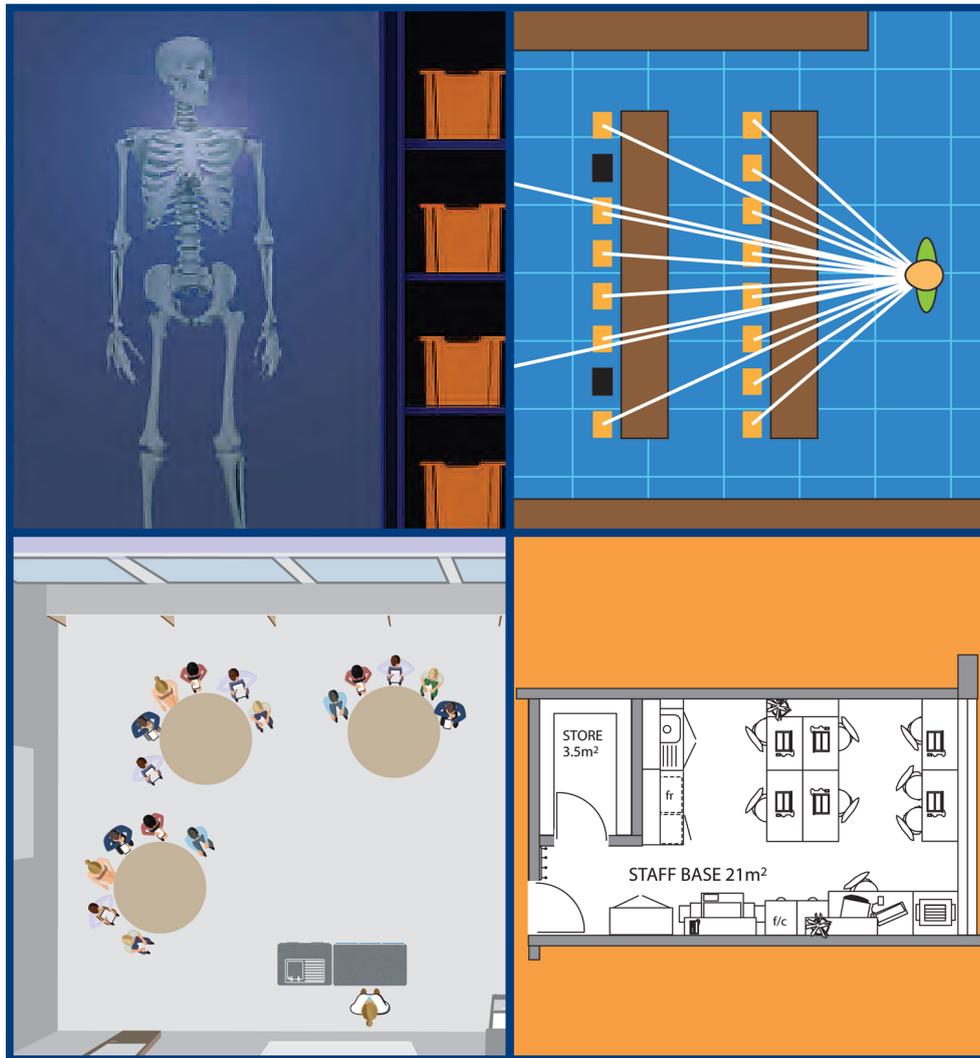


Uniclass D71821:A4
CI/SfB 718 (A)jv



School Science Accommodation

An overview of design for architects, designers and schools





School Science Accommodation

An overview of design for architects, designers and schools

A special report commissioned by Gratnells Ltd
Published by Gratnells Ltd and The Association for Science Education

Written by Andy Piggott, Independent Science Education Consultant, retired

Gratnells are manufacturers of tray storage systems, for equipment and chemicals. The Association for Science Education (ASE) is the largest subject association in the UK and is the professional body for all those involved in science education from pre-school to higher education. Gratnells and The Association for Science Education have joined forces to present the following Special Report as a guide for architects, technicians, teachers and others involved with the design of new school buildings or the refurbishment of existing buildings.

Design and production of this Special Report is copyright Gratnells Ltd 2015. All rights reserved.

You may print copies of any part of this Special Report in hard copy provided that it is for your personal use or for use by others in your organisation and provided that you do not edit, alter, amend or delete any part of it or combine it with other material. You may re-copy the material to individual third parties for their information only if you acknowledge Gratnells Ltd as the source of the information by including such acknowledgement and the website address of Gratnells (www.gratnells.com) in the copy of the material AND you inform the third party that the material may not be copied or reproduced in any way. A pdf copy of this Special Report is available for download at www.gratnells.com/PlanningDesign/Architects.aspx and at www.ase.org.uk/resources/lab-design.



Gratnells Ltd, 8 Howard Way, Harlow, Essex CM20 2SU
T: 01279 401550 F: 01279 419127 E: trays@gratnells.co.uk W: www.gratnells.com



The Association for Science Education, College Lane, Hatfield, Hertfordshire AL10 9AA
T: 01707 283000 F: 01707 266532 E: info@ase.org.uk W: www.ase.org.uk

'Communication between architects, designers and manufacturers on the one hand and science teachers and technicians on the other is essential for developing science provision for the highest standards of teaching and learning.'

– *The Association for Science Education*

Foreword

This report was written for schools in England, although much of the general advice applies across the United Kingdom. Scotland and Northern Ireland have different rules and regulations regarding numbers of pupils in laboratories and different provision of technical assistance.

Project Faraday and the *Baseline Designs* are projects based solely in England, as are the research projects published by the RSC and DfE/PwC. Wales generally follows the guidance published for English schools, but has not taken up the measures for reducing guidance that are being undertaken in England.

CLEAPSS is an organisation that provides H&S guidance, including model risk assessments for science, D&T and Art in schools and colleges with pupils aged between 5 and 19. In England, Wales and Northern Ireland, educational employers buy into CLEAPSS services to fulfil their duties under the Health & Safety at Work Act, 1974, and instruct their employees to follow CLEAPSS advice. SSERC (The Scottish Schools Education Research Centre) provides a similar service for schools in Scotland.

Many thanks go to Matt Endean of CLEAPSS and Chris Lloyd of SSERC for comments made on drafts of this report.

‘There is little, if any, current research on the state of laboratories in schools, but an educated guess suggests that standards of laboratories are unlikely to have improved as planned in 2004.’

Introduction

Improvement since 2004?

A decade ago, the government at Westminster was concerned to improve the provision of science laboratories in schools; replacing many within the Building Schools for the Future programme and, later, encouraging different forms of provision under *Project Faraday*. A major aim in 2004 was to ensure all laboratories were at a good or excellent standard by 2014; rather than the 35% of labs judged good or excellent at that time. A great deal of finance was put into *Project Faraday*, looking to encourage a range of different types of accommodation for science learning, rather than just ‘all-laboratories’.

Years of austerity and lack of finance followed and the Baseline Designs currently produced by the Education Funding Agency for schools in England (EFA) look just like science suites designed over 50 years ago. There is little, if any, current research on the state of laboratories in schools, but an educated guess suggests that standards of laboratories are unlikely to have improved as planned in 2004; indeed standards are likely to be slipping again, as they were in the 20th Century. Schools would be well advised to continue to plan for a 20-30 year replacement cycle for science laboratories.

Finance

The cost of just one laboratory is far more than many schools would estimate. In 2004, the cost of refurbishing a laboratory was put at about £55,000, while building a new one was estimated at £145,000. At first sight, schools find the refurbishment cost to be very high because manufacturing firms will quote around £15,000 - £20,000 for supplying and installing the furniture. However, this lower price ignores all the other work required at the same time in order to match current building regulations and national guidance; e.g. uprating services, windows, insulation, lighting, doors, flooring, etc..

Because the cost seems so high, schools are tempted to accept the lowest ‘first cost’ and ignore the full life-cycle costs. For example, cheap, poorly-designed lab stools will degrade sooner and damage (expensive) floor coverings very quickly. Such stools can lead to the floor coverings requiring replacement within just one year, or run the risk of accidents due to trips where holes

‘Schools should never leave decisions about science accommodation design and installation to a Bursar, Finance Officer, Premises Manager, etc. If there is no science teacher with the necessary expertise, then the school should arrange for appropriate consultancy independent of the main contractor or appointed sub-contractors.’

have been dug through to the floor itself. Again, the school may wish to have high-specification bench surfaces, but accept lower specification due to costs and then, in addition, not realise that the cheap carcasses supplied will fail long before any 20 year life-cycle.

Schools need knowledge and experience

Few science teachers have the experience of laboratory refurbishment or new build to ensure that the school gets the best deal possible, but the school does need that expertise. The head of science, or other designated science teacher, should be encouraged to undergo CPD to enable a good understanding of what is required and what the pitfalls are. This should be arranged in advance of any discussions and designs and will also be useful to the designing architect as s/he is then able to discuss problems and get answers far more quickly and reliably.

Schools should never leave decisions about science accommodation design and installation to a Bursar, Finance Officer, Premises Manager, etc. If there is no science teacher with the necessary expertise, then the school should arrange for appropriate consultancy independent of the main contractor or appointed sub-contractors. *CLEAPSS* is an organisation that can either supply advice itself or put schools in touch with independent consultants; *SSERC* will do the same for schools in Scotland.

During building works

With remodelling / refurbishments, or new builds on the site of working schools, there are a range of factors that schools and architects need to take into account.

Teaching programmes will have to be maintained during the building works, which often means the planned moving of classes to other rooms for long periods of time, or decanting the whole science department to temporary buildings (which can very expensive). Without a great deal of organisational support, science teachers will find it difficult to maintain standards of practical work during this time. Moving of equipment and hazardous materials is a specialised job and should be factored into the contract.

Major repairs and re-routing and/or up-rating of services are very likely to be required. The dangers of removal of asbestos are well known (the school must have an asbestos log), while the removal of old lead-based paint can also be a problem.

‘The whole-school timetable often has to change in order to provide (much) longer periods of time allocated to science; traditional 1-hour periods constrain the movement of pupils far too much.’

Types of departmental organisation

Before building new science accommodation or remodelling / refurbishing existing accommodation, schools should be clear as to what model of teaching organisation they subscribe to, or wish to implement in the future. The choice is important, not only for the design of the accommodation but also for the whole school curriculum and the timetable arrangements that are needed to make the model work.

The traditional science department provides for all teaching rooms to be laboratories, with the aim of having one laboratory for each science teacher. Current EFA Baseline Designs reiterate this. This model allows each teacher to follow their own independent scheme and can promote really creative teaching, which can also be very responsive to pupils’ learning. Its down-side is that teachers can easily become isolated within their own laboratory and it is not easy to support weaker teachers, nor promote teachers learning from each other.

Project Faraday was a well-funded attempt in England to find different models of teaching organisation in science. The designs that emerged reduced the number of laboratories, making them available for practical work only. At the same time, a range of other learning spaces was introduced in order to facilitate other types of learning; direct teaching, group work, discussion, individual research, role-play, etc. Many of these designs were very forward-looking and some have proved to be very successful. They do require science teachers to work in teams in order to make proper use of the learning spaces available.

Such team organisation promotes teachers learning from each other, support of weaker teachers and those newly qualified, and exposes pupils to a wider range of learning methods. However, team working often requires a lock-step approach to schemes of work and a great deal of day-to-day management to ensure that groups of pupils have equal access to all the types of space and learning provided. The whole-school timetable often has to change in order to provide (much) longer periods of time allocated to science; traditional 1-hour periods constrain the movement of pupils far too much.

‘Schools that have enthusiastically adopted the *Project Faraday* approach have achieved success, but the notion of team-work and the organisational model has to be maintained over time and through changes of staff.’

All-Laboratories	<i>Project Faraday</i> style
<ul style="list-style-type: none"> • High teacher centrality • Teachers working solo (and creatively / responsively?) • Traditional 1-hour periods 	<ul style="list-style-type: none"> • Teachers working in teams • Lots of management and Scheme of Work in lockstep • Longer time periods (half-days?)
<ul style="list-style-type: none"> • 1 lab per class and 1 teacher per lab 	<ul style="list-style-type: none"> • Fewer labs, but a range of other learning spaces

■ Figure 1: Organisation of teaching in science.

Regrettably, the ideas of *Project Faraday* have frequently been (deliberately) misunderstood, when schools have opted for fewer expensive laboratories without properly considering the need for the other learning spaces required. The original *Project Faraday* designs cost quite a lot more than the traditional all-laboratories model.

Schools that have enthusiastically adopted the *Project Faraday* approach have achieved success, but the notion of team-work and the organisational model has to be maintained over time and through changes of staff. Where such an approach is imposed without the support of the science teachers and technicians, success may well be limited. Some of the difficulties posed by different approaches can be illustrated by the (somewhat sarcastic) comments from a very senior national adviser:

‘Is it being suggested that you move a class into a lab, do some practical work, move them out to discuss it and write it up, move another class in to do some practical. Move the first class back in and so-on ...? Or are (they) suggesting that kids work largely unsupervised on a huge variety of different experiments within some vast central space...What’s that?...Of course, I’m well aware that every practical goes well right from the start, they all take exactly the amount of time allocated to them, no-one ever breaks anything, no-one ever needs to follow up an interesting anomalous result with a further experiment, etc, etc...’

Types of science spaces

Guidance on the numbers of laboratories needed for a science suite is given in Section 1 of Building Bulletin 80 from the DfE. However, the EFA’s building design team has recently produced, under the austerity model, an interactive Schedule of Accommodation (SoA) which allows a very quick overview of the combinations of types of space that could provide a working science department (and, indeed, the whole school). These are summarised in BB103, June 2014. Assuming 30 pupils to a group in KS3, they are shown opposite in Figure 2:

Type	Floor area	Short description
Large Laboratory	97m ²	Additional space allowance for project work
Specialist Laboratory	90m ²	A-level (and other key stages), with fume cupboard(s)
Standard Laboratory	83m ²	KS3, general purpose
Science Studio	69m ²	Demonstration bench / area, plus desks and chairs
Classroom	55m ²	Desk and chairs only – no practical work
Preparation area(s)	0.4m ² per pupil	working space within science
Chemical store	7m ²	

■ Figure 2: Types of science spaces.

Areas in Figure 2 need to be compared with previously existing guidance from EFA's predecessor departments (see BB80, 2004) of all laboratories at 90m² and classrooms at 56m². The EFA's Baseline Designs consist of all laboratories, most (if not all) at 83m², which makes provision for A-level groups, even KS4 groups, something of a problem.

(As science classes in Scotland are limited to 20 pupils, the above guidance does not apply in the same way. Northern Ireland has similar restrictions on pupil numbers in science classes.)

Science suites based on *Project Faraday* ideas have also included:

Large group / demonstration spaces	100-200m ²
Interactive / immersive spaces	range of floor sizes
Informal group / discussion spaces	≥ 9m ²

In addition, types of space can be linked together, often with good-quality folding walls to enable separation or linking as desired, for instance:

- Standard Laboratory/Specialist Laboratory
- Standard Laboratory/Standard Laboratory
- Standard Laboratory/Science Studio

One solution that might appear half-way along the spectrum between All-Labs and PF-style (see Figure 1) is to design for equal numbers of Specialist Laboratories and Science Studios. Teachers then work in pairs with a laboratory and studio for each pair. This is not full team-working, but does require sets of two teachers working closely with each other.

‘National science education guidance in England has been that practical work of some kind should be taking place in at least 75% of all science lessons.’

Science Suites – The Hub

Whole-school designs may also decide to emphasise the science department as an ‘area’ of the school and include a ‘Hub’ that acts as a centre to the Science Suite. Other types of spaces might also then be included, for example:

- Circulation space(s)
- Teacher work spaces and offices
- Learning resource areas/ICT provision
- Individual learning areas
- Social areas
- Eating areas
- Toilets for staff/pupils/special needs
- Special Needs equipment – parking/storage areas (e.g. for wheelchairs)

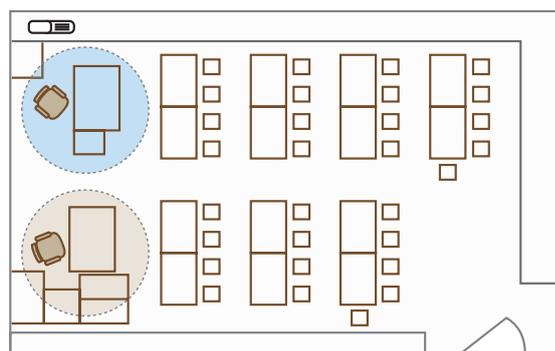
Science Teacher and Technician influences

Laboratories (and Science Studios) are intended for practical work, vital for pupil learning in Science. The design of new or remodelled science accommodation is an excellent time to examine the current practices that exist amongst science teachers and technicians and plan to change them, in tune with the design, if thought necessary.

National science education guidance in England has been that practical work of some kind should be taking place in at least 75% of all science lessons. Some heads of science have analysed their teachers’ methods and concluded that there should be more practical work than currently, reducing the amount of unnecessary writing that goes on. The organisation of science communities in England, SCORE, is also adamant that practical work is essential to good science education. Therefore any practices and/or designs that impede practical work should be removed or modified.

‘Teacher moved in’ is a major detriment to practical work. A particular problem under the traditional all-lab design, this is where a laboratory becomes the ‘property’ of one teacher. That person then moves all their personal material into the laboratory, which removes substantial amounts of floor area and facilities from the pupils.

Pupils’ folders, exercise books and text books are stored in piles around the room, while the teachers own books and personal computer take up ever more space. Plants, fish tanks and non-science notice-boards proliferate. In an extreme example, two teachers ‘shared’ a lab and both ‘moved in’ (Figure 3 opposite). Together with some unnecessary perimeter benching, this removed over 40% of the floor area from pupil use!



■ Figure 3: Two teachers moved in – 41% of space denied to pupils.

Space for teachers to work outside of laboratories is essential, so that laboratories become places for pupils to learn, not for teachers to inhabit. Teachers' work spaces should be properly planned and not be allowed to encroach on preparation and storage areas.

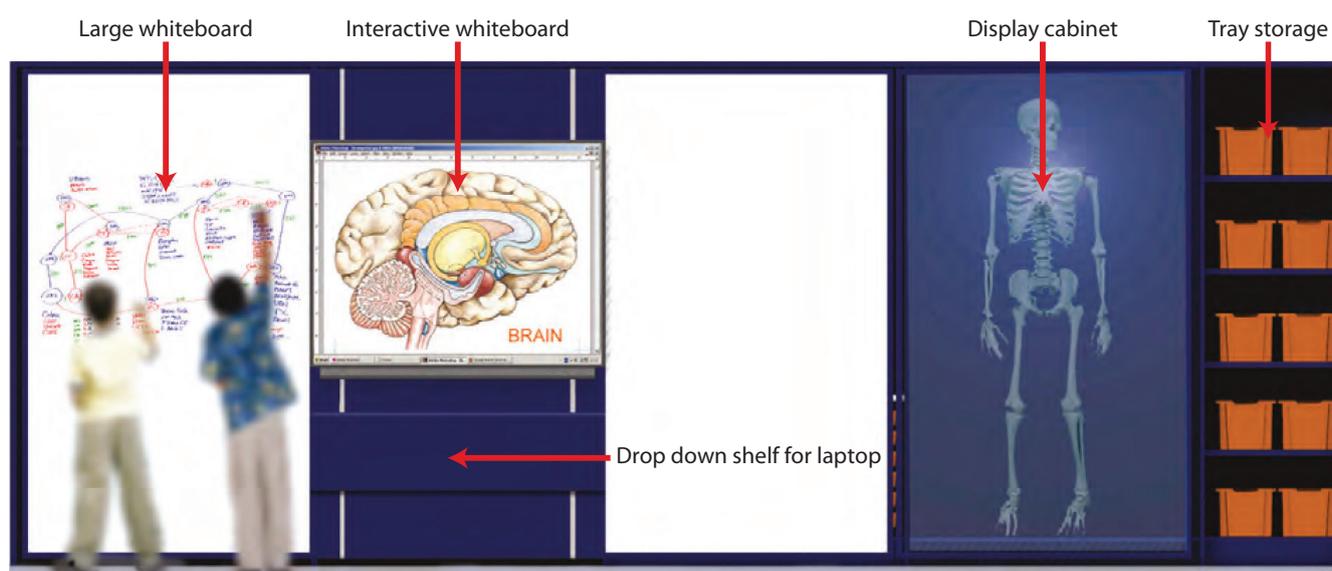
Technicians may also contribute to lack of space in pupil practical areas. When space is cramped in preparation and storage areas, they move equipment, materials and trolleys into laboratories. It is essential that sufficient storage space is provided for equipment and materials within the preparation areas and this should be provided in the first design stages.

Filing cabinets and recycling bins take up precious space and lead to paper piling up, forming a potential fire hazard; particularly when Bunsen burners and chemicals are in use. Such items have no place in a laboratory.

Pupils' personal lockers sited in laboratories take up space and also lead to security problems. Laboratories should be locked when unoccupied, but pupils inevitably want to access their lockers at such times or when another class is using the laboratory. Schools should therefore plan for pupils' lockers to be installed in communal spaces, not in laboratories. Advice in Scotland is that it is entirely inappropriate that pupils have lockers in a science lab.

Thoughtful design can alleviate some of these problems, while changes in teacher and technician attitudes can be encouraged as part of the new atmosphere that new and remodelled accommodation can provide.

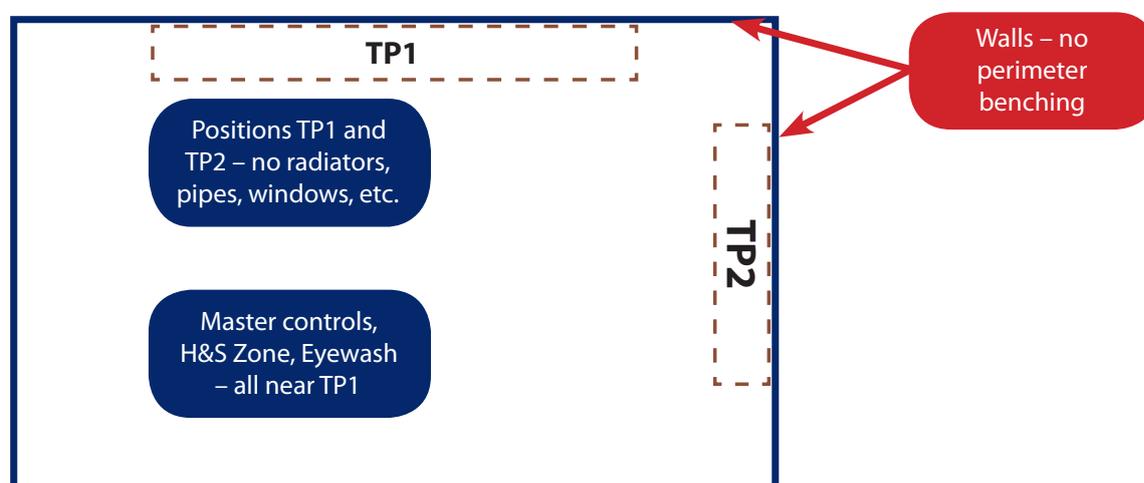
In the laboratory, it should be possible for any teacher to take over the space at a moment's notice; something that is absolutely essential in the PF-style design or, indeed, any design other than one lab per teacher. Getting teacher clutter out of the way and in the smallest possible space can be helped by installing a 'Teaching Wall' (see Figure 4 overleaf); with much storage being placed out of sight behind wall-to-ceiling sliding doors, whiteboards, projection screens and display cabinet.



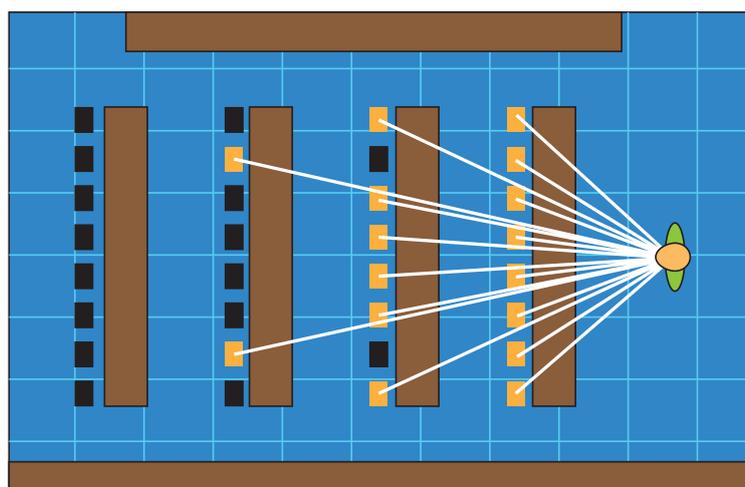
■ Figure 4: Teaching Wall – taken from Laboratory 21, NEELB.

'Pupils must face the front' is often the first cry of many science teachers when faced with a possible laboratory redesign; it also implies that teachers always stand at the front. An analysis of teaching and learning styles (APEC, 2006) shows that this is required in only a small minority of teaching and learning styles and is certainly not the case for practical work, indeed it may actually be dangerous. During practical work, pupils must focus on the apparatus and teachers must be everywhere around the laboratory.

Where laboratories are the only form of provision, then teaching and learning of a non-practical kind is necessary in the laboratory. Having pupils focussed on one place is then needed for some of the time, but this need not always be the same place. Projection screens and whiteboards on two walls gives a much greater range of possibilities; also enabling flexibility of instructions during practical work. Two teacher positions are shown in Figure 5 below.



■ Figure 5: Teacher positions 1 (TP1) and 2 (TP2).



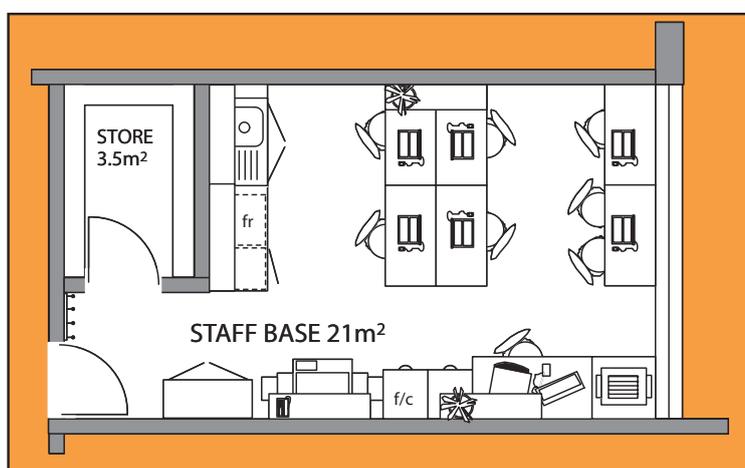
■ Figure 6: 16/32 cannot see.

‘The traditional form of laboratory has been around for a very long time, early examples being chemistry labs in German universities in the 19th Century. It really is about time that different designs were in use.’

Some science teachers, of all ages, tend to the traditional and want their laboratories to be the same as they have always been, except better decorated and serviced. Often this means a long laboratory with lines of benches facing the teacher at one end. Design can do so much better than this, indeed the traditional design can be shown to obscure the view of around 50% of the pupils and ensure that the teacher cannot in fact see many pupils, even if they are all ‘facing the front’! It is not unknown for pupils to use this fact to ‘hide’ from the teacher; adults do this too when at conferences, preferring to sit at the back for the same reason.

Designers and manufacturers can provide a wide range of different layouts and it can be very productive to take teachers through the range during initial discussions; e.g. by using the *Lab Design Gallery* from the ASE website (www.ase.org.uk/resources/lab-design).

The traditional form of laboratory has been around for a very long time, early examples being chemistry labs in German universities in the 19th Century. It really is about time that different designs were in use.



■ Figure 7: Staff Base – taken from BB80.

Teachers' needs

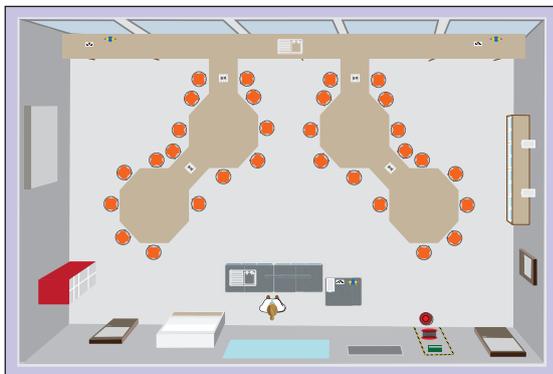
Under the *Project Faraday* style of design, teachers and pupils move from laboratory to other space frequently. Due to the smaller number of laboratories, teachers tend not to have their 'own' laboratories and, in effect, they 'hot-lab'. Consequently they need somewhere to call their own space; a desk and filing space away from the laboratories (and not in the preparation areas!).

Some schools have decided, on finance/space grounds or on principle, that teachers should 'hot-desk' because they spend most of their time in laboratories with their pupils. This is a false economy as human nature results in teachers moving back into laboratories and taking up space pupils need. It also creates a restless anxiety about where they belong; something that is a well-known problem in commercial offices that use hot-desking.

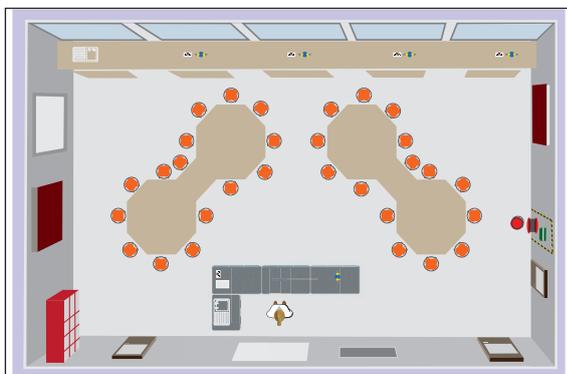
As for the school that insisted on teachers hot-desking as well as hot-labbing ...!

Pupils' needs

Teaching and learning, especially practical learning, is the priority in any laboratory or science studio. Pupils (and teachers) need easy access to a range of services and plenty of space to work with equipment.



■ Figure 8a: Benches connect to perimeter, cutting off areas from each other.



■ Figure 8b: Free standing benches – much better access.

Design of benches and the supply of services to these benches must take teaching and learning as its priority and not the ease of installation or cheapness. Safe distances between benches is imperative and easy access for the teacher (especially in the event of an emergency) is vital. Safe distances come under national guidance, based on building regulations; see Appendix 1, Safe Distances.

Routing of services (gas, water, electricity, etc) is a design issue, but taking the easy way out by using only perimeter benches or long runs of benches with no easy access routes is not an option. Neither is installing a teacher dais just to make running services to a demonstration bench easier; such dais may be traditional but are distinct trip hazards and encourage teachers to stay behind the demonstration bench.

Figure 8a shows an example of restricted access for the teacher, where services are run under a long run of benches which, in turn obstructs free flow of movement. Much the same design, shown in Figure 8b, avoids the problem, but services have to be run underneath the floor (either in channels or under a completely false floor).

‘School science laboratories are an expensive investment and are expected to last for many years. A poor design will impact on generations of pupils, teachers and technicians.’

– *The Association for Science Education*

Technicians’ needs

Traditionally, the ‘Prep Room’ has been separate to teaching laboratories and they remain so in most designs. It is vital that the design of preparation and storage areas (including the Chemicals Store) is accorded the same importance as design of laboratories and other learning areas. Pupils’ practical work will be greatly diminished if there is no proper provision for preparation, clearing up and storage.

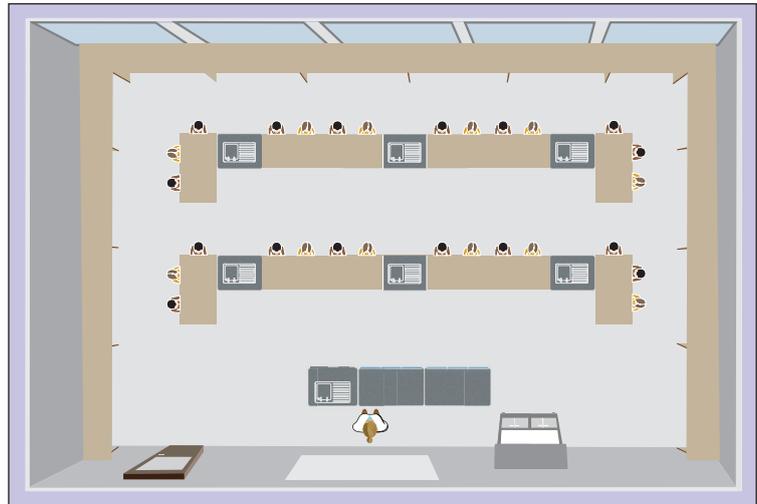
Prep Room Design, Gratnells Special Report Part 1, goes into detail for this area. For a long time, main guidance has encouraged large prep rooms placed centrally for all laboratories (and science studios). This means that technicians can work as a team, supporting and learning from each other; rather than the very old-fashioned system of each technician labouring away in a small, isolated prep ‘cupboard’. Large, airy, well-designed prep rooms also ensure that the working conditions for technicians are as they should be for any employee; technicians are humans too!

In some recent designs, preparation areas have been made an adjunct of the pupils’ learning area(s). Technicians then work with pupils as well as on preparation, maintenance and cleaning up. Their routine work will also be on display at all times, which will give pupils a real understanding of what such work entails but demand high levels of behaviour from the technician acting as a role-model. This radically extends the technicians’ job description and schools will need to consider the qualifications and experience needed for this new role, as well as the increased pay commensurate with the additional responsibilities. There are also problems associated with health and safety. Chemicals, apparatus and equipment that may have been left out on benches in an enclosed preparation room will have to be securely locked away whenever they are not in active use.

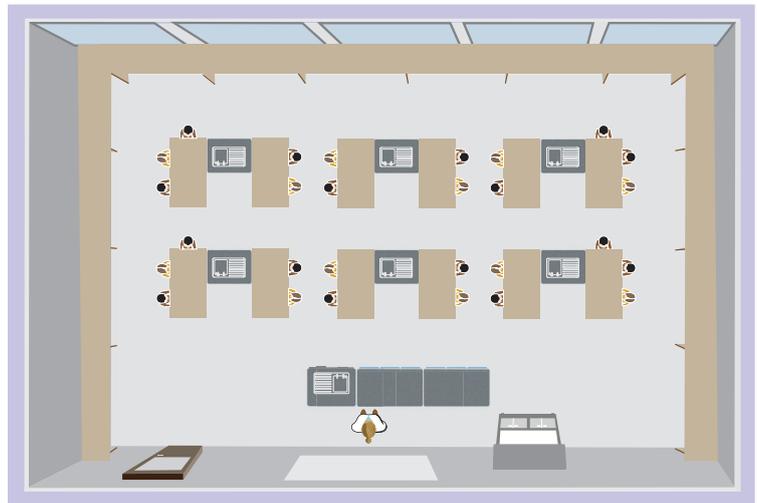
Flexibility

Over the decade from 2004, there has been a great deal of discussion about the flexibility needed for good teaching and learning. Certainly it was at the forefront of much of the *Project Faraday* discussions and designs. ‘Flexibility’, however, means different things to different people; so, following ideas from Darren Atkinson (formerly of Edunova):

Agility is the ability to make changes within the teaching space within lesson time. Many science teachers believe that this can only be done with movable benches and service bollards. However, this design (see overleaf, Figures 9a and 9b) means a great deal of lifting and moving (sometimes re-attaching services), which takes time and creates a deal of noise and fuss; it also assumes that benches are light enough for the pupils to move without injuring themselves.



■ Figures 9a: To change layout, move 8 benches and 16 pupils (+ stools) as in Figure 9b.



■ Figure 9b: Revised layout from Figure 9a.

A fixed bench design, with appropriate teaching spaces, can mean a much quicker transition, with less noise and fuss. (See Figure 10a this page, and 10b next page).



■ Figure 10a: To change layout, move 1 teacher and 8 pupils (+ stools) as in Figure 10b.



■ Figure 10b: Teacher and 8 pupils (+ stools) moved from Figure 10a layout.

Flexibility is the ability to link or separate spaces between lessons/between days. Where labs or labs and studios are divided by a movable wall, the wall can be drawn back or closed to between lessons or between days. Thus there can be one large space or two smaller spaces depending on what is needed. However moving a good quality wall takes time and often manual effort. Who will be tasked to do this? Is this a case of adding more to the technicians' tasks?'

A good quality, movable wall is sound proof and does not allow fumes or smoke to leak through when closed. Such walls are costly and may need maintenance. Cheaper, poor quality walls merely make both spaces terrible places to work and learn in.

Where spaces can be separate or combined, it is essential that ventilation arrangements and master controls for services can be operated, and be effective, both separately and together. It is imperative that any one space is controlled from within itself and not 'at-a-distance' in another space.

Adaptability is the ability to strip out and redesign whole areas of the science department, replacing walls, furniture and equipment. The original idea behind this was to install cheaper furniture and replace it (and the walls) every 5/6 years in order to keep pace with changing ideas of science education. Some walls would need to be non load-bearing and all services limited to a few perimeter benches on the other walls.

Given recent austerity budgets and designs, the only feasible part of this scheme is for non load-bearing walls; which under the modular systems from Baseline Designs would be easily accomplished. No school could seriously expect to be funded to strip out and redesign its science accommodation every 5 years without a great deal of independent finance and compelling reasons to indulge in short-term extravagances.

Common spaces

In *Project Faraday* type designs there are often large spaces for lecture presentations, demonstrations, performances, etc. Not unnaturally, such spaces are not always intended for the science department alone; perhaps being available to the D&T department, to drama and/or to the whole school. This means issues of 'ownership' may arise. Even within Science, it may be that the current trend for separating out into the 3 sciences (biology, chemistry, physics) will lead to differences in approach to such spaces. Figure 11 shows issues that cannot be ignored:

Common spaces – issues

Ownership:
Who arranges the timetable? Or...
...Is it first come, first served?
How many teachers/pupils can use it at once – and what for?
Do all pupils have equal access?

Flexibility:
Who moves the walls/furniture/services/seating?
When do they do this and what time is allocated?

Maintenance:
Who decides what needs doing?
Who pays?

Health and Safety:
Whose rules apply (e.g. rules for Science and D&T are similar but *not* the same)?

Isolation of areas:
In terms of noise/smoke/fumes/fire/illumination/discipline?

■ Figure 11: Important issues regarding common spaces.

Information and Communication Technology (ICT)

Provision of ICT in the science department depends greatly on whole-school policy and provision in this area. Equally, the pace of change for ICT is very high and anything written here stands a good chance of being out-of-date almost as soon as it is printed.

At the time of writing, the following ideas should be considered:

ICT suites, as a separate entity within the school, have been discredited by many. Where large numbers of computers are placed together, the trend is for open-access, often for individualised learning. Wireless connection is now the norm, but can still suffer from lack of capacity and/or blind spots. Many schools look to providing every pupil with their own device, with wireless access and monitoring; some are looking at BYOD

(Bring Your Own Device), but this still has connectivity and monitoring issues.

Dedicated interactive whiteboards are not regarded as a panacea by a significant number of people. A data-projector and screen arrangement is much more flexible and can be converted into interactive mode with the appropriate sensors and software.

Within the science department, demonstrations require cameras and/or visualisers to project enlarged images of smaller apparatus and meters. Short-throw data-projectors, projecting onto a screen or a wall, should now be the norm as they prevent eye damage from looking up the beam. However, projectors can now also be mobile and throw images onto the floor, the desk-top or the ceiling, as well as on the wall. While these mobile projectors are very flexible, the danger of eye damage returns.

Other technology

Lifts

Where schools have more than one floor, lifts will be required to enable access for disabled pupils, staff and visitors. Science departments on more than one floor also require hoists or lifts to transport equipment and materials between prep rooms on each floor. Custom-made hoists are expensive and cannot take people. Therefore, if possible, people-carrying lifts should be sited in or close to the science department so they can also carry the equipment and materials, obviating the need for a hoist.

Such lifts should have doors wide enough to take the standard trolleys that the science department uses; and wide and tall enough to take mobile fume cupboards if these are used.

Fume Cupboards

Filter fume cupboards are cheaper to install, but are more difficult to use and more expensive to test and maintain. They also can not deal with the entire range of experiments that a science department may want to use. Schools should insist on ducted fume cupboards.

Mobile fume cupboards require docking stations at every point of use and that doors (including lift doors) are wide enough and tall enough to allow the fume cupboards to pass through.

Many science departments find moving mobile fume cupboards far too much of a problem and they get far less use than is designed for. It is actually far easier to move the class to the laboratory with the fume cupboard.



■ Static fume cupboard; photograph courtesy of ALS. www.als-uk-ltd.com.

The preparation area for chemicals requires a fume cupboard and at least one in three laboratories in the All-Lab system should have one fume cupboard; for A-level Chemistry 2 or 3 fume cupboards per laboratory. *Project Faraday* style suites would probably have fume cupboards in every laboratory. National guidance and regulations are given in *Fume Cupboards in Schools*, Building Bulletin 88, DfE.

Environment and technology

Ventilation in science laboratories and studios is vital and often depends on some form of boost ventilation to deal with the heat, fumes and smoke generated by some experiments. The same is true of prep rooms and, in particular, of chemical stores (where ventilation rates are crucial).

'In science laboratories (and in prep rooms) it is essential for windows to be under the control of teachers so that fumes, etc, can be removed when necessary.'

Over the last decade there has been a movement to 'manage' the total environment with sensors and computer controls. Despite having vociferous advocates amongst some architects, these systems have often proved to be problematic in practice. In science laboratories (and in prep rooms) it is essential for windows to be under the control of teachers so that fumes, etc, can be removed when necessary. Part of the current Baseline Designs from the EFA is the requirement for natural ventilation, using manually operated windows.

Sprinkler systems are now a regular feature of schools buildings, but the sensors used can cause severe problems in science laboratories (and prep rooms, and chemical stores). Sensors that react too sensitively to heat and/or smoke can result in the whole school being sent repeatedly into emergency evacuation. Standard smoke sensors should not be installed for this reason. Either the sensors should be impervious to the normal run of science experiments and demonstrations, or teachers and technicians should be able to turn the sensor system off when such activities take place. Sprinkler systems should not be installed in chemical stores as water can promote fires / explosions with some chemicals.

Auto-control of lighting is frequently installed in order to 'save energy'; operating on sensors that detection movement within the room. This type of control can actually cause safety problems when the lights go out during a demonstration or experiment; or in the prep room when technicians are sitting still doing preparation or repairs. While such control may prevent lights wasting electricity overnight, florescent lighting actually uses more electricity if it is constantly turned off and on. More sophisticated controls operate on movement sensors outside of normal school hours only, although ordinary switches and sensible operation are almost certainly a cheaper and more reliable system.

‘The accommodation needs of science should be considered in the context of the whole school development plan and it is important that science staff and pupils are consulted about their teaching and learning needs before an accommodation brief is drawn up.’
– *Building Bulletin 80*

Dim-out. Physics teachers, in particular, are liable to request blackout for their laboratories; mostly for experiments in optics. True blackout is *not* required; indeed it can be dangerous, as people stumble around unable to see! Also, black blinds will stop light but admit heat; over-heating laboratories in summer. Therefore dim-out should be installed; light-stop blinds, which should be white/light coloured to reflect heat at the same time as stopping light. Many optical experiments and demonstrations can now be performed using LEDs or lasers, which reduces the need for ‘black-out’ and uses more up-to-date technology than traditional ray-boxes.

Changes in guidance

Building Bulletin 80, Science Accommodation in Secondary Schools was updated by the Department for Education, DfE (then the DCSF) in 2004. It remains the chief guidance in its field for both architects and schools.

Project Faraday, a project in England, that was funded quite generously by the DfES (later the DCSF), started around this time; its report being published in 2008. Funding was made available to introduce or change designs for new build schools and remodelling of science accommodation in existing schools. There is no question that the discussions with schools and the planning by some enlightened architects resulted in some radically new and technically ambitious designs for the six new builds and six refurbishments across the regions of England. There is also little question that some designs since then have used *Project Faraday* ideas to reduce the number of (expensive) laboratories within a school, while paying little or no attention to the requirements for a range of other learning spaces that are essential to this style of design.

An *austerity programme* was introduced in England by the current Westminster government. This placed many of the recommended floor areas near to the bottom of the ranges described in BB80, rather than near the middle of the range as before. As costs for schools buildings are generally reckoned by the square metre, this is a blatant attempt to reduce costs at the expense of children’s learning spaces.

Baseline Designs have been introduced in England as part of the austerity programme. These designs attempt to provide ‘standard’ designs that can be used flexibly on different types of sites. Part of the rationale is to work on a modular system, enabling more factory-style building methods. Apart from stifling the creativity that was encouraged under *Project Faraday*, there is

nothing inherently wrong with standardised designs. For science laboratories, however, there is one aspect that is worrying. The modular system suggested stipulates a maximum width to rooms of 7.8m in order to capitalise on natural daylight through the window wall. With many rooms this is no problem, but with a floor area of 90m² (or 83m²) this width will give laboratory a length of 11.5m (10.6m); that is, it results in a long thin space.

This goes against the DfE's own guidance in BB80 that recommends that length: width ratio is above 1:0.8 (with a 7.8m width, a 90m² lab leads to a ratio of 1:0.68, an 83m² lab to 1:0.74). The Baseline Designs are therefore emphatically outside the BB80 recommended range, with BB80 maintaining that such rooms 'are too long and narrow (and) difficult to plan; viewing distances may be too long or viewing angles too wide.'

Much of the DfE's guidance was archived for a time; much of it is destined to be rewritten in a much reduced form. However, in the meantime, the original guidance is still pertinent; indeed essential as much of the rewriting is of the form that '*xxxx shall be suitable for...*' (e.g. *The School Premises (England) Regulations, 2012*) with no indication as to what is 'suitable'. Building Bulletins and Baseline Designs can be found on the DfE's website, or through the ASE or CLEAPSS websites.

Laboratory 21 is an interesting report produced in Northern Ireland (NEELB, 2006). Unusual, in that it was produced by a team of science and technology advisers working together with designers from the University of Ulster. Its designs are aimed at agility, using benches sliding on rails. It also features one of the first mentions of 'Teaching Walls'.

CLEAPSS is the leading organisation for health and safety and advice on practical matters in science education for England, Wales and Northern Ireland. It publishes its own guide on lab design, *Guide G14, Designing and Planning Laboratories*, last updated in 2009. This is freely available to everybody. Almost all schools are members of CLEAPSS and they and their architects are therefore able to consult CLEAPSS by e-mail and telephone, as well as accessing guidance documents on the website.

SSERC (The Scottish Schools Education Research Centre), is a sister organisation to CLEAPSS which offers similar guidance for schools and colleges in Scotland. Its guide, *Design Brief Summary for Science Laboratories in Scottish Schools*, was published in 2014. Almost all schools in Scotland are members of SSERC and they and their architects are therefore able to consult SSERC by e-mail and telephone, as well as accessing guidance documents on the website.

‘Good design can help with a large number of issues, but cannot, on its own, resolve problems of poor class management; nor can it make pupils behave better, although they often do when given a better environment to work in.’

The *Laboratory Design for Teaching and Learning* project, funded by NESTA and managed by the ASE, operated throughout 2003/2004. It produced guidance and interactive planning software. The software has been superseded by technological advance, but the guidance produced can still be accessed via the ASE. Most guidance, from whatever source, is also available for download from/through this website: www.ase.org.uk/resources/lab-design.

School Science Architecture Special Reports have been published by Gratnells from 2010 to 2015 in the following parts:

Science Prep Rooms in Secondary Schools, 2010.

Science Labs in Secondary Schools, 2011.

The Chemicals Store, 2013 (co-published with Timstar).

School Science Accommodation, 2015 (co-published with ASE).

The *Lab Design: Future Science Accommodation for Teaching and Learning* course is run annually by the National Science Learning Centre. Having started in 2005, it is updated each year and is open to all: heads of science, science teachers and technicians, as well as architects, designers, local authority officers and senior school leaders.

Best Designs

Good design can help with a large number of issues, but cannot, on its own, resolve problems of poor class management; nor can it make pupils behave better, although they often do when given a better environment to work in. High standards of design of science accommodation happen when:

- Architects, designers, contractors, science teachers and technicians talk to each other...and...
- Both sides are knowledgeable about national guidance...and...
- Whole school leadership and management is in accord with departmental ideas...and...
- The Client (i.e. the finance) allows good, sustainable design and installation and allows time and resources to make this happen.

While the number of negative comments about standards of lab design and installation are legion, positive comments exist and show how some schools and their architects are getting it right:

Teachers are expressing a renewed pride in their role...while pupils' confidence levels in their approach to science-based subjects has improved greatly. – PwC report

Our newly refurbished labs are having a significant positive effect on pupils' and teachers' motivation... – RSC report

'Recently moved into purpose built labs. Consultation has been excellent.' – RSC report

References

APEC, APEC Educational Consultancy
Teaching & Learning styles analysis, 2006
andy.piggott@btinternet.com

ASE, Association for Science Education
Lab Design for Teaching and Learning, LDTL
Lab Design Gallery
National guidance, including Building Bulletins, and
archived material on website
www.ase.org.uk/resources/lab-design

CLEAPSS
G14, Designing and Planning Laboratories, 2009
CLEAPSS offers a wide range of advice and guidance
for member schools
Their website includes links to some Building
Bulletins and other guidance
www.cleapss.org.uk

DENI, Department of Education Northern Ireland
www.deni.gov.org

DfE - EFA, Department for Education – Education
Funding Agency, Buildings and Design team
BB80, Science Accommodation in Secondary
Schools, 2004
BB88, Fume Cupboards in Schools, 1998 (in the
process of being rewritten at CLEAPSS)
Interactive SoA, (Schedule of Accommodation), V4.7
and later, 2012 onwards
Baseline Designs, 2012 onwards
Project Faraday, Exemplar designs for science, 2008
The School Premises (England) Regulations, 2012
BB103, Area guidelines for mainstream schools,
June 2014
Plus other Building Bulletins
For BB103, Baseline Designs and some other
guidance see: [www.gov.uk/government/collections/](http://www.gov.uk/government/collections/school-building-design-and-maintenance)
[school-building-design-and-maintenance](http://www.gov.uk/government/collections/school-building-design-and-maintenance)

Gratnells

School Science Architecture Special Reports:
– 1: *Science Prep Rooms in Secondary Schools, 2010*
– 2: *Science Labs in Secondary Schools, 2011*
– 3: *The Chemicals Store, 2013 (with Timstar)*
– 4: *School Science Accommodation, 2015 (with ASE)*
www.gratnells.com/PlanningDesign/Architects.aspx
www.timstar.co.uk
www.ase.org.uk

NEELB, North Eastern Education & Library Board
Laboratory 21, School Science Laboratories Design
for the 21st Century, 2006
www.neelb.org.uk

NSLC, National Science Learning Centre
Lab Design: Future Science Accommodation for
Teaching and Learning
[www.sciencelearningcentres.org.uk/consortia/](http://www.sciencelearningcentres.org.uk/consortia/national/cpd)
[national/cpd](http://www.sciencelearningcentres.org.uk/consortia/national/cpd)

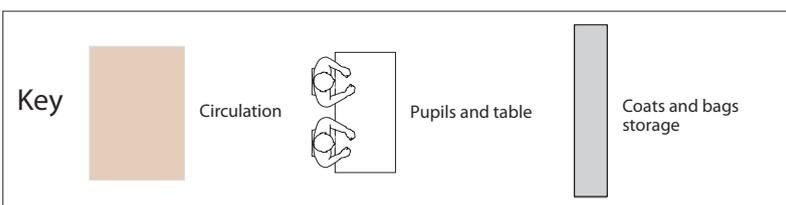
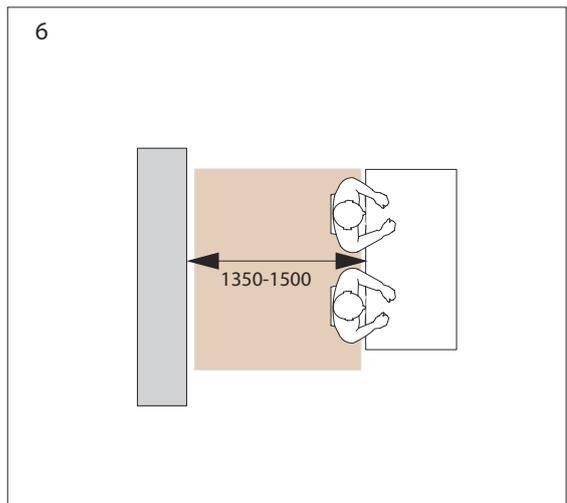
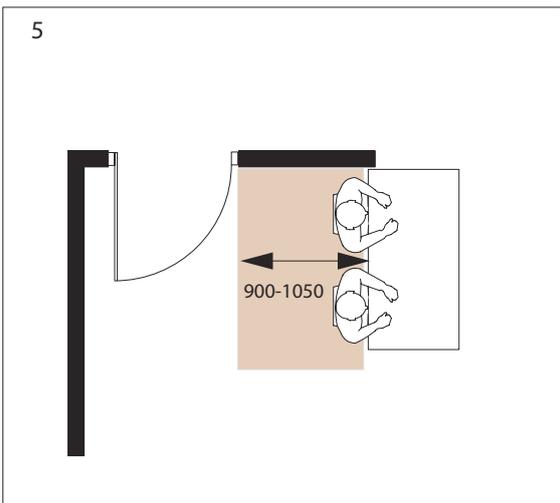
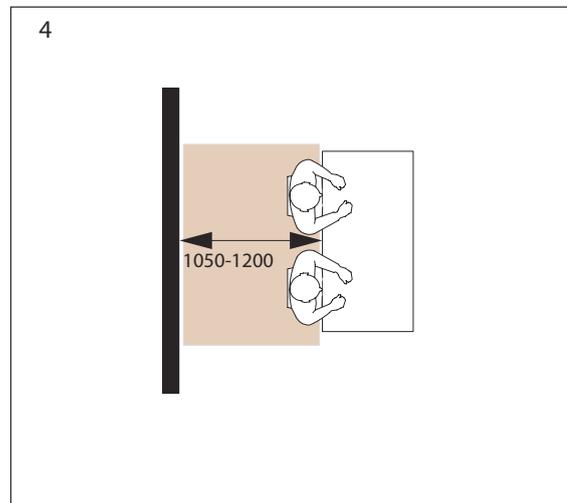
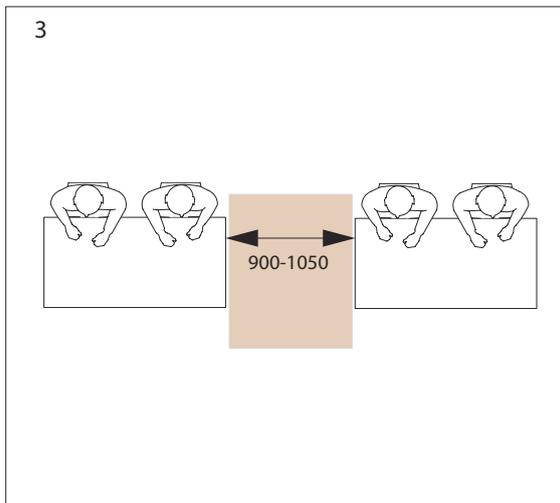
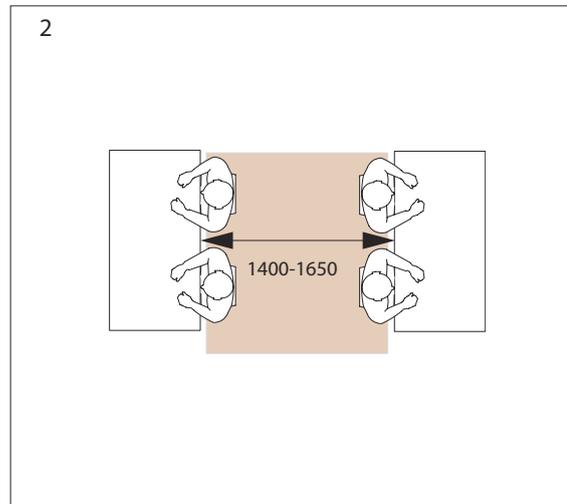
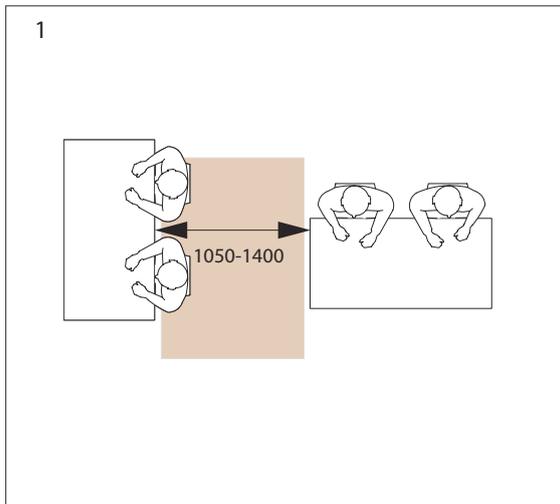
PwC, PricewaterhouseCoopers
Evaluation of Science Laboratory Funding,
DfES, 2003
www.pwc.co.uk

SCORE, a group of scientific organisations
supporting science education in England,
comprising: ASE, Institute of Physics, Royal
Society, Royal Society of Chemistry, Society
of Biology
www.score-education.org

SSERC, The Scottish Schools Education
Research Centre
Design Brief Summary for Science Laboratories in
Scottish Schools, 2014
Wide range of advice and guidance for member
schools
Website includes links to some Building Bulletins
and other guidance
www.sserc.org.uk

RSC, Royal Society of Chemistry
Laboratories, Resources and Budgets, 2004
Improving school laboratories?, 2006
www.rsc.org

Appendix: Safe distances.



From BB80, *Science Accommodation in Secondary Schools*, 2004. Used with permission.





Gratnells has been supplying integrated science storage system to schools worldwide for over thirty years. Our frames hold different depths of strong, sturdy trays, and our tray inserts ensure safe handling of laboratory materials and equipment. We also have a range of trolleys which enables safe transportation from the Prep Room to the Science Lab.

If you would like to know more about how Gratnells can help you design the perfect School Science Lab and/or Prep Room, using our FREE GratCAD software, which contains 2D and 3D modelling for AutoCAD*, Autodesk 3ds Max* and most other ACIS*-based modelling programs, then call us on **01279 401550**. We also offer consultancy and assistance in implementing School Science Lab and Prep Room storage areas.



Gratnells Ltd, 8 Howard Way, Harlow, Essex CM20 2SU
T: 01279 401550 **F:** 01279 419127 **E:** trays@gratnells.co.uk **W:** www.gratnells.com

The Association for Science Education (ASE) is the largest subject association in the UK. As the professional body for all those involved in science education from pre-school to higher education, the ASE provides a national network supported by a dedicated staff team. Members include teachers, technicians and advisers. The Association plays a significant role in promoting excellence in teaching and learning of science in schools and colleges. Working closely with the science professional bodies, industry and business, the ASE provides a UK-wide network bringing together individuals and organisations to share ideas and tackle challenges in science teaching.



The Association for Science Education, College Lane, Hatfield, Hertfordshire AL10 9AA
T: 01707 283000 **F:** 01707 266532 **E:** info@ase.org.uk **W:** www.ase.org.uk