

Science Prep Rooms in Secondary Schools

An introduction to Prep Room design for architects and designers



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A special report commissioned by Gratnells Ltd.

Prepared by Andy Piggott, Independent Science Education Consultant
specialising in lab design and science health and safety.

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‘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*

Introduction

School science laboratory design has changed little in the past six decades. But over the last few years, the role of science teaching in secondary schools has been a focus of attention for both government and leading science bodies. Many have voiced concern that without improvements in the practice of teaching science and the science curriculum – including learning environments – children would not meet the desired high levels of interest and achievement in science.

The *Roberts Review* of 2002 found that ‘suitable science laboratories and equipment are vital to pupils’ science education, not only directly (meeting curriculum need) but also indirectly by interesting them and enthusing them to study these subjects further.’

This has led to major new initiatives in the way science teaching spaces are designed. The *Building Schools for the Future* rebuilding/remodelling scheme opened the doors for architects to address the needs of science labs in the 21st century.

Project Faraday, launched in 2006, has encouraged practical and creative designs for secondary school science facilities which support more interactive and exciting ways of teaching and learning with innovative use being made of ICT.

This is all good news. But there is a downside. Many architects have been commissioned to design and specify science Prep Rooms and Laboratories to meet these new and exciting initiatives with little or no experience in what is a very specialised area. For example:

A new school was built with no chemicals store. When a specialist moving firm came to transfer hazardous chemicals from the old school to the new they refused to move them, as there was no safe area where they could be stored. School staff only found this out after the new building had been signed off, and it cost the school £15,000 to build a store in the new building.

An Academy built in West London had only simple ‘industrial style’ shelving provided for thousands of pounds worth of science equipment. It ended up being put on the floor.



- 21% of Prep Rooms are poor, with 43% at only a basic level.

In another Academy, all the science equipment storage was placed in the teaching labs. The Science Technicians were unable to prepare experiments and equipment without disturbing whole classes.

So, who was at fault? In the first example, the design brief had not included a chemicals store or an adequate Prep Room, and the architect had not included one. Whoever compiled the design brief had obviously not taken specialist advice. However, such a glaring omission should have been picked up by any experienced architect. The architect and contractors were exonerated as the building had been signed over before the problem was discovered, but the damage to their reputations might easily affect bids for future work.

In the latter two examples, it was simply a case of inadequate knowledge on behalf of the architect and specifiers.

This lack of knowledge and experience of Prep Room design on both sides is the cause of a great deal of poor or inadequate design that blights the working lives of many Science Technicians and downgrades the service that they can provide for pupils' science education. In the report, *Laboratories, Resources and Budgets*, 2004, Royal Society of Chemistry, 21% of Prep Rooms were described as poor, with 43% at only a basic level. Subsequently designed schools have done little to change these percentages.

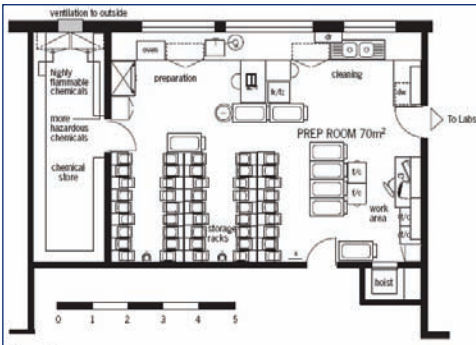
This report aims to point architects and compliers of design briefs toward the major issues in Prep Room design. Checking designs in detail requires specialist advice and reference to national guidance contained in:

Science Accommodation in Secondary Schools, Building Bulletin 80, 2004, DCSF

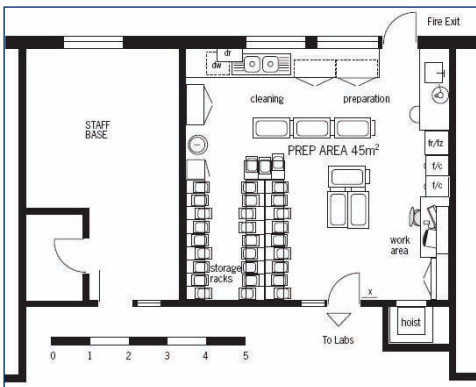
Designing and Planning Laboratories, G14, 2009, CLEAPSS

Project Faraday, Exemplar designs in science, 2008, DCFS

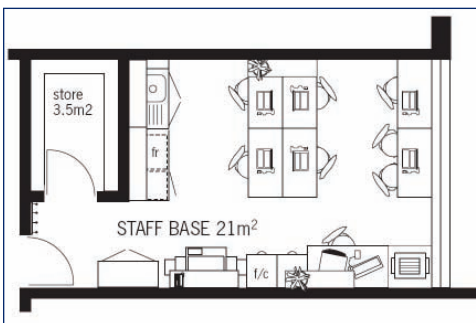
The Good Lab – Concise Guide, 2009, APEC



■ Preparation on two floors in 7-science lab suite:
First floor.



■ Preparation on two floors in 7-science lab suite:
Second floor.



■ Staff base.

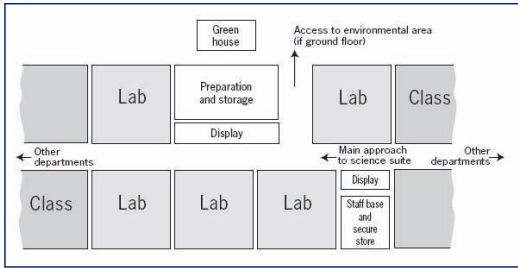
Where should the Prep Room be?

All national guidance points to one large central preparation and storage area per floor of the science department. The days are long gone of a multitude of tiny little Prep Rooms scattered all over the place, with one isolated technician per room. All storage should be accessible from the central Prep Room; in particular, the chemicals store should open off the Prep Room near to where chemicals are handled. At the same time, there should be clear and easy access to all laboratories and demonstration areas, as well as to corridors and circulation areas.

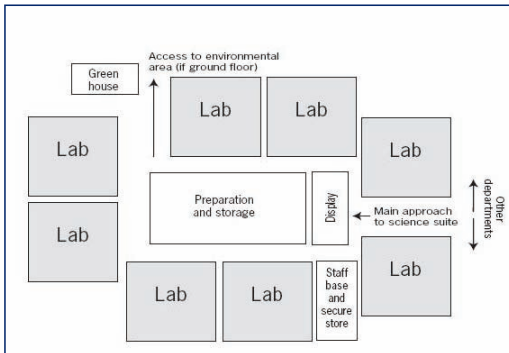
Having a central preparation and storage area can create problems for the working environment. It is not unknown for designs to place the Prep Room in the centre of all the laboratories, which then precludes any natural light or ventilation. Science Technicians spend the majority of their working lives in these areas and should not be subjected to such unnatural conditions.

If the science department is on more than one floor, and/or is not on the ground floor, then a hoist between Prep Rooms is advised. However, custom-made hoists can be expensive, so placing Prep Rooms next to the passenger lifts required by DDA (Disability Discrimination Act) could save on costs, provided the lifts are big enough to take large equipment, people and are proof against hazardous materials.

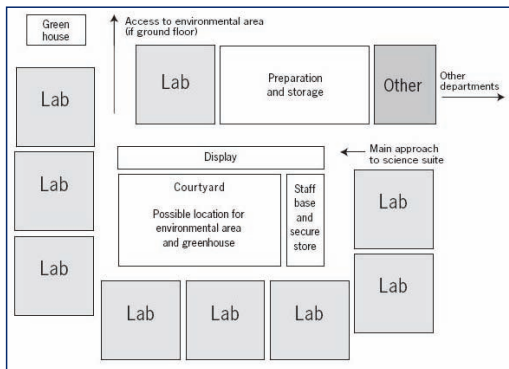
Access to the Prep Room for delivery of hazardous materials is also important. Direct, or very close, access for delivery vans is important for health and safety as well as for manual handling. It could also be useful to combine this access with that for the design technology department.



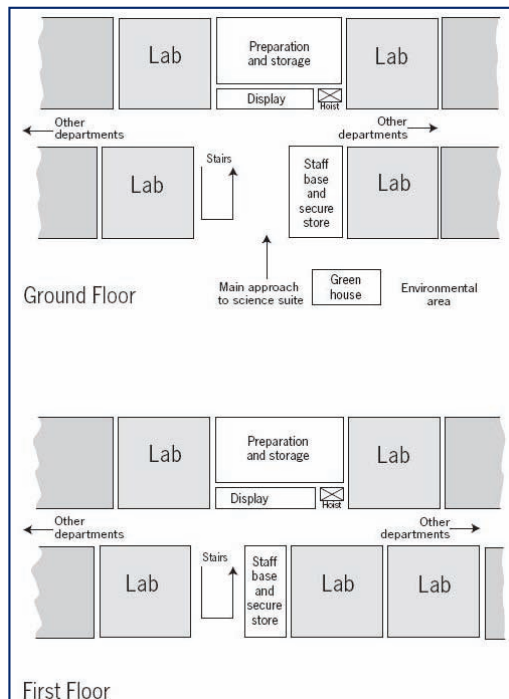
■ Linear Plan.



■ Central Preparation Plan.



■ Courtyard Plan.



■ Linear Two Floors Plan.

Prep Room design options

Building Bulletin 80 shows four main types of design. A linear plan for smaller numbers of laboratories, with the Prep Room centrally placed on one side of a central corridor. A central Prep Room with the laboratories placed all around, although this is best used for a one-storey building in order to bring natural light into the Prep Room via the roof. Laboratories and the Prep Room grouped around a central space, which also allows access to greenhouses and environmental areas. The linear plan on more than one floor, but with central Prep Rooms placed over each other if there is to be a science hoist and/ or the Prep Rooms placed next to passenger-carrying lifts.

Floor area and its uses

Because few people outside science education fully understand what Science Technicians do, and there is always financial pressure, poor designs attempt to 'economise' on floor area for preparation and storage. This must be strongly resisted if good support for the practical science curriculum is not to suffer. *Building Bulletin 80* guidance states that the total area for preparation and storage areas should be based on 0.4 – 0.5 m² per (pupil) workplace. So, for a school with six labs, taking 30 pupils each, the total prep and storage areas should be 90m² (6x30x0.5); or the size of a standard laboratory.

Allocation of space within the total should give approximately:

- Practical work areas ~ 30%
- Storage ~ 30% (including the chemicals store)
- Mobile storage ~ 10%
- Administration ~ 10%
- Circulation space ~ 20%

In addition to preparation and storage areas, good overall school design will want to provide space for staff workrooms, office for the head of science department, interview room(s), social and refreshment area, storage for cleaners' materials, and toilets for staff and pupils.

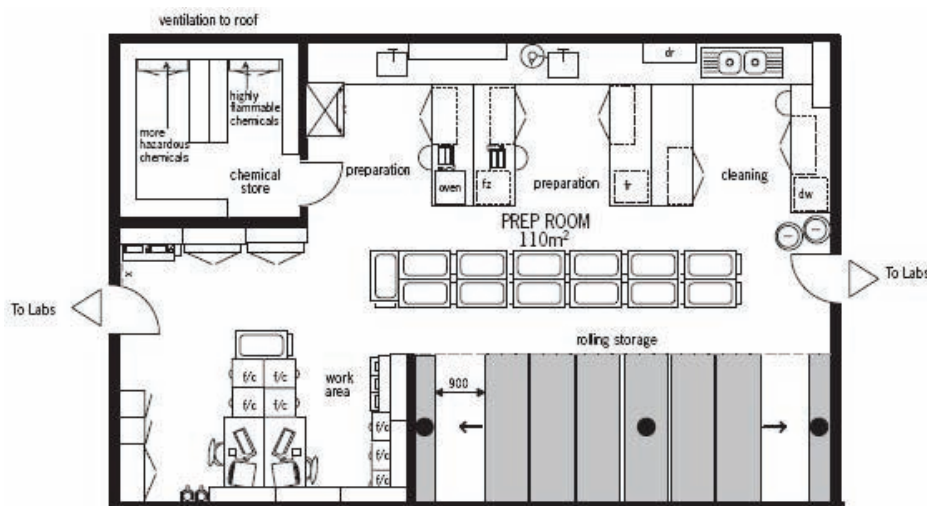
Working areas

Preparation areas should be considered in terms of zones, in order to separate different types of work:

- Chemicals preparation and dispensing with bench space by the chemicals store and a ducted fume cupboard.
- 'Clean' area for microbiology work.
- Dry preparation, repair and maintenance with bench space, plenty of mains electrical sockets, a metal-working vice (and local exhaust ventilation if there are large amounts of soldering to be done). Collation and return of equipment with free bench space and floor areas for parking and use of trolleys that shuttle back and forth to the laboratories.
- Administration, which is a dry area away from the practical activities, with computer and intra/internet access, filing cabinets and shelving

Although it is possible to combine some zones, for example wet preparation and chemicals dispensing, it is important to keep all these zones as distinct as possible for health and safety reasons.

Where there is too much overlap, poor working practices will inevitably result, leading to accidents. In particular, lack of space for trolleys and insufficient circulation space leads directly to overcrowding.



■ A central Prep Room serving seven Laboratories, based upon the zoning principle.

Particular equipment, including fume cupboards

There is a range of large equipment needed in Prep Rooms that requires thinking through at the design stage. This is because of the space needed, the dimensions of furniture around them and the services required to make them work.

The most important piece of equipment is the fume cupboard. Without it, chemicals dispensing and preparation becomes hazardous, either through risk assessments being ignored or by work having to be rushed through at odd times in laboratories that do have a fume cupboard. The *2004 Royal Society of Chemistry Report* shows that only about half of current Prep Rooms had a fume cupboard, which highlights the scale of the problem.

Not only is it probably the most expensive piece of equipment, but it must also comply with regulations and requires a range of services. The regulations that the fume cupboards must be installed and commissioned to are *Fume Cupboards in Schools, Building Bulletin 88, 1998*, DCSF. Despite much myth to the contrary, these fume cupboards must be ducted in order to cope with the work that technicians have to do. Such ducting, like that for chemicals stores (covered later), has to reach above the roof line and not interfere with the intakes for any other ventilation system. Gas, mains electricity, cold water and drainage are all required. At the same time, the actual positioning of the fume cupboard is vital; within the chemicals preparation zone is important for instance. At the same time, it should be sited away from drafts in order that the air-flow into the fume cupboard is not affected.

There is a range of equipment that requires either floor space or bench space and mains electrical power to operate it. Examples are fridges, freezers, drying cabinets, incubators and even, for larger departments, an ice-maker. Fridges and freezers may be tall or under-bench designs. If for under-bench, then the benches themselves need to be tall enough, with no framework clutter underneath, to enable the equipment to fit under. Standard lab bench heights and designs have often prevented the retrospective installation of such equipment and it has ended up placed in circulation spaces, laboratories, or even corridors.

Stills for producing distilled water cause a lot of problems if services for them are not designed in. The standard electrically heated version requires a cold water supply, drainage and two 13A electrical supplies (there being two heating elements). The cold water supply and drainage should be separate from the preparation sinks as the sinks otherwise become cluttered and a single cold tap cannot be used for both the still and the sink.



■ Fume cupboards, the most important pieces of equipment, must be ducted.

‘Fume cupboard systems must be considered at an early stage in the design of a building as provision may need to be made for ductwork, including a stack; the architect and others concerned with the design are advised to consult a specialist supplier.’

– DCSF

Designing a science department without a proper chemical store room – or, even worse, without a Prep Room – demonstrates total ignorance of how science departments function. Architects and contractors may turn around and say that store rooms and Prep Rooms were not specified in the contract – but then who drew up the contract, how much expertise and experience did they have in designing school science departments?

– Royal Society of Chemistry



A dishwasher should be standard provision for Prep Rooms, although the 2004 Royal Society of Chemistry Report showed only 63% of Prep Rooms have them. Domestic versions are often considered, but in a new build a laboratory glass washer may be required by water regulations. Electrical supplies may need to be upgraded for the professional models.

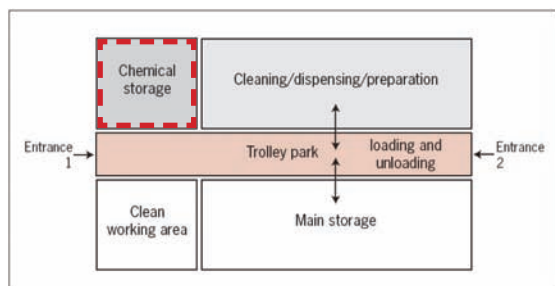
Storage areas

Without proper storage, health and safety can easily become an issue. Management of resources becomes very difficult and even basic teaching can be problematic, let alone good standards of learning. The 2004 Royal Society of Chemistry Report also assessed storage in Prep Rooms and rated 18% as poor, with 45% as only basic.

A leading firm of architects designed and built a new school, with a science specialism, which opened in 2008 at a cost of £23 million. However, little attention was paid to the design of the science preparation areas, particularly not to storage. The result was that hundreds of thousands of pounds worth of new science equipment remained dumped in piles on the floor long after the school opened. Chemical storage was questionable, as was the storage of radioactive sources. One commentator described the situation as 'absolute disarray, disruption and disorder!' The equipment suppliers themselves, along with the new school's Science Technicians contacted Gragnells for help. The firm was able to remedy some of the major storage errors, but it is considered that support of the practical curriculum in this science-specialist school will be blighted by poor storage for many years to come.

What is not often appreciated is that three groups of hazards should be stored separately to each other. Chemicals should be stored in a separate room, about which more below. Radioactive sources have to be securely stored away from chemicals and also away from cylinders of gas and from areas where people habitually work. Guidance on storage of radioactive sources comes from *Managing Ionising Radiations and Radioactive Substances in Schools, etc*, Guide L93, 2008, CLEAPSS. However, the final word on storage should come from the school's RPA (Radiation Protection Adviser). There should only be one cylinder for each type of gas used by the science department and this means that it is 'in use' and can be stored inside. In other words, a special outside store is not required. Cylinders should be kept secured, away from radioactive sources and chemicals, in chained racks or special trolleys.

A secure chemicals store of at least 10m² (more for bigger schools) is essential. The detailed design of this room would take several pages, but the major features are that it shall be fire resistant, be



- A secure chemicals store should be at least 10m² (more for bigger schools).

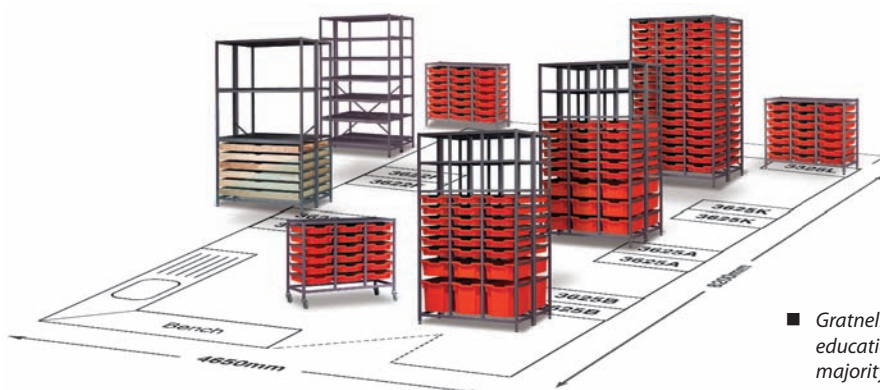
ventilated and be inside, next to the Prep Room. It is possible to use natural ventilation, but the constraints on this are so severe that nearly all designs will need to provide forced ventilation to maintain ventilation rates at better than 2 air changes an hour, on an automatic system. Such a system should be quiet in operation to enable people to work in the Prep Room and so that neighbouring residents do not complain (as has happened!). Ducting required for this ventilation should reach up above the roof line and, obviously, not vent in the vicinity of windows, intake pipes for other ventilation systems, etc.

There should be no windows in the chemicals store for both safety and security, nor should there be additional heating in an internal chemicals store or any heating being 'borrowed' from the Prep Room itself. Flammables are stored within the chemicals store, but in a flammables cupboard that complies with flammables regulations. The chemicals store itself should open directly into the Prep Room so that chemicals can be transferred directly and security is maintained. Examples of poor design are numberless, but one school's quote gives a flavour: '(Accessing) our bulk / flammables store involves two locked doors, one locked gate and a "key pad" controlled door – two self-closing doors and a flight of stairs. It's a nightmare!'

Science equipment storage

A science department has a myriad of different types of equipment and all must be stored in an accessible fashion. The storage area should be secure as some of the equipment is hazardous and a good proportion of it 'attractive' to children.

Many science technicians are adamant that organisation of their resources relies on the standard plastic educational tray. They will want to be in racks of open adjustable tray storage taking various depths of trays and special wide trays for long glassware as well as various widths of shelves for items not suitable in trays. They are preferred to cupboards whose doors reduce space and require opening to access every item.



- Gratnells frames and shelving, built to school science educational standards, can provide proper storage for the majority of science materials and equipment.



No shelving should be more than 2m high to avoid 'working at heights' and trays 1.5m so as to see the contents.

The trays should be compatible between the racks and trolleys as well as under bench laboratory furniture so they are all interchangeable. Trays should have the option of lids and inserts with compartments for small items in the shallow trays. The biggest supplier of such trays, racks and trolleys is Gratnells and almost all Science Technicians who use tray systems refer to this firm's products.



Where this organisational system is required, the easiest method is to use the purpose built racks and trolleys to go with standard size trays. It is a false economy to install furniture systems as their dimensions and designs often frustrate the use of trays. Recent letters from technicians to *EIS (Education in Science)* June 2009, illustrate the problem.:

'Perhaps the firm used by the school was not a specialist laboratory supplier'... 'The drawers are not as deep as the cupboards, so Gratnell trays will only fit sideways'... and 'The cupboards are not deep enough to take Gratnell trays, even sideways!'

Trolleys

Equipment trolleys are an essential item of the Prep Room. CLEAPSS recommends two trolleys should be provided per laboratory (plus one for the Prep Room). This allows for one trolley to be in the Science Lab (with delivered equipment) and the other in the Prep Room (with returned materials and those awaiting delivery). Trolleys can be used for storage but more importantly they should be used by Science Technicians for moving equipment from room to room instead of carrying it. Where equipment and materials need to be carried from one site to another across a playground trolleys must have larger and more robust wheels. The trolley park will take up around 8% of the space in a prep room.



Roller Storage

When floor space is restricted and static storage systems cannot be considered, roller storage presents a practical alternative. The use of floor-mounted tracks and anti-tilt devices ensures the stability of units on uneven surfaces. Ramps can be fitted to every access point, allowing access into the open system by trolley or wheelchair.

Floor loadings should be taken into account when designing shelving areas, particularly when rolling end systems are proposed as these can all bunch up together, greatly increasing point loads .

- The Gratnells storage system provides an integrated storage facility comprising frames, roller storage, trolleys, trays, inserts, lids and labels for Prep Rooms.

‘Some schools have installed time switches and other systems to control lighting on environmental grounds. Unless these can be reprogrammed or overridden then they can be a considerable nuisance to a teacher or technician working in the room.’

– *CLEAPSS*

‘Technicians deal with chemicals in bulk often in small rooms. Ventilation is no less important for the Preparation Room than the teaching laboratories.’

– *CLEAPSS*

Working environment

Science Technicians are employees and entitled to healthy and safe working conditions. Far too many are expected to work in cramped, ill-lit and poorly-ventilated rooms, many of which become unpleasantly hot and humid during the summer months, even in newly built schools. Like teachers and pupils, Science Technicians work best when they have a well-designed, well built working environment.

Natural light helps provide a good environment and also economises on power for artificial illumination. With a balance of natural and artificial illumination, there should be greater than 300 lux on working surfaces, with task lighting in addition. Using natural light has the disadvantage of solar gain and glare (a problem with Bunsen burners, for example), so the siting of windows should be carefully considered and blinds installed as a matter of course.

Ventilation is important for any working area, but particularly so in Prep Rooms where a lot of washing-up is done and chemicals are prepared, producing both humidity and fumes. The specification should be better than that for laboratories, i.e. greater than six air changes per hour. If this requires artificial ventilation, then this should be quiet in operation!

For the British climate heating is an obvious necessity, with the Educational Premises Regulations demanding a minimum of 18°C. At the same time, stress from temperatures that are too high is becoming more common, especially where windows face South. If natural ventilation and passive cooling cannot be shown to be capable of keeping working areas below 28°C, then installation of air-conditioning will need to be considered. Recycled air should be avoided as this could easily recycle contaminants such as smoke, fumes and chemicals and biological agents.

Good design of acoustics also helps produce a good working environment. Most of the furniture, equipment and fittings are very ‘hard’ acoustically, so the addition of absorbent materials for notice boards, for example, can help reduce the ‘echoey’ feel associated with many Prep Rooms.

All floors should be on one level to enable the movement of equipment trolleys. Ramps are not advisable and steps should not

be part of the design at all. The need for lifts between floors has already been mentioned in this report.

While it is not a major design-build feature, it is worth noting that décor should consist mostly of light, neutral colours in order to help with illumination and provide visual relief from the wide range of harder, darker colours associated with science equipment. Drab, grey, bare concrete is not helpful in this respect.

Health and safety

Every practical area in science, laboratories and Prep Rooms alike, requires equipment for health and safety. There is a long, unsatisfactory tradition of leaving this provision until the building is nearly ready for occupation; sometimes installation is even left beyond the occupation date!

Prep Rooms, and laboratories, require emergency eyewash, first aid kits, fire extinguishers and fire blankets. Emergency eyewash requires a cold water supply (and preferably drainage as well). The other equipment is best provided for by a dedicated wall area near to practical work areas; which entails leaving such a wall area free of furniture, radiators and other paraphernalia. Placement of fire equipment in particular should not be left to the whims of a fire extinguisher contractor's maintenance technician.

All services to Prep Rooms, as well as laboratories, need master controls or shut-offs to be able to leave them in a safe condition when the room is unoccupied and to enable fast shut off in an emergency. For gas piping this is a mandatory regulation, and it is very good practice for mains electricity and for water. In-line valves that control sections of pipe for gas and for water are also very good practice to enable service work to be done on those sections without affecting others.

Other areas

Staff work rooms enable teacher's working spaces to be separated from practical preparation areas. It is also important to remove the 'coffee area' from practical work areas on grounds of health and safety. Obviously the 'coffee area' will require services for kettles, microwaves, fridge, etc, and drinking water, hot water and drainage. It should be a separate area for cleanliness, whether a part of the staff workroom or next to it.

The head of the science department is likely to need an office, especially in larger schools and there should be rooms available for interviews and small group work.

'The Prep Rooms would be adequate ... however, they are used by teachers as a dumping ground and as a place to work.'

'Despite repeated requests, (the) main Prep Room (is) used as a science staff room for coffee, marking, prep work...'

– *Quotes from two Science Technicians*



■ A Prep Room at The King's School, Peterborough, one of GovEd's partner refurbishment schools in the DCSF's Project Faraday. Gragnells products are featured throughout.

Project Faraday (DCSF) shows exemplar designs that provide a wider range of spaces for learning than just laboratories and some of these integrate some of the preparation areas. Where such integration is contemplated as part of the overall design for science, the job descriptions, management and pay of Science Technicians should be reviewed to ensure that they are commensurate with any new roles that this puts upon technicians.

Greenhouses and environmental areas should be designed so that they can be directly supervised from the Prep Rooms and at least some of the laboratories. This also means more efficient use as technicians can easily access these areas for maintenance and development work.

Cleaning and maintenance equipment and services should be kept completely separate from science storage, which therefore entails additional, separate storage cupboards / rooms.

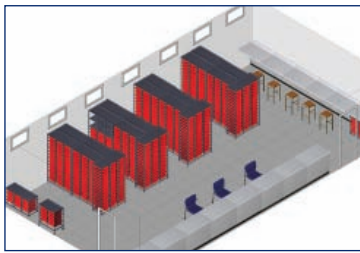
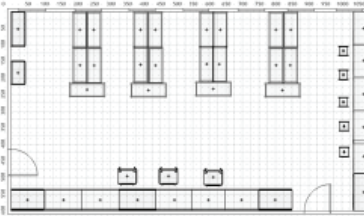
Summary

Prep Rooms and storage areas are vital to good science education. Architects and compliers of design briefs must ensure that specialist advice is taken so that a range of important features are included at the design stage, rather than left to be corrected later on and at great expense. Many good design features cost no money at all if input at the beginning of the process. Failure to follow specialist advice in the designs of preparation areas will mean that science teachers and technicians will be handicapped in their pursuit of good science education for pupils for many years. Architects and designers also risk their professional reputations when things go wrong for want of a little checking up in advance.

References:

- ROBERTS REVIEW** *Sir Gareth Roberts' review of the supply of science and engineering skills in the UK*
http://www.hm-treasury.gov.uk/ent_res_roberts.htm
- DCSF** *Department for Children, Schools and Families*
Schools Capital Assets Design Team
Room 702, Caxton House, Tothill Street, London SW1H 9NA
Tel: 08700 000 2288
<http://www.dcsf.gov.uk>
- PROJECT FARADAY** <http://www.goved.co.uk/projects/faraday>
- CLEAPSS** *The Gardiner Building, Brunel Science Park,*
Kingston Lane, Uxbridge, UB8 3PQ
Tel: 01895 251496
<http://www.cleapss.org.uk>
- APEC** *Andy Piggott*
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Case study: Science Preparation Room Chafford Hundred Campus Secondary School



■ Floor plan of the Science Preparation Room and 3D rendering of the staff resource area, both featuring the Gratnells storage system.



■ Chafford Hundred: Science Preparation Room fitted with Gratnells science storage system.

Chafford Hundred Campus Secondary School is a unique educational institution serving Chafford Hundred and the surrounding catchment area.

The Campus is also a Business and Enterprise College, so the facilities need to reflect the modern technological, vocationally orientated and personalised education package that it delivers.

In this regard, Chafford Hundred has invested heavily in providing storage and preparation areas for its science department, emphasising the need for key issues surrounding science equipment to be considered.

These include:

- *Health and safety issues when preparing experiments and class materials.*

- *Appropriate storage for a multitude of science apparatus.*
- *Efficient and effective identification of materials and equipment.*
- *Flexible storage that is able to respond to changing needs of science and learning.*

Gratnells supplied a full science storage system for the Campus Science Preparation Room working to the school's demanding specification. The system included metal frames and accompanying shelves and trays, plus trolleys for transporting equipment and



■ Design and technology room.

materials from the preparation room to the classroom.

In addition, Gratnells provided the storage systems for the school's design and technology area, as well as the staff resource room.



■ Classroom featuring Gratnells tray storage.

For the classrooms, Gratnells provided its range of patented four-depth storage trays and tray runners to fit the wooden furniture specified.



Gratnells have been supplying science storage system to schools worldwide for over thirty years. Unlike rigid industrial shelving and incompatible flimsy plastic trays, our approach is flexible and integrated. 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 classroom. What's more, we've designed complete storage areas for numerous schools throughout the UK.

If you would like to know more about how Gratnells can help you design the perfect 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 Prep Room and Science Laboratory storage areas.

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Worlddidac Award
for tray design



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