Koto-in Zen Temple, 1601, Kyoto. Illustrated in *Spiritual Path and Sacred Place, Myth, Ritual and Meaning in Architecture*, p 204

ARCHITECTURE AS FACILITATOR

Can the pursuits of architectural theory be compared with the ceaseless analysis of theoretical physics or the relentless quest of Zen Buddhism? All three share a need to find *meaning* within their discipline, whether it is authenticity in architecture, a unified theory in physics, or enlightenment in Zen Buddhism. But perhaps the similarity for architecture ends there. Although architecture can be argued as having been burdened with its own paradox (being understood both as a conceptual exercise as well as a sensory experience), it flourishes within a material world that can be perceived and ultimately understood. Architecture does not have to grapple with questions of an ultimate meaning of reality that lies beyond our perception because it is precisely our perception that gives architecture its meaning.

Space, in most any form, acts to render human activity within it. When architectural space is composed that space, by definition, also supports the activities it contains. Even if these spaces are ill-suited or inappropriate forms for their given uses, we must still accept their physical existence and formal attributes that define them as shelters. I will avoid the discussion on the ongoing challenges in architectural theory over what forms of shelter can be deemed architecture over those that should be merely defined as buildings. Instead, I will separate the definition of space, and the forms that contain it, into what does or does not constitute a facility. A facility can be described as: a place built or set aside to provide a special service absent of any difficulties in the achievement of this service. When a building's primary purpose is to facilitate a thought process, as in a Zen monastery, it acts as a lens, focusing the actions and movements within the building and its surroundings into a clear and unobstructed series of experiences. It is the facilitation of these experiences that is instrumental to the thought processes required for the study of theoretical physics.

Facility a place built or set aside to provide a special service absent of any difficulties in the achievement of this service

We have witnessed a number of building types and systems of human behavior that have tried to

facilitate the attainment of the higher level of consciousness, or what can be referred to as the *consequence* to these endeavors. The architects of the Gothic cathedrals, in their pursuit of rendering the Catholic goal of achieving a divine connection, chose to portray the insignificance of human existence by situating them in a backdrop of impossibly vertical spaces (see figure 4) in an effort to deny our instinctive awareness of self in light of a superior existence. This is contrary to the Zen monastic approach of immersing man in the mundane and the ordinary (see figure 5) so as to free him from the possessions and insignificant trappings of his immediate and fleeting existence. Although the Gothic cathedral and the Zen monastery are in almost every way opposing conditions, what they are both able to establish (and I would argue that all successful architectural facilitators provide this opportunity) is the instituting of a framework; a correlation of spaces that focuses on these experiences for the attainment of higher aspirations. Can we hope to fulfill these austere demands solely through the proper identification of what needs and activities may be performed within designed space? I do not propose that the accomplishment of man's quest for religious enlightenment rests solely on the surroundings that define or control his actions. Rather, the setting in which he acts can be said to facilitate the set of events that may lead to this *consequence* (enlightenment, fulfillment, inspiration etc.). The ritualistic component that I hope to develop in my building design is significant in its ability to produce a consequence, or the ritual is what I believe to be the *cause* of the *effect* to the achievement of this aspiration. Architecture that acts as a facilitator is explicit about its purpose but only implicit about its execution. It allows for various interpretations and interactions that occur in spite of an architect's best efforts, because often it is the accidental and the spontaneous that creates the rich and varied texture that becomes the foundation in the establishment of any meaningful interaction. If architecture is to act as a facilitator, its formal gestures should not define what interactions and dialogue can transpire between the building and its inhabitants, but only what interactions can occur between the inhabitants themselves.



Figure 4: Cologne Cathedral, 1248-1322, Cologne, Germany. Illustrated in A History of Western Architecture, p 158



Figure 5: Koto-in Zen Temple, 1601, Kyoto. Illustrated in: Spiritual Path and Sacred Place: Myth, Ritual and Meaning in Architecture, p 204

Consequence A logical result having come from a course determined by deduction or inference

PROGRAM

In spite, or perhaps because of the integral role program plays in creating architecture it usually does not generate the same level of attention paid to other matters of design such as massing or spatial configuration. Its significance is often reduced to a single-minded obligation, one of mere purpose. I do, however, believe that for architecture to succeed on levels other than aesthetics, and before architects can discuss the esoteric questions of space, they must answer the fundamental challenges of function. By definition the program in architecture is the manifestation of a building's intended use. It is also the principal generating source from which both the physical and phenomenal organization of the building rises. It is conceivable that it is because of the nature of a program to be an innate aspect of a building's design that it, at times, goes without due notice. Bernard Tschumi claims in his essay Spaces and Events that there is no architecture without program⁵. This statement proclaims the obligation that should be required of program in the discourse of architecture.

Like Tschumi I believe that there is an elemental aspect of a building's program that allows and perhaps demands a greater deal of attention. It has been utilized in most instances exclusively as the prescriptive outline in generating the utilitarian needs of the functions within a building, resulting in architecture that is concerned exclusively with how people use a space rather than how they experience it. The purely prescriptive use of the program, even in its most efficient form, is unable to create the depths of experiences required to establish the organization that can form the expressive events that architects strive for within the design of a building. Although the practical and functional obligations associated with program requires diligent administration, a complete understanding of the building's phenomenal nature, or what experiences it can provide above purpose and utility, must also be undertaken.

One architect who embraces the properties of a building's program by adopting what may be

Program To cause to follow any planned sequence of steps or operations, to direct, control or channel in accordance with a plan, schedule, or code

Event A happening, especially an important happening. An occurrence, phenomenon, or complex of process occupying a restricted portion of four-dimensional space/time a happening represented by a point designated by x, y, and z as coordinates of place and t as time in the space/time continuum, it being a fundamental, physical measurement reduced to observations of relations between happenings

thought of as restraints and allowing these infrastructural components to inform the narrative progress of the spaces designed is Rem Koolhaas. He argues that it is the infrastructure that successfully casts the events of a building into motion, forming the principal framework of the building's design. What Jeffrey Kipnis, in his essay Recent Koolhaas⁶, refers to as an infrastructural tenet in the work of Koolhaas is the rational concept of accepting that any built work of architecture cannot resonate to its full ability unless critically analyzed in full use. By accepting this simple tenet Koolhaas takes the mundane structure of organization and translates it into events of great meaning, both spatial and metaphorical. Kipnis' description of the sequence and event at the Kunsthall art gallery in Rotterdam captures Koolhaas' ability to employ sequence in a manner that elevates the program of a gallery to the level of an event: the appreciation of art. What Koolhaas is also able to render is a coherent perception of the condition of art and its place in the city, a condition performed within a structure whose primary function is the simple act of assembling and viewing. He is able to achieve this primarily by creating an experience that was not restricted to the observation of exhibits but also encouraged the contemplation of art and its place in an urban condition. Not only does Koolhaas enhance the sequential movements that are indicative of art galleries, he also creates some of the most dramatic spaces through the use of classic formal devices. One could never mistake Koolhaas' work for anything but truly current and groundbreaking. However, because of the blatant acceptance of and inclination to the mandate of program and its requisite organizational framework, he has located and employed explicit formal devices to render spatial meaning. His approach to the design of the entry sequence is a successful interpretation of the delicate condition facing the value of art within the urban context:

The visitor leaves the street by climbing a staircase and landing on a great, empty concrete plinth overlooking the whole of the cultural district. Such rising to a second datum is an elaboration of the curtain-rising entry sequence of the Renaissance church, where the staircase elevates the parishioner from the profane to the sacred. Isolated at the center of the plinth is a platonic, glass and steel pavilion,

Infrastructural Tenet The proposition that the architecture of a building be biased toward its performance in full use

Jeffrey Kipnis⁶

at first impression, the arrival point. Soon, though the visitor discovers that the pavilion, too, is empty save another staircase that descends into the plinth, now a bunker/crypt for art. Continuing through the underground galleries, the visitor's journey ends as he exits to a sunken sculpture garden, a sanctum sanctorum carving out a profound retreat from the destitute forces of the city.

Jeffery Kipnis⁷

By embracing the primary nature of movement inherent in the program of any gallery and creating moments along the path that defines the building's place within the surrounding context, Koolhaas ties the integral, but often antagonistic, position of city and art. He exhibits the tenuous relationship the gallery holds within the backdrop of the city, constantly reminding the galleries visitors of the importance of having this oasis amidst the urban landscape. Koolhaas and many other architects who hold active human intervention within space as the vital component to architecture are simply accepting an unconditional truth. If a basic presumption regarding the program and its critical position is recognized, architects may effectively utilize elements beyond those used in formal composition, producing spaces that flourish with the human interaction that help to define them.

As exemplified by Koolhaas, the program can set the stage in which the human behavior within a building can harmonize into a coherent system of actions and movements; it is when purpose, form, and function are able to work in unison that spaces can resonate with meaning. When functional determinism pervades the manipulation of the components that make up a building's program, all that we can hope to accomplish is a clear but mostly rigid compartmentalizing of actions. What we should obtain from the program is an introduction to the more significant parts that play a role in the production of meaningful excursions within a building. A building's phenomenal needs, although not usually prescribed and accounted for by its primary usage and thus not formally outlined, are nonetheless specific attributes that can be derived, manipulated, and ultimately made to perform within the organizing structure of a building. Combining components of architecture to generate richer experiences is certainly not a new idea, practitioners and theorists

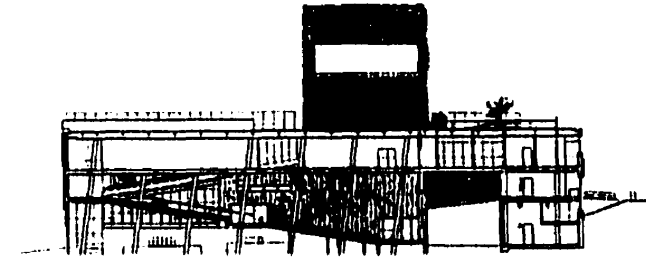


Figure 6. Rem Koolhaas Kunsthal Art Gallery, 1992, Rotterdam, Holland. Illustrated in *EL Croquis* Issue 79, p.86

alike have observed the power found within the orchestration of phenomenal elements in built form. Michael Benedikt in his book For an Architecture of Reality, proposes the composition of *presence*, *significance*, *materiality*, and *emptiness*⁸ in securing the perception of the *real* in architecture. Christian Norburg-Schulz maintains the association of *place*, *path*, and *domain*⁹ to achieve the creation of existential (or meaningful) space. The position I contend is similar to that of Benedikt's insofar as I also believe that the nonphysical components found to exist in architecture can be, and should be, discussed as attributes and effects that can be investigated and analyzed under critical scrutiny.

Besides developing the outlining structure of a building's functional organization, a program can establish relationships between elements, both spatial and functional, by prescribing attributes that define the necessary relationships that occur between them. Fundamental compositional elements such as scale and location can be organized to establish a framework that informs the following stages of the design process. This framework can be established in a number of ways to define what aspects of the program are deemed as vital components to the design. An example of this would be the creation of an organizational system of layers that composes integral relationships between elements or through a development of a hierarchical arrangement. There are undeniably countless approaches to the execution of a design process. Some architects prefer to delineate spatial sequences that define movement within a building by developing plans that relate adjacent conditions that compel a progressive sequence of experiences. Other architects favor the production of massing strategies that help to define major spatial components. While others still prefer the formulation of bubble diagrams that schematically represent the building's areas and their relation to one another. Although these methods differ greatly in their execution of the design process, what they do share is the manipulation and combination of elements that can be described and understood within the conception of a programmatic framework. However, I do not believe that there is a universal programmatic layout that can define every aspect of a building's

design, nor do I advocate an explicit, or prescriptive, composition of architectural elements that describes every possible spatial condition. What I do believe is that the rich and vital process of design, sought by all architects, should incorporate fundamental issues pertaining to the program within the conceptual framework of the design method.

RITUAL

The movement between activities, which relates to the utilization of the building by its inhabitants, is what creates the sequences from which rituals within a building can transpire. The task of developing architecture as a medium for the enactment of rituals is commonly found among the specific programs of sacred architecture where rituals are enactments of faith and myth. In addition, a preconceived understanding of human actions prescribes the events that occur within these buildings. When the secular realm of architectural spaces searches for a phenomenological system that can exalt the nature of dwelling beyond the isolated experiencing of events, it often turns to the ritual. Most people exhibit signs of the performance of rituals outside of a religious context throughout their lives whether it is a systematic organization of one's occupational duties or simply a processional experience of the everyday that one has developed. Despite the repetition of activities and the provisions that may lead to the encountering of events in a customary fashion, there is a distressing similarity between an honored ritual and a trivial routine. The subtle difference that occurs between them, separates routine and ritual distinctly into one that finds the reward in completion of a task and the other which considers reward as the performance of the task itself. A routine is often simply a series of responses that have been repeated so often that the effort to complete it is an unconscious one, holding little or no sense of accomplishment upon its completion. Its occurrence could never harmonize into a tangible perception of wholeness and is plainly reduced to a series of repetitive actions that may, in time, even become instinctive but will always be condemned to a shallow existence of indifference and mechanical reflex.. A ritual, on the other hand, must arise from a conscious effort to perform a repeated, but also deliberate, set of actions which I refer to as reiteration.

Ritual A form, or system of formal procedures or acts in an observance of a particular customary ceremony

A ritual, outside of a sacred or religious context, acts to display a sense of freedom that is derived from a seamless set of conditions that has been implicitly laid to form the necessary foundation for its occurrence. When architecture succeeds in becoming a part of the establishment of a ritual, or

when it is able to facilitate a ritual, it has succeeded in sacrificing its formal physical presence, dissolving into a backdrop to the human events it accommodates. Instead of asserting its object-defining qualities, it acts slowly and silently to render the intricate texture of human activities - activities which are often accidental and spontaneous - into a cohesive set of events.

Along with the sequence of events, a ritual gains the intensity and capacity to harmonize the surrounding external conditions from the reiteration of those same events. Despite the hierarchical organization that underscores the establishment of a ritual, the properties required to bring it to life are more difficult to observe or examine. How conditioned responses to a systematic organization of events are ultimately realized, and how human interaction and intervention relate to these conditions have been, and continue to be, elusive components of architecture. What can be established, however, is the certainty that without this structural system of movements and sequences, a higher level of understanding or the attainment of an enlightened experience through the practice of architecture may not be gained. Perhaps we can establish this intervention on the understanding of the self-evident truth that out of *sequence* comes *consequence* and if we maintain the position that built form is to suit our existential needs as well as our physical needs then the intent of architecture can be further focused into its development as a *facilitator* to the attainment of existential human endeavors.

The determinism inherent in the ritual, much like architectural determinism, can be plagued by the contradiction derived from intent, but without intent the reiteration of the events that comprise a ritual is doomed to lapse into the mediocrity surrounding routine. The failure of this system is in establishing a framework that becomes prescriptive; one that does not allow for individual interpretation nor evolution and falls prey to the shortcomings of a routine. When this framework is successfully established and when intent harmonizes with the *events* within a building, an iteration of these sequences of experiences follows, leading to the ritual. The successful establishment of

this ritual does, of course, require a period of time to become fully realized. When framework, intent and the events within a building synthesize into a seamless backdrop, reiterating the sequence that develops becomes effortless and natural. Although this reiteration is developed from a framework, this framework does not necessarily have to be confined to one specific environment. Events arising from another location can also support the founding of a ritual outside of a specific context. Not unlike a particular monastery for a Zen Buddhist, the monk may still be able to reiterate a specific sequence of events that has become a ritual for him in a previous setting; provided the environment wherein he is practicing his reiteration can support and respond to the needs required throughout the ritual and in each specific event.

For architecture to support the various sequences that any individual may require to create a ritual, it must provide for the basic set of events that the specific discipline exercises. Establishing these events comes from understanding and interpreting the program that must be developed for the building. The ability to transfer rituals from one setting to another, even within similar settings, can not be accomplished by simply recreating the environments from which they had originated. An architectural setting is only able to intervene in this process if it can respond to an inhabitant's established sequence, and only then, if the events instituted by the program are present and successfully rendered. The architecture in any meaningful event meant to serve in a ritual framework must participate in its use, not simulate it. A ritual can only exist outside of the environment from which it was produced if the framework, mainly the building's program, the intent of the user and the events being reiterated are also present in the new setting. This complex system is elusive in optimum conditions and balances on one point outside of its original setting, and that is, the motivation of the subject. Architecture that is meant to facilitate a ritual can only participate in its development if the subject has established a discipline rooted in achieving a consequential experience through the reiteration of meaningful events.

THE FACILITY

Researching the complex and often paradoxical realm of theoretical physics requires a great deal of thought. Creating a place where these physicists not only can formulate a thought process, but also sustain it, is the principal goal of this research facility. The intervention begins by accepting that the discipline required for this level of deliberation comes from the restrained practice of contemplation. This stream of thought, or the processes of insight, can be conceived through participation in active discussions: from casual conversations with colleagues to formal public lectures. What the discipline will require is the forum in which these levels of thought are encouraged. Each aspect of the building's design helps to facilitate any and all forms of thought that can lead to a moment of clarity and perhaps a brilliant piece of insight that leads to the formulation of a provable theory.

There is an interesting correlation that can be made in understanding how physicists might practice their science in relation to the environment that they are in. In general, the correlation between the scale of discussion corresponds to the scale of the space in which the discussion takes place. Some physicists find that issues concerning universal theories are best discussed in a larger arena where they can introduce their hypothesis. This can be seen as the passive discipline of contemplation where discussions generally do not demand a tasking mental performance but where lively conversation usually turns to discussions of larger issues. Intricate operations dealing with mathematical formulations and theorems, on the other hand, are more difficult to execute outside of an intimate and secluded chamber. They require an atmosphere free of distractions where active mental discipline can be performed. This association can also be made with one's connection to the natural environment where the intricate work prefers an intimate connection to the natural surrounding while the larger forum discussions would sit within a larger backdrop of an expansive landscape.



Figure 7 View towards tree colonnade from private entry

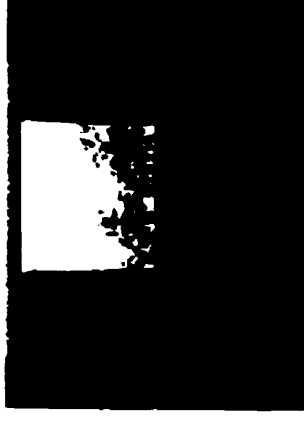


Figure 8 View towards tree colonnade from underside of public block



Figure 9 View to inner courtyard from public gallery

Because the discipline of theoretical physics has a fundamental academic component, the facility will combine the private aspects of this intellectual pursuit with the necessary areas designated for the teaching and sharing of ideas. There are few facilities of this nature in existence around the world. One example is the Max Planck Institute which is an astrophysics research centre in the Netherlands, but no examples can be currently found in Canada. There is also an opportunity to introduce the discipline to a greater audience, perhaps to establish a wider array of communication with lay people to help to strengthen the complex metaphysical model missing in most current theories.



Figure 10: View from private court to interior ramp



Figure 11: View to tree colonnade from interior ramp

The research facility is located at the northwest sector of the University of Calgary campus within the campus nursery (see figure 12), sitting in the sheltering margin of the campus, insulated, but not removed, from the urban condition of Calgary. The active nursery is found just south of the married student housing complex and is accessed from Collegiate Boulevard through a designated public parking lot adjacent to the Grounds building. Considering the significant role the academic community plays in studying science, there is an inherent bond between the facility and a university campus. The complex of buildings and disciplines that comprise a campus can be perceived to have similar qualities to the organization of larger Zen Buddhist monasteries. Like the campus, a large monastery houses various sub temples with each temple having its own ritual. It is also not

THE SITE: THE UNIVERSITY

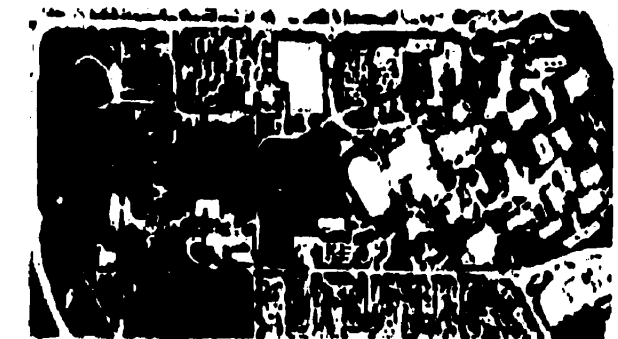


Figure 12: Aerial photograph of University of Calgary Campus

uncommon for these sub temples to have a strong individual identity, with its own private group of monks and followers assigned to its maintenance.

A university campus contributes a significant atmosphere that unites various academic disciplines, but the strong social impression always present within campus grounds would create an unnecessary distraction. By placing the facility outside of the group of buildings that comprises the main campus area but within the boundary of the university grounds, the building is associated with the academic arena without having to play an explicit or active role in the social community of the university. The vicinity to the U of C campus also allows the program of the facility the flexibility to reduce the supportive and administrative components to only those that have an essential and active participation in the everyday affairs of the scientists. Being a part of the campus also allows for utilization of university amenities such as larger lecture halls and on-site housing for visitors. This distinct academic and urban fabric provides the context that is essential in creating a sense of participation that is lacking in scientific retreats that have similar aims.

THE NURSERY

Standing in relative isolation, the University nursery is like Calgary's own secret garden. Reachable only through pay lot #59 on Collegiate Court, it starts as an open expanse of native prairie grass, one of the only few patches remaining in Calgary. This area terminates with the eastern most section of plantings of trees and shrubs (the only active section of the nursery) in the last stages of maturity before its transplantation on the campus proper. At its western boundary is a large public field that acts to dissolve the unpleasant adjacency to Shagannappi Trail. What is most striking about the nursery is the impression of isolation one acquires upon entering it. The slow progression away from the normative campus buildings, past the prairie field, and into the controlled landscape creates a natural threshold; a decompression pathway that eases you into the

Decompress the removal or lessening of pressure in a chamber in which a person working in abnormal pressure is gradually readjusted to normal pressure

contextual transformation. Where this isolation is most tangible is within the permanent old growth of poplar trees already too mature for transplantation. At the boundary edge between the public field and the university stands three impossibly linear colonnades that create a spectacular correlation between the intent of designed space and the power of natural landscape (see figure 13). I chose to site the facility at the originating / terminating end of the colonnade, with the building itself acting as a threshold to the interior natural hallway (see figure 14).

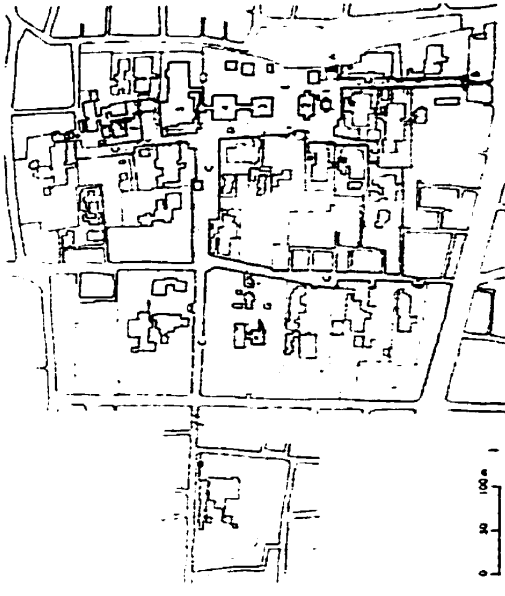


Figure 13. Daikoku-ji Zen Buddhist Monastery, 1319, Kyoto. Illustrated in *Spiritual Path, Sacred Place*, p. 182



Figure 14. Aerial photograph of the University nursery

PROGRAM: INTERIOR SPACE

The facility is comprised of three major sections: a private section that consists primarily of individual offices, a semi-private section that houses the administrative offices and dining area, and a public section with a lecture hall and gallery. The private section is appropriated to parts of the program that deal principally with the *active* study of the science and consists of twenty individual offices. Half of these offices are assigned to physicists with permanent academic

positions within the University while the other half is reserved for visiting physicists which also feature a library and computer work stations. The semi-private section, acting as the hub of the building, has the administrative offices, the main reception, and the social component of the program: the open kitchen and dining hall. Separated from the two other sections is the public area which holds a small lecture theater with a maximum capacity of 100 but is convertible to contain a more modest gathering of 20 to 50 people. This area also includes a gallery adjacent to the main entry where exhibitions can be held to present a greater awareness of theoretical physics at a public level.



Figure 15: Photograph of tree colonnade

EXTERIOR SPACES

The exterior designed spaces are established to act primarily as interstitial zones that connect the interior spaces of the program to the existing conditions found within the nursery. They are also meant to draw people back to the natural landscape from the interior of the building through various zones that act as accesses into the nursery. The main exterior spaces consist of: a main interior courtyard with a reflecting pool, a private deck that runs the length of the physicist's office, a court that links the private areas to the main courtyard (see figure 10), a dining hall terrace, and a raised court adjacent to the lecture hall which accesses the interior courtyard (see figure 9). Along with the main exterior spaces there are a number of paths and ramps around the exterior of the building that supports the vital connection of the facility to the nursery while orienting each of the major exterior spaces throughout the complex.

Having established the functional components required for this type of facility, the next step in the design process was to conceive the framework from which the formal design of the building would continue. This was accomplished by formulating a spreadsheet that included the interior components of the building, the exterior spaces around it, as well as two additional layers that organized these components in a comprehensive system. These two additional layers were: scale, which directly translated to a hierarchical organization of public and private spaces, and transparency. The transparency defined by this system relates to how one spatial component of the program relates to another and how these spaces can be intimately connected to one another while having distinct programmatic and physical identities. This simply means that each functional element of the building may not necessarily require an explicit separation from the rest of the program; rather, the layering of these components through spatial definition is what can create a richer, layered experience within the building.

Generating the program within a spreadsheet format allowed the manipulation of this system according to practical considerations in the utilization of the building, considerations that had to be satisfied because of its influence on the progression of the design. The spreadsheet format proved a most useful tool in conceiving the program. Not only did it outline the various elements required in the design in a clear and systematic manner, but the nature of the computer program allowed the orchestration of these elements in an explicit fashion by clearly indicating the various levels in which all the components were connected. Because a spreadsheet is not read in a linear fashion but is understood and conceived as an aggregate compilation, it distinctly represented the interconnectedness of a comprehensive program study. Editing the program, from room sizes to public and private sequences, invariably meant that even the most minor of changes would influence the organization in some manner. In the end, the objective was met by conceiving a

programmatic framework that responded to both the functional and phenomenal requirements of the building.

PROGRAM: a theoretical physics research facility

Public (scale & sequence)

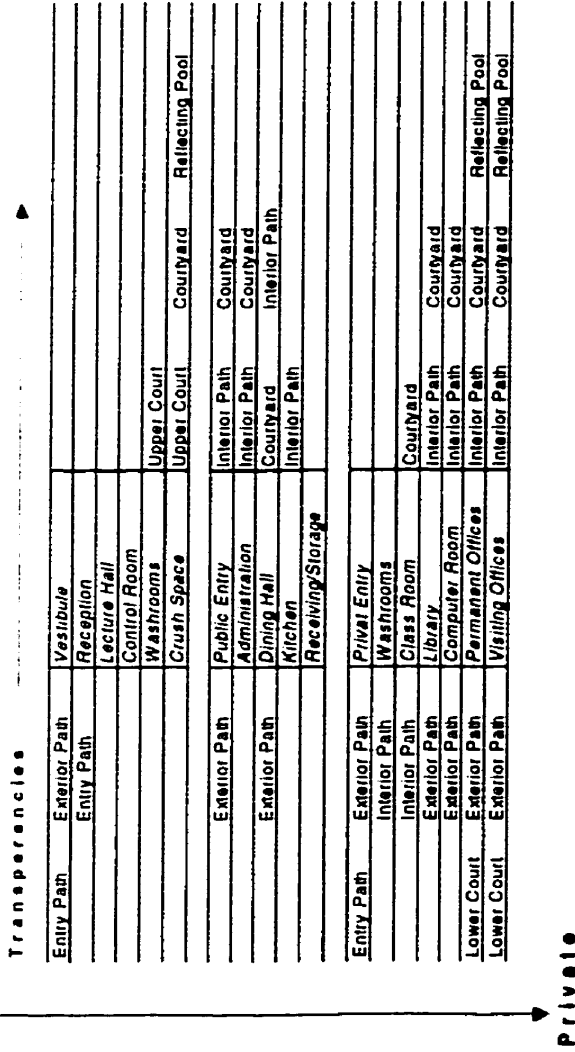


Figure 16. Programmatic framework spreadsheet

The organization that was produced by this framework informed the direction of the design on a number of significant levels. The program laid out the primary areas that constituted the public, semi-private, and private sections, established the hierarchical relationship of scale between the components, influenced the manner in which these areas were to be connected, and finally clarified the sequence of movement between these spaces. This provided a direction as to how the infrastructural spaces, or the interior and exterior movement systems, could facilitate the reiteration of the experiences and perhaps inspire the cultivation of a ritual.

MASSING

The public component of the building is furthest removed, in program and in formal representation, from the rest of the facility (see figure 17). Its roof lines are disengaged and tectonically representative of each of its components: the box of the lecture theater, the spine of the gallery and crush spaces, and the public amenities and exterior access. This wing of the facility hides nothing, clearly identifying and revealing what constitutes it. The semi-private and private areas, however, are less revealing (see figure 18). Each of the components for these two sections sits beneath one seemingly normative roof line; a typical overhang runs the length of the facade that faces the university creating a singular horizontal datum opposite the verticality of its campus neighbors. The spine of the public section intersects with the private wing to create a void between these two masses that reveals the main public entry. Below this overhang the mass undulates against the force of two major programmatic areas. The first, a two-storey section defining the administrative hub, separates itself to produce a transparency to the colonnade of trees for the office hall with its clerestory windows creating a lantern against an otherwise blank facade. The second programmatic force that breaks away from the wing is the row of private offices, or cells (in the monastic, not the detention sense), that hover half a storey above grade. This most private of spaces is concealed behind another colonnade of trees and earthwork that terminates the parking lot, and regardless of the offices' proximity to the main entry condition it does not reveal itself to the public occupants until they have traversed the entry ramp, once removed from the adjacent area. The opposing side of this wing is much more revealing. The interior areas open themselves up to the main courtyard, creating every advantage to participate in the exterior spaces. The roof no longer continues its protective overhang, instead it transforms into part of the wall plane, framing its exterior adjacencies (see figure 19).

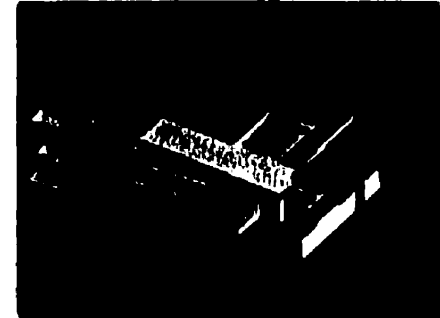


Figure 17. Massing Model Public Section

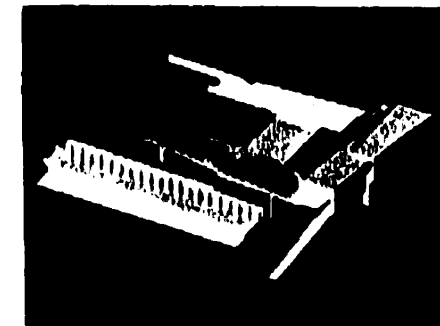


Figure 18: Massing Model Private Wing

MATERIALITY

The four major massing elements are also distinguished by their material. The material found on the facility is meant to connect it to its natural as well as contextual environment. The natural tones of the wood siding that clads the physicists' cells helps to merge that element of the facility with the adjacent trees but separates it from the concrete panel cladding of the administrative hub. These concrete panels resemble the prevalent cladding found throughout the buildings on the University campus. Their reddish tones help to balance the shift of material from the clear stained wood siding of the cells to the smooth finished, bare concrete, monolithic rampart walls. The smooth concrete in turn intersects with the smooth finished material of the theater. The theater is clad as a box of smooth limestone, the polished contrast to the wood cells. By being structured from natural elements these materials assist in both: identifying the programmatic components of the facility and rooting the masses of the building to its natural environment.

Most of the building's perimeter is defined by a monolithic, smooth finished concrete rampart (see figure 20). One section of this system of walls acts as a foundation for the public sector, interrupted only by the massive corner of the theater that breaks apart from the rigid geometry. By raising the public entry, the gallery and the adjoining theater vestibule above the ground, it attenuates the public participation to the immediate landscape, further defining the programmatic elements within it as purely destination. The public functions observe, not participate, in their natural surroundings, creating a landscape appropriate as a backdrop to the size and nature of the proceedings held within it. This separation is not purely restrictive. An exterior court that runs the length of the crush space, or vestibule, of the lecture theater has a commanding view of parts of



Figure 19 Massing Model Private Wing Roof

THE RAMPARTS



Figure 20 Massing Model Ramparts

the city as well as a direct connection to the main courtyard.

The rampart around the private wing, and directly adjacent to its kindred public form, acts in a completely different manner. Instead of isolating the mass it supports from its immediate landscape, reducing the occupants to mere observers of their surroundings, this section of the rampart promotes an active participation in the natural environment by directing and integrating the user's focus to the tree-lined pathway. This wall exposes itself at the front of the building as the backdrop for the main entry ramp; however, to the occupants of the private wing it is their main entry condition: pulling away from the ramp and the building, creating an exterior hall that turns the corner of the wing to reveal a direct line of sight to the colonnade of trees and as it moves beyond the public section it fragments: promoting the transparency between the private wing and the main courtyard.

MOVEMENT

By providing a coherent sequence of movements in and around the building it creates the necessary interaction of related functional activities while promoting meaningful excursions and associations with occupants and guests of the facility. As well as promoting intellectual exchange between the building's physicists, the movement that is generated around the building is meant to encourage a connection to its surrounding landscape. These sequences are inherent aspects shaped by: the entry conditions, an interior vertical movement system (the ramp), and by the exterior pathways created by the building's intervention with the colonnade of trees. Providing for various paths of travel is meant to suggest a more intimate connection with the facility and its setting. The path chosen is dependant on the level of engagement the user wishes to have with the natural environment. The building's site at the focal point of the centrum created by the rows of the old growth poplar trees, is meant to suggest the extension of the facilities connection to its

natura! surrounding. By creating the system of circulation around the nursery any individual (private or public user) can engage with the entire building and its surroundings at a more intimate scale.

My intent in providing for these pathways is to create a fluid framework of movement, not just within the confines of the building's structure, but around the natural landscape of the nursery that encircles it. The anchor to this tapestry of movement is the line of existing poplar trees. Its dominating presence is the catalyst to the sequence of movements that enriches the experience of visiting the facility. Starting with the *decompression* pathway that defines the entry promenade, the system of paths directs you into the facility where you are connected to the internal circulation as well as the continuous avenue that circulates through the main courtyard, into the tree lined colonnade, around the nursery and back through the main threshold of the ramparts that introduces you, once again, to the main courtyard. This system creates a fabric of movement that maintain varied levels of transparencies with interior and exterior components of the facilities program. Because movement is a key element in the operation of the facility, the structure of the circulation system is rooted in maintaining a direct association with the exterior spatial anchors. These connections are formed by generating layers of transparencies which are correlated to the level of participation the user engages with the program of the building (see the programmatic framework). Although the most private of programmatic functions maintains the most direct of these connections, the interior public participants are initially introduced to the system of movement as observers but are given the opportunity to participate with the fluid framework at a more intimate scale upon engaging the exterior public spaces. The various levels of participation and transparencies that exists in the fluid patterns of motion exists to generate the rhythm of movement required during the course of developing rituals within the facility.

ENTRY

As previously described, the public entry condition acts to delineate the course of arrival to a specific destination. The explicit separation from the surrounding landscape, particularly the colonnade that this entry promotes, is made to reduce any public interference with the private sequences. This does not, however, reduce the public's experience to a typical lecture venue. Although their participation in the facility is ancillary, they are only one transparency away from engaging in the rich exterior spaces.

The principal entry for residents of the private wing, the administrative and academic staff, is a less explicit way of entering the building. Rather than create conditions that point one directly to the interior of the facility, the path defined by the private wing rampart promotes the traversing of the nursery. By placing this path directly on the centrum, or focal point, of the colonnade, one is invariably drawn into it, demanding an intimate engagement, a diversion into a powerful and perhaps inspiring environment (see figure 7).

There is only one major movement system found in the facility, with all other motion promoted by programmatic transparencies (overlapping functions) that flow from one area to another (see figure 21). This interior ramp system is intended to encourage a social atmosphere for the residents of the facility. With its slow and broad incline it does little to accommodate a rapid progression to a given destination; instead, it advocates discussion along its path while offering a pause at the intermediate landing where an oversized window seat focuses on a view to the main courtyard. The interior ramp shares its capacity to encourage discourse with its placement along the centrum of the colonnade. By placing the ramp along this course it once again stands in service to the overwhelming attraction of the nursery (see figure 11). Even as they enter from the parkade below the private wing, they find themselves ascending directly into the centrum where

INTERIOR

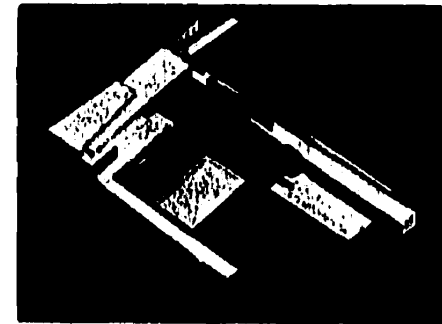


Figure 21. Massing Model Interior Ramp

the west curtain wall frames your view directly into the colonnade.

The paths around the facility relate directly to the hall of trees in one form or another. The movement patterns defined by the ramparts as well as the courts, extensions of the interior spaces, all engage this colonnade. These paths guide your way back into the facility grounds through a focal point extended beyond the row of trees, at the separation of the public and private sector ramparts, and below the spine of the public block (see figure 8). When the trail is completed you find yourself at the termination of this centrum with the mass of the facility and the breach between the concrete walls refocusing your perspective back into the facility and into a serene interior courtyard and the stillness of its reflecting pool.

Amidst the invitation for movement and the active engagement of the natural landscape, a respite reveals itself quietly for both; a public participation at the reflecting pool in the main courtyard, and a private space for contemplation in the physicist's cell. These serene areas promote the more introspective discipline required for studying theoretical physics.

The reflecting pool, shielded by the mass of the private wing and the ramp off the public court, is the harmonizing point of the focal energy constructed by the row of poplar trees (see figure 22). The pool's horizontality, antecedent to the vertical presence of the trees, offers a contrast without antagonizing the authority of its natural surroundings. The formation of the pool, besides adding meaning and purpose to the courtyard, generates the desire for the public audience to participate

EXTERIOR

STILLNESS: THE REFLECTING POOL

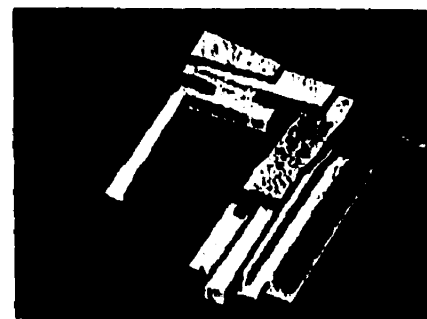


Figure 22 Massing Model Reflecting Pool

in areas outside the defined forum. Here they are invited to participate in the surrounding landscape as well as gaining insight to the spatial definitions that support the facility. Only its materiality challenges the spatial configuration of the interior courtyard. The western edge of the pool abuts the public ramp to the inner courtyard and the intersecting masses define the gap of the spout of running water. The water cascades smoothly past the low lying curb and into a flat landscape of natural rock (slate and shale) that lines the bottom of the pool. These rocks create a pattern along the reflective smoothness of the water's surface as well as acting as a sculpted rock garden during the colder seasons.

THE CELLS

The designated space for the physicist's work area does everything to turn its back on distractions however attractive they may be (see figure 23). The office cells have no immediate connection to the courtyard and reflecting pool and are removed from viewing the line of trees that pervade most every other area. The physicists, once inside their cells, are insulated from both interior and exterior activities. From the interior ramp and the public movement system in front of the private offices there is an interstitial zone defined by the edge of the floor plate and guard rail above. This zone creates a threshold for each of the doors that runs the length of the twenty offices. Without explicitly defining their private zone, this threshold acts as another decompression section that relates each of the cells to one another and also prepares the scientists for their detachment from the surrounding activities.

Once inside, each physicist resides within an office that sits silently behind another dense row of trees. The east end of the office is defined by an exterior door to the private deck and a built-in system of millwork furniture that frames a solitary corner window. When a scientist takes possession of his office, he is able to configure the built-in unit to suit his needs. From storage, shelving, or even a desk, this unit is flexible enough to permit various solutions for the relationship of the scientist to the solitary window. The built-in unit and a bulkhead above that houses task lighting frame the window which sits at standing eye level. This window does not bestow an expansive view to its surrounding. Instead, it frames an immediate view of the trees in the foreground, indicating its proximity without dramatizing its overwhelming presence. The focal point of the room is the east wall. It is the sole connection to the outdoor setting and the principal work space for most of the scientists. Whether the occupant is a member of the permanent academic staff or a visiting lecturer, each is given the opportunity to arrange the wall unit in any suitable manner. Composed of a free-standing composition of millwork, this piece of furniture is a

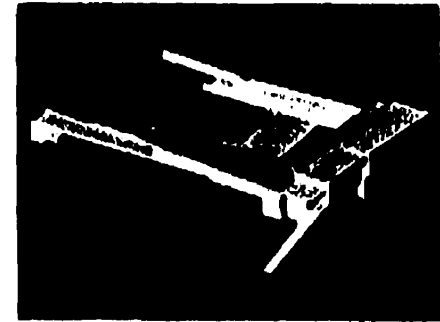


Figure 23: Massing Model. Private Offices

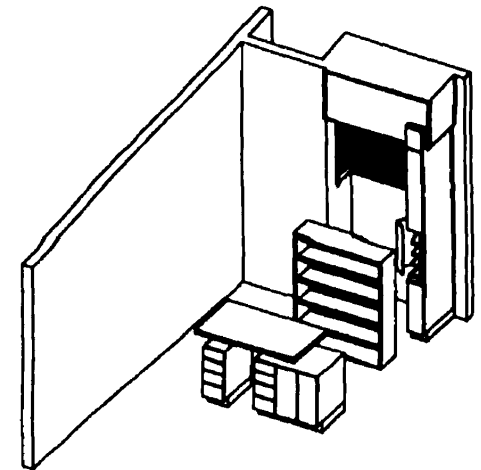


Figure 24: Interior Model

complementary unit of 'plug-ins'. These plug-in components define the ultimate use of the wall unit, each user's connection to the outdoor transparency and ultimately the function of the immediate space. If the physicist prefers to rearrange the wall units, they can be simply separated from the standard five unit configuration. Once separated, each component can stand on its own or in another assembly with the other units in another part of the office or simply stored away.

The five unit composition is made up of a tower storage unit (the only unmovable part), two lower cabinets, a desk top and a stackable book shelf (see figure 24). When all in place, the unit is a compact arrangement of work space and storage (see figure 25) but the built-in castors on the bottom cabinets and the interlocking joinery of the desk top allow for easy detachment. The individual units can be simply removed from the wall and storage tower (see figure 26) leaving the alcove free for furniture placement or the units can be configured more sparingly to accommodate a large desk (see figure 27) or a full height shelving system (see figure 28). While one physicist may choose to fashion his unit with the desk and drawer, allowing for a direct connection to the window while working, another might choose to utilize the space exclusively as book shelves, reducing the direct connection to the view from the window. This unit is not intended to be the sole piece of furniture found in each office, but it does act as the primary functional element for those physicists visiting the facility for a limited time. For the permanent staff members, it is the solitary spatial component that they have direct control over, providing them the opportunity to engage with the inherent relationship of the office with the exterior landscape of trees.

When a physicist ventures into the exterior landscape adjacent to the cells, he finds himself on a wooden deck the length of the twenty combined offices. This verandah placed underneath the backdrop of the canopy of trees acts as a release from the intimate scale of the cells creating a semipublic area exclusive to the use of the physicists. It is a place where they can discuss, exclusively, areas of their profession understood by the few that share the private area.

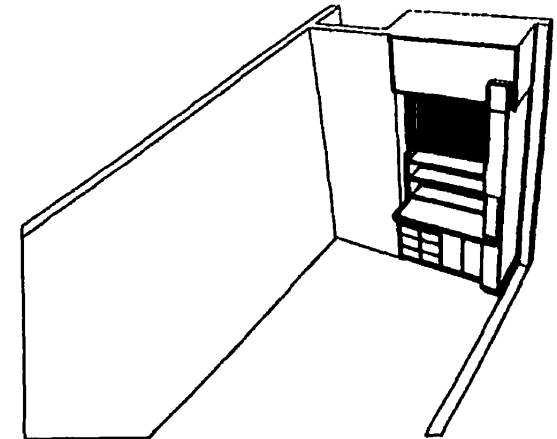


Figure 25: Interior Model

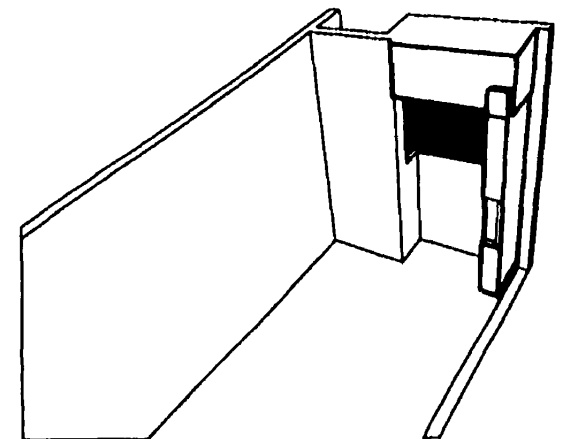


Figure 26: Interior Model

Free from distractions, the cells' connection to the surrounding landscape occurs at the opposing perception of the centrum created by the row of trees, amidst the canopy and perpendicular to the colonnade it generates. These offices are situated to offer the most potent connection to nature, participating at the most intimate of levels where the viewpoint belongs to the trunk of a tree or a branch of leaves (see figure 24): a scale void of diversions where the rhythm of complex thinking can harmonize to unhindered clarity.

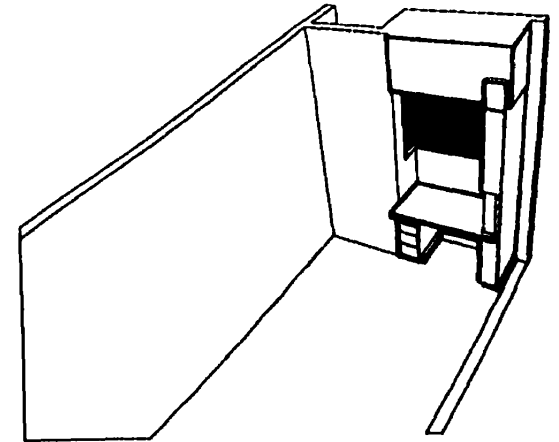


Figure 27: Interior Model

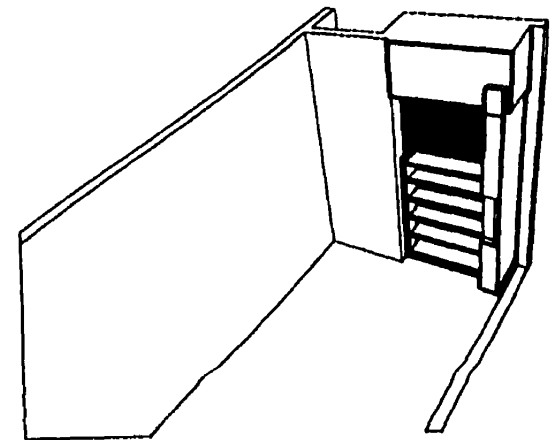


Figure 28: Interior Model



Figure 29. Photograph: Close-up of poplar trees

CONCLUSION

When architecture is able to resonate with purpose it can assume a greater role of harmonizing the human interaction within it, acting as the facilitator to consequences that transcend typical aspirations. These aims, however commanding and ideal, are firmly established on the basic assumption that any built form designed for human interaction can be given the opportunity to generate a profound impact on its users. By composing the conceptual framework of a building's purpose and function into a coherent organization, I believe the impact and meaning of space can be achieved through our understanding of the hierarchy defined by the constituent elements of program and the resulting events and sequences that it creates.

Architecture can be seen as an instrument, not an instrument of measurement in the scientific definition, rather: a musical instrument.

Lebbeus Woods¹⁰

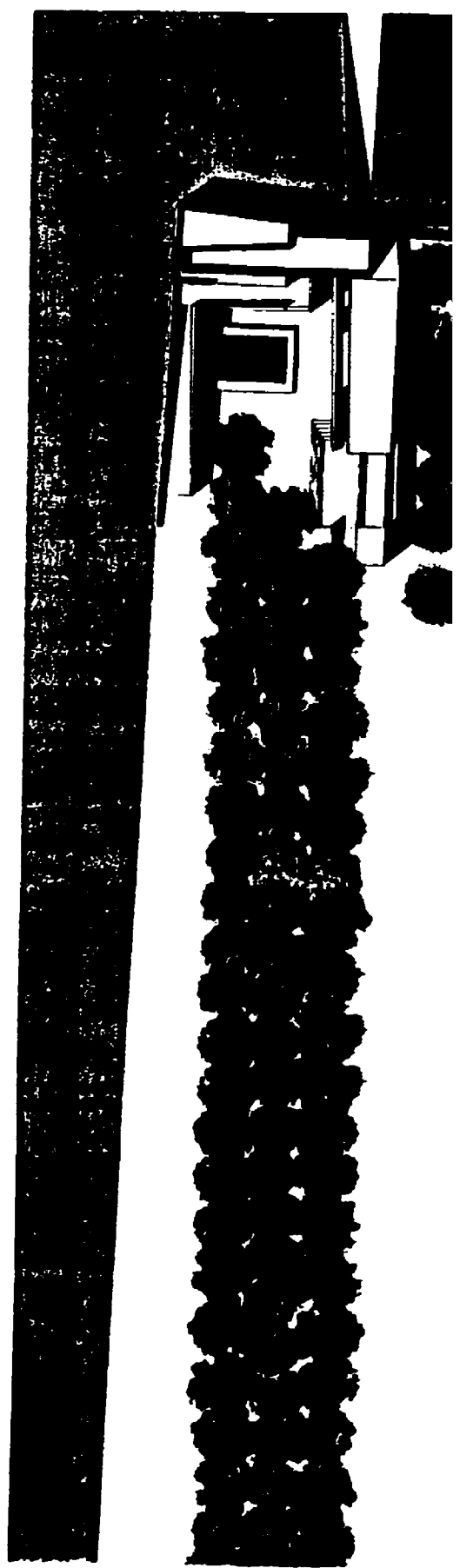
In Lebbeus Woods' statement regarding architecture he states its poetic strength but also reveals its structural weakness. How easy the practice of architecture would be if, like a scientific instrument, one could implement it to achieve a given set of goals, but certainly how dull. Instead, much like a musical instrument, its capacity to evoke greater human emotion lies in its elusive

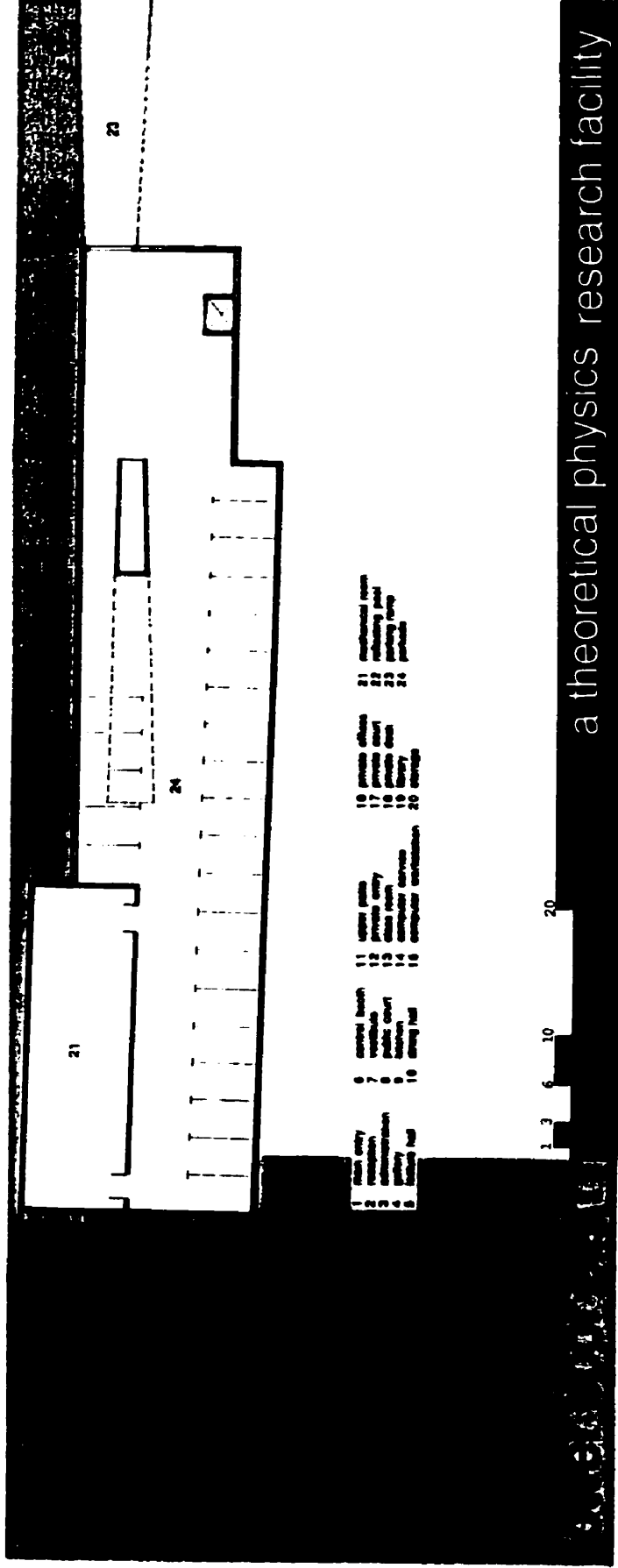
nature. Architecture as facilitator is instrumental in encouraging the process of discovery that underscores the researching of theoretical physics. The determinism of architectural intent, however, contradicts the indeterminism of human action. Whether the space designed is actually utilized in the manner for which it was intended in the end is perhaps inconsequential. The incidental, accidental, and coincidental is what in some instances gives life to an otherwise inert space, but as architects we cannot assume this will occur, only encourage that it can.

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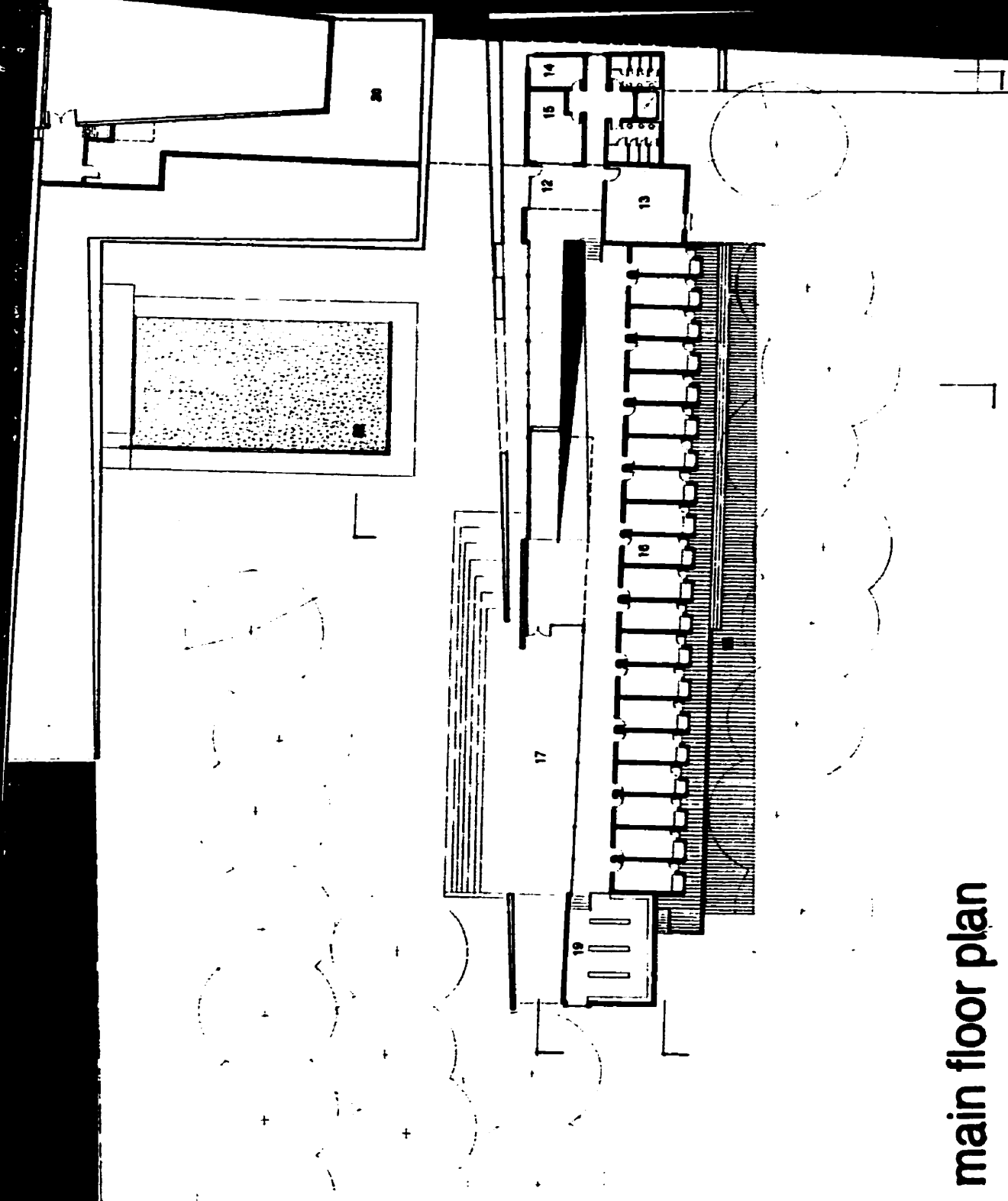
APPENDIX: DESIGN DRAWINGS



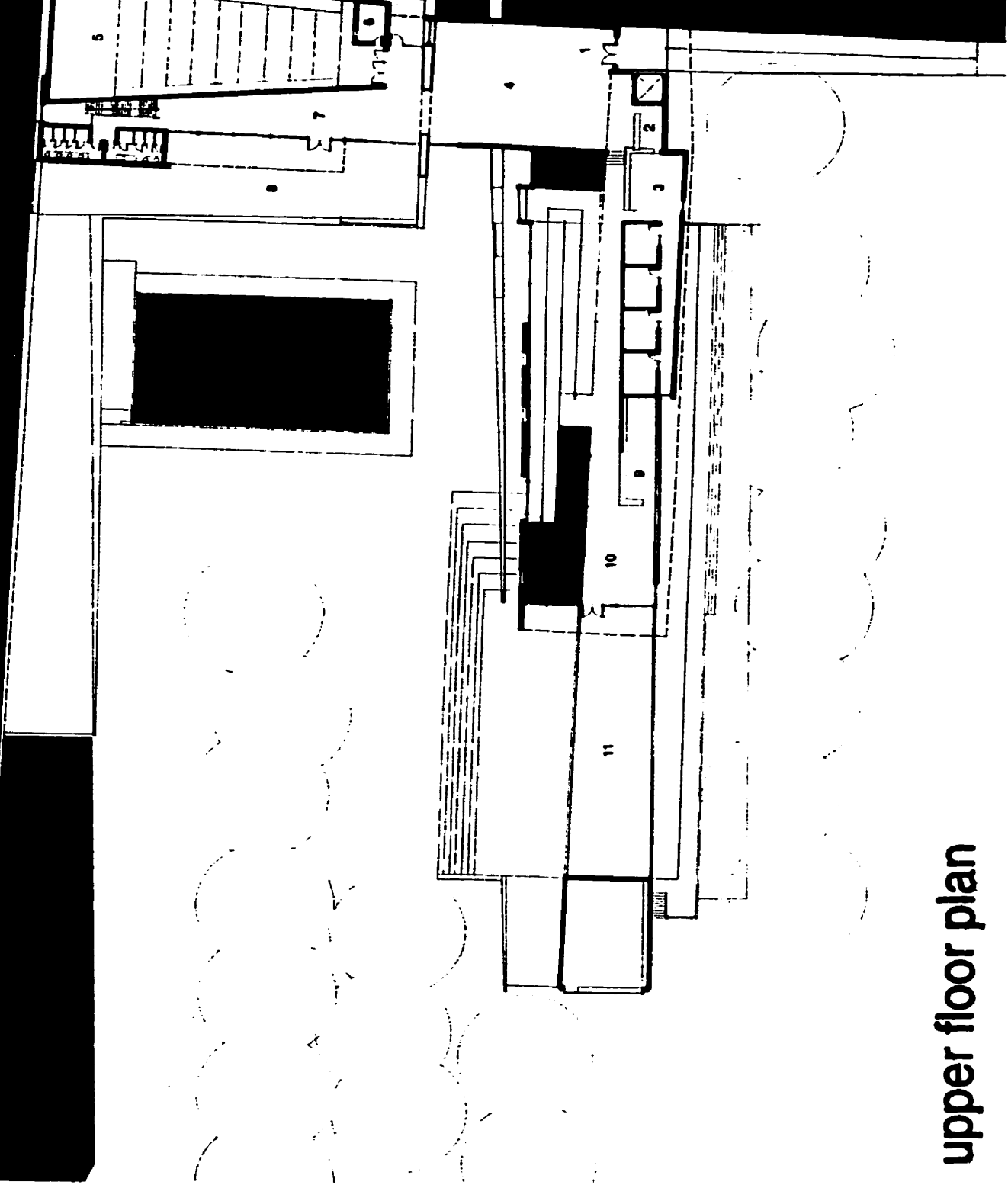


- 1 main entry
- 2 main office
- 3 main office
- 4 main office
- 5 main office
- 6 main office
- 7 control booth
- 8 control booth
- 9 control booth
- 10 control booth
- 11 control booth
- 12 control booth
- 13 control booth
- 14 control booth
- 15 control booth
- 16 control booth
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- 24 control booth

a theoretical physics research facility



main floor plan



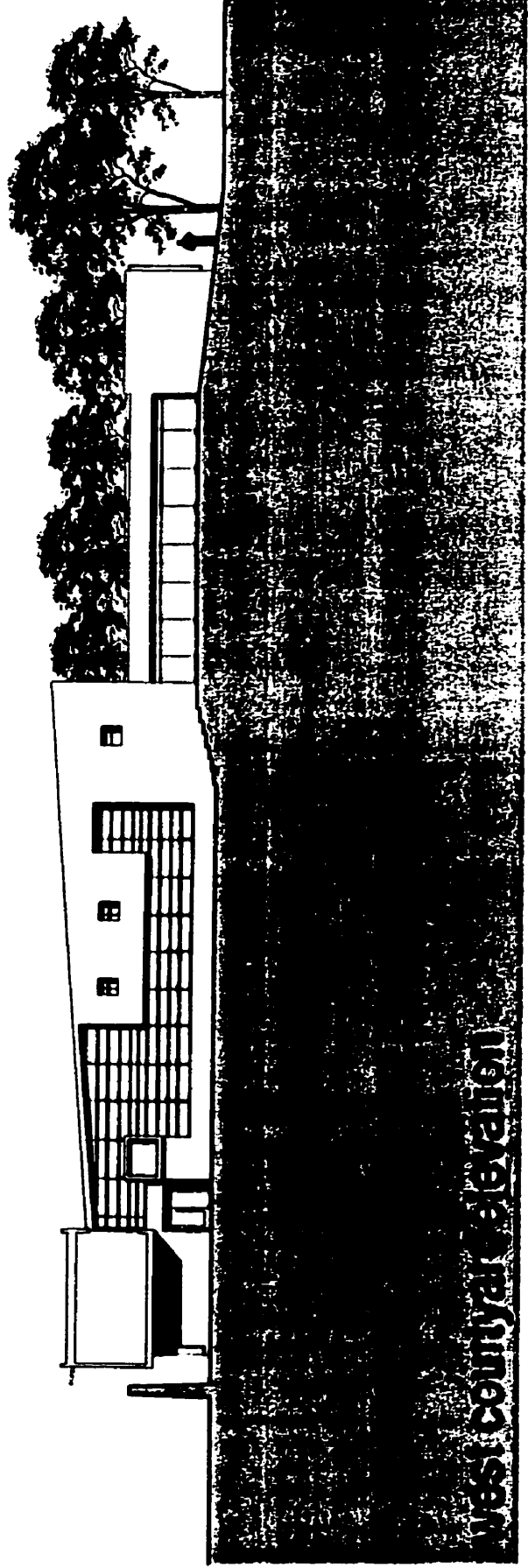
upper floor plan



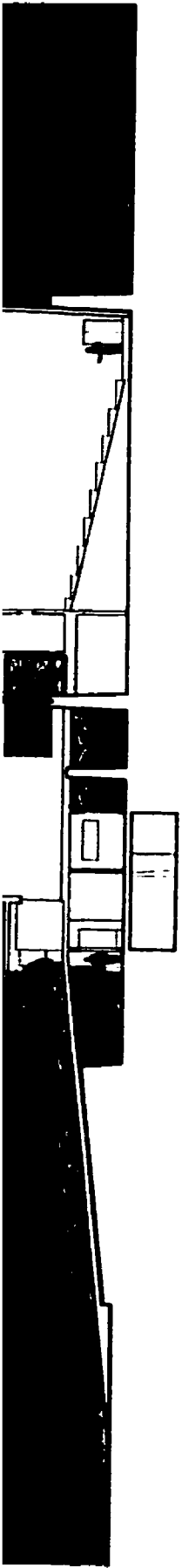
COMPTON

north elevation





West County Jail Elevation



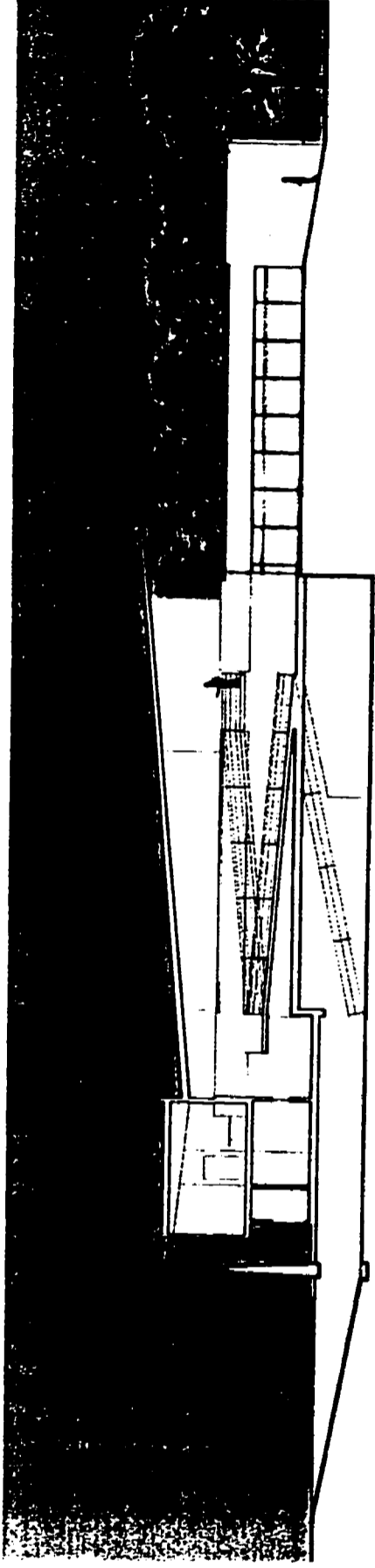
section A



section B



section C



section D



section E