URBAN SUNSPACES

Ecology Of Atria and Arcades

by

Joachim W. Glässel

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Submitted in Partial Fullfillment of the Requirements for the Degree of Master of Science in Architecture Studies at the

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Ecology of Atria and Arcades for Northern Climates

by
Joachim W. Glässel

Submitted to the Department of Architecture on May 7, 1981, in partial fulfillment of the requirements for the Degree of Master of Science in Architecture Studies.

ABSTRACT

Historically, atria were protected interior patios; well perceived for their climate temoering and spatial amnenity to the building; matching a peaceful private outdoor with the yearly climate cycles. Public buildings adopted this in larger scale, and with the ending 18. century, atria and arcades merged to a period of architectural highlights of glass covered interiors in steel and glass. Passages, hotels and public buildings of a emerging industrial society in Europe and Northern States spured the evolution of the "Great Indoors" as an urban feature. The ecology of these indoors were consciously achieved by passive means of temperature control.
With the rise of mechanical conditioning and excessive use of glass at facades by the beginning of this century, atria and acrades disappeared more or less form the architectural vocabulary. The late 195oies though experienced a revival of atria as a commercial amenity in malls, hotels and similar type of public places. These atria, however, were generally mechanical conditioned; just typically being enourmous energy wasters.

With the growing urge for energy conservation today, new parameters form our buildings. For this, atria and arcades of urban scale and passive control achieve a new validity as energy conscious urban form.

As the key to our energy future in buildings lies well in the urban context, whose inventory per se offers already a fair degree of energy efficiency, improvements there would yield greatest rewards compared to current suburban solar sprawl. The re-interpretation of atria and arcades will provide a perfect planning tool for this urban energy conservation. The glass covered indoors will match with urban scale and site restraints and spur urban life for livable norther winter cities.

Exploring atria and arcades as climate buffers and interior amenity for snow belt latitudes, this thesis presents an architectural review, and concludes with design patterns for habitable and energy conscious urban indoors.

Thesis Supervisor : Gary Hack
Title : Associate Professor

Thesis Co-Supervisor : Harvey J. Bryan
Title : Assistant Professor

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and thanks to Isabella for many marvelous days, patience and many cheering words on the night line.

Everybody Talks About The Weather,
But Nobody Does Anything About It.

Mark Twain 1881

I Hope That With This Work,
This Matter Will Be Helped
A Little Bit

The Author 1981

Slightly more erotic, perhaps, were the atrium and green houses that were favorite settings for romance in Victorian England. The lovers could get lost among the leaves of exotic tropical plants and possibly mistake the hot humid atmosphere for their own concealed passion

Lisa Heschong, Thermal Delight (37)

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DEFINITIONS

The moderne version of the atrium implies since the turn of the 19. century a weather-proof, multistorey space which is totally within the building, as a central court or hall to serve as formal circulation within the overall floor plan scheme.
Moderne Movement architecture adopted the term foremost for open courtyard gardens in low rise residential tissues.

The recent notation of "atrium" describes a multistorey glass covered court of substantial dimensions in relation to its surrounding building, serving as a central organisational space of superior design, as imagery to the building, as entrance and semi-public space.
In terms of this study, atria and arcades of multistorey scale are jointly discussed as "Urban Sunspaces"

With solar exposure, both spaces have a familiarty to greenhouses and can be well described as "sunspaces". Sunspaces are defined as: "A place in the sun, of favorite or prominent position or use...". (Webster's Dict.) Most commonly, sunspaces are perceived as attached greenhouses to live in. This study however distinguishes from this, as the urban sunspcace is of multistorey scale and incorporated in a building of urban density, and embraced by interior facades.

As a projection of the concept developed with this study, "Urban Sunspaces" imply a glass enclosure of urban scale, with passive thermal comfort conditioning and intended solar exposure.

Atria and arcades as "the great indoors" had their ups and downs of economical success and demolition, and were noted urban attractions to their contemporarians. By the end of the last century, "a city without an arcade was like a couch without a cushion", as John Russell puts it (67).

With the merge of refined street design and pavement, the automobile's rise and the related dissolution of the notion of space confining urban design, and with the final divorce of the building from the street space, arcades became obsolete. The street line became the only selling address--visible from the commuting traffic. Urban design focused on the facade, on the building as a solitary movement of itself and with an abstract relation with the city space. Outdoor plazas and landscape replaced urban "indoors" and passages.

For decades, after 1910, no major arcade or atrium was built. Tempered urban "indoors" as a climate conscious amenity to city life were not in general, utilized.

This was so until V. Gruen responsed to the rise of the american suburban shopping mall with the simple economical consideration to enclose the malls with skylights, provide internal streets and thus save expenses on the shop front design , plus, adding adaptability to the retail area. Air conditioned at cheap energy costs, these new "indoors" became a commercial success and a driving real estate feature as retailers discovered the subtle, familiarity hominess and obvious climate protection as an attractive environment for their clientele.

And with the last 15 years, a series of hotels by John Portman adopted the glamour of these malls and revived the atrium tradition of 19th century hotels--such as the Brown Hotel in Denver (16) or the grand court of the Palace Hotel in San Francisco (1878)--nearly constituting a return of the soaring glass interiors of the noted Parisien department stores. This new celebration of the built forms interior surely merged notions of sense of place, spatial sensation, imagery, and even community spirit for a anonymous hotel society, where on the other hand construction costs and thermal conditioning was of minor financial concern.

And it is in the recent years, that atria have experienced a return as splendid corporation imagery in office complexes and warehouses again. Typically, though, these spaces added enourmeous costs to the projects (Tamblyn) since they were primarily aesthetically designed and required artificial air conditioning.

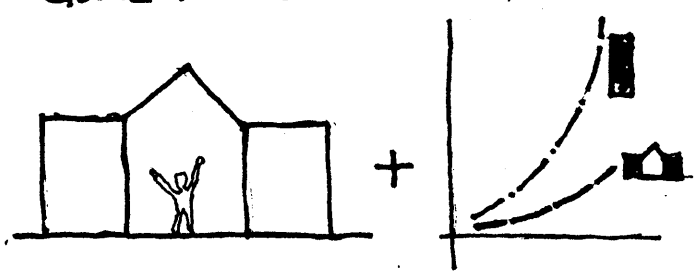
The return of the atria was costly and energywise terrifying as the design approach fought actively against nature's forces, rather than working passively as the early historical designs did, with nature and sun impact. For that, the revival of the atria as a new generic building type is yet cautionsly perceived, and noted examples remain exclusive, for energy conscious design, physical issues, fire safety and thermal prediction adds a difficult set of complex parameters to the architect's task.

Most architectural firms that once built a atrium or arcade seems to be somewhat disappointed by the performance of the space, and dismayed about the problems faced with the planning process.

The mistakes of these projects are obvious and mostly due to "experimental" approach. The specific design implications are often not considered beyond the regular concerns with the given program.

In this sense, the study kind of disregards John Portmann's hotels, since they are designed "with money unlimited" and do not refer to a commononly via ble design approach

GOAL TO THE DESIGN



Projects to adopt atria for housing development and highly economical, energy efficient office buildings just recently signal a new trend.

Evaluating the previous failures with new knowledge on energy conservation design, this study will explore for the first time the potential and architectural implications of urban sunspaces as a viable, valid design approach to thrilling "indoors" and energy conservation of an urban scale.

Pursuing this design theory, one discovers certain institutional and professional obstacles to the success of sunspaces in city halls, architecture offices and real estate agencies. It is the thought, that this study will help to dismantle this state of:

-preoccupation relative to bad experiences with the effects of previous design efforts in relation to energy performance; to in turn lack of knowledge and teaching on the subject in the profession

-lack of monitored data

-lack of compiled design concepts

-conflicts with building codes and fire regulations

-reluctance on developers' side to "gamble" with this more complex design approach as it might face unexpectable problems to get permissions, etc, as a reaction to initial costs and possible regulatory hassles.

....and the energy issue today

Only with numerical proofs, of efficient energy performance will the atria approach be economically acknowledged beyond its aesthetic ends, which is actually obstacle to wider and more residential, less exclusive application. Less the aesthetic-commercial backed up approach but rather the general common application is concern of this study. Thus the study promotes foremost the atria approach as a generic building type for urban housing office and service buildings that can meet today's quest of: "How many miles does that building to the gallon?"

PERSONAL MOTIVES

Since early in my studies, I was intrigued by glass covered spaces. Jonas Geist's book "Passagen" (29) was instrumental to perceive built form as a means to contain and confine interior "open" space as a protected, highly usable environment added to the building as opposed to indifferent street space and merely aesthetic plazas. The objective of shaping "inner protected" space with a donut building concept became a consistent pattern through my design work. The idea of a common "agora" interior to the building, the determination of interior landscape rejected buildings as solitary monuments dominating surrounding "plazas".

The continuation of my architectural studies at MIT, with emphasis on the environmental programming, neighborhood planning and passive energy design brought upon the fusion of the "donut approach" of community appeal with the urban sunspace as a passive solar environment. Opposing the one-sighted suburban detached family house approach of passive solar, these urban

sunspaces matched perfectly with community planning and energy conservation and encouraged this research to make the case for the atrium.

Impressions from the Alberta Student Union Housing (E5), J.B. Godin's remarkable "Familistere de Guise" (G1) and ongoing ecological urban renewal projects in Berlin, the Isabella Gardener Museum in Boston all this put together with passive greenhouse technology and thermal calculations promisses feasibility.

The proliferating recent trend towards atria, still regarded with doubts by those looking ahead to a expensive energy future today, is yet accompanied by only little, and merely experimental knowledge in some architectural firms.

This new design trend urgently calls for a comprehensive study, to put forward a compiled design manual, to communicate individual design experiences, and especially to encourage atria buildings through a passive conditiong approach.

Early rough data collection, contancts and literature search indicated a gab of documentation and design knowledge to be explored to prove feasibility of this approach for the northern snowbelt city context as a responds to the future energy quest and the goal of a livable winter city.

Structure of Study

The study incorporates essentially two parts, an architectural design review section to explore qualitative aspects of the urban sunspace; and an energy package to investigate environmental

controls and quanititative energy efficiency. Both parts could be a subject of their own but then would not allow comprehensive design recommendations, since passive buildings systems are above all interlocked with the building as an energy collector and heat trap envelope itself by shape, floor plan, orientation and interior finishes.

With the merging of design and energy analysis, design patterns for programming this sunspace type of building are concluded and energy comparision are established to prove feasibility.

A documentation of referred projects, both realized ones or those yet still on the drawing boards are compiled in a appendix as background data to the design recommendations and typology classifications.

Scope of the Study

The study covers two aspects of the Urban sunspace. One, an architectural review including historical background merging to a design criteria set of a generalizing format as a primer for programming sunspace buildings.

The second part explores the energy issues as the critical clue in making an economical argument. This is a quantitative assessment in terms of energy efficiency with respect to climate demands, thermal comfort, and space conditiong devices of passive modes. Again, in a sort of design primer, the effects of a "thermal break", direct solar gains and reduced perimeter losses will be bought to correlation for a comparison with conventional design approach, as seen the same building shape without sunspaces.

The intent is to develop basic rules of thumb to predict passive energy performance and thus justify proposed concepts already in the design phase to the clinet, since this is critical to early design phase decisions, while later on as the scheme gets defined, more accurate dynamic calculations with DOE 2 will have to be applied beyond the scope of this study.

Under this notion, the study assess commercial and residential structures, as both types equally include demand for thermal comfort and visual quality for inhabitation. Daylighting and building depths are major issues to both types, and both are compatible to mixed use concepts of urban ambience. Though thermal energy implication in commercial and residential structures are quite different due to operation and inhabitation modes, the study feels comfortable to look at both for the sake of a wider experience built from examples, and in turn for a wider application of the study result.

It is also regarded hereby, that the environmental qualities of office space tends increasingly to resemble residential amenities if we consider developments like Central Beheer and the Bulter Square (M2) as habitable office designs of the future.

Method

The study established a base of knowledge from literature search to be then held against the reality of built samples on a extended study trip. With this, the case assessments on site were guided by knowledgeable objectiveness: rather than have the sample impose objectives and establish the theoritical concept alone.

Case observations were documented right on site, and backed up with interviews wity related professionals and casual tenant questioning. However, a more consistent user evaluation of sun-spaces would be resourceful, as already the few responses were quite eloquent. Overall, the study trip led to a redefinition of the conception and shifted emphasis to qualitative aspects.

Data Collection

Hardly any of the architects had data and performance assessments of the buildings at hand. Referred to mechanical engineers, these mostly "predicted" performance from previous project knowledge. Accordingly innovative approach is suppressed, since the "experience approach method" is time saving and safets...on short term no matter which oversizing of equipment and energy consumption will be paid in the long run. None of the buildings were monitored and the data hardly represented actual, but rather estimated performance. Calculations were found rough as they did not refer to the architect's specifications "to be on the safe side", since specifications are arbitrary" (Cooper). Performance was mostly discussed along the lines of the owners heat bills.

Other problems arose from inconsistency in data formats. Standarization is necessary to become reliable.

Typically, architects were not particularly concerned with "done jobs" and engineers claimed an overload of tasks leaving no spare time to follow-up on the buildings actual performance. It is doubtful where alternative a profession can ignore the knowledge to be gained from experience to such an extent. With the call

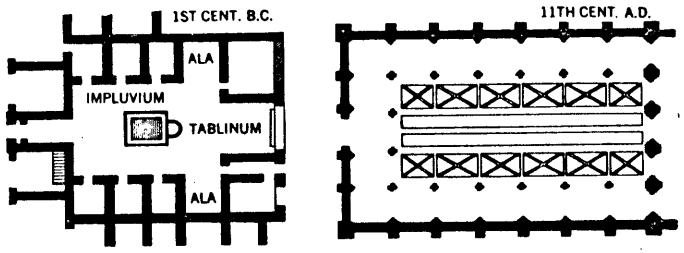
for energy consciousness, there should be also the quest for data consciousness.

In this respect, the proper assessment of the sunspace approach is fairly difficult, since performance efficiency is largely a matter of "trade-off" points, which in turn can only be defined with accurate base figures.

HISTORIC REVIEW

Origins

The use of sunspace as a conscious architectural means of trapping sun for energy gain is, of course, not a new feature. Likewise, the atria reflects a long history of climate conscious design. Focusing on the energy considerations in time, this survey will in brief trace the evolution of glass enclosures to interpret the objectives and design implications. Since this study shall exclusively follow the contemporary development of glass-architecture, the analysis will focus on glass care indoors and draw conclusions for contemporary objectives.

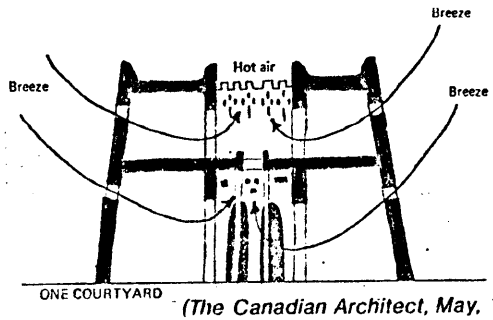


(TOP) ALINARI; (BOTTOM) BY COURTESY OF MAU, "POMPEII, ITS LIFE AND ART" (MACMILLAN); DARTEIN, "ÉTUDE SUR L'ARCHITECTURE LOMBARDE" (DUNOD)

TOP: ATRIUM OF THE "HOUSE OF THE SILVER WEDDING," POMPEII. BOTTOM: FLOOR PLANS OF ATRIA. (LEFT) HOUSE OF PANSA, POMPEII; (RIGHT) CHURCH OF SAN AMBROGIO, MILAN

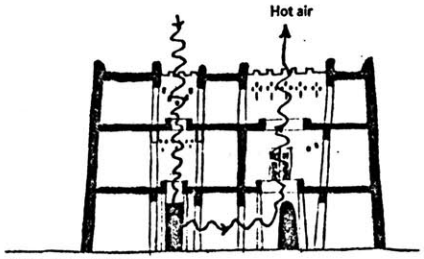
Atrium, as a Latin word, originally described the central room of a Roman house (Enzy.Brit.) in which the hearth was placed. Essentially a small court, it had no roofing to vent out the smoke. As kitchen and hearth were moved to other places in the house, the atrium became a formal reception room and the official center of family life. Therefore, the atrium emerged as the representative, decorative space of the house with water foundains and greenery.

Medical sciences adopted the central vital character of atria to name the two upper chambers of the heart after it.(Enz.Brit.)



(The Canadian Architect, May, 1972)

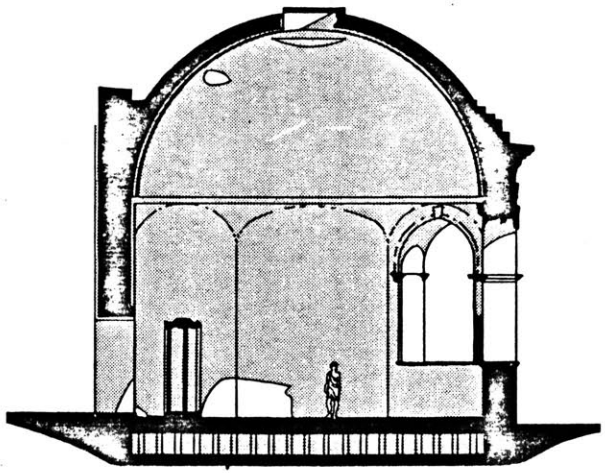
Later on, for churches e.g. San Clemente, Rome; San Ambrogio; Milan; Cathedral of Parenzo, Istia, and public buildings, the atrium was adopted to serve as a decorative procession space for entrance transition. The residences of Pompeii are noted for their classic atria. For centuries the atrium was a significant, generic device for residential floor plans, responsive to local climate conditions, as it is still found today in Northern Africa and Arab countries (31).



TWO COURTYARDS

The more recent history of the atrium as a glass covered interior incorporates the evolution of glass technology, both, as an industrial feature and as an aesthetic application. With this, it touches also the grounds of the emerging age of industrialization expressed in built form. Likewise, it meets the thoughts of social utopian and the objective of the early hygienists as well.

The unprecedented advent of technological achievements such as the industrialized production of glass and the growing demand for weather protected public functional space advanced the use of glass. The historical rational now merges with a new energy related architecture of a solar age as an existing fusion of glass design, greenhouse technology, steel and glass construction aesthetics with the knowledge of solar design.

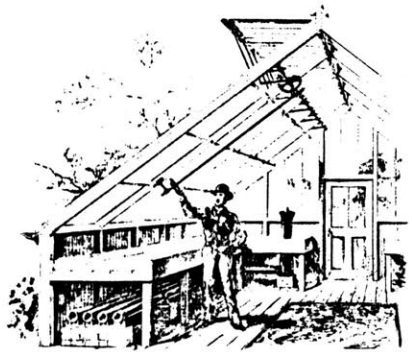


Top right: Cross-section of a Roman heliocaminus *in the public baths at Ostia, from studies by Edwin D. Thatcher. In winter, the large, transparent windows admitted plentiful sunlight but slowed the escape of solar heat.*

Glass and Solar design

The discovery of glass traces back to Syria, from where it was brought to Egypt and later on to Rome (A. Dietz 32) to be initially used for fake jewelry and then for decoration and pavements. The first solar heat trapping with glass is found as a "Heliocaminus" (solar furnace) in Hadrians villa in Tivoli, and also in the villa of Pliny the Younger in Laurentum, 1. century A.D. Using the Greek style solar oriented home (38) , Pliny explicitly described economic savings from tapping the sun's energy with transparent glass covered windows, "collecting

illumination broke the prerogatives of the churches, glass became the precious attribute of rich mansions.



57 Patent self-locking sash operating apparatus. Hitchings & Co. catalogue of greenhouse heating, c. 1880.

121 'He felt somewhat as if he were walking in an enchanted ground as he followed her into the large room, the windows opening into the conservatory, the whole air fragrant with flowers . . . the door into the conservatory was opened, and Meta cut sprays of beautiful geranium, delicious heliotrope, fragrant calycanthus, deep blue tree violet, and exquisite hot house fern; perfect wonders to Norman. . . . Margaret, I would give something for you to see the beautiful conservatory. It is a real bower for a maiden of romance, with its rich green fragrance in the midst of winter. It is like a picture in a dream. One could imagine it a fairy land, where no care, or grief, or weariness could come; as choice beauty and sweetness waiting on the creature within. I can hardly believe that it is a real place and that I have seen it.' Charlotte M. Yonge, *The Daisy Chain*. Drawing: Conservatory at Lessness by Messenger & Co.

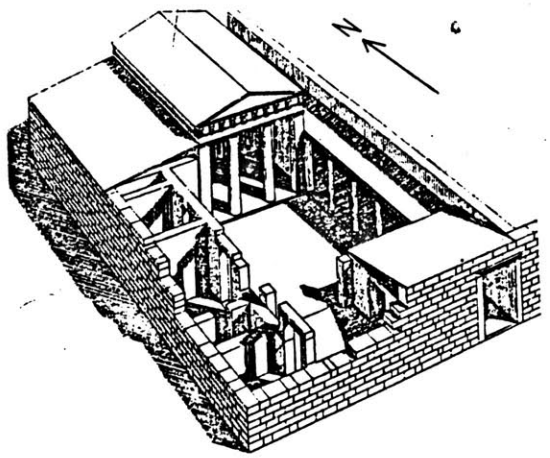
Greenhouses

The times of 1550 to 1850, also reported as the little ice ages (38 p. 42) seriously threatened agriculture and domestic food production in Northern Europe and brought about the use of glass technology for commercial greenhouses, "to assist nature by art" (38 p. 42) by times of a seemingly natural energy crises. Continued import of exotic plants from far countries later promoted with the beginning of the 17. century botanical gardens and domestic greenhouses for aristrocratic architecture. These greenhouses were appropriately designed as solar spaces. (19. ref.)

In 1817, John C. Loudon writes "Remarks on Hothouses" and compiled an approach of scientific design embodying the spirit of enthusiastic advances of a century of science. (19. p. 19) At this time, first full glass structures are technically feasible. (19. ill. 16, 21). Glass manufacturing has dialectically improved with the horticultural science and allows wider domestic application.

The fusion of first cast iron and glass technology was instrumental to the first curvelinear conservatory designed by W. & D. Bailey in 1827 (19. ill. 24). The Pantheon greenhouses which were attached to English mansions by 1830 as an important

Diogenes, greek philosopher (413 - 327 A.D.) was once visited by Alexander The Great, seeking for the philosopher's advice, and asking, whether he'd needed something - responded Diogenes promptly : "Yes, if thou might get out of my solar access! Sir!"



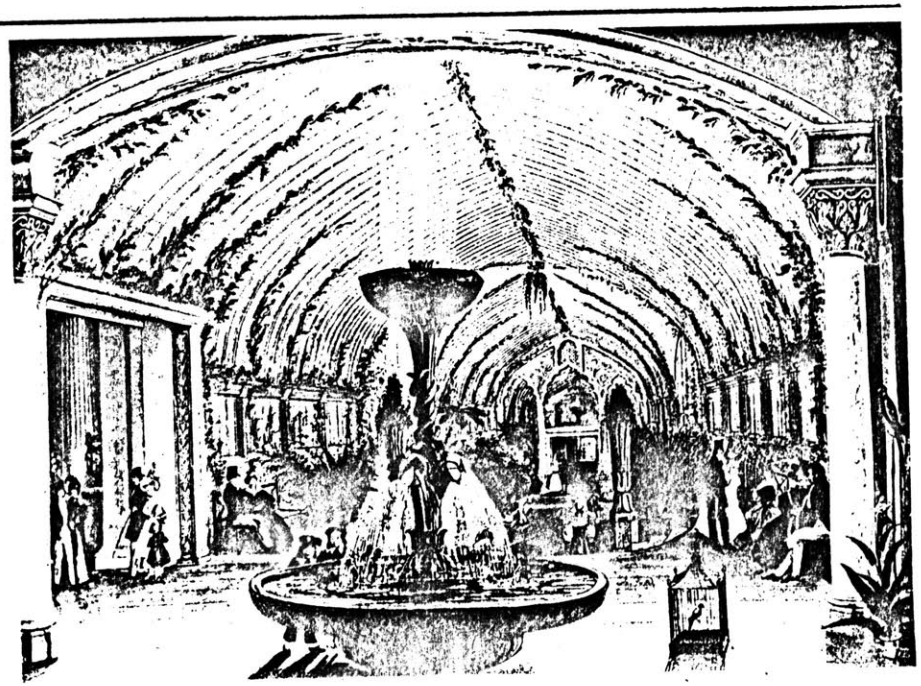
Reconstruction of a Classical Greek home, from excavations of the city of Priene by Theodore Wiegand. The rooms behind the portico faced south onto the courtyard.

plentiful sunlight, but capturing the heat from escape." Seneca was first to note the climate advances of the window pane, "to let sun in, admit light through....but keep snow, rain and cold out." (38 p. 19)

The concept of the house as a climate protective envelope, and the windows as its transitional element made Corbousier once argue that architecture can be described as the struggle for th window, therefore, the materials for the window as crucial tool to the evolution of design. Once glass manufacturing was at hand by the late middle ages, architecture advanced with the improvements of glass particularly in countries of northern climate. As the demand for the improved daylighting increased, illumination in the more and more complex architecture of palaces and cathedrals yielded glass quality of high transparency and reasonable size.

For a long period (ref.38 1700) the churches and the state were the only authorities to use glass, and besides only the rich could afford its casts, the application was fairly restricted to superior buildings, thus generating the myth of glass. Adolous Huxley describes the exploitation of glass for theatrical effects, conveying the glory of life in heaven beyond death with the huge glass walls of gothic cathedrals not without synicism, while the myth was enhanced by restricting glass from ordinary residential use. After sciences and the age of

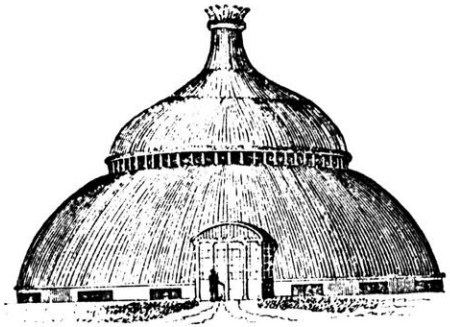
„The Burlington Arcade", 1815–1819



Hix (38) ill. 25

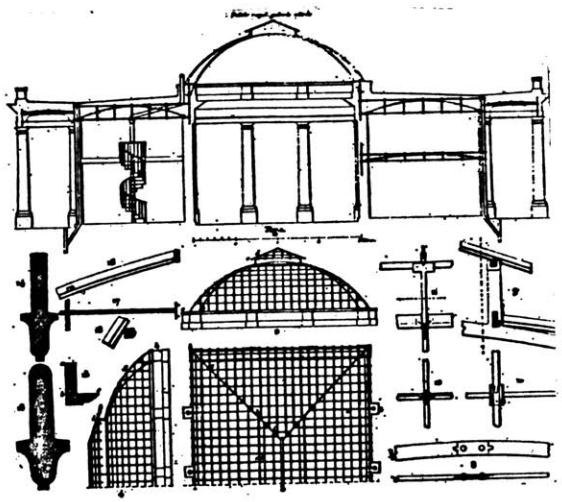
Die Arkaden in Letchworth.
(1923) der Architekten Benett und Bidwell

Bollerey (17) ill. 111, 112



Hix (38) ill. 24

Above: 'parlour's formal gloom'. Below: the delights that come from an attached conservatory (Humphry Repton).



182 Galerie d'Orléans.

architectural reflection of "an integral way of life." (19) Since heating of this fairly large structure was a severe problem during this time, the energy potential of the sunspace was quite consciously regarded. (38 p. 53)

Glass and the Wake of the Great Indoor

In 1829, Pierre Fontaine combined glass and iron frame for the first time in a large structure of the Galerie d'Orleans. (29 p. 285) Joseph Paxton's Crystal Palace brought standardization and prefabrication of glass to a fusion in a new concept of building. Glass and the perfection of iron mounting became available to a scale of large construction. Where glass was used mainly as climate protection in the beginning, now daylight and the aesthetics of the material itself became the objective.

With the industrial growth of the cities and related public transportation, and area of commercial and public glass roofings, arcades and galerias emerged and spread the notion of habitable indoors over Europe. The French Revolution of 1789 had liberated the bourgeoisie, academic life and the performing arts, generating a new public urban life and a free cultural scene with a prime demand for public space in the dense urban environment of Paris.

Since streets back then were merely gutters of traffic and garbage, courtyards and building throughways were preferred meeting retreats and the only secured environments to operate

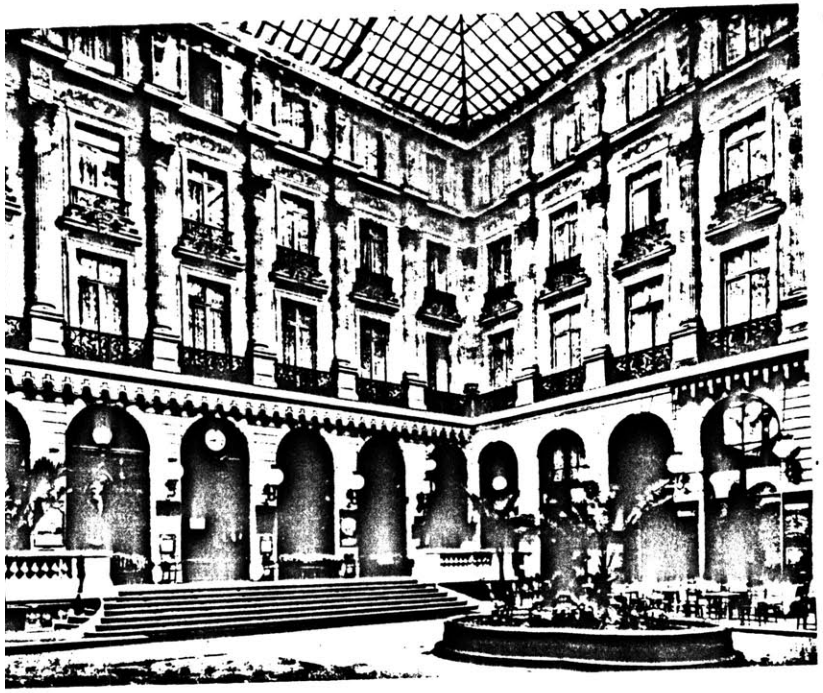
shops, cafes and restaurants. Fouriere's concern about getting home safely and clean after evening events derives from that. (See Geist 29, p. 63 & p. 90). Arcades and atria were logical architectural responses when building technology provided suitable glass roofings to generate weatherprotected urban interiors as vital focuses of a new public cultural life.

Thus, urban public vitality interfacing with urban density generated the Parisian "passage," such as the "Galerie Vitree" from 1792, also known as the Galerie de Bois (the wood galery) which became a focal place for business, leisure, performance, politics and intellecturals as a communication center. Its "public" role within the revolution 1789 is explicitly described by H. Balzac (29., p. 259). From 1814 on, the same gallery known as "Palais Royale" continues this tradition as a mix use center of hotels, casinos, cafes, offices, merchant counters, saloons and shops. Attracting the social life of Paris for over 60 years (29 p258) it is renown as the prototype of glass enclosed indoors.

In the year 1800, the first explicit "commercial" Passage des Panorama" is noted as a merchandising luxury showroom, a mall of all attractions, shops and restaurants. From there, the generic passage design spreads over Europe, England and the U.S. There, most renown, the Cleveland Arcade of 1890 and the Providence Arcade of 1828 are still unchanged in use.

The 19th century was the birth and evolution of the "passage" as

the following listing shows (Geist, 29., p. 95).

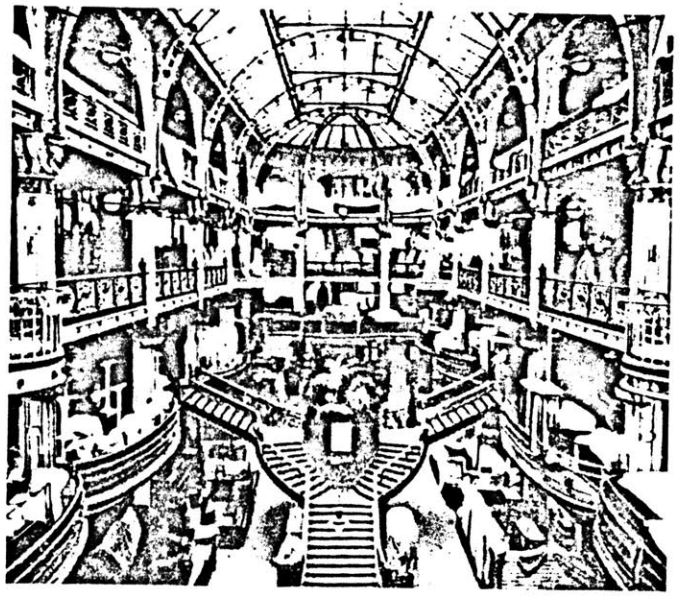


The Palais Royale Hotel itself (29, Geist p. 175, 176) can be held as the historical prototpye of today's atrium concept. Unfortunately, there is only a non reproducable interior view print available (picture), but the Hotel de le Paix gives a congruent image. For the first time, there was a conventional interior courtyard covered with a steel truss glazing construction as the hotels lobby. The same concept, however, with less commerical success was executed at the Galerie Colbert by J. Billaud 1828 (29. p.277) The "retrofit" was also attached to the Ecole de Beaux Arts and other public buildings such as Henri Labrouste's notable Bibliotheque Nationale in Paris. Glass covers and large scale glass vaults became integral parts of railway-stations, exhibition buildings and the emerging great department stores.

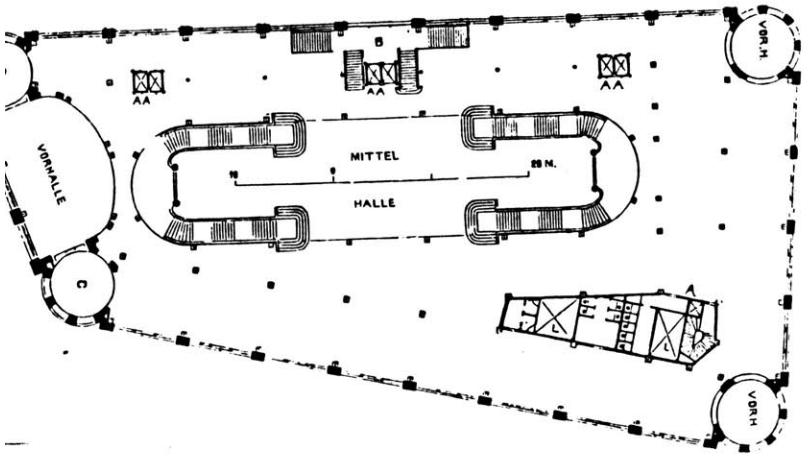
see also : Berlin und Seine Bauten
Bd VllA. 1978

Julius Posener : Berlin im Aufbruch
zu einer neuen Architektur
Prestelverlag 1979

The great department stores of Europe, providing exotic, noble interiors in Paris, Bruxells and Berlin developed the glass covered atrium beyond the basic functional and daylighting aspects to a level of interior art. Initially intended as "lightcourts" (Posener p. 456), these atriums developed into powerful interiors of decoration and spatial stimulating circulation: cascades of stairs and landings created a procession of the building's vitality. As imagery of the store, these spaces become direction and perspective through the building, and finally a sculptiral



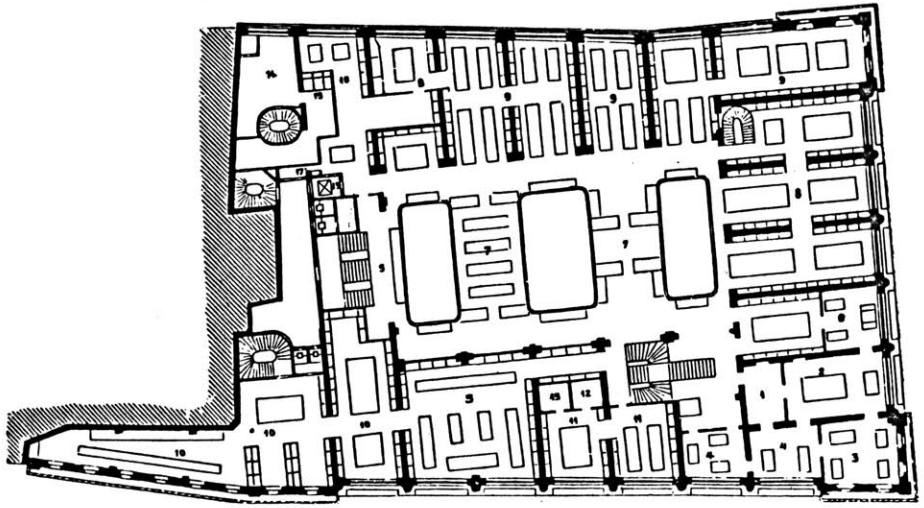
12 und 13 Paul Sédille. Magasins du Printemps. Paris. Lichthof. Grundriß



space of its own. The features of the glasscover acquiesed to the decorative excesses. The climate conscious space becomes an artificial space - with the "dust glass ceiling" as second glass layer for thermal protection: a predecessor of the sealed curtain wall age in architecture.

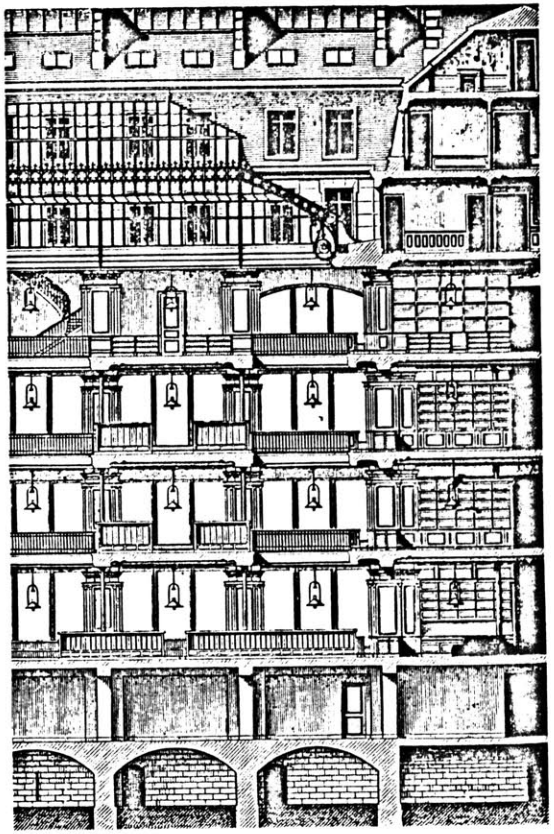
The feature of the glass sky and the daylighting were abused and slowly converted into an exercise in ornamental expressionism and spatial pomp. Notable examples are the Bon Marche, Paris 1876 by Eiffel, The Magasin de la belle Jardiniere by Henri Blondel in 1863, in Berlin Messels Grosser Lichthof, Warenhaus Wertheim 1896 (Posener p.460), architect Frantz's Jourdain Magasin de la Samaritaine, Paris 1905 and the Magazine Au Printemps by Paul Seille, ,. As ceilings and walls became a holistic design, the glazing became a glass tapistry. With the vanishing of the positive courtyard approach towards design, this movement died out a little after the turn of the century.

The Chicago School picked up the innovative use of glass with the skyscraper design, where the "Rookery" -type courtyard glass cover remains the last remnance of the greenhouse era. (Bruham & Root, Chicago 1886 and South Michigan Ave 225, A 23). Of the subsequent decades, F.L. Wright's Larkin Building in Buffalo, N.Y., remained the last notable design which developed the concept of organization around courtyards.

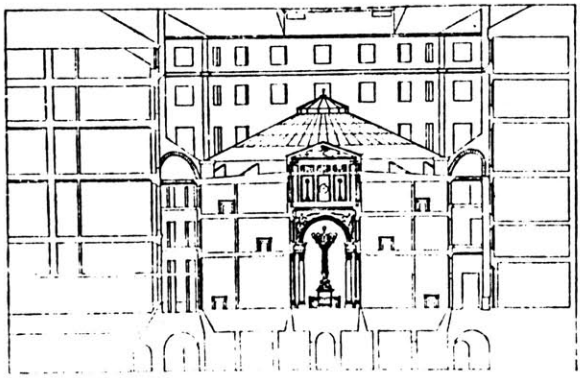


Henri Blondel. Magasins de la Belle-Jardinière. Paris. 1863.
Grundriß. Normalgeschoß

Julius Posener : Berlin auf dem Wege zu einer neuen Architektur
p. 457



Henri Blondel. Magasins de la Belle Jardinière. Paris. Schnitt

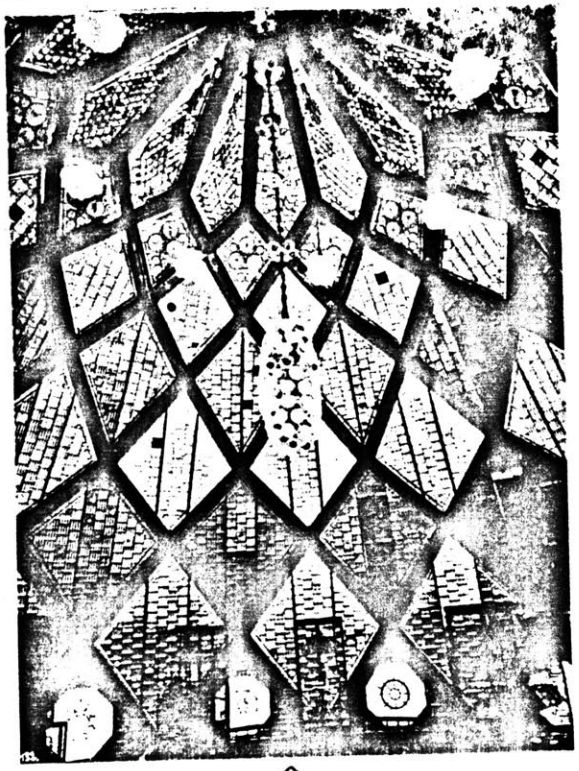


176 Galerie Colbert. Querschnitt

175 Galerie Colbert. Längsschnitt

J. Geist (29) p. 277

PAUL SCHEERBART AND THE MODERNE MOVEMENT



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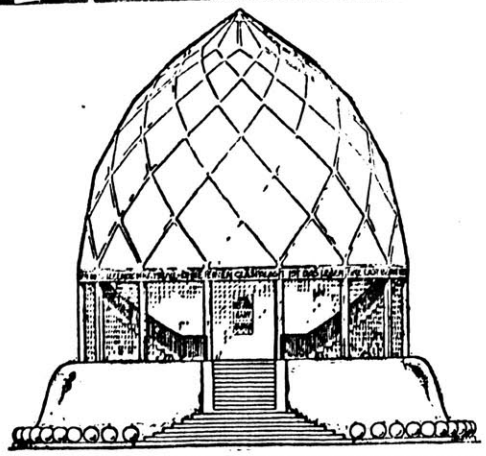
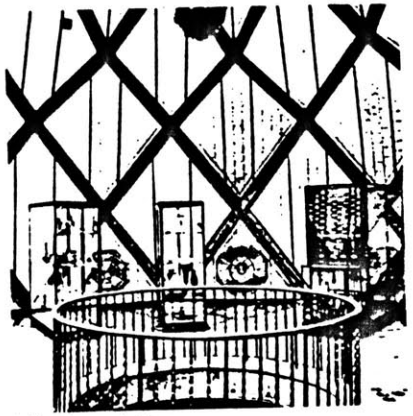


2

At this time of a degrading of the great glass indoors, the writing of the German utopian poet Paul Scheerbart (1863-1915) was instrumental in passing the ideas and vision of glass in architecture to a new generation. As early as 1990, he studied the phenomenon of the window as a device of ventilation, lighting view; prophetically and astonishingly proposing the sealed building,...."where windows no longer will be opened to vent, where fans will substitute all window-likes." (71. p.144). It is doubtful which directions B. Taut, W. Behrens and W. Gropius and the entire Bauhaus itself would have pursued without Scheerbart's poetry. At a point where glass design lost its myth and glory, and became an ordinary window material, it was to him a future culture of the pureness of glass crystal as the cheerful liberation of men from dirt and darkness of a prior "backsteinkultur." He envisioned double glass walls (Thermopane, 1937) and palaces totally built of glass. He discussed the sensuality of transparency, the invisible transition between indoors and outdoors, and raved about delightful sunspace, (2. p. 60) and the new aesthetics of glass as a new milieu of sun and light which would elevate society and culture.

His writing is the source of the Berlin Fantasists and their "Fruhlicht" publications, Mies van der Rohe's entry to the Friedrichstrasse Competition is an exact rendition of Scheerbart's early predictions of glass enclosed space as men's



5 Kuppelraum Interieur

3

4

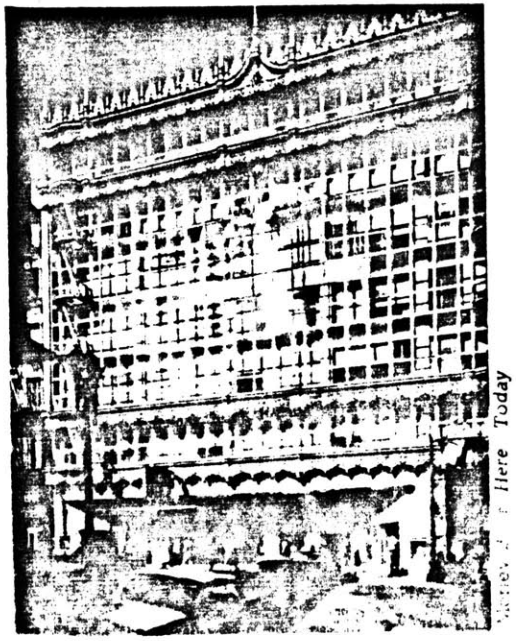
1-4, B. Taut, Werkbundpavilion Koln, 1914

ultimate environment. Bruno Taut carried on the illuminating fiction of Scheerbart's architecture, as the Werkbund Exhibition Pavilion in Cologne (1914) became the reality incarnate with an additional aspect of a new aesthetic of daylight. Under this premise, a new, modern architecture was unleashed and also legitimatized to provide unknown, exciting, environments as statement of men's technological power over the forces of nature.

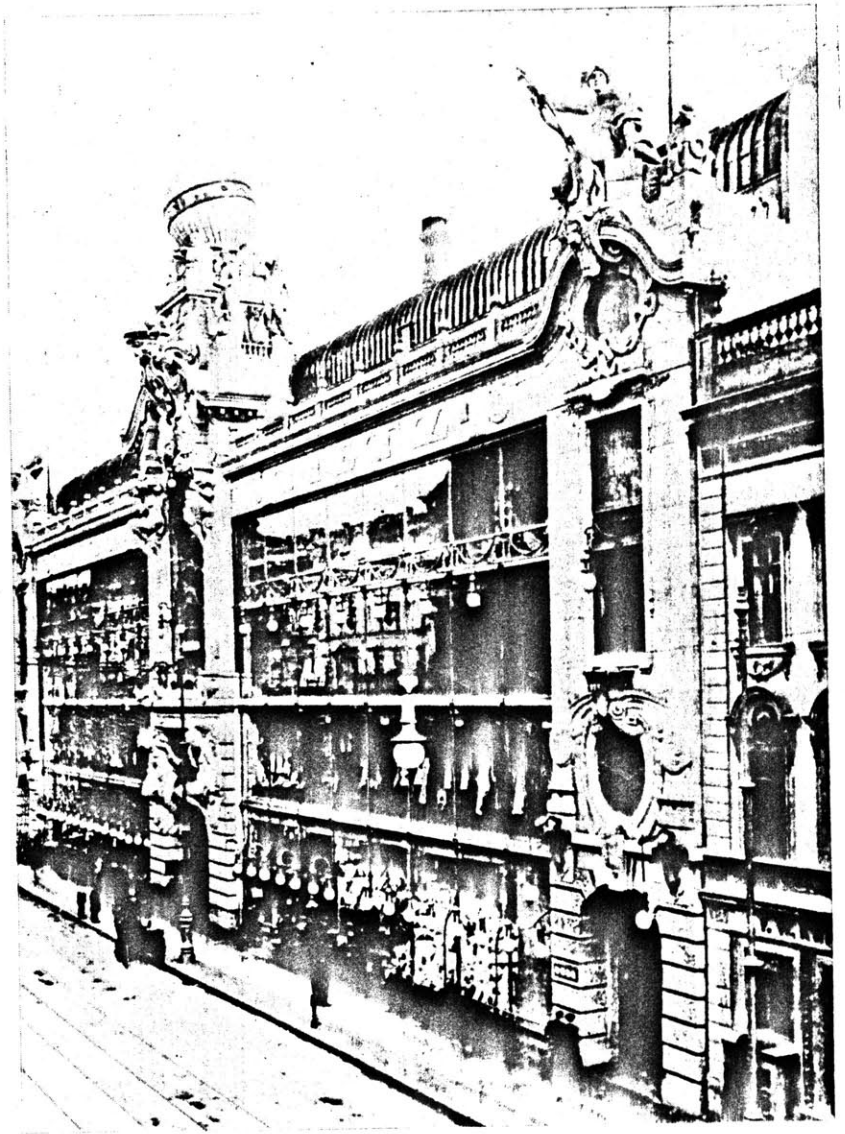
Reinforced concrete and skeleton steel constructions took command with a new movement in architecture, noted as Neue Sachlichkeit, and spread from Europe to introduce the non-bearing facade by the turn of the century. Glazing technology discovered and promoted the fascade with a new glass aesthetic for improved daylgiht and visual qualities. This new technology was instrumental in the evolution of the new, modern movement, where glazing replaced decoration at the facade, and became an outgrowth of geometry itself. Outstanding examples are the Hallidie Building in San Francisco (Willis Polk 1917) and the Warenhaus Tietz, Berlin (Adolf Messel, 1900), the latter perfectly demonstrating the new aesthetics of a major daylight facade, and the (decorative decay) of interior light courts.

These two buildings succinctly marked the turning point, where an aesthetic fascade of excessive glass was perceived as providing the healthy benefit of daylight to the building, not yet considering the thermal problems involved which was addressed later by mechanical conditioning and excessive heating with

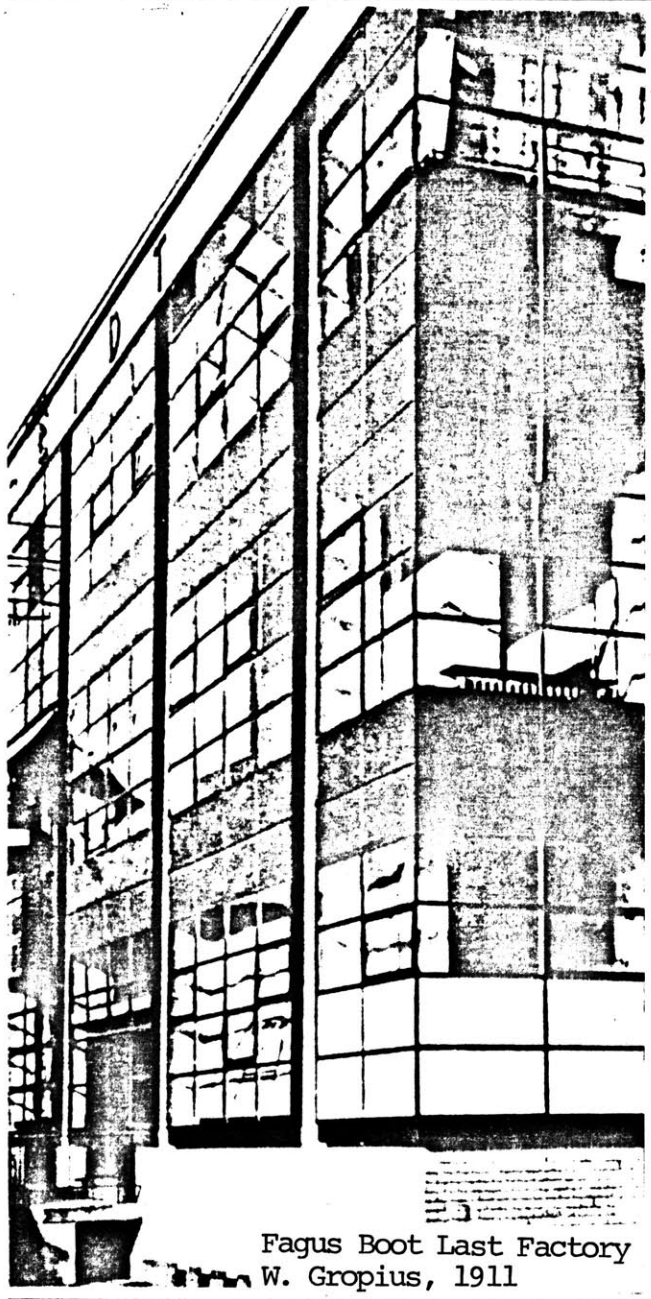
With the skin and skeleton technique, the facade became non-bearing feature to the buildings, and an object of aesthetical play with glass and iron griders - excessive glass-facades with the anticipation of maximum and healthy daillight to the interior. The interior light-well became obsolete.



Hallidie Building, Willis Polk & Co
13o Sutter St., San Francisco 1917



Kaufhaus Tietz, Arch. A. Messel
Berlin 19oo



Fagus Boot Last Factory
W. Gropius, 1911

cheap oil. The International Style took on to reduce urban space confined to a purely aesthetical assembly of sculptural buildings, and to likewise convert the fascade to a pure aesthetic skin irrespective of climate. The environmental properties of glass were perverted through the mechanization of buildings and disregarded natural climate conditions.

Under this premise, a new modern Architecture was unrestricted in developing formerly unknown sealed environments as man's statement of technology over nature. Formerly conscious design for climate became obsolete. Subsequently, architects forgot passive natural building conditioning. With this, large glass roofings remained only in the design of factories and railway stations. Glass atria were replaced by the advent of the glass fascade, from San Francisco to Berlin, with the Fagus Suhuleistenfabrik by W. Gropius 1911 as an outstanding example. As W. Pehnt, architectural historian puts it, this new design approach drew its only reputation merely from the unprecedented spectacular and excessive use of glass. (71. p. 197)

The renown historical examples of passively operated glass atria succumbed finally under the dissolution of the urban space and the related abuse of the approach, made possible by the means of non-polluting, increasingly cheaper and efficient lighting and mechanical air handling in massive building bulks. Electric lighting and air conditioning in turn became self perpetuating

and incarnation were associated with progress itself.

Richard Stein : Architecture and Energy (76. p 5o) writes :

With the confidence in capability of mechanical systems to overcome any aneven or unsatisfactory internal conditions caused by too much sun, special programmatic needs, too much heat loss, or inadequate light, architects considered their buuldings to be liberated form the local and specific demands that had shapened architectural design in the past. This permitted a formality to enter architecture ...it became an abstraction.... of a building frame, and a suggestion of gossamer lightness and transparency by the use of glass.

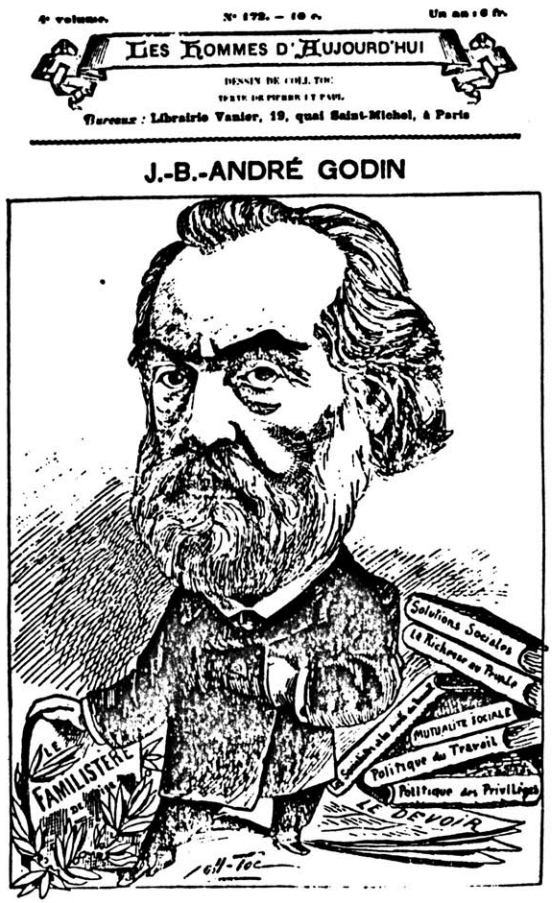
Once fascades were established primarily as an aesthetic feature achieved through the indiscriminate use of a curtain wall, it was intuitively assumed that daylight would optimally be introduced in the building. Unfortunately, this assumption led to neglect on the part of architects in the conscious consideration of natural light in design and neglect of thermal loads of the fascade at relative to winter and summer sun incident.

With "perfect" mechanization of buildings, the solar conscious application of glazing was disregarded as well.Glass was reduced to an ordinary window and major fascade material to seal the interior against outdoor climates rather than taking advantage of natural forces by being properly oriented towards the sun.

With this notion, the knowledge on atria and arcades as energy conscious design was distorted. The myth of mechanization and active control of buildings took hold, overruling common sense and historical experience - in practice as well as in teaching.

GLASS, UTOPIA, AND THE FAMILISTERE AT GUISE

The industrial liberation and its technical achievements threw feudalism and the social tissue into a turmoil, leading to new structures of political power and social concepts, that in turn demanded new concepts of urban planning and housing provisions



J.-B.-ANDRÉ GODIN

FRIEDRICH ENGELS

La Colonie de Guise a été érigée par un fouriériste, non en vue d'une affaire de spéculation, mais dans un but d'expérience socialiste.

In La Question du Logement, 1887.

as the rural population poured into the cities for factory work places. From this and from the production conditions, housing became a rentable asset and thus an industrial commodity. Urban worker's housing turned into a new "feudal" exploitation. Inhumane housing conditions raised the concerns of socialists, hygienists and utopians, as well.

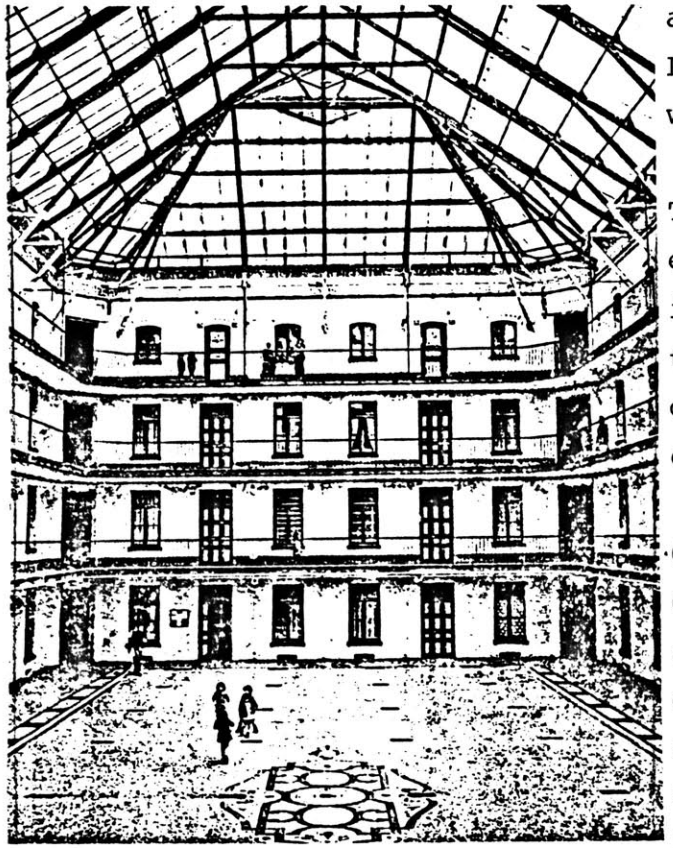
Owen and Saint Simon (29. p.63) called for expropriation of rural land to the poor and thus founded tne garden housing movement of socialistic ideologies to preserve morality and to provide humanity with detached family housing, none-the-less disregarding the issue of rural solitude and abusing urban cultural interaction. Conversely, Charles Fourier alone sought an urban utopia in housing, and interpreted the feudal palace as "worker's place" of articulate physical community design and urban density as a living unit for 2000 people. He proposed the "Phalanstere" as a self contained satellite community of a communal palace design with glass covered hallways and inner courtyards with respect to communal life styles. He proposed group dwellings served by a public interactive circulation for social intercourse and weather protection for social activities. (29. p.63) Fourier cites the model of the "Palais Royal" (17) and applied glass construction as the embodiment of social progress. Like the utopian Phanalstere, the Palais Royal, as a mixed use structure consisting of a hotel, casinos, cafes, offices, saloons, and boutiques became the ancestor of arcades with glass enclosures, and accommodated the social life of Paris over a period of sixty years

(29. p.258). Especially the glass covered hotel court (1829,17. P. 160) can be held as the paradigm for Godin's Familistere glass courts. Under the visions of emerging socialist thought, B. Godin implemented these ideas with a historically unique prototype of a community courtyard housing complex with a glass enclosed interior.

The quality of this successfully realized utopia and its unique design implications bear substantial impact on this study. This project is the unique fusion of a socio-political program to oppose existing economic conditions with an urban-community idea of education and interaction, given shape with a distinctly innovative built form.

Fascinated by Fouiere's utopia, Godin, the universalist, politician, entrepreneur, who felt apprehension against the repressive forces of the rising industrial age, developed this scheme to house his factory workers in a coop, as an enclosed monastic community. To improve the social level and humanistic ideals of his workers, Godin treated housing as a social interlocking factor in a broader political problem.

As a non-architect, his holistic programming of an economical, physical and educational structure achieved a clear success beyond all other historical utopians from Eugen Sue to Owen to Howard. His model bore out - as programmed for over 80 years; physically,



La Familistere de Guise
Jean Baptiste Godin 1867

as well as addressing issues of communal conditions of housing. Life in this project achieved a consistency and physical parity which is noteworthy over other workers' housing projects.

The overriding feature to the project's design is the glass enclosed atrium. Godin's rational for this design is of primary interest. How did he actually specify this approach? What are the reasons for this urban dimension in that rural site - actually opposing the utopia of contemporarians? Were the central glass-courts essential to the projects success?

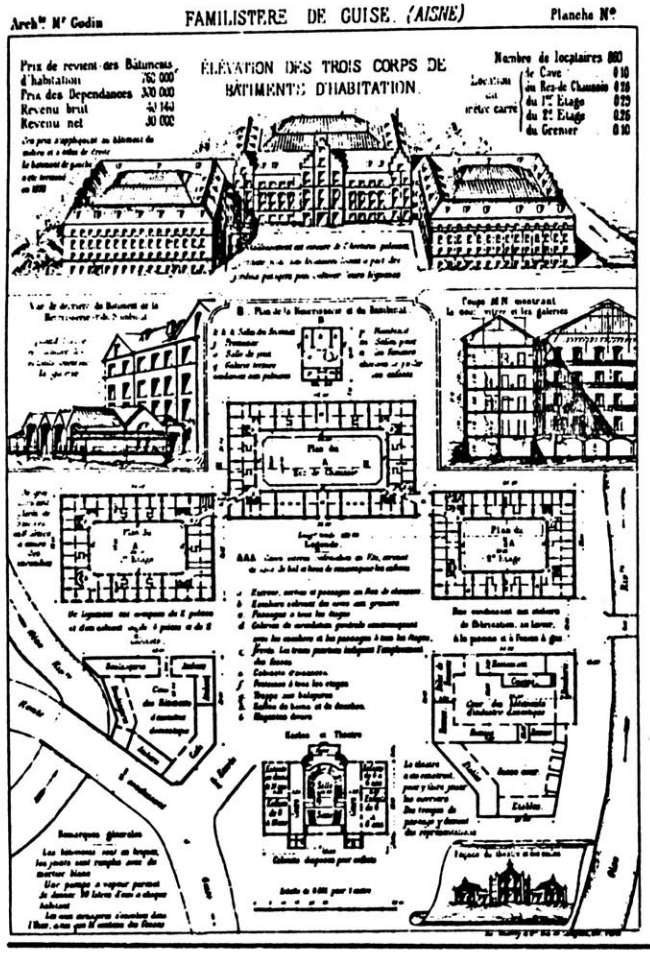
Opposing the tenets of the "rural design" movement of this time, Godin referred to the pattern of a palace and sited the building against the rural landscape. He was "concerned about the wrecks of social ideas" (24, P. 45) and social worker's housing elsewhere and searched for the true immutable architectural form. He adopted Fourier's ideals partially and intentionally redesigned Fourier's physical lay-out, stressing its pragmatic aspects like the communal weather protection, buildings of the interconnection and the urban density of social-cultural interaction.

Following the image of a palace as aesthetic expression "to bring about equality of wealth" (24.p46), he reduced the complexity of form of the Phanastere to a simple "bipolarity of space" (24p.46). He introduced the courtyard as a meeting palce, and as a principle of circulation to serve separate family dwellings around the

common space.

He interpreted the courtyard initially as a symbol of progress in the utilization of air, space and light, since intelligence (according to his educational lecture program) was proportional to the way light illuminates the dwelling (Godin 501). In the sense of progress, he presumably applied the theories of the early hygienists with sanitation features, but also to electric lighting, to ventilation and to central heating, similarly the glass roofing of the courts could be perceived as the technologically progressive feature to provide human comfort against the threats of northern climate. Significantly, Godin attached "light, air and space" to the enclosed environment. The underlying rational was that he opened the "monastery" circulation to create a space to vent and to light the dwellings more effectively, explicitly citing the draught system (24.p. 9) as a draft through the interior by a stack effect.

Godin p. 5ol, see (24) literature list on Godin's own writings



Secondly, he conceived this interior space as "moralizing" focus (24.p.49) in the educational spirit as the goals of the familistere. Beyond the spatial and social interaction, the climate space was to serve as a lecture hall, performance space, dining room, playground - all in all as a means of surveillance and community participations " - "the social progress of the masses, the improvement of the worker mental and intellectual situation.... subordinated to the progress of the social provisions of architecture." (24.p.43)

28. Courtyard of the central pavilion.

The inside courtyard is the geometrical site of the social life of the members of the "familistère". The weekly lectures on morality and the participation system, the reading-out of announcements, the Sunday dances and the annual workers' and children's festivals all take place there.
A perfect example of the implementation of the "hygienist" theories, its technical arrangements summarise all their imperatives: the glass-roof dispenses light, ventilation is provided by a circuit based on the draught principle, while salubrity is guaranteed by the rubbish-chutes, the drinking fountains and sanitation blocks at the corners of each storey.

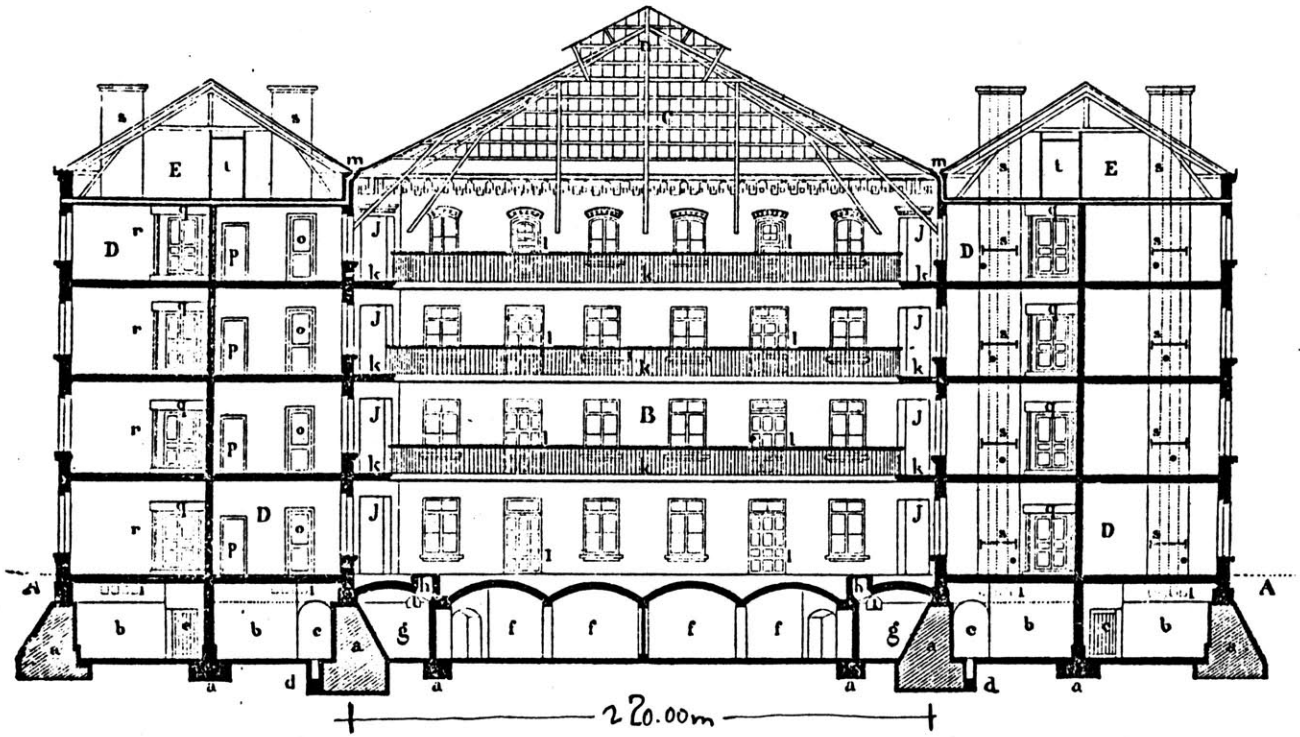
(24) p.8o

Under this notion, the atrium is a means of defining a communal world, where every member is known, and where the spatial lay-out provides identification and relation among tne community. Godin's atrium - still habitable today after 110 years - is truly conducive to thsi spirit of the courtyard approach, whereas Fourier's covered hallway concept hardly would have provided this spatial articulation.

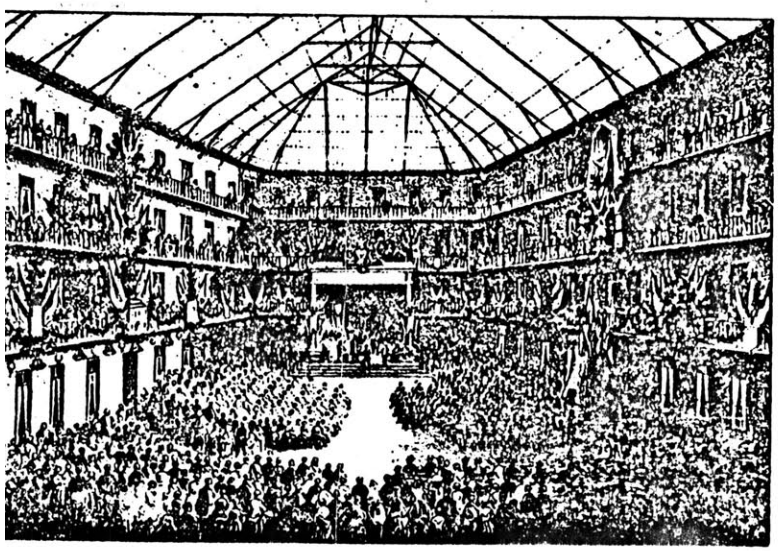
Dimensions, proportions of the atrium, transparency of the circulation balconies, the pavement finish of the ground floor, the service and lavatory units of communal use, the linking circulation, the introspective view of the dwellings - all these details match appropriately the program objectives as the occupancy over the decades attest. Visual quality and functional adaptiveness made the place a desirable environment, even by today's standards.

The interior design is simple, very rigid and consistent in its use of details. There is hardly any opulence or grand architectural gesture. The design has no landscaping, the fascade is repetitive, stark, but a pure and simple design. As a modern design, the building lacks articulations on the balconies, alcoves for siting, spatially effective stairs in the court itself. Also, the atrium is one scale in itself that needs some intermediate definitions of detail scale.

In terms of dimensions, it is most likely, that the width of the space was defined by the glass roof technology available at this time. In this respect, the dimensions refer very accurately to the construction of the Gare St. Lazare (1850,73, p.159). The bearing steel construction on the other hand uses the conventional clay tile roof construction of the adjacent building.



Glass As Architecture Media



. First workers' festival in the central courtyard of the "familistère" in 1857.

Each year a labour festival and a children's festival are held in the central courtyard, setting the seal on the efforts of workers and pupils.
These moralising celebrations are intended to reinforce, among the members of the "familistère", the feeling of belonging to a community and an élite.

For J. B. Godin (1817-1888) as a social utopian, the glass atrium linked the spatial congruence to communal spirit and social progress. The glazed courts of his "worker's palaces" at Guise were a festive hall of his familistere design

For P. Scheerbart (1863-1915) as a visionary poet who quite romantically but astoundingly concise pictured a future glass architecture (Glassarch). For him, the glass pavilion was the palace for the liberation of mankind from the misery and the darkness of the stuffyness of the "brickculture" buildings. To him glass was the image of enlightment and a new emerging culture - a culture through the crystal pureness of glass.

In 1934, the architects Keck & Keck of Chicago seek the future with "the house for Tomorrow" with a all glass house of high tech design as image of pureness and cleaniness of details and firbishes of a new industrial age of full mechanization. However, the abandonne mechanization design, as they rediscover the delight and solar termal potential of the glass envelope. Delighted by pure glass architecture, they take on to pioneer passive solar design.

In 1974, B. Myers, practicing architect in Toronto cites the glass covered indoor space, the glass arcade as the flowing continuous spatial relation between building and its users, and claims that the arcade is the generic building type for the 20th century, as a spatial paradign of climate conscious architecture of the future for the northern snowbelt.

All these visions incorporate a singular fascination beyond the atrium concept itself: the glass space as a light flooded, total experience of spiritual comfort and physical sensation with

total transparency to the outdoor elements. The historic myth of glass still touches transcendent spirituality in each of us, as we look up the glass panes that turn interiors into glass catherdrals; as a sensual place, as decorative formal space, as imagery of preciousness and wealth and aristocratic comfort.

The medium glass obviously with its pale light and reflections engages our attention, exagerates the perception of outdoors and the blue sky, while the sunrays behind the glass radiate comfortable warmth. Even at higher air temperatures, people obviously seek this warmth in a natural way, and enjoy the contrasts and "summer" sensation.

Historical associations with the crystal smoothness of the glass surface, the fragileness and the myth of glass manufacturing made glass a very special material to build with. This historic myth still lives on in our perception, attached with the myth of glory, wealth and superiority, as this was also well perceived by the modern movements decision to employ glass as major design element.

Likewise, the paradox of transparent glass being "there but not there" appealed to builders of all times. The precision and pureness of the material, light-weight of the construction, and intellectual elegance of geometry merged into the expression of ornament free design in the modern movement. Conciseness and harmony of contruction already mystified the light flooded spaces of the noted glass designs of the last century; e.g. the

English conservatories, the museums, railway stations and market halls of the big cities.

The Sunspace as Distinct Spatial Display

A. L. Harney, freelance writer in Washington writes: The experience to use an atrium gives a remembrance, that the building is architecture" (35.) not merely a functional object of built floor area. For John Russell (67.) arcades are "living rooms" of the big cities, "like a home, but better than home: "Bliss, in a word".

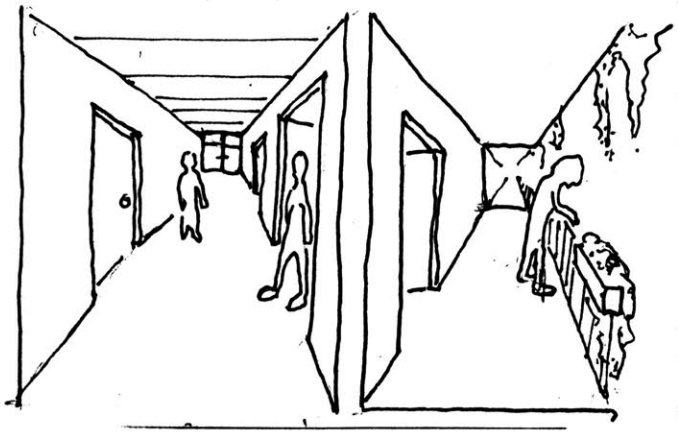
The German journal "spiegel" cites the Galleria Vittorio Emanuel as the real living room of Milan (72.) where each milan citizen seems to be obliged to stroll at least once a week, as a kind of secular counter piece of a cathedral.

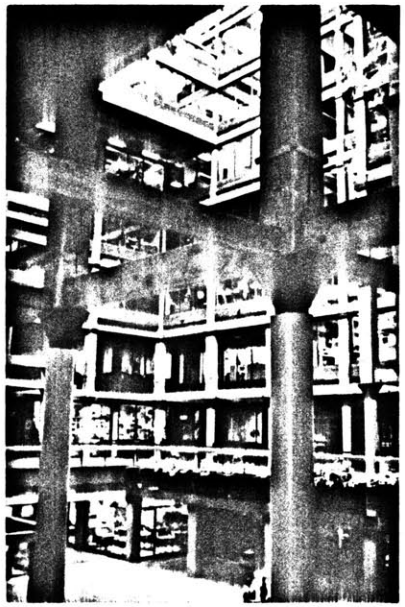
While F. L. Wright cites on the Larkin Office Building; "...the daylight flooded dourt, the vitality of the central space, the atmosphere of assembled community create the interior as a airy whole of a spatial thrill" (35).

A real estate developer from Huston says: "The Atrium is a runner, cause it got simply sex appeal!".

Clearly, the atrium is expression of a trend towards an introspective pattern of buildings, towards a new interior vitality of our architecture responsive to communicative use of buildings and spatial sensation as a biological need. And above that responsive to the trend of energy efficient design, that sees more plain geometric building bulks with highly closed periemters that will reduce exterior expression.

Besides, our daily experience can not be singlely reduced to the outer city space; we search for identification not only with our routine street or the city as a whole environment, but with





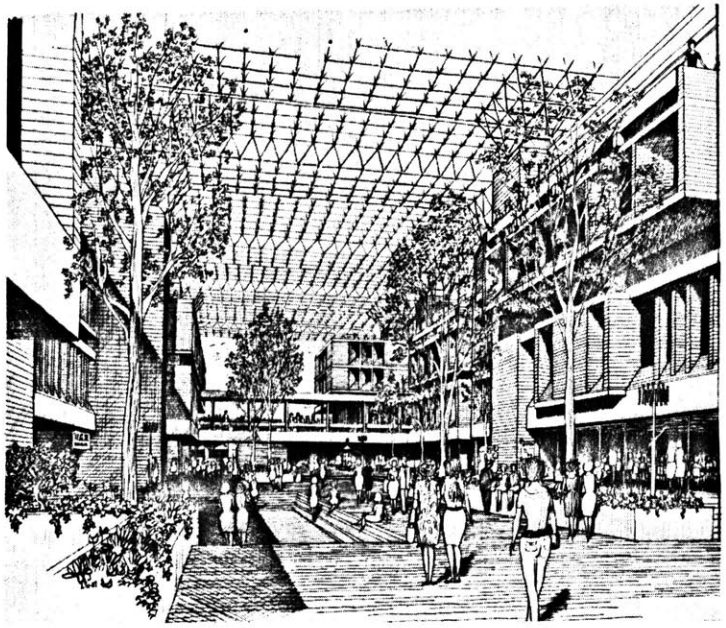
the building that we live an work in. This adaptive identification is depending on comfortable use and match of biological needs in that building - and this in turn is closely defined with the interior livability of a building. For this, the atrium provides a mediating focus, a central place of recognition of the building in terms of user adoption of space.

The atrium sets a contrast into a building, sets a liberation of spatial generousity against the confinement of shallow floor area. Spaceness counters the limitness of the simple floor heights and make the circulation through the building a dimensionful sensation opposed to the confinement with boring view of straight corridors of dimish and sinister interior. The spatial width of the atrium sets forth visual richness and choice of movement to enhance the experience with the building.

Only from this interior sight, the interior, the plasticity, the dimensions and the organization become readable. By the atrium as the hollow core of the building three dimensionality becomes vital, as it would be impossible from the street view.

And only rarely a building can be read from all its sides at one instance, or the user, the atrium is thus the endoscopy of the built form, the totality of built form experience, the flipp-side fassade. This in turn can be used now as a major design tool to provide a perceptable building for the user need - nearly comparable to the buildings model to the architects design process.

The introverted flip-side fassade also reflects the signs of our upcomming energy future which foremost sees flat, geometric defined simple building bulks. This "energy form" has a highly closed fassade, where rather the overall geometric form than visual details convey the image of the building. Thus, expression, differenciation, yes "fassade" in its generic meaning comes to happen in the interior. Buildings become simple "cubes" with interior fassades. As the fassades turn to be "energy-envelopes" the stomach of the built form becomes the major design element, as a great portion of critics to the cundius low energy for the future - competition shows ( ).

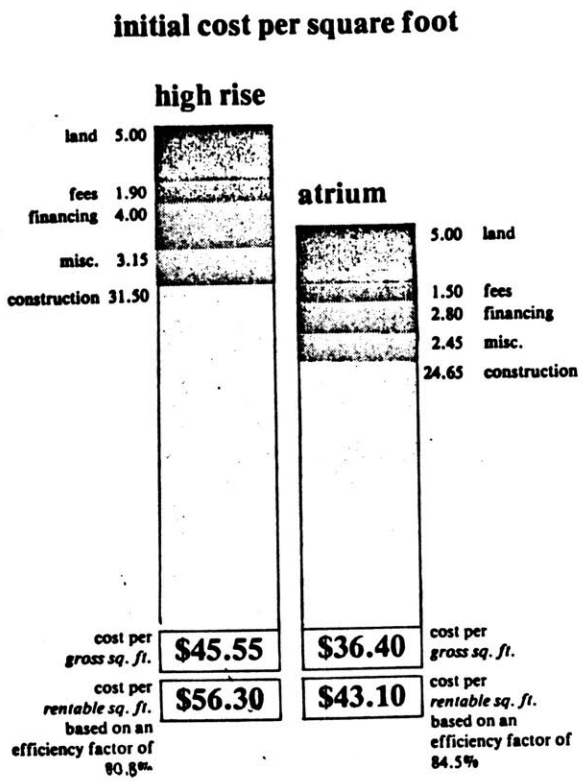


Skylit street is the heart of Lesley College, just across the street from Harvard in Cambridge, Mass. A pair of buildings two blocks long will form an interior student street that will eventually be covered with a skylight. The buildings, consisting of 60-ft modules, contain service functions below grade, student services at ground level, and classrooms and dormitories above. First phase includes library, classrooms, lecture hall, faculty and administration offices, and dorms for 155 women students. Architects for master plan and phase one are Smith/Barker/Hanssen.

With this, the atrium gives indoor protection to site facilities like shops, restaurants, recreational spaces, etc. In course of the lofe cycle of the building, the atrium provides spare space to variable demand for these spaces, which at any time can be easily plugged in with light, not weatherseal required elements. With this integral adapatability, the atrium building suits well to mix use structures, where the atrium or arcade becomes the quality of a passage, of a vital shopping mall as a path through the building.

In this sense, the urban sunspace building can become a "non-Building" (D. Oleson - B. Myers) with the function of a "link-object" or a bridge within a cities pedestrian network on a urban planning level (HUB, Hambrurg Arcade Network plan Spiegel, 8/81).

The Sunspace as a Marketable Feature



Beyond the fact of being an accessable, tempered indoor recreational shopping or garden space, the atrium is highly praised for it's distinct imagery as a notable address - for office tenants as well as for condominum living. The indoor provides additional interior amenities and convey a flair of luxury. The address there is distinct, but not necessarily more expansive. The view to an atrium is highly sellable at even higher rents. At the atria north surprisingly, inward offices rented first, while perimeter locations are still vacant. Better tempering of the inner core and "controlled" landscape are appreciated, since they can be more homey, with operable windows and plants (see Butler Square) of visual delight.

On the quanitative side, the atrium building yield straight $ savings to the developer. Citing the atrium study by Bob Tamblyn (81) 1976, as a comparison of an critirum over a high-rise tower office complex of same soft and program, on same site conditions, concludes promising facts for the atrium approach.

	2 Story High Rise	4 Story Atrium
- construction cost	45.55 $/SQFT	36.40 $/SQFT
- construction time		3 months earlier finished
- thereof capital costs (deleted)	32,900,000	26,135.00
- thereof net present value	4,020,000	12,635,000

- return of investments	12%	48%

Which would allow a reduced rent due to reduced cpaital cost by 2.00$/sqft. Which means in fact even faster payback.

- elevator systems	2,100,000	1,000,000
- elevator maintainance	80,000	35,000
- airconditiong due to distribution devices		1.07$/sqft less
- usable floor area	81%	85%
- energy efficiency projected	(method of calculations unknown, but, according to ASHRAE standards)	

The energy savings that result from the atrium design are also interesting.

Equivalent kWh savings/sq. ft./yr. for Atrium Design (derived from Meriwether and Five Degree Band simultations)

Fabric Heating and Cooling	**1.45**
Infiltration	**0.50**
Fanning	**0.05**
	2.00

In 1978, this energy will be worth an average cost of 3 cents per equivalent kilowatt hour, over 700,000, and that means $42,000 per year. For a 30 year life cycle with 10% present day value, and 12% escalation, an average taken from NRC publications, these savings have a present worth of $1,250,000.00.

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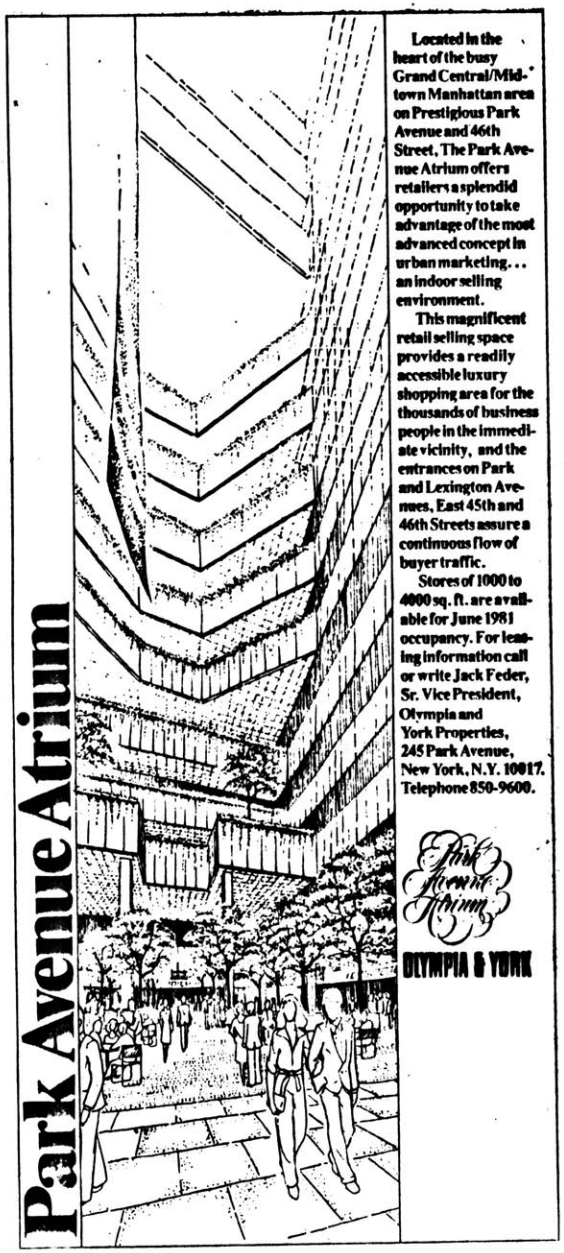
Besides this, a developer can take advantage of additional interior space which is not accounted as floor area, which comes with the built containment, but which is highly rentable with shops, restaurants on basises higher than the office space possibly. Likewise, in terms of "servicing" the building with facilities, including restrooms, lobby, reception, etc., circulation overall, the atrium design is space saving and provides unobstructed floor areas for multifold segmentation which in turn is profitable for spec office development. Adaptability for changes especially with tenant offices, expansions can be easily manager by three dimensional connector through the atrium space bridges .

In special cases, impressive savings from unique construction potential is cited as with the Hennepin county buildings (M1) where the two highrise slabs were interconnected with a steel frame to ease foundation moments . The CHOP (P2) claims savings of about 100.00 $ from using the atrium as a return/discharge plenum to substitute duct work.

The Edmonton Health Science Center (E4) surely yields high savings from employing the sunspaces to carry huge ductwork which otherwise would use up costly intersituational space, and which in turn ishighly adaptive to changes and maintance.



Of course there are margins to consider, above which the sunspace approach starts to become economically feasible. In office projects an minimum size of $60.000^2 m^2$, in residential structures a minimum of 40 apartments is anticipated to built enough bulk around a suitable size of atrium. There is no scientific evaluation on these numbers, but interviews point this direction form practice experience. Above this margin, the atrium would actually start to yield construction savings. (Jo Rohn, Rustland Corp., Toronto - Developer for Offices Complexes for a all northern America).

In terms of the "selling" effect of sunspaces in real-estate, different objectives apply to office and tenement structures.

Office projects are conceived as an industrial product, with a certain pattern, to be changed only gradually to meet incrementally the market's pre-expectations. The atria approach is still perceived as controversal, totally new pattern, which is a risk at the market, but a even stringer image to the building that progressive firms would buy preferably. As they do so, and as advantages are perceived, the whole market could shift, but again only incrementally away from the convention.

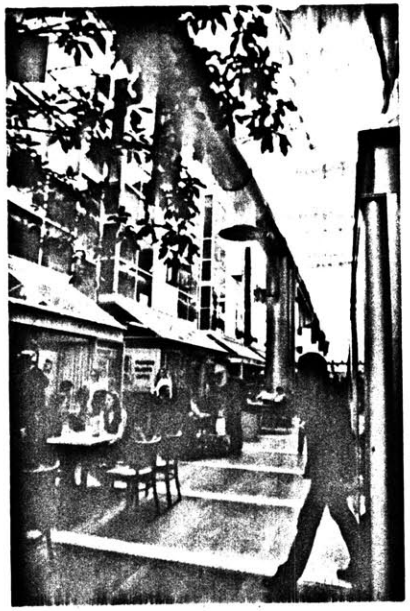
Clearly, real estate developers advertise with the atrium feature "as the outstanding address", and praise interior convenience of services and inviting prestige for hosting visitor the atrium.

For residential projects, the selling effect is crucial, since strong pre-conceptions object to live to indoors, to be enclosed under a glazing. The HUB project in Edmonton (E5) conflicted in that sense extremely with the rural preconcept of Edmonton - but against all dispites, is now perceived as the most demanded student housing by far. There is definitely some teaching and learning involved in selling tenement atria. Once seen in built reality, and form perfect renderings, the interior garden amenity, the climate protection and the "neighboring" communal ambience as precious image of a "city living" is the argument; especially in severe climates where communal disintegration is a major issue.

For tenement application, the energy conservation issue however becomes a major benefit, as optimized building bulk reduces skin losses and glazing adds solar gains. Additional space is passively heated and ambihent without extra costs.

In office buildings, the atrium is not so much an energy device, as internal gains heat the building anyway sufficiently. There it is more a tempering of additional space for services, an imagery lobby and a temerature balancing air plenum. As a floor plan efficiency, there is more window locations available with even better view and thermally balanced ambience compared to the direct sun-impact or cold draft of the exterior perimeter.

The Sunspace as Interior Landscape



From its historical evolution, the atrium implies landscaping. Initially the atrium was a decorative court garden for special care of an artifact garden similar to the japanese teahouse garden.

Two major design directions have to be noted: spatial greening combined with gallerias and stairs, as a sequency and interconnection of several circulation levels to merge in the atrium as focal space. Secondly, actual gardening landscape with greenery and topological features.

Both are decorative and convey exclusiveness, in cases even quite formally as a piece of art. But they do not pretend a real garden. They rather are a setting of "garden pieces" as intriguing design elements - an alientation of nature for the purpose of a soaring display. In that sense, the landscaping has to be understood as a "stage setting" of theatrical alienating effects. Thus, the display of greenery can be also quite minimal and decorative but still of high effect with little efforts. In the frame of the buildings setting and enhanced by the sunlight penetrating the glazing and playing on the foliage, this landscaping gets exaggerated and pops out as a special attracting visual effect. More than most exterior displays of conventional site planning would achieve.

Like we perceive at our homes window greenery as a hint of special care for a home and a means of personal expression of the occupant, we understand atrium greenery as a feature of

Excerpt from sales broschure

Galleria, Edmonton
Arch. P & J. Patkau (E1)

Reclusive Privacy

Imagine the boundless beauty of large, open winter gardens arrayed with tropical plants and blossoms of every kind. A private, glass enclosed tropical paradise of tumbling water, peaceful ponds, quarried stone tile floors and spectacular trees that make up your garden entry.

Galleria, unlike any address before, offers the unparallelled luxury and distinction of true penthouse living for many buyers.

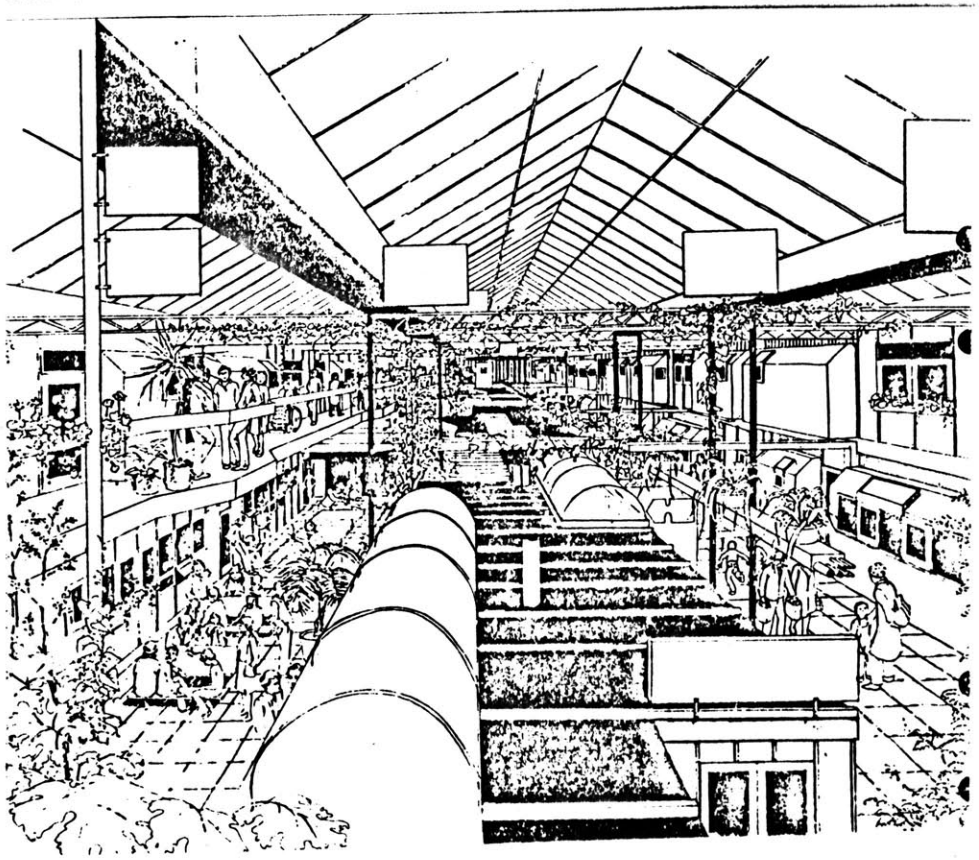
superior care and maintainance for the building and as well as a touch of hominess and personality of the buildings operation. Employees in such buildings develop a certain affinity to the garden and its progress and in the same instant consider the building as "theirs" and of superior quality. The greenery can be something like the sould to the building as a source of identification as well.

Though an artificial setting, the use of nature is quite deliberate and sensitive in amount and choice. Avoiding the sun spaces amaster as the greenhouse, would drown the user's recognition of the architectural setting. An overcrowdednees (Fairview Atrium T7 , John Deree HQ M3 , Kemper Insurance HQ B6) is a costly and less effective experience, while a lot of great indoors also work best without any greenery (Galleria Vittorio Emanuel, Milan M5). (It has to be perceivable that its architecture and not landscaping.)

Greenery has to sense that it is part of the building and be commited to the buildings rules and match to the architectures discipline, as opposed to a part landscape that would counterpart the building.

The Atrium as Residential Environment

In its generic form, the atrium is the circulation space of the building, meeting place and the vital breething lobby. In this form it can well to resolve the individual dispair for high privacy but instant collectiveness in the same building: the dwelling is hereby the enclosed private territory, the retreat - the communal open space right off from the dwelling's door offers activities and is an extended living room. As a defined part of



"Nya Esle" Project

Arch. : Landskronagruppen (E6)

Eslvös Kommun, Sweden 1980

ENERGI- OCH FÖRSÖRJNINGSSYSTEM.

Genom den överglasade huvudgatan uppstår ett gaturum som fungerar som en storskalig solfångare för luft. Personer och belysning i gaturummet samt solinstrålningen ger ett stort värneöverskott. Med hjälp av en luftvattenvärmepump samlas överskottsvärmen från luften i gaturummet och lagras i ett värmelager placerat under gatan. Värmeinsamlingen kompletteras med solkollektorer på husens sydvända taksidor. Lågtempererat värmevatten till golvvärmen och tappvarmvattnet distribueras från en dieselvärmepumpcentral till alla bostäder och verksamheter i kvarteret. Denna central fungerar som ett närvärme-

Förutom insamlandet av värme bygger energisystemet på begränsning av förluster och utnyttjande av spillvärme. Således skall gatans glasytor förses med fördragbara isoleringsgardiner nattetid så att värmeutstrålning från hus, lager etc bromsas upp i gatan.

Försörjningssystemet – rör, kablar, ledningar etc – är placerat, frilagt mitt i gaturummet. Detta rörknippe fördelas från huvudlinjen in till de olika verksamheterna. De installationsknutna funktionerna ligger i största möjliga mån placerade i fasad mot gaturummet så att byggnaderna frihålles från installationer.

the building, a conscious part of the dwelling itself. In conventional design, these "outside" territories hardly ever achieve this level of communal adpotion - they mentally mostly not belong to the dwellings and become apparently vacant open space of no use. The users loose their relation and retreat in their dwellings in solitude. The urban sunspace however, always gives a option of rommunal activity at hand, and tenants might leave doors and windows open for contact with the community - a much easier barrier control than in conventional walk-up apartments.

The individual tenant feels himself a part of the atrium space as his "outer living room". He shares this room consciously with his neighbors as expression of a house community. The physical definition of space and survelability promotes adaptability. Opposed to a open park garden, the atrium display conveys semiotically clear a distinct territoriality conducive to "neighboring".

This spatial relation generates a "vis-a-vis" and togetherness, close to the ambience of small italien or viennice backstreet tenement. Additionally, in the atrium, the common glass roof, the actual physical connection of space creates impressively the comunal hominess, "Street" and building merge to a unit, as built from and as well as community. J. B. Godin's familistere livied this ideal in a promising way.

Excerpt :

Discussion on the award-winning Galleria in Edmonton, 1981 PA Awards

Arch.(E1) P.&J. Patkau

Progressive Architecture 1/81

Cranz: Their argument is that the winter is so severe you're not going to be outside in the public scene anyway, so this is a way to "neighbor" in the bitter cold.

Stein: The University at Edmonton has that as the fundamental organizing principle, and a friend of mine who is a professor there says it's an extremely successful method for building in that climate, and it permits people to meet outside of their own apartments.

Cranz: Clare Cooper would argue that that kind of definition for those people allows them to use that outdoor space; without that [illegible]

More detailed knowledge from a concise post occupancy evaluation would surely yield more confidence in the profession for a wider application of this new type of urban sunspace housing

From the sales broschure of the Galleria Project in Edmonton

"The moment you approach Galleria, you enter a very special environment. n interior of outstanding character....with a tropical paradise of falling water and spectacular foliage....the residents will enjoy the ultimate in lifestyle."

The atrium feature is straightly used to avertise the building's quality, turnin a prejudiced dis advantage into a major selling amenity to expect with the project.

Urban apartments thus have not necessarily to be the monotonous stapling of confined dwellings in anonymous buildings. The atrium connects the individual dwelling to a dwelling palace that provides more than just the dwelling container, that is a holistic spatial concept.

Godin's "worker's palace" and the HUB student arcade in Edmnton clearly states the appropriateness and social promises of this concept. The residential structure is no longer an isolated building but a communal place as a home.

Visiting the Butler Square in Minneapolis (M2) on a Sunday morning, vistors comming into the atrium cheered delighed when looking up the skylight. One said: "Je, this sould be my home". And in fact, the offices in this projects are like home living-rooms" with balconies and sofas to the common court. Says the touring guard" "It's a pitty, they should rent that as flats, I would right away take one. This is living with class, I don't need to look to the outside here, the interior and the sun is much nicer and pieceful".

And the Edmonton Galleria condominiums slae with the notion "living to a central court of pieceful interior garding - a retreat from the bustling city noise. (Interview P. Patkau Feb.81)

And then feeding back to the historic atrium as center space with the hearth, symbolicly the communal atrium turns the simple condominium house into a pieceful home as a whole. And maybe, just as in a college hall, one should have a fire place down in the

atrium, just as a reference.

Says a 68 year old inmate of Hennepin Elderly House in Minneapolis:...the atrium is not a dull hall way, when you leave your apartment, you can look down and see something..."you will feel free," not like in these confined coordior types..."and its always something going on..."and look", people don't use the extra lounges," they want to set here in the atrium as I do..."

The Atria as Offic Environment

Mainly office complexes employ recently atria, as the historic gallerias and arcades (Cleveland Arcade) did. For offices, the atrium provides an interior landscape as lounge and lobby. As that, the offices looking to the atrium view a controlled interior as the firms living room. As there is no problem in having just the internal view, the atrium office building can achieve quite a economical depth to which the atrium serves as a light well. The atrium side is astonishingly even easier to control in terms of thermal comfort and window glare. Executive favorate space is to the atrium, due to overall comfort and view to the buildings unique image.

Atria North, a 1,400,000 square foot office complex, comprising four interconnecting four storey buildings, each with its central glass-enclosed interior courtyard or atrium, offers the discriminating tenant a year-round summer working atmosphere. Atria North is a bright and refreshing alternative to the high rise tower, isolated in a field of parked cars. It is a self-contained office community set in a natural and productive environment.

Clearly the atrium is a non-distracting relaxing environment conductive to work concentration. Windows and balconies can open into the atrium and convey a homelike ambience. Observations in the Cleveland Arcade and the Atria North (C8) (T3) show that tenants enjoy the transparency, and thus the "being seen" as opposed to the corridor type office complex - regardless whether

the building is a corporate one or a speculative project least not to various tenants. Like in Butler Square (M2) blinds or curtains remain open, which explains the attraction and homelikeness of the atrium, that makes everyone actually preferring the inner location in the building.

The atrium serves as circulation center and lobby, even in a spec project the self containment of the office building conveys a community setting "in a natural and productive environment" (Marathon Atria North broschure p. 1). This is a unique new notion in the world of anonymous office spaces in high-rise towers, which refers to office buildings like J. Hertzbergers Central Beheer in Apeldorn, Netherlands, when an open, multilevel interior provides interior views on a homelike landscape of workplaces and greenery, where circulation is also developed to a particular theme over the mere function, thus adds character to the building to which employees consciously refer: "I know exactly who is executive and where located...you get to know people...and I sometimes bring along my theatre spectacles", says a secretary in Atria North.

The central lobby offers casual opportunity to contacts when a landscaping provides amenties for remaining there, unlike the lobbies of skyscrapers and the corridors of conventional approach, where "meetings" are psycologically confined. In the atrium, one can intend to meet any community member with ease, since the place is perceived as a common one, that inherently belongs to the

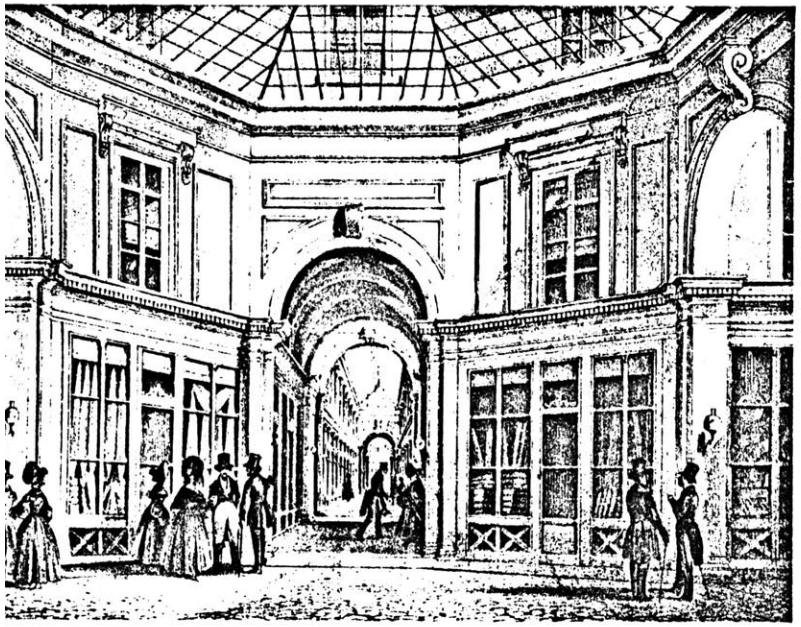
building, as thus oneself does. People communicating under this conditions don't feel that imposed", which provides a intended easement to collaborative working in the building as intended at Central Beheer explicitely to promote joint team work.

The Atrium as Semi-Public Indoor Space

The urban sunspace is transistional space between street access and building, and in turn between buildings themselves. The transitional character can be a path through the building or just an extended entrace lobby of formal pattern. As a rode of activities and retail the atrium competes with the street space draining population in.

Historically, the atrium is a very private family place, than the formal reception area of larger buildings. This division takes on today where some residential structures definitely exclude public for the sake of "exclusiveness". The community alone represents its own public. (Winnipeg Towers, Edm. Galleria). These places look then some kind of sterial compared to the prevailing pattern of vital mix use projects that match the underlying potential of the Urban sunspace approach, also that as more self contained building to unite various uses.

Besides, compared to the generic atrium, the urban sunspace provides weather-protection which is not required so much for tenants of the building, since they have their apartment there, then for a public use. Inherently, the mode of the sunspace is more a public one, as all surveyed projects show. Even that for



126 Oktogon über der Rue Lulay des Fèvres

the benefit of activating the building for visual attraction and richness of environment for the tenants. Yes, most of the building would not function successfully without public. Many projects (Butler Square, Merchantile Wharf) thus considerately employ provisions to allow public at any time but separate the circulation to different levels and distinguished elevator systems. It is thus well conceived that public belongs to this buildings and that distractions and malfunctions from that objective can be controlled.

Public in the building on the other hand does not demand security provisions, since (there is a high level of surveilance, the place is well observed) from tenants, even up to the scale of the Atria North. Dimensions like the Eaton Center surely got off hands in that respect. The circulation areas are also much more visible, compared to the corridors and elevators of highrise. Elevators and stairs can be well exposed for that reason.

Public access demandspublic facilities, shops, seating areas, restrooms even, direction signs in case, but a garden alone can already be a public facility of retreat in the city. Greenery moreover is not threatened by public as it is in public gardens. As the indoors are that spatially confined, there were no damages reported from the surveyed projects. Likewise interior furniture provides no problems.

A certain attraction lies well in the meeting of public and tenants. May this be in residential structures (HUB), hospitals

or office complexes. In all cases people prefer the public mix over the separated cafeterias. In the CHOP and the Thomas Jefferson Hospital, Philidelphia, staff andpatients meet for lunch in the public space. All around the sunspace, staff members took their trays from the cafetria for lunch break. The con-ept of the Edmonton Health Science Center implies the same and refines the functional lay-out to that. The patient rooms feed directly over catwalks to this semi-public spaces as kind of an interior Garden of Eden for a whole hospital community.

The Urban Sunspace as Low Rise Construction

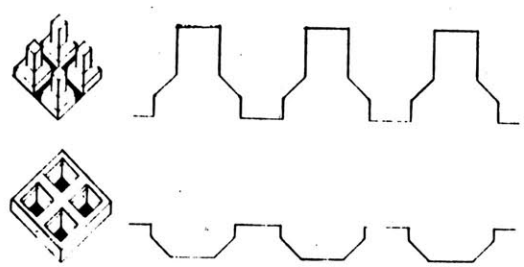
In tendency, atria and arcade buildings are inherently dense building bulks of low rise between 4 to 8 stories, due to common sense of interior spaces and proportional conceptions.

Higher interiors create undoubtly psychological security problems on galleries (Hennepin, Season Towers Winnipeg) as deepth of space and the visual connections get beyond percepatability, and thus abuses the atria environmental ends for the user. Inherently, the urban sunspaces are bound to a certain scale relative to human perception of space. Above a certain dimension, like in the San Francisco Hyatt Regency, the visual spatial ties and homelike ambience gets abandoned, while the Cambridge Hyatt still provides a space that can be visually adopted and personalized.

Scale and Porportion

It is a shocking sensation to look down from a 2o. floor into the confinement of an atrium - while it is a relax to look out form the same height over a city or landscape and relate perception to this dimension of view

Same effect allpies looking down a high narrow staircase,where deth get exaggerated



Martin Center Study
G. Saxon (7o)

With appropriate scale, the sunspace building approach responds well to the trend of height down zoning in the cities, while an other hand still yielding the same floor area. The Atria Noth (41) actually achieved a higher density and efficiency of floor space the comparative highrise on same site and office conditions. Studies for the Martin Center in Cambridge UK yielded the preference for the atrium solution to achieve same floor area and daylighting than the highrise concept. Same findings merge from R. Steins considerations on the tall buildings in this book on Architecture and Energy," Chapter 4.

Calculations for the Atria North (41) also recognize cost benefits for the construction, "due to faster construction time," less concrete mass per m^2 floor area, and least steel for reinforcement, in summary achieved as off less vertical circulation elements.

In effect, more actual usable floor area is produced by less construction including abvoe all reduced costs to the perimeter, as the building shape gets closer to a cube.

The Sunspace as Site Planning and Building Organization Device

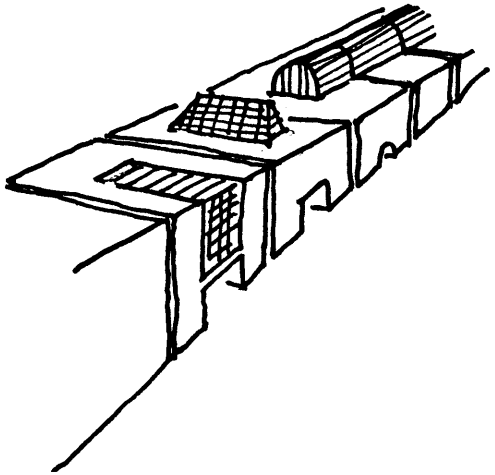
Above the achievement of an interior architectural quality, the atrium design approach can be regarded as a tool to structure the building itself and to fight certain site constraints for a better building display.

Bascially, the urban sunspace is an additional fassade the building can be oriented to, for daylighting, view of functional purposes. Trying to get the program fit to the site, the atrium gives options of additional orientation and circulation and more natural daylight to cut the depth of spaces. Hollowing the building allows density with sacrifice to environmental qualities. With more "fassade" to display, the disign approach is more variable and adaptable.

At the same instance, the inner circulation relations can be allocated more freely and even changable with bridges etc. As an organizational device, this circulation is visual exposed, allows three dimensional interwinding and is as theme to the building itself - a theme that is readable for the user, in terms of orientation and identification of ways to take. Characteristically, the atrium circulation leaves floor spaces free from circulation and due to more horizontal mode, and remote vertical circulation.

Having an interior orientation, the building can develop an interior excellence, a world of its own without mismatching the related urban context or design codes. The building does no more exclusively depend on its street fassade, but must not dissergard this context-links as of program contraints. Possibly, the atrium leaves more freedom to develop an appropriate fassade design to the street.

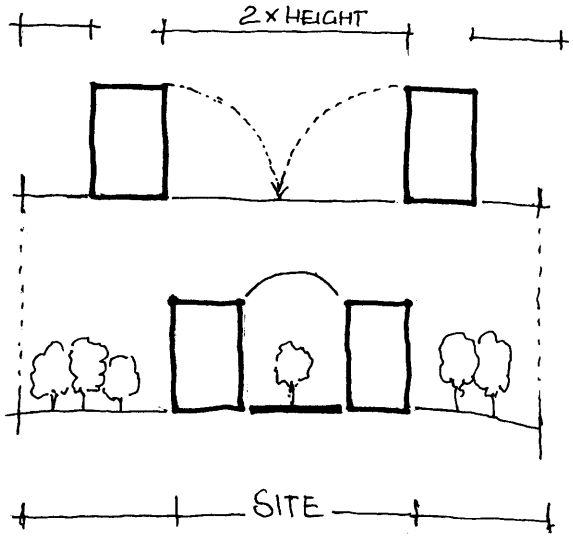
Buildings not operating on air condition need natural ventilation. In many cases this is obstricted by a noisy urban



location where opening the window at daytime would distract office use. The atrium gives here an option to vent to the inner core of the building, and moreover even to reclaim the vented air after filtering for reuse without heat loss.

Facing outdoor extremes of noise and heat and cold, the atrium sided spaces are much better "controlled", of less requirements for shading and isolation. With cheaper fassades, they are conceived as better tempered.

On an urban observation level higher density on a low rise base yields better site planning to its environment, provides possibly better context match on the same economical conditions.

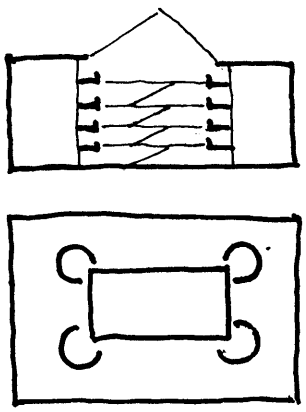


The trend back to urban design with confined street space referring to the closed street lining building bulk, call for the atrium design. Due to "inner design" easements the atrium building also matches better to infill or pochee sites. Not by incident did the pochee with atria and arcades emerge in Paris, when Haussman had opened up a lot of quite restraint new sites by cutting the new boulevards through the built-up area. Regarding the limited window access of this block structure city planning, the atrium as interior light well serves approprately to close infill sites with economical density as a new formula for urban building bulk of moderate height.

Building slabs linked with glass roofing also can be sited closer together, as by code they can be perceived as a unit, thus distance regulations do not apply an interrelation of the "inward

facades." pay justice to the visual density. In that respect, buildings can then be clustered together and preserve site landscape.

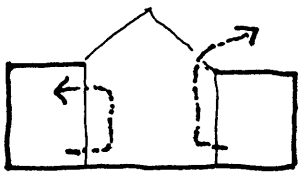
Overlook: Building Organization and Site Planning Means of atria approach

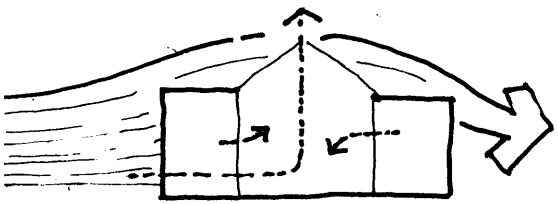


Organizational/Interior Layout	Site Planning
additional fassade area - view, daylight, biological needs	easement for context fitting
	easement for fassade design
easement to floor plan layout form bi-sided option of orientation	daylighting for retraint pochee sites
daylighting for dept of building	means for density bulk at restaiunt infill sites
potential for articulate interior interior character/public	
circulation - visual exposed horizontal	semi-public
free floor area	pedestrian link as a arcade
a theme to the building	
reducing vertical cir. use	
3-dimensional interconnections changable	optimized building bulk for floor area and micro climate response

(Continued)

Organizational/Interior Layout	Site Planning
quite, noise and pollution protected space	- increase density by attaching mall and facilities & housing to conventional slab = tenements
additional floor area for future uses and suriviv facilities, etc.	
incorporation of passive energy control	mediating connector between old and new structures
building services space - free displayable as "intersitional space adaptive to change and maintainance exposed - readible	close clustrering of buildings
Passive ventialtion	retrofit - lowering density with hollowing atria





Typology of Application

Overall, the energy future of northern snow belt attempts sees potential of the sunspace as in new constructions as central building core as access, circulation or path through the structure

- residential tenements
- office buildings - speculative , owner tenant
- hospitals
- convention buildings : centers, universities, theatres
- hotels
- shopping malls
- museums
- city halls

For renewal and energy conservation-retrofit of existing structures

- hollowing out of excessive deep building structures to meet functional and daylighting requirements
- atrium conversion of interior courtyards with glass covers
- glass covering of confined outdoor building pockets
- glass covering of intermediate space between buildings
- glass covering of intercirculation space between buildings
- use intenisification of sites with additional indoor area without affecting floor area ratio measures
- indoor connector between old and new structures

Current Trends of Application

From sample survey and interviews, the following trend and rationals for urban sunspaces emerge:

- Since buildings in northern climates act like heat radiator, it is of common sense to bulk building space tight together. The atria glazing becomes a "stormwindow to the city" (D. Oelson). The buildings of this approach also tend to appear as climate envelopes containing a collage of interior buildings, or cluing several buildings together. Circulations space becomes articulate space as buffer between the containers elements.
- This approach is not even aesthetic oriented, but referring to common sense responding to northern climate conditions. Accordingly, energy efficiency is not monitored or calculated. "We just know, that it is better". (Myers)
- Another approach emphasizes on generating "marketable space" in commercial buildings. Rentability is perceived as higher, not only as imagery but as environment amenity. (M. Beynon) The commercial applications clearly focuses on the building shape efficiency in terms of flexibility of floor area and minimized circulation contraints form low rise design. Artificial lighting savings, reduced perimeter heat loss, cheaper construction are the objectives.
- Energy improvements are hardly consciously considered. Most commonly lack of knowledge and conservative consulting of mechanical engineers neglects this potential.

Some projects on the boards recently show an attempt to incorporate solar gains (Winning Low Energy Building Designs, (64)), but effects are still perceived as unreliable to perdict, thus difficult to sell as unknowns especially in large scale projects this approach is feared as a risk to real estate expectations.

Typology of Urban Sunspaces

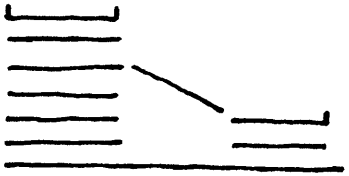
A typology can be classified in: sunspace figuration operation modes

Figuration

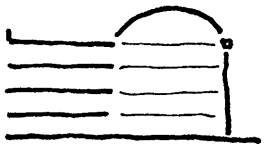
in section

Central Symetrical Atrium

2 Sloping Atrium

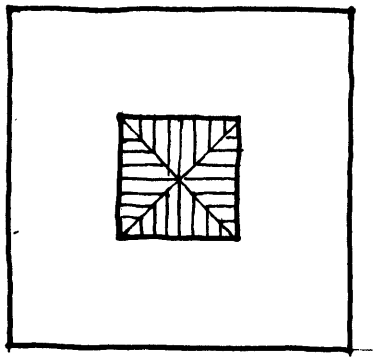


3 South Facing

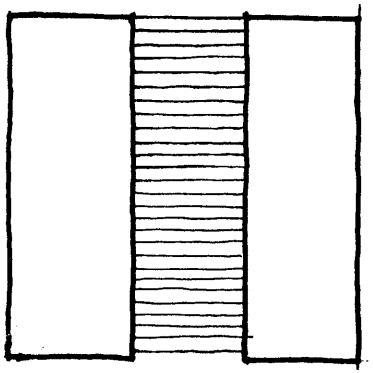


in plan

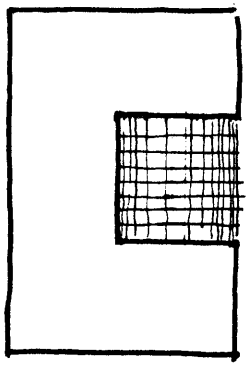
A Donut Building



B Arcade



C U-Shape



Combinations 1A, 1B represent the generic type
2B, and 3C are recently common, however often turned to to north for solar control

Energy Conservation With Urban Design

The prevailing research of passive solar design looks currently still on the suburban sprawl of detached family housing. Most publications and hands-on primers promote small scale solar application, whose efficiency is marginal compared to the overall energy consumption of buildings.

While thus suburban sprawl is encouraged with only relatively efficient solar homes, the cities' dense building bulk as generic energy conservation, the major amount of built space is still neglected in its potential for passive energy savings. Implementation of passive energy in the urban context is by nature of density and share of consumption thereof most promising--in terms of absolute savings and also relative to the individual building over a conventional concept.

Energy cost in the city are highly a social quest, since the urban tenants are typically rent-tenants, completely exposed to increasing energy costs, since landlords pass these costs straight on to the rent. These landlords thus do not find incentives in energy savings, but would only see increased initial costs for energy improvements, so there is no solar option for the urban center...while the rural homeowner with direct impact on his

house seeks definitely for a solar efficiency economics.

Solar knowledge for this is at hand--while for the urban context it is yet to be developed and introduced.

However, the implementation of passive design in the city context is of more complexity than the suburban: due to complexity of the urban buildings themself, due to figuration and scale, but also quite related on site conditions and orientation to south. City streets grids just do not follow solar objectives, site planning is restraint and existing density often casts shading onto the structures.

As the roof landscape is mostly unobstracted in that term, it offers a threshold of large surfaces to receive solar radiation, and the glass roofed atrium offers a promising solar device.

Converting parts of the roofs to solar apretures provides an amount of solar collector area which in turn is preferable to make up for the lower sun radiation of northern latitudes. Large scale apreture thus compensates for; less intensity

promising solar application to work well even for the snowbelt latitudes.

Predominately though, the sunspace's potential lies in the layering of the building in thermal zones and thus utilizing a buffer effect for passive energy conservation.

Optimizing the building shape for reduced skin area to minimize perimeter heat losses, plus retaining facade losses in insulated courtyards and arcades is the major feature of the urban sunspace approach to an overall energy efficient building.

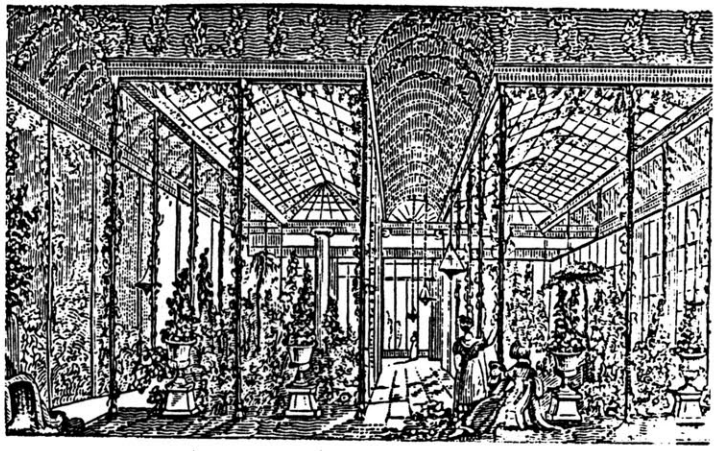
A sunspace as atrium also matches inherently urban demands of scale and spatial conception. The glass roof collected independent form site constraints and can be well shaped with tilts for proper solar orientation since the roof landscape is fairly unrestricted from design regulations--as opposed to fascades which have to stay consistent with the neighboring design objectives. There, any exceptions or changes of facades could be subject to minute permissions, and often not even permissable, especially in historical preservation context.

Atria As Energy Concept

Generically the atrium is a climate design tool. In southern latitudes of Europe, Atrica and the Middle East, atriums of indigeneous design apply the interior courtyard for cooling in summer, and catching solar heat for cold winter nights. In summer, the court collects cool night air, which is released at day into the rooms, natural convection through the structure. In winter, the containing walls store heat for release at night. Built form and thermal demand are in a perfect match.

In northern latitudes atria though, have some disadvantages. In winter too much shaded, and cooled by night air sinking in the court, in summer overheated from relatively low sun incident uncovered atriums can enhance extremes of the microclimate.

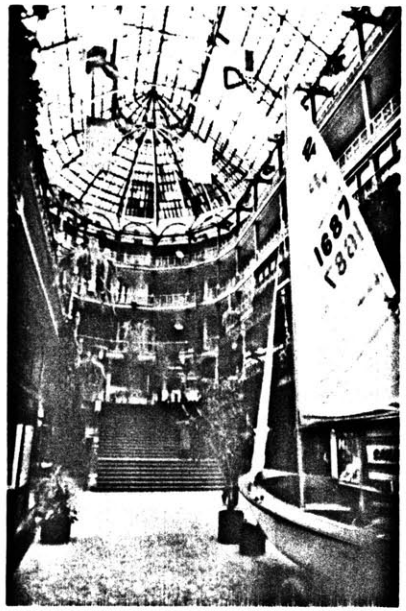
Reconciling appropriate greenhouse design techniques, these extremes can be controlled. Glass covering the atrium yields a well temperatured solar space to protect against winter colds sinking into the court and to reclaim the buildings own heat with an "envelope" to the interior facades.

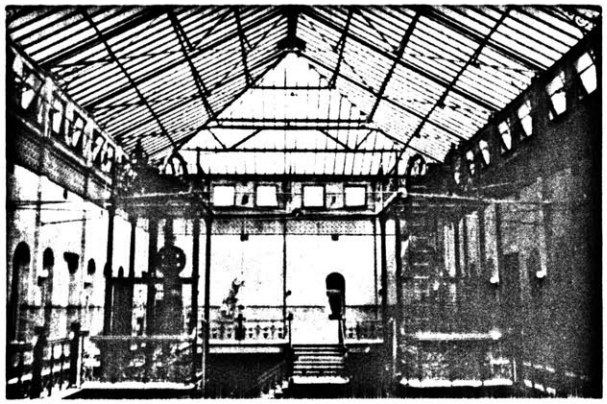


As a huge solar trap, and as thermal buffer, the glazed atrium generates a comfortable tempered indoor climate. As a relatively large air plenum to the building, this atrium also balances internal temperature swings and pressures. "The atrium is the urban storm window to buildings in northern latitudes" (David Oleson--Office Barton Myers). Beyond thermal comfort to northern communities, the sunspace adds outdoors space, habitable all year around to the building.

But just too typically, modern atriums are energy wasters since they are operated with complete mechanical conditioning for temperatures of indoor characteristices.

Was the aesthetical trend one failure, the mechanized, all controlled "steady state" artificial climate, was the second misconception in the tradition of the international style. Local microclimate, sun, winds, seasons were "slightly" ignored, and subsituted by mechnaical engineering establishing a international comfort standard. Building were to be machines against climate, rather than taking advantage of natures energies.





It is the merit of todays energy "shortage" to make these approaches absurd and point the path to passive conditioning. We rediscover, that thermal comfort is well achieved without artificial climate.

Under the premisses of energy conservation, the quest in designing atria is for passive operation as semi-outdoor of moderate temperatures. This refers to a series of historic examples that evidently worked solely passive and well under the absence of mechanical equipment. (Examples: Cleveland Arcade 1888, La Familistere de Guise 1853, Bradbury Building 1896, to list only a few.)

Not weak thermal performance, but the abundance of knowledge on "natural design" of atria with the wake of air conditioning and International Style design, abused the atrium approach.

The first key to this approach is thus to "condition" the sunspace by thoroughful configuration and layering of the building in thermal zones and to shape appropriate glazing to meet the suns dynamics for winter and summer modes. Overheating is an issue requiring design procedures for proper perdiction of thermal swings.

Outdoor temperature and solar impact will generate temperature swings in the sunspace with the trend of overheating. Perdiction of thermal swings for comparison with an "adaptable human comfort range" are to determine selected passive control devices and required capacities for colling draft, thermal storage and insulation.

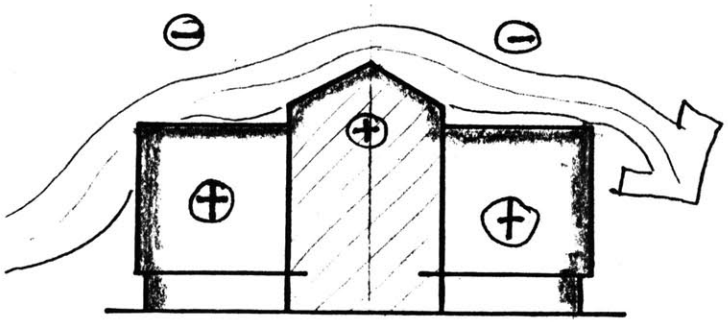
Secondly, it is thus essential to understand, that atria must not be of total indoor climate. Sunspaces are inherently semi-indoors where people still wear suitable clothing, where people do not expect more than a tempered ambience. Nearly all visited projects do not expect more than a tempered ambience. Nearly all visited projects do not consider this "low grade" demand, and thus typically operate with highest cooling and heating loads—in fact condition that way the whole air volume, instead of just conditioning the "bodies" where needed. Taken people perceptiveness and adaptability to temperatures, only the range of temperature swings, especially overheating in the upper portions of the atrium have to be of concern according to human comfort criteria.

Nearly all projects were machanical conditioned to 70°F at outdoor temperatures of 32°F. Coming from this cold, wearing regular clothing, people asked perceived this as uncomfortable. They would sweat and thus catch a cold when leaving again and thus would rather ask for a mediating temperature. No response was concerned about frezzing in the atrium if held at a very low temperature of merely 10°C.

Observations and common sense form indigeneous architecture

and recent experience with solar desings clearly call for an appropriate new definition of human comfort, as related to environmental sensation and objective bio needs of people in semi-outdoors.

The Buffer Effect



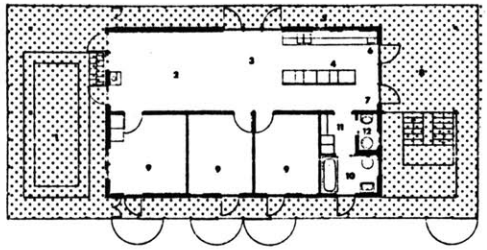
Glass spaces, attached or incorporated into a building, warmed by the sun essentially work as a climate buffers, as an intermediate zone, tempering the temperature differences between indoors and outdoors like an animals fur. They create an air cushion, warmed up by solar incident radiation, and are heated by the building's heat loss, retaining this conductance capacity from leaving directly to the outdoors. In this sense, the buffer is a heat reclaiming device. But this heat captured is sort of isolated from the building's interior and the quest is the interface and return with the floor area space (solar, and minute loss).

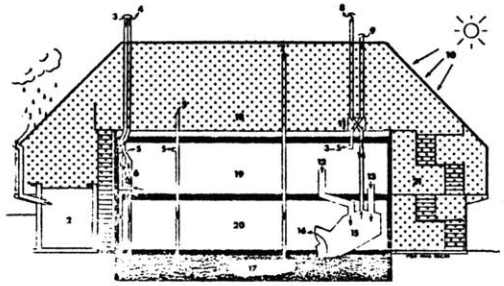
Three types can be considered:

1. the "surrounding" sunspace as an envelope
2. the attached sunspace as
    a) a greenhouse

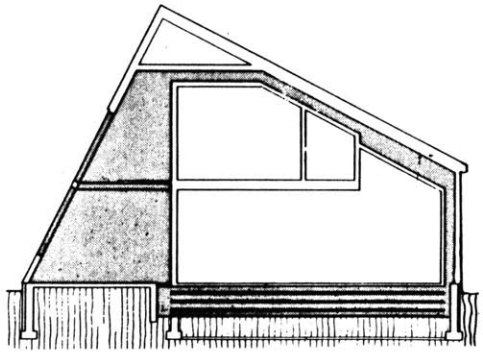
b) as double shell house

3. the interior sunspace as atrium or arcade





Bengt Warne
House
Sweden



Galen Beale
Canterbury,N.H.

1. The surrounding sunspace is currently a fashionable conception in Europe, as a tool to meet northern latitude's low solar incident with maximum apreture to all directions. While heat gains are appealing, solar controls are a problem. Essentially, these spaces work with high temperature swings, gain a lot the day over, but loose tremendously at night. Provision of thermal shutters is complex due to figuration and area. Same applies to shading devices.

In effect, the space is too uncontroled exposed to the sun, unusable on summer days and winter nights, obstracts the buildings ventilation and visual connection. The space is foremost a limited habitable buffer to insolate the building against solar heat and winter cold. Users must adapt to a wide decimal and secisonal temperature swing.

2a. The attached sunspace faces due south as a direct gain solar collector. Appropriate shape and venting with natural draft can avoid overheating. Perceiving those buffers as "isolated" from the floor plan, its warmn air can be exhausted into the building and stay cold at night to the extend that plants still remain comfortable. Only with movable shutters, the space can be habitable all day and winter.

b. The envelope house is a "advanced" application of this type, as it circulates the warmn air from top of the greenhouse over the attic down on the northside through the open basement back to the greenhouse. A warmn air envelope kept in a physical "envelope" around the house (except east and

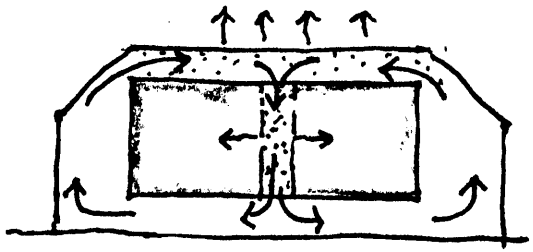
west side) is to heat and insulate the building.

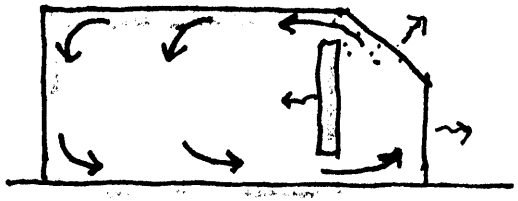
Clear disadvantage of this approach is again...like in the case above, that the warmest air cushion is kept, where most losses occur due to the high T at the buildings perimeter. Costs of this construction which require good air tightness of high craftsmenship quality to make the system work, are a matter of other discussion. (In fact the clue about the envelope house is the "controlled natural air circulation" with the earth ground as tempering storage for cooling in summer and warming in winter--this can be as well achieved in a thoughtful "open" floor plan to allow rise and fall of air on south and north side.)

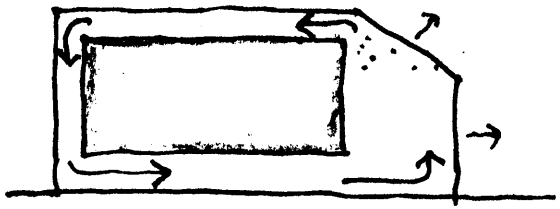
In summary: Both systems work limited in retained solar gains and distributing gains to the building. Besides, these sunspaces are fairly reduced usable for habitation.

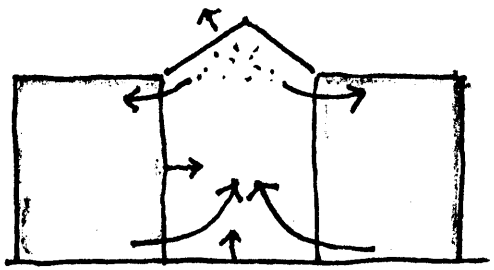
The "atrium sunspace" approach

The interior sunspace, or atrium, is generically much more climate conscious as it refers to the atrium as indigeneous climate control device. The solar atrium takes the sunspace into the core of the building, well regarding that today, a perimeter wall can be well insolated and windows can be triple glazed and reduced in size on east, west and north. Additional moveable shutters would allow perimeter insolation that would abuse suplmentary heating besides internal gains. So why worry about a buffer at the perimeter? A perimeter can be well appropriate designed to meet all weather and









sun impact conditions. Functional openness of the floor areas can face to the interior of the building, to serve biological needs of view and daylight. Restraints of revions sunspaces turn vite the atrium into benefits.

The atrium sunspace works as a heat sink, which is insulated by the building itself. At least three sides and the floor can provide direct storage and raditiona and neat convection is received by all surrounding building sides. The "warm spot" of the house is well protected—and habitable, since its own containment provides shading. Its skylight glazing area to conduct heat is minimal compared to size of space, and the surrounding building mass in turn tempers temperature in the night. In fact, building's heat loss is "reclaimed" in the atrium.

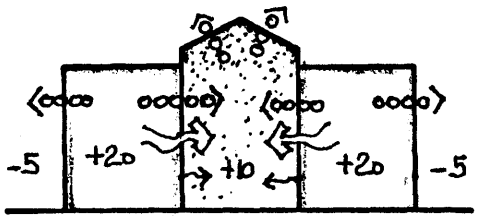
Like placing the hearth of a home in the core, it is of common sense to place a sunspace as a heat collector in the building's core, to distribute its warmth evenly to the building mass. And using the building's "whole" in its height as a "chimmney", applying the stack effect of a natural draft from the bottom of the court to the top, assuring air supply at the bottom and ventilation on the top, the atrium can be passively cooled in summer.

Passive Design Features of the Sunspace

Regarding sunspace as semi-outdoor environments, and with the understanding of thermal comfort in passive buildings, the atrium can be reasonable designed and calculated on a passive mode - as an urban sunspace.

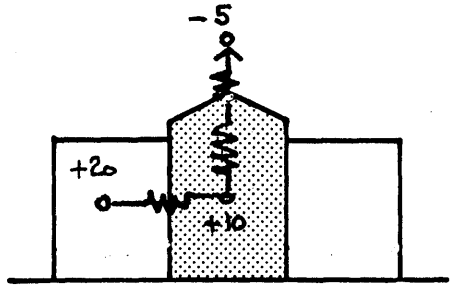
For this approach, heat transfer trhough the sunspace buffer, heat stratification, solar impact, thermal storage, air change rates, humidity and cooling draft control have to get explored. To avoid costly air conditiong, diurnal and seasonal temperature swings have to determine by passive means thermal ambience.

With a passive operation mode, the sunspace sythesises several features :



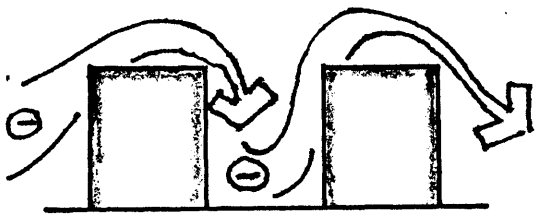
Buffer Effect

the buffer effect due to mediating temperature built up in the sunspace from internal gains and convection form the floor areas perform an isulating cushion of warm air



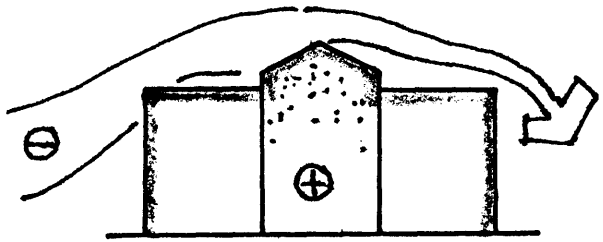
Thermal Brake

accordingly, the sunspace acts as a "thermal brake", as heat transfer trough the two additional media, respectively air and the insulation glazing slow transmission losses down by increased U-value and reduced temperature differences

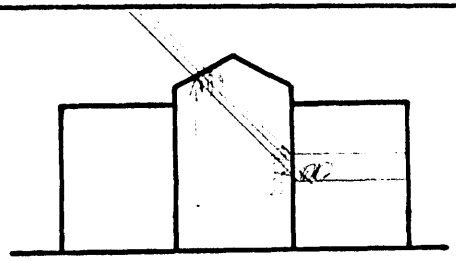


Optimazing Building Bulk

by optimizing the building bulk as a floor area to skin area ratio by clustering buildings together with glass covers, skin losses get reduced relative to less skin area and less wind impact to the building

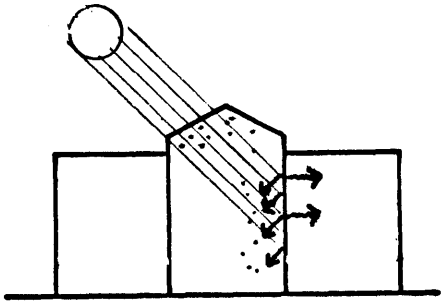


with improved micro climate, the warm air film around the building is retained, skin losses reduced and especially wind presured building inflitration (as greatest share of the skin losses) substantially reduced.



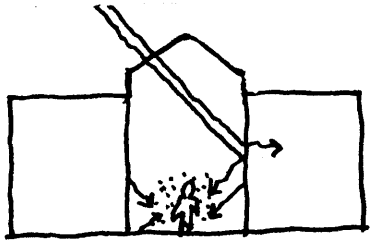
Daylighting

the depth of the building bulk is penetrated by daylight to be sufficient ambient light in adjacent floor areas, reducing artificial lighting energy and thus cooling loads in office buildings



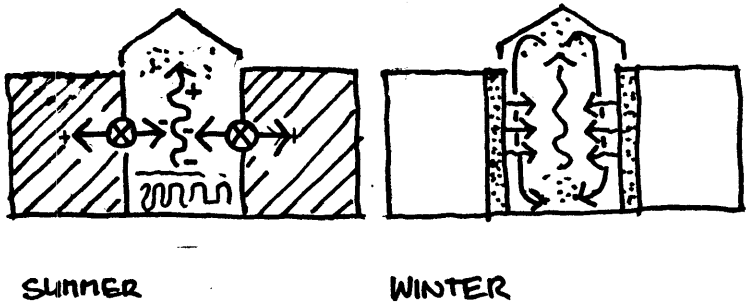
Solar Gains

solar gain from diffuse and beam radiation transmitted through the glazing and trapped in the sunspace, relative to local weather conditions and angeles of solar incident



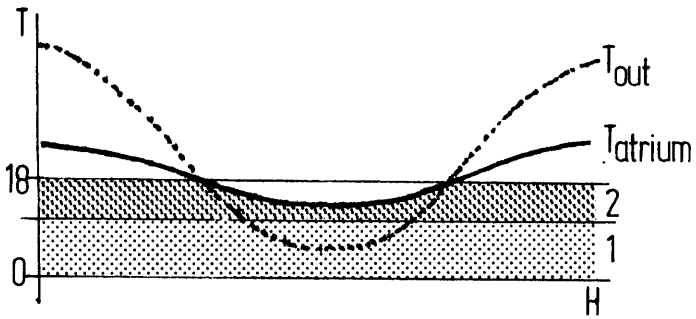
Radiant Heat

sun radiation gets absorbed by interior surfaces, reflected as radiant heat, or, stored and re-radiate with time lack to heat essentially the human beings with radiant heat as opposed to heating the volume of air.



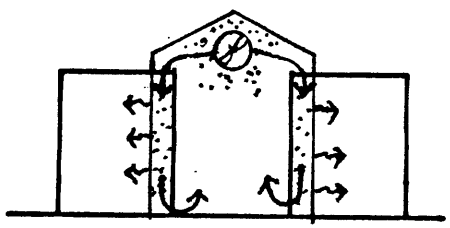
Thermal Zoning

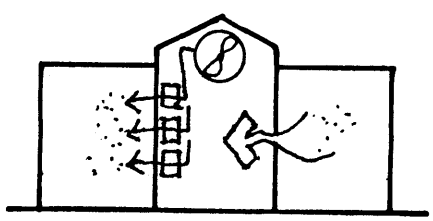
a interior facade separates sunspace from floor area thermally. The operable facade thus controls heatflows in either direction according to passive temperature swings of the sunspace. Low and high peaks of sunspace temperature do not affect the floor area's thermal comfort.



Thermal Balance

overall, the sunspace balances outdoor extremes to the buildings interior temperature - supplementing heat to the space heating, or, shading the building form summer heat and direct sun

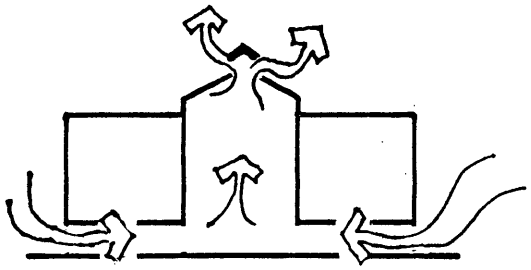


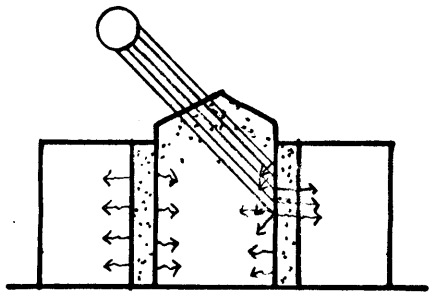


Hybrid systems

As a second level of measures, forced air or heat movement can be employed, using fans and air-to-water heatpumps, to improve energy savings a essentially reclaiming captured warm buffer air heat.

These measures have to be regarded in the calculation as subtractive components to the "internal gains" computation to the atrium, and as additional heat to the floor areas.





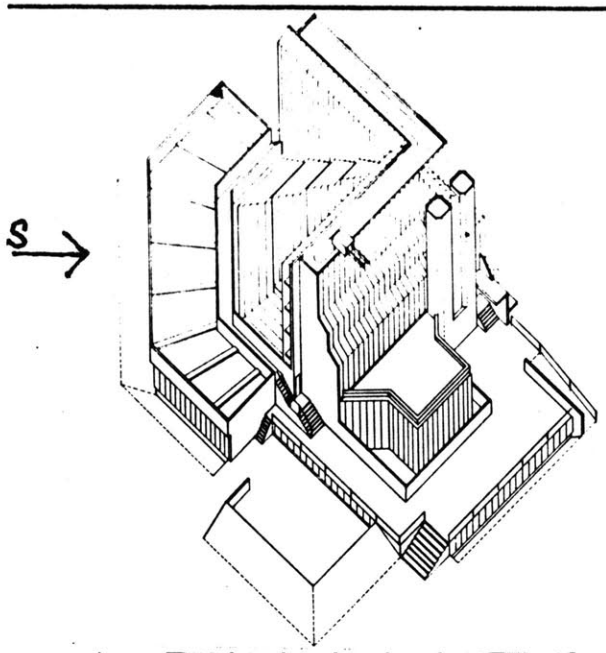
Impact and energy savings from these faetures have to be determined separately, according to building configuration, use pattern and passive control devices lay-out.

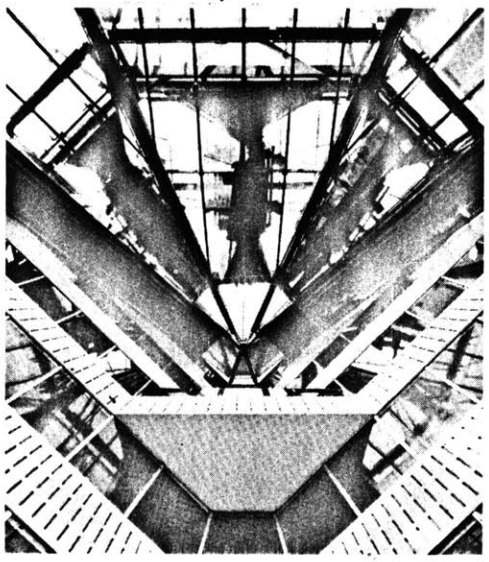
Passive controldevices are

- glazing insulation, transmission and geometrical configuration
- shading fins and overhangs, external or internal
- natural ventilation with outdoors by wind and thermodynamics
- orientaion of sunspace to sun incident
- ventilation with indoors
- thermal storage

Thermal Comfort and Sensation

Sunspaces create thus a distinct internal climate condition to buildings' interior that essentially swings in temperature rellative to outdoor temperatures. For passive building handling, thus, criteria of acceptable temperature ranges, different from the "steady state" standards as commonly used, have to be applied. However, properly designed and oriented with the sun, with shading devices and natural ventilation, the sunspace acts as a tempering space and as an air plenum to balance the buildings indoor climate.





Exactly this potential was completely abused by moderne architecture. Resentments and objections origin hereoff. As an example: James Stirling's History Faculty building in Cambridge, UK. Known widely in the profession, but the worst failure as a glass covered indoor. The sloped glazing faces south, and only a octopus of air handling ducts in the glazings airspace can control overheating—instead of a blue sky, -he user is repelled by pale light and a milky glass sky. The glazed in catwalks to the offices are only for use as a hot-greenhouse, once the is out in summer. The building's glazing, by initially reversing the site orientation works against the solar dynamics.

As a mediating space to outdoors, the sunspace "swings" with outdoors temperatures without sacrificing use qualities. It is a common experience that glass spaces heated by the sun keep comfortably warm in daytimes, retaining fairly low--lr°C even on severe winter days. This unheated conditiong saves substantional energy, but also challenges the common standards of thermal comfort. The objective is thus: <u>appropriate energy saving versus appropriate comfort</u>.

Opposed to centuries of architecture, todays standards define a steady state comfort, which in turn is also achievable for the first time in history by "perfect" mechanization to predeterminate undifferentiated form individual and cultural habits the line of whats supposed to be comfort. With this

however, neglecting energy involved, yes, even promoting excessive energy consumption.

Human's are comparatively temperature sensitive, but also has no fur or fat to buffer off temperature extremes like animals. Accordingly he socialized other climate controls, such as clothing, movement and finally change of place. HUmans seek and create for themselfs suitable conditions. Once this is achieved, once thermal comfort is felt, these concerns vanish and thermal perception becomes obsolete. Thus human perception is mainly oriented to changes of temperature. He hardly senses steady state modes, as long as comfort is provided.

Comfort climate thus also lives off from temperature differenciation like a gourmet meal lives off cool wine and hot meat. Men experiences comfort mostly as a change of temperature, attaching this mentally to a spatial experience of the environment. Men does not remember temperatures, but spaces, where temperature adds a positive recognition and thus identifies the space itself as comfortable.

We remember tropical warmth with the image of a greenhouse, or, extreme coolnees in summer with the interior of a cathedral.
Temperature is thus not an objective experience, but a sensation related and remembered with space, or, other significant environmental identities

All our senses react as or with temperature. We feel a cold shiver over our back in fear, we sense cold climate as threat to our well-being. All our body reactions are related to thermal reactions - our psychology thus as well.

The British psychologist D.J. Stanley Jones (82.) argues likewise, that our first senses were means of temperature regulation. Thus, we still deeply relate our feelings and motions to temperature - to thermal comfort as a key to mental comfort.

L. Heschong (37.p.39) writes :

" It (temperature) contributes to our senses....and we identify thus places."

The creation of spatial recognition thus should contain the aspect of thermal comfort

This is well adopted with the design of a sunspace. Men desires to sense temperature by contrasts to wake his mind and to pull his recognitive sense. A "swinging atrium" temperature thus enhances our spatial perception. Constant air temperature bores our senses.

B. Fuller's climate super domes, covering a whole city with consistent climate contradicts our mental comfort needs. We need for instance seasons, diurnal changes, sun warmth and shadow cooliness as an impulse to our activity patterns. Thermal-contrasts are instrumental to our biological rhythm. The sunspace draws its popularity surely from this subconscious sensitivity. This "natural climate" is the means of real comfort and criteria of a "genus loci" in buildings.

NOTE: Opposed to ASHRAE and other HVAC standards, thermal comfort is thus not merely to define as "sensation of neither slight warmth nor cold" (58 p. 27), but is a matter of a holistic temperature sensation relative to space, psychological expection, activities, uses, season and regional characterics of weather.

Prime designs parameters for thermal comfort in our spaces are these:

- -mean radial temperature (MRT)
- -diurnal swing
- -our temperature
- -activity expectation
- -air movement
- -metaboic rate and clothing

Thermal Comfort In Passive Buildings

In passive solar heated buildings, especially in direct gain spaces, thermal comfort deals with a non-uniform tempertured environment. Mean radiant temperature is quite different from air temperature according to sun radiation bouncing into the space and also reradiating from the walls. With that, ASHRAE standards do not apply correctly any more. (62 Chs. 8 Ps-siology Principle Comfort and Health.)

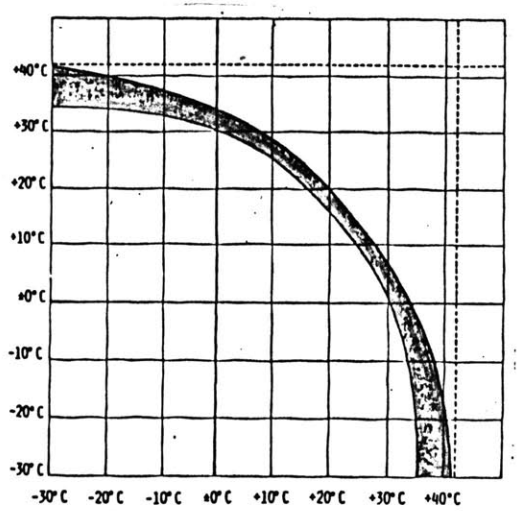
ASHRAE (11.), 8.15 :

"Human performance in extreme cold ultimately depends on maintainance of thermla balance."

For passive buildings, new thermal comfort standards have to be implemented. In addition, the psychological expectations on thermal condition related to the space can be regarded. Taking

Adaptable (passive) comfort range means a temperature range between 3o to 1o^{0}C with respect to medium humidity, wind and radiant heat, where men can compensate lacks of comfort with behavior.

Trade-off between air temparature and radiant heat for comfort



(Das Haus Spezial : Energie, p.115 Burda Verlag, Offenburg, Germany 1980)

this, human comfort is a matter of adaptiveness where men "reacts" to temperature by behavior as a passive corrective measure. With this a "adaptible comfort range" can be applied to save energy with respect to spatial expectation, activity level, clothing, and radiant heat.

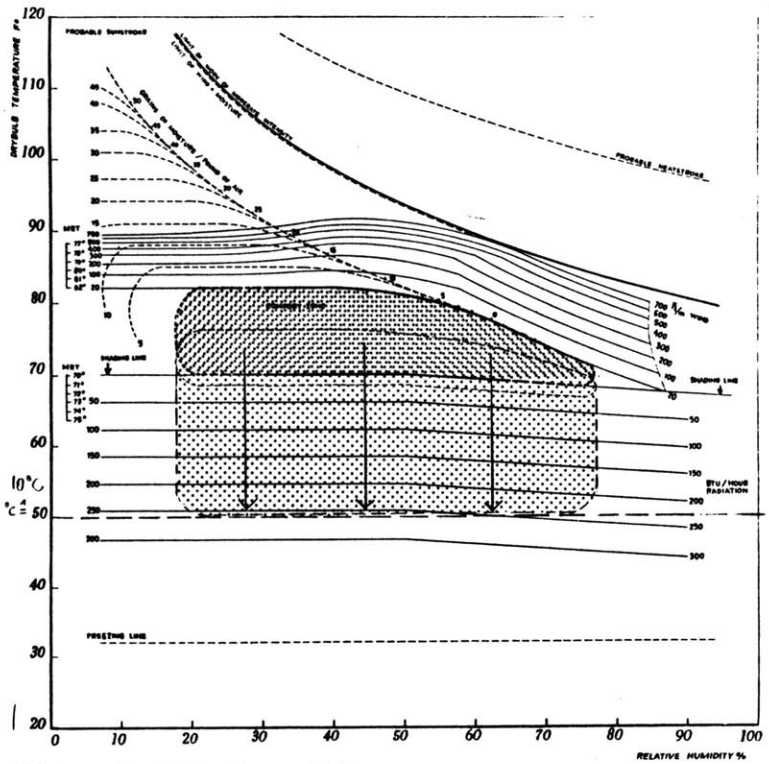
"It turns out that most people are comfortable when they receive radiant heat at a slight higher temperature than the temperature of the air around them." (Christopher Alexander, A Pattern Language (83) p. 1078.

This conforms with an observation at the CHOP (P2) where staff members took lunch in the strongly sunlight radiated spots (which I personally as observer felt as too hot) but from interviews was found to be highly desired for a certain duration of time as a special relaxing sensation.

Taking V.Olgyay (60) and especially the work of Fanger (27), where comfort is determined as a function of activity level, clothing insulation, relative humidity in addition to air and mean radiant temperature. This approach reconciles the

physiologial basis of comfort, where body comfort is foremost a matter of thermal equilibrium of heat loads (27, p. 327). Passive conditiong of buildings thus means to acknowledge the thermal trade-offs.

In the sunspace, a considerable amount of heat can be supplemented by solar radiation, counting 50 BTU to compensate for 2.2°C temperature drop. From observation and suggestions (study trip) on site, a low indoor temperature of 10°C can be satisfiable in winter, and in turn 25oBtu/h would supplement this to Olgyay's comfort range (60.). Accepting the thermal swing of solar radiation would then allow to offset backup heating. Again keeping with the notion, to the whole air volume of the atrium, but condition the human bodies with radiant heat



45. Bioclimatic Chart, for U.S. moderate zone inhabitants.

Table 5-B Determination of Metabolic Activity for Office Work†

Activity	Metabolic Rate, W/m²
Seated Reading	55
Seated Writing	60
Seated Typing	65
Seated Filing	70
Seated Talking	65
Standing Talking	70
Standing Filing	80
Walking	100
Lifting/Packing	120

†$M = M_1$ × Percent Time + M_2 × Percent Time + etc.
where
M = total metabolic activity, watts per square metre. $M_{1,2}$ metabolic rates given above.
Examples: Seated typing, 50%; standing filing, 50%: $M = 65\ (0.5) + 80\ (0.5) = 32.5 + 40.0 = 72.5\ W/m^2$.

Other compensation for adaption of thermal comfort is given by activity levels of people.

Source: Ashrae Handbook (11), 8, 13.

To plot this "human heat gain" into comfort diagrams the Metabodic Rate in MET is established, as of Ashrae 21.8, table 5A. Application is shown with comfort-tolerance charts and as 3b and 3c, which can be adopted for "activity" in sunny-outdoor space. Thus given comfort zone is related to indoor condition expectations, and designed for sizing mechanical temperature conditioning.

Table 5-A Metabolic Rate at Different Typical Activities[46-50]

Activity	Metabolic Rate in Met units*
RESTING	
Sleeping	0.7
Reclining	0.8
Seated, quiet	1.0
Standing, relaxed	1.2
WALKING	
On the level mph	
2	2.0
3	2.6
4	3.8
MISCELLANEOUS OCCUPATIONS	
Bakery (e.g., cleaning tins, packing boxes)	1.4 to 2.0
Brewery (e.g., filling bottles, loading beer boxes onto belt)	1.2 to 2.4
Carpentry	
Machine sawing, table	1.8 to 2.2
Sawing by hand	4.0 to 4.8
Planning by hand	5.6 to 6.4
Foundry Work	
Using a pneumatic hammer	3.0 to 3.4
Tending furnaces	5.0 to 7.0
DOMESTIC WORK, WOMEN	
House cleaning	2.0 to 3.4
Cooking	1.6 to 2.0
Washing by hand and ironing	2.0 to 3.6
Shopping	1.4 to 1.8
OFFICE WORK	
Typing	1.2 to 1.4
Miscellaneous office work	1.1 to 1.3
Drafting	1.1 to 1.3
LEISURE ACTIVITIES	
Stream fishing	1.2 to 2.0
Calisthenics exercise	3.0 to 4.0
Dancing, social	2.4 to 4.4
Tennis, singles	3.6 to 4.6
Squash, singles	5.0 to 7.2
Basketball, half court, intramural	5.0 to 7.6
Wrestling-competitive or intensive	7.0 to 8.7
Golf, swinging and walking	1.4 to 2.6
Golf, swinging and golf cart	1.4 to 1.8

*Ranges are for activities which may vary considerably from one place of work or leisure to another or when performed by different people. 1 met = 58.2 W/m^2; 50 kcal/hr m^2; 18.4 Btuh/ft^2. Some activities are difficult to evaluate because of differences in exercise intensity and body position.

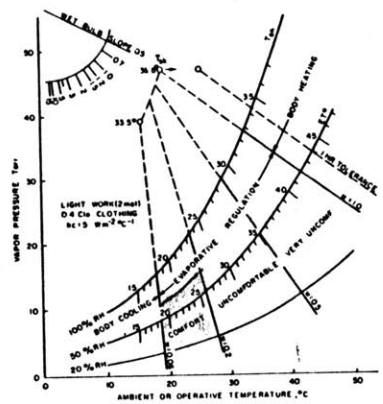


Fig. 3c Comfort and Heat Tolerance during Medium Activity (3 met)[15]

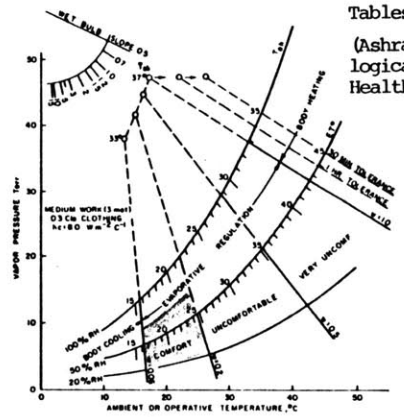
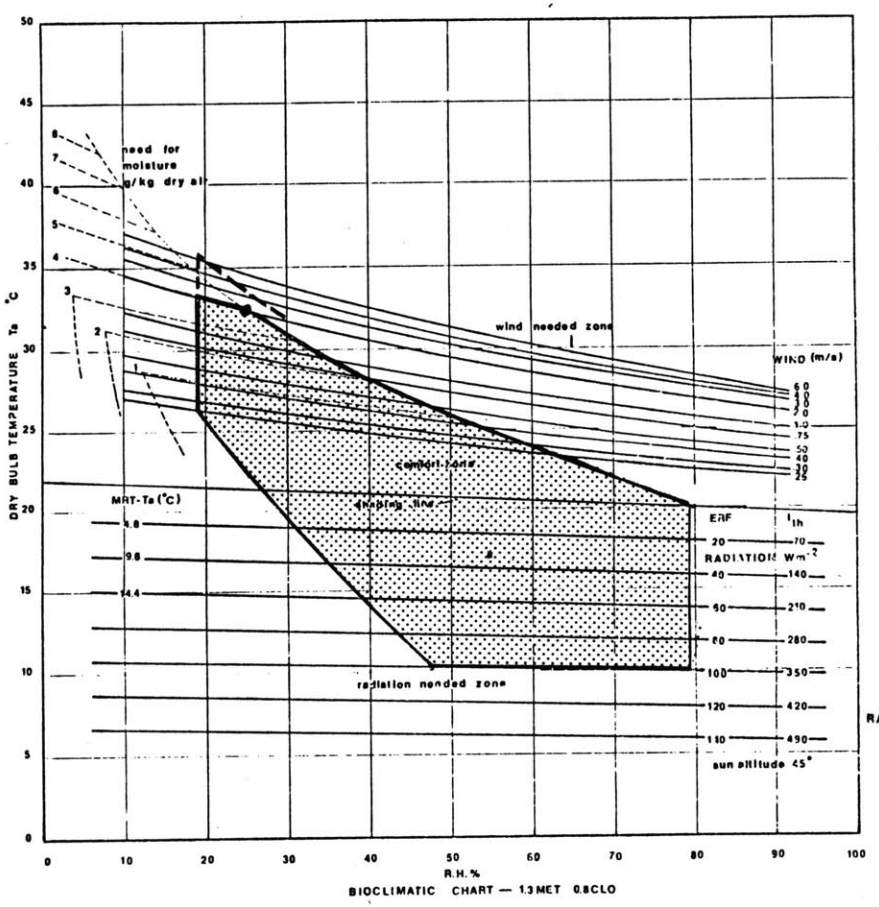
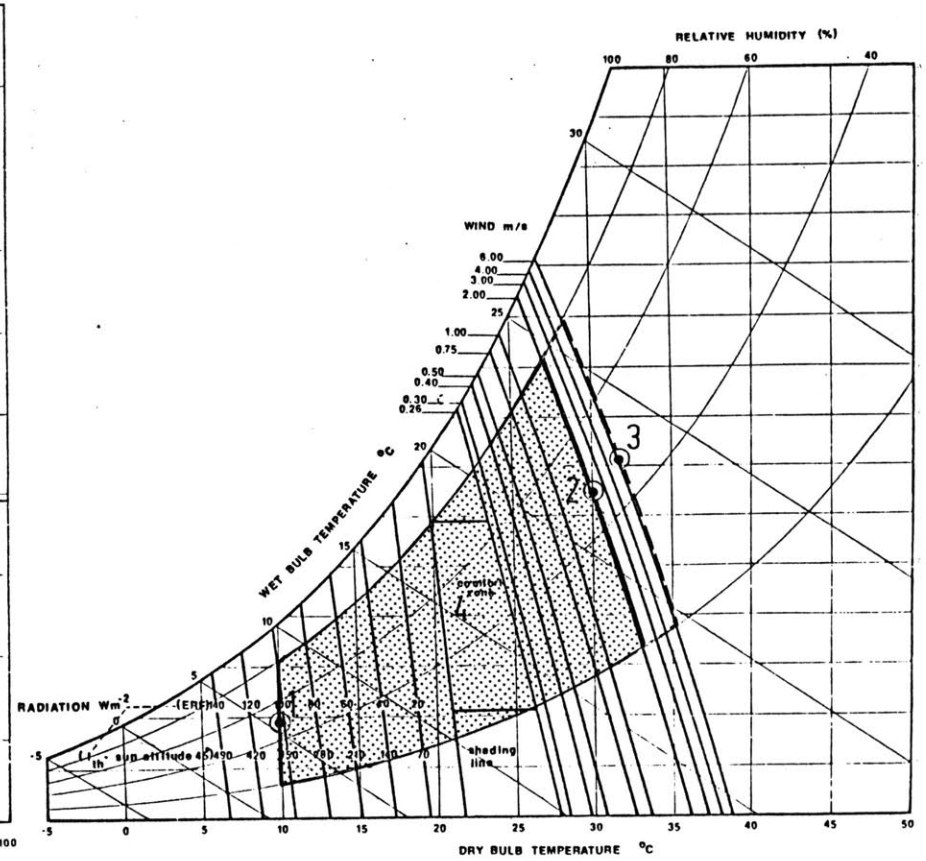


Fig. 3b Comfort and Heat Tolerance during Light Work (2 met)[15]

Tables : Metabolic rate and comfort (Ashrae Handbook 77, Chs. 8, Physiological Principles of Comfort and Health - ( ))

Taking additionally clothing levels as of Ashrae (11) 8.7 table 1D into consideration, regarding thus that people in sunspaces are dressed according to outdoor climate, one can define a adaptable thermal comfort range with Edward Arens Bioclimatic Charts (8) (5th Passive solar conferences proceedings, p. 1202). The examples shown here relate to 1.3 MET an, 0.8 clothing rate. (other charts are available)

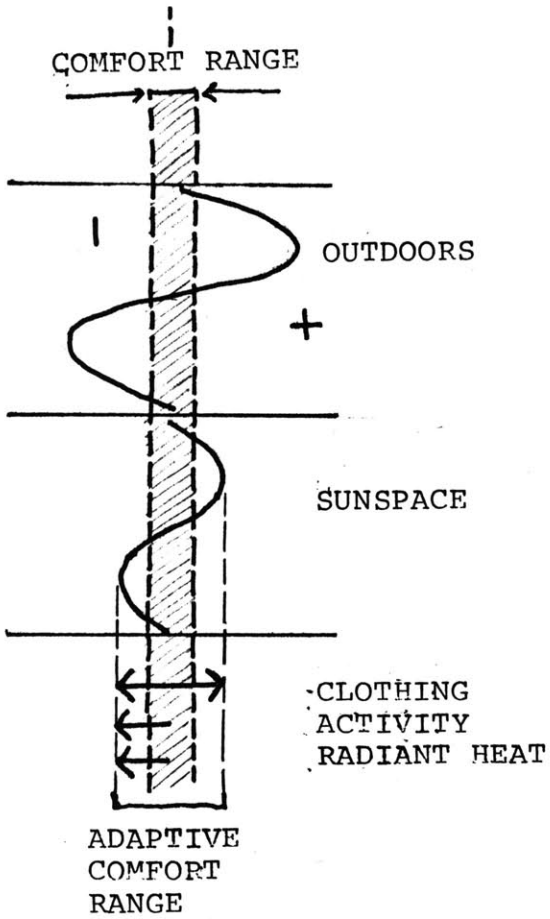




BIOCLIMATIC CHART PSYCHROMETRIC FORMAT

1.3 MET 0.8 CLO

Adaptible Comfort Range



With this, passive buildings accept varying temperature conditions within a range that can be corrected for comfort by human behavior passive venting, or, solar radiant heat.

Utilizing natural energy properties, such as solar radiation, internal gains etc., the building is exposed to diurnal and seasonal temperature swings which have to be balanced with shading, natural convection for cooling, and sufficient thermal building mass for appropriate time lag of redistribution of radiant heat when natural energies fall back.

Atria and arcades by scale and configuration work perfectly for this requirements: the indoor space and its facades trap radiant heat from the building, reclaims building losses, collects solar gains, and provides controlable wind velocity by own warm air stratification and air pressure differences in height of space. If demanded, cooling draft can pass through the space, driven by solar stack effect, and winds, as top venting louvers and bottom air supply is provided properly.

As it is found from site observations, urban sunspaces even in northern climates of up to 3600 DD^{18C}, and as simulated in the energy calculations, stay at bay at around at least 10°C at winter days as they are moderately feeded by the building losses.

In winter, this low temperature is still well 14°C above average outdoor ambience t, and thus will be delightfully adopted by winter dressed users.

The prime thermal lack of urban sunspaces is summer overheating, due to solar incident on excessive glazing, and convective accumulation of internal gains. The crucial control for thermal ambience lies thus solely in thermal comfort ventilation.

Thermal Comfort Ventilation

Other than "health ventilation", thermal comfort ventilation is dependent on climate conditions and temperature within the building. In cases, health ventilation might thus be far exceeded by thermal ventilation requirements in summer. This ventilation, driven jointly by thermodynamics in the building, or, by outdoor wind effects can perfectly substitute for a steady state artifical air conditioning of sealed buildings.

The air movement in buildings is caused both by winds and thermal forces, operating each in same or opposed direction. To maintain pressure differences for consistent ventilation is thus crucial for passive operation.

Fans and estimate wind pressure for as give natural ventilation capacity:

$$Q = 7 \text{ xvolume } \sqrt{\text{height x } \Delta t} \; [m^3/min/m^2]$$

Finally sizing and distribution of openings is crucial to "local" wind velocities.

Assumed that all openings are equal and even distributed, one can estimate air velocity at all openings (outlets = inlets) as:

$$V = \frac{Qex}{A} \; [m^3/m^2h] = m/h$$

Qex = volume to remove
A = area of opening

(yet with no regard to uneven air distribution flow)

If Q natural is smaller than Q ex, fans have to be employed. To an extend one could employ wind pressure forces, but with no liability. Thus, one calculates for the worst "non-wind" case to let the fans come up.

The fan would be roughly sized in horsepower as:

$$HP = Qex - Qnatural \text{ x } dp = Velocity \text{ x } A \text{ x } fV^2,$$

where f is a friction from .95 - 1.2.

As air conditioning systems can break down on this in balance, atria are revelaed to serve passively for better pressure balance. As internal pressure balances are hardly to predict,a maximum venting capacity determined by maximum overheating peak is recommended.

Maximum overheat conditions in the sun space can be determined from solar impact by June 21., approximately from noon to 3PM on an hourly basis with TEANET simulation or CALPASS 3 (see calculation). This peak load can be calculated as a product of sunspace air volume times specific heat of air (about .28 to .34 Kcal/degC) multipled by the desired cool down temperature difference to give the quantity (Q) of air to be removed on a an hourly basis.

$$Q_{cx} = .34 \times \text{Volume } (tl - to)$$

This requirement can now be expressed as air change ratio of volume to be remove, or, in turn as air flow speed/min. in m^3. Thermal forced air movement as suggested by Ashrae 14.1 and B. Givoni can be subtracted from that capacity.

Allowable wind velocities depend on proximity to use levels. According to McIntyre (8 ref. 6 p 1202) wind velocities up to 2m/s still maintain comfort, while speeds up to 6m/sec could only be employed for short time peak control (Hunt (8, ref. 7, p. 1202). With handling wind velocities, also relative humidity should be maintained around 50%, or, not exceed 20 to 80% to account for the wind chill temperature drop.

Alternative

Alternative to this procedure is to simulate the overall building performance and input various air exchange rates (inflitration) of the sunspace and read respond of temperature swing at an hourly basis. This iterative approach could again be run for several days of clear day with TEANET or CALPASS 3 insulation in June to assume the worst overheating condition.

Building Performance Evaluation Methods

The argument for the passively operated atrium and arcade requires a numerical evaluation of achievable energy conservation and temperature swings. These figures compared with performance of the same building program without an urban sunspace as climate buffer can justify this design approach beyond its environmental incentive and make financial incentives clear to owners.

Secondly, the calculation methods are essential as design process tool.

- to perdict scheme performance and related corrective measures in the design phase with quick but appropriate conciseness and yet user accessable means.
- to analyse diurnal and seasonal peaks of thermal swing to be matched with adaptive thermal comfort range
- to control impact and directions of changes in building configuration, materials, mass and control devices.
- to determine accurate insualtion properties for the interior facade
- to determine reduced energy losses for optimal sizing of heating systems

A conversation with Fred Dubin of Dubin & Bloome Assoc., New York, engineer and himself haevily involved in sunspace design concluded :
"Well, don't calculate the atrium performance...it's a absolut hassel, and we did several approaches. Let it be. You know, you got enough energy comming in - and if its too much, you just vent it! You have plenty of energy!" (Amherst, MA. Oct.24.8o)

Overall, the calculations are to demonstrate feasibility of passive operation of the sunspace's final design, as a critical factor to the building's lifecycle costs.
To really utilize the sunspace building's efficiency for energy conservation, it is important to learn about the performance parameters, and also be able to cut back on the conventional heating.

Approach

For thermal peak analysis it is sufficient to asses the sunspace's passive temperature swing at four characteristique key days of the year : Nov. 21, Jan. 21, Mar. 21, and Jun. 21.
For this dates, hourly calculations for solar impact, "internal gains" and losses based on local outdoor temperature and radition are sufficient.
From this daily temperature swing, day and night losses can be averaged to perdict energy savings form the skylight.

The building total heat loss is then a compound of the skylight loss, plus the roof and exposed perimeter wall loss, plus a reduced reduced air change rate of o.5 of the building vloume. The sunspace can be anticipated with a air change of .7 in winter and up to 7.o in summer for ventilation.
The "potential savings" in kW/h can be established by calculating the buildings configuration without sunspace, then counting all perimeter surfaces U.A factors and a regular .75 infiltration rate.

Reclaim of heat capacities to the floor area from the sunspace, by whatever mode, are accordingly to be subtracted from "internal gains" of the sunspace and in turn also subtracted from the buildings overall losses when establishing the energy key figures per m^2 floor area.

For yearly energy perdiction, the seasonal key day figures can then be averaged proportional to monthly degree day numbers as compound of montly performance.

Base Case : HUB - Student Union Housing Edmonton, University of Alberta 1973

Arch. : B. Myers & R. Wilkin

see also : Project listing (E5)

see also : TVA Office Project (C4)

As a base case for performance calculations, the HUB project got selected for its prototypical design, for its typical dimensions and residential mix use. The section of the project has proportions which can be generalized. The length of space can be varied, either as arcade type or as all enclosed atrium. Te the locig of the calculations remain the same.

Other reason for this choice is the advantage, that the University of Alberta monitored the actual performance of the building since its opening in 1973 monthly in terms of steam,electricity and gas. For a further detailed assesment, this will be a perfect comparison parameter.

Also instrumental to this choice was the thermal load characteristic as a residential structure, where ambient sunspace temperature swing and subsidary heating is desirable. In office complexes such as the Atria North, Toronto (T3) thermal loads and air handling typical to office buildings operate with internal overloads to be cooled off. For these structures, daylighting savings are the priority for the atrium.

Modifications :

In reality the HUB building's passage is air heated and cooled. The interior facades are nearly all glass and thus provide no thermal storage at all, but conversely highest "internal gains" from the floor areas to the sunspace. Essentially, the floor area and the arcade are thus one thermal zone. As this schematic would yield no

acceptable passive operation of the sunspace, the interior facade got re-designed with an appropriate mass wall and merely 5o % window area. It is understood, that at times of this project on the drawing board, the energy was not conceived as that, then, the building energy performance was not understood due to the prototype approach, and thirdly, cheap construction costs of the arcade were the center concern.

Building Data

Building Measures

floor area total		32 5oo m^2
residential		29 ooo
sunspace		2 52o
perimeter facade	29o.oo x 15.oo x 2	8 75o
	26.8o x 15.oo x 2	1 6oo
interior facade	29o.oo x 15.oo x 2	8 75o
roof	29o.oo x 9.9o x 2	5 761
skylight	29o.oo x 8.5o (horizontal)	2 465

Building Mass

slabs	29o.oo x 9.8o x .16 x 5	4 562 m^3
	29o.oo x 6.oo x .16 x 2	558
walls	15.oo x 9.8o x .16 x 52x2	2 446
arcade slab	29o.oo x 8.5o x .2o	495
interior facade	29o.oo x 15.oo x .12 x 5o%x2	522

Volumina

building	29o.oo x 15.oo x 1o.oox2	87 ooo m^3	
arcade	29o.oo x 16.oo x 8.5o	39 576 m^3	= 44%

Internal Loads

			hourly	daily
964 students	964 x 68W/h	1o h	66 552 Wh	655 52o W
lighting/stoves appliances	2 W/m^2	5 h	58 ooo	29o ooo
retail	33 75oft^2x5W	12 h	168 75o	2 o25 ooo

Inflitrations

floor areas	V x 5.o	43 5oo m^3 x .34	14 841 W/h	(9)
alternativ	V x 7.5	65 25o x .34	22 185	(1o)

ventialtion retails

3ocfm on 5o Occupants/1oooft^2	2 23o cfm	
1o hours	1 215 ooo cft^3	
x specific heat .34	116 977 W/h	

ventilation arcade

	39 576 m^3 x .5	52 768	6 727 W/h	(11)
alternativ	x .75		1o o91 W/h	(12)

U.A Factors

		k = ($W/m^2{}^oC$)	Area (m^2)	U x A	
perimeter		.5678	437o	2 484	(1)
glazing	single	3.55	437o	15 531	(2)
	double	2.84		12 425	(3)
sills interior		.5678	437o	2 484	(4)
roof		.45	5761	2 592	(5)
fronts		.5678	16oo	9o8	(6)
skylight	double	2.84	29oo	8 236	(7)
	heat mirr	1.4		4 o6o	(8)

Assumptions

The sunspace is understood as a separate thermal zone within the building. As passive space within a "active" building, the sun - space remains unheated, but supplied with radiant heat by transmission losses form the adjacent floor areas, counted as "internal gains" to the sunspace; additional to its actual internal gains form people and uses such as restaurants. The adjacent floor areas are herefor assumend on a base temperature set of 18°C, disregarding which soures of heating supply this room temperature.

Solar gains transmitted through the glazing, and losses through the glazing are accounted as external impact, realtive to local average daily radiation received on horizontal surface, and mean outdoor temperature ($t_{ambient}$).

Ref.: T. E. Johnson, MIT (46)

Average transmission of solar radiation through the skylight glass is accounted with 66% as related to a clear double layerd glazing with U-value of k=2.85 W/m^2h^oC. Mounting construction as thermal bridges are negelected at this stage. Inflitration of the building is reduced to o.5 air changes/h, due to,large interior volume of air and improved mirco climate reducing wind pressured inflitration.

In terms of the heatlosses at the skylight, warm air stratification is not considered.

"Steady State" Estimation

Following ASHRAE (11) 24.2, Estimation of Temperatures in Adjacent Unheated Spaces, one can determine a mean sunspace temperature at certain key dates as mentioned before, and form that found T_{sun} assign also a heat loss to the UxA glazing according to $t_{outdoors}$. It is however preferable to separate day and night conditions for higher average accuracy.

This procedure yields a rough though vaild design estimate - though does not yet incorporate solar gains. The estimation is thus for winter condition far on the conservative side.

Formula ASHRAE 24.(2)

$$t_u = \frac{t_i(A_1U_1 + A_2U_2 + A_3U_3 + \text{etc.}) + t_o(2.16\,\dot{V}_o + A_aU_a + A_bU_b + A_cU_c + \text{etc.})}{A_1U_1 + A_2U_2 + A_3U_3 + \text{etc.} + 2.16\,\dot{V}_o + A_aU_a + A_bU_b + A_cU_c + \text{etc.}} \quad (1)$$

where

t_u = temperature in unheated space, Fahrenheit.
t_i = indoor design temperature of heated room, Fahrenheit.
t_o = outdoor design temperature, Fahrenheit.
A_1, A_2, A_3, etc. = areas of surface of unheated space adjacent to heated space, square feet.
A_a, A_b, A_c, etc. = areas of surface of unheated space exposed to outdoors, square feet.
U_1, U_2, U_3, etc. = heat transfer coefficients of surfaces of A_1, A_2, A_3, etc.
U_a, U_b, U_c, etc. = heat transfer coefficients of surfaces of A_a, A_b, A_c, etc.
$\dot{V}_o$ = rate of introduction of outside air into the unheated space by infiltration and/or ventilation, cubic feet per minute.

Skin Load Comparison

Based on this estimation, and later with improved temperature swing simulations, a comparison of building configuration efficiency can be established.

Form the previous UA factors :

Conventional building :	(1+3)x2 +(5)+(6)+(1o)	55 694 W/h°C
	t_{out} = 15	835 41o W/h

Sunspace building	(1+2+3+4)+(9) T +(7)	562 62o W/h	= 67%
Sunspace heat mirror	+(8)	531 3oo	= 63%

This figures already argue for the sunspace building configuration, not yet regarding though any solar gains or potential for reclaiming buffered heat.

In short form, the "potential savings" can be described also as:

$$UxA_{\substack{Perimeter \\ conventional}} \times T - UxA_{\substack{Perimeter \\ sunspacebdlg.}} \times T + UxA_{skylight} \times T = UxA_{reduced}$$

Overall Comparison

These figures have to be assesed in an overall view of buildings energy consumotion, to demonstrate the high "relative" efficiency over the efficiency of other building configurations.

single family detached house	15o m^2 winter	87.5 W/m^2	1oo %
tenement multy storey house		37.5.W/m^2	42 %
HUB Student Housing	conventional	25.7 W/m^2	29 %
HUB	sunspace	17.3 W/m^2	2o %
	heat mirror	17.o W/m^2	19 %
Nya Esle Kommun, Sweden*		4.8 W/m^2	5.5%

* These figures are calculated form the Sydkraft rapport (77)

Conclusion

The conscious clustering of buildings, optimizing the built bulk and reclaim of internal gains is the major energy conservation strategy to be persued

Simulation Programs

Once solar insulation, thermal storage, "internal gain" flow interwind , four interrelated dynamic heat flows have to be considered with a calculation method that allows hourly dynamic computation of a series of thermal nodes and related conductances.
Also, a simulation must incorporate local weather data, to determine skin losses, especially that of the glazing on an hourly basis relative to outdoor ambient temperature.

For their accessability and appropriateness for the sunspace buildings configuration and the desired simulation data, TEANET and CALPAS3 is preferred. DOE 2 is at this point too voluminous to operate since foremost sunspace temperature swings and related losses are in question. P. Nile's program would perfectly provide this temperature swing, but would not process "internal gains" to the sunspace from adjacent thermal zone (floor areas), which in turn is greatest source of energy to the sunspace buffer.

TEANET-Program

for reference see :

TEA-TEANET Program Instructions

Chris Benton, Teanet Version Benton

The TEANET program is run on a Texas Instrument TI-59 calculator and allows the computation of up to seven temperature nodes, interrelated by conductances incoporating UA factors of the building's walls.

Weather data is inputed as solar noon insulation, outdoor temperature and $^{1}/2$ temperature swing. A subrountine generates from this and computed sunrise hour the diurnal cycle of insulation and temperature.
The print out gives weather conditions, auxiliary heat and temperatures of the models nodes. (1-7) on a hourly basis.

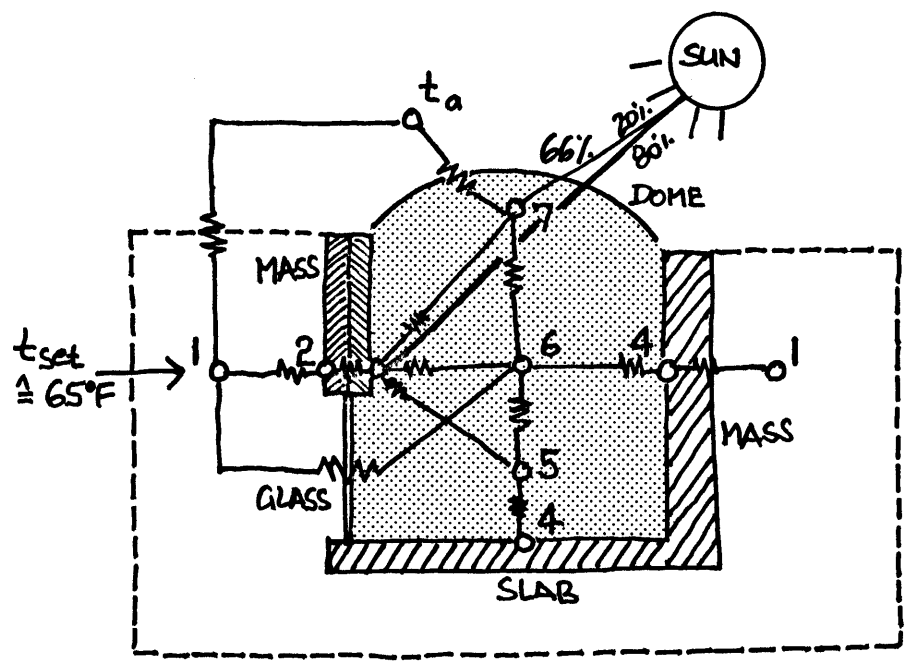
Crucial to the accuracy of the TEANET is the design of the simulation model.

Several abstraction are to be made to account for horizontal sunspace glazing, different thermal masses, "internal gains" form floor areas, thermal lag and stratification in the height of the sunspace.

Thus, the floor areas are perceived as one zone with t_{set}, with one compound transmission loss trough interior glazing, and one heat-transmission through the mass wall compound of either side of the aracde.

Model and Matrixes

the matrixes were first computed in W units, but appeared to be better scaled for the solar input (B3 column) in Btu units.



Weatherdata

EDMONTON				lat. 53.3	
	HS	Smax	Srise	Tswing/2	DD^{65}
Nov	4o6	95	8	7	1247
Jan	326	75	8	14	1832
Mar	1149	172	7	8	1362
Jun	2o6o	21o	4	1o	-

	1	2	3	4	5	6	7
1	144	61	0	34	0	0	0
2	61	290	34	0	0	0	0
3	0	34	246	0	20	20	20
4	34	0	0	304	61	61	0
5	0	0	20	61	157	7	0
6	51	0	20	61	7	157	3
7	0	0	20	0	0	3	65

	1	2	3
1	937	112	0
2	195	0	0
3	152	0	15
4	140	0	0
5	69	0	0
6	15	0	0
7	15		
	CAP.	TOUT	SUN

MAXIMUM SOLAR RADIATION
SUNRISE HOUR
AVERAGE TAMBIENT
TOWING / 2

STARTING TIME

INTIAL TEMP. NODE 1
NODE 2
NODE 3
NODE 4
NODE 5
NODE 6
NODE 7

THERMOSTAT SETTING
NODE 1 CAPACITANCE

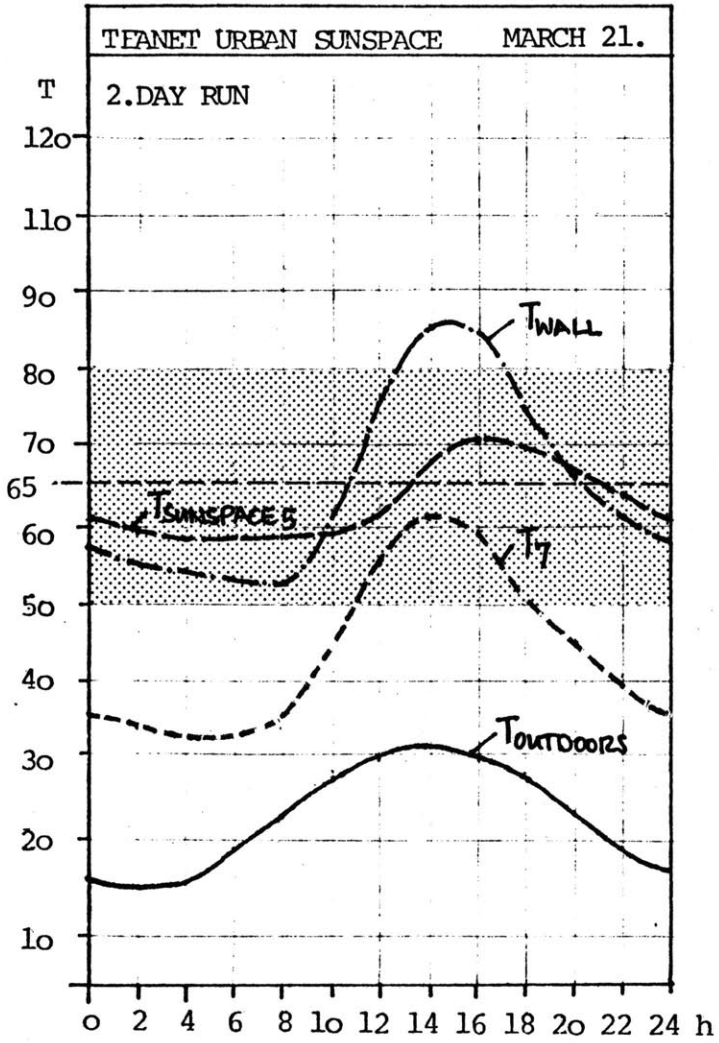
Conclusions

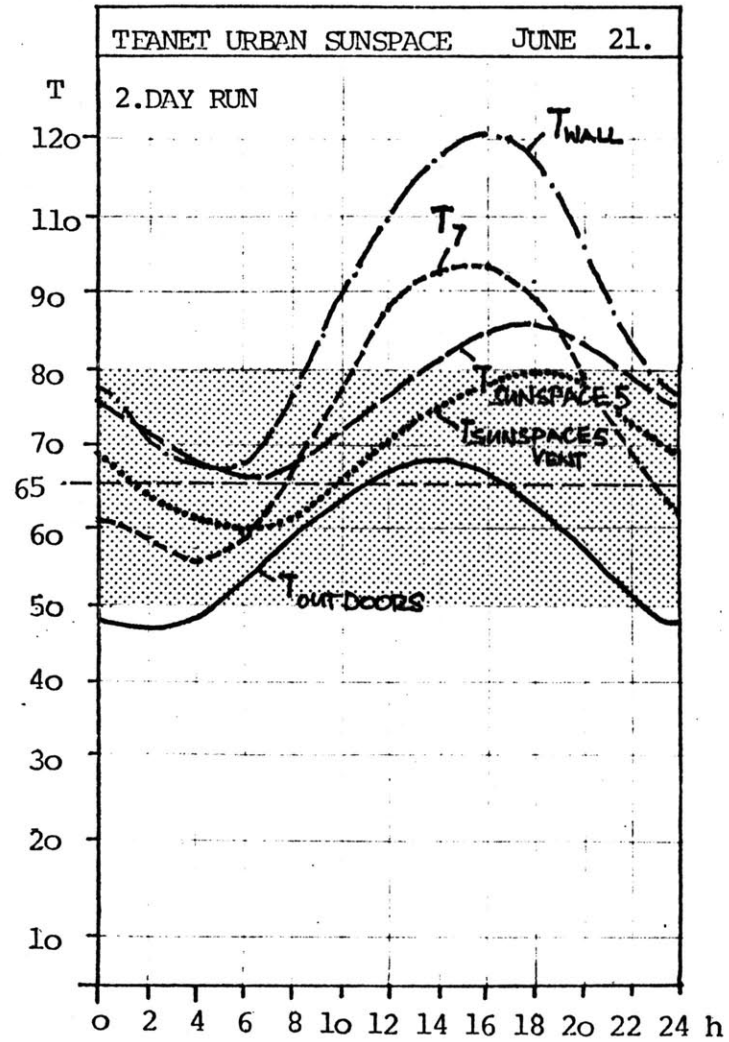
The passively modified arcade of the Edmonton Student Union Housing stays well within comfort range in March and even November. Tempertures in Node 5 keep at least above 52°F, and reach in the afternoon fair indoor conditions.

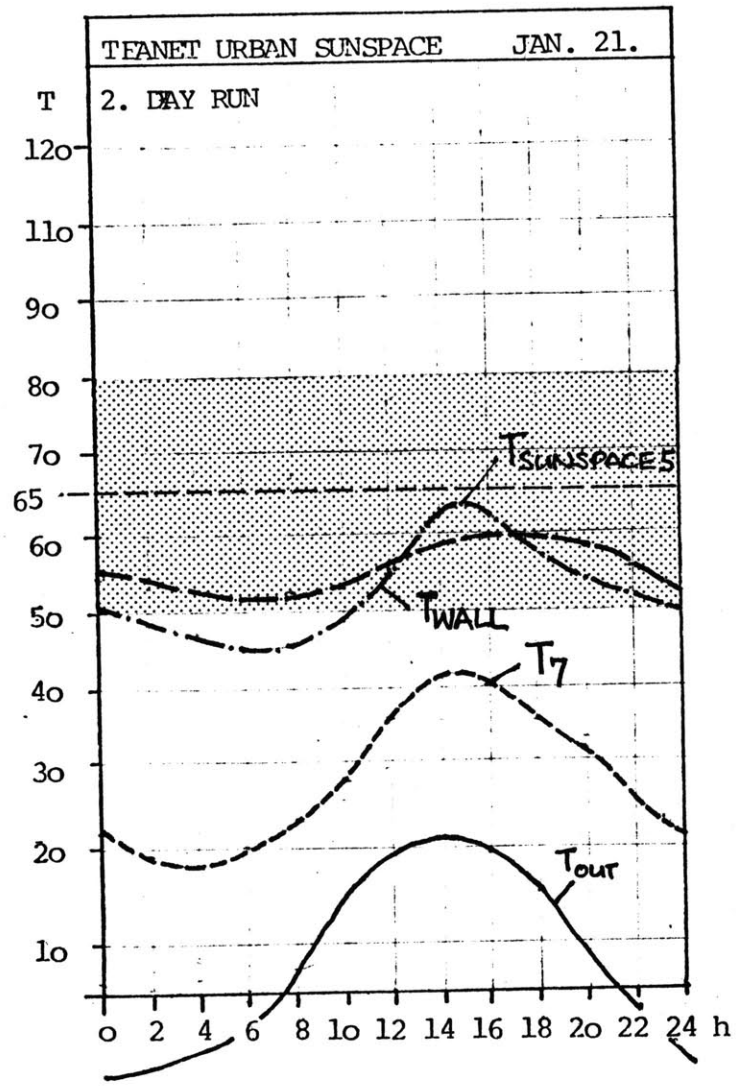
In January, the morning hours until 10h stay at bay, but below comfort. Likewise in June, noon to afternoon hours reach excessive temperature, which in turn was vented off in a further simulation run. This venting does not yet account for excessive night cooling with the building mass on tuned schedule.

Overall, the lacks of the performance in January and especially in June can be passively controlled with design improvements

Performance Graphs






TEANET URBAN SUNSPACE JAN. 21.
2. DAY RUN
T
120
110
90
80
70
65
60
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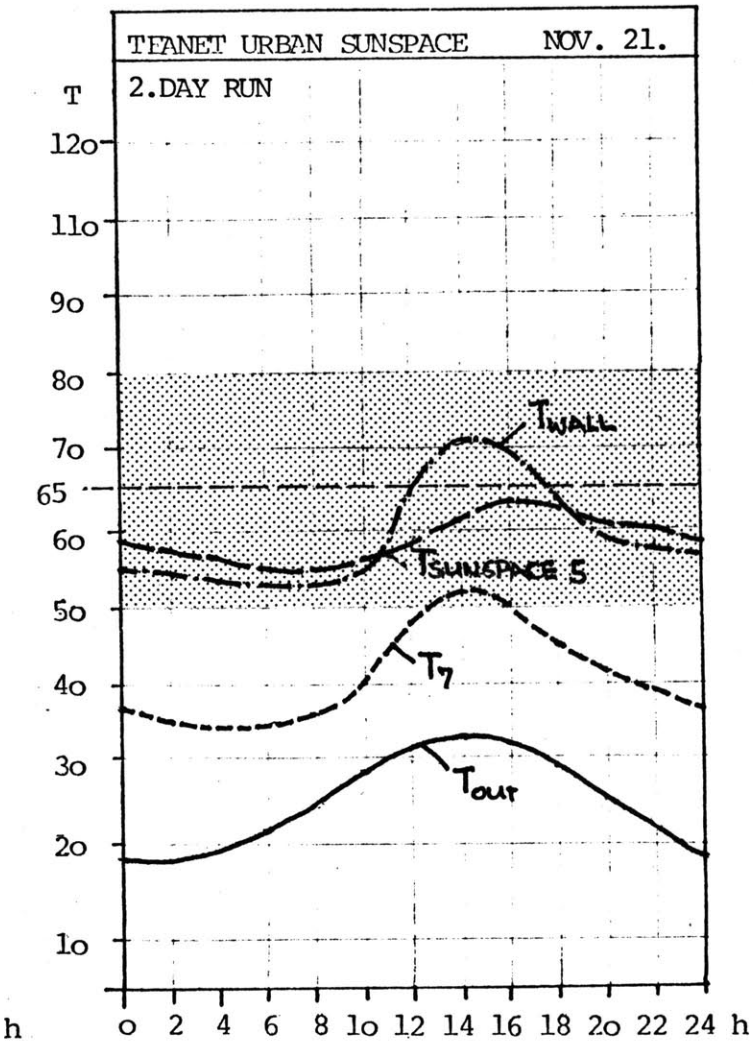
TSUNSPACE 5
TWALL
T7
TOUT
0 2 4 6 8 10 12 14 16 18 20 22 24 h


TEANET URBAN SUNSPACE NOV. 21.
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TWALL
TSUNSPACE 5
T7
TOUT
0 2 4 6 8 10 12 14 16 18 20 22 24 h

DESIGN PATTERNS

Following the format of Ch. Alexander's pattern language, the following patterns first describe the design principle to the problem, then give a discussion of considerations leading to a set of recommendations to the problemsolution.
As such, the patterns are meant as a tool for programming sunspace buildings and especially the sunspace itself.

Assessing visited projects to develop these patterns, it turned out that most atria and arcade schemes remain isolated experiments by architectural firms, responding to a certain design problem or idea. Thus, there are some prototypical configurations, but final building designs are fairly unique, especially recent projects which are largely the response to particular site constraints. Even schemes which could have prototypical value like the HUB building in Edmonton, have found no successors. The unconventional problems faced with this largely unprecedented type of building often leaves the designer frustrated. Confidence and design knowledge is fragmented, perpetuated by the lack of documentation and experiences of the type.

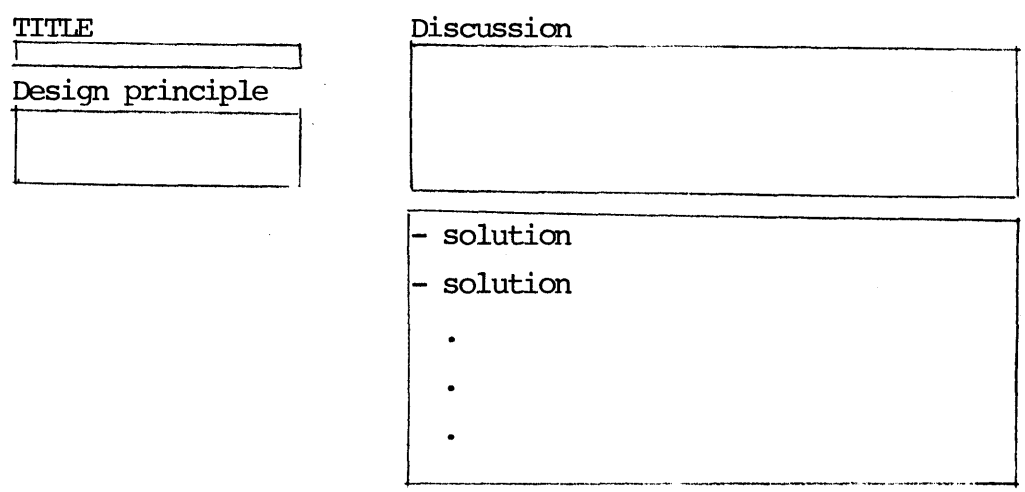
Thus, the following patterns seek to compile these fragments, to point out the common pattern to designsoultions to provide a more knowledgable sunspace design approach.

The patterns can be understood as a condensed dictionary for sunspaces when employed as a passive design concept.

Differing from building classifications and constructions, where

components are highly repeatable, particular site constraints and use programs pose most individual problems to the sunspace's design solutions. The applicability and inclusiveness of any set of patterns to a particular circumstance is thus hard to determine. In light of this, the patterns focus on priority issues more likely to have common applications. In their application they should thus be seen rather more as a way of conceptualizing these issues, as qualitative guidelines for problem solutions, not as straight quantitative measures to be followed mechanically.

Format display



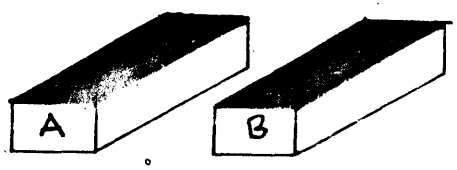
Listing of design patterns

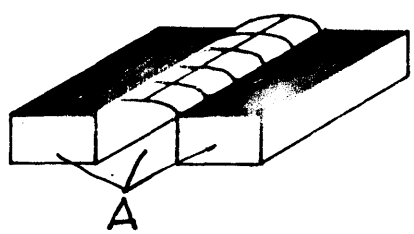
Conceptual integration of the sunspace in the building design
Regional climate response with passive operation mode
A peoples place
Living aside to indoor spaces
Relation and competition of the sunspace with the streetlife
Entering Transition
Circulation
Transparency and mass
Proportions and Dimensions
Collage interior
Floor plan with interior and perimeter facade
Use zoning
Thermal comfort
Odors
Accoustics
Fire and smoke Provision
Artificial Lighting
Daylight dynamics and qualities
Daylight glare
Distribution of daylight

Solar orientation
Solar controls
Solar heat gain storage
Air handling and energy conservation
Interior facade
Windows
Railings and sills
Floor pavements
Greenery and Landscape
Fountains
Sit spots and balconies
Seating areas
Mix of uses
Restaurants
Services and retail

CONCEPTUAL INTEGRATION OF SUN-SPACE IN BUILDING DESIGN

Technical and organizational implications of the sunspace should determine the buildings overall concept.





The sunspace generates a central core to the buildings lay-out, influencing zoning and circulation, and with additional interior facade area internal orientation of the floor plan with a number of design easements, such as interior daylighting, exposed extra circulation floor area, weather protection to inner facade and its balconies, accomodation of services and ducts. Even in restraint site conditions, the sunspace improves thus the overall floor plan efficiency. By conscious configuration of the building mass, an interior space gets enclosed to create a tempered climate pocket for all year around "outdoor living" in severe climates, though with energy conscious buffering of waste heat and solar radiation with appropriate large glazing. Simply attaching the sunspace to a conventional building would not utilize this potential and its final cost savings. A superior match of sunspace layout and floor plans, in dimensions and in spatial interrelation is superior requirement for optimal utilization of these gains. The sunspace must be an integral part of the design evolution.

- Design floor areas simultaneously with sunspace circulation, interior visual relations, daylight and thermal zoning.
- Incorporate the skylight in the overall built form as a dominand feature to unify the building elements.
- Orient floor areas with the sunspace.
- Use thermal comfort of the sunspace for additional use density, as amenity and service, and as a potential for interior collage elements of the building.

REGIONAL CLIMATE RESPONSE WITH PASSIVE OPERATION MODE

The decision to glaze-in artria as sunspaces should assess environmental incentives and feasibility of passive operation relative to local climate conditions.

For further information see :

F. Gutheim (32) : A livable winter city

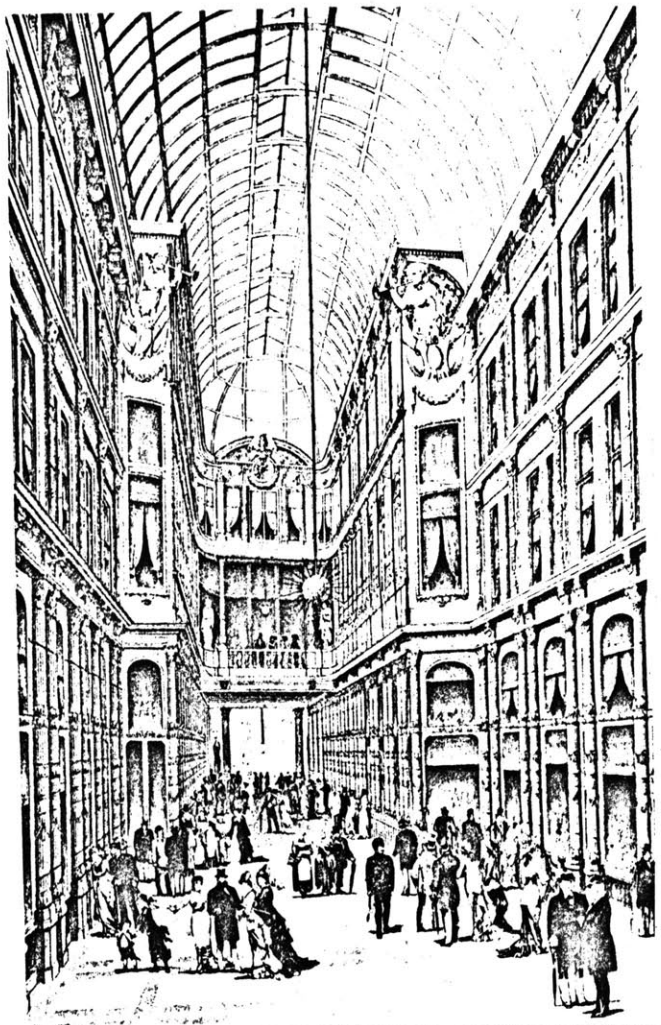
Glass covered atria as passive designs work in response to local climate conditions of northern latitudes. By building configuration and glazings, sunspaces improve the buildings micro climate and utilize solar radiation and natural thermal flows. Incentives for tenants and energy conservation depend on careful assesment of passive temperature swings in the separated sunspace zone. If this swing can be kept in acceptable ranges (see) and the space need not be heated or mechanically cooled down, substantial energy savings are achieved.

Against common prejudice, appropriate comfort can be designed with the built form, providing a habitable extra space for all year use. With non-mechanical control, a wider application of glazed atria can be envisioned. For example, in residential structures, where commercial incentives as in mall or hotels, etc. would not take up with increased costs, but where the amenity is even more desirable. The passive operated sunspace offers a clear improvement of otherwise marginally habitable outdoors space - accepting though, some days of chill conditions for the sake of energy saving, and for economically justifying the space in first sight.

- Glaze atria and arcades as passive buffer spaces with regard to occurring thermal swings relative to local weather data.
- Calculate passively achievable tempering of the space to assess climate incentives and range of passive controls.
- Calculate potential energy conservations and related costs.
- Investigate demand for semi-outdoors space and its utility relative to the buildings' uses and site location in context.

A PEOPLES PLACE

The sunspace should be an amenity to the public.



Sunspaces offer climate protection and a spatial frame for outdoor activities. Its spatial amenity calls for urban vivacity as public space and as a "stage setting" for people's activities. With a scenario of facilities, furnishing elements and a mix of uses, seating areas and interior greenery, sunspaces extend outdoor living into severe winter times, and thus work inherently for and with people - and less as interior landscape, greenhouse imagery or merely private interior.

As a public amenity, the atrium scenario is also conducive to people's desire to observe public life, and to perform themselves as part of this public in a known, spatially determined setting of theatrical character. As a stage, the sunspace meets the social expectations of seeing and being seen.

- Provide spatial lay-out and uses for public draw.
- Provide inviting seating areas and other habitable facilities to encourage people's adaption and remaining in the sunspace.
- Provide coves and edges for people to take a relaxing moment and observe the scenery.
- Treat the sunspace's setting as a stage, with reserved indoor greenery, "backstage" spatial elements and facades as a frame to the scenery of people using the space.
- Display furnishing elements with emphasis on the least obstruction of movement of people in the space.
- Provide distinct activity areas.
- Enhance spatial sensation of "stage setting" with stair, light and perspective effects.

LIVING ASIDE INDOOR SPACES

For tenants, living aside an indoor environment is a new experience that has to offer superior utility and communal advantages.

Residential living facing one facade to an interior communal space poses psychological fears and prejudices. Living under a glass enclosure is unusual and contradicting the common concept of a home. Mostly, daylight sacrifices and accoustic problems are expected as obstacles. Experience with dense housing, narrow unusable backyards and the concern for free view, the fear of lost privacy drives prejudices. People actually living in urban sunspaces though, praise comfort advances and the richness of urbanity and interior gardening, and even surprisingly a certain peacefulness.

In smaller scale though, it is a favorite place in recent single family home designs, whereas the "public privacy" in urban scale seems to threaten expectations. Though with a revival of urban life style, and sunspace advances such as weather protection, unconfined circulation, communal sense of place, all year ambient balconies being more frequently experienced, the sunspace concept will prove it's advances and find it's market as the townhouses and condominiums currently do.

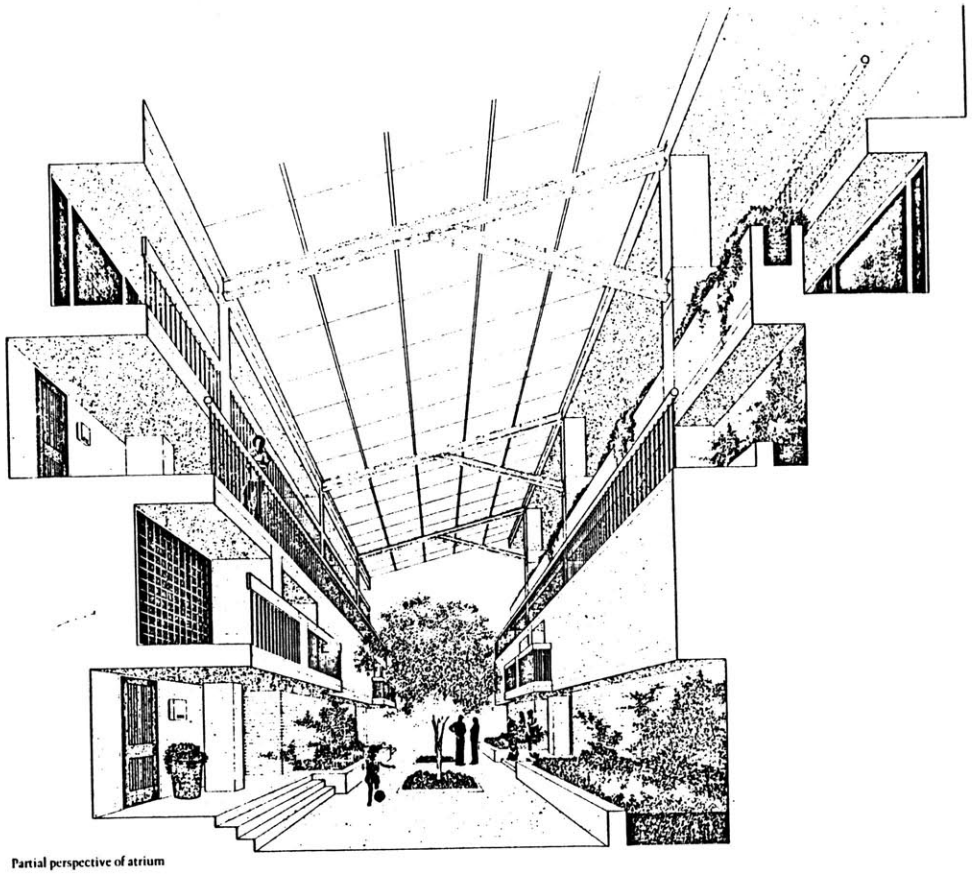
- Focus the buildings' scheme on its distinct character as a communal setting with services and weather protected communal interior.
- Provide projects of large interior scale of at least four stories and 30 - 40 dwelling units to avoid spatial unease from claustrophobia, and to create a community large enough for social interaction.
- Provide the glazing as maximum light construction, for most

This conservatory and swimming pool in Los Angeles, built in 1913 by Lord & Burnham, recreated the Garden of Eden in the 1920s.

Hix (38)p.91

prejudices on stuffy air and less light are related to the sky-light enclosure.

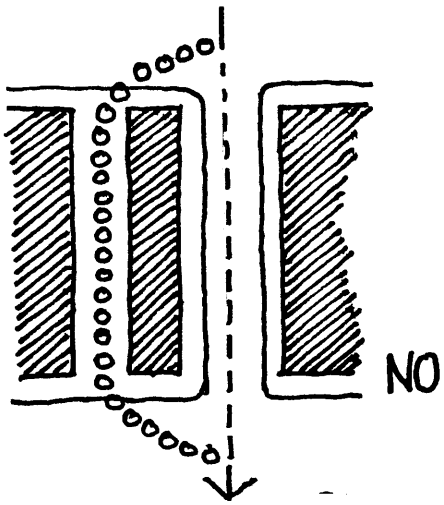
- Encourage interior habitation amenities with well placed and scaled balconies for the dwellings and seating areas at ground plane.

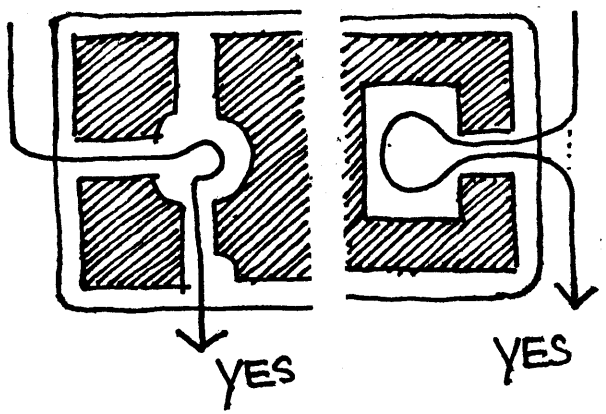


Partial perspective of atrium

RELATION AND COMPETITION OF THE SUNSPACE WITH THE STREETLIFE

The sunspace should provide a source to the street life vitality, and not a drain.





The sunspace is remote from the street side walk and thus competing with the attractions there. The introverted character of the atrium does not play with the sidewalk activities, but, if adequately designed, is a source of vitality as it intensifies the utility of the area, drawing additional people to visit. Even though introverted, the atrium's activity pocket is conducive to urban vivacity.

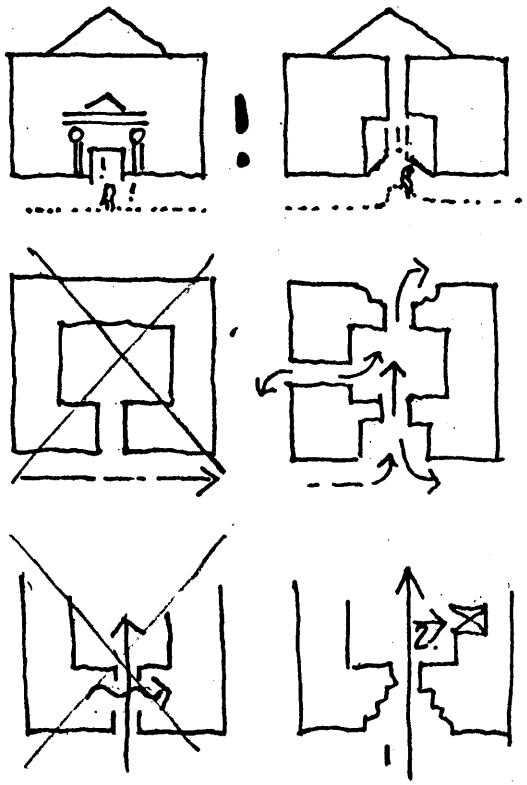
Critical to this concept is that the atrium's activity is interlocking and feeding the street life, and not bypassing it. The created amenity in the building vaults thus adds to the cities' tissue and draws attention, more than merely the sidewalk of the climate enclosure alone. Against urban blight, the sunspace is a notable additional landmark.
None of the visited spaces drain out street life. Even the Eaton Center with a repelling street side enhances the opposite side.

Another relation to the street can also be as a quiet atrium, a non-commercial retreat and rest area remote from the pulsing city street.

- Design the sunspace as an activity supplement to the street, as an orthogonal path or throughway, but not substituting and running parallel to the street.
- The use pattern of indoors should be complementary to street.
- Create a spatial sequence as a loop to feed back to the street.
- Tie the confined sunspace, a "world of its own," into a pedestrian network complementing the street.

ENTERING TRANSITION

The sunspace should serve the building as central, scale mediating entrance spine of spatial sensation to the building.

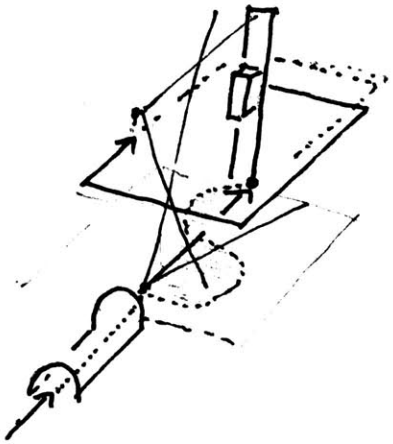


Contained by the building mass, sunspaces are mostly hidden away from the public. However, they can also provide the best entrance transition to a building. When an inviting entrance image transmits the spatial generosity to the street, the sunspace becomes a perfect semiotic link as mediator and guide of the user approaching the building. The atrium inherently expresses itself as the lobby and circulation hearth of the building.

The transition though, is twofold: one, to the sunspace, penetrating the building shell, second, from the sunspace into the building itself. The street transition is mostly a large scale opening to the inner spaces in actual perception. As a space within and as exposing the building's interior and scale, the sunspace is conducive to a psychologically easing adoption of space. The sequence of spaces from the street introduce the user incrementally, give him a clear image of the organization for comfortable orientation. A sunspace building hardly needs any directory, the space is selfreading.

With progression in this transition, scale and visual clues guide the user to the spatial edge of the building for comfortable access.

- Provide identifiable entrances with sunspace-related materials and scale from the street.
- Display receptive scenarios right at the street edge.
- Mark the sequence of space with changes of lightlevels and door-barriers.

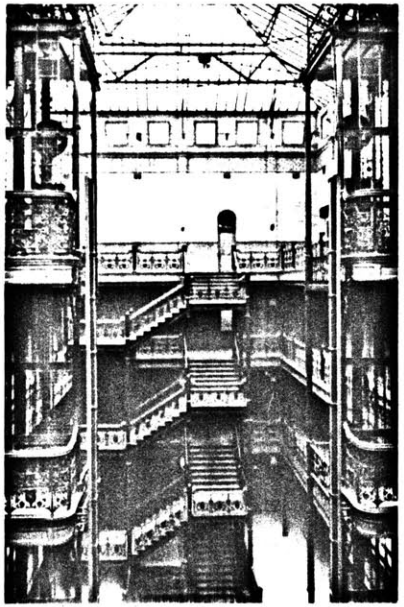


- Avoid intersection of entrance paths with other circulations.
- Enter sunspace in center axis, or, if an atrium diagonally from corner position.
- Define sunspace as space of its own with facades as a clear edge to the building.

Galleria Umberto I, 1887-1891

CIRCULATION

The circulation should tie into the sunspace as the buildings focal core - to enhance and utilize visual and spatial sensation of movement through the interior.



Circulation on galleries, stairs and exposed elevators is the spatial sensation of the sunspace, of the building's interior vault. It is the procession through space with best instant orientation by built form itself. As a large staircase to the building, spatial relations are highly exposed and self-explanatory, allowing repeatedly a total view for orientation control. The spatial unconfinement liberates from elevators shafts and stair cases, giving the opportunity to develop the circulation as an articulated theme. Generous galleries are a commonly expected feature and skylight shooting elevators were already explored in the Bradbury building of 1893. The spatial and constructive liberation of the circulation allows total three-dimensionalality and unconstrained interwinding of stairs and bridges, providing a touch of monumentality already with little design effort. Skylight and greenery adds to this open character of spatial movement - unmatched by any other building configuration.

- Concentrate and expose the circulation with stairs, galleries and elevators around the sunspace.
- Use elevators as sculptural elements shooting through space.
- Provide galleries for continuous "space walk" around the space.
- Allow bridges and spiral stairs for special connections.
- Articulate circulation nodes on galleries with bays.
- Connect inner corridors with nodes on galleries.
- Give clues to lateral direction orientation, escpecially in arcades.
- Separate tenant and public circulation with vertical circulation systems.

TRANSPARENCY AND MASS

The transparency of the sunspace's glazings should be an aesthetic counterpart to the built mass

AESTHETICS

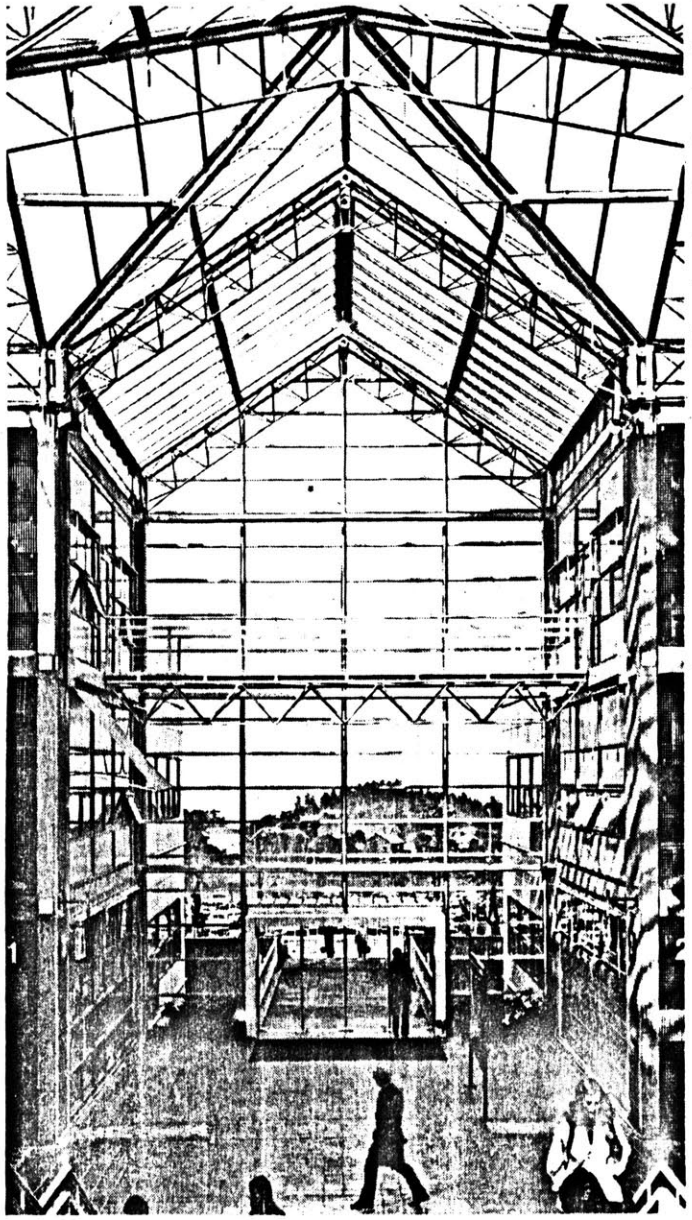
Sunspaces draw delight and vitality from their aesthetic balance of light and airy skylight construction in contrast with the built form. The glazing's transparency and lightness complements the building's solidity.

Many atrium designs though, reduce the function of glazing solely to that of a weather protection, missing the essence of the spatial design of a cheerful opening of the building to the sky and sunlight. In other respects, the glazing is not merely an "add on" but should integrate with the structural and spatial logic of the building, as the skylight "grows" out of the structure as an overriding concept. Not as a simply attached top hat, as it might be acceptable in the case of a retrofit scheme.

- The glazing's design should echo the building's mass, as a continuation of the facade, provided with a transitional edge to merge into filigran trellises work.
- Metaphorically, the glass structure has to read as a transformed sky sitting like a sunweb over the heavy building mass.
- Provide "strong" materials at facades to counterpart the light and airy skylight trellises.
- While the interior facade defines the space, the glazing confines the space to the sky as a delicate visually appealing membrane from facade to facade.
- Visual overlap with the facades should be avoided by distinct edges to the facade and construction differentiation of the skylight grid.
- For aesthetics, use symmetrical, self-bearing dome and gable

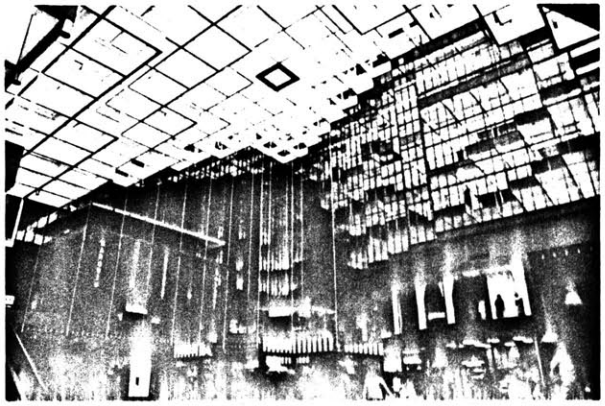
constructions for most lightness and visual balance in the form itself.

- Related to building in section, use asymmetrical glazing slope only with aysymmetrical section, for otherwise spatial imbalance distracts. Sloped skylights to "skip" the space.
- Avoid horizontal trusses with crosswise folded glazing, as this construction lacks lightness and appears as a heavy, bold, merely functional lid to the sunspace.
- Use a spatial skylight dome as opposed to a flat construction for improved thermal qualities given by excess height for collection of warm air and thermo-syphoning in the sky dome itself.
- For maximum daylight and solar aperture, use also a domed geometry to provide a larger window to the sky.
- Regard the size and location of louvers and openings to match with the scale of the glazing grid.



UNIVERSITY TRONDHEIM YES!

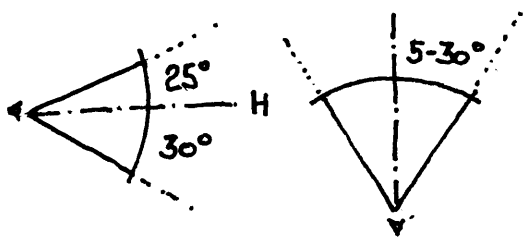
IDS-CENTER NO!



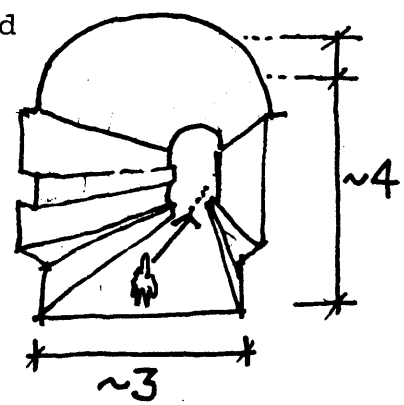
PROPORTIONS AND DIMENSIONS

Proportions and dimensions should be a function of human perception of distance and vision.

H. Maertens (67,p.178)
Human eye sight angles

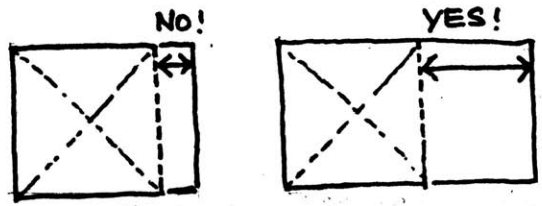


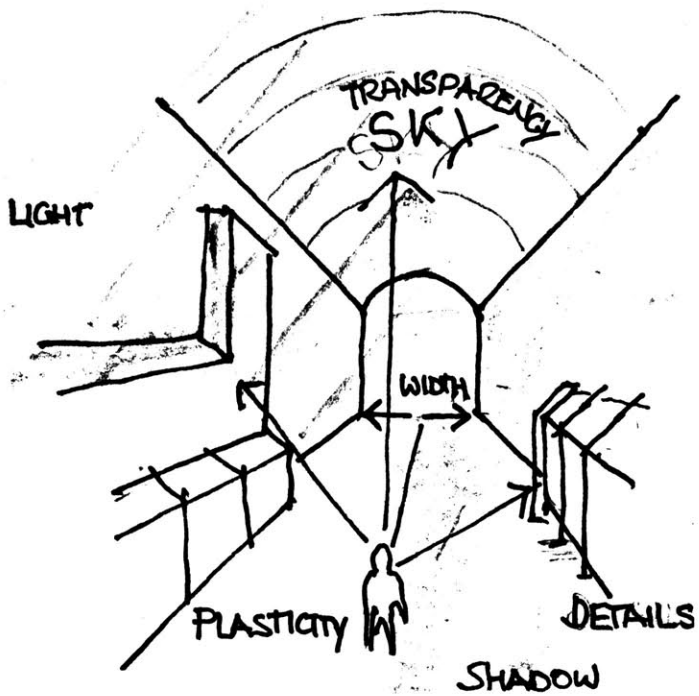
sight recognition 22.00m, and face recognition 10.00m empirically determined



The width of the atrium or arcade is critical to people's movement and visual relations from side to side. Dimensions and depth enhances direction, encourages movement and spatial appeal.
Just as early indigenous townplanning determined height of buildings relative to width of street, atria spaces should regard height and width as a proportional function.
In early arcades, dimensions were taken from an existing street pattern. Shops demanded side to side contact and width was adequate to visual distance, and height was in turn related to street width for fine proportion.
In recent designs, dimensions were derived from construction potential and functions of space, removed from human scale and perception by technical means. Opposed to that, the performance of an interior very much depends on human eye movement and visual recognition, the scale of circulation, the scale of intended activities, the scale of materials to the touch, or to be read from the distance. There is an overall scale and proportion, and an incremental break into grids of sub-scales.

- Use the width of the space as determined by activity patterns to determine height of the vault, with the recommendation of a 3:4 proportion.
- Regard visual recognition limits of 22m for configurations, and 10m for "face-detail" as measures for side to side relations.
- Stay below 8 stories since for heights greater than this, visibility angles oppose human horizontal perception and related width would exceed construction objectives. An exceeding height



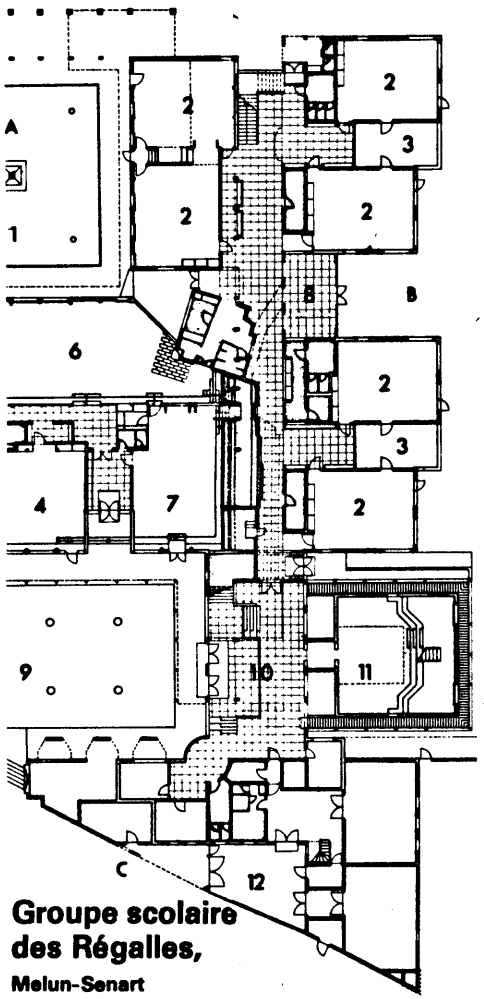


contradicts groundlevel movement and is depressing as a view.

- Depth of space can be unlimited, but should be defined with intersections for a sequential sensation.
- In plane, use either perfect square, or, exceed a square format only to articulate distinction form square. Configurations slightly off the square are distractingly undefined.
- Choose a dominating scale of skylight to contain and counterpart the detail scale of the space and the facades.
- Avoid proportional imbalance of space from asymmetrically sloping glazings when space is itself symmetrical.
- Take advantage of the facade being free from weather proof implications for articulate plasticity, recesses and projections as a scale to the space.
- Detail highly expressive material for close scale touching perception.

COLLAGE INTERIOR

The urban sunspace's scale can assemble a controlled collage of built forms unified by the skylight.



Groupe scolaire des Régalles,
Melun-Senart

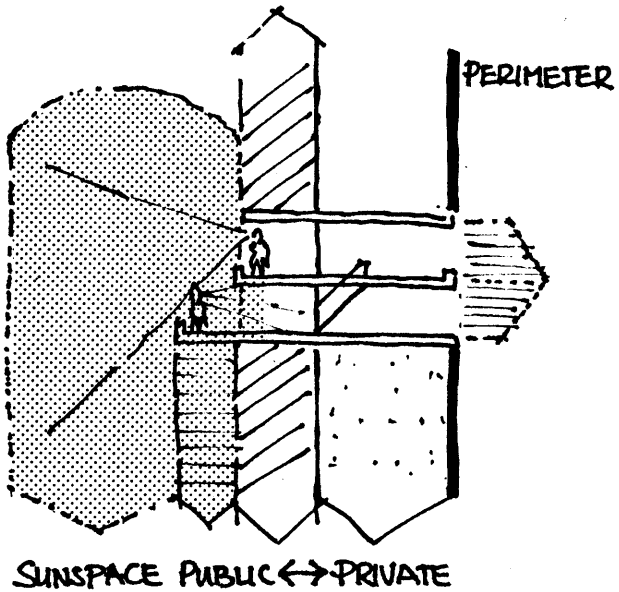
The glazing ties essentially two parts of the building together. The created intermediate space is potentially unrestrained as a display area at the groundfloor and with facades. Under the weather protective glazing, architectural elements can be collage-like assembled, project into space or be free standing elements.

A collection of collage elements can create a whole spatial sequence of an indoors street where the evolution of the facades becomes a free composition of elements as sensation aesthetics, alienation of space elements and sculptural qualities.

- Distinguish the interior design, either as a strong straight space, with clear cut edges, or otherwise as an articulate modulated space sequence with collage elements. In the latter, the elements perform. In the first the vault of space itself dominates.
- Take advantage of design freedom with individual collage elements as a "house in a house" collage.
- Use free sculptural elements in space.
- Twist facades into the space as spatial interaction.
- Explore three-dimensionality of interior elevations.
- Develop semiotic elements for uses plugging into the sunspace such as articulate doors, stairs, bows, porches, arches supported with color and by material choice.

FLOOR PLAN WITH INNER AND PERIMETER FACADE

The inherently contrasting qualities of inner and outer floor plan zones must be matched with programmed uses and privacy levels of spaces.

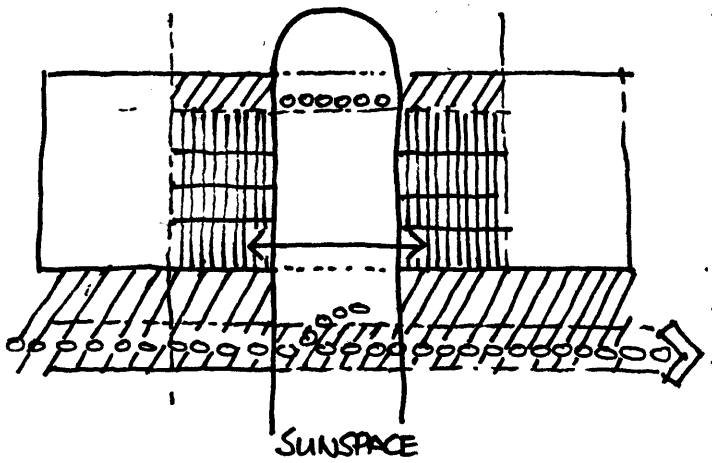


An atrium building implies a bipolarity of an inner and a perimeter facade aspect as determinant to the floor plan's various room functions and privacy levels.
This impact applies both to tenements and office projects. Planning of these horizontal zones has to coordinate the different needs of the programmed spaces with appropriate location within the sunspace or on the perimeter. The need for light, access, height and depth, privacy and public appearance determines the individual location of spaces. Dimensions and activity characters of the sunspace imply privacy and auditory levels, while the perimeter location does not.

- Orient public functions, such as kitchen, livingroom, porch, play-area, children's room, and entry at the sunspace side.
- Functions with high privacy demand place at the perimeter.
- Bypassing galleries are preferable as a communication amenity, however poses privacy distractions. Duplex flats can provide in these cases additional unobstructed interior facade.
- In office complexes, place superior functions, such as convention rooms and executives to the atrium, to take advantage of the indoor imagery.

USE ZONING

Uses and activities of high public appeal should be placed adjacent to the sunspace.



oo PUBLIC

VISUAL ATTRATION

PUBLIC ACCESS

...OF NO SPECIAL ATTRACTION

↔ VISUAL RELATION

Spatial openness of the sunspace and invert character of the building demands allocation of all major uses with public appeal and access to the indoor.

As the sunspace is not just a hollow space, but a focal point to which the building presents itself foremost, visibility of uses from the sunspace give the visitor essential orientation and the building its image.

In nearly all visited examples, the distribution of uses regards the draw to the atrium space. While the ground floor is typically used for public interaction, the vertical accessability is often limited, though people are generally curious to the downward view and appreciate to migrate to the top floor.

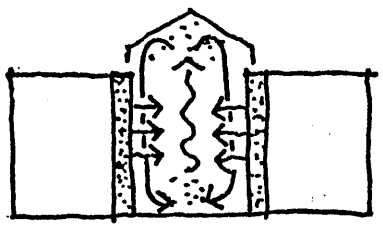
Use zoning is further closely related to the circulation pattern, whether galeries or cooridors are used or not. The depth of the floor area gives another parameter, as for twoloaded or single oriented floor area zoning.

Clearly, the sunspace facade is the more atttractive side, and in office coplexes mostly preferred by executives for its better tempering, visual ambience and exceptional image.

- Place active uses with contact and view to the sunspace
- Locate public accessed uses at bower and most upper levels
- Locate visually non attractive and less public accessed uses at the perimeter of the building and at middle range levels
- Moderate public uses of median space to act as buffer between activity levels
- Consider accoustic relations and incpmatabilities.

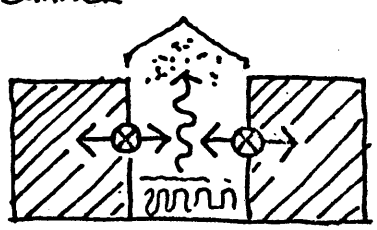
THERMAL COMFORT

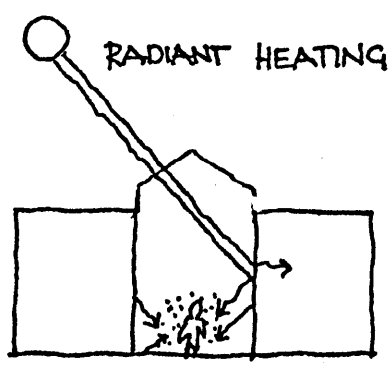
Design devices like convective ventilation, thermal storage, radiant heating and thermal zoning should balance the sunspace passively for an adaptable thermal comfort.



WINTER

SUMMER





Since sunspots are semi-outdoors, a wider range of thermal comfort then indoors is acceptable, due to clothing, activities and expectations related to the space and seasonal condition.
With this, the sunspace can practically remain passively "heated" from adjacent floor areas and solar gains. In turn, this means a diurnal and seasonal temperature swing in the sunspace that needs thus thermal separation from the floor areas. This thermal zoning is essential to the buffer erect of the sunspace and related controls of heat flows. Only with thermal zoning, outdoor temperatures can be mediated for comfort and cooling ventilation be maintained by stack effect, while otherwise thermal flows and air pressures interwind creating uncontrollable heat, and cold pockets in the floor areas.
As a passively, non-uniform tempered zone, the sunspace provides seasonal and diurnal temperature ambiences, to be adapted by the user, but kept within the range of +10° to 26°C.

- Provide an interior facade as an operable thermal membrane to control temperature swing, air pressures in the sunspace and interchanging heat flows from floor areas.
- Temper people's levels and let warm air collect under the glazing for reclaimation.
- Use building mass, transmission from floor areas, ventilation and insulation to balance seasonal and diurnal temperature swings in tune with an adaptable confort range (see p.).
- Supplement cool conditions with radiant heat - heat bodies, not the air! - form solar heated surfaces and direct solar incident.

ODORS

Major odors should be excessively vented right at the source to outdoors, while "inhabitation odors" should be controlled by regular air change rates.

see also Givoni, (3o)p.266

Accumulation of odors in an atrium or arcade is common resentment that the design approach has to deal with. It is conceived that ventilation from apartments and restaurants, from inhabitation itself, builds up bad odors in the indoor space. Due to the optimized building skin area, the reduction of wind forced infiltration to an estimated .5 air change odors have to be more of a concern than in conventional projects. In sunspaces, also the discharge of "used air" can be anticipated to worsen the air quality indoors.

However, it must be considered that there is nearly a third as much air volume in the building for compensation. The observed projects did not show tenant complaints, even with restaurants in close reach. Smells were noted as "sometimes" but perceived as "sensation, that there is life in the building" (HUB, Edmonton) - a sensation, that air standards would not allow.

Besides, as odors are very subjectively perceived, and do not pose a health threat, control of them is determined along with oxygen and carbon monoxide ventilation. These standards are by experience sufficient. For particle air cleanliness, intake filters from sunspace to apartment can be employed.

In urban settings, pollution is a much higher threat against which the atrium to some extent can even be perceived as a protection. By pebble ducts and top air intakes, the sunspace's greenery, indoor air can be even improved over outdoor condition.

- Standard health ventilation is fairly sufficient to control

bad odors while normal good odors might well be perceived as a positive sensation in the building if they remain reserved.

- The reduced infiltration of the sunspace building is compensated for by excessive air volume.
- Use the sunspace as discharge and return air plenum for heat to the sunspace, and reclaimation of ventilation losses.
- Vent strong odors, such as from restaurant kitchens, right at the source more aggressively than would be normal.

ACCOUSTICS

Conscious use of sound absorbing interior surfaces should compensate for excessive areas of sound-reflective glass on skylight and windows.

Exceptions are related to activity level our sound perception and measure of sensitivity to instant subjectivity. Likewise, the individual's freedom for control of his auditory environment seems essential.

Source;
A. Ruben, (65), Chs. 10, p.129.

Sound levels in urban sunspaces are critical due to intense activity noises bounced in the large vault of excessive sound-hard glass areas. Many objections to living aside an atrium lie in sound distraction, as also found from measures taken at the case surveys. Levels were found around 62dBA , which is already distracting for concentrated work. In other respect, use and activity related expectations built very subjective auditory comfort demands. In tenements, any disruptive noise would be counted, while outdoor street sound levels would be much higher and even non-uniform. The indoors setting though poses higher comfort expectations but also offers wider potential for passive sound control.
In most cases, little provision was made for sound damping. Large glass surfaces were highly reflective, and mechanical equipment jumped levels in the Edmonton Galeria from 52dBA to 67dBA. While the designer has control of ambient noise (equipment, fans, outdoor noise penetration, etc.) occupancy noise is only roughly possible to predict and hard to control at the source, but possible to absorb in surfaces.

- Provide maximum absorbance of surfaces on facades and floors (materials listed Ashrae chs. 25, 12).
- Trade off minimal glass use on facades versus transparency.
- Avoid non-visual glass and other sound reflecting materials.
- Additional absorption should be provided with canvas and canopies.

Speech-Interference Levels that Barely Permit Reliable Conversation

Distance between talker and listener (ft)	Normal	Raised
0.5	71	77
1.0	65	71
2.0	59	65
3.0	55	61
4.0	53	59
5.0	51	57
6.0	49	55
12.0	43	49

A. Ruben (65)p131

Distance where speech understanding is judged	Acceptability category
More than 70 ft	Clearly Acceptable
26-70 ft.	Normally Acceptable
7-25 ft.	Normally Unacceptable
Less than 7 ft.	Clearly Unacceptable

[4] T. J. Schultz and N. M. McMahon, *HUD Noise Assessment Guidelines* (Washington, D.C., 1971).

- For sound protection, fans should be employed as little as possible, be operated on low revolutions, and located outside the glass roof or in remote ducts.
- Sound blankets with fountains are not to "low" sound levels - they rather add to the noise gradient and are only valid in terms of their "natural sound" to mask out disruptive noises.
- Within the setting of a sunspace, a multiplicity of expectations are given, demanding distinct auditory edges, quiet retreats in balance with loud, conversation over-playing sound areas to allow user's choice.
- For auditory privacy, especially in residential structures, again maximum absorption is essential, and distance to opposite a side of more than 8 m, at least, is required (62 p.136, HUD Walkaway Test according to J. Schultz & N.M. McMahon, HUD 1971)

Remark : Sound levels measured on sites ranges around 62 dBA, and only minor damping provisions could be observed. Merely the John Deere HQ showed merely 45dBA, and Butler Sugre read 52dBA, as their occupancy noise levels were damped already in the office areas.

Levels of 30 NC (NC means noise criteria measuring in dBA with relativation to frequency) are "quiet." 50 dBA are acceptable without complaints in offices, and 55 dBA are assessed as distraction for concentrated work. Levels over 65 dBA are found a critical noise level. This always assumes a constant sound

FIRE AND SMOKE PROVISIONS

The sunspace's smoke compensating volume and visual openness should be consciously used as a separate fire zone for fire control and safe egress.

THE BOCA BASIC BUILDING CODE/1981

SPECIAL USE AND OCCUPANCY REQUIREMENTS

SECTION 631.0 OPEN WELLS

631.1 General: Open wells are to be classified as either atriums (Section 631.2) or floor openings (Section 631.3) and shall be permitted in all buildings in other than Use Group H when provided with the protection herein required.

631.2 Atriums: Atriums shall be constructed as herein required except atriums in buildings two stories in height shall not be required to be equipped with a smoke control system as indicated in Section 631.2.1. For purposes of this section, the volume of the atrium shall include all spaces not separated from the atrium in accordance with Section 631.2.2.

631.2.1 Smoke control: A smoke control system shall be designed to control the migration of products of combustion in the atrium spaces. Upon detection of a fire or smoke, the system shall shut down the air supply to the fire floor and the return air from all non-fire floors.

631.2.1.1 Atriums 55 feet or less in height: In atriums 55 feet (16764 mm) or less in height with a volume of 600,000 cubic feet (16800 m^3) or less, a smoke exhaust system shall be located at the ceiling of the atrium. Such system shall exhaust 40,000 cfm (18.88 m^3/s) or six air changes per hour, whichever is greater. When the volume of the atrium exceeds 600,000 cubic feet (16,800 m^3), the exhaust system shall be sized to provide a minimum of four air changes per hour.

Supply air inlets may be provided at the lowest level of the atrium. These inlets shall be sized for 75 percent of the exhaust.

631.2.1.2 Atriums in excess of 55 feet in height: When the height of the atrium exceeds 55 feet (16764 mm) an exhaust system shall be provided as required by Section 631.2.1.1. However, supply air shall be introduced mechanically from the floor of the atrium and shall be directed vertically at the exhaust outlet above. The capacity of the supply shall be 75 percent of the exhaust.

For years, fire and smoke considerations were the greatest obstacle to atria. Stack effect and interior fire bridging were assumed as a security problem and uncontrollable. Recent insights shift this concept. The atrium offers a great volume of air, where smoke can be smelled instantly, smoking-in however takes a considerable time, compared to a conventional corridor, which is instantly unpassable. The atrium allows a good time slack, visual detection of smoke and even better smoke exhaustion by stack effect and the skylight louvers, forced or even by natural draft.

The vastness of space further demands fire zoning of the building, where the atrium becomes a zone of its own, its perimeters fire rated to the adjacent areas, a measure which is quite conventional for larger building bulks.

Due to their low-rise scale, sunspace buildings pose less access problems for fire fighters. All floors can be reached, possible also from inside the building without the trap effect of corridors. Compared to highrise towers, fire provisions are substantially eased.

- Create the sunspace as a separate firezone with perimeters rated to 1 hour, by means of materials of direct sprinker systems to the interior facade (doors, walls, windows, fire sills).
- Provide for the building's circulation concept to feed into the atrium as a major fire egress.

631.3.1 Smoke control: The approved automatic exhaust system may be a separate unit or integrated with an approved air handling system and shall be thermostatically controlled to operate simultaneously with the detection of fire.

631.3.1.1 Capacity of exhaust system: The exhaust system shall be of adequate capacity to create a controlled draft in the floor opening with sufficient velocity of flow over the entire area of the floor opening under normal conditions of window and door openings in the building.

631.3.1.2 Operation of mechanical system: The exhaust system herein required shall be so arranged as to automatically stop the operation of the normal mechanical air handling and ventilating systems, and close the dampers of the return air duct connections, in the event of fire.

631.3.2 Draftstop: An approved draftstop shall be installed at each story of the floor opening. The draftstop shall enclose the perimeter of the opening and shall extend from the ceiling downward at least 18 inches (457 mm) on all sides. Automatic sprinklers shall be provided around the perimeter of the opening and within 2 feet (610 mm) of the draftstop. The distance between the sprinklers shall not exceed 6 feet (1829 mm) center to center.

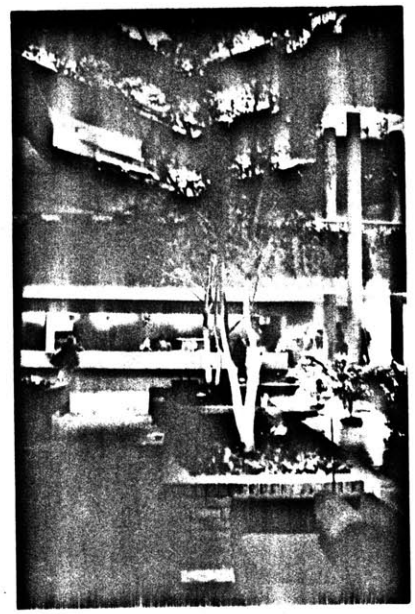
631.2.2 Enclosure of atriums: Atrium spaces shall be separated from adjacent spaces by a one hour fire separation wall. A glass wall forming a smoke partition may be used in lieu of the required fire separation wall where automatic sprinklers are spaced 6 feet (1829 mm) or less along both sides of the separation wall, or on the room side only if there is not a walkway on the atrium side, and not more than 1 foot (305 mm) away from the glass and so designed that the entire surface of the glass will be wet upon activation of the sprinkler system.

Exception: The adjacent spaces of any three floors of the atrium shall not be required to be separated from the atrium; however, these spaces shall be included in the atrium volume according to Section 631.2.

- Provide doors to other zones with automatic shutters.
- Provide mechanical top smoke exhaustion and ground level air supply for atrium fires, the utility of the system should be smoke tested to insure capacity.
- Induce slight air pressure with fans to prevent smoke spread for floor area fires.

ARTIFICIAL LIGHTING

Artificial lighting should be reduced for night hours to merely render the space vault, while giving fresh light to activity areas.



It is essential to only light nodes - not the overall space - so that the facades can appear similar to street facades. Like wise it is effective and ambient to light greenery and especially trees as well.

Urban evening activity demands artificial light that still allows a sense of the glass enclosure.

Artificial lighting is hardly required at daytime according to measured figures (see table). Even on overcast days with only 1000 ftc., sunspaces provide 50 - 100 FC., mostly sufficient for even task light. Though, with the arrival of dusk, light gradients fall rapidly off and artificial light has to supplement early.

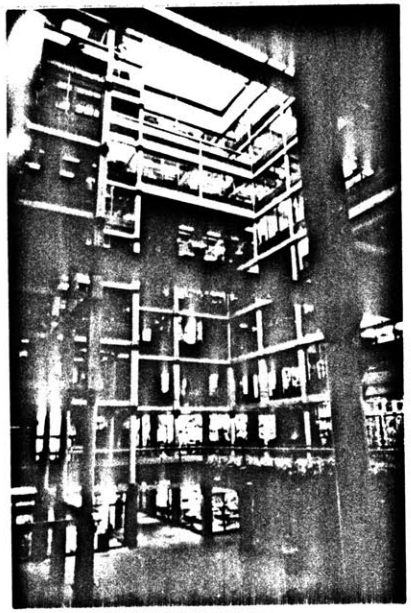
Relative to its use character the sunspaces must not be illuminated completely, rather it demands a side walk level of ambient light that still allows one to perceive the night sky above and a rendering of the facade. Only the groundfloor activities demand particular areas of task light (more than 70 FC).

- Reduce artificial lighting to night hours and to an ambient 15-25 FC. level.
- Choose the lowest overall light level for a semi-outdoor feeling to merely render structure contours with least light gradients.
- Feature the skylight vault with a silhouette rendering light.
- Light activity areas to additionally bounce ambient light to surrounding areas.
- Use light posts as a path through the building.
- Employ only background lighting with light posts and incandescent light on galleries.
- Enhance vertical circulation elements with contour rendering light distinct from the skylight.

DAYLIGHT DYNAMICS AND QUALITY

The sunspace should be perceived and perform with the ambient mode of diurnal daylight changes from outdoors.

Daylight yields an increased sense of color perception, or visibility due to a match of spectral characteristics of daylight and sensitivity of the human eye.
AIA Journal Sept. 79 p.88



Other than constant artificial lighting, natural lighting is a dynamic phenomena used to change the interiors' ambience widely with the outdoor light ambience.
Diurnal dynamics of the solar path over the sky module brightness and distribution patterns of sunbeams, shadow cast and diffusion as an ever changing experiential link of the user to outdoors, giving a sense of time, of night and day, and stimulating awareness of mind. It is this psychological difference compared to consistent artificial light, that makes tenents want to have an office on the sunspace. More sensational than indoors, changes are perceptable and the light is softened and enhanced in its spectral color distribution by the glazing.
This fascination with sunlight derives from our fundamental biological needs and aesthetical socialisation. Orientation in time and space is critical to our comfort. Changing daylight gives orientation and diversity to an environment.

- Allow diurnal changes unmodified beaming into the sunspace for there is no "overbrightness" or too low light levels at usual daytime hours if glazing is provided properly.
- Regard diurnal light levels as a psychological amenity to the user and as ambient lighting of no energy costs.
- Beyond the mere satisfaction of task and ambient light levels (Ambient 10-25ftc., tast 50-70ftc.), daylight is foremost a qualitative tool to enhance the interiors' perceptability with smooth contrasts, shadows and warm colored light.

- Provide bright light bouncing surfaces for even distribution and maximum utilisation of daylight on overcast dark days.
- Test light patterns with sunmachine for best display of areas focused in sunlight, such as seating areas.

DAYLIGHT MEASUREMENT CHART

In Footcandle

	center	wall	galery	outdoors	ratio	glazing
Atria North	7o	1oo		38oo sun.	1:54	clear double
Butler Square	5o-7o	3o-2o		11oo ovc.	1:18	clear double
CHOP	4oo	18o		4ooo	1:1o	clear wire glass
Cleveland Arcade	7o-1oo	15o		39oo	1:54	clear single*
Dayton Arcade	3o	15		2ooo	1:66	tinted, 2o%trans.#
Galleria Edmonton	1oo	1oo		15oo ovc.	1:15	tinted acryl double
Hennepin County	5o	5o		9oo ovc.	1:18	tinted, double #
HUB-Edmonton	1oo	3o-5o		4ooo	1:4o	clear acryl double
Jefferson Hosp.	8o	1oo		4ooo	1:5o	? clear
John Deere HQ	1oo	3oo		5ooo	1:5o	tinted 2o%trans.#

* glazing is of very small pieces and quite polluted

\# transmission rate from architects, not of manufacturer specifications

Measures were taken with General Electric Light Meter 214, triple range. Hours of measurement were 11 - 12 AM, lightmeter in shaded position. Measurements were also taken on galeries (upper floors) but occured to not be very accurate because of reflections and direct light, and also not comparable due to very distinct spatial differences of the projects.

Conclusions

Though with very different spatial characteristics and also differing glazing qualities, for sunny day conditions a ball-park ratio of 1:5o seems to be valid.

Overcast conditions are still viable with ratios of 1:15 to 1:2o

More important than glazing figuration thus is the interior surface treat as means to bounce captured light in space

DAYLIGHT GLARE

Daylight glare from the skylight should be controlled with blinds and curtains behind the interior facade.

Glare is defined as uncomfortable brightness of a light source or reflection, mostly occuring at windows' openings as a sort of camera whole effect. The same phenomenon can occur with skylights. However, with large skydomes, daylight glare is comparatively marginal and only on the brightest days. Large scale skylights don't produce the camera effect and the light transmitted is mainly vertically bounced and thus is in most cases indirect to task levels or objects. It is more diffuse and of less veilance. The skydome sees the whole skyvault, while windows mostly catch horizontal light which as a direct beam sets up strong patterns of dark and light contrast. Light levels from windows also fall off rapidly with distance, and show a very uneven distribution. Vertical light of skydomes produce a quite even light distribution, when properly bounced within the sunspace. As the TVA report cites, large sunspaces yield a reduction in shadow and veiling glare on tasks, and thus, overwhelmingly this natural light would be preferable as source of office illumination. (AIA Journal Sept. 79)

- Use canopies and hanging flags to offset glazing glare right at the glass dome.
- Test facade light patterns with sunmachine(App. B)for requirement of blinds or curtains against low sun incidents. Prefer blinds over curtains, as blinds were more consciously operated and kept open when not needed. Place blinds at interior facade for direct user control.
- Bounce and diffuse light with bright interior surfaces.

DISTRIBUTION OF DAYLIGHT

Daylight should be evenly distributed for maximum utilisation, while sun light should be used to render superior areas for light and radiant heat sensation.

Beaming sunrays, shadow cast and smooth diffuse light is conducive to human perception for a subjective ambeince as well as for objective readability. The intake of daylight with the skydome thus emphasizes particular areas, details, greenery, materials and colors in the sunspace.
Characteristic to the skydome is the vertical light intake. More than at a regular window, patterns of light paths and castings are visibly floating the space. Contours and surfaces get framed by light and shadow, while bouncing light enhances overall illumination.
Further, the dynamic light setting illustrates the three-dimensionality of space as shadows move over edges and corners.
The potential of daylighting for adjacent floor areas is explored as a substantial energy saving for deep office floors, referring to the TVA scheme (AIA Journal Sept. 79). Large mirrors at the floor edges bounce light to horizontal into the office depth. However, assuming a "thermal membrane" facade with windows and storage mass, this approach does not apply, and would be anyhow quite costly. Measures on sites with no diffusing provision at the skylight like in the TVA case though only supplied 15-30oftc. (ambient light level) behind the glass facade.

- Regard the daylight supply foremost as a source to the atrium itself, and only secondly as ambient light for adjacent floor areas.

SOLAR ORIENTATION

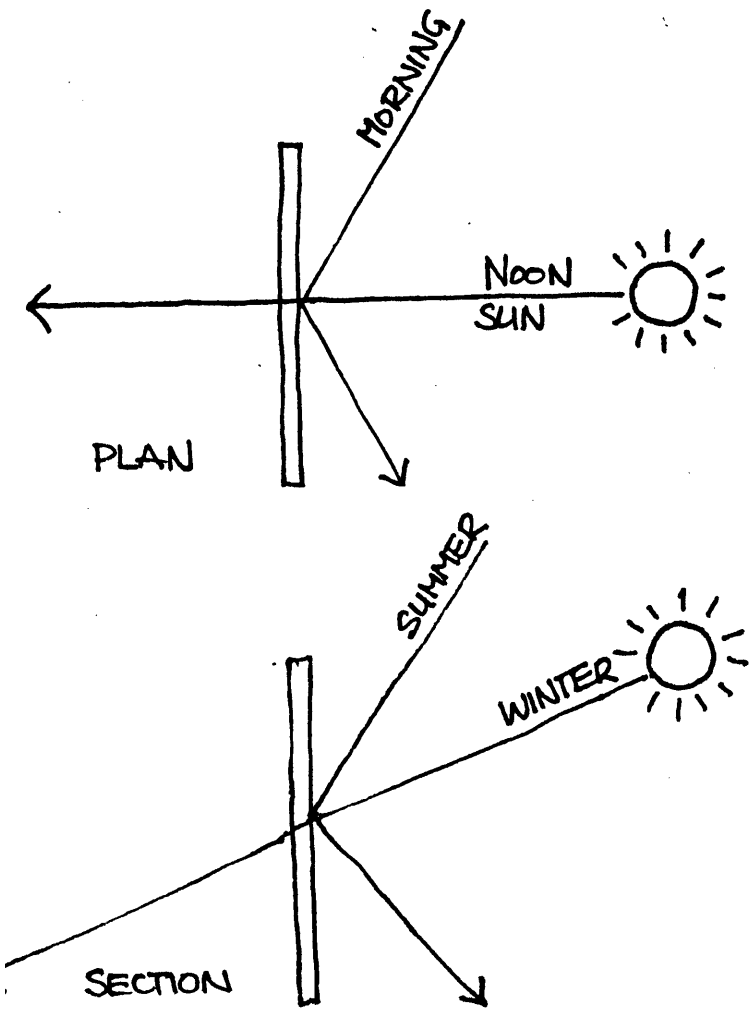
The solar orientation of the sunspace building should be determined by floor area uses.

As the solar gain aspect is marginal compared to the buffer effect savings, the considerations of floor area orientation overrule the sunspace objectives. While close to horizontal sunspace glazing is fairly neutral to orientation, the perimeter of the building is quite critical to orientation, in turn also relative to uses. In residential structures, north-south stretching facades yield mostly unequal daylighting and overheating from low morning and evening incident sun. East-west running facades offer south exposure, where high summer sun can be shaded off and reflected due to an incident angle greater than 45°, but winter solar gains can be utilized. In residential projects though this orientation yields an asyymetrical building section with complex duplex designs to avoid north facing apartments.
In office structures the orientation is determined by daylight efficiency, whereas solar gains are not desired because of high internal gains.

- Determibe building orientation relative to floor area demands on daylight and solar radiation, with priority over the sunspace's orientation.
- Adjust sunspace glazing to this parameter by applying vertical glazing only due south, and shallow tilts only to east/west
- Give south exposure to dwellings.

SOLAR CONTROLS

Solar control measures should be taken by appropriate glazing geometry, orientation and material properties.

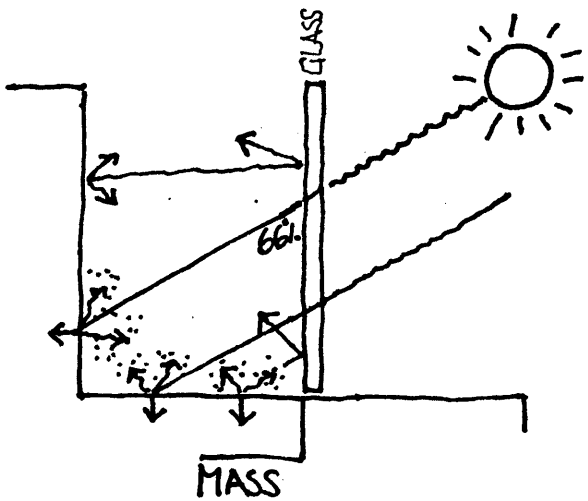


The solar transmission through glazing depends on angles of incident, and the glazings' transmissivity and reflectance. Incidents of angles larger than 45° are reflected. Normal (orthogonal) incident is transmitted with 80% with clear double glazing. Average transmission would be then 66% with regards to the sun's path over the day (south facing orientaion). By reflecting angles of incident greater than 45°, glass lends itself a diurnal and seasonal adjustment to control overheating, while low incidents of winter sun get fully transmitted. Vertical glazing would thus be most preferable for solar control. Construction requirements and also aesthetics of the skylight though are likely to overrule glazing geometry objectives. Architectural controls for shading are less known for skylights. Only suntracking fins and blinds allow proper seasonal control, though they involve costly mechanics and maintenance, and might not be reliable over the lifecycle of the building.
A common approach is thus tinted or mirrored glass, which in turn abuses the natural quality of daylight and solar gains in winter.

- Use preferably south facing vertical glazing for self-suntuning.
- Keep all other glazings on shallow angles below 45°.
- Use clear, non-reflective glass of lowest U-value for highest solar gains and trapping.
- Avoid exterior mechanical fins and blinds.
- Provide summer shading with interior white reflective canopies under the glazing, to also create layer of warm air for direct dome venting. Keep these canopies moveable for seasonal tuning.

SOLAR HEAT GAIN STORAGE

Trapped solar heat must diurnially be stored for interior temperature balance and efficient utilization of the received energy amount.

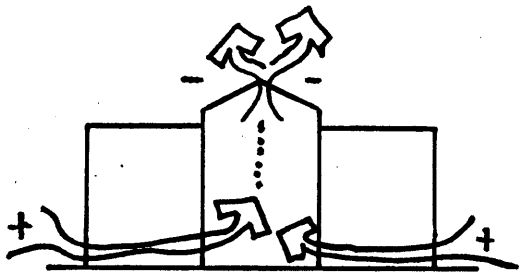


Short wave sun beams pass through the glazing and the indoor air to be converted to longwave radiant heat at shined surfaces. Due to properties of surfaces, heat gets partly absorbed and partly re-radiated relative to temperature differences with surrounding air. As this sunimpact accumulates in the hours from 9AM to 3PM with peak temperatures, thermal storage must prevent quick overheating and allow release of stored heat with appropriate time lag to balance non-solar hour's heat demand. Thermal storage determines the utility of solar gains, since excess heat st sunshine hours would otherwise be vented, and thus essentially lost for the buildings' heat supply.
Efficient spring and fall operation mode needs storage for release at nights, while the summer mode's massive overheating is foremost subject to ventilation and night cold wants to be stored for day release.

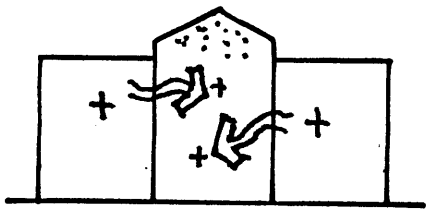
- Determine with sunmachine modelling (APP.B) shined surface areas for potential storage for winter and spring/fall mode. Calculate effective thermal capacities to be subtracted from overall solar input to receive remaining direct heat gain.
- Utilize the warm air cushion of the skylight dome by fan fo forced transfer to basement storage or vertical pebble beds.
- Use optimal air-to-water heat pumps to utilize warm air, and feed directly into low grade temperature heating systems or water storage tanks.
- Improve thermal mass capacity and absorptivity with "brick fin walls" and hollow cavity wall systems for enlarged surfaces.

AIR HANDLING AND ENERGY CONSERVATION

Buffered excess heat in the sunspace should be reclaimed to supplement the building's energy consumption.



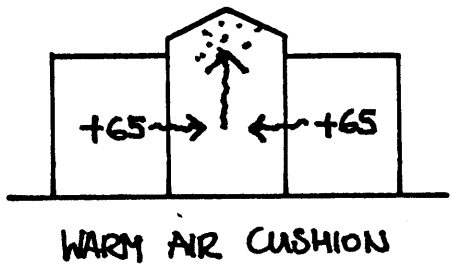
VENTILATION

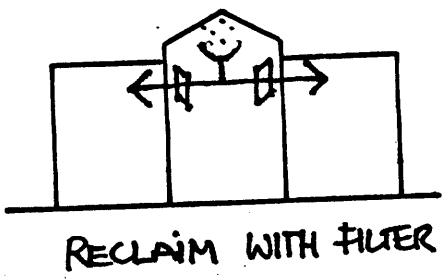


DISCHARGE

Solar and internal gains to the sunspace amount to excessive heat, subject to ventilation in summer, and reclaim for the building's supply in the other seasons.
The large scale glazing collects a considerable amount of solar energy, to be diurnally stored in building mass for balancing diurnal temperature swings. With this, night temperature drops in spring/fall and general temperature fall backs in winter can be supplemented with radiant heat.
Largest heat supply though occurs from internal transmission losses from the floor areas. Internal infiltration is only marginal since there is barely pressure differences to drive this flow.
By natural stratification the skydome collects these warm air capacities as latent potential for re-use. Discharge and reclaim of air from floor areas though might conflict with health standards and fire provisions. Any excess heat vented out, except in summer mode, though misses the ends of energy conservation, and does not utilize heat recovery techniques which can conform with building codes. As additional balance air volume to the building and as air plenum, the sunspace offers substantial savings in kW reclaimed, and as reduced ducting. Moreover, extra internal air volume allows for reduced air change rate as a major factor of energy conservation in buildings.

- Account "internal air change rate" and reduced wind infiltra-



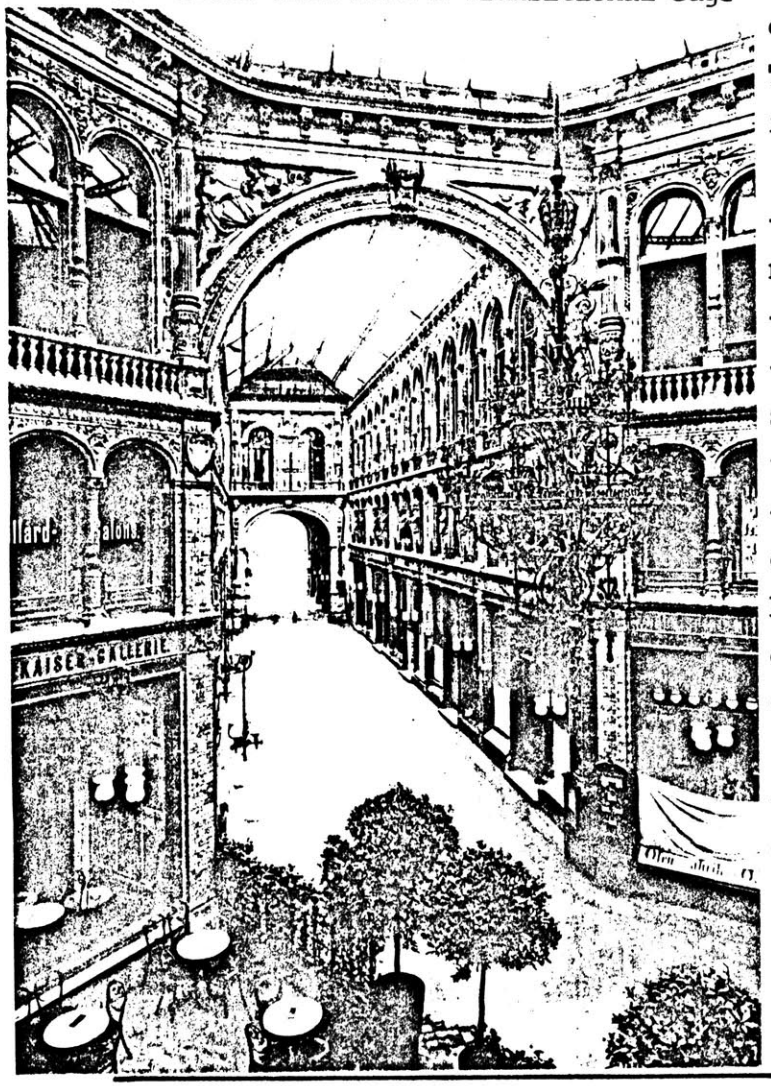


tion with 0.50 air exchange rate.

- Regard the "internal transmission losses" as heat capacity to the sunspace.
- Utilize solar energy as additional supply.
- Use sunspace as return air plenum and allow fan forced reclaim from sunspace as preheated air through filters, or, as make-up-air to reduce outdoor air to 33% according to Ashrae 62/73, Chs. 21, 13.
- Subtract reclaim capacity from venting capacity.
- Control overheating with natural convective cooling.
- Add back-up fans to drive convection draft for maximum peak cooling for short period peak control at 6m/s and regularly up to to 3m/s.
- Size openings for hourly overheating capacitance for June 21. following the procedure described on "thermal comfort ventilation."
- Provide excessive valut height over last floor area to collect warm air cushion, and to vent dome by vault turbulances already.
- If air reclaim conflicts with local building codes, apply air-to-water heatpumps to recharge into heating system and water storage tank.
- Use inducing back-up fans for intake of summer night cooling air supply, but also for slight overpressure to prevent smoke spread.

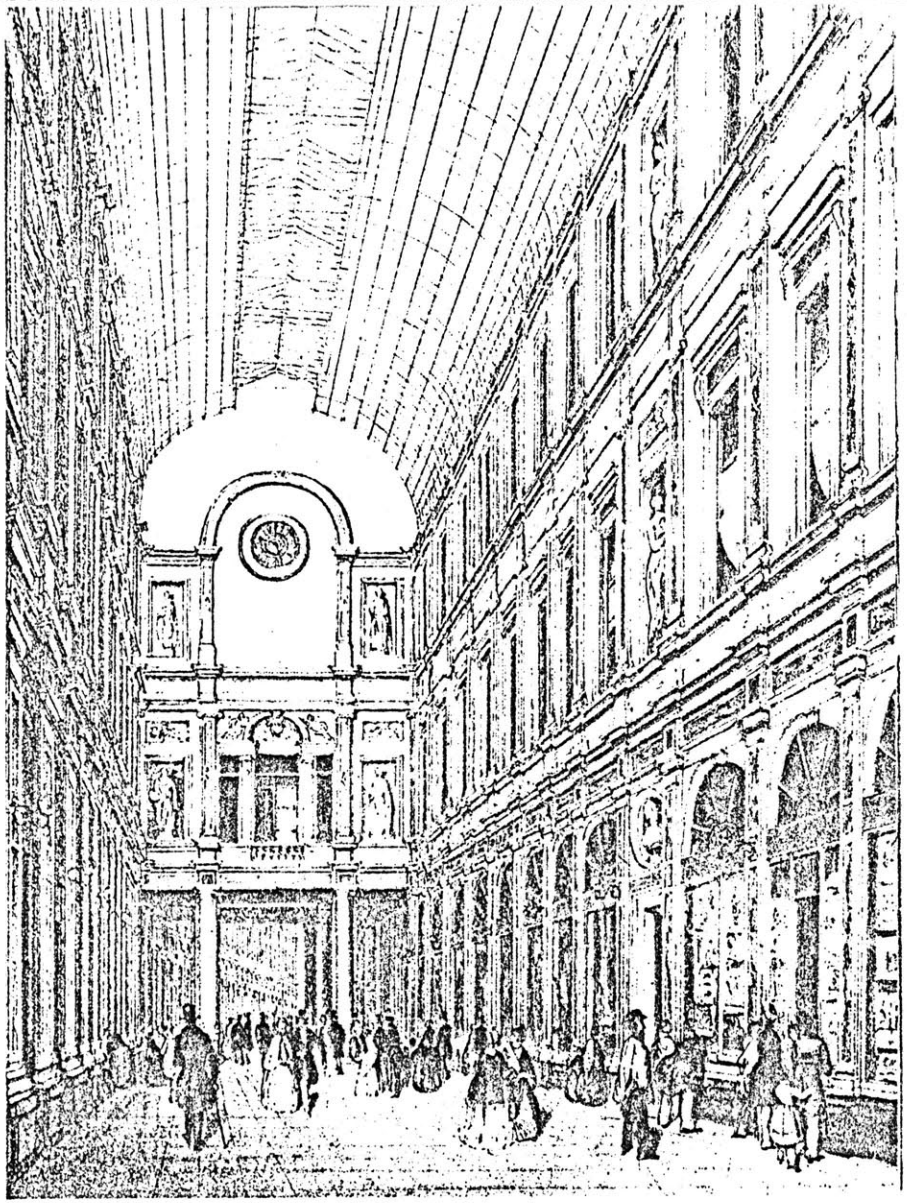
INTERIOR FACADE

The interior facade is instrumental to spatially distinguish sunspace and floor area with a transitional edge

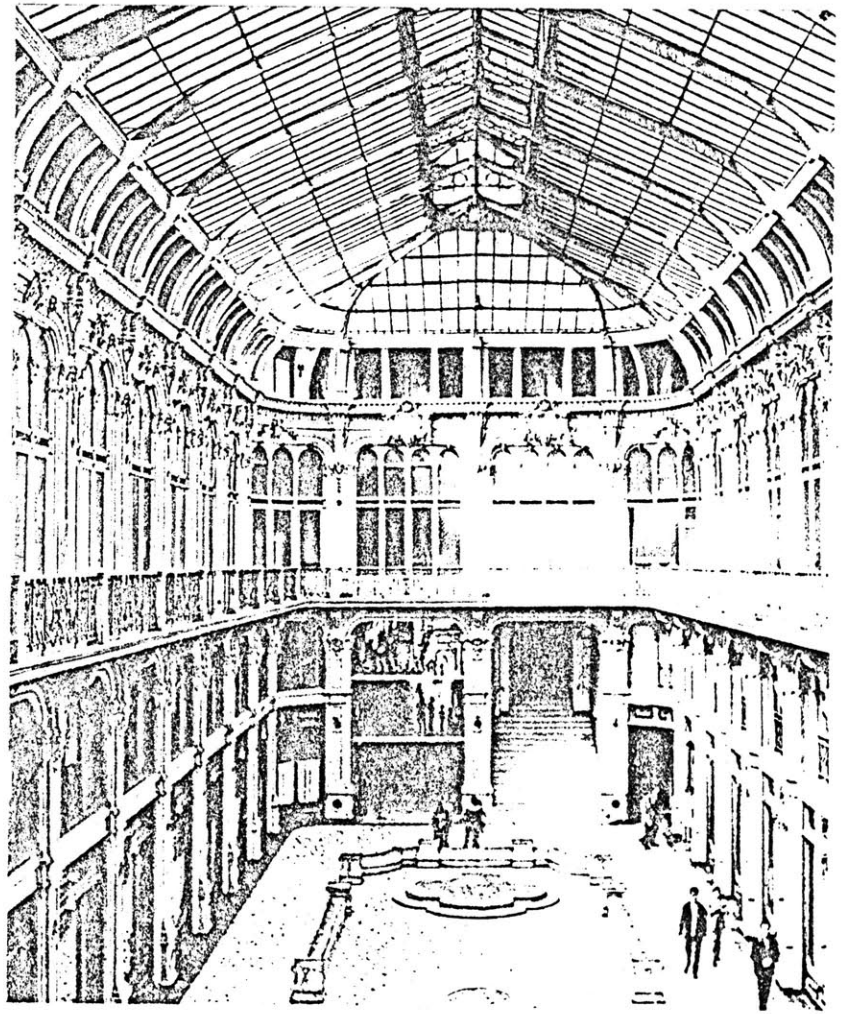


The interior Facade defines the visual frame of the indoor setting. While the skylight is large-scaled and light, the facade is the grain and mass, with proportions, details and inhabitation behind color. Freed from weather impact, under the climate envelope, a facade collage can articulate spatial sensation. Thus, more than usual large windows with high plasticity, balconies and galleries contribute to the sunspace's architecture.

- Have the interior facade provide plasticity and grain, lightness and brightness, as defining background to the sunspace.
- Use the facade as clear spatial determination of the sunspace.
- Regard functional demands with specifications for: fire and security partitioning, thermal insulation for indoor ambient temperature heatstorage and sound absorption.
- Due to indoor conditions, reduce construction specifications of water seal, thermal bridging and air tightness. Apply possibly single glazing and clear galss in cheap framing, partly operable.
- Generally, all finish specifications can be reduced due to lessened thermal friction and less condensation.
- Economize insulation values to indoor design temperature as determined from thermal swing at Nov. 21 and Feb. 21.



Passagearm, Galerie de la Reine, Lithographie



253 Gailleria dell'Industria Subalpina, 1872-1874

WINDOWS

Most amount of window images should vitalize the sunspaces' visual ambience.

Windows are the homely clue form the floor area to the sunspace. Conversely, the sunspace lives also form the scenery of the windows, which thus provides not merely view, but gives places to observe and interact with the atrium. Physically, they provide daylighting, relate the user to outdoors, to climate, sunshine, the sky and the indoor's greenery.

Compared to outdoor facades, the inner facade demands a stronger window transition in terms of transparent area and plasticity - for maximum interior daylight and best viewangles, and for a direct "taste" of the atrium with operable windows.

As windows are "tapistry" to the atrium, design emphasis is on details and function. Due to indoor conditions, constructions should be filigran light-weight, with bays and french windows of transparent aesthetic.

Visual density in the sunspace demands adjustable view protection to neighbors. Use of curtains and shutters is often crucial crucial since "closed-off" windows appear repelling to public ambience. Likewise, mirror glazing is abusing the two-way transparency objective.

- Place most window area with lowest sills, and partly operable.
- Consider the window zone as foremost public image and recess privacy zone from the facade.
- Provide operable blinds. Curtains should be avoided as they tend to remain closed off and diminish daylight.
- Provide window bays oriels, or french windows for best view

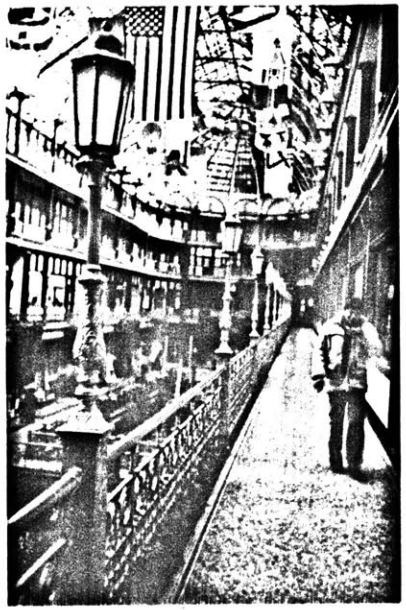
angle, with regard to sedentary activity recessed from the facade.

- Swing window open into the atrium as a "decorative" element.
- For fire provision sprinkler window areas directly, or else provide wire glass, as otherwise window area would be minimized.
- A single fire rail at .90m height adds scale to window and provides security.

See also Fire Provisions and Appendix C

RAILINGS AND SILLS

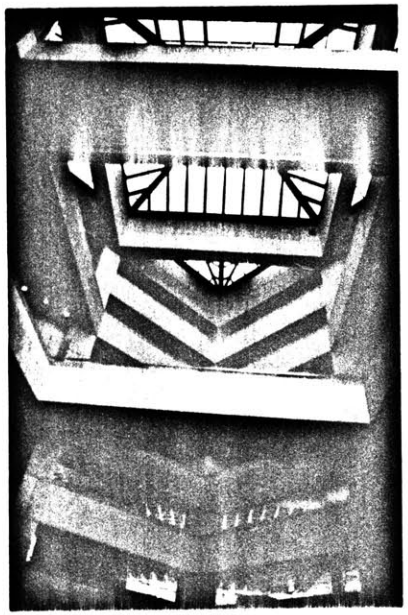
Railings and window sills should be with light weight and transparent construction to avoid visual barriers.



Galleries with light weight railings enhance the spatial display and movement on the sunspace. Treatment of rails and also window sills must be tuned for the visual sensation of looking down into the atrium, and conversely looking up from ground plane to floor areas. Bold heavy design of rails and sills obstruct people's view and cuts the floor area and gallery off from visual openness of the atrium. Open visible gallery areas and floor floor activities behind windows give the sunspace "southern ambience" and an inviting mode. The building is highly readable by the user, while an obstructed view and hidden galleries convey insecurity from hidden unknowns form behind visual barriers. The light-weightness of rails and sills adds essentially to the demanded transparency of the interior.

- Railings and sills must allow view from either direction in space, especially if in seating position and little recessed behind the facade or rail.
- Leight weight image and maximum transparency should be achieved with glass or steel supported rails.
- Rails and sills should convey feelings of security. Glass works critical. Additional security bars just for vision should be placed.
- As orientation thread through the building, rail design should be consistent throughout in form with as little elements as possible.
- Match rails with lighting system in style and function for orientation.

- Window sills especially on upper floors should be as low as possible within security requirements to ease downwards view. Partitioning and security bars can make up for security regulations.
- Break long horizontal bands of rails and sills which line on with frequent material changes, offsets and returns.

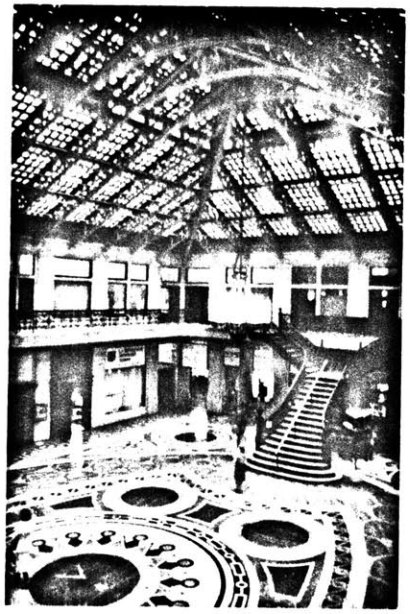


NO!

YES!

FLOOR PAVEMENTS

Floor pavements should add a scale to the space and bounce bright with ambient color.

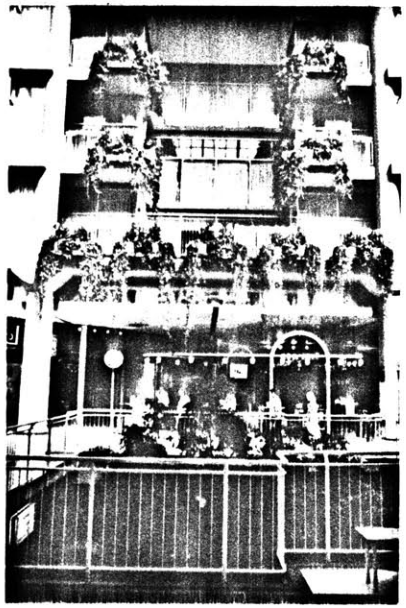


Fabrics, colors and patterns of pavement enhance the visual delight of views for the galleries and windows. Besides, they can spur the play of colored light bouncing off the floor. Pattern and textural quality of floor finish also conveys preciousness of place - regarding the visual function of the sunspace, as historical examples show (Sullivan Bldg., Buffalo; Galleria Emmanuel, Milan). Other than on street, this interior pavement is more visible exposed - a carpet to the sunspace and a continuation of the facade. Geometric relation and pattern with the facade completes the design and will control ground floor scale and light ambience. In other cases, floor pattern can articulate space geometry, focuses, can shorten dimensions by visual distortion. Color of floor in cases also serves for orientation, marking paths or particular areas.

- Use light, yellow, tones colors for ambient light reflection.
- Relate pattern to overall geometry of space, to enhance or counter directionality, or, articulate a focus.
- Articulate seating areas and paths if not dominated by overall space geometry.
- Regard view from above galleries for sizing pattern grid.
- Regard accoustics and close up view as well for "walking ambience" in terms of textures and surface materials.
- Use grid matching with the facades, enhancing the visual perception of the space.

GREENERY AND LANDSACPE

Landscape and greenery should merely enhance the indoor setting as an artificial one - with guarded sense of nature within the building



The interior greenery and especially landscape ia an artificial setting of nature as a stagelike decoration; in tune with the interior scale and used as a device to enrich the bold emptiness of the interior. In general, greenery conveys familiarity and care for a place. It is an element of design that people can best relate to and that also yields most response. Greenery is the feature of advertising for the atrium, and clearly a special delight for visitors, being surprised by the alienation of nature within an enclosed space. Already little planning yields a colorful object of "soft" design elements to play with the sunlight.

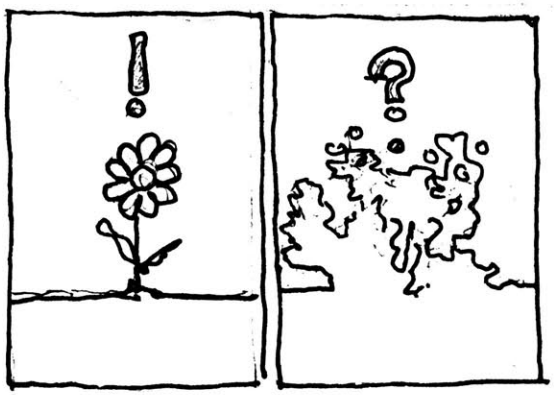
As a natural element, the greenery adds human sacle to the space. Forcoves and seating, greenery provides protection, as trees can build a green roof for certain areas, often complimentary to pergolas and canvas shadings.

Complete landscape is usually not practical - and also not essential for the setting of the sunspace. The attempts for real natural landscape often fails and becomes hostily unusable, or else, becomes a fake pretention to a garden. Real landscape is also quite costly and intersecting of free movement and vision, crowding in the space.

- Display greenery as artificial nature, not as a pretention to outdoors and wilderness
- Use sparingly but effectively placed greenery at galleries, in sunlit spots, on balconies, at entrances and around fountains
- Use VicusTrees as "greenery scale" to the space. They also work best best all year around, provide ambient light diffusion from their

leaves and play colorful reflections. Also, seen form above, they play well against the bold surfaces and the floor textures.

- Place greenery planters on galleries and balconies
- Limit selection of greenery to some types of known reliability and low maintainance. The adaptability of plants to indoor life is a superior issue over a would-be selection of overwhelming green generousity which might not sustain the indoor performance.
- Allow also potential for a participatory planting by tenants for user identification
- Avoid crowed landscape areas, for the sake of usable space
- reduce planting to a few elements with regard to clear perceptability in the sunspace's light. Avoid simply overcrowdedness. Look for comparison with the Japones teahouse garden patterns where only few plants catch most attraction.



BALCONIES AND SIT SPOTS

Bays and poarches vitalize "occupancy" of the facade as an articulate transition form privacy to sunspace community.

Solely window transition does not account enough for the thermal comfort given with the sunspace as semi-outdoor. Also, windows fairly restrict thescope of view and leaves the facade less articulate. Sundecks and balconies are therefore superior transition and are highly usable due to all year ambient conditioning
The indoor balcony is a major attraction in living aside an atrium. Iy is not a "lost" space as a conventional outdoor balcony is for a good part of the year. With respect to passive temperature swing, this space is virtually an extension of the living room and kitchen. In other building types, offices lounges and meeting spots can promote a habitable facade to the sunspace.
With high utility and frequent inhabitation all year, the balconies become the true transition form privacy to the sunspace community. Designed together with the individual decoration and the personalization of the users, the facade becomes and identifiable clue of vital habitation.
Unlike outdoor balconies the indoor construction does not pose thermal bridges and drainage problems, and utility throughout the year justifies costs of even larger sit spots.

- Extend facade bays into usable size balconies
- Attach sit spots to galleries and stair landings
- Provide public and provate sit spots
- Use balconies to articulate window strips and lining up galleries
- Apply highly transparent ralings for most visual transition to the sunspace.

FOUNTAINS

Fountains and waterplays can add visual focus to the space and also serve as sound blanket.

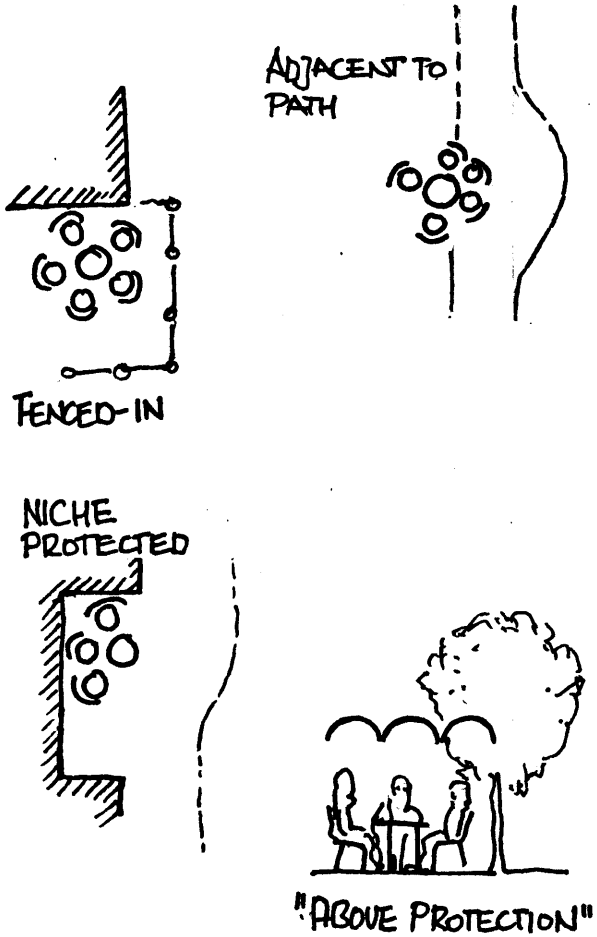
Fountains and waterplays are the focusing attraction in an atrium and inherently refer to the generic atrium type with the central water supply to the house. The fountains further conveys a sense of the artificiality of the indoors, and certainly enriches the interior design with artwork of appealing dynamic with the play of water.

Most commonly, waterplays are used for imagery, but also quite consciously for a sound blanket with reasonable effect though being a sound source itself. A humidifying effect can be achieved with high water dispersing design, but is mostly not desired. Compared to outdoor design, indoor water plays work with little pollution or winter drainage problems. Maintainance is eased and the systems can be incorporated best in the building systems. Wind and sun do not carry away the water supply of closed systems. As for a sunspace setting, founatins are a classical feature, referring to the aristorcatic English Garden, enhancing its designed landscape. In residential settings, fountains are an amenity of high costs, and thus possibly better suited for commercial applications as imagery - in residentials though possibly traded off against communal facilities.

- Employ fountains as features with regard to cost tradeoffs for other amenities, since the fountain is not an essential element.
-Design in a residential application for play-use as well
- Use fountains to focus the space, or else, integrate them in the landscape

SEATING AREAS

Thermal ambience, weatherprotection and vivacity in the sunspace should be matched by a variaty of use related seatings.



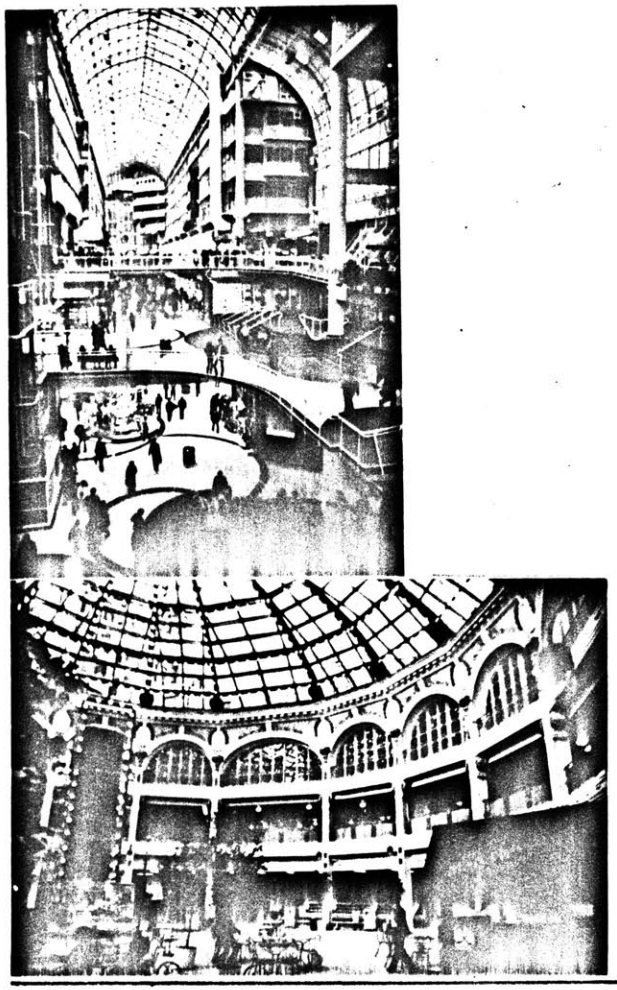
Both tenants and public seeks relaxation in the atrium, by observing or active participation. Thus, a variety of seating areas is is needed to encourage this inhabitation of the space, but must not restrict the sunspace as a circulation arena. As people stroll around and use the facilities, they also stop to rest, demanding a diversity of seatings. A hotel will be more decorative, while a corporate headquarters will avoid casual seating as found in many residential projects.

The seating arrangements are related to communicative functions and the trend is to cluster in groups, around activities and in particular niches with good views of activities. For ambient seating, sunshine and cooling drafts have to be regarded. Though spatially defined with the atrium facades, seating areas yet require a fair backing protection.

- Provide use oriented seating in connection with services and supplement the limited number of seats with casual adaptable seat elements as part of the landscape, rails or barrier walls.
- Attach sit spots with inviting views for small groups in mobile arragement for multiple use
- Forsee distinguished potential niches for mobile seat assembly
- Provide "backing" protection against the volume of space with pergolas, sun umbrellas, trees and overhangs of the facade
- Regard sunshine pattern in the space for placement of seatings
- Allow seating to be placed by tenants, since favorite spots are often hardly to be determined on the planning boards

MIX OF USES

Public building character and protected, additional floor area of the sunspace should be utilized by a balanced mix of uses.



The mix of uses is essential to the sunspace's ambience as resort of leisure and shopping. Parameters for the selection of uses come with the developer's package and the match with the projects location in its context demand. In other respects, the use mix is tuned with the actual tenants'demands, and the commercial objective to encourage public clientelle for the benefit of a vital setting and adequate support of shops. Butler Square is for this a perfect example, where retail areas match with tenant and public draw alike.

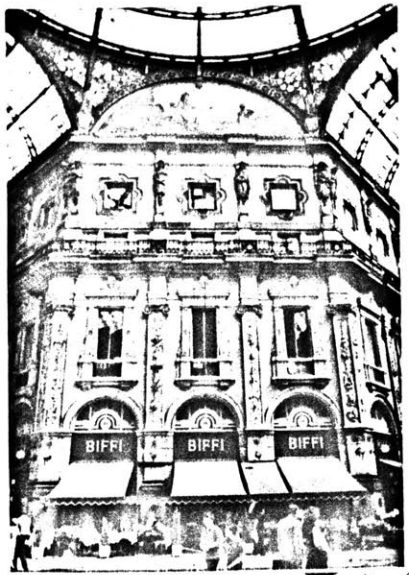
The CHOP hospital ( ) also mixes service facilities, waiting area, play area, seating and related restaurant and shops in its sunspace. The HUB's ( ) essence lies in the urban mix of uses as established over time due to definite demand.

In general, one finds the base use (office, housing, hospital) to be followed by relatable service uses - but hardly major self-sufficient supermarket or alikes.

- Match mix of use with base use, regarding tenant's and visitors demand
- Display mix od uses according to public access or privat protection
- Tune mix of uses with daily schedule for vital operation at most parts of the day
- Forsee diurnal adaptability of restaurnats and services to various hourly demands
- Direct public access and its limits with use distribution
- Allow for competing services and little casual retail-market areas

RESTAURANTS

Add hospitality to the sunspace with restaurants and snacks as communal and public amenity and visual object to the interior.



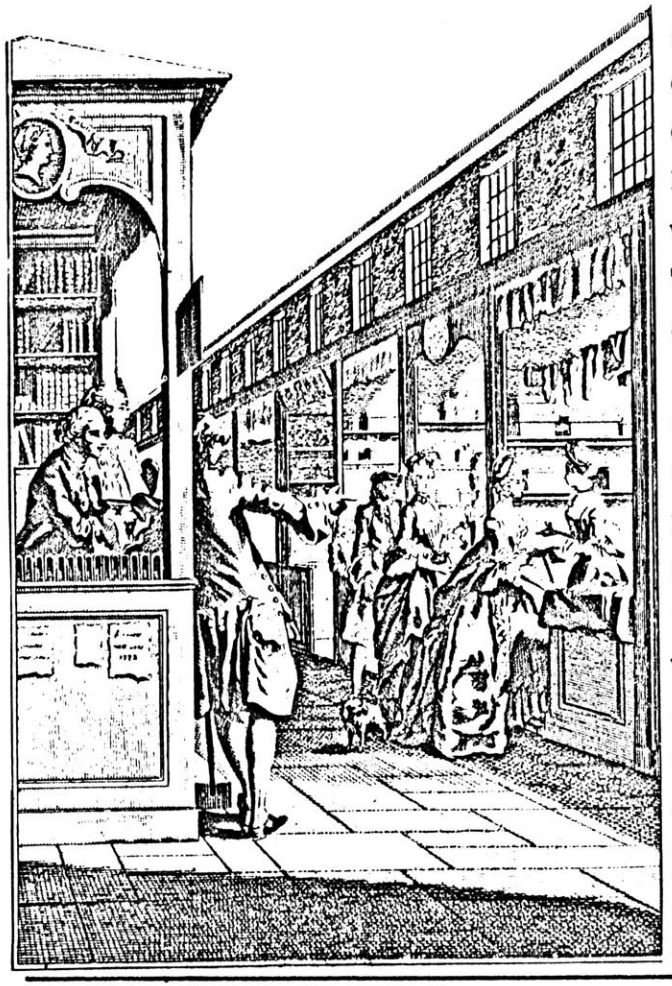
Restaurants are a centering activity in the sunspace - as meeting place for tenants and as public draw. The restaurants display, its interior and seating is a visual offer to participate in the sunspace. Tenants might see the restaurant as vitality to observe, but also as service right at hand.

In other respect, restaurants can rely on tenant clientele. They also utilize expanadble seating in the sunspace all year round. Restaurants thus furnish the space on possible a cheap rent basis. The odors of restaurants and snacks can be controlled at the source, and might as well add a posistive flair to the space from time to time. Tenants reported no ditraction form this, rather perceive smells as indicator of urban life in their building.

- Place restaurants in entrance position, or, in a focusing background.
- Provide a highly open two way visual transition from restaurant interior to sunspace
- Have circulation paths casually inteesect the restaurant seating in the sunspace, or, have circulation well tangent
- Divers restaurant servive for a daily schedule
- Give kitchens excessive exhaustion fans to the outdoor

SERVICES AND RATAIL

Small scale shops and retails should be placed for casual and daily attraction for tenants and public markets.



Services and retails depend largely on local markets and the scale of the project; especially with the fact the sunspace being a linking path as arcade.

Small scale shops and retailers though prevail as a type of boutiques, bakeries, pharmacies, stationery, for example. All the shops are foremost for "quick buys" or sort of luxury goods for people strolling by. The essence of the services lies in a richness of contrasting daily and casual supply to embrace either market grouping.

Besides customer flow, shops also add "decoration" to the sunspace with "on-street" display, which is in turn well weather protected. This gives the special amenity to the shop owners and clientele alike, since a perfect informal transition to the shop is provided.

- Place shops on ground levels with regard to accessability and vision
- Keep store fronts totally open with sliding doors and allow display and carts into the street within a varying margin, according to circulation and shop character
- Restrict shop signs to a certain size to aviod visual noise with overall design scale and lighting
- Allow shops to operate dually with street side and sunspace and thus provide possibly tansvisibility if siting allows
- Give an exchangable "apadotive" design framework to shop displaying facacdes
- Provide a "shop-plug-in" system for incremantal use changes over time

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APPENDIX A

SELECTED PROJECTS

These listed projects were used as references to the survey and developement of design guidelines.

The projects are listed alphabetically according to location name (Boston = B_n)

Abbreviations

RES	residential
OFF	office use
M	museum
R	restaurant
S	shops
F	facilities
COM	commercial shopping mall
HOS	hospital
HO	hotel
SCH	school, university bdlg.
L	laboratory bdlg.
M	mix use

B1	Isabella Stuart Gardner Museum	M	Boston, MA.
B2	Westland Ave. Apartments	RES	
B3	Merchantile Wharf	RES/S	
B4	Transportation Office BLDG	OFF/S	
B5	Navy Yard Tenement	RES	
C1	Main Street Mall Conversion	COM	Cambridge,Ont.
C2	The Atrium	OFF/R/S	Cambridge,MA.
C3	Hyatt Regency	HO	
C4	Tennessee Valley Authority Office	OFF	Chattanooga,Ten.
C5	CIVIC CENTER	OFF/S	Chicago, Ill.
C6	North Loop Developement	O/S/R	
C7	Chicago Trade of Board	OFF	
C8	Cleveland Arcade	OFF/R/S	Cleveland, Ohio
D1	Arcade Square	COM/O/R	Dayton, Ohio
D2	North Main Street Atrium	OFF	
E1	Galleria	RES	Edmonton
E2	Jasper Senior Citizen Apartments	RES	
E3	Edmonton City Hall Competition	OFF/S/R	
E4	Health Science Center	HO/R/S	
E5	HUB-Student Union Housing	RES/S/R	
E6	Eslövs Kommun	RES/S/F	Eslövs,Sweden
G1	Familistere de Guise	RES/F	Guise, France
L1	Middlesex Polytechnic	SCH	London, UK
L2	Covent Garden	COM	

L3	Coutts Bank	OFF	
L4	Leisure Center	-	
M2	Butler Square Bdlg.	OFF/S/R	Minneapolis,Min.
M1	Hennepin County Gov. Center	OFF	
M3	John Deere Headquarter	OFF	Molline, Ill.
N1	Monticello Arcade	O/S/R	Norfolk, Virg.
P1	Habitation Rue de L'Ourcq	RES	Paris, France
P2	Childrens Hospital CHOP	HOS	Philadelphia,Penn.
P3	Thomas Jefferson Uni. Hospital	HOS	
P4	Pickle Lake Developement Plan	RES	Pickle Lake,ONT.
P6	Providence Arcade	O/S	Providence, R.I.
P7	Pioneer Square	-	Portland, Oreg.
P8	Artic Tenement	RES	PrudhoeBay, Alaska
T1	St Lawrence Housing	RES/S/O	Toronto, Ont.
T2	Percy House	R	
T3	Atria North	OFF	
T4	York Row	RES	
T5	The Oaklands	RES	
T6	Trondheim University	SCH	Trondheim,Norway
S1	County Grammar School	SCH	Sonderborg,Sweden
S2	First Bank Center	OFF/COM	SouthBend,Ind.
W1	Science Center Wellesly College	SCH/L	Wellesly,MA.
W2	INTELSAT	OFF	Washington, DC.
W3	The Courtyard	O/S/R	Winnipeg,Manitoba
W4	All Seasons Tower	RES	Winnipeg
W5	Rust Oleum Headquarters	OFF	Vernon Hills, Ill.

1	ISABELLA STUART GARDNER MUSEUM Boston, Fenway 1902	M

ARCH E. H. Sears OWNER Isabella Gardner Museum

PROGRAM Originally home of Ms. Gardner , designed as a suburban landscape villa on the fenway park as a spatial arragement to accomodate her arts collection, such as furnitures, paintings, wall decors, gobelins, wohle interiors and building parts.

The interior court yard was intended to convey the ambience of a italian atrium with garden and foutain decoration, and for exposition of a fake venetian facade.

SUNSPACE The sunspace is a decorative interior with highly aethetical gardening, seating arangements, monumental stairs and fountains as a arts object itself. In other respect, it is a sculpture garden. Formerly, the court also served for formal receptions.

Openings without windows and little french balconies on the upper floors give a close transition to the floor areas, and by being left open, convey a southern summer ambience of venetian context. Regarding the exterior repelling functional facade, the scheme clearly approaches a inverted building design - rigid and flat on the outside, turning its richness to the interior for most private enjoyment.

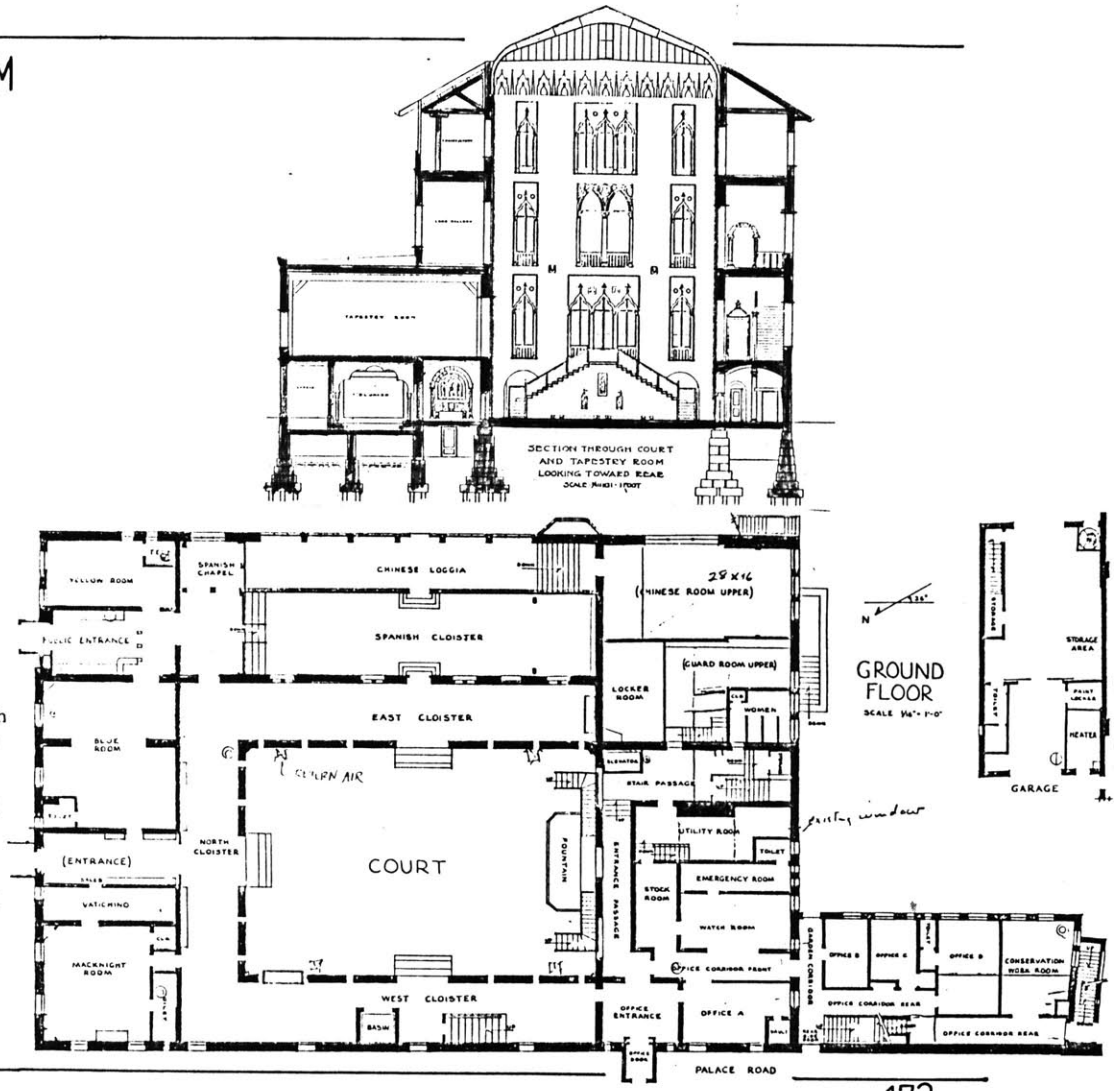
CONTROL The couryard is thermally not separated from the floor areas for the sake of unobstricted spatial sensation. The sunspace is perceived as integral part of the setting, and the "ventian openness" of the facade does not allow for windows.

Energy audits have been conducted by Anderson & Nichols of Boston, as humidity and heat loss problems became a concern. Findings conclude uncontrolled startification and 1/3 of the heat losses through the skylight, as warmed air flows unrestricted from the floor areas to the court. Conversely, in summer, heat built up in the court by solar gains poses problems in the upper floor.

These thermal problems are clearly due to the unwindowed facade and the unshaded and single glazed skylight.

FIRE PRO -

REF. Isabella Gardener Museum SLIDES 7/2 - 12/2 VISIT X
Studio documentation MIT Prof.
Tim E, Johnson



B2	WESTLAND AVE APARTMENTS	Boston Westland Ave, Fenway	1981

RES

ARCH. D.Powers & J. Crowley — OWNER
Skidmore Owings & Merril

PROGRAM Rehabilitation of arsoned rowhouses

Gross floor area m^2 tenants Apart,
Sunspace area m^2 height 15.00 m width 14.00m

SUNSPACE CONTROL Heat supply by transmission loses of apartments and exposed to solar gains and outdoor temperature swing, summer shading with vertical clearstorey glazing south and back-up chiller, heat reclaim with heat pump water-to-air

cl

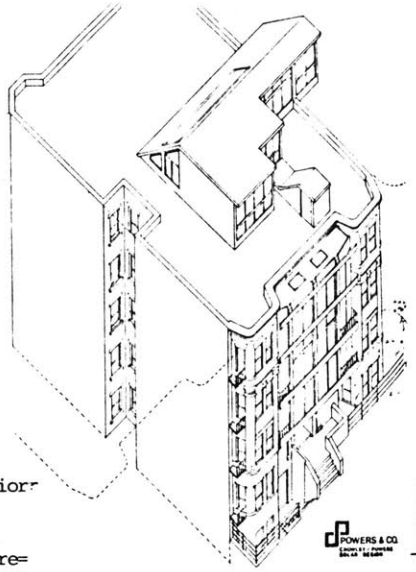
GLAZING Clear vertical south glazing, double pane of .....m^2 and additional north window for diffused light

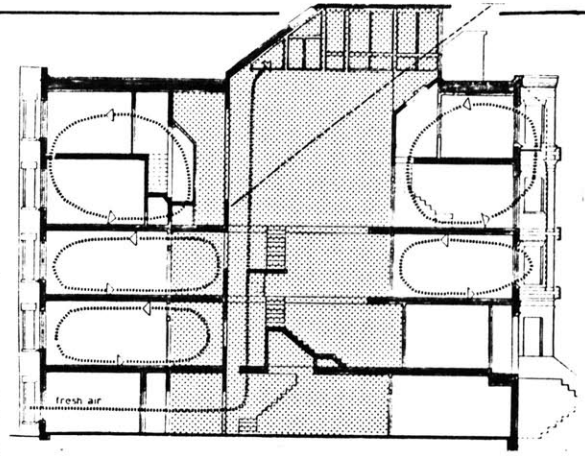
FIRE PRO Sprinkler system, fire rated doors and exhaustion on top

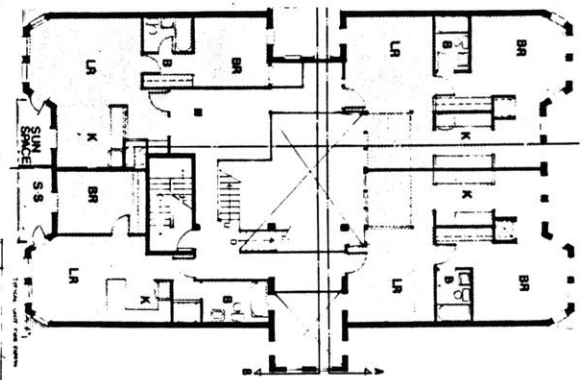
REF D. Powers Office — SLIDES — VISIT X
FEMPAC NEWSLETTER

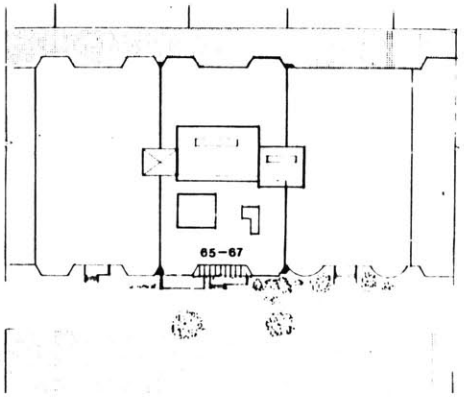
Rather then tearing down the backpart of the dense building bulk for daylighting improvements, the architects hollowed the building with a central atrium. Haevily fire damaged floor area subject to rehab costs was reduced, and intact perimeter wall was kept. Likewise, the new atrium take up the reorganisation of the circulation to a new subdevision of apartments. An interior galery adds also sit spots to kitchens - in total a house community setting.

With this approach interior daylighting is meeting standards, as tested with model. Energy consumption is backed up by solar gains trapped. Further cost reductions could be achieved with non bearing interior facade without weater seal.









B3	MERCHANTILE WHARF	Boston, MA.	186o - 1976

RES'S

ARCH John Sharratt Assoc. OWNER Peabody Reality

PROGRAM Re-use of historic merchantile warehouse at the Boston harbor with condominiums and shops

gross floor area	1 1oo m^2	tenants	25o	apart.	122
sunspace	47cm^2	height	24.oom	width	7.6om

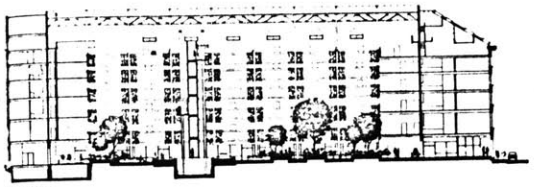
SUNSPACE The depth of the structure with 3o,5o m was not adaptive to housing use. Carving the building out with an atrium as central circulation space and lightwell solved the approach, providing a unique feature to the apartments.
The atrium was then designed to provide most visual relations, though fire requirements seem to have abused transparent design of the railings. With the massive horizontal railings, the space appears quite narrow. Maximum transparecy of the ground floor shops though gives visual ease with view to the shops and outdoors.
Tenant and public circulation is perfectly separated. Public access is attracted by ground floor facilities operating to the indoor.

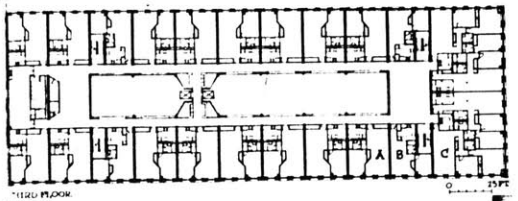
GLAZING Steel rafter mounted clear acryl glazing as single layer is applied.

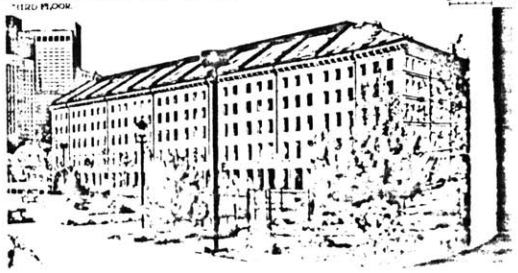
CONTROL With a relative small glazing area, the atrium is keeping ambient temperature. A backup heating is said to be not in use.

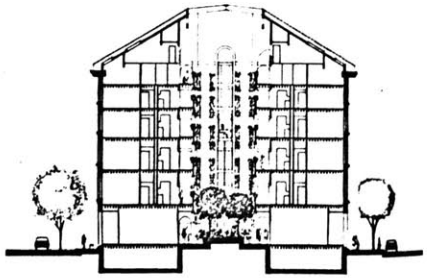
FIRE PRO The project was one of the first of its kind, and fire provisions were eased to preserve the building.

REF John Sharrett Assoc. SLIDES 13/5 - 2o/5 VISIT X
House and Home March 77 p.78
Architectural Review Feb. 78









B4	TRANSPORTATION OFFICE BUILDING	Boston, MA Stuart St.	1981	O/S

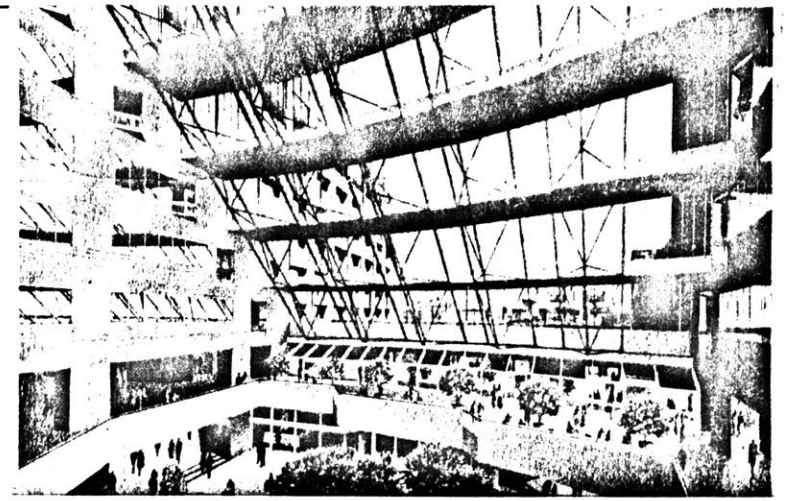
ARCH. Goddy Clancy & Assoc. OWNER
( )

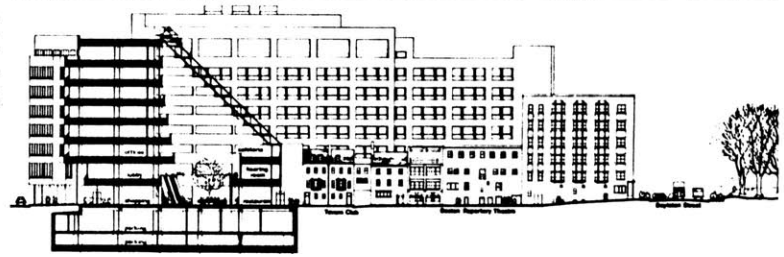
PROGRAM Goverment office complex for transportation agencies, library, car-garage, conference facilities

gross floor area 80 100 m^2
sunspace area 1 000 m^2 height 22.00-10.00m width 10.00m

REF. Boston Globe Feb. 1. 81 SLIDES - VISIT -
Public relation material form
Goody and Clancy

The project attaches an north facing atrium to a regulâr office slab construction as entrance lobby and circulation concourse with public facilities, retail and cafeteria. A pedestrian short cut and the dead end Boylston Place turns the atrium into a focal circulation node





Architectural sketches of interior atrium spaces of $91 million state transportation building for which construction has begun along Stuart and Tremont streets in downtown-theater section. Retail activity will line atrium area and upper offices will overlook this activity. Pedestrian walkways through the building will link areas surrounding the building. Architect is Goody, Clancy & Associates of Boston.

B5	NAVY YARD TENIMENT	BOSTON Charlestown	1981	RES

ARCH. Anderson, Notter & Finegold — OWNER Codman Management Co

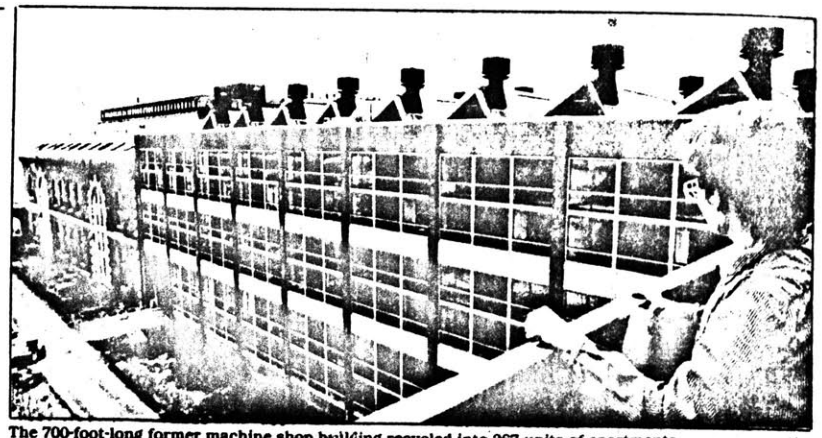
PROGRAM Conversion of a former machine shop building into tenement with community retail area at groundfloor

gross floor area — tenants 7oo — Apart. 367
sunspace area 1loo m^2 — height 22.oo — width 9.00 m

SUNSPACE CONTROL Heated with top venting mechnaical

FIRE PRO. -

REFERENCES Boston Globe Apr. 18. 81 — SLIDES - — VISIT -



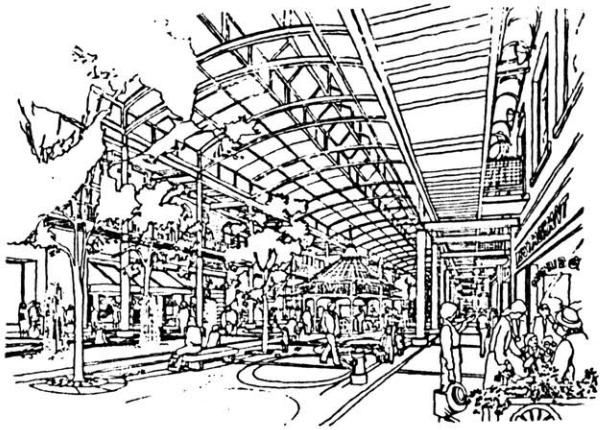
The 700-foot-long former machine shop building recycled into 367 units of apartments.

C1	MAIN STREET MALL	Cambridge, ONT.	Project	COM. / M

ARCH. Barton Myers Associates

PROGRAM Downtown shooping street cover for weather protection

SUNSPACE This large scale sunspace is essentially a conversion of a street to a retail and office mall for commercial improvement. The scheme seeks its reference with the Covent Garden in London (') and cites feasibility and climate appropriateness with this. As an amenity to the street, the space would also provide a second floor galery to narrow space visually, but also intensify office access there - in total, spur the streets commercial value with enhanced inhabitation and protected uses.



C2	THE ATRIUM	Cambridge, MA Church St	198o

O/R/S

ARCH. Luis Serts Assoc. OWNER DiGiovanni

PROGRAM Commercial spec structure as renewal and addition, offices cafe, shops, restaurant

Gross floor area	3o.5oo m^2	Tenants	-	Apart.	-
Sunspace area	3oo m^2	Height	18.oo	Width	1o.oo m

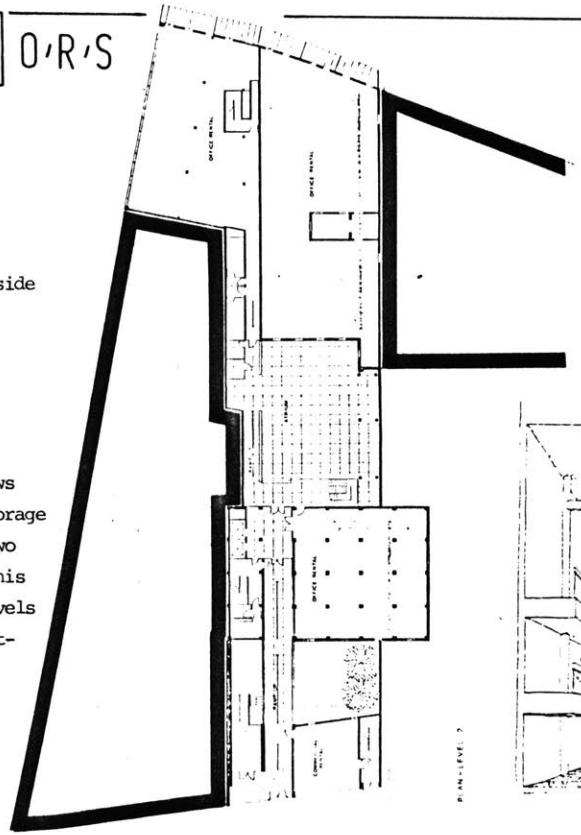
SUNSPACE CONTROL Conditioned with 1/3 of the complexes air-to-water heat pump capacity for discharge and reclaim with water loop on 6o°F additional venting with top louvers, shading canvas on south side

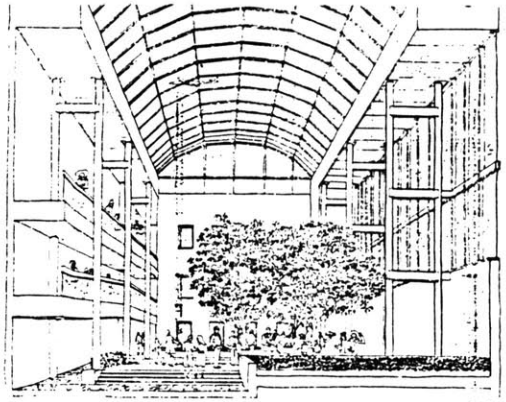
GLAZING 2o% tinted glazing, dome double pane

FIRE PR. no particulars

REFERENCES Nick Ferron Company ( ) SLIDES 2/13 - 2o/13 VISIT X
Boston Globe, Dec.2o , 1979

The overwhleming feature of the project is the hybrid solar and heatpump technology controling building on high efficiency energy. The system allows distinct summer and winter mode, reclaim of any waste heat and diurnal storage with a loooo gallon tank. The atrium itself is only a joint between the two building parts, essentially missing the all side real facade enclosure. This facades also provide no articulation with regards to the facade. Light levels range with a ratio of 1/4o. Sound levels are disturbing at 7odbA from heat-pump system





C3	HYATT REGENCY, CAMBRIDGE	Cambridge, MA	1976	HO

ARCH. G. Gund Assoc. OWNER Hyatt Regency Cambridge

PROGRAM Hotel for convention and business clients with panorama to Boston

gross floor area 13.7oo m^2 tenants Apart. 5oo
sunspace area 35o m^2 height 45.oom width 18.oo m.

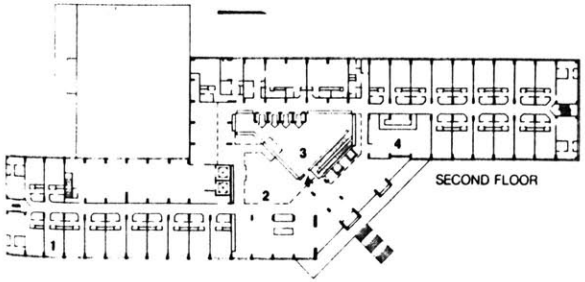
SUNSPACE CONTROL Air conditioned with top chiller and top to bottom return shaft

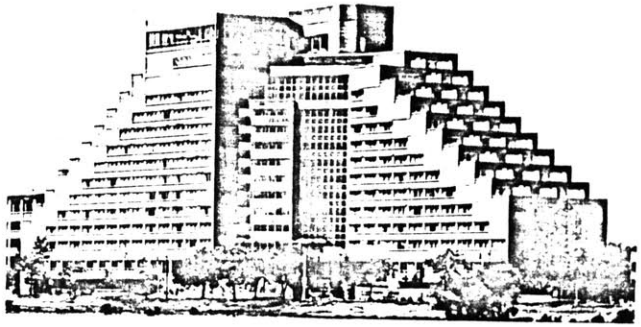
GLAZING Vertical glass wall, no skylight

FIRE PRO Forced smoke ventilation on top, sunspace as emergency egress, separated from corridors with automatic shutters

REFERENCES G. Gund Assoc, Peter Madsen SLIDES 13/1 VISIT X
AR Mar.77, Interiors, Nov. 78

The atrium is a joint between tow two loaded regular slab building parts providing the major circulation focus, where all activities are connected The space provides sensitive scale with a sensentional progression when entering the building. Confinement of entrance opens into a decorated height of space, galeries and interior balconies are highly mediating with the space and conveying a very homy and communal scale to the guest-tenants.The atrium is foremost a interior world for a transient community, a discovery, and a complex path-from doormat to bestaead.
Not the vault of space is the grandeur, but the proportioning of human scale throughout this space makes it a superior appropriate sized interior over the other "Protland Hyatts".





C4	TENNESSEE VALLEY AUTHORITY OFFICE Chattanooga, TN Project 82	OFF

ARCH. S.Matthews & P. Calthrope OWNER Tennesse Valley Authority
Van der Ryn and Partners

PROGRAM' Office complex

gross floor area 12o 7oo m^2 teanants apart.
sunspace area 8oo m^2 height 28.oo m width 15.oo m

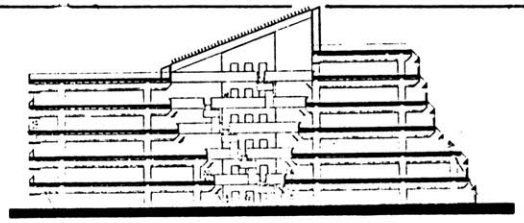
SUNSPACE CONTROL Souuth sloped glazing with tracking mirror/white refector fins to control direct beaming, difusion for maximum daylighting without glare. Spacehaeting from floor area internal gain

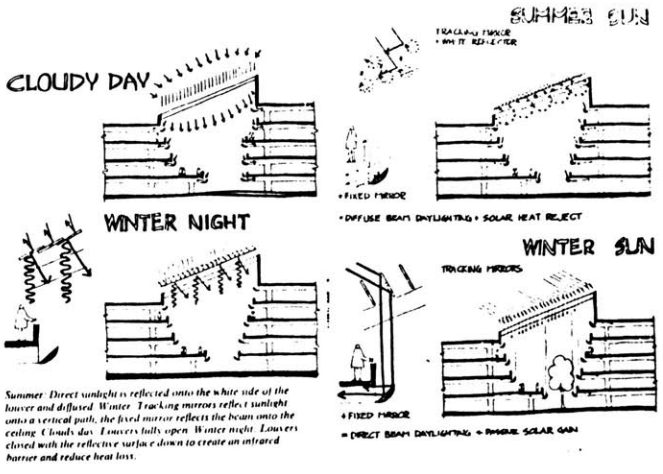
GLAZING Clear double glazing, sloped 2o° southfacing

FIRE PRO -

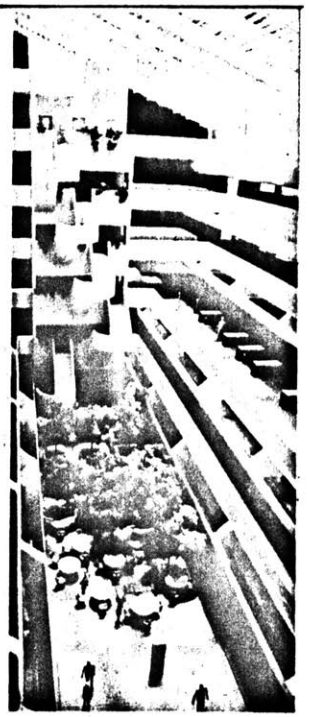
REF. AIA Journal Sept 79 SLIDES - VISIT -
William Lam

A "solar court" is used to shape optimized building bulk with least facade exposure. Due to warm-climate of location, internal gains of offices would overheatthe building all year. The approach seeks thus balance between losses and internal gains by reducing artificial lighting loads for cooling. The solar court works thus with a system of bouncing mirrors for daylighting extreme depth of office floors (1,2,3) and collects solar gains in winter.
As a buffer zone, the sunspace reduces the energy consumption by 23% (AIA, Sept 79. p. 87) due to reduced skin loads. 6o% energy savings were perdicted from daylight technique and related cooling savings.





Summer: Direct sunlight is reflected onto the white side of the louver and diffused. Winter: Tracking mirrors reflect sunlight onto a vertical path, the fixed mirror reflects the beam onto the ceiling. Cloudy day: Louvers fully open. Winter night: Louvers closed with the reflective surface down to create an infrared barrier and reduce heat loss.



ATRIUM of planned TVA office and service complex will be illuminated with sunlight directed by a computer-controlled louver system.

C5	CIVIC CENTER	Chicago, Ill.	1981	OFF/S

ARCH C.F. Murphy CLIENT State of Illinois

PROGRAM Office complex for the State agencies to compete within the Chicago loop skyscraper collage with a statement of the importance and dignity of state goverment. (H, Jahn, Inland Architect May 80 p. 12)

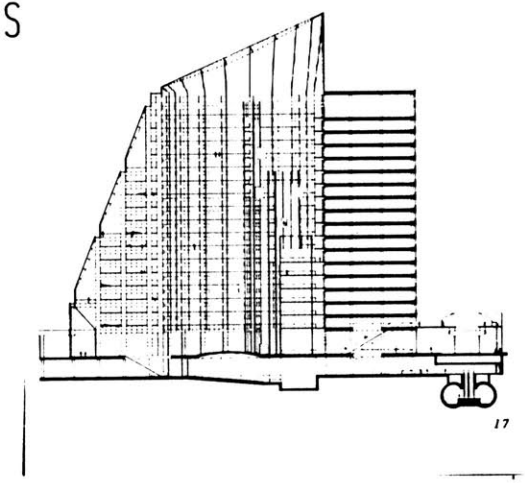
gross floor area	112 000 m^2	occupancy	4 600 employees
sunspace area	2 000 m^2	height 80.00m	width 50.00 m
retail area	14 000 m^2		

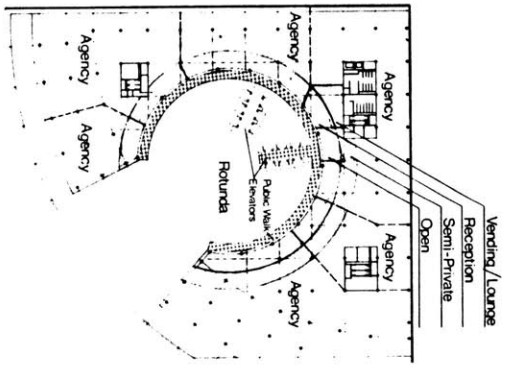
SUNSPACE The sunspace seeks its reference in the dome space as historic architecture form to reflectcentralistaion of power. The abstract glass interior seeks synthesis of moderne material and conceptual form.
In other respect, the sunspace spreads daylight into the depth of the street block sized building. As core to the building, the sunspace's galeries and elevators take up the processual circulation with unique sense of place to the public.
The all glass space will be a unique setting in light and reflections, top light louvers will track for ambient tuning. The facadde exposure to the south east will beam morning sun into the glas dome.
The setting is foremost an aesthetic imagery, with very little greenery, posing probably an accoustic problem due to excessive surface of sound hard glass. Likewise, there is no heat absorbtance with building mass.

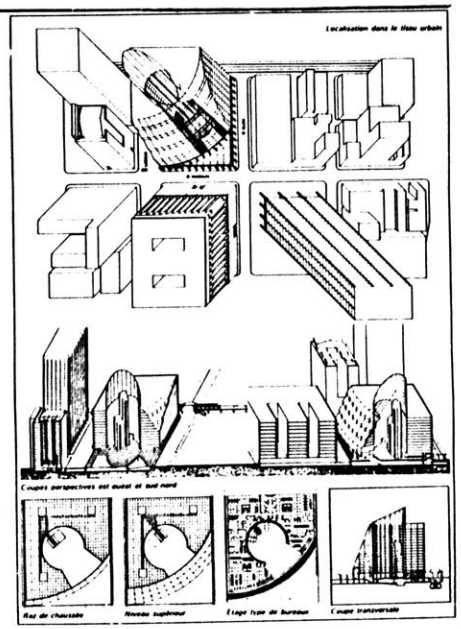
CONTROL The buildings energy management is related to the implications of the office use, where the sunspace takes up daylighting tasks. As office building, the diurnal management of internal gain peaks is major concern. Thus, the mechnaical operation wil vary from the summer day/night to the winter day/night. With a ice bank storage of 800 000 Lbs., coiled air handling units and heat pumps, waste heat can be reclaimed, building core heat surplus can be transferred to the perimeter. For cooling mode, heat pumps reclaim heat and ice water is circulated in the air handling units. Daytime surplus is stored for night use in the ice storage. (for further details see Ashrae Journal Nov.80) A DOE 2 simulation perdicts a energy consumption 0f 45 000BTU/ft^2.yr.

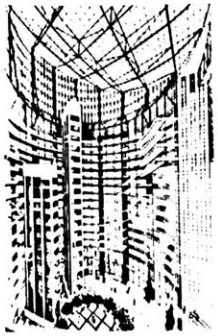
FIRE PRO ?

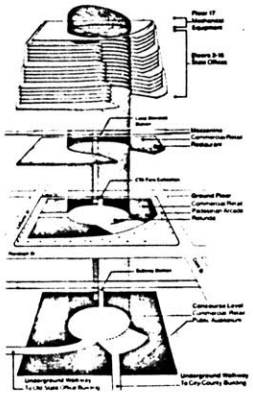
REF. ASHRAE Journal Nov. 1980 SLIDES - under construction
L'Architecture D'Aujourd'Hui Dec. 80
Inland Architect May 1980
Keith Palmer of C.F. Murphy Assoc.











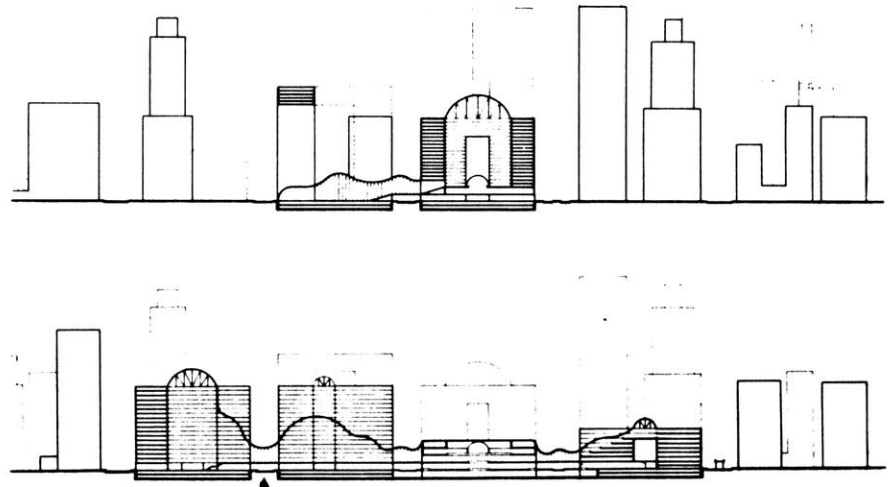
Keith Palmer: "The thing is, that once you get efficient with your building shape and the skylight, solar panels get obsolete."

C6 NORTH LOOP REDEVELOPEMENT Chicago, Ill. Project1980 O'S'R

ARCH C.F. Murphy, H. Jahn CLIENT Arthur Rubloff Developement Corp.

PROGRAM Redevelopement scheme for a seven block area in the Chicago loop to upgrade commercial utility

SUNSPACE Atria and arcades are empolyed as ordering concept for a urban network of connected buildings. Establishing a low to mid- rise scale for the district, the scheme focuses foremost with the existing buildings on a sequence of spaces and spines that tie the area together.
Without radically redesigning the uban tissue, the urban sunspaces create a physical framework of intelligent land use.
(Architectural Record Aug. 1980 p.74)

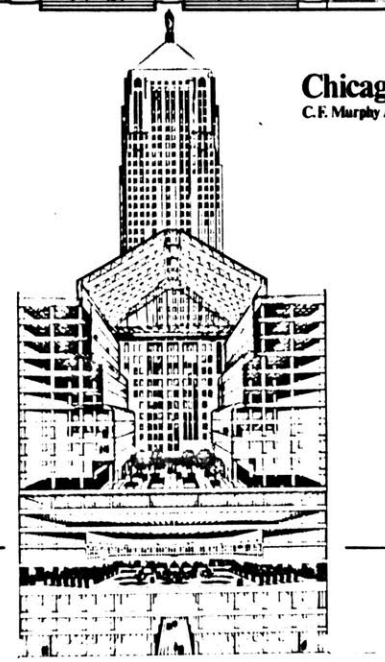


C7 CHICAGO BOARD OF TRADE Chicago, Ill. 1981 OFF

ARCH C.F. Murphy & H. Jahn

PROGRAM Addition to the 1920 Board of Trade Building

SUNSPACE The upper section of the addition will be used for offices. For a viable office depth, natural daylighing and at least for a visual transition to the old structure, an atrium opens up to the sky form the 11. floor on.
Part of the interior facade will be the old structure, other facades will be of glass curtain with three curved recessings.
The skylight over the eleven storey sunspace.



Chicago Board of Trade Addition
C.F. Murphy Assoc./Shaw, Swanke, Hayden & Connell Architects

C8	CLEVELAND ARCADE	Cleveland	1888

OFF/R/S

ARCH. John Eisenmann & George Smith OWNER Oppman Properties Cleveland Arcade 244

PROGRAM Office and retail complex with throughway mall

SUNSPACE CONTROL Passively operated with natural ventilation, excessive height over last floor, thermal storage for heating and cooling with building mass, heating by transmission losses form offices

GLAZING Clear, single pane glazing on exposed steel truss construction

FIRE PRO -

DIMENS Space height to top of dome 3o.5om, 12.oom on concourse level to 18.5om on top level

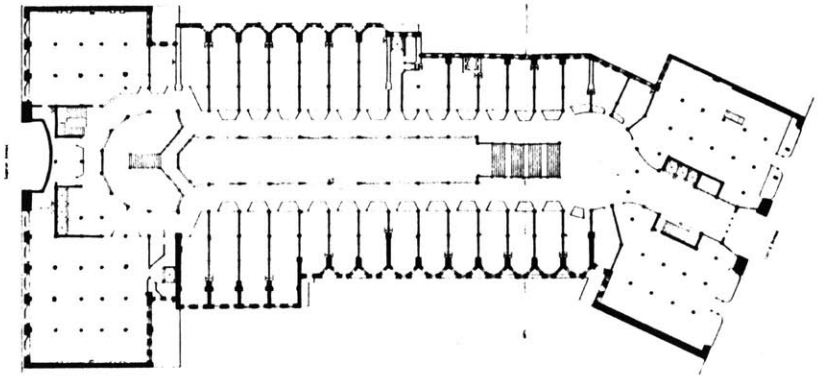
REF. Geist ( )p.17o SLIDES 1/25 -7/25 VISIT X
Progressive Architecture 9/1956
Architectural Forum 1966, M.P.
Schofield

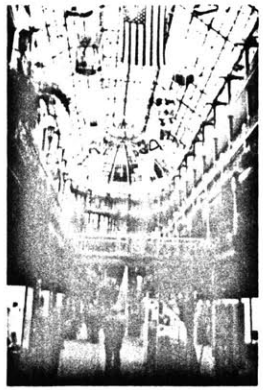
The building, in fact designed by bridge engineers with study background form Germany,can be perceived today as unique protype for design guidlines - in terms of thermal control and spatial display of highly disciplined imagery.

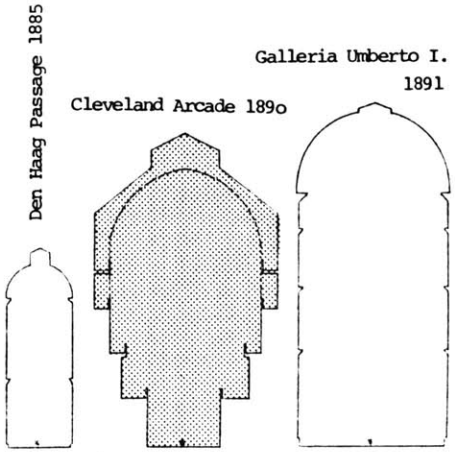
The arcade acommodates over 1oo shop-spots with small restaurants, retail, and services on the two ground levels. The three upper floor are for office use, and potentially also for walk by shops on the galeries. With only little spots of greenery, the two ground level mediate the level difference form Euclid to Superior Ave with galery and spatial stair display, providing a inspiring spatial sensation of scale and visual relation. Walking through the space gives a clear impression of the buildings threedimensionality and organisation. With this spatial composition, the building is unchanged in use since its opening, and never required rehabilitation with new uses. The shops and offices rent suucessful.

Spatially, the arcade is a total-theatre of galeries, skydome and movement of pedestrians. The spatial arena is a dominant self containment, a focus to the building, and thus less of a throughway character. The composition lives from the penetration of the horizontal galery levels, recessing with height, and the emerging vertical steel strukture skeleton to climb up with the glass dome. The spatial transformation has a distinct hierachý of readable logic. Articulate plasticity and cohesive confinement of the space is both achieved.

Thermal control is passivley handled. The height of space induces selventing, side and top louvers control the draft. Excessive height of glass dome allows warm air cushion to built up without drawbacks to use areas. Shopqwners asked reported adequate temperatures to seasonal conditions, slight overheating in summer and mostly resonable in winter. Coffe tables along the groundfloor galery are all year in use.
Mechanical problems of louvers and new sealing doors to obstrict bottom air supply though seem to hinder optimal thermal control.







D1	ARCADE SQUARE	Dayton, Ohio	198o

COM/O/R

ARCH. Lorenz & Williams Inc. OWNER Arcade Square LTD.
( )

PROGRAM Rehabilitation of run down structure from 19o2, formerly farmer's market with goverment functions, now shops, offices, restaurants

gross floor area m^2 tenants apart 56
sunspace area 6oo. m^2 height 27,4om height 18.oom

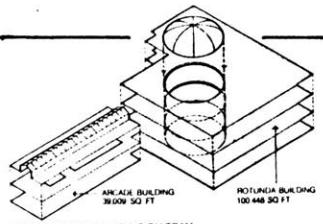
SUNSPACE CONTROL Airconditioned space together with building, no shading devices or dome venting

GLAZING Brown tinted 2o% transmission glazing

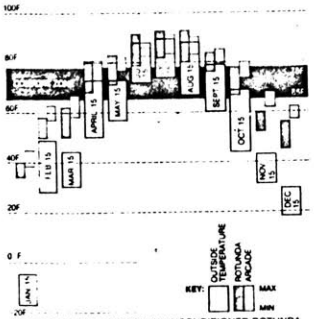
FIRE PRO Direct sprinkler system to the dome construction and fire separation of dome and arcade

REF Materials Lorenz & Williams SLIDES 1/24 - 12/24 VISIT X
Progressive Architecture 11/8o

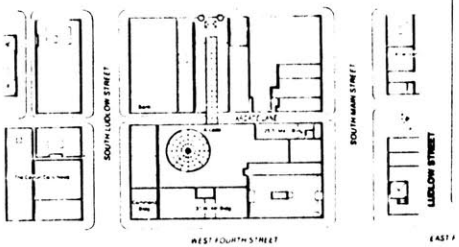
With the newly glazing of central skydome and a short arcade, a new commercial vaild use could be introduced. The skydome offers a circulation pocket, however is not sufficiently use. Provided seating area is to little and are uncomfortable spatially "lost" Moreover, the glazing tint and the grey tile floor yield an unpleasant light condition. Sunambience is very reduced. The second commercial floor is fairly disconnected, functionally but also visually too far recessed from the railing, or, partly with dark tinted glazing to obstrict any transparency.Likewise the massive escalotor cuts the space atrocious. The third floor is again hidden behind repelling tinted glazing. Only adaption with the geometry of space is with the skydome contour lighting and a central corona
The place per se has more potential for ambience and leisure then the scheme developes.
However, the concern to mix the project with housing for a off-hour base vitality is encouraging.

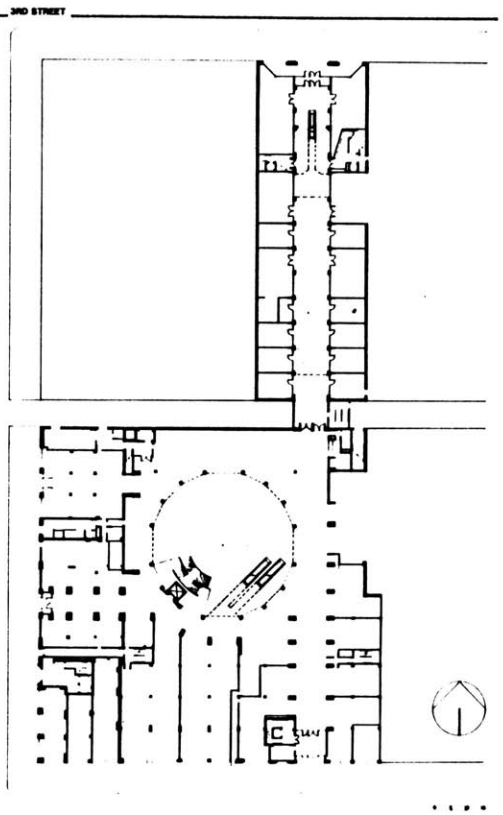


ARCADE SQUARE BUILDING DIAGRAM



TEMPERATURE FLUCTUATION IN UNCONDITIONED ROTUNDA AND ARCADE





D2	NORTH MAIN STREET ATRIUM	Dayton, Ohio	1981

OFF

ARCH. I.M. Pei
Lorenz & Williams

OWNER

PROGRAM Office complex

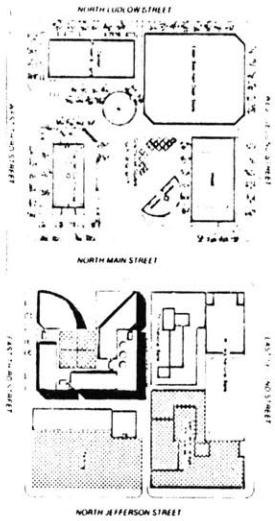
gross floor area m^2 tenants apart
sunspace area 38o m^2 height 28.oo m width 19.5o m

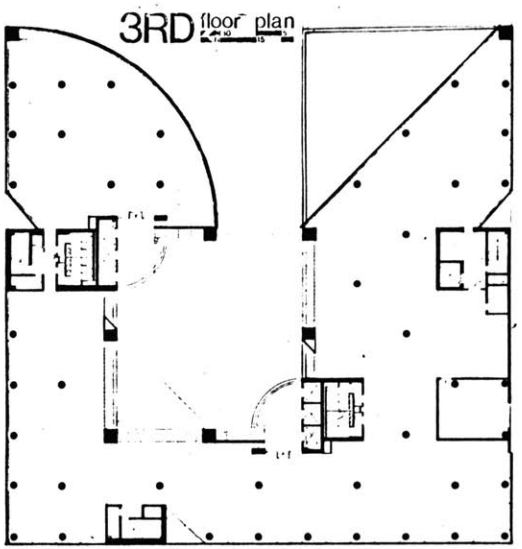
SUNSPACE CONTROL Air conditioning with floor areas, little skylight area and large west facing vertical glass wall, shading by building shape

GLAZING Clear glazing

REF. Materials by Lorenz Williams SLIDES 13/24 - 19/24 VISIT -

The office complex incoroprates a small atrium as circulation core and formal reception to the building. Aesthetic approach prevails to flood the galeries in vertical light. Office areas are separated form the atrium and visibility is heavily obstricted by massive concrete railings. The atrium. looking up appears more like the interior of a tower, missing human touchable scale and perceivable seuence of spatial senstation. The atrium is more a lobby gimmick then a ambient sunspace





E1 GALLERIA Edmonton, Alberta 1981 RES

ARCH. John & Patricia Patkau OWNER Lorden Wolf Developement Corp. Edmonton

PROGRAM Low rise condominium project on existing garage structure for a cancelled high rise tower.

SUNSPACE CONTROL Passively operated, fan vented space

GLAZING Sloped 3o% transmitting tint acryle double domes on exposed steel trusses, partly clear glazing strips

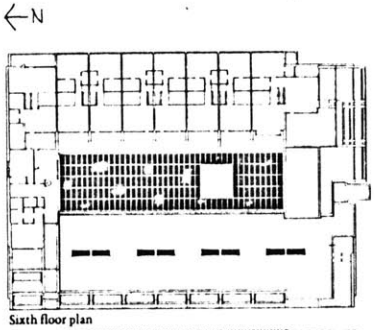
FIRE PRO 1 hour rated bearing interior facade with reduced wire glassed windows, emergengy exhaust fan

REF. Interview Particia Patkau SLIDES 1/14 - 16/14 VISIT X
Progressive Architecture Jan 81

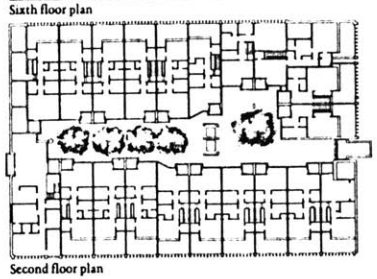
The project emerged from fairly restaint site conditions of a abandonned tower parking garage. Resonding to severe climates of -4o°C in Edmonton, and for intensive building bulk, the atrium approach was chosen. The sunspace is kept as a very quiet, piecbeful interior greenery, faced by usable balconies and galeries all second floors. Apartments thus offer duplex typs with interior and exterior balcony, the interios ones featured as special amanity to the northern climate as exterior is unusable 7 months of the year.

The solely residential application clearly utilizes the indoor amenity, though in a too private, exclusiev way. Daylight conditions are dimish with the glazing tint which was applied due to east-facing slope. This slope also skips the space out of balance and misses some lightweight elegance. The facades do not generously utilize constructive freedom as interior membrane.

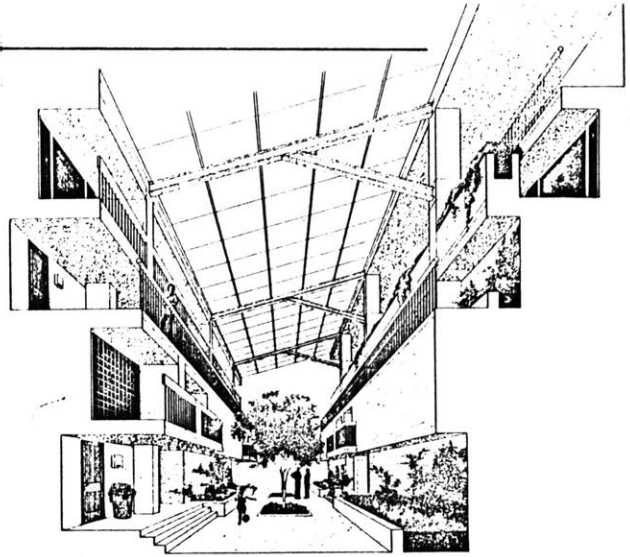
In Canada's most northerly major city, housing units are built around a wintergarden

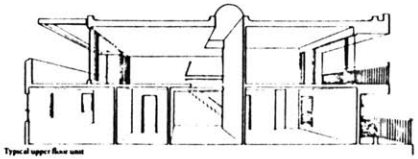


Sixth floor plan



Second floor plan





Typical upper floor unit

E2 JASPER SENIOR CITIZEN APARTMENTS Edmonton, Alberta 1981 RES

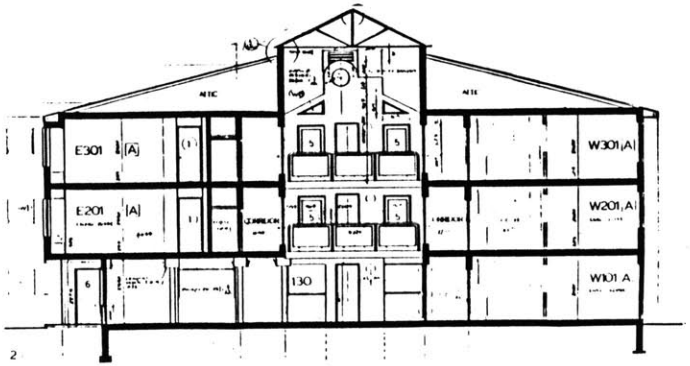
ARCH. Rick Wilkin-Architects OWNER
( )

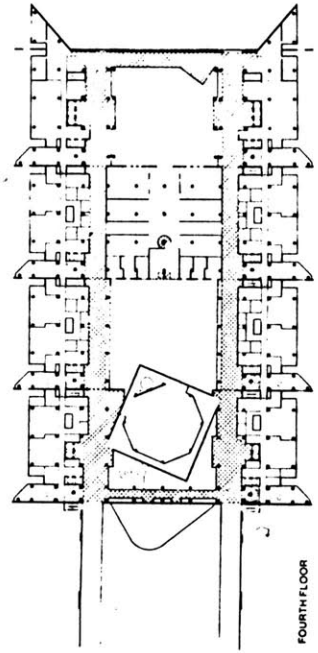
PROGRAM Senior apartment complex

SUNSPACE Circulation hall with galeries on three storeys height, 5.oo x 11.oom

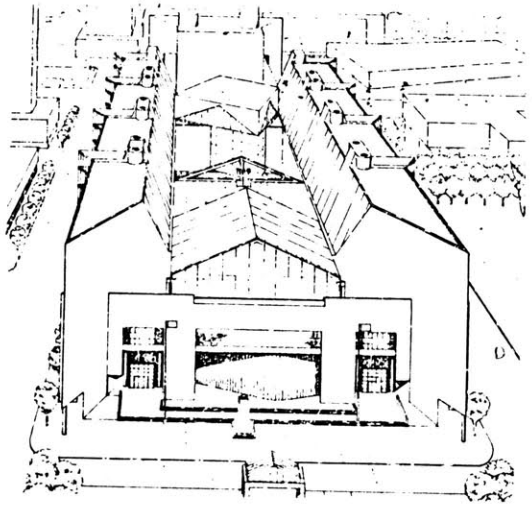
CONTROL Passive vented and heated form adjacent building, with back-up heating for cold peaks

no further details yet available




FOURTH FLOOR

D



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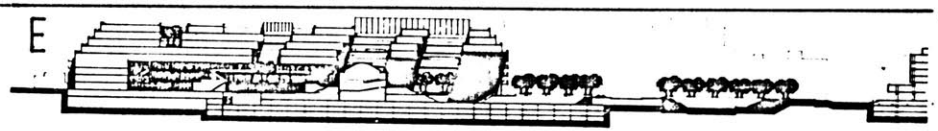
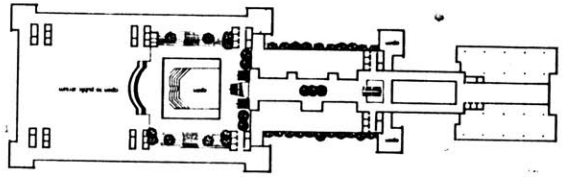
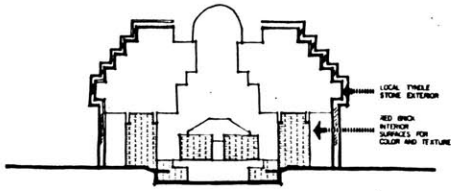
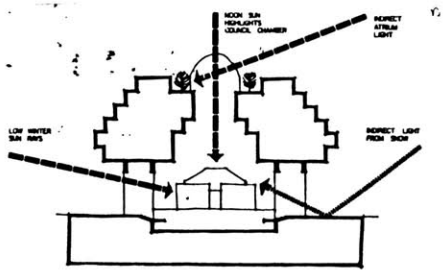
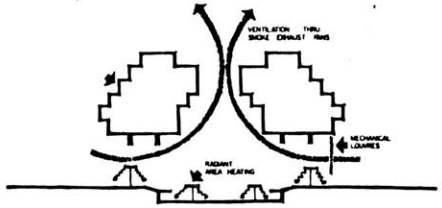
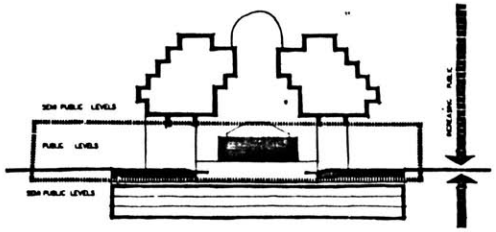





LOCAL TRADE STONE EXTERIOR
RED BRICK INTERIOR SURFACES FOR COLOR AND TEXTURE


NOON SUN HIGHLIGHTS COUNCIL CHAMBER
INDIRECT ATRIUM LIGHT
LOW WINTER SUN RAYS
INDIRECT LIGHT FROM SKIP


VENTILATION THRU SMOKE EXHAUST FANS
MECHANICAL LOUVRES
RADIANT AREA HEATING


50M PUBLIC LEVELS
PUBLIC LEVELS
50M PUBLIC LEVELS

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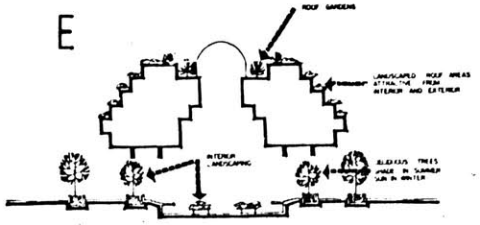
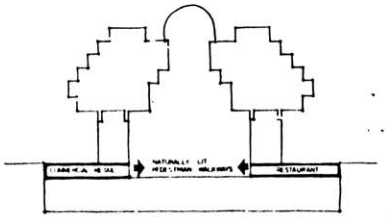

ROOF GARDENS
UNDISTURBED ROOF AREAS ATTRACTIVE FROM INTERIOR AND EXTERIOR
INTERIOR LANDSCAPING
DECIDUOUS TREES SHADE IN SUMMER SUN IN WINTER


NATURALLY LIT PEDESTRIAN WALKWAYS
RESTAURANT

E3	EDMONTON CITY HALL	Edmonton, Alberta	Competition 1980

OFF'S'R

PROGRAM City Hall and redevelopement of public park as "urban park" which will serve as a major focus. Design is to integrate the Sir Winston Churchill Park.

Gross floor area 137 000 m^2

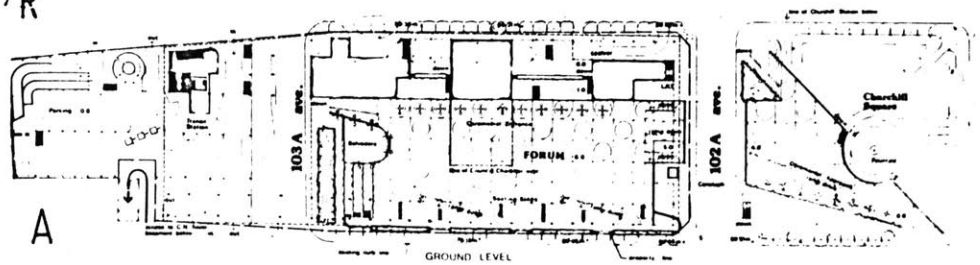
" As a major event in the Canadian architectural world, the competition might easily be seen by the public in general as a 'state of the art' comment. " (The Canadian Architect March 81)

Related to the Edmonton severe winter climate, most entries responded with schemes incorporating large urban sunspaces as public amenity and circulation throughway in the urban context.

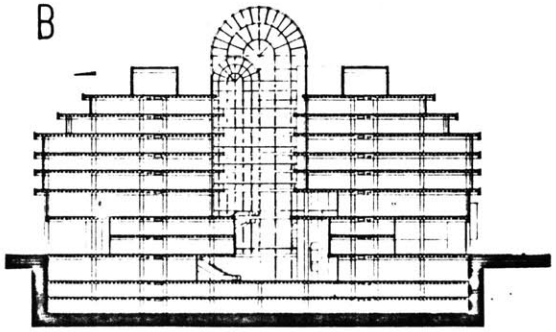
ARCH

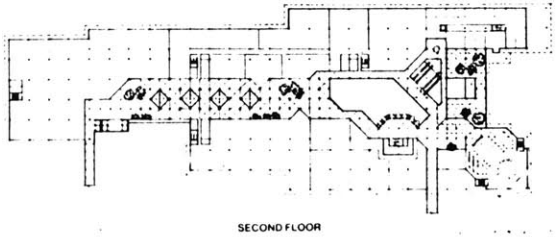
Neish, Owen, Rowland & Roy	- Toronto	(A)
Barrett & Johnson/Ho-You,	- Calgary	(B)
Chandler, Kennedy,	- Edmonton	(C)
Kirkland, Boigan & Armstrong	- Toronto	(D)
		(E)

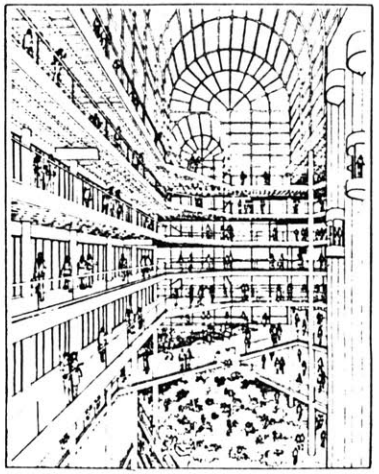
A



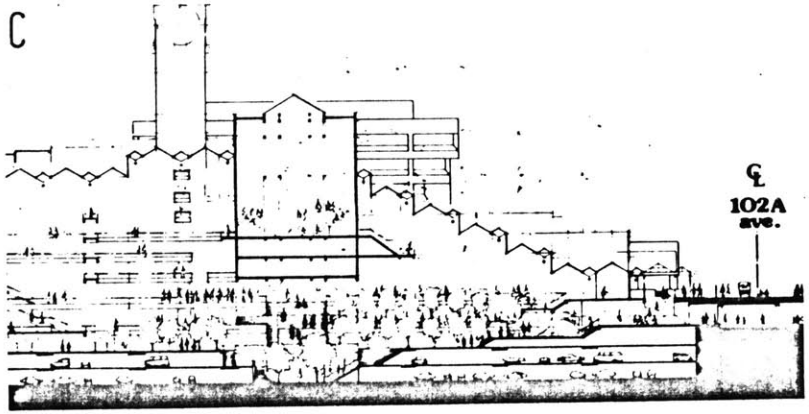
B







C



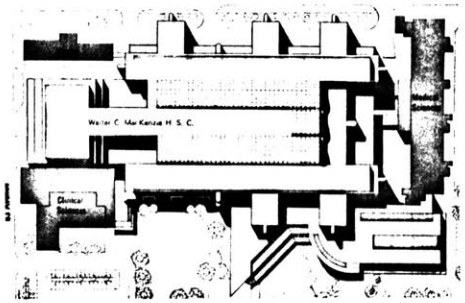
E4	HEALTH SCIENCE CENTER	Edmonton, Alberta	1982

HOS/R/S

ARCH ( )	F.Zeidler, Fred Kulscar UESC Architects Group Ltd.	OWNER	University of Alberta
PROGRAM	Gross floor area 150 000. m^2 Sunspace area 1 200	Height 24.00 m	Width 9.60 m
SUNSPACE CONTROL	Airconditioned,		
GLAZING	Skydome with geometric pattern of diffenrently tinted colored glazing		
FIRE PRO	sprinklered galeries, and reduced interior window sizes		
REF	E Zeidler	SLIDES 1/15 - 12/15	VISIT X

With the double bay arcade, the scheme takes a step towards a futuristic concept. The interior appears like a spacecraft. Light and space is ambient as a world to its own, providing unasble interior amenity - a recreational space for patients and staff with regards to severe outdoor climate at most part of the year in Edmonton.
The curved skydome is light and elegent, playing with the high tech interior of ducts and ship galeries. The interior is sculptural but with flat facades. The landscaping is atrificial, matching with the shiplike railing of galeries. Pergolas and coves define aesthetically seating areas and retreat places, coveying a southern beach restaurant ambience.
Bridges and galeries help the transition from the treatment areas, as the facades are of little transparecy, appear like outdoor facades with little window area. Programatically the sunspace houses all the hostpitals service areas as large waiting and reception room. Additionally the space is open duct space, adaptive to any changes and maintainance of appliances.
The sunspace creates protected leisure space, save 700m^2 floor area with services, and additional space for ducting - a budget saving of possibly 400 000 $ at least. Other feature is connectability of function room to either side of the sunspace with bridges.
Daylight to the services area is also a considerable saving.
Compared to other hospital schemes, the sunspace concept offers best orientation for the complexity of function rooms and the builk of floor area.

Ultimate Site Development



E5	HUB - STUDENT UNION HOUSING	Edmonton Alberta,	1973

RES/S/R

Stein: The University at Edmonton has that—as the fundamental organizing principle, and a friend of mine who is a professor there says it's an extremely successful method for building in that climate, and it permits people to meet outside of their own apartments.

ARCH. Barton Myers & Rick Wlikin OWNER University of Alberta
( )

PROGRAM Student housing for 9oo tenants, campus center facilities such as shops, restaurants services, launches
Campus integrative function as linking pedestrian street with winter climate protection.

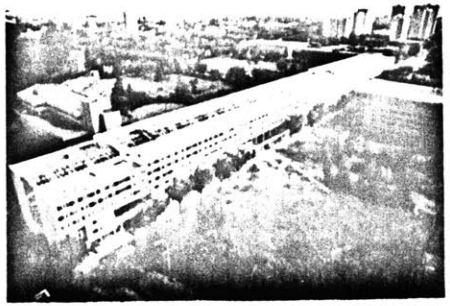
gross floor area	32 5oo. m^2	tenants	964	apart.	5o8
sunspace area	2 52o m^2	height	15.oom	width	8.5o m

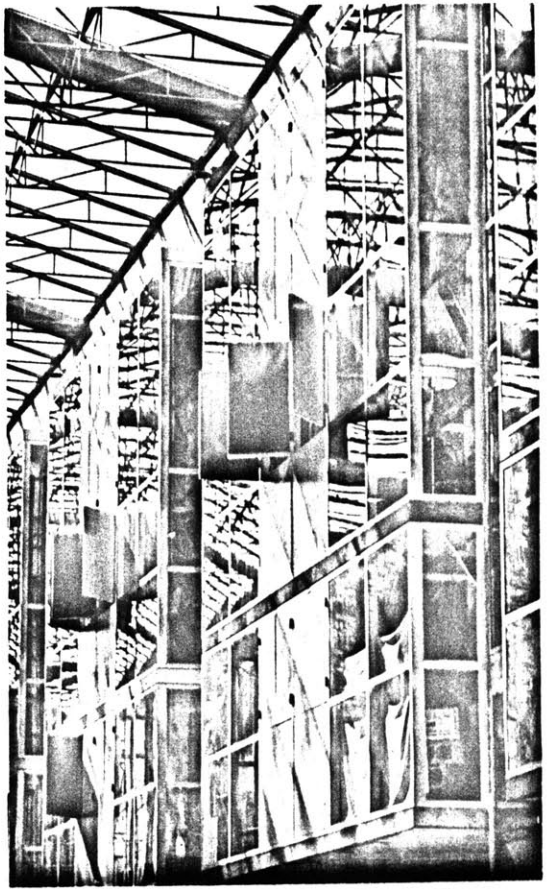
SUNSPACE CONTROL heated essentially form transmission losses and internal gains of adjacent floors, additional conditioning with warm/cool air induction sunshading with white canopy under glazing, venting on glazing edges

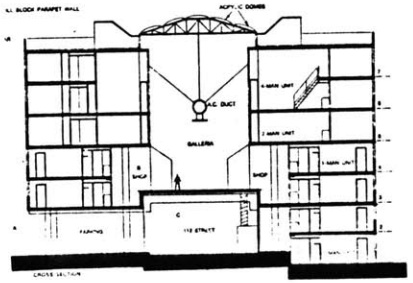
GLAZING Acryl double dome glazing, clear

FIRE PRO slight positive pressure induced with fresh air supply to limit fire and especially smoke spread, other then that, the building is conceived as one fire zone, not even the interior facade is fire rated no additional emergency exhaust - but sofar little fires were easily controlled due to best accessability of building

REF. Interview David Oelson ( ) SLIDES 1/12 - 2o/13 VISIT X
Rick Wilkin ( )







The building is surely a world unique concept. The approach oppoesd the common dorm tower design and intended an integration of housing with demanded campus facilities to meet growth problems of the expanding university. The only site available was a street, to become theme for a pedestrian liking mall, "a non-building"as the office of Barton Myers puts it.( ) With this, urban density was implied. Responding to climate, winterprotection of a mall charachter was also demanded. Site narrowness demanded tight clustering of the slabs. By bridgeing the intermediated space with glazing roof, one building was created in terms of buidling distance code requirements - and, the mall was weather protected. To succeed with this density and related fire provisions, the "Alberta Code" was amended.

With this, on actual no site, an arcade with shops and services and dense housing was generated, a mix use building of integrative urbanity and vivacity as campus pedestrian network link.

Pulling together the two building slabs with protecting lazing provided a "storm-window" (David Oelson) to the building of inwared urbanity. For introspective character of the sunspace, highest transparency with excessive facade glazing was used. To intensify sunspace arcade use, launches and retail areas are highly adaptive to change of use, and related with a split level lay-out to the arcade.

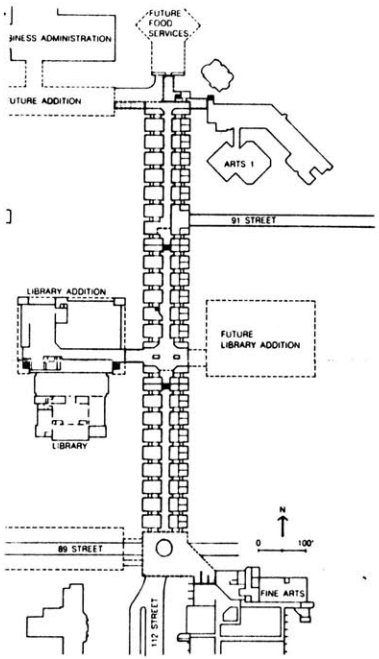
The building initially stongly challenged the local rural minded preconceptions, howver works today widely acknowledged as vital visited central place of the campus and most demanded housing facility.

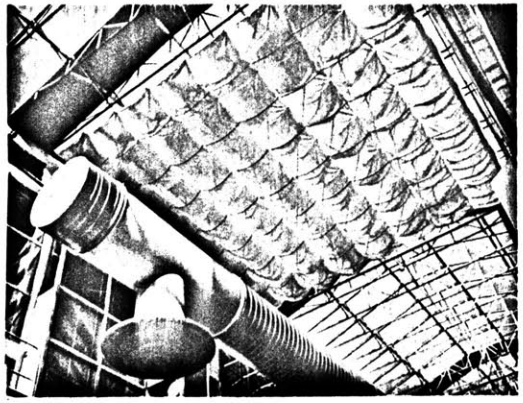
Hardly any other visited project was so urban, protective and ambientin light and tone, and easing the user's adaption. To be free to walk in, get a coffee somewhere, get a chair and sit under some tree, talk with tenants right away is a unique reception to a building. In this case, it completely lets forget the 95o student tenant scale of the project, which would otherwise be quite repellent.

Environmental problems, such as heavily discussed in the profession, are minor, and far overruled by the many amanities the concept offers. As an interviewed tenant puts it, "...if you live here, you have everything in reach right down there. An as you use the building, you understand the concept, and you even enjoy the homyness of some good kitchen odors, or, the continuous vivacity and sound form the street mall". The density is perceived as a communal character opposed to the lonelyness living in highrise tower dorms.

Due to the prototypical approach, energy management and accoustics pose some lack. Too excessive use of interior glass facade, surfaces are sound reflecting. There is no absorbtion. Likewise, heat peaks, partially from solar incident can not be stored, but need to be vented out with cool air induction.For passive thermal swing of the interior with the outdoors, the interior facade is not sufficient.

Costwise, the buildings construction was cheapest on campus (15$ 1973/sqft).Costs of the acryl glazing could be compensated by reduced specification for the inter ior facade. In total, the building materials are cheapest, traded off for most space possible. Interior balconies were thus also abused, though they would have added to the introspecive ambience of the apartments.





E6	ESLOVS KOMMUN - AGGREGATA URBANA Eslövs, Sweden Project 8o	RES·S·F

ARCH Landskronagrüppen
Broberg, Johansson, Anders Wallin

CLIENT Agri Consult Malmö
Eslovs Kommun

PROGRAM Community developement project on ecological and participatory objectives

SUNSPACE The sunspace acts as a communal spine and as climate responsive ecological system to the community setting. The sunspace accomodates community services, social places and finally the communities energy "system". With regard to nother climate of upper 56° latitude, the sunspace serves as heat buffer and windshield. Heatpumps reclaim collected surplus heat from buildings and solar gain for storage

CONTROL The energy system works with the sunspace as climate buffer and solar collector. By building bulk and improved micro climate between the builingd, wind inflitraion and skin losses are minimized. A consumption of 925 Mwh for 83 dwellings of 11om^2 would yield appr. 12 W/m^2. 6o% of this consumption though would be supplied by solar input and most of all, heat recovery systems with thermal storage and heat pumps. Inflitration reduction also makes up 12% of this.

Simulated options of energy handling

Seasonal storage, making up 7o% of the total sytem cost ($ 51o ooo) would operate on 6$/kwh.

Heatpumps would be able to reclaim 7o% of the waste heat collected and thus supply 85% of the space heat demand, at costs of $.25/kWh.

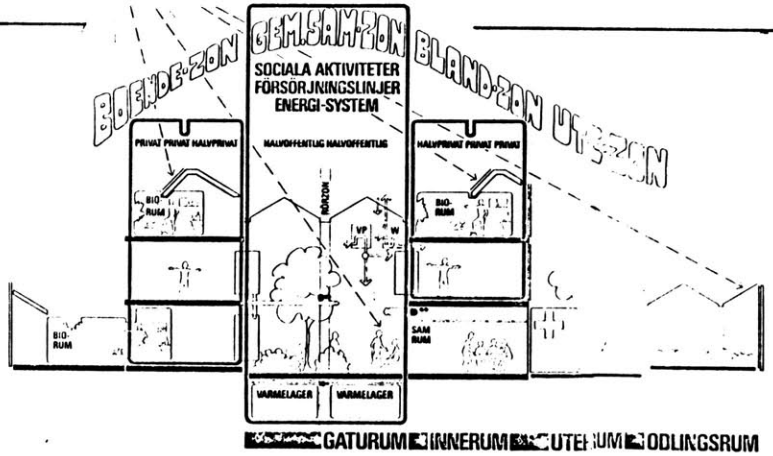
Temparature in the sunspace for this modes is defined between +5°C and +3o°C, with an air change rate of .7o in winter upt to 7 times air change in summer for ventilation.

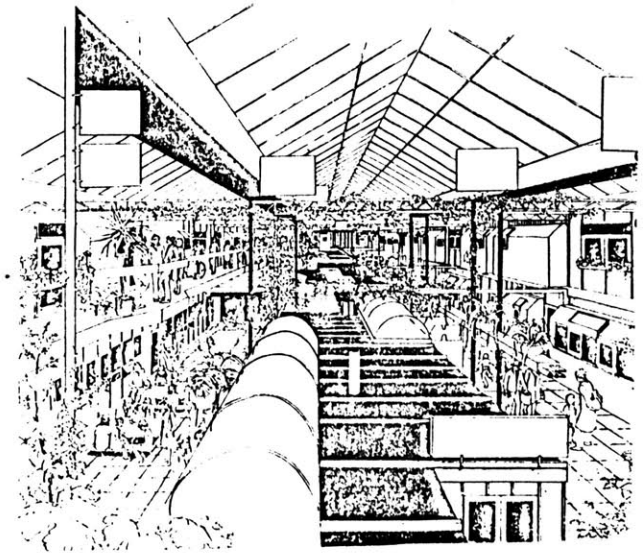
Besides the wide "comfort range" accepted in the sunspace, main feature is the storage system as subject to various simulations, due to highest costs implied with the seasonal storage technique.

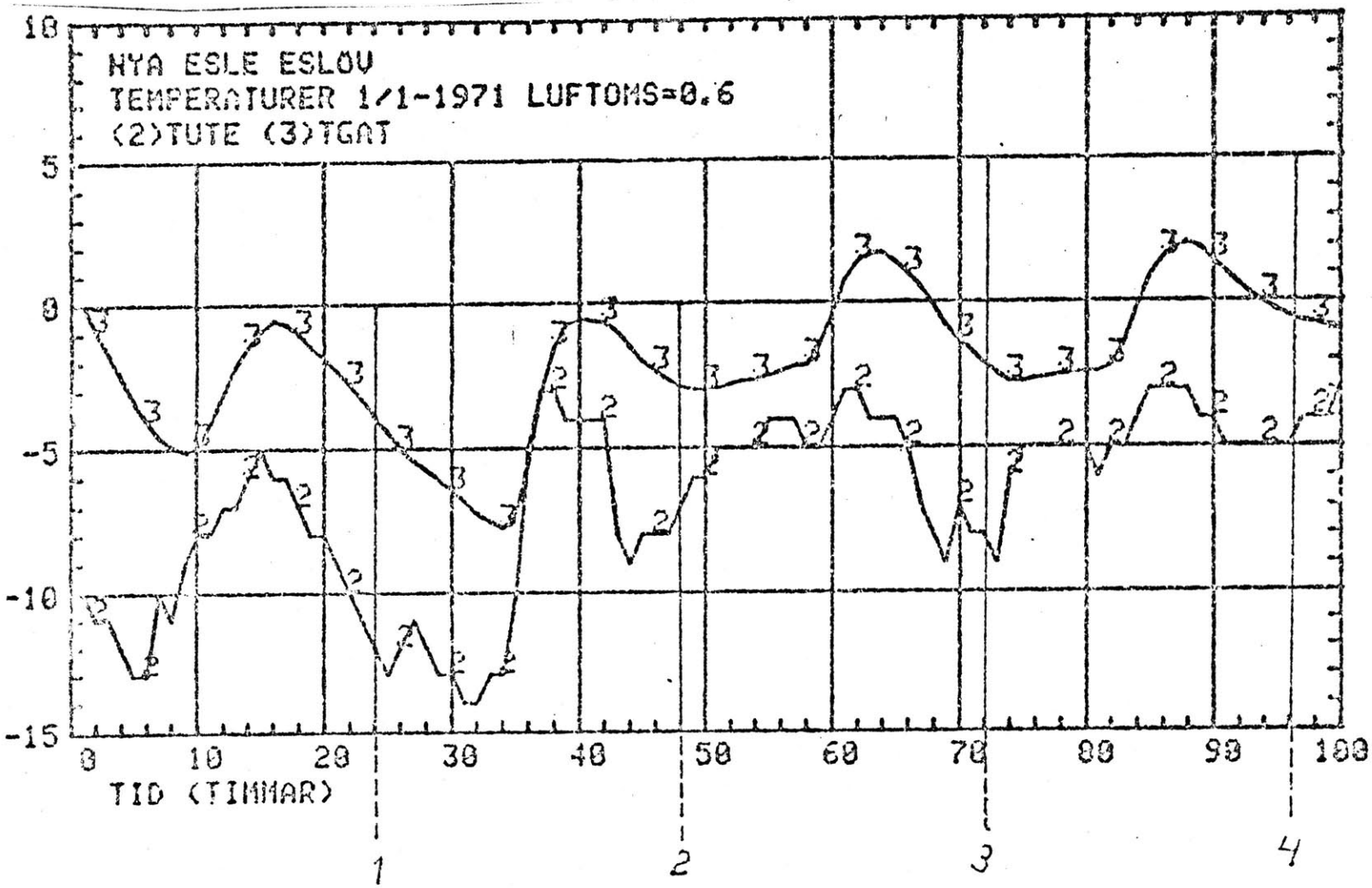
GLAZING Anticipated is a clear double glazing with moveble insulation of reflective plastic foil (k=.5W/m^2) or heatmirror glass (k=2.oW/m^2)

REF. SYDKRAFT Energy rapport "Nya Esle"
G. Perman, Malmö Oct. 198o

Projectbroschure Landkronagruppen
Peter Broberg, Anders Ekholm,



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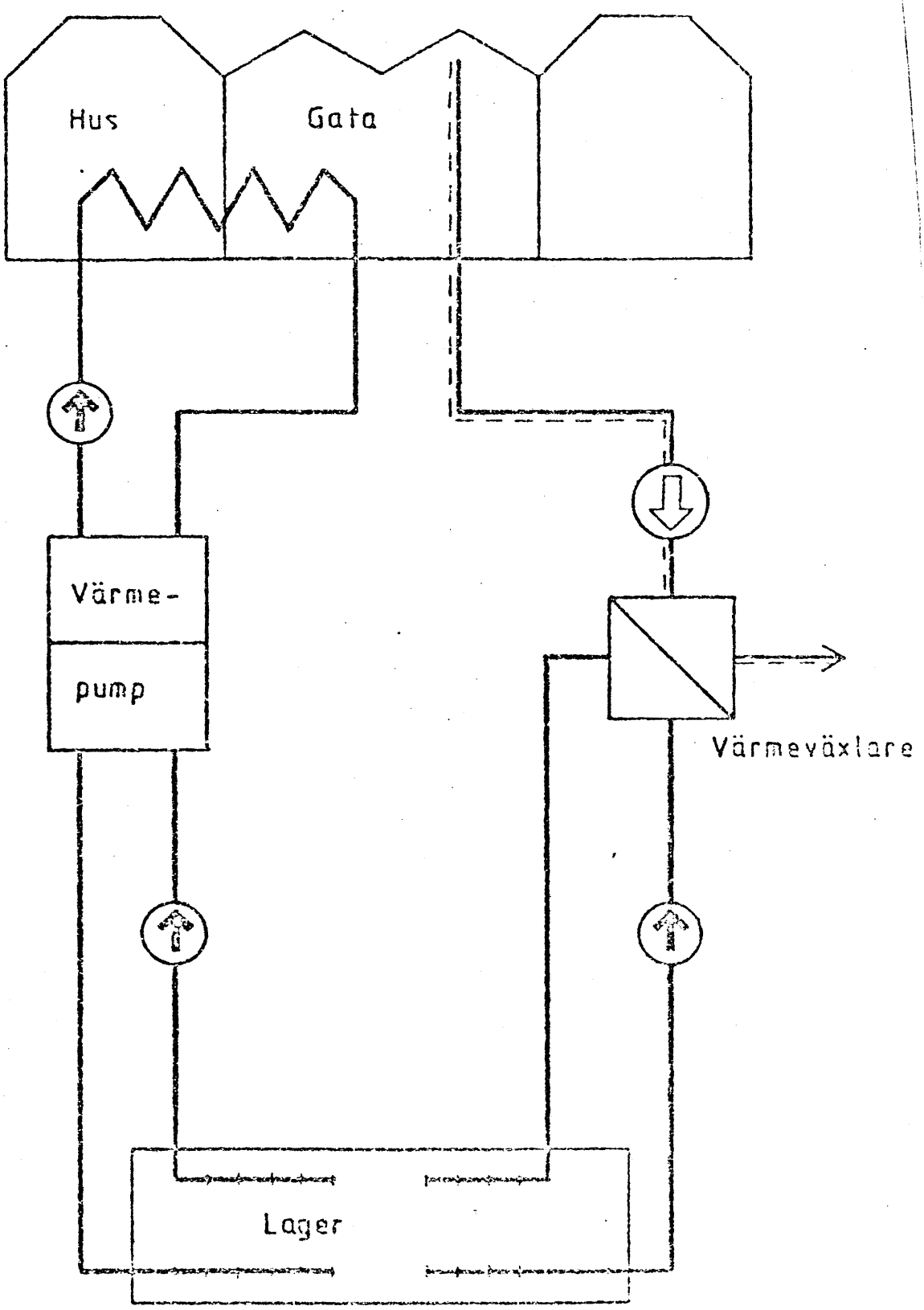
Hus
Gata
Värme-
pump
Värmeväxlare
Lager

Överglasad gata som energisystem

Temp i gatan min +5°C, max +30°C

	Passivt Lagervolym 3 000 m³	Utan uppvärmning av gatan	Utan överglasad gata
ärmebehov otalt	371,4 Mwh	351,5 Mwh	466,4 Mwh
ärmebehov us	342,1 "	351,5 "	466,4 "
ärmebehov ata	29,3 "	0 "	0 "
ransmissions-örlust	178,0 "	180,2 "	186,2 "
entilations-örlust	164,1 "	171,3 "	280,2 "
1 till VP	70,9 "	-	-
örluster till mg från lager	88,6 "	-	-
agrad värmemängd från gatan	12,0 "	-	-
ttagen värmemängd från lager	300,0 "	-	-
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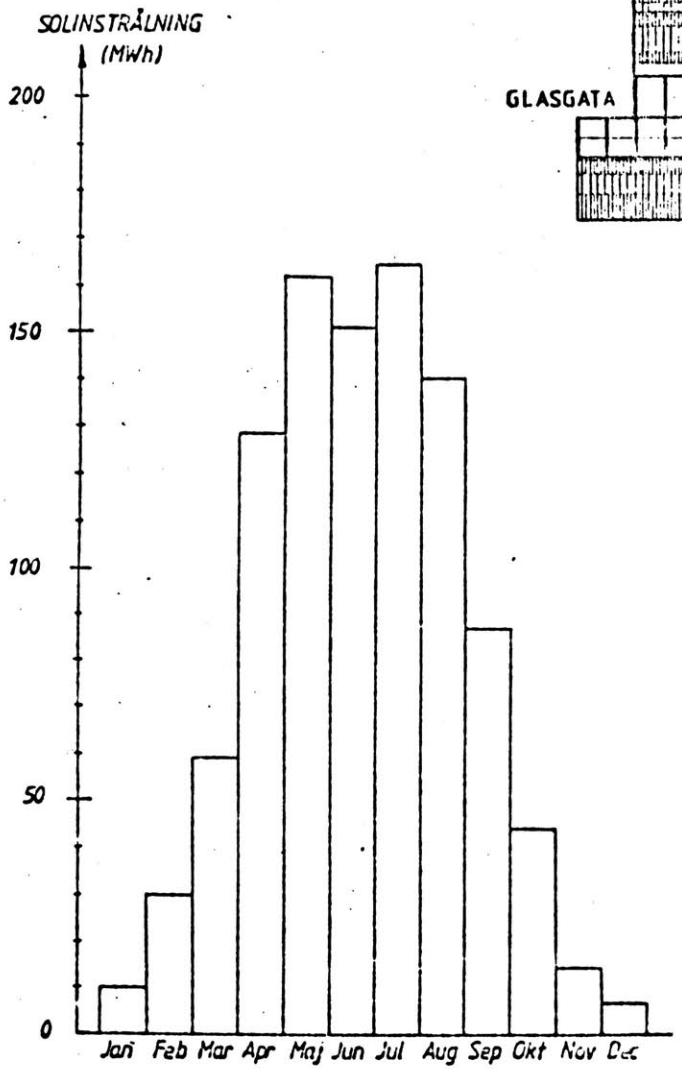
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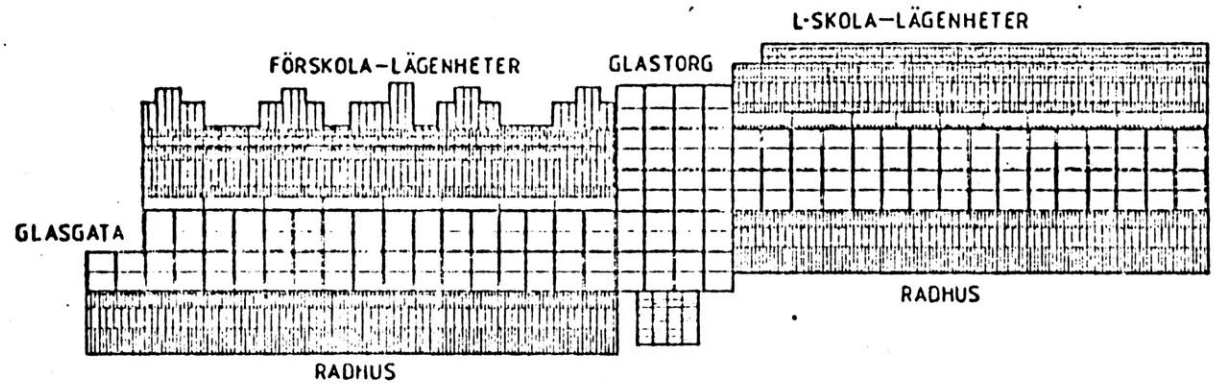
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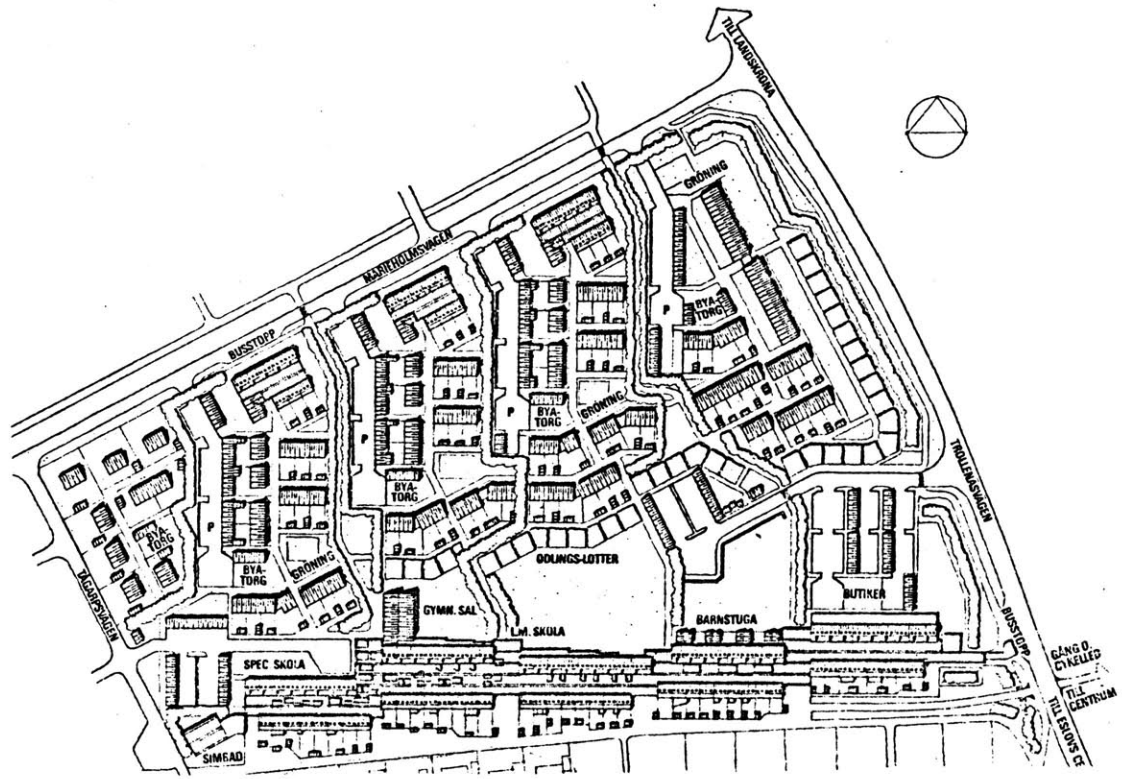
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BARNSTUGA
BUTIKER
SPEC SKOLA
SIMBAD
GÅNG O. CYKELLED
TILL CENTRUM
TILL SÖDRA ÅS

G1	FAMILISTERE DE GUISE	Guise, France	1853

ARCH. Jean Baptiste Godin OWNER same

PROGRAM Labours community palace in family units

gross floor area m^2 tenants Aart:
sunspace 5oo -4oo -4oo m^2 height 17.oo m width 16.8cm

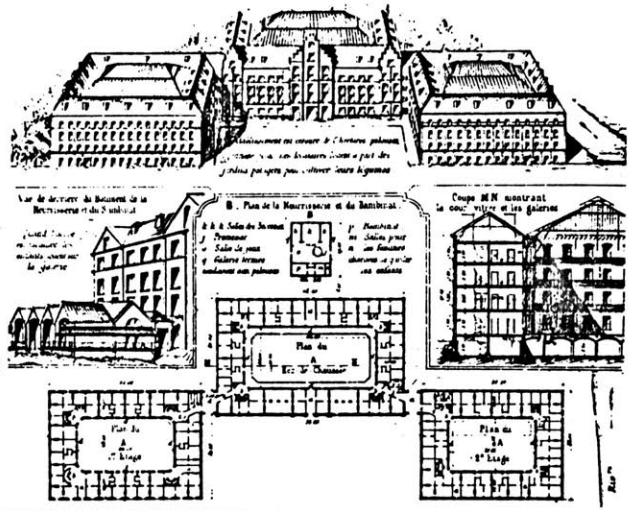
SUNSPACE CONTROL passively heated form apartments, naturally vented with louvers

GLAZING clear single glass as gable roof with steel construction

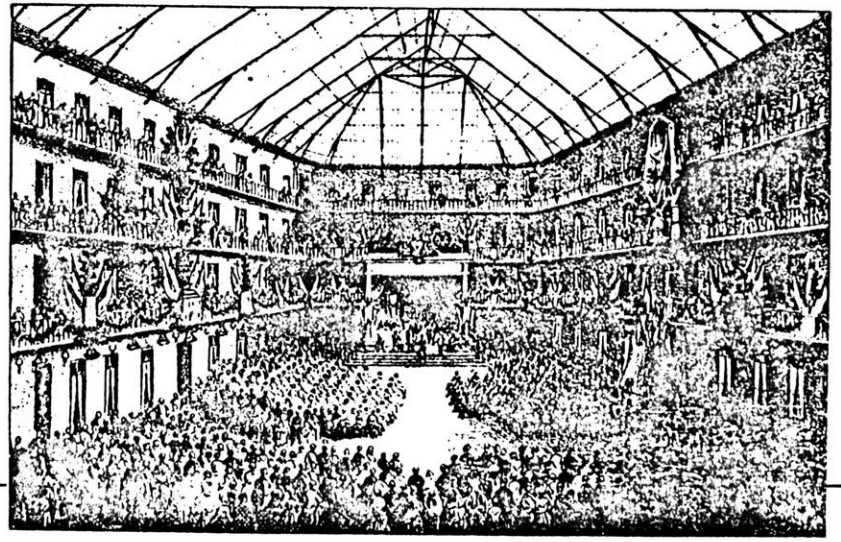
REF. ( ) therein orientaion ref. SLIDES VISIT -
( ) Benevolo
( ) Geist

The complex is perceived as an urban socialistic utopia, where the sunspace explicitely takes the role for communal interaction and visual expression of the monatic life form. The applied glass roofing was by its time the image of progress, of a new age, but beyond that intende by Godin as protected indoor for communal gathering and unification. The inner circulation is developed to a social connector space. While Charles Fourier invisions the royal palace with catwalks protected, Godin features the building as a protective fortress to the skylit inner core of communal focus.

For further discussion see Chapter ,p.



7. Cross-section of the central part of Godin's Familistère, from *Solutions Sociales*.



First workers' festival in the central courtyard of the "familistère" in 1867.

Each year a labour festival and a children's festival are held in the central courtyard, setting the seal on the efforts of workers and pupils.
These moralising celebrations are intended to reinforce, among the members of the "familistère", the feeling of belonging to a community and an élite.

L1 MIDDLESEX POLYTECHNIC London, UK 1979 SCH

ARCH. PMC / Martec International

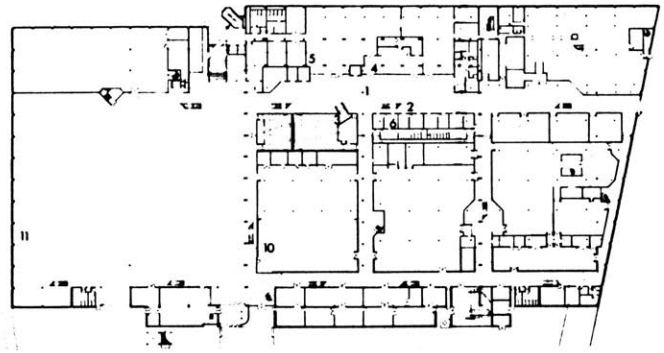
PROGRAM Technical school for 1500 students with re-use of some existing structures with a flexible circulation system

gross floor area 2 200 m^2 occupancy 1500
sunspace area 500 m^2 height 9.00 m width 5-8 m

SUNSPACE "Shipdeck like" spine of the building, with stairs, doors, galeries and collage elements projecting into. Railings and stairs are kept in a highly transparent ship design. ıanging width and circulation nodes generate a spatial sequence. Service and seating areas plug into the street. Bridgings cross the space. Ducting and technical appliances exposed convey technical tone of an engineering school.

GLAZING Gable roof with clear glazing, mounted on T-trusses. Every eighth glazing rafter bay is reserved for a louver system. Shading devices are not applied

REF. L'Architecture D'Aujourd'hui No 212 Dec. 80



L2 COVENT GARDEN London 1979 COM

ARCH OWNER

PROGRAM Re-use of former market facility hall as sheltered shopping area

gross floor area m^2 shops 50
sunspace area m^2 height m width m

SUNSPACE The market hall glazing is reused as shelter to a light flooded indoors space as concours to the shops. generous opening courts to the basement level give a two level concourse appeal and add retail area to the overall vitality. The place is kept as a urban sidewalk with hardly any greenery.

CONTROL The shopping shelter is kept unheated, perceived as semi outdoor. Summer mode operates with louvers in the glazing attic and on the edge to the facades

REF. B. Myers office materials SLIDES - VISIT -
Architectural Design 3/76

L3 COUTTS BANK London, Strand 1978

OFF

ARCH. Frederick Gibberd & Partners OWNER Coutts Bank

PROGRAM Rehabilitation and use upgrading of a historic Nash building. Addition of usable floor area

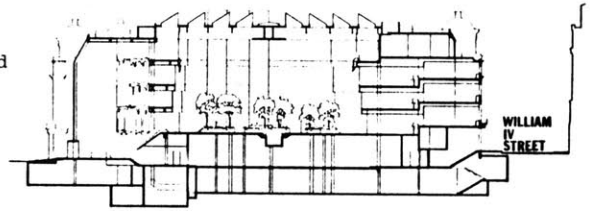
SUNSPACE The triangular court was glazed in lobby to the building with office landscape for banking service. A new vertical circulation, galeries and interior facades were introduced. Existing buildings were kept separated from atrium for thermal zoning and smoke protection.
The atrium in turn in on a second-floor level, with banking hall below (section 1)
Greenery is achieved with planter trees and on galeries

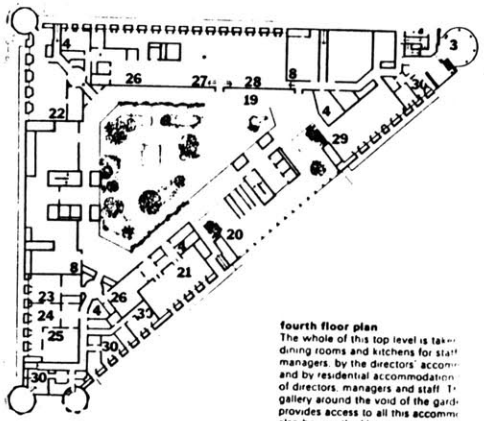
CONTROL The building is fully airconditioned with 2o decentralized circles and 66 separate air handling plants, to reclaim surplus heat from inner areas to perimeter areas. Essentially, a heatpump system recalims form the atrium for redistribution on the perimeter. Thus also solar gains get utilized.
Further performance data not available.

FIRE PRO Zoning of building with interior facades.

REF Architecture Design Vol 41 SLIDES - VISIT -
Architectural Review March 79

section
This shows the garden court and banking hall in the centre of the site and at first floor level, with the office accommodation planned as galleries at the upper floor levels around the perimeter of the site. The garden court rises through the full height, bringing natural light into the heart of the building at all levels. Because of the slope between the Strand and William IV Street, and the need to relate to the levels of the original Nash window openings, the office floors on William IV Street step up in their full width. The change of level is marked by a continuous planting trough.





fourth floor plan
The whole of this top level is taken by dining rooms and kitchens for staff managers, by the directors' accommodation and by residential accommodation for directors, managers and staff. The gallery around the void of the garden provides access to all this accommodation also houses the library

L4 LEISURE CENTER London, Hammersmith Project

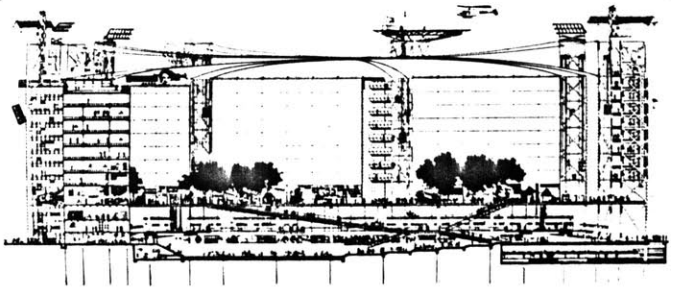
ARCH. Foster Assoc.

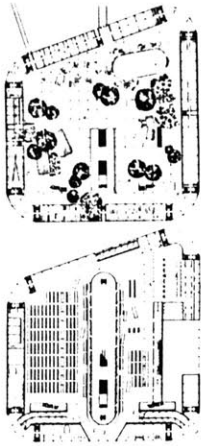
PROGRAM Communal leisure center and transportation exhibition, incorporating and old bus station, a garage and transportation equipments as "furniture" of a vast public, membrane coverd space.

SUNSPACE The sunspace is core of a building ring, covered in by a tensile mebrane dome. Inside a colage of elements and circulation between exhibition pieces developes.

"Primarily studies of the internal micro climate ...indicate... that even without application of heating or cooling, tolerable temperature conditions can be anticipated. In winter, the space will always be warmer then the outside.... in summer, internal temperature will be similar to the outdoor shade temperature"(a+u Feb. 81 p.85)

REF. L'Achitecture D'Aujourd"hui Dec.8o
a+u Feb. 81





M1	HENNEPIN COUNTY GOVERMENT CENTER Minneapolis, Min. 1977	OFF

ARCH Carl Warneke Assoc. OWNER Hennepin County

PROGRAM Office complex for accomodation of county adminstration and judicial facilities, to express these two distinct services.

gross floor area 110 000 m^2
sunspace area 1 100 m^2 height 96.00 m width 20.30 m

SUNSPACE The 24 storey twin towers are joint by a vertical atrium space of 96.00m height - a huge impressive space that opnens up to the top skylight. Large vertical glazing areas give daylight to the atrium facing offices. Bridges at every thrid floor connect the two slabs

With this, the sunspace serves as a daylight and visual outdoor connection to bulk of office floor area. Likewise, the configuration reduces the skin area by 8'500m^2, which equals 20% of the overall area.
Structurally, the atrium is cited to yield most savings, as the a total space frame stifens the two towers, for reduced foundation costs and 85% free usable floor area, unobstricted by bearing walls.

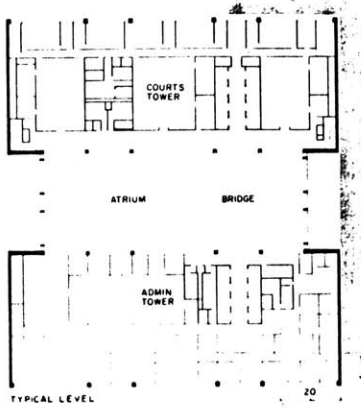
Amount of greenery is quite reserved. A central fountain is major feature to the groundlevel.

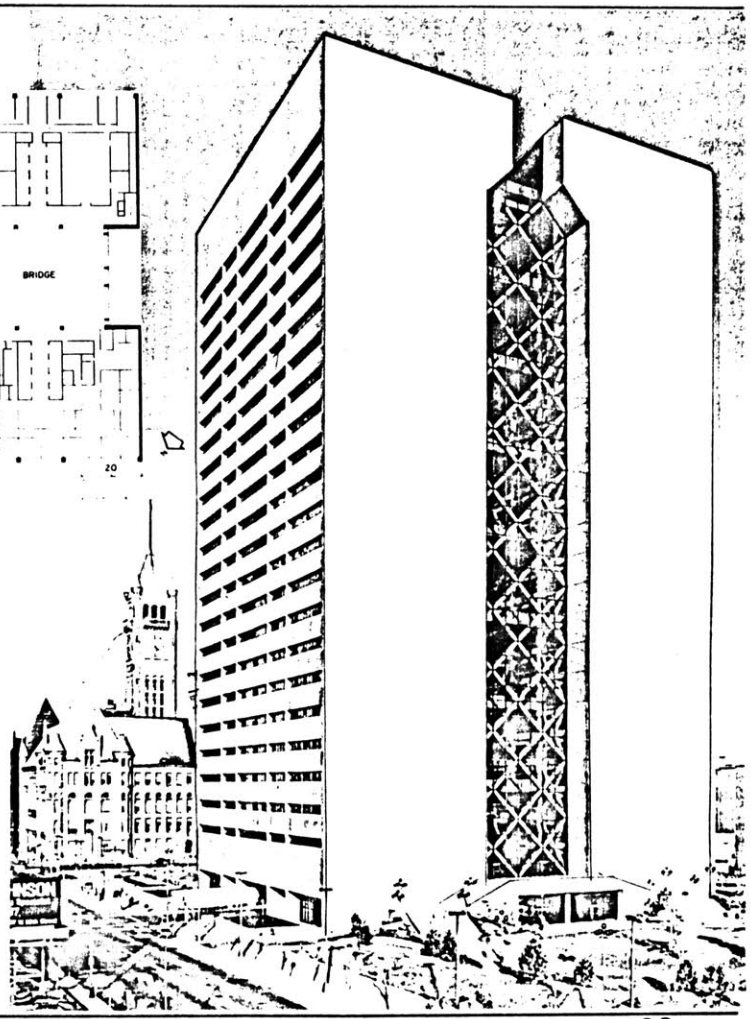
CONTROL The sunspace is fully airconditioned with the function of a return air plenum, and since either side of office floors is recently glazed in against the atrium, the space can also act as a balancing heat buffer reclaiming waste heat.
Temperature distribution is surprisingly uniform against an expected stratification. Discharging and moving the air in the plenum controls this balance.
Daylight glare from vertical glazing could not be assesed due to overcast conditions at the day of visit. Likewise, the daylight impact to the floor areas was minimal as low as 12 ftc. behind the office facades. (900 ftc. outdoors) With regular 4000ftc outdoors, this would however yield 50 ftc. within 3,00m from the inner facade.

FIRE PRO Emergency exhaust fans were installed at top louvers. Essential provision were several smoke tests to simulate the distribution pattern of smoke. Results were noted as "satisfiying" (building maintainance crew), with the regard, that the atrium volume can compensate a good volume of smoke, but still be passable for sufficient time.

SECURITY Special problems occur with excessive height of the space, which turned to become a draw for people to jump from the galeries, until glass curtains were put up on the railings.

REF. Architectutral Record March 77 SLIDES 9/18 - 20/18 VISIT X





M2	BUTLER SQUARE	Minneapolis, MIN. 1906- 1975	OFF/S/R

ARCH Miller Hansen, Westerbeck OWNER Charles B. Coyer
Arvid Elness

PROGRAM Rehabilitation of warehouse structure in downtown location for offices, shops, restaurant and 300 room hotel in a second construction phase. Overall, preservation of the building landmark

gross floor area	46 540 m^2	
sunspace area	640 m^2	height 31.50 m width 21.20 m
Hotel	23 250 m^2	

SUNSPACE The approach was to create an internalized environment, to leave the historic facade and patina untouched. Besides, the 6 000 m^2 of floor area seemed to be to excessive for luxury office market. With the sunspace, the scheme thus reduced floor area and provided daylight for ambient interior to the building. Basement areas and offices would be higher rentable, and the hotel would achieve better organisation and image with interior court.
In both project parts, interior balconies and high transparency was intended to yield "a multi layered social space" (PR10/75 p 77)

In other ways, the atrium approach ties into Minneaplis' climate related skywalks and interior plazas, such as the near IDS.Center. ( )

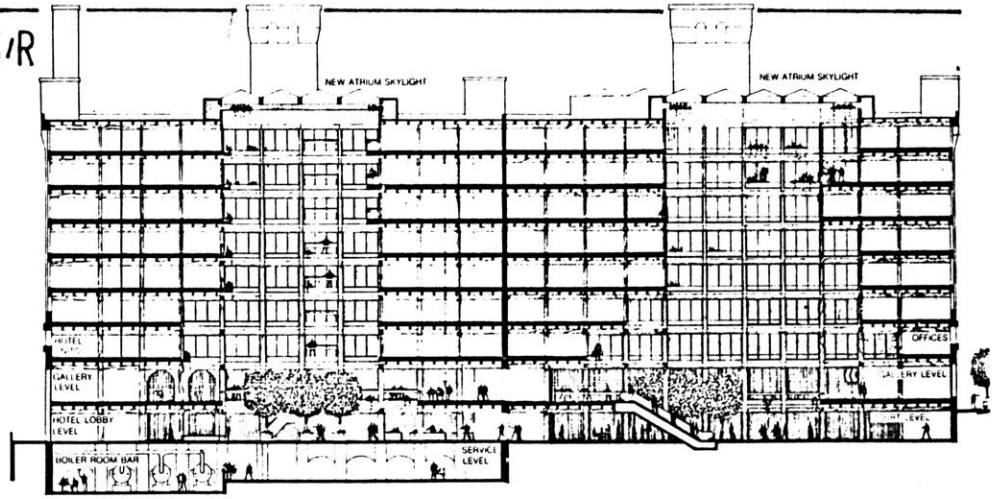
CONTROL The sunspace is separated form the floor areas by a glass curtain wall and wooden greenery planters. The single glazded façade is more a auditory and privacy control - it's transmissionlosses essentially heat the atrium. On the ground levels, also back up heating is provided.
Visual provacy and glare is achieved with user operated blinds, which in nearly all windows were kept up for transparency and view to the colorful atrium.

GLAZING The skylight is of saw tooth configuration with clear glass (double?) The bearing structure is not exposed and appears as horizontal bar as fairly haevy and unelegent. No shading devices empolyed

FIRE PRO The building is equipped with complete sprinkler system as for the exposed timber wood studs of the bearing structure.

REF Progressive Architecture 10/1975
AIA Journal Jul. 1979

Greenery is related to the office balconies and planters on the upper floors, providing a homelike ambience and "take care" to the offices.



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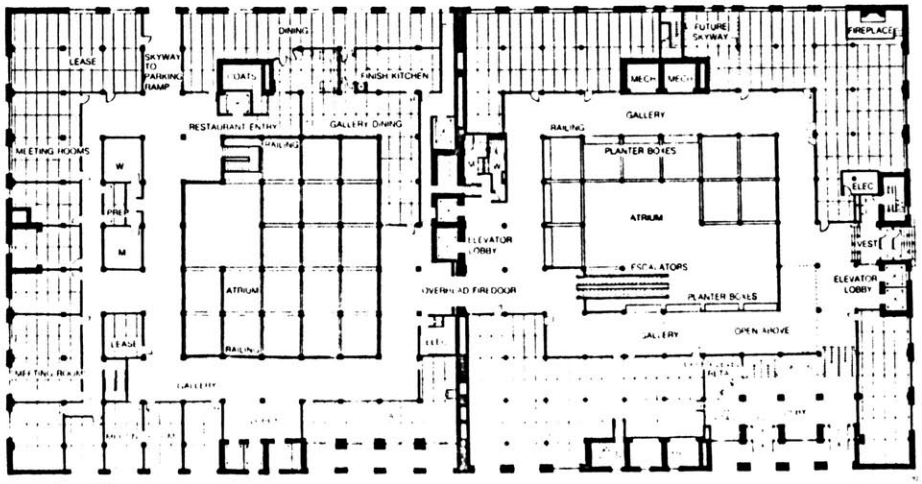


M3	JOHN DEERE HEADQUARTER	Molline, Ill.	1978

OFF

ARCH. John Dinkeloo & Kevin Roche OWNER John Deere Corp.

PROGRAM Office complex as extension of existing structure in same format to match with the architectural landmark of a Saarinen design from 1960. The building is to be a firm corporation imagery
gross floor area 18 500 m^2 Tenants
sunspace area 1 000 m^2 height 11.00 m width 10.00 m

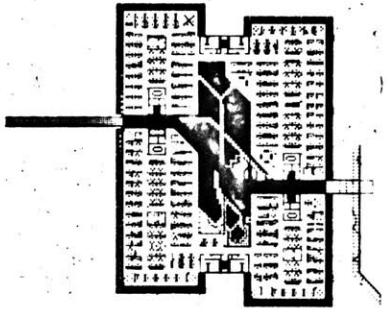
SUNSPACE CONTROL air conditioned from heat or cooling freely flowing into the sunspace form the open office areas

GLAZING 20% Transmission tinted glass, without any shading or louvers double pane, providing fairly dark daylight, in winter requireing suplementary light to plants

FIRE PRO Office areas completely sprinklered , steel studs all fully exposed

REF Architectural Record Feb. 79 SLIDES 1/21 - 9/22 VISIT X

The sunspace is spatially fully integrated into the design, but as a decorative garden , only bridged by some paths, unusable to employees. The sunspace is a mere imagery, an advertising feature, less an amanity to the building. The setting is too natural as landsacpe to match with an interior of an office complex. Even dining areas take only reserved advantage of the greenery. Like the overall design approach, aesthetics dominate the sunspace's ambience. Moreover, the path axis through the building, suddenly shifting in the atrium, crossing the directionality of the skylights and the angeled office floor edge are a confusing instant. There is also no distinct circulation node at this point, to make the diverting composition reasonable. There is no node in the sunspace to invite for remaining there, and the path has no readable end.



N1	MONTICELLO ARCADE	Norfolk, Virginia	Project	O'S'R

ARCH. Barton Myers OWNER

PROGRAM Renovation of the 19o7 Monticello Arcade as a major feature to Norfolk dowtown district. The receycling of the historical noted building is in contect to a overall downtown revitailsation.

SUNSPACE The three storey arcade is essentially passive operated, with canopies for shading. Office galeries surround a ground floor with cafes and shops. Greenery is decorative with the railings.

P1	HABITATION RUE DE L'OURCQ	Paris	1979	RES

ARCH J. Levy & Ch. Maisonhaute OWNER

PROGRAM Infill housing

gross floor area - m^2 tenants apart. 76
sunspace area 1 ooo m^2 height 9.oo m width 7.oo m

SUNSPACE The sunspace is a connector to the apartments open corridor system. With the sunspace, a central space opens to a communal area with entrance and vertical circulation. In plan, the sunspace is sort of a buffer to arrange and tie togehter the building parts, as they were restraint apart by the site configuration.
Regualr facades face to the sunspace of steel trusses and decorative greenery

REF. L'Architecture D"Aujourd'hui ?/79 Slides VISIT -

P2	CHILDRENS HOSPITAL	Philadelphia	1974	HOS

ARCH. Harbeson, Hough, Livingston & Larson OWNER
( )

PROGRAM Childeren Hospital with research facility

gross flòor area 92 9oo m^2 occupancy beds
sunapace area 4oo m^2 height 24.5o m width 2o.oom

SUNSPACE CONTROL air plenum to the overall air conditioning, as discharge and return volume, as this also reclaiming waste heat and solar gains, though not numerically monitored in efficiency, south elevation selfshading

GLAZING Clear glass double pane with shed folding

FIRE PRO Direct sprinkler system to interior facade, atrium closed off as sepaerate fire zone, top emergency venting

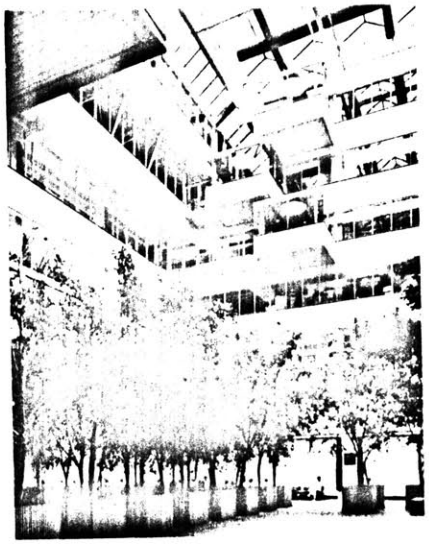
REF. Mechanical building management SLIDES 1/26 - 16/26 VISIT X
CHOP
Progressive Architecture 5/75

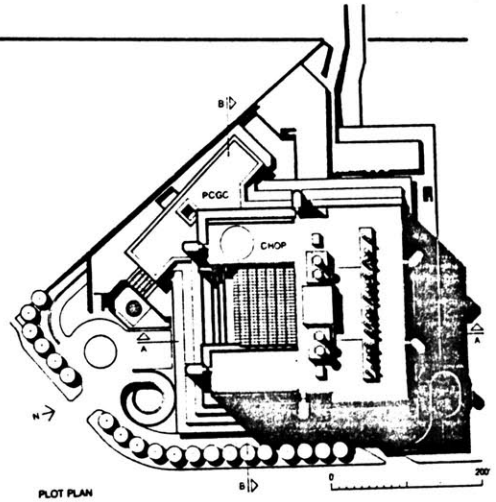
For energy conservation, the design approached a cube shape as optimization of floor area to skin area ratio.This brought also along depth of space and built up of internal gains. The atrium solution works well as buffer for both. Bringing light into the depth, and collecting surplus heat for reclaim and demand.
With solar gain and waste heat reclaim of the atrium, at temperatures above -2°C outdoors, heat energy self sufficiency is given.
Subsyantial savings were accounted from reduced facade construction due to cube bulking, and from saving of duct construction with the atrium as plenum (loo ooo$ as of PA 5/75 repost:)

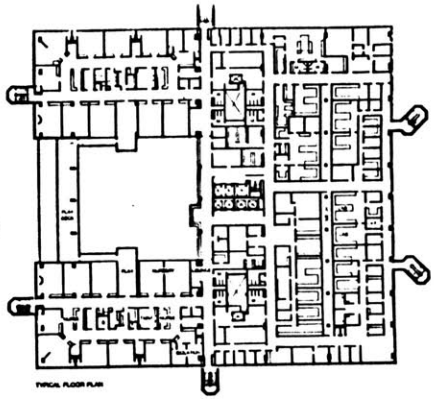
As amenity to the building, the sunspace works as waiting room, playgròund, dining area for a MacDonnald shop, reception area and informal leisure area to staff members. The court offers a vital inhabited setting with trees, shops and offices for public use.
Though seven floors deep, but with partially south glazing, the ground is well lit with a 1:lo light level ratio to outdoors. The white interior facades bounce light perfectly allover.

Trees, carpeting and configuration of the facades hold sound level resonably down to 62dBA, though the space is densèly inhabited.

The project is fairly sucessful, though not utilizing all potential. Temperature monitoring of the sunspace and mor sofisticated handling of air would improve the approach. The south glazing for example does not need shading, while the top horizontal is fully exposed to summer sun incident as subject to cooling load.







P3 THOMAS JEFFERSON UNIVERSITY HOSPTIAL Philadelphia 1977 HOS

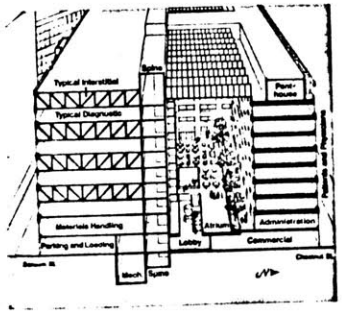
ARCH. Harbeson, Hough, Livingston Larson OWNER University of Pennsylvania

PROGRAM Hostpital and medical research facility in downtwon location, to still offer recreational space with appropriate building density on constraint site conditions

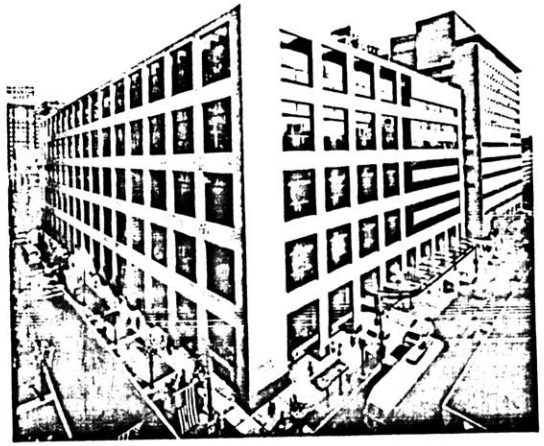
SUNSPACE The street block building centers around two skylight covered court yards were on the second level public reception, dining, shops and offices are accomodated. "Fancifully decorated to afford a cheerful view for the patients and to provide simulated "outdoor" seating for dining patrons." (Annual Hospital Report, 78/79), the sunspace works as an artificial outdoors. Though spatial proportions of the eight storey atriums are fairly off, and the facades are repelling flat, not utilizing any indoor articulation potential, the space is still ambient and in bright light.

The flat truss, sawtooth skylight in turn is somewhat bold and not appealing to the space, it is rather a mere lid.

CONTROL The sunspace's operation works with the overall buildings air conconditioning, using the atrium as return plenum.
Hanging flags are the only shading and porbably accoustic device to the space.



Cross-sectional view shows how patient rooms are separated from diagnostic areas by a building-high atrium.

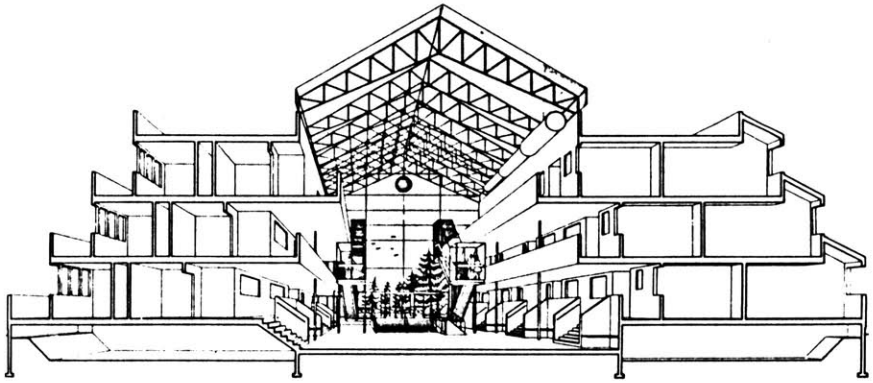


P4 PICKLE LAKE DEVELOPEMENT PLAN Pickle Lake, Ont. Project RES

ARCH Barton Myers Assoc. CLIENT Union Miniere Explorations UMEX Corp.

PROGRAM Ecologically sympathetic community developement for 4ooo tenents

SUNSPACE The building is designed with natural features, such as wind conditions, southexposure and severe winter climate temperatures.
The sunspace thus is utilized as communal axis, for accomodation of services and to enhance the communitie's neighboring ties.

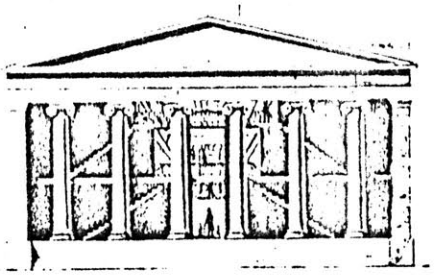


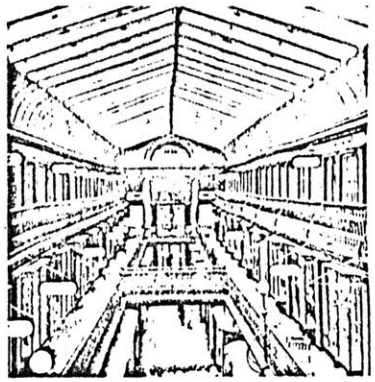
P6	PROVIDENCE ARCADE	Providence, Rhode Island 1828	O/S

ARCH. Warren Russel

PROGRAM The building was intended as a marketable landmark to Providence dowhtown (Geist, 62,.p.293). 78 shops were accommodated on three levels of the arcade, on a site merely 68.oo by 23.oom. The high density was a comercial success. The upper galerise recess each by 1.5om. Uniform signs allow to read to upper facilities form teh ground level.

SUNSPACE As a metter of its time being built, the arcade works passively as a merely weather protected indoor.The glazing area is comparatively small and shallow. Venting devices and shading is not detectable. Scale and transparency of shop display is derived form the Burlington Arcade, London. Lighting and railing found its successor in the Cleveland Arcade ( ). Scale and detailied projections and returns of the interior facade is prototypical disciplined

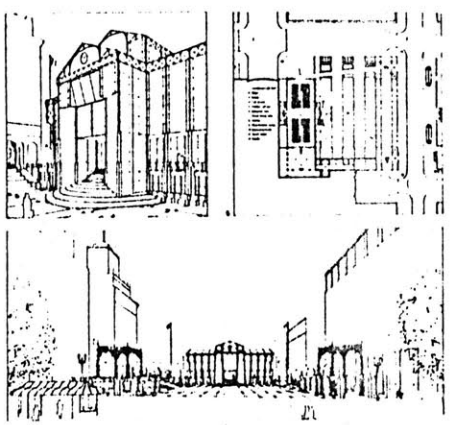


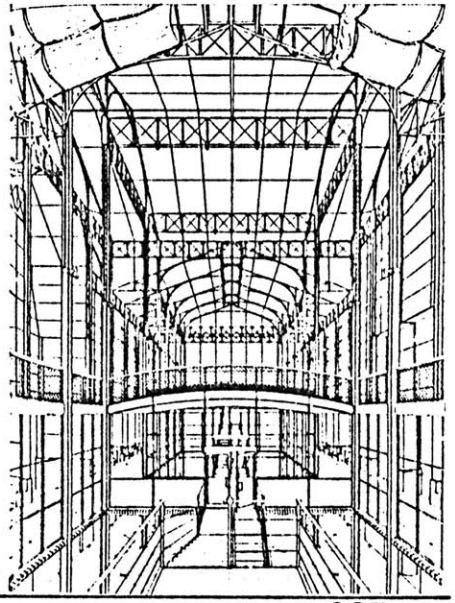


P7	PIONEER SQUARE	Portland, Oregon	Project

ARCH. Machado, Silvetti, Schwarz, Silber

PROGRAM Glasspalace as staging background to a public plaza
Exposition pavilion with restaurant and cafe
Buildings as part of a "street furnishing" setting with a path through the building





P8	ARTIC TENEMENT	Prudhoe Bay, Alaska

RES

ARCH Wallace, Floyd, Ellenzweig Inc. British Petrol

PROGRAM Base camp design for oil drill workers, to match nothern climate with low temperatures of -40°C and provide modern technology life to the tenants.

SUNSPACE The sunspace is the central hall to the Alaska community - as a protected livable "outdoors" with garden and playgrounds. Against the servere climate, the sunspace provides optimized building bulk against winds and lowest temperature , where outdoor activities would be impossible at most part of the year.

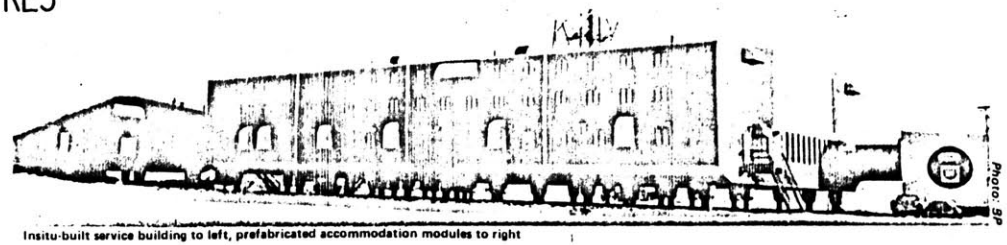
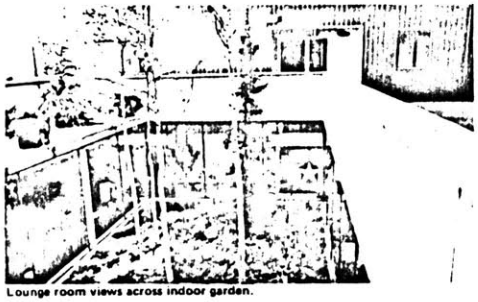
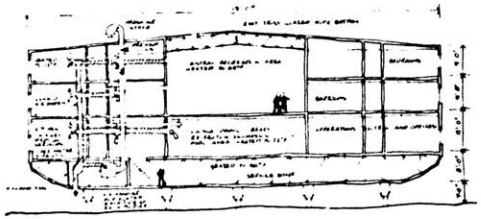


Photo: BP

Insitu-built service building to left, prefabricated accommodation modules to right



Lounge room views across indoor garden.

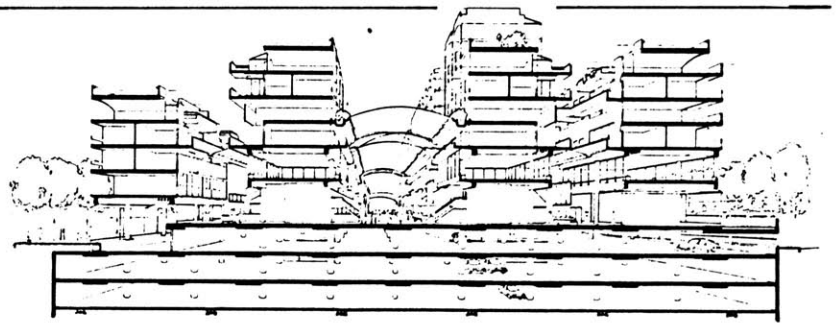


T1 ST. LAWRENCE HOUSING — Toronto, Ont. — Project 76 — RES/S/O

ARCH. Zeidler Partnerships
Harald Ensslen, Jo Rohn

PROGRAM Urban tenement housing on low-rise high-density scale with interior pedestrian streets as weather protected arcades with community facilities, maximum of 8 storeys, with office floor areas

SUNSPACE $3^1/2$ storey heigh glass cover over 17m and 8.5om "streets", with shops, office acceses, restaurants and community rooms adjacent
Second level laid out to accomodate offices



ST LAWRENCE PERSPECTIVE

ZEIDLER PARTNERSHIP ARCHITECTS

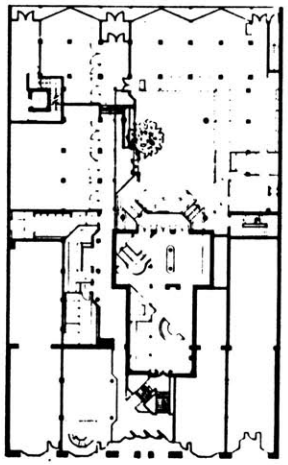
T2 PERCEY HOUSE — Toronto, Ont. 96 Bloor St. — 1884, 198o — R

ARCH. Daniel Li Architects — OWNER Mews Restaurant Ltd.
3D International (Interior)

PROGRAM Use upgrading of a 196o retail mall, conversion into a office bar and cafe/restaurant with performance stage to meet increased land value thread to the site with intensified use.

SUNSPACE The existing building complex was a collage of the original victorian 1884 house, with an 1926 office addition to Bay St., and a 196o back-yard two storey shopping mall.
The new acryl glazing covers the 196o courtyard and the victirian house in, and thus enhances an highly aesthetic collage setting of real stage appeal to the cafe use. With the glass cover, the whole site became waether proof against severe Toronto climates, where close to seven month no outdoor saeting is possible. Conversion of the former shops, throughway for pedestrians and extra gained floor area created a super restauant for 5oo seats plus bar and stage.

CONTROL The sunspace is provide with air conditioning, but was not yet opereted. Even under construction in summer, natural venting appeared to be feasible. For the first comming summer, simple canopies are intended as glare and direct sun control



T3	ATRIA NORTH	Toronto, Ont.	1978	OFF

ARCH Thom Partnerships OWNER Marathon Corp.

PROGRAM Spec office building on low rise construction as prototype for a larger developement

gross floor area 27. 87o m^2 occupancy 17oo - 2ooo
sunspace 76o m^2 height 19.oo m width 27.4o m

SUNSPACE The atrium is employed as daylight tool to a cube optimized building bulk depth. With this, an office depth of 27.5o m is achieved and the building as a square of 83.oo m, yielding substantial skin area reduction of the building though not sacrificing daylighting.
The sunspace acts an an air plenum and reception lobby, with a reserved design garden and trees. No activities are projected for this groundlevel, though cafteria and services might be incorporated in the next project phase. The sunspace is thus kept as a quiet pieceful leisure place. Vertical circulation is in the floor area. merely the garage elevator uses the sunspace exposure.
All offices face with large window areas to the atrium, visually providing a sense of buildimg community.

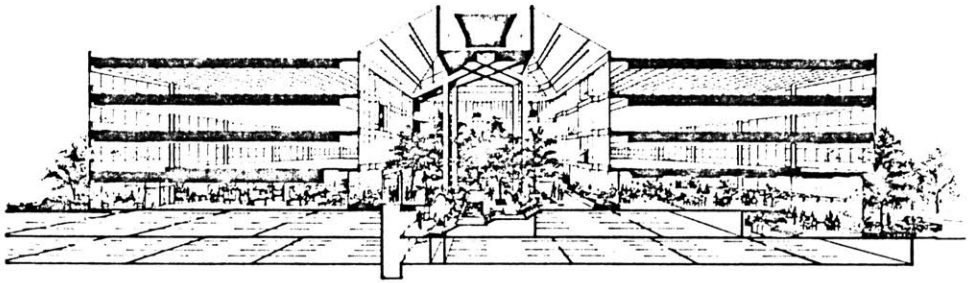
The inner facade is found to be much better tempered, and preferred in any case as ambient work place with view into a controlled garden world of its own. Interior office spaces rented first and go mostly for executives.

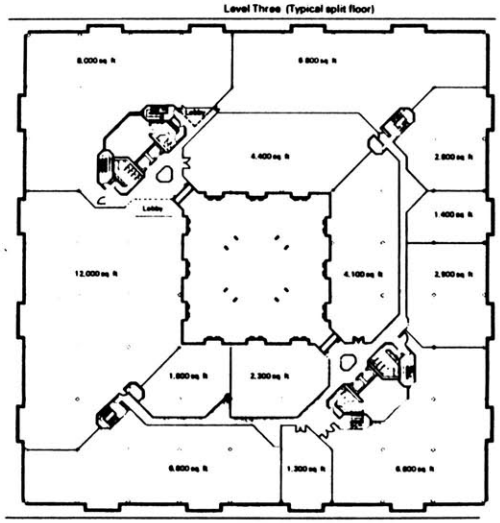
CONTROL The sunspace is air conditioned with the building though acting as a separate zone with the interior facade. With already low artificial lighting loads of 1.75 W/ft^2, because of the extreme building bulk, nearly all year cooling is demanded and recalim of inner internal gain to perimater areas with heat pump systems. This, the atrium stay essentially with the buildings temperature, with very little stratification and no further heat control.
Coversely, the control of the perimeter faacde poses discomfort by solar heat and glare. Air leakage and thermal mass properties will thus be improved in the next construction phase.
However it bcomes clear, that the atrium itself is a perfect thermal balance control to the interior, and to the whole building.

GLAZING The glazing area is relatively small with approximate 5oo m^2 sloped, clear double glazing.There is no shading control.

FIRE PRO Glazing area of atrium and interior facade is directly sprinklered.

REF Thom Partnerships, Mr. Murray Bainon SLIDES 1/8 - 16/8 VISIT X
Marathon Reality Sales Broschure
Canadian Interiors May 79
Canadian office Oct 78
Winning Low Whergy Building Designs ( ) p.119





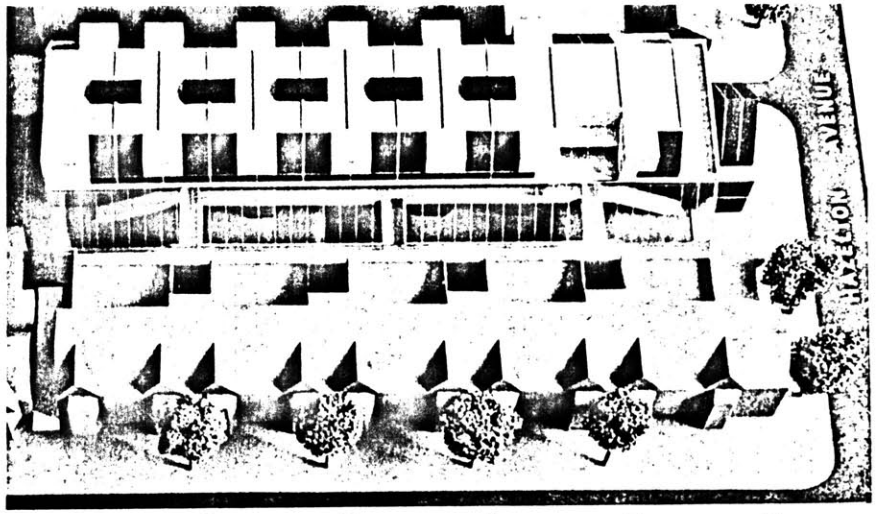
T4 — YORK ROW — Toronto, Ont. — Project — RES

ARCH Barton Myers — CLIENT York Row LTD.

PROGRAM Mixed use new infill housing in old rowhouse context.
gross floor area new 5 600 m^2 , 2 500 m^2 renovation

SUNSPACE The sunspace acts as transitional zone between the street lining old row house and the new infill structure as site circulation spine Two levels of shops and offices overlook the arcade, with entrances to the dwellings

GLAZING 45^0 southsloping glazing



T5 — THE OAKLANDS Condominium — Toronto, Ont. 315 Avenue Road — 1980 — RES

ARCH. DuBois Plumb & Assoc. — OWNER Canada Realities Ltd, Canlea Ltd.

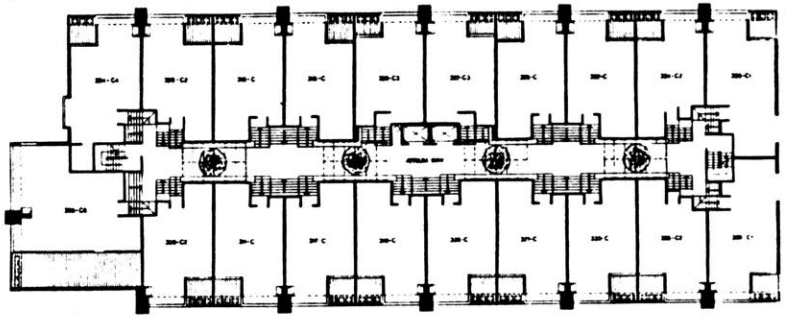
PROGRAM Low-rise, highest-density sturcture for 51 luxury condominiums
gross floor area 8 926m^2 tenants 120 apart 51
sunspace area 170m^2 height 6.00m width 3.20 m

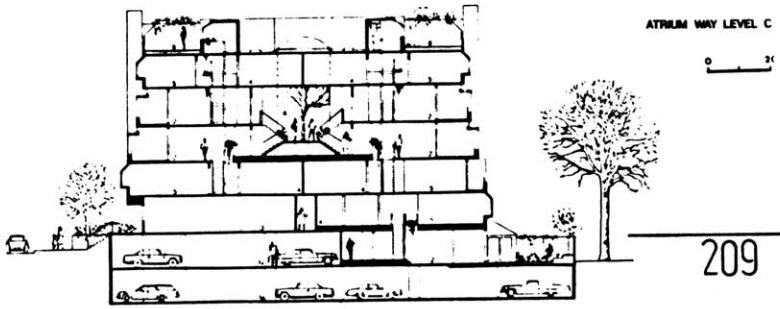
SUNSPACE The sunspace works as "atrium way" circulation to the duplex apartments as the buildings spine "creating a streetlike relationship" (project discription DuBois). From this spine, up and down the apartments have their access.
Greenery such as trees and evey convey gardening. Skydomes yield natural light. Only blind bathroom windows convey transparency to street

CONTROL The sunspace is heated, but thermaly separated from the apartments. For overheating, cooling pumps are installed. The marginal skylight areas do not consider solar gains as source. The atrium's efficiency only relates to optimized building bulk and attractive circulation area

FIRE PRO Interior facade is 1 h fire rated and practically with no regular sized windows. Even door do not have a certain amount of glass. The transition of the apartments to the street is thus repelling
Second egress is over balconies

REF Project discrition M.DuBois — SLIDES 1/10 - 4/10 — VISIT X





T6	TRONDHEIM UNIVERSITY	Trondheim, Norway	1978	SCH

ARCH. Henning larson & Assoc. OWNER University of Trondheim

PROGRAM Institute building for new university to incorporate campus streets of climate protection due to northern latitude
First phase of network

SUNSPACE gross floor area 25 ooo m^2 occupants 17oo
sunspace area 75o m^2 height lo.oo m width 5.5o m

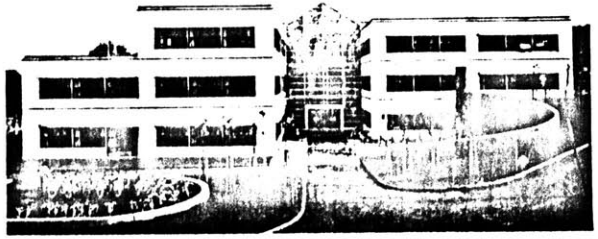
SUNSPACE The building are joint by gable roofed glazing, creating protected interior streets, with services, offices and cateria at ground level. The vertical circulation is dominant exposed feature with brick walled stair cases and free standing elevators. Horizontal circulation is with light truss bridges, interchangable to connect opposite building levels. The interior facade is distinguished and of filigran construction with changable elements as plug-in system, taking advantage of the sunspace weather. protection.
Greenery, benches, launches add homy ambience to the setting.

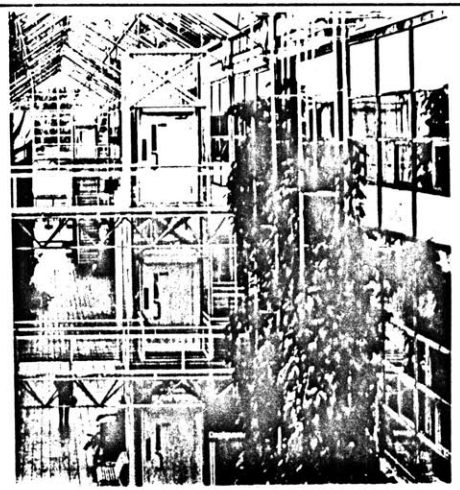
Roller awnings at windows control direct sunlight ahd glare. Provisions for large canopies right under the glazing, to be operated with ropes allow post occupant adjustment to performance demand as actually occuring.

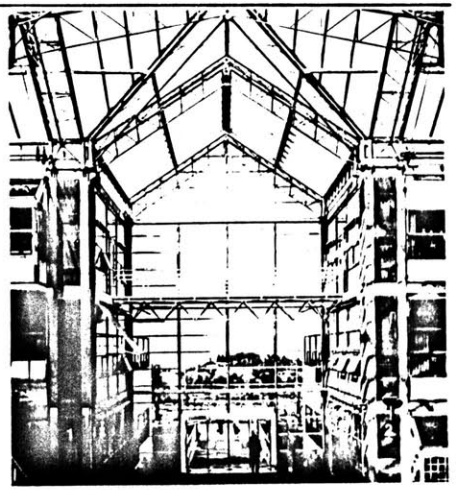
GLAZING Clear glazing of double glass (?) is mounted in greenhouse technique on exposed space frame trusses.

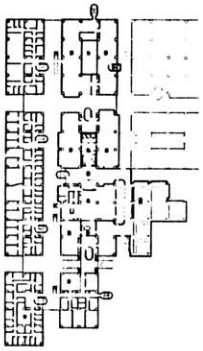
FIRE PRO ?

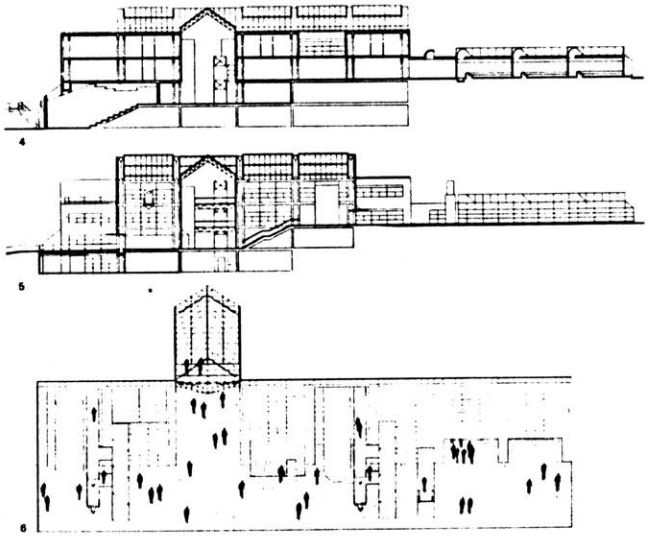
REF. L'Architecture D'Aujourd'hui Dec. 8o SLIDES 1 VISIT -
architektur wettbewerbe aw lo4
Dansk Archetectur 4/8o











S1 COUNTY GRAMMAR SCHOOL — Sonderborg, Norway — 198o — SCH

ARCH. Henning Lasron & Assoc. OWNER Goverment

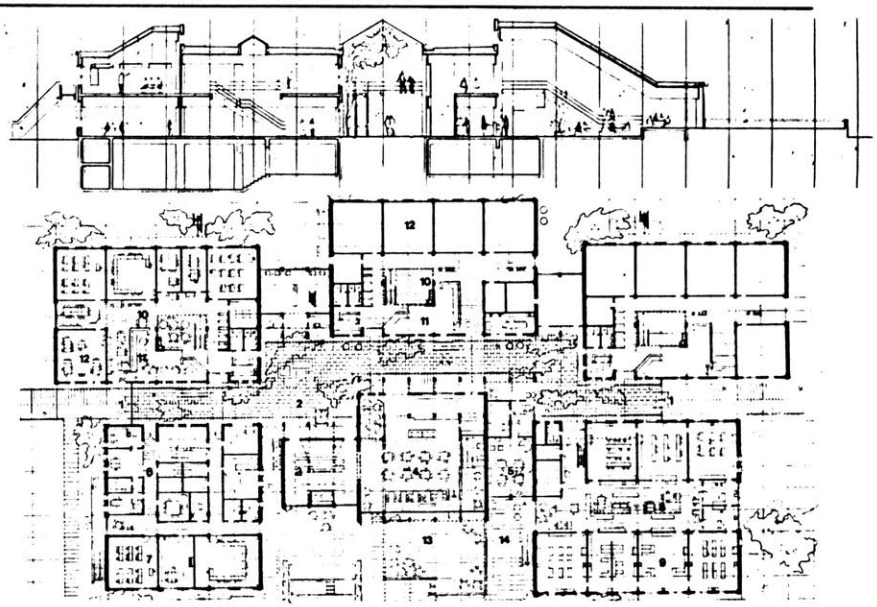
PROGRAM Central school building for higher education for capacity of 75o pupils. Because of size of complex, a break down in scale with identifiable units, "houses" or pavillions was invisioned.
For readability of the school, the analogy of a small village was taken

SUNSPACE Central axis to connect classrooms with activity areas is the internal street spine. Facades, entrances, balconies, bay windows project into the "village street" as the students daily "market place" to meet for all occasions. The house pavillions are clearly distinct as houses. The street shows as a street.

CONTROL The sunspace is heated without supplementary heat, merely from the dajacent buildings and sun - and is said to stay at least at 1o°C in winter time. In spring and fall, excessive heat accumulated there is returned to heat class rooms. Shading is provided with movable canopies right under the glazing

FIRE PRO Every "house" is perceived as single fire zone

REF. DANSK ARCHITECTUTRE 3/81 SLIDES - VISIT -



S2 FIRST BANK CENTER — South Bend, Ind. — Project — OFF/COM

ARCH. C.F. Murphy, H. Jahn OWNER

PROGRAM Comlex for bank center, hotel, atrium plaza with retail and restaurants and car park underground

gross floor area 14 ooo m^2 garage 7oo lots
sunspace area 2 3oo m^2 height 18.oo-28.oom width 25.oo m

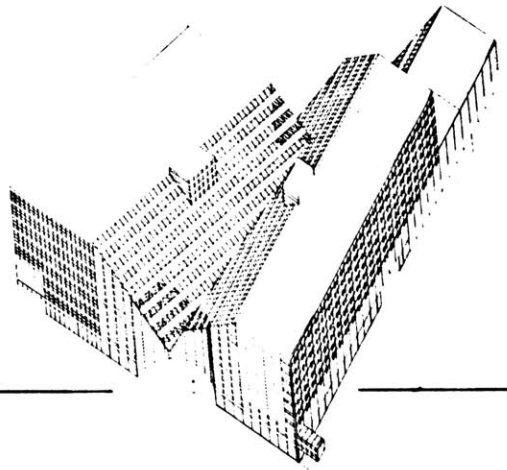
SUNSPACE The sunspace is eeentially roofed in intermediate space of the building slabs in an angle, as joint lobby and retail area

CONTROL ?

GLAZING Clear and tinted glazing used as a pattern lay-out, sloped without shading devices

FIRE PRO ?

REF. Architectural Record 7/79 SLIDES - VISIT -



W1 | SCIENCE CENTER | Wellesley, MA. | 1978 | SCH / L

ARCH Perry, Dean, Stahl & Rogers OWNER Wellesly College

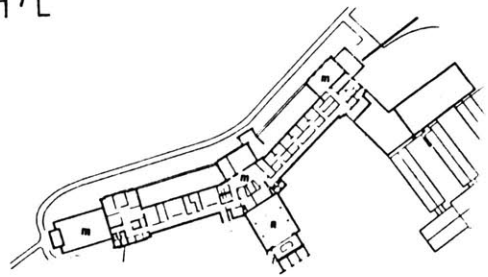
PROGRAM Science center as laboratory building joint with the renovation of a Neo Gothic seminar and auditorium building.

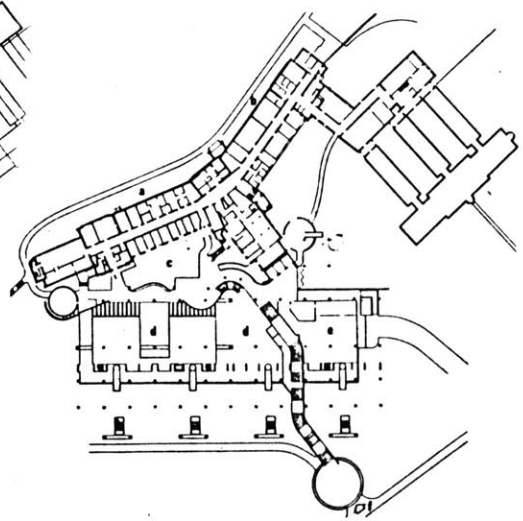
SUNSPACE The sunspace acts as "open space in between" new and old structure, tieing the building collage together with a skylighted atrium called "the focus". Both buildings open themself deliberately to this atrium with launches, galeries and interior windows.
The atrium is the reception and central circulation node as the heart of the two buildings. The vast interior is traversed by bridges to connect the complex on three levels.
"Bridges, ramps, spiral stairs and balconies, and a multiple level oft the ground levelplane activate this space to make it dynamic as seen in some of the new hotels" (Progressive Architecture 3/78)
The "found space" between the building parts is consciously used in its design freedom as spatially articulate collage of elements of a "built landscape", taking advantage of the quite differentiated facades, old and new as complimantary effect for orientation and distinct identification.
Though the skylight is a sheer opaque lid with only some small glazing areas, and glazed edges to the facades, the spatial fuse of the collage interior is an impressive example to follow.

CONTROL The sunspace is heated and conditioned with the buildings - no thermal separattion.

FIRE PRO Sprinklered

REF. Progressive Architecture 3/78 SLIDES VISIT X



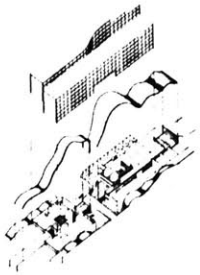


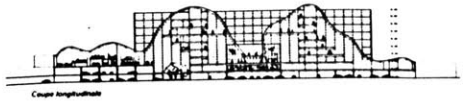
W2 | INTELSAT BUILDING | Washington,DC. | Project | OFF

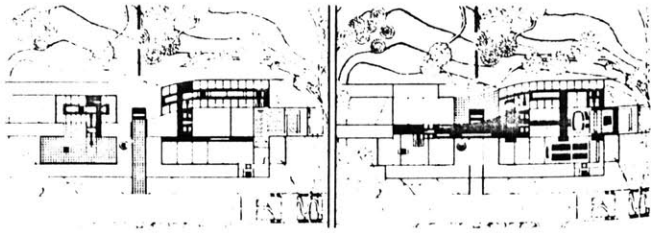
ARCH. Holabird & Root

PROGRAM Office complex for the goverment with pedestian path to public park

SUNSPACE Threedimensional "wave" cuuting" the building in two rectangular slabs. Daylight and the wave of the glazing roof, together with the swing of the building is invisioned for a dynamic space guiding through the building as activity axis and reception. Launches, shops and restaurants add to the publicity of the sunspace.







W3	THE COURTYARD	Winnipeg, Manitoba	1978	O/R/S

ARCH. Stechson, Friederickson, Katz OWNER Osborne Muse Ltd.

PROGRAM Renovation and re-use of a 1912 street block structure, with restaurants, offices and shops

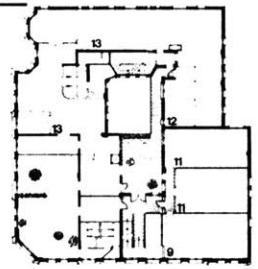
SUNSPACE The interior light court was glazed in a clue to the reuse approach. With the integration of the courtyard, the circulation could be completely be rearranged for more complex use, and additional use area in basements and added platforms with sit areas. The sunspace became essentially the interwinding circulation core, with shiplike bridges and stairs to adapt any floor height. Gardeening, floor pavement and fountain create an intospective world to the building. With relatively little glazing area this and substantial energy gains could be achieved. Casual seating arrangements and a surprising spatial sensation form the railings invites for remaining in the atrium.

CONTROL The amount of glazing is little, thus with no shading devices. Louvers control summer overheating, while heat loss and building brick mass balances the space in other seasons. The roofing is of clear glass as gable contruction.

FIRE PRO -

REF. The Canadian Arch 4/78 SLTDES16/1o - 2o/1o

gross floor area	3 000 m^2	tenants	-
sunspace area	72 m^2	height	15.00 width 6.00 m



1 View of lower courtyard, showing fountain and entrance to Victor's restaurant.

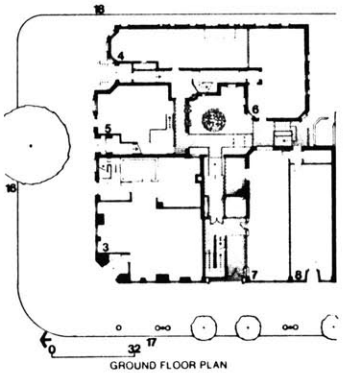
2 View of courtyard before restorations.

3 Dining lounge in Victor's restaurant.

4 Exterior view looking north.

5 View looking south into courtyard.

6 View of rear main-level bridge.



GROUND FLOOR PLAN

LOWER FLOOR PLAN

FLOOR PLANS 1 Eden Way Accessories 2 Copper Works 3 Thomas Gallery 4 Victor's Restaurant 5 Tyrone Mens Wear 6 Icelandia Trading Company 7 R B Ormiston Florists 8 Arosa Delicatessen 9 Child's Play Toys for Children 10 Richard J Broker Fine Jewellery 11 Swallow's Restaurant 12 Peterson Woodcraft 13 vamp 14 Kaufman Arenson Law Office 15 Stechesen Frederickson Katz Architects and Planners 16 River Avenue 17 Osborne Street 18 public lane

EAST-WEST SECTION

W4 ALL SEASONS TOWER — Winnipeg, Manitoba — RES

ARCH. Waisman Architectural Group OWNER

PROGRAM Residential highrise slab with climate envelope

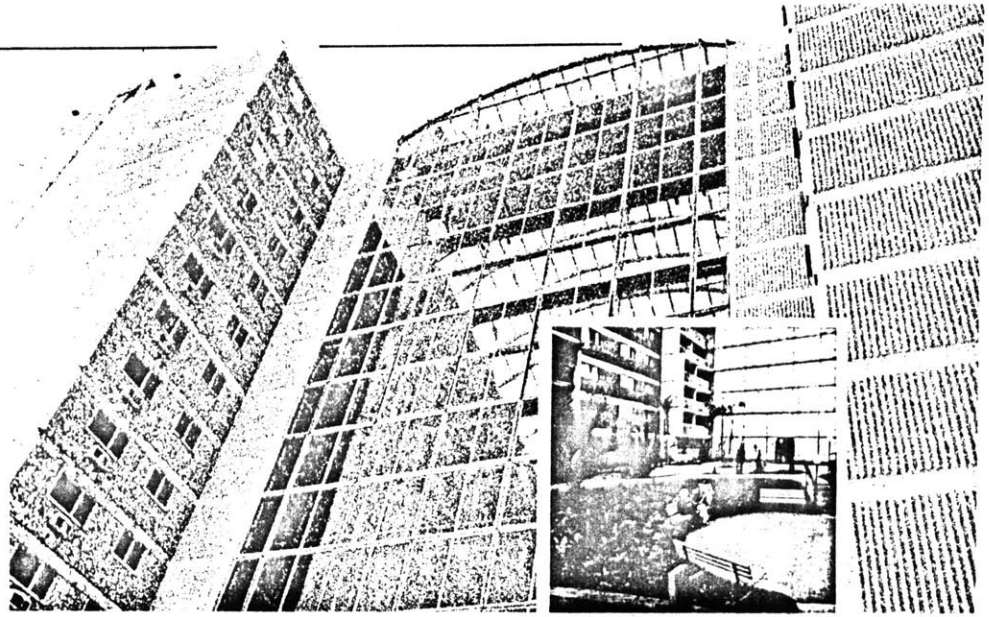
gross floor area	m^2	tenants	38o	apart.	12o
sunspace area	m^2	height	47.oo m	width	12.oo m

SUNSPACE The atrium is a huge, 15 storey high structure to connect to conventionaly built slabs with a glass skin. All balconies to the apartments are interior to the sunspace. The interior facade however no distinction from the remainder facade.
The groundlevel is a intentionally rich gardening with sit spots, swimmingpool and exotic plants to coney a winter garden paradise. but faking a real landscape. Because of its vertical scale, the space appears unbalanced and frightening. There is also not connection from the sunspace directly to outdoors for summer mode

CONTROL The space is heated form the adjacent buildings and supplementary with ground floor heaters. Exhaust fans operate on top of the space for overheating control.

GLAZING The glass skin is of green tinted doyble glazing (Transmission ?)

REF Prof. John Welsh, U-Manitoba SLIDES 16/12 - 16/18



V1 RUST OLEUM HEADQUARTERS — Vernon Hills, Ill — 1979 — OFF

ARCH. C.F. Murphy, H. Jahn OWNER Rust Oleum Corp.

PROGRAM Office corporation complex

gross floor area	8 3oo m^2	
sunspace area	66o m^2	height lo:oo-14.oom width 6.lom

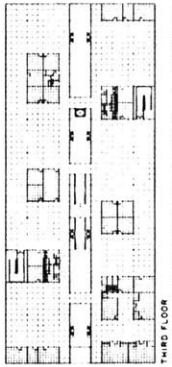
SUNSPACE The sunspace is circulation spine to the two loaded office floors cobining three levels. Spanned by several bridges and with a dramatic stair movement, the space is orchestrated in a very formal order in natural light. Air conditioning duts are also accomodated there With the interior light spine, the 18.6o deep office areas receive daylight from either side, though the building bulk is optimized.

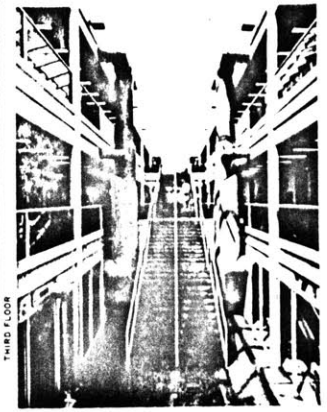
CONTROL The sunspace is airconditioned and only by interior partition walls separated form the office areas.

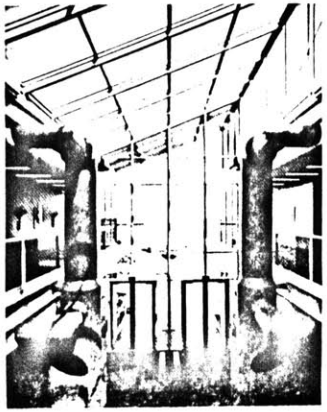
GLAZING Sloped glazing with slight blue tint (Transmission ?), unshaded

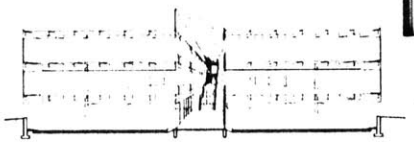
FIRE PRO -

REF. Architectural Record 7/79 SLIDES - VISIT -









APPENDIX B

SECTION 631.0 OPEN WELLS

631.1 General: Open wells are to be classified as either atriums (Section 631.2) or floor openings (Section 631.3) and shall be permitted in all buildings in other than Use Group H when provided with the protection herein required.

631.1.1 Fire suppression: An approved electrically supervised automatic fire suppression system shall be installed throughout all floor areas connected by the open well in accordance with the provisions of Article 17, except those floor areas separated from the open well by fire separation assemblies conforming to Table 401.

631.1.2 Use: The floor of the open well shall not be used for other than low fire hazard uses and only approved materials and decorations may be used in the open well space.

Exception: The open well floor area may be used for any approved use when the individual space is provided with an automatic fire suppression system.

631.1.3 Exits: An open well connecting not more than three floor levels may contain an exit as permitted by Section 816.10.

631.1.4 Emergency power: All equipment required to provide smoke control shall be provided with an emergency source of power in compliance with Article 700 of NFiPA 70 listed in Appendix A.

631.1.5 Acceptance of the smoke control system: Before the certificate of occupancy is issued, the smoke control system shall be tested in an approved manner to show compliance with the requirements of this section.

631.1.6 Inspections of the smoke control systems: All operating parts of the smoke control system (including dampers) shall be tested by the owner every three months and a log of the tests shall be kept for examination by the fire department. At six month intervals the system shall be inspected and operated in accordance with the fire prevention code listed in Appendix A.

631.2 Atriums: Atriums shall be constructed as herein required except atriums in buildings two stories in height shall not be required to be equipped with a smoke control system as indicated in Section 631.2.1. For purposes of this section, the volume of the atrium shall include all spaces not separated from the atrium in accordance with Section 631.2.2.

631.2.1 Smoke control: A smoke control system shall be designed to control the migration of products of combustion in the atrium spaces. Upon detection of a fire or smoke, the system shall shut down the air supply to the fire floor and the return air from all non-fire floors.

631.2.1.1 Atriums 55 feet or less in height: In atriums 55 feet (16764 mm) or less in height with a volume of 600,000 cubic feet (16800 m^3)or less, a smoke exhaust system shall be located at the ceiling of the atrium. Such system shall exhaust 40,000 cfm (18.88 m^3/s) or six air changes per hour, whichever is greater. When the volume of the atrium exceeds 600,000 cubic feet (16,800 m^3), the exhaust system shall be sized to provide a minimum of four air changes per hour.

Supply air inlets may be provided at the lowest level of the atrium. These inlets shall be sized for 75 percent of the exhaust.

631.2.1.2 Atriums in excess of 55 feet in height: When the height of the atrium exceeds 55 feet (16764 mm) an exhaust system shall be provided as required by Section 631.2.1.1. However, supply air shall be introduced mechanically from the floor of the atrium and shall be directed vertically at the exhaust outlet above. The capacity of the supply shall be 75 percent of the exhaust.

631.2.1.3 Smoke detectors: Smoke detectors shall be provided at the ceiling of the atrium and on the underside of each floor area projecting into the atrium space. Detectors shall be located in accordance with their listing.

631.2.1.4 Smoke control activation: The smoke control system required for the atrium spaces shall be activated by the fire suppression system, by smoke detectors required by Section 631.2.1.3 and by manual controls provided for the fire department use. The system shall not be activated by a manual fire alarm system required by Section 1717.0. Manual controls shall be located in the central control station or other location approved by the fire department.

631.2.1.5 Other approved methods: Any other approved design which will achieve the same level of smoke control as described in this section may be used in lieu of these requirements.

631.2.2 Enclosure of atriums: Atrium spaces shall be separated from adjacent spaces by a one hour fire separation wall. A glass wall forming a smoke partition may be used in lieu of the required fire separation wall where automatic sprinklers are spaced 6 feet (1829 mm) or less along both sides of the separation wall, or on the room side only if there is not a walkway on the atrium side, and not more than 1 foot (305 mm) away from the glass and so designed that the entire surface of the glass will be wet upon activation of the sprinkler system.

Exception: The adjacent spaces of any three floors of the atrium shall not be required to be separated from the atrium; however, these spaces shall be included in the atrium volume according to Section 631.2.

631.2.3 Voice alarm: In Use Groups R-1, R-2 and I, a voice alarm system complying with the requirements of Section 629.5.1 shall be required on the floors communicating with the atrium. The alarm shall be initiated by either the fire suppression system or the activation of two or more smoke detectors in the atrium.

631.2.4 Travel distance: In other than the lowest level of the atrium, when the required means of egress is through the atrium space, the exit access travel distance shall not exceed 150 feet (45720 mm).

631.3 Floor openings: Floor openings for unenclosed supplemental stairways, or escalators conforming to Section 2118.3 shall be permitted when protected on every floor pierced by the opening with an approved automatic exhaust system or by other approved smoke control method as herein required to prevent the passage of products of combustion to the story above.

Exception: Supplemental stairways conforming to Section 816.8.

631.3.1 Smoke control: The approved automatic exhaust system may be a separate unit or integrated with an approved air handling system and shall be thermostatically controlled to operate simultaneously with the detection of fire.

631.3.1.1 Capacity of exhaust system: The exhaust system shall be of adequate capacity to create a controlled draft in the floor opening with sufficient velocity of flow over the entire area of the floor opening under normal conditions of window and door openings in the building.

631.3.1.2 Operation of mechanical system: The exhaust system herein required shall be so arranged as to automatically stop the operation of the normal mechanical air handling and ventilating systems, and close the dampers of the return air duct connections, in the event of fire.

631.3.2 Draftstop: An approved draftstop shall be installed at each story of the floor opening. The draftstop shall enclose the perimeter of the opening and shall extend from the ceiling downward at least 18 inches (457 mm) on all sides. Automatic sprinklers shall be provided around the perimeter of the opening and within 2 feet (610 mm) of the draftstop. The distance between the sprinklers shall not exceed 6 feet (1829 mm) center to center.

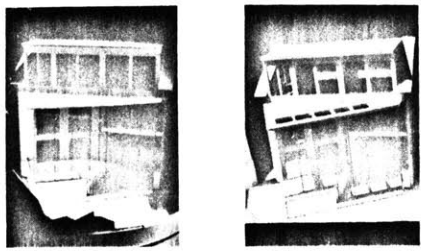
APPENDIX C

The Sun Machine System™: Recommended Methodology

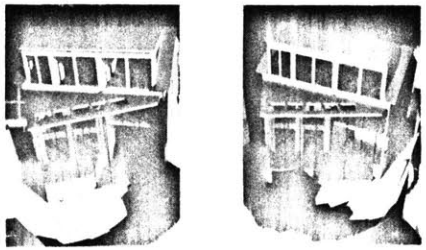
Solar potential of a building site can be assessed in the field using either Model No. 50-A or Model No. 100-A Sun Machine™. A qualitative understanding of the site's relationship to the sun can be ascertained by projecting the path of the sun across the sky for the entire year in a matter of minutes. Potential solar obstructions will be clearly visible. Select the point at which solar collection is either required or most desirable. Sight azimuth and altitude bearings of solar obstructions within 120 degrees east and west of true south. Plot each bearing on the sun path diagram closest to your latitude provided in the owner's manual. A scale shadow mask unique to your position on the site has been created. It condenses everything between you and the sun onto one plane and indicates what percentage of total daily radiation striking a horizontal surface is available.

Based upon your site data, architectural program, proposed solar collection system, and preliminary calculations, develop and build a scale study model of your design or building being analyzed. Where applicable, proportion the shadow mask to the model as directed in the owner's manual. Position, adjust, and calibrate either Model No. 100-A or Model No. 200-A as directed in the owner's manual. Clamp the study model onto the Sun Machine,™ darken the room and turn on the artificial light source. You will see a three dimensional simulation of solar exposure and penetration characteristics unique to your project. Evaluate both the solstice and equinox settings, rotating the model hour by hour through the light. Measure and note exposure and penetration characteristics.

Compare the results with preliminary design and calculation assumptions. Reiterate the process by revising the study model to reflect the modified design and calculation assumptions, and then retesting. Continue until the solar exposure and penetration characteristics, and the estimated system performance are optimized.



Summer Solstice, 10 AM & 2 PM, 42• Latitude



Winter Solstice, 10 AM & 2 PM 42• Latitude

Solar Simulation

Solar Simulation with Model No. 200-A

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