Denmark's Puk Studios has become a place of great international interest in a short space of time. They have chosen the untried path rather than the, conventional route. Janet Angus visited, studied and reports

One of Denmark's larger recording facilites, Puk Studio's recent expansion and re-design has focused the recording world's attention on the most unlikely site for an innovative recording facility.

Previously a monastery and more recently a remote farm, Puk is a good hour's drive from Jutland's largest town Aarhus and the journey ends down a winding track across flat countryside to the studio.

The facility has been in operation since 1978 on a much lesser scale. The transformation and expansion which it has undergone in the last two years is no less than dramatic. Christened after owner John 'Puk' Quist, the studio has caused a stir for a number of reasons: the control room is designed on LEDE principles; the console is a Calrec UA8000 with MasterMix automation; the facility is of huge proportions; the design set out to capture as much of the atmosphere and picturesqueness of the countryside as possible; and there is a monitoring system which turns the traditional concepts of control room monitoring upside down.

The original facility is a relatively modest affair which runs alongside Studio A. Puk himself seems to have been the type of client any studio designer could ask for. His attitude throughout the whole project has been to do everything absolutely right - whatever the cost and even though the project was financed almost exclusively by loans he had the courage to spend over three times the original projected figures.

Monitors and racks are symmetrically placed in Control Room A

Danish audio company SLT supplied most of the equipment and designed the monitor system in conjunction with consultant Andy Munro with whom they worked on the whole project. Having established with Puk that the LEDE design was what was needed, Andy Munro was finally approached for various reasons including England's relative proximity to Denmark, the requirement for a unique design, as well as his personal attitude, the Danes having found the American approach rather aggressive and overpowering.

Having presented Andy with their field and told him that in principle they could do whatever they liked, it took a further 12 months of discussions and exchanging of ideas before the final design decision was reached.

SLT's Ole Christensen outlined their conclusions thus: they wanted an LEDE room. They also wanted to take advantage of the views and have very light and airy surroundings, particularly wanting to capture the northern light. It was important that artists playing in the control room should have a good sound in their playing position. They didn't want a traditional control room: "They all sound different anyway and you can't play loudly in them without getting a confused sound". They wanted space, so that to all intents and purposes the control room became the recording room: "Everyone should be able to play in the control room with amps in the studio so that they can all feel involved in everything. It is psychologically good to have the musicians looking down on the producer and engineer instead of the other way round." This was what prompted the large 'stage' area at the rear of the control room.

As for the monitoring system, Puk told Ole that he wanted to be able to operate at very high volume: "I want to wind the speakers up. I want no compromises and we had to get it right from the start. There was no room for error." Ole's major role appears to have been indulging in a tremendous amount of research. Equipped with a degree in electroacoustics and years of electronics work he read and talked to many experts in the field.

Seating area on the stage behind the console

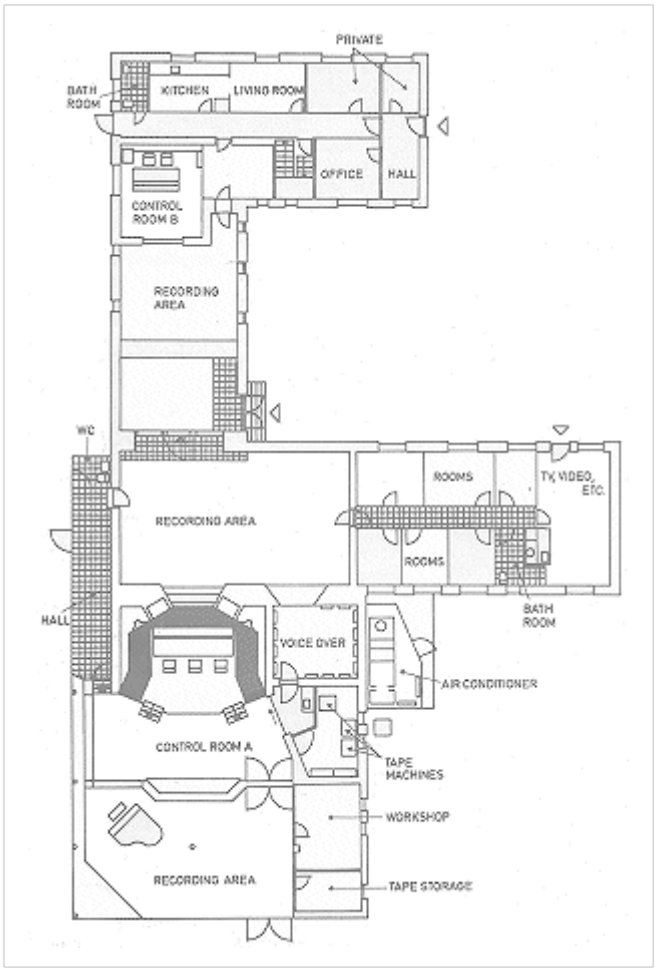
"The specification was all textbook stuff. The studio is built on clay soil which is dead and a bit elastic - perfect isolation material! Part of the problem was wanting so much daylight and trying to capture the views, all those windows needed acoustic isolation.

"Our design approach was to look at the theory and then just go all the way. Caution only slows you down. Sometimes you have to say 'scrap everything' and look at the basic theory, research, talk to the scientific experts like Bruel & Kjaer and taking a combination of all these factors into account, draw logical conclusions. With things like the air conditioning, it was not worth risking spending half as much on a system which might not work - better to go straight for the best and most expensive and get it right first time.

"I don't say that the LEDE design is the only correct way to do it or even that it is totally correct. What I do say is that the TDS measuring system used by Bruel & Kjaer shows that you should not have reflective surfaces round the monitors. Practical experience shows this to be also true. Research by the hi-fi companies such as KEF and B&W shows that cabinet reflections are also to be avoided. The proximity of the speakers is then brought into question. There are basically two opposing groups in control room design: the LEDE vs traditional. To claim that LEDE is the one fixed solution is too much, but it is definitely along the right lines."

The room itself is extremely difficult to describe. It is very big-almost 100m². The 'stage' referred to earlier does not really feel like that, more like sitting in the upper part of the bar in a Scandinavian hotel! Although it is away from the mixing console in that it is placed behind and above, you do not have the impression of having been removed from the heart of the matter quite the reverse.

Because digital recording requirements were to be the main consideration here the room itself had to be very quiet. The air conditioning system had to be exceptionally quiet: the system chosen is designed to Danish broadcast standards and, as Puk explained: "It's huge. It was a big shock to me. I had no idea what it was going to involve. It ended up costing £30,000 - but I wanted the best so that is what I had to pay."



Floor Plan

The room itself gives an unusually wide dynamic range. Details such as the control room window needed re-thinking. In the first instance normal glass windows were installed but the sound isolation achieved did not meet the specification and it was replaced with 0.7 in thick laminated glass. There are three panes each consisting of three layers: glass/plastic/glass and the result is very dead; each pane is more effective than three layers of normal glass.

The interior design is by local architect Mogens Hansen who, along with Puk built a live room on the back of the control room. A large wood-clad space it commands views across the countryside. This is a good example of Puk's attitude and determination to achieve the best possible facility. The studio is slowly spreading out across the land. He will not remain static with either the physical building or the equipment within it-so long as the industry continues to change, so will he.

Monitor system

One must wonder what makes a man spend an absolute fortune on a speaker system which has never been tried or proven in any way. Puk seems to have that rare quality of trusting other people's judgement to a degree far beyond that of the average man. His explanation: "I can't understand the sort of people who build a very expensive and very very nice studio and then end up having to monitor on the small speakers."

Looking at the traditional monitoring systems, it was decided that these were too harsh and at high volume, a violin for example would hurt your ears. "The JBLs and Altecs etc - are all designed by concepts made in essence during the 1930s and which haven't really changed. These concepts were made when amplifier power was very scarce and therefore they had to use horn-loaded speakers to achieve adequate volume."

Whilst reading for his degree Ole wrote a paper on horn-loaded speaker design and concluded that one could not expect such a system to sound 'properly'. "That's why there is a huge difference in quality between speakers of the BBC style which you cannot play very loud and the traditional high volume American-style monitors.

"Peter Ladegaard of B&K and I set out to design the ultimate speaker system using the TDS measuring system, and applied a lot of power-approximately 4,000 W per side. The loudness was one of Puk's requirements and it is an unfortunate law of physics that if you want to play low frequencies (ie 20 Hz as opposed to 40 Hz) you need four times the movement of air and therefore you need cones four times the usual size. The 20 Hz requirement is for the digital recording room. In an analogue room the machines will act as a filter for anything below 40 Hz and the normal studio monitoring will not let you hear it. Nowadays, however, with digital recording and compact discs you can't afford to mask these things. Although this system might seem like overkill it is actually the logical conclusion and is in line with the changing recording requirements of today."

The system is designed entirely on theory and was only put together one day prior to the studio's first booking. Ole: "Luckily it worked! I was pretty sure it would, but I was still a bit nervous - I think Andy was too, after all his reputation was at stake."

One of SLT's designers Knud Rosenskjold was called upon to design the necessary crossover for the system. He had previously designed the power amplifiers, already in use in the original Puk studio. Ole: "I don't do very much the

design work - it is more of an organisational role getting the right ideas together with the right people in the right place at the right time. I do, however, take full responsibility for the speaker system because nobody believed it would work! In fact, the structure for mounting the 30 in speaker is built of very thick wood (instead of concrete like the rest), at Andy's insistence so that if they didn't work they could be removed again."

The system finally arrived at after much discussion and measuring is 5-way and consists of two 30 in and two 15 in Fostex, 8 in JBL, JBL 2445 and a Fostex tweeter per side.

Ole: "For the mid range we tried a lot of horns. They had to be very big which gave a lot of reflections and phase cancellation problems. Finally we decide not to use horns, but rather a large dome tweeter. A normal JBL loudspeaker has a 4 in dome tweeter with a titanium membrane which works very well."

The monitor wall is totally dead and the speaker mountings are completely isolated from the room to avoid transmission of speaker vibrations.

So what does it sound like? If you stand at the back of the stage and walk up (or rather down) to the console mixing position the sound will change only in level. You are not, however, aware that this is what is happening until you try to say something. The normal criterion for judging high volume is the amount of distortion generated. Here you can only judge by trying to speak. It did not hurt my ears at all but it did practically knock me over! That was loud!

Comparing the sound against the Yamaha NS10Ms there was more detail on the main monitors although the actual balance did not change. Behind all the speakers there are absorbers ensuring no reflections from the speaker cabinets.

Outside engineers who are not particularly used to working with digital recording and are furthermore thrown by a monitoring system which acts as a magnifying glass, take a while to get used to things. Time and again engineers and producers are being shown out to the machine room to hear the noise which the tape recorders are making and told: 'This is what you are used to hearing in the background in the control room all the time; that's why you can hear all those extra things now.' One's usual references are confused. Similarly turning up the volume-because there is no distortion-you can turn it right up and it is only when you try to talk to someone that you discover how loud it is.

Ole finally said that if you did work with the system at full volume for too long you will, eventually, hurt your ears. Puk describes it as his ears getting warm. Puk: "It is so clear. You hear everything; reverb, the minutest bit of panning. People cannot believe the pinpoint accuracy you can achieve from such large speakers. Then when they are convinced, they start wondering about what it would be like in a small room or in the car-but of course it sounds great."

Ole Lund Christensen is preparing an AES paper on the system. SLT would be very happy to supply it to anybody else and they are currently working on a smaller version.

The blue material around the console area is covering absorbers while the back of the room is covered in Scandinavian pine and is therefore reflective

Console

When it came to buying the mixing console for this facility the choices at the time were SSI, or Neve; there was nothing currently available on the American market which they felt would have suited their purposes. The reason they looked at the Calrec was that Polar Studios in Sweden had done a lot of research into various console possibilities and eventually chose Calrec to custom build for them. Being familiar with the expertise and knowledge to be found at Polar, the Puk team decided to take a look. The console they finally bought was the UA8000-a mixture of traditional Calrec and the Polar specifications.

The console is a 64-channel frame, fitted 56; each channel has in essence, two inputs: when mixing there are two times 56 channels available and all sections can be switched line or monitor.

Features include console split left and right, with zoned auxiliaries. The four mono sends and four stereo cues can provide eight mono and eight stereo sends on a single channel which can be combined with the main mix signal so that, for example, the musician may hear in his foldback the main mix plus any extra tracks he should require. The mic input has two different circuits-one transformer and one electronically balanced, switching automatically depending on the gain setting. Should you require a lot of gain it selects the transformer to give low noise; if you need a little gain, electronic balance is selected to give low distortion at high levels. It is simple to use: the operator simply turns the gain switch. There is no pad because the mic input will handle any kind of level-even line level.

The console also houses the Soundfield microphone controller, and Audio Kinetics Q.Lock and the MasterMix automation. Apart from all that, Puk felt that it offers all the usual features of an 'SSL-type' mixer as well as having two VCAs rather than one per channel.

The craftsmanship evident in the Calrec was also important to Puk. Ole: "It is built in the traditional way with individual cassettes screened the way consoles used to be built. All the legending is engraved instead of just painted on, It gives better crosstalk and less hum due to the shielded design. Once again, the only disadvantage is the cost."

Equipment

Choosing the digital equipment was not easy-all they could do was look at the systems available from 3M, Sony and Mitsubishi, read and listen to everything said about them and then finally choose. They are very pleased with the Mitsubishi they finally selected although Puk is quick to point out that should something better come along he will not hesitate to change. He is puzzled by studio owners who agonise over equipment choice saying it has to last for ten years so it has to be right. "Of course it doesn't have to last for ten years. If things change you just have to go with them."

Ole: "The only difference to us between this Mitsubishi X800 32-track and the newer X850 is the look of the remote and the lack of razor blade edit, but we remain sceptical as to the quality of the razor blade edit available so far and don't feel we are missing out by not having it. The machine tape transport is the same as that on the Otari MTR90 so it is very easy to work with."

Isolation room with Synclavier II and Fairlight

Puk: "Compared with the Mitsubishi, the Sony PCM F1 sounds much harder; it was designed for the consumer market not pro audio - the Mitsubishi has a much warmer sound. You would not always be able to hear the distinction but in this control room you can hear everything."

Tape recorders: Mitsubishi X800 32-track and X80 2-track digital. Two Otari MTR90 24-track recorders, two Otari MTR10 2-track recorders, Tandberg and Harman-Kardon cassette machines and a Sony PCM Fl.

Ancillary equipment includes: two AMS 15-80S DDL, two Eventide Harmonizers, Eventide Flanger, Lexicon DDL, Aphex II Aural Exciter, Aphex Compellor, two dbx 165A compressors, dbx 903 compressor, dbx 902 de-esser, dbx 904 noise gate, Audio+Design Transdynamic processor, Audio+Design Vocal Stressor, Klark-Teknik DN30130 graphic equaliser, EMT 251 reverb, EMT 140 stereo plate reverb, Lexicon 224XL reverb, AMS RMX 16, Quantec QRS and Klark-Teknik DN780 reverb.

Synchronisers are Q.Lock and Dr Click,

Additional monitoring includes JBL 4350, JBL 4333, JBL 4312, JBL 4311, Visonik David, Yamaha NS10M and Auratones.

Puk Studios use the following microphones: Calrec (including Soundfield), AKG, Neumann, Bruel & Kjaer, Electro-Voice, Shure, Sennheiser and Sanken.

Instruments on offer are: Synclavier, Fairlight CMI, Bosendorfer grand piano,

Oberheim OB8, Hammond A100, Rhodes piano, Slingerland drum kit and Latin plus assorted other percussion.

Recording areas

Apart from the live room already described, where the Bosendorfer grand piano lives, there are two other recording areas belonging to Studio A.

The isolation room, part of the Munro project, is the only dead area in the entire building. It is full of custom-made screens which match the control room decor. The studio area itself is all wood-pine ceiling and floor with moveable rugs at one end. This room was originally part of the farm and retains the old beams, from these curtains are hung which may be pulled across as and when required.

Studio B

In comparison, Studio B doesn't look all that much although the recording area is every bit as impressive. The control room is an original and both areas were built by Puk himself without any guidance from anybody. In fact, the only thing that has been changed recently is that the recording area's egg boxes have been replaced with brown Illsonic tiles!

This studio however is what the whole set up is all about. Puk himself started out as a bass player and became very keen on recording. He recalls with mirth those far off-days and the early equipment that always broke down but he loved it and it has stayed in his blood ever since. The farm belonged to Birthe, now his wife; Puk moved in with his gear and set up shop as a studio.

The studio has been the scene of many of Denmark's biggest selling records including Midt om Natten (Middle of the Night) which was later made into a film and sold 400,000 copies; a good selling figure in Danish terms is around 50,000.

From those modest early days the studio is now based around the original Sounderaft Series 2400-Serial no. 0001-and Otari MTR90 and MTRIO machines.

Monitoring is on JBL 4333s modified with bigger mid range drivers and Fostex tweeters; small monitors are Auratones. The monitor power amps are SLT. Outboard equipment includes Kepex noise gates, dbx 1.18 dynamic range enhancer, Drawmer gate, Drawmer compressor/limiter, AMS 15-80S DDL, Klark-Teknik digital reverb, Eventide Harmonizer, Gemini Easyrider and a Scamp rack.

The recording area is live at one end in what used to be a drum booth (beech floor and pine ceiling and wall slats with trapping behind), and damped down at the other with the aforementioned Illsonic tiles.

These days the studio is used mainly for Danish productions and jingles as well as a programming base for the Fairlight and Synclavier, etc.

Munro Associates

The Puk project started for Andy Munro and his associates when they were contacted by SLT in Denmark to discuss the update of Puk's studio complex. "The existing studio seemed to be an American-style rock'n'roll studio which I thought was very professionally built, with a good dead American 'Westlakey' space and a very good live room. It was all finished in nice Scandinavian woods with a standard of carpentry the like of which I have never seen in the UK."

The control room on the other hand was the worst he had ever set eyes on. "It was atrocious. The room had never been designed as such and it was all wrong. The monitoring was lopsided and there was no front to back distance in the control room. It just couldn't be improved. "

The brief was to build the ultimate control room, making no compromises whatsoever; even when the designers themselves wanted to compromise because they felt it was starting to go over the top they had their wrists slapped. So here was every designer's dream.

Ole Lund Christensen, managing director of SLT briefed Munro and together they sat down and worked out the parameters for a purpose-built digital control room. "To the best of my knowledge that was the first time that a ground upwards digital control room was ever discussed-this was in 1982."

The parameters they decided were: an enormous dynamic range of around 90 dB; an extended frequency response, and as far as distortion was concerned, system non-linearities of non-existent proportions. In other words flat to zero, no background noise and a monitor system with no distortion. The only way this could be achieved was to build a very large room to eliminate the low frequency standing waves. The resulting room is nearly 100 m'.

"The monitors had to extend down to 17 Hz - we decided that was the lowest we could find anything capable of driving down to. The monitor system needed to be one you could relate to in terms of Urei or Eastlake but with extended low frequency using subwoofers crossing over to give an extra octave, because that's all you need. They always have a choice whether to use them-they can switch them out.

"We had to maintain the dynamic range for digital. The lowest practical noise floor in a working control room is NC 20dB. You can't treat it as an anechoic chamber. It had to easily match the dynamic range of the digital machines, including the drivers and the amps. There was nothing commercially available that could do that and maintain low distortion. ATC Softdome did not have enough sensitivity and headroom to match the design brief, although it is a very good system. In this situation it would not have been loud enough for the job."

In the end SLT and Andy Munro designed their own system. The result was a system which in theory gave incredibly high sound level, acceptably low distortion, which would only work with a very carefully worked out electronic crossover. Because the crossover was a one off it was impractical to follow the normal R&D processes of building models and testing until the right formula was found. The man who built this crossover is SLT's Kund Rosenskjold who carried out the calculations, made it up and aligned and tuned it on site with Andy using the Tecron TEF10 analyser, making anechoic measurements in the control room using time delay spectrometry. "The Tecron is the only machine in the world that will give anechoic measurement in a live room. Without Knud's crossover the monitor system would never have worked, and I must emphasise his contribution. My measurement and his electronics knowledge combined to make the system work.

"I don't think the distortion performance is quite as good as a good softdome system but compared to any current horn-loaded system, it wipes the floor with them. They wouldn't have worked in there. It is a rock'n'roll system with less distortion than any other. If anybody else wants one it will cost them £ 15,000 just for the parts! So, as such, it is unique and is quite likely to remain so."

Because of the SPL and low frequencies involved Munro decided the monitor wall should consist of dense concrete blockwork, so the actual housings of the monitor cabinets are in dense concrete. Thus they maintain the transient

response and frequency response down to design specification, "Which is nothing less than miraculous I should point out."

The monitoring is driven by a 5-way amp system consisting of custom-built SLT MOSFETs in bridge mode, very carefully quality matched and giving a total power of something like 4,000 W per side. It is designed to give peak transient sound pressure levels in the region of 140 dB with comfortable maximum SPL of 130 dB. "The point is riot to generate sound pressure levels of 140 dB, but to get a minimum headroom of 10 dB even on what would normally be considered to be peak levels."

As for the rest of the room, it had to have an acoustic performance to cope with it all. They utilised fairly radically modified bass absorbers for down to 20 Hz low frequency damping. "We actually changed our thinking about bass traps as a result of that. We have decided that they are a waste of time in that situation. To make them work at all they would have to be rather large-4 m deep in fact, which in normal control room architectural terms is out of the question; a studio cannot normally afford to lose that much space. So we had to design an alternative. We now use heavily damped membrane absorbers, which I don't think anybody else uses."

The Bosendorfer is housed in the new airy piano room at the back of Control Room A

The basic design of the room is on the LEDE principle, which was a client requirement from the start. It was most unusual for a client to even know about such fine details and for Puk to be so positive about what he required was refreshing. For more information Andy Munro wrote an article on the subject in Studio Sound back in October of 1980.

The general atmosphere of the room is one of space and openness. At the back Puk wanted to create the impression almost of playing on stage, the audience being down at the mixing console. "Puk wanted a totally state of the art recording set up technically, while at the same time wanted the musicians to feel as though they were playing in a club."

The back end of the control room then is a stage, 11 m wide at its widest point.

The raised playing area is itself larger than most control rooms. It does not cause monitoring environment problems because of the time delay. If you produce a sound in the live area you will hear it at the console as if you were sitting in the audience listening to a band on stage. If you produce a sound on the monitors, your perception of that sound will not be influenced by sounds from the stage because they are so different. Acoustic treatment at the back of the room prevents sounds bouncing back to the mixing console, avoiding echoes.

In order to satisfy ' noise requirements, the removal of low level clicks and pops etc, a machine room was built for almost all fan-driven pieces of equipment. Those that had to remain in the control room are housed in an acoustically designed racking system. The performance of the air conditioning system also had to he below the ambient noise level of the room itself.

It was equally important to have no noise breakthrough from the studio, which it is especially difficult to achieve at low frequencies; there is a limit to how much isolation you can get. So the control room is in a totally physically detached building and the separation between the rooms is therefore excellent.

The existing studio lacked a very tight acoustic isolation room for vocals and instruments with no acoustic coloration. This is built in a separate shell, but the separation requirements are not as great here as for the main room.

The design of the building as a whole involved things such as the abundance of windows and therefore daylight. This is controlled by the roof overhanging the windows, creating a shadow in summer, but allowing the sun in during the winter, maintaining a consistency in the level of light. The finishes reflect the original design of the studio. All the hardware and ironmongery is Scandinavian, the only UK materials being the bass absorber material.

Monitor specification

SLT/MA5 5-way system: each unit comprises 2 x 800 mm sub bass, 2 x 400 nun bass, 1 x 200 mm low mid, 1 x 100 mm dome high mid, 1 x 44 ram HF. Five-way stereo electronic crossover with full group delay compensation,
Nominal sensitivity: 109 dB for 1 W output from each power amplifier,
Frequency response: 17 Hz to 21 kHz.
Maximum output level: 135 dB unweighted peak programme material driven by 5 x 500 W amplifier.