UNIVERSITY OF CINCINNATI

Date: March 16, 2005

I, Eric Mendell,

hereby submit this work as part of the requirements for the degree of:

Master of Architecture

in:

It is entitled:

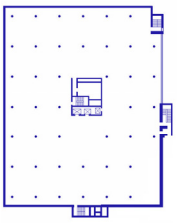
Architecture Alive:
Buildings that Evolve in Response to Changing Needs

This work and its defense approved by:

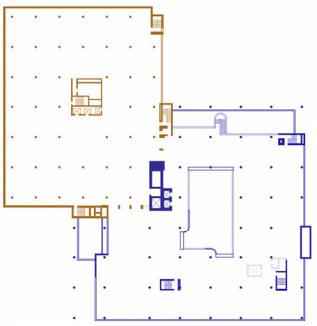
Chair: Jeffrey Tilman

Robert Burnham

Architecture Alive

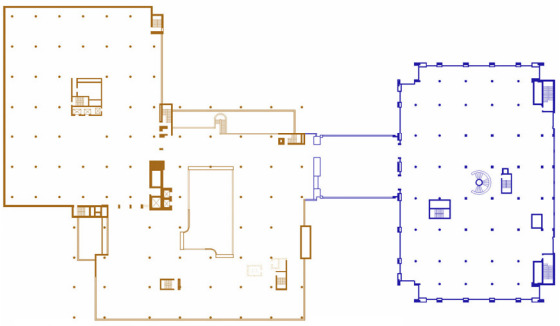


Buildings that Evolve in Response to Changing Needs



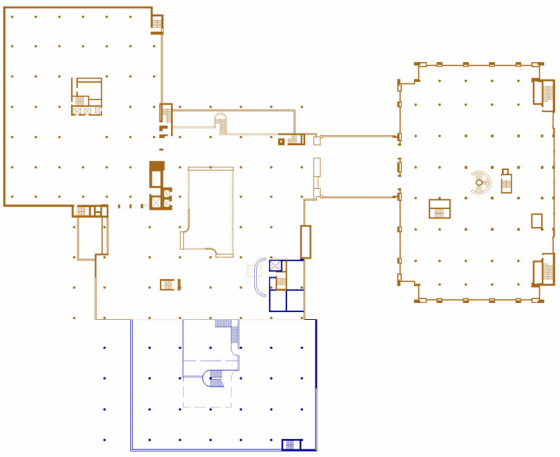
A thesis submitted to the Division of Research and Advanced Studies of the **University of Cincinnati**

in partial fulfillment of the requirements for the degree of



Master of Architecture

School of Architecture and Interior Design
In the College of
Design, Architecture, Art, and Planning



May 16, 2005

by

Eric Mendell
B.S. Arch., University of Cincinnati, 2003

Committee Chairs:

Jeffrey Tilman

Robert Burnham

A b s t r a c t

Time is a frequently overlooked dimension of architecture. Most buildings are designed as a static solution to an immediate set of needs, but the occupants' needs are never static. Inevitably, every building must change in some way to respond to these dynamic forces, whether change has been planned for or not. Sometimes the users succeed in adapting the architecture to their new needs in a way that gradually improves the building over time, but too often the quality of a building begins to decline the day it opens, eventually becoming obsolete.

This study began with the question, "Could buildings function more like dynamic, living systems in order to respond to the lives of the people that they support and the changing social contexts in which they are used?" It turns out that traditional building methods often worked in this way very successfully, so the paper starts with an overview of the history of this problem and the reasons why the contemporary situation calls for a new method. Through a survey of the typical causes of change a case is made for the value of designing buildings in terms of the unknowns.

Much of this paper is devoted to establishing some general strategies in order to provide a framework for responding to a building's needs in terms of change. This is done by analyzing and comparing the many theories and successful precedents that have already addressed this critical issue, and by evaluating the appropriateness of each strategy for different situations. The result of this research is an alternative design process that takes into account the unknowns of a building in conjunction with its needs. As an example, the design process is then applied to a hypothetical project for a media center addition to the Main Public Library of Cincinnati and Hamilton County—a type of building which by necessity must undergo a multitude of unpredictable changes.

Table of Contents

Images and Illustrations

Introduction

Architects have always looked to nature for inspiration, from the ancient Greeks to Gaudi and Frank Lloyd Wright, and so called "organic architecture" continues to gain in popularity. The sensuous curves of Frank Gehry's designs resemble the petals of a flower or the scales of a fish. Santiago Calatrava's buildings and bridges evoke images of bones, insects, and other animals. Recently, Charles Jenks has written *The Architecture of the Jumping Universe* to explore the way that architects have modeled the form of their buildings on processes in the natural environment.

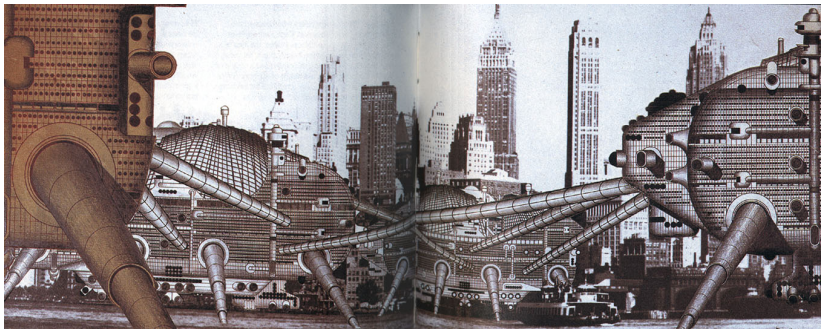


Figure 0.1

The Archigram Group imagined cities that mimicked life through their actions, as in "Wlalking City."

But what if buildings did more than mimic the appearance of living creatures, and they truly started acting like living systems? Every building serves some purpose in support of human activities and life, so every building is biological in much the same way that an ant hill is an extension of the biology and society of the ants and their colony. If we think of buildings as living organisms, we may be one step closer to achieving the same kind of symbiosis between life and environment that can be found in nature. One of the most important reasons why life is so persistent, and even tends to better itself, is that it is extremely flexible. All organisms live unpredictable lives that can change significantly from day to day or year to year, and life has an uncanny way of adapting to unexpected changes. To successfully bring buildings (and the activities within and around them) to life, they too must be designed to accommodate growth and adapt to the changing needs of the occupants.

The goal of this study is to understand how the dimension of time can be taken into account in order to design buildings that can better adapt to the changes they encounter. Throughout this discussion a few sources emerge as dominant influences. In particular, Stewart Brand's book, *How Buildings Learn*, seems to be the most comprehensive investigation into how and why, or why not, buildings change. Brand is widely known as the creator of the *Whole Earth Catalogue,* and his involvement with global issues, media arts, and systems theory has given him keen insight into the processes that shape our built environment.

Brand acknowledges the influence two other theorists whose works also appear frequently in this paper. A friend of Brand's, and a Professor of Architecture at the University of California at Berkely, Christopher Alexander became well known for his Pattern Language theory in the seventies, proposing an adaptation of traditional building methods to modern life, in which organic order arises out of a kind of responsible anarchy of construction. Frank Duffy was also a contemporary of Alexander at Berkley but left academia to become a partner in DEGW, a firm that focuses on combining research with design to reinvent the way architects help clients meet their building needs. He has published much on the architect-client relationship and is often regarded as "the" expert on the study of buildings in time.

Many other writers' works were crucial to developing and understanding alternative design strategies for dealing with change. They include N. J. Habraken's Support Structure concept, Renato Severino's plan for Equipotential Space, and a variety of adaptable housing solutions by Donald MacDonald. The most important is probably John Christopher Jones, who is known as the founder of the design methods movement. His book, *Design Methods*, draws from a multiplicity of design disciplines, from music composition to boat building, in order to better understand the creative process and how to solve the increasingly complex design problems of post-industrial society.

The problem of fitting a dynamic set of needs to a static building has roots in ancient building strategies, but the nature and severity of this challenge has changed dramatically in recent times. *Chapter 1* (*History*) provides a brief overview of how change was accommodated traditionally, as well as why this process no longer works as it once did. Time is depicted as a crucial yet

frequently overlooked aspect of architecture, and the reasons for this modern crisis of oversight are also examined.

The argument for the necessity of designing for change is laid out in the second chapter (*Buildings that Live*). First, change is shown to be an inevitable result of the dynamic forces that act on a building: functional requirements, changing user groups, maintenance, technology, and fashion. Second, evolution is valued over revolution, meaning that allowing a building to gradually adapt rather than replace it all at once is more sustainable, can simplify the work of the architect, and lets buildings change as they (and we) are naturally inclined to evolve. Finally, when buildings are able to adapt they have added value to us as individuals and as a society because they fit our patterns of use more appropriately.

Chapter 3 (Accommodating Change) categorizes change in order to better understand how certain types of change work and how we might plan for them. We begin by outlining the different varieties of change—in terms of where it occurs in the building process, scale, intensity, and the mechanisms and mediums through which it works. A discussion of the primary obstacles to change follows. Then, a survey of existing strategies for accommodating change demonstrates how an architect might design a set of rules and relationships that permit multiple states of a building. Important precedents also appear in this chapter to illustrate the different types and methods of change.

The final chapter (*A Media Center for the Public Library of Cincinnati*) serves as an example of how the design principles set forth in the first sections might be implemented for a building type that typically undergoes a variety of changes. First, a history of the library reviews some of the changes that the institution has already experienced. This leads to an analysis of the existing building, starting with its needs in terms of image, program and the role of a modern library. The analysis continues with a study of the building's needs in terms of change, carried out using the framework established in chapters two and three, and a look at how the strategies for dealing with change might already exist in the building. It is then possible to evaluate the appropriateness of each of the strategies in the context of this media center, and to develop a design methodology to address the changing demands of such an institution.

Chapter 1 History

The Tradition of Change

At one point in time the need for buildings to adapt to changes was not much of a problem. People have always had fluctuating needs, but the traditional building process had an inherent ability to accommodate the more gradual and steady changes typical at the time without much additional effort on the part of the designer or builder. The independent acts of hundreds of craftsmen working on small projects had a way of coming together to make a whole. Christopher Alexander describes the University of Cambridge as the perfect example of the kind of organic order that came out of traditional building methods: "Somehow, the combination of tacit, culture-defined agreements, and traditional approaches to well-known problems, insured that even when people were working separately, they were still working together, sharing the same principals."[1] All building projects were made up of many local responses to immediate problems, which ensured steady growth and change and that every part of the built environment was uniquely suited to its purpose and context, while a common language of building tied all of the autonomous projects into a coherent whole.

Figure 1.1
The University of Cambridge

Traditional building processes also tend to bring together the actions of many craftsmen over time, so that certain 'species' of objects or buildings appear to progress with conscious direction towards a goal, similar to the natural process of evolution found in organisms. John Christopher Jones calls this

phenomenon "craft evolution".[2] He explains how the ideal forms of specialized building types, tools and vehicles evolve over years of refinement to produce construction standards and patterns of functional relationships uniquely adapted to certain groups of users in a region. Jones gives the example of wagon building, in which craftsmen stored information on how to build a wagon in the form of patterns of relationships and direct memories from experience. No one involved in the process had direct knowledge of either the overall form of the product or the reasons for its shape. A craftsman could not explain why he did what he did, but over his lifetime he learned to instinctively follow a process and modified it slightly each time, allowing the process to gradually improve and be adapted to the specific situation. This information carried almost subconsciously by the craftsperson is the "genetic coding" upon which craft evolution depends.[3]

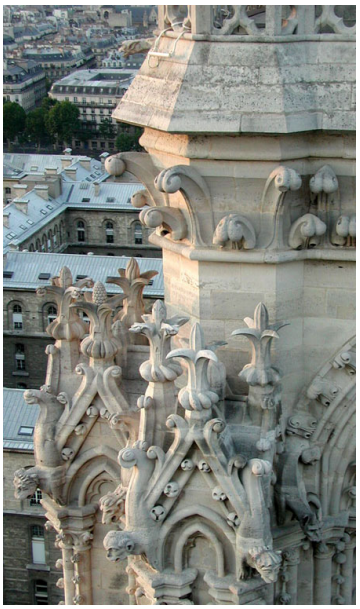


Figure 1.2 A&B

The traditional method of craft at Notre Dame ensured that every part contributed to the whole, even over many generations of construction.

This genetic language is beyond the control of any single individual, though everyone can play some role in it. Victor Hugo describes how the actions of many anonymous architects working in different styles converged to create the organizational depth of Notre Dame: "The man, the artist, the individual are lost sight of in these massive piles that bear no regard of authorship; they are a summation and totalization of human intelligence. Time is the architect—a nation the builder."[4] This reflects architect and inventor Tony Gwilliam's suggestion that as historic buildings evolve over centuries they develop a sort of memory or consciousness that bring together disparate human experiences.[5] The traditional methods of building once guaranteed that every building and every part of a building were diverse and well suited to their purpose while still part of a unified whole that improved over time.

The Crises of the Present

As times change, so does the appropriateness of approaches to building, and unfortunately the traditional process no longer holds. In *The Oregon Experiment* Christopher Alexander writes, "[T]raditions have vanished; problems change fast; cultural agreements have disappeared; individual acts of building carried out within tradition, can no longer be relied upon to create

organic order…"[6] He claims that the languages that once united the actions of many builders have broken down and that it is nearly impossible for anyone in our time to build a building with the same kind of life found in traditional structures.[7] This failure of contemporary society to produce buildings and urban places that are truly full of life is largely the result of recent revolutions in industry and culture that have permeated architectural thinking ever since.

Figure 1.3

Fritz Lang reacts to rationalism and industrialism in *Metropolis*, where the workers and architecture are as mechanical as the machines they serve.

The Industrial Revolution was the first major blow to the traditional process. The mechanical processes of production met the needs of an emerging mass society and its mass consumption.[8] However, these processes often relied on the flawed assumption that these needs could be met through efficiency in terms of materials and labor alone. The needs of individuals were generalized into a generic solution incapable of responding to the unique changing needs of real people. Habraken points out that society has always objected to the impersonal nature of large series of identical parts.[9]

Modernism continued to develop the application of industrial production methods to architecture. The metaphor of the machine became central to design. Le Corbusier studied products like cars and ocean liners extensively and adopted their design principles to his architecture. As entire generations of architects accepted the determinism of mechanical processes and functionalism, architecture began to reflect the monotonous repetition of the machine. When coupled with the increasing specialization and isolation of professions these modern means of construction and manufacturing produced buildings that were out of touch with individual needs and incapable of creating lively spaces or adapting to change.[10]

Figure 1.4

Modernism lead to many technical advancements, but often produced placeless buildings that could not adapt to their users or context, as seen in Stockholm's modern city center.

Fortunately, an even more recent cultural shift offers possibilities of changing the direction of architecture once again. One of the main events that distinguishes the late twentieth century is a shift in all fields from the notion of *progress* towards a well defined goal to an emphasis on *process* as an end in itself.[11] For example, in physics, space, time and atoms are no longer regarded as finalities or objects but instead analyzed in terms of events or processes. The same can be said of contemporary art in which the notion of

creating objects with fixed meaning has been largely abandoned as the act of creating (or viewing) itself becomes the art—as in the work of composer John Cage, whose "four minutes and thirty-three seconds" for piano consists only of the sounds made by the audience and not by the pianist. William McDonough explains the architectural significance of such a change in worldview: "What we need to be doing is saying not that a house is a machine for living, but that it is a living machine."[12] However, with this new paradigm have come new problems that render traditional methods of creating living buildings of limited value in the modern context.

Faster Change

The type of evolution typical of traditional building processes (as in Jones' description of wagon-making) can produce beautiful, well adapted results, but it takes centuries. The long process of trial and error eventually produced great buildings and tools, but also a lot of inferior ones along the way. However, each iteration was a response to changing standards or needs and was in some way more suitable than the one before it. The difference today is that change occurs on a faster time scale, so that it becomes necessary for a single building to transform and adapt to major changes within its lifespan.[13]

This pace of change is so fast that many architects seem to have given up (or never tried in the first place) and now only design for the present. Buildings are cheaply constructed and designed solely as temporary solutions to immediate problems. Instead of responding to the increased rate of change with adaptable buildings we have made them disposable. Tom Mayne of Morphosis predicts that buildings are quickly becoming more like cars and other industrial products.[14] More and more they are constructed from high-tech, inexpensive, low maintenance materials with a short lifespan.

Increasing Complexity

The task of constructing and designing buildings has recently built up layers of complexity far beyond the problems faced by traditional builders. New problems have arisen with the extensive use of man made products. Traffic congestion, for instance, has reached a scope that demands planning approaches that did not exist before cars.[15] Rapidly advancing technology also complicates the design process and requires a steeper learning curve to understand how to use new products and materials. And with the burgeoning number of available materials comes new issues of compatibility among

products. Now, designers must also consider the possible overlapping consequences of seemingly unrelated technologies. Jones gives the example of a plastic chair with minute projections from its surface that might snag nylon stockings, making it unprofitable.[16]

Another result of recent technological progress has been an increase in the scale of design problems. Craftsmen once worked primarily on very small component-oriented problems—their inherited, time-tested process guided the integration of these separate projects. Later, designers began to rely more heavily on drawing so that they could control the project on the scale of an entire product or building. The current dilemma results largely from the need to design on the level of communities and integrated systems of products.[17]

All of these new complexities mean that it is much more important to plan for change and adaptability than in the past. As Alexander argues, the unregulated piecemeal accumulation that once created harmonious communities like the University of Cambridge will now only lead to thousands of mistakes of organization, twisted relationships and missed opportunities.[18] Unfortunately, our reaction has been to assume totalitarian control over building projects. Our new challenge will be to manage modern complexities within a system of management and control that is capable of responding to unforeseen forces and changes.

NEW EMPHASIS IN BUSINESS AND INDUSTRY

Since the Industrial Revolution new methods of manufacturing have made traditional approaches to construction impractical in most situations. Products and buildings began to focus more on efficiency of economic and material resources than on adapting the buildings to real needs. For example, Victorian homes accommodated unexpected activities with the provision of all sorts and shapes of rooms with lots of excess space.[19] But as space becomes more precious, rare and expensive, such solutions to the problem of change are seldom possible.

Renato Severino describes a similar recent problem in architecture that is caused by the dichotomy of quality and quantity.[20] The production methods that came out of the Industrial Revolution were and are primarily focused on meeting the need for a growing quantity of buildings. Technology is often applied to the task of providing more things, more quickly and more cheaply. At the opposite extreme is the search for refinement and quality, isolated

from the greater needs of society. When architecture fails to address the problem of quantity it becomes mere aesthetic play.[21] Our challenge now is to learn to apply our more efficient construction and manufacturing approaches to provide more affordable architecture that is also capable of better serving its purpose. We must relate problems of production, employment and administrative programs to architectural and technical issues.[22]

SHIFTING FOCUS OF ARCHITECTURE

Architects see themselves more and more as artists whose primary asset to their clients is in their design skills and the ability to create an image or aesthetic, rather than the capability to thoroughly investigate a problem and propose a long term solution to the client's needs. This indicates the growth of a gap between the goals of users or owners and those of developers and design professionals.[23] Adrian Leamen contends that buildings are complex systems that rely on the integration of two categories of performance: the performance of a building in *space* is based on its physical and spatial characteristics; *time* performance is based on management and occupant criteria for the use of the building. Since the construction professionals dominate the criteria for design, most buildings are based too heavily on the relationships between spatial characteristics and building performance as a physical or economic system.[24]

Frank Duffy confirms Leaman's assumption, but offers new hope. As users become increasingly interested in time, architects are also beginning to concern themselves more with the duration of the problem-solving capacity of each component.[25] "The notion of signature architecture as monolithic and immune to the forces of change has been exposed as impractical and irrelevant," writes Jeremy Myerson to introduce the work of Duffy and his firm DEGW.[26] So the fundamental problem is in the commonly accepted notion of what a building should be—a view in which the significance of time and change is ignored. By ignoring this problem we are also passing up a great potential for buildings to evolve and adapt over time. As Victor Hugo said, "Great buildings, like great mountains, are the work of ages."[27]

Endnotes

[1] Alexander, Christopher. *The Timeless Way of Buildin*g. New York: Oxford University Press, 1979.
[2] Jones, J. Christopher. *Design Methods*. 2nd ed. New York: John Wiley and Sons, 1992. p. 15.
[3] Jones, *Design Methods,* p. 20.
[4] Hugo, Victor. *The Hunchback of Notre Dame*. 1831. Book 3, Chapter 1.
[5] Gwilliam, Tony. "Organic Building." Zelov p. 88.
[6] Alexander, Christopher. *The Oregon Experiment*. New York: Oxford University Press, 1975. p 14.
[7] Alexander, *The Timeless Way of Buildin*g, p. 225.
[8] Severino, Renato. *Equipotential Space; Freedom in Architecture*. New York: Praeger Publishers, 1970. p. 7.
[9] Habraken, N. J. *Supports: an alternative to mass housing*. London: Architectural Press, 1972. p. 48
[10] Alexander, *The Timeless Way of Buildin*g, p. 232.
[11] Jones, *Design Methods,* p. xxxiv.
[12] McDonough, William. "Not a Machine for Living in—A Living Machine." Zelov, 94.
[13] Gwilliam, "Organic Building," p. 88.
[14] Mayne, Tom. "Not Neutral." Lecture at the University of Cincinnati. October 27, 2004.
[15] Jones, *Design Methods,* p. 31.
[16] Jones, *Design Methods,* p. 34.
[17] Jones, *Design Methods,* p. 32.
[18] Alexander, *The Oregon Experiment*, p 15.
[19] Educational Facilities Laboratories. *SCSD: the Project and the Schools*. New York: Educational Facilities Laboratories, Inc., 1967. p. 32.
[20] Severino, *Equipotential Space,* p. 11.
[21] Severino, *Equipotential Space,* p. 11.
[22] Severino, *Equipotential Space,* p. 25.
[23] Leaman, Adrian. "User Satisfaction." Baird 41-43. p. 42.
[24] Leaman, Adrian. "User Satisfaction." Baird 41-43. p. 43.
[25] Duffy, Francis. "Building Appraisal: Measuring the Capacity of Office Buildings to Accommodate Change." Baird 27-30.
[26] *Design for Change: the Architecture of DEGW / with contributions by Francis Duffy*… Basel: Birkhauser; Haslemere: Watermark, 1998. p. 10.
[27] Hugo, *The Hunchback of Notre Dame*, Book 3, Chapter 1.

Chapter 2 Buildings that Live: Why we need new methods of growth

We have now briefly reviewed the history of how buildings adapt to changing conditions, from the evolution of traditional buildings as the natural result of the craftsman's method, to the open plan approach of modernists. We have also established that these conditions, and the way they change, are currently much different than before, though very little has been done to address the problem. But is it a problem? How much do the changing needs of users actually affect a building? Is it worth it for architects to worry about how a building will change after it is constructed, even though they will no longer have any control? This chapter attempts to answer these questions and explain the advantages of planning buildings to adapt.

The Inevitability of Change

Figure 2.1
This house grew with the family that lived in it.

Whether or not we plan for it, all buildings change. They are added onto, their skin is replaced, rooms are rearranged and heating systems are updated. People move in and out, need more space or need a different type of space. In fact, more money is spent on changing buildings than building new ones. During the 1980s commercial rehabilitation expenditures grew from three-fourths of new construction to one and one-half times new construction, and is likely to continue to increase.[1]

Why do we spend so much on renovation? Can't we design things right the first time? The answer is no. Buildings exist to satisfy people's basic needs, but the exact nature of these needs is in constant flux. People are always growing, changing, multiplying, dying, and so their buildings do the same. There are so many intermediate states between the construction of a building and its eventual decay or demolition that Frank Duffy claims, "there isn't such thing as a building."[2] The following describes some of the primary reasons that buildings do not, and cannot, exist as complete, static things.

CHANGING FUNCTIONAL REQUIREMENTS

Figure 2.2
When this silo no longer served its purpose it was converted into a hotel

The way that people want to use a building and what they want to use it for is constantly reshaping the built environment. New uses are added, old activities become obsolete, and functions are always being moved from one room to another or rearranged within a single space. Although all buildings go through refinements of function, this sort of change is most noticeable in residential architecture and workspaces, where individuals have the most control to change their own surroundings.

Stewart Brand took monthly photographs to study the transformation inside an office for an equestrian mail order catalogue in Sausalito, California.[3] The series of photos revealed that workers like to move things around much more than most office environments allow. The changes ranged from significant renovation, adding a bathroom and closing off part of the building for another tenant, to minor adjustment of furniture. Nearly every month there was a noticeable, if not major, change from the previous month.

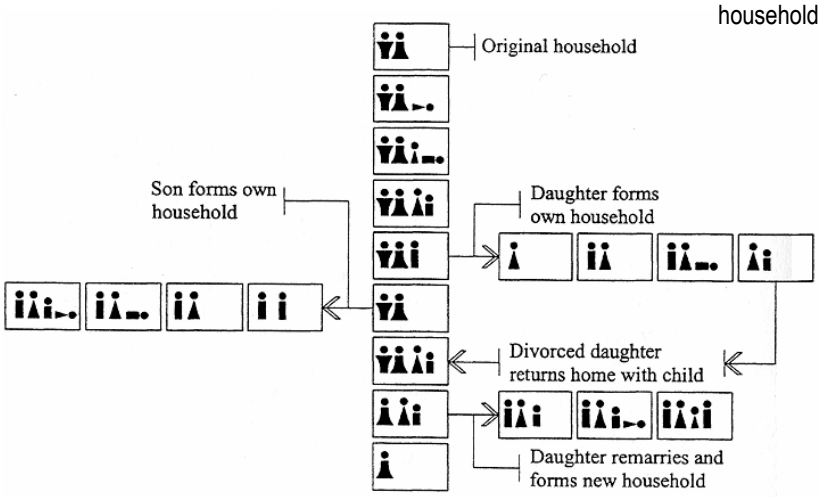
José Callado, an architect and professor at the School of Architecture in Lisbon, has looked at how similar changes occur in housing[4]. He and his students conducted a series of case studies on flats of various architectural styles in three different districts of Lisbon, Portugal. The results depict the use of living space as a complex, unpredictable process of interaction between people and buildings. He attacks the fixed behavioral model used by the modern functionalist movement, arguing that this standard, simplistic

approach to programming is insufficient to account for the way people really use buildings.

Schools are another building type that undergoes frequent changes and relocations of use. Stewart Brand cites the Main Building at MIT as an example of a building that was required to be adaptable and has succeeded.[5] Here departmental space is being constantly reassigned. About five percent of MIT's buildings change use each year. Often laboratories are converted to offices when technology becomes obsolete, then become classrooms, and may eventually be fitted with new equipment for use as a lab once again.

Figure 2.3

The changing composition of a household



More Users

Even if a building is used for the same exact purposes in the same location, it is likely that the amount of space necessary for these activities will change. This usually happens when more people start to use the building, but it can also be a result of less people using it or simply that the people who use it need a different amount of space to continue with their purpose. The size of a workforce often changes with the economy, resulting in a sparsely populated office at times, or crowded office at others. Libraries are a perfect example of buildings that grow even when their user base remains constant. Their collections force them beyond the original building no matter what the size.

Homes also tend to grow in response to the size of the family. In *The Adaptable House*, Avi Friedman diagrams the changing composition of a household.[6] (see Figure 2.3) It begins with a couple; they have children; the daughter grows up and moves out with her husband; then the son forms his own household; the daughter gets divorced and returns to the home with her daughter, only to get remarried and move out again; the father dies, leaving only the mother. Even if these changes do not lead to an expansion or contraction of the house's area, they will certainly modify they way the space is used and its physical qualities.

NEW USERS/OWNERS

In addition to changing the number of users, a new owner or a completely new group of users may take control of the building. Adaptive reuse is the most noticeable version of this type of change, but even when the building serves the same general purpose, the new users tend to modify their environment. For some building types this is a rare occurrence, but for others it can happen frequently. This is often the case with retail facilities, but it is also common in dormitories and some other types of residential buildings with rapid turnover of tenants. Each time someone new moves in, their idiosyncrasies leave an impression behind.

The notion that the dweller and dwelling are separate, that they are strangers who come together after the completion of the dwelling, is completely unrealistic. This is one of the central problems with mass housing according to the Dutch theorist N. J. Habraken. People want to take possession of a space, which is much different than having property. To take possession of something we must make it part of ourselves, we feel the need to change it.[7] Although Habraken's discussion is specific to housing, it seems like a small jump to assume that this intimate relationship between people and architecture could also apply to workplaces and many other building types.

NEW TECHNOLOGY

Technology probably has the most rapid rate of change of any factor with a major impact on society and our buildings. Since the Industrial Revolution, technological innovations have taken off with exponential momentum. Intel founder Gordon Moore's law claims that the speed of computers roughly doubles every 18 months. Most building technology does not become obsolete that quickly, but buildings are expected to have a much greater lifespan than computers, so it can be a serious problem when they aren't built to the most current standards. Building owners strive to keep up with the latest technology by gradually updating components piece by piece, but if change is not anticipated it may be necessary to retrofit a building with an entirely new system.

Communications technology is surely the fastest changing system that affects buildings. It can be a daunting task to wire a historic masonry building for new communication systems. This will become less of problem as these systems turn wireless. However, we keep adding more communication

functions to the mix and the technology will continue to change the way we use buildings. There is a growing trend toward what has been termed "Intelligent Buildings", where security, communications and environmental controls are all integrated into a single responsive system.[8] There is no telling what the next step will be.

MAINTENANCE

Figure 2.4

Ta Prohm temple in Angkor, Cambodia: Even if people ignore a building, nature inevitably will change it.

The need for maintenance is another unavoidable force that shapes buildings. Even when building components don't require a high-tech replacement, the nature of materials inherently leads to change. As they weather or otherwise require replacement they are usually updated or changed in some way. When neglected, the need for maintenance changes a building by destroying it. When thoughtfully integrated with the design, the maintenance and aging of materials can help a building mature appropriately. More commonly, maintenance just leads to a change in style as the building is updated. Brand provides an example by comparing photos of a house whose Victorian detailing was eventually smoothed out as modern materials replaced the woodwork.[9]

FASHION

Change is often initiated for no practical reason other than for the sake of fashion. Think of the number of home improvement and remodeling TV shows that have aired since 2000. People take delight in changing their environment. It's part boredom, part wanting look trendy, partly a show of wealth, and mostly just fun. The changes range from new wallpaper to an entire newly stylized façade. We simply could not be ourselves if we could not change our buildings.

OTHER FACTORS

The truth is people almost always want change. Even when the same people continue using a building for the exact same purposes, they often still desire change for its own sake. Imagine working in the same exact room, every day, for the rest of your life. Uniformity is stifling, as humans we thrive on

change. Of course we need some sense of permanence, in our homes for example, but change can still occur within that.

Evolution or Revolution?

We know that change is inevitable, but this still doesn't answer the bigger question: What should we do about it? Before that question can be answered, one might wonder whether we should do anything at all. Very few building professionals seem to be thinking about what will happen to the buildings after they are built. It's not that they are totally oblivious to the fact that buildings change—it just isn't part of their job.

Maybe this means we need to approach architecture and building in an entirely different way. In his famous trilogy of *The Timeless Way of Building*, *A Pattern Language* and *The Oregon Experiment,* Christopher Alexander proposes a new attitude toward architecture, in which buildings are able to evolve in much the same way that living organisms grow. Through the active involvement of the user in adapting the building to resolve local forces, buildings and towns can be grown rather than designed and built as a singular entity. From this perspective change occurs gradually and peacefully in immediate response to the changing environment.

Maybe we shouldn't worry about change, as some architects believe. In a lecture at the University of Cincinnati, Tom Mayne of Morphosis mentioned his interest in how buildings change and the unpredictable aspects of architecture. But when someone asked him how we can design buildings in anticipation of change, using materials and building techniques that seem to resist it, he replied "we won't need to".[10] He argued that buildings are becoming more like new cars. They require almost zero maintenance and allow no modification by the users. Soon, he speculates, the engines will be completely sealed, so that you never have to touch it—by the time it wears out you'll want a new one. As a comparison he used Peter Cook's Kunsthaus in Graz, Austria, which has a skin made of a fiberglass-like material. He estimated that it couldn't last more than 8 years, but the client didn't mind. The building was disposable. In this view change takes place through a series of architectural revolutions, sudden destruction of one building accompanied by a surge of construction on a new one.

CHANGE EQUALS STABILITY

So the alternative to designing buildings for change is to design them as disposable, consumable products. The problem with this approach is that a building is fundamentally different than a car, or a computer or other such limited lifespan commodities. The user's demands on a car do not change the way they do with a building. All that a person needs from a car is to get safely and comfortably from one place to another. The only factor that would require a different type of vehicle is changing who or what the vehicle is moving (for example, needing a truck to carry a couch or a van to carry more people). Every other type of change is based strictly on image or fashion. Therefore, fashion-based changes prevail in our car-buying habits, and so they are made and marketed to be unchangeable and disposable.

Like a car or any other product, a building that fails to change is guaranteed a short lifespan. It sounds like a paradox at first, but a building that changes is, in a way, more permanent. A building is only able to endure its unstable environment by accommodating change. It is important that buildings endure the test of time, because it is the only way that they can be truly sustainable. It would be absurdly wasteful in terms of time, money and quality to completely start over each time a building needed to be updated. The right synergy between human and building can never quite be reached if the building isn't given a chance to adapt.

Making an adaptable building then means maintaining an appropriate balance of change and permanence. Christopher Alexander proposes creating buildings from a set of patterns which define certain characteristics of a part of a building and its relationships to other parts. These patterns ensure that a building endures because they are stable yet dynamic, allowing the building to change as needed, without destroying its essence. "In short, a pattern lives when it allows its own internal forces to resolve themselves. And a pattern dies when it fails to provide a framework in which forces can resolve themselves, so that instead, the action of the forces, unresolved, works to destroy the pattern."[11]

In nature too it is a balance of metamorphosis and stability that has been so successful in supporting life. Evolution spends most of its time not changing very much, points out Kevin Kelly.[12] Changes come gradually as they are needed. The flexibility of an organism's body keeps the population alive until the body can catch up with the changes. "Nature is the realm of ordered

change," he says. And although technological change has historically been characterized by revolutionary leaps of change, Kelly predicts that it will give way to a more evolutionary sort of change. "Science and commerce now seek to capture change—to instill it in a structured way—so that it works steadily, producing a constant tide of microrevolutions instead of dramatic and disruptive macrorevolutions."[13] Buildings work the same way, so we must design them to adapt.

NATURAL ADAPTATION

The portrayal of buildings as biological entities is by no means a coincidence. It is not merely a metaphor but a new paradigm that has found use in many professions. From business to psychology and from music to computer science, leaders in all fields are beginning to think about the systems they work with less as mechanical processes and more as biological.[14] Factory owners are finding that by giving up central control in favor of bottom-up self-organization, production levels and quality can shoot through the roof. Computer programmers have learned that when a problem is too complex for them to solve they can use artificial evolution to grow an optimal solution within the computer.

Many theorists now consider evolution the most crucial force in creating and sustaining life. It goes far beyond the natural selection that Darwin described. Zoologist Richard Dawkins proposed in 1987 that evolution itself evolves according to a meta-level of natural selection. His view suggests that the universe is predisposed to evolve, that it is has a clear direction in working (though blindly) towards ever higher levels of order. [15] In 1972 the engineer James Lovelock and microbiologist Lynn Margulis published the Gaia Theory, which claims, "The entire range of living matter on Earth…could be regarded as constituting a single living entity, capable of manipulating the Earth's atmosphere to suit its overall needs and endowed with faculties and powers far beyond those of its constituent parts."[16] This notion that organisms and environment co-evolve as a single living being sounds remarkably close to the ideas of Habraken and other architectural theorists about the relationship of dweller and dwelling.

The comparisons of buildings to organisms are everywhere in architecture. Their organization from the whole, to systems, to organs, to individual components parallels that of our own bodies. We think of the structural system as a skeleton; the HVAC as a circulatory system; and many architects

spend much of their time designing "skins" of buildings. A process called versioning is gaining popularity, in which the form of a building is "grown" in a computer through a process of artificial evolution.[17] One of the pioneers in this line of research is Gordon Pask, who claims that the quality of buildings will improve greatly if architects see themselves more as a catalyst, acting so that the building can evolve instead of designing the final product.

Every architect knows what a headache it can be to try to resolve all of the conflicting forces that shape a building. And with the invention of new materials and technologies, along with more complex social and economic variables, buildings only get more complicated. They are extensions of our own biology, and so they share the same complexity as living systems. In order to create buildings that work with us, not against us, we must learn to adapt them as we change.

The Value of Adaptation

So far, the argument is that buildings will last longer, and will therefore be more sustainable, by accommodating change. When buildings are allowed to evolve, the architect's job becomes much easier since the details can be worked out during or after construction. But are there benefits to the people who use the building? Actually, the user is at the center of this idea. When buildings are allowed to change responsively there are great advantages in terms of the building's functional performance, the social and political aspects of the action of building, and in the emotional and psychological response of the users.

Resolving Action and Space

Christopher Alexander identifies two types of patterns that make up buildings. There are geometrical patterns of *space*, and there are the social and biological patterns of *events*.[18] The patterns of space do not cause the patterns of events, just as the patterns of events do not cause the patterns of space. He contends that the total pattern of the relationships between events and spaces is an element of culture, and it is this connection that is at the fundamental core of what makes a building "alive" and successful. The use of these patterns is successful because it creates spaces that are stable enough to allow the events to repeat over and over again no matter where they are applied, and the patterns are dynamic enough to allow endless variation. The patterns establish a framework in which forces can resolve themselves.

This approach has a much greater chance of success than the more common method of programming a fixed relationship between the geometry of a space and the actions that take place within it. As mentioned in the section on the inevitability of change, functional needs of the users are bound to change and they will put pressure on the building to change. If the action does not fit the space the building will fail, or it will have to change, and in a building designed to be static it is likely that the resulting changes would make the architect shudder. Take for example the overcrowded Jefferson Building of the Library of Congress in 1969, where the dropped ceiling of temporary offices cut a column in half, file cabinets crowded its base and a narrow passage to a door squeezed between the column and an added wall.[19] This is why Jose Callado argues so passionately against the fixed behavioral model that is used so often for programming.[20]

The relationship between a building and the actions of its users is more than just a way that two separate entities mutually affect each other. As implied in the Natural Adaptation section, the two can work together to function as a single living organism. Habraken argues that we cannot even draw a line between building and dwelling.[21] Dwelling by definition involves many actions related to building—decorating, moving furniture, changing lighting, or even tearing down a wall—so that the two are indissolubly connected. This relationship, he says, is the outcome of human nature, so he calls it the "natural relationship." It is the dweller's ability to change his or her environment that allows building and dweller to exist in harmony.

This ability of buildings to adapt can also help meet the people's needs on a larger scale of the community or city. Donald MacDonald proposed the idea of convertible residential spaces in order to respond to changing trends in housing.[22] He had observed a disproportionate amount of unsold, high-price, large three to five-bedroom houses in a small upper-middle-income California city. He supposed that if developers of the houses could break them into smaller, more affordable units they could rid themselves of the debt and help meet the housing needs of the community. When buildings accommodate change they are also accommodating the needs of the people who use them and the community as a whole.

EGALITARIAN ARCHITECTURE

If buildings that change are better suited to the way people live, work and play, why would anyone prefer a static building? One answer would be that

those who have the means to create architecture on a large scale tend to use it to serve their own purposes, often at the expense of others. Renato Severino presents the case that cities were first formed to support the monarchy, and architecture traditionally served to uphold the power of the elite.[23] As an example he cites Versailles, which gave Louis XIV better domestic control and anchored European culture in France for nearly two centuries. Although the leaders of the modern movement recognized the power of architecture to affect cultural direction, Severino maintains that in the end they really only succeeded in changing facades.

Jonathan Hill has also recognized that the active user has often been seen as a threat to the architect's goals[24]. He quotes Henri Lefebvre's assertion that architects are assigned to "the space of the dominant means of production, and hence the space of capitalism." Lefebvre explains that capitalism dominates space by imposing functional categories upon it. The difference between the space of architects and the space of users must be recognized and understood to avoid this oppressive controlling of the use of space.

Hill goes on to show how Roland Barthes' concept of "the death of the author" can provide a new understanding of the roles of the architect and the user. The user can no longer be assumed to be a passive observer. New types of users must be considered: the *reactive user*, who modifies space according to a range of configurations largely defined by the architect, and the *creative user*, who creates new space or gives existing space new meanings. According to Hill, the implications of the new concepts of users are *flexibility*, through the use of demountable or adjustable elements or by spatial redundancy, and *polyvalence,* when a form may be used for multiple purposes with a minimum of flexibility.

Donald MacDonald discusses the value of the creative user in relation to our political system. He says that Americans rarely consider how lucky they are to have the ability to effect change peacefully. With ease that is nonexistent in many parts of the world, they are able to "change jobs, move about the country, install and remove officials, start businesses, go bankrupt, and reinvent themselves continually. Traditional architecture has never reflected that empowerment of the people." [25] He proposes buildings with capabilities for expansion and individualization to express the spirit of choice.

Another aspect of this freedom of choice on the part of the users is the possibility for experimentation. The School Construction Systems Development (SCSD) project cited this as one of the reasons for wanting flexibility. Some teachers felt that by having a flexible school they would not be committed to any changes made to the building layout, leaving them free to try new things without the costs and possible consequences usually associated with building something that doesn't work. "The possibility, for the first time, of doing that is leading us to reconsider our whole instructional program," remarked one teacher. "A building open to change is opening the eyes of our teachers."[26] Functional needs are not our only criteria for building—the freedom to effect a change in the built environment is deeply rooted in our way of life.

BUILDING HAPPINESS

The subject of freedom brings us to the right to happiness. Even if a building works well and we able to change it, something is still missing. If a building prevents us from being happy while we are in it, everything else has not been worthwhile. Christopher Alexander refers to the buildings that do this as dead.[27] For a building, or a pattern that makes up a building, to be alive it must allow the immediate forces to resolve themselves. When this happens, he says that the building possesses the "quality without a name". This quality is present in the building because it is present in us.

This quality, which makes us feel free, alive and happy, cannot be built or designed into a building as a singular whole, but only generated from the bottom-up by autonomous processes adapting to local conditions. Again he compares buildings to living organisms, "If you want to make a living flower, you don't build it physically, with tweezers, cell by cell. You grow it from the seed."[28] The psychological importance of allowing buildings to evolve through a series of adaptations to complex local forces was also recognized by Habraken. He emphasizes the "natural relationship" (between dweller and dwelling) not only to ensure that the building meets the functional needs of the users, but also because it allows man to fulfill his deeper need to take possession of his environment. The problem with almost all mass housing is that it doesn't permit the user to take part in shaping his or her environment, so they can never feel at home.

This issue is related to a larger scale problem known as the "New Town Blues."[29] The tabula rosa development that occurs in rapidly expanding areas

leaves a kind of cultural amnesia in its wake. The buildings have had no time to adapt to their inhabitants or to each other. Some urban planners have attempted to get around this difficulty. Lucien Kroll uses user participation, plural design, eclecticism and the superposition of multiple complex organizational systems to build-in time to a masterplan.[30]

When the complexities of how we use buildings and towns are not able to resolve themselves, there is a noticeable emotional response. We feel that something is missing, that nothing fits together. On the other hand, buildings that can change and evolve in response to people's actions become alive. And living buildings are best suited to the living people that use them and the living universe of which they are a part.

Endnotes

[1] Brand, Stewart. *How Buildings Learn: What happens after they're built*. New York: Penguin Books, 1994. p. 5.
[2] Duffy, Francis. "Measuring Building Performance." *Facilities*, May 1990: p. 17.
[3] Brand, *How Buildings Learn*, p. 216.
[4] Callado, José. "The Architect's Perspective." *Urban Studies*. Vol. 32, No. 10, 1995: pp. 1665-1677.
[5] Brand, Stewart. *How Buildings Learn.* p. 176.
[6] Friedman, Avi. The Adaptable House; Designing Homes for Change. New York: McGraw-Hill, 2002. p. 6.
[7] Habraken, N. J. *Supports: an alternative to mass housing*. London: Architectural Press, 1972. p. 12.
[8] Harrison, Andrew, Eric Loe, James Read, eds. *Intelligent buildings in South East Asia*. London ; New York: E & FN Spon, 1998.
[9] Brand, Stewart, *How Buildings Learn,* p. 119.
[10] Mayne, Tom. Lecture at the University of Cincinnati. October 27, 2004.
[11] Alexander, Christopher. *The Timeless Way of Buildin*g. New York: Oxford University Press, 1979. p. 120.
[12] Kelly, Kevin. *Out of Control; The New Biology of Machines, Social Systems and the Economic World*. Reading, Massachusetts: Addison-Wesley Publishing Co., 1994. p. 352
[13] Kelly, Kevin, *Out of Control*, p. 353.
[14] Petzinger, Thomas Jr. A New Model for the Nature of Business: It's Alive! The Wall Street Journal. February 26, 1999. p. B4.
[15] Dawkins, Richard. *The Blind Watchmaker*. New York: W.W. Norton & Co., 1987.
[16] Kelly, Kevin. *Out of Control* p. 83
[17] Frazer, John. An Evolutionary Architecture. London: the Architectural Association. 1995.
[18] Alexander, *The Timeless Way of Buildin*g, p. 92.
[19] Brand, *How Buildings Learn*, p. 169.
[20] Callado, "The Architect's Perspective."
[21] Habraken, *Supports*, p. 18.
[22] MacDonald, Donald. *Democratic architecture: practical solutions to today's housing crisis*. New York: Whitney Library of Design. 1996 p. 147.
[23] Severino, Renato. *Equipotential Space.* New York: Praeger Publishers, 1970. p. 3
[24] Hill, Jonathan. "The Use of Architects." Urban Studies. Feb 2001, Vol. 38 Issue 2, pp. 351-365.
[25] MacDonald, *Democratic architecture*, p. 148.
[26] Educational Facilities Laboratories. *SCSD: the Project and the Schools*. New York: Educational Facilities Laboratories, Inc., 1967. p. 10.
[27] Alexander, *The Timeless Way of Buildin*g. p. 229.
[28] Alexander, *The Timeless Way of Buildin*g, p. 162.
[29] Jencks, Charles. *The Architecture of the Jumping Universe*. London: Academy Editions, 1997. p. 77.
[30] Jencks, *The Architecture of the Jumping Universe*, p.77.

Chapter 3 **Accommodating Change**

Now that it has been established that buildings work best when they are designed to change in response to the users and changing circumstances, we must face the daunting task of figuring out how to accomplish this goal of a building alive with change. I have outlined the principal causes of change, but this list does not describe the ways in which these changes take place, which is the first step in understanding how to create an adaptable building. There are also a number of forces that exist beyond the scope of any single architectural project that tend to prevent successful adaptation. The existing strategies and precedents for overcoming these challenges will be the focus of this chapter.

Varieties of Change

It is first necessary to study the many forms of change. Change takes place over several phases, occurs in varying intensities, is initiated through a number of responses, and affects the building on many levels. Each one of these varieties of change is appropriate to slightly different situations, and helps us to better understand how to incorporate adaptability into a specific design problem.

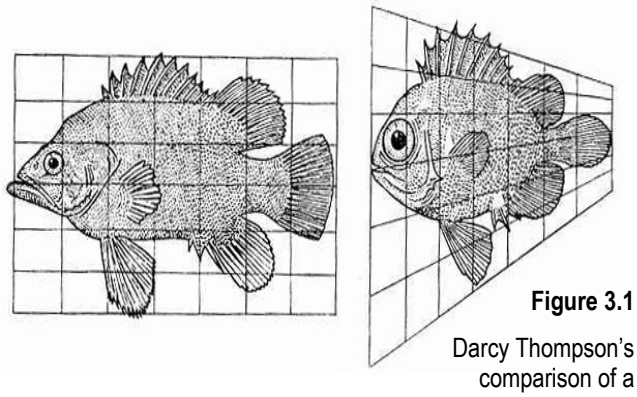


Figure 3.1
Darcy Thompson's comparison of a species of fish at two different evolutionary stages

Processes of Change

Avi Friedman argues that the concept of adaptability to change should extend throughout the entire building process.[1] Planning for change begins with the earliest conception of the project and continues through its occupancy. He identifies three primary stages in which adaptability takes place.

DESIGN

The design for change occurs on two levels: preoccupancy and postoccupancy adaptability. *Preoccupancy adaptability* is important when the specific users and their needs are not known at the time of design. Take for example a large housing project planned for a variety of unspecified clients, which provides a means to allow the tenants to personalize their units before they move in, just as in Donald MacDonald's plan to adapt the housing supply to its market (see "Egalitarian Architecture").

Postoccupancy adaptability differs in that it implies continual change, even after the building has been occupied for years. It is impossible to predict the future conditions that will influence a building, so the designer must keep in mind the open ended possibilities of the user's evolving needs. This is much more complicated than designing a generic housing unit that can be matched to varying tenants before the unit is complete. The construction methods and spatial qualities must be designed so that they will not restrict change even if it is something that never crossed the mind of the architect or client.

CONSTRUCTION

The success of a building also depends on the ability of the design to respond to changes that arise during construction. Design strategies that enable the builder to make modifications while the building is in progress help the project react to changing market conditions or to the client changing his or her mind upon seeing the actual construction.

OCCUPANCY

And of course the most change occurs during the user's occupancy. This is where the action of change takes place, and as outlined above in "The Inevitability of Change," nearly all buildings encounter some form of it. The user's desire to modify space is the reason why it is so important for architects to plan for change.

SCALES OF CHANGE

Varying rates of change are a direct result of the multiple layers that make up a building. As Frank Duffy says, "there isn't such thing as a building."[2] Instead, he sees the building as several layers of physical elements of varying longevity. Duffy distinguishes four layers—shell, services, scenery, and set—which relate to his list of four time scales of change (see Figure 3.2).

He observes the current trend to invest an increasing proportion of budgets on the short term fitting out of things like mechanical services and furniture. If this continues, the longevity of the shell will become more and more questionable as buildings are demolished and rebuilt at an increasing rate. The only way to counteract this wasteful trend is to learn to design our buildings to change on all time scales.

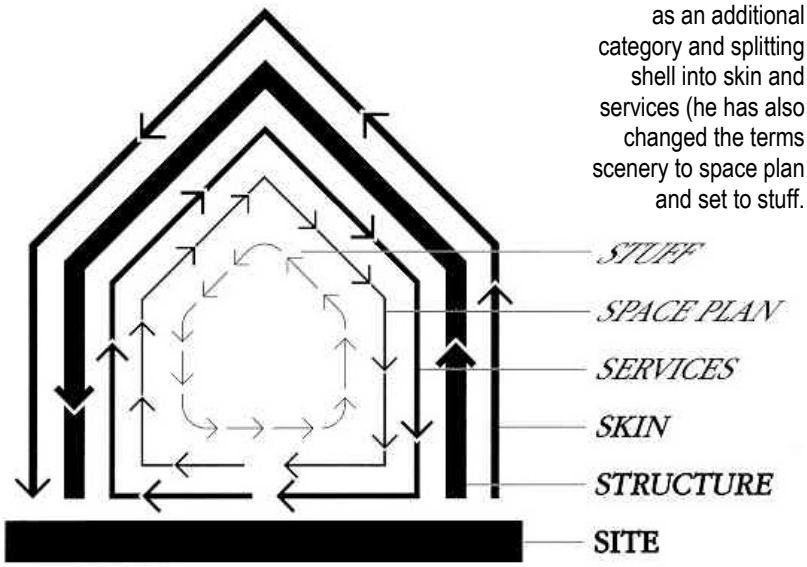


Figure 3.2

Brand completed Duffy's idea about shearing layers of change by adding site as an additional category and splitting shell into skin and services (he has also changed the terms scenery to space plan and set to stuff.

Very Short Term

Very short term change usually happens over the course of weeks or months. It involves mostly *stuff*, such as the rearrangement of furniture, but also the *space plan*. This sort of change results from the desire to periodically reorganize a space and the objects within it, for example in order to adjust a workspace to the idiosyncrasies of multiple users. Very short term change is also an excellent way to gradually and steadily evolve the arrangement of stuff and the site plan to a specific set of needs. A sort of "natural selection" can occur with furniture placement, where something will be more likely to stay in a certain location if it worked well in the past.[3]

Short Term

The patterns of use in a building tend to change on a yearly basis. This deals with the reorganization of the *space plan*, but more drastically changes the functioning of spaces and the relationships between them and on a larger scale. Short term modification is more the result of a changing purpose than an adaptation to very specific needs.

Medium Term

In the range of five to seven years there is often a need to accommodate growth. Additions or minor renovations are made to respond to the slower, more comprehensive changes in an institution, organization, or user group. This is also the time frame for updating buildings for new technology by adding or changing services.

Long Term

In the longer range of about fifteen years major redesign and renovation takes place. This is about the typical lifetime of services, so they will often require replacement. Also, changes in the shell can happen at this scale: the skin may be replaced, or the structure could be modified or expanded.

Degrees of Change

Stewart Brand describes two different types of environments in which change occurs—the "Low Road" and the "High Road". To these two he contrasts the "No road" that is all too common in magazine architecture. I have added a fourth possibility of a totally ephemeral architecture that is "All Road". Together they represent a scale of the possible intensity of change in a building.

No Road

The No Road building completely ignores time and thwarts any attempt by the users to update it according to their evolving needs. Frank Duffy complained to Brand about "the curse of architectural photography, which is all about the wonderfully composed shot, the absolutely lifeless picture that takes time out of architecture—the photograph taken the day before move-in."[4] The over-design of a building to achieve a static, timeless image has drained the life from many of our contemporary buildings. The No Road building is rarely, if ever, appropriate, because all groups of users change in some way. The exception is a dead user—No Road buildings work best as tombs.

High Road

High Road buildings embrace change, but they look permanent since they change in a conservative, long-term, accumulative way.[5] They are flexible enough to deal with changes, but their existing integrity and duration of purpose permit only the renovations or additions that will continue to enhance their intent. They show continual progress through a series of refinements. Often institutional facilities or prestigious homes, these buildings aspire to be eternal, but rather than opt for a fixed monumentality they successfully survive by means of gradual expansion and adaptation. Many historic buildings evolve this way over centuries to build up what appears to be a sort of memory and consciousness. The visible history of the building puts us in connection with the past, ourselves and our continuity.[6]

An excellent example of High Road adaptation is the London Library. Although libraries, like any institution, demand some notion of permanence, they are always forced to grow by the pressures of an expanding collection. The London Library has succeeded in growing on its restrictive urban site by accretion of neighboring buildings, forming a labyrinth of disparate pieces that are somehow united. The result is a feeling of maturity, an impression of many layers of soul.

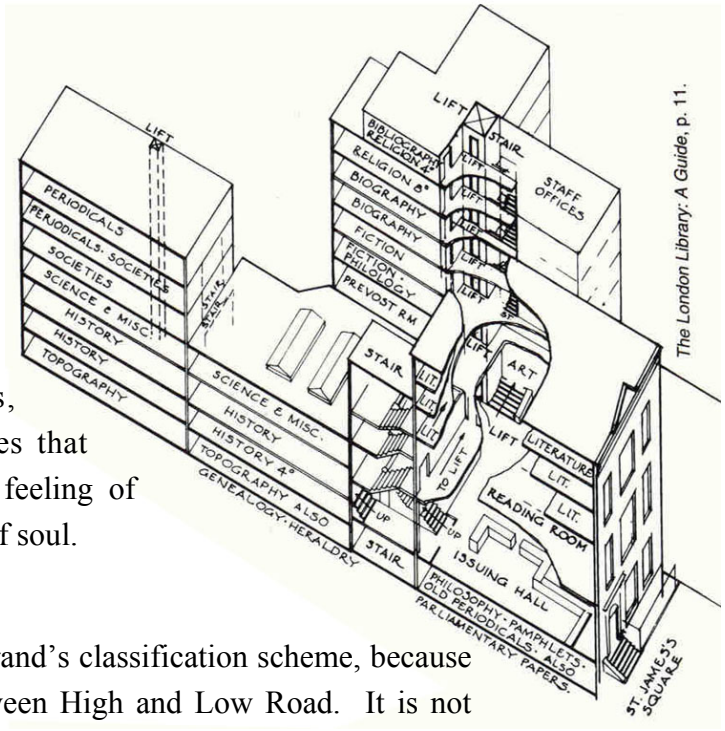


Figure 3.3
The London Library

MIDDLE ROAD

I feel the need to add another level to Brand's classification scheme, because so many buildings fall somewhere between High and Low Road. It is not really a totally different third type of change but more of a hybrid of the other two. Most homes would probably fall in this group. Sim Van Der Ryn differentiates between three types of buildings that change in separate ways. Commercial buildings must adapt rapidly, institutional ones resist change whenever possible, and domestic buildings are the steadiest changers, responding directly to the family's ideas and annoyances, growth and prospects.[7] Homes almost always have some degree of messiness and the unfinished quality of a Low Road building, but at the same time they aspire to the permanence and integrity of the High Road.

LOW ROAD

While High Road Buildings evolve progressively with direction (whether intentionally or not), Low Road structures invite cyclic transformation. They thrive in environments of constant flux. "Nobody cares what you do in there" is Stewart Brand's motto, which describes why these humble buildings are so open to any kind of change.[8] Completely unrestrictive, these buildings offer a great deal of freedom to the users, which is why they seem to foster creativity. Research facilities, offices with high turnover or frequent reorganization, studios, factories, and entrepreneurial businesses all tend to be Low Road buildings. Think of the garages of the Silicon Valley. The high-risk, high rate-of-change of developing electronics demanded that the revolution take place in cheap structures with maximum flexibility.[9]

ALL ROAD

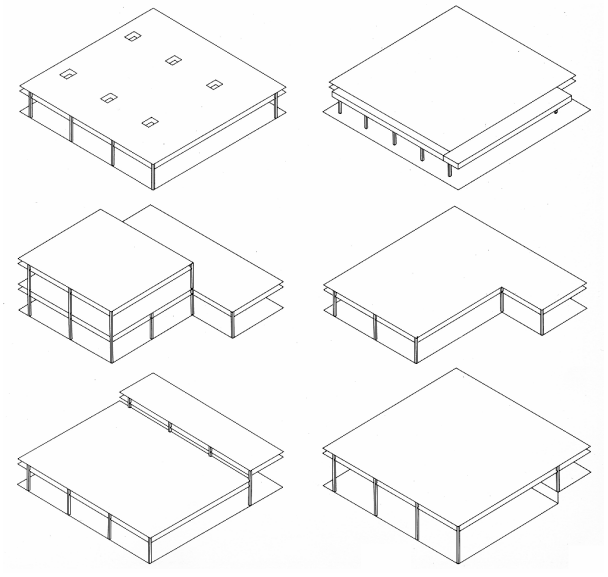
The last category of change intensity includes things that hardly even qualify as buildings since they are in constant flux. The Bedouin tent used by Middle Eastern nomads is a classic All Road "building". The tents constantly move from place to place, the exterior "walls" are continuously readjusted in response to changing weather, and they offer maximum flexibility of interior division. Other examples include temporary stages, emergency facilities used for natural disasters, and mobile homes. All Road structures are appropriate in rare circumstances, for those with an alternative lifestyle or a set of needs that is totally unpredictable and transient.

MECHANISMS OF CHANGE

In addition to varying intensities of change there are also different methods by which a building can adapt. As the title of Stewart Brand's book suggests (*How Buildings Learn*), buildings can respond to their changing environments, improving themselves in a way that approximates the growth and learning of living things. Heritable learning is one definition of evolution, and an organism's body learns in much the same way as a building. Biologist Robert Reid identifies five types of plasticity that allow an organism to respond to environmental change (keep in mind that environment means all of the external factors that impact behavior or form, not only climatic conditions).[10]

Figure 3.4

The system developed by SCSD can take many physical forms.



MORPHOLOGICAL PLASTICITY

This means that an organism can have more than one body form. Some buildings can also have multiple forms, allowing them to accommodate a number of different programmatic layouts, sizes and spatial qualities. An extreme example is the "Cloud" project by Coop Himmelblau composed of a foldable lattice structure supporting inflatable rooms. The rooms can change size and be rearranged, while the entire structure can join with other similar units to give the building an endless number of forms.[11]

Physiological Adaptability

The tissues of an organism have the ability to modify themselves to accommodate stress. An architectural equivalent would be updating communication systems to support new technology, or using photosensitive glazing that increases its transparency when more light or heat is required. There have also been proposals for construction systems that could respond to changing user needs by altering their size, shape or layout. One example is the project called the "hybgrid" (Figure 3.5), a curved structural space frame that can modify its form.

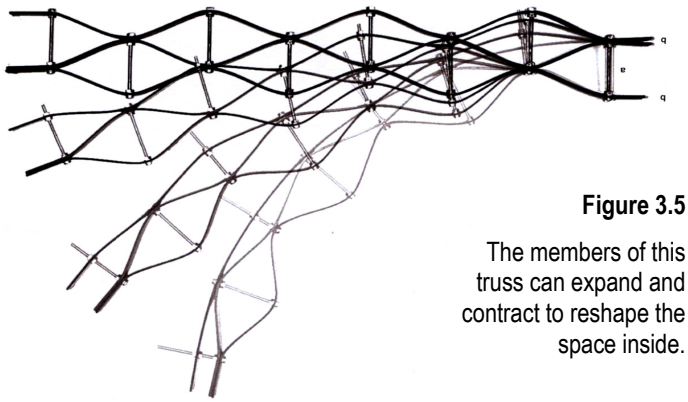


Figure 3.5

The members of this truss can expand and contract to reshape the space inside.

Behavioral Flexibility

Sometimes it is necessary for an organism to change its behavior slightly, to do something new or move. In a building this means that a single space, without significant modification, can be used for a function other than its original purpose. A school cafeteria might be used for a special event when its normal auditorium is in use or be designed as a "cafetorium".

Intelligent Choice

This refers to an organism's ability to make a decision based on its past experiences. Although a building itself cannot make a conscious decision, its occupants give it a kind of collective consciousness. The users can anticipate change and respond preemptively, for example, the prediction of a change in the housing market may encourage a home owner to divide part of the house to lease for extra income.

Guidance from Tradition

Organisms can also learn from the accumulated knowledge (not necessarily held consciously) of others' past experiences. In the architectural realm this amounts to the development of a vernacular tradition. Through the lessons of others' mistakes and successes, a method of construction and style becomes uniquely adapted to its function and environment.

The reason that Darwinian evolution is said to work is that these five means of flexibility are built into the body, allowing the population to survive long enough for mutation to arise and affix itself in the genes. These five varieties

of inheritable learning are the mechanisms of evolution, and they are the same for buildings as they are for living creatures. Now we will look at some of the methods of making possible these means of structured change.

MEDIUMS OF CHANGE

While there are certainly dozens of strategies that architects can use to allow buildings to adapt, the ways that the methods affect a building fall into just a few categories. These categories are the means of change, and are the critical areas of intervention in order to achieve adaptability. Avi Friedman calls them "forms of adaptability" and puts them into four groups. [12]

MANIPULATION OF VOLUMES

This refers to the consideration given to the overall volumes and massing of a building. It would include the possibility of dividing a multistory single-family dwelling into two or more volumes for other tenants. By manipulating the building on this scale it is possible to change the relationships between different parts of the building or even the functions that those areas serve.

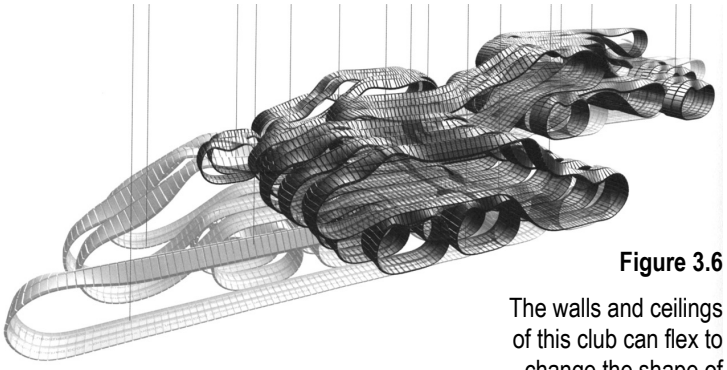


Figure 3.6

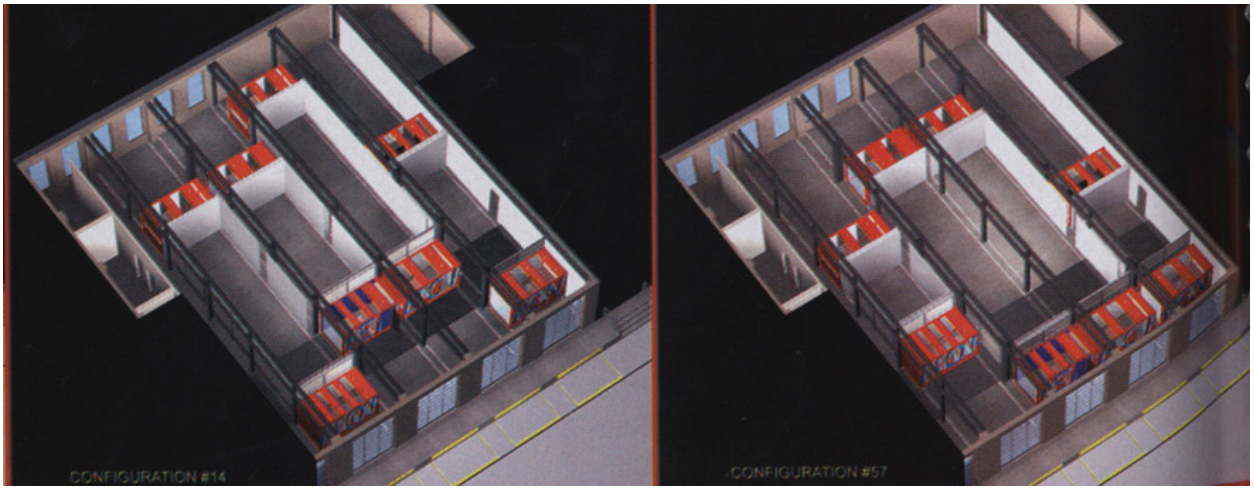
The walls and ceilings of this club can flex to change the shape of the spaces and overall volumes

SPATIAL ARRANGEMENT

Spatial manipulation is on a smaller scale than that of volumes. A space refers to anything from a defined area within a room to an entire floor within a larger volume. It involves changing the way a space is used, modifying its layout, or even just moving or replacing furniture.

Figure 3.7

The Bohen Foundation by LOT/EK uses mobile partitions and shipping containers to change the spatial layout



Growth and Division

The possibility of expansion and reduction of spaces or volumes is another important means of change. As the economy changes offices tend to hire additional workers or lay off current workers. This leads to either overcrowded or empty spaces, both of which are less than ideal working conditions. Similar pressures to expand and contract influence most building types, from houses to libraries. By designing the space to grow into extra program space, such as balconies, or to easily separate into areas for additional tenants, many of these stresses can be resolved.

Figure 3.8

In some Middle-Eastern cities houses are commonly planned to grow skyward.

Manipulation of Subcomponents

Subcomponents are the basic elements of construction. The ability to move lights around or exchange one plumbing fixture for another encourages flexibility at this level. Providing for easy manipulation of a building's subcomponents often leads to larger scale flexibility as well.

Precedents

The School Construction Systems Development Project (SCSD): 13 Schools Built in California; 1961-1967

Perhaps the most comprehensive development of an original, flexible system of construction is the SCSD project used to build a number of experimental schools in Northern California during the sixties. The roots of the project go back to 1954 when Ezra Ehrenkrantz studied the prefabrication techniques used by the British to address their shortage of schools following World War II.[13] Ehrenkrantz then developed and applied these concepts to an experimental program for the Cupertino Elementary School in California. Out of this project came the beginnings of some of the designs for SCSD. In December of 1961 the Education Facilities Laboratories approved funding for research

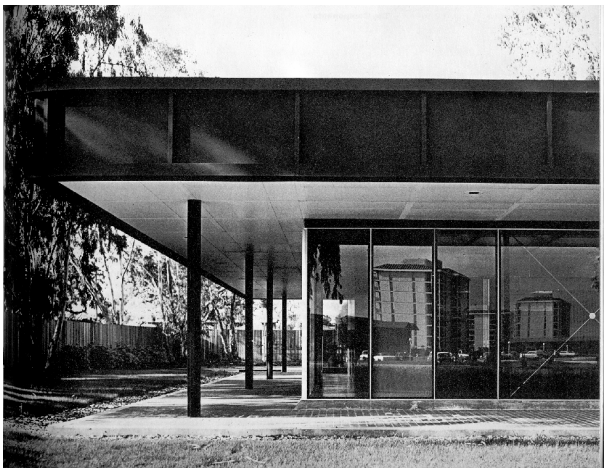


Figure 3.9

A completed SCSD school

and development of the "systems" method of construction. This systems approach was quickly adopted by other school districts throughout the US and Canada.

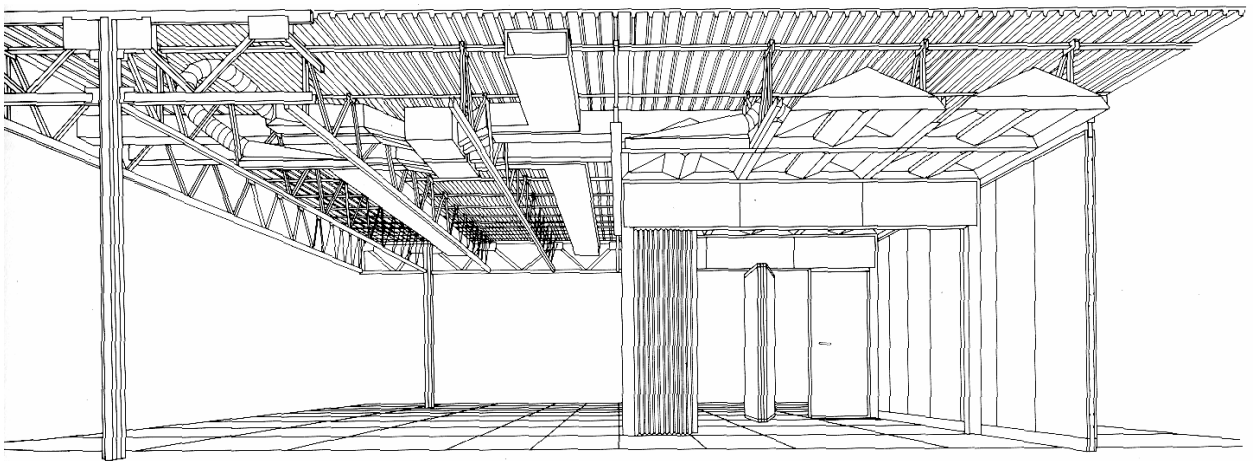


Figure 3.10
The "systems" approach.

DESIGN CRITERIA

The overall goal of the project was to refine a method of building better schools more rapidly and economically, which they decided, largely through the influence of Ehrenkrantz, could best be accomplished by the systems approach. [14] This method emphasized the compatibility and flexibility of building components through modularity and standardization. It was a means of capitalizing on the efficiency of mass production while avoiding the monotonous repetition usually associated with such manufacturing processes.[15]

In order to meet the changing needs of many different school systems, the flexibility of the construction systems was crucial. The team identified four basic forms of required flexibility: *spatial variety*-providing spaces with a range of characteristics; *immediate change*—primarily accomplished with operable partitions; *long term change*—for example, demountable partitions and moveable air diffusers; and *expansion*. [16] To achieve these goals maximum flexibility was built into the design of the six systems developed by SCSD: structure and roof, HVAC, lighting/ceiling, partitions, cabinets and fixed lab furniture, and lockers. In theory these systems could be combined to form an infinite variety of schools that would be able to adapt to the changing needs of each body of students and faculty.

SALK INSTITUTE: LOUIS I. KAHN - LA JOLLA, CA; 1968

Figure 3.11

Left: tower scheme
Right: final masterplan

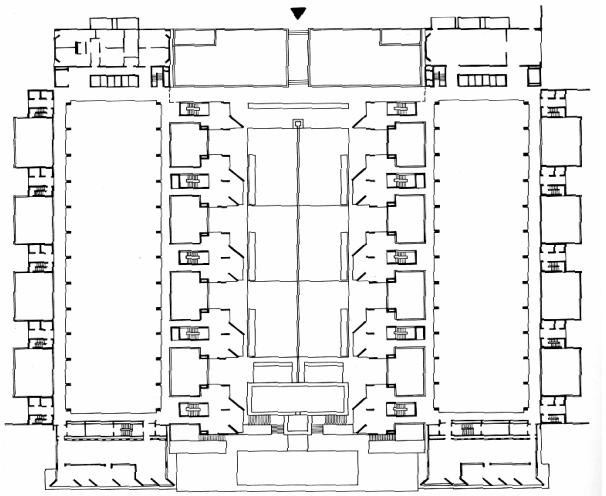
Figure 3.12

Below: plan of labs at courtyard level

Figure 3.13

Bottom: The courtyard

The Salk Institute is often thought of as the artistic masterpiece of Louis Kahn, known as it is for its spectacular courtyard overlooking the cliffs along the Pacific Ocean. Its success is the result of a rich, decade long collaboration between the architect, visionary client Jonas Salk, and ingenious structural engineer August E. Komendant. Kahn's first scheme included a series of service and lab towers that came directly out of his recent design of the Richards Medical Research Building for the University of Philadelphia.[17] The scheme that Jonas Salk first approved consisted of two pairs of identical two-story buildings, each running perpendicular to the coast with planted courtyards between each pair.



Salk later decided on two buildings with a single courtyard because he feared the four buildings would compete. He also expressed concern with Kahn's five-foot-deep mechanical spaces, which lead to Komendant's solution of nine-foot-deep concrete Vierendeel trusses.[18] The trusses allowed for a 65 foot clear span in the lab areas, with generous interstitial spaces between floors. These interstitial spaces, combined with Kahn's generous circulation and common areas, light wells, and individual studies overlooking the courtyard to the ocean, all make this building incredibly innovative for its time and contribute to its flexibility and success.

SENDAI MEDIATHEQUE: TOYO ITO - MIYAGI, JAPAN; 2000

The Sendai Mediatheque is a particularly relevant precedent because of its unique program and design process, which planned for change. The facility combines an art gallery, media center of visual images, a library, and a service center for people with visual or auditory impairments.[19] The programming phase began with discussions among the designers and citizens, which continued through construction. Since the debate about the nature of the "mediatheque" was endless, never reaching any conclusion, the building had to be designed to be flexible enough to accommodate any program. The details of the actual program remained ambiguous throughout design and construction, and the designers started by dismantling the archetypes of libraries and museums to create a fluid space capable of supporting any use the facility could require.

Figure 3.14

The three-part system is visible in the elevation

Figure 3.15

The structural tubes create places

The building is composed of a three part system.[20] The "plates" of the floors are made from a honeycomb-like sandwich system of welded steel plates, which permits long spans with very thin, flat floors. The "tubes" are the structural, tree trunk-shaped columns that sway randomly up through the plates. They allow the flow of information, people, light, air and services between floors. "Skin" separates the indoors from outdoors, but most important is the full height double-layer glass façade on the major street elevation, which establishes a connection between the two. Ito stated his goal that the building would be a place for the integration of the material architecture, the fluid body of electronic information and nature.

External Challenges

After considering all of the reasons why buildings change, and why they should change, it's hard to imagine why any building would be designed without the keeping in mind the element of time. But until recently we have not really had to worry about change, and it is always easier to continue with the status quo than to do something differently (and it is easier to design a building to continue the status quo than one that changes). We have complexly developed industries and institutions for creating and regulating buildings, and the established ways of doing things can create obstacles for dealing with change that are beyond the control of any single project.

Administrative Control

Christopher Alexander argues that the nature of administrative control must change before any there can be any full realization of organic growth, user participation or sustainable design. The established hierarchical structures throughout our society—whether the government, public institutions, large corporations, or building professionals themselves—are incapable of dealing with change.[21] When these entities are involved with a project, and they always are to some extent in our country, they make it difficult to make changes during the processes of design and construction. This, in turn, makes it impossible for the building to successfully adapt to its specific site and the way people will use it in that context.

Legal Regulations

One form of administrative control that can make it particularly difficult for a building to evolve is legal regulations, particularly building codes and permits. Too often the strict requirements of code, combined with the excruciating process of getting a building permit, actually prevent people from making renovations to their buildings—even when the changes might be in the public's best interest. In New York City, for example, the cost of a building permit to remodel can exceed the price of the work itself.[22] "Communities that want their built environment to improve over time would do well not to punish remodeling work," writes Stewart Brand. The permit process can also stunt progress in the area of building technology by preventing innovation in our approach to managing the building process. For example, in Japan, where construction and design are integrated, a much more flexible construction culture is better able to adapt a project as it is

being built and come up with innovative solutions on the spot.[23] However, this integration is impossible in North America, where liability issues and permit requirements keep these processes separated.

Economic Forces

There may sometimes be a reluctance to design for change due to financial considerations. Some strategies may require more time or money when compared to a more common design approach, but that is not really the problem. If a building is sufficiently designed for change the savings should more than counteract any additional design fees or first costs. The real problem is in the way we finance and budget construction projects. Frank Duffy points out that there is a tendency, especially for Americans, to ignore the lifetime costs of a building.[24] When only the first cost is considered, payoffs such as easy service upgrades, more effective use of space or the ability to expand the building efficiently go unnoticed.

Another economic problem surfaced in Alexander's work with the University of Oregon. The university is a huge institution with a centralized budget, so there will always be some element of totalitarian control in any project they finance.[25] For his pattern language method to work properly, decisions about repairs and additions need to be made by the people locally involved and affected by the project, which can never happen when the final say comes from a centralized group that controls the money. To correct this problem he had to initiate policies to enforce the distribution of funds throughout the school and limit the cost of any single project.

Traditions of the Building Process

Architects and other construction professionals are themselves guilty of overlooking the inevitability of change. However, they are usually not given any incentive to consider it. Just as many building owners do not budget according to lifetime costs, the typical fee structure and program for an architect does not take the future into account. The architect's brief usually represents the client's requirements (and not the user's) at a single point in time.[26] Architects are responsible for design, and they are praised for creating the instant work of art. When a building fails they will certainly hear about it, but no one seems to notice when a building continues to work for ages, even in the face of drastic change.

Part of the problem is that design, construction, and other related processes have become isolated fields.[27] In this situation each person has a specific task to focus on completely—conceptual design, construction documents, electrical design, pouring foundations, and so on—but no one is paid to think about how the building or situation might be different in the future. Many of the strategies for accommodating change, such as Jones's Collaborative Strategy for Adaptable Architecture, relies on an integration of processes and professionals, but in reality this is very hard to accomplish. On the other hand, in a systematically collaborative building process like that common in Japan, the team has a much greater ability to make changes during construction, better enabling the building to adapt to its context and program.[28] Integration of all professions also means that more aspects of the project come into view for more people and the long-term performance of the building will play a bigger role.

Education and Participation of Users

Even when all of the other issues have been overcome and a building has been thoughtfully designed to change it is still likely that changes will not occur as the architect intended. If the people who use the building do not want to change or do not know how to take advantage of the building, all of these strategies will be in vain. In fact, behavioral resistance to change is often more difficult to overcome than the technological problems associated with change.[29] This problem was revealed in a post-occupancy study of the SCSD schools. Although years had been spent designing the systems to be adaptable and interchangeable the study revealed that very few of these features had been used. In a survey of teachers seventy percent said that they would like to make changes to the building, but only twenty-five percent had done so. About two thirds of the teachers claimed they knew that cabinet interiors could be repositioned, but when asked if they thought other elements were changeable a large majority reported "no" or "don't know" for each system.[30] The participation of users in the project, and educating them about the unique qualities of the building, is critical for the building to change as designed.

Strategies

The challenges above illustrate why the element of time is so rarely considered by architects and other building professionals. However, they do

not make it impossible to plan for adaptation, as the described precedents show. The following strategies come from a broad range of sources and ideological positions, but each suggests some way of working around or within the obstacles to change.

SUPPORT STRUCTURES

Figure 3.16

The adaptation of a support structure in Hollabrunn, Austria based on Habraken's methodology—for a competition titled "Design Without Information" in 1971.

Many theorists have made proposals that fall in this category, but I have borrowed N. J. Habraken's term, because it is the most descriptive and he goes into the most detail about the concept and its implications. By his definition, a support is a construction (not a building itself) capable of lifting dwellings off the ground in a way that allows them to be built, altered, and taken down independently of other units.[31] The main problem it solves is that the urban requirement to build vertically often leads to a dangerous increase in scale. This larger scale threatens living conditions and the subtleties of town organization by making it extremely difficult to adapt any single piece of a building to the changing local forces acting upon it. By creating a support structure to hold individual housing units each home becomes free to evolve as necessary. The supports include everything necessary to support the construction of dwellings: the major parts of the structure, vertical and horizontal circulation to access the homes, and provisions for services.

Habraken acknowledges that the supports will likely be expensive and take time to construct, but they will last much longer than the typical residence, foreseeably for centuries.[32] The cost will also be offset by the possibility of using more efficient means of prefabrication for the individual dwellings, and because all of the costs of site preparation will already be taken care of when new dwellings are added. More importantly, supports will allow for the unexpected. Supports will permit each household to express their own identity and change their environment much easier and cheaper than is possible with traditional housing.

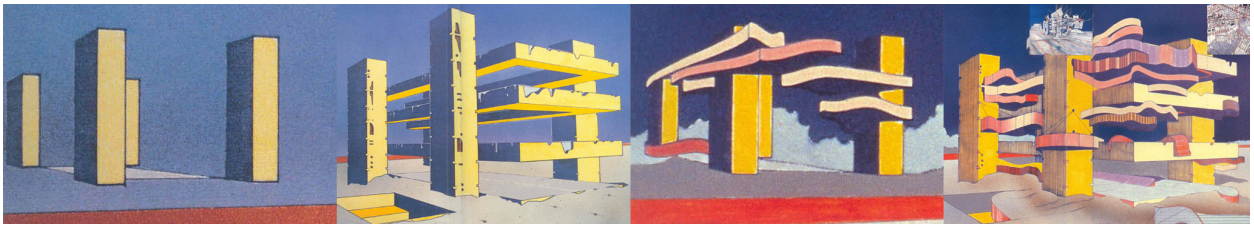


Figure 3.17

Peter Cook's illustration of the evolution of a support structure.

Though Habraken delivers the concept of the support structure as a solution to shortages of housing and the inadequacies of mass housing, proposals by other architects prove that the strategy is applicable to many other situations. Frank Duffy writes about the "shell and core" concept adopted by British developers, in which the fitting out of office spaces was left to the tenants.[33] This ensured that the building was designed to be easily adapted to any tenant's needs. Unfortunately, the idea was dropped in the eighties as the switch to a buyers' market put pressure on developers to design the entire building to the original tenants' needs.

In his Collaborative Strategy for Adaptable Architecture (or CASA) John Christopher Jones describes a related approach to the building process intended to integrate the decisions of the many individuals involved with creating a building and to increase the building's adaptability through better compatibility of its components.[34] Jones proposes that the "system" (the parts and features that will not change over a building's life, e.g. structure) of the building be designed separately and before the "sub-systems" (such as interior partitions, finishes, environmental systems, and maybe even enclosure). Separate design and construction contracts are negotiated for each step, so when design is complete on the system level construction begins before the subsystems are designed. CASA also includes provisions for subsequent generations of sub-systems, allowing the building to evolve over time. By designing sub-systems that are independent of a building's primary "system," users can more easily modify the sub-systems, and a certain degree of flexibility is built into the project.

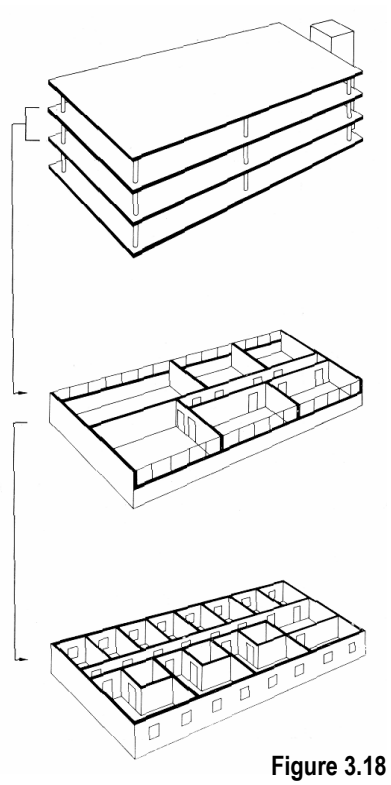


Figure 3.18

Jones' illustration of CASA: on top is the support system, with the first and second generation subsystems below

Another, more detailed account of a multi-purpose support structure system is the Equipotential Space approach by Renato Severino. Equipotential Space extends the definition of space from strictly geometrical characteristics to

include a consideration of the changing patterns of relationships.[35] To accomplish this Severino proposes a system of Frame Objects and Function Objects. Function Objects are small, self-contained units that define and structure the physical limits of a volume or territory in predetermined scale increments. Frame Objects provide the necessary environmental conditions and apparatus to allow function objects to be used for a particular program.

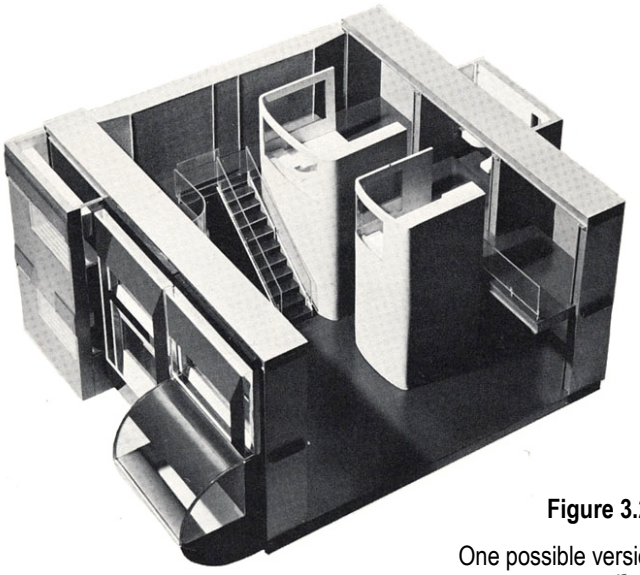


Figure 3.20

One possible version of the system

It should be noted that the effect of Equipotential Space differs from that of Habraken's support structures. The dwellings within support structures are relatively autonomous and allowed to evolve in a more High Road sort of way, according to the individual forces acting upon them. The goal of Equipotential Space, on the other hand, is more about the flexibility to continuously redefine the qualities and patterns of use within a space. However, a common theme exists—both concepts employ the use of a very permanent, often primitive, sort of structural system, within which individual functions and parts can evolve independently of the support or each other. Henceforth, when I mention support structures I am referring to this common concept.

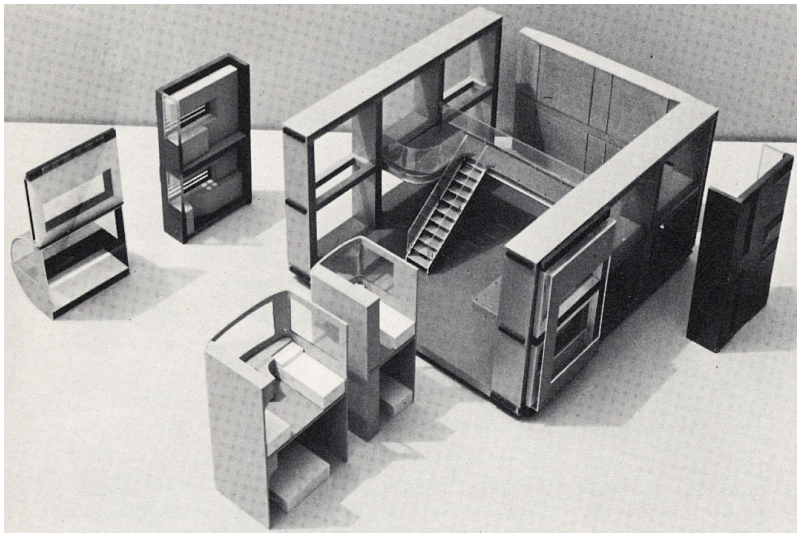


Figure 3.19

Equipotential Space: The Function Objects are shown outside the Frame Object.

PIECEMEAL GROWTH

From small spaces, to large buildings, to entire urban communities, many of the most beautiful and well-adapted places have evolved by piecemeal growth. Christopher Alexander is probably the most dedicated supporter of this process, but other researchers have reached similar conclusions on their own terms, including Jane Jacobs. Alexander defines it as "growth that goes forward in small steps, where each project spreads out and adapts itself to the

twists and turns of function and site."[36] The result is a series of unique but related parts that have each been adjusted to resolve all of the complex internal and external local forces. Think of the stereotypical historic European town. Somehow an overall unity exists among the hodgepodge of seemingly autonomous buildings. Over centuries of repair, renovation, and gradual accumulation, a rich variation arises that expresses both the individual purpose of each element and the overall harmony.

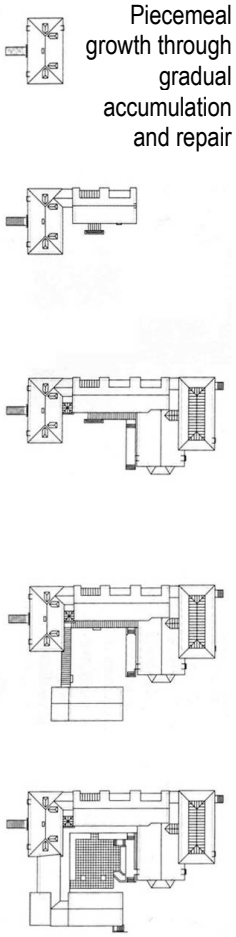
Figure 3.21

Siena, Italy has the kind of unity within variation produced by piecemeal growth.

The alternative to piecemeal growth is "large lump development" (Alexander's term). In this process, the built environment grows in massive chunks. This type of development relies on the belief that perfect buildings are possible to design as a whole, before even touching the site.[37] The problem is that mistakes and changes are inevitable. When an entire budget goes to creating a large building that is considered finished once it has been constructed, chances are that most of its insufficiencies will never be addressed. Instead it will be replaced after a few decades by another large, not quite good enough building.

Figure 3.22

Piecemeal growth through gradual accumulation and repair



Piecemeal growth bypasses the problems of such development strategies because it is based on repair instead of replacement. Growth happens in small steps that allow each piece to satisfy its own needs and respond to the other parts nearby. This also makes it much easier to modify the pieces to correct any mistakes or respond to any changes. Piecemeal growth is characteristic of High Road buildings. The slow, steady accumulation gives them their sense of maturity, as in the case of the London Library.[38]

The drawback of course is that continual repair costs money. However, the money is spent much more efficiently. Because growth occurs in small steps, the money is always spent on satisfying immediate needs, so there is no reason to exaggerate needs to accommodate future growth in something that is built now. When new needs arise, piecemeal improvement accommodates them. With this method money is also distributed more evenly.

The Salk Institute requires some analysis from the perspective of growth since it has recently been added to in the large lump way, although the original building suggested piecemeal growth was possible. Kahn's design had open-endedness and modularity in mind, which invites extension.[39] The

building consists of a rhythm of smaller parts, indicating that more pieces like these could be added without taking away from the original meaning of the building. However, it could be argued that the abrupt truncation of this system is what made it so visually effective. But the bigger problem was that the Salk Institute had become so revered by artists, architects and historians that it became untouchable, and the addition was the subject of great controversy. In the end, the second building was designed to connect to Kahn's building only through an underground tunnel, and it defied every rule that Kahn had established for the original. Another reason for this departure may have been the original building's strict repetition and formality of layout, which makes it difficult for piecemeal growth to take place. These circumstances limit the ability of an addition to take on idiosyncratic adaptations to its evolving purpose.

In a way, support structures allow piecemeal growth to happen more easily. They provide a framework in which this kind of continual refinement may take place. However; these supports are likely to have problems similar to the Salk institute. The support approach limits the full realization of piecemeal growth because it predetermines the relationships between the parts by specifying circulation patterns of the whole, the overall form, locations of open space, and site conditions.

MODULARITY

Modularity is the standardization of building components based on some sort of module, usually in terms of its dimension. John Christopher Jones argues that the use of modules may be "THE way of designing independently of any exact knowledge of aims, purposes, functions."[40] He says that the best examples of designs all rely on some kind of module: the words of a language, bricks, playing cards, alphabets, numbers, and musical notation. Whatever it is applied to, modularity offers possibilities for using the parts to make a whole that the designer could have never imagined. It serves as a means of achieving either behavioral or morphological plasticity.

Figure 3.23

Modular construction in a traditional Japanese home

The use of a module permits morphological change through the compatibility of building components. This is one of the main strategies used in the SCSD project. (see Figure 3.24) Every component was designed around a five by

five by two foot module, except the partitions which could be placed anywhere on a four by four inch grid in plan. This made it possible to cut construction costs by manufacturing many of the same parts, because the parts could be recombined in an endless number of variations. Also, once in use the module allowed interchangeability of parts, so things could be rearranged and added onto easily.[41]

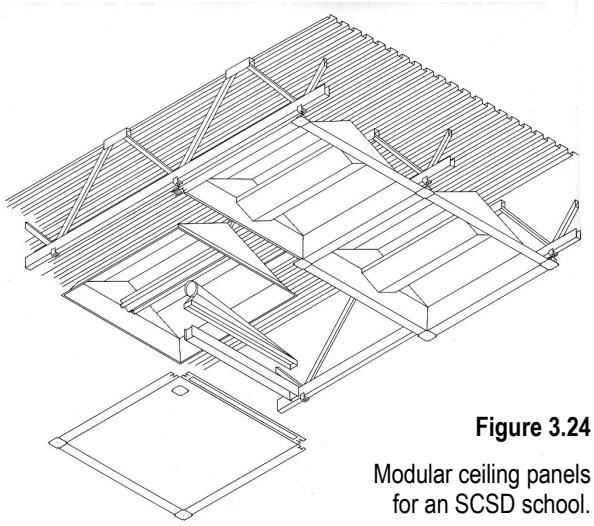


Figure 3.24

Modular ceiling panels for an SCSD school.

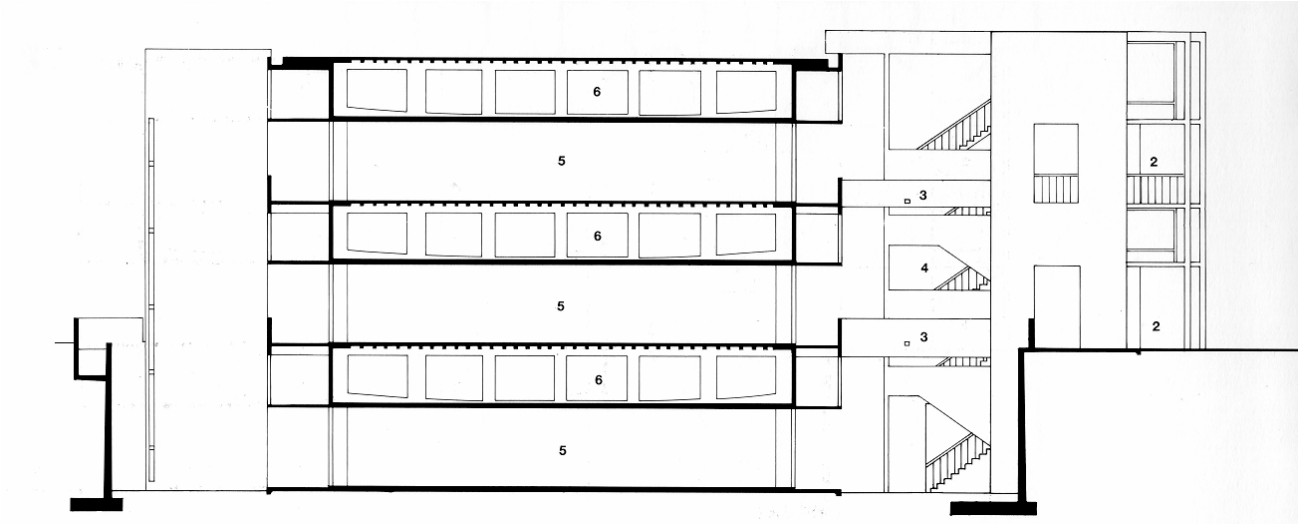
Behavioral flexibility results from the use of a module because rooms or spaces become interchangeable when they are all designed around certain parameters. For example, if partitions, ceiling systems, services, and furniture are all designed around the same module the functioning of the space plan can be changed very efficiently. The modular planning of the labs for the Salk Institute permitted effortless reconfiguration of lab utilities and services in just this way.[42]

INDEPENDENT SYSTEMS

Since most of the systems that make up a building undergo very different varieties of change, the stresses of these forces can be relieved by separating the systems. It becomes much easier to accommodate change because each part of the building must only resolve the issues specific to it. Facility managers and owners can avoid the domino affect that results from complex interdependencies between structure, enclosure, space plan, lighting, heating and other services. Sometimes a synergy of systems can increase the

Figure 3.25

A section of the Salk institute reveals the interstitial spaces between labs.



efficiency of the project as a whole, for instance passive solar design could incorporate enclosure, water heating, lighting and climate control into a single system, but in these cases a necessary minor change to one building component tends to trickle down into unexpected parts of the design, which can make the change prohibitively costly.

Usually, it is possible to identify certain systems that are likely to change in different ways than the rest of the building and then design those parts to be modified independently. An extreme version of this strategy was used in the SCSD project. Every system was developed independently and with no knowledge of what the final outcome would be.[43] This ensured both that the systems could be combined in an infinite number of ways to produce multiple context-specific buildings and that the systems would be easy to modify after construction. There are two commonly used methodologies for producing this sort of flexibility.

SUPERPOSITION OF SYSTEMS

Superposition of Systems is Charles Jenck's term for "building-in time" to give a new project a higher level of organizational depth. It started with city planners, who applied methods from Colin Rowe's *Collage City*, applying or juxtaposing new layers of order to the existing urban fabric.[44] Later, architects including Peter Eisenman, Rem Koolhaas and Bernard Tschumi used similar approaches to combine layers of simple arrangements of design elements, forming a set of complex interactions, beyond what any individual could consciously design.

Superposition is a bottom-up design process, so it is well suited to allowing a range of possibilities from the interaction of a few simple systems. It is for this reason that the approach is gaining popularity among architects. For instance, Tom Mayne was speaking about the complexities of contemporary architecture, and described Morphosis' strategy of using multiple layers of interfering systems to ensure that buildings will have the flexibility to respond to the unpredictable realities of building. To some extent, superposition is already common practice. The way we produce construction documents separates the building into layers that correspond closely to their relative degrees of permanence. Peter Calthorpe points out that as architects develop a set of drawings they typically proceed from the most permanent systems (site plan and structure) through skin and services to the space plan, following the order of Duffy's diagram of shearing layers of change.[45]

INTEGRATED SERVICES

Since services are sometimes the most crucial and frequently updated systems, another common approach is to crate a distinction between the "served" and "servant" spaces. This was a major theme throughout Louis Khan's work, and the Salk Institute is the fullest, or at least most successful, realization of this idea. Interstitial spaces efficiently contained all services within the structure, providing unparalleled flexibility in the lab spaces below, which were free of columns and could access services at any point. For this reason many of the scientists praised the building as the best lab of dozens that they had worked in.[46]

Interstitial space is not for every building though, since most of them don't have the constant demand to rearrange and revise services, as in a laboratory or hospital. At the Sendai Mediatheque, Ito used a more space efficient means of integrating the services. This time they were housed in vertical structural elements, since the horizontal distribution of large services like HVAC was not as important. The services can be accessed easily in the large, open tubes, and there was no need to add an entire floor height of service space.[47]

POLYVALENCE

Polyvalence is closely related to behavioral flexibility. It occurs when a space can accommodate many diverse uses with a minimum of physical change. Sometimes polyvalence is achieved simply by adding extra space to the plan. Rem Koolhass notes, "Perhaps the most important and least recognized difference between traditional and contemporary architecture is revealed in the way that a hypermonumental, space-wasting building like the Arnhem panopticon proves flexible, while modern architecture is based on a deterministic coincidence between form and program."[48] Flexibility, he argues, is not the anticipation of all possible changes, but the creation of a margin excess capacity to allow different and even opposite uses of the space. This is precisely the goal of polyvalence.

Figure 3.26

Koolhaas proposed new uses for the large central space of the Arnhem panopticon to make it compatible with society's changing ideas about control.

The notion of polyvalence gained wide popularity during the modern movement with the concept of the open plan or universal space. Entire floors of large office buildings were designed without partitions (or with demountable partitions) to allow endless reorganization of the office. This approach is extremely flexible, but in creating large undifferentiated spaces the need for individual identity and convenient groupings for communication were often overlooked. The concept of *Bürolandschaft*, or "office landscape", was a refinement of the open office, which attempted to keep the flexibility without sacrificing the social and psychological advantages of well defined rooms.[49] The managers were still out on the floor with the rest of the staff, but now subtle differences established a hierarchy, such as in the amount of space in his or her area, the degree of privacy, the type of equipment and the location. The open spaces of the office were landscaped with furniture, equipment, and partitions, breaking it down into workable communities and groups in order to structure interactions and provide the limited privacy and sense of individuality that workers required.

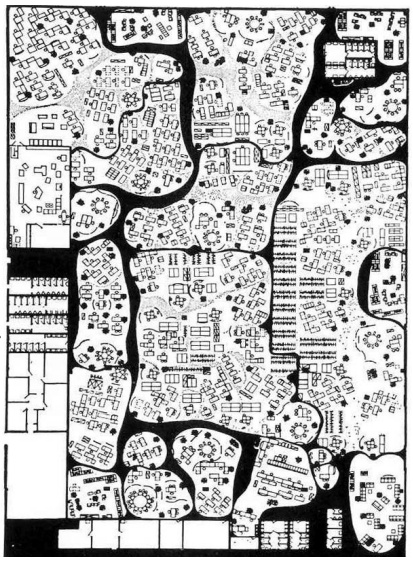


Figure 3.27

An example of Burolandshaf in plan

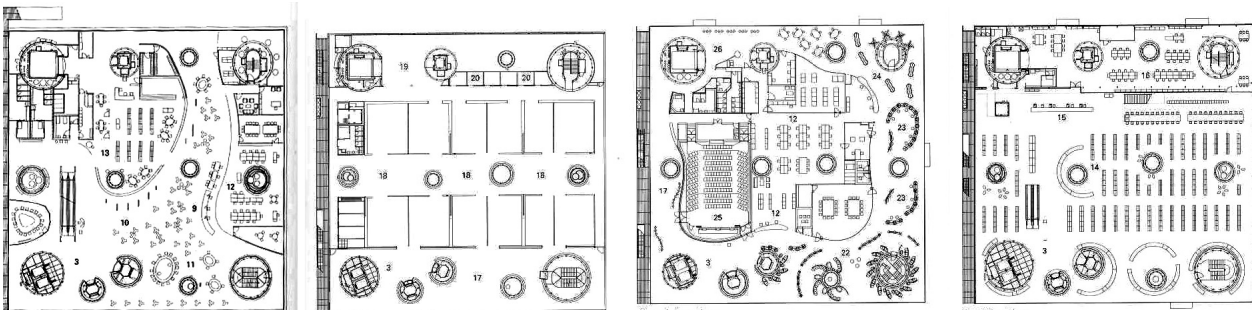


Figure 3.28

The system used for the Sendai Mediatheque allows many variations on the floor plan.

The Sendai Mediatheque is another contemporary revision of the open plan idea. Toyo Ito writes of his desire to create fluid, undivided space, which sounds much like the idea of universal space.[50] The plate structure he used provides long open spans free of beams, with irregularly positioned tubes that are intended to prevent walls from breaking up the flow of space into functionally deterministic rooms. But instead of stripping the vertical structure down to the minimum sized columns so as not to interfere with the space, Ito uses less frequent, but very wide tubes to differentiate space and create places. This leaves the space free to meet changes, but also gives it the character and definition needed to make it truly useful and not overly generic. The flexibility of this system can be seen in the variation between the floor plans.

MOBILITY

Buildings can move primarily in three different ways. Their classification depends on scale, and can be related to the scales of organization in an organism: from the level of the cell to the organ to an entire body or group of bodies. However, the more important difference is in which characteristics of the building remain constant and which change. Mobility takes place through the manipulation of either the relationship of building components to the spaces they serve (fixtures move), the relationships between functional units (rooms or function-defining objects move), or the relationship of the building to its context (the whole building moves).

FLEXIBILITY OF BUILDING COMPONENTS

Figure 3.29

Traditional Japanese houses used sliding partitions to change spatial qualities for different uses.

Adrian Forty identifies two technical means of flexibility.[51] Both methods make a building easier to adapt to changing purposes by designing the elements of construction in such a way that they can move. In the first way, individual building components may be moveable through the use of *demountable elements*, in which the character of the building and the way it functions remain almost the same while the fundamental pieces of construction are flexible to be rearranged as needed. This is more of a means to adaptation than adaptation itself. The ability to move a light fixture, for instance, is not all that interesting on its own, although it could lead to a slightly better quality of lighting, but more importantly it leads to possibilities of using the space differently or the ability to completely change the layout of spaces. In the SCSD project the goal of demountable building components was achieved largely through modularity. This ensured the compatibility of all elements so that fixtures, partitions, ceiling panels, and other objects could be exchanged or reconfigured.

The second method of making building components mobile is *flexibility by the movement of intricate elements*. Now the component stays in a fixed location, but it can move in ways that permit alternative uses of space. Folding or rotating parts, such as pivoting walls, collapsible partitions, and Murphy beds fall into this category. SCSD schools used some of these

approaches, for example folding partitions could divide space or be stored next to the wall out of the way as needed. Forty gives an even better example, the 1924 Rietveld-Schroder House in Utrecht. The function of each space was well defined in the design, but folding walls provided for varying subdivision of spaces and the possibility of reworking the relationships between spaces.[52]

Figure 3.30

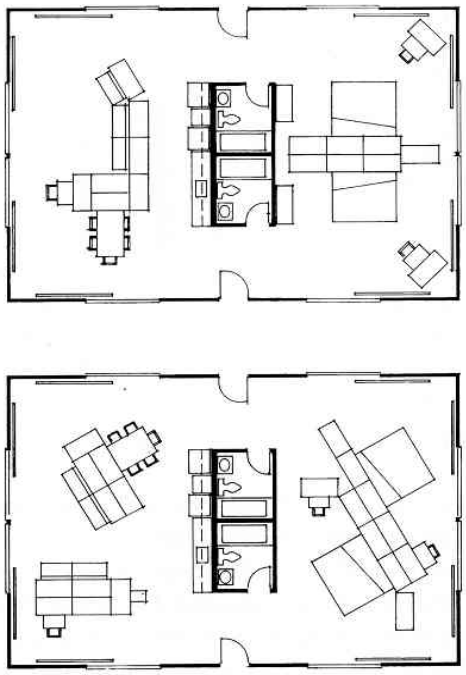
Sliding partitions in the Schroder House.

ARCHITECTURE AS FURNITURE

In other cases, the individual elements of construction may remain intact and the overall character of the building the same, while the basic elements of architecture associated with various functions move freely. In his Equipotential Space concept, Severino refers to these elements as Function Objects. "The most important characteristic of the Function Object is its mobility, which can be obtained by wheels or air-cushion devices," he writes. He also illustrates a number of schemes where the objects are moved by some sort of vehicle, such as a forklift. Function Objects can be mobile because they condense all of the architectural devices necessary for a specific use into a single freestanding object or a compact part of a group of objects that serve one purpose.[53] The benefit of this approach, aside from the flexibility to instantly revise patterns of use, is that these compact, self-contained objects are subject to the efficiency and refinement of industrial production. Severino suggests that there will be as many types of Function Objects as we have appliances today, and they will also take advantage of similar advanced techniques and materials. [54]

Figure 3.31

MacDonald's plan for spaces defined by furniture

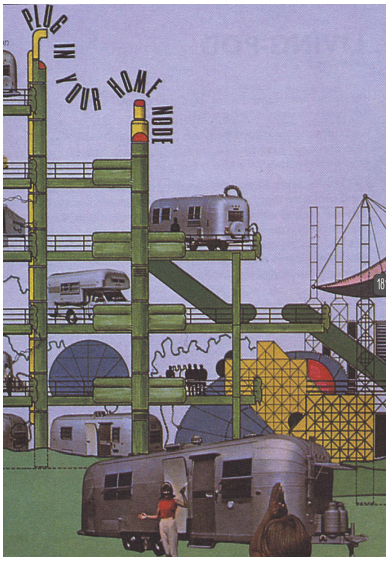


Another way of thinking about the use of compact, mobile objects that serve a specific function is as furniture. Frank Duffy notes that the budget for furniture in an office is often comparable to the budget for the building shell, even though the interiors are replaced several times during the life of the structure.[55] Furniture manufacturers have addressed the change much better than most architects. More and more functions of architecture are migrating to furniture (area separation, acoustic control, storage, lighting, wiring distribution, and even local air conditioning), so it might make sense for architects to get in on the process.

Donald Macdonald envisioned one solution to the idea of an adaptable house using furniture-like elements.[56] His inspiration came from traditional Japanese homes, which generally have rooms that serve changing functions throughout the day. Rooms expand and contract through sliding partitions, freestanding screens further divide space, and furniture is stored in modular wall cabinets. Another influence was the loft spaces often inhabited by artists who typically use most of the space for a studio and divide their own living area with furniture. The solution consists of a more permanent "wet core" containing services and baths. The rest of the space is then divided by large pieces of furniture, which serve as storage or contain everything to support a certain use (like a workstation or kitchenette).

Figure 3.32

New kinds of infrastructure would be needed to support mass nomadism, as seen in this proposal for a place to "plug in your home" by the Archigram group



NOMADISM

Nomadism is the most common version of the All Road building, such as the Bedouin tent or contemporary mobile home. MacDonald's interest in flexibility was not satisfied by the convertible dwellings, so he turned to an even more ephemeral approach. For his next project he fitted out a van with all of the systems and furnishings necessary for a self-contained home. His goal was to create a home that offers maximum affordability and freedom. He predicts that as the makeup of office workforces become more dependant on fluctuating market forces, more people will go mobile in order to find and keep work.

Figure 3.33

Vernacular Thai houses combine modularity and prefabrication with a pattern language that allows them to grow gracefully as families change.

PATTERN LANGUAGE

Christopher Alexander is a devoted advocate of piecemeal-type growth, but he acknowledges its impracticality in many modern situations. Complete autonomy of each piece of a building and each building within the urban fabric will only lead to chaos in the contemporary situation. Traditionally, people shared patterns with which to build, ensuring some degree of unity on all scales, but these languages died with the rise of industrialization.[57] Today, we cannot hope for piecemeal growth to work without some kind of intervention. Alexander's solution for the problem is to develop a "pattern language" for each project (or group of projects) to guide growth and repair.

The Timeless Way of Building describes the theory and implementation of this alternative design methodology. The basic idea is that a building should be grown organically, not by planned to every last detail, "just as a flower cannot be made, but only generated from the seed."[58] The pattern language is the equivalent of the flower's genetic code—it guides the development of the cells, allowing them to remain relatively free to adapt to local forces as necessary, while ensuring that they work together to form larger patterns that support the whole. In *A Pattern Language*, Alexander synthesizes the results of his studies by giving examples of patterns that have been proven to work, and he ties them all together into a network of relationships intended to help unify the use of patterns on different scales. Each pattern is simultaneously three things: a physical element in the world (a relationship between a context, system of forces and a spatial configuration), a set of instructions on how to resolve a given system of forces with a spatial configuration, and an event that happens in the world.[59]

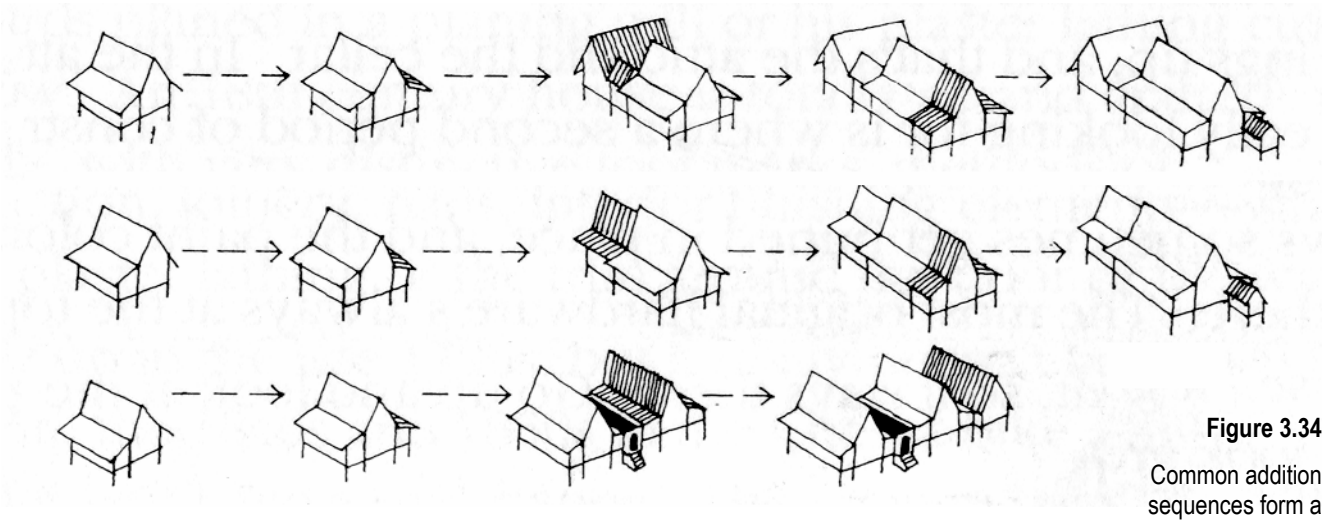


Figure 3.34
Common addition sequences form a pattern language for Malaysian houses.

The comprehensive use of this strategy is given in *The Oregon Experiment*, in which Alexander works on the master plan for the University of Oregon. Here he introduces another aspect of his methodology and another parallel to his metaphor of organic growth. Since all organisms must adapt to the specifics of their environment, an analysis of the site and context is also crucial to a building. Alexander equates this "diagnosis" to the endocrine system in animals, which regulates "growth fields" by describing where and what kind of growth must take place, while the genetic code determines the nature of this growth.[60] Therefore, the master plan for the school involves a continual process of analyzing existing conditions in parallel with the creation, establishment as policy, and periodic reevaluation of patterns.

Summary

The chart on the following page summarizes this chapter by describing each of the strategies in terms of its purpose, advantages, the types of change for which it is appropriate and examples of theoretical and built precedents. Each of the headings under *Types of Change* corresponds to a category in the "Varieties of Change" section, where the terms are explained (*Intensity* has replaced "Degrees of Change"). This chart is the first step in analyzing the appropriateness of the strategies for a particular project, as carried out in the next chapter.

Although the many approaches to flexibility and adaptability differ widely, and may even seem contradictory, one thing is universally accepted: the goal of the designer is not to conceive of a complete building, but rather to create a system of rules and relationships that will aid in the successful generation of many possible states of a building. As Gordon Pask says, the role of the architect should be, "not so much to design a building or city as to catalyze them; to act that they may evolve."[61] This is on the opposite end of the scale from the more modernist concept of *Gesamkunstwerk*, in which the architect designed from the top down, making sure that the main idea permeated the entire work and every detail related to the whole. The same unity between the whole and the parts is expected in each, but in the former approach this unity is the result of a natural evolutionary process that responds to real needs as they occur. The later assumes that all possible needs can be predicted and accounted for from the start and that the architect can imagine a single solution to appropriately accommodate all those needs.

These opposite approaches can also be described as the difference between genotype and phenotype. Alexander compares the Pattern Language to a genetic code, because it works in much the same way. All of these strategies differ from the more common approaches to architecture in that they deal with space less as volumes that are defined by geometric properties and more as "changing patterns of relationships."[62] The designer produces a genetic system to describe the growth process and qualities of the building, rather than a specific blueprint of the physical appearance of the building.

STRATEGY	GOALS / BENEFITS	TYPES OF CHANGE				THEORY / PRECEDENTS
		TIME SCALE	INTENSITY	MECHANISMS	MEDIUMS	
SUPPORT STRUCTURES	Alternative building process gives user freedom to easily adapt parts that undergo rapid change without affecting the whole building	short term - long term	rapid - gradual	Morphological Behavioral Intelligent Tradition	Spatial Gowth + Division	Renato Severino - Equipotential Space *Supports* - N. J. Habraken CASA - John C. Jones "Shell and Core" Offices
PIECEMEAL GROWTH	Incremental repair and renovation naturally solve the complex problems of a building and let it evolve	medium term - long term	moderate - gradual	Intelligent Tradition	Growth + Volumetric	London Library Connected Farmhouse Historic Town
POLYVALENCE	~Design of a space so that it can serve multiple purposes with little modification ~Saves cost / resources	very short term - short term	rapid - moderate	Behavioral	Spatial	Sendai Mediatheque Salk Institute Open Plan Bürolandschaft
MODULARITY	~Standardization of materials to permit interchangeability of building components ~Efficient growth/movement	involves mostly short term - medium term	rapid - moderate	Morphological Physiological	Subcomponents Spatial Gowth + Division	SCSD Salk Institute
PATTERN LANGUAGE	A "genetic" description of the building helps achieve unity, variation and resolve the complex forces in a space	medium term - long term	moderate - gradual	Intelligent Tradition	Gowth + Division Spatial Volumetric	The Oregon Experiment
INTEGRATION OF SYSTEMS	~Independence of services for ease of maintenance, growth, and rearrangement ~Prevent conflicts of systems	short term - medium term	rapid - moderate	Physiological Behavioral	Subcomponents Gowth + Division	Salk Institute Sendai Mediatheque SCSD Lucien Kroll
MOBILITY BY: NOMADISM	~More flexible industrial and social organization ~Personal freedom to move	very short term - long term	constant	Intelligent Behavioral	Volumetric	Bedouin Tent Mobile Home Vendor Kiosks
FUNCTION OBJECTS	Efficient changes of use by making functional parts self-consained and moveable	very short term - medium term	rapid - moderate	Behavioral	Volumetric Spatial	Equipotential Space Donald MacDonald Japanese Homes
DEMOUNTABLE ELEMENTS	Flexibility of building components as a technical means to accomdate change	very short term - short term	rapid	Physiological Morphological	Subcomponents Spatial	SCSD

Endnotes

[1] Friedman, Avi. *The Adaptable House; Designing Homes for Change*. New York: McGraw-Hill, 2002. p. 12.
[2] Duffy, Francis. "Measuring Building Performance." *Facilities*, May 1990. p. 17.
[3] Brand, Stewart. *How Buildings Learn: What happens after they're built*. New York: Penguin Books, 1994. p. 216
[4] Brand, *How Buildings Learn*, p. 55.
[5] Brand, *How Buildings Learn*. p. 38
[6] Gwilliam, Tony. "Organic Building." Zelov 88-90.
[7] Brand, *How Buildings Learn*, p. 7.
[8] Brand, *How Buildings Learn*, p. 24.
[9] Brand, *How Buildings Learn*, p. 29.
[10] Kelly, Kevin. *Out of Control; The New Biology of Machines, Social Systems and the Economic World*. Reading, Massachusetts: Addison-Wesley Publishing Co., 1994. p. 358
[11] Werner, Frank. *Covering + Exposing: the architecture of Coop Himmelb(l)au*. Basel; Boston : Birkhäuser, 2000.
[12] Friedman, *The Adaptable House*, p. 16.
[13] Boice, John R. *A History and Evaluation of the School Construction Systems Development Project 1961-1967*. Menlo Park, CA: Building Systems Information Clearinghouse, Educational Facilities Laboratories, 1971. p. 49.
[14] Boice, A *History and Evaluation of the SCSD Project*, p. 57.
[15] Educational Facilities Laboratories. *SCSD: the Project and the Schools*. New York: Educational Facilities Laboratories, Inc., 1967. p. 9
[16] Educational Facilities Laboratories, *SCSD*, p. 36.
[17] Crosbie, Michael J. "Dissecting the Salk." *Progressive Architecture.* Oct 1993, Vol. 74, No.10; Research Library. p. 41.
[18] Crosbie, "Dissecting the Salk," p. 43.
[19] Futagawa, Yukio Ed. *Toyo Ito 1970-2001*. Tokyo: A.D.A. Edita, 2001. p. 190
[20] Futagawa, *Toyo Ito,* p. 190.
[21] Alexander, "The Living Structure Approach to Design." Zelov 270-275. p. 273.
[22] Brand, *How Buildings Learn*, p. 75.
[23] Buntrock, Dana. *Japanese Architecture as a Collaborative Process: Opportunities in a Flexible Construction Culture*. New York: Spon Press, 2002. p. 54.
[24] Duffy, Francis. *The Changing Workplace*. Ed. Patrick Hannay. London: Phaidon, 1992. p. 130.
[25] Alexander, Christopher. *The Oregon Experiment*. New York: Oxford University Press, 1975. p. 163.
[26] Duffy, *The Changing Workplace,* p. 129.
[27] Buntrock, *Japanese Architecture as a Collaborative Process*, p. 47.
[28] Buntrock, *Japanese Architecture as a Collaborative Process*, p. 49.
[29] Crawford, Walt. "Uncommon Knowledge: Myth Breaking for the Future." LaGuardia 16-27.
[30] Boice, A *History and Evaluation of the SCSD Project*, p. 442.
[31] Habraken, N. J. *Supports: an alternative to mass housing*. London: Architectural Press, 1972. p. 59.
[32] Habraken, *Supports*, p. 67.
[33] Duffy, *The Changing Workplace,* p. 127
[34] Jones, J. Christopher. *Design Methods*. New York: John Wiley and Sons, 1981. pp 156-166.
[35] Severino, Renato. *Equipotential Space; Freedom in Architecture*. New York: Praeger Publishers, 1970. p. 27.
[36] Alexander, *The Oregon Experiment*, p. 67.

[37] Alexander, *The Oregon Experiment*, p. 77
[38] Brand, *How Buildings Learn*, p. 45
[39] Benedikt, Michael. "Between Beakers and Beatitudes." *Progressive Architecture*. Oct 1993, Vol. 74, No.10 pp. 52-53.
[40] Jones, *Design Methods*, p. xxxv.
[41] Educational Facilities Laboratories. *SCSD: the Project and the Schools*. New York: Educational Facilities Laboratories, Inc., 1967. p. 9
[42] Crosbie, Michael J. "Dissecting the Salk" *Progressive Architecture.* Oct 1993, Vol. 74, No.10; Research Library pp. 40-46
[43] Educational Facilities Laboratories, *SCSD*, p. 36-37.
[44] Jencks, Charles. *The Architecture of the Jumping Universe*. London: Academy Editions, 1997. p. 77
[45] Brand, *How Buildings Learn*, p. 17.
[46] Crosbie, "Dissecting the Salk," p. 40.
[47] Futagawa, *Toyo Ito,* p. 190.
[48] Hill, Jonathan. "The Use of Architects." *Urban Studies*. Feb 2001, Vol. 38 Issue 2, pp. 351-365
[49] Duffy, *The Changing Workplace,* p. 10
[50] Ito, Toyo, and Mutsuro Sasaki. *Toyo Ito: Sendai Mediatheque, Miyagi, Japan, 1995-2000*. Tokyo: A.D.A. Edita, 2001. p. 6
[51] Hill, "The Use of Architects," pp. 351-365.
[52] Hill, "The Use of Architects," pp. 351-365.
[53] Severino, Renato. *Equipotential Space.* New York: Praeger Publishers, 1970. p. 28
[54] Severino, Renato. *Equipotential Space.* New York: Praeger Publishers, 1970. p. 33
[55] Duffy, *The Changing Workplace,* p. 124-126
[56] MacDonald, Donald. *Democratic architecture: practical solutions to today's housing crisis*. New York: Whitney Library of Design. 1996 p. 152-156
[57] Alexander, Christopher. *The Timeless Way of Buildin*g. New York: Oxford University Press, 1979. p. 231.
[58] Alexander, *The Timeless Way of Buildin*g, p. 157.
[59] Alexander, Christopher. *The Timeless Way of Buildin*g. p. 249.
[60] Alexander, *The Timeless Way of Buildin*g, p. 150.
[61] Frazer, John. *An Evolutionary Architecture*. London: the Architectural Association. 1995. p. 17
[62] Severino, *Equipotential Space*, p. 27.

Chapter 4 A Media Center for the Public Library of Cincinnati

The Main Public Library of Cincinnati and Hamilton County

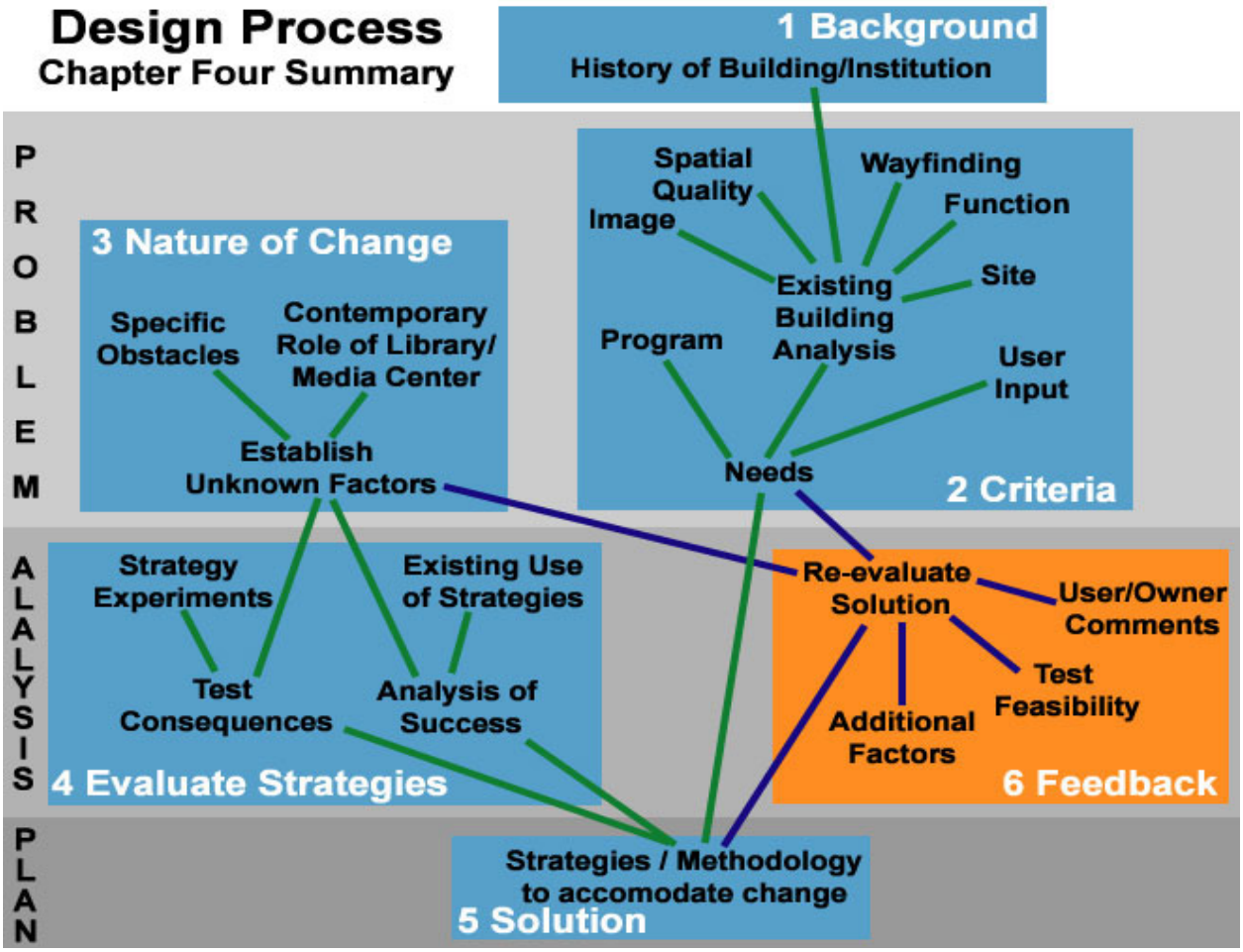
From left to right: the 1955 building, the 1982, and the 1997 additions

The necessity of designing buildings that evolve in response to the changing needs of users has now been well established, and we have identified many of the possible methods of accommodating such change. However, it is obvious that these methods vary greatly and often may even contradict each other. There are many types of change and many types of buildings, and each situation requires a different way of dealing with change.

Figure 4.1

The Walnut Street entrance of the 1982 building

This chapter serves as a model of a process to determine the appropriate response to an individual project's need for change. As an example we will look at institutions in general, and more specifically libraries—the particular project being a media center addition to the Main Public Library of Cincinnati and Hamilton County. The linear, narrative structure of a paper is hardly representative of any sufficiently thorough design process, so the diagram below provides the larger picture of this process. Each blue box corresponds to a section in this chapter, indicated by the white, numbered titles. It begins with a history of the library, which serves as the background of the problem. This leads to a number of parallel inputs used to define the problem in terms of needs and unknown factors. These criteria are then used to evaluate the strategies laid out in Chapter Three. Once the applicability of the strategies has been tested and evaluated we arrive at a plan for accommodating change. The process continues indefinitely by reevaluating the solution and problem in light of feedback. Like the building it seeks to create, the design process continues to change.



Background

One starting point for the library's story is March 14, 1853, when the Ohio Common Schools Act authorized school libraries and entitled every family to use the books, marking the date of the official founding of The Public Library of Cincinnati and Hamilton County.[1] An actual main library building did not exist at this time but the act paved the way for the eventual formation of a public library. The rest of the evolution can be told through the illustration below, adapted from the "Pen and Ink Chronograph of Vine Street" by David Day.[2] The library made its next step towards a physical presence in 1856, when the Ohio Mechanics' Institute (OMI) urged

Figure 4.2
The Ohio Mechanic's Institute building

the school board to pool their libraries under one roof. A collection was established on the second floor of the 1847 OMI building on the southwest corner of Sixth and Vine streets (**1**).

The library finally got its own building when it moved a block north into Truman Handy's Opera House in 1870. The opera house was intended to fill a very large site, but Handy went bankrupt after completing only a small four-story section at the front of the lot (**2**). Architect James McLaughlin finished the shell allowing the library to open its doors on March 12, 1871. The new librarian, William Frederick Poole, already had big plans for expansion. Working with McLaughlin, Main Hall opened in 1874, a new five-story atrium (**4**) with cast iron book alcoves connected to the former opera house by a new vestibule (**3**).

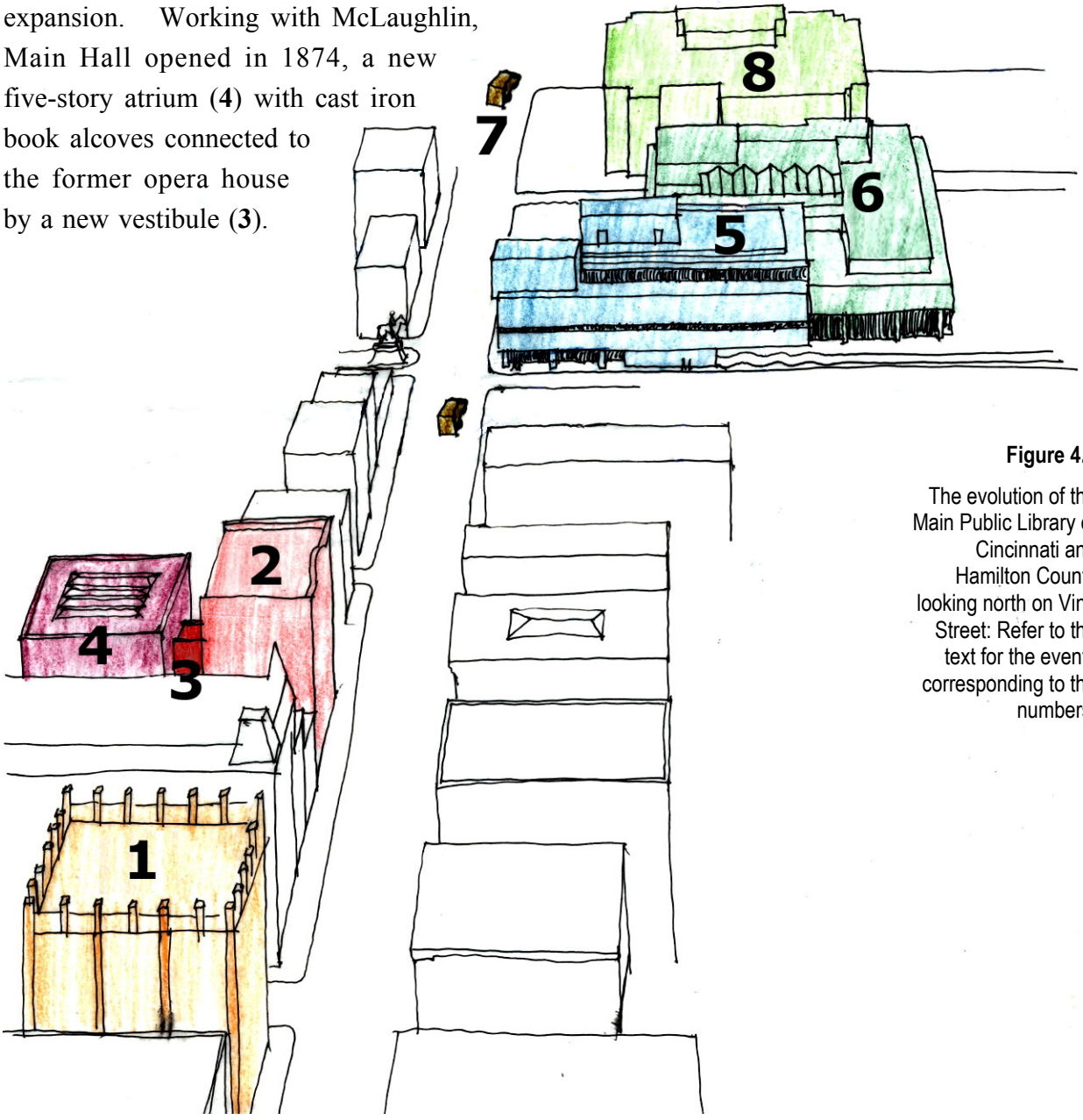


Figure 4.3

The evolution of the Main Public Library of Cincinnati and Hamilton County looking north on Vine Street: Refer to the text for the events corresponding to the numbers.

Main Hall served the library's need for more than eighty years. In 1955 the library moved north again, this time into a starkly modern building designed by Woodie Garber on the northeast corner of Eighth and Vine streets (**5**). Once again the growth of the library began to press beyond its container, and in 1982 an addition wrapped itself around two sides of the 1955 building, mimicking its style (**6**). A new atrium became a central element of the complex through a renovation of Garber's building, which united the two interiors. The library postponed the need for another addition by storing books at remote locations where they could be delivered on request (**7**). With the development of CINCH, the library's electronic catalogue, the way the institution used its building began to change even without another addition. The next year the virtual realm of the library expanded even more with the possibility of home access to CINCH.

Figure 4.4
The atrium of Main Hall

But the library continued to grow and there was another addition. In 1997 the library leapt across Ninth Street by means of a three story glass and steel bridge (8). Both existing buildings were heavily remodeled as the children's department and administration moved to the new building. Along with the renovation the library was equipped with free public internet access, allowing it to branch out in yet another way.

Criteria

The history of the library building and the institution housed there helps lead us to a program for a new addition. It sets the stage for an analysis of the building as it exists today and provides a framework for understanding user comments and suggestions. The combination of all of these things represents the current architectural needs of the institution.

An overview of the Library's history provides us with a basic understanding of how the institution has grown over the last century and a half, and indicates how it might continue to evolve in the future. This section can then begin to determine the library's needs for renovating and adding on to its

existing complex of buildings, and in the next section we will try to imagine likely scenarios for the future of the library in order to establish what aspects of the building will need to change. These two processes are explored simultaneously because each influences the other, and the criteria will continue to be developed throughout the design process. Together they will aid in evaluating and determining the appropriate strategy for dealing with change.

PROGRAM

DESCRIPTION OF EXISTING BUILDINGS

In order to establish a program for growth, it is first necessary to look how the existing building works. The library tour begins in the city with the approach, which can be from any direction. There is parking on the street and in lots all around site, and there is a bus stop for both of the major streets on either side of the building. The main entrance is off Vine Street: an intentionally downplayed recession in the urban fabric that leads visitors beneath the hovering monolithic brick mass of the closed stacks and through the two-story glazed volume where the more public functions of the library reside. The Walnut Street entrance is equally popular but even more hidden in a smaller glazed void under a large brick volume. Facing the entrance is a small amphitheater that functions as an exterior lobby, and the diagonal approaches around either side bring the hidden doorway to the attention of passersby.

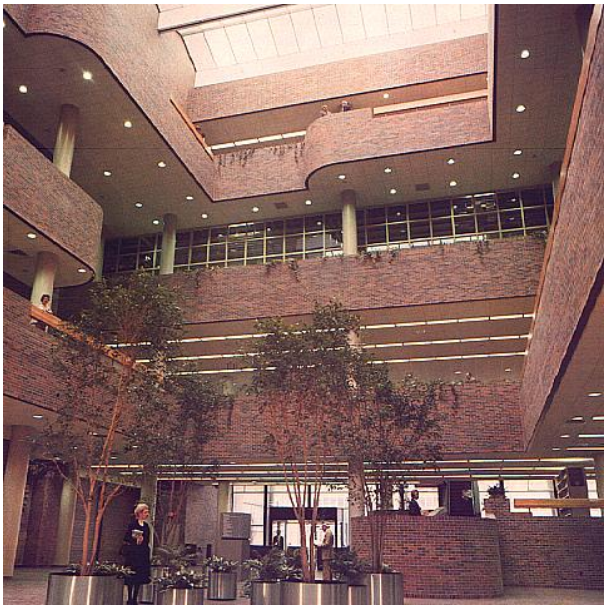


Figure 4.5

The atrium of the 1982 building, facing the Vine Street entrance

Both entrances lead to a very open first floor focused on the atrium at the heart of the building. In the middle of this space there are always a number of people browsing through the new releases. Nearby, there is an information desk, the check-out desk and a bank of computers for browsing and internet access. Open to the atrium on one side is a multipurpose presentation space, and on the other side a generous circulation area serves as exhibition space. The atrium also provides access to the main elevators and is the intersection of many functions and circulation paths. The busier, louder, public feel of this space and its use of materials, such as brick pavers, help mediate between the city and the quieter study and browsing areas on the upper floors.

The 1955 building feels somewhat separated from this very open part of the 1982 addition, but that seems appropriate since it houses less extroverted functions. On the first floor it contains the young adult section and some reading areas which look out to a walled garden for relaxation and study. The largest part of the old building on the first floor is devoted to a "library within a library": the Films and Recordings department. It has a separate check-out desk and is divided from the rest of the building by a glazed wall, with only one point of access for the public. Here the low shelving and large windows facing the street make it feel much more open than most of the browsing areas. This small fraction of the building experiences higher circulation rates than all of the print media in the rest of the building combined. It is noticeably more active and this is one of the reasons why it seems necessary to create a new space for multimedia that is more integrated with other parts of the library.

The 1997 addition serves mostly administrative functions, but it also contains the children's area, periodicals and a library for the blind and physically handicapped. The children's room is distinguished from the adult spaces by its colorful materials and playful design, which includes a large aquarium and access to an outdoor garden. The third, fourth and basement levels of all of the buildings are reserved for closed stacks and storage, and they are probably not appropriate for any other use since there are no windows and the stacks are fixed.

The majority of the space in the library holds stacks of print media, with reading areas dispersed throughout. This function of the library is divided into nine departments based on subject. At each department is a help desk around which computers, resources, and study areas are gathered, forming a more public area from which patrons can retreat into the stacks and reading spaces.

The primary experience of this part of the library is one of introspection. The atrium opens the building to natural light but keeps its focus on the interior. There are windows that provide occasional views into the city in the more public areas, but most of them are up high to allow for shelving and to protect books from direct sunlight. This experience is also supported by the muted visual and auditory environment. Occasional use of brick and wood give the building a subdued, natural texture and color. The floor is covered with reddish-brown colored carpet and most other surfaces are off-white. The

brick surfaces in the atrium reflect sound, and contribute to the feeling of a large, open public space, but ceiling tiles, carpet and other soft materials help absorb the sound and maintain the mood of contemplation in the rest of the building.

The library invites one to get lost in the world of books—to temporarily remove oneself from the life of the city and to discover the secrets waiting on the shelves. It serves other purposes as well—occasional community programs, group meetings and study, a place for the local youth to hang out, and even as a place to sleep—but most of the space in the library is devoted to this kind of introspection.

Proposed Program

A new kind of space will be necessary for the growing films and recordings department which will merge with some additional functions to form the new multimedia center (see "Appendix A: Program" for a breakdown of the initial requirements). As outlined in the next section, The Nature of Change, libraries are taking on new roles). As a community center, the multimedia department will have a new emphasis on participation, interaction with media, teaching technological and research skills, and the creation of new works. The building must shift its focus to engage the public more actively while upholding the contemplation and introspection supported by the old library. The ability of the building to accommodate people's work habits and their interface with media technology, along with its integration of these new roles with the old, will be crucial to the success of the project.

Therefore, this project is largely about connections. In the original library (and in most libraries) there are three distinct types of spaces: places for people, for media, and for staff (service areas being a unique subset of this). In the new building the proportions of these spaces will change and the lines between them will be blurred. All spaces must be people places—for staff and patrons to interact with each other and with the media.

At the core of the building will be a very lively zone that will make these connections possible and practical. While much of the library should remain somewhat muted to avoid distractions, touches of vibrant color and a more dramatic use of materials will lend to a more energetic feel in this area. The media center will not have the same issues with sunlight as the old library, which needed to protect books and provide shelving at the walls. Glare will

still be a major concern, but the addition will have a higher tolerance for natural light and it will make sense for the media center to be very bright with daylight, especially in this animated zone.

The goal is to create a focus of activity at the heart of the building that will become a collaborative and creative environment, so it must be a welcoming place. People should be comfortable here and feel free to use all of the media center's services. This will be accomplished partly through the very clear organization of the library and its services and partly by enhancing the openness of the buildings. By opening up the interior of this zone of the building, the ease of wayfinding and the flow of traffic should improve. Establishing visual connections across this area will also strengthen the connections among the different functions and zones of the library, as well as contribute to the sense of community and collaboration. The library should also be open in the sense that it is inviting to the public. The existing buildings attempt to be unobtrusive at the cost of fading from view. The goal for the addition is to engage the city more enthusiastically by increasing its transparency, imagability, visibility from the street, and by strengthening the link between the entrances and the patterns of circulation in the city.

We have mostly discussed the more public areas of the library, but there will also need to be zones that have different characteristics. It is important for the spaces in the media center to be varied so that as it changes it can continue to support a range of activities and a range of work habits for different people. While the central zone will be open, busy and energetic, there must also be some quieter, more intimate places for working and studying. The existing library does a good job of incorporating some of these spaces into the stacks and at the periphery of group work areas, but the media center will require more of them. These new work areas must be at once more integrated with media resources and more conducive to independent study, since people will be working with distracting audio and video media. People should feel as comfortable working here as in their own home, so these areas will use more warm but neutral materials (though not too bland), and it must be possible to break down the scale of the space to something more appropriate for individual work.

An example of another type of space is the areas that will initially store and display media for browsing. Eventually this function of the media center may become obsolete so these spaces should be appropriately convertible to

individual workspaces, viewing areas or larger meeting places. These spaces will have a mixture of the qualities of the communal and independent work areas. They should have a more personal scale for browsing while remaining open and inviting to all patrons.

BUILDING ANALYSIS

According to circulation statistics in the library's Annual Report it is currently one of the most popular libraries in the country, so something must be going right for it. We will try to identify some of the strengths of the existing building to take advantage of these characteristics and avoid working against them. On the other hand, there are some obvious problems with the current state of the library that must be corrected with the new addition. For an extended comparison of the positive and negative attributes of the building see "Appendix B: Building Analysis."

One of the best things about the existing building is its openness. The uniform and unobstructed plan has proved flexible enough to accommodate a number of changes over the past fifty years. Also the atrium provides visual connections between floors and across the central public space to tie together different departments. However, this openness can also be a detriment since it makes the circulation patterns unclear in places, weakening the connections between buildings.

The sequential experience encountered by a visitor to the library also has both positive and negative characteristics. There is a good transition from the street to an urban plaza to an entrance portal to a large open space. The atrium uses outdoor materials and natural light to further help transition to the more interior-feeling areas. The problem is that the experience dead-ends here. Wayfinding becomes a problem because there are no clues where to go next. Another obstacle to wayfinding is the lack of imagability, caused in part by the fact that the entrances are hidden from view.

The library's ambient lighting is another feature that permits flexibility of the spatial layout. The lighting is appropriate for reading at any point in the library and makes it possible to move stacks, study areas, and computers to any point in the building. Unfortunately, there is little or no task lighting to supplement the florescent ambient lighting. This makes it difficult to write or work in many places, especially in certain spots where there are shadows.

The best places to work have access to natural light, for example around the atrium or on the bridge, but the new media center will need much more.

The Nature of Change

Before we can design for change it is necessary to understand the ways in which the building in question will need to change. Identifying the primary causes of change will lead to an understanding of the types of change that the building must accommodate. The first consideration is the causes of change (as outlined in Chapter Two under "The Inevitability of Change") and the evolving role of a contemporary library and media center. Next, we will identify the obstacles to change that are specific to this problem. The last part follows the same framework outlined in the "Varieties of Change" section in Chapter Three to determine the way that the building is most likely to require change.

Causes of Change: Libraries in the Age of Information

The chart on the next page compares some of the social and technological trends that affect the library, including future predictions below the dotted line. There is not a direct causal relationship from any single trend to another. They are complexly interrelated, with developments of one trend influencing others, which in turn feed back and change the direction of the first. We often think of new technologies as "producing" dramatic social consequences. In reality there is an intermingling of cause and effect in which social needs often drive technological change, rather than new inventions as sole agents of social revolution[3]. When looked at independently, extrapolated social and technological trends shoot off the charts.[4] The purpose of this chart is to understand the relationships between these trends in order to make educated guesses at how social and technological progress might evolve in the approaching generations, and how the library will change in this context.

This chart is somewhat deceiving in its representation of progress, because in reality these developments are additive. For example look at the trend in the "Value of Media" (or the epistemological role of communication media). As new forms of communication develop, we continue to develop ever higher levels of abstract thought. Technology is able to serve lower level tasks, while our minds are left increasingly free to pursue more creative activities that machines, computers, etc. are incapable of. When we are able to begin

using media to accomplish higher intellectual tasks we do not cease to think on other levels or stop using technology for those purposes.

MEDIA/COMM. AGE	VALUE OF MEDIA	MAJOR INNOVATIONS	IMAGE OF MIND	ROLE OF LIBRARIES	INFLUENCE OF TECHNOLOGY
Oral	passing on stories *memory*	speech			
Chirographic	abstract thinking *knowledge*	writing	scroll	protect documents	production/storage of media
Typographic	accumulating knowledge *rationality*	machines-printing photography	clock	collect documents classify information	
Electronic	processing information *creativity*	telegraph telephone radio film, TV computer digital media internet	telephone switchboard computer	searching universal access interaction w/ media	catalouging/ browsing distributing interface
Bio/Nano-technologic	asking questions *imagination*	nanomachines genetic engineering computational - prosthetics	self-organizing network	manipulation and (re)production synthesizing info.	editing analyzing/ understanding

Figure 4.6
The Evolution of Communications Technology[5]

Likewise, when the library assumes a new role it does not replace previous functions. This is why the book will never die. When older technologies become outdated they are usually still useful—they just move into a niche where they are most appropriate, so the new technology can be used where it has the most benefit.[6] Libraries will continue to change in the old ways (accumulating materials, serving more patrons, updating services and rearranging the space plan), but they will develop new patterns as well. Most

importantly they will grow as places of information interaction, among both people and technology, rather than places of information retrieval.

CHANGING FUNCTIONAL REQUIREMENTS

While a library is always a library, it is a place for many differing users and uses, and the functional requirements of any given space often endure changes. Sometimes new functions arise. One example is when a new form of media becomes popular. The growing popularity of CDs and DVDs has spurred the appearance of large audio/visual departments where once there were only a few racks of VHS tapes, and these areas have different requirements than traditional stacks and reading areas. Also, the proportion of space required for each function may cause changes in the use for a space, as is the case with the rapidly growing audio/visual department at the Cincinnati Public Library. Also, since some administrative and workplace functions are part of any library, it is in some ways similar to an office environment, which means it will undergo regular organizational changes.[7] Together, these things mean that space devoted to one function must be convertible to others.[8]

PEOPLE PLACES VS. BOOK PLACES

The overall purpose and function of libraries can even be forced to change with long term changes in cultural attitudes and trends. One way that many librarians believe their buildings are currently changing is that they are becoming more of a place for people and less of a place to hold books. The significance of ownership of materials is on the decline (that doesn't mean that collections won't still grow), while there is an increasing need to provide access to nearly unlimited materials.[9] There is also a trend toward digitization. Books will probably never become totally obsolete, but it will become more practical to use electronic versions of at least some resources. And since most multimedia has already been digitized, those materials are likely to nearly vanish from the building as the space required for the storage media becomes insignificant. The library's role as a community center will gain importance, emphasizing the need for assembly rooms, exhibition spaces, group work areas and production rooms.[10]

Another implication of electronic media and the appearance of the computer is that the library becomes a place for both research and writing. Now with just a computer it is possible to locate materials, view multiple forms of

media, and edit and create new works. The production and distribution of digital media can be done increasingly by individuals and small groups.[11] This means that the user begins to spend much more time in the library, and the building begins to lose its role as a warehouse in favor of becoming a place for work, study and entertainment.[12] Since the patron spends a greater amount of time in the library there is now much more of an emphasis on interior design to make the building a pleasant environment conducive to such activities.

Library Organization

Even the library's traditional role as a place for storing media will lead to noticeable changes in the layout of the building. It is becoming much harder to draw the line between different categories of media. Now that most information can be digitized there is more overlap between different types of media, accompanied by an increasing blurring of genres.[13] The changing content of the media means that the media center will not have the same sort of departmental organization by subject found in the current library. Librarian Jane Carlin says that this concurrent proliferation and amalgamation of types of technology and media has triggered a desire for "one-stop-shopping," where the patron can get easy access to all of the library services and make sense of a bewildering mass of information.[14] It is also likely that whatever type of organization is used will need to change, especially at first when it is in experimental phases.

New Users/Owners

Most institutional buildings do not change hands very often, if ever. The individuals who use the building may be different, but the things they have in common and their general characteristics remain the same. What is more common is that the number of users changes. As collections grow, there is often an increase in circulation as well, and a larger staff is required to keep up. Libraries are almost always pressed for storage space and they are typically bursting at the seams before an addition or new building can be approved, financed and constructed.[15] According to Ted Ellington, of the Facilities Services Department for the Public Library of Cincinnati, the rapid growth of their collection has led them to keep many materials in remote locations, which are then delivered to the library upon a patron's request. The number of patrons can also put pressure on a library to change or expand.

NEW TECHNOLOGY

Today, changes in technology are rapid compared to the past, where libraries could go very long periods of time without being significantly affected by any new innovations. Even when changes did occur they did not considerably change the way the building worked. Instead, the technology was made to mimic the appearance or functioning of the outdated technology. For example when digital catalogues first became popular, large banks of computers sat in the exact places where cabinets of cards had once been. For the most part, the architecture of the library kept its traditional form, even though the ability to access a complete catalogue from any computer anywhere offered great potential in changing the relationships between reference resources, materials and people. But now, electronic information retrieval is changing the scope of library services and buildings.[16]

INFORMATION STORAGE

One obvious consequence of the information revolution is that an increasing amount of texts and other media have gone digital. While libraries will almost certainly always play a role as a repository for a collection of print and other media, the significance of this role is diminishing. Libraries will become more and more geared to providing access to materials that they do not own.[17] It is even foreseeable that in the near future the storage capacity of digital media will grow until size and distribution is no longer an issue. There is much hype about the computer revolution, and it is not uncommon to hear predictions about the demise of libraries due to global digital distribution of information. For example, the movie *I Robot* was set in the near future, where libraries had been replaced by internet. This view fails to recognize an important point: libraries are more than just storage facilities. As this purpose of libraries diminishes they may begin to play an even more crucial role in the community.

Libraries have always provided what most people can't have on their own. Once it was books, then VHS, then CDs, DVDs and the internet. However, there is an important difference between the new media and traditional forms of communication. Books were, and usually still are, based on a culture of authors, while audio-visual media are the products of industrial processes and are controlled by companies, institutions and partnerships.[18] For this reason, legal and economic forces will require people to use the library, even if it is technologically feasible for them to get the material at home. And even if

people did not need to come to a library to access media there would still be other reasons to use the building. As Walt Crawford points out, "A good library is not an Info Kiosk." "It's a vital part of the community, one that electronics won't and can't replace."[19]

FASHION

Sometimes a building, even a seemingly permanent institution, can change simply to keep up with current trends. Libraries especially perform a service to the community so they must always reflect the changing cultural image of the role of a library. As information systems become more prominent "librarians will increasingly assume the role of consultants and teachers," claim Richard Bazillion and Connie Braun.[20] In addition to being places for doing research, libraries will become places for learning electronic research skills. Libraries have always served a role in self-education, but now this role is extended as they increasingly turn into places for learning how to learn. Librarians, libraries and the organizational systems they use function more than ever as a tool that helps a patron confront an overwhelming (and multiplying) amount of information in order to find what they need.

JUST-IN-TIME VS. JUST-IN-CASE

In many ways, libraries are finding that they need to function more like businesses in their ability to respond to the needs of their patrons.[21] And one major change in our expectations of libraries closely matches a trend in the business world that is helping companies more efficiently meet their customers' needs. The move from a *just-in-case* to a *just-in-time* philosophy of collection management and acquisitions signals a change in the function of libraries. They are still important as archival facilities, but there is a shift in focus from the museological purposes to libraries as community centers for the exchange of information.

> "As texts become digitized, acquisitions based on the fear of having materials go out-of-print will diminish. Some fraction of acquisitions in the future will move toward purchasing materials when needed rather than in anticipation of need. This should fine-tune the rate of acquisitions growth; collections will still grow, but perhaps at well-defended reduced rates."[22]

This is the equivalent of "just-in-time" manufacturing. Economic constraints are part of the cause of this shift. For example, The Albert Einstein College of Medicine decided to go to a commercial document delivery provider to

avoid purchasing costly journals.[23] This allowed them to save money while actually increasing the number of resources they provided for researchers (though after a 24 hour delay) and allowed them to respond to new requests as they came up, rather than as the funds could be acquired. As the trend towards the increasing digitization of media continues this process could be sped up, making delivery truly "in-time" rather than next day.

SPECIFIC OBSTACLES

CONFLICTING NEEDS OF PERMANENCE AND CHANGEABILITY

Perhaps the largest problem, or at least the first, that must be addressed is the building's contradictory requirements for both permanence and change. While so far this paper has advocated the necessity to design flexible buildings, it should be acknowledged that there is such a thing as too much change. Too much change leads to chaos, and if every aspect of a building is constantly changing, it is likely that no one will care about. A building must have some continuity in its character that defines it and makes it understandable, or there is no building at all. Institutional buildings especially demand some type of recognizable public presence to create a lasting image of their mission, which is why they are so often resistant to change.[24] And since Cincinnati's Public Library is currently lacking such a prominent presence on the street, it is even more crucial that the addition provide some sort of lasting image.

But since we know that all institutions inevitably do change, there must be some way to reconcile the need for change with the need for permanence. Once again the best precedent of something that achieves this balance is a living organism, in particular a human being. A person consists of millions of cells that are always being damaged and replaced by new cells, and according to quantum mechanics, even the matter that makes up the cells is in constant flux on the quantum scale, flickering in and out of existence as we understand it on the macro level. And on the larger scale, someone's physical appearance can change remarkably over the course of his or her life. Even personalities change in response to the environment. All of these things might make one declare, much as Frank Duffy said of buildings, that there is no such thing as a person. Yet the fact remains that each person does have an identity, something lasting that we are able to comprehend and care about.

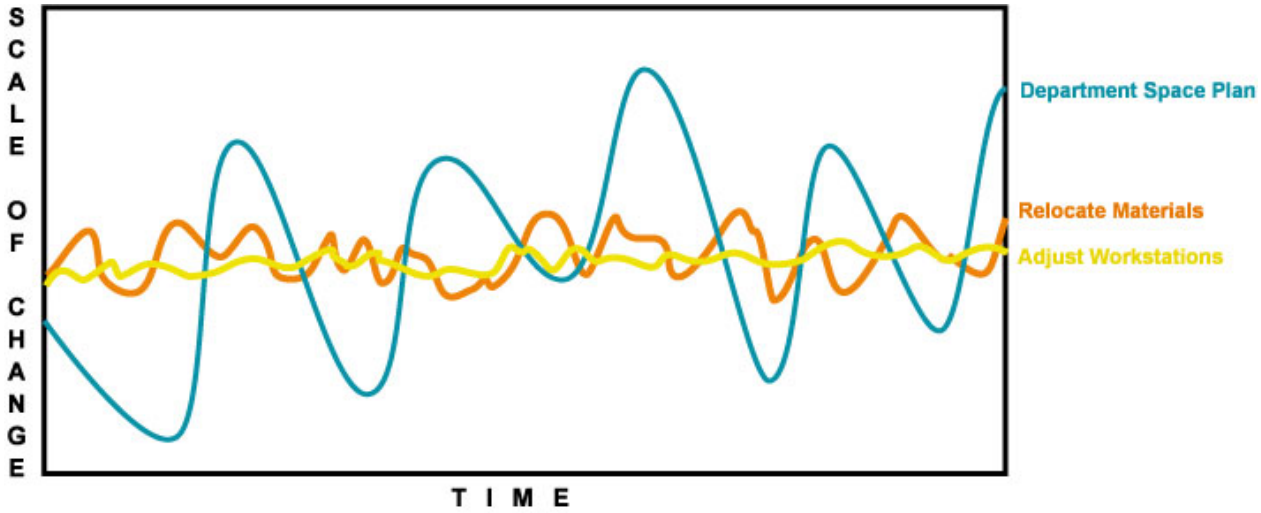
Multi-use Flexibility vs. Specific Adaptation

A one-fits-all generic flexibility tends to be a mediocre solution to multiple situations. The converse is a space uniquely adapted to its specific circumstances but unfit for other uses. The right balance of these two must be maintained (or a creative solution that permits the advantages of both) in order to create a space that will be appropriate in the present without becoming quickly obsolete. As mentioned, libraries play multiple roles and serve many purposes—they include many private functions such as study areas that need to be specifically suited to a particular activity, but at the same time libraries need the capability to change the proportion, location, and character of these many uses. One possible solution is to serve the individual functions with furniture-like elements, which can be refined, exchanged and moved around independently of the rest of the building, much the same as Function Objects in the Equipotential Space strategy.

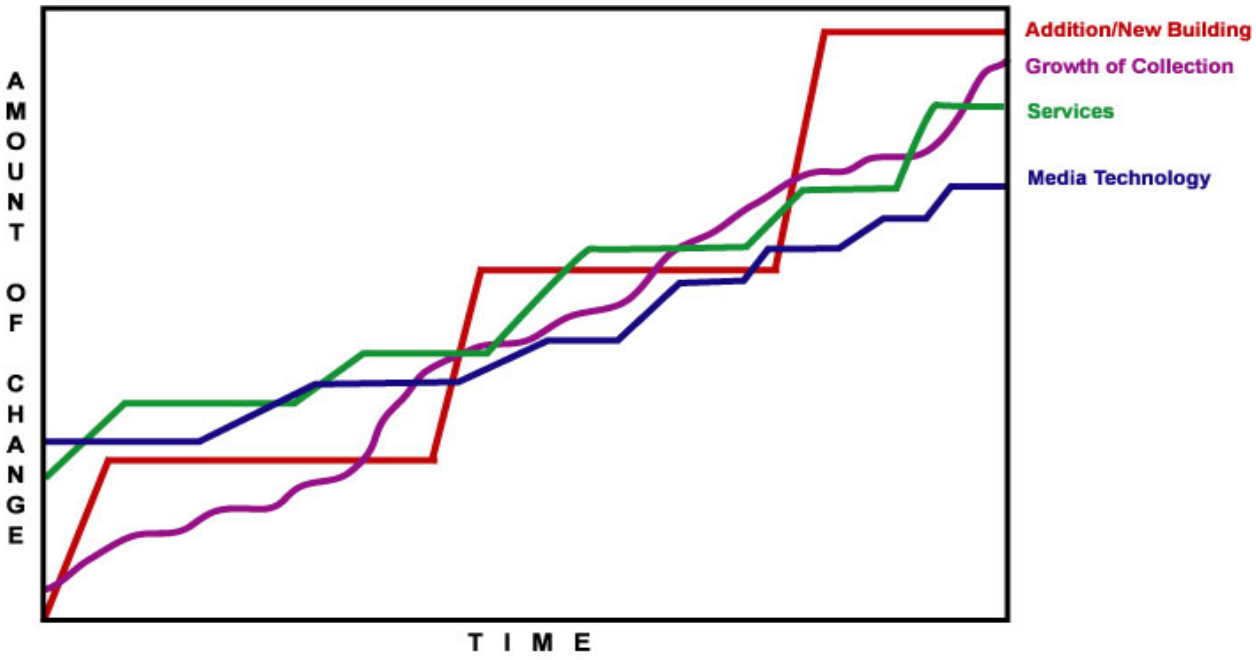
Types of Change

Scales of Change

Libraries experience pressure to change on all time scales, the relative magnitudes of which can be compared in the two diagrams below. The first graph shows the kind of changes that are usually cyclical. This includes most of the very small scale events such as the adjustment of a workstation to individual needs, which can happen several times per day. Relocation of materials occurs on a slightly longer time frame, but also involves changes that that are not permanent. Similarly, on the larger scale of entire departments things are often moved from place to place and then back again.



Other types of changes are cumulative. In the second graph the height of each vertical jump represents the scale of the change, while the horizontal sections delineate periods of stasis. The majority of built responses to an institution's evolving needs tend to lean toward the long term end of the spectrum. This is because they receive most of their funding in large lumps for building new buildings or huge additions. However, the most common force that demands change is the steady accumulation of new materials, which might be handled more gracefully with more continuous growth. In the media library addition change will depend heavily on technology. As the storage medium of multimedia information changes, so will the media center. Even more importantly, the method of viewing and interacting with media is likely to change significantly, so the building will need to accommodate revisions of the human-information interface on the medium term time scale.



Degrees of Change

Libraries have needs for both the cyclic growth associated with Low Road frequent reorganization, and the progressive growth typical of the High Road. By definition institutions are High Road buildings, probably more than any other building type, and they tend to resist change.[25] However, many institutions are really not much more than offices, which tend to lean towards the Low Road end of the spectrum. And a library is even more than just an institution—it contains a multitude of diverse functions, many of which are more suited to Low Road approaches. Computer labs for instance, which are

an important part of any library or media center, can most easily respond to rapid technological progress in cheap spaces with maximum flexibility.

MECHANISMS OF CHANGE

MORPHOLOGICAL PLASTICITY

Most libraries require fairly low levels of morphological plasticity. The biggest changes occur over the long term as a result of the need to expand, so they are accommodated with new buildings or major renovations and additions. In the shorter term, some degree of plasticity in the physical form of the building is required to allow the reorganization of relationships of different functions and to provide for changes in the spatial qualities as needs change.

PHYSIOLOGICAL ADAPTABILITY

Physiological adaptability is crucial to accommodate technological changes. Services, especially communications, require frequent updates, reorganization, extensions and even complete replacement. The provision of interstitial space, as used in the Salk Institute, is one means for accommodating physiological changes. This makes it easy to modify the services themselves or their relationship to users and other parts of the building.

BEHAVIORAL FLEXIBILITY

As identified by a number of library building planning guides, the most critical way that libraries must be designed to change is in terms of behavioral flexibility. The functional makeup of a building is always changing, so each space must be capable of conversion to another function with minimal changes.[26] This has important design implications: for example, using modular dimensions to promote compatibility of furniture and equipment, or providing natural light even in the closed stacks in case they must one day be converted to work areas.

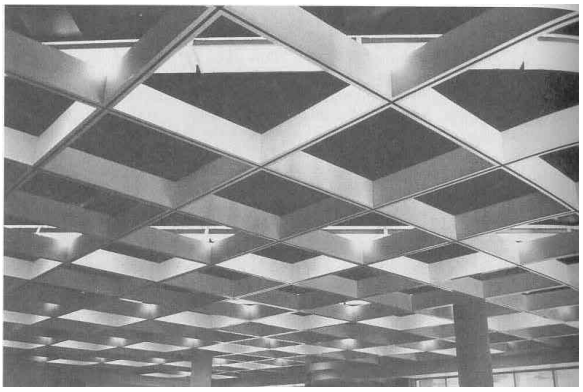


Figure 4.7

The library at Brandon University uses diagonal lighting to ensure that light levels are always the same, even if the stacks move.

MEDIUMS OF CHANGE

MANIPULATION OF VOLUMES

The use of the building on the large scale of overall volumes remains relatively constant. It is not critical to design specifically for this sort of

change, since when it does occur it accompanies a major addition. However, this sort of change requires some consideration, because it is almost guaranteed that the library will eventually need to expand again, and it is possible for a poorly considered addition to prohibit subsequent growth or reuse of large volumes. Already this library is in danger of becoming an awkward complex of poorly connected buildings, so this new expansion must be designed in a way that will allow future additions to be integrated with the rest of the library.

Spatial Arrangement

As just mentioned in "Behavioral Flexibility", libraries often must endure revisions of function, which inevitably changes the spatial layout. As collections grow, new classifications emerge or the proportions of media in existing sections change, leading to a reorganization of the spatial arrangement. Changes in how we use libraries, and therefore how the space is organized, also typically accompany changes in technology and the cultural role of the library. By planning for spatial rearrangement, these kinds of change can be welcome signs of progress rather than a burden on the building and its staff.

Growth and Division

The most common pressure for change in a library is growth.[27] This is typically the result of increased circulation and staff needs, an increasing number of patrons, and the constantly growing size of the collection. Usually, libraries can only grow in large lumps due to the way they are funded, but they are often in desperate need of more space by the time they get it. For this reason it will be important to accommodate some growth within the building, by the provision of additional space or a creative method of storing materials in a condensed area.

Manipulation of Subcomponents

This is not important in itself, but could be a means of accommodating other changes. For example, it could help make workstations adaptable to different individuals' preferences. The ergonomics of physical comfort and the idiosyncrasies of individual work habits vary significantly from person to person. By building a certain degree of flexibility into the components that make up a workstation, a person can reorient and adjust each part to fit his or her own preferences.

Evaluation of Strategies

Now that the specifics of this design problem and the type of change it involves have been defined we can test the applicability of each strategy to accommodating the growth of the library into a media center. The building analysis provided a diagnosis of existing problems and successes of the building, but now we must turn back to the building to analyze it in terms of the strategies for dealing with change. Although the use of these strategies is not as pure or as prominent as in the precedents, almost all of the strategies exist in some form. One by one, each strategy is identified in the building (if it exists) and then studied to see how successfully it is working and whether it is appropriate for the new media center.

Figure 4.8

The library first went mobile in the 1930s.

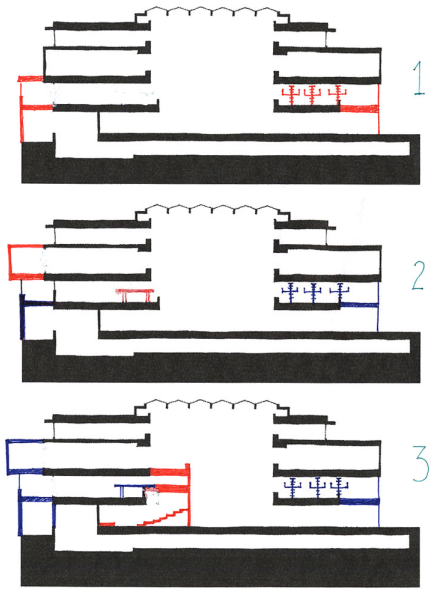
At the same time that the existing use of strategies is analyzed, experiments with the strategies in their purest form determine their hypothetical applicability to the situation. Each one is carried to its logical extreme in a way that relates to the existing library and the new media center. This process helps identify any potential opportunities that the strategies provide. Equally importantly, by running through these thought experiments the designer brings into focus any potential difficulties or disadvantages of the using the strategies.

Piecemeal Growth

Piecemeal is a good idea but it is not likely to be feasible for this project due to the way that institutional building projects are financed. The large lump sums of money that fund projects prohibit piecemeal growth. In The Oregon Experiment, Alexander acknowledges that The University of Oregon is a less than ideal client for his ideas. In addition to funding projects in large parts, institutions like the university have centralized budgets, which will always have some element of totalitarian control. The true organic order that he advocates can only be created by "responsible anarchy" in which people are free to build as they please but always contribute to the greater whole.[28]

Figure 4.9

Piecemeal growth could begin by expanding within the existing space.



Support Structures

The support structure approach may provide one way of 'cheating' at piecemeal growth. It permits continual piecemeal style refinement within a larger structure that helps keep costs down by limiting the refinement to the parts of the building that can be changed more efficiently. Specifically, Jones' Collaborative Strategy for Adaptable Architecture will be appropriate since it allows free movement of the things that will need to change frequently (technology, services, space plan), while fitting them into a shell that has the permanence needed by an institution.

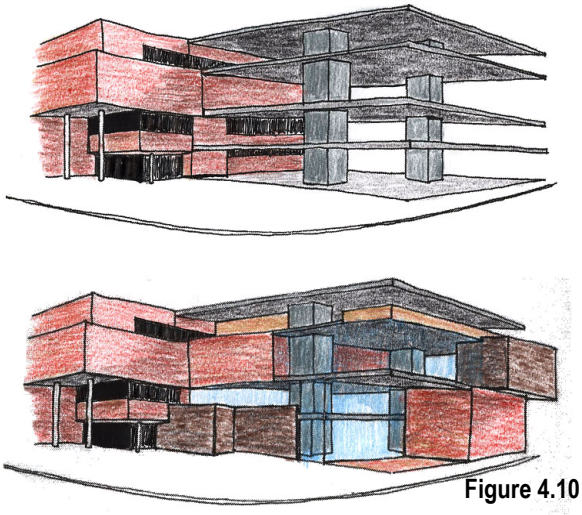


Figure 4.10

An extreme version of a support structure starts with an empty frame and is gradually filled in.

Modularity/Standardization

David Kaser credits modularity with "allowing the development of utilitarian library structures appropriate to their present-day egalitarian societal roles."[29] Since the spaces in a library, and especially a media center, must be capable of changing function easily, library planners have often praised modularity as a means of providing functional flexibility. Modularity here is much different than the idea of prefabricated building components in standardized systems, as commonly associated with modularity. In this case modularity just means laying the building out, particularly its column grid, based on a module with dimensions appropriate to the furnishings and equipment. This allows different functions to be interchangeable. For example, if the distance between columns in a reading room is based on the dimension of a bookcase, it will be much easier to convert the space into stacks if necessary.[30]

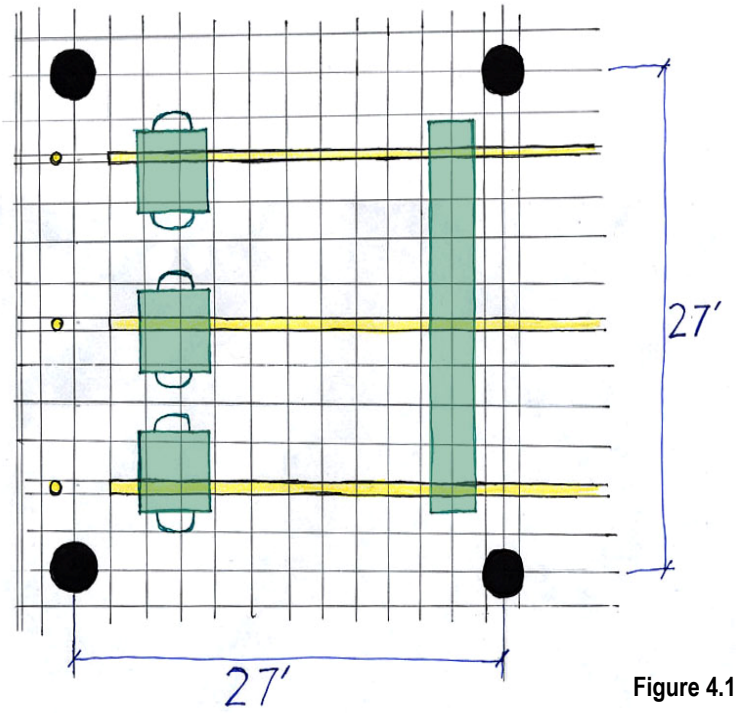
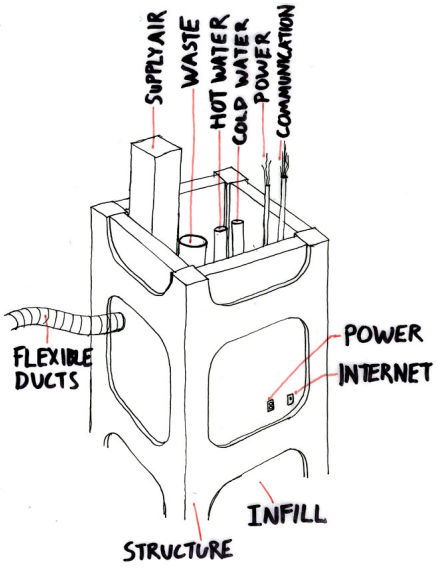


Figure 4.11

The structural module of the existing building approximately fits the stacks, or three work tables. The lighting and surface treatment also fit this module.

Integration or Superposition Systems

Some integration of services is necessary to provide easy access. The independence of the systems will also be important to ensure that they are flexible enough to support any arrangement of functions. However, going to the extreme of interstitial space, or a vertical equivalent may be unnecessary, or unaffordable.



Polyvalence

The use of polyvalence will be essential in providing for the necessary behavioral adaptations common in libraries and media centers. Much of this flexibility can be achieved through open plan, or some variation of the idea, as in the Sendai Mediatheque, but to make this approach work the implications must be followed down to every detail of the design. For instance the lighting must be designed to support as many possibilities as the space plan. Richard Bazillion suggests running lights diagonally so that aisles receive good illumination no matter how the stacks are configured. Another solution might be to fix those lights to the stacks themselves.[31] Similarly, task lights for things like reading should be adjustable, and could be integrated with the furniture or equipment associated with the task so it is always where it is needed.

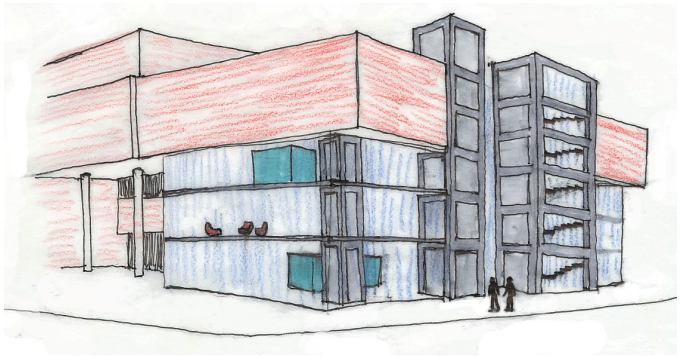


Figure 4.12

The integration of services into large structural tubes allows easy maintenance (top). When combined with an open plan it leads to polyvalence (above).

Pattern Language

The actual patterns in *A Pattern Language* are not specifically applicable to a media center since this building type is relatively specialized and did not exist at the time the book was written. However, the method put forth in *The Timeless Way* is intended for any type of project, and it describes a universal method of ensuring that many autonomously changing parts keep a continuous relationship to the whole.[32] For this reason it can be useful to use pattern-like descriptions to specify the character of and relationships between the different elements required by the program and site. *The Oregon Experiment* also provides an alternative way of approaching the design process. For example, in larger scale planning, the products of the designer

are not the more traditional master plan as a blueprint for the development; instead the designer is involved in a process of diagnosis to determine where problems exist and what improvements are necessary.[33]

Solution

Like any living organism, the evolution of a building is guided by three things: genotype, environment, and phenotype. The architectural equivalents are the genetic description of the building's systems and growth processes, the environmental forces that shape the specific development and application of those processes, and the appearance and characteristics of the physical systems used to construct the outcome. The design process outlined in this chapter has covered each of these things. It began with the historical, environmental and contextual analysis of the problem. It proceeded with an evaluation of the strategies, some that deal with genetic processes and some about physical systems.

We can now clarify how the appropriate parts of these strategies can be combined into a solution for a new media center. The environment or context of the problem provided the driving force behind the design process and determines how these strategies work together in the end. Some of these methods will be used to regulate the process of growth and change: piecemeal growth, pattern language (theory), support structures, superposition of systems and mobility (architecture as furniture). Other strategies aid in the technical problems of accommodating changes with physical building elements: polyvalence, modularity, pattern language (patterns), integration of services and mobility (of building components).

But just like buildings, designs change, and any solution will be a tentative one. Each iteration is fed back through the process in light of new constraints. Users, owners and members of the community give their reactions to the design. Additional factors such as building code and security must be considered. Also the feasibility of actually funding and constructing the project is reviewed in more depth each time around. Eventually a "final solution" is produced, or at least one sufficiently developed to be built. While the process has no definite end, the idea is that with enough cycles through this loop the many aspects of change will penetrate the design concept in a way that will allow the project to continue to evolve after construction.

Endnotes

[1] Fleischman, John. *Free & Public*. Wilmington, Ohio: Orange Frazer Press, 2003. p. 11.
[2] Fleischman, *Free & Public*, p. 70-71.
[3] Smith, Anthony. *Books to Bytes: Knowledge and Information in the Postmodern Era*. London: British Film Institute, 1993. p. 4.
[4] Smith, *Books to Bytes*, p. 4.
[5] The columns titled for Media/Communications Age, Value of Media, and Image of Mind came from Anthony Smith in *Books to Bytes*. The Role of Libraries and Influence of Technology came out of "Garage Cinema and the Future of Multimedia" by Marc Davis, *Academic Libraries as High-Tech Gateways* by Bazillion and Braun, and an interview with Jane Carlin. Predictions in blue are mostly from Rex Stevens. (*The Preparation*. 1999-2005. <www.thepreparation.net> January 30, 2005)
[6] Nobel, Philip. "2020 Hindsight." and "Notes on the Lessons of Technology in William Gibson." *LOT/EK : Urban Scan*. New York: Princeton Architectural Press, 2002.
[7] *Design for Change: the Architecture of DEGW.* Basel: Birkhauser, 1998 p. 24.
[8] Bazillion, Richard J., Connie Braun. *Academic Libraries as High-Tech Gateways: A Guide to Design and Space Decisions*. Chicago: American Library Association, 1995. p. 42.
[9] Bazillion, *Academic Libraries as High-Tech Gateways*, p. 156.
[10] Carlin, Jane. Senior Librarian, DAAP Library, University of Cincinnati. Interview February 1, 2005.
[11] Davis, Marc. "Garage Cinema and the Future of Multimedia." *Communications of the ACM*, Vol. 40 No. 2 1997 p. 47.
[12] Bazillion, *Academic Libraries as High-Tech Gateways*, p 32.
[13] Davis, "Garage Cinema and the Future of Multimedia." p. 43.
[14] Carlin, Jane.
[15] Brand, Stewart. *How Buildings Learn: What happens after they're built*. New York: Penguin Books, 1994.
[16] Bazillion, *Academic Libraries as High-Tech Gateways*, p. 2.
[17] Crawford, Walt. "Uncommon Knowledge: Myth Breaking for the Future." LaGuardia 16-27. p. 24
[18] Smith, *Books to Bytes*, p. 32.
[19] Crawford, "Uncommon Knowledge," p. 21.
[20] Bazillion, *Academic Libraries as High-Tech Gateways*, p. 23.
[21] Weingand, Darlene E. "Marketing the Library of Today…to Meet the Challenges of Tomorrow." *Creating the Agile Library*. eds., Lorraine J. Haricombe, and T. J. Lusher. Westport, CN: Greenwood Press, 1998. p. 96.
[22] Leighton, Philip D., David C. Weber, Eds. *Planning Academic and Research Library Buildings. Third Edition*. (First Edition by Keyes W. Metcalf) Chicago: American Library Association, 2000. p. 253.
[23] Malamud, Judie, Florence Schreibstein. "Just in Time vs. Just in Case." LaGuardia 306-309. p. 306.
[24] Brand, *How Buildings Learn,* p. 17.
[25] Brand, *How Buildings Learn,* p 17.
[26] Bazillion, *Academic Libraries as High-Tech Gateways*, p. 42.
[27] Brand, *How Buildings Learn,* p. 40.
[28] Alexander, Christopher. *The Oregon Experiment*. New York: Oxford University Press, 1975. p. 163.
[29] Bazillion, *Academic Libraries as High-Tech Gateways*, p. 46.
[30] Bazillion, *Academic Libraries as High-Tech Gateways*, p. 47.
[31] Bazillion, *Academic Libraries as High-Tech Gateways*, p. 45.
[32] Alexander, Christopher. *The Timeless Way of Buildin*g. New York: Oxford University Press, 1979. p. 165.
[33] Alexander, *The Oregon Experiment*, p. 151.

Conclusion

In recent history, Western society has been obsessed with the notion of progress, but when it comes to planning for change in our own time most of us ignore the issue or have no idea where to begin addressing it. This problem is becoming even more acute as the pace of scientific, technological, political and cultural transformations continue to speed up, and the nature of these dynamic relationships shows a corresponding increase in complexity. All of us face these changes in some way but architects are particularly affected. We must face change in the larger context of the business environment, the sorts of tasks we do each day, the tools we use, our strategies for design, and even the criteria for what constitutes a successful building. But most importantly, *what* we design is guaranteed to change even after we design it. For certain economic and cultural reasons, this aspect of architecture has been too often overlooked, but it is getting harder and harder to ignore. One goal of this study is to offer new hope in that by conceiving of buildings as living organisms we can make them more adaptable to our needs over time.

The design of a building in the biological terms of genes, systems or organs is appropriate because buildings, like the people they hold, are essentially biological (and therefore also social). Buildings, as with any tool we make, are extensions of ourselves and will therefore change according to our needs.[1] Every building inevitably undergoes such changes of function, size, fashion and technology. If buildings are able to adapt to these changes they will be more sustainable, better suited to the specific needs of users, longer lasting, and more egalitarian in the possibilities for individual expression and control over the environment. As buildings become more like living things they will also become more lively places where people will potentially be happier.

There are many varieties of change that affect a building on a number of levels. Through a system of classification and evaluation, we can better understand the nuances of how different types of buildings change in different ways. It is also important to take note of the obstacles that typically hinder the adaptation of a building so that we can learn to better address these problems. There have been many diverse proposals for dealing with change. These frequently contradictory strategies must be evaluated for their appropriateness to each design problem. The advantages of the different methods may then converge into a suitable design process capable of allowing a building to respond to its particular sort of change.

The one thing that all of the methods have in common is that design is geared to creating endless possibilities rather than narrowing the possibilities down to an ideal solution to an immediate problem. As John Christopher Jones puts it, we need new methods of design that shift "from the specifying of geometry, physical form, to the making of a context, a situation, in which it is possible for others…to determine the geometry."[2] We will be able to better accommodate change by thinking of buildings, not as objects defined by spatial qualities, but as living organisms composed of many complexly integrated systems that are intimately connected with the dynamic processes of living, working and social interaction. In this way the evolution of buildings may finally keep up with the pace of our culture and at last enable our environments to adapt to our changing needs.

The resulting methodology used in the example project of a Media Center is a more scientific process than architects typically use, one that begins with intense investigation into the history of the site, the background of the users or owners, and their needs. Renovation and reuse are closely tied to the subject of change so an analysis of any existing structures on the site is crucial. Once the existing use of strategies for accommodating change is understood, these strategies can be revised and reapplied to continue the building's successful evolution. The major concern of this approach to architecture is to establish a dynamic synergy between people and their built environment, so correspondence must be maintained with all user groups.

User participation in design is a related problem to that of change, but one that requires a whole new body of research. Many architects and theorists have been working on this problem and perhaps architects will soon be better educated on the subject so that they may better inform their clients, bringing

us one step closer to achieving the goals outlined in this paper. However, it will take changes on an even higher level of social structure before the issue of building adaptation receives the attention it deserves. As Christopher Alexander pointed out, we live and work within management systems incapable of dealing with change, and it will take large scale political and social transformation before our ideas about sustainability, user participation, pattern language, and so forth, can be carried out as intended.

Until then, one important step that architects can take is to study how their own projects have evolved over time. How can we design for change if we don't even know how the users have changed buildings we already designed? In depth post-occupancy evaluations could be an invaluable addition to the existing body of research. Of all the proposals for design strategies discussed here, there were few published examples of their faithful application to real situations and almost no analyses of the success of these projects. A revolution is building, or rather, architecture is evolving to where it can actively adapt and function appropriately for the living people it supports. But we still have a long way to go.

Endnotes

[1] Gwilliam, Tony. "Organic Building." Zelov 88-90.
[2] Jones, J. Christopher. *Design Methods*. 2nd ed. New York: John Wiley and Sons, 1992. p. xxxvi

Bibliography

1 Alexander, Christopher. *The Oregon Experiment*. New York: Oxford University Press, 1975.

2 ---. *The Timeless Way of Buildin*g. New York: Oxford University Press, 1979.

Baird, George, et al. *Building evaluation techniques*. New York: McGraw-Hill, 1996.

3 Duffy, Francis. "Building Appraisal: Measuring the Capacity of Office Buildings to Accommodate Change." Baird 27-30.

4 Leaman, Adrian. "User Satisfaction." Baird 41-43.

5 Bazillion, Richard J., Connie Braun. *Academic Libraries as High-Tech Gateways: A Guide to Design and Space Decisions*. Chicago: American Library Association, 1995.

6 Benedikt, Michael. "Between Beakers and Beatitudes / The Salk Institute's dual role of function and landmark." *Progressive Architecture*. Oct 1993, Vol. 74, No.10 pp. 52-53.

7 Boice, John R. *A History and Evaluation of the School Construction Systems Development Project 1961-1967*. Menlo Park, CA: Building Systems Information Clearinghouse, Educational Facilities Laboratories, 1971.

8 Brand, Stewart. *How Buildings Learn: What happens after they're built*. New York: Penguin Books, 1994.

9 Buntrock, Dana. *Japanese Architecture as a Collaborative Process: Opportunities in a Flexible Construction Culture*. New York: Spon Press, 2002.

10 Callado, José. "The Architect's Perspective." *Urban Studies*, Vol. 32, No. 10, 1995: pp.1665-1677.

11 Carlin, Jane. Senior Librarian, DAAP Library, University of Cincinnati. Interview February 1, 2005.

12 Crosbie, Michael J. "Dissecting the Salk." *Progressive Architecture.* Oct 1993, Vol. 74, No.10; Research Library pp. 40-46.

13 Dawkins, Richard. *The Blind Watchmaker*. New York: W.W. Norton & Co., 1987.

14 *Design for Change: the Architecture of DEGW / with contributions by Francis Duffy…* Basel: Birkhauser; Haslemere: Watermark, 1998.

15 Duffy, Francis. *The Changing Workplace*. Ed. Patrick Hannay. London: Phaidon, 1992.

16 ---. "Measuring Building Performance." *Facilities*, May 1990: p. 17.

17 Educational Facilities Laboratories. *SCSD: the Project and the Schools*. New York: Educational Facilities Laboratories, Inc., 1967.

18 Fleischman, John. *Free & Public: One Hundred and Fifty Years at the Public Library of Cincinnati & Hamilton County 1853-2003*. Wilmington, Ohio: Orange Frazer Press, 2003.

19 Friedman, Avi. *The Adaptable House; Designing Homes for Change*. New York: McGraw-Hill, 2002.

20 Frazer, John. *An Evolutionary Architecture*. London: the Architectural Association, 1995.

21 Futagawa, Yukio Ed. *Toyo Ito 1970-2001*. Tokyo: A.D.A. Edita, 2001.

22 Habraken, N. J. *Supports: an alternative to mass housing*. London: Architectural Press, 1972.

23 Harrison, Andrew, Eric Loe, James Read, eds. *Intelligent buildings in South East Asia*. London; New York: E & FN Spon, 1998.

24 Hill, Jonathan. "The Use of Architects." *Urban Studies*. Feb 2001, Vol. 38 Issue 2, pp. 351-365.

25 Hugo, Victor. *The Hunchback of Notre Dame*. 1831.

26 Ito, Toyo, and Mutsuro Sasaki. *Toyo Ito: Sendai Mediatheque, Miyagi, Japan, 1995-2000*. Tokyo: A.D.A. Edita, 2001.

27 Jencks, Charles. *The Architecture of the Jumping Universe*. London: Academy Editions, 1997.

28 Jones, J. Christopher. *Design Methods*. 2nd ed. New York: John Wiley and Sons, 1992.

29 Kelly, Kevin. *Out of Control; The New Biology of Machines, Social Systems and the Economic World*. Reading, Massachusetts: Addison-Wesley Publishing Co., 1994.

LaGuardia, Cheryl, Barbara A. Mitchell, Eds. *Finding Common Ground : Creating the library of the future without diminishing the library of the past*. New York: Neal-Schuman Publishers, 1998.

30 Crawford, Walt. "Uncommon Knowledge: Myth Breaking for the Future." LaGuardia 16-27.

31 Malamud, Judie, Florence Schreibstein. "Just in Time vs. Just in Case." LaGuardia 306-309.

32 Leighton, Philip D., and David C. Weber, eds. *Planning Academic and Research Library Buildings. Third Edition*. (First Edition by Keyes W. Metcalf) Chicago: American Library Association, 2000.

33 MacDonald, Donald. *Democratic architecture: practical solutions to today's housing crisis*. New York: Whitney Library of Design, 1996.

34 Mayne, Tom. "Not Neutral." Lecture at the University of Cincinnati. October 27, 2004.

35 Nobel, Philip. "2020 Hindsight." and "Notes on the Lessons of Technology in William Gibson." *LOT/EK : Urban Scan*. New York: Princeton Architectural Press, 2002.

36 Petzinger, Thomas Jr. A New Model for the Nature of Business: It's Alive! The Wall Street Journal. February 26, 1999. p. B4.

37 Severino, Renato. *Equipotential Space; Freedom in Architecture*. New York: Praeger Publishers, 1970.

38 Smith, Anthony. *Books to Bytes: Knowledge and Information in the Postmodern Era*. London: British Film Institute, 1993.

39 Weingand, Darlene E. "Marketing the Library of Today . . . to Meet the Challenges of Tomorrow." *Creating the Agile Library: A Management Guide for Librarians*. eds., Lorraine J. Haricombe, and T. J. Lusher. Westport, CN: Greenwood Press, 1998.

40 Werner, Frank. *Covering + Exposing: the architecture of Coop Himmelb(l)au*. Basel; Boston: Birkhäuser, 2000.

Zelov, Chris, Ed. *Design Outlaws on the Ecological Frontier*. Easton, PA: Knossus Publishing, 1997.

41 Alexander, Christopher. "The Living Structure Approach to Design." Zelov 270-275.

42 Gwilliam, Tony. "Organic Building." Zelov 88-90.

43 McDonough, William. "Not a Machine for Living in-A Living Machine." Zelov 94.

Appendix A: **P r o g r a m**

Total area = 75,000 sf

Patrons: 32,600 sf

MEETING: 7400 SF

LARGE AUDITORIUM
Lectures, video presentation, conferences
3500 sf total
400 people x 7 sf / person = 2800 sf

SMALL AUDITORIUM
1400sf total
150 people x 7 sf / person = 1050 sf

CONFERENCE ROOMS
Informal meeting places and group work spaces
(4) @ 200 sf = 800 sf total
10 people x 20 sf / person = 200 sf each
- Small, semi-private rooms
- Acoustic separation
- Some visual separation

EXHIBITS
Exhibition space for projects by local artists, schools, etc.
1800 sf

GATHERING
Outdoor space for people to wait or relax
- Sunlight, or shade when appropriate
- Access to public transportation and parking
- Connection to library entrance

SEARCHING: 20,000 SF

For storing and accessing materials:
Film, Audio, Software, Graphics
- Large, open, clearly organized spaces that display materials in an attractive, compact and easy to find manner
- Very public areas that are inviting the user and indicate free access to information
- Research aids (computer/way-finding devices) easily accessible from any point
- Absorptive materials to control noise: carpet, wood shelves, ceiling tiles or baffles

STUDYING: 2,300 SF

For researching, reading, listening and viewing multimedia

READING ROOMS

30 people x 50 sf / person = 1500 sf

- Proximity to stacks and materials
- More private, intimate spaces for individuals
- Calm, muted colors and materials to avoid distractions, but bright enough to feel lively and reflect light
- Good lighting, especially natural
- Muted auditory environment

LISTENING/VIEWING STATIONS

(4) @ 100 sf = 800 sf total

- More private, intimate spaces for individuals
- Some spaces geared to small group work
- Soft materials for comfort and sound absorption: fabric, wood
- If closed in, glaze at least one side
- Muted auditory environment
- Proximity to stacks and materials

WORKING/CREATING: 2,800 SF

WORKSTATIONS

Individual multipurpose stations for use with personal computers
20 people x 50 sf / person = 1000 sf

COMPUTER LAB

Word processing; sound, video and image editing; internet and email access
50 people x 20 sf / person = 1000 sf

- Some degree of privacy to avoid distractions, but
- Must be easy to monitor for abuse/inappropriate use
- Flexible for easy to updates to technology
- Possibly integrated with study areas

RECORDING LAB

Small studio for producing audio recordings
(2) @ 400 sf = 800 sf total
6 people x 50 sf / person = 300 sf + 100 sf equipment = 400 sf each

- Small studio
- Soundproof
- Easy to update technology
- Visual connection to library so other people feel involved

Staff: 26,500 sf

Circulation Services: 5200 sf

Check-out desk
8 people x 100 sf / person = 800 sf

Processing / Retrieving: 4000 sf

Drive-through window
200 sf + 200 storage = 400sf total
2 people x 100 sf / person = 200 sf

Closed Stacks/Storage: 20,000 sf

Books, additional multimedia, electronic equipment

- Possible extension of Level C and D closed stacks
- Efficient layout for easy locating
- Durable, inexpensive materials

Information: 600 sf

(2-3) Help Desks for general information
2 people x 100 sf / person = 200 sf

Security: 400 sf

Office and surveillance room for guards
4 people x 100 sf / person = 400 sf

- Proximity to exits
- Maximum of two main entrances per block

Administration: 500 sf

Offices for managers of Media Department
5 @ 100 sf = 400 sf

- Accessible from circulation desk
- Sense of privacy and separation from rest of library
- Warm, natural materials

Service: 15,900 sf

Restrooms: 900 sf

(2) female @ = 250sf = 500sf
(2) male @ = 200sf = 400sf

Services and Maintenance

15% of net area (60,000) = 9000 sf

Circulation

10% of net area = 6000 sf

Staff and Accessible Parking

Appendix B: **Building Analysis**

POSITIVE	**NEGATIVE**
■ Openness and uniformity permits polyvalence to some degree ■ Openness of atrium ☐ Visual connection between floors and public areas on opposite sides ☐ Natural light in circulation/study areas	■ Deceivingly open ☐ In reality stacks often block view ☐ Makes circulation pattern unclear
■ Image ☐ Layering of solids and voids consistent in addition, and has become logo	■ Weak Image ☐ Pulling facades back from major streets downplays building's significance and urban presence. ☐ subdued architecture / not memorable
■ Outdoor areas near entrances are used frequently by both patrons and others.	
■ Sequential experience ☐ Good transition from street-urban place-entrance portal, large open space with outdoor materials and natural light-more interior-feeling areas	■ Sequential experience ☐ Dead-ends at atrium ☐ Buildings are poorly tied together ■ Wayfinding ☐ Hidden entrances, esp. Walnut St. ☐ Entrances are not sited for typical means of access (only bus) ☐ No public stair ☐ Connections to other buildings are hidden
■ Acoustic absorption is mostly good	■ Acoustics ☐ Annoying humming noise in places ☐ Atrium amplifies/echoes sounds a little, but it works for that space ☐ Loud mechanical system, but white noise is not bad for most areas
■ Ambient lighting ☐ Fluorescent lighting is appropriate for reading or browsing anywhere.	■ Almost no task lighting ☐ Shadows make writing annoying ☐ Not enough work spaces have access to natural light.
■ Some desks are equipped with internet and power for future or personal computer use.	■ Power boxes on the floor are rarely used and prevent mobility of workstations.
■ Excess space is good for exhibitions and free circulation.	■ Wasted space ☐ Untapped potential for vertical storage ☐ Presentation area by atrium on 1st floor is often empty and not good for pres.