## Introduction

I graduated with a 2.1 sandwich Degree in Mechanical Engineering, sponsored by Armitage Shanks Ltd, from the Polytechnic of Wales in Mechanical Engineering in 1988. Next, I went on to obtain a Masters degree from Cranfield Institute of Technology, in Energy Conservation and the Environment. [1]After the MSc I spent a short time (approx 18 months) in the Automotive Industry with [redacted] and [redacted] I moved into Building Services in 1990.

I have spent the last 20 years at BSRIA, formerly Building Services Research and Information Association. BSRIA is an independent, non-profit distributing, member-based research and information organisation. The key aims of the association are to assist the Building Services industry to improve its products and services, the efficiency of their provision and the effectiveness of their operation. During the last 20 years I have contributed towards these objectives in the four roles I have held during my career in the Building Services Industry.

[1] See Appendix D for Qualification documents

| Career Episode | FCIBSE Competence Objectives |
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| **Graduate Engineer [redacted] June 1989 – Feb 1990**<br>When I was at [redacted] I introduced a method of transferring data from temperature recorders to a PC. At that time this process was quite revolutionary as previously it had been the job of a technician or secretary to copy numbers off a chart recorder and plot data graphs by hand. The new automated process that I introduced not only increased the accuracy of the results but also allows the data to be analysed much quicker than previously. Due to the success of this technology I had developed at [redacted] I was tasked with implementing a similar system once my employment began at BSRIA. (January 1990) | A2, B2 |
| **Project engineer BSRIA Feb 1990 to July 1994**<br>The systems I introduced at BSRIA were used to record temperature, pressure, velocity and gas concentrations, and are still in use today.<br><br>One of the more memorable times I used this technique was to track how the plumes from gas boilers interact with windows and ventilation grills, within a façade of a terraced house constructed in a laboratory. Having constructed the façade I managed the design and installation of a traversing robot that moved within the house recording the pollutant concentration within the dwelling. This work was validated when the equipment was moved to the Building Research Establishment test house at Watford and the tests were repeated in an actual house.<br><br>The final output of this work was to determine the location of balanced flues in respect to windows in the Building Regulations (approved documents for part J Building Regulations 1994). The work was peer reviewed and presented to [redacted] The Health and Safety Executive and also the technical experts of the Building Regulations Division. | D3 |
| **Project Engineer / Senior Project Engineer July 1994 – September 1997**<br><br>In the 1990's BSRIA used to propose new research ideas for the Department of the Environment, typically a number of these projects were approved and subsequently received government funding at a level of 50%. BSRIA was responsible for obtaining the other remaining 50% of the funding from industry<br><br>As a result of each project, BSRIA would produce a best practice guide or a code of practice for the Building Services Industry. | B2, B1 |

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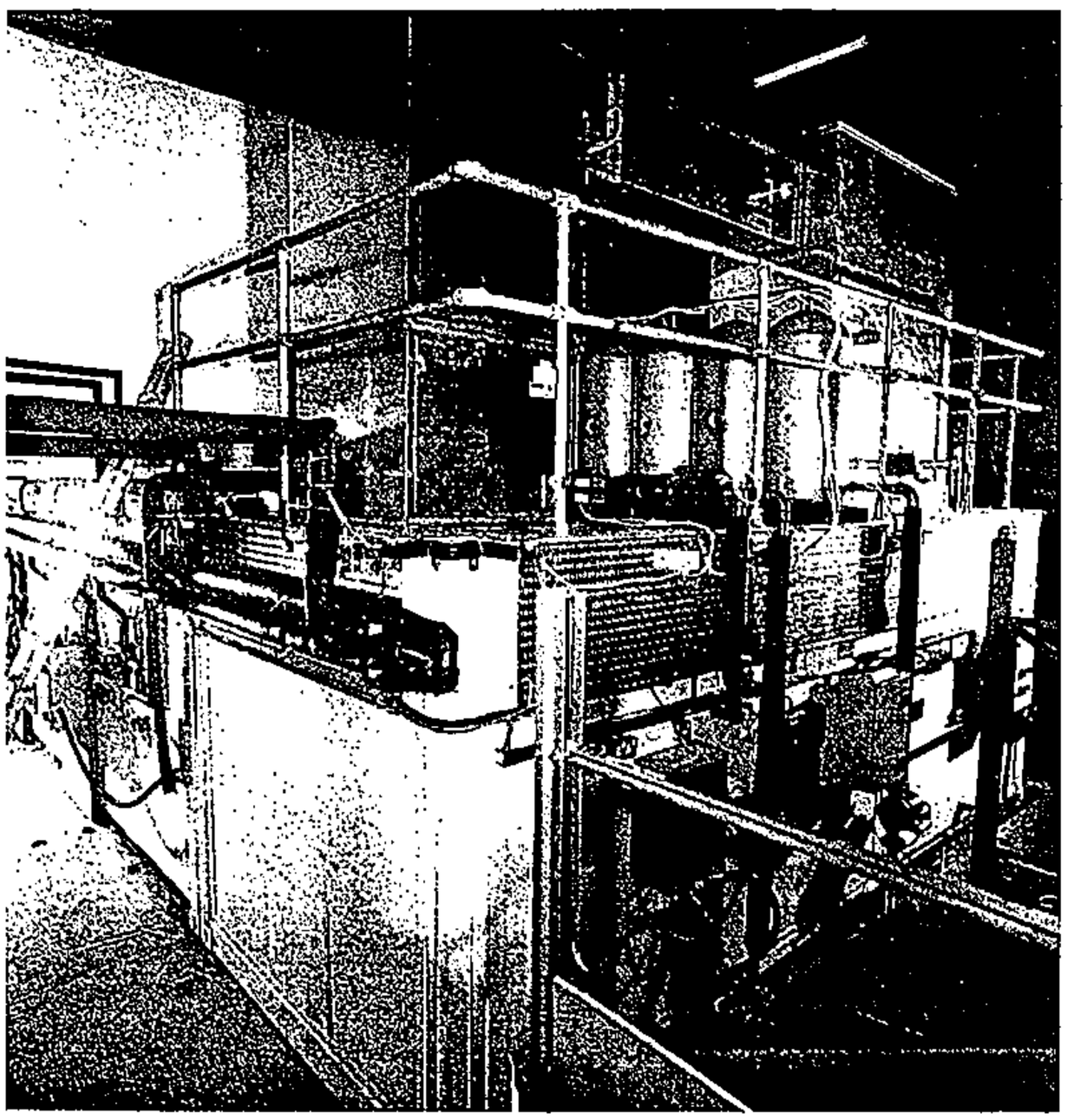
| As a Project Engineer it was my responsibility to research and manage each project and subsequently report my progress to the Departmental Manager on a regular basis. Part of my project management role consisted of formulating a plan for the research and producing a time/cost schedule in order to ensure that all areas of the subject were covered within the constraints of the time/budget allowance. In addition to the project management, I was responsible for the design and construction of the rig. This involved producing work plans for subcontractors and in-house workshop staff, and sourcing materials to my specified requirements. | C1, C2, A2 |
| Occasionally the project would present difficulties and it was my role as the Project Engineer to make balanced judgements, which at times, would take the project in new directions in order to fulfil the original brief. | B3 |
| During my time as a Research Engineer I was responsible for a [redacted] research project on Variable Refrigerant Flow (at the time this was one of the largest projects ever undertaken by BSRIA). The project consisted of designing, constructing and commissioning a 7-chamber test facility and testing four complete systems. At the time, it was thought to be the only facility in the world, which could measure the performance of a 6-indoor and 1-outdoor unit. The project concluded with the publication of a BSRIA Guide. | E2, B3 |
| **Figure 1 Refrigeration testing facility** | |
|  | |

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| A similar research format was used for three more projects in which I was involved. These were the performance of small-scale air-conditioning performance equipment [redacted]; Chiller control techniques [redacted] and I also ran a project to monitor the installed performance of refrigeration equipment. Also, I was involved with the UK response for the European energy labelling of air conditioning products. This involved liaising with 5 other European Test houses to determine the Test Methodology. This methodology is used today to rate all small-scale air conditioning products sold in Europe. | E1, B2, B3, A2, C1 |
| **Department Manager September 1997 to April 2003**<br>In September 1997 I was promoted to Section Leader of the Microclimate Centre. At the time of my promotion the section had reduced in size from 7 to just 3 people and it was my personal objective was to rebuild the section. Under the direct supervision of the Technical Director, [redacted] I had to produce, quotes and technical reports produce monthly income forecasts and formulate business plans for the section. Over the next 5 years the team grew from 3 to 7 engineers. The portfolio of work comprised of computer modelling (CFD and Thermal modelling), thermal comfort testing and Mock up testing. To drive the growth of my department personnel I used industry contacts, recruitment consultants and advertising effectively. During my time as Departmental Manager I encouraged two of the engineers within my team to obtain higher degrees (one to complete her PhD and one to undertake a part time MSc).<br><br>The mock-up testing accounted for over 50% of the section income. The principle of mock-up testing is that a full-scale model is built, using both the installation team and the components that will be used in the final building. The model is then tuned for optimum performance and thermal comfort. These settings are then used to commission the final building and to validate the design concept. | E1, E3, C2, C3, D2 |
| **Group Manager April 2003 – to date**<br>In April 2003, my Microclimate section took over the running of the BSRIA test house, resulting in the formation of a multidisciplinary team. The Test House typically undertook test that ranged from [redacted] this was significantly different to the Microclimate centre that worked on higher value projects from [redacted] or the fine detail of the computer modelling team project value [redacted]. During the amalgamation process the working processes of both departments were examined and some compromises were made. The resulting section was streamlined and once again became useful and profitable. Over the next 7 years the team income rose [redacted] | A1, A2 |

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| **Nature of my role and the work at BSRIA**<br>The BSRIA membership encompasses Consultants, Contractors, Manufacturers, Building Owners and Operators. In addition to this we also work for governmental bodies. In my 20 years at BSRIA the type of work I have been involved with has been very varied and has depended upon the individual needs of the client. [redacted] | B1, B2 |
| During my time at BSRIA I have worked in the Middle East, Africa, and Continental Europe. In the UK I have worked in high security environments [redacted] Some of the prestigious buildings I have worked on are the Swiss Re building (the Gherkin), 1 Hyde Park, Covent Garden Opera House, and the Prince Albert Mausoleum.<br>During the last 12-13 years, my career has developed into a managerial role. However, I am still involved actively in my areas of specialised of HVAC, such as chilled beams, data centres and refrigeration system performance. This involves site and laboratory investigation as well as technical trouble-shooting in the laboratory. | B3 |
| The managerial role that I now occupy at BSRIA means that I report directly to the Chief Executive, [redacted] The BSRIA Management Team, of which I am a part, at BSRIA consists of four Directors and four other Group Managers (see Appendix A). The team is responsible for the long-term success and stability of BSRIA. | C1, C2, C3, C4 |
| My Managerial role includes producing yearly budgets and income forecasts, undertaking staff appraisals and disciplinary matters. In addition to the financial side I am also responsible for the technical output of the team, and the day-to-day safety of employees and the workplace environment. This aspect of my role involves keeping up with European and ISO standards, and liaising with other European Test Laboratories. As well as the technical side I also provide a sales role involved with any high risk or high value projects that are undertaken by the group. This duty involves the preparation of quotes, reports, proposals and review of risk assessments and method statements. A lot of the work BSRIA undertake is confidential but wherever possible we like to Publish Best Practice Guides, running training courses, and giving presentations. Recently I have given presentations about Data centre cooling (CIBSE 2008, Data-dynamics 2009, BSRIA webinar 2009). The presentations covered energy saving techniques that could be used on existing data centres, and included common mistakes that could be easily overlooked at the design stage. My next presentation will be about the latest designs concepts in high-density rooms (August 2010). | D1, D2, D3, A2, E1 |

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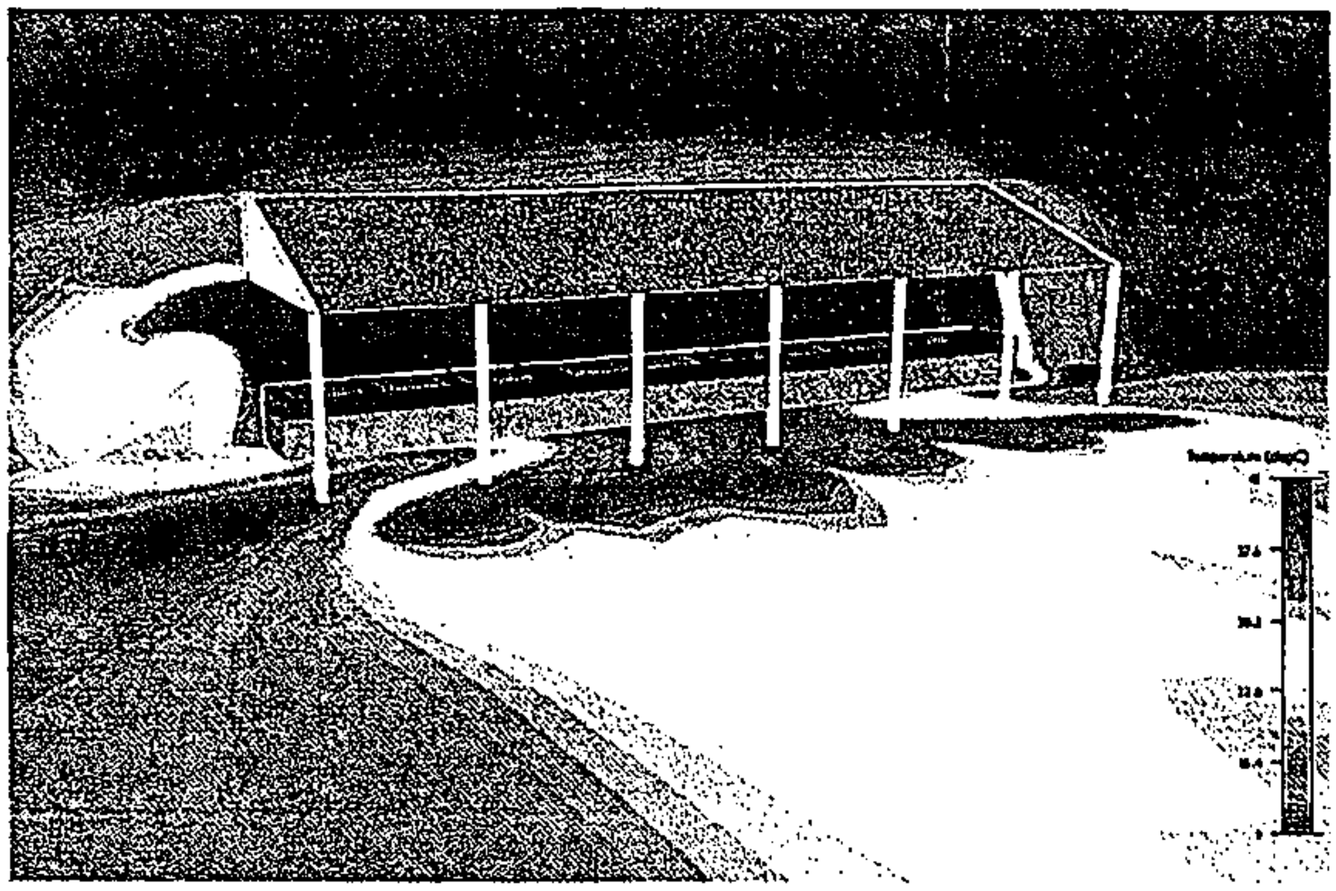
| In September 1997 when I became a Department Manager, I began with a team of two engineers with a predicted income of [redacted]. In the last thirteen years, under my management, the team now consists of 18 members (3 PhD, 10 BSc Graduates, 4 technicians, and 1 support member) with a turnover of [redacted]. The laboratory is accredited to standards EN 17025 and each year we have a UKAS accreditation visit. Typically we run approximately 200 projects per year within four areas, which I am ultimately responsible for. Over my time as manager I have encouraged 4 members of my team to become chartered and a Spanish engineer that I employ to register for a work-related PhD. Most of the engineers in my department attend in-house 'Continuing Professional Development' talks, and some also accompany me to the Institute of Refrigeration lectures (I have been a member of the Institute of Refrigeration for the last 10 years). | E4, C3, C4 |
| **Example of recent work**<br>As mentioned earlier, as group manager I have taken on the role of looking after the non standard projects. Two such projects that I have undertaken recently were: | |
| **Packaged Water Chiller Performance Test**<br>BSRIA has been testing the performance of boilers and chillers for over 50 years, so this type of enquiry was not uncommon. The aspect that made this particular project challenging was that the chiller was a 1.5 MW unit, that weighed over 10 tonnes, and the proposed test area was within 20 m of a main railway line, so this was a completely novel situation for BSRIA. Unlike smaller chillers there is no independent test facility in Europe that could test over 750 kW. The client, Johnson Controls International, approached BSRIA with a brief requesting ambient conditions at 35°C, water supply temperature of 12°C at 75 l/s, with a three-phase power supply of 750 kW. | E3, D1 |
| As part of the feasibility assessment I commissioned a CFD model to design an air recirculation system in order to raise the ambient conditions around the chillers. Next I assigned a graduate engineer to source pipe work from our suppliers and to approach local rental companies for generators, boilers, flexible hoses and labour costs. With this information I produced a cost breakdown, a quotation, risk assessment and method statements. Finally a project plan including pipe work schematics, uncertainty budgets for the measurement accuracy was generated. | C4, D2, E1, E2 |

**Figure 2 CFD model of chiller test**



The test facility was constructed within two weeks, including the installation of 3 oil fired 750 kW packaged boilers, 100m of 12" flexible hose, including diesel driven water pump, and a 1MW generator.
As part of the test programme the end user asked BSRIA to demonstrate that the unit could run at part load. I incorporated a three-port valve into the design to mix the water on temperature with the hot water from the boiler. This mixing system allowed a load between 150 kW and 1.5 MW to be applied to the chillers. E1, F2

The data logging system recorded the air on and off temperatures, water on and off temperatures and the water flow rate. With this data, instantaneous coefficient of performance and duty could be determined.

The final outcome showed that the chiller was within specification (i.e. 1500 kW cooling duty ± 7%). Because of this the end user went on to invest in 14 more units, total value over [redacted] E1, E3

To summarise, the test was successful by every measurable criteria, the chiller manufacturer's theoretical performance data was good, the data centre would get the cooling they required, and everybody was paid. Additionally, from my point of view, junior members of the team saw what could be done when they are prepared to push their own capabilities.

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| **Condensation investigation**<br>[redacted] contacted BSRIA regarding condensation issues with a building they had designed. Photographs showed condensation dripping off walls and ceilings, causing mould and structural issues. The apartments in the development each cost [redacted] and were located in Equatorial Guinea.<br><br>[redacted] previously sent Architects, Surveyors and Refrigeration Technicians to the site, and they had been unable to solve the issues. After successfully undertaking a "beauty parade" interview with [redacted] I was commissioned to go to Equatorial Guinea. My brief was to test, evaluate and diagnose the problem, and develop a practical solution that would save the existing units (48 flats and 16 town houses), and that could be incorporated into the next two planned developments of 48 units. | E3, A2 |
| Due to the attempted coup in Equatorial Guinea, logistics were not easy. Firstly we had to approach the Equatorial Guinea government for Visas, get inoculations, and arrange transport for test equipment and itineraries for a myself and a junior engineer. This was all done within a two-week deadline. With the time available I reviewed the design data and assembled appropriate Personal Protection Equipment and medical supplies.<br><br>On arrival at site, I first attended the mandatory site induction and safety course. On inspection, the problem became quite clear, the buildings were being run under negative pressure, and hot humid air was actually drawn into the building! The cause of this problem though was a bigger issue altogether. | B1, C1, C2 |
| The buildings were constructed to the International Building Guide, though unfortunately the guidance had been misinterpreted and the builder had said that the holes left in the building were intentional to allow ventilation into the property. The outcome meant that the permeability of the house was 5-6 times worse than typical UK construction techniques and therefore not airtight. The problem was further exaggerated with the mechanical ventilation system, which was extracting 3 times more air than it was actually supplying.<br><br>Using basic commissioning equipment (hand held anemometers, temperature probes and micro manometers) we were able to rebalance the ventilation system and to neutralise the pressure differential. However, this still left the problem of the holes in the building fabrication. | D1, D2, E1 |

Using techniques that BSRIA has developed over the years we examined the existing buildings in phase 1, and the buildings under construction in phase 2 and 3. The holes in the building structure were found using thermal imaging (as the existing cold air could not have come from elsewhere). To allow the cold air to leave through the building holes, I pressurised the apartments using fans that were fitted into the doors. This approach was successful and solved the issues within these buildings. Furthermore these finding were implemented as design changes for the new build.

At the end of the test programme I produced a detailed report listing the ventilation faults and also the remedies employed.

At the request of the oil company, I went to discuss the remedial work with the architects in Turkey. The remedial works were undertaken and a building operational guide was produced in order to minimise the chance of this situation reoccurring. Some 18 months later the guidance is still being used and the condensation problem has not returned. E1, E3

## Conclusion

Over the twenty years since graduation I have been continuously employed in an engineering role and have moved from a Junior Engineer to Group Manager. This has brought me a wealth of experience in the Building Services industry, and I have learned a lot from both my successes and mistakes[2]. In the late 1980's when I left college, Energy Conservation was the "buzz word", today the expression has been replaced with terms like " Carbon Reduction" or "Sustainability", but fundamentally the physics are still the same. Understanding the basic engineering principles of thermodynamics and design, getting the maximum out of any process (for the minimum input) and conveying that understanding to non-engineers is a substantial part of my role today. E4, D3, C4, B3, A1, A2

As a member of the BSRIA Management team my role is now changing into a position of help and guidance rather than the hands-on engineering role that I originally embarked on. My aim over the next twenty years will to keep my knowledge current, maintaining a professional code of conduct and to help, guide, and assist junior engineers for the benefit of all.

[2] See Appendix C for CPD record