



Document title: Memories of an Acoustic Consultant, 1961 to 1980.

Author/s: Ross Thorne,

Summary / abstract: This memoir is specifically about my interest in acoustics, from my learning about the discipline of architectural acoustics to starting consulting, first for architects, Joseland & Gilling in 1961.



I then met H. Vivian Taylor in Melbourne who was possibly the first acoustic consultant in Australia. He became an acoustics mentor and we undertook some commissions in Sydney in association. They were specifically the new ANZ Bank building on the cnr of Pitt and Hunter Streets, Cowells' White House (floor isolation) and the Staccato Club, Kings Cross.

Psychologist, John Metcalfe, had been approached to work on the acoustics of some recording studios. I did the architectural work, including quite a luxurious control room for the studios at J. Albert and Sons, King Street, Sydney.

My final commission was for the acoustics of a small theatre in the RMIT Union building, Swanston Street, Melbourne, designed by John Andrews and Associates, architects.

NOTE to elucidate the reproduced graph on the Staccato Club sound level measurements: The top curve is the traffic noise immediately outside the front door of the club, it masking all noise from inside, wherever the position of measurement was outside the club.

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## **Memories of an Acoustic Consultant, 1961 to 1980**

Referrals for acoustic consulting arose out of my University of Sydney Bachelor of Architecture thesis. In our third year at the University, nine lectures were given in acoustics by Evan Trevor Jones. As well as being a teacher of building construction he taught acoustics. From him I learnt some principles, some of which stayed with me. It only needed a relatively small amount of additional reading to be able to design the acoustics of a concert hall for my Bachelor of Architecture thesis. What was lacking in my education was the acoustics of vibration that comes from machines. However, I did find an excellent mentor with respect to this aspect of acoustics in H. Vivian Taylor from Melbourne.

It was my former University student colleague, Ken Reynolds, who contacted me in 1961. He was working for the architectural firm, Joseland and Gilling (later becoming a partner), when he phoned, remembering my thesis specialisation, wondering whether I could help with a few of his firm's acoustic worries. At first they were simple noise control problems – checking, for example, design proposals for the new ANZ Bank building on the corner of Pitt and Hunter Streets, Sydney (May 1961). Car parking would be immediately above the banking chamber accessed from a ramp off Hunter Street. Would noise penetrate the banking chamber? They were worried about possible noise of stamping passbooks, and from typewriters reverberating around the high-ceilinged space of the banking chamber. Noise penetrating down from the top floor machinery plant room was also a risk.

There were smaller but significant problems of a high level of air-conditioning noise at the Perpetual Trustee's offices (May 1961), and ledger machine noise in an office of the Colonial Mutual Life Building on the corner of Martin Place and Pitt Street (July 1961); while at Industrial Acceptance Corporation noise from "Addressograph" and "Graphotype" machines (before the days of computers with "mail-merge" and laser printers) was causing stress to office staff working nearby (September 1961).

For these jobs, since I was also tutoring at the Department of Architectural Science (University of Sydney), I was able to borrow the department's sound level meter. That meter measured the level (or in common language, volume) of the whole sound or noise in decibels. It was a fairly gross form of measurement because the problem might be a high pitch, or low pitch sound. And different building materials act differently to sounds of different pitch. Equipment was needed that would split up the incoming sound or noise into pitch segments – in fact, octaves. It would be like carving up the octaves on a piano keyboard and only hearing the notes being played on one selected octave even while all the others in the piece of music were also being played. That is, one octave is selected and measured while all the others are filtered out. What I needed was a sound level meter with an octave band filter.

In 1962, when I became a tenured full-time lecturer in the Department of Architecture, Professor Ashworth encouraged me to enroll in a Masters degree. I at first wanted to do it on acoustic design of theatres but such a thesis would come under the purview of Ashworth's *bete noir*, the Department of Architectural Science. He told me that it had to be within the envelope of subjects administered by Architecture. Perhaps I could still research historical examples of theatres in an acoustical framework. My interest was in the reverberation times of the auditoria.

Reverberation time is the time it takes for the sound to fade away ("decay" in the jargon) in a space. Clap one's hands once in an open field the sound seems to stop as soon as it is made. Do the same in a large stone cathedral and the sound of the clap will slowly fade away. From the clap of the hands, to its generated sound being completely inaudible, is the reverberation

time. An auditorium requires a reverberation time that suits the type of performance. For example, an auditorium that makes an orchestra sound “dry” or dead may be too reverberant for speech, with each syllable seeming to flow into each other thus making intelligibility difficult. To measure this decay time I needed a graphic recorder – one that transferred the sound via a pen onto paper that moved at a standard speed per second.

Being dissatisfied with the 40-year old unchanging curriculum of first year Architecture at Sydney University, I sought special leave to investigate major schools of architecture in the USA and Europe. During this special leave at the end of 1962, I also arranged to see Robert B. Newman of Bolt, Beranek and Newman, major acoustic consultants in the USA. At a meeting with Newman, he recommended that I visit Bruel and Kjaer, in Denmark, the then major manufacturer of acoustic measuring equipment. This I did, and immediately purchased a sound level meter with octave band filter and a graphic recorder. The latter was a robust, extraordinarily heavy piece of “portable” equipment. Robert Newman thought these two pieces to be basic equipment for an acoustic consultant at that time<sup>1</sup>.

I did not however, get to test many historical theatres – the Theatre Royal, Hobart (November 1963), which was helpful in its later restoration after a fire that destroyed the stage; and the Capitol Theatre, Melbourne, before the removal of the stalls level. To obtain a reverberation (sound decay) time a sudden explosive sound or constant sound that abruptly stops is necessary. For the Theatre Royal test, pricked blown-up balloons were used. At the Capitol Theatre, a “Ramset” explosive power tool, loaded only with the explosive charge, and held firmly onto two phone books to prevent any hitting sound on the stage, was used. (This latter method was recommended by H. Vivian Taylor, although he himself used a small pistol with blanks.)

In the consulting work the sound level meter was essential for virtually every commission except for those that only required commenting upon proposed designs. A forecast use of the graphic recorder was seen in 1961, when in August, Joseland and Gilling asked me to peruse the sketch plans for the music unit, including a 200 seat auditorium at Wollongong Teachers’ College (now the University of Wollongong). They were designing it for the Public Works Department which was the consultant to the Department of Education of NSW, the actual client. One report was made in 1961, and another in 1962 when the reverberation times for the auditorium were recalculated, together with recommendations for materials to achieve optimum times in all octaves. A third was made near completion in 1965 when, to my amazement I was still being presented with inappropriate furnishing materials. It should have been obvious to a building design professional that they would not achieve the required times. Indeed I was quite furious when I saw that the Department of Education had installed seating (without consulting Public Works, the architects, or myself) that was quite inappropriate if good acoustics were to be achieved.

Robert Newman had told me, at our meeting in 1962, that acoustics was largely common sense. You only had to understand a few principles that can be observed every day. He meant that there was a simple logic to understanding those principles – what sort of materials absorbed sound (basically thick soft fluffy ones), what materials reflected sound (hard surfaced ones), and the heavier and thicker a material the less likely that sound will pass through (i.e. in everyday language it will produce soundproof conditions on the side away from the sound source). Relying on these principles are many of the compound materials. However, when a heavy

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<sup>1</sup> On 18 December 1962 I met Robert Newman for lunch at the Faculty Club at the Massachusetts Institute of Technology where both he and Leo Beranek taught acoustics. Beranek had written and/or edited a number of books, particularly on noise and vibration control in buildings, and on concert hall acoustics.

woolen curtain is required for its high absorptive value to cover a glass wall, and something akin to mosquito netting is suggested as an alternative by an architect or building engineer, one wonders about people's intelligence. When an architect, who was about my age and should have had similar training, could not understand what was meant by the sound transmission coefficients (the 'sound proofness') in a catalogue of pre-made doors, I thought, "No wonder people complain about noise in buildings".

Not only did architects not seem to understand much about noise and how to avoid or eliminate it but electrical/mechanical engineers, who designed air conditioning systems, amazed me for what seemed a complete lack of knowledge. Excessive sound would come through ducts; rigid connections would be made, resulting in the transmission of noise from machines into the building structure; and machines would not be installed with adequate anti-vibration mounts.

Joseland and Gilling, in one of their commissions, were aware of what might happen with plant room design and said they did not want the result that was in the United Insurance Building in Sydney. That building, on the north-east corner of George and Hunter Streets, was a relatively new 1960s building at the time. I went to the staff cafeteria immediately under the air-conditioning plant-room on the top floor. I stood there, or tried to, in disbelief. My whole body was quivering like jelly and my teeth were chattering, as if I was extremely nervous or suffering shock after some dreadful event. The air-conditioning cooling compressor, to service the whole ten or so floors of the building, had simply been placed on a block of concrete that only had between it and the plant-room floor, a sheet of cork that was allowing the machine's thumping vibrations to radiate through the building structure to the floor(s) below.

H. Vivian Taylor joined with me for a couple of consultations that required very careful acoustic design for air-conditioning and electrical systems. As he mainly stayed in Melbourne, I helped him out on a couple of his commissions in Sydney. I had contacted Mr. Taylor in 1963 as part of my theatre history research. His architectural firm of the 1930s, Taylor Soilleux and Overend, had designed a number of cinemas in Victoria, and he had been an acoustic consultant on some hundreds of cinemas to improve their acoustics when sound films were introduced (1929-30). We discussed my interest in acoustic consulting and my limited knowledge with regards to designing the mounting of machines to prevent transmission of vibration. Vivian Taylor belonged to the 'old school' of professional person. He was tall, straight, although thickened around the waist, grey-haired with a grey moustache, wore a grey suit, collar and tie, rarely divesting himself of his suit jacket. His only apparent affectation was the tilt on the rim of his hat. Whereas the English had particularly shaped and styled hats for people of different classes or class aspirers – such as the bowler and homburg hats – most Australians resorted to a soft fur-felt hat, moulding it to suit their personal taste. Although a very few people may have had a brim that rolled up slightly all round, a few had the brim turned down all round, the majority had it turned up at the back and down at the front to shade the eyes. Taylor had his unusually turned up on one side and just slightly turned down for the remainder.

Vivian Taylor was a fatherly figure in the 1960s, never ruffled, but quite concerned and positive in his diagnosis of, and solution to a problem. He was both willing to learn and unstintingly generous in passing on his knowledge. In an interview with him, hopefully to document his life, I made little progress in discovering much about him. He would discuss some commission in detail but finding out general biographical information and history of his practice, was like drawing teeth. Yet he must have had both a passion for acoustics and a quiet drive to

understand the then new science, and become, in his consideration, the first professional architectural acoustician in Australia.

It should be remembered that public radio broadcasting started in the early years of the 1920s; electrically recorded gramophone discs started to come onto the market in 1926, thus permitting electrical reproduction of music on radio. The years 1929/30 saw the introduction of sound films into Australia, and conversion of cinemas to allow the reproduced voices to be heard by audiences. Before the 1930s, acoustic testing of auditoria was undertaken by dropping a pin on a hard-topped desk, tuning forks, and organ pipes. Reverberation was timed by human hearing in conjunction with a stop-watch.

Taylor went to World War I, then could not afford to be indentured (as an apprentice) to an established architect, so worked on building sites. Finally, he sat for the Royal Institute of British Architects examination and became an architect in 1921. Prior to 1928 he was asked to assist with acoustic difficulties mostly in churches; then, in 1928, he professionally became an acoustic consultant. It was very timely. He would shortly design or correct the acoustics of over 500 auditoria, predominantly those of picture theatres. With the Australian Broadcasting Commission being set up in 1932 and quickly establishing radio stations across the country, new studios were required. Taylor started designing such studios in 1931<sup>2</sup>, and continued through the decade to finally design the ABC studios for 2FC and 2BL in Forbes Street, East Sydney, to replace the primitive ones in a little building at 96 Market Street, Sydney<sup>3</sup>.

I first asked him to assist with the ANZ Bank (Pitt and Hunter Streets, Sydney) for machinery isolation. He really knew his theory and practice and, unlike so many mechanical/electrical engineers, would not accept almost any manufacturer's claim that would give the 'answer' to machinery isolation. Lead-asbestos pads, promoted by a manufacturer, were not to be used, according to Vivian Taylor, and cork had to be very carefully designed and used. You might say he was a 'springs man'.

When you think of a motor car, this made sense. If the road is the 'machine' that is 'vibrating' (through the wheels passing over corrugations, etc.), something has to iron out those vibrations from the passenger compartment. The springs do this, but only if they have the capacity to deflect, or for coil springs, compress a considerable amount. They must be under constant deflection to be effective. We have seen how an empty truck will chatter along a road as if it has no springs, but when full, some of the road surface roughness is ironed out. In some cars it becomes apparent that the ride is 'smoother' when fully loaded than when empty. This is because the springs deflect more and remain with that deflection while there is a greater load. This deflection allows the vibrations imparted from the road to be absorbed by the springs. In a machinery plant room the whole thing is reversed. You do not want the building to vibrate (as happened at United Insurance) so each machine needs to have springs (or equivalent) with sufficient deflection to absorb the vibration from the rotating or reciprocal moving parts in a machine. Frequently, to make the springs more effective the machine is loaded up with a block of concrete (like loading up the car, or putting a bag of cement in the boot). This makes the machine more inert -- less likely to bounce around on the springs. Vivian Taylor designed the mounts for the machines in the ANZ Building plant room, and also for the large air conditioning plant room at the ANZ Data Processing Centre at North Sydney (1968).

<sup>2</sup> Biographical information on H. Vivian Taylor is from responses to a questionnaire I sent him on 1<sup>st</sup> October 1968. On file under "architects".

<sup>3</sup> The design of the new Forbes Street studios was announced in 1940, but only the lower floors were built, work being stopped during World War II. The offices and studios at 96 Market Street remained for some years in the domestic scale building of around 1860 vintage. It was adjacent to a side exit to the stalls of the Theatre Royal (Castlereagh Street), almost backing on to the side of the stage of the original Her Majesty's Theatre (Pitt Street), and at the ground floor of which was one of the chain of Repin's Coffee Lounges. As the ABC expanded and leased more accommodation 96 Market Street became used almost solely for drama and children's hour production. The building was demolished for the Centrepoint development.



Another problem that was frequently overlooked by mechanical/electrical engineers, plumbers and electricians was with the pipe and electrical connections to the machines. These tradesmen connected machines when they were idle, forgetting that, when operating, the vibration would be transmitted by their pipes to the building structure. Flexible connections were required at the machine, and possibly further vibration isolation would be needed for some distance along the pipe before fixing directly to the building. In buildings where only very low levels of noise can be permitted, like theatres and recording studios, whole plumbing systems and toilets might have to be isolated from the structure.

*ANZ Bank building on corner of Pitt & Hunter Streets, Sydney.*

Additional vibration and air-borne noise reduction from machines can be had by sitting all the machines with their spring mounts and inertia blocks onto a superimposed concrete floor that 'floats' above the structural floor. My first experience of one of these was in Cowell's White House in George Street, Sydney, three doors north from Market Street. Mr. Taylor asked me to supervise the laying and 'jacking up' of a floating floor. It was not for mechanical equipment in the usual way. Silhouette Studios had an exercise gymnasium in one of the upper floors of this Edwardian warehouse. The floor structure was of heavy timber, typical of the period of building. There were offices in the floor immediately below. The office workers would figuratively leap out of their respective skins when the muscle builders upstairs dropped their bar weights; and there would be the thump, thump, thump, thump of running on the spot. It all became too much to bear. The solution was a 'floating floor' to isolate the vibrations. The

whole floor, extending from the George Street front almost to the rear at York Street, was covered with a waterproof membrane, steel reinforcement and concrete (floor) in which, on a grid of almost a metre both ways, circular pots had been incorporated. These were of a special design to take a kind of neoprene ‘rubber spring’ (rubber-in-shear mount). A team of men, starting at one end of the room would, with long spanners, gradually jack up the cured concrete floor by making one turn at a time, of bolts in the pots. Once jacked up, one bolt at a time would be unscrewed and be replaced by a rubber ‘spring’. After removal of all the bolts all mounts would deflect about 8 millimetres, thus producing a ‘floating’ floor<sup>4</sup>.

Stage 1 of the ANZ Bank Data Processing Centre had one such floating floor in its plant room. In 1968 computing equipment required for central data processing of a bank was large. (This was long before computer terminals appeared on teller’s counters.) There were rows of main frame machines on which were large reels of wide magnetic tape. Unlike today’s PCs they were very sensitive to vibration and changes in temperature and humidity; and they generated considerable heat that had to be counteracted by an extraordinary amount of air-conditioned air. All the customer-written cheques ended up at this Centre, and they had to be (mechanically) sorted and manually entered for the amounts (as a bank teller now does at the counter). Three floors were taken up with this activity, including (on one floor) the computers and ancillary equipment. In the basement was a large diesel stand-by generator in case of power failure. That was set into the rock foundation with a huge inertia block of concrete sitting on compressed cork pads (cork being sufficient for this environment).

The job was an acoustic consultant’s dream or nightmare, depending upon how one views complexity and detail. The three floors of used space had to be thoroughly considered to reduce air-borne noise to the workers. Air conditioning ducts had to be only at the north and south perimeter walls to maintain the space between as open as possible for complete flexibility. The ducts dropped down from the plant room; they themselves were a possible cause of transmitting vibration and noise that had to be eliminated before it happened. It was very rewarding to see it all come together and work. For the time it was a state-of-the-art solution, but unfortunately, because of the high security nature of the business, students could not be taken on a site visit.

Over the years the number of computers was increased – and in 1973 I was again commissioned to consult on the acoustics of adding a second stand-by generator – much more precariously placed on the roof this time. It was to be adjacent to the Pacific Highway, together with an additional air intake for cooling it, thus requiring a huge fan. At night, in particular, the fan could cause an environmental noise problem. I was then working with psychologist-acoustics lecturer, John Metcalfe, on a few recording studios, so we worked together on this job. However, whereas he did the acoustic calculations for the studios and I designed and detailed the architectural fabric to suit, the vibration isolation calculations and specifications were carried out by myself for this second stage of the Data Processing Centre.

It was not simply a matter of plomping a generator on the roof. The English Electric diesel motor and generator set was as large as the one in the basement – 750 KiloVolt Amperes, V12 (cylinders) engine – weighing nine tonnes. And sixty thousand cubic feet (approx 600 cubic metres) of air was required to pass over it every minute to maintain the engine at constant operating temperature. Also, it could not be supported on the floor/roof structure: this was made up of many Tee shaped beams to span across the building without intermediate columns; they were in pre-stressed concrete which produced a floor that was equivalent to a taugth drum.

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<sup>4</sup> The work was carried out in January/February 1965, and filmed on 16mm to show the technique. The film titled “Reducing Sound Transmission Through a Floor” on the DVD-R, *Two Acoustic Films*, is deposited at the National Film and Sound Archive, Canberra.

Even if it was possible, the generator, on such a floor, would have bounced and set up a trampoline-like wave motion in the floor. It could only be supported by the relative rigidity of the northern and western walls through a new structural frame beneath it. English Electric normally installed the generator on rubber mounts, but these only isolated high frequency vibration. It was essential to reduce low frequency vibration which was more likely to be transferred through the building. Whereas the rubber mounts only compressed (deflected) about one centimetre we required a compression in excess of four centimetres. Steel coil springs were needed. When completed, a push on the frame of this nine tonne weight, made it move slowly and gently like slow-motion jelly, or the languid wobbles of a water bed after someone moves on it. Of course, with this kind of fluidity of movement it would move even further when starting up, with the reciprocating engine placing an additional force on the springs down one side.

The lability of the machine produced another problem to solve: the usual so-called flexible connections for pipes, including a large diameter exhaust to the engine, were not designed to accommodate the large anticipated movements. Different methods of connection had to be evolved. The exciting part about designing such a scheme is not only the complexity but having to use what I might term peripheral attention – like using peripheral vision if you are a racing car driver – to be aware of all possibilities and have one's attention drawn to them. For example, a simple ladder was needed to get up to service the engine or observe it while operating. No trouble, just lean one against the engine. But the vibrations would immediately be transferred to the floor and building. A ladder therefore was needed to be welded onto the supporting frame of the engine, hang down, but remain short of touching the floor. Every pipe, duct, waste-trap and electrical connection had to be thought of in this way.

Such complex noise and vibration jobs were fairly rare; most were mundane tests and analyses that were an outcome of complaints, although local councils were becoming a little more aware of possible community concern, and required reports on anticipated noise levels and their effects from industrial development proposals.

For example, in 1963, the blue metal aggregate quarry at Hornsby (a far northern suburb of Sydney) was being surrounded by housing development but the company wished to extend operations. The company sought the assistance of John Clarke of the Department of Architectural Science at Sydney University but the Department did not have a sound level meter with an octave band filter, and I did. We needed this to establish what were then called noise criteria curves, similar to noise rating curves. These were required since the human ear is more sensitive to high frequencies (or high pitched sounds) than low, but the sensitivity to low frequency sounds increases as the noise or sound becomes louder. Such curves, drawn as graphs from the readings on the meter, were used in all noise analysis reports. The RSL Club, conducted in the Memorial Hall at Bellingen, was worried that the noise on show nights might worry the reverend occupant of the Presbyterian Manse next door (1967). There had been complaints against noise from the "Balmain Volunteer" restaurant in 1973, so measurements were made in January and February the next year – a time when the opening of doors and windows would be maximised. It turned out that extraneous noises such as dogs barking were the only sounds that rose above the ambient traffic noise. In examples such as this the complainants may not have liked a restaurant next door, or close-by and had developed an "attentive perception" for the particular sounds, so reinforcing their dislike of the restaurant. In such cases the sound level meter picks up no increase of sound level but the human hearing system can pick out different components of the sound even when they might be considerably lower in level than the ambient or general noise created by traffic and the pub (or similar) over the road.

Two clubs had similar ‘problems’, the complaints about which may have been initially due to dislike of the premises, then attentive perception of any noise associated with the premises. The Ryde Businessmen’s Club wished to increase its facilities but there were complaints of the noise of cars leaving between 10.00 and 11.00pm. Yet the club was on one of the busiest local roads – a main road to Parramatta and the West<sup>5</sup>.

The second “club” (by name only) was at Kings Cross. It was in Orwell Street, a narrow, almost lane, but with considerable ambient noise from traffic and sounds from adjacent streets. When I approached the building that housed the Staccato Club on the ground floor, at about 9.00pm, I could not even hear anything except the ambient noise. With the case containing my sound level meter, I opened the outer door and was met by a gruff man of seemingly ex-footballer build. I told him who I was and what I had to do. “Feel free” he said, without a smile. When my eyes became accustomed to the dim light I saw that I was in a rectangular room with a catwalk extending two-thirds from a very small platform at the far end. That platform occupied about half the width of the room while a kitchen adjacent occupied the other half. The quite loud dance band music being played through a poor sound system was squawky and distorted. A woman was on the catwalk. On the main floor were some tables at which a few men were sitting motionlessly and quietly. At first glance they mostly seemed middle-aged.

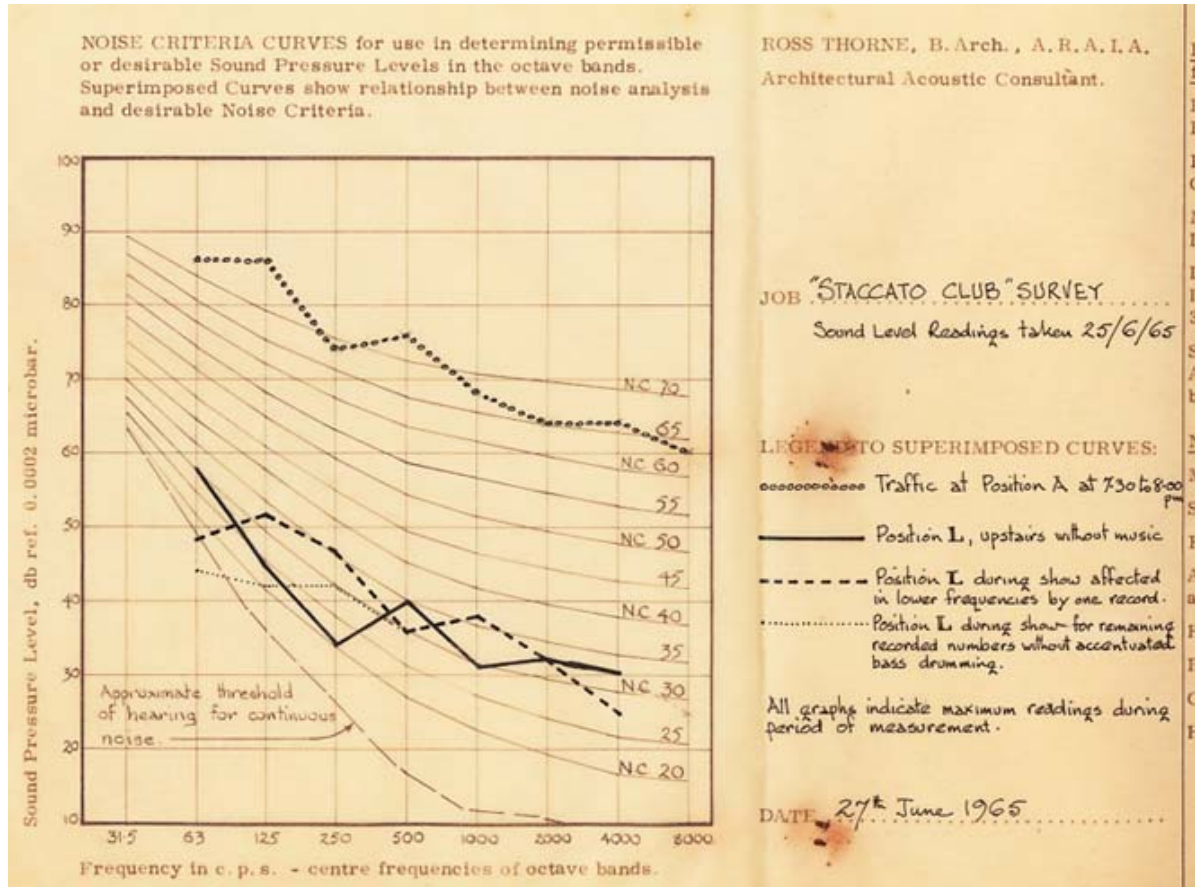
I unpacked the sound level meter and started to take a full range of readings at different positions in the room. I peered at my clipboard at intervals to write down what I had read, then I would lift my head to assess where next to move for some more readings. I would see the first lady or another walking down the catwalk in a state of partial undress. She would walk up and down in a desultory manner, her high-heeled shoes hitting the catwalk almost in time to the raucous beat of the music. The seated men remained quiet and motionless. She would remove her shoes, unclip a suspender, slide a nylon stocking off her leg, then extraordinarily draw it slowly through her groin as if to gratify a fungal itch. I continued to take my measurements.

Next time I raised my eyes the lady was on the small platform, back to the audience. She was groping with both hands up her back trying to unclip her brassiere, which, with a few wiggles of her body, she accomplished. After twirling it around a few times with her right arm, she threw it away, turned and presented herself in a defiant way to the motionless audience. It remained motionless and silent. She did a similar routine with her basic undies except this time she did not turn around; there was a blackout and she had disappeared.

I continued my measurements while this routine repeated itself with another lady, introduced through the loudspeaker system with some incredibly exotic name. Only now do I realise how strange I must have appeared to that motionless audience with its studied boredom. The sound level meter was the length of a loaf of bread but half its height. One end was flat and the other tapered to a silver cylindrical knob (the microphone) about 25mm long by the same in diameter. Due to the weight of the whole unit it was held, both hands each side, the tapered end farthest from the body and the flat end stabilised against one’s waist. For such a ‘club’ it seemed to take on remarkable phallic symbolism.

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<sup>5</sup> Walumetta Ryde and District Business and Professional Men’s Club Limited, 826 Victoria Road, Ryde; from 21 December 1964 to 19 January 1965.



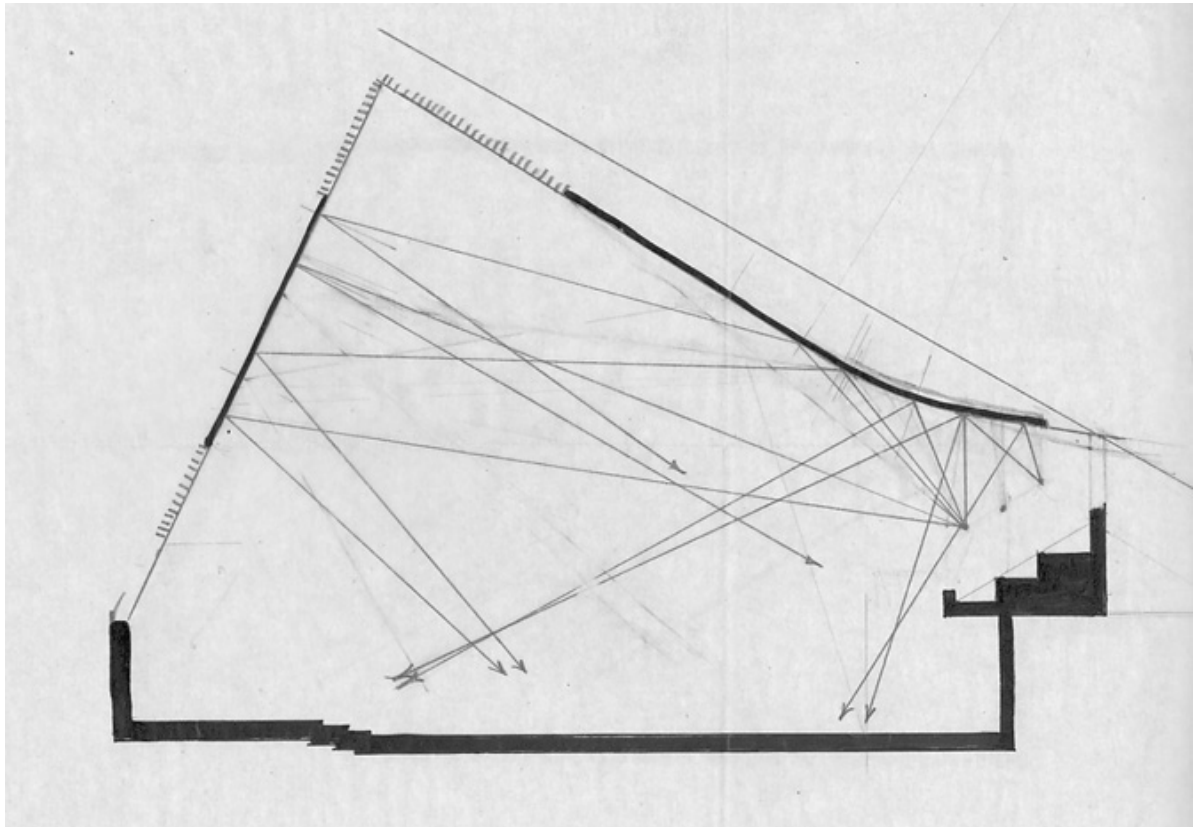
When I had completed my readings and was walking out, I was passed by one of the participating ladies (now fully clothed), chewing gum and carrying a "long-play" vinyl record. She was on her way to 'perform' at another of the three or four strip clubs at the Cross. In an hour or so's time she would be back at the Staccato Club in Orwell Street to repeat her strip for the next 'show' to another group of motionless mostly middle-aged men. I then knew why Vivian Taylor passed this consultation job over to me. He would have been business-like, but embarrassed while inside, but then chuckled in his quiet way once outside.

The report had to be written, then I was called upon to give evidence in the case brought against the club in the Supreme Court of NSW. From my professional standpoint there were no noise problems that could have affected neighbours – the noise from inside could not be heard outside. There were obviously other reasons of perceived undesirability that caused the court to rule in favour of the complainants (and close down the club)<sup>6</sup>.

Interesting, but in a totally different way, were the commissions that required acoustic treatment or design of interior spaces where particular 'listenable' qualities were desired. Architects, Woodward, Taranto and Wallace, on behalf of the NSW Public Works Department, asked me to modify the acoustics of the old Campbelltown Court House in 1964. It was a large, high-ceilinged space that was too reverberent for speech, therefore making it difficult to understand what was said. There were also problems of noise entering from traffic on the then main road (Hume Highway) that passed immediately in front.

<sup>6</sup> This seemed to be a last minute effort by the solicitor (W. H. Clark, Cole & Co, 841 George St., Sydney) who commissioned H. Vivian Taylor, to write a report on the Staccato Club (6-8 Orwell Street, Kings Cross). I had to take only five days to do the measurements, write the report, and attend court to give evidence, from 23<sup>rd</sup> to 28<sup>th</sup> June 1965.

A new church for the Presbyterian faith was being designed by Robertson and Hindmarsh (architects) in 1964. Instead of pursuing any traditional church style they only retained the notion of loftiness, so often seen in churches, but achieved it through a high asymmetrical somewhat pyramidal shaped roof over quite low perimeter walls. The 'pyramid' had two opposite sides of the same shape, but the other two opposite sides were different thus producing a steep pitch over the sacristy and altar, and a lesser pitch over the nave. It would have been relatively simple if all the sound to be heard by parishioners came from one end, but it didn't. The preacher was at one end, the choir in a gallery over the entry at the other end. The sound from each source had to be studied separately, then both reconciled so one solution did not affect the other. A former student of mine, Fritz Rieth, was working for me over the University vacation, and made a light reflecting model of the ceiling, similar to the one I had made for my B. Arch. thesis. This model was tested using a light source first at one end then the other, to confirm or otherwise the geometrical drawing analysis of the shape. I sought minor changes including the specification of where hard (reflective) and absorbent ceiling surfaces should be. The church was built in a quiet street in Roseville, a northern suburb of Sydney, so should not have had problems from outside noise. Professional soprano, Pearl Berridge, had sung in the building, and commented that she liked the acoustics<sup>7</sup>.



*The "ray" diagram, long section of the Roseville church after suggested corrections. Pulpit is at left; choir gallery at right. Dotted lines on ceiling are absorptive areas*

In the early 1960s two doctors were referred to me, one at Castlecrag (Sydney) the other in Canberra. Both wanted music rooms in which music could be played to a small audience. These gave me a chance to design spaces or environments for a listening audience rather than for office workers.

<sup>7</sup> In the 1970s Pearl Berridge was employed as a soprano for many concerts by the Australian Broadcasting Commission in recital, or with the Sydney Symphony Orchestra (as well as by other organisations).

It was some time after meeting John (Jack) Metcalfe (in 1969) that I first realised he was interested in acoustics, and second, that he had friends in the music industry, and was keen to design recording studios. I had met Jack through Terry Purcell whom, in turn, I had met through one of my former students, John Witzig, in 1967<sup>8</sup>. Terry and I would travel to the Hunter Valley vineyards once or twice a year and, on the way, discuss the psychology of visual perception (in which I was interested for the teaching of architecture). Then the topic of our discussions developed into people's reactions to the built environment, particularly buildings. Both he and Jack Metcalfe were pursuing Ph.Ds in psychology – in two different areas of perception. They were often together, both interested in a wide range of topics, and would be constantly discussing one thing or another in a mode of inquiry and exploration. Terry was introverted, thoughtful, careful in his analysis and his comments. Jack was extroverted, lunging at one idea then another, having to restrain himself (and be restrained) by the learnt logic of his Ph.D training. He was tall with a classic physique (that seemed to remain trim and taught with little specific maintenance), good looking, and he knew it. He wore high-heeled riding boots (with tapered heels), tight jeans and shirt open half-way down his chest. There was always a ready wide smile, stretching the “Viva Zapata” style moustache that extended down each side of his chin. He was intelligent, handsome, and liked beautiful, elegant but intelligent women. Jack would be enthusiastic about something or someone, but when what he was interested in didn't progress as he would like, his interest waned; then he would jump onto another ‘band wagon’. He seemed to be looking for something – perhaps it was himself.

Jack Metcalfe knew composer-musician Chris Neal who, around 1971, was establishing his career, and interested in producing rock groups<sup>9</sup>. He was involved in a small ‘four-track’ recording studio in the rear of premises at Brookvale (Sydney) that was mainly used to produce “demo” tapes for aspiring bands<sup>10</sup>. For a time I even leased my own four-track tape recorder to it. Jack helped improve the studio in a modestly economic manner. As the recording industry was small, apart from the establishment companies, such as EMI and Festival, word travelled. Jack was approached to convert a small single storey factory in Trafalgar Street, Annandale (Sydney) to a recording studio in 1973. There were some front rooms to be retained for administration, then the factory space, and access to a rear lane, good for bringing in musical instruments and equipment.

The Trafalgar Street studios presented problems that were not only of producing a suitable studio and control room. It was under a flight path to Sydney Airport, and there were economic restrictions. The factory only had a roof without ceiling so a considerable amount of noise had to be eliminated by new ceilings and walls within the existing envelope. The floor was concrete on the ground which was considered satisfactory – not requiring an additional ‘floating’ floor. One double-layered ceiling was installed immediately under the roof-supporting trusses. A new wall enclosure within the existing (cavity brick) external walls was built. A second ceiling was hung on rubber-in-shear ‘springs’ below the fixed ceiling. Both ceilings and the new wall were covered in sheet lead to act as a ‘fluid absorber’ of sound waves. (I had used sheet lead in the walls and door of my bathroom in 1963, then in the floor of my living room in 1976 to reduce transmission of sound passing out to my neighbours.) When completed, the studio was so quiet that it was almost eerie. What we had not foreseen was just audible in the eerie quiet at night: the ships, berthed a kilometre and more away had their generators running – the very low

<sup>8</sup> John Witzig, after leaving university, became a publisher of a surfing magazine, doing much of the photographic and layout work. He then became a general graphic designer, with one of his most recent works being the book by Nat Young, *Nat's Nat and that's that: a surfing legend*.

<sup>9</sup> Chris Neal wrote not only jingles for commercials but (after I had met him) music for television drama and Australian films.

<sup>10</sup> The studio was named “Airborne” and was the last premises in an arcade of a light-industry development in the main business centre of Brookvale on Pittwater Road. Associated with the studio was the electronics workshop of David Moore who traded as *Galloping Red Horse*, providing the technical back-up for the studio.

frequency component of their noise was being transmitted through the water and the land mass all this way<sup>11</sup>.

Another studio commission was from a guy who lived behind a then closed small shop at Kogarah (1976). The shop was converted to a studio and control room by building a complete room within the space. The owner was interested in recording small bands, particularly for “demo” tapes<sup>12</sup>.

The third, in 1977, was for a company that specialised in recording advertising jingles and clips. The company was known as Madrigal Sound Recording and it was leasing space in a 1950s/60s-built low rise office block in North Sydney. Fortunately, it possessed the old minimum ceiling height of nine feet (2.76 metres) because this studio would require a full floating studio space and control room – isolated rooms within a room, yet maintain an eight-foot (2.46 metres) ceiling. It was not so much noise entering but noise exiting that had to be controlled. We only had 12 inches or 300 millimetres in which to have a floating floor and ‘floating’ suspended ceiling, and retain a minimum ceiling height of eight feet (2.46 metres). There was also a theatrette and projection booth to design in this small complex<sup>13</sup>.

Jack Metcalfe would design the acoustics, using the large main-frame computers at the University of Sydney, and provide me with a specification of requirements. There were no standard methods of constructing such spaces so one was constantly devising ‘new’ ways of producing an almost soundproofed space. That is, the construction was a highly detailed design task in itself, and it was that which I enjoyed. Jack designed the acoustics with a ‘flat’ frequency response. That is, all note pitches being emitted from the musical instruments could not be enhanced or ‘coloured’ by the space itself to make them sound ‘better’ to the human ear, as in a good concert hall where there might be a lift in low frequency sounds compared to higher notes. But that was not to say there were to be no reflections of sound within the studios. They were not aimed to sound as if the performers were playing in a wheat field on a flat plain in the outback. The two larger studios – Trafalgar and Madrigal – needed an area in their spaces that could be converted to being ‘live’, with reflections off floor, ceiling and adjacent walls for a small orchestra, while, at the same time, requiring a ‘dead’ booth for a singer, and often for a drummer. With multi-track recording (which for professional recording was then rapidly rising from 8, 16, 24 to 32 tracks) leakage of sound from one instrument and microphone to another had to be minimised (yet the musicians needed to hear their colleagues).

J Albert and Sons Pty Ltd, music publishers, had a narrow, but deep building at 139 King Street, Sydney, in which they wished to upgrade some recording studio spaces. Jack was approached to redesign a large control room in the first half of 1976. The building was of turn-of-the-century (19<sup>th</sup>/20<sup>th</sup> centuries) warehouse construction with heavy timber-framed floors. The walls and floor of the new control room were ‘floated’ off the structural floor, and the ceiling was hung with rubber mounts off the structural floor above. Acoustic conditions in such a room necessitated precision of listening without any extraneous influence from reflections of sound. The sound had to be as pure as possible, only from the left and right loudspeakers (set flush in a bulkhead above the viewing window to the studio beyond). Multiple tracks had to be mixed down to two for release on stereo discs. Important was the imaging (or spread) of

<sup>11</sup> The studio was at 74B Trafalgar Street, Annandale, conducted by Chaluz Enterprises Pty Ltd, Recording and Production Company. John Metcalfe’s and my involvement in its design and construction was from June 1973 to October 1974.

<sup>12</sup> Ross McGregor owned this small studio at 11a Queen Street, Kogarah. The drawings are dated November 1975. They show that the original floor of the shop had been removed and a new room built within the space as a box with no parallel surfaces (thus achieving a more diffuse sound).

<sup>13</sup> This design was with both John Metcalfe and Chris Neal, consultants to Madrigal Sound Recording Pty Ltd, 86 Berry Street, North Sydney, the drawings being done in June/July 1977. The building at Berry Street had a complete rehabilitation in the 1980s (when it is assumed the studio disappeared) then it was demolished for a taller edifice.

*Below: The recording control room at J Albert and Sons on the top floor of Alberts' building King Street, Sydney (demolished). Design by John Metcalfe and Ross Thorne.*



sounds between left and right. For example, a rock band may need to sound in stereo with instruments at left and right, and points between, while a singer may need to be perceived as sounding dead centre between the left and right speakers. With the exception of a reflective bulkhead, and small section of ceiling to enhance the distribution of sound from the two large built-in speaker boxes, great pains were taken to make everything else highly absorptive, particularly on the remainder of the ceiling and wall opposite the speakers. Large volumes of space, thickly lined with acoustic absorbent material, were located at the sides and rear of the room to act as “bass traps” – to take up bass sounds and prevent them reflecting within the room. Another thing that both Jack and I wanted was to make these virtually hermetically sealed environments pleasant to work in. As a considerable amount of fabric was used in curtains, or to cover mineral wool absorptive material, and carpet would be used (on floor and at times, walls), reasonable colour schemes could be devised. The Alberts’ control room had the small amount of hard surfaces covered in natural finished pine boarding with the remainder in orange and charcoal fabric and carpet. The building task was rapidly completed during August 1976, but it has also disappeared due to redevelopment of the site.

Jack went on a trip to USA and Europe later in 1976, and was enthusiastic about what was happening with the design of recording studios in the USA. One thing that impressed him was the amount of money lavished not only on the finished products but also on the fees for the consultant designers. All of our studio clients either had little money to spend or were unwilling to spend it if they had it. By comparison with many British studios he felt that our designs were better, rather bitterly commenting that Alberts’ were certainly getting a cheap job for what they

were receiving<sup>14</sup>. However he seemed enthusiastic to continue. We worked on the Madrigal Studio in 1977. After that, John Metcalfe's life changed. He had departed from his lecturing position and there were personal upheavals. He became interested in building development then what I may (perhaps incorrectly) refer to as alternative spiritual wellbeing, through Diane Cilento's influence.

Over the previous couple of years, from 10<sup>th</sup> September 1975 until the same time in 1977, I was the representative of the Royal Australian Institute of Architects on the Noise Advisory Committee of the NSW State Pollution Control Commission. This Commission was a precursor to the Environmental Protection Agency and, at the time, was just exploring the possible 'pollution problems' that could arise from noise. Every month the Advisory Committee met and at first attempted to set out general guidelines, but then it gradually became known and received complaints of noise problems. These were used as case studies to establish hours of operation of 'noisy' industries and equipment. The Committee would usually set down particular requirements such as the time when delivery trucks could arrive at a site, or having steel trays of trucks lined with rubber sheeting to dampen the clanging sound of loading large rocks, or restrict the use of chain saws in metropolitan areas. These cases built up a body of knowledge, from which general principles would be enshrined in the legislation and regulations that are in place, more than a quarter of a century later.

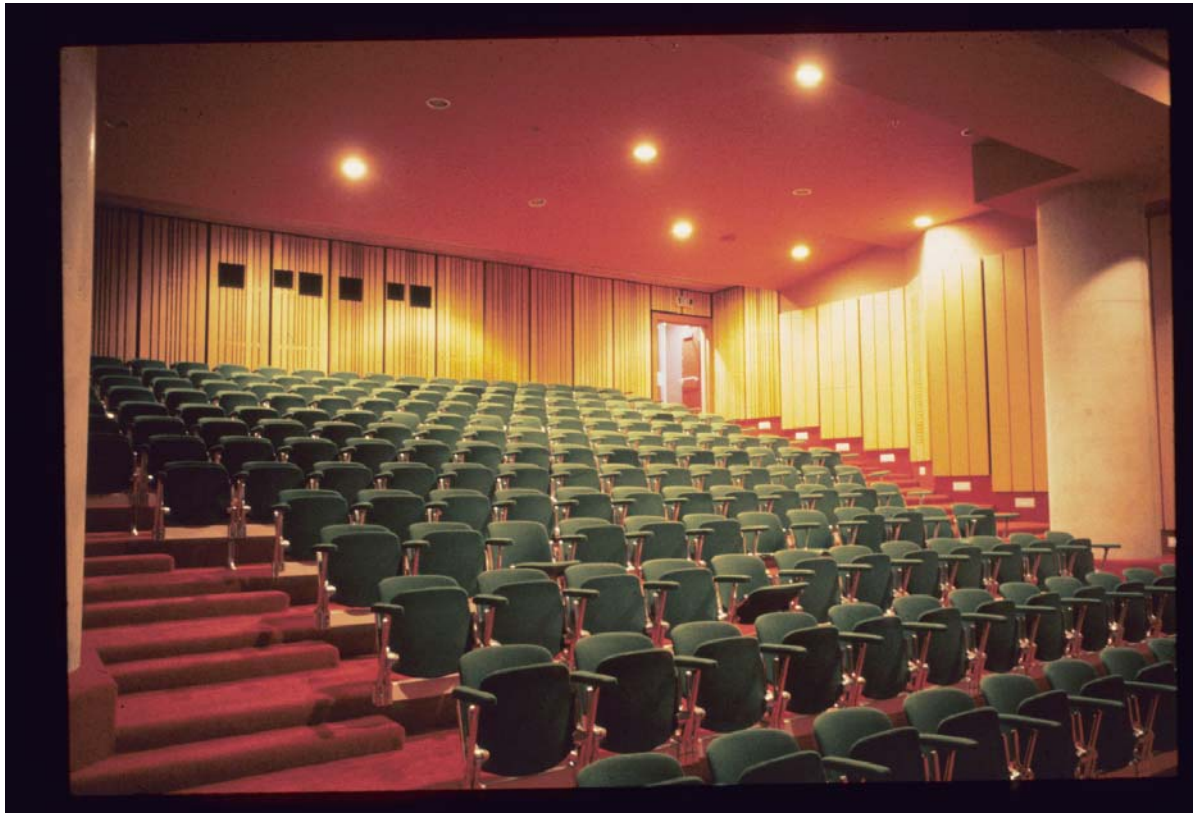
I thought that the Madrigal Studio at North Sydney would mark the end of my part-time architectural/acoustic consultant practice since I was becoming more heavily involved in housing research in my full-time capacity as Associate Professor and Director of the Ian Buchan Fell Housing Research Centre within the Faculty of Architecture. Also, technical aspects of understanding acoustics had become more complex; mainframe computers were not the easiest to cope with, and PCs with the type of programs needed were some years away. I did not have time to keep up to date with this field, but when approached for what would be my last acoustics consulting job, I could see that it was of a nature requiring only the tools with which I had been familiar. It was mainly for a small theatre within Stage One of the Royal Melbourne Institute of Technology [student] Union Building (1980), being designed by John Andrews International Pty Ltd. The acoustics of the cafeteria and music practice rooms only required the usual reporting and recommendations that might or might not be taken up by the designers, usually for visual aesthetic reasons if the latter. The small theatre however, was not quite what I had hoped for. It was in a basement with its own air conditioning plant room adjacent (behind the stage), and a truck dock at the side. If the truck dock had been only for the theatre there would be little problem but it was for the whole building, including the bars for which there would be unloading of metal beer barrels bouncing onto a concrete floor.

For good acoustics and a satisfactory reverberation time it was soon discovered that the ceiling of the auditorium was too low and was to be made a shade lower. This could also cause an unacceptable diminution of sound towards the rear of the one-level auditorium. All that could be done was to shape the ceiling so as to reflect as much sound as possible towards the rear of the space and avoid cross echoes from the side walls. As with all the air-conditioning suppliers or mechanical [design] engineers for the studios, I stipulated a noise rating required at the outlets of the ducts in the auditorium space. Also, as with all of them, there would be agreement that the system would comply with the required rating. However, a glance at their original engineering design drawings showed that there was no hope in hell that the noise rating would be achieved. I found it somewhat incredible that I was telling mechanical engineers what to do. For example, in the RMIT theatre I specified that the machinery room had to sit on a

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<sup>14</sup> Letter from J. Metcalfe, Arden House, London, 17<sup>th</sup> September 1976. On Albert's file together with a letter dated 23<sup>rd</sup> September, 1976, from Hotel Eden du Lac, Montreux, in which he summarises who and what he has seen.

floating floor, and all ducts had to have flexible connections between that room and the theatre (otherwise the vibrations and noise from the machinery would be transmitted along the ducts to the theatre).



*Theatre at RMIT Union Building, Melbourne, Architect: John Andrews; acoustics by the author (1980).*

On the original engineers' drawings there were no flexible connections. In addition, the outlet (return) air from the auditorium to the machinery plant room was ducted under the stage by a straight line of ducting without any silencing provision, thus allowing the fan noise to be directly transmitted into the theatre. Both these failures in design had to be drawn to the attention of the engineers. The result was only fair; the air-conditioning plant was too close to the stage and, when completed, I could hear machinery noise radiating from the duct that passed through the stage.

I was surprised that the project architect, working in John Andrew's office, knew so little about acoustics, but I was amazed to the point of incredulity that mechanical engineers were so ignorant – incompetently ignorant of the acoustic performance of what they were specifying and designing (in the way of machines, ducts and pipes) on a daily basis.

After this occasional consulting work, the era of mechanically setting up ray diagrams, ripple tanks and light-reflecting models, and calculating simple formulae for reverberation times, was virtually at an end. The times now required acousticians who would be prepared to learn new computer-assisted models, which I felt that I neither had the time (nor the ambition) to pursue. I therefore dropped this aspect from my interests, whence I concentrated on housing research and the history of cinema.