Field Hospitals – Lessons Learnt

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SSgt Tarrant joined the TA when she joined MWF(V) – now 170 (Infra Sp Engr Gp)(V) – in 2002 where she has undertaken engineering tasks in the Falkland & Ascension Islands, Brunei and Nepal and has taken part in several ski, rock and sky-diving exercises/expeditions. She has also deployed with regular works teams – in Kenya 2010 and two 6 month tours in Afghanistan 2007 and 2010/11.

In her spare time, SSgt Tarrant enjoys going to the gym, swimming, playing squash, skiing, ski touring, climbing, hill walking and every few years high altitude mountain climbing.

Introduction

HAVING been closely involved with the hospital in Camp Bastion (BSN) at various stages of its life, it seems the time is right to put pen to paper to assess the process from initial design through to completion on site, the end product and the process of developing a working hospital and to make note of what has been successful and what should never be repeated.

The BSN hospital was itself a development of the process and ideas behind the British medical facility in Iraq. One of the principal ideas was that the medical facility in Iraq could be dissembled and relocated anywhere in the world, whilst it did get relocated to BSN it died a death in a compound.

The design and construction of the hospital were riddled with so many problems that in 2007 construction virtually came to a halt and, anyway, it would not have been 100 per cent fit for purpose had it been constructed to its original plans.

Three years after completion it was clear that the rate of evolution and growth of the hospital has fast outpaced any predictions made at initial design stage both in its construction and in its space planning. A lack of a development plan that charts the changes and additions meant that the overall site has been allowed to grow organically in a haphazard manner resulting in a site that is too crowded and services unable to expand sensibly to extend the hospital further. The construction materials have not lived up to the massive surge in use to the point that a full building and services condition survey was required in early 2011 to see if a complete rebuild would have been a cheaper option!

Whilst the engineering processes have blundered along and huge sums of money been wasted, there are many lessons to be learnt from these experiences that can be easily put into practice for the next time. When the thought, design, construction, procurement and estate development processes are all coordinated, planned and financed properly a new level of efficiency can be instigated to maximum effect with minimum financial waste. After all, what goes on inside the BSN hospital is so extraordinary that one can not now envisage a theatre of war without a hospital of this kind.

My Involvement with the Hospital

IN June 2007, I arrived in BSN as Supervising Officer (SO) of the Role 2 Tier 2 Hospital (Figure 1). The Tier 1 hospital was in full use 50m away from the building site that was to be the new Tier 2 hospital with all its associated infrastructure and buildings. The building itself was about 40 per cent complete, a shell consisting of floors, walls, ceilings and roof structure with no sign of any services other than two huge air handling units and some of its associated ductwork. It was already nearly a year over-due and several million dollars over-budget and work had all but ground to a halt on a site that was being run by an ex-military ambulance driver who knew nothing about construction or running a construction site and with highly qualified tradesmen resigning every other day with the remaining ones achieving very little for every reason (many legitimate) under the sun. Five months later the building was 85 per cent complete and with a good momentum of work that saw it opened in February 2008.

In January 2011, I was tasked to work with the Fluor Turners Design Management Team (DMT) to complete a comprehensive building condition, services and structural survey of the hospital including all the support buildings and infrastructure. By this time the hospital had grown enormously and included the Regimental Headquarters (RHQ), the Aeromed building on the NW part of the site, two new CT scanners, accommodation for patient escorts and interpreters, the chapel and numerous additional services. From this survey a number of projects fell out, one which landed on my desk was to produce an Estate Development Plan. This plan utilized the new 40-bed ward that the US had started building as a temporary decanting area so that areas that required essential re-planning or construction maintenance could take place whilst maintaining the operation of the hospital. During this time the Tier 1 hospital had been reduced in size but was still set up as a hospital maintained as a Resilience Hospital (in emergency).

Figure 1. Aerial of T1 & T2 hospitals in 2007

Why Hospitals are no Ordinary Building

On almost every new hospital or hospital refurbishment that I have ever been involved with, I have heard someone (usually the contractor) say about hospitals ". . . it can't be that hard, it's just another type of building, they're all basically the same . . .". Out of all the contractors who said that, not one made any money on the project. Hospitals are highly specialised building types with reams of guidance notes to build them properly.

They are specialised for two principal reasons; first, they have a huge quantity of services that requires careful coordination, often there are specialised services such as medical gases and clean air; and second, because hospitals have such a huge potential for harbouring diseases in dusty corners, air and water systems and have a huge potential for cross-infection from either person to person or building to person.

The Department of Health (DoH) has spent many years collating best practice guidance for buildings and publishes it in the form of Health Building Notes (HBNs), which give guidance to the space planning of hospitals, and Health Technical Memoranda (HTMs), which provide guidance for building components, assemblies and services; there are HTMs for doors, walls, plumbing units, medical gases, acoustics and fire strategy to name a few.

It is physically impossible to build a hospital that complies with every single HBN and HTM. Therefore when starting a hospital design it is essential to list out as part of the briefing document which ones (and sometimes which parts) are to be used because many of the HBNs and HTMs appear to contradict each other and in some cases do actually contradict thereby requiring decisions from the client and users as to which is the preference. Any building contract that requires every HBN and every HTM to be complied with makes a mockery of the contract and only displays ignorance of what the guidance is for and how to use it.

As with all guidance and all evolution of practice, users have sometimes discovered better ways of doing things and the guidance has yet to catch up. The user group consultations are essential to bottom this out, to pin down exact requirements and to list all assumptions and criteria that inform the decisions made. The output of these consultations forms part of the briefing document which in turn forms part of the Employers Requirements in the building contract. The more specific and accurate this document, the smoother the whole design and construction process.

The Difference between NHS Hospital in the UK and a Military Field Hospital

There are three crucial differences between UK and military field hospitals that make it difficult to apply the same legal applications, even though they both come under the same British Law and DoH guidance; first, the construction of these hospitals; second, how the hospital is used; and third, theatre-specific requirements.

Construction

The army categorises buildings into three types: Tier 1 (T1), Tier 2 (T2) & Tier 3 (T3). T1 structures are tents used either individually or in a formation. T2 are also temporary structures usually in the form of a portakabin-type unit, again used either individually or in a formation. T3 are permanent buildings.

It is obvious that tents cannot be expected to comply with DoH guidance or building regulations (with the exception of water and power supply) and that they do apply to permanent buildings whether in the UK or on a British military base abroad. This leaves the T2 buildings in a state of confusion: whilst several building contracts inevitably require full compliance, it clearly is not physically possible – how many portakabin-type units meet Approved Document (AD) Part L for thermal resistance or air leakage and how many comply with AD Part B for fire resistance or Part M for disabled access?

Use

Hospitals generally, are used in different ways and come in all shapes and sizes, some general, some specialise but there are a few things that makes the hospital in BSN and, thereby, future field hospitals unique.

Virtually all the patients entering the Emergency Department

(ED) in BSN are trauma patients who require surgery whereas in a UK hospital very few are trauma patients.

The operating theatre has a one-way patient flow, they only enter through the ED (with the exception of where a patient who has already had emergency surgery has developed post-surgical complications and is taken back into theatre usually from High Dependancy Unit (HDU) or Intensive Care Unit (ICU)). In UK hospitals patients do enter through the ED but more commonly, they are admitted and prepared in the ward and then taken to surgery if they actually require surgery.

The diagnostic unit is used in an unusual way in BSN. Whilst the pathology and x-ray are used at any or all stages of the patient's movement through the hospital as in a UK hospital, the CT scanners are used solely as an extra pair of eyes for the surgeons to see the exact location and extent of damage. So it is not really used to diagnose anything as it would be in the UK. In a future field hospital, the CT scanners should be located adjacent to the ED – currently patients in a critical condition are wheeled across the main reception and busiest section of corridor in the hospital.

Figure 2. Basra Hospital having been relocated to a BSN compound.

These differences affect how the HBNs are used as they are not likely to be fully relevant to a field hospital situation, adaptations would likely be required.

Security Requirements

The theatre-specific requirements are generated from the requirement to protect the hospital patients, staff and equipment from external attack (CBRN, missiles, small arms etc) as well as from the requirement to protect patients and staff from the patients who are enemy fighters and must be kept separate from each other and guarded by armed guards. UK hospitals also have to consider security and plan for events, however, those kinds of events are not war-specific but generally are related to crime, disorder from drunks and people with mental health problems and arson to name a few. Generally every hospital does a risk assessment of security threats as part of the initial briefing document.

Expectation Management and Ensuing Identity Crisis

The expectation management (or lack of it) and the identity crisis that the hospital in BSN has are closely intertwined and like the chicken and the egg, one is not quite sure which came first. A good starting point therefore, is the British military medical facility in Basra, also a field hospital and often referred to as "the Basra Hospital".

The Basra Hospital was smaller than the BSN hospital but the construction was very similar – assembled steel-frame cabins clipped together with a large over-roof and fitted out as best they could with medical standard finishes and fittings with the intention that the whole building could be dissembled and relocated to anywhere in the world and then reassembled quickly for re-use. Eventually it was relocated to BSN where it arrived towards the end of 2010. However, by the time it arrived in its compound it was so damaged that to re-use any of it, the cabin would have had to be stripped back to floors, ceilings and a few undamaged wall panels and "refreshed" by a well-paid contractor. Sadly, it was looted daily and none of the Basra Hospital was re-used as a medical facility (Figure 2).

So what went wrong? Certainly, temporary cabin units are a fairly flimsy form of construction and therefore they are prone to damage and make an easy target for looters at all stages of storage and transit but there is also the fact that during construction, once the cabins had been fitted together, the floors were covered in continuous vinyl sheets welded at the seams – a requirement under the HTM – which then had to be cut up when the hospital was dissembled. Likewise, water and foul drainage pipes, power and data cables all had to be disconnected, basically the cabins needed to be stripped right back to the shell just for transit. Sanitary fittings which were left in-situ became loose in transit due to the flimsiness of the panels and would require re-fitting if they are to be re-used.

That is not to say these cabins shouldn't ever be re-used; they *should* be re-used whenever possible but there is a cost associated to refreshing them. However, the point here is that these cabins are probably not the method of construction to be used if wanting to move hospitals around the world every few years.

It seems that two types of field hospital have evolved in our modern army as the healthcare provided in the field has become increasingly sophisticated: *mobile* and *in-situ* hospitals.

We have tented hospitals (Figure 3) and they work well. A developed or hardened version of a tented hospital would be a containerized hospital based loosely on the mobile (and often expanding) containers used by NHS Trusts in the UK that are driven around to hospital sites and which often contain breast screening, blood collecting, etc. A series of these containers could be set up off a spine corridor in a similar layout to the T1 hospital in BSN. If containerized units are ever considered for use as a field hospital then tests should be undertaken to prove their suitability in various climates and for means of transport. Another type of construction would be a modular (for example a hesco protected) shelter with assembled elements that are similar to the hospital set-up found on a C17 (Figure 4).

Figure 3. Tier 1 Operating Theatre.

In-situ field hospitals are the new-comers and now that we have had a go at them they need to be reassessed. We can safely say that the BSN hospital is not going anywhere – if this had been known at the beginning what would it have looked like? That depends if the hospital is to be semi-permanent (ie stripped out and disposed of at the end of operations) or to be handed over to another nation, in which case it would depend on whether a semi-permanent or permanent hospital is required. This requires serious forward-planning and the ability to design in flexibility.

It might be that a future hospital is designed as a series of compounds or buildings, a T3 main hospital with all the support buildings – the RHQ, primary care, physio, chapel and mortuary, storage, accommodation for on-duty staff including interpreters and patient escorts, pathology and laundry facilities – built as T2. This would enable each area to maintain enough space around it for future expansion.

Or it might be that a future hospital is designed on a similar format as the T1 hospital with a spine corridor with departments located on either side and an open end that can be extended when necessary.

The construction method used in both Basra and BSN Hospitals has been in part why the hospital has developed an identity crisis – it is a sort of Tier 2.5 – T2 on the outside and T3 on the inside as well as in the roof structure. Whilst the design intention for BSN might have started with the Basra Hospital (already a hybrid), there seems to have been little control over the expectation management throughout the design development and construction phases – 3 to 4 years – thereby allowing the brief to grow in an uncontrolled manner so that everybody who had anything to do with the project had a different view of what the end product would look like once it was built.

In 2007, I heard everything from "Its just a hardened tent which they will move their T1 furniture and equipment into" to "Most of the doctors and nurses who work here are from NHS hospitals; this is supposed to be a home from home for them" and everything in between.

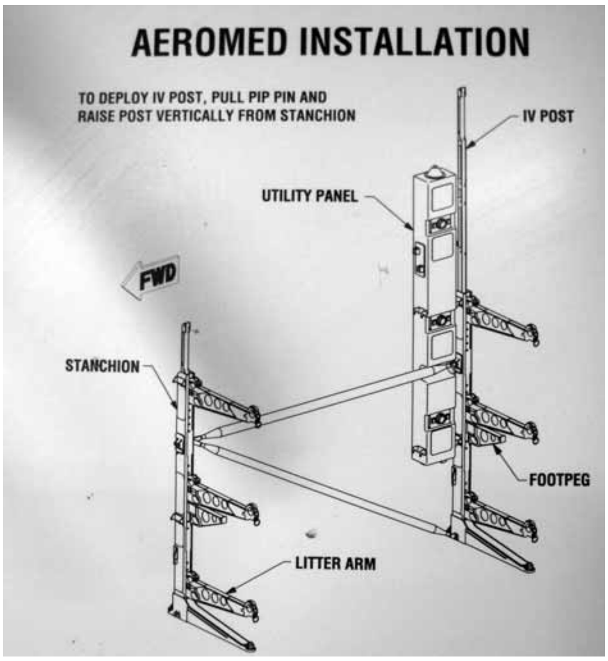

Figure 4. Aeromed installation instructions in a C17.

Camp Bastion Hospital – The Design Process, Construction and Redevelopment

Design Issues

It is clear from the original plan of the hospital that the user-group consultation process that took place was the edited version; there is also significant evidence that there was an assumption that the clinical staff knew the HBNs and HTMs. Getting these wrong is stepping off on the wrong foot just to play catch-up for the entire existence of the hospital.

Instead of controlling a user-group consultation process where 1, 2 or 3 representatives of each department are consulted usually three times over a minimum of six weeks, it seems that ITU and HDU staff and surgeons were consulted (the operating theatre was disproportionately huge) but neither the nursing staff – the ones who use the clinical areas day-in day-out – nor infection control were consulted; both of these are critical to the effective running of a hospital. In fact it is doubtful whether the dentists, pathology clinicians or Medical and Dental Service Support (MDSS) staff were consulted either. It is important to stress that the user-group process needs to be controlled and managed by both the medics and the designer(s) – a single point of contact for both and every meeting and decisions made outside of meetings properly minuted are essential.

In 2007, during construction, problems with several areas of the design came to light: some that could be rectified and others required an alternative solution. The Central Sterile Supply Department (CSSD) located next to the operating theatre was originally intended to house the four field sterilisation units which were then being used at the T1 hospital. The equipment was so old that they kept imploding; they also needed to be fixed to the floor which would have had to have been strengthened. When this came to light, new sterilization machines had to be purchased which were much bigger, required more space around them and extra services, such as drainage, water and power supply, had to be installed. In the Pathology laboratory there were not enough electrical sockets and no supply of red-sockets, not only that the ones that had been allocated to this room were in the wrong place, also there was a chronic lack of worktops. This room was not going to work by simply moving the T1 furniture into the T2 – the Pathology Lab had four work areas which under HBN should have been in separate rooms to prevent cross-contamination, the new room was smaller than the tent they previously inhabited therefore after an assessment of fixed furniture and electrical sockets across the hospital a reallocation exercise was undertaken thereby ensuring that the cost did not increase.

There were some rooms that were not fit for purpose at all – the MDSS was housed in two 18 x 24 tents (approx 5.5m x 14m in total) in the T1 hospital. In the T2 hospital they were allocated 4m x 3.5m with two double electrical sockets for 98 pieces of electrical testing equipment plus tools and workspace for four people plus the booking in and out of the broken and mended equipment. Eventually the MDSS were housed in the new RHQ. The laundry room was never used because the floor was not strong enough for the machines.

There was one area that was not fit for purpose but could not be resolved – it certainly did not comply with any UK infection control practice or HBN guidance. In fact, Florence Nightingale had got rid of this kind of layout in the Crimean War – and that was the post-surgery ward with the two infectious diseases isolation rooms. Bed spacing, ratios of dirty utility rooms to beds and separation of infectious diseases from each other as well as other areas of the hospital were all aspects of health space planning that she dealt with but seem to have been resurrected especially for the BSN hospital. Originally the post-surgery ward was labelled infectious diseases ward – this had to change but because the isolation wards had already been built, this was never truly separated. However, a permanent solution to isolate the infectious diseases ward was achieved in the 2011 development plan (it is not known whether this plan was subsequently implemented).

During the design process, it seems that there were several discussions about services supply: who was to supply it and in what form. This is evident from several places. In the contract there was a requirement that the contractor should design the plumbing system to take 7bar water pressure off the mains. When the cold water system was commissioned, there was barely 1bar of pressure in the mains and therefore could only be commissioned during the night when the pressure was slightly higher. Dedicated water storage tanks had to be added later to ensure a permanent pressurised water supply to the hospital. Another example was when the hospital was originally designed and contracted out, it was to receive power from a grid system as there were plans afoot at that time to install HV power in BSN. At the point when HV power was no longer considered viable, a design for five huge generators and the associated fuel storage and pipelines was quickly put together and the contract let. The water, generators and fuel tanks were all located on the south side of the hospital thereby blocking possibilities for future expansion – the other three sides were bound by roads, one of which was later closed off to build the covered ambulance drop-off area and the RHQ (Figure 5).

This again touches on forward planning. When the US

Figure 5. Concrete pads along the south side being prepared for services.

arrived in Camp Leatherneck an HV power plant and grid, sewerage disposal and fresh water supply were installed at the speed of light along with the usual roads, fences, sangars, accommodation, dining facilities and work compounds. It seems that we like to evolve our military base like a village and see what happens – which is very expensive and does not lend itself to proper forward planning.

Construction Issues

It is interesting that a steel frame structure (Figure 6) with unsealed insulated panel walls and ceiling and with floors only strong enough for office or sleeping accommodation was chosen for a hospital in a harsh desert environment with extreme temperature ranges. It is not known why this type of construction was chosen other than for the ease and ability to transport and assemble the individual units and the remote possibility that the hospital could be relocated every few years .

Steel frames expand and contract with temperature change creating all sorts of weaknesses within the building. It can only be put down to the extraordinary care of the tradesman that laid the vinyl floor that the floor has lasted as long as it has – it seems that when the floors started failing in 2010 it was due more to the increased weight of traffic than the movement of the steel frames.

With a pressurised clean air system that is required for areas such as the operating theatre, pathology laboratory, infectious diseases isolation rooms, ITU and CSSD a sealed environment is essential – choosing panels 1.2m wide which require literally miles of sealant is not a sensible choice. A single panel or rendered/sealed masonry wall sourced locally and constructed carefully would have facilitated the commissioning and operating of the clean air system; as it is, a high maintenance system has been made even higher maintenance.

Having solid walls in the hospital would also have helped with the dire shelving and lack of storage problems found in the BSN hospital. Whilst open shelving in wards and corridors is particularly bad practice, few store rooms had adequate shelving for the consumable medical supplies.

The fixtures and fittings that are required under the HTMs also need to be sourced properly. In 2007 doors, fixed furniture and plumbing units had already been ordered, if not already installed and would have incurred a huge cost to have them all changed; a decision was made by the medics that they would accept what was there as “it was already so much better than what they had” in the T1 hospital. However, the sands should not be constantly shifting, either the hospital complies with the HTMs or it doesn’t. There is nothing for it other than to get stuck into the HTMs. The same goes for the acoustics and the fire strategy – it is horrifying to see just how many designers and contractors don’t even know these HTMs exist.

So what can be suggested for the future? A concrete floor is required for CT scanners, x-ray machines, laundry machines, ED, operating theatres and corridors, therefore it would seem sensible to have concrete floors all over. The disadvantage of this is reduced flexibility of relocating or adding new ground drainage when re-planning a department at a later stage, however, this can be compensated by planning in more external walls and taking waste out through them.

There are two types of wall construction to consider – one is a steel frame with panels of either pre-fabricated material or built in-situ with brick or block. Manufacture and transport costs need to be factored in when using steel and pre-fabricated materials and unless the pre-fabricated materials have a specific design function then they are best avoided in preference to local building materials which are best suited to the local climate and provide work for the local population. The other is solid construction made of local material which is good for low rise buildings and in a hot country where the local material is brick; this is a cheap option both in the initial purchase of the building product as well as keeping the operating costs lower due to the inside temperature remaining more stable therefore requiring less heating or cooling.

Figure 6. Steel frame cabins clipped together.

The large over-roof structure is really the only sensible option for a field hospital due to the miles of large ductwork (Figure 7) required for the air handling system and numerous other services supply which all require regular access for cleaning and maintenance. At BSN some bright spark came up with the idea of pressurising the roof space in order to keep the dust out – this is an excellent idea and in future should be designed in from the start, however, the solution at BSN is lethal – the foul air expelled from the pressurised clean air system has been redirected into the roof space thereby contaminating the air (sometimes with tuberculosis) for maintenance workers. The HTM is quite clear about expelling foul air to the outside and sets minimum

Figure 7. The roof void with services under construction.

distances to doors, windows and air intakes .

It might be that there were political reasons for choosing a "temporary" T2 structure for the hospital; with hindsight the T1 and T3 hospital should be quite clearly defined. A T1 hospital only has an 18 month life before needing refreshing – as soon as a T1 hospital is erected planning of a T3 hospital should start in haste. There are so many reasons why a permanent structure should be built for this type of building.

Redevelopment Issues

Without either an allowance for future expansion or a redevelopment plan the hospital has been allowed to evolve organically. In this way services and new buildings have been allowed to clutter the site surrounding the main buildings thereby blocking access to potential sites for expansion (Figures 8 and 9).

When a department runs out of space the first support rooms to disappear are the store rooms, also when a department increases in capability and capacity there is a disproportionate increase in the amount and size of medical equipment used. Inevitably shelves are brought in to line walls in the clinical areas so that consumables, electrical equipment, holders etc are stored on open shelves where they collect dust and eventually diseases. The practice of open storage is totally unacceptable and contravenes all DoH guidance and good practice. It is no wonder that in early 2010 the hospital in BSN had its first four super-bugs, the worst of which was found in dust around the open shelves in the operating theatre. At the time the hospital squadron were strongly resistant to improving the storage crises, it is not understood why (Figure 10).

When providing storage rooms in hospital departments it is essential that many small store rooms are provided (with central storage elsewhere) rather than single large rooms. This is to make it more difficult to re-use them for something else. In January 2011 no less than 11 welfare and on-call rooms had popped up throughout the hospital leaving very few dedicated store rooms; entire bed-spaces in the wards were crammed with bulky equipment and the corridors were lined with so many shelves that beds could not be taken out of the operating theatre through the normal route.

In a development plan, space for expansion must be allocated so that when departments evolve such as the CT scanners they can be located in an appropriate place. Currently, the CT scanners are located to the north and off the main entrance to the hospital instead of to the south of ED, where, theoretically, there could be direct access. Patients should be protected from view of other staff, patients and visitors and not taken through the busiest corridor of the hospital.

Redeveloping a hospital without a development plan has serious implications on services too, particularly the clean air-handling system. This is a pressurised system where clean air is supplied in clean areas such as the operating theatre, scrub room, CSSD etc and extracted from connecting dirty areas such as dirty utility rooms, changing rooms etc. In order to maintain pressure in the air, the construction must be sealed air-tight and doors that are designed to be kept closed must be kept closed.

Figure 10. Corridor outside operating theatre crammed with storage blocking bed egress.

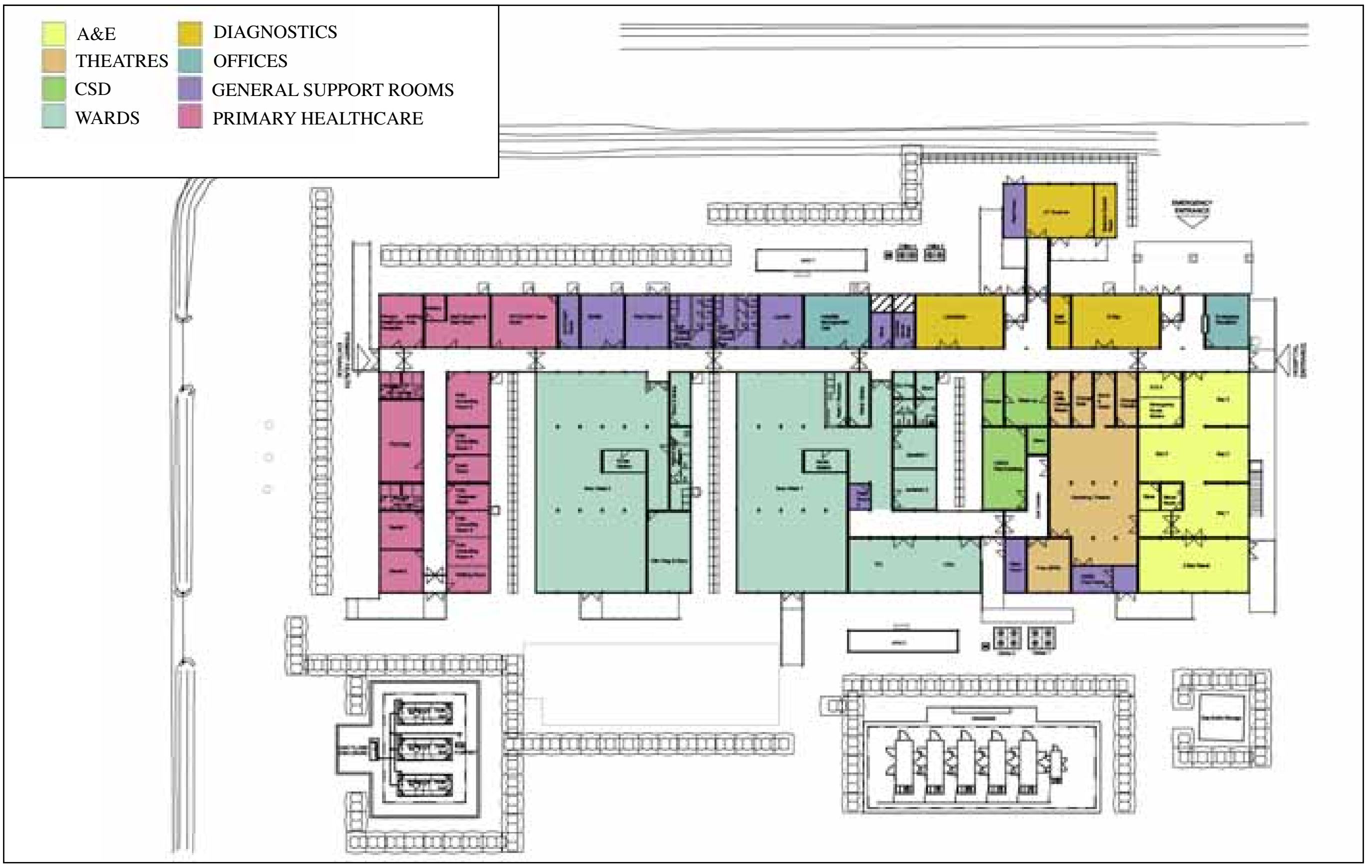

Figure 8. Plan of original hospital as built in 2007.

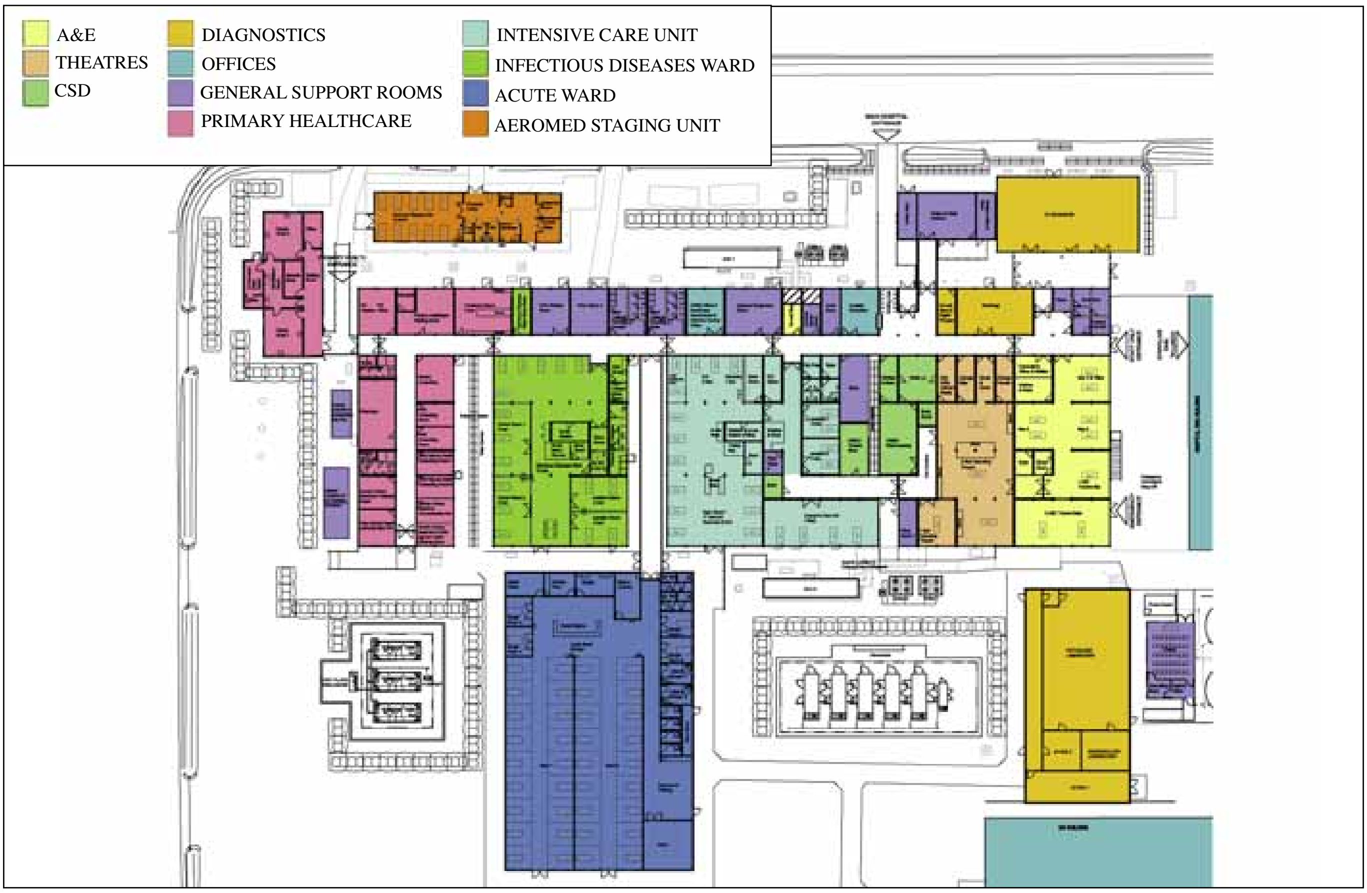

Figure 9. The development plan of future hospital – circa 2013.

In BSN the size and function of rooms have been changed without consideration of this pressurised, balanced air system. This is a serious failing; should faults occur between the branches of ductwork, contaminated air could leak into clean air supplies creating the potential of contamination of airborne diseases. Where rooms have increased in size such as the Operating Theatre, positive pressure is likely to have significantly dropped causing re-routing, stagnant or back-flow of air. These situations are serious infection control hazards and contravene HTM guidance.

The original pathology laboratory had a dedicated clean air handling system owing to the bio-hazard present in the room. By 2010, the laboratory had been relocated to the original ITU/HDU ward and was then on the same air-handling system as the Operating Theatres. Likewise, the micro-biology part of pathology moved into the original laundry, which is a room that does not have any air extract at all; this is a concern as this is one of the most infectious areas of a hospital and it is essential that foul air is extracted.

It is important to realize that when a room needs to expand then all the support rooms need to expand proportionately. For example an operating theatre is not just a room with operating beds in it, there are staff changing rooms where clinical staff change into scrubs, a scrub room, a clean utility room for storage of consumables, a dirty utility room which leads onto a corridor as well as the wash-up room where instruments are washed, this room leads onto the sterilisation room which in turn has its own support rooms all of which have specific adjacencies that are required to keep the clean and dirty routes and various functions separated. The operating theatre in BSN in 2011 has double the original number of operating beds but not one support room has increased in size.

Having a plan for future expansion can also be used to help resolve problems such as when the space planning has become muddled a new area can temporarily be used to decant another area whilst it is sorted out thereby keeping the hospital operational at all times. The department or rooms that the new area has been built for have to wait a bit longer but that just has to be weighed up with all the other urgent requirements.

The mock-up of the BSN hospital currently used by the medics in Yorkshire has come out of the hospital from BSN but perhaps this is the tail wagging the dog – maybe the mock-up should be where the design improvements are tested before they are implemented abroad.

Shortfalls from the Contractor side

In June 2007, the contractor had been on site for nearly two years and the build had come to a virtual stand-still despite numerous assurances that it would all be handed over in six weeks (at a point when construction was 40 per cent complete). They had over-sold themselves, they did not have any expertise in building hospitals other than the Basra Hospital, which was a lot more experience than any of the other contractors. They also did not have much experience with large building projects although they did have the capability as far as services were concerned. They were also caught out by the HBNs and HTMs and consequently components were often already installed by the time it was discovered that many of them were not compliant. The medics and engineers had to accept it – to have made the contractors change it all would have broken the contractor and would probably have caused another 15-20 months delay and that is if another contractor could be found who had appropriate experience.

The construction site was being run by an ex-military ambulance driver who was not qualified or experienced to run a building site. He knew nothing about construction and regularly ordered his often highly qualified and experienced tradesmen to do their job wrong creating a terrible work environment. Not surprisingly there were on average three resignations a week and the dwindling numbers together with the haphazard arrival of stores that was coming through the Purple Gate reduced the work output to almost nothing. This was dealt with at high level and three weeks later a new site manager arrived who knew what he was doing, had the site cleaned up, processes in order and work and morale picked up very quickly.

The lack of leadership on site from both the military engineers and the contractor up until that time also meant that the medics attempted to maintain momentum by involving themselves on site, partly out of curiosity and partly because no one else seemed to be making decisions. As SO I was constantly throwing medics off site – they would be marking out “their office”, giving instructions to the contractors and dragging the assembled but not yet fixed furniture across the finished vinyl flooring leaving dreadful scratches in order to “see how big their room was”. It was chaos and as if that was not enough, a team from the signals squadron that installs all the data and communications wiring had at the beginning of the year been wondering around the site on a recce reading the plan of the hospital up-side-down and issuing instructions to the contractors thinking that the IT hub room was on the other side of the building. Needless to say everybody who was not authorized or accompanied was thrown off site and a booking-in procedure established and crucially the process of issuing and receiving instructions was formalized.

Shortfalls from the Military side

There was no professional lead in the design process and for a large part of the construction – when there was professional lead it was by accident rather than design.

The Design and Build (D&B) form of contract in all their variations is a standard procurement method for building hospitals in the UK but it only works if the Employer’s Requirements and the Contractor’s Proposals – the two parts of a D&B contract – are clear and specific. Giving a contractor a scheme that looks like a full design but at the same time handing over all of the design risk is very confusing for the contractors and therefore confusing for everyone. Either the contractor should be given a performance specification (and no drawings) with the full design responsibility and with that full design risk, or, they should be given a full design and specification to build without any design responsibility. To give them what looks like a full design without specifying what has and has not been done leaves too much room for dispute. Attempting to avert all the risk in a building contract can be really bad for the end product and anyway the contractors are so rarely held accountable for poor design or buildings that are not fit for purpose.

The constant change-over of military personnel every six months lost continuity and momentum contributed to the chaos – in recent years this has been addressed and improved with the use of civilian DMTs based within the works group in theatre. A lot of the historical decision making was lost because decisions were badly recorded and the key points were lost in the depths of the files. Contractors take full advantage of this kind of chaos and the success of the DMTs has proved this point and should be remembered for next time.

Military Infrastructure Resources

170 (Infrastructure Support) Engineer Group is unique within the Royal Engineers – the units rarely deploy as a regiment, instead teams of specialists are regularly deployed for relatively short periods of time and are deployed to any British military estate in the world making them one of the most deployed units in the Army. It is a unit of regular soldiers who have a basic infrastructure training combined with a TA component which draws specialists from the construction industry nationwide. The whole purpose of having the TA component is to increase the specialist capability of the unit to include virtually every infrastructure engineering scenario.

The admirable military attitude of "We'll do the best we can with what we've got" and "We'll make it up as we go along" work well when there are severe skills shortages more usually found in front-line situations where man-power is severely stretched. However, it does not work effectively when the skills exist but are not utilized. It seems that specialist skills required for such a task would be hard to access within the military but the specialist TA component within 170 have a huge range of skills at a professional level; there is an architect and services engineers who specialise in healthcare, but, they were not consulted at any stage of the design or construction of either the Basra or BSN Hospitals, even for a desktop study.

Plan and Control

The lessons learnt from these two hospitals affect every aspect of its design, procurement and existence. It is essential for the decision-making process to become far-sighted, streamlined and co-ordinated whilst still sitting within the political landscape. This is not always a comfortable juxtaposition but essential to prevent financial waste.

The principal lessons learnt at the design stage are to 1) **plan** carefully – to choose the type of construction appropriate to the situation including climate, to design in flexibility, future expansion and good healthcare practice and to consult the right people, and 2) maintain **control** over the design and construction processes and people's expectations.

The on-the-edge fast paced medical advances that takes place within the field hospital creates a huge impact on the building itself therefore the hospital evolves at a much faster rate than a UK hospital, consequently it must be flexible in design and services should come off mains supplies. The only way this can be done is to 1) have a plan for expansion – a development plan, and 2) maintain control over the plan throughout the lifetime of the hospital. A development plan needs to be regularly updated to adjust to changing requirements and kept up to date with what is actually built.

Summary

The greatest success of the hospital in BSN is the fact that it exists and that such incredible things go on within it from saving so many lives to making amazing advances in medical technology. Whilst these advances take place at the speed of light, the engineering solutions that house them can easily catch up. It is essential that it does catch up because the financial resources no longer exist to continue funding its bumbling evolution. This requires a new level of strategic thinking and flexible planning that is utterly streamlined and coordinated.