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ACOUSTIC DESIGN FOR THE REBUILT ST.AUGUSTINE'S CHAPEL, TONBRIDGE SCHOOL, KENT

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1. THE ORIGINAL CHAPEL

The grade II listed Chapel to Tonbridge School, Tonbridge, Kent, was built in two stages between 1900 and 1909 to the design of William Campbell Jones. The plan footprint was very similar to King's College, Cambridge, but featured a hammerbeam roof with faceted barrel timber boarding ceiling. An organ loft sat above an ante-chapel, one bay in from the east end. The arrangement of widely-spaced organist, choir, and clergy at the west end ambos, made coordinated performance at services difficult. Pews were grouped in school houses, facing across a central aisle.

2. THE FIRE

A fire in September 1988 totally destroyed the roof and internal features. Remaining upper walls and window stonework was taken down for reasons of safety. An initial proposal to build a new modern chapel designed by Richard MacCormac was vigorously and successfully opposed by local residents. Three years were to elapse before the commencement of a scheme comprising traditional forms to recreate a period exterior, with more modern internal interpretation. Present-day requirements for seating, liturgical flexibility, and acoustic performance were key aims. The architects were The Buttress Fuller Alsop Williams Partnership.

3. THE BRIEF

The £7m rebuilding of the chapel was funded by that ancient institution, the Worshipful Company of Skinners, assisted by fire insurance monies. The brief included expanding seat numbers to up to 750, with appropriate conditions for worship,

assembly, choir and orchestral concerts, organ recitals, recording or broadcast sessions, lectures, and even drama. To achieve the increase in seat numbers, the organ is moved to the extreme east bay and a lady chapel is added. The choir bays were moved one bay eastwards to maintain an already tenuous relationship. The Headmaster is an organ enthusiast and was firm that a powerful new instrument should fill the east end, and that the natural acoustics should favour organ recital as the priority use. This created a significant challenge for the incorporation of a high quality speech reinforcement system, considering the target of mid-frequency reverberation times of 3.5 seconds. The desire was to have state-of-the art technical facilities within a deceptively traditional exterior.

4. ACOUSTIC DESIGN

Initial study centred on environmental noise: the site has activity at 5000 feet from Gatwick, Heathrow, London City, Luton, and Stansted airports as well as local low-level overflights from West Malling and Rochester airfields. The resulting design incorporated lined attenuation paths from roof-level natural ventilators opened seasonally, and roof upgraded in mass by counterbattening and decking, as well as thermal insulation and decorative soffit boarding.

As no records of the previous acoustic of the Chapel interior existed, ODEON 3D computer modelling techniques were used to compare the original hammer-beamed barrel vault with favoured new arrangement options - flat ceiling or angled ceiling on the same profile as the roof. A flat ceiling proposal was dismissed after consideration of room modes and sound reflection patterns. Results indicated a much improved pattern of sound dispersion from organ or choir sound sources, for the angled ceiling option.

Context for the acoustic was assisted by measurements at two longstanding spaces for worship and organ recital - King's

College, Cambridge, and St John's, Smith Square, London. These are shown on the graph alongside measurements we undertook earlier at two other organ recital / ceremonial halls, the Victoria Hall at Leeds Town Hall, and The Great Hall at St George's Hall, Liverpool.

Ventilation noise is not a welcome intrusion of modern life in a place of quiet worship. Originally, a conventional fully ducted system was proposed with air change rates meeting statutory minima for places of assembly. However, as a place of worship it was found permissible to provide only a nominal air change rate by eleven fan coil units concealed behind heavy oak panelling. Sample fan coil units (more familiarly used in offices) were tested first in the University of Salford's laboratories and later in a whole-bay mock-up, against specified permitted sound power levels to achieve NR25 for the low-speed normal setting. The units are attenuated by lined supply and return air passages, working within the operational limits of such units.

5. THE ORGAN

The organ is a powerful instruments designed by Marcussen and Son, who have since completed installation of the organ to Bridgewater Hall, Manchester. The architects expressed concern that the 32-foot Subbass and Bombarde pipes would cause sympathetic resonance in the exposed structural steelwork or chandeliers but this has been avoided.

6. SOUND SYSTEM

A £60,000 specialist subcontract was let within the electrical subcontract. A high-quality speech reinforcement system comprises 30 loudspeakers and 19 microphone locations, divided into time delay zones.

The main loudspeakers sit on pedestals, two per bay. The architect would only accept minimally thin column loudspeakers, mounted vertically directly against chamfered

pier sides. The desired placement would have been skewed on plan and tilted downwards from the vertical. It was necessary to design from scratch: cones, mounting, casing, and drive unit. One-off prototypes were laboratory tested so the desired propagation characteristics could be obtained electronically, ie the directional beam was 'bent' downwards.

Each main loudspeaker serves a discrete area of pews, a House of pupils, on the opposite side. Directional characteristics are essential to enable reasonable speech intelligibility in a space problematically over reverberant for speech.

Aided by intercoms and monitor loudspeakers, organ music at the west end can be coordinated to the choir in the centre, and addresses from the east end ambos. Young chorister voices are slightly amplified to subtly lift the command of the choir, using microphones concealed in the chandeliers. The Lady Chapel can be served from the body of the Chapel, or have its own gathering relayed.

Lighting and sound systems are run from a mimic control panel location at the west end. Racks are set in the vestry switch room.

An AFILS system is set under the floor, care being taken that metal grilles over floor heating pipes do not adversely affect the loop's efficiency. Segregation of cabling to the lighting, power, and deaf loop runs was strictly adhered to.

7. COMMISSIONING

Attendance at commissioning, instructional sessions to operators, and on-call at the Service of Dedication, were important to ensure that a complex system can be used adequately by pupils rather than, say, a resident sound engineer.

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Reverberation times and other natural acoustic parameters were taken near to handover. Target values of 3.5 seconds at mid frequencies, unoccupied, have been achieved. Occupied values are around 2.6 seconds, depending on format numbers.

The project was completed in October 1995 and has since won several awards for design and craftsmanship including in November 1996, an RIBA Regional Award and the Downland Design Award.

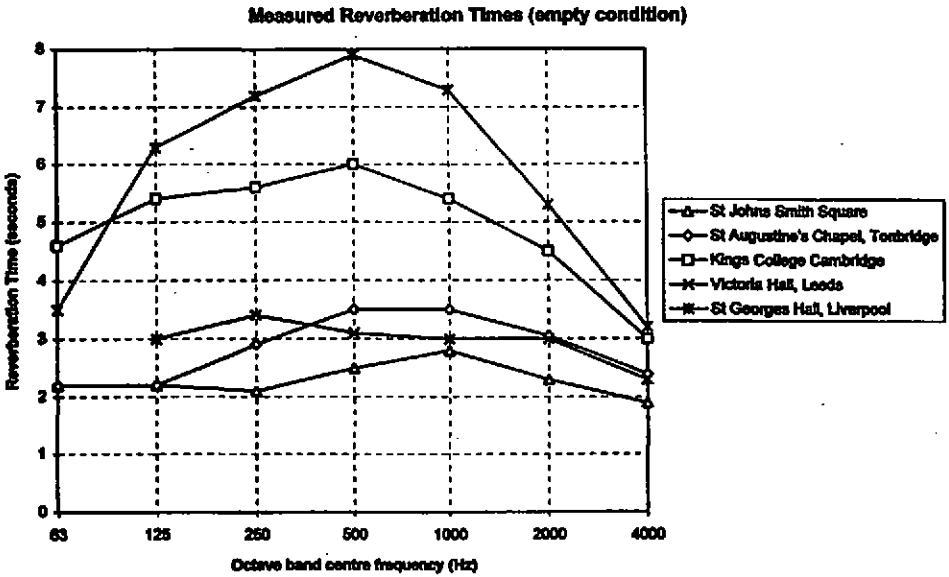

FIGURE 1: Reverberation times in 5 organ recital/ceremonial halls (unoccupied seats; seats present)

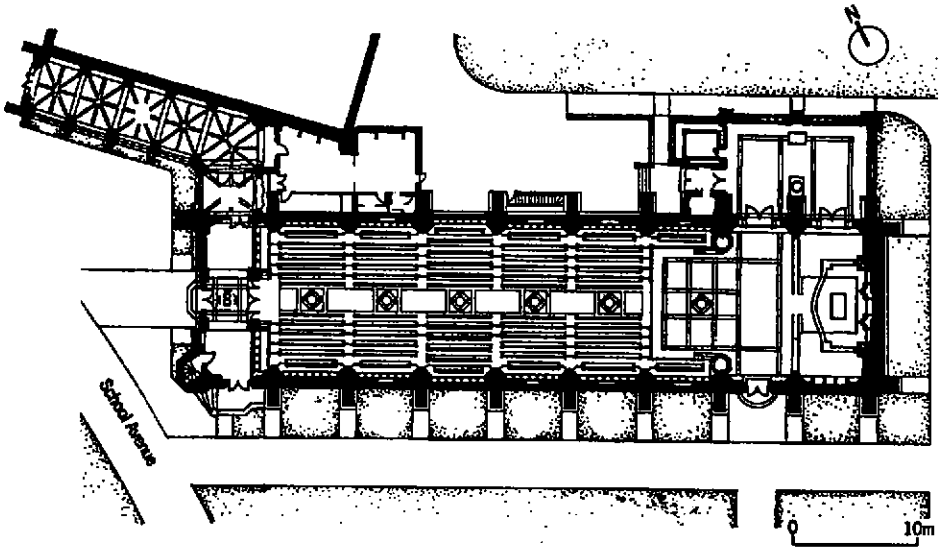

FIGURE 2: Plan

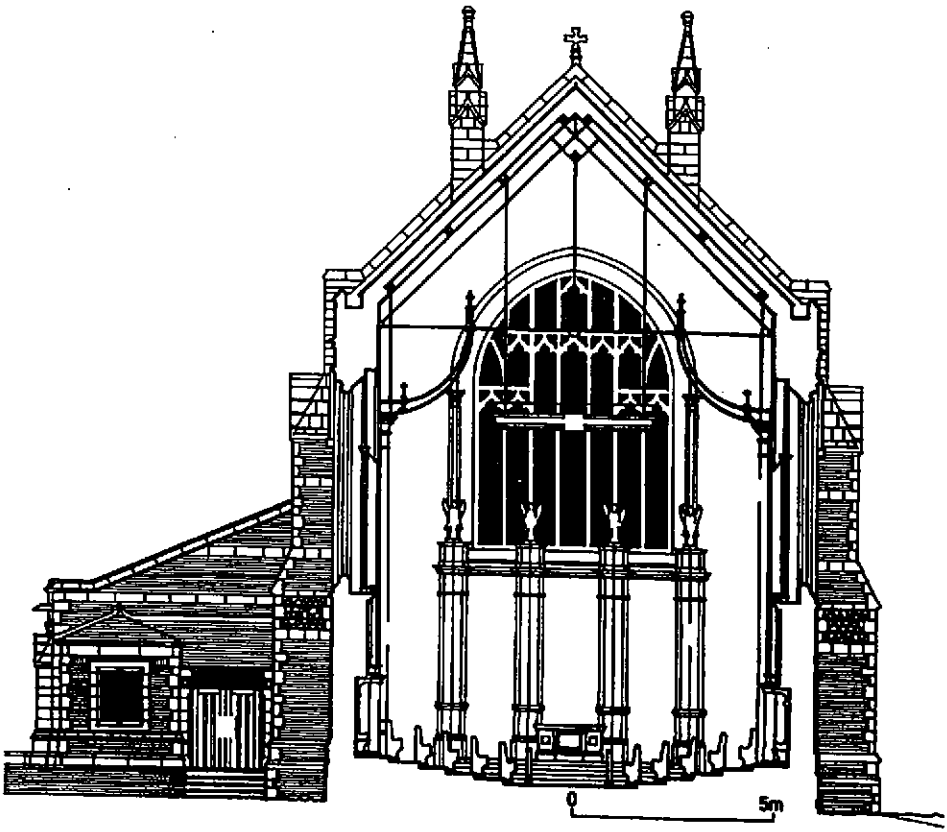

FIGURE 3: Section

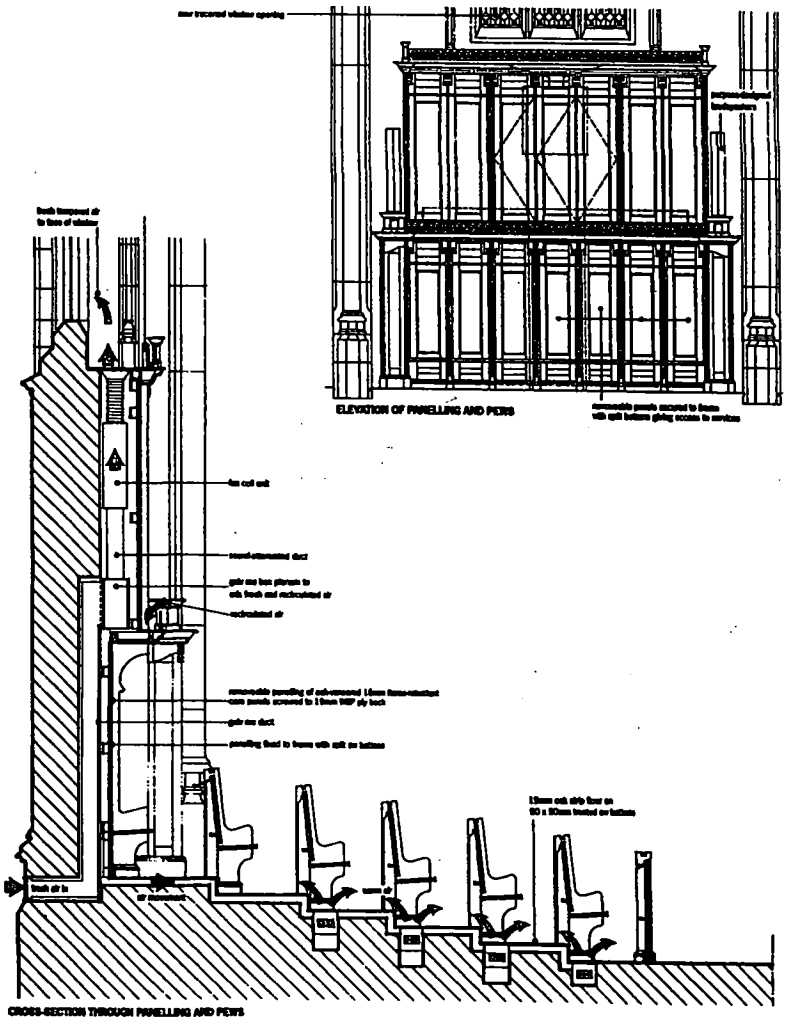

FIGURE 4: Typical bay - ventilation unit and loudspeakers