Scottish Hospitals Inquiry
Witness Statement of
Matthew Lambert

This statement was produced by the process of sending the witness a questionnaire with an introduction followed by a series of questions and spaces for answers. The introduction, questions and answers are produced within the statement.

Personal Details

1. Name, qualifications, chronological professional history, specialism etc – please provide an up-to-date CV to assist with answering this question.

A Matthew Lambert, BSc Building Services Engineering, BEng (Hons) Building Services Engineering, MCIBSE, specialise in the design and specification of mechanical building services. CV attached for reference, which includes career history.

Professional Experience and Qualifications

2. Provide details of any experience you have working in healthcare facilities and settings. Experience gained and qualifications obtained etc.

A I have been directly involved with detailed design and specification of most mechanical building services (natural gas, domestic water services, heating, ventilation, air conditioning, etc.) for numerous healthcare projects during my career. This also includes surveying and reports pertaining to existing installations/systems.

3. Confirm your understanding of the importance and purpose of SHTM/HTM guidance in respect of ventilation in a healthcare setting? Do you hold any qualifications relevant to this?

A (Scottish) Health Technical Memorandum are a suite of guidance documents covering a range of engineering topics specifically relating to Healthcare, which include ventilation (SHTM/HTM 03-01, Parts A & B).

SHTM 03-01 offers detailed guidance with regards to the design, selection, operation, verification, maintenance, etc. of ventilation systems with a view to supporting design engineers, estates teams, installers, and maintenance personnel, to ensure that systems are fit for purpose (i.e. achieve required function/performance, are safe, are reliable, appropriately maintained, etc.).

No, I do not hold specific qualifications relative to SHTM/HTM's.

4. What is your understanding of the need to appoint post holders in respect of ventilation compliance, such as Authorised Persons etc in accordance with SHTM03-01?

A To ensure that ventilation systems are designed, installed, tested, commissioned, operated and maintained appropriately and safely.

5. Please provide details of any qualification and experience that you hold in respect of Health and Safety at Work Act 1974 compliance within a healthcare setting.

A No specific qualifications. When involved with the design of mechanical building services within a Healthcare setting I would refer to SHTM's, Scottish Building Regulations, and CIBSE Guidance, which would effectively achieve/better requirements set out within the Health and Safety at Work Act.

Innovated Design Solutions

7. Describe the services that Innovated Design Solutions provide, including areas Innovated Design Solutions offer experience and knowledge in?

A Predominately specialise in the design and specification of mechanical and electrical building services, including site monitoring. Also offer various other services such as feasibility studies, advice with regards to renewable/sustainable technologies, capacity analysis, surveying and reporting (condition reports, pre-acquisition, dilapidation, etc.).

8. Describe any areas of specialism or particular focus that Innovated Design Solutions offer experience and knowledge in

A As point 7 above.

9. The Inquiry is aware that Innovated Designs were instructed in respect of the refurbishment works to Ward 2A and 2B, is this usual, or are you normally instructed in respect of new build projects?

A We were not initially instructed with regards to the refurbishment works within the Wards, albeit we did retrospectively produce a brief/scope to facilitate the appointment of a Lead Consultant to undertake refurbishment works (attached for reference).

A large extent of our previous experience relates to existing buildings. We are also experienced/knowledgeable with regards to mechanical ventilation systems (in most buildings), therefore this request was not deemed to be unusual.

10. Describe the company structure of Innovated Design Solutions and the role you hold, and provide details of the training have you undertaken/ which is relevant in order to meet the needs of this role?

A Please refer to attached CV.

11. Describe your day-to-day duties within Innovated Design Solutions

A Typical daily duties involve the design and specification of mechanical building services, attending site meetings, reviewing progress of installations on site, and general administration (emails, fee quotations, answering queries, etc).

Initial involvement with QEUH/RHC

12. Provide details of when Innovated Design Solutions were first involved with QEUH/RHC;

a) What, in broad terms, were the terms of your involvement?

A Initial scope/duties were to determine the viability of providing 6 air changes per hour (6 ac/hr) within the existing single Bedroom spaces located in Ward 2A, and within the DCU and BMT Day Wards of Ward 2B.

This typically entailed collating and reviewing record information from Zutec, ascertaining existing room air change rates, determining the increase in air change rates to achieve the desired 6 ac/hr, establishing if the existing ductwork distribution systems were capable of handling the additional air flow rate requirements, and providing a brief outline report appertaining to findings.

b) Who instructed you?

A Following initial discussion with Mary Anne Kane and Alan Gallacher, we were asked to liaise with Ian Powrie thereafter. From memory, our instruction/appointment was raised by Ian Powrie.

c) Who did you deal with?

A Predominately Ian Powrie.

d) What was the nature and purpose of the work carried out by Innovated Design Solutions at QEUH/RHC?

A As described in point a. above.

13. Please explain, in broad terms, what at the time you understood to have been the event or events which prompted your instruction?

A From memory, we were not aware of any particular events at this time. We understood, from the request, that there was concern air change rates within these rooms were below 6 ac/hr.

Being instructed to carry out reports

14. The Inquiry is aware that Innovated Design Solutions produced 2 reports in respect of feasibility studies for Wards 2A and 2B. The Ward 2B report: '*Report prepared by Innovated Design Solutions dated 15 October 2018 titled "Feasibility Study Regarding Increasing Ventilation Air Change Rates within Ward 2B'*– Refer the document 33 Bundle 6, Miscellaneous documents.

a) What, in broad terms, was the remit of your instructions? Were there specific instructions given in relation to Ward 2B?

A Our initial remit was as described above in Point 12 a.

During the analysis process we were asked to incorporate/include additional aspects such as the impact increased air change rates would have on the systems (generally), a high-level outline of what alterations could be required to the existing systems in order to facilitate the increased air changes (together with outline cost/time estimates), and a note of any additional observations made with regards to the existing system installations.

b) At the point of initial instruction what issues, if any, with the ventilation system in respect of Ward 2B were you made aware of?

A As Point 13.

c) Why was the feasibility study instructed?

A As Point 13.

d) Who instructed you?

A As Point 12.

e) What background information, if any, were you provided with and by whom?

A We were given access to Zutec, and online/digital record documentation system. From memory this was provided via Colin Purdon from the site Estates Team.

15. The Ward 2A report: *Report prepared by Innovated Design Solutions dated 24 October (revision 01, 30 October 2018) titled "Feasibility Study Regarding Increasing Ventilation Air Change Rates within Ward 2A"* Refer to document 34, Bundle 6, Miscellaneous documents.

a) What, in broad terms, was the remit of your instructions? Were there specific instructions given in relation to Ward 2B (assumed this should refer to Ward 2A)?

A As Point 14 a) - In terms of specific instruction with regards to Ward 2A, we were asked to incorporate additional options in relation to upgrading the facilities, taking cognisance of guidance within SHTM03-01 and SPHN 04 (Isolation Facilities in Acute Settings).

b) At the point of instruction what issues, if any, with the ventilation system in respect of Ward 2A were you made aware of?

A As Point 14 b).

c) Why was the feasibility study instructed?

A As Point 14 c).

d) Who instructed you?

A As Point 14 d).

e) What background information, if any, were you provided with and by whom?

A As Point 14 e).

Addressing the Ventilation System

16. Who designed the ventilation system for QEUH/RHC?

A I believe Multiplex were the Main Contractor, and TUV SUD were appointed as the design consultant in relation to the mechanical ventilation systems, along with the other mechanical services within the building.

17. What information were you provided with in respect of the design of the ventilation system prior to carrying out the feasibility studies?

A None from memory, I was afforded access to Zutec.

18. To what extent were you able to ascertain the design philosophy underlying the ventilation system, or different elements of the ventilation system?

A Unable to provide comment with regard to the underlying design philosophy (unknown), however, we believe our analysis enabled a relatively accurate interpretation of the probable design intent and operational functionality of the ventilation systems.

19. What hinderances presented themselves you in attempting to ascertain the thinking underlying the ventilation system?

A Zutec was difficult to navigate, especially at the start of the process.

Lack of definitive design brief/scope.

As-Fitted drawings were deemed to be incomplete and inaccurate in some instances. Drawings also lacked detail, particularly with regards to terminal devices and associated air flow rates. It was necessary to relate third party commissioning data (from H&V) to As-Fitted record drawings in order to carry out the analysis.

Discrepancies were noted between air flow rates stated by the AHU manufacturer, H&V commissioning data, the designer, and from our own calculations.

There was a lack of technical literature/data within record documentation with respect to some elements of equipment and terminal devices.

It was necessary to liaise directly with the AHU manufacturer in order to establish AHU capacities/limitations and selection principles.

20. Please comment on the extent of available documentation to enable you to do so. Did the availability of information match your expectations?

A As Point 19.

21. You mention in your reports occasions on which you had to work on the basis of assumptions. In what areas was this required? To what extent did you have to revisit assumptions while carrying out your work? Did that in itself lead you to draw inferences about the ventilation system?

A Whilst undertaking our analysis concerns regarding the ventilation systems became more apparent and the urgency to complete our findings and issue the associated reports was duly emphasised on numerous occasions. We were also asked to include additional elements within the reports. In view of this, the practical viability of revisiting calculations, record documents, etc. to check various aspects was unfortunately very limited, which essentially resulted in the use of phrasing such as ‘anticipate’, ‘assumed’, etc.

In some instances there was absence and/or inaccuracy with regard to aspects of record documentation (such as discrepancies pertaining to ductwork dimensions, system air flow rates, terminal devices, etc.), which would have also led to the use of this form of terminology.

Ward 2B report

Please refer to document 33, Bundle 6 for assistance.

22. What did you understand to be the patient cohort intended for Ward 2B?

A Record drawings intimate BMT Day Ward and Day Stay Ward, thereby implying they are utilised by patients being cared for in terms of bone marrow transplant.

23. What specialist ventilation requirements, if any, did the patient cohort require?

A Design guidance within SHTM 03-01 relating to Neutropenic Patient Ward would be more appropriate (10 ac/hr, positively pressurised).

24. What ventilation specification would you have expected to see?

A As Point 23.

The Lead Consultant Appointment Brief (produced after feasibility reports) essentially outlined what we considered appropriate to this type of facility, whilst also taking cognisance of supplementary facilities/ancillaries agreed following discussions with estates and infection control (i.e. monitoring and automatic control of Bedroom/Corridor pressure differentials, etc.). Note this brief related to works within Ward 2A, and not Ward 2B.

We were subsequently asked to produce an Appointment Addendum with regards to Ward 2A BMT and Ward 2B areas (both appointment documents are attached for reference). The purpose of these works was intended to 'improve' air cleanliness, air movement (differential pressures), and air change rates, without significant modification/replacement of existing ductwork distribution installations.

25. To what extent were you furnished with material to enable you to verify what specification had been used, and what had been the thinking behind that choice?

A The verification of specification did not form part of our scope as we were instructed to determine the viability of increasing air change rates to 6 ac/hr. Reference was made to SHTM 03-01 within the report as it was related to observations.

26. What initial observations, if any, did you have regarding the design of the ventilation system?

A Existing ventilation air change rates seemed abnormally low and supply/extract air volume flow rates tended to suggest the potential for air movement from circulation spaces towards patient areas.

27. Describe your understanding of why the ventilation system was designed as you found it?

A When considering air change rates, AHU/fan selections, resilience, ductwork selection, etc., it is very difficult to understand any rational in terms of the design intent, even when considering a ‘General Ward’ or ‘Single Room’ application.

From a completely speculative viewpoint there could be multiple reasons, such as:-

- Design carried out by an inexperienced engineer that was unfamiliar with associated design guidance, and/or the design was not appropriately checked by a senior/experienced engineer.

- Pressure to achieve additional project cost savings. Decreasing air change rates would reduce AHU requirements, reduce ductwork sizes, etc., thereby reduce the overall capital cost of the installations. Although this wouldn’t seem to justify reasoning in terms of dirty extract systems being integrated within the Ward 2A system.

- Inaccuracies with regards to the design brief, and/or an agreed deviation from the design brief/SHTM's. However, there would normally be formal/written record in relation to any deviation from design brief, especially in terms of such a significant/abnormal deviation from SHTM guidance.

- Misinterpretation of the proposed function of the facilities, although if this was the case we would still expect the systems to have been designed based on 6 ac/hr (General Ward / Single Room).

- A post-design change in terms of the use/function of these rooms/areas, that was not appropriately communicated to the design team. However, record drawings intimate the use of these facilities (room names), and this would still not justify the extent of deviation from SHTM guidance relating to General Ward/Single Room requirements.

28. Please describe the significance of SHTM 03-01 with respect to the task for which you had been instructed.

A As Point 25.

29. In respect of Ward 2B, what concerns, if any, did you have regarding compliance with SHTM 03-01?

A Ventilation air change rates seemed abnormally low, and supply/extract air volume flow rates tended to suggest the potential for undesirable air movement from circulation spaces towards patient areas.

Air handling unit (AHU) supply and extract fans were not capable of providing the necessary air volumes.

AHU selection did not appear to be afforded with appropriate resilience with regards to spare capacities, to facilitate ongoing maintenance regimes without undermining patient comfort and safety, and/or to protect against critical plant fault/failure. Selection was also made on the basis of clean filters, which

suggested there to be a risk of abnormally low air change rates decreasing further.

Air terminals did not appear to be suitable in terms of potentially increasing air flow rates. Moreover, there was dubiety with regards to the appropriateness of supply air terminals relative to the design/installed air flow rates.

The use of a thermal wheel heat recovery device, and associated risks in terms of potential cross-contamination (leakage and carryover).

H&V commissioning records stated that AHU 24 fan chamber was full of water, thereby implying the equipment was potentially not fit for use.

30. What other guidance, if any, did you have in mind when carrying out your assessment of Ward 2B? Please describe your assessment of any such compliance, and the significance of this.

A CIBSE ventilation design guidance relating to maximum ductwork velocities within critical care facilities. Numerous sections of the installed ductwork distribution system was deemed to be inappropriately sized relative to the associated recommended maximum air velocities. This not only restricted the feasibility of increasing air change rates, it also suggested that there could be excessive noise generation from the distribution that could cause annoyance to the patients, particularly where routed within ceiling voids directly above Bedrooms.

DW/144 (Ductwork Specification) provides minimum requirements with regards to the manufacture of ductwork in terms of velocity/pressure classifications. We anticipate the ductwork was designed and installed relative to a low pressure Class A system, and not in accordance with the pressures stated within final commissioning records. Moreover, pressure losses at commissioning stage would be based on a completely new and clean system, thereby system resistances would appear only likely to increase once in use.

CIBSE guidance with regards to heat recovery devices. Guidance identifies there could be a 1% to 10% risk of cross-leakage with the use of a thermal wheel device.

Air handling units

31. In section 1.01 of you report you write that 'a significant discrepancy was identified with the selection of the air handling units'.

a) Can you explain the nature of this discrepancy?

A AHU selections were based on abnormally low room air change rates, did not appear to be afforded with appropriate resilience with regards to spare capacities, did not facilitate ongoing maintenance regimes without undermining patient comfort and safety, and/or afford protection with regards to critical plant fault/failure. Selection was also made on the basis of clean filters, which suggested there to be a risk of abnormally low air change rates decreasing further.

b) You mention having proceeded on the assumption of a 125% capacity level for these units. Why did you make that assumption?

A From memory, this level of spare capacity was stated within record documentation contained on Zutec.

c) How did you come to the view that it was unfounded?

A From our analysis (calculations, assessing record drawings, commissioning data, etc.) and the subsequent direct communication with the AHU manufacturer to verify selection parameters.

d) Please explain the significance of the units instead having been selected based on 100% air volume, with clean filters?

A Limited spare capacity in terms of air volumes and pressures, which could undermine the (intended) performance of the system once in use.

It also limits the viability of increasing air volumes at a later date (i.e. to facilitate building/facilities modifications, etc.), and could adversely impact the life expectancy of the equipment by continuously operating near full capacity.

e) How important is the 25% additional capacity?

A In my opinion it is very important to afford some level of resilience/spare capacity with respect to the design and selection of equipment, for most systems. If a 25% spare capacity formed part of the Clients requirements, and/or was offered/stated as part of record documentation, it would be deemed a critical aspect (effectively a non-compliance with contractual obligations that adversely impacts the entire system).

f) How did this, if at all, impact on the air changes?

A As Point 31 c.

g) How significant is the assumption of 'clean filters'? How does that affect the performance of the units? How did this, if at all, impact on the air changes?

A Very important/significant. Filters would only be completely clean until initial operation, and/or following replacement. Once operational, filters, ductwork, terminal devices, dampers, etc. would accumulate dust/debris/dirt, which would increase external system resistance and adversely impact air flow rates. The resultant impact of this could be a reduction in air change rate(s), which would be exacerbated relative to operating hours, cleanliness of the environment(s), and frequency of cleaning (ductwork, terminals, filters, etc.).

h) What issues, of any, were created by the selection of these air handling units?

A As described in Points above.

i) What impact, if any, did this have on the ability to carry out air change compliance with SHTM03-01?

A It was not deemed feasible to increase air change rates to 6 ac/hr, thereby compliance with SHTM 03-01 would not be viable.

j) To what extent was any such difficulty a result of the air handling units, and to what extent was it the result of other factors?

A As described in Points above. The inability to achieve 6 ac/hr was not only linked to AHU selection.

k) Are you able to draw any inference as to why those particular air handling units were selected?

A Only speculatively, incompetence in terms of the design.

Competence of the manufacturer could possibly also be questioned, if the 'peak design air flow rates' were advised and the AHU's were selected by them without any meaningful extent of spare capacity. Notwithstanding this, it is ultimately the designers responsibility to select and specify the AHU, not the manufacturer (i.e. designer should check information provided by the manufacturer, if they do not select equipment/duties).

l) What air handling units in your opinion should have been selected?

A Reference should be made to the attached 'Lead Consultant Appoint Brief', which duly outlines performance criteria (relative to Ward 2A).

AHU's (and associated ductwork, ancillaries, etc.) with higher capacities to afford air change rates more akin to the proposed purpose of the facilities being served, along with some degree of spare capacity to facilitate future flexibility.

Occupants are completely reliant on fresh air supplies derived from the mechanical ventilation systems in these rooms (for regulatory compliance, disregarding any other guidance documents such as SHTM's and CIBSE). Resilience (i.e. twin fan motors, duplicate AHU's, twin heating/cooling coils, etc.) should also be duly considered given the importance of maintaining the continued operation of the facilities.

Thermal wheels

32. You made reference in the Executive Summary to: *"Other significant potential issues identified include the installation of thermal wheel type heat recovery devices serving areas where the risk of cross-contamination may require further consideration"*. Please explain your comment regarding the use of thermal wheels? Why was this described as a potential issue?

A Due to potential risks in terms of cross-contamination (leakage and carryover). AHU manufacturer confirmed the installed thermal wheel heat recovery devices do not afford complete segregation of airpaths.

33. What experience do you have of dealing with thermal wheel devices?

A Minimal experience in terms of specifying the use of thermal wheels, however, we have encountered these devices on projects previously. We tend to specify the use of cross-flow heat exchangers. These do not exchange humidity, avoid risks associated with cross-contamination of airstreams (leakage and carryover), and are normally of lower (capital) cost.

34. In your experience are thermal wheels used in areas which house immune compromised patients?

A Unless there was absolutely no risk of cross-contamination (throughout the life expectancy of the device), I would not recommend the use of a thermal wheel heat recovery device in a critical care facility, especially where immune compromised patients are cared for.

35. Does the use of thermal wheels create an additional avoidable risk of infection? If so, how so?

A We were advised the thermal wheel heat recovery devices do not afford absolute segregation of airpaths, and therefore, yes it does create additional avoidable risk when other forms of heat recovery devices could have been utilised.

36. Is the use of thermal wheels compliant with SHTM03-01 in areas which house immune compromised patients?

A SHTM 03-01 states the use of a plate heat exchanger (i.e. cross-flow type) or run-around coil system would be suitable. Guidance further notes that thermal wheels may be used providing they are fitted with a purge sector, as the small amounts of air leakage are not considered significant.

Therefore, whilst it could be argued the use of thermal wheels would be acceptable in terms of compliance with SHTM 03-01, I would argue that any potential risk associated with cross-contamination and ultimately patient safety should be completely mitigated wherever possible to do so.

Cooling Devices

37. At para 4.03 of your report you identify the presence of "ceiling mounted Swegon Parasol heating/cooling comfort modules", and draw a distinction between those and Chilled Beams. Please explain the distinction.

A They function in a similar manner, however, the installed comfort modules are effectively a compact version of a chilled beam, which distributes supply air in four directions in lieu of two, within a smaller footprint (square module instead of a linear beam).

This aspect could adversely impact the energy performance rating of the system/building (BREAMM), should induction modules not hold the same standard of accreditation as chilled beams.

38. You note that it was Swegon Parasols which were a feature of Ward 2B. Is there any particular significance to it being those which were chosen?

A No particular significance. This was simply something noted from record documentation. We anticipate this form of terminal will be available from other manufacturers.

39. In which areas were they present?

A Swegon Parasol modules were installed within the BMT Day Ward and Day Stay Ward of Ward 2B. They were also installed in other rooms of Ward 2B, such as Consultation and Examination rooms.

40. In your experience is it usual to see these devices in areas which house immune compromised patients? Would it be usual to see chilled beams in such areas?

A We would in all probability not select/recommend the use of chilled beams, or the installed modules, for rooms housing this patient group. Perforated sections would seem to be inherently difficult to clean properly, and given that the rooms could be in use for prolonged periods, undertaking cleaning whilst occupied would not be deemed practical/appropriate in terms of patient safety.

SHTM 03-01 emphasises these aspects, with regards to the use of chilled beams, along with the need to ensure external surfaces remain below dewpoint (i.e. to avoid condensation forming).

41. Does the use of Swegon Parasols create an additional avoidable risk of infection? If so, how so?

A Arguably no more so than the use of chilled beams, however, the use of this type of terminal should have been better considered relative to the function of the facilities (in my opinion).

42. Is the use of Swegon Parasols compliant with SHTM 03-01 in areas which house immune compromised patients?

A Arguable not, when taking cognisance of points relating to access for cleaning and impact of maintenance in terms of room availability (SHTM 03-01, Clause 2.40).

43. Please explain the mechanism by which the noise output of Swegon Parasols is affected by increased air flow. Does this represent a practical limitation on their capacity?

A Forcing additional air through the supply openings would increase face velocity (speed of air going through the openings), create more resistance/pressure drop through each opening, and subsequently increase the noise generation from the terminal. The same would apply in terms of the extract air path through the perforated front face.

Yes, it represents a practical limitation on their capacity. Excessive noise generation would adversely impact occupant comfort. Also, increasing air flow rate would increase air velocity and associated throw from the terminal (i.e. how far the air is distributed into the room from the terminal), which could adversely influence occupant comfort in terms of air speed / draught.

Increasing air flow through the terminals would also increase pressure drop in the system (albeit only on index terminal), however, it would further reduce any spare capacity on the AHU/fans.

44. To what extent, if at all, did the cooling or heating devices constitute a limitation on the capacity of the ventilation system? How did this compare to other limitations?

A Approximate calculations carried out suggested that existing heating/cooling (distribution) installations could be retained, and/or locally modified/adjusted, relative to the desired increase to 6 ac/hr. In that regard, the extent of modifications deemed necessary relative to other limitations would be regarded as minimal.

Filters

45. You identify at 4.05 that *"AHU supply and extract fans were apparently sized and selected based on 100% air duty with clean filters … As AHU capabilities are based on clean filters, we anticipate there will be a reduction in current/existing air volumes (i.e. ac/hr) as filter free areas diminish.".* Please explain the mechanism by which filters affect the volume capacity of a ventilation system.

A As filters become dirty (clogged by debris, dirt, etc.) the free area for air flow through the filter is reduced. This reduction in free area increases resistance through the filter, essentially making the fans work harder. As the fans were selected near peak capacity there would be a point at which they reach maximum duty, and may not be capable of overcoming resistances (through filters, and the rest of the system). Once peak fan capacity is exceeded, the resultant air volume/flow rates from the AHU would decrease, thereby decreasing the air change rates within the facilities.

46. Does it follow that the presence of filters represent an inherent limitation on capacity. By what means might/can/should this be addressed?

A Yes. Fan duties should be selected with a view to overcoming resistances when the 'system' is in a 'dirty' condition (i.e. filters, terminals, heat recovery devices, heating/cooling coils, ductwork, etc.). Noting that a 'dirty' condition should take cognisance of appropriate maintenance/cleaning/replacement regimes, to avoid putting undue strain/pressure on the fans and minimise energy consumption.

47. To what extent does it appear to you that this was taken into account in designing the ventilation system?

A Sizing/selecting fan duties based on clean filters tends to suggest that cognisance was in all probability not taken with regards to system degradation.

48. Please comment on the adequacy of this aspect of the ventilation system.

A Inadequate.

Air change rates

49. At para 3.01 you record the Day Stay ward as having a ward air supply of 2.33 ACH.

a) Is this compliant with SHTM03-01?

A No.

b) Was this air change as agreed at the design stage?

A Unknown.

c) What documentation did you see regarding this?

A None.

d) Should the ward have been operating at slightly negative pressure?

A No.

50. You also record the BMT Day Ward as having a ward air supply of 2.79 ACH.

a) Is this compliant with SHTM03-01?

A As Point 49 a.

b) Was this air change as agreed at the design stage?

A As Point 49 b.

c) What documentation did you see regarding this?

A As Point 49 c.

d) Should the ward have been operating at slightly negative pressure?

A As Point 49 d.

51. At the time of the report, did the ventilation system as installed in ward 2B create an additional risk of avoidable infection? Please explain your view: if so, how so? If not, why not?

A In my view yes, for reasoning outlined in previous points.

52. At para 3.02 you set out the 'Proposed Air Volumes' required to achieve an air supply of 6 ACH in those wards. In broad terms, would those have been achievable with the wards designed as they were?

A No, the systems were not deemed suitable to achieve the desired increased air change rate of 6 within the Wards.

53. What conclusions, if anything, would you draw from this as to the aim of the design of the hospital in respect of air change rates?

A Inadequate.

54. At section 4 of your report you describe the 'Impact on Existing Installations'. At para 4.01 you describe learning that your assumption of 125% capacity had been incorrect.

a) Please describe why you made that assumption.

A As described in points above.

b) Were you surprised that that assumption turned out to be erroneous?

A Yes.

c) What conclusion, if any, did that lead you to draw as regards the design of the ventilation system?

A Inadequate.

Supply & Extract Air Ductwork

55. At para 4.02 you set out the parameters of the ductwork and considered whether it would be able to handle an increase to 6 ACH. Broadly it appears that the Extract ductwork would have been able to cope with 6 ACH, whereas the Supply Air ductwork largely would not. Is that correct? Do you have anything to add at present.

A Incorrect. Various sections of the extract system were also deemed to be at/above recommended velocity.

56. The Supply Air exception is the Main 1000x600mm rectangular ductwork first described at para 4.02, which would be able to cope. Why, in your view, might this have been different from the rest of the Supply Air ductwork?

A Probably as larger sections of ductwork can accommodate higher air volumes, thereby a marginal increase in the quantity of air would have a lesser impact in comparison to smaller sections of ductwork.

57. Would you draw any inference from this? What might it say about the coherence of the Supply Air ductwork system?

A No, this would seem to be incidental.

58. Why might the supply and extract ductwork have differed in this way?

A The design of both the supply and extract ductwork distribution seemed to be similar.

59. Please explain the significance of the noise levels described at these passages.

A Excessive ductwork air velocities can create noise generation, which could be detrimental to patient comfort.

Supply & Extract Air Terminals

60. Please explain the significance of your conclusions on Supply Air Terminals at para 4.03.

A Increasing the quantity of supply air via existing terminals could cause discomfort to the patients, plus there would be additional external resistance within the system.

61. You describe the Extract Air Terminals as capable of handling the volumes required for 6 ACH. Again, why might the supply and extract systems have differed in this way?

A Technical literature for the installed extract grilles was unavailable so we utilised literature for a similar grille from a different manufacturer. We established that the grilles would likely be suitable for an extract rate of 500l/s (i.e. oversized).

Extract grilles do not appear to have been appropriately sized, they seem to have been selected to suit the ceiling grid size in lieu of the extraction rate from the ventilation system (in my opinion). Note that we have discovered this same issue on numerous other sites/projects.

LTHW Heating & Chilled Water Installations

62. At para 4.03 your conclusion appears to be that these installations would be capable of handling an increase to 6 ACH. Is this correct? Do you have anything to add?

A Indicative calculations/estimations carried out suggested the existing heating and cooling systems would be capable of achieving the necessary increase in duty (i.e. in terms of pipe sizes). However, this would have involved re-balancing/replacing commissioning valves (to suit increased flow rates), and the associated pump sets would also require re-commissioning.

63. Why might these installations have differed in capacity from the air ductwork and terminals described above? Would there be any operational reasons for this?

A It wouldn't be unusual for different engineers to be tasked with the design of different systems, especially for a building of this size. Another reason could be that the design of the heating/cooling systems was checked more appropriately than with the ventilation systems.

From memory, the piped distribution systems were reasonably well selected and could accommodate the increased loads. The heating/cooling system pumps were also utilised to serve various/numerous areas throughout the building, thereby the associated increase in flow/pressure was marginal/negligible (in the same manner the larger section of supply air ductwork could accommodate a marginal increase in duty).

64. What inference might you draw regarding the coherence of the ventilation system?

A As described in points above.

System Alterations Required

65. You describe options at section 5 of your report. Do you have anything to add?

A Options were relative to increasing air change rates to 6 ac/hr, as noted in the report. We were not asked to provide 'upgrade' options for Ward 2B with regards to compliance with SHTM 03-01 (as we were with Ward 2A).

66. Are you aware of the remedial works undertaken? Do you have any comments to make in that regard?

A Following the appointment of the Lead Consultant undertaking remedial works we attended meetings and provided comments pertaining to the proposed design, up to tender stage. From memory at/around tender stage various other/additional concerns were discovered on site, which led to re-design, and we were not asked/appointed thereafter.

In view of this, no, we are not aware of the remedial works that were eventually undertaken on site.

Additional Notes

67. At section 6 you set out a number of additional points identified in your analysis. Please comment as you think fit on the following aspects:

a) The quality and availability of Zutec or other documentation.

A As described in points above.

b) The robustness of the AHU 24 system. You mention that your observations here may be applicable to other systems within the building. Do you mean other systems feeding off AHU 24, or other independent systems? If the latter, did you see any evidence of this?

A Other independent systems. Again from memory, we discovered an Excel Sheet within Zutec that implied various other/most AHU's were equipped with thermal wheel heat recovery devices. It also seemed reasonable to presume that other systems installed elsewhere within the building may have been inappropriately selected in a similar manner as the systems we had reviewed appeared to be.

c) That the commissioning data relative to AHU extract system indicates that the fan chamber was full of water. What might this indicate? How might it have come about? Did you see evidence of this?

A It would indicate inadvertent water ingress into the system. This may have occurred during installation, or perhaps due to water ingress as a result of external discharge terminal positioning, but essentially unknown.

No, this installation was not reviewed on site and we are unaware if remedial works were undertaken prior to handover.

Ward 2A report –

Report prepared by Innovated Design Solutions dated 24 October (revision 01, 30 October 2018) titled "Feasibility Study Regarding Increasing Ventilation Air Change Rates within Ward 2A" Refer to document 34, Bundle 6, Miscellaneous documents.

68. What did you understand to be the patient cohort intended for Ward 2A?

A Teenage cancer patients, and patients being cared for in terms of bone marrow transplant.

69. What specialist ventilation requirements, if any, would that patient cohort require?

A Design guidance within SHTM 03-01 relating to Neutropenic Patient Ward would be more appropriate (10 ac/hr, positively pressurised).

70. What ventilation specification would you have expected to see?

A As Point 69.

The Lead Consultant Appointment Brief (produced after feasibility reports) essentially outlined what we considered appropriate to this type of facility, whilst also taking cognisance of supplementary facilities/ancillaries agreed following discussions with estates and infection control (i.e. monitoring and automatic control of Bedroom/Corridor pressure differentials, etc.).

71. To what extent were you furnished with material to enable you to verify what specification had been used, and what had been the thinking behind that choice?

A The verification of specification did not form part of our scope as we were instructed to determine the viability of increasing air change rates to 6 ac/hr.

72. What initial observations, if any, did you have regarding the design of the ventilation system?

A Existing ventilation air change rates seemed abnormally low and supply/extract air volume flow rates tended to suggest the potential for air movement from circulation spaces towards patient areas.

73. Describe your understanding of why the ventilation system was designed as you found it?

A As Point 27.

74. Please describe the significance of SHTM 03-01 with respect to the task for which you had been instructed.

A Under initial instruction, as per Point 25. We were subsequently asked to include within the report upgrade options within Ward 2A relative to the patient group. To facilitate this aspect guidance contained within SHTM 03-01 and SHPN 04 : Supplement 1 (Isolation Facilities in Acute Settings) was significant/fundamental.

75. In respect of Ward 2A, what concerns, if any, did you have regarding compliance with SHTM 03-01?

A Similar concerns to those identified as part of the Ward 2B analysis (As Point 29).

76. What other guidance, if any, did you have in mind when carrying out your assessment of Ward 2A? Please describe your assessment of any such compliance, and the significance of this.

A As Point 30.

Cognisance was also taken with regards to guidance within SHTM 03-01 and SHPN 04.

77. You considered both Ward 2A and 2B when compiling your report. In general terms, was there any significant difference between the ventilation system in the two wards?

A In terms of Ward 2A, we identified that exhaust air from 'dirty' environments (i.e. such as Toilets, Shower Rooms, Dirty Utility Rooms, Disposal Rooms, Cleaners Stores, etc.) was being routed back to the AHU, whereas exhaust air from cleaner environments was being discharged directly to atmosphere (i.e. dedicated extract system).

Ward 2A and Ward 2B also differed in terms of individual Bedrooms/Ensuites and communal Ward environments, albeit ventilation strategies were similar.

78. You did not consider the ventilation installations pertaining to the BMT area within Ward 2A and 2B when compiling your report. Why not?

A These areas were excluded from our remit.

Immunocompromised patients

79. You state in the first paragraph of your para 1.01, and again at para 6.01, that you did not consider the original design philosophy of ward 2A to be intended for use for immune response impairment/deficiency patients.

a) Were you able to determine the 'design philosophy'? What assisted/hindered you in doing so?

A No, we were not able to establish the design philosophy, however, we believe our analysis enabled a relatively accurate interpretation of the probable design intent and operational functionality of the ventilation systems.

b) Why did you form the view that it was not designed with immune-deficiency patients in mind?

A For various reasons, including abnormally low air change rates, the probable direction of air movement, the AHU being equipped with a thermal wheel that did not afford complete segregation of airpaths, the interconnection of exhaust air from 'dirty' environments into the system/AHU, and lack of system resilience.

c) Had it been so designed, what would you have expected to see?

A As Point 70.

d) Please explain what conclusions you drew from the absence of any such features or items. In particular, did the ward appear to have been designed with such features or items in mind, or was there no indication that they had been in contemplation?

A The ventilation installations were not deemed appropriate relative to the care of the particular patient group.

The ventilation systems within Ward 2A did not appear to have been designed with appropriate, or compliant, features/items in mind, nor did there appear to be any indication that they had been considered.

80. You also indicated at those paras that the design was likely to promote risks.

e) Please explain what risks you had in mind?

A Potential for air from the adjacent circulation areas entering patient Bedrooms, risk of cross-contamination occurring within the AHU (via thermal wheel), and various single points of failure that could undermine occupancy supply air provisions.

It should be noted that the mechanical supply air provisions were the only means of affording fresh outside air for occupancy purposes (from a regulatory perspective, disregarding the use of the facilities). Failure of the system, and resultant loss of fresh air provisions, would essentially necessitate the complete relocation of occupants from the Ward.

f) What items or features caused those risks?

A As generally described in foregoing Points, and fundamentally the design of the system.

g) Are there examples of the absence of particular items or features causing such risks?

A Probably, however, it should be recognised that guidance within SHTM's is not simply based on assumed best practice, but experience and knowledge acquired by a multitude of Healthcare professionals (such as infection control specialists).

h) Did the layout of the ward (in terms of its being composed of single bedrooms with en-suite facilities) contribute to your conclusions regarding promotion of risk?

A No, I do not remember this aspect being of particular concern in terms of our conclusion.

i) Were there measures which ought to have been taken prior to your involvement either to eliminate or mitigate the risks (if any) posed by that layout?

A As above.

Air change rates

81. At para 2.01 of your report you describe its purpose as being: "…to determine the viability of increasing mechanical supply and extract air volumes to achieve 6 air changes per hour within the upper Single Bedroom spaces located within Ward 2A, including those situated within the Teenage Cancer Trust zone".

a) Who asked you to use the parameter of 6 air changes per hour?

A From memory this was advised during initial discussions, as Point 12 b. I do not remember who in particular mentioned this parameter.

b) Do you know why that rate was chosen?

A No.

c) In light of the intended patient cohort, are you able to give a view on the appropriateness of a 6 air changes per hour rate?

A Inappropriate.

d) Are you aware of guidance suggesting 10 AC/h?

A Yes, within SHTM 03-01 guidance pertaining to Neutropenic Patients.

82. You mention the presence of the Teenage Cancer Trust zone.

a) How did that affect your view of the ventilation system in ward 2A?

A In terms of viability of increasing air change rates to 6 ac/hr, this did not impact our assessment any more so than other areas within the Ward.

With regards to upgrading the facilities, it was deemed that this zone should be afforded with enhanced provisions in the same manner as the other areas of the Ward.

b) Were there any specific or enhanced requirements posed by the presence of that zone, in respect of ventilation?

A As Point 82.

83. In the remainder of your report you largely discuss the feasibility of achieving an air change rate of 6 changes per hour.

a) Does it follow from your conclusions regarding 6 air changes per hour, that 10 air changes per hour would have been no more achievable?

A Achieving 10 ac/hr would have been significantly less viable.

b) What do you conclude from that as regards the design choices around the ventilation system for ward 2A?

A Inadequate.

c) Are there any parts of the ventilation hardware which would have been able to cope with a rate of 10 air changes per hour?

A In all probability no, albeit this would need to be assessed in further detail.

d) Please add any comments you consider may assist the Inquiry in understanding the difference between 6 and 10 air changes per hour, in terms of the demands placed upon a ventilation system, and consequences for its design?

A This is roughly a 66% increase in terms of air volume, which would impact the entire installation (i.e. AHU, ductwork, dampers, room supply/extract terminals, intake/discharge terminals, etc.). The size/scale of the ventilation

installations would in all likelihood be considerable larger, and more expensive.

The increased size of the system would also need to be accommodated within the building (i.e. structural weight of equipment, larger voids/zones to accommodate ductwork, etc.).

84. You state (at para 1.01) that the rate of 3 air changes per hour was 'significantly lower than would normally be expected'. Please explain your expectations, by reference to guidance and by reference to any requirements which you understand may apply to the patient cohort.

A Bedrooms should have been afforded with 10 ac/hr, and positively pressurised, relative to SHTM 03-01 guidance in terms of Neutropenic Patients. BMT and cancer patients receiving intensive treatment would be deemed more susceptible to infection due to weekend immune systems.

Even if the original design intent had considered the Bedrooms to be 'Single Rooms', we would still have expected a minimum rate of 6 ac/hr (relative to SHTM 03-01 guidance).

85. In broad terms, what was your view of the air change regime which you found in place at ward 2A?

A Inadequate.

86. At para 4.05 (first bullet) you imply that you had seen no agreement to vary from the expected standard.

a) What would be your view were such a variation to have been agreed?

A It would be irresponsible and alarming to do so.

b) Would you have expected to be appraised of it from the documentation available to you when compiling your report?

A Yes, I would have expected this to be clearly identified within record documentation, and within the Health & Safety File.

c) What would be acceptable circumstances, in your view, for agreeing to such a variation?

A None.

87. At paras 4.01 to 4.03 you set out by reference to certain metrics the shortfall in performance of the ventilation system (by reference to the parameter of 6 air changes per hour), and identify what might be required in order to achieve that level.

a) Is there any significant difference between your analysis at these paras and your analysis at the equivalent paras in respect of the Ward 2B report?

A No significant difference.

b) In broad terms, is it the case that (in terms of achieving 6 air changes per hour) the ventilation system would be inadequate in terms of supply, but adequate in terms of extraction? Please explain your answer if required.

A No, various sections of the extract ductwork distribution were also deemed to be at/above recommended velocity.

88. In terms of heating and cooling air, was your conclusion at para 4.04 that the ventilation system in ward 2A was broadly adequate to handle 6 air changes per hour? Please explain your answer if required.

A As Point 62.

89. Overall, if your answers to the questions above indicate that parts of the system would be adequate to handle an air change rate of 6 air changes per hour, but that other parts would fall significantly short of that, what conclusions (if any) would you draw? How coherent would that suggest the design philosophy of the ventilation system was in ward 2A?

A As Point 63.

Other air change issues

90. At para 4.05 (second bullet) you explain your conclusion that air was likely to flow from other areas into the bedrooms.

a) Please explain how you reach that conclusion.

A The volume of air being extracted from the Ensuite was higher than that being supplied into the associated Bedroom, thereby this differential in 'make-up air' must be derived from somewhere. The adjacent corridor was also equipped with mechanical supply air.

b) Are you able to offer a view on whether that conclusion is positive or negative for the operation of ward 2A? Please explain.

A A negative impact.

The purpose of maintaining a positive pressure within the Bedroom is to reduce risks associated with inadvertent air ingress from adjacencies (i.e. such as a circulation corridor utilised by staff, patients, visitors, etc.).

c) At para 6.03 you make a proposal for modification by way of making the bedrooms pressure-positive? Please explain why you proposed this.

A As Point 90 b.

d) What conclusion, if any, would you draw from the fact that such an arrangement was not already in place?

A There would be a risk of inadvertent/undesirable air ingress into the Patient Bedroom.

e) At para 6.04 you make a similar proposal should the Teenage Cancer Zone be repurposed? Please explain why you proposed this.

A We were asked to consider the viability of creating individual positively pressurised suites throughout Ward 2A, which was deemed impractical due to the probable reduction in accommodation (from forming lobbies). However, the TCT zone appeared to be more suitable in this regard due to the existing

circulation space positioned between the Bedrooms and main Ward 2A corridor.

91. At para 4.05 (third bullet) you describe the supply and extract fans being selected at 100% capacity.

a) Please explain the significance of that.

A Same reasoning as described for Ward 2B AHU.

b) Did that match your expectation when commencing your report? On what basis had you formed an expectation?

A Same reasoning as described for Ward 2B AHU.

c) Please explain the third para of this bullet. How can the fans be both 'based on 100% design air volume' and having '15.5% and 9.5% air volume' spare capacity?

A The AHU manufacturer selected the nearest fan sizes to achieve design parameters. Following discussions with the manufacturer, the actual/resultant fan selections afforded 15.5% and 9.5% spare capacity, based on clean filters.

For example, calculating a room heat loss of 2.7kW, and then installing a 3kW radiator (the nearest suitable radiator size/output to achieve/exceed the design duty).

d) Please explain the consequences for life expectancy. How likely is their means of operation to be harmful to them?

A From memory this aspect was discussed/confirmed with the AHU manufacturer, but would need to be verified.

Notwithstanding this, operating most appliances/equipment at/near full capacity (continuously) would in all probability be detrimental to life expectancy.

e) Please explain the significance of clean or otherwise filters.

A Same reasoning as described for Ward 2B AHU.

92. Please explain the significance of air velocity. How confident are you of your estimates in that regard?

A Significance as described for Ward 2B installations.

From memory, we either referenced terminal schedules and/or H&V commissioning data/sketches to the record drawings in order to establish air flow rates for the various sections of ductwork. We then referenced these to CIBSE guidance as intimated below.

Table 2.18 Guide to maximum duct velocities in risers and ceilings

Duct location	Duct type	Maximum air velocity / $m \cdot s^{-1}$ for stated room type		
		Critical	Normal	Non-critical
Riser or above plasterboard ceiling	Rectangular	5	7.5	10
	Circular	7	10	15
Above suspended ceiling	Rectangular	3	5	6
	Circular	5	7	10

I have checked two separate sections of Ward 2A supply air ductwork and velocity calculations were accurate. Could you please advise if there are any other/specific concerns with regards to same?

93. Please explain your observations in the last bullet of para 4.05. How much work would be required in each bedroom to bring the air change rate up to the desired rate, as opposed to in other areas?

A Initial assessment of the heating/cooling pipework sizes must have intimated that these services would be capable of accommodating the additional loads.

Therefore, if additional supply air (i.e. circa 3 ac/hr) was introduced via new terminals into the Bedrooms, we anticipated that heating/cooling pipework could be locally interconnected to existing piped distribution within the Ward 2A ceiling void (together with new valves and re-commissioning, etc.).

94. At para 6.02 of you report you disregard the viability of creating isolation suites within ward 2A. To what extent, if any, is this as a result of your observations on the ventilation system?

A From memory we queried if any form of reduction in accommodation (Bedroom numbers) would be considered to facilitate the introduction of isolation suites/lobbies. As a reduction in accommodation was not deemed practical/viable, this option was disregarded.

System Alterations Required

95. You describe options at section 5 of your report. Do you have anything to add?

A Options were described with regard to introducing additional supply air to achieve 6 ac/hr. Could you please be more specific?

96. Are you aware of the remedial works undertaken? Do you have any comments to make in that regard?

A As Point 66.

Additional Notes

97. At para 7.01.1 you describe the extract system configuration as abnormal.

a) Please explain the significance of having separate arrangements for ‘dirty’ and ‘clean’ areas.

A To minimise risks associated with cross-contamination.

b) Are there negative implications from the configuration observed by you?

A Yes.

c) If so, please explain any conclusion you would draw about the design of the ventilation system within ward 2A.

A Connecting the ‘dirty’ exhaust system into the AHU, whilst discharging exhaust from ‘cleaner’ environments directly to atmosphere, would appear to

have been a mistake with regards to the design of the system(s). It would also only appear likely to increase any potential risks associated with cross-contamination within the AHU (i.e. via thermal wheel).

Should the AHU/extract system fail there would also appear to be potential risk in terms of contaminated air inadvertently entering Ward 2A Bedroom Ensuites (backflow of air via extract terminals), due to differential pressures within rooms/floor levels, although that aspect would need to be considered/assessed in greater detail.

Furthermore, the dirty extract system served various facilities within the hospital, on multiple floor levels, thereby suggesting inherent vulnerabilities in terms of resilience (i.e. fan failure would result in complete loss of numerous facilities).

98. At para 7.01.6 you mention humidity. Please explain the significance of this metric.

A SHTM 03-01 guidance states parameters pertaining to humidity levels, primarily due to condensate risk, which could undermine the safety of patients if not controlled/maintained properly.

99. Do you have anything to add regarding the matters covered at your 'Section 7 – Additional Notes'?

A The positioning of isolation suites at the bottom section of Ward 2A (through a set of double doors) was not deemed to be ideally located in terms of the patient group within the upper section of Ward 2A. Another consultant/contractor was involved with re-design works within these areas at the time of our analysis, and these areas were not to form part of our remit.

As part of the Lead Consultant Appointment Brief it was recommended that consideration be given to the introduction of positively pressurised lobbies within the Ward 2A corridor.

Views on ventilation system Ward 2A and 2B:

100. What if any, impact did the ventilation system in 2A & 2B have on the increased risk of avoidable infection?

A I would consider that the ventilation systems would have a negative impact with regards to avoidable risk of infection.

101. Are you aware of whether following works carried out to Ward 2A and 2B the ventilation systems in place in those wards complied with SHTM guidance?

A No, our input/appointment ceased prior to this stage.

102. Are you aware of any other areas of the hospital which did not comply with SHTM guidance in respect of ventilation? Please explain your answer.

A During our analysis we discovered an Excel sheet intimating the installation of thermal wheels in other/most AHU's within the hospital. We would also be concerned that inadequacies identified as part of the Ward 2A & 2B analysis were applicable to other systems within the hospital.

Declaration

103. I believe that the facts stated in this witness statement are true. I understand that proceedings for contempt of court may be brought against anyone who makes, or causes to be made, a false statement in a document verified by a statement of truth without an honest belief in its truth.

Appendix A

The witness was provided the following Scottish Hospital Inquiry documents for reference when they completed their questionnaire statement.

A33795394 – QUEH Forensic Analysis – Energy Centre/MTHW (Innovated Design Solutions) 10 May 2018

A43293438 – Bundle 6 – Miscellaneous Documents

Appendix B

The witness provided the following documents to the Scottish Hospital Inquiry for reference when they completed their questionnaire statement.

A49471926 – Matthew Lambert CV
A49377285 – Ward 2A Ventilation Consultancy Scope of Works
A49377009 – Appointment Addendum

INNOVATED
DESIGN SOLUTIONS

Matthew Lambert

Job Title : **Director**
Qualifications : **BSc Building Services Engineering**
BEng (Hons) Building Services Engineering
MCIBSE (Member of Chartered Institute of Building Service Engineers)

Matthew has worked in professional Building Services design consultancy engineering since 1998, being part of a private engineering practice throughout this period. He has extensive experience and technical knowledge gained from working on a wide variety of complex projects ranging across most industry sectors, including domestic/housing, residential care facilities, hostels, office accommodation, community buildings, education (nursery, primary, secondary, and special needs facilities), leisure, fire and rescue, police, healthcare, and industrial.

Matthew also has significant experience with regards to undertaking the lead role, and associated responsibilities, on numerous new and refurbishment/upgrade projects, often requiring meticulous planning and delivery in difficult environments. This experience includes where properties/facilities must remain fully operational throughout the works (such as healthcare facilities, large residential care properties, and educational buildings), listed buildings involvements, and undertaking the role of Principal Designer on numerous occasions. He is also accustomed to undertaking the role of lead technical advisor/manager, having carried out these responsibilities on numerous occasions for complex projects, including a large PFI development for Avon Somerset Police.

Matthew is a firm advocate of fundamental engineering principles and philosophies, encouraging and mentoring developing engineers to ensure these essentials are fully recognised and appreciated from the outset. Matthew's knowledge and technical expertise has also led to a significant extent of repeat business for the practice.

Matthew is the Managing Director of the company, thereby responsible for managing all aspects of the business. Whilst this includes administration of contracts, Health and Safety, quality of output, business development, and ultimately delivery of service, he remains fully involved in the design aspect of the company from inception to completion/handover.

Career History

Date	Position	Company
2018 – date	Director	Innovated Design Solutions
2015 – 2018	Associate Director	Clancy Consulting
2013 – 2015	Principal Engineer	Clancy Consulting
2012 – 2013	Senior Mechanical Engineer	Clancy Consulting
2006 – 2012	Senior Mechanical Engineer	Mexel Design Consultants
2002 – 2006	Mechanical Engineer	Mexel Design Consultants
2000 – 2002	Intermediate Mechanical Engineer	Mexel Design Consultants
1998 – 2000	Trainee Mechanical Engineer	Mexel Design Consultants