KNOWLEDGE IN FORM
Design Projections for a Museum for Learning and Environment

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"Children learn by looking. Do we remember the layout of the flat or the house where we spent our childhood? - We would have to think for a while. But we do recall the worn sandstone steps, the flaking rendering on the bottom of the wall, the colorful glazing in the front door, the striking of a clock, the sound of a door closing, the smell of warm wood, the rain on our hands, the feel of the sand beneath our feet..."

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And because there are certain types of debts which can never be repaid, this thesis is . . .

for my parents . . .
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ABSTRACT

This thesis is an effort to begin to understand some of the problems and possibilities of architectural production in an age of advanced information technologies. The driving concern behind this work is the increasing distance between our environmental understandings, as they are affected by these new technologies, and the immediate physicality of the world around us. This increasing distance has been further exaggerated by our shift into more and more complex systems of architectural production, making us less and less likely to stay in touch with the full informational content of the physical materials and processes involved in that production. This thesis strives toward an attitude toward design which respects the information and knowledge content of the components and processes of architecture as a complex artifact. Part of the attempt here is to consider the opportunities for relaxing the tendency to impose our will insensitively on the the true nature of things. It seems that as we alleviate this tendency, we might begin to construct environments which sustain us in more meaningful ways.
The thesis itself is composed of six parts:

- Section One discusses developments in the cultural role of museums in recent years and the importance of museums as a way of transferring knowledge. Also introduced in this part is the notion of a host museum; responding to a perceived need for local forums to foster greater awareness of our physical and cultural environments.

- Section Two introduces the site in Cambridge as an urban setting, including some of its history and its physical and social significance.

- Section Three presents general architectural concerns addressed in the project, illustrated through references and diagrams of design decisions, grouped into five categories of issues, from urban context to material deployment.

- Section Four elaborates on the setting of these design decisions within the larger context of 'forming', regarding the process of design as a decision structure for the management of physical information.

- Section Five presents the specific design decisions realized in the project (in accord with the five categories established in Section Three) illustrated through plans, sections, detail studies, etc.

- Section Six proposes an understanding of architectural artifacts as manifestations of their decision structure and offers the beginnings of a theory of production based on the exploitation of "cheap information".

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Top Part of the Machinery Court.
Top right The Indian section.
Centre Powers's 'Greek Slave'
Below left Greek and Persian sections.
Below right Egyptian, Turkish and Greek stalls.
The role of the museum as a building type has changed considerably since its introduction during the Enlightenment only two centuries ago. In the last ten years or so there has been a rapid rise in the interest in and construction of new museums in virtually all major urban centers. It has been suggested that this is primarily due to a renewed interest in institutional culture. I might suggest however that this is at least equally due to an increasing dependance on the institutional structuring of our social or cultural consciousness. Seen in this light, the recent boom reflects not so much a social interest as a social need.

The use of these new museums is consequently of an entirely different nature from those early "temples of art". We no longer necessarily go to the museum to spend an afternoon in contemplation of the sacred icons of history, but perhaps to learn and/or assert our place in the world and our role in society. This desanctification or demystification has led to the current interpretation of museums as places of social activity, social learning and cultural work.

1.0.1 Reforming the Museum

These changes of interpretation have led to significant programmatic changes of increasing complexity. Permanent exhibition space is no longer the singular driving force of museum planning. Places for the sale of publications and other retail trade, cafeterias, work and research space, administrative offices, performance space and space for "new media" presentations are all becoming increasingly important.
Some have argued, in fact, that the 19th century notion of the museum as an accumulation institution has been made obsolete by the mass media. The implication in this argument is that a physical knowledge repository can be transformed into a non-physical one, with an implicit assumption that the appropriate knowledge can be successfully transmitted through these new information technologies. I would suggest that this negates the possibility, as well as the necessity, of direct physical involvement as a means of knowledge acquisition.

Another trend of recent years is the increasing interest in museums of science and technology. While scientific museums are not a new phenomenon, their social importance and proliferation since the fifties is clear evidence of the changing role of the museum. These museums, as well as others offering themes ranging from film to anthropology, also tend more toward the active, social, participatory role of a cultural institution.

Likewise, the architectural intentions for recent museums have become more participatory, although the range of responses within this one intention have varied dramatically. Two clear attitudes emerge from this recent work. The first is transparency. The archetypal version of this attitude is Beaubourg in Paris by Piano and Rogers. The second attitude is what might be called micro-urbanism. An archetypal example of this is the municipal museum in Mönchengladbach by Hans Hollein.

The building form of Beaubourg could be described as demonstrating a complex simplicity. While the overall spatial configuration of the building is simply a single large container within the city, its technical execution results in a very refined techtonic
assembly. This assembly not only reveals its contents to city in an enlivening way, but reveals its own nature and making: its services, components, connections, and forces.

Hollein's museum achieves its version of openness through a smaller, incremental deployment of specific places, knitted into the surrounding urban context. The resulting form or "landscape of buildings" of the Mönchengladbach museum tends toward an opposite pole from the Beauborg: simple complexity. This integration of the museum as an institutional presence within its own constituency avoids the impression of an exclusionary withdrawal or cultural fortress.

It should be understood that the two attitudes described above are not executed simplistically in either of these buildings, nor are the attitudes mutually exclusive. One of the intentions in this thesis, in fact, is to employ both of these strategies in offering a cultural institution which might help to reestablish the connection between a population and their cultural and physical environment.

1.0.2 • A Museum for Learning and Environment

Returning for a moment to the changing role of the museum, we can characterize the current trend as a transformation from museums as warehouses of sacred artifacts to places of social learning. One might begin to make a projection from this trend to the overtaking of the civic stewardship of the artifacts by the civic dependence on a place of social exchange. It is worth considering implications this has on the role of the curator. If we are actively interested in forging our own collective consciousness, we must take on
the role of the curator ourselves. This can only come through a participatory dialectic social exchange. The museum, then, acts as a forum of social conflict and discovery.

The significance of this projection of the museum's role is that the permanence of the urban institution as a place begins to overshadow the permanence of a restricted theme of knowledge for which the museum is responsible. From this I am offering an altered strategy for a museum program: an intersection of museum and gallery, a local host museum.

A metropolitan region such as Boston, rich in physical and cultural history, has a large body of artifacts and museal institutions in which to house them. An interesting problem which accompanies this is not unrelated to the essential problem which accompanies any significant accumulation of knowledge: organization and unification. How does one preserve the developed specificity of knowledge while maintaining the coherent relationships between larger levels and categories of knowledge?

The proposal for the Cambridge Museum of Learning and Environment is intended to respond to this opportunity. Acting as a local host, the museum would serve the community as a forum for the exchange of ideas, drawing from the wealth of artifacts and experts in Boston and Cambridge. As a civic institution the museum could bring forward issues and information which are of interest and importance to self-conscious life of this urban community.
1.0.3 • A Loose Program

Programmatically the museum is established on only a few premises. The first is a flexible exhibition space, not overly large but transparent in its presentation to the city. The second is the use of spaces for movement and access through the museum as a more informal type of flexible exhibition space. The third is a pair of auditoriums for public and educational use, one for interior and one for exterior gatherings, again not overly large but addressed to the city. The fourth is the use of advanced information technologies to facilitate public accessibility to issues and information for individual or collective users. The fifth and last premise is the need for ancillary spaces for retail, research, and administrative space which respond to more incremental urban patterns of building rather than a single large "container" strategy.

The program for the museum anticipates the involvement of a wide range of users, from specialized communications researchers to anyone trying to understand the operations and management of their own local environment. Additionally, the time frame of this use should push beyond the normal daytime hours of many museums, offering events and activities late into the night. In fact, the idea of the museum as a place for communication, conflict and learning seems more strongly rooted in the disorder of the night than in the institutional organization of the day. Certainly in Harvard Square the nocturnal setting of streets, cafés and clubs is a last frontier of alternative viewpoints, spontaneity, aggression and magic.
1.0.4 • Information and Artifacts

Another determinant in the changing role of the museum is the transformation of information dissemination. If the museum is being pushed from a place of material preservation to a place of social education in response to general cultural change inspired by the advent of the information society, it is also being pulled by specific changes in the way in which society holds, transmits, and recovers knowledge. The growth in the complexity of society's organizational matrix and the proliferation of the communication technologies as an essential mediator between individual and society and between individual and environment has added a layer of abstraction between personal experience and global reality. This abstraction increases the distance between thing and idea, between decision and outcome, between action and impact.

Given the assumption that this tendency will not begin to reverse itself of its own accord, one might argue that the reestablishment of the connection of a population and their physical and cultural environment depends on both these advanced information technologies and on the physical presence of things. The museum then, must respond to both ephemeral information and physical things, and most importantly, in order to fulfill the demands of social learning it must look for the intersection between the two: the informational content of the things themselves.

In a sense, the agenda of this museum as a cultural institution could be seen as a compelling challenge to overcome the distancing of our collective apprehension of life from physical and social reality. It is admittedly an ambitious agenda to be pursued through such a modest vehicle.
1.0 • THE MUSEUM IN AN INFORMATION SOCIETY

1 Sola-Morales, Ignasi de. (The Museums of the Last Generation, Montaner and Oliveras, p.7.)

2 Architectural ReProduction, p. 79.

2.0 • THE SITE

The city of Cambridge is a diverse, lively agglomeration of various peoples, places, and opinions; a place where dissent has traditionally been a virtue. Between the institutional poles of MIT and Harvard and the earnest working neighborhoods of East Cambridge and Central Square there exists a patchwork of economic, ethnic and social chaos. The city was long ago described as "an aggregation of three villages held together by visionary bonds and an absolute antagonism."¹ In the spirit of its long history of growth through the conflicts of forthright people and their strongly held convictions, the site I have chosen is an aggressively prominent location at the fringe of Harvard Square.

The site occupies the spot where Massachusetts Avenue joins with (or diverges from) Mt. Auburn Street. The virtual spine of the city, Mass. Avenue links MIT and Harvard, or if you prefer, Boston and Old Cambridge. The juncture of the two streets not only marks one of the recognizable limits of Harvard Square, but is part of a general area currently undergoing urban change and speculation, with gentrification attracted to the high imagability of the Square.

The site is currently occupied by an unlovable white stucco and glass office building and a handful of more and less lovable older commercial and office buildings. The last section of the site has recently been cleared for development. For the sake of the exercise, I have assumed a great and troublesome fire which has cleared the remainder of the site, leaving an open territory from the point of the vee all the way back to the old brick bookbinding warehouse (now an outlet for expensive but conservative furniture).
The existing street level café and bookstore are reincorporated into the new retail program. Surrounding uses included further retail (with a preponderance of furniture stores), a few restaurants, several other bookstores, high-rise housing, several beautiful older churches, and a saturation of architect's offices.

The site enjoys a concentration of energy from both the angular severity of the street intersection and from the anticipatory clues of the nearby buzz of Harvard Square. It also gains strength from the stolid presence of the brick warehouse buildings: a cliff-like wall from which to push out into the city.

This place of conflict and potential seems to present a desirable opportunity for an intervention which encourages local environmental awareness, as well as an awareness of our larger cultural and physical setting.

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1 S.B. Sutton, *Cambridge Reconsidered*, p.3.
Four maps prepared by the Cambridge Historical Commission show street development of the territory that now makes up the City of Cambridge. The dates are approximate. The shaded areas represent marshes and mudflats which were eventually filled. The 1840 map clearly shows the three independently developing parts: Old Cambridge, Cambridgeport, and, at far right, rimmed by marshes, East Cambridge.
From the point of the vee, looking down Mt. Auburn

Looking down Mass. Ave.
The old book-binding warehouse
(now Shilling Furniture)
The northwest corner of the site

Looking up Mass. Ave.
"Each form is the frozen temporary image of a process. Thus, any work merely represents a way station in the process of becoming, and not a frozen goal."

The design process is a forum in which the lives of the physical agents of the building are played out. It is by nature dialectic, messy, and fascinating. This process could also be abstractly considered as an evolutionary network of decisions. The priorities and relationships of these individual design decisions are also played out against one another.

Another interpretation of the design process worth considering is its role in allowing or restricting the flow of information regarding the materials and processes of the artifact. It is within this context that the design issues of the museum are most clearly expressed. Within the web of architectural determinants of this project, those decisions of special interest are ones which allow a greater transmission of knowledge through the direct expression of physical information.

In current architectural production, the design process not only involves complex relationships within both the physical systems and the decision structure, but also enjoys (or suffers) the added complexity of multiple agents advocating their own semi-autonomous agendas within that process. For the sake of this thesis, a necessary leap of faith is the trust that the purposeful semi-autonomy of the decisions made in the design process in some way represent the semi-autonomous (multiple-agent) decisions which exist in our present system of production.

I should emphasize, however, that in spite of this attempt to avoid the serious differences between an individual’s design effort (as a complex single-source decision process) and a cooperative building effort (as a multiple-source process), there is an inevitable tendency for the production to be driven by the primary concerns of that single
producer. In other words, it is difficult for one person to mimic the constant advocacies of multiple agents involved in the present system of production. This issue of decision structure, control, and production will be addressed further in Part 4.2.

What follows in this section is a survey of five realms of design intentions and decisions which establish the matrix of multiple goals for the Museum, primarily addressing those goals which most encourage informational content.
"The variety we see in our environment is directly related to the process involved in its assembly."

--John Habraken, Transformations of the Site, p. 140.
3.0.1 • Site

Responses to the site include:

a: intensifying the definition of the museum's urban edges;

b: providing movement through the site;

c: deploying the large collective spaces as virtual objects to define a continuous open access area for exhibit space;

d: emphasizing accessibility and openness to encourage public use.
3.0.2 • Structure

Structural considerations include:

a: concentrating the structural presence within explicit zones;
b: using repeated structural elements in variable configurations;
c: using the structure to positively contribute to the architectural form by offering some spatial definition;
d: liberating the ground plan for flexible use and reconfiguration by providing a heavily structured horizontal zone from which a smaller structural system reaches up or hangs down;
e: providing an exterior datum from which closure systems extend or recede;
f: allowing variable relations not only with other spatial definition, but also with building service systems.
3.0.3 • Service and Access Systems

Decisions regarding the deployment of services include:

a: promoting the relative autonomy of the service networks within their own defined territory;
b: revealing their presence behind diaphanous screens;
c: prominently displaying communications technology;
d: repeating identifiable forms associated with specific services such as elevators, fire stairs, communications, hvac.
e: using generous access territories as interior streets for exhibition and social exchange.
Herbert Bayer, Newspaper kiosk, 1924
Bayer, Bauhaus, 1919-1928
3.0.4 • Spatial Definition and Closure

Considerations in developing systems of spatial definition include:

a: clearly separating ground-form definition from panel and screen assemblies;
b: using repeating dimensions and components to illustrate decisions made in spatial deployment and offer clues for future change;
c: using containments in states of partial completion to encourage variable relationships of elements and spaces rather than discrete singular experiences;
d: allowing the development of these containments with their share of autonomy, not limiting their role to the subdivision of larger spaces.
Dynamic Colour Composition
80.5 x 81 cm, oil/canvas
Russian Museum, Leningrad
3.0.5 • Materials

Decisions regarding the selection of materials include:

a: using concrete at the larger structural size to provide both structural capacity and usable spatial definition;
b: using steel at the smaller structural size to build up screens through density of assemblage;
c: using masonry as virtual ground-form containments for its earthen qualities and labor process;
d: using glass, perforated metals, and translucent panels to encourage the "transparency" or revealing of the building.
"The craftsman's universe is that of the identification of the object with the world. This continuity between man and object belongs to the classical notion of the artifact."

---Architectural ReProduction, p. 8.
This section attempts to relate design intentions from the previous section to an understanding of the production of built form as a complex, information-laden process. This production is a unique blend of industrial and non-industrial processes.

4.0.1 Craft

Traditional crafts arise from a specialization of knowledge regarding the forming of material and in response to needs of use and desires of expression. The depth of knowledge embedded in the artifacts of these crafts not only inspires specialized professions of archaeological recovery, but generates the human counterpart to the wealth of natural environmental information.

The beauty of craft has always been the close relationship between the active knowledge of the craftsman and the physicality, or internal information, of the material being transformed. In today's setting of industrial artifacts, the choice of buying a handcrafted item is not necessarily the pursuit of higher quality or a more artistic execution, but is often a reaffirmation of the dignity of human knowledge in labor.

Considered in terms of design production, architecture is a highly complex artifact, though not beyond comparison with any number of other modern products. The relative parity begins to fall away however, when the terms of evaluation are extended to user consideration and finally an absolute uniqueness with regard to the fundamental foundation of industrial (re)production.
As a way of introducing the underlying notions of what is meant by "forming" and "informing" in the context of this thesis, some basic concepts and definitions should be clarified. Foremost, it should be emphasized that architecture is being interpreted here as an inseparable continuum of interaction in the exchange of the inhabitants and their environment.

**KNOWLEDGE:** Distinct from information, knowledge in the dialectical sense refers to both the structures which organize thoughts and concepts and the empirically based systems of acquisition and transference. A necessary condition of all knowledge formation is action.

**TECHNOLOGY:** For the purposes of this reading, technology must be understood in its broadest and most fundamental Aristotelian definition as the arrangement of human knowledge and technics. This is critical to avoid the equating of technology with mechanization; as something outside of humanity.

**PRODUCTION:** Production can be understood as the transformation of either material or ideas through action. The vehicle for this transformation is technology (as described above). The close relationship between the production of artifacts (material) and the production of knowledge (ideas) encourages the escalation of technology as an organizational structure.
ARTIFACT: The physical evidence of human action. The architectural significance of this definition is the explicit avoidance of the separation of the objects/environments created from ourselves. While built environments are often considered somehow fundamentally different from other artifacts of production, this thesis attributes the differences to variations in state, not in kind.

AGENTS: A notion borrowed from research in artificial intelligence, denoting a functionary within an organized system to which a simplistic concern can be attached. In the architectural sense it represents singular interests operating within the matrix of production (or organizations acting as singular interests) and acts as a mental construct for looking at the self-serving interests which could be ascribed to autonomous physical systems (i.e. in an ecological model of the building each of the construction subsystems could be seen as having over-lapping and often conflicting agendas).

LIMITS: Prescriptive determinants for ranges of variable behavior. The importance of this notion of constraints on systems recurs throughout explorations of goal-satisficing within non-deterministic environments.
Filters of perception. As a direct result of the explosive growth in mass media and information technologies there have been substantial changes in society's structures of apprehension and environmental expectations.
4.0.2 • Agents of Production

Organizationally, architectural production is more closely related to industrial production than traditional craft production, although it continues to resist pure industrial methodology. The primary justification for its association with industrialization lies in the level of organization necessary for its "rationalized" execution. While the construction industry relies on the manufacturing sector for its primary inputs, its most sophisticated aspect remains the coordination of an astounding number of flexible, autonomous agents of labor and production. The production decisions of these agents are at times marginally cooperative and at times completely independent. One only need study the coordinating performance demanded of the general contractor (and more recently, the construction manager) to begin to appreciate the diverse, often conflicting interests of building trade labor alone, outside of considerations of component acquisition, permit execution, design changes, etc..

Gunter Behnisch proclaims "Techniques and materials have their own structures and are subject to their own laws." In the same volume on his work (Behnisch & Partners: 1952-1987) there is a wonderful essay on the potential of the relative autonomy building systems:

"Industrially manufactured products, including building components, are externally simple but internally complex. With their standard measurements, modular order, fixed tolerances and joints they create seemingly logical, necessarily correct, often dogmatic buildings. The conditions governing a specific system determine the entire construction. All the other components of the building are subjected to this system, whether it is load transfer or the space-enclosing system, though often it is a building services
Thus the individual components can only fulfill their functions within the context of this system, on which everything depends. Somewhere among them is architectural space: a left-over, a remnant. But systems can also be separated from one another and subjected primarily to their own conditions. In this way they can find their own form: load-bearing, space-creating, functional, decorative, furnishing and other systems. Thus a new entity can come about, the result of overlapping structures. They complement one another without coercion - complex, lively, transparent.”

4.0.3 • Use, Goals and Multiplicity

All artifacts of use (within whatever limits that definition may entail) involve the satisfaction of goals. Within architecture it is not only the size and number of components but the multiplicity of goals that drives the unusual level of complexity. Not only is difficult to specify who the users are (owner, developer, occupant, community, etc.) but the demands each of these users place on the artifact may vary significantly over time, including any number of simultaneous conflicting or coincident demands.

In recent times performance criteria in buildings have reached such a high level and such a rapid rate of change that institutions are being forced back into meeting broader criteria at one level, while responding with situational specificity at another level.

Additionally, performance criteria in buildings now frequently includes a live economic profile as the construction industry shifts from an emphasis on new construction to a
The coexistent nature of these many complex use and production demands still are somehow not entirely satisfactory for explaining the fundamental difference between architectural production and other complex forms of industrial production. In considering questions such as this we are so often victims of both our hopes for clear elegant theoretical notions and our skepticism of naive simplifications. What is it about the production of built form that often makes it such a nebulous, frustrating, unquantifiable, and absolutely rewarding endeavor?

In this case the elegant solution seems to offer a wealth of insight. Buildings, unlike Toasters, exist in determinate locations. What is interesting about this banal observation is the implications it has for industrial (re)production. If industrial production is essentially the application of scientific methods to solve specifically formulated goals so as to arrive at reproducible results, not only do buildings fail to provide the singular goals of most other industrial artifacts, but without fail they are intrinsically unable to be duplicated.

Nevertheless, there are obviously many applications of industrial technology within the production of built form. The curious aspect of these applications, however, is that the complexity and sporadic nature of the labor structure itself muddles pure

maintenance and repair strategy. Buildings are quickly losing their privileged position as an environmental given in return for a new role as a capital commodity.

4.0.4 Site and Production

industrialization. It is instead the sub-assemblies that enter the production matrix as rationalized input.

4.0.5 • Elements and Organization

Built form can be thought of both in terms of a temporal reality and as underlying processes (or determinates). In order to better understand the role of the processes in determining the form we can dissect the whole into the components (hereafter referred to as elements, from Habraken) which are being affected by the various processes.

Formal complexity can be categorized according to two fundamental types. The first is arrived at through the complex action of production on one element. An extreme example of this would be a heavily carved baluster. The second type is arrived at through the establishment of complex relationships between elements. Clearly, the two categories could be coincident within one formal system. It is primarily the second type which this thesis is concerned with.

The abstraction of form according to this type was the basis of a great deal of "scientific" exploration of both modern art and architecture. The work of the Suprematists and Constructivists in Russia offers some prime examples. Malevich's works, including pictorial compositions and architectons, were based on a pure elemental simplicity: line, rectangle, square, circle. The dynamic complexity of these compositions comes entirely from their positional relations.
The number of compound relationships in formal systems such as these, can exponentially escalate the overall complexity.

4.0.6 • Chaos Theory and Complexity

The study of the coexistence of simple processes leading to complexity suggests a quick reference to current developments in the science of Chaos. Two fundamental principles of this new science are of particular interest.

The first is the precisely the coexistence of simple processes (in the case of science, natural processes) as the generator of non-deterministic complexity.

The second principle is that of "sensitive dependence on initial conditions" as the key to the network of relationships between these simple processes. In other words, there is a structure of dependencies which are non-hierarchical, therefore the behaviour of the whole system is non-deterministic. (Suggested further reading on this and other topics in Jon Teicher's '89 M. Arch. Thesis, Enabling Housing)

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1 Webster, F. Hood. The Aristotelian v. the Heideggerian Approach to the Problem of Technology, p. 347.

This section attempts to address the issue of the relationship between the production of physical information and the structure of the control hierarchy determining its production. What in previous times was a protracted transformation of the environment by fine-grained decisions of inhabitants has in modern times concentrated into larger, denser, swarms of labor activity operating under the auspices of fewer and fewer decision makers. As decision-makers are further distanced from the physical realities of the artifacts of production they are more inclined to resort to remote abstractions or methods to establish external controls on design decisions. The quick summary of this section would be that as deterministic control increases, physical information in the environment decreases.

4.1.1 Mass Production and Labor

Except in cases of special industrialized housing (trailers, etc.) there is no system of mass production in architecture operating beyond the component level. Even when one looks at so called mass housing, it is actually reiterations of labor, not of object. In other words, unlike classic industrialization, once a design objective is "solved", the solution can never be reexecuted without taking into account the specificity of the site, even on a simple production level of available material, site access and utilities, labor, local codes, etc. In this sense a building is a very different product than other industrial goods. The factory (site) is far too messy and individualistic, the product (building) is not transportable, copiable (even McDonald's franchises show considerable variation), and the labor is not an internal organization but, amazingly, exists as autonomous multiple organizations working within various hierarchical and heterarchical networks attached not to the singular corporate procurer, but to the individual products themselves.
In his book, *Building Construction Before Mechanization*, John Fitchen attributes the
difference between the production of buildings and other handicrafts to size, complexity,
the cooperation of multiple crafts, and the site as factory. I might suggest, however, that
in terms of industrial production these factors could be reduced to just three: the
organization of its multiple crafts, the multiplicity of its performance criteria, and the
specificity of its site.

To illustrate this point it is worth comparing the production buildings to that of an
industrial artifact which shares as many attributes as possible. Shipbuilding, it seems,
offers such a comparison. Ships can certainly match the size of buildings (often much
larger), demand the same level of physical complexity (again, often much higher), and
require a complex structuring of labor. Ships, however, are perfectly capable of being
produced through traditional applications of mass production.

Although labor involved in ship building is highly complex and performed by multiple
trades it still functions under the control of a single corporate owner or producer and is
produced within the arena of shipyard as a factory. The difference this seems to point to
is partly a function of multiple vs. singular control systems, and partly a result of use of
the site as an unavoidably unique factory.

The multiple control systems of the building trades generates the most sophisticated
aspect of the production of buildings: the complex organization of labor. While this is a
messy and robust system, it is also a truly rationalized system of execution, or within our
given economic context, it would cease to exist. This temporal act of labor (manual and
intellectual) should be recognized as a real component of architectural form (again the specificity of human thought and action denies the possibility of reproduction).

There is a fundamental difference between the information content of labor (as knowledge) and the quantifiable aspects of other building inputs, such as material or finance. As Fitchen points out in his attempts at recoveries of premodern building methods in the historical record-keeping of the building trades, no documentation existed on the methods or descriptions of labor, while information regarding the payment for labor was widely available. This small insight helps clarify the differentiation that we traditionally allow between active, earned (dialectic) knowledge and raw quantifiable information.

4.1.2 • Agents of Production

Coincident with questions regarding the organization of control in the production process are questions of the relations between agents generating those decisions. The non-deterministic dialectic of relations between various building systems (i.e., the architectural production process involves constant coordination of various disciplines in a complex network of agents). It is a dialect of the needs of the various semi-autonomous building systems as well as an exchange between producer agents. In other words there is not only a dialectic of formal production but also of knowledge production. The greater the number of decisioning agents the higher the number of specific, opportunistic advocacies.
This section illustrates specific realizations of the design intentions introduced in Section 3.0. In arriving at these specific decisions for determining a form for the museum, two criteria were always present: how to encourage the relative independence of the building's various subsystems in order to allow a fuller expression of their informational potential, and how to develop a richness of physical information while maintaining a reasonable economy of means.
5.0.1 • Site
5.0.2 • Structure

deployment of columns

deployment of double trusses
5.0.3 • Service Systems

doubling of structure to allow service arteries
5.0.4 • Spatial Definition and Closure
Ground Floor Plan
1. electronic "reading room"
2. exhibition space
3. café
4. bookstore
5. terrace
6. amphitheatre
Reference Level Plan

1. auditorium
2. exhibition hall below
3. exhibition space
4. administrative offices
5. library
6. research suite
7. open to below
8. vertical service trunk
9. video "drum"
Section A
1. research suite
2. lobby exhibition
Section B
1 library
2 electronic "reading room"
Section C
1 electronic "reading room"
2 exhibition hall
3 exhibition
Section D
1 lobby
2 exhibition
3 administrative offices
4 link to stair tower
Partial Mass Ave. Elevation at auditorium
Partial Mt. Auburn Elevation at amphitheatre
View up Mass. Ave.
View up Mt. Auburn (Shilling is on the left)
5.0.5 • Materials
The capability of an environment to inform and transfer knowledge is intrinsically tied to the processes of its production. This section broaches the suggestion that our difficulty in producing environments which respond to the full information content of production is strongly related to our inability to reconceptualize long held paradigms of individualistic design into new ones of multiple processes of heterarchical decisioning.

In attempting to clarify the relationship between society's production, use, and apprehension of the environment and the environment's ability to support and inform society, it is helpful to consider the issues from the point of view of recovery rather than projection. The underlying foundation here is that how we work is absolutely inseparable from the form or nature of the artifacts of production; that the quality of each will tell us something of the quality of the other. The hope is that an information-laden environment not only might tell something of its own inhabitation and making and also increase our awareness of artifacts and production as a link in the social dynamic of learning and acting.

The information content of an environment ranges from the immediately observable qualities of objects to the more obscure encoding of principles, processes, and relationships. This information provides the raw input which we process in infinitely variable ways, allowing our production of knowledge. In prehistory the source of this input was typically the natural environment. Historically, the environment has provided humanity with an endless stream of "information" from which increasingly complex and multiple knowledge structures have been built. At the same time it has acted as the silent recorder of the human acts which have enabled that acquisition.
The interpretation, of course, is subject to transformation, as is evidenced by the on-going transformations in our understanding of the natural environment. Nature, in its remarkable consistency, never contradicts itself and never changes its rules. As a limitless source of complex information, it has inspired our contemplation and our efforts at discovery since the beginnings of recorded history. In the ages following the scientific and industrial revolutions, the rapid rise of our capacity for production has come to generate another realm of environmental information: that of our physical artifacts.

6.0.1 • Observation

Seeing is typically one of our primary steps toward knowing. The act of seeing, along with other means of perceiving, is always active, never passive, in spite of our tendency to take it for granted. It is constant through our waking hours, though it varies dramatically in intensity and importance. It is essentially common among us, yet personal and editorial. We use our perception as input for the interpretation of things; to begin the processes which filter, sort, order, and comprehend.

We exercise our perception in much the same way as we exercise our other physical capabilities. There is a need, therefore, for a level of quality of environmental information which is able to inspire the multiple structuring of the raw input into forms of knowledge. (Lisa has no subject worth painting in our apartment interior. Where can the eye of the painter rest when faced with the industrialized poverty of physical form?)

Though we sometimes train ourselves in our perception, more frequently we are trained by society or our immediate sub-culture; to focus on, to see, or to ignore that which is collectively considered important or unimportant.
The relationship between observation and knowledge hinges on the notion that while we are actively observing we are simultaneously (and unavoidably) projecting a structure of cognition onto the object observed. In hopes of skirting an insufficient glimpse into millenia of subject/object philosophy, suffice it to say that just as surely as our knowledge is (in)formed by our perceptions, our perceptions are shaped by our knowledge. The essential commodity facilitating knowledge acquisition is the information content of our environment, including our own physicality.

6.0.2 • Environmental Learning

Learning, or knowledge acquisition, is fundamental to our conception of free will. There is something about knowing that the great truth of the natural environment is out there: equally, for all, across all boundaries of culture, time, power, etc. Built environments, on the other hand, spring out of those very constraints.

In *The Open Work*, Umberto Eco advocates the dynamic exchange between reader and observer in opposition to Croce’s concept of role of the work as a purely mental phenomenon which can be communicated directly from the mind of the artist to that of the reader, viewer, listener.

As an information society we are especially dependent on the individuality of interpretation of information as a guard against the sort of religious or fascistic centrisim of past societies. The control exercised by the modern media of cultural transmission has profound implications on the quality of our powers of observation.
6.0.3 • Recovery

One cannot easily or necessarily read the intentions behind human acts. The acts themselves however, in archaeological fashion, unravel themselves to the careful observer. Layer upon layer of the evidence of action, both human and natural, related and unrelated, forms the whole of our environment.

In this sense archaeology is the requisite partner of architecture. Acting and interpreting; projection and recovery. The simultaneity of these two processes constitutes the unity of habitation.

The recovery of acts, of course can never match their original temporal reality. It is only too obvious that will can never truly understand past (or present) societies solely on the basis of their production of tools, environments, or other physical evidence.

6.0.4 • Knowledge and Artifact

All decisions made in the shaping of physical form by mankind spring from a condition of knowledge. Common to the many definitions of knowledge is the fundamental concept of the holding of information based on experience and the processing of this information into knowledge. Although there is a tendency for the word "knowledge" to be associated with the idea of "truth", there is no direct correlation. This implies the possibilities of "incorrect" knowledge, certainly not uncommon in the act of building.

In the production of artifacts, it is this capability of developing knowledge structures, which are then tested over long periods of time by many different people under a wide range of conditions, and the ability to transmit this knowledge to others through all
methods of communication, including the observable knowledge carried by the artifact itself, that promotes the evolution of techniques and the refinement of form. Each reenactment of the creation of an archetype washes its development with another layer of knowledge.

However, as previously pointed out, that body of knowledge which directs change in artifactual production may contain a component of "incorrectness" or may simply not be utilizing the level of knowledge which had been acquired up to that point. In a sense, knowledge can be lost through the lack of transference. Among countless other examples, we may be reminded of the remarkable loss of craft since industrialization, or the disappearance of Roman concrete technology in mideaval times.

Acts which we consider to be involved in the most primal technology are, in fact, supported by vast knowledge structures. When a potter shapes a clay vessel, her hands carry an entire body of directly related and indirectly related knowledge about the act: the form of the hands of future users; the density, moisture content, and elasticity of the clay; the form of thousands of pots seen before; the relation between the speed of the wheel and the resistance of the wet clay to deformation; the possibilities of its destruction before or after completion; the market value of her labor; the possible future desire to place a ladle within; the required thickness of its walls for firing; etc.

What then could be said about the knowledge which lies behind the production of architecture?
In the case of the potter, there is a direct relation between the mind in which the knowledge is lodged and the execution of the work. Given the complexity of the architectural artifact, this direct relation of entities is not always possible, especially today. The holding of knowledge is transformed into a collective act of exchange, as are the physical efforts of construction.

The conception of knowledge as fundamental in any constructive act raises the issues of the types of decisions in building and which agents are making them. The categories of obligatory, preferential, and incidental decisions can be seen as constraints within which objective ends can be reached. Even incidental decisions are based in some form of knowledge (topological forms of historic buildings, etc.). The significance of this understanding is in the appropriateness of the application of knowledge towards the "satisficing" of goals: the fewer or weaker the goals which are set, the lower the decision category which must be met.

Furthermore, it raises questions about the limits of the specificity of goals. Goal-setting is necessarily a fundamental aspect of the design process. It is also a function which can be either tacit or explicit. As previously described in the case of the potter, the connectedness of the body of knowledge and the process of production in non-industrialized systems encourages a fine-grained set of goal determinants (considered responses to immediate empirical concerns).

The breadth of this knowledge across directly related and indirectly related topics becomes the engine behind the broadening of goal-setting and the elaboration of performance criteria. For example, if a potter knows that a cup is not only intended to hold liquid, but
hot liquids, what may have developed as a simple cylinder now incorporates a handle. If it is then learned that it would be desirable for the cup to sit within the depth of an existing rack, a size constraint arises. And on and on in this way, as this multiplicity in the satisficing of goals begins to drive complex artifacts, and discourages their production from a singular idealized abstract inspiration.
One of the striking aspects of the information age is the definition of a new breed of artifactual complexity. Computerization, unlike mechanization, is not founded on the application of a range of principles and physical realities, but from an almost biological complexity woven from an abstract binary system.

6.1.1 • Form and Information

The beauty of the binary system is the level of information which can be carried with only a minimal level of coding decisions. All inputs are yes/no, while the variable precision is achieved through periodicity, alternation, repetition and the building up of these patterns into increasing complexity.

Information can be viewed as either a condition of existence (as recoverable) or as a dynamic decisioning process. In other words, any generative process involves decision making, of which information stands as the record of that process. The architectural significance of this notion is that behind the nebulous complexities of building one can begin to tease out a fairly codified structure of decisions. And perhaps more interesting still is a somewhat altered perspective on the generative acts of the design process.

The abstract yes/no of binary behavior can be translated into physical artifacts only within a given information context. For example, to say that there will be a column at this location can only be considered binary if a column is expected there (as part of a larger pattern).
To make more explicit the notion of binary and other discrete decisions in form, let us examine a simple design of a columned arcade against a continuous wall. The first physical determinant would normally be direction. That established, the next determinant would probably be "sidedness". In other words, which side is wall and which is columned. Given the context of the direction decision, this second decision could be considered binary. To carry the example further, we see that the positional determination of the columns could be broken into several incremental decisions. By this point, the decisions are clearly non-hierarchical in that the spacing or rhythm of the columns along the direction is neither dependant on, nor is determining their distance from the reference line or datum line of the wall.

While this example is admittedly quite mundane, it traces a relation between the information content of form and its generation through the design process. One begins to think of the information content in the generation of a point in space, a line, a grid, an array... New York City.

6.1.2 • Cheap Information

Operating within a culturally imposed minimalist economic investment in building a desire to invest the artifact with a wealth of information content, we tend to look for effective sources of "cheap information". This information could be characterized as approaching a binary state (i.e. achieving the desired richness with the cleanest, most elegant code). For example, the sidedness of the arcade described above is a simple binary reversal, with out adding information. This state requires very little producer input while yielding high environmental information within a larger system.
6.1.3 *Uncertainty and Probability (Information Theory)*

In the mathematical understanding of Information Theory, information is directly linked to uncertainty. By definition, information is present only when uncertainty is reduced.

6.1.4 *Information and Production*

The "rationalization" of production in the industrial revolution was precisely a project for the removal of uncertainty. As we are all too aware, the rapid rise of productive power along with the curtailment of uncertainty can result in vast physical environments not worthy of human habitation. Also being aware of economic realities, however, uncertainty appears to be proposition of allowances, not an operative norm. The question then, is how to apply rationalization in a more humane fashion, responding more to the complexities of society and environmental needs.

As described previously, the patterns of complex information rely on simple principles. Considered in terms of production technique, the parallel might be gained from building comprehensible (more codifiable = more affordable) systematic rich complexity from simple incremental moves, running concurrently and heterarchically.
- *Parting Thoughts:*

Of course, the end of thesis research and production is precisely the moment at which you begin to discern the beginning of the true thesis which lies behind the immediate one.


**MIT Theses:**


