General guidelines

Secondary schools (with no 6th form)

e.g. 2 or 3 classes per year
10 (12) or 15 (18) classrooms each 65-70 m²
1 extra-large classroom (can be divided) 85 m²
3 classrooms for special courses 40-45 m²

Science rooms
1 or 2 for demonstrations & practicals, or each 70-75 m²
1 for physics demonstrations & practicals 70-75 m²
1 for chemistry and biology demonstrations & practicals, or 70-75 m²
1 for biology demonstrations & practicals 70-75 m²
1 or 2 preparation rooms, plus rooms for collections and materials, or each 40 m²
1 preparation room for physics and chemistry (also used for collections and materials), or 30-35 m²
1 physics preparation room 30-35 m²
1 chemistry preparation room 20 m²
1 biology preparation room 30-35 m²
1 or 2 science rooms each 30-35 m²
1 room for photography 20-25 m²

Domestic science
1 kitchen 70-75 m²
1 classroom/dining room 30-40 m²
rooms for provisions, materials and household appliances 30-40 m²
1 washroom/changing room 15-20 m²

Art, crafts and textiles
1 drawing studio (arts and crafts)
1 or 2 rooms for technical crafts
1 or 2 rooms for materials
1 washroom/changing room total of approx. 180-220 m²
1 room for textile design 70-75 m²
3 rooms for teaching materials each 10-15 m²
1 music room 65-70 m²
1 storeroom (instruments, music, stands) 15-20 m²

Language lab
1 room for language teaching system 80-85 m²
1 room for materials and equipment 10-15 m²
1 room for library and magazines 60-65 m² or 70-75 m²
1 room for pupils' committee 15-20 m²
1 recreation room (to accommodate a maximum of half the total no. of pupils at 1 m²/pupil)

Administration
1 staffroom (meeting room) 80-85 m²
1 staff study (staff library) 100-105 m²
(or can be combined)
1 office for headteacher 20-25 m²
1 office for deputy head 20-25 m²
1 office 15-20 m²
1 room for meeting parents, doubles as sickroom 20-25 m²
1 caretaker's room (also for milk distribution) 20-25 m²

Sport
Gymnasium (per 10-15 classes)
1 exercise area of 15 x 27 m
Sports grounds according to requirements

Secondary school (with 6th form)

e.g. 2 classes per year
18 classrooms: 65-70 m²
12 classrooms
6 classrooms (upper level) 50 m²
5 classrooms:
2 supplementary classrooms 65-70 m²
3 supplementary classrooms 50 m²
1 extra-large classroom (history, geography) 50 m²
1 room for social sciences

Science rooms
Physics and biology
1 classroom each 55-60 m²
1 room each for collections and materials 30-35 m²
1 room each for preparation 30-35 m²
1 room each for demonstrations & practicals 70-75 m²

Chemistry
1 room for theory and practical work 80-85 m²
1 room for preparation 30-35 m²
1 room for collections and materials 30-35 m²
2 rooms for science groups each 30-35 m²
1 room for photography 20-25 m²

Domestic science
1 kitchen 70-75 m²
1 classroom/dining room 30-40 m²
Rooms for provisions, materials and household appliances 30-40 m²
1 washroom/changing room 15-20 m²

Art
1 drawing studio 80-85 m²
2 rooms for crafts 60-65 m²
2 rooms for materials each 20-25 m²
1 washroom/changing room 15-20 m²
1 room for textile design 70-75 m²
1 music room 65-70 m²
1 storeroom 15-20 m²

Language lab
1 room for language teaching system 80-85 m²
1 room for materials and equipment 10-15 m²
3 rooms for teaching materials each 10-15 m²
1 room for school library 70-75 m²
1 room for pupils' committee 15-20 m²
1 recreation room to accommodate a maximum of half the total no. of pupils at 1 m²/pupil

Administration
1 staffroom (meeting room) 80-85 m²
1 staff study (staff library) 100-105 m²
(or can be combined)
1 office for headteacher 20-25 m²
1 office for deputy head 20-25 m²
1 office 15-20 m²
1 room for meeting parents (doubles as sickroom) 20-25 m²
1 caretaker's room (also for milk distribution) 20-25 m²

Sport
Gymnasium (per 10-15 classes or part of)
1 exercise area of 15 x 27 m
Sports ground according to requirements
SCHOOLS

Cloakroom facilities can be decentralised by allocating space outside the classrooms but directly linked to them. The number of toilets, urinals and wash-basins required, based on total number of pupils and separated according to sex, should be as set out in the local school building guidelines (e.g. see (3)). Sanitary installations with direct daylight and ventilation are preferable, and there must be separate entrances for boys and girls. Examples of different toilet facilities for schools are shown in (1) - (8).

Horizontal and vertical circulation usually doubles as an emergency escape route. Escape routes must have a clear width of min. 1m/150 people, but min. width of corridors in classroom areas is 2.00m or 1.25m for less than 180 people. Stairs in classroom areas must be 1.25m, other escape routes 1.00m. Max. length of escape routes: 25m measured in a straight line from the stairwell door to the furthest workplace, or 30m in an indirect line to the centre of the room. Capacity of stairs is dependent on number of users, average occupancy, etc. Width of stairs: 0.80m/100 people (minimum 1.25m, max. 2.50m). Alternatively: 0.10m/15 people. (Only the top floor is calculated at 100% occupancy, remaining floors at 50%).

General-purpose teaching area includes standard classrooms, supplementary classrooms, extra-large classrooms, rooms for special courses, rooms for teaching languages and social studies, language labs, rooms for teaching material, maps and other ancillary rooms.

Space requirements: classroom for traditional teaching 2.00m²/pupil; for teaching in sets 3.00m²/pupil, for open plan teaching 4.50m²/place including ancillary areas needed for each subject.

Standard room shape: rectangular or square (12×20, 12×16, 12×12, 12×10); with a max. room depth of 7.20m it is possible to have windows on one side only. – (7)

Floors areas are: traditional classroom, 1.80-2.00m²/pupil; open plan 3.00-5.00m²/pupil. The clear height should be 2.70-3.40m.

Language labs should be within or directly related to the general-purpose teaching area, and close to media centre and library. Approximately 30 language lab places per 1000 pupils will be needed → (9) - (11). The size of LT (listen/talk) and LSR (listen/talk/record) labs is approx. 80m²; booths 1×2 m, number of places/lab 24-30, i.e. 48-60m², plus ancillary spaces (e.g. studio, recording room, archive for teachers' and pupils' tapes). Artificially-lit internal language labs with an environmental control system are also possible.

<table>
<thead>
<tr>
<th>Term</th>
<th>design</th>
<th>segregated boys/girls</th>
<th>position</th>
<th>use</th>
<th>miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class WC</td>
<td>sanitary inst. with lobby</td>
<td>next to a classroom</td>
<td>during lessons</td>
<td>for pre-school or kindergarten places</td>
<td>2 WC and lobby</td>
</tr>
<tr>
<td>Lession WC</td>
<td>installation</td>
<td>accessible from corridor or lobby</td>
<td>several classes during lessons</td>
<td>from each classroom without WC, the max. distance inc. spandrel from a lession WC should be 40m</td>
<td></td>
</tr>
<tr>
<td>Break WC</td>
<td>installation</td>
<td>accessible from schoolyard or entrance lobby</td>
<td>during breaks</td>
<td>WC at ground floor level, on perimeter of building, accessible from areas used during breaks</td>
<td></td>
</tr>
<tr>
<td>Staff WC</td>
<td>installation</td>
<td>segregated women/men</td>
<td>part of the staff or office area</td>
<td>during breaks</td>
<td>possibly linked to staff cloakroom</td>
</tr>
</tbody>
</table>

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SCHOOLS

Science area includes rooms for teaching of theory and practice, practicals, preparation and collections, photographic studios and labs. Classrooms for biology, physics and chemistry 2.50 m²/place. For lectures and demonstrations in practical work 4.50 m²/place including special-purpose ancillary space but not including ancillary rooms.

Room sizes for demonstrations and practicals in chemistry and biology, physics, or combinations should be 70–80 m². Ideally, for physics, biology and chemistry lectures (possibly including demonstrations) 60 m² is needed, with fixed raked seating. Second entrance/exit. Possibility of internal classroom with artificial lighting.

Room for practical work, group work in biology and physics and as well as interdisciplinary work, space divisible into smaller units. 80 m² per individual room or space.

Rooms for preparation, collections and materials for individual subjects or combinations of subjects. Total of 30–40 or 70 m² depending on the size of the school and the science area. Internal rooms with artificial light allowable.

Rooms for photographic work and photographic labs are best associated with the science rooms. Ideally, they should be in the form of a studio, with a lobby between the lab and teaching area. Dark room with areas for printing (1 enlarging table for 2-3 pupils, combined with wet-processing places), for developing negatives and rooms or area for loading film.

Position of rooms: best north-facing with constant room temperature. Space required depends on number of pupils, generally 6–14 pupils per group, at least 3–4 m² per workplace. Type of photo lab depends on areas and sizes:

- one-room lab 20–30 m², minimum size with separate bay of 1.50–2.0 m² for loading film.
- two-room lab 30–40 m², consisting of lit room, light lock and dark room (positive and negative work), film-loading room 2 m².
- three-room lab, printing room, lit room with necessary light locks, light locks 1–2 m² without furniture, dark room lamps only.

For exhibitions, etc. shared use of other rooms is possible.
Library, media centre and central amenities:
Purpose: information centre for classwork, further education and leisure and may be used by pupils, teachers and non-school users.
Library includes a conventional school library for pupils and teachers with books and magazines, lending facilities, reading and work places. The media centre is an extension of the library with recording and playback facilities for radio, film, TV, i.e. audio-visual equipment and a corresponding stock of software, microfilm and microfiche facilities.
Standard space requirement overall: library/media centre 0.35–0.55 m²/pupil. Broken down into:
- book issues and returns, 5 m² per workplace, and catalogue space of 20–40 m²
- information: librarian, media advisor, media technician, etc. 10–20 m² per person
Compact book storage in 1000 volume stacks at 20–30 volumes/metre run of shelving. Free access bookcase approx. 4 m² including circulation space, reading places and catalogues. For 1000 volumes reference books 20–40 m², study area generally per 1000 volumes reference books 25 m² for 5% of the pupils/teachers, but at least 30 study spaces at 2 m² each, i.e. 60 m² carrels 2.5–3.0 m². Room for work in groups of 8–10, 20 m² → 1 – 2.

For kitchen and ancillary rooms, the size and equipment specification depends on the catering system. Table service for food and table clearing for young children (portions possibly served by teacher), otherwise self-service (e.g. from conveyer belt, counter, cafeteria line or free-flow system). Distribution capacity of 5–15 meals/minute or 250–1000/ hour, variable staffing levels. Space required for distribution systems 40–60 m². Dining room size depends on number of pupils and number of sittings, min. of 1.20–1.40 m² per place. Larger spaces should be divided up. For every 40 places, 1 wash-basin in the entrance area → 3 – 4.

Meals and crockery distribution and dining area
SCHOOLS
Primary schools

Classrooms: one classroom per class, square if possible, in exceptional cases rectangular, max. 32 pupils, min. of 85-70m² (approx. 2.00m² x 2.20m² per pupil) if possible daylit on two sides - 3 + 6. Furniture either in rows or informally arranged.

Front of class: chalkboard with sliding panels, projection space, socket for TV, radio, tape recorder, etc., wash-basin near entrance. Provision for hanging maps. Facility to black out windows. Group rooms divided into separate workspaces to accommodate mixed ability classes only in special cases.

Alternatives to individual classes and group rooms: 2-3 classrooms joined together to make teaching spaces for discussions between pupils and teachers, or lessons in larger groups; can also be divided by partitions. Draught-excluding lobbies and entrance areas also connect to horizontal and vertical circulation (corridors, stairs, ramps) and can be used during breaks (0.50m²/pupil). Multi-use area for parties, play or exhibitions.

Room for teaching materials 12-15m² centrally positioned, part of the staff area or in a multi-purpose room.
Nowadays, it is often considered normal for offices to be open plan. This sometimes influences school architecture. The two have similar requirements regarding size of room, lighting, ventilation, acoustics, floor and ceiling finishes, furniture, and colour.

Main advantage: flexibility → 1 + 2. Team teaching in groups of up to 100 pupils. Space per pupil (not incl. core) 3.4 m²–4 m².

The later addition of partitions should be possible → 3. There are many US examples. German model example: Tannenberg School, Seeheim → 3. However, vertical drainpipes and service ducts, etc. are a problem because of the need to fix sound-insulating partitions → 4. Ceiling panels should be removable so that services in the ceiling void are accessible → 5.

Large groups of 40–50 pupils, divided into medium-sized groups of 25–26 pupils, small groups of 10 pupils → 3.

Planning grid 1.20 × 1.20m throughout; clear room height 3m. Movable partitions which can be taken down to provide a solution for the transition from old fixed classrooms to open plan → 4. Also, building forms which create small spaces → 5, 6, and → 6–8. Examples of seating arrangement for watching films, slides etc. → 9, 10–12.

Educational experts maintain that, during conscious learning, people best retain information that they have obtained themselves, more precisely:

10% of what they read;
20% of what they hear;
30% of what they see;
50% of what they hear and see;
70% of what they say themselves; and
90% of what they do themselves involving their own actions.
FURTHER EDUCATION COLLEGES

Technical colleges and colleges of further education

The type of college depends on regional and local factors, so that it is not really possible to give absolute sizes for systems. The figures cover both part-time and full-time students; as an approximate guidelines, and depending on the area served, there are 2000-6000 pupils per 60000-150000 inhabitants. Owing to the large catchment areas, the schools should be well served by public transport. Site: at least 10 m² per part-time student and at least 25 m² per full-time student of college site area, as far as possible free of pollution from noise, smoke, odour and dust. Ensure a good-shaped site and the possibility for extension. Arrangement on the site, type of construction and building design depend on the sizes of the spaces that can be accommodated on several levels (classrooms for general subjects, specialist subjects, administration) and those which cannot - areas for non-academic work, e.g. workshops or sports areas. College buildings are, as a rule, 2-3 storeys, higher only in exceptional cases. Workshop buildings with heavy machines or frequent deliveries are single storey only.

Access: entrance area and foyer with central facilities used as circulation space connecting horizontal and vertical movement as in general school centres or comprehensive schools. Teaching areas divided according to type of teaching and their space requirements. General-purpose teaching areas occupy 10-20% of the space. General classrooms as normal with 50-60 m², small classrooms 45-50 m², oversize classrooms 85 m², possibly open-plan classrooms doubling as a film or lecture hall of 100-200 m².

Building requirements, furnishings and fittings basically the same as for general school centres and comprehensive schools. An assembly room of 20 m² per 5 normal classes.
COLLEGES AND UNIVERSITIES

Lecture Theatres

Central facilities
Main lecture theatre, ceremonial hall, administration, dean’s office, students’ union building. Also libraries, refectories, sport facilities, halls of residence, parking.
Technical facilities for central services supply:
Boiler room, services supply.
Subject-specific teaching and research facilities.
Basic facilities for all subjects:
Lecture theatres for basic and special lectures, seminar and group rooms (some with PC workstations) for in-depth work. Departmental libraries, study rooms for academic staff, meeting rooms, exam rooms, etc. → ①.
Subject-specific room requirements:
Humanities: no particular requirements.
Technical/artistic subjects, e.g. architecture, art, music, etc.: rooms for drawing, studios, workshops, rehearsal and assembly rooms of all kinds.
Technical/scientific subjects, e.g. civil engineering, physics, mechanical engineering, electrical engineering: drawing studios, labs, workshops, industrial halls and labs.
Scientific and medical subjects, e.g. chemistry, biology, anatomy, physiology, hygiene, pathology, etc.: labs with adjoining function rooms, workshops, rooms for keeping animals and for long-term experiments.

① Schematic layout of university facilities

② Drawing for calculating view curve

③ Long section of a lecture theatre

④ Standard lecture theatre shape

⑤ More steeply raked lecture theatre

⑥ Lecture theatre with demonstration table (medical)

⑦ Tiers in life drawing studio: 0.65m² seating space per student
It is preferable to group larger lecture theatres for central lectures in separate complexes. Smaller lecture theatres for lectures on specialist subjects are better in the individual department and institute buildings. Access to the lecture theatre is separated from the research facilities, with short routes and entrances from outside at the back of the lecture hall; for raked seating entrances can be behind the top row and larger theatres can also have them in the centre on each side. Lecturers enter at the front, from the preparation room, from where equipment carrying the experimental animals can also be trolled into the lecture theatre.

Usual sizes for lecture theatres: 100, 150, 200, 300, 400, 600, 800 seats. Theatres with up to 200 seats have a ceiling height of 3.50m and are integrated into the departmental buildings; if larger they are better in a separate building.

- Lecture theatres for subjects involving writing on chalkboards and projection have seating on shallow rake - p. 315
- Demonstration lecture theatres for science subjects have experiment benches and seating steeply raked - p. 315
- Medical demonstration lecture theatres, 'anatomy theatres', have steeply raked seating - p. 315
**Physics lecture theatre with double wailing to prevent sound and vibration travelling**

1. Section
2. Plan

**Lecture Theatres**

3. Lecture theatre at the TH Delft
   - Architect: Brlek + Bakema

4. Typical floor
   - Entrance hall and two-storey main lecture theatre; typical floor with seminar rooms and administration offices
   - Architect: O.E. Schweizer

5. Ground floor of the theological college at the University of Freiburg

6. Teaching building at Dusseldorf
   - 1 lecture theatre
   - 2 preparation room for lecture theatre
   - 3 entrance
   - Architect: Pfau

7. Lecture Theatre at the ETH Honggerberg in Zurich
   - 1 lecture theatre
   - 2 projection room
   - 3 cloakroom
   - Architect: Steiner + Gehry

**Colleges and Universities**

**Educational and Research Facilities**

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COLLEGES AND UNIVERSITIES

Lecture Theatres

Seating in lecture theatres: combined units of tip-up or swing seats, backrest and writing ledge (with shelf or hook for folders), usually fixed. → ① - ③.

Seating arrangement depending on subject, number of students and teaching method: slide lectures, electro-acoustic systems on a gentle rake; surgery, internal medicine, physics on a steep rake. View curve calculated using graphic or analytic methods. → ④ - ⑤.

Amount of space per student depends on the type of seat, depth of writing shelf and rake of floor.

Amount of space per student: for seating in comfort 70×65 cm; and on average 60×80 = 55×75 cm. 0.60 m² needed per student including all spaces in larger lecture theatres under the most cramped conditions; in smaller lecture theatres and in average comfort 0.80-0.95 m². (Cont. next page)
Experiment benches suitable for laboratory work should, if possible, be interchangeable units on castors and must be provided with a power point.

Projection screens and boards can be designed as a segmented, curved wall or simply fixed to a flat end-wall. Wall blackboards are usually made up of several sections which can be moved up and down manually or mechanically. They can be designed to drop down beneath the projection area. Blackboards on wheels can also be considered.

**Acoustics and lighting**

Sound should reach each member of the audience with equal amplitude without any echo. Suspended ceilings for reflection and absorption. Rear walls lined with sound-absorbent material, other walls smooth. Light level in a windowless lecture theatre: 600lx.

**Related additional spaces**

Each lecture theatre should have an ancillary room, with no fixed function which can also be used for storage. In lecture theatres where animal experiments are performed sufficient space for preparation should be provided. It should be on the same level and close to the stage. Standard minimum size for a rectangular shaped lecture theatre: 0.2–0.25 m²/seat; for trapezoidal shape: 0.15–0.18 m²/seat. For scientific and pre-clinical lectures: 0.2–0.3 m²/seat.

Spaces for storage and service rooms are essential for the proper running of a lecture theatre complex: a service room for the technical staff servicing the equipment in the lecture theatres, a service room for cleaners, storeroom for spare parts, light bulbs, fluorescent-light tubes, chalkboards, clothes, etc. Minimum room size 15 m², overall space requirement for ancillary rooms at least 50–60 m².

Clothes lockers and WCs: rough estimate for both together 0.15–0.16 m²/seat as a guideline.

**Basic room requirement for all subjects**

General-purpose seminar rooms usually have 20, 40, 50 or 60 seats, with movable double desks (width 1.20, depth 0.60); space required per student 1.90–2.00 m2 → ①.

Different arrangements of desks for lectures, group work, colloquia, language labs, PC’s, labs and meeting rooms have the same space requirements → ①.

Offices for academic staff:
Professor 20–24 m² → ② A
Lecturer 15 m² → ② B
Assistants 20 m² → ② C
Typists 15 m² (if shared by two typists 20 m²) → ② D
Departmental (open shelf) libraries:
Capacity for 30000–200000 books on open shelves
Book space: → ③
Bookcases with 6–7 shelves, 2 m high (reach height)
Distance between bookcases 1.50–1.60 m
Space required 1.0–1.2 m²/200 books
Reading spaces: → ④
Width 0.9–1.0 m/depth 0.8 m
Space required 2.4–2.5 m² per space

Control counter at entrance with locker for personal property, catalogue and photocopying rooms.
DRAwING STUDIOS

Various space requirements for technical subjects, including architecture, and art academies (painting and modelling rooms) → ① - ②

**Basic equipment**

Drawing table of dimensions suitable for A0 size (92 × 127 cm); fixed or adjustable board → ②, ⑥ - ⑦. Drawings cabinet for storing drawings flat, of same height as drawing table, surface can also be used to put things on → ②. A small cupboard on castors for drawing materials, possibly with filing cabinet, is desirable → ② + ① - ②. Adjustable-height swivel chair on castors. Drawing tables, upright board, adjustable height or usable as flat board when folded down → ⑤ - ①. Further accessories: table top for putting things on, drawing cabinets for hanging drawings or storing flat, suitable for A0 at least → ⑨ - ⑩. Each workplace should have a locker.

**Drawing studios**

Each space requires 3.5 - 4.5 m², depending on size of drawing table → ①.

Natural lighting is preferable and so a north-facing studio is best to receive even daylight. For right-handed people it is best if illumination comes from the left → ③. Artificial light should be at 500 lx, with 1000 lx (from mounted drawing lamps or linear lamps hung in variable positions above the long axis of the table) at the drawing surface.

Rooms for life drawing, painting and modelling:

Accommodated if possible in the attic facing north with large windows (1/3 - 1/4 of floor space) and, if necessary, additional top lights.

**Rooms for sculptors and potters**

Large space for technical equipment such as potters’ wheels, kilns and pieces of work, also storeroom, plaster room, damp room, etc.

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① Workplace in drawing room
② Work surface
③ Light for writing coming from behind left, and for drawing from the front left
④ Drawing board sizes
⑤ Adjustable drawing table
⑥ Section → ⑤
⑦ Work space plan → ⑧
⑧ Drawing office
⑨ Drawings stored upright
⑩ Sheet steel drawings cabinet
⑪ Section → ⑩
⑫ Adjustable angle desk and drawing table
Laboratories differ according to type of use and discipline.

According to use:
Laboratories for teaching and practicals, comprising a large number of workstations, usually with simple basic equipment. Research labs are usually in smaller spaces with special equipment and additional rooms for activities such as weighing and measuring, centrifuges and autoclaves, washing up, climatized and cold storage rooms with constant temperature, photographic rooms/dark rooms, etc. → ④.

According to subject:
Chemistry and biology labs with fixed benches. Rooms have frequent air exchange, often additional fume cupboards (digestors) for work which produces gas or smoke. Digestors often in separate rooms. Physics labs mainly with movable benches and a range of electrical installations in trunking in the wall or suspended from the ceiling; few air changes. Special labs for specific requirements, e.g. isotope labs for work with radioactive substance in differing safety categories. Clean-room labs → ② for work needing dust-free filtered air, e.g. in the field of microelectronics or for particularly dangerous substances, which should be prevented from entering surrounding rooms by separate air circulation and filtering systems (microbiology, genetic engineering, safety levels L1–L4).
LABORATORIES

Unserviced work rooms are also part of the lab area:

Study cells, service rooms for lab personnel. Also central rooms such as general storerooms, chemicals stores and supplies with special protective equipment, isotope stores with cooling containers, etc. Experimental animals are kept in a special location. Particular kinds of equipment are needed, depending on the type of animal and they have differing requirements for separate air circulation.

Lab workstation

The bench, fixed or movable, is the module which determines the lab workstation; its measurements, including work space and passage space, form the so-called lab axis, the basic spatial unit. Normal measurements for standard workbench: 120cm width for practicals, several times this for a research lab, 80cm depth of work surface including energy conduit.


Benches and fume cupboards are usually part of a modular system, width of elements 120cm, fume cupboards 120 and 180cm. The conduit carries all the supply systems; benches and low cupboard are placed in front of it.

Benches are made of steel tubing, with work-surface of stoneware panels without joints, less frequently tiles, or chemical-resistant plastic panels. Low cupboards are of wood or chipboard with plastic laminate. Supply services are from above from the ceiling void, or from below through the floor structure.

Ventilation:

Low-pressure or high-pressure systems, the latter are recommended particularly in multi-storey buildings for institutes with higher air requirement in order to reduce the cross-sections of the ducts. Cooling and humidification as required. Ventilation systems have the highest space requirement of all services.

Labs where chemicals are used must have artificial air supply and extraction. Air changes per hour:

- chem. labs 8
- biology labs 4
- physics labs 3–4 (in extraction area)

Electrical services:

Where a high number of connections and special supplies of electricity are required, a separate transformer in the building is essential. Electrical plant must be in a fireproof enclosure without any other cables running through it.
LABORATORIES

There are various possible arrangements of service ducts, columns and vertical circulation cores:

1. Services concentrated in internal main shafts at each end of the building, vertical circulation core inside
2. Services concentrated in external shafts at each end of the building, vertical circulation core outside
3. Services concentrated in main shafts centrally in each part, circulation core as link element
4. Services distributed in discrete duct installations, vertical circulation core inside
5. Main services inside linked to vertical circulation core

Vertical services system

There are many vertical service ducts inside the building or on the façade, taking the services directly into the labs in separate ducts: decentrally distributed air supply and exhaust air to fume cupboards, separate ventilators on the roof.

Advantages:
Maximum supply to individual workplaces. Short, horizontal connections to the bench.

Disadvantages:
Plan flexibility limited, more space needed on services plant floor → 7.

Horizontal services system

Vertical main services concentrated in shafts and distributed from there horizontally via the service plant floors to the bench by connections from above or below.

Advantages:
Fewer conduits and less space needed for the services ducts; greater flexibility of plan, easier maintenance, central ventilation plants, later installation easier → 8. High density of services requires more space. Vertical mains ducts with concentrated services are more manageable, access is easier and they can be installed later. Conduits insulated from heat, cold, condensation and noise → 9 - 10.

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8. Horizontal services system

9. Horizontal conduit distribution on one storey → 10

10. Main services concentrated in shaft: plan → 9
Rooms are used according to a schedule of accommodation and plan. Rooms with natural or artificial light and ventilation, with high or low servicing, allow the creation of zones of differing use and technical qualities. For this reason laboratory buildings often have large internal areas (with two corridors) - 1 + 3. The building length depends on the longest reasonable horizontal run of wet services.

Services floors for plant in the basement or at roof level.

**Grid for structure and fittings:**

For adaptability of use, a reinforced concrete frame structure, pre-cast or poured in-situ, is preferable. The main structural grid is a multiple of the typical planning grid of 120 x 120cm (decimal system). A convenient structural grid for a large proportion of rooms without columns is: 7.20 x 7.20m, 7.20 x 8.40m, 8.40 x 8.40m. Storey height normally 4m, clear room height up to 3.0m.

Columns stand on the grid off-set from the planning grid to increase the flexibility of the servicing. Separation is by a system of partitions and suspended ceilings which enclose the rooms. Movable dividing walls should be easy to assemble and have chemical-resistant surfaces. Ceilings should be designed to be disassembled and should absorb sound. Floor coverings should be water- and chemical-resistant, without joints and be poor electrical conductors: as a rule welded plastic sheet or tiles.

Provide viewing windows into the labs from the corridor or in the doors.

Isotope labs have smooth surfaced walls and ceilings without pores, rounded corners, shielded in lead or concrete, waste water monitoring, with shower cubicles between the lab and exits. Concrete container for active waste and refuse, concrete safe with lead doors, etc.

A weighing table is part of every lab, usually in a separate balance room. Benches lie along the wall in front of vibration-free walls.
CHILD DAYCARE CENTRES

Child daycare centres provide social and educational facilities for daytime care of pre-school children and school children up to the age of 15. Children's needs should be taken into consideration in the planning. Division according to age groups:

Creche from 8 months to 3 years, groups of 6–8 children; kindergarten from 3 years to school age groups of 25–30 children; children's after-school care centre from 6–15 years, groups of 25–30 children. If possible, provision should be made for age groups to be combined. The centre should be near housing and traffic-free.

Size of rooms, schedule of accommodation and details → 1 + 2.

Creche 2–3 m² floor space/child (babies, crawlers and toddlers) plus spaces for: nappy changing table, playpens, cupboards, toy racks, child-size tables and chairs.

Kindergarten 1.5–3 m² floor space/child. 15–30 children/room plus spaces for cupboards, toy racks, child-size tables and chairs, and after-school care.

After-school care centre 1.5–4 m² floor space/child. 20 children/room plus spaces for cupboards, toy racks, child-size tables and chairs, chalkboards, storage facilities, homework room with cupboard for teaching material, shelves, desks and chairs. Arts and crafts room with cupboard for tools and materials, workbench, carpentry bench, etc.

With more than two groups two rooms a multipurpose room is required, preferably next to the group rooms and with a view of them. Good sound insulation, so as to help concentration in group learning processes, e.g. play rehearsals, etc.

If the room is large enough (min. 60 m²) it can also be used as a gymnasium and for afternoon naps. Apparatus store. There is a trend towards two-storey buildings with staircases and emergency stairs, especially in high-density urban areas; and child daycare centres with longer opening hours for working or single parents (07.30 – 17.00). Facilities for disabled children, WCs and washrooms accessible to wheelchairs, therapy room. Min. 6 parking spaces and space for bicycles and prams.

Driveway and parking for staff and people collecting children, playground.

---

1. common room 47.5 m²
2. WC/ washroom 9.5 m²
3. group room 20.0 m²
4. care room 16.0 m²
5. cloakroom 4.0 m²
6. storeroom 9.0 m²
7. play equipment 11.0 m²
8. hall 37.0 m²
9. multipurpose 86.0 m²
10. staff/WC 7.0 m²
11. kitchen 13.0 m²
12. supervisor 10.0 m²
13. lobby 34.0 m²
14. heating 6.0 m²
15. main intake 4.0 m²
16. cleaner 2.5 m²

---

1 common room
2 group room
3 terrace
4 multipurpose
5 head
6 office
7 office
8 parent visits
9 first aid
10 laundry
11 games hall
12 playroom
13 doctor
14 kitchen
15 gardener
16 store
17 heating
18 non-front area
19 quiet area
20 playroom

---

1 common room
2 group room
3 play hall
4 quiet room
5 babies' changing
6 kitchen
7 staff
8 head
9 WC AND washroom
10 cloakroom
11 storeroom
12 cleaning materials
13 lobby
PLAYGROUNDS

Play makes a fundamental contribution to the development of a child's personality. It is mainly through play that small children adapt to their environment. Play areas must be varied, changing and changeable. They must meet children's needs. Play is a social experience, through it children learn to understand the consequences of their behaviour.

Requirements of play areas: traffic safety, no pollution, adequate sunshine, ground water level not too high.

Play areas should be focal points within residential areas and should be connected to residential and other areas by simple networks of paths. They should not be pushed out on to the periphery but planned in connection with communication systems. Guidelines for planning playgrounds take into account the following data: age group, usable space per person, play area size, distance from dwellings, etc.

<table>
<thead>
<tr>
<th>age group</th>
<th>area (m²)</th>
<th>distance from home (m)</th>
<th>distance from home (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 6</td>
<td>0.6</td>
<td>110 – 230</td>
<td>2</td>
</tr>
<tr>
<td>6 – 12</td>
<td>0.5</td>
<td>350 – 450</td>
<td>5</td>
</tr>
<tr>
<td>12 – 18</td>
<td>0.9</td>
<td>700 – 1000</td>
<td>15</td>
</tr>
</tbody>
</table>

When building housing, private outdoor playgrounds in the grounds of the housing complex should be provided for younger children up to the age of 6, for children from 6–12 and for adults. A basis for calculating the size of all public playgrounds can often be found in planning regulations. For example, 5m² play area per housing unit, minimum size of playground 40m². Open spaces for play must be enclosed by a barrier at least 1 m high (dense hedge, fences, etc.) to protect them from roads, parked cars, railway lines, deep water, precipices and other sources of danger.
Libraries perform a range of functions in society. Academic libraries, for example, obtain, collect and store literature for education and research purposes, and are usually open to the general public. Public libraries provide communities with a wide choice of more general literature and other information media, with as much as possible displayed on open shelves. The functions of academic and public libraries are often combined in a single library in larger towns. National libraries, for example, may house collections of literature and historical documentation produced in one country or region (deposit copies) and are open to the public, whereas specialist libraries for the collection of literature and media in limited subject areas often have limited access.

In academic libraries, reference rooms are provided. There may also be counters for loans from the closed stacks, and free access to the open shelves of magazines, books or separately presented educational material in reading rooms. Apart from books and journals, almost all the different information media forms are collected and presented for use in an accessible way. The number of reading places depends on the number of students in the various subjects. The information is arranged in a systematic way, i.e. by subject. The services offered include inter-library loans as well as photocopying, and reading and printing from microforms (microfiche and microfilm). In addition, an on-line literature search and a literature search on data bases stored on CD-ROM are available.

University libraries are organised in either one or two layers. The one-layer system is administered centrally (book processing and services) and normally has very few separate branch or subject libraries. The two-layer system includes a central library and usually a large number of faculty, subject and institute libraries. The stock is held on open shelves in reading rooms, or in accessible book stacks (with the same shelf spacing as in closed stacks), as well as in restricted-access closed stacks. Arrangements such as these are found in various proportions in almost all academic libraries. The proportions of loan (open and closed access) and reference stocks depend on the type of organisation, i.e. the aims of the library and the form of the buildings often have a significant effect. The number of book shelves depends on the type of organisation, accessibility for users, type of shelving (fixed or mobile), the system of subject ordering in use and its method of installation, the separation of different formats and also the structural grid of the building → ④ - ⑦.

Reading room areas, with space for reading and working, should be easily accessible and therefore situated on as few levels as possible. This also aids book transport. There should be a clear directional system with easily read signs giving directions to services and book shelves. Avoid offset levels. Access to the operational areas and reading rooms on different floors should be by staircase, but lifts must also be provided for the use of disabled people and for book transport. Floor loadings in the operational and reading areas should be ≥ 25.0 kN/m².

Circulation routes should be >1.2m wide, and clear spaces between shelves at least 1.3-1.4m wide (in accordance with local regulations). Avoid crossings and overlapping of routes for users, staff and book transport. Access to reading rooms can be through control gates equipped with book security equipment and, if possible, only one entrance and exit. For functional reasons, the control gates should be near the lending desk/central information desk.

### Libraries

<table>
<thead>
<tr>
<th>Stack Type</th>
<th>Volume per Shelf (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stacks</td>
<td>1.05</td>
</tr>
<tr>
<td>Open-access shelving</td>
<td>1.10</td>
</tr>
<tr>
<td>Reading room</td>
<td>1.80</td>
</tr>
<tr>
<td>Work spaces (2%)</td>
<td>2.40</td>
</tr>
<tr>
<td>Group work spaces</td>
<td>4.40</td>
</tr>
</tbody>
</table>

### Example Distances between Shelf Unit Centre-lines; Common Grids

<table>
<thead>
<tr>
<th>Structural Grid</th>
<th>3.60</th>
<th>4.20</th>
<th>4.80</th>
<th>5.40</th>
<th>6.00</th>
<th>7.20</th>
<th>8.40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stacks</td>
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<td>1.08</td>
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<td>1.20</td>
<td>1.20</td>
<td>1.20</td>
<td>1.20</td>
</tr>
<tr>
<td>Open-access shelving</td>
<td>1.10</td>
<td>1.13</td>
<td>1.16</td>
<td>1.19</td>
<td>1.20</td>
<td>1.20</td>
<td>1.20</td>
</tr>
<tr>
<td>Open-access reading</td>
<td>1.44</td>
<td>1.50</td>
<td>1.54</td>
<td>1.59</td>
<td>1.62</td>
<td>1.68</td>
<td>1.80</td>
</tr>
<tr>
<td>Reading room</td>
<td>1.92</td>
<td>2.00</td>
<td>2.07</td>
<td>2.10</td>
<td>2.18</td>
<td>2.26</td>
<td>2.34</td>
</tr>
<tr>
<td>Work spaces (2%)</td>
<td>2.40</td>
<td>2.40</td>
<td>2.40</td>
<td>2.40</td>
<td>2.40</td>
<td>2.40</td>
<td>2.40</td>
</tr>
<tr>
<td>Group work spaces</td>
<td>4.40</td>
<td>4.80</td>
<td>5.20</td>
<td>5.60</td>
<td>6.00</td>
<td>6.40</td>
<td>6.80</td>
</tr>
</tbody>
</table>

### Floor Area for Open-Access Bookshelves 8.70 - 6.00 m per Block of Shelf Units

<table>
<thead>
<tr>
<th>Structural Grid</th>
<th>7.20m</th>
<th>7.50m</th>
<th>7.80m</th>
<th>8.10m</th>
<th>8.40m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centre-line Distance (m)</td>
<td>1.35</td>
<td>1.44</td>
<td>1.50</td>
<td>1.56</td>
<td>1.60</td>
</tr>
<tr>
<td>Stacks (1.20)</td>
<td>1.40</td>
<td>1.50</td>
<td>1.60</td>
<td>1.70</td>
<td>1.80</td>
</tr>
<tr>
<td>Open-access shelving</td>
<td>1.40</td>
<td>1.50</td>
<td>1.60</td>
<td>1.70</td>
<td>1.80</td>
</tr>
<tr>
<td>Enquiry area and reading room</td>
<td>2.00</td>
<td>2.10</td>
<td>2.20</td>
<td>2.30</td>
<td>2.40</td>
</tr>
</tbody>
</table>

### Floor Space for Bookshelves in Areas Close to the Public

<table>
<thead>
<tr>
<th>Adjacent Aisle</th>
<th>0.00</th>
<th>0.10</th>
<th>0.20</th>
<th>0.30</th>
<th>0.40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelving</td>
<td>6.20</td>
<td>6.25</td>
<td>6.30</td>
<td>6.35</td>
<td>6.40</td>
</tr>
<tr>
<td>Aisle</td>
<td>4.80</td>
<td>4.87</td>
<td>4.95</td>
<td>4.16</td>
<td>4.68</td>
</tr>
</tbody>
</table>

### Suitable Officers for Common Structural Grids for Functional Library Functions

| Shelving above another | 7   | 6   | 5   |
| Maximum book height (cm) | 25  | 30  | 35  |
| Average book depth (cm)  | 18  | 20  | 22  |
| Load per shelf (kg)     | 0.38| 0.51| 0.55|

### Loadings for 7.5 kN/m² book stack floors

| Load per Shelf (kg) | 0.38 | 0.51 | 0.55 |
### Educational and Research Areas

<table>
<thead>
<tr>
<th>distance between centre lines of shelving (m)</th>
<th>volumes per metre of single shelf</th>
<th>volumes per metre of double shelf</th>
<th>volumes per metre of triple shelf</th>
<th>volumes per metre of 4* shelf</th>
<th>volumes per metre of 5* shelf</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.20</td>
<td>30</td>
<td>60</td>
<td>90</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td>1.25</td>
<td>30</td>
<td>60</td>
<td>90</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td>1.30</td>
<td>30</td>
<td>60</td>
<td>90</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td>1.35</td>
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<td>60</td>
<td>90</td>
<td>120</td>
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<td>1.40</td>
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<td>150</td>
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<td>60</td>
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<td>1.50</td>
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<td>60</td>
<td>90</td>
<td>120</td>
<td>150</td>
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<tr>
<td>1.68</td>
<td>30</td>
<td>60</td>
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<td>150</td>
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<tr>
<td>1.80</td>
<td>30</td>
<td>60</td>
<td>90</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td>1.87</td>
<td>30</td>
<td>60</td>
<td>90</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td>2.10</td>
<td>30</td>
<td>60</td>
<td>90</td>
<td>120</td>
<td>150</td>
</tr>
</tbody>
</table>

**Floor area calculation for double-sided shelving**

<table>
<thead>
<tr>
<th>library area/ floor type</th>
<th>closed and open stacks</th>
<th>compact storage systems</th>
<th>reading room and open-access shelving</th>
<th>administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>on floors with lateral distribution</td>
<td>7.5</td>
<td>12.5</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>on floors without lateral distribution</td>
<td>8.5</td>
<td>15.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

**Assumed floor loads (kN/m²)**

<table>
<thead>
<tr>
<th>number of shelves</th>
<th>distance between centre lines of shelf units (m)</th>
<th>1.10</th>
<th>1.20</th>
<th>1.30</th>
<th>1.40</th>
<th>1.50</th>
<th>1.60</th>
<th>1.70</th>
<th>1.80</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3.83</td>
<td>3.72</td>
<td>3.62</td>
<td>3.54</td>
<td>3.46</td>
<td>3.39</td>
<td>3.33</td>
<td>3.27</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4.38</td>
<td>4.24</td>
<td>4.11</td>
<td>4.00</td>
<td>3.90</td>
<td>3.81</td>
<td>3.73</td>
<td>3.65</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>4.93</td>
<td>4.75</td>
<td>4.60</td>
<td>4.46</td>
<td>4.34</td>
<td>4.23</td>
<td>4.13</td>
<td>4.03</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>5.48</td>
<td>5.27</td>
<td>5.09</td>
<td>4.93</td>
<td>4.78</td>
<td>4.65</td>
<td>4.53</td>
<td>4.42</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>6.03</td>
<td>5.79</td>
<td>5.58</td>
<td>5.39</td>
<td>5.22</td>
<td>5.07</td>
<td>4.93</td>
<td>4.80</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>6.58</td>
<td>6.31</td>
<td>6.07</td>
<td>5.85</td>
<td>5.66</td>
<td>5.49</td>
<td>5.33</td>
<td>5.18</td>
<td></td>
</tr>
</tbody>
</table>

**Live floor loadings for different numbers of shelves and centre-line distances**

Facilities inside the controlled area should include reading room information, bibliographies, on-line catalogue terminals, the issue and return of books which can only be used in the reading room, copying equipment (in separate rooms), open-access book stacks, work spaces and, if necessary, the open-access book stacks.

The provision of work spaces in college libraries depends on the number of students and the distribution of individual subject groups. Special work places are required for people with disabilities (wheelchair users and the visually impaired) and for special operations (microform reading and enlarging equipment, PCs, terminals, use of CD-ROMs etc; take note of the relevant guidelines), as well as for individual study (cubicles, carrels, individual work rooms). Work spaces should preferably be in daylight areas. The area required for a simple reading/work place is 2.5 m²; for a PC or individual work place, ≥ 4.0 m² is needed.

Security is vitally important in user areas. Fire precautions must comply with national and local building regulations and procedures. The installation of a book security system will prevent theft, and the optimal security of unsupervised escape exits is achieved with automatic electronic lock-up when an alarm is triggered. Securing emergency doors mechanistically with acoustic and/or visual alarms is less effective.

The archive store is best situated in the basement because of the high floor loads and the more even climate. 'Book towers' are not convenient because of the increased need for climate control, transport and staff, as well as limited flexibility. The most efficient method is to have linked areas which are as large as possible without changes in level. The divisions between fixed stacks and those of mobile (compact) systems are dependent on the structural grid of the columns. Capacity can be increased by approx. 100% by using mobile stacks. The floor loading with fixed stacks is at least 7.5kN/m²; with mobile stacks it is at least 12.5kN/m².

The internal climate in user areas should be 20° ± 2°C, with approx. 50% ± 5% relative air humidity and air changes (fresh replacement air) of 20 m³ per hour per person. These values can be increased or reduced depending on the weather conditions. Avoid direct sunlight, since UV and heat radiation destroy paper and bindings. Because of the high energy consumption, and therefore high running costs, air conditioning should be introduced only where absolutely necessary. Natural ventilation is possible with narrow buildings.

The internal climate in archive stores should be 18° ± 2°C, with 50 ± 5% relative air humidity and air changes (fresh replacement air) of ≥3m³h⁻¹·m⁻¹. Air filtration is necessary to eliminate any harmful substances in the atmosphere (e.g. dust, SO₂, NOₓ etc.). By using wall materials with good moisture- and heat-retaining properties, it is possible to reduce the necessity for air conditioning. Slight air circulation is necessary to prevent the growth of mould, particularly with mobile stacks (use open ends). Special collections and materials (e.g. photographic slides, film, and sound data media, as well as cards, plans and graphics) require a special internal climate. The internal environment should be appropriate to each area of the library, rather than being uniform throughout, and no open-plan offices should be sited in administrative areas. However, full environmental control is needed in stacks, because the building structure alone cannot provide suitable conditions.

Floor loading in administration and book-processing areas should be >5.0kN/m². In technical areas (workshops), individual structural requirements will depend on the types of machinery and equipment. Reinforced concrete and steel-frame buildings with a structural grid of ≥7.20 m × 7.20 m have been found to be suitable owing to the flexibility they allow in fitting out. Room heights should be ≥3.00 m.

Transport books horizontally in book trolleys (avoid thresholds; changes of level should have ramps ≥5% or platform lifts) and/or on conveyor belts. Transport books vertically in lifts, on conveyor belts (the route must be planned very carefully, with sloping inclines; very low maintenance costs), by a container transport system (mechanically programmable, a combination of horizontal stretches and paternoster lifts) or by an automatic container transport system (routes can be horizontal and/or vertical as desired, fully automatic, generally computer-controlled; high investment cost, rather high running costs).
A pneumatic tube system can convey information such as lending tickets. Modern systems tend to use plastic conveyors, running in plastic tubes, with comparatively small plants. Other methods of sending call-slip information to the stack as part of retrieval communication are faxes, gravity tubes and document carriers. A computer link between the request counter and the stack is also possible. Ideally, all material should be moved directly to where it is required. The return of books to their correct place on the shelf is very important.

Lighting should be appropriate to the use to which the area is put. Bookshelves should be protected from daylight. Sensitive materials should not be exposed to a level >50lx. Artificial light is preferable in an exhibition area since it is easier to control. The best illuminance distribution ratio at workstations is 10:1 (book: surface:background). Non-work rooms need 100-300lx, stacks need 150-300lx, office and administration blocks need 250-500lx, and reading rooms without individual lights and catalogue rooms need 300-450lx. Lighting should have separate switches in each area and be individually adjustable at each work station.

Building design should be based on climate, and internal environmental control should be based on the building. The recommended temperature for reading rooms is open access areas is 22°C in summer and 20°C in winter, with 50-60% relative humidity and six or seven air changes per hour. Stacks should be kept at 17–22°C in summer and 17°C in winter, with 50–60% relative humidity and six to seven air changes per hour. The recommended humidity level in libraries is between 45% and 55%.

Special measures should be taken for unusual and sensitive materials; humidity which is too low or too high can damage films. The air should be changed at least three times per hour, depending on the area of the library and time of year. The air intake per cycle should preferably be 25%, but is often reduced to 15% for economic reasons.
Public libraries offer general literature and other information media which are directly accessible on open shelves. Systematic collections and subject searches of material in print and in other media are limited to the larger public libraries. Public libraries have no academic collection obligations or archiving functions, and are usually without, or with only very small, archive stores. They are freely accessible to the public, and are used by children, adolescents and adults. Public libraries orientate their level and choice of stock and services to the needs of their users.

As a communication 'market-place' for all population groups, in addition to the traditional provision of books, the library may have browsing areas, a citizens' advice/enquiries desk, a cafeteria, music listening facilities, recreation and meeting rooms, and study seating for groups and individuals. It may also include a music library, an art lending library and a mobile lending service. In addition to books and newspapers, the collection may include periodicals, brochures, games, or new media (CDs, videos, PC software) to be used in the library or borrowed.

The room design should encourage adults, children and young people to spend time in separate open-plan spaces where activities take place. The floor area depends on the size of the collection. There should be 300 m² of usable floor area for every 10 000 units of media in the collection. The objective is to have a minimum of two media units per occupant.

Ideally, the design should include large, open, extendible multipurpose areas, which are roughly square, and organised horizontally rather than vertically, and an inviting entrance. Areas for adult users can have five or six shelf levels (maximum reach 1.80 m - 3). In the children's area there should be four shelf levels with a reach height of around 1.20 m. Shelf aisles should not be more than 3 m long, and can also be used to produce niches and exhibition stands. Book transport should be with book trolleys 920 mm × 990 mm × 500 mm (D × H × W). The goods elevator should be at the service entrance, and larger libraries should also have book conveyors.

Floor loadings in public libraries should not exceed 5.0 kN/m², in archive storage and similar open access areas with closely spaced stacks they should be 7.5 kN/m² maximum, and with compact storage (mobile shelving) 12.5 or 15.0 kN/m².
Science libraries have always had a central position in science and life of universities. They are not only locations to store books, but also places to work with books. Important and decisive contributions to world literature have been produced in libraries. The erection of libraries is one of the most notable building duties of society. Important architectural examples from the 19th century (such as the Biblioteca Laurenziana, Florence, and the Bibliothèque Nationale, Paris) show how these demands were met. The Bereichsbibliothek Berlin → ① has a gross area of 3800m² containing 200,000 books in the reading rooms, 300,000 volumes in the open stacks and 8500 journals.
1. Ground floor of Düsseldorf University Library

2. Ground floor of institute library

3. Cross-section

4. Upper floor

5. Large library in USA

Architect: Düsseldorf Architects Department

Architect: author

1. entrance hall
2. catalogues hall
3. periodicals
4. natural sciences
5. reference section
6. human sciences
7. arts and music
8. poetry and fiction

Architect: Curtis and Davis
MUSEUMS AND ART GALLERIES

Museums and art galleries tend to have several of the same concerns, and as building types they tend to share many of the same features. In general, the main concerns of museums and art galleries are collecting, documenting, preserving, researching, interpreting and exhibiting some form of material evidence. For this purpose, many people with varied skills are required. There are, however, important distinctions not only between museums and art galleries, but also between the different types of museum and art gallery. There are institutions such as heritage centres, exploratoria and some cultural institutes which are considered to be types of museums.

To show works of art and objects of cultural and scientific interest, the institution should provide protection against damage, theft, damp, aridity, sunlight and dust, and also show the works in the best light (in both senses of the term). This is normally achieved by dividing the collection into (a) objects for study, and (b) objects for display. Exhibits should be displayed in a way which allows the public to view them without effort. This calls for a variety of carefully selected, spacious arrangements, in rooms of a suitable shape and, especially in museums, in an interesting and logical sequence.

As far as possible, each group of pictures in an art gallery should have a separate room and each picture a wall to itself, which means small rooms. This option also provides more wall space in relation to floor area than large rooms, which are nevertheless necessary for big pictures. The normal human angle of vision starts 27° up from eye level. For a standing viewer, this means that well-lit pictures should be hung 10 m away with the top not more than 4.90 m above eye level and the bottom about 70 cm below. The best hanging position for smaller pictures is with the point of emphasis (the level of the horizon in the picture) at eye level.

It is necessary to allow 3-5 m² hanging surface per picture, 6-10 m² ground surface per sculpture, and 1 m² cabinet space per 400 coins.

Calculations for museum and art gallery lighting are highly theoretical; the quality of light is decisive. Experiments carried out in America can be useful. Recently there has been a steady increase in the use of artificial lighting instead of daylight, which constantly changes even if north light is used.

According to experiments carried out in Boston, a favourable viewing space is between 30° and 60° up, measured from a point in the middle of the floor. This means a sill height of 2.13 m for pictures and a viewing range of 3.00-3.65 m for sculptures.

In art galleries there is generally no continuous circular route, just separate wings. Both museums and art galleries need side rooms for packing, dispatch, administration, a slide section, conservation workshops and lecture theatres. Disused castles, palaces and monasteries are usually suitable for housing museums. They are particularly suitable for historical objects, for which they provide a more appropriate setting than some modern museums.
MUSEUMS: EXAMPLES

Nowadays, many museum buildings are also used as culture centres, and this possibility must be included in the planning stage. Spaces must be available for permanent and temporary exhibitions, libraries, media rooms and lecture theatres. There should also be places for relaxation and refreshments, as well as space for transport, storage, conservation, workshops and administration.

Technological innovations are having a big effect not only on museum function, but also on the design of exhibits. Two examples are the computerisation of collection records and design documentation, and lamp miniaturisation and fibre optics and their effect on lighting design.
MUSEUMS: EXAMPLES

1. Art collection of North Rhine-Westphalia, Düsseldorf

2. Lighting detail

3. Plan

4. Museum of Modern Art, Münchengladbach

5. Extension to the Staatsgalerie in Stuttgart

6. Museum of Arts and Crafts, Frankfurt: east elevation and section

7. Ground floor plan

8. Wallraf Richards Museum, Ludwig Museum, Cologne

9. Typical cross-section, northern light, 53° glazing