Reinforced concrete
Positive: Thermal mass allows for regulation of temperatures.
Concrete can be moulded to a variety of forms
Conventional building material in South Africa, therefore skilled workers are available.
Negative: Expensive to demolish
Concrete is strong in compression and the reinforcing steel is strong in tension.

Steel
Steel elements can be taken apart and reused
Strong in tension- use smaller amount of material for spans. Can be shaped (hot rolled or plate folded) to create a variety of sections.

Glass
Glass is used to allow natural light into the building, to allow viewers to see into the building and to allow for a visual link between the different functions.
Sandblasted glass is used on the southern façade as natural light is beneficial to the occupants but the glare from the adjacent home affairs could be a disturbance. Self cleaning glass (rough surface dust cannot settle on).

Timber
Many elements can be factory produced and fitted on site – this provides higher quality. Timber is light and is used for the flexible walls and floors so they can easily be moved. Timber is also used for the interior cladding of the pods. High friction surfaces such as stairs and handrails should be varnished with colourless resin.
Louvre System
The ‘Colt’ glass louver system is investigated for the roof of the circulation hub. The louvers provide sufficient shading from the sun but still allow enough light through to illuminate the entire circulation hub. The louvers are controlled by a computer system in the BMS (Building Management Services) room on Level 3, to follow the sun’s path and change direction throughout the day. Louvres are also equipped with Photovoltaic Cells to generate electricity.
Technical Investigation

Structure
Technical Investigation

Structure

**MAIN BUILDING**
Reinforced concrete floor slabs of approx 300 deep supported by a grid (5x5m and 5x8m) of reinforced concrete columns varying in sizes from 500x500 in the basement to 300x300 on level 3.

**SERVICE CORE**
300 thick off-shutter reinforced concrete walls with 300 deep reinforced concrete floor slabs at every 3030 meters.

**AUDITORIUM POD**
Walls: 300 thick off-shutter concrete
Roof: Fitch truss consisting of 10x120 steel plates fixed between 50x152 timber beams with two M12x110 bolts. Trusses spaced at 2500 centres.

**LECTURE PODS**
Columns: 600x800 reinforced concrete columns
Beams: Three 400x400x10 thick steel double flange I-beams at the top and bottom of the structure to support frames.
Frames: Five 300x300x10 thick steel I-beam frames supported by beams.

**CIRCULATION HUB**
219x6x31.5kg/m hollow steel tubes each with four steel flanges of 100x6x4.7kg/m supporting 200 thick reinforced concrete floor slabs where platforms are required.

**WORKSHOP PODS**
Floor slabs: 300 thick off-shutter reinforced concrete slabs supported by 600x800 reinforced concrete columns.
Walls: 300 thick off-shutter reinforced concrete wall supported by 600x800 reinforced concrete columns.
Trusses: Three 300x300x10 thick steel I-beam trusses supported by three 400x400x10 thick double flange I-beams at to of structure.
Technical Investigation

Structure

Pods

The structure of the pods consists of steel frames supported by steel beams. Beams, in turn, are supported by concrete columns. The materials were chosen according to their structural qualities. Concrete is strong in compression and is therefore used in the columns where the strongest compressive forces are found. Steel, which performs well in tension, is used for the beams. For extra stability the steel beams are braced together at 1250 centres using a steel plate.

Due to the weight of the nose cone, distortion may take place in the steel frames. To prevent this, bracing is placed around the pod.
STEP 1: Reinforced concrete columns are erected.

STEP 2: Steel beams are fastened to concrete columns

STEP 3: Steel frames are fastened to beams.

STEP 4: Bracing is fastened around frames.
SLABS IN MAIN BUILDING

A conventional slab should have a depth of about 280-300mm and has a recommended span of 6 - 7.5m.

Slab thickened at columns: This method is used due to the fact that the slab can be more slender than a conventional slab. Only the part of the slab that meets the column is thickened to the depth of a conventional slab. This slab has a recommended span of 7-10m.

Reverse slab with thickened columns: The strength and calculations stay the same when the slab is reversed. The decision was made to reverse it to accommodate the access floor. This option results in the smallest overall depth for the floor and therefore allows for more headroom.

COLUMNS IN MAIN BUILDING

The columns in the main building are constructed of reinforced concrete. The sizes of the columns are determined by the load it carries; therefore those on the top floors are smaller than those on the bottom floors. Sizes range from 500x500mm in the basement to 300x300mm on Level 3. This will be sufficient in carrying the heavy load of the books which has a service load value of 5kN/m².
Formwork

Two formwork systems by Peri Wehahn have been explored. The first of which is the ACS (Adjustable Climbing System) which will be used for the reinforced concrete work supporting the pods. This system proves to be least time consuming and also more economic as one cladding system can be used for all columns in the pods.

The second cladding system to be used is the Quatro Cladding System. This will be used for the construction of the columns in the main building and is most economic due to the fact that it is adjustable to a variety of sizes ranging from 200mmx200mm to 600mmx600mm.

(Peri Wehahn Catalogue 2002)
Technical Investigation

Accoustics

Sound Quality
Sound quality in a building is affected by two factors, the first is the quality of the sound generated inside the building and the second is the amount of outside noise (unwanted sound) transmitted into the building.

Part of the sound is absorbed when it strikes a surface, part is deflected and part is transmitted. Soft, porous materials absorb a large amount of sound, therefore reduce the reverberation and improve sound quality inside the building. These materials include insulation materials, perforated timber, and furniture.

Materials that deflect most of the sound are good insulators. These are materials with high density and thermal mass such as masonry and concrete.

The average noise level in the CBD is 75-80dB but the accepted amount of background noise in an auditorium is 45dB. This is achieved by using materials with high sound insulation values.

Auditorium & Lecture Halls
Roof: The roof of the auditoria especially should be sound insulating to block out noise of a rain- or hail storm.

Two options were explored for the roof. (See calculations)

Shape: Parallel walls can cause sound waves to get trapped. This will result in distortion of the sound. To avoid this, the side walls of the auditorium and lecture halls are non-parallel and open up from the speaker towards the audience.

Profile plywood acoustic board: The roof and floor are parallel to each other at the end where the speaker stands. This will

<table>
<thead>
<tr>
<th>OPTION 1:</th>
<th>OPTION 2:</th>
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</thead>
<tbody>
<tr>
<td><strong>Option 1:</strong></td>
<td><strong>Option 2:</strong></td>
</tr>
<tr>
<td>1mm Copper cladding:</td>
<td>40mm cement mortar screed:</td>
</tr>
<tr>
<td>16mm Plywood,</td>
<td>150mm precast concrete slab:</td>
</tr>
<tr>
<td>230mm High Density Polyurethane Foam,</td>
<td>250mm cavity with 16mm plywood:</td>
</tr>
<tr>
<td>16mm Plywood</td>
<td>TOTAL:</td>
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<td><strong>TOTAL:</strong></td>
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If the average noise level outside is accepted to be 80dB, Option 1 will transmit 18dB which is well within the accepted range for auditoria.

If the average noise level outside is accepted to be 80dB, Option 2 will transmit no sound into the auditoria.
Technical Investigation

Accoustics

cause flutter echoes that could confuse the speaker. This is avoided by placing curved reflective panels above, that will reflect the sound to the audience instead of back to the speaker. The boards are fixed to a lightweight steel frame, welded to flat steel bars which in turn are bolted to the steel frames which form the structure of the pods.

Ceiling: Two thirds of the ceiling, from the speaker to the audience, is reflective so that the sound will be reflected to the audience. The back third of the ceiling is absorbent as it is not desirable for sound to reflect from here.

Walls: Apart from being non-parallel, the walls consist of a layer of high density polyurethane foam insulaton with plywood panelling over. The absorption quality of the walls are worked out as follows:

- 1mm Copper Cladding: 0.01 per m²
- 16mm Plywood: 0.15 per m²
- 230mm High Density Polyurethane Foam: 0.4 per m²
- 16mm Perforated plywood: 0.15 per m²
- TOTAL: 0.8 per m² (optimum for auditoria)

Furniture: Seating and other furniture, within the auditorium and lecture halls, are chosen to be made of absorbent material. The audience also acts as sound absorbers.

Sound insulation room: The lobbies of the auditorium and lecture halls are designed to act as sound portals and are
Technical Investigation

Accoustics

covered with sound absorbent material on the walls and ceilings.
All windows will be double-glazed for further sound insulation.

Audio Rooms

Walls: Complete sound proofing is required to avoid loud noises filtering through to the library and office space. This is done by using a 300mm concrete wall. Because of the high thermal mass of concrete, no sound will be transmitted. Absorbent panels are placed on the walls and ceilings to avoid sound distortion and flutter echoes between parallel surfaces.

Sound isolation portals: To avoid sound pollution into the library and office space all entrances into the audio rooms are fitted with double doors and sound insulation portals. This is also done because recordings are taken within the rooms and any noises from outside could be disturbing. All windows will be double glazed for further sound insulation.
Technical Investigation

Fire Regulations

An interview was conducted with Mr A. Steyn of the Tshwane Fire Department. All structural steel used for the pods will be treated with fireproofing paint according to NBR TT7 (SABS 0400). Sufficient escape routes are provided in accordance with SABS 0400. The main building has two fire escape stairs provided, thus ensuring that the maximum travel distance to a fire escape staircase does not exceed 45 meters. Each pod is provided with two to three escape routes of which at least one is a fire escape staircase. The auditorium is provided with two separate fire escape staircases due to the amount of users. Staircases comply with the national building regulations. All fire escape routes are fitted with fire doors with self-closing devices according to SABS 1253.

A sprinkler system is fitted throughout the building and fire hose reels are provided throughout the building at a rate of 1 hose reel per 500m² according to SABS 534. The concrete structure provides sufficient fire resistance according to the fire regulations. Signage will clearly mark escape routes and exits throughout the building.
A service core gathers all services in a central location allowing freedom to the surrounding spaces in terms of space planning, cross-programming and improved usability. A service core also makes the building more readable and is more economic as infrastructure can be grouped together. The services act as constants for the rest of the building to refer to. The correct placement of the services allows for design opportunities and can emphasise the concept.

**Sewerage System**
1 Stack system with no more than five appliances per branch pipe.
Stack pipes 150mm diameter
Soil pipes 100mm diameter
Waste pipes 50mm diameter.

**Water**
Water heated with solar power in service core with backup electricity. Water to be heated up in close proximity to where it will be required.

**Electrical**
1 distribution board per 2500m²
Emergency generator for power failure and for lighting of escape routes for minimum 60 minutes
SEWERAGE SYSTEM

Above Ground
Single stack system where the stack serves as both the discharge and ventilation component. No more than five appliances are permitted per branch. Each waste appliance shall have a ‘P’ trap with a water seal of no less than 75mm.
The 2 way vent must be located minimum 2500mm above any surface used for pedestrian circulation.
A minimum radius of 300mm must be provided at the foot of the discharge stack.
Stack pipe: PVC 150mm diameter
Soil pipe: PVC 100mm diameter
Waste pipe: PVC 40mm diameter

Below Ground
The invert level at the foot of the stack may not be less than 450mm.
Drain pipes must be laid in a straight line with a minimum slope of 1:60. Rodding eyes and inspection eyes must be provided as stipulated by SABS 0400.
Technical Investigation

Ventilation

Because of the functions housed in the building, it could not rely solely on passive ventilation. The temperature in the library has to be kept constant and mechanical ventilation is required. Mechanical ventilation is required for the auditorium, lecture halls and offices to obtain optimum comfort levels because of the large volumes of people that will use them at a time. However, other passive design techniques can be used to reduce the demand on the mechanical ventilation system. These were discussed in the design investigation chapter.

![Diagram of ventilation system]

**Plant Room**
- Watertight spring loaded floor
- All surfaces finished in white ceramic tiles
- Space requirements:
  - Length: 16,000
  - Width: 4,000
  - Height: 3,500

**fig. 6.19 & 6.20**
Centre Pompidou, Paris, France. 1971-1977 by Renzo Piano and Richard Rogers. The services are placed on the outside of the building, freeing up the interior to allow for flexibility.