

ARCH 121 – INTRODUCTION TO ARCHITECTURE I

WEEK 9: Form and Space in Architecture

Organization of Form and Space in Architecture

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1. Solids and Cavities in Architecture

Architecture is the art of playing with solids (forms) and cavities¹ (spaces). Cavity is the clearly defined space enclosed within the outer walls. It is the limited, architecturally formed space. Some architects start their designs by playing with solids (forms) and some of them start by playing with cavities (spaces). However, for the creation of a good architectural product, both of them are necessary. Great architects play with them at the same time.

The solids (forms) enclose and form the cavities (spaces) that we live in. In other words, solids are the containers and the cavities are the contained. Their relationship is quite similar to the glasses we use every day and the liquids that are kept in them. The form (solidity) of the glass defines a space (cavity), which contains the drink that is put in it. The form of the glass differentiates according to the drink to be put in it. Moreover, the form of the glass also differentiates according to the material out of which it is made. Same is true in architecture. The form and space in architecture differentiate according to the function and structure (material) of the building.

Glasses

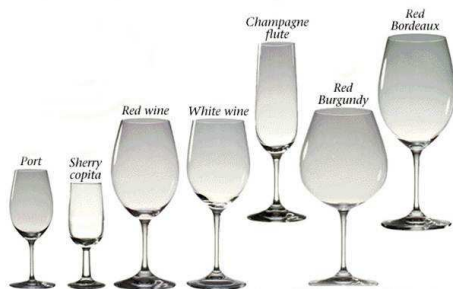
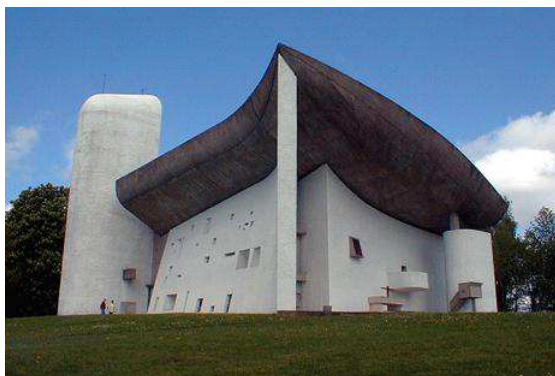
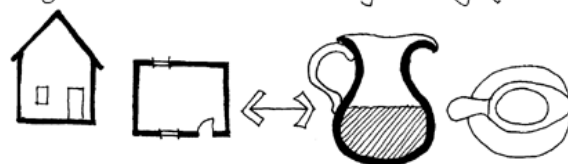


Image (container)

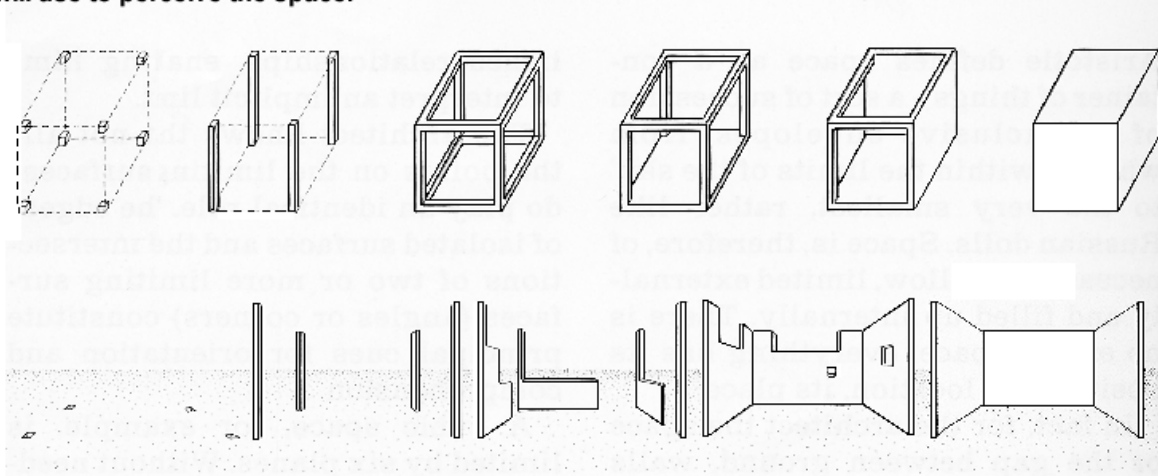
Analogous Image (container)



¹ Cavity is also called as 'void'.

a. Elements that create solids (forms) and cavities (spaces) in architecture²:

Architectural space is born from the relationship between objects or boundaries and from planes which define limits. These limits may be more or less explicit, constitute continuous surfaces forming an uninterrupted boundary, or on the contrary, constitute only a few cues that the observer will use to perceive the space.

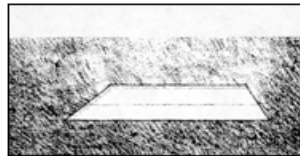


Spaces can be either explicit or implicit, and all the possibilities in between.

SOURCE: VON MEISS

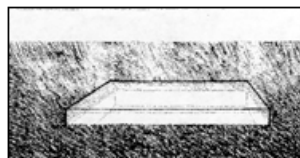
i. Horizontal Elements

BASE PLANE
A horizontal plane
lying on a floor



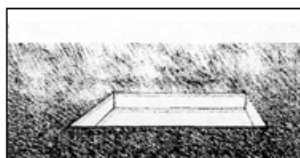
It defines a simple field of space

**ELEVATED
BASE PLANE**
A horizontal plane
elevated above the
ground plane



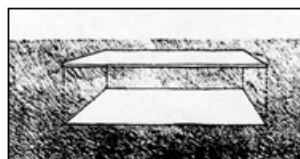
Vertical surfaces along its edges reinforce the visual separation between its field and the surrounding ground.

**DEPRESSED
BASE PLANE**
A horizontal plane
depressed into the
ground plane



Vertical surfaces of the lowered area define a volume of space.

OVERHEAD PLANE
A horizontal plane
located overhead



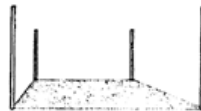
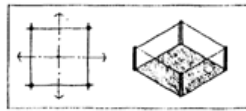
It defines a volume of space between itself and the ground plane.

SOURCE: FRANCIS CHING

² Source: http://meydian_s.staff.gunadarma.ac.id/Downloads/files/14178/LECTURE3.ppt

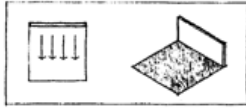
ii. Vertical Elements

VERTICAL LINEAR ELEMENTS



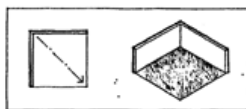
It defines the perpendicular edges of a volume of space

SINGLE VERTICAL PLANE



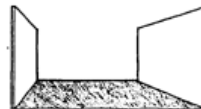
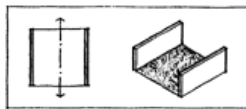
It articulates the space on which it fronts

L-SHAPED PLANE



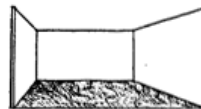
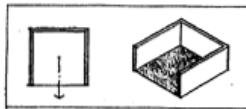
It generates a field of space from its corner outward along a diagonal axis.

PARALLEL PLANES



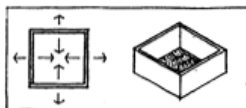
They define a volume of space between them toward both open ends.

U-SHAPED PLANES



It defines a volume of space that is oriented toward the open end of the configuration

FOUR PLANES: CLOSURE



They establish the boundaries of an introverted space and influence the field of space around the enclosure

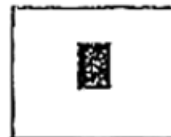
SOURCE: FRANCIS CHING

iii. Openings

Openings in the enclosing planes of the spatial field provide continuity with adjacent spaces.

OPENINGS WITHIN PLANES

an opening located within a wall or a ceiling plane appears like a figure against the background



CENTERED



OFF-CENTER



GROUPED



DEEP-SET



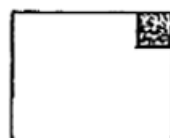
SKYLIGHT

OPENINGS AT CORNERS

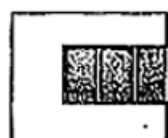
Openings located at corners give a diagonal orientation to the space and the planes in which they are located



ALONG ONE EDGE



ALONG TWO EDGES



TURNING A CORNER



GROUPED

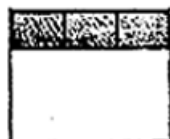


SKYLIGHT

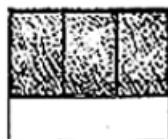
OPENINGS BETWEEN PLANES



VERTICAL



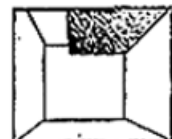
HORIZONTAL



3/4 OPENING



WINDOW WALL



SKYLIGHT

SOURCE: FRANCIS CHING

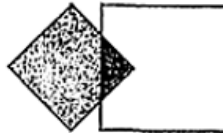
b. The relationship of formal and spatial elements³:

SPACE WITHIN A SPACE



A large space can envelope and contain a smaller space within its volume. Visual and spatial continuity between the two spaces can be easily accommodated.

INTERLOCKING SPACES



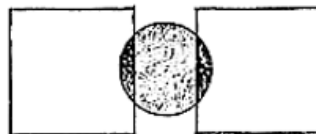
An interlocking spatial relationship results from the overlapping of two spatial fields and the emergence of a zone of shared space. Each space interlocking retains its identity. But the intersection of the two spaces is subject to a number of interpretations.

ADJASCENT SPACES



Adjacency is the most common type of spatial relationship. Each space is clearly defined.

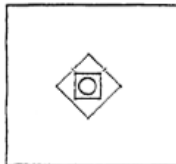
SPACES LINKED BY A COMMON SPACE



Two spaces which are separated by distance can be linked or related to each other by a third, intermediate space. The visual and spatial relationship between the two spaces depends on the nature of the third space.

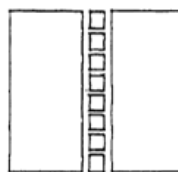
SOURCE: FRANCIS CHING

c. Some organizing principles of formal and spatial elements⁴:



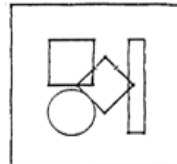
CENTRALIZED

A central dominant space about which other secondary spaces are grouped



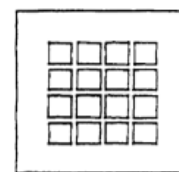
LINEAR

A linear sequence of repetitive spaces



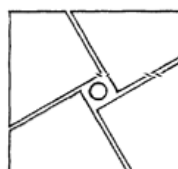
CLUSTERED

Spaces grouped by proximity or the sharing of a common visual trait or relationship



GRID

Spaces organized within the field of a structural grid or another 3 dimensional framework



RADIAL

A central space from which linear organizations of space extend in a radial manner

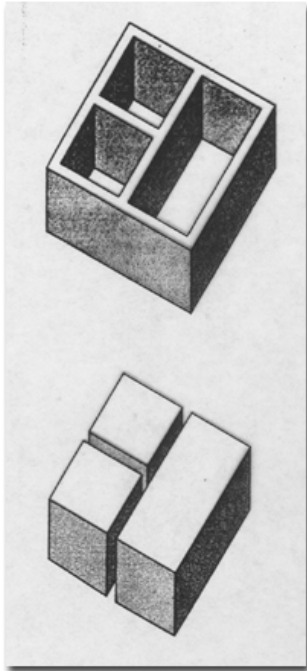
SOURCE: FRANCIS CHING

³ Source: http://meydian_s.staff.gunadarma.ac.id/Downloads/files/14178/LECTURE3.ppt

⁴ Source: http://meydian_s.staff.gunadarma.ac.id/Downloads/files/14178/LECTURE3.ppt

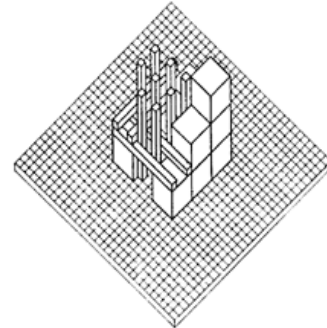
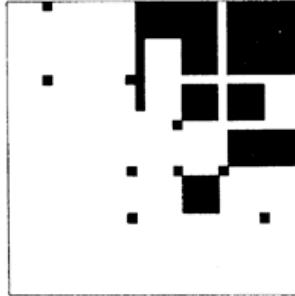
d. Perception of Forms (Solids) and Spaces (Cavities) in Architecture⁵:

Solid and cavity has the figure and ground relationship between themselves. Here are some examples:

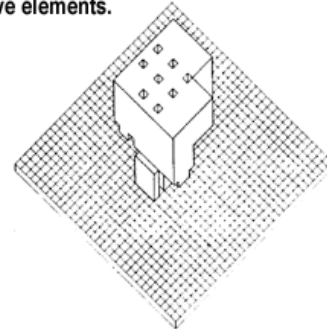
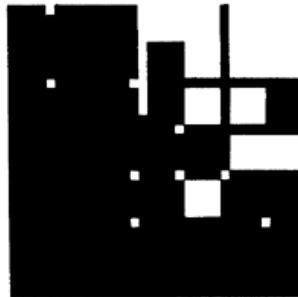


When we design, representations of closed volumes appear both as solid construction elements (columns, beams, etc) and as bounded voids (rooms)

In our visual field we can interpret figures against backgrounds; figures are perceived as positive elements, while backgrounds are negative elements.



Normally solid mass is considered a positive element, while the space surrounding it is the negative element. We can intentionally reverse figures and backgrounds / positive and negative elements.



SOURCE: MITCHELL, FRIEDMAN

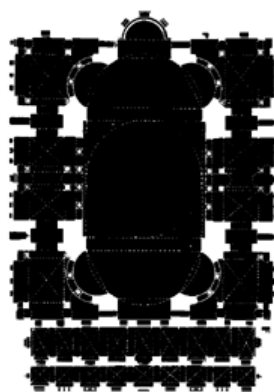
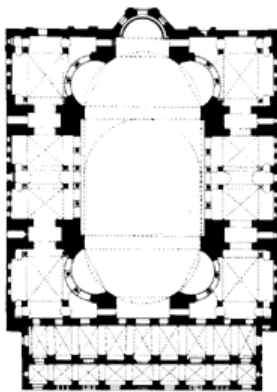
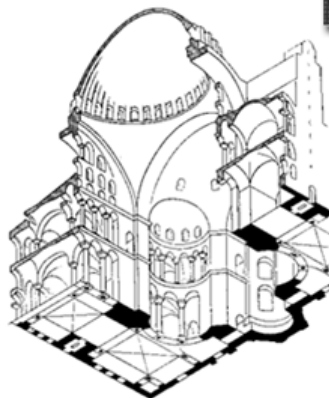


Figure and ground reversal of plans allows us to perceive spaces as figures against solids, the background. In this way we accentuate the formal characteristics of the void. But it is not sufficient simply to present a negative plan, because one would again read the white lines which were black before.



One could also have made a model representing space as moulded solid. By this means we generally obtain a rather strange form. It remains alien to what that space is and to the way in which it can be understood. Being a solid it prohibits any mental penetration.

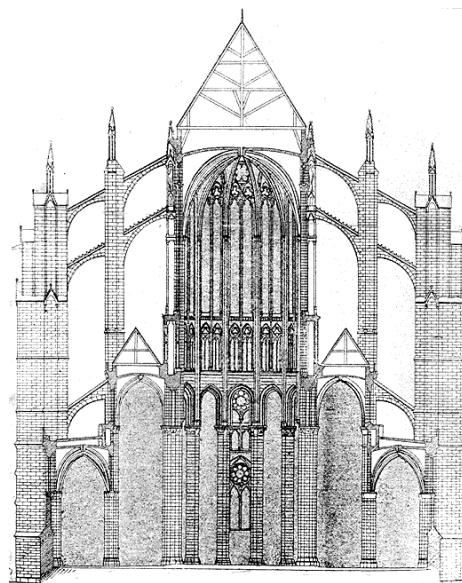
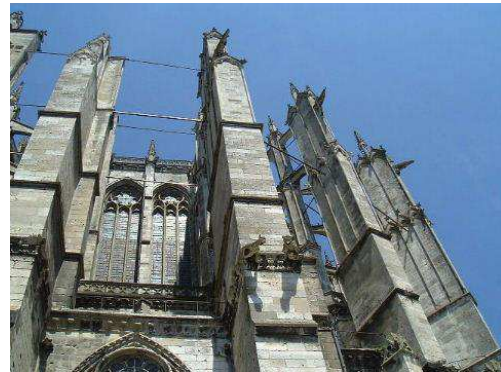
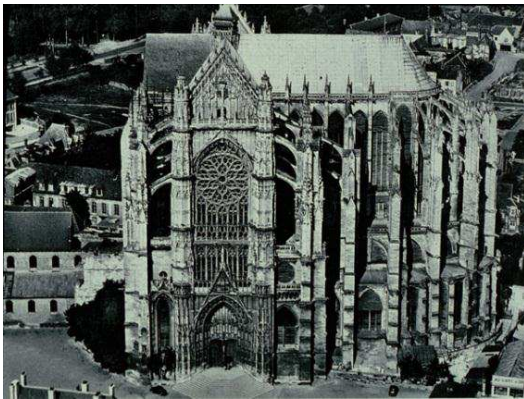
SOURCE: VON MEISS

⁵ Source: http://meydian_s.staff.gunadarma.ac.id/Downloads/files/14178/LECTURE3.ppt

2. Architecture as a play of forms (solids) and Architecture as a play of cavities (spaces):

The architect might choose to start designing firstly by the design of main forms. He/she might think about the space and other details later. (However this is not a preferred way to go, because, ideally the architect should think about the forms and spaces altogether, at the same time).

Beauvais Cathedral (a Gothic architectural example) is such an example. Here the architect has focused on the design of the structural forms for the creation of the fantastically high nave. He treated the purely structural features aesthetically and gave each one almost sculptural form.



Beauvais Cathedral

But, you may ask, can there be any other? And the answer is yes; it is possible to have quite a different conception. Instead of letting his/her imagination work with structural forms, with the *solids* of a building, the architect can work with the empty space—the cavity—between the solids, and consider the forming of that space as the real meaning of architecture.

Ordinarily a building is made by assembling the materials on the site and with them erecting a structure which encloses the space of the building. But let us suppose the site to be an enormous, solid rock and the problem was to hollow out rooms inside it.

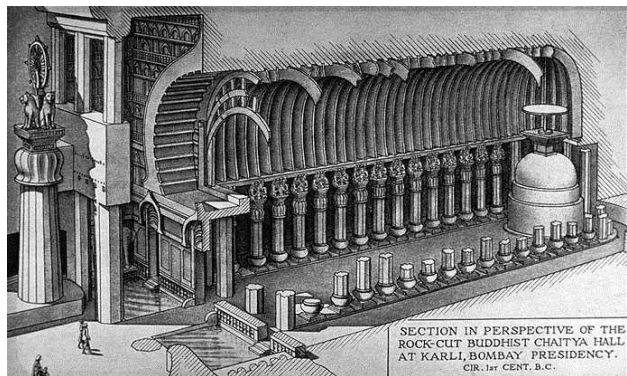
Then the architect's job would be to form space by eliminating material—in this case by removing some of the rock. The material itself would not be given form, though some of it would be left standing after most had been taken away. In the first example (Beauvais Cathedral) it is the stone mass of the cathedral which is the reality, in the second the cavities within the mass.

This can also be illustrated by the two-dimensional vase example. You either consider all the black as "figure" and all the white as background and see a vase; or you consider the white as figure and the black as ground and see two faces in profile. We can shift our perception at will from one to the other, alternately seeing vase and profiles. But we cannot see both vase and profiles at the same time. We see one of the colors as figure and the other as ground.

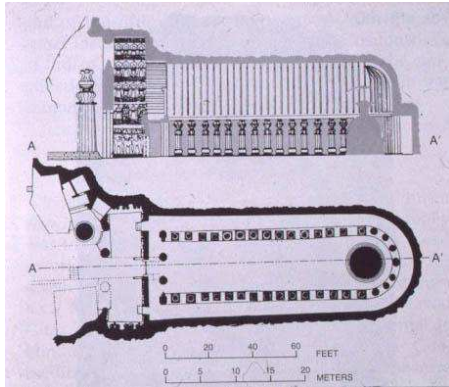
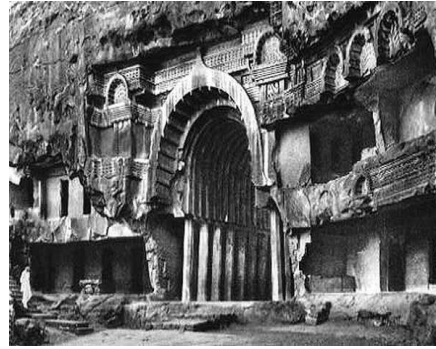
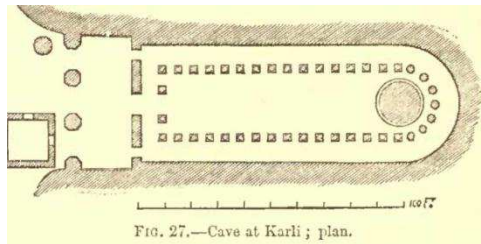


In Carli in India there are a number of cave temples. They were actually created by eliminating material—that is by forming cavities. Here the cavity is what we perceive while the solid rock surrounding it is the neutral background which was left unshaped.

However, here the problem is a more complicated one than in two-dimensional figures. When you stand inside the temple you not only experience the cavity—the great three-aisled temple hollowed out of the rock—but also the columns separating the aisles which are parts of the rock that were not removed.



Cave temple at Carli, India. The temple was hollowed out of rock.

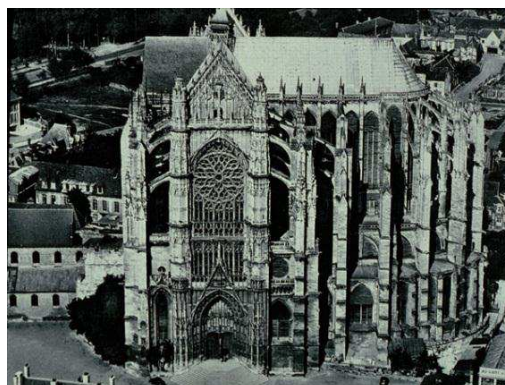


Cave temple at Carli, India. The temple was hollowed out of rock.

Therefore, some architects are "solid-minded," and others are "cavity-minded;" some architectural periods work preferably with solids, others with cavities. However the buildings contain both the solids (forms) and the cavities (spaces), and they are equally important. When you experience a building, do not just observe forms or space, but you experience both of them.

We can give some examples from different architectural periods, which work preferably either with solids or cavities.

In Gothic architecture for example (12th to 14th centuries), the emphasis was on structural forms. Forms were mostly vertical and designed as sharp pointed structures.

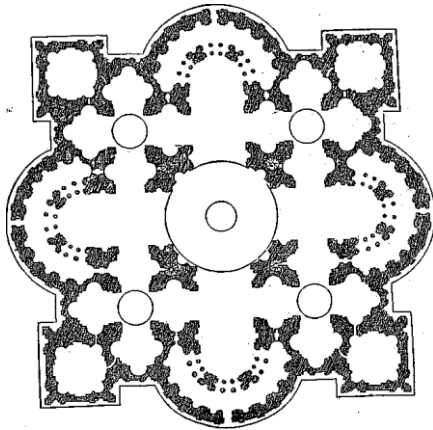


Gothic architecture: Beauvais Cathedral

In Renaissance period (14th to 17th centuries), the emphasis was on cavities. The transition from Gothic to Renaissance was not only a change from dominating vertical elements to

dominating horizontal ones, but above all a complete transformation from an architecture of sharp pointed structures to an architecture of well-shaped cavities.

A favorite Renaissance form is the circular, domed cavity. And just as the Gothic pillar was expanded on all sides into a cluster of shafts, the Renaissance cavity was enlarged by the addition of niches. For example, if you consider the black parts in the plan S. Peter's in Rome as "figure", you will find that they are the remainders, which are left after the cavity has been hollowed out of the great wall masses. It is like a regular cave temple dug out of the enormous building block.



Bramante's plan for St. Peter's, Rome (left)

Round, domed cavities joined together and expanded on all sides by semicircular niches.



St. Peter's, Rome

This contrast between the love of forms and love of cavities, as the contrast between Gothic and Renaissance times, appears again and again. In late 1800's for example, in the City Hall designed by the Danish architect Martin Nyrop (1849-1921) in Copenhagen, we observe the love of structural forms (as in Gothic architecture). The building demonstrates how it was constructed by way of its irregular, pointed silhouette of gables and tower tops.



Copenhagen City Hall; the architect has particularly stressed the solids terminating them in peaks and spires

However, in another building that is also built in Copenhagen around the same time, namely Police Headquarters, we observe the love of cavities. The building is formed as a huge block cut off flat at the top. What you experience here is a rich composition of regular cavities: circular and rectangular courts, cylindrical stairways, round and square rooms with absolutely smooth walls. The building is a composition of regular cavities joined together in dramatic sequence leading to the innermost rectangular court where the huge stone cylinders of columns are set up in effective contrast. There is an effective contrast between the solids and the cavities because of the courts.





Copenhagen Police Headquarters. Here the architect has formed the cavities. The courtyards seem to be hollowed out of the enormous block.

3. Contrasting Effects of Solids (forms) and Cavities (spaces) in Architecture:

The contrast between the solids and cavities (solids and voids) in architecture creates visual drama in architecture. The employment of masses and cavities together in effective contrasts leads to works that use grand architectural/visual effects. We observe that effective use of contrast in many edifices and buildings.

In the city gateway Porta di Santo Spirito, which is a Renaissance monument by Antonio da Sangallo, we observe an impressive example of this contrast. By way of columns and niches, a contrast is created between concave and convex forms, which produces an effect of order and harmony. The intervals between the contrasting shapes create a rhythmic movement that could be followed by the eye.

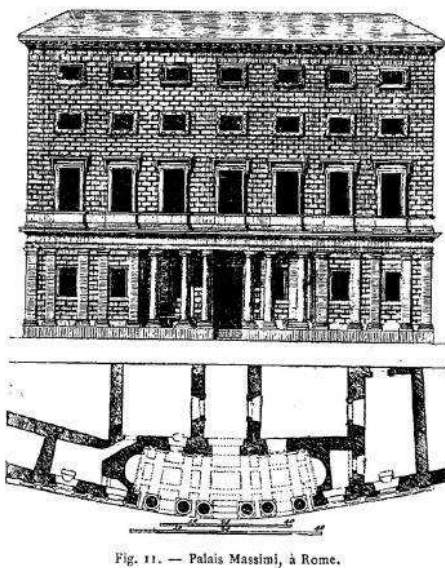


Porta di Santo Spirito, Italy

Therefore, an architect who wishes to create a dramatic visual effect can employ the contrast between solids and cavities. He/she can emphasize certain parts of the work by creating a deep cavity by its black shadow.

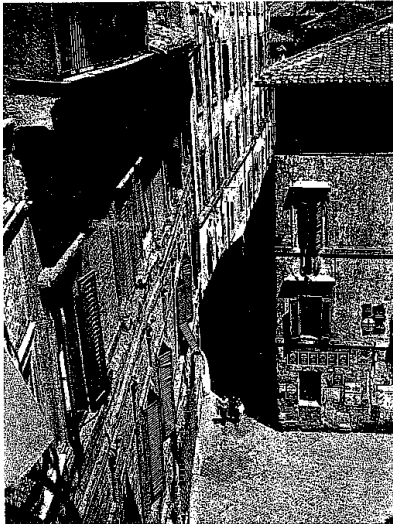
This contrast between solids and cavities (solids and voids) have been effectively used after Renaissance, in the period of Mannerism (late 1500's). Mannerist architects worked with the same forms with that of the Renaissance but they experimented with them to create combinations that were rich-in contrasts of form and color.

In *Palazzo Massimo alle Colonne* in Rome (designed by Baldassare Peruzzin, d. 1536) for example, we observe the contrast between the solid and cavity in the entrance, by way of the deep cavity cut into the solid block, which seems darker behind the pairs of columns. In addition to that, we also observe the solid-cavity contrast in the courts that are hollowed out of the great walls. The building exists as a composition of light and dark, open and closed.

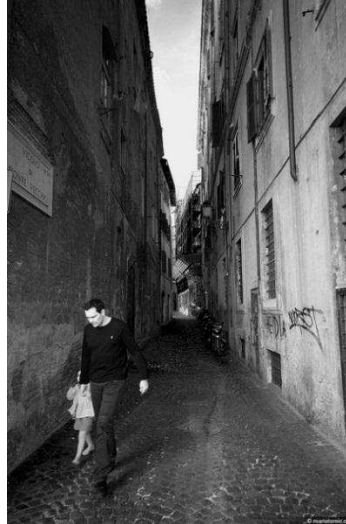


Palazzo Massimo alle Colonne in Rome (designed by Baldassare Peruzzin, d. 1536)

The contrast between solids and cavities could also be observed via narrow streets. The architects might take advantage of the spatial effects that are created with very narrow streets. In Rome for example, the word "corridor" has often been used in connection with the narrow streets.

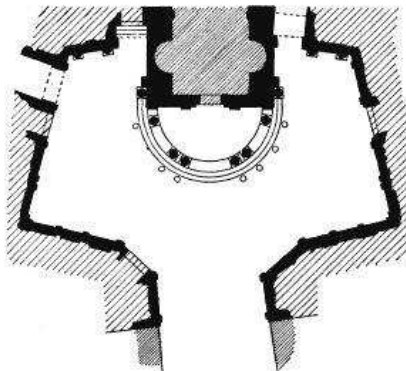
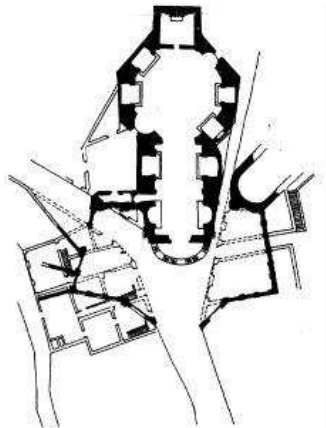


A street like a corridor: Via di Monte Vecchio in Rome seen from a roof



A street like a corridor: Via di Monte Vecchio in Rome

Very impressive solid-cavity (solid-void) contrasts are created by way of the narrow streets that open to piazzas or courtyards. One example is the dark, covered passageway, which leads to the forecourt of the church of S. Maria della Pace. The court is closed in as it is by architectural structures on all sides. It is a breath-taking experience to come from the dark, narrow passage out to the sunlit courtyard.



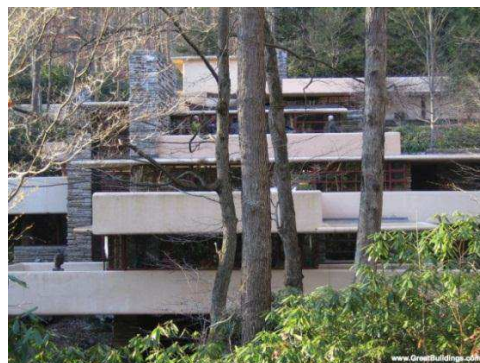
S. Maria della Pace, Rome

Fontana di Trevi is another example that uses the contrast between solids and cavities (voids), and rough and smooth elements. In it, a landscape of rugged rock clashes with the smooth stone of the basin. Water pours in cascades over the rocks and in the foam smooth marble. Above it all, a Renaissance palace, with columns, statues and heavy cornices, presides serenely over the fantastic scene.

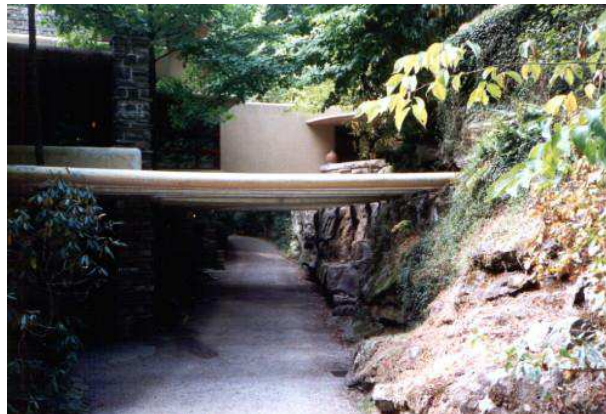
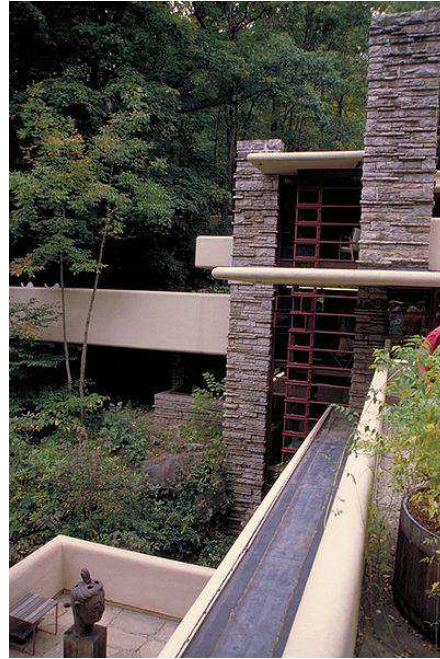
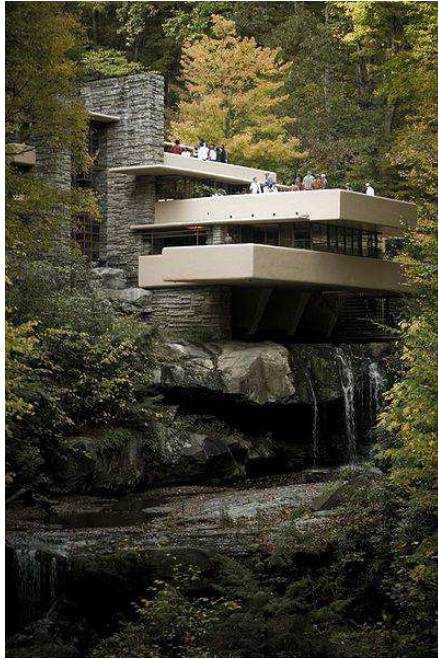


Fontana di Trevi, 1762, Rome

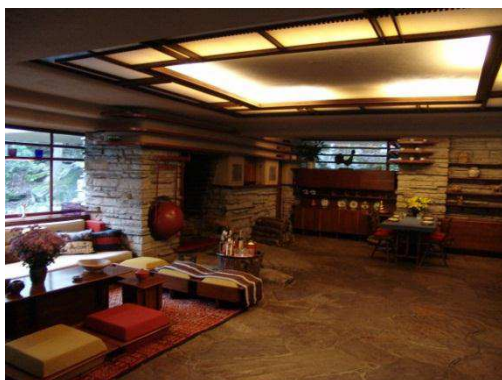
In modern times, Frank Lloyd Wright has created his fantasy over the use of contrasting materials and effects in Falling Water House, Pennsylvania. He used the contrast between the nature and the man-made form, and the rustic stone and smooth white concrete walls. The smooth forms of the house are placed in juxtaposition to the rusticated blocks of stone just as in Fontana di Trevi. The building appears as a composition of large concrete horizontal slabs cantilevered out over a waterfall. The visitor finds it as an organic part of its environment. Wright has continued Nature's composition of horizontal elements and massive rocks in the green hollow of the valley.



Falling Water House, Frank Lloyd Wright

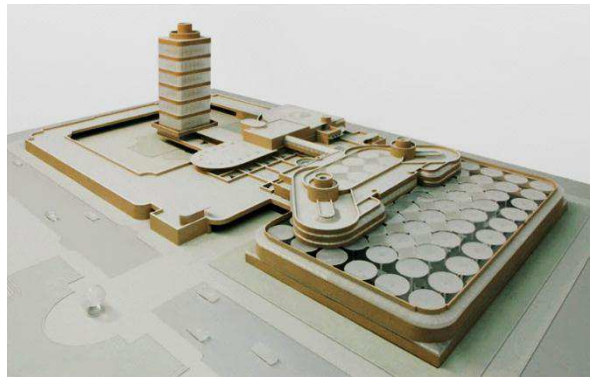
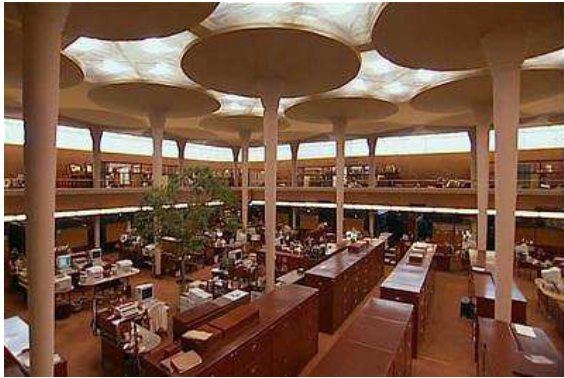
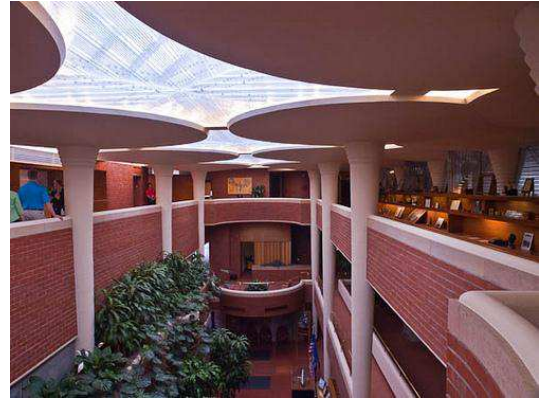
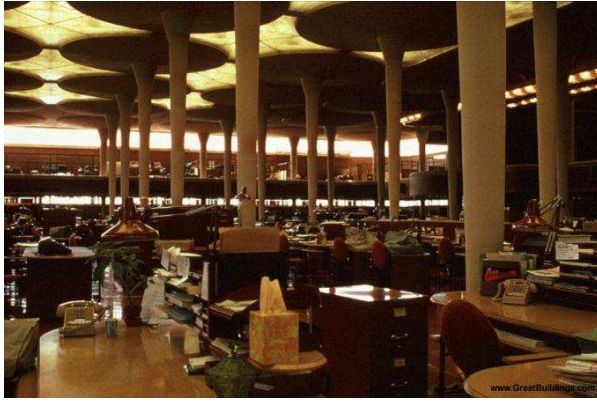


Frank Lloyd Wright's "FallingWater", Bear Run, Pennsylvania



Frank Lloyd Wright's "FallingWater", Bear Run, Pennsylvania

In his desire to obtain unusual effects Frank Lloyd Wright uses in his architecture skilful contrasts between concave and convex forms, juxtaposition of raw and refined materials. He also works with contrasting forms, curves which change from concave to convex, as in interiors in the famous Johnson Wax building in Racine.



Johnson Wax building in Racine

Another architect who has worked with effective contrasts of solids and voids is Eric Mendelsohn. He emphasized the horizontal elements by way of the contrast of solids and voids in the publisher's, building, Mossehaus in Berlin.



Eric Mendelsohn, the publisher's building, Mossehaus, Berlin

In Denmark, the architect Carl Petersen, contrasts concave and convex forms. In Faaborg museum there is a cavity—the deep-cut hole of the entrance, and in this the architect has placed the round bodies of columns.



Faaborg museum, Denmark, by Carl Petersen (photo by Thomas Noble)

4. Examples of Solid And Cavity (Void) Use In Architecture



Beaumaris, Melbourne, by architect Jeremy Wolveridge
Contrast of textures, contrast of light and dark, and contrast of solids and voids



Behet Bondzio Lin Architects, House Peng
Compositional theme: the juxtaposition of alternating solids and voids, opaque and transparent surfaces. Bands of regular-shaped volumes intersect, separating or uniting the different blocks of the building.



House in Meco by Jorge Mealha Architects (right)

The resultant form proposes an almost accidental arrangement of different and overlapped solids, dealing with mass and voids. Windows are opened in a free way trying to catch the most interesting spots in the surrounding landscape or the attached external spaces and volumes. (<http://www.chictip.com/dream-homes/dream-home-house-in-meco-by-jorge-mealha-architects>)



House in Meco by Jorge Mealha Architects (right)



Aires Mateus Arquitectos, an apartment building for the elderly people, Portugal (left);
Church of Light by Tadao Ando (right)



A house in Paço de Arcos, Lisbon, Portugal, by Jorge Mealha



The Swedish School of Social Science by Juha Leiviskä, Helsinki, Finland
Leiviskä's subtle permutations of solid and void



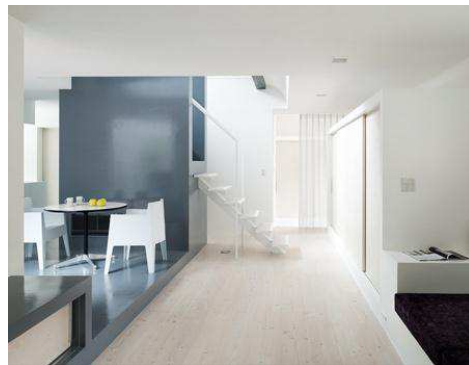
House IJburg by Marc Koehler Architects

<http://dailyarchitecture.blogspot.com/>

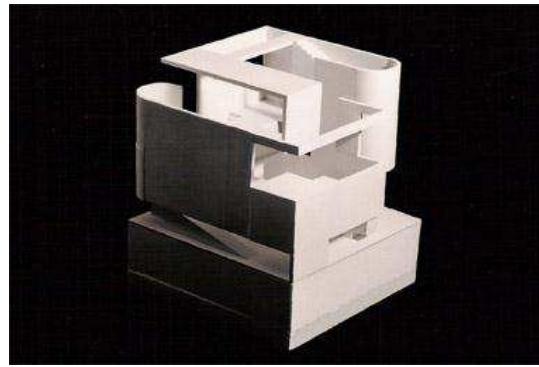
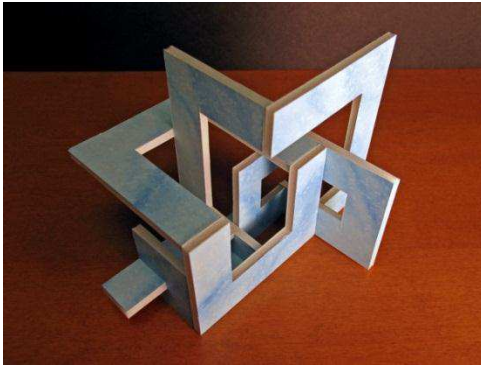
The house is located on a small plot in IJburg; a suburb of Amsterdam. Designed as a vertical garden giving space to flora and fauna to grow in a densely urbanised area. Closed private spaces contrast with open collective spaces, that seem to have been 'carved out' from the solid volume as a continuous transparent void.



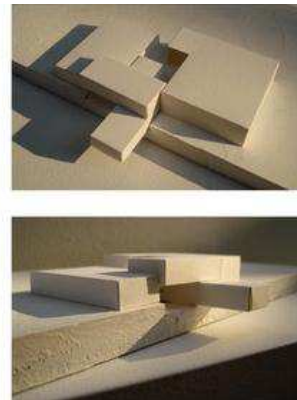
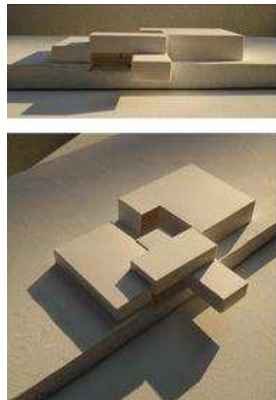
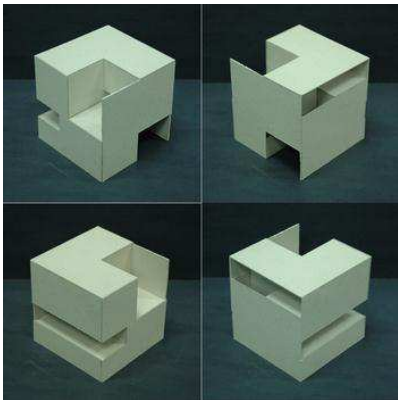
House of Reticence by FORM/Kouichi Kimura Architects – Dezeen



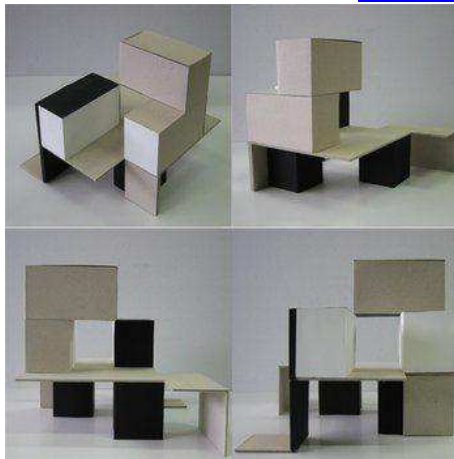
5. Examples of Solid And Cavity (Void) Use In Student Projects



<http://jcola-architectureisfun.tumblr.com/>



<http://www.tudelft-architecture.nl/chairs/form-modelling-studies/education/form-studies/bsc1-2>



Organic Cube by Danish Architect Søren Korsgaard