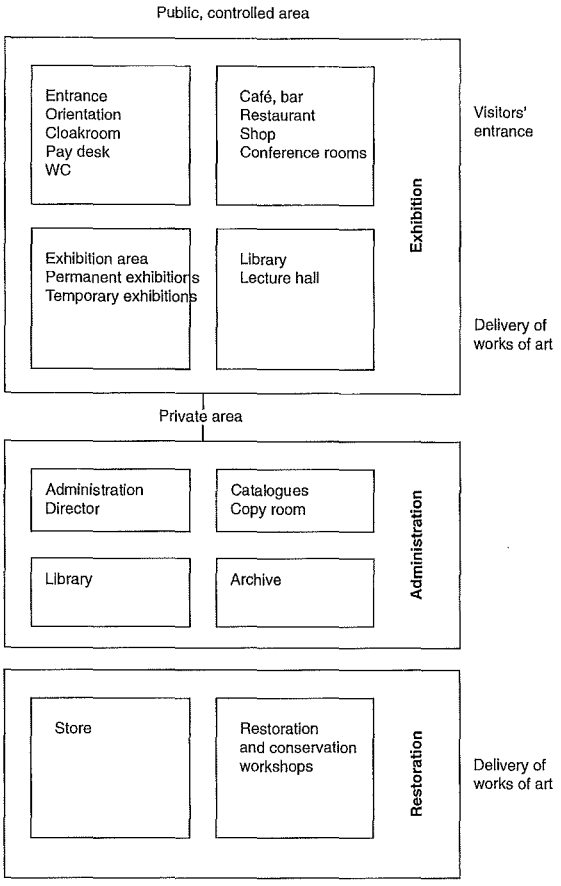
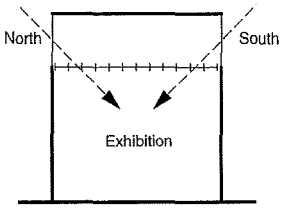
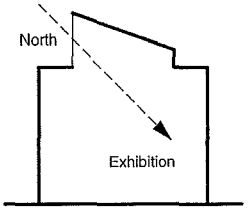


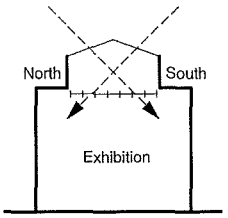
1 Functional scheme



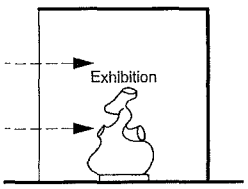
2 Indirect lighting filtered through suspended glass ceiling



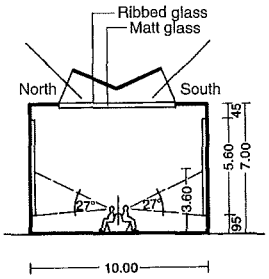
3 Lighting of display from rooflight facing north



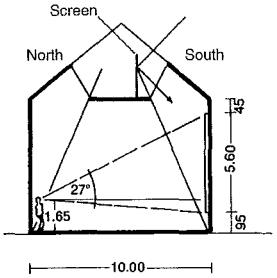
4 Indirect lighting filtered through suspended glass ceiling



5 Side lighting from north



6 Well-lit display room according to Boston tests



7 Uniformly lit gallery with light according to S. Hurst Seager

MUSEUMS AND ART GALLERIES

General

A museum is a public collection of objects testifying to human cultural development. It collects, documents, receives, researches, interprets and communicates these through display.

The following museum types can be categorised according to the origin and nature of the items in the collection:

Art gallery: Collection of works of fine art (including craftworks and graphics).

Cultural history museum: Collection of devices, weapons, clothing, written documents etc. which show the cultural development of a geographically restricted area (ethnological museum, open-air museum, local history museum).

Ethnology museum: Works from the cultural heritage of traditional peoples and lost cultures.

Science museum: Collection of educational and display material connected with scientific and technical themes.

see also:
Lighting, pp. 501 ff.

Lighting

There should be no direct daylight falling on museum objects as this could cause damage. Therefore display rooms should be provided with flexible lighting systems: no permanently built-in lights, no fixed wall and ceiling lights.

Guidelines for lighting:

Very sensitive display objects	50–80 lx
Sensitive display objects:	100–150 lx
Less sensitive display objects:	150–300 lx

UV radiation must not be exceed 25 W/m^2.

It must be possible to completely darken all display rooms. In public rooms where no items are displayed, e.g. entrance area, café, library, a greater amount of daylight is desirable.

The lighting calculations for museums are highly theoretical: the quality of lighting is decisive. American tests can be more informative.

Room climate in the store and the display areas

The ideal temperatures in the store and the display areas are 15–18°C in the winter and 20–22°C in the summer. Except as short peaks, in the summer 26°C should not be exceeded. Stores should not therefore be located in uninsulated attics, for example.

Because the reproduction of insects is very limited under 15°C, above all for science and ethnography collections a temperature of 12–13°C is optimal.

Photo and film material is relatively chemically unstable and the material should therefore be stored cool and dry at temperatures under 16°C (ideally at approx. 5°C).

The relative humidity in the store and the display areas depends on the displayed and stored materials: the optimal values are for wood 55–60%, canvas 50–55%, paper 45–50% and metals, max. 40%. It is important to avoid short-term variations in relative humidity: the variation within one hour should not exceed 2.5%, or not more than 5% in one day. Seasonal variations should not be more than +5% in summer or –5% in winter. The changing flow of visitors in museums leads to continuous variation in the climatic parameters.

MUSEUMS AND ART GALLERIES

Display Rooms

The decisive factor in the layout of display rooms is the relationship between the collection and the way it is to be displayed (display concept). There are the following basic types of layout → ❶ – ❻:

Open plan → ❶: large and visually autonomous items on display, free circulation, function rooms in basement.

Core and satellite rooms → ❷: main room for orientation in the museum or the exhibition, side rooms for autonomous displays (themes/collections)

Linear chaining → ❸: linear sequences of rooms, controlled circulation, clear orientation, separate entrance and exit.

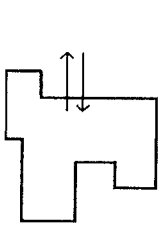
Labyrinth → ❹: free circulation, guided route and direction are variable, entrance and exit can be separate.

Complex → ❺: combined groups of rooms with typical features of → ❶ – ❹, complex organisation of collection and display concept.

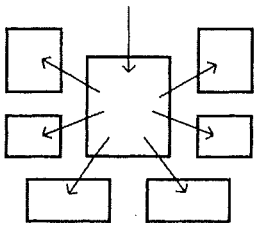
Round tour (loop) → ❻: similar to linear chaining → ❸, controlled circulation leads back to entrance.

Display concept	Spatial arrangement
oriented on display items	open plan → ❶
systematically oriented	main and side rooms (core and satellites) → ❷
thematically oriented	linear chaining → ❸, round tour → ❻
complex oriented	labyrinth → ❹, complex → ❺

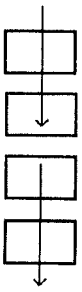
The size and height of the display and store rooms depend on the dimensions of the works and the extent of the collection, but the minimum height is 4 m clear.



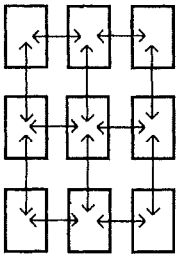
❶ Open plan



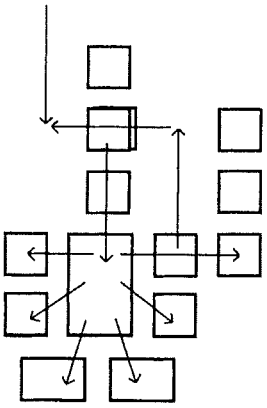
❷ Main and side rooms (core and satellites)



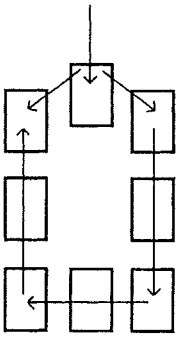
❸ Linear chaining



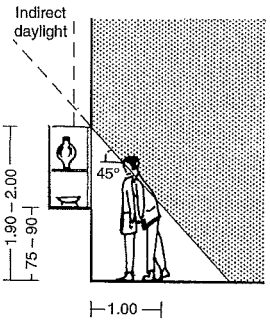
❹ Labyrinth



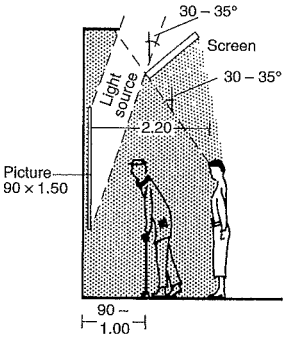
❺ Complex



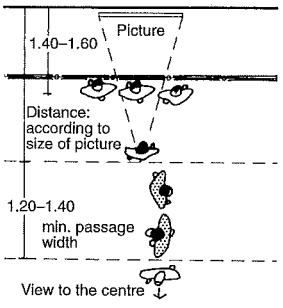
❻ Round tour (loop)



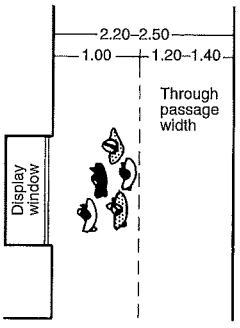
❼ Light and shadow in display cabinets



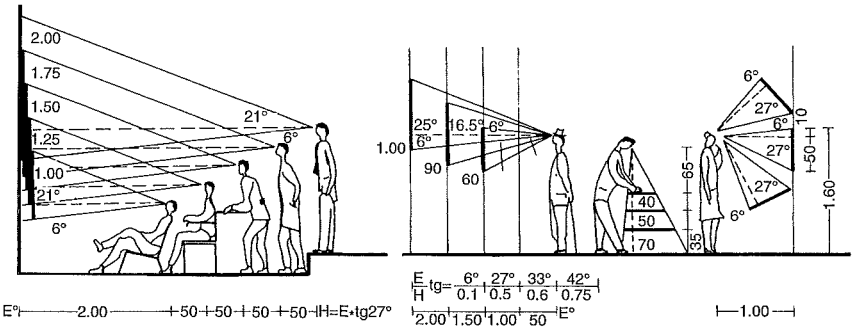
❽ Distance and light



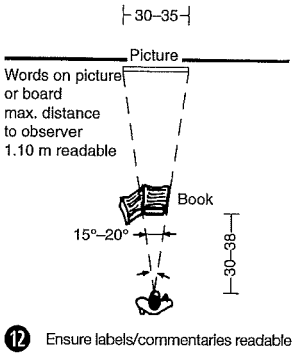
❾ Pictures on the wall: viewing and traffic



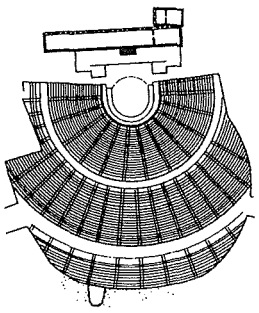
❿ Space in front of display cabinet



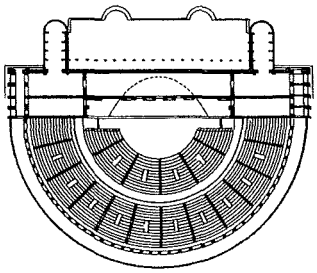
⓫ Field of view: height, size and distance



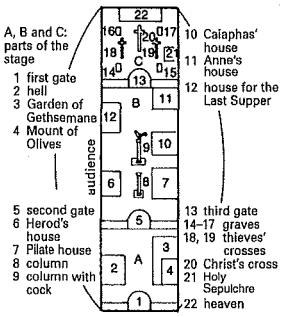
⓬ Ensure labels/commentaries readable



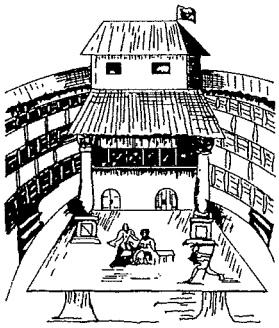
❶ Theatre of Dionysos, Athens, 452–330 BCE: plan



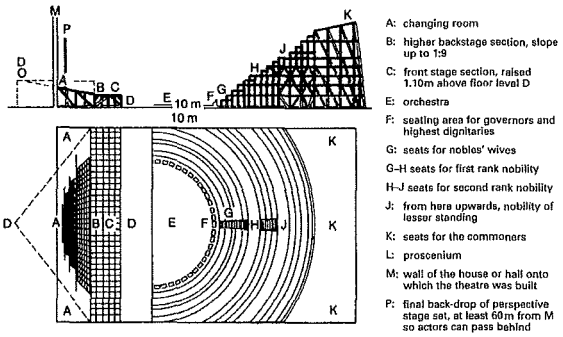
❷ Theatre of Marcellus, Rome, 11,500 seats, 11 BCE: plan



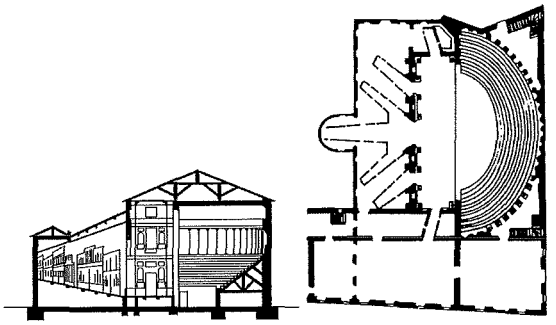
❸ Plan of medieval stage facilities



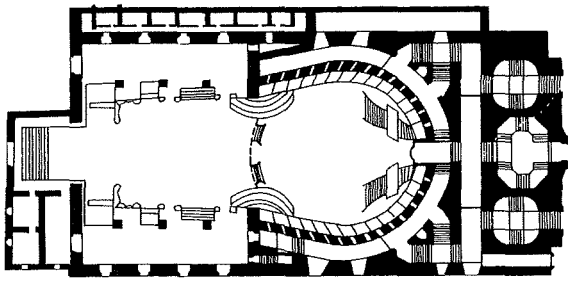
❹ Swan Theatre, London



❺ Theatre layout, Sebastiano Serlio, 1545



❻ Teatro Olimpico, Vicenza, 1585, section and plan Arch.: Andrea Palladio and Vicenzo Scamozzi



❼ Teatro 'San Carlo', Naples, 1737 Arch.: Antonio Medrano and Angelos Carasale

THEATRES

Historical Review

The design of theatres requires an understanding of complex functional interactions, of which much is explained by the history of theatres. This is an architectural challenge, which has been interpreted by various societies for more than 2500 years. Each theatre building today stands in a great tradition, even if it is marked by efforts to escape from this. A few examples should throw light on the historical development of this type of building → ❶ – ❾ → p. 210 → ❶ – ❻.

Ancient theatres

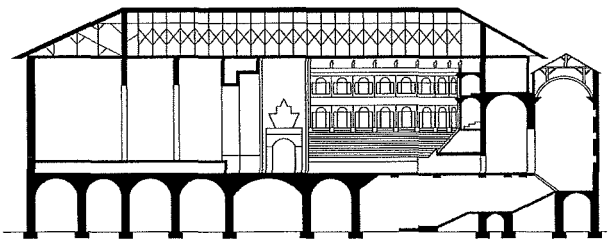
Theatre of Dionysos, the start of European theatre building → ❶. Greek theatres were located next to towns and embedded in the landscape. Theatre of Marcellus, Rome. The first theatre in Rome built completely of stone → ❷. Rows of seating and the back wall of the stage were connected and of the same height.

Middle ages

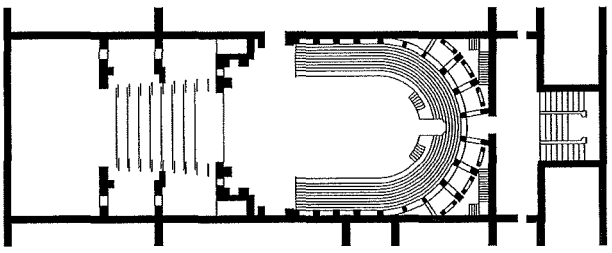
Medieval stage theatre. Temporary stage and buildings → ❸. Interior space of the Swan Theatre, according to a drawing by van de Witt 1596. Only a curtain separated the front and back stages and the upper stage served for balcony or siege scenes → ❹.

Renaissance

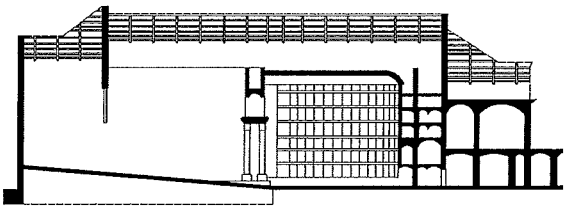
The early Italian Renaissance theatres were temporary wooden installations in existing halls → ❺. Vasari, for example, developed a wooden, reusable system for the theatre installation in the Salone dei Cinquecento in the Palazzo Vecchio, Florence. Teatro Olimpico, Vicenza → ❻. The first permanent theatre of the Renaissance, which resumed the ancient tradition of theatre building. Semi-circular and rising rows of seating for the audience and a stage house with façade. Next to this were the loggia courtyards with spectator boxes arranged in a horseshoe. The Teatro Farnese, Parma → ❽ + ❾ was the first building with movable scenery system in a deep stage space.



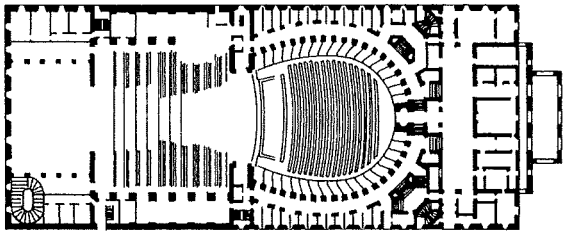
❽ Section of Teatro Farnese, Parma, 1618–1628 Arch.: Giovanni Battista Aleotti



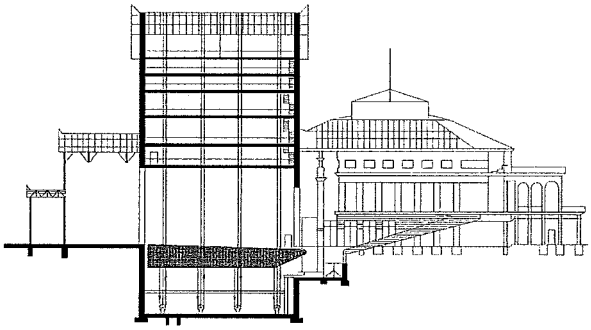
❾ Teatro Farnese, Parma, 1618–1628 Arch.: Giovanni Battista Aleotti



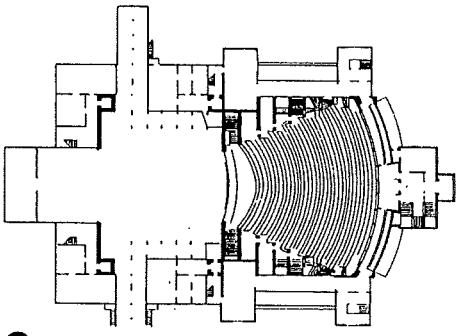
❶ Section, Teatro alla Scala, Milan, 1779 Arch.: Piermarini



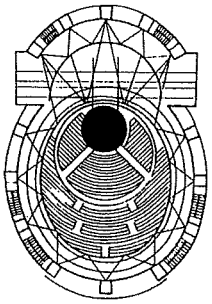
❷ Teatro alla Scala, Milan, 1779 Arch.: Piermarini



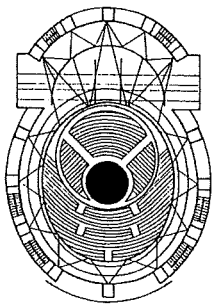
❸ Section, Festival Opera House, Bayreuth, 1876 R. Wagner and Arch. O. Bruckwald



❹ Festival Opera House, Bayreuth, 1876 R. Wagner and Arch. O. Bruckwald



❺ Walter Gropius: Design for the 'Totaltheater', 1927



❻ → ❺ Stage rotated

Baroque
The theatre with boxes and a 'peephole' single-room stage steadily became more prevalent. Teatro 'San Carlo', Naples, p. 209 → ❼, and Teatro alla Scala, Milan → ❶ + ❷ are considered the models for the building of opera theatres in the 18th and 19th centuries, but also the new 'Met', in New York 1966.

19th and 20th centuries
Festival Opera House, Bayreuth → ❸ – ❹. Richard Wagner introduced this form of theatre (auditorium in a classical semi-circle and rising) and set a counterpoint to the Grand Opéra in Paris. Totaltheater Project (Gropius/Piscator), cf. 'The Stage in the Bauhaus', Dessau 1924. Note: audience space can be rotated, stage with paternoster system, surrounding projection on walls and ceilings → ❺ – ❻. Playhouse on Lehniner Platz, Berlin, first large new building of a flexible theatre space (rebuilding of the Mendelsohn building, 'Universum', of 1928) → p. 213 → ❽ – ❾. Opéra Bastille, Paris, the largest theatre yet, with 10 side stages on two levels.

Tendencies in current theatre building
There are two tendencies today:

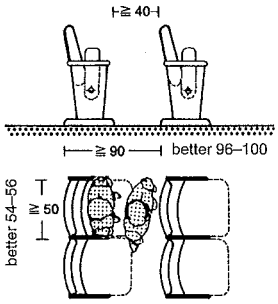
1. Preservation, restoration and modernisation of existing theatres from the 19th to mid-20th century → p. 218
2. New buildings with 'experimental' open-space character, e.g. Playhouse on Lehniner Platz → p. 213. A similar direction is demonstrated by the many projects to rebuild existing spaces into workshop theatres with a size of 80–160 seats.

Different types of theatre building
1. Opera house:
This belongs to the tradition of 18–19th century Italian opera buildings → ❶ – ❷. It is characterised by a clear spatial and architectural separation between auditorium and stage, by high numbers of seats (1000 to nearly 4000) and the corresponding system of boxes or tiers, which is necessary for so many theatre-goers, e.g. Scala, Milan, 3600 seats; Deutsche Oper, Berlin, 1986 seats; Metropolitan Opera, New York, 3788 seats; Opéra Bastille, Paris, 2700 seats. The counterpoint to the form of opera house as tiered/box theatre is the Festival Opera House, Bayreuth → ❸ – ❹. This is designed as a theatre with stalls according to the Greek and Roman pattern, but has only 1645 seats.

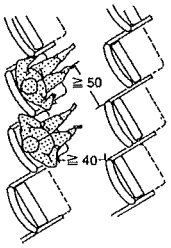
2. Playhouse:
This is in the tradition of the German reform theatre of the 19th century. It is characterised by the stalls layout (that is, the audience sit on a large, rising and curved floor) and by a pronounced apron stage (area in front of the proscenium), which can be used for the play as well. The playhouse also, however, follows the tradition of the English theatre → p. 209 ❹, i.e. theatre in the round. The open and variable layout became more intensive with the spatial experimentation of theatres in the 1970s. Variations in layout are shown, for example, by the Playhouse on Lehniner Platz, Berlin → p. 213.

3. Multi-purpose theatre:
This mixed form of opera, theatre and ballet is a speciality in German-speaking regions. The space is mostly characterised by the predominant influence of the opera. The frequent changes of scenery are enabled by the appropriate subsidiary rooms (store, scenery store, workshops). Example: Heilbronn City Theatre, Arch.: Biste u. Gerling 1982 → p. 217 ❹.

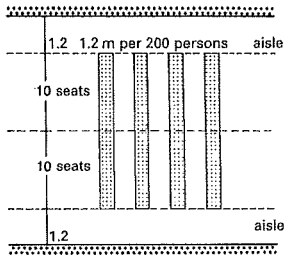
4. Musical theatre:
Actually no separate type of building, but rather a theatre built, usually, for a particular musical by an impresario. A specific challenge for the designer is the adaptation of the building to the concept of the musical without neglecting the needs of later uses for other productions.



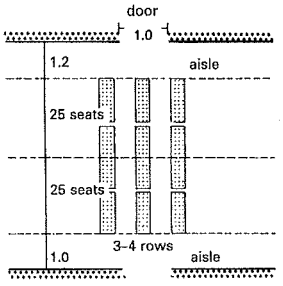
❶ Seating must be fixed according to Places of Assembly Regulations. Minimum dimensions are not adequate for theatres!



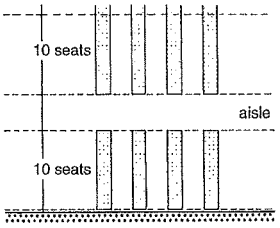
❷ Staggered folding seats offer freedom for elbows



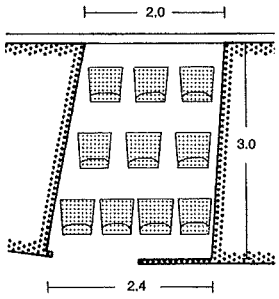
❸ Row width 20 places



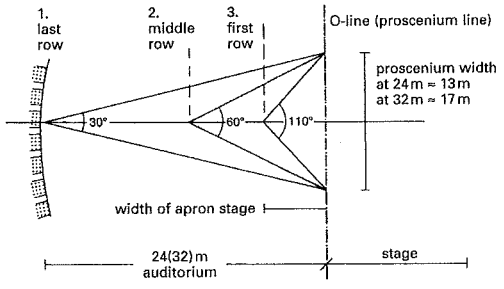
❹ Row width 25 places, door needed



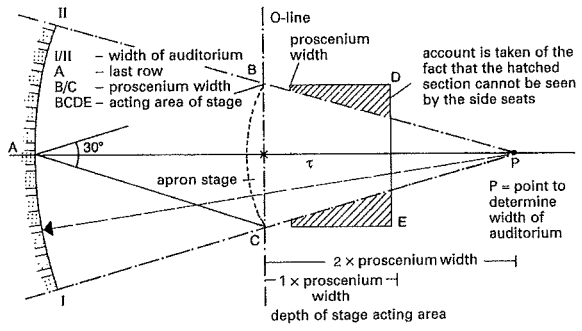
❺ Row width max. 10 places, side aisle at left and right



❻ Boxes may have ≦20 loose chairs, or fixed seating if necessary; per person ≧0.65 m² floor area



❼ Proportions of traditional auditorium plan



❽ Auditorium width

In addition to the local building regulations, decisive for the design of theatres are the Places of Assembly Regulations of the relevant state. This is based on the Model Places of Assembly Regulations, which can vary in detail from those of a particular state! This legislation applies from 200 spectators. It should be noted that it is not the actual number of seating or standing places that counts: it is assumed that there are two spectators per m² in the place of assembly (for rows of seats; two spectators per running m for standing places).

Auditorium and stage/acting area

Size of auditorium: the number of people in the audience gives the required floor area. For seated spectators, assume ≧0.5 m²/spectator. This number results from:

seat width × row spacing

	≧0.45 m²	/seat
add ≧0.5 × ≧0.9	= 0.05	/seat
	≧0.50 → ❶	

Length of the rows of seats per aisle: 10 places → ❸ + ❺, 25 places per aisle if an exit door of 1.2 m width is available at the side per 3 or 4 rows → ❹

Exits, escape routes 1.2 m wide per 200 people → ❸ – ❺.

1% of the seats (at least two) must be accessible for wheelchair users, if possible in connection with a seat for an accompanying person.

Auditorium volume

This is determined by acoustic requirements (reverberation) → p. 221 as follows: playhouse approx. 4–5 m³/spectator; opera house approx. 6–8 m³/spectator. Air volumes must not be less for technical ventilation reasons, in order to avoid too rapid air changes (draughts).

Proportions of the auditorium

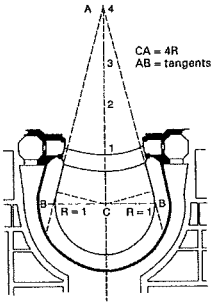
These are derived from the psychological awareness and angle of view of the spectator, or the requirement for a good view from all seats. Options are:

1. Good view, without moving head, but light eye movements of approx. 30°.
2. Good view with slight head movements and light eye movements of approx. 60° ❼.
3. Max. awareness angle without head movement approx. 110°, i.e. all actions in the field are 'in view'. Outside this field, there is uncertainty, because 'something' is out of view.
4. Full head and shoulder movement allows an angle of view of 360°.

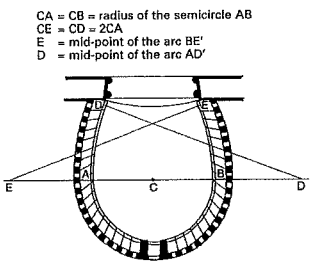
Proportions of the classic auditorium

Opera, multi-purpose theatre, and traditional playhouse → ❼: distance of the furthest row from the start of the stage should not exceed: – playhouse, max. 24 m (max. distance for the recognition of facial expressions); opera, 32 m (large movements are still recognisable).

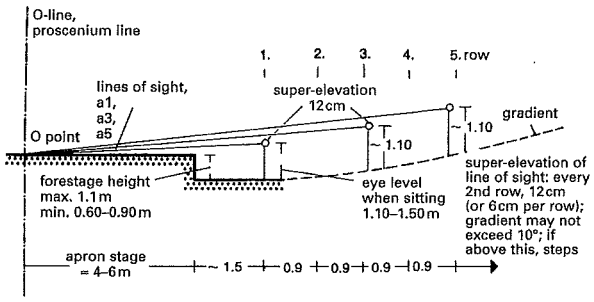
Auditorium width is determined by the spectators at the side being able to see the stage adequately → ❽. The comfortable proportions and sometimes good acoustics of the classic theatres of the 18th and 19th centuries are based on particular rules of proportion → ❾ – ❿.



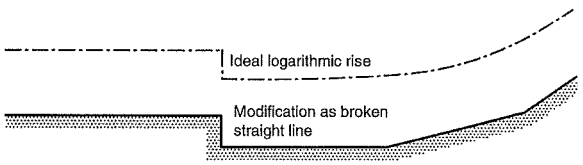
❾ Design of auditorium's contour, Grand Théâtre, Bordeaux
Arch.: Victor Louis 1778



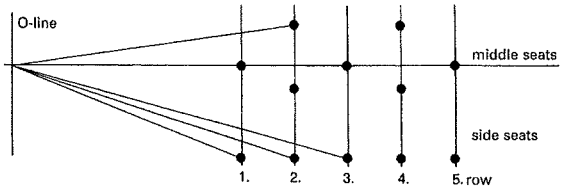
❿ Design of the auditorium's curve, Teatro alla Scala, Milan.
Arch.: Piermarini



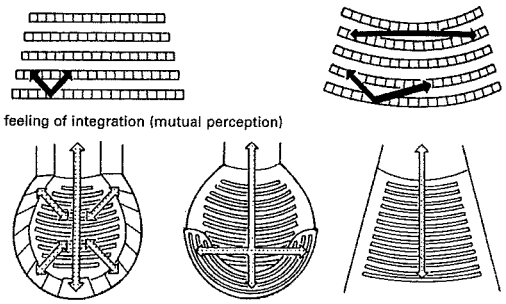
❶ Elevation of seating (gradient)



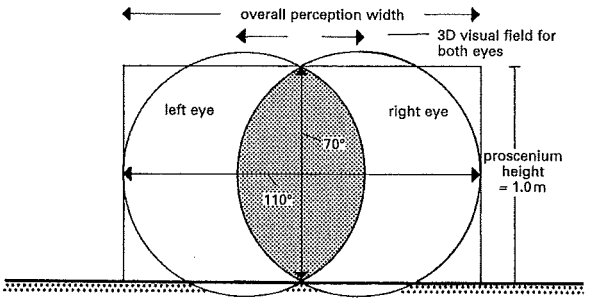
❷ Gradient curve and its modification



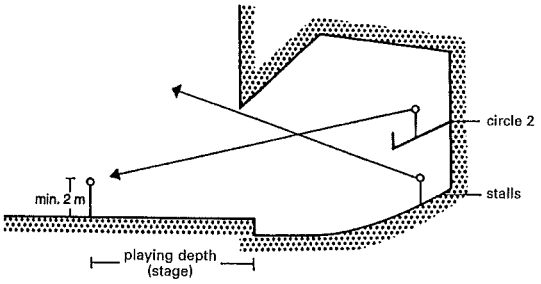
❸ Offsetting of the seats in a row is achieved through variable seat widths (0.50–0.53–0.56)



❹ Contact relationship between the audience and the stage and with each other



❺ Field of perception and proportions of the proscenium arch



❻ Tiered theatre and view of stage

The elevation (gradient) of the seating in the auditorium is derived from the sight lines. The sight line construction applies for all places in the auditorium (stalls, but also tiers) → ❶. It can be assumed that the spectators sit sensibly and so only every second row requires full sight super-elevation (12 cm). Specialised mathematical literature addresses problems of view in the theatre, including, for example, the distribution of people's heights.

Rows of spectators should be positioned in arcs, not only for better alignment toward the stage, but also to achieve a better perception of each other (security effect) → ❹. The stepped side aisle must rise 10–19 cm and the tread must not be less than 26 cm. The floor between the seats must be on the same level as the adjacent aisle at the side.

Overall layout of the auditorium

Firstly, determine the height of the proscenium. In stalls theatres, the relationship should be:

$$\frac{\text{proscenium height 1}}{\text{proscenium width 1.6}}$$

This derives from the golden section and the physiological field of awareness, respectively → ❺. After determining the proscenium height, the ramp height, the pitch of the stalls and the volume of the room, this gives the room height. The ceiling is to be adapted for acoustic requirements. It should be the case that the noise reflected from the stage and apron is distributed evenly over the room → ❼.

For tiers, it is important that there is also a sufficiently deep view of the stage from the uppermost level → ❻. This may render it necessary to make the proscenium higher.

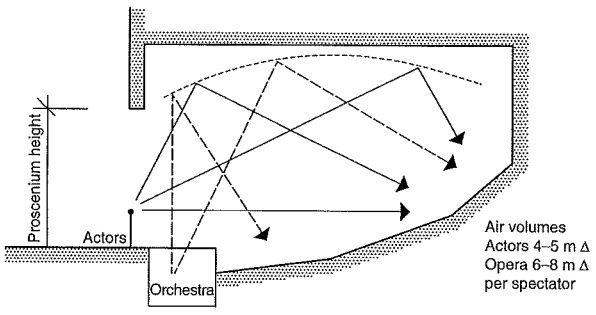
Proportions of an experimental space → p. 213

These are neutral or open theatre spaces, which permit different arrangements of spectators and stage areas. This variable arrangement is achieved through:

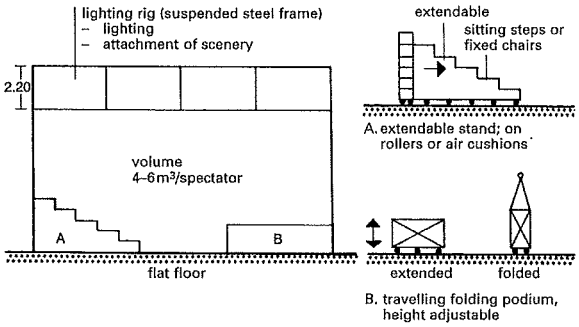
A. Mobile stage platforms and mobile stands for the audience on a fixed floor.
B. Mobile sections of floor, which consist of moveable podiums. This solution is technically more elaborate and is therefore used only in larger spaces for min. 150–450 or more people.

The simpler option A is particularly suitable for smaller theatres and for unused spaces, which normally do not have extensive space underneath. Size: up to max. 199 places, because the regulations apply from 200.

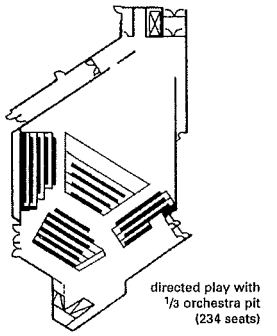
199 seats × 0.5 m^2 = 100 m^2 (2/3) + 30 m^2 (1/3) stage area = 130 m^2.



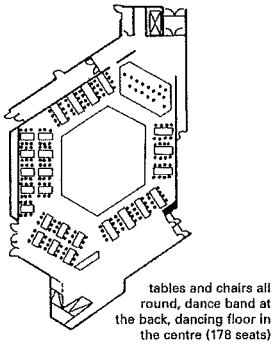
❼ Acoustics must be adapted through appropriate measures like ceiling shape or acoustic 'sails' → p. 220



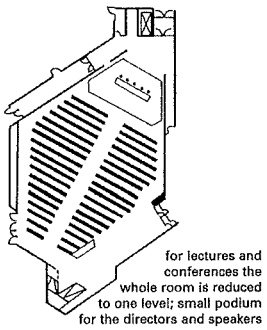
❶ Experimental theatre space



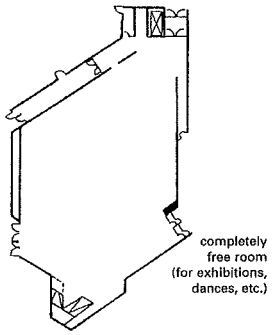
❷ Space variants, at the Münster City Theatre, Kleines Haus



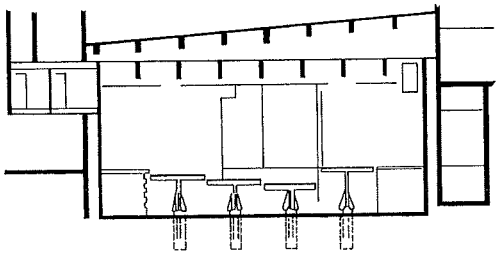
❸ → ❷



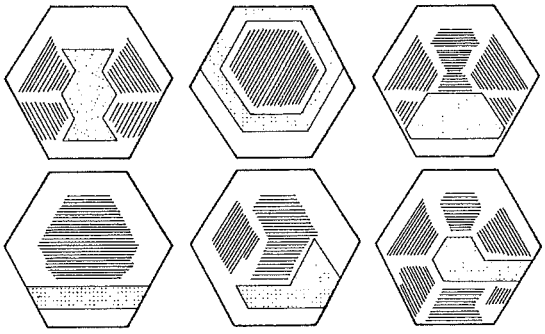
❹ → ❷



❺ → ❷ Arch.: v. Hausen, Rawe, Ruhnau



❻ Ulm Theatre, section through podium Arch.: Fr. Schäfer



❼ Podium Ulm, six variants for arrangement of performance areas

Size of stage

The Places of Assembly Regulations, which apply to all venues with audiences of more than 200, differentiate two types of stage: large stage and open stage (single-room theatre).

Large stage

Large stages are defined as having a stage area of more than 200 m² behind the stage opening and with an upper stage of 2.5 m height above the stage opening or an apron. The essential requirement is the fire-resistant separation of stage and auditorium. This necessitates an iron protection curtain between the stage and the auditorium in case of danger.

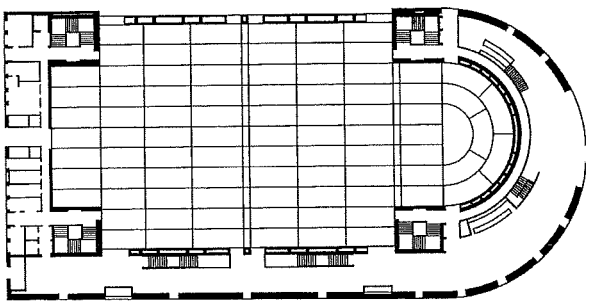
Open stage

Open stages are divided into those with more or less than 200 m² and those with or without sprinkler systems. The special feature of open stages is the regulations about curtains and scenery. These affect above all the operation and not the design of the open stage.

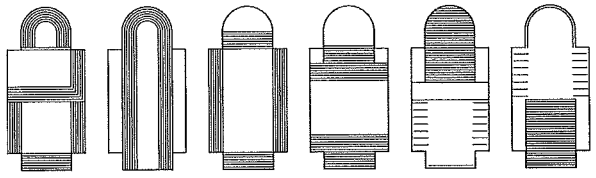
Spaces for experimental forms of theatre (black box theatres) can abolish the separation of stage and audience in various ways through differentiated design of the floor topography (mobile sections of floor or podiums) and the free distribution of audience area and stage. Example: Playhouse on the Lehniner Platz, Berlin → ❽ – ❾.

Section of the room for single-room (black box) theatres

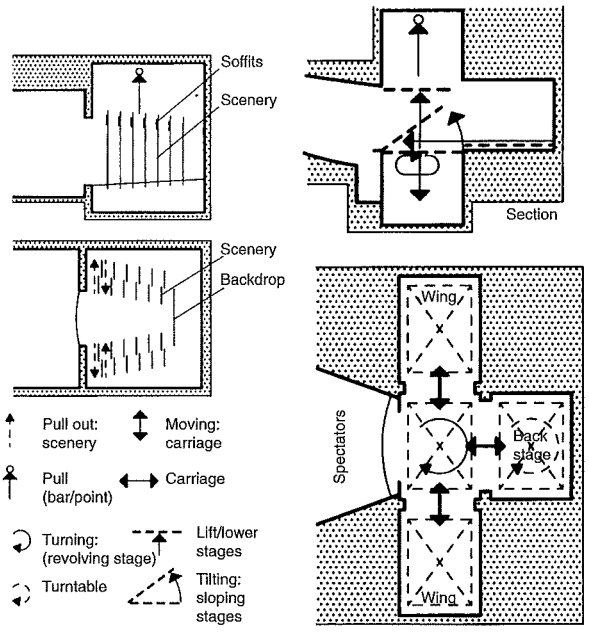
Single rooms can make do without the technical ceiling → ❶, but manual lifting devices can be provided (battens, which are lifted into the ceiling with manual hoists). In large theatres, a smaller, more variable space is often included for experimental theatre. Examples: Podium Ulm, Arch:. Schäfer, approx. 150–200 places, 1969 → ❻ + ❼; Kleines Haus Münster, Arch:. v. Hansen, Rane, Ruhnau, 1971, 180–380 places, central field of the floor can be varied with mobile podiums → ❷ – ❺.



❽ Playhouse on the Lehniner Platz, Berlin, 1982 Arch.: J. Sawade

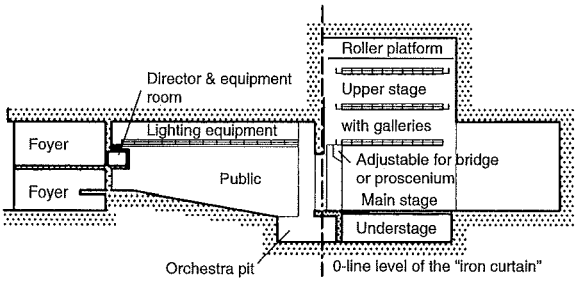


❾ Playhouse on the Lehniner Platz, six variants for arrangement of possible open stages

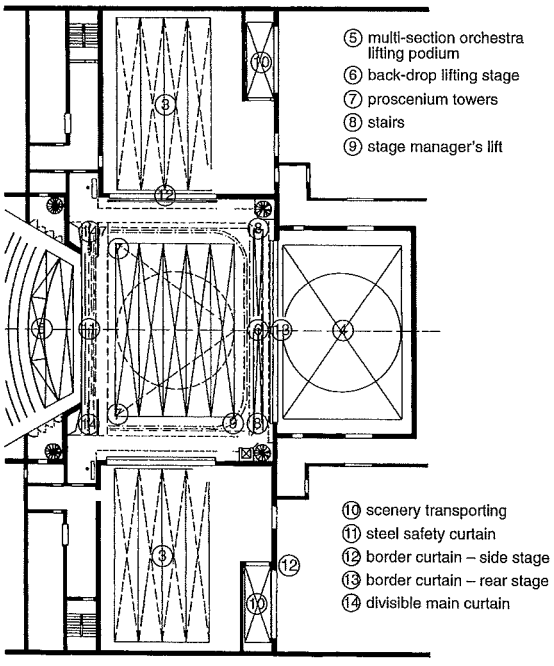


❶ Backdrop theatre: change of scene by pushing the painted scenery

❷ 'Peephole' single-room stage. Large wing and rear stage areas enable the quick changing of scenery structures



❸ System section of theatre



❹ Typical plan of opera house

Scenery stage

The classical stage system of the 18th and 19th centuries had only the main stage; the scenes were changed, in little space and with uncanny speed, using sliding painted scenery. A small rear stage had the function of providing room for deeper stage perspectives → ❶.

Full stage

In order to be able to quickly change more elaborate and sculptural scenery structures, stages were supplemented by wings and under-stages of about the same size. Complete sets of scenery were mounted on wagons, lifting platforms or turntables and could be prepared with little effort during the performance → ❷.

For design purposes, the technical constraints must be established early, e.g. whether a turntable on a wagon is sufficient or whether a turntable with single lifting elements or even a two-level turntable should be used.

Proportions of the stage

The proportions of the stage are developed from the sight lines in the auditorium. The stage is the area for acting and also a handling and working area. The conventional layout of a traditional full stage → ❸ – ❹.

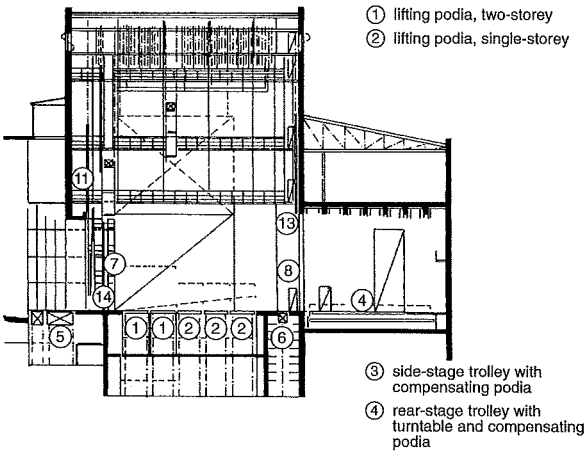
The mobile scenery surface is formed by platforms of adjustable height or through lifting platforms. The variability of form is achieved by splitting the surface into separate flats. Basic module 1 × 2 m.

Section of stage

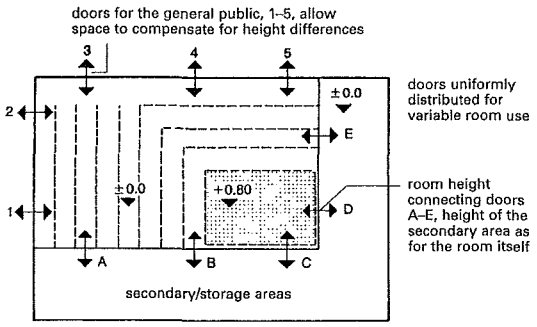
The size of the stage space is determined by the number of scenery sets to be kept ready, which can be moved into the stage quickly by lifting or pushing. At least one rear space and one wing are usual. The height of the stage space is determined by the (iron) safety curtain, which must be able to close the fire compartment between auditorium and stage within 30 s in case of fire. It is a complete closure joined at the ends to a fire wall (F90) and no cables or scenery are permitted in the space for the safety curtain.

Stage direction room

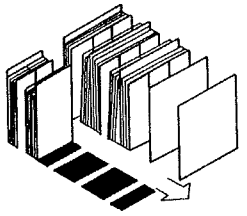
Control of lighting and sound on stage, with sound mixing desk, light controls, computer connections and projection equipment → ❸.



❺ Typical section of opera house → ❹

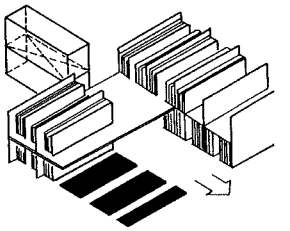


❶ Subsidiary areas/storage space for open stages



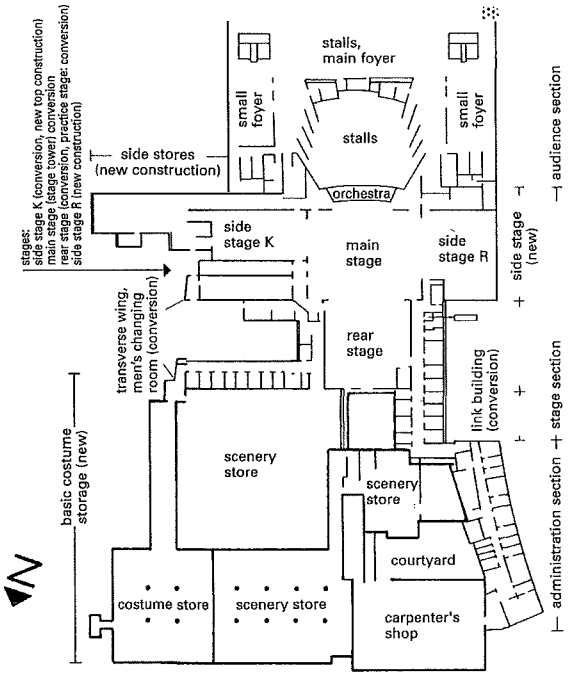
traditional storage of back-drops
- on edge in boxes, manual transport, large proportion of area required, height: 9–12m
- in boxes, manual transport, large proportion of area required for moving

❷ Storage near the stage

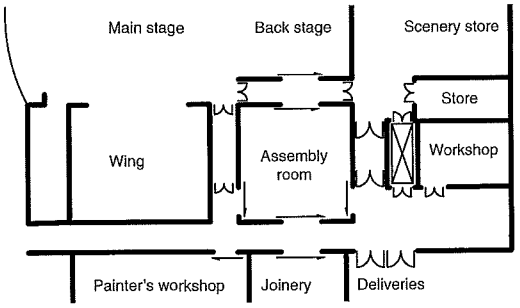


modern back-drop storage
- loading of containers by hand from secondary stage, or specific storage areas
- transport of container to external store
- computer-controlled storage of containers in multi-storey shelving

❸ Storage in containers



❹ Deutsche Oper Berlin, plan



❺ Access points from the subsidiary areas to the stage. Height and location of doors and lift must be determined from max. backdrop height and fire protection measures

Experimental (black box) theatre

Open stages require subsidiary areas for scenery and storage places for platforms and stands. The subsidiary areas should be of the same size as the stage. The space required for storage can be calculated from the folded platforms and stands. Subsidiary areas plus storage area amount to about 30% of the total area → ❶.

Considerably less scenery is used with open stages than with normal stages, the reasons for which are:

- the stage is viewed from many sides.
- regulations limit the use of scenery for safety reasons.

Large stages

Storage areas are required for:

Scenery, backdrops, furniture, props, costumes, hats, shoes, make-up, wigs, lighting, etc. Scenery and costume stores require a great amount of space.

Scenery store:

Specially for heavy items. Location: at stage level and immediately next to the stage. At access points and on traffic routes (particularly at fire exits and lifts), the height of the scenery, normally proscenium height + 2 m, must be taken into account.

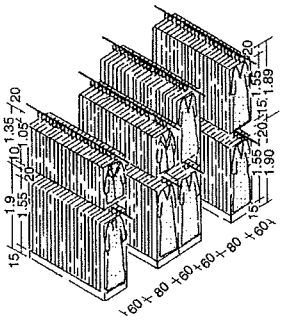
A rough estimate for the size of the scenery and costume store can be made from the number of productions in the repertoire and the frequency with which they are played. For theatres the number of productions might be 15–20 and for multi-purpose theatres and opera up to 50 per season. About 20–25% of the stage area is required for storage per production, i.e. for theatres about 3 times the stage area, for the opera at least 10 times. Practice shows that, as time passes, the store always turns out to be too small, and theatres, and particularly operas, have to make arrangements outside the building.

The high cost of transport has forced the introduction of the most modern transportation and storage technology: container systems with computer-controlled warehouse technology (per performance about 2–4 containers – in special cases for operas about 12 containers).

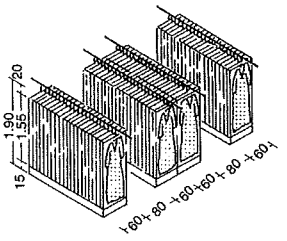
Examples:

- Deutsche Oper Berlin: the stores are in direct connection with the stage → ❹
- Nationaltheater Mannheim: storage outside the building in containers.

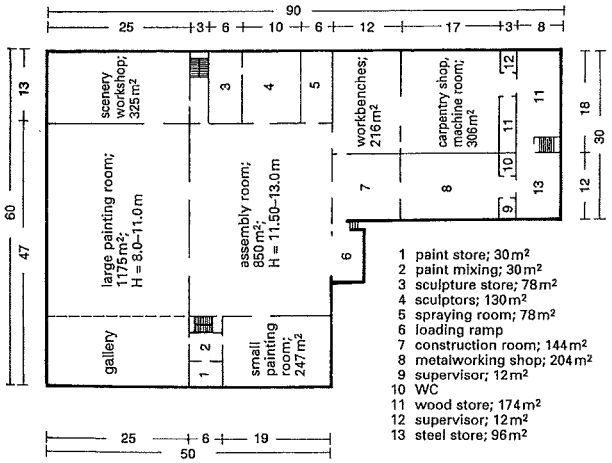
The storage area required for costumes is determined by the number of productions in the repertoire and the size of the ensemble, e.g. for opera: the chorus and ballet in addition to the singers. Space required for costumes: 1–12 cm/costume or 1–15 costumes per running m of rail → ❻ – ❼.



❻ Two-level hanging and storage of costumes in fixed clothing storage

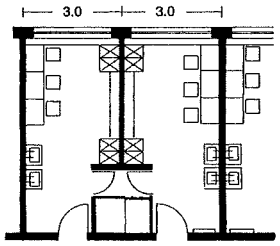


❼ Single-level → ❻

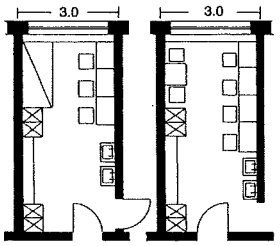


❶ Workshop building, ground floor

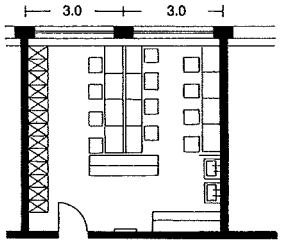
Arch. + Techn.: Biste u. Gerling



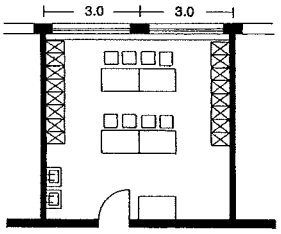
❷ Soloist dressing room ≧3.8–5 m²/person



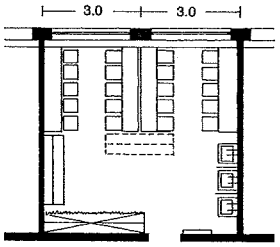
❸ Soloist dressing room ≧5 m²/person



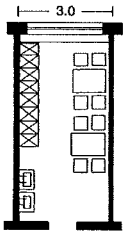
❹ Chorus dressing room ≧2.75 m²/person



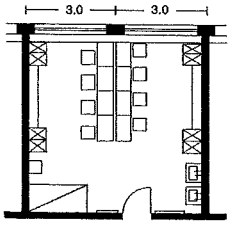
❺ Dressing and tuning-up room for orchestra players ≧2 m²/person



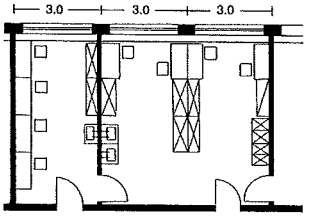
❻ Dressing room for additional chorus and/or extras ≧1.65 m²/person



❼ Changing and rest room for technical staff



❽ Dressing room for ballet group ≧4 m²/person



❾ Make-up room and work room for make-up artist

Workshops for production of scenery

The area required for scenery workshops is 4–5 times the main stage area for medium-sized theatres (theatres and multi-purpose theatres); in large opera houses or double theatres (opera and theatre), 10 times. Workshops, in or outside the building, should always be accommodated on one level. The Workplace Regulations and their technical rules and the work protection and accident prevention rules of insurers have to be taken into account in the design. In some cases, the company and collective agreements with the employees can also have an effect.

Scenery workshops are categorised as follows:

a) Painting room:

The floor area must be designed to accommodate two large backdrops or 'cycloramas' (Rundhorizonte – curved backdrops) rolled out on the floor for painting. The average size of a cyclorama is 10 × 36 m. It must be possible to sub-divide the room with a thick curtain for spraying work. Also required are underfloor heating to dry the painted backdrops; wooden floors for spreading out the canvases; a gallery from which to check the work lying on the floor. The painting room is located next to the sewing room (with a size about ¼ of the painting room) joining the pieces of material.

b) Carpenter's shop:

Divided into bench and machine rooms, it has wooden floors and an adjoining timber store for 3–10 productions.

c) Upholstery: approx. 1/10 area of painting room.

d) Metalwork: as carpenter's shop, screeded floor.

e) Sculpture workshop.

f) Workshops should be grouped round an assembly room, which serves to test-assemble the scenery and has the same floor area as the stage. The height should be proscenium plus 2 m, diameter 9–10 m.

g) Changing, washing, and rest (canteen) rooms are to be provided for technical staff, and offices for the technical management. Further workshops for sound, lighting, props and costumes, size as required (production intensity, personal equipment).

Personnel rooms

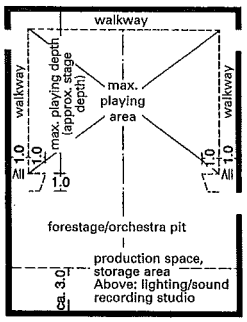
Artistic staff, stage manager, administration. Historically, personnel rooms were situated on both sides of the stage: left, ladies, right, gentlemen, although this was operationally impractical. Today, these rooms are located on one side, opposite the technical side on several floors. This includes make-up, frequently also the costume workshop, administration and stage manager.

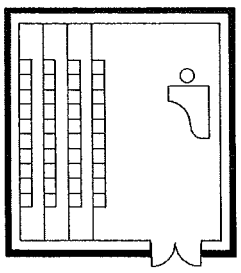
Dressing rooms: → ❷ – ❾ typical floor plans.

Visitors	**Sanitary facilities**
for 30–40 female visitors	1 WC, 1 washbasin
for 40–50 male visitors	1 WC, 2 urinals, 1 washbasin
for 1000 visitors	1 wheelchair WC, accessible
Theatre and opera performers incl. chorus, ballet and extras	
for 10 female performers	1 WC
for 15 male performers	1 WC, 2 urinals
for room for 1 soloist	1 washbasin
for dressing rooms for 2 soloists	1 washbasin, 1 shower
for the soloist dressing rooms[1] together	2 baths
for every 4 ballet, chorus member or extra[1]	2 washbasins, 1 shower
for the ballet[1]	2–4 foot washbasins
Staff of workshops etc.	
for 15 women	1 WC
for 20 men	1 WC, 2 urinals
for 4 people[1]	1 washbasin
for 5 people[1]	1 shower
for 10 people[1]	1 bath

The composition of the visitors is assumed to be 3/5 women and 2/5 men.
[1] The facilities are to be provided separately for women and men.

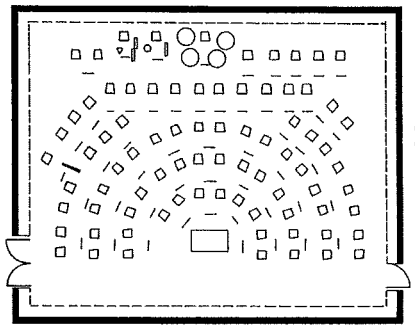
❿ Guidelines for sanitary facilities in theatres





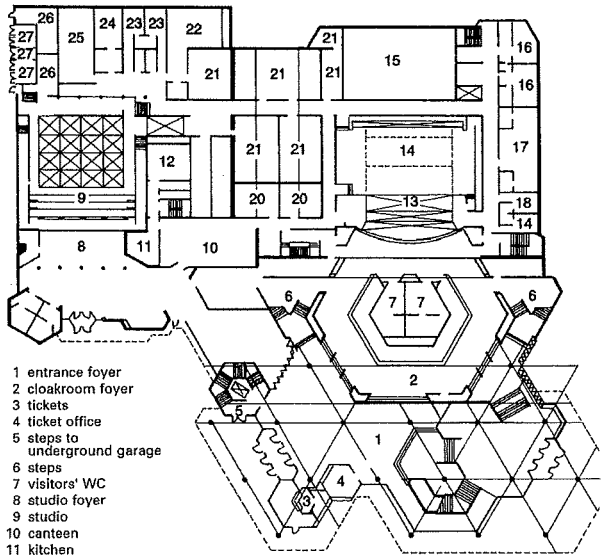
ca. 1.4 m²/singer, minimum 50 m²
ca. 7 m³/singer

❶ Large rehearsal stage, typical plan ❷ Chorus rehearsal room, typical plan



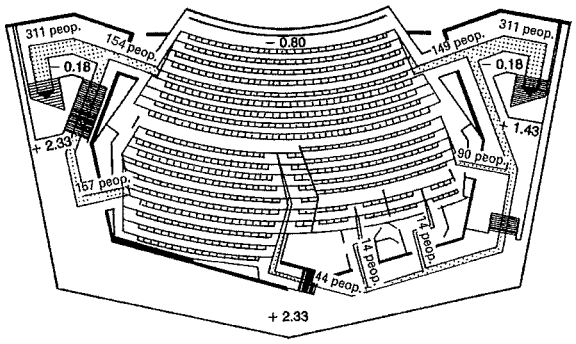
ca. 2.0–2.4 m²/musician
ca. 8.0–10 m³/musician

❸ Orchestra rehearsal room, typical plan



1 entrance foyer
2 cloakroom foyer
3 tickets
4 ticket office
5 steps to underground garage
6 steps
7 visitors' WC
8 studio foyer
9 studio
10 canteen
11 kitchen
12 kitchen store
13 orchestra pit
14 substage
15 rehearsal room
16 extras
17 choir
18 conductor
19 director
20 tuning room
21 stores
22 electrical shop
23 changing rooms
24 battery room
25 low-voltage switchroom
26 medium-voltage switchroom
27 transformer cells

❹ Entrance floor of Heilbronn City Theatre Arch.: Biste u. Gerling



❺ Evacuation plan, Trier City Theatre (626 seats) Arch.: G. Graubner and H. Schneider; stage technician: A. Zotzmann 1964

Rehearsal rooms

Every theatre needs at least one rehearsal stage to back up the main stage. For example, a small theatre: the main stage has the scenery of the current play and the rehearsals take place on the rehearsal stage. The dimensions should correspond to the main stage. Typical floor plan of the rehearsal stage of a traditional theatre → ❶. Multi-purpose theatres and opera houses also require: orchestra rehearsal room → ❸, chorus rehearsal room → ❷, soloist rehearsal room and ballet room.

Experimental theatres

These also require, in reduced form, staff and rehearsal rooms, workshops and stores, if in continual operation.

Technical rooms

Rooms for transformer, medium- and low-voltage switchgear, emergency power supply batteries, air conditioning and ventilation plant, water supply (rainwater system), according to local conditions and specialist design work.

Public rooms

The classical Italian opera had only narrow entrances and stairs, with no actual foyer. This makes the generous public rooms at the Grand Opéra in Paris particularly impressive. The Vienna theatre fire in 1881 led to extensive changes: the audience is now required to have enclosed emergency stairs for each tier. This requirement continues in principle today (Public Assembly Regulations).

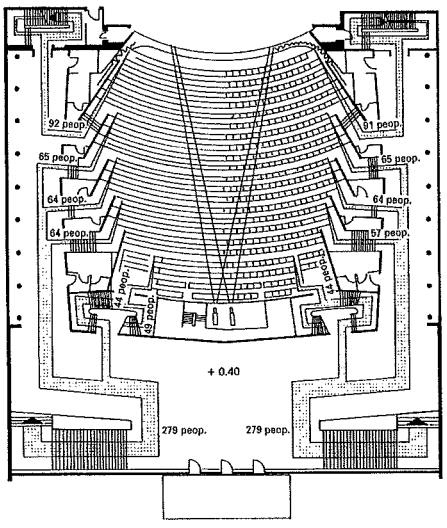
In the traditional theatre, the foyers are split into: actual foyer (lobby), restaurant (buffet), smoker's foyer. Area of the foyers 0.8–2.0 m²/spectator (more realistic is 0.6–0.8 m²/spectator). The function of the foyer has changed today: it must include provision for exhibitions, performances and regular plays there.

Cloakrooms

Per 100 visitors: 4 running m of rail. Sometimes lockers are also provided: one locker for every four visitors. The foyer is also a waiting and queuing room, and has the usual extent of associated WCs: one WC/100 people. 1/3 gents, 2/3 ladies; min. one gents' and one ladies' WC. Total number of sanitary facilities: → p. 216 ⓾. Entrance hall (lobby) with day and evening cash desks, which should be opposite each other.

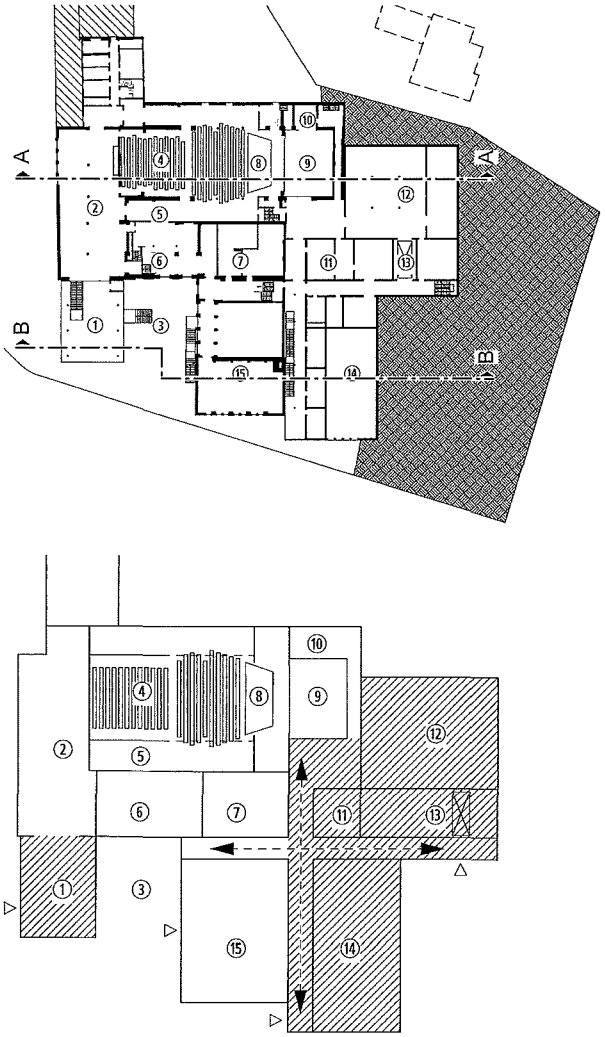
External access, emergency exits

According to local conditions → p. 211 ❸ – ❺ and Public Assembly Regulations.



❻ Evacuation plan, Lünen City Theatre (765 seats) Arch.: G. Graubner; stage technician: W. Ehle 1958

see also:
Location of building → p. 223 ❹ – ❺



1 Saxony State Theatre Radebeul, ground floor with new building hatched

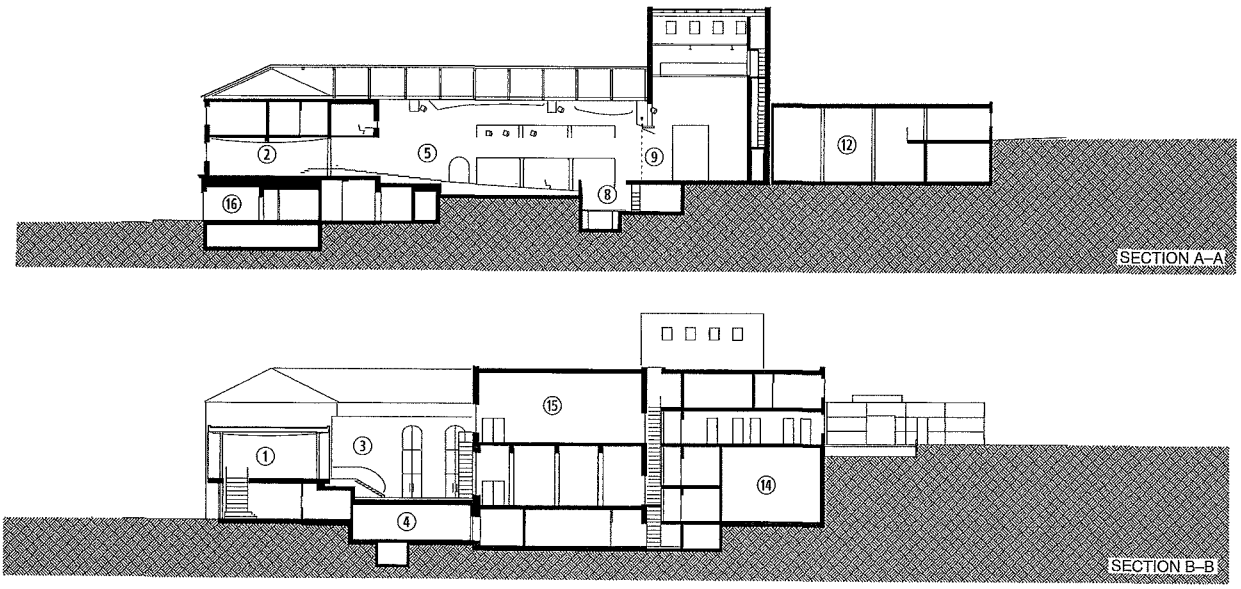
Saxony State Theatre, Radebeul
The home base of a renowned travelling theatre that covers the entire spectrum of a multi-purpose stage company (music, dance, theatre) consisted before rebuilding of a conglomeration of extensions and reconstructions at various times of a former hotel hall. The intention was to relieve the resulting functional and organisational problems and improve the external appearance.

The entrance for the audience was extended with a new two-storey foyer area of steel and glass, in which the cloakrooms, lobby and a snack bar could be integrated.

An extension of the storeroom and wings was possible only on one side because of the plot boundaries and the topographical situation, but the most functional possible connection of workshops, rehearsal rooms and props was still the intention. Another feature was the improvement of fire protection and workplace safety.

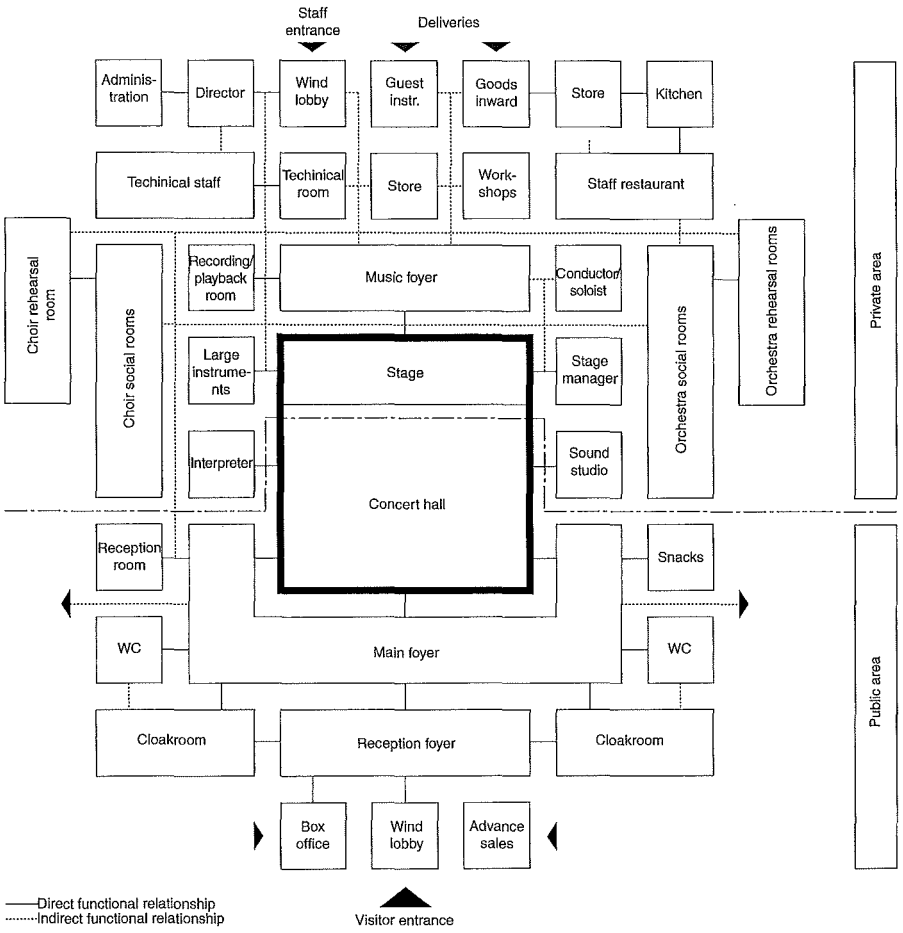
The existing stage equipment was only renewed and slightly extended. No elaborate solutions like lifting platforms or turntables were planned, in order that plays developed here can also be presented on simple stages on tour.

The extension of the existing building with new elements will still be possible after completion.



2 Saxony State Theatre Radebeul, sections

Arch.: meyer + bassin, Dresden



❶ Functional scheme of a concert building with one hall (Skoda → refs)

Concert houses

Intended for musical performances, but other uses are also possible (congresses, lectures etc.), can also if required be supplemented by chamber music hall, rehearsal hall, tuning and warming up rooms and stores. Hall sizes of 1500 and 2000 (in isolated cases 2800) seats in the audience have become usual, for chamber music 400 to 700 seats.

Block form
Rectangular plan
Pattern: redoubt, ballroom and dance hall
View is not optimal due to flat stalls
Polyfunctionally usable with level seating
Primary structure according to conditions, similar to the golden section enables a very good sound

Arena
Polygonal ground plan
Pattern: amphitheatre
Orchestra area is completely surrounded by audience
Optimal viewing conditions, communicative effect
Good direct sound transfer
Optimal acoustics are possible, but expensive to create

Horseshoe form
Horseshoe-shaped plan
Pattern: box theatre
Good view, good direct sound transfer
Sufficient short reflections, few complex reflections
Little space and good sound transparency

Circle/arc form
Fan-shaped plan
Good view, good direct sound transfer
Acoustic disadvantages due to fan-shaped opening of hall
Optimal acoustics are possible, but expensive to create

Acoustic multi-purpose rooms

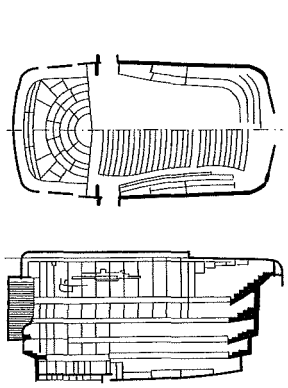
Churches were the first form of concert hall, with strong reverberation. The echo increases the holiness of the place, but domes and vaults are problematic for sermons and orchestral music.

The first theatres and opera houses were stages and auditoriums installed into existing halls. There was good understanding of speech due to the open view and short distance to the stage, but insufficient reverberation due to decoration with soft materials and surfaces with little reflection of sound.

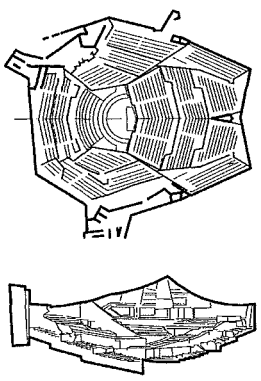
In a tiered theatre, the stalls are surrounded on three sides by tiers, generally leading to short reverberation times, as empty wall surfaces are obstructed by boxes and galleries and are full of people. This is advantageous for the understanding of speech but music sounds rather dull and toneless.

Concert halls

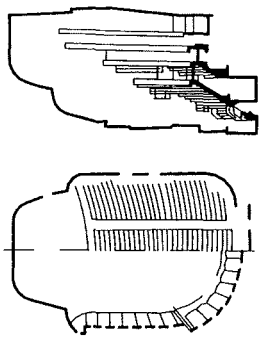
Today four types of concert hall are common (possibly modified): block, arena, fan and horseshoe → ❷ – ❺. The selection of hall type depends on the urban planning situation, intended space and acoustic requirements.



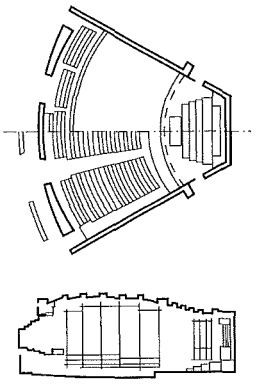
❷ Block form: Lucerne Concert Hall, 1995–98 Arch.: Jean Nouvel



❸ Arena form: Philharmonie Berlin, 1960–63 Arch.: Hans Scharoun



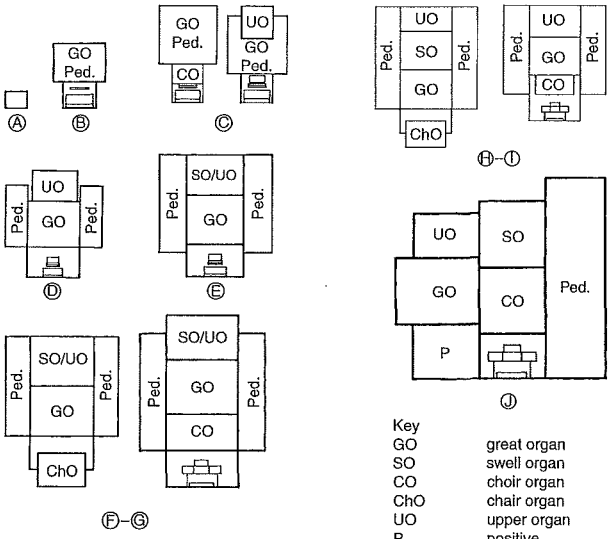
❹ Horseshoe form: Carnegie Hall, New York, 1888–91 Arch.: W.B. Tuthill



❺ Fan shape: Brucknerhaus Linz, 1969–73 Arch.: Heikki Siren

CONCERT HALLS

Technical Requirements, Organ, Orchestra



Key

GO	great organ
SO	swell organ
CO	choir organ
ChO	chair organ
UO	upper organ
P	positive
Ped	pedal organ

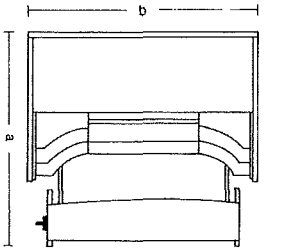
❶ Sizes and forms of organs

Type	Size	Registers	Height (m)	Width (m)	Depth (m)
A	chest	3–7	0.6–0.8	1.0–1.2	0.7–1.2
B	positive	8–12	2.5–3	1.6–2.5	0.8–1.6
C	small organ	12.20	4–6	3–3.5	1.2–1.8
D	II manuals	20–30	6–7	5.5–6.5	1.2–2
E	II manuals	25–35	6.5–9	4.5–7	1.5–2.5
F–G	III manuals	30–60	7.5–10	7–9	2–3
H–I	IV–V manuals	60–100	9–13	8–12	2–4

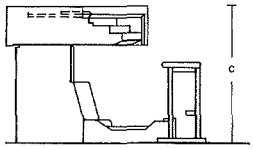
❷ Organ types and sizes (housing)

Register number = room volume in $m^2/300$ + number seats/50

❸ Formula to determine the number of registers (according to Walcker)

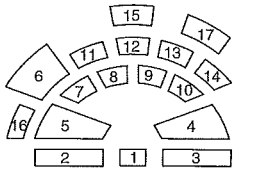


a = Width including filing
b = Deep including bank
c = Height without music stand

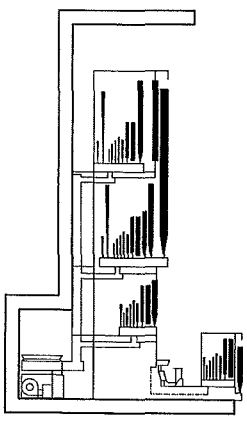


	2 Manuals	3 Manuals	4 Manuals
a	180	200	220
b	150	160	170
c	110	120	130

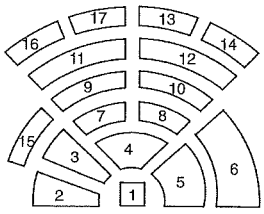
❹ Free-standing console and its dimensions



❻ German seating arrangement



❺ Organ with IV manuals (section)



❼ American seating arrangement

1. Conductor
2. 1st violins
3. 2nd violins
4. Violas
5. Cellos
6. Basses
7. Flutes
8. Oboes
9. Clarinets
10. Bassoon
11. Trumpets
12. Horns
13. Trombones
14. Tubas
15. Harps
16. Percussion
17. Kettle-drums

There is little stage equipment: elements of floor structure in the area for the orchestra, adjustable wall and ceiling fixtures, transport aids, loudspeakers and lighting equipment.

Lifts to extend/reduce the stage

Large concert halls have special compartmentalised systems in the orchestra area to make various orchestra configurations possible, enlarge the stage area or maximise the number of seats in the hall by placing seating units on lifts. There is also transport of items between basement and stage, electrical spindle drive with limited lift and low raising speed.

Mobile seating units

The lifting platforms can be lowered to allow a smaller stage and the positioning of additional seating, which can be in the form of mobile units.

Orchestra stage

Modular system with flexible stage options for music groups. Transport and storage is on storage wagons in the store room. The floor covering matches the concert platform.

Choir platforms

Additional to the choir seats, when extra space is required, large seating platforms are rolled onto the stage and mounted in front of the fixed choir seating; the seating in both types is identical. Access is via detachable balcony elements in the choir seating area or up temporary stairs on the choir platform.

Mixing desk

Area consisting of three rows in the auditorium stalls; can be quickly adapted for the most varied performance and conference conditions.
A motorised platform under the stalls can be occupied in various ways: mobile seating unit, mobile mixing desk, or empty (e.g. if guest musicians bring their own mixing desk).

Cyclorama scaffold

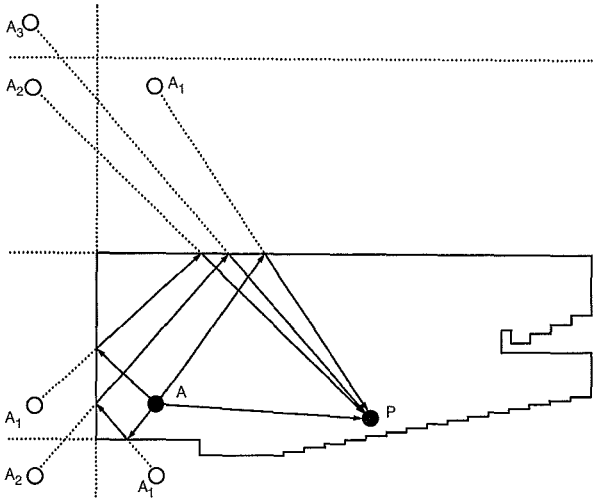
Motorised tubular scaffold, used to fix curtains and banners, portable stage lighting and other production elements at the rear of the stage, and can if required be partially or completely dismantled.

Organ built into the concert hall

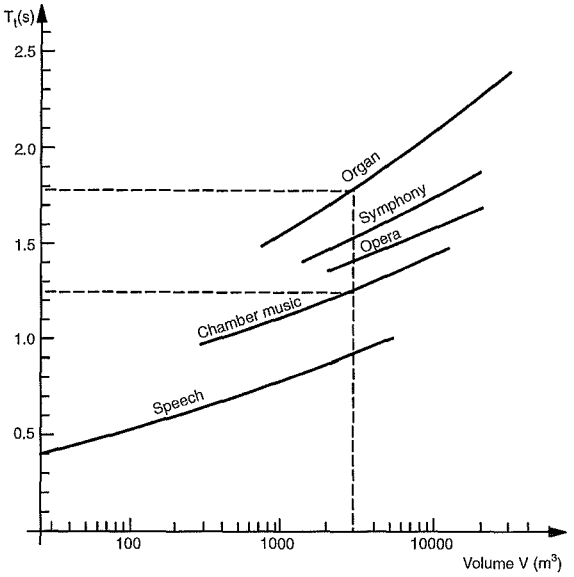
There is no fixed standard for the layout, with organs being designed musically and architecturally for each individual space; it is an important visual eye-catcher. The location of the organ should be at the back of the stage, with a location in front of the back wall being ideal, free-standing and not in a niche.
The size depends on the volume of the hall, acoustics, position in the room, number of seats, musical requirements (solo or accompanist instrument). The better the acoustics and the location of the organ, the smaller can it be → ❶ – ❸.
To the depth of the organ housing should be added: 1–2 m for the organist and min. 0.5 m for tuning access behind the organ, min. 1.5 m free space necessary above the organ → ❸ – ❹.
In concert halls, a second organ platform is necessary (electric, mobile); this is placed near the orchestra, so the organist becomes part of the orchestra. The dimensions depend on the size of the organ → ❹ + ❺. Necessary cable connections should be provided.

Orchestra sizes and layouts

The various orchestra seating layouts, formerly German and today mostly American, are important for the sound in the hall → ❻ – ❼.
The following sizes of orchestra are usual today in Europe and North America: large symphony orchestra with 60–150 musicians and chamber orchestra with 25–40 musicians; this determines the additional space requirement on the stage (e.g. Gewandhaus Leipzig, approx. 180 m^2).



❶ Sound waves and sources of reflected sound in an auditorium. A = sound source A1 = source of first order reflected sound etc. (Kuttruff → refs)



❷ Relationship of reverberation, hall volume and music type (Hall → refs)

The most important objective in designing a concert hall is a superb sound. Acoustics result from the interaction of various elements: size, volume and proportions of the concert space, number and arrangement of the seats, materials used, surfaces and finishes.

The sound properties of various instruments and the human (singing) voice have to be taken into account, alone and together, and also differences in pitch range and character (volume, frequency distribution and time structure of a sound). The various layouts of the orchestra are of significance for the sound in the hall: the positioning of various groups of instruments (particularly the string section).

For the effect of the instruments in the hall, the relationship of the sound travelling directly to the listener to the early reflection from the sides plays a decisive role → ❶.

Optimal reverberation is important for the quality of hearing: excessive reverberation reduces clarity, and too little reverberation makes music sound dull. It is dependent on air changes/person (older concert halls 4–5 m^3/seat, newer over 6–15 m^3/seat).

The acoustics are influenced by hall size, shape and (surface) material used; these can be adapted for different acoustic requirements through the selection of various materials. The following variants are possible and usual:

Acoustic reflector
Installed over the stage, this is an adjustable, wide, heavy, sound-reflecting surface consisting of two or three independent sections; each section must be 2–3 m above the stage and adjustable up to 2 m under the ceiling. The height and position of reflectors is determined by the type of concert: smaller concerts, light chamber music and concerts with string instruments require a lower height for the reflectors.

Sound-absorbing curtains and banners
These influence the length and strength of the reverberation (lowered by widening the curtains). If not required, the curtains are retracted into curtain niches (and must then be without effect).

Acoustic regulation spaces (promenades)
Additional volume can be gained for works with long reverberation (those for organ, large orchestras and large choirs, as well as with acoustic amplification) through the extension of the auditorium. Access passages and foyer areas can be used for this. They can be opened into the hall with movable panels using central control.

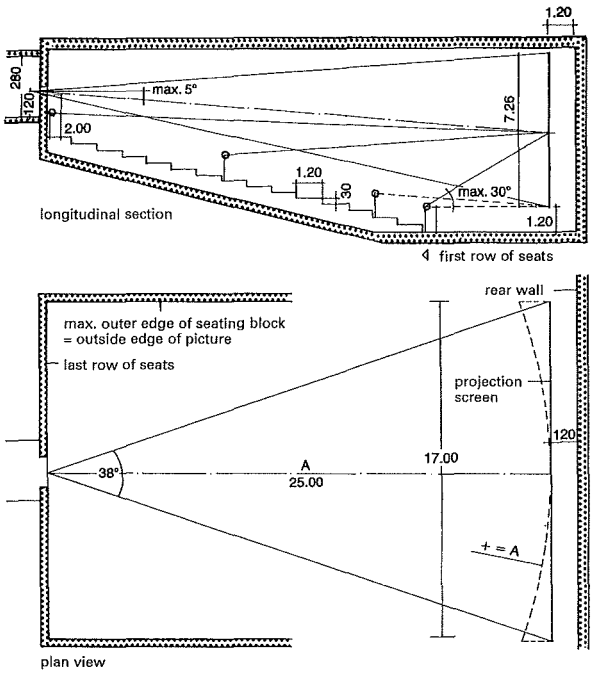
The reflection characteristics of various materials are of great importance for the acoustic design. Hard surfaces are preferable to achieve long reverberation. The seats should also be provided with surfaces of hard material. Upholstering of seats can achieve uniformity of reverberation, even with different numbers in the audience.

❸ Degree of sound absorption (alpha) of various surfaces (Hall → refs)

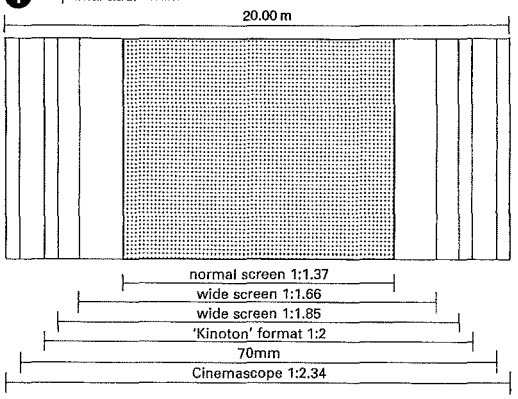
Frequency (Hz)	125	250	500	1000	2000	4000
acoustic board, suspended hard	0.2	0.4	0.7	0.8	0.6	0.4
acoustic board, suspended in frame	0.5	0.7	0.6	0.7	0.7	0.5
acoustic rough plaster	0.1	0.2	0.5	0.6	0.7	0.7
normal plaster on laths	0.2	0.15	0.1	0.05	0.04	0.05
plasterboard 16 mm on squared timber	0.3	0.1	0.05	0.04	0.07	0.1
plywood 8 mm on squared timber	0.6	0.3	0.1	0.1	0.1	0.1
artificial stone, untreated surface	0.4	0.4	0.3	0.3	0.4	0.3
painted concrete	0.1	0.05	0.06	0.07	0.1	0.1
fair-faced concrete	0.01	0.01	0.02	0.02	0.02	0.03
brick	0.03	0.03	0.03	0.04	0.05	0.07
heavy carpet on concrete	0.02	0.06	0.15	0.4	0.6	0.6
heavy carpet with felt underlay	0.1	0.3	0.4	0.5	0.6	0.7
stage flooring, wood	0.4	0.3	0.2	0.2	0.15	0.1
window glass	0.3	0.2	0.2	0.1	0.07	0.04
wall hanging, medium velour	0.07	0.3	0.5	0.7	0.7	0.6
upholstered seats, occupied	0.4	0.6	0.8	0.9	0.9	0.9
upholstered seats, unoccupied	0.2	0.4	0.6	0.7	0.6	0.6
wooden or metal seats, unoccupied	0.02	0.03	0.03	0.06	0.06	0.05

CINEMAS

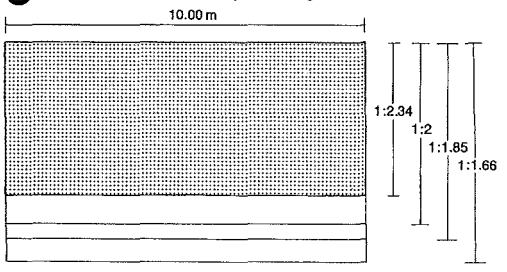
Projection



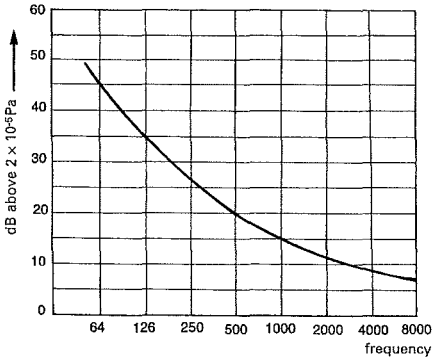
❶ Optimal auditorium



❷ Picture formats with same picture height



❸ Picture formats with same picture width



❹ Permissible disturbance level

Before embarking on the design of a cinema, ask the advice of a cinema equipment company.

Picture projection: Fire-separation materials are no longer required in the projection room due to the use of safety film. One projectionist operates a number of projectors, so the projection room is no longer considered as continuously occupied by staff. It has 1 m spacing from the projector at the back and on the operator side, 2.80 m height, ventilation and extraction, and sound insulation to the auditorium. The projection rooms of several auditoriums can be combined together.

Film widths are 16 mm, 35 mm and 70 mm. The centre of the projection beam should not deviate more than 5° horizontally and vertically from the centre of the screen or it should be redirected by a deflection mirror → ❶.

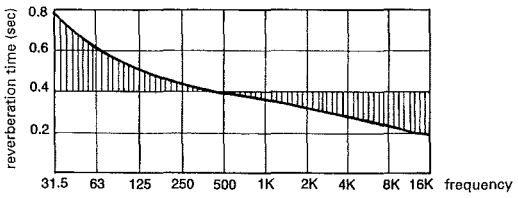
Conventionally, two projectors are operated with cross-blending. Automated operation with one projector plus horizontal film tray showing 4000 m reels without pause has become established worldwide, in many projection rooms remotely run from projection and control points. The film gives automatic signals for all projection functions like lens changing, hall lighting, stage lighting, curtain and picture covering.

Picture sizes: These depend on the distance of the projector from the screen and having a height-side relationship of 1:2.34 (Cinemascope) or 1:1.66 (wide screen) with a narrow auditorium width. The angle from the centre of the back row of seating to the outer edge of the picture should not exceed, for Cinemascope, 38° = distance of the back row : screen = 3:2 → ❷ – ❸.

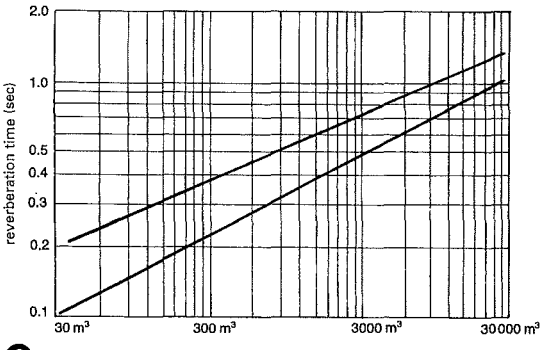
Screen: Distance of the screen from the wall with BTX (→ p. 223) is min. 120 cm; according to cinema size and system this can be reduced to 50 cm on the setting up of the sound system.

The screen is perforated (sound-permeable). Retracting blinds or curtains restrict the screen at the sides with the same picture height. Large screens are curved in a radius centred on the back row of seats. The lower edge of the screen should be min. 1.20 m above the floor → ❶.

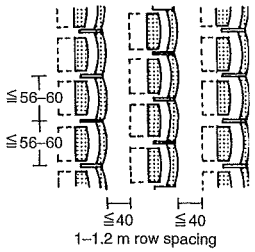
Auditorium: This should receive no incoming light except for emergency lighting. The walls and ceilings should be of non-reflecting material in relatively dark colours. The audience should sit within the outer edge of the screen. The viewing angle from the first row of seats to the centre of the picture should not exceed 30°.



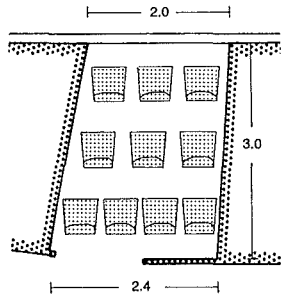
❺ Permissible reverberation time depending on frequency



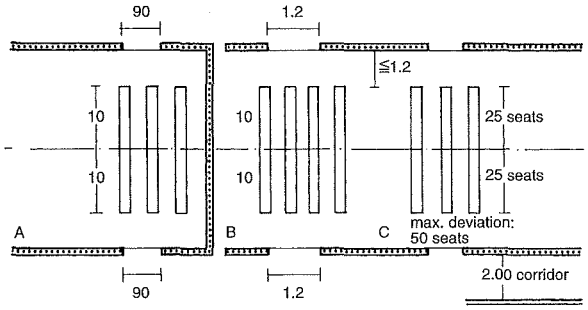
❻ Reverberation time relative to auditorium volume



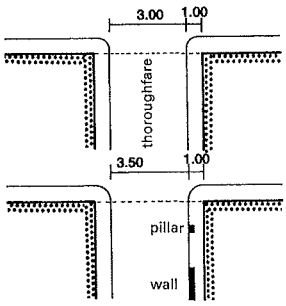
❶ Spacing and rows of seats. Cinema seats are normally larger than the minimum dimensions stipulated by the Public Assembly Regulations.



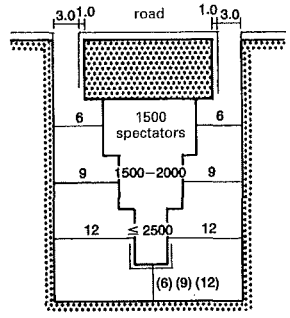
❷ Boxes may have ≧20 loose chairs; ≧0.65 m² floor area for each person



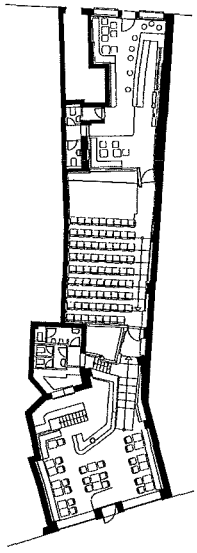
❸ Seating – A: for auditorium ≦200 people; B: ≧200 people; C: 50 seats, if there is a door at the side for every four rows



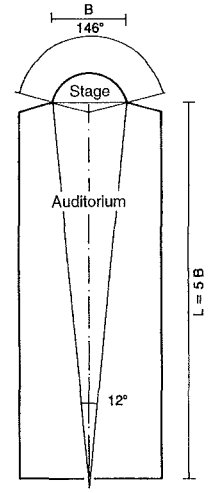
❹ Access roads and through roads



❺ Distance of the building from the plot boundaries depending on number of visitors



❻ Zazie 'programme cinema' with café and bar, Halle (Saale)
Arch.: Complizen.com



❼ Auditorium for flat films

Up to a 10% floor gradient is permissible, or else steps with max. 16 cm risers and aisles of 1.20 m width → ❶. Up to 10 seats may be arranged on each side of each aisle → ❸.

Acoustics

Adjacent auditoriums should be separated by walls of approx. 85 dB 18–20 000 Hz → p. 222 ❹. The ceiling should feature sound-directing surfaces with low acoustic delay difference time.

The reverberation time can increase with growing auditorium volume and reduces from 0.8 to 0.2 s from low to high frequencies. → p. 222. The rear wall behind the last row of seats should have an insulated surface to prevent echo.

Loudspeakers are distributed in the auditorium so that the difference in volume between the front and back rows does not exceed 4 dB.

Sound reproduction

In addition to mono optical sound reproduction, the Dolby stereo optical system with four channels will be required in the future, using three loudspeaker combinations behind the screen and additional speakers at the sides and back. For 70 mm film, 6 channel magnetic sound, there are additional speaker combinations behind the screen. With BTX, behind the screen there is a sound-absorbing wall (following the Lucas film system), in which the loudspeaker combinations are installed.

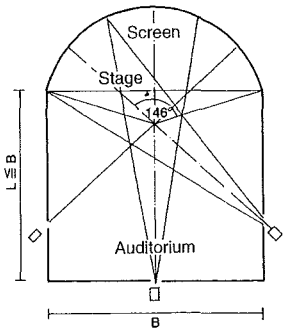
Cash desks

Predominantly electronic booking and reservation systems: 1 cash desk per 300–400 seats, requiring approx. 5 m².

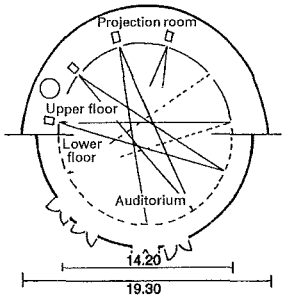
Types of cinema

'Programme cinemas': As a counter-trend to multiplex cinemas → p. 224, city centres have seen the establishment of 'programme cinemas', which mostly show specialist films. Sizes of 50–200 seats are usual, normally in combination with eating/drinking facilities → ❻.

Circarama/Panorama cinemas: Round or spherical screens increase the impression of being directly involved in the action. Because special film techniques are required for these (a number of cameras have to film the same view simultaneously), there are only a few films available, and this type of cinema is therefore restricted to adventure parks and planetariums → ❽ – ❾.



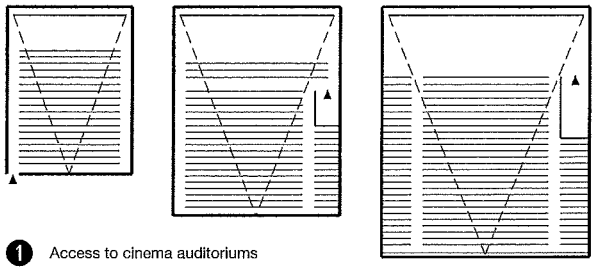
❽ Auditorium for panoramic films



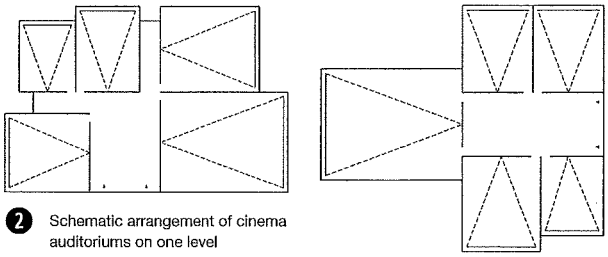
❾ Circarama. Picture surface spherical (360°), on which a consolidated picture from 11 simultaneously running projectors can be shown. Example: Brussels Expo

CINEMAS

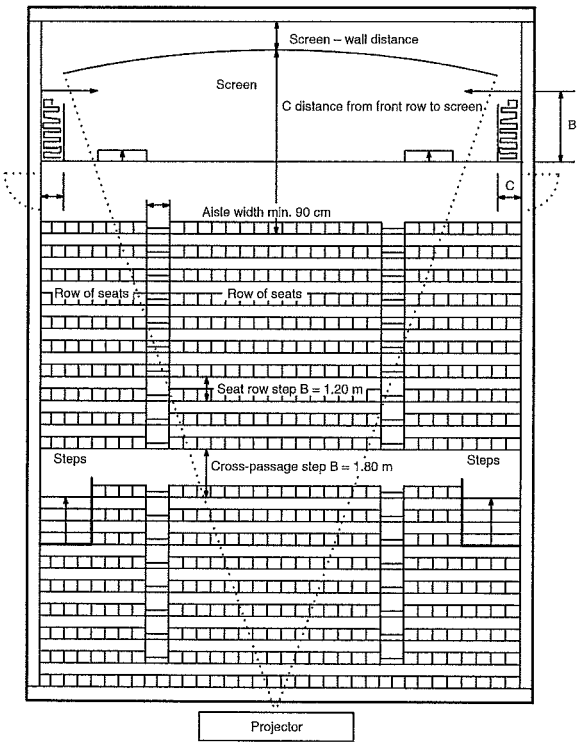
Multiplex Cinemas



1 Access to cinema auditoriums

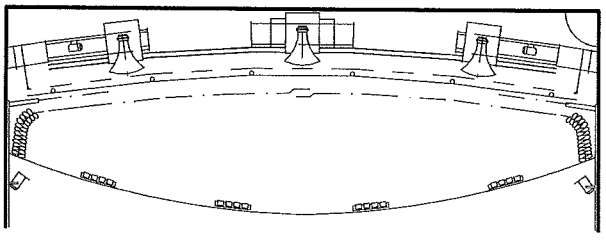


2 Schematic arrangement of cinema auditoriums on one level



Hall proportions: 1.1.3 – 1.4:0.5 (W x D x H) Screen distance A = 1.20 – 1.50 m
Curtain storage space B: each side approx. 10% of the screen width
Distance C (head front row – screen): approx. 75% of the clear room height
Width of curtain pocket: approx. 40 cm
Screen curvature: circular arc (centre projector), from about 500 seats
Top of screen: about 0.30 m below ceiling, bottom of screen: about 0.80 m above FFL
Height of screen: results from the values given above
Width of screen: screen height x 2.35 (largest format: Cinemascope)
Clear ceiling height above the back row: min. 2.30 m

3 Generalised ground floor plan of a larger auditorium with technical dimensions



4 Wide screen projection equipment

With a number of screens of various sizes in one building, multiplex cinemas are often combined with shopping centres, car parks etc, which require extensive parking space → p. 225. The auditoriums are reached via a common entrance and sometimes stacked. On account of the large numbers of visitors, good orientation and clear signing to the individual screens is important. The location of the screens in relation to the entrance foyer should be according to their size (large screens nearest to the foyer), or the largest screen in a central location/on the direct route from the foyer. The sizes of the single auditoriums depend on the requirements of the operator, as also the spacing of the rows, foyer design etc.

The cash desk zone should be near the entrance, the number of desks dependent on the number of seats: approx. 5 m^2 floor area/ cash desk; for 2500 seats, approx. 6–8 cash desks.

The entrance foyer should be of generous proportions, clearly laid out and at a prominent location in the building; it includes the main entrance, food/drink counters and access to the screens. Before the access points to the individual screens on different floors, there are normally additional foyers with bar counters, WCs etc. The main foyer should be of adequate size for events (premières, presentations etc.).

Because eating and drinking are normally a significant part of the cinema concept, counters should be provided in central locations with the necessary storage and service facilities.

Cinema auditorium

The screen should fill the entire wall; there should be no exits in this wall or the side walls near to it. Cross-passages should be provided as a connection between the doors or at a side entrance to reach the side aisles → p. 235.

Projection room

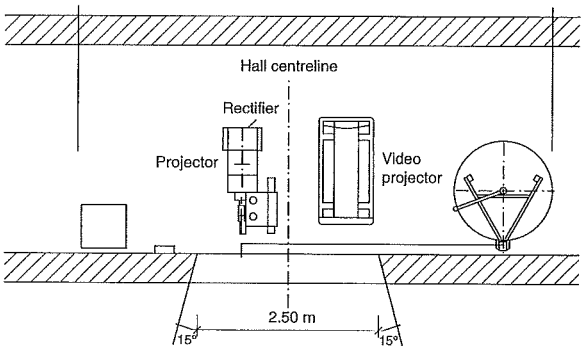
Minimum room size: 6.50 x 2.80 x 2.80 m (W x D x H). Projection window size approx. 150/250 x 50 cm (one or two projectors) Film can be supplemented by video projectors, and space should also be provided for horizontal film tray equipment and control desk.

The platform under the projectors should be vibration-free. A noise level of approx. 75 dB must be damped to 30 dB by the projection window. The working temperature should not exceed 22°C in order to protect film copies and equipment.

Subsidiary rooms

These are to be provided as required: offices for the manager, secretary and employees, archive, IT room, staff rooms (changing rooms, ladies' and gents' WCs, staff rest room).

For the foyer and food/drink area: catering stores, counter stores, cool room, room for empties, rubbish room, cleaning equipment room, stores for cleaning firm and decoration.

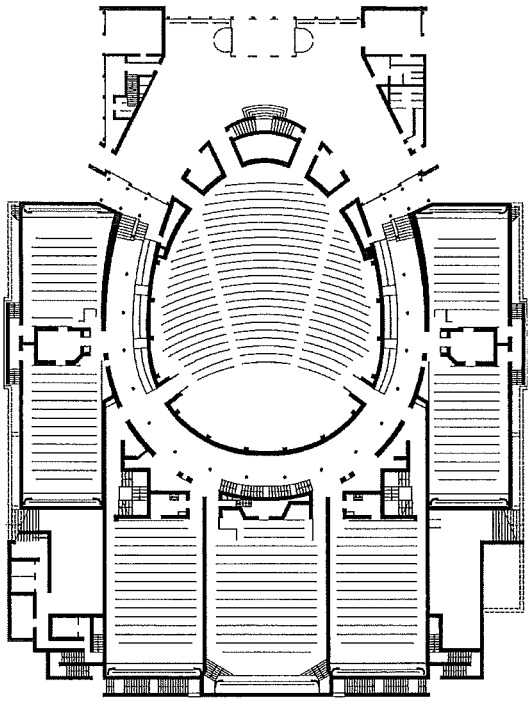


5 Projection room

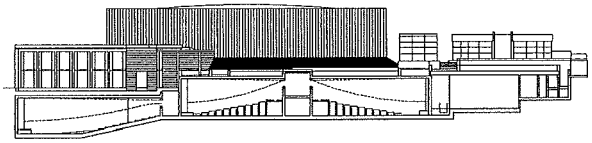
CINEMAS

Multiplex Cinemas, Examples

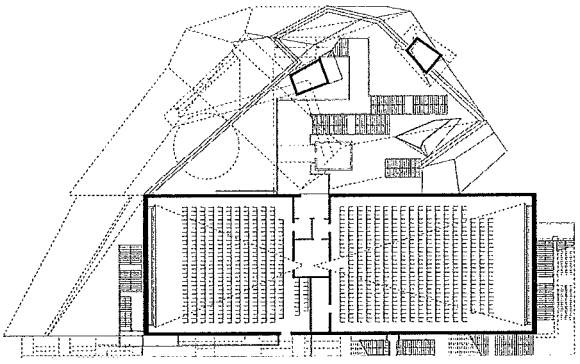
The town-planning situation plays a significant role in the number of cinema screens that can be combined into a unit. Possible forms are layered stacking (screens stacked as a cube, access and service functions connected in free form at the side) → ❸ – ❹, or a horizontal row of screens (larger cinemas from the 1960s were extended with further screens, sunk into the ground for conservation reasons) → ❶ – ❷ or combination forms. A common form is the combination with other functions like shopping centres and car parks, with sales areas on the ground floor, cinema screens and parking on the first floor: a prominent urban landmark in conjunction with two high-rise point buildings → ❺ – ❼.



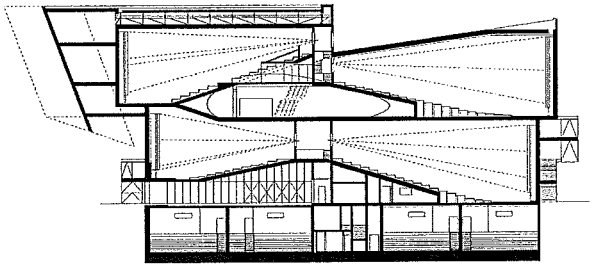
❶ Kosmos cinema, Berlin, plan Arch.: Rohde Kellermann Wawrowsky



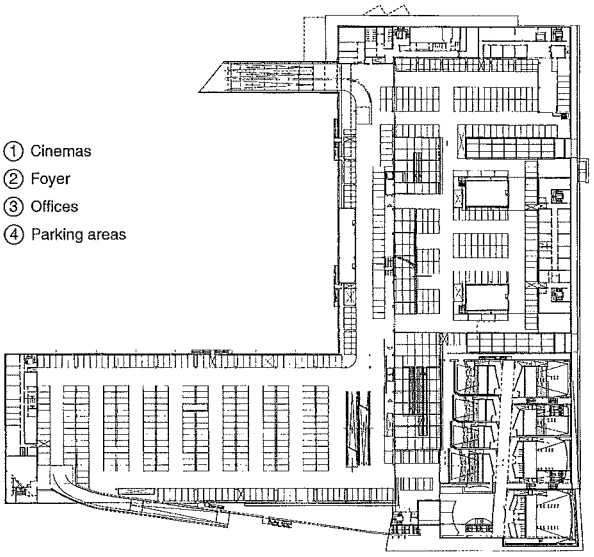
❷ Kosmos cinema, Berlin, elevation/section Arch.: Rohde Kellermann Wawrowsky



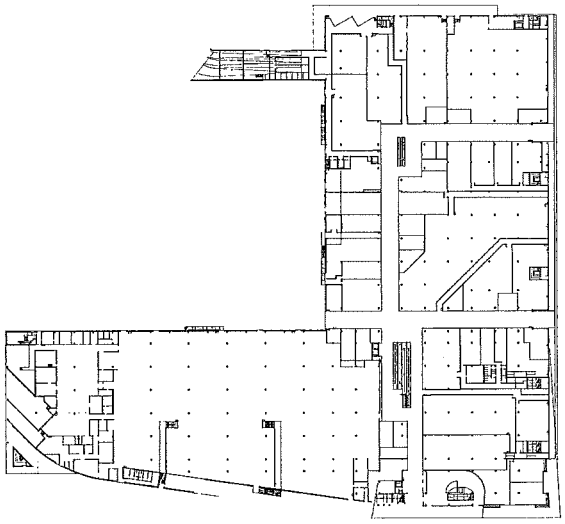
❸ Filmpalast Dresden, plan Arch.: Coop Himmelb(l)au



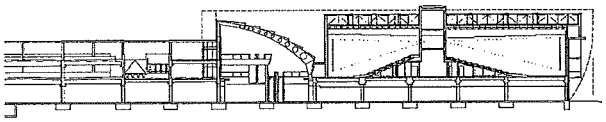
❹ Filmpalast Dresden, view/section Arch.: Coop Himmelb(l)au



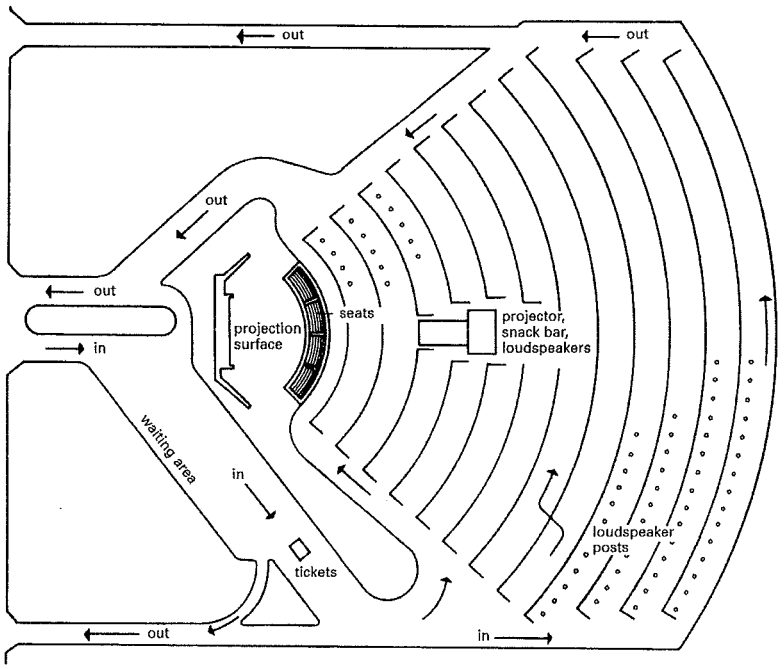
❺ Neustadt Centrum Halle, first floor plan (cinema level 1)
Arch.: Hermann & Valentiny with Noack und Partner



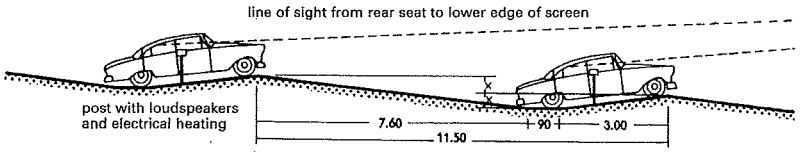
❻ Neustadt Centrum Halle, ground floor plan (shopping level)
Arch.: Hermann & Valentiny with Noack und Partner



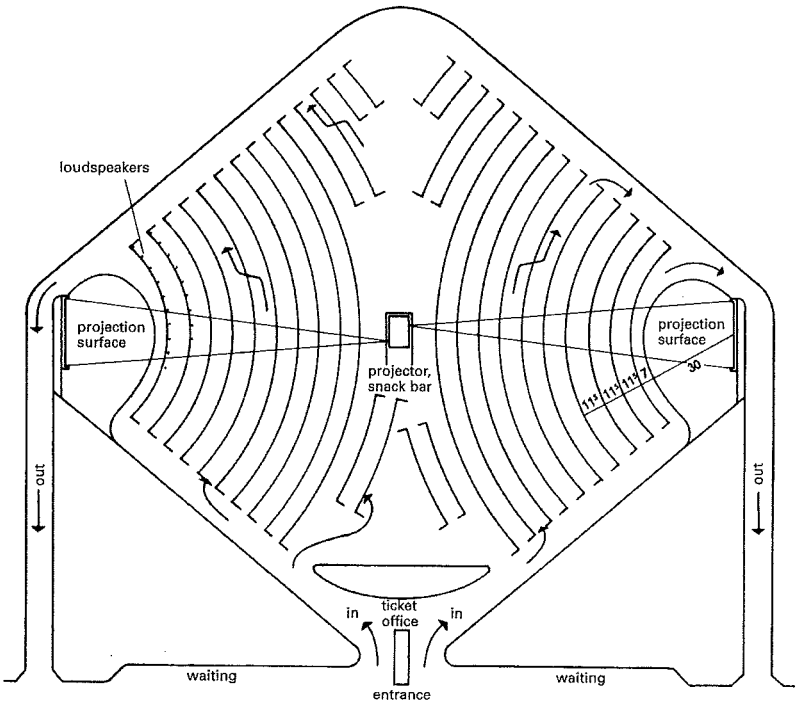
❼ Neustadt Centrum Halle, section
Arch.: Hermann & Valentiny with Noack und Partner



1 Drive-in cinema in a fan shape with inclined ramps and low projection cabin, which only takes up two rows



2 Ramp arrangement and dimensions: elevations can be different according to screen picture height



3 Double cinema. One projection room for both screens, with the possibility of staggered starting times. All other areas (cash desks, bar, toilets etc.) are common

CINEMAS

Drive-in Cinemas

Drive-in cinemas, where the audience do not have to leave their cars.

The size is limited by ramps, number of cars ≦1000–1300, while still ensuring a good view. Normal is 450–500 cars → ❶.

Cars	No. ramps	Screen to back edge of ramp (m)
500	10	155
586	11	170
670	12	180
778	13	195
886	14	210
1000	15	225

Location: on the motorway, near petrol stations and services, with screening so that light and sound do not distract passing traffic.

Ramps are curved and sloping in order to lift the front of the cars, so back seat passengers also have a good view of the screen → ❷.

Entrance road: with waiting area, in order to avoid backing up of traffic on the road. Drive-past ticket counter, so that tickets from the cars can be checked → ❸.

Exit: ideally after leaving the ramp forwards.

Detailing of the entire area to avoid dust and skidding in wet weather.

Ticket counter: one counter for 300 cars; two for 600; three for 800; four for 1000.

Screen: depends on the number of cars: for 650 cars 14.50 × 11.30 m; for 950 cars 17.0 × 13.0 m. Ideally facing east or north, which enables earlier performances. For the Central European latitude, the screen is better installed in a solid, permanent structure.

Cinema screen in the Billbrook drive-in cinema near Hamburg: 36 m high × 15.5 m wide. Height above ground level depends on ramp gradient and sight angle. Screen tilted upward avoids distortion. Scaffolding and screen must be able to bear wind loading.

Rows of seats should be provided, and a play area for children is also a good idea.

Projection building: mostly central, at a distance of 100 m from the screen.

Projection room contains projectors, generators, sound amplification system.

Sound reproduction ideally has loudspeakers inside the cars; the loudspeakers are attached to a post for every two cars at 5.0 m separation and are attached inside the cars by the visitors.

Heating: on loudspeaker posts, possibly also a connection for heating in the cars.

CIRCUS

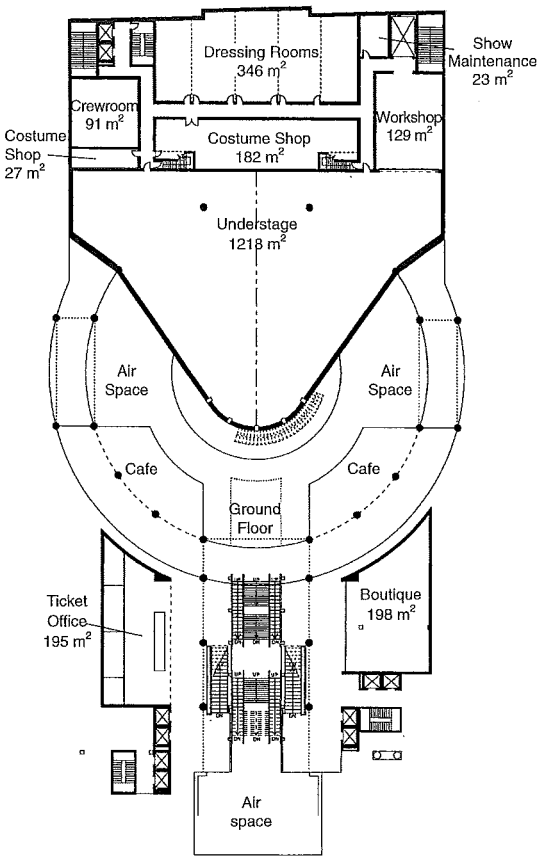
Stationary

Show theatre, permanent venue

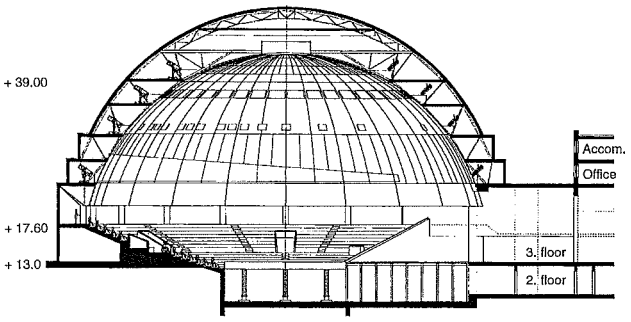
Amphitheatre-type hall, laid out as three quarters of a circle, offering seats for an audience of 1600. The last quarter is intended for the stage, which consists of five stacked lifting platforms. This enables the stage sets to be changed very quickly → ❸.

Access to the hall on the third floor + 13.00 m above road level. A 27 m high reinforced concrete dome spans the circus arena.

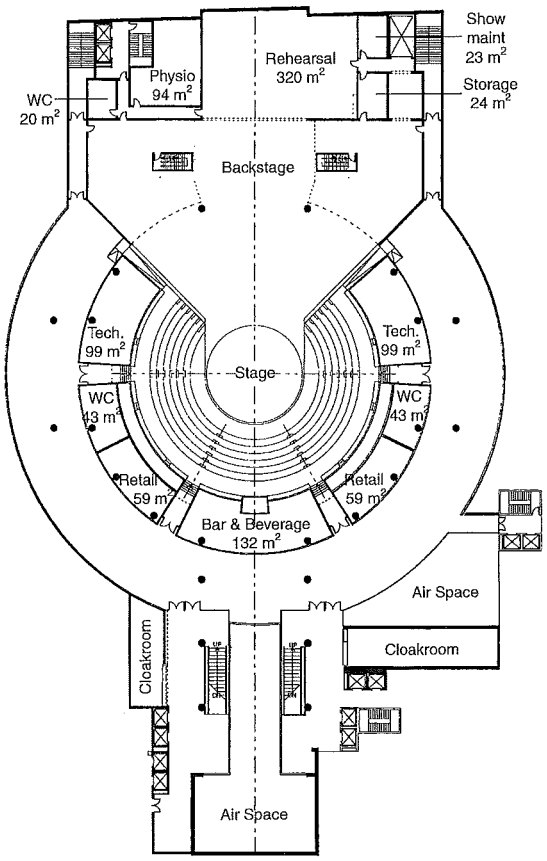
Project: Berlin Leipziger Platz
Arch.: Aldo Rossi Milan
Planungs AG Neufert/Mittmann/Graf, Berlin
Sceno-Plus Experts-Conseils, Montreal



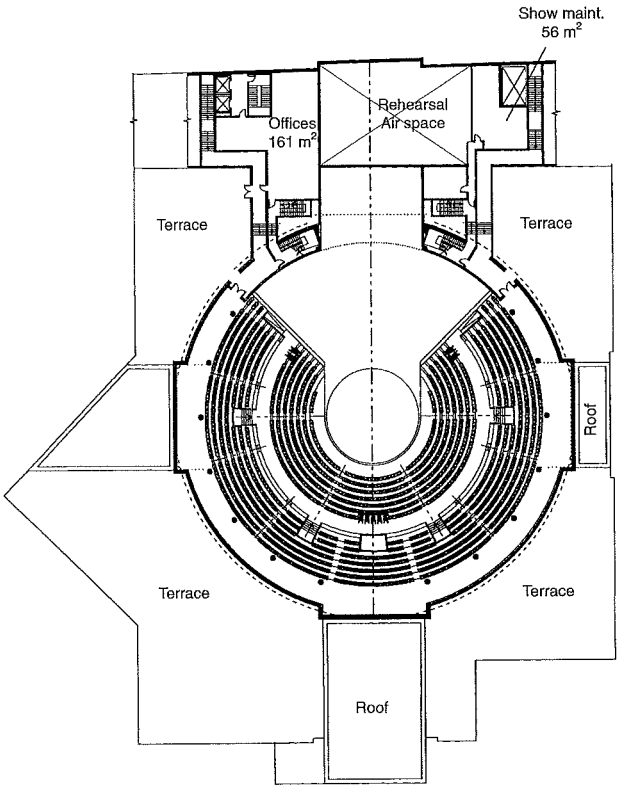
❶ Second floor + 9.00 m (underfloor theatre)



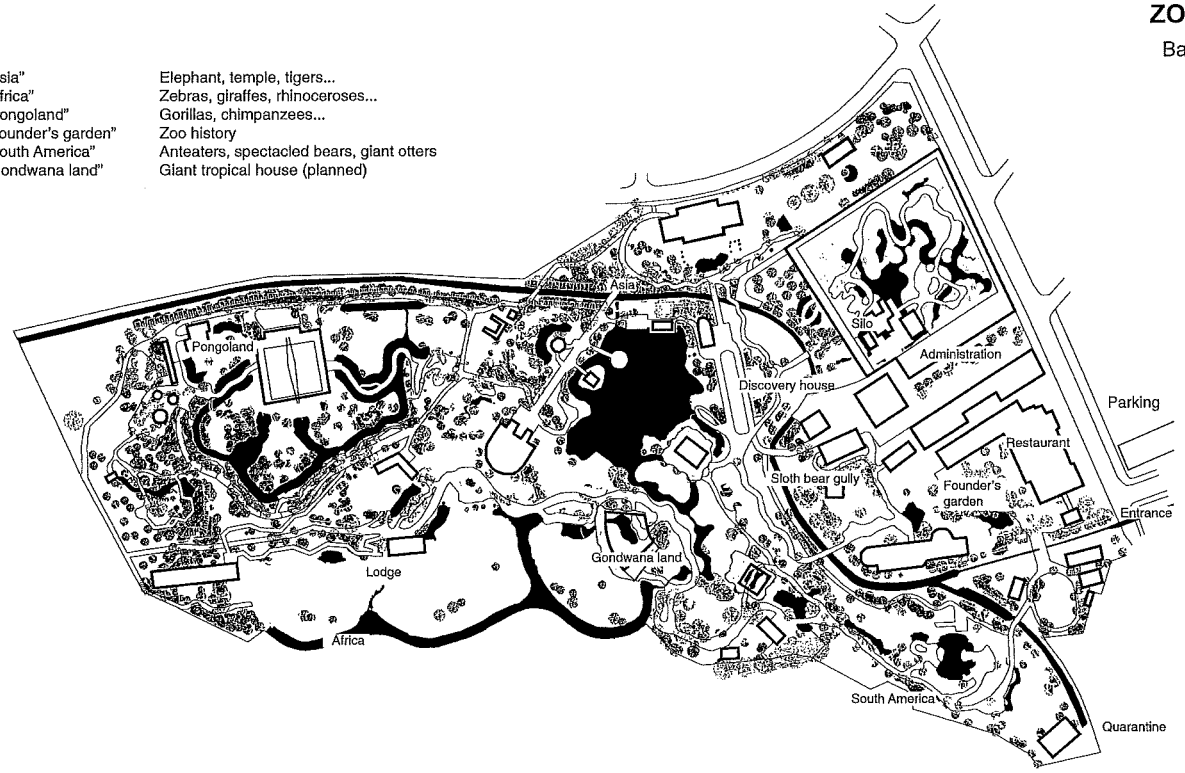
❸ Section



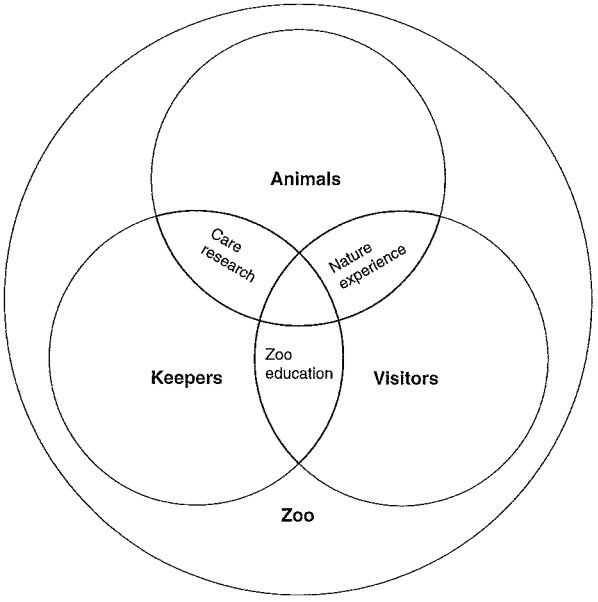
❷ Third floor (stage area) + 13.00 m



❹ Fourth floor (audience seating level) + 16.50 m



❶ Master plan of a modern zoo with adventure world (animal geography), from the example of Leipzig Zoo Arch.: Rasbachr Architekten



The modern zoo attempts to balance the interests of research, animal protection and the experience of nature.
On one side stand the requirements for keeping the animals, feeding, cage design and veterinary care in line with the needs of the species, research activities for the conservation of species, participation in international breeding programmes and zoo educational publicity work.
On the other hand, the zoo is also a business, whose success mainly depends on visitor numbers and is in competition with other leisure providers.
The basis of any zoo design is therefore the orientation on the state of research into the keeping of animals in a way suitable for the species, and also the consideration of the demands of the potential visitors. The staging of exotic ("near to nature") animal worlds and spectacular visitor facilities should therefore be evaluated against this background.

❷ Tasks of the modern zoo, combining the interests of research, animal conservation and providing exciting experiences

Objectives of zoos
Starting with Directive 1999/22/EC, zoos are subject to the following requirements → ❷:

1. Involvement in research activities for species conservation
2. Zoo educational publicity work
3. Keeping and feeding the animals correctly for the species
4. Protection against animals escaping or pests and vermin infiltrating
5. Keeping a register of the zoo collection

Infrastructure of a modern zoo → ❶
Access: good accessibility, clear signposting, sufficient number of parking spaces, stops for public transport

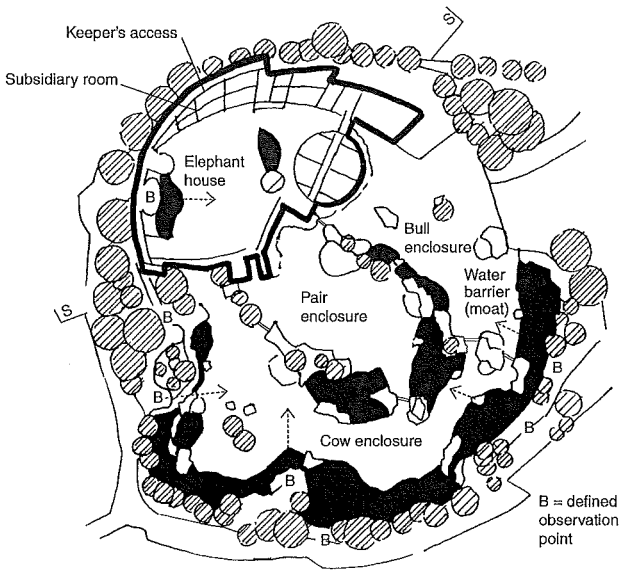
Main entrance: distinctive entrance area, pay booths/counters, kiosks, administration, tidy paths, welcoming seating

Further infrastructure: event and lecture room, high-class restaurant with view of zoo facilities and separate entrance from outside (for evening business), further restaurants according to zoo size, self-service cafeteria, kiosks, toilets, picnic sites, zoo shops, zoo school

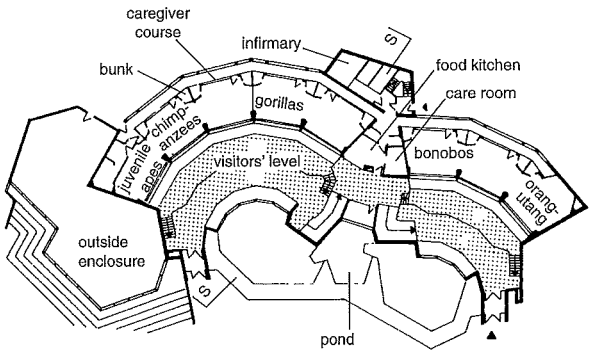
Operations and staff building: separate access (out of public view) with adequate external areas for the storage of feed and litter, building materials, etc., staff department with washing and changing facilities, cafeteria, training and rest rooms (security staff), breeding of feed animals, central/dispersed feed preparation, water distribution, storage and cool rooms, rubbish removal, sheds for parking and maintenance of cleaning machines, transport vehicles and cages, workshops, gardening, heating, air conditioning, ventilation

Medical care of animals: animal clinic, quarantine station, laboratories, research facilities, acclimatisation and breeding areas, cadaver storage

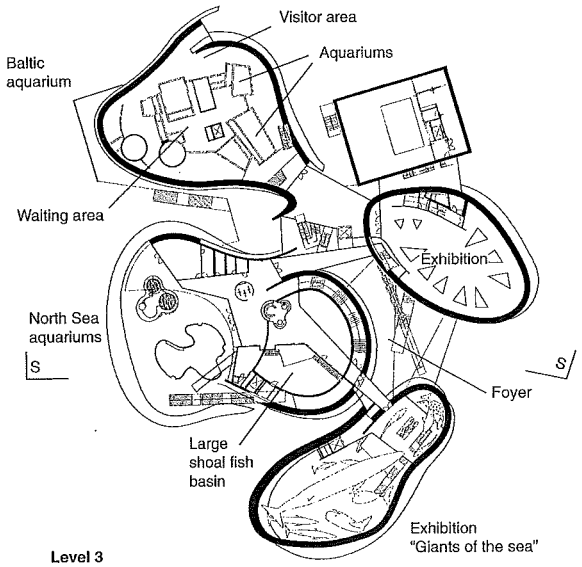
Access roads and paths: wheelchair-accessible main paths (5–6 m wide), with weather protection, laid out as round route, side paths (3–4 m wide) to each group of animals, independent operational roads (3–4 m wide) for supply, waste disposal, animal transport and as emergency access (fire service, ambulance).



❶ Elephant park, Cologne Zoo — Arch.: Oxen und Römer, external works: Fenner, Steinhauser, Weisser



❷ Great ape facility, Wuppertal Zoo — Hochbauamt Wuppertal

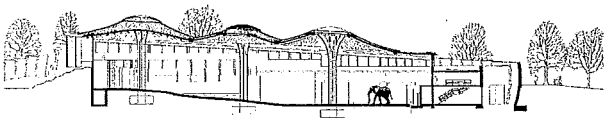


❸ Ozeaneum, Stralsund — Arch.: Behnisch, Behnisch und Partner

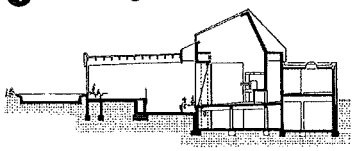
'Hands-on', the traditional principle of keeping zoo animals: it denotes direct contact between the (tame) animals, the keepers (feeding, care) and the zoo visitors (petting zoo) → ❷.

Functional aspects include separation into public and private or invisible areas, assignment of visitor areas, enclosures, keeper access and subsidiary rooms. The most important aspects are hygienic considerations and the presentation of the animals.

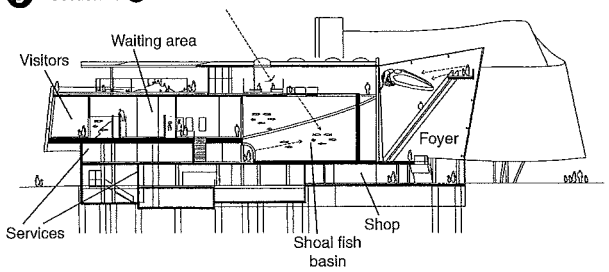
Hands-off' (protected contact) was originally developed as a safe method of handling dangerous animals (indirect, technically supported contact between animal and keeper), and today often corresponds to the expectations of zoo visitors for species-appropriate keeping of animals in zoos → ❶: The large area and natural character of the reproduced original habitat, with appropriate fixed points (drinking trough, climbing rocks, etc.) and the possibility of observing from selected and protected (secretive) positions are also seen as desirable regarding lack of disturbance and encouraging reproduction in human care. "Hands-off" facilities have excellent potential for research and breeding.



❹ Section → ❶



❺ Section → ❷



❻ Section → ❸

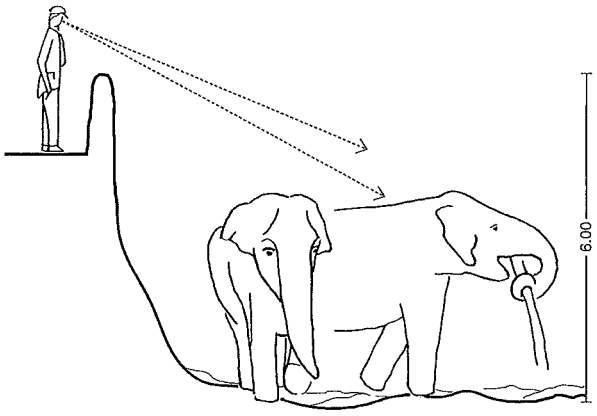
Examples

Animal houses and open-air enclosures are differentiated. Combinations are possible, with and without water:

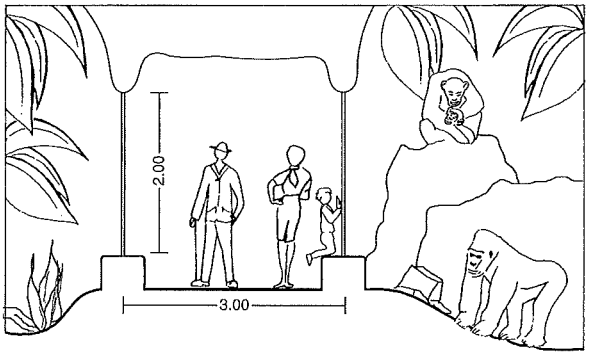
The elephant park at Cologne Zoo → ❶ is an example of an integrated **'hands-off' facility** (animal house and open-air enclosure). The partially roofed area can be divided into various sections from a control centre by means of mechanical gates. The visitor areas are separated from the enclosures by water-filled ditches or differences in level

The great ape house at Wuppertal Zoo → ❷ is an **animal house** (with outside enclosure built subsequently), consisting of the internal enclosure lit from above with protected sleeping bunks, glass partition to the visitor area, keeper access from behind, feed kitchen and special cages (sick bay, baby apes).

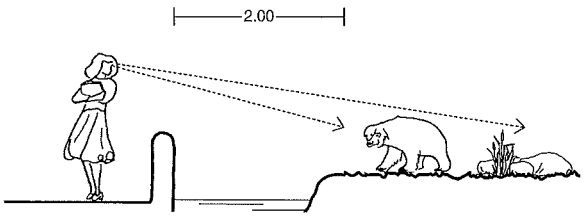
The Ozeaneum, Stralsund → ❸, as an example of a **multifunctional animal house/aquarium** with an extensive round tour for visitors, thematically divided aquariums (Baltic, North Sea) and central area for keepers. The facility serves the purposes of **exhibition and research** and is elaborately conceived with spectacular views into the tanks (shoal fish tank with 15 × 5 m glass pane, tunnel aquarium, overhead aquarium, touch pools, simulation tanks).



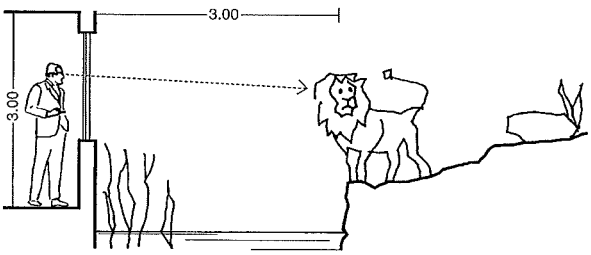
❶ Concealed visitor position



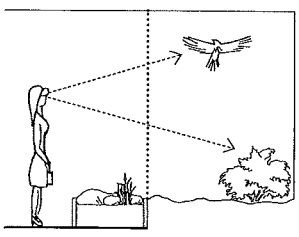
❷ Indoor enclosure with glass corridor: view from dark into light



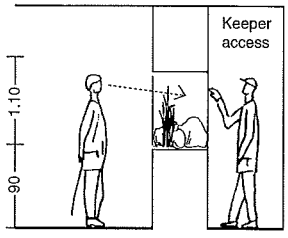
❸ Water barrier: visitor and animal outdoors



❹ Water barrier: visitor behind protective glass screen and animal outdoors



❺ Aviary



❻ Terrarium

Design aspects

Near to nature: The enclosure should correspond to the ideas of the visitors regarding the appropriate habitat for the animals, be aesthetically pleasing and give a generous impression.

Physical nearness: The nearer people can come to the animals, the greater the interest and the longer they stay.

Emotional nearness: Enclosure boundaries should scarcely be noticed.

Observation: Animal enclosures should work secretively and be an invitation to exploration (e.g. view into the enclosure through a cave or a waterfall). Routes should invite lingering, not passing an enclosure but rather leading to it. It should be possible to see only one enclosure from each location; distracting views, and also masses of people in front of the enclosure, should be avoided.

Enable comfortable observation in a relaxed position, not into the sun or through a reflecting pane of glass; the visitor should look into a bright, lit enclosure from shadow (this also has the advantage that the animals do not immediately notice the visitors). Areas where the animals like to pass the time and are active should be clearly visible.

Withdrawal: It is, however, also important that the animal can withdraw from view and be unobserved.

Information: Signage; sufficient information should be available

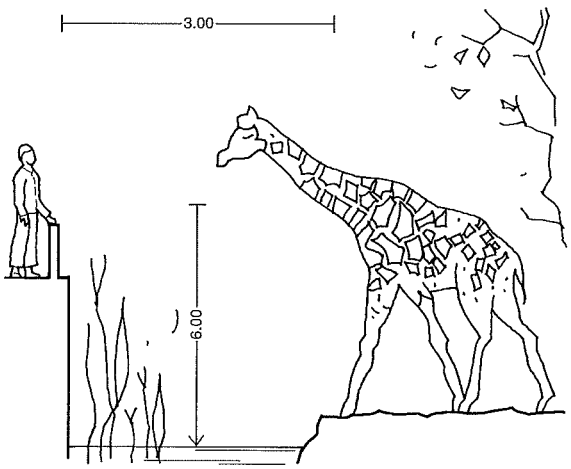
Accessibility: Access to the enclosures (only for the zoo keepers) is provided by dedicated roads and care areas; the appropriate animal catching and transport facilities are here.

Barriers

Ditches were originally developed as dry ditches, but are today generally constructed as **water barriers (moats)** → ❸. A natural appearance is advantageous, but the water becomes dirty quickly and the animals can leave the enclosure over the ice if it freezes over, so the water level therefore has to be lowered in winter. There are normally fences or walls to provide additional protection.

Glass is becoming accepted by most zoos → ❷ + ❹, because it gives the impression of direct contact with the animals and also prevents the infection of animals by humans.

Iron bars disturb the visitor and the animal. The classic method of keeping animals in cages is therefore avoided in modern zoos.



❼ Water barrier: the moat should be wide enough for large animals