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A REVIEW OF THE EFFECTIVENESS, PRACTICAL IMPLICATIONS AND IMPACT OF GUIDELINES ON ACOUSTIC CONDITIONS IN UK HEALTHCARE PREMISES

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The paper includes a review of the NHS guidance on acoustics and vibration in healthcare premises, Health Technical Memorandum 08-01. In the 8 years since its first publication, the document's recommendations have become part of the UK's healthcare estate standard suite of technical guidelines. Its advice has also been incorporated to BREEAM assessment guidelines for improving the internal and external acoustic environment of health building projects.

HTM 08-01 superseded a more acoustics-focused document (HTM2045). Creating a more readily achievable set of criteria, and adopting a more practical approach, the understanding and implementation of acoustic considerations in healthcare design has been increased. The paper discusses how this has improved the acoustic environment, working conditions and healing capabilities for patients in projects across the UK. It will also review the innovation in product design that it has helped drive, and give thoughts on where improvements to the guidance could be made.

Project examples will include improved acoustic design on many internationally renowned healthcare schemes across the UK including some of the largest health building projects seen in recent years.

Keywords: healthcare acoustics, patient privacy, innovation

1. Introduction

Acoustic design is fundamental to the quality of healthcare buildings, as sound affects us both physiologically and psychologically. Noise, or ‘unwanted sound’, can increase heart rate, blood pressure and respiration rate. Pleasant sounds help create a sense of well-being. Music can be used to treat depression, to reach autistic people and to calm tense patients.

Good acoustic conditions improve patient privacy and promote essential sleep patterns. Such conditions are key to healing. Good acoustic design brings benefits of patient and staff comfort and morale, as well as improved efficiency. It is important to create an acoustic environment that allows rooms to be used for resting, sleeping, treatment, consultation and concentration.

Despite good acoustic conditions being critical to the aims and functions of the healthcare environment, many other more factors must be considered. In some cases, these inevitably compromise the acoustic environment that can be achieved in practice. Product innovation has helped reduce these compromises but more can be done.

Behaviour of people (conscious or subconscious, voluntary or involuntary, deliberately or blissfully unaware - by staff, patients and visitors alike) is also a key factor in the overall acoustic success of a space. Giving those people the optimum acoustic environment will reduce the effects of the "wrong" behaviour and help to demonstrate the desirable behaviours.

2. Background to UK acoustic design criteria for hospitals

In the UK, acoustic design has been a notable part of the design considerations for all healthcare buildings since NHS Estates published its Health Technical Memorandum (HTM) 2045 in 1996. Before that acoustic criteria were often contradicted, and poorly defined, within design guides for building elements and healthcare departments. These included guides with design criteria for mechanical services, partitions, ceilings and layout design.

For example, HTM 56 on partition design gave R_w (laboratory-test) criteria for partitions, with no targets to aim for on-site. Not only were the R_w values relatively low, design decisions were often made without considering the implications on acoustic performance. A notable case which I was asked to help solve had rows of maternity delivery rooms, separated by only mid-range partitions, and which stopped just above the mineral fibre-tile ceiling. Expectant parents were so highly distressed by the sounds coming from the surrounding rooms that the hospital staff would only use one out of every three delivery rooms.

HTM 2045 described performance requirements which were appropriate for a high acoustic standard. It was intended as guidance and explained how to achieve a high acoustic performance in an atmosphere where acoustics had often been considered unimportant. Determining sound insulation requirements, for example, was done in a flexible way, but this meant the guidance was open to interpretation and relatively complex to determine.

Just after HTM 2045 was published, a new form of building contract was created. The Private Finance Initiative (PFI) gave the NHS a new, sometimes controversial, way of procuring large new acute hospitals. The entire series of HTM, Health Building Note (HBN), and other guidance documents was usually issued as part of the contractual documents. Compliance with all the documents was often required and meeting HTM 2045's recommendations was often made mandatory. HTM 2045 (amongst other documents) was intended as guidance rather than a contractual specification; achieving the recommended criteria was often impractical where other factors were more critical.

Contractual compliance with HTM 2045 therefore became an issue for many projects and led to design conflicts and lengthy discussions between the client, the contractor, and each of their consultant teams. Often it was felt that a project was not getting the acoustic performance that it was entitled to and there was reluctance to accept an alternative approach. Much time was required to educate all parties in the intentions of HTM 2045, the implications of achieving its recommendations and the results of accepting a design solution that took all relevant factors into account. Some projects succeeded in securing complete derogation from all aspects of HTM 2045, which could have led to some state-of-the-art new facilities with a poor acoustic performance once again.

Due to the way the document was used in the contractual process, HTM 2045 became a problem to the design process, rather than a help. Action was therefore needed to update the guidance to make it more appropriate to the way the documents were used.

The Department of Health therefore decided to revise the acoustic guidance (amongst many other documents) and commissioned HTM 08-01. It was published in June 2008 and has now become an established part of the HTM series. It takes a more pragmatic approach than its predecessor, by addressing issues experienced during real and practical acoustic design, while still aiming to provide good acoustic conditions in healthcare buildings.

HTM 08-01 clearly explains the acoustic criteria and, perhaps more importantly, the implications of decisions that may need to be made if conflicts with other requirements occur. As a result, the advantages of good acoustic performance, the disadvantages of poor acoustic performance, the practical issues and the acoustic targets are more readily understood and accessible by non-specialists. This has led to a wider adoption of the subject itself, which, in turn, has put acoustics back on the agenda as an important design consideration.

For a brief period, HTM 08-01 was re-branded as Technical Design Manual (TDM) 4032 by Department of Health. It has subsequently returned to HTM 08-01. NHS Scotland has a version named SHTM 08-01.

The BRE's Environmental Assessment Method (BREEAM) for rating the quality of new building projects adopts the criteria in HTM 08-01 to award up to four credits. It specifically requires the objective recommendations of HTM 08-01 to be achieved, and therefore implies that meeting the criteria is the benchmark for good acoustic conditions.

3. HTM 08-01 overview

HTM 08-01 gives acoustic guidance and recommends targets for:

- Noise levels in rooms: noise from outside and noise from mechanical services must be at suitable levels. Rain noise is also considered
- External noise levels: noise created by the building and its operation must not affect those around it
- Sound insulation between rooms: private conversations should not be overheard and noisy activities must not interfere with the needs of patients and staff in other rooms. Floor layouts should be designed to avoid people being encouraged to wait or linger outside doors to consulting rooms, for example
- Impact sound insulation: footfall noise from people walking over rooms must not interfere with rooms below
- Room acoustics: acoustically absorbent materials need to be used to provide a comfortable acoustic environment. No reverberation times are specified, simply that a certain proportion of the surfaces should be acoustically absorbent.
- Audio systems: audible announcements must be properly heard
- Vibration: must not affect the use of the building, medical equipment and people
- Control of Noise at Work Regulations: designers and estate managers are reminded of their duties under this legislation that protects staff from being exposed to damaging noise levels.

3.1 Acoustic Strategy

HTM 08-01 describes the impact that some acoustic requirements have on other technical and operational needs to aid decisions about design priorities for each project. The keystone of the HTM, and its usefulness in the contractual setting, is that a bespoke acoustic strategy must be developed for each project. The main reason for this is to make sure that informed decisions are made, especially if there are potential conflicts between acoustics and other issues. These decisions need to be based on the user's acoustic requirements, expectations and operational management policy, and take a balanced approach of the relative priorities for each project. Thus, a specific acoustic strategy is expected on each project rather than be considered undesirable.

An important issue for existing buildings is the acoustic performance of temporary and refurbished structures. If the acoustic targets are appropriate for new healthcare buildings, then they are also appropriate for temporary buildings and those being refurbished. The issues, the people and the acoustic considerations are the same whatever type of accommodation they are housed in. However, there can be good, practical reasons why the targets may not be achievable and this is also discussed. For example, if the refurbishment is only to change the internal walls, then noise from outdoors may not meet the targets in HTM 08-01. Again, these issues need to be understood so that informed decisions can be made.

3.2 Reducing noise by design

HTM 08-01 also advises that a strategy should consider how construction noise and vibration might affect users and buildings in other parts of the estate.

Acoustics should become a consideration right from the beginning of a project, whether it is a new build or a small layout change. Acoustic performance is easily integrated into designs at an early stage but is very difficult to achieve later, so an experienced acoustic consultant should be part of any design team.

For example, consider a site next to a busy road. The design must consider whether openable windows are appropriate for providing the ventilation. Energy and emissions targets mean this is often the preferred solution, but it may lead to acoustic problems. The acoustician should be involved to measure noise levels on site and establish the likely noise levels inside and outside the new building and then to advise on the site layout to reduce the impact of noise.

Solutions could include putting rooms that must be mechanically ventilated for clinical reasons on the noisy façades, and making sure appropriate fixed glazing is used. Other rooms where openable windows are clinically appropriate, can then be located at the rear of the building, where noise levels may be lower and allow natural ventilation to be used without compromising the acoustic requirements.

If fundamental issues like this are not identified early enough, significant issues may include:

- Unachievable energy targets
- Unacceptable noise levels in the building
- Project redesign required to relocate departments/rooms
- Extra plant, plant rooms and ceiling void space needed to provide extra ventilation.

3.3 Hearing through doors

Another example of the process of making informed decisions is the common conflict between the acoustic performance of doors and the needs of infection control regimes and accessibility strategies. HTM 08-01 describes that acoustic privacy through a door is maximised when doors have seals on all edges, including the threshold. However, a seal at the threshold can be undesirable if it introduces a trip hazard, causes a cleaning problem or makes the door difficult to open. In addition, a threshold gap is often used to allow air to flow between spaces, and this means threshold seals are not acceptable.

The HTM also describes how a determined eavesdropper might still hear a private conversation in a room, even if a door has seals on all edges. A door with a high acoustic performance could be used, but this may be too heavy for frail or infirm people to open, leading to the possibility of needing doors that open electrically. The project team must consider all these issues to determine the most appropriate and best value solution while maintaining the acoustic properties.

The HTM also contains useful check lists that non-specialists can use to consider some of the main fundamental issues for their project. Simply reading through these can help inform the client and the designers about how acoustics may influence the project.

4. Practical examples and positive acoustic designs

It is not appropriate to give names of specific projects in the following sections. The examples described include projects that include internationally renowned acute hospitals and Trusts. Experiences come from a wide range of project and contract types, from local health centres to very large projects of £500m and above.

Acoustic considerations really are being integrated to improve the environment, healing and working conditions, right across the UK healthcare estate.

4.1 £200m+ Acute hospital

The Trust wanted groups of consulting rooms, each with an interconnecting door into a common area. Their preferred working practice was for a senior doctor to be in the common area, available to assist junior doctors with advice on their patients. I was concerned about the level of speech privacy that would be practical to achieve between the areas; conversations between medical staff about a

patient could easily have been overheard by the patient themselves, and by other patients in the cluster of rooms.

After demonstrating the lack of privacy and the concerns about patient privacy and dignity, the layout of the rooms and the Trust's intended operation was changed. Interconnecting doors across the whole project were subsequently omitted unless there was a demonstrable need for them and their use would not compromise speech privacy.

Having input to the project from an acoustician at an early stage created a highly positive outcome for this essential part of the layout design. The changes influenced by acoustics have resulted in appropriate acoustic conditions, compared to the lack of privacy and operational difficulties which would have been very likely to result from the original suggestion.

4.2 £150m+ Cancer care centre

The operational requirements wanted open plan lounges in which patients and staff could discuss sensitive clinical diagnoses in an informal setting. Yet patient privacy was still an important factor, as is patient dignity. A selection of consulting rooms leading off the open-plan lounges were also proposed for situations where an open-plan space was not appropriate. The principle was that for the most private conversations, or those where there was most distress, the patient would be seen in the consulting room. Otherwise the more informal lounge would be used to help meet patients' expectations of a modern, caring health service.

The challenges were to achieve some speech privacy between spaces within the open-plan lounges, and to achieve good speech privacy between the open areas and the consulting rooms.

The solution to the first challenge was to carefully design the internal acoustic environment with the right amount and location of acoustic absorption and to use a reasonable level of background noise as speech masking. In a space with exposed concrete soffits, hard flooring and concrete or glass walls, the absorption was integrated into in strategically-placed structures which were also used as conduits for carrying the ventilation, liquid and cabled services through the space. The space is mechanically ventilated too and so the ambient noise level criterion was set at an appropriate level to provide sufficient masking noise.

The second challenge was subject to the important requirements of infection control. After demonstrating the issue, I obtained permission from the Trust to use drop-down threshold seals in the doors connecting the consulting room and the open-plan lounge area. This is hard to achieve in most healthcare environments as drop-down seals are notoriously hard to clean and therefore can be a hidden source of infection. They were eventually permitted in relevant parts of this project as no medical procedures take place in them.

A good example of the benefits offered by HTM 08-01's pragmatic approach. The project-specific acoustic strategy recommended in HTM 08-01 enabled contractual compliance with the technical aspects of design whilst achieving the desired operational methods and environment for patients and staff alike.

4.3 Ward / staff base layouts

Sources of noise such as telephones and audible medical alarms are a common source of complaints from patients staying in hospitals. Technological improvements are available to make such alerts less intrusive but the audibility of important alarms is of course a key factor in achieving a response of the required urgency. Nevertheless, these can still disturb other patients and frequently do. Staff need to speak to each other regardless of whether there are patients trying to sleep. Behaviour is key in improving the acoustic success of a ward yet the design of the layout and its surface finishes can help mitigate unintentional poor behaviour. The general requirement in HTM 08-01 to include acoustic absorption in all occupied areas has helped to achieve less noisy corridors and staff bases. Careful design can further improve the situation, by providing areas for longer staff conversations, as long of course as its balanced with the need to give suitable patient supervision. Acoustically

absorbent screens round staff bases and reception areas, and suspended canopies above them can be appropriate in some situations, as long as important issues like infection control are also considered.

4.4 Natural ventilation

HTM08-01 recognises the importance of natural ventilation on the acoustic performance in hospitals. The obvious noise break-in issue is dealt with, including some guidance to help determine under what ventilation conditions noise levels should be achieved. Furthermore, the impact of openable windows on speech privacy between rooms is dealt with. This helps inform decisions on whether natural ventilation through openable windows is appropriate for specific room types and locations.

At a brand new hospital, I observed the only means of ventilating a department of consulting rooms was to open the windows. The windows opened on to the area where visitors line up to wait for the bus, directly outside the open windows. Within weeks of the building's first opening, the staff had placed large signs on the windows saying to shut them when a confidential conversation was taking place!

The guidance in HTM 08-01 alerts the designer to these issues, though an acoustician is often still required to notice and assess where an issue may occur. Leaving windows closed for privacy purposes is a costly decision to make, in both finance and energy terms as well as room for extra mechanical plant.

The acoustic consultant can add most value by advising on these issues at an early stage so that they can be "designed out"; if the site layout can be altered then the issue can be resolved with minimal cost implications.

Another issue with openable windows is sound transfer between rooms via open windows. A simple yet effective way to minimise the reduction in privacy is to make sure that open windows do not directly reflect sound from one room to another. Having this written in HTM 08-01 has prevented several such situations from becoming reality.

5. Product innovation in the health care industry

Some examples of product innovation, driven by the need to improve acoustic qualities in healthcare premises are summarised below.

5.1 Glazed walls and sliding-doors

In recent years, many Trusts and project teams have turned to glazed walls to separate bedrooms from corridor / communal areas. Critical Care Units, for example, have the ultimate requirement for staff observation of patients, easy and rapid access to patients, yet clinical isolation and acoustic privacy. Traditionally glazed walls and sliding accessible doors have resulted in a poor acoustic performance.

This conflicting set of requirements has been addressed by improving the acoustic design of glazed wall and sliding-door systems. Using HTM 08-01 as the driver, the industry has been encouraged to develop solutions to these issues.

Acoustically robust, yet easily openable designs have been developed and are now in use, and in the design of, several major new acute hospitals. These improve clinical care and hence patient outcomes.

5.2 Hygienic Ceiling systems

Driven by requirements in HTM 08-01 several products now exist to allow acoustically absorbent ceiling systems to be used in areas where hygiene is a top clinical priority. Encapsulating the absorbent material in a sealed yet "acoustically transparent" membrane has enabled mineral fibre tile systems to provide acoustic absorption in spaces where it has previously not been permitted, but where it is of significant benefit.

For example, an operating theatre is a space full of people and instruments. The staff must remain calm under pressure and a more relaxing acoustic environment is one way to help this. Acoustically absorbent ceiling systems are now available* which meet the stringent hygiene and washing requirements, and the acoustic performance.

* Ceiling grid systems are not always allowed, however, in some room types. A further enhancement which needs to be created in the market will enable such ceiling materials to be installed homogenously, and without requiring an external grid support system.

5.3 Partition Systems

Instrumental in hospital partition design has been the sound insulation requirements of HTM 08-01 (and previously HTM 2045). When HTM 2045 superseded acoustic guidance in documents like HTM 56, the requirements on acoustic properties of partitions rightfully took a step up. Partition manufacturers responded by developing new plasterboards, and lightweight wall stud types. They needed to minimise the increased space necessary from what was traditionally designed, and the cost, yet achieve better sound insulation.

To minimise the width of partitions, and ultimately the size of the building needed to accommodate the required number of rooms, new products included denser boards and acoustically-enhanced studs and insulation quilts. Cost and installation time was reduced by creating and testing enhanced systems that used one plasterboard each side of a stud frame, when two boards had been needed before. This product development has saved significant sums of capital expenditure, whilst enabling good acoustic performance to be achieved in a practical way.

5.4 Crosstalk attenuation in ventilation ducts

The cost and space required for crosstalk attenuators in ventilation ducts has been a common issue for ventilation designers. Essentially crosstalk attenuators are needed when neighbouring or nearby rooms require a reasonable level of speech privacy and are connected by ventilation ductwork.

They were often not considered necessary by traditional designers based on the lack of attention given to acoustic performance before HTM 2045. But given targets for good on-site sound insulation to achieve sufficient speech privacy means they are commonly required. Fitting traditional podded cylindrical attenuators into existing designs, and new designs where space is always a premium, has often been challenging.

Alternative solutions have however been developed, or used in a different way to originally intended. Perforate-lined acoustic flexible duct has proved to be effective as a way of providing sufficient crosstalk attenuation. This can be used cost-effectively by replacing the flexible duct commonly used in the final run out to the back of the ventilation grille. Foam inserts have also been developed for use inside ductwork, and so no extra duct length is required. Both solutions have successfully been designed and implemented on many healthcare projects, from local health centres to large regional acute hospitals.