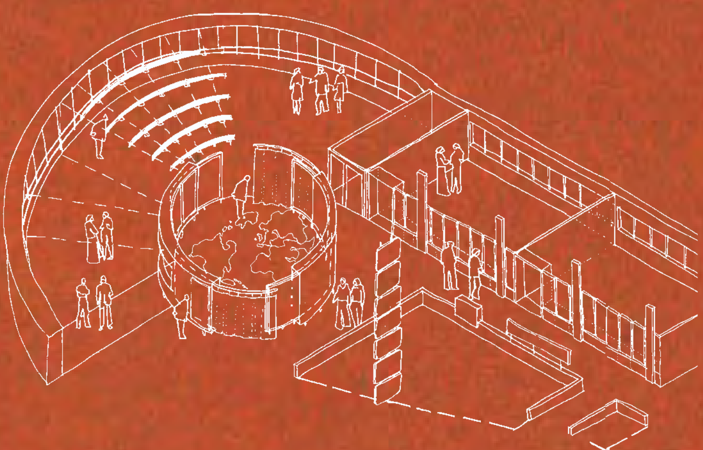
schools for the
future

Project Faraday

Exemplar designs for science



department for
children, schools and families

project
faraday

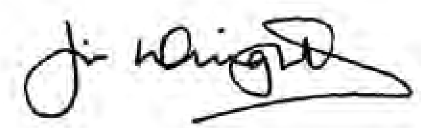
Foreword

Science and innovation are vital to a successful economy and a sustainable future. A good science education is important for ensuring that children and young people not only play a full part in the future world market but also fully understand, benefit from and shape their natural and technological environment.

This is why DfES is working with key partners to implement the Government's commitment to making science a priority in schools at all levels; to improve science learning and teaching and to inspire more young people, from all backgrounds, to study and work in science. Project Faraday aims to improve the design of school science facilities, as part of a wide programme to support these goals. A well designed environment can have a major influence on both staff and students, supporting inspirational learning and teaching.

£6.7 billion of capital funding is available for investment in schools this year. It will rise to over £8.2 billion a year by 2010–11. This includes the Building Schools for the Future and Academies programmes as well as the money allocated to schools and local authorities for their own priorities. This unprecedented investment is a wonderful opportunity to provide schools with 21st century science facilities that support excellent teaching and capture the imagination of students.

I'm very pleased to introduce this book on Project Faraday which showcases exemplar designs for science areas in schools that will be enormously valuable to local authorities, building professionals and schools. These designs result from a close collaboration between designers, educationalists, school staff and students and were guided throughout by experts in science and education. The twelve schools that took part in this initiative will act as demonstration projects for their regions and I am looking forward to the first of these designs being completed and in use by their pupils and teachers at the end of 2008.



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Acknowledgements

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Demonstration projects: renewals
Abraham Guest High School, Wigan
Bideford College, Devon
East Barnet School, Barnet, London
Estover Community Campus, Plymouth
Joseph Rowntree School, York
Rednock School, Gloucestershire

Demonstration projects: refurbishments
Cramlington School, Northumberland
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Contents

Introduction

Project Faraday set out to promote innovative science facilities that not only support 21st century approaches to learning and teaching but also inspire teachers and learners themselves.

The project is part of a wider Department for Children, Schools and Families (DCSF) programme to encourage more young people to continue studying science beyond the age of 16. It addresses in particular a commitment in the Government's Ten Year Science and Innovation Framework 2004–2014 to "review the Building Schools for the Future (BSF) exemplar designs for school labs to ensure they reflect the latest thinking on what is required to ensure effective, interactive teaching". The project is aimed at schools catering for the secondary age range (11–19 year olds).

Why Project Faraday?

A thorough understanding and enjoyment of science at school builds an invaluable foundation for later life. The new secondary science curriculum has been designed to inspire and challenge all learners and prepare them for the future. It engages learners at many levels, linking direct practical experience with scientific ideas. While investigative and practical science continue to be key parts of a student's experience, hypothesising and debating are playing an increasing role.

Science spaces need to reflect this stimulating curriculum, along with the latest developments in a student-centred approach to learning. Inspirational environments can excite students as soon as they pass through the school gates, starting a 'voyage of discovery' that continues throughout the whole school campus.

Project Faraday's main objective was to develop exemplar designs to inform and inspire all those involved in renewing or refurbishing their science facilities, particularly those in major capital programmes such as BSF and Academies. In particular, it set out to deliver:

- science facilities in six school renewals
- science facilities in six school refurbishments
- a series of suggested 'interactive experiences', some of which will be installed in the 12 school renewals and refurbishments

How it worked

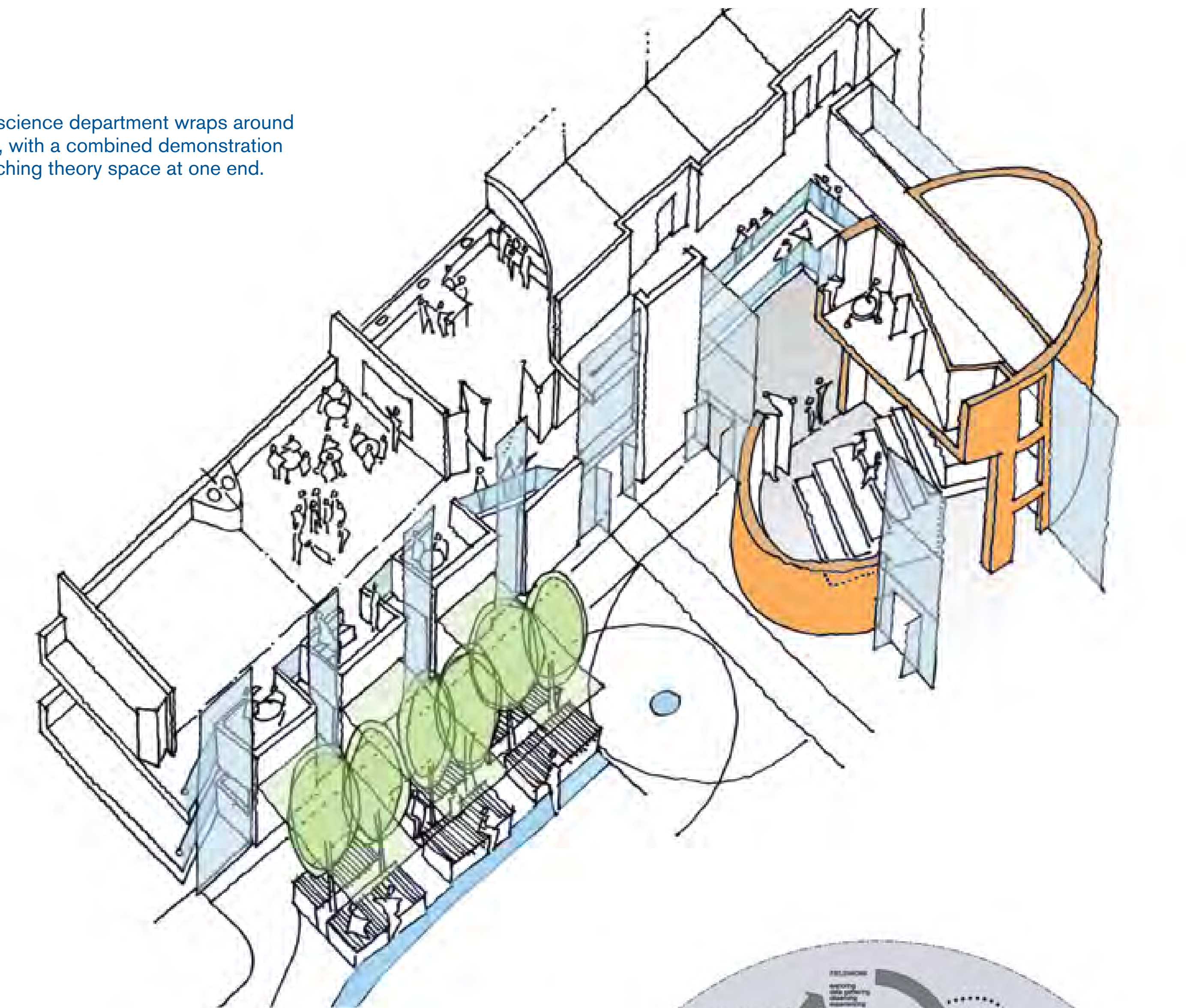
Three teams were involved in the project, each including designers, educationalists and construction specialists. Working in collaboration with science and education organisations, they made sure that all aspects of developing new science facilities were looked at in detail. Each team was partnered with two schools that were being re-built as part of the 'One School Pathfinder' programme (part of BSF). The teams were asked to work in partnership with teachers, students and technicians to develop innovative solutions by considering:

- the current and future requirements of their partner schools
- designs that would be practical and affordable for other schools to replicate
- the most effective learning and teaching settings and spaces, including practical work, for example alternative or multi-functional learning spaces
- the needs of individual learners, including those with special needs, and the wider community
- the whole school building and its grounds as places for learning and a learning and teaching resource
- how to fully exploit the latest technologies, including those from other disciplines (such as museums)

Six more schools were selected from regions across England, either to refurbish or extend their existing science facilities. The Faraday teams supported the school refurbishments' existing design teams and provided input from their work with the One School Pathfinders.

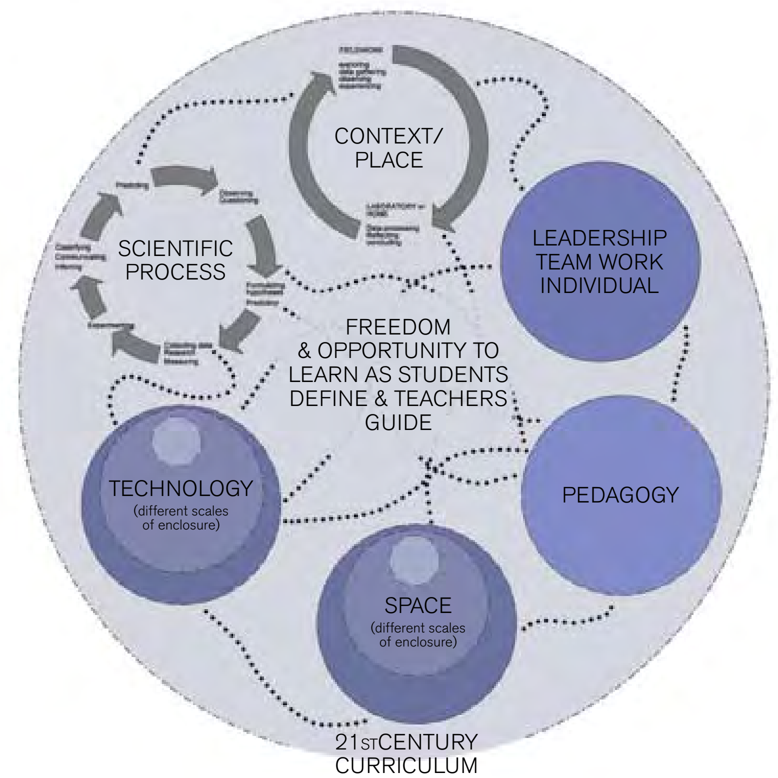
As part of Project Faraday, the teams and schools also had to develop 'interactive experiences'. These would combine tactile learning and/or information technology to create for the whole school practical learning activities which illustrate important science principles. The experiences were to be inspiring and memorable, to fire the imagination even of students who normally show little interest in science.

Bideford's science department wraps around a courtyard, with a combined demonstration theatre/teaching theory space at one end.



As demonstration projects, the 12 Faraday schools will be a valuable resource for their local regions and act as real-life exemplars nationally. The DCSF hopes that other schools and local authorities will visit these schools to see the spaces and interactive experiences in use – but it's equally important to understand the process that the Faraday schools went through to ensure each solution reflects the individual school's needs and budget. Although the process described in this book relates to science, it can be applied equally well to any curriculum area and ideally to the school as a whole, allowing flexibility across curriculum areas.

The first refurbishment demonstration project will be completed at the end of 2008 and the last school renewal in 2010.



Buildings are only part of the equation, and the Faraday teams also had to assess the wider context for their work.

About this book

This book shows exemplar designs for new and refurbished science facilities and interactive experiences, describing the process the teams and their partner schools went through to reach their final solutions. It will be valuable to all those involved in school capital programmes, including local authorities, school heads and governors, and building professionals.

Section 01: The process

Describes the process followed by the Faraday teams. It spells out a clear plan of action that other schools can follow, from initial research through to establishing a vision, developing a learning and teaching strategy, and finally designing spaces.

Section 02: Main themes

Presents the key themes emerging from the project. It summarises the design concepts and ways of working that are common to all the schools involved.

Section 03: Design proposals – renewals

Showcases the designs for the six renewal schools, showing floor plans, furniture layouts and artists' impressions of how the schools will look when they're complete.

Section 04: Design proposals – refurbishments

Presents designs for the six refurbishment schools, where existing buildings are being reconfigured.

Section 05: Interactive experiences

Describes some prototype interactive activities developed by Faraday teams to inspire learners and teachers. These will be trialled in the Faraday schools.

Section 06: Learning from overseas

Outlines what the Faraday teams drew from their study trips in the UK and abroad – and may help to show why some of the Faraday designs developed as they did. It may also give readers who haven't been able to study science teaching outside their region an insight into the advances in other parts of the UK and overseas.

Section 07: More information

Presents the key points from Project Faraday, a discussion of costs, checklists on practical design issues and contacts and references.

CD-ROM

The CD-ROM accompanying this book contains detailed information from each Faraday team: brochures and fly-throughs showing the school designs, literature reviews and visit reports. This information is also available on the DCSF Teachernet website.

Section 01

The process

Project Faraday set out to provide ideas and principles that could be adopted by other schools to create accommodation for the 21st century.

One of the core objectives of the project was understanding that the learning and teaching model should influence the eventual designs. All schools going through Project Faraday have different designs, that have resulted from decisions about how learning and teaching will work.

The process outlined on the next pages combines work from the three Project Faraday teams into a logical process. It can be used by schools and design teams to plan their own briefing process for innovative designs that support learning and teaching.

The process

The project adopted an integrated and collaborative approach. Similar approaches may be appropriate for other schools that want to improve science accommodation.

Introduction

This section summarises the various stages of the Faraday process, giving the goals of each stage (what it aimed to achieve), the tools that schools or designers can use to meet their goals, and the outputs that should come out of the stage.

There were many different tools and techniques used by the Faraday teams, and these are described in the Faraday teams' brochures, which are on the CD-ROM accompanying this book.

The diagram opposite shows that no component of the process should be dealt with in isolation. People engagement, including teachers and learners, is crucial throughout to ensure that each component is planned effectively. Although the Faraday process followed a logical order, with iteration between stages – Research > Vision > Strategy > Practice > Environment – all components must be re-examined when one of them changes, to ensure compatibility. In particular, learning and teaching environment should not be changed in isolation from the other components. If design changes, the other components must crucially be aligned with it.

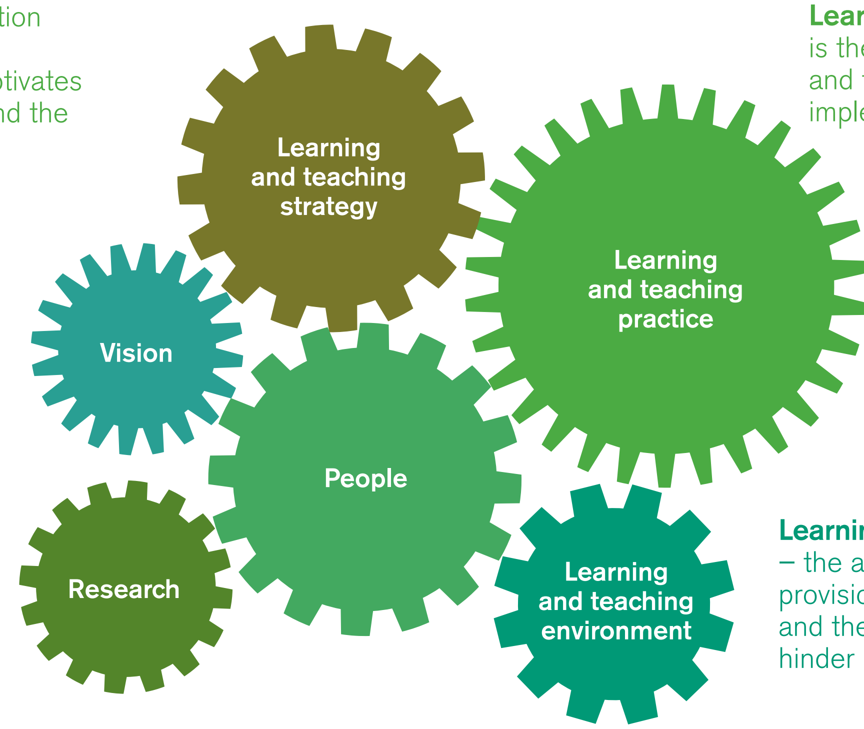
Although Project Faraday was focused on science accommodation, much of this can be adapted to other subjects, and the process would benefit from a whole-school approach (especially in the vision and strategy stages).

Schools that want to use this process should use it as a guide, structuring their own programmes around the different themes. Most of these activities could be done without professional advice, until the space design. But it's highly advisable to put together an integrated team – comprising educationalists, teachers, students and design specialists – as early as possible.

Learning and teaching strategy describes the planning, structures and systems that allow the implementation of the vision and drives the practice.

Vision sets the direction for the strategy to be implemented, and motivates people to think beyond the day to day.

Learning and teaching practice is the day-to-day activity of learning and teaching at the school. It's the implementation of the strategy.



Research provides an opportunity to learn from external sources. Literature reviews or visits to other schools can provide new ideas on learning strategies and design.

Learning and teaching environment – the arrangement of furniture, provision of services and technology and the level of enclosure – can help or hinder people's ability to teach or learn.

People are the lifeblood of the school. This cog combines the culture, attitude and skills of staff and learners that enable learning and teaching to happen. Continuing professional development (CPD) and change management are critical here.

People

At the heart of Project Faraday were people, the stakeholders who will be engaged with the science accommodation finally created, in particular:

- The learner – Project Faraday was focused on inspiring and encouraging science students. All Faraday teams spent a good deal of time meeting learners at their partner schools to understand how they wanted to learn.
- The science workforce, including teachers, technicians and support staff – the exemplar designs needed to reflect how staff would use the department day to day.

Research has shown that changes to an environment or learning activities are far more likely to be successful if staff are fully engaged with the change process and have training to help them adapt.[1]

Project Faraday had to be focused on learning and teaching practice, not just on design. It meant making sufficient time for engagement with the school and the local authority. It also meant considering staff training in preparation for the new building. DCSF is considering developing a CPD project in support of this.

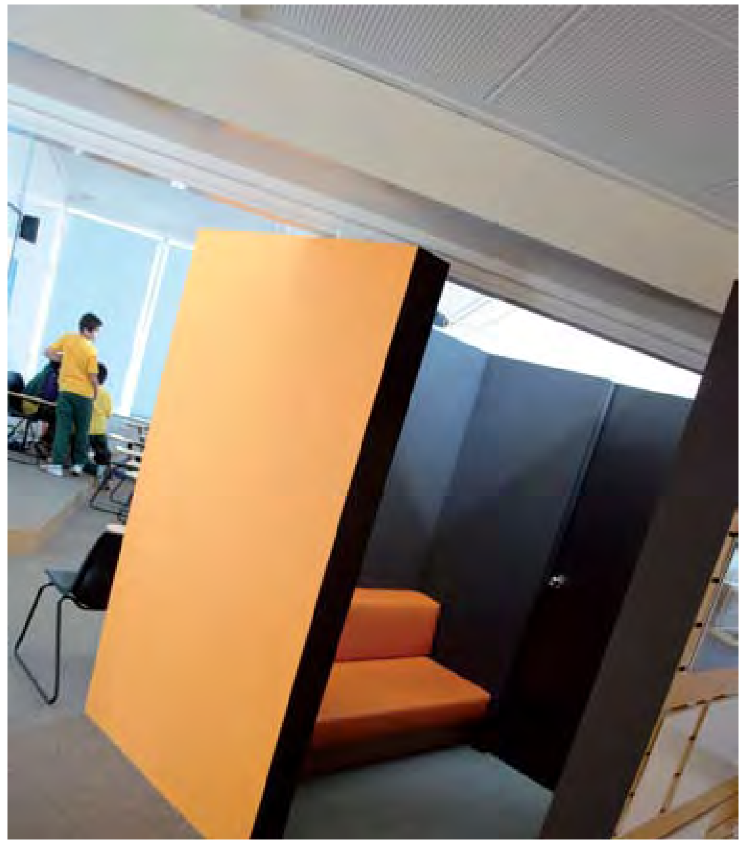
East Barnet School takes part in a Lego serious play workshop, explaining abstract ideas about learning science. "What I really want in science lessons," explained one learner, "is to feel like I'm really doing science, that I can get something wrong, think about why that was, and try something different."

[1] For example, research into open plan design found that: "teachers lack specific training for this environment", and there is "little evidence of teachers putting into practice the methodologies open plan was supposed to encourage" (CfBT, undated)

Research

Research need not be an arduous process: it's about equipping your team with the facts before starting to prepare for design, to build a base vocabulary and understanding that other work can build upon.

Reading this book is the beginning of the research process, but outlined here are two more steps that could be useful in building up the knowledge and expertise of your stakeholders.



With small spaces for personal reflection and larger spaces for group activity, Woorana Park Primary School in Australia enables children to make their choices about where they learn

	Literature review	Case studies/visits
Goals	To pull together existing thinking and research to inform the design of spaces for science, and establish a common understanding.	To learn from other schools or environments, and if possible to see, in practice, alternative implementations of learning and teaching.
Tools	The Faraday teams produced literature reviews covering policy, whole campus learning, curriculum, learning spaces, the role of technology, and learning styles. These are included on the CD-ROM accompanying this book.	One Faraday team developed a selection process for evaluating schools to see. All teams produced a visit report outlining the learning points from international visits.
Outputs	A common understanding from key stakeholders of common practice (outside of the Faraday schools).	An understanding of how other schools have implemented learning and teaching strategies, and what could be improved.
Comment	The literature review doesn't have to be repeated by schools or design teams wanting to design science spaces, but they may want to distil key points on both learning and design from the Faraday reviews.	It's valuable for key stakeholders to see new environments, but they need to look beyond the design to different ways of learning and teaching. It's better to visit somewhere with a very innovative strategy, not purely innovative design.

Vision

"A man without a vision is like a ship's commander without a destination."
(JC Penney Corporation, internal communication, 1918)

Vision can be an overused term, yet most research agrees that without a vision – a destination for the ship to reach – it's difficult to set in place the route (strategy).

In a change process like Project Faraday, vision is critical in making sure new ambitions are set and expectations are aligned. It's also vital that all stakeholders are involved in developing the vision – students, teachers, technicians, local authority officers and others.

Teams used a large variety of workshops towards this end, to 'deconstruct the current paradigm' or 'reconstruct a new paradigm'. Deconstructing was about enabling stakeholders to discard their current assumptions about learning and space, and how teaching currently takes place. Reconstructing focused on building new ideas and understanding how things could be done differently. A selection of these workshops is listed below, but there's more detail in the individual teams' design brochures.

Workshop examples

Happy/sad game

Students and teachers (separately) in groups draw and name two real students, one who is a happy science student and one who is unhappy in science lessons. Having created these characters, they then discuss what makes them happy or sad.

This is valuable to explore students' basic feelings towards science and what it is that triggers those feelings.

Forced connections

Groups of staff explore how difficult elements of science can be taught in unusual ways and spaces. Small groups collate a list of:

- areas of the curriculum perceived to be difficult to 'teach'
- different artistic media
- existing locations within the school

By selecting random numbers, connections are forced between items in each list and ideas generated for solving problems creatively. For example: how could you teach cell division in the canteen using printmaking? Or how could you teach enzyme excretion in the gym using animation?

	Deconstructing current paradigms	Reconstructing new paradigms/ vision statement
Goals	For stakeholders to begin imagining the possible options and remove constraints or barriers.	To build a new understanding of the possibilities, and state a vision that the school can unite behind and work towards.
Tools	What if?* Happy/sad Forced connections Radical departure Lego serious play Learning impact map Shared belief *See the Faraday team brochures on the CD-ROM for more details on these tools.	Briefing cards* Kaleidoscope Brainstorming Day in the life
Outputs	A sense among the stakeholders that there is the opportunity to do things differently, should they choose to.	A vision statement, ideally: Imaginable – conveys a picture of what the future will look like Desirable – appeals to the long-term interests of stakeholders Focused – is clear enough to provide guidance Communicable – can be explained in under 5 mins
Comment	It can be very difficult to step out of the day-to-day reality of the stakeholders' current situation when you're designing new spaces. This strand is aimed at allowing that to happen to encourage innovative thinking from the start.	This should act as a reference point for the rest of the project, to guide you through decisions about strategy and design. It may continue to evolve, but shouldn't change direction, so it needs to be something everyone is comfortable with.

Learning and teaching strategy

It's as important to state and work towards the learning and teaching strategy as it is the vision. It's the link between the vision and the day-to-day practice of learning and teaching and includes decisions about all the elements that make the day-to-day practice function, including, for example:

- curriculum organisation
- timetable structure
- size of learner groupings
- whether teaching is a solo, paired or team task
- how students progress through the school
- the role of the teacher

These are all elements that, among others, affect the eventual design, because together they will define how the space will be used. It's important not to make generalisations, like "learning will be personalised", but instead to express what the implications of personalisation would be on these factors.

It's also crucial to consider that changes to some factors will affect the whole-school organisation, such as timetable (for example, moving from a six session day to a two session day to support a project-based learning implementation).

Teachers and technical staff need to discuss how learning will be organised before thinking about design.

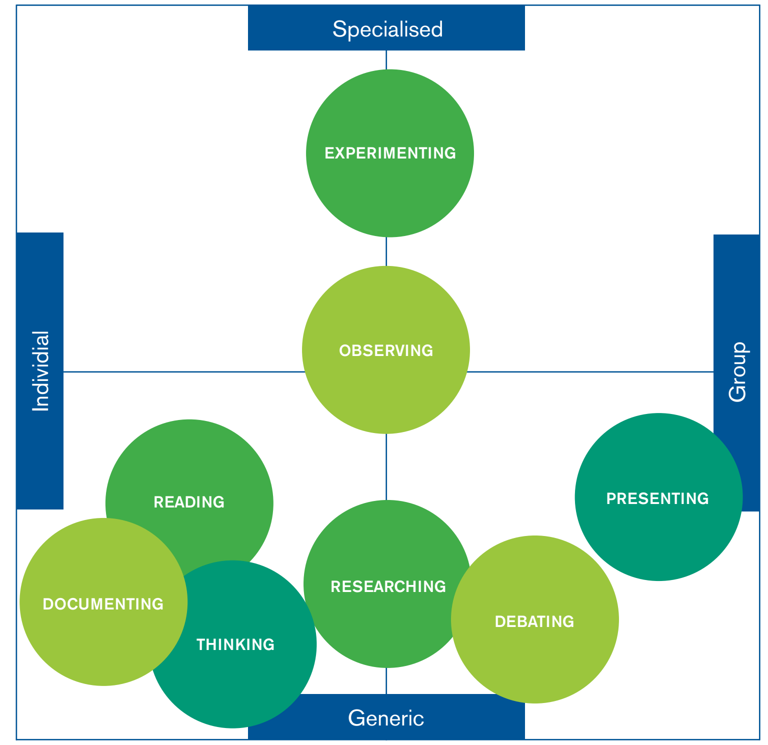
	Organisational model	Curriculum model
Goals	To define the strategic implications of the vision on the basic model of the school, for elements such as curriculum organisation and timetable.	To explore approaches to the science curriculum, including a range of models and scenarios, to establish preferred ways of working.
Tools	The National College for School Leadership has a tool for diagnosing these decisions, part of the Changing Boundaries project.	One of the Faraday teams developed a future scenario workshop where participants ranked various curriculum models and identified levels of transformation they were comfortable with, e.g. student-managed learning, with a selection of sessions to attend.
Outputs	A common, whole-school consensus on the organisational model underpinning learning and teaching, including any changes that need to be made.	A consensus as to how the science curriculum should be approached.
Comment	This is the step that makes a difference in how spaces are organised and what kind of spaces are needed, overall. It's also the most important aspect to consider in terms of change management if the new strategy is different from the old.	It's very important that all strategies are heavily grounded in the curriculum offering taking place.

Learning and teaching practice

Learning and teaching practice is the core of the whole learning experience. It's the day-to-day activity of learning and teaching, so the eventual design must support it.

At the research stage, the Faraday teams found that their partner schools' existing science accommodation didn't work for many learning and teaching approaches that were meant to be a core part of the science curriculum. 'Debating' was one example, with staff in one teaching lab, for instance, unable to configure the furniture so that learners could interact well. 'Small group work' was another, where students found it hard to work together in a traditional lab without distractions from other groups. 'Individual study' is similarly very difficult to arrange in traditional science accommodation.

All these findings were fed into the new designs, which were developed from first principles to ensure they supported all the activities taking place within the everyday learning and teaching at the schools.



It's often useful to think about different learning activities in terms of how specialised or generic they are, and how much they depend on group or individual work.

	Learning and teaching practise	Pedagogies or activities
Goals	To define which basic day to day aspects of practise need to change to meet the vision and strategy.	To identify either the core pedagogies that science learning consists of, or activities (such as individual work, group work), or both.
Tools	One team used 'transformation ladders' to define the change, expressing at the top what you want to change, in the middle how you will change it, and at the bottom what it will look like when it has changed.	One team defined eight key pedagogies for science learning: experimenting, researching, debating, observing, listening, documenting, reading and presenting. These can be used as a basis for discussion, or alternatives could be created.
Outputs	A series of ladders that express scenarios to change.	A basic unit to structure the design or settings around.
Comment	For example: Top (what): teachers teaching from the front Middle (how): develop facilitation skills Bottom (final): teacher using a broad range of pedagogies in a lab.	This is an important step to build designs around learning activities, rather than assumptions based on how teaching currently takes place.

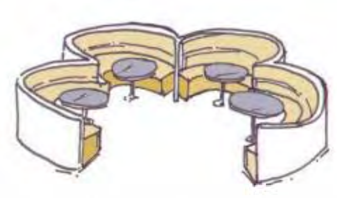
Learning and teaching environment

The core aim of Project Faraday was to design exemplar types of science spaces to harmonise with changes in the vision, strategy and learning and teaching practice. The teams explored with their partner schools the characteristics of the science learning environment including furniture groupings, services provision, level of enclosure and scale. This led to a range of spaces that are more flexible and better suited to personalised learning than traditional science facilities with labs and labs alone. Additional settings proposed in Project Faraday (sometimes as a space in themselves and sometimes one of many possible settings within a space) include areas specifically designed for:

- small group work (e.g. informal seating around tables, or practical areas for small groups)
- individual study (e.g. 'touchdown' ICT stations)
- large group presentations and discussion (serviced to allow for practical demonstrations)

These new arrangements are achievable within the normal DCSF floor area guidelines.

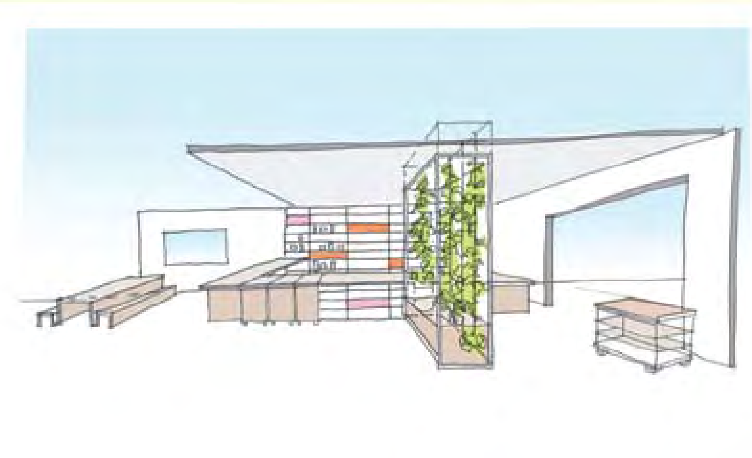
Net area workshop: card may be used to represent guideline areas for 'net' (or usable) area in the school.

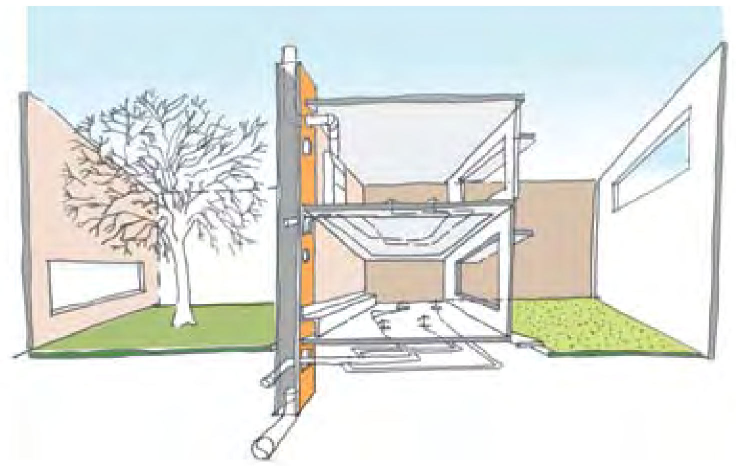


Group work/demo

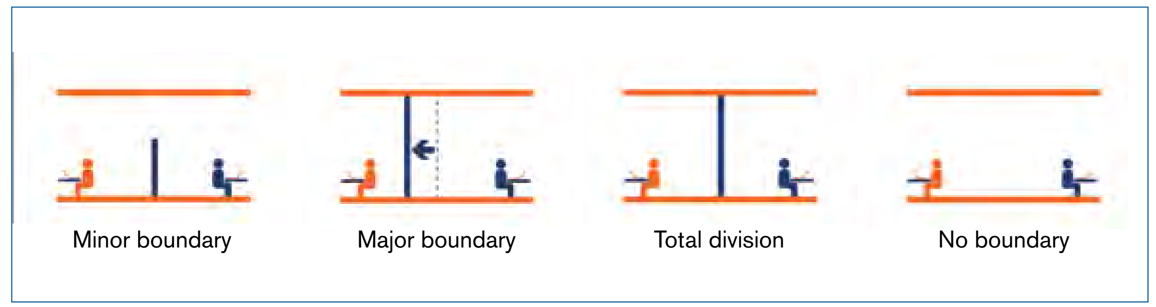
Group experiment

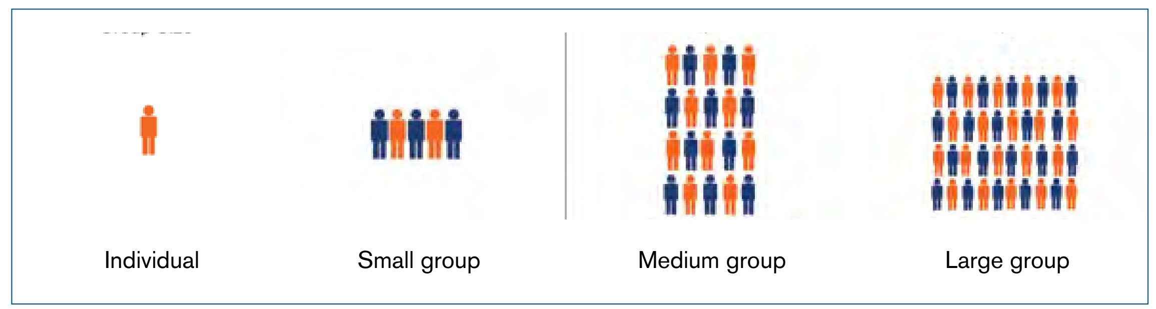
	Net area analysis	Choosing spatial requirements and settings	Space planning
Goals	To consider the overall area allocated for science, taking account of the available budget.	To choose the basic spatial needs of learning and teaching approaches, exploring factors such as boundary control and group size, plus choosing settings that best support learning or teaching.	To plan settings within a space, then explore the concept design and test it against the vision, strategy and learning and teaching practice.
Tools	One team ran a workshop where groups of stakeholders were provided with card, representing the areas suggested in BB98 guidelines. This allowed them to divide area between formal learning space such as labs, and other types of learning settings.	One team developed a 'taxonomy' of decisions (e.g. boundary, learner interaction, and group size). Another team explored scales of science (different opportunities and group sizes). All teams developed a range of settings that could populate science spaces.	This requires expertise from architects or space planners.
Outputs	A model of the preferred departmental organisation within the confines of the total net area. This should be looked at from a whole-school perspective to allow flexibility between curriculum areas.	Some basic principles that will inform the space planning, and decisions on the most appropriate types of settings to support the learning activities defined in the previous stage.	An initial design.
Comment	It's crucial for stakeholders to understand that space can be reallocated within the net area allowance, which is based on the number of teaching spaces needed for the curriculum.	This is an opportunity to explore innovation within space by stripping away assumptions (e.g. that a science space must have four solid walls and be designed for a group size of 30 students), and to select settings that enhance learning.	This is the first step that links with the architectural shell of the building, and it may take many iterations to accurately reflect how the workforce want to manage the science accommodation.





One of the Faraday Teams explored the idea of a family of science spaces. Above left is a lightly serviced lab. Above right is a prep room designed like a pharmacy, and left is a fully-serviced lab.





Faraday teams unpacked the basic characteristics of science settings, like boundaries and group size, to inform their decisions.

Section 02

Main themes

The Faraday teams used a new process leading up to design work, and came up with a series of innovative design ideas.

While each Faraday school was different, and each of the Faraday teams had slightly different approaches, there were clear, consistent messages about the direction of design solutions and the ways of learning and teaching.

This section describes the key concepts and strategies that emerged from Project Faraday. These have been grouped into five themes using common threads that joined the concepts and strategies together.

Each theme is illustrated by examples from the case study schools, which are described in more detail in Section 03 and 04.

Underlying all of the themes is the idea that science facilities must inspire students. This helps students to enjoy science, remember what they learn, and reach their full potential.

Main theme 01

New settings for science

The Faraday designs provide a rich and varied range of settings for science which reflect the schools' inspirational learning models.

The Faraday teams and their partner schools developed settings that would both meet the schools' learning and teaching needs, and inspire teachers and learners. The specific arrangements of space, furniture, fittings and equipment were developed from analysis of learning activities (described in the process section).

The science activities that emerged from the Faraday workshops ranged from 90 people watching a presentation, to one person sitting quietly to consider how to solve a scientific problem. The teams found that, although some practical activities may call for a fully serviced enclosed space (such as a laboratory), there are many science learning activities that can benefit from very different kinds of spaces. By liberating space that may have been used to provide more fully serviced laboratories, other configurations are possible.

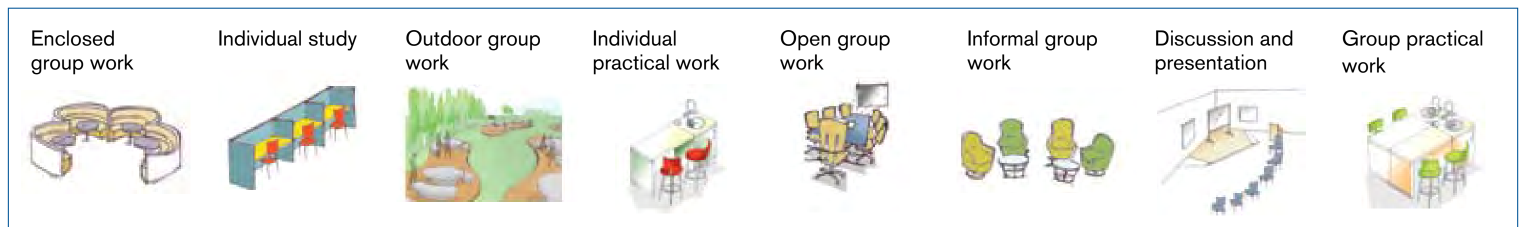
All of the Faraday teams explored differences in scale, inspired by the fact that science itself encompasses every scale from sub-atomic to outer space. They examined the scale of learning groups (from an individual to large gatherings) to the scale of particular areas (from intimate 'thinking pods' to the wide open space of the school grounds).

Each exemplar design has a different range of spaces, reflecting the particular learning model of the school. Typically they include:

- fully serviced practical spaces for a group of 20-30 dedicated to practical work
- lightly serviced spaces for a group of 20-30 involved in a range of activities
- places for large groups (e.g. 100) to gather for presentations or demonstrations
- informal places for small groups or individuals to think and discuss
- open air 'amphitheatres'
- highly interactive areas full of technology/theatrical settings (e.g. immersive)
- outside practical spaces

As these new configurations were developed, a new language or terminology emerged which reflected their function: super labs, studios, theatres, zen zones. Describing settings in this way can help break down preconceptions, making it easier for schools to look beyond their recent experience.

Inspirational learning and teaching can be sparked by a versatile environment empowering teachers and students to use space in different ways.

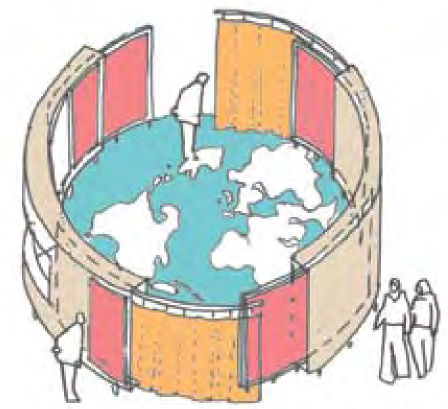


Settings like these, explored by one of the Faraday teams, can be part of a space or (if enclosed) a whole space.

East Barnet School will have this multi-purpose space, which can be re-organised to accommodate large group presentations.

Cramlington High School will have a glass bio-dome to protect students from the elements when they study plants.

Joseph Rowntree School will have this informal breakout space for reflection and discussion.



Rednock School will have this immersive setting full of ICT for role-play, real life experience and debate.

Three kinds of versatility were explored by the Faraday teams:

- **Agile** – immediate, giving staff and students control over their environment, for example by providing power and data services wherever they may be needed
- **Flexible** – short term, allowing areas to be varied from day to day to suit activities, perhaps by sliding back partitions between two spaces
- **Adaptable** – long term, where building construction and servicing don't restrict changes in response to new learning methods or pupil numbers. The Faraday teams worked very closely with their partner schools to ensure their design solutions meet their current needs and are adaptable enough for the schools' evolving learning models.

All the Faraday designs made highly effective use of the available area – both inside and out – providing a fluid environment that allows different configurations to be combined and spaces opened up. Areas between specific spaces can be seen as 'connective tissue', offering numerous opportunities for impromptu activities.

Faraday has produced inspirational and innovative configurations – but the teams still had to ensure they could accommodate a full range of science activities in safety and comfort. Some of the pragmatic considerations that had to be addressed were safe practical working, adequate acoustic environment in open plan areas, and accessibility for all students, including those with a disability.

The project teams also thought through ongoing maintenance implications of their decisions, ensuring that buildings, grounds and technologies are simple to maintain in the long term.

Inclusion

All the Faraday teams designed with inclusion in mind. For example, DEGW proposed loose tables in all their spaces. Furniture can be moved to support different activity requirements and to ensure clear circulation widths for wheelchair access. DEGW also specified height-adjustable laboratory tables throughout.

Main theme 02

Managing transition and change

Science as a way of understanding the world continues to evolve, and science education responds to this evolution.

Buildings and other facilities need to move forward in step with science education. Changes like those emerging from Project Faraday have to be managed in an integrated way, taking account of processes, people and places.

- Processes – consider current and future learning activities to get the most from new science facilities.
- People – involve staff and students fully in any proposed changes and support them during the transition and beyond.
- Places – design facilities to reinforce the school's current and future learning model (see Process, p10) and be flexible enough to respond to future changes.

All the schools involved in Project Faraday were exploring varying degrees of change in their ways of learning and teaching. They worked with their Faraday teams to create designs that would meet today's learning and teaching needs while having the flexibility and adaptability to meet the science departments' long-term aspirations.[2] They also had to consider the possibility of the new models being unsuccessful after a period of time and the school moving back to more traditional teaching methods.

All three Faraday teams and their schools were aware that the process of change can't happen overnight – and can only be successfully realised if all staff and students are supported in this period of transition. They typically planned for a continuing process of change, which starts before work begins on site (with teachers trialling a new learning model), carries on when the facilities are complete, and is sustained for several years afterwards.

Well supported gradual change is more likely to be successful, creating a positive environment that new staff and students can adapt to equally well.

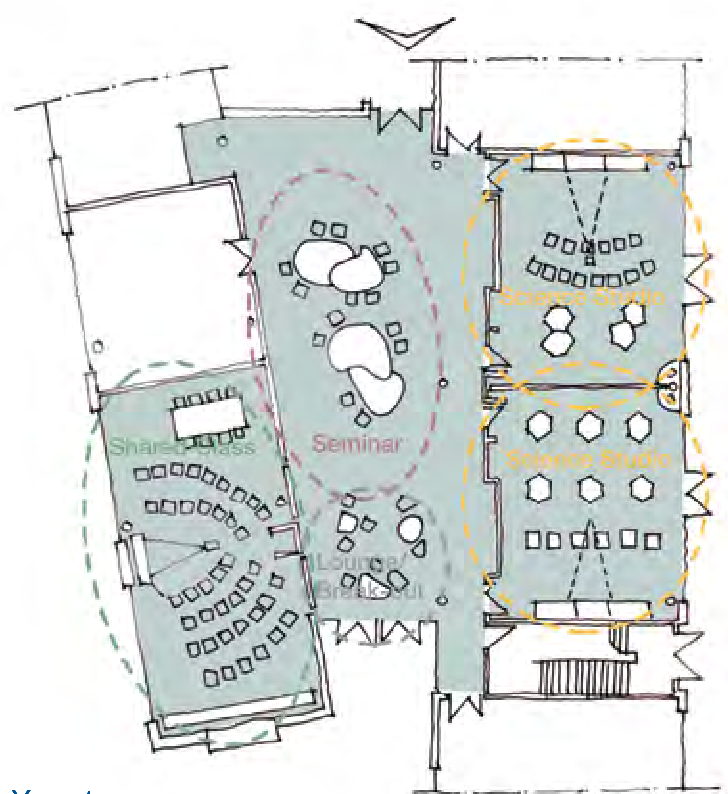
All the Faraday exemplar designs comprise a varied range of spaces that complement each other. They work best when they are seen not as individually owned spaces but as a whole, as 'our space', where staff have shared access and shared responsibility for it. It may mean a change of approach but it can be empowering to everyone, giving staff and students the opportunity to shape the whole science department, and making it easier for staff to share their teaching approaches.

The Faraday schools discussed practical questions like 'Who will maintain shared ownership areas?' and 'Who will move furniture around in flexible spaces?' It's important to agree these matters to get full benefit from shared ownership. A well planned and positive approach to change will make it easier for new staff to adapt to the new way of working.

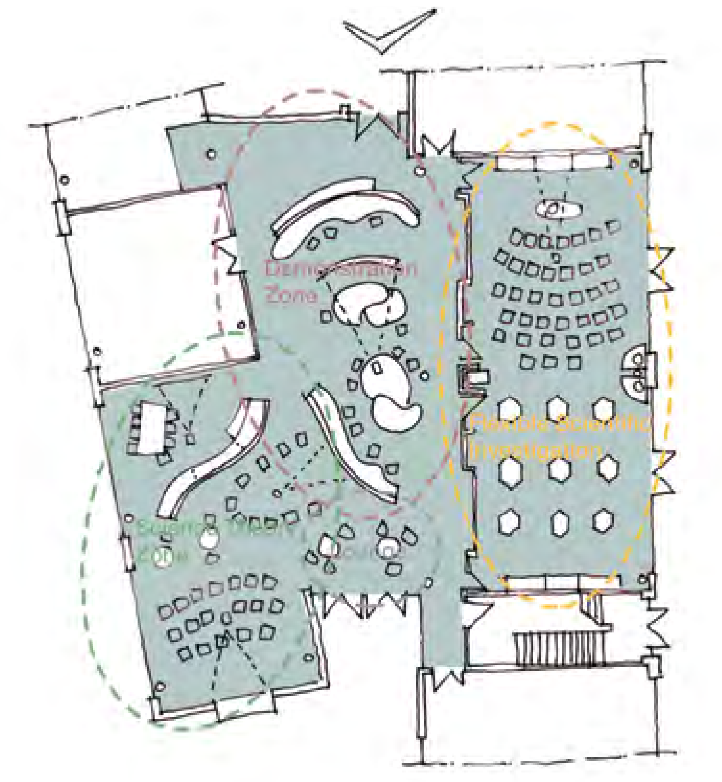
Thinking long term, they also tried to future-proof facilities by making them easy to adapt. One of the considerations was ensuring the school can still function even when refurbishment work is underway.

The Faraday schools planned how their science learning will evlove in future, and built this into their designs.

[2] This is one of the key messages to come out of the government report '2020 Vision' about personalisation in schools.



Year 1



Year 3

Year 7

How facilities can evolve over time

These 'time lapse' plans show how the science accommodation at Joseph Rowntree School will change as the school's learning and teaching strategies evolve. In the first year (top left), patterns of use are familiar to most teachers and students. The studios are mostly used separately, with the occasional opening of a sliding wall for shared teaching on science theory. In the third year (top right), there's greater transformation, with studios open for most of the time and partitions between the classrooms and atrium removed for a large, flexible theory space. In the seventh year, the whole floor becomes an open plan 'learning common', with activities clustered around settings within the space, separated from a central demo area by moveable furniture with ICT docking and areas for writing up.

"If you go round the average science department you see the physical compartmentalisation of the curriculum by subject. In future we will have to take risks – but this means more freedom".

Teacher, Abraham Guest High School

Main theme 03

Getting the most from technology

Technology in science can make it easier for teachers and learners to achieve what they want to do – by releasing their creativity.

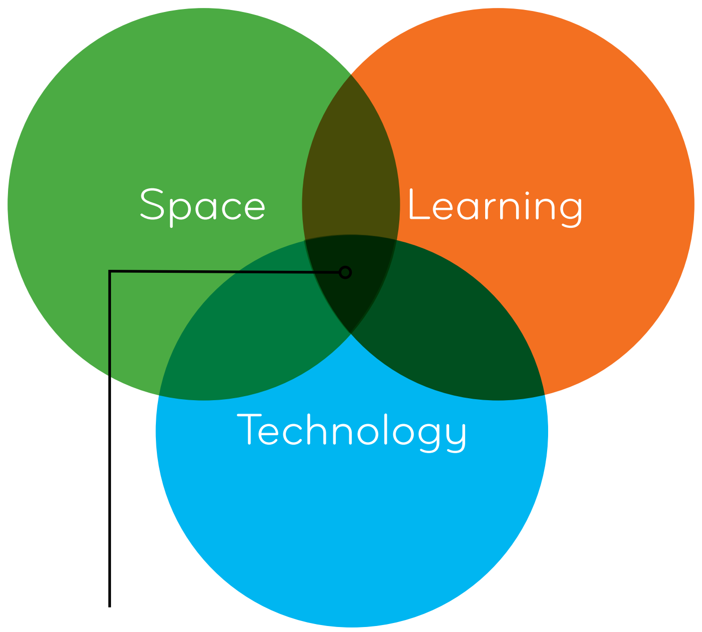
The Faraday teams and schools started from the position that information and communications technology (ICT) is a tool, not a topic. In some cases, they used it to do things that simply couldn't be done without it. They found that ICT can make sophisticated science engagement easier and draw in students who might not otherwise show much interest in science.

The first key point to emerge was that, when you're planning ICT and how facilities will accommodate it, it's better to start by thinking about what you want it to do, rather than rushing into decisions about the technologies.

The second key point was that the Faraday schools integrated space and technology but avoided 'lock-in', so they don't get stuck with outdated technology or inappropriate accommodation simply because it's hard to replace. Integrated project teams (where the architect works with mechanical and electrical engineers, ICT specialists and furniture designers) go a long way towards addressing these issues, and such integration nearly always makes school design more robust.

These schools also recognised that technology has a different lifecycle from a building – replacement times for ICT are often no more than five years. They worked hard to get the infrastructure right, making it versatile and 'layered' so that different parts of the power, communications, computers and peripherals network can be replaced without affecting other parts of the network.

The schools also had an eye on financial and environmental sustainability, considering the long-term cost and energy implications of their ICT decisions.



Focus for design – where space supports learning and is enhanced by technology

Joseph Rowntree

At Joseph Rowntree school there was a major shift in the way ICT was conceived and applied over the course of Project Faraday. The new philosophy aimed to make it ubiquitous and available throughout the school, including in informal learning areas, where it can support students' creativity and independent learning.

Large screens like this can help engange students, but schools should also think about replacement costs.

Digital posters

Digital posters combine real-time live data connection with a traditional poster display to bring home the importance of science in the modern world.

Project Faraday showed that ICT has an important role to play in supporting personalised learning. It can allow students to work through material at their own pace, with different levels of support according to their own preferences. Inevitably, different students will embrace technology to greater or lesser extents and in different ways. The planning for these facilities accepted this and recognised that some learners will use ICT much more intensively than others.

Some of the schools in the project see tremendous opportunities in personal technologies (like games consoles, MP3 players, mobile phones). These can make learning possible anywhere, including outside and beyond the school, and may help make science 'fashionable' among students. There can be risks associated with students using their own equipment – such as the incompatibility between home and school devices, software and connections.

Sharing inspirational teaching

Some Faraday schools are looking at technology to make the best teachers accessible to students anywhere, at any time. This can take pressure off the timetable and can bring in experts on particular topics from other schools. The Faraday designs facilitate this by providing, for example, places where students can listen to podcasts or take part in video conferences.

One of the most important ways technology can enhance student engagement with science is by providing direct links to real-time data and the world beyond the lab, transforming abstract and dry topics into concrete experiences. The Faraday teams looked for ways to capitalise on these opportunities.

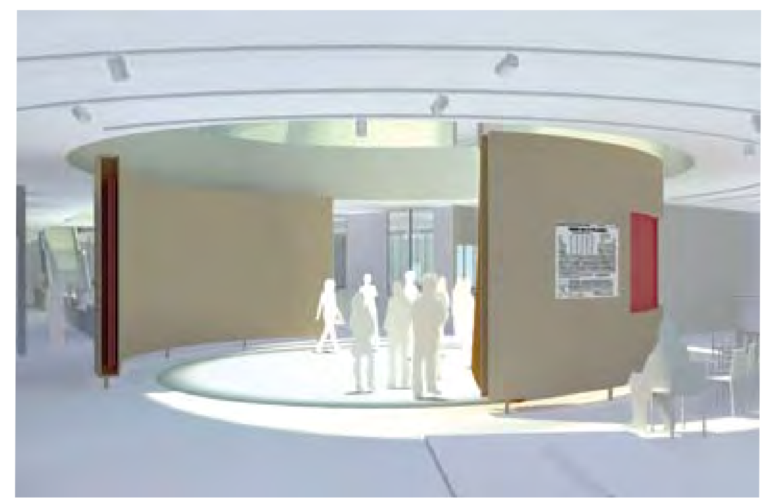
Harnessing innovation

Three major advances in ICT could offer real potential for science learning in schools, and all have been adopted by some of the Faraday schools:

- Haptic devices – give students a sense of touch when they interact with virtual objects, often in three dimensions. The devices may consist of a stylus attached to a moveable arm, or a glove with instruments built into it, or a mouse that works in three dimensions.
- Immersive technologies – allow students to immerse themselves in virtual environments, often by using novel screens or goggles. These can help make computer-generated situations real to students, and therefore more memorable and engaging. For example, allowing students to fly a virtual plane they've designed themselves, to experience the aerodynamic effects of different wing profiles.
- Mediascapes – sounds, images and video placed around the students. Students use a handheld computer and headphones to see and hear the stimuli, which can be triggered by pointing to locations on a map, or linked to a global positioning system. The mediascapes can enhance students' experience of exploring their school or neighbourhood.

Rednock School

Rednock School will have an incident centre at the heart of its science facilities. Budget permitting, this will be fitted out like a stage set for role plays, with layer upon layer of flexible enclosures and technologies to establish a framework for the school to use in different ways. It will have screens, theatrical lighting and virtual reality facilities, including three-dimensional projection so that the architecture is fully integrated with the technology and the students can immerse themselves completely in their science tasks.



Main theme 04

Science across the whole campus

Project Faraday found that school buildings and grounds can be a vast, real-life resource for science learning.

The whole campus can offer opportunities for students to put their classroom and lab-based learning into context. It can also help to inspire students and underscore the importance of science. The Faraday teams were briefed to look at how grounds and buildings could contribute to learning and teaching, and their designs use the campus in two main ways:

- by exploiting what will be on the sites – building structures, measuring energy use in buildings, natural features
- by creating additional facilities – landscaping the grounds and embellishing buildings to provide learning opportunities

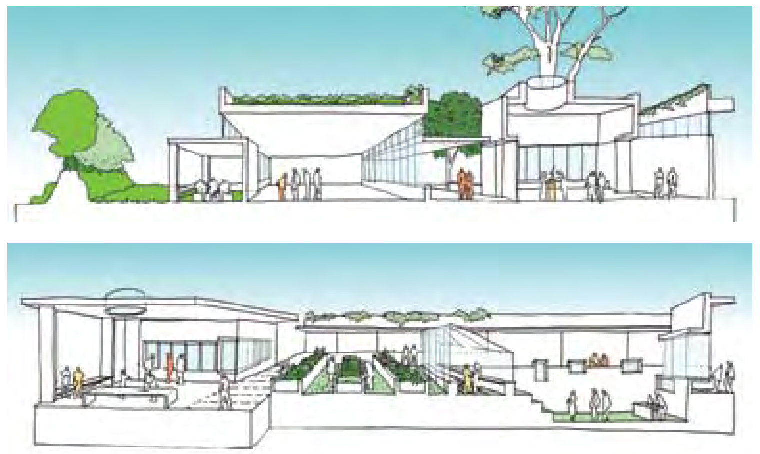
Every school in the project had different, often unique, opportunities for enhancing engagement with science. It was often possible to use school grounds to provide access to a living, changing environment. Some of the most challenging aspects of a site offered the greatest potential.

Where possible, the Faraday schools looked for ways to promote wildlife on their grounds, by creating new habitats, or preserving existing ones. Coupled to outdoor teaching facilities, this will bring science alive to students.

Project Faraday showed that even neglected areas of a school's ground can be transformed into new environments that are both beautiful and help to increase biodiversity.

All the Faraday schools wanted to improve the potential for using the outdoors as part of a family of learning settings (See 'New settings for science', p20.) The designs addressed this, blurring the boundaries between indoor and outdoor spaces.

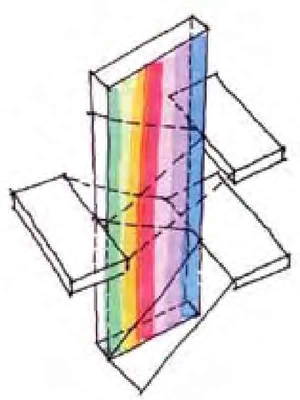
Estover Community College



Estover Community College will have a green roof and a courtyard enclosed by the science spaces, seen as an extension of the internal facilities. It's a living resource for science, with planting areas for students and space for technicians to grow experimental crops.

Rednock School

Rednock School will have a large prismatic partition built into a stair balustrade, which will split light entering through a rooflight and be invaluable for teaching how different wavelengths of light are refracted and reflected in a prism.



A lot of the schools also considered ICT facilities for their outdoor 'classrooms' – in particular power for laptop computers and/or wireless communication links so that teachers and students can access the internet outside.

Many proposals focused on how to make use of a building's structure and fabric as learning resources, making abstract topics concrete. Some schools integrated energy monitoring into their facilities – useful in teaching about the environment, levels of CO_2 and climate change – while others incorporated rainwater harvesting with displays showing how much water is collected.

Many of the Faraday designs support 'kinaesthetic' learning, where students can move around and use their bodies to improve their understanding. For example, one school is using a neoprene mat that students can walk on, linked to a PC so that students can mimic the movement of molecules in gases, liquids and solids. (See p104.) Others are using 'drop zones', where students allow objects to fall several storeys under experimental conditions, using sensors and cameras.

The designers in Project Faraday also used other areas of the school for science learning, building in chance encounters with science artifacts, for example – a fossilised dinosaur, a stairwell designed to look like a rainforest canopy, or slow-run experiments like a drop of tar falling.

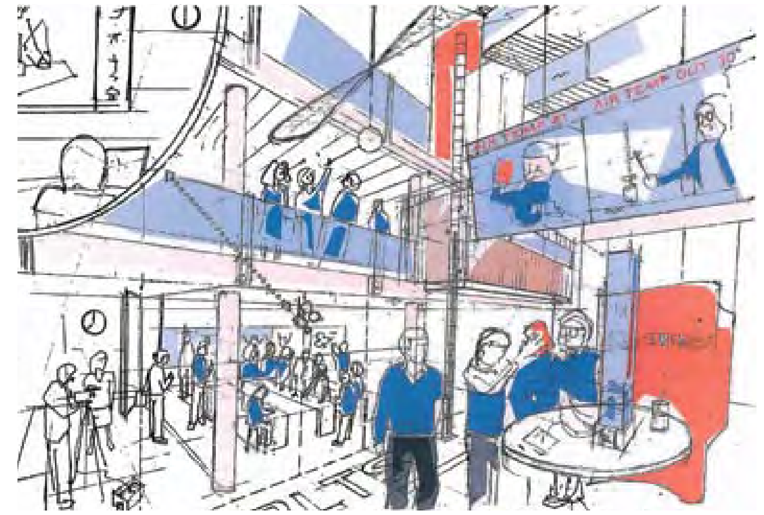
The cross-curricular nature of science will also be capitalised upon in many Faraday designs – especially by using ICT and displays – combining science with design technology or geography for example. But getting the most from these opportunities relies on carefully considering this at the earliest opportunity.

East Barnet

East Barnet will have a Knowledge Garden (below), a living recycling system which allows students to explore the natural world, ecology and biodiversity immediately and continuously. It comprises a constructed wetland which recycles water naturally, without harmful industrial reprocessing.

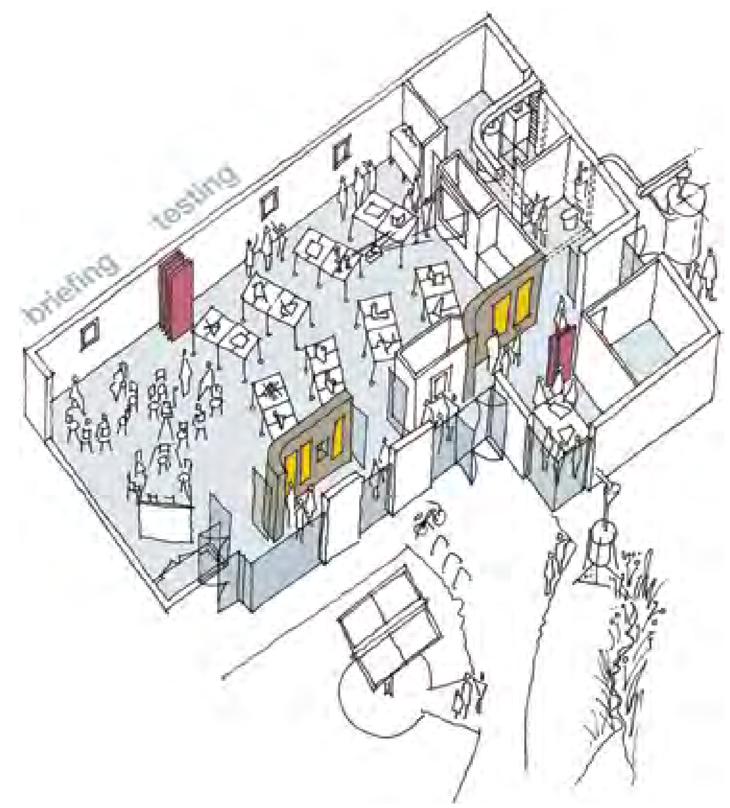
Bideford College

Bideford College (below) has a series of low energy design features and a sustainable drainage system. Displays in the central area show how the building uses energy.



Mary Webb School

The eco-lab at Mary Webb School will be used by students and the wider community to learn about environmental issues. It's been designed to reduce CO_2 emissions and will be equipped with cutting edge technology that will allow students to capture and analyse data e.g. energy use.



Main theme 05

Beyond the school gates

The Faraday Schools are all building bridges with other organisations, garnering unrivalled learning opportunities for schools and partners alike.

School leadership teams recognise the value of working in partnership with other schools. A focus on collaboration enables a school to build additional capacity and capability to maximise the learning opportunities they provide for young people. All the schools in this project collaborate with other schools and various other partners, including local businesses and museums.

Recognising that science accommodation designed today will outlast most current school users, Faraday schools are adopting a custodial approach to their designs, considering not only the role they play in the immediate community but also beyond – and are striving towards science facilities that create a legacy of scientific excellence in education for all. Well designed science facilities can help support the creation of such networks and partnerships.

Faraday schools already use video conferencing facilities to link up with other organisations, including schools, some of them overseas. Some are actively considering starting peer reviews (similar to those widely used in science research), whereby one school reviews the science work of students in another.

Workshops run by the Faraday teams found that students crave direct connections with the real world and the world of work. They showed that students become more involved and motivated in science topics if they use real data – and preferably live data. This makes lessons both meaningful and immediate. An example is using live data from NASA's website to enliven the abstract topic of space science.

Faraday schools also draw on the real world by bringing in outside scientists as new 'learning agents', to give presentations and demonstrations to groups of students. In some cases, the schools plan to use ICT to record presentations so that there's flexibility about when and where they are seen – and to share them with other schools.

Similarly, the schools use some of the highly specialised facilities of their partners, such as photographic developing facilities.

All the Faraday schools are working to involve the local community in their science teaching, encouraging feeder schools and local people into the school to learn more about science. The Faraday designs are flexible enough to accommodate events such as family science days or presentations from external scientists, which can be organised more easily in spaces suitable for large groups equipped for practical demonstrations.

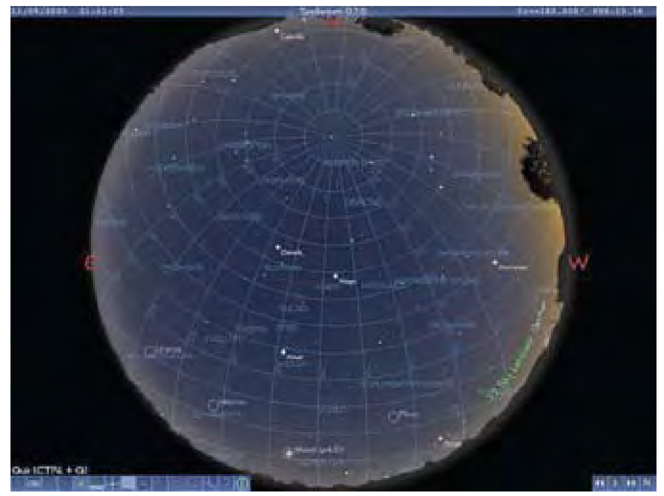
Bideford College

Bideford College has a Key Stage 2-3 coordinator (a teacher) and a 'lab on loan', which goes out to its feeder primary schools.

These arrangements help to build an appetite for science at an early age, and help to cement good links between the primary and secondary schools.

East Barnet

The school's demonstration area provides a flexible space, with moveable furniture and a serviced demonstration bench that can make it easier to bring in outside speakers and/or the local community.



Priory LSST

The school's planetarium (above) will display the changing night sky. This space can become a cinema and will be available to the wider community outside the school – not just for science, but for artists and musicians.

50 feeder primary schools will be able to use the planetarium and extended hours are planned. It will also be used to host the annual Science Day for local primary schools.

Estover Community College

Estover works closely with the Tamar Science Park and can use its specialist facilities. There are also many opportunities for student placements in companies on the science park, which helps to reinforce the message that science is a route into an exciting, dynamic career.

Bideford College also plans to invite professional scientists as guest scientists to present to students.

The DCSF 'Children's Plan: Building brighter futures'

This report, published in December 2007, emphasises the importance of agencies, including the voluntary sector, working together. Many local authorities are already bringing other services onto school sites and BSF is promoting such co-location. Having a health centre or GP's surgery, for example, on a school site is a perfect opportunity for students to link science learning with a real application of science.

Rednock School

Rednock School runs regular family science days, where students' parents are invited in to learn more about science. The school is building on this model through Project Faraday to act as a science hub in the region.

Design proposals:

renewals

Section 03 describes the six design proposals that emerged from the process described in Section 01. These are not necessarily the final designs, because the work continued to evolve after this book was written.

This section describes six school 'renewals' – where new science facilities will be created as part of a whole school rebuilding project. When Project Faraday began, these schools were at different stages in developing their ideas, so the input from Faraday teams varied from project to project. In some cases, for example, the outline design had already been agreed when the Faraday teams made their contribution.

All of the project teams aimed to balance innovation and practicality. They all worked within the budgets schools had available, although as prototypes intended to test new ideas they cost a little more than traditional science accommodation.

The teams took account of DCSF and other school design guidance and all designs are based on the DCSF's area recommendations for the equivalent number of $90m^2$ labs and associated prep space. They always ensured that they were designing for inclusion, so all students can benefit from the improvements.

Alongside each of the design proposals is a cost commentary and comments from CLEAPSS. Further information about costs and practical aspects of designing science facilities is included in 'More information', p114.

Faraday teams worked closely with the schools' own architects, but they were never intended to replace them. The designs shown here reflect this collaboration.

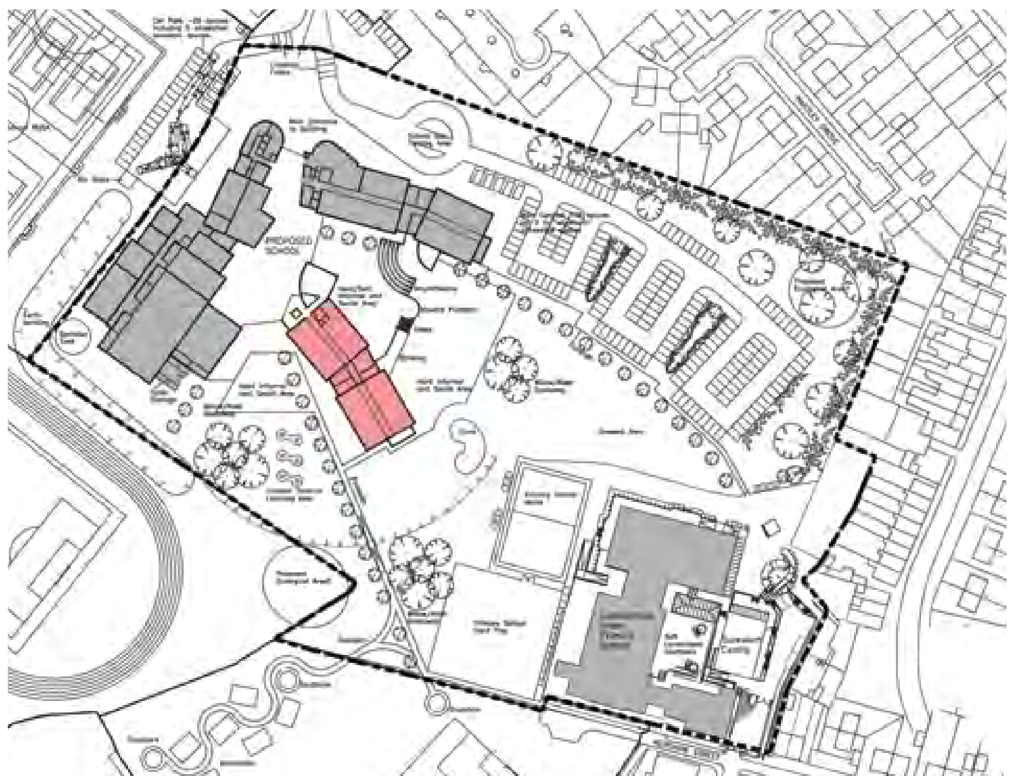
These designs should not be seen as blueprints, because every school is different. Instead this work should inspire local authorities and schools and illustrate what is possible.

Renewals case study 01

Abraham Guest High School

A school that blurs boundaries between circulation and teaching space to provide a flexible central area with direct access to an outdoor study garden.

Number of students 930
Local authority Wigan Council
Age range 11–16
Project Faraday coordinator DEGW
School's architect NPS North West



The site plan shows how the new science block (pink) is positioned to provide wonderful opportunities to connect with the outdoors.

This study garden, bounded on three sides by trees and the science block, will provide space for 30 students to work in small groups.

Context

Abraham Guest High School is a specialist sports and arts college, with a powerful drive to implement personalised learning and make the educational experience more relevant to its pupils. Before Project Faraday, it had already put a great deal of thought into personalisation. For example:

- Deep learning is embedded across key stages, allowing students to assess their own and their peers' progress in different ways.
- It's one of the leading schools in the region for multi-sensory learning.
- Students are encouraged to take account of their own learning.
- It has a varied and flexible Key Stage 4 curriculum (for ages 14+).

Abraham Guest High's science staff are ICT enthusiasts, and the school was the first in the local authority to have wireless laptops and a full complement of interactive whiteboards. The school is also successful in bringing in outside speakers to give presentations to students. Links with industry and universities, as well as an international link to Uganda, have made a significant contribution to science teaching.

The vision

The school currently delivers its education in disciplines and wants to retain a science department, grouping all the science facilities together. However, the school's brief was to make this department completely learner-centric, and to use the whole of the area to support personalised learning (here interpreted as: 'individuals or small groups planning activities and then implementing them, potentially doing a wide range of tasks or repeating certain elements until understood').

One of the options that emerged from the Faraday workshops was a half-day structure, allowing learners the flexibility to plan and do various activities without having to stop and go somewhere else to study something different. Teachers would work in teams and the technician's role would evolve to provide further support and mentoring to learners.

The final decision was to provide facilities that could cope with a wide range of teaching styles at once. But, in case this was later deemed not to work, the space should be adaptable and easy to reconfigure.

Fully serviced science labs were intended for practical work only, with learners possibly using them for as little as 15-20 minutes to do an experiment. Theory, demonstrations, research and group work were to happen in other spaces in the science department.

Design rationale

The school and designers took a strategic approach to the brief, to understand the People (learners' experience), followed by the Process (how people learn), followed by the Place (what spaces are needed to support learning). (This is described in more detail in the Process section, p10.) The school and advisers settled on four main objectives for the work:

- Broadening science learning and teaching opportunities outside (using ICT) and ensuring landscape design supports this and links to sustainability objectives
- Building on past outreach events and increasing the links with primary schools and local science organisations
- Developing a demonstration theatre and teaching theory space as non-timetabled spaces, focused on demonstrating science experiments to large groups and making further improvements to the quality of teaching
- Supporting better links with the wider science and non-science community

The school agreed that the ideal learning experience allows learners to find their own pathways, facilitated by science staff, as well as using a broad range of learning styles. This was seen as the best way to engage the current and future generations of learners – and to equip them for 'knowledge economy' working styles.

The organisational model to support this had two notable implications for the space. First, designing a department, recognising that the school might eventually move to an inter-disciplinary model of learning and teaching. Second, providing a wide range of learning spaces to stimulate the maximum number of learning styles and give learners greater choice as to how, when and where they do science in the facility.

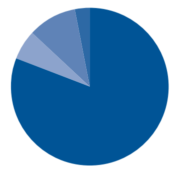
The project team therefore looked in detail at the different teaching methods used for science learning, and defined spaces that could be evaluated by staff and arranged around the site. These different settings were then planned into a layout of zones.

The design team ran a series of workshops to develop elements of the design, including:

- Briefing cards – a specialist tool to engage with students, the science faculty, non-science teachers, and senior management. This improved the school's understanding of its own aspirations for the learning experience.
- Denmark visit – Abraham Guest High School sent two of their staff to Denmark with the design team to look at alternative learning and organisational models.
- Design workshops – with pupils, science staff, technicians and senior management to progress the design to its final stages.

Pre-Faraday schedule of spaces

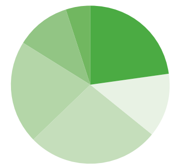
Space	no.	Size(sqm)	Total
Science laboratory	7	78	546
Small classroom	1	39	39
Science prep	1	30	30
Science prep	1	24	24
Staff work room	1	20	20
Store	1	5	5
Store	1	10	10
			674



- Science laboratory
- Classroom
- Prep rooms and storage
- Staff work room

Project Faraday initial schedule of spaces

Space	no.	Size(sqm)	Total
Laboratory	2	80	160
Practical work space	1	90	90
Science work area	1	180	180
Science studios	2	72	144
Main prep room	1	39	39
Storage walls	1	6	17
Small prep rooms	1	11	22
Staff space	1	37	37
			689



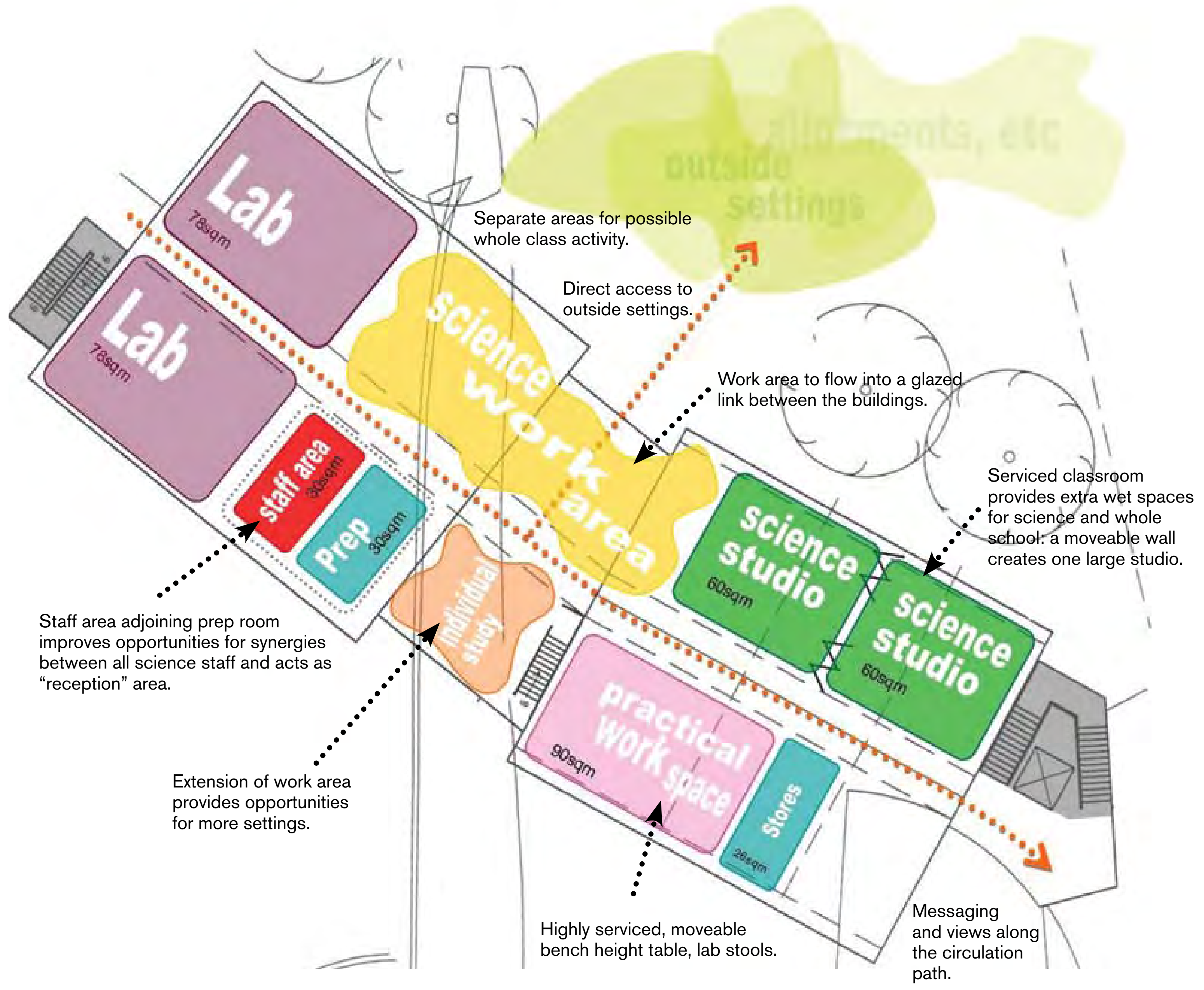
- Laboratories
- Practical work space
- Science work area
- Science studios
- Prep rooms and storage
- Staff space

The designs

The original (pre-Faraday) schedule of spaces, based on the school's timetable and pupil numbers, included seven labs of 78m² and one classroom of 39m². Project Faraday work recast the schedule, based on the same overall area, for a much more diverse range of teaching spaces, to meet the school's vision for science. See tables on left hand page.

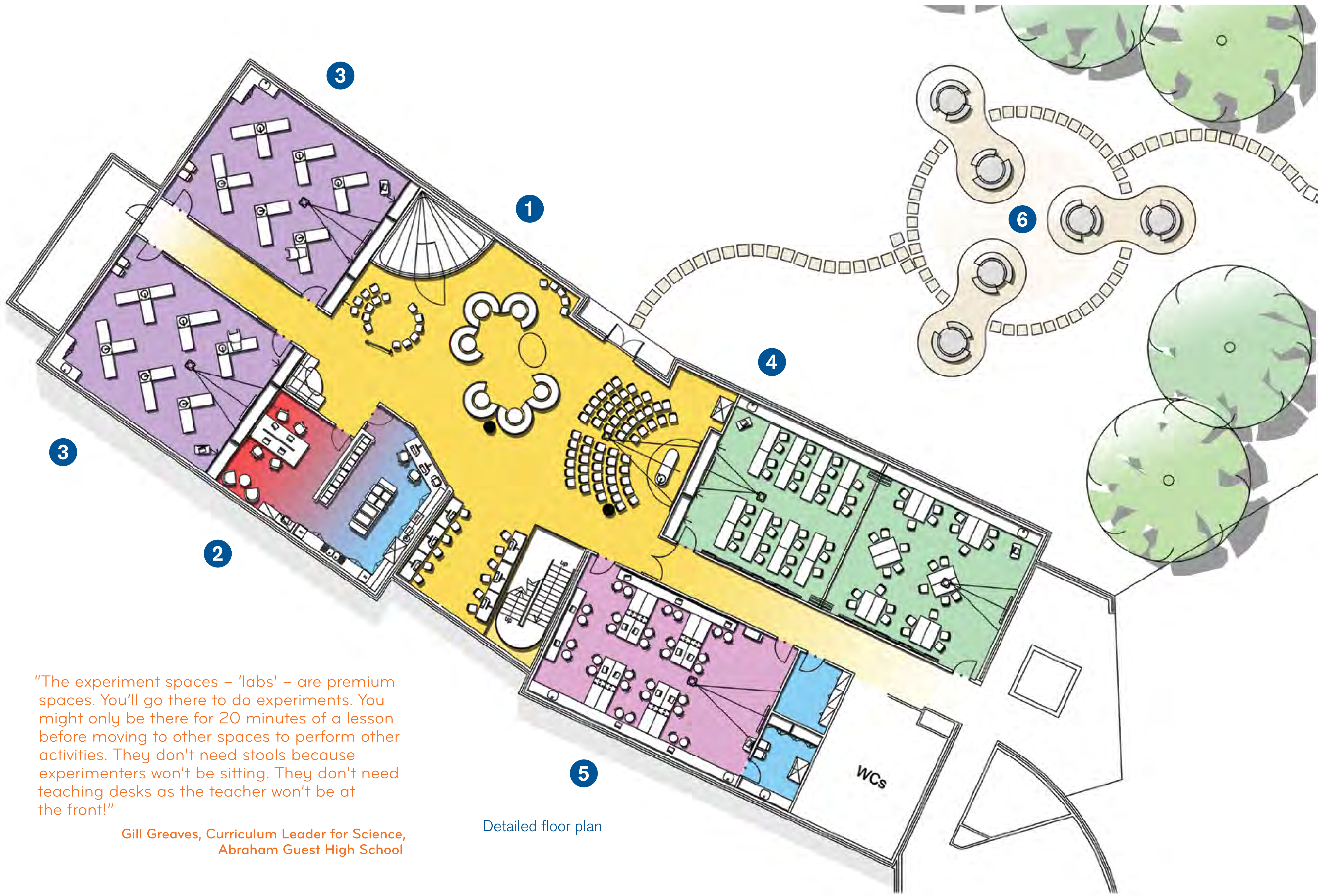
Initial design work included two square blocks of accommodation. These were reworked through Project Faraday to make use of the circulation space between them.

The final design provided five enclosed learning spaces, a staff room/prep area, and one open learning space (equivalent in size to two labs). The school saw learning spaces as the most important aspect in the department, putting less emphasis on storage, so there will be storage walls accessible from the two labs and the science work area.



Concept plan showing key features of the design

The exemplar design provided five enclosed learning spaces, a staff room/prep area, and one open learning space (equivalent in size to two labs).



"The experiment spaces – 'labs' – are premium spaces. You'll go there to do experiments. You might only be there for 20 minutes of a lesson before moving to other spaces to perform other activities. They don't need stools because experimenters won't be sitting. They don't need teaching desks as the teacher won't be at the front!"

Gill Greaves, Curriculum Leader for Science, Abraham Guest High School

Detailed floor plan

1 Science work area (149m^2)

Equivalent to two traditional lab spaces, it's intended as the centre piece of the science department, where learners will start and end their learning session.

There's space for presentations to 60 students, with a small, serviced demonstration desk. Behind this, two large group 'snugs' are big enough to seat 15 students per snug, positioned so that a teacher or technician could show a demonstration to an additional 30 students at any time, using a mobile science trolley. The plan shows one arrangement but the furniture can be rearranged to suit different activities.

There's a 'creativity pod' in one corner, where small groups of students can discuss and write ideas on the surfaces. Outside it are soft seats and a mobile whiteboard for group brainstorming.

By the stairs is a series of desks for private study, equipped with PCs and arranged for pairs to research together.

The creativity pod.

2 Staff/prep room (79m^2)

The prime welcoming point, with a glazed reception desk onto the main space to handle enquires. The main meeting space has been moved outside the enclosure to provide more visibility and passive supervision, as well as extra space for project groups.

The prep room and staff room are combined so that teaching staff can work closely with technical staff.

3 Two serviced labs (80m^2)

The design team provided a number of options for labs. The school chose the one below where the learners face a direction that's easy to supervise, but without rows (which could feel like a traditional teaching space). Because they are practical-only spaces, they are smaller than normal teaching labs. And because the school had considered in detail how the labs will be used, flexibility is of secondary importance in the choice of furniture, with storage available under the benches.

View of laboratory.

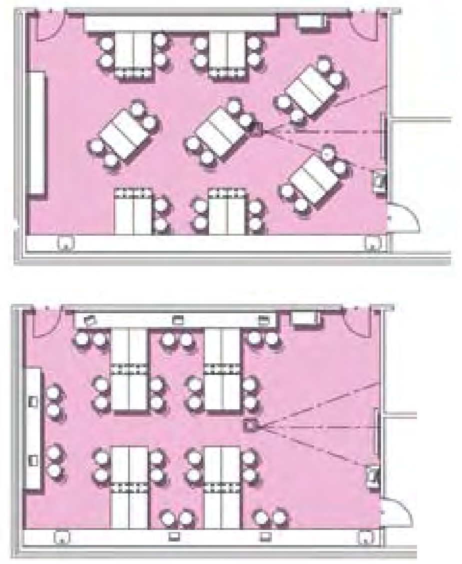
4 Two science studios (72m^2)

These studios are larger than those in East Barnet School (72m^2 instead of 56m^2, see page 76). This allows lightly serviced workbenches on the perimeter, containing spot sinks.

Large enough for a wide variety of layouts and teaching styles, they have teaching podiums located away from the centre of the studio. The whitewall between the studios can be retracted completely to use the entire space, or closed, when its rotating panels allow ideas to be shared between neighbouring classes.

5 Practical work space (90m^2)

Moderately serviced, this space is suitable for group-based experiments relying on collaboration or group work. It's perfect for lengthy experiments, which could be conducted without obstructing the main labs. Serviced bollards are provided, with spot sinks on the benches along the edge. The area near the whiteboard is as open as possible to allow a small group to cluster around the board and discuss ideas.



Alternative furniture layouts.

6 Outdoor setting

The outdoor setting, immediately accessible from the science work area, will allow 30 students to work in groups that are easy to supervise. The tables will be durable concrete, but finished with wood for comfort and good looks.

Cost commentary

- The Faraday team made good use of the space available for science accommodation at the school. The main additional cost items in the proposals are in the central demonstration area: providing the 'creativity pod' and enhanced services equipment and services to maximise flexibility.
- The extra cost of the conceptual design compared to a traditional science facility of 7 labs is £176/m^2 of the gross internal floor area. This is at the lower end of the range of extra costs identified for Project Faraday renewal projects.

CLEAPSS comments

- At 80m^2, the labs are below the suggested 90m^2 for a school science lab, which may limit what changes might be made in the future to furniture arrangements or how the labs are used.
- The design could lead to greater pupil movement than normal – teachers will need to manage this and technicians will need to plan carefully how the labs are supplied with practical materials and equipment.
- CLEAPSS advice is to separate the teacher's area from the prep room for various reasons, including security, separation of preparation and eating and drinking, and the provision of a suitable environment for technicians to carry out difficult and potentially hazardous tasks without being interrupted.
- If there are practical activities in the outdoor area, there should be nearby provision for pupils to wash their hands with soap and water.

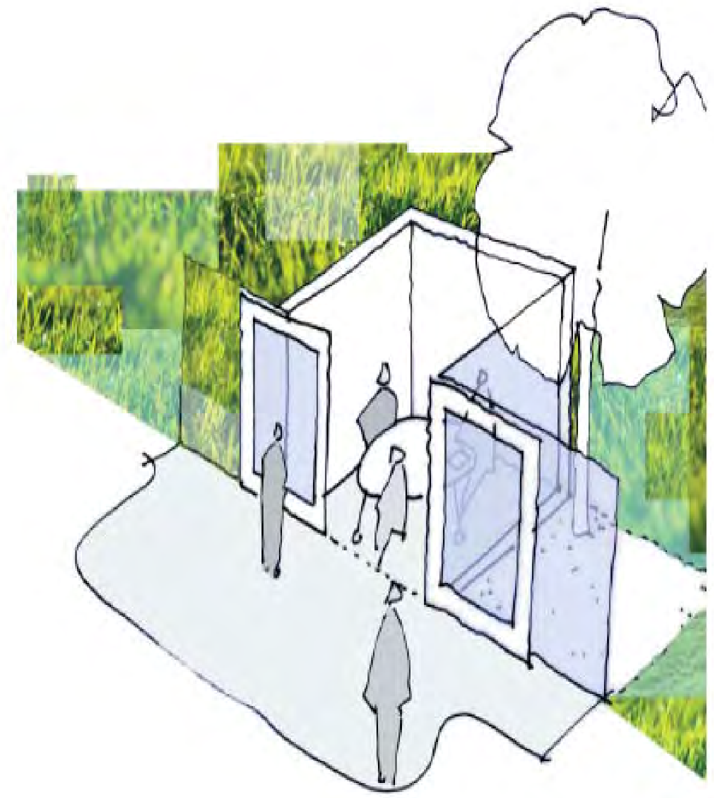
Renewals case study 02

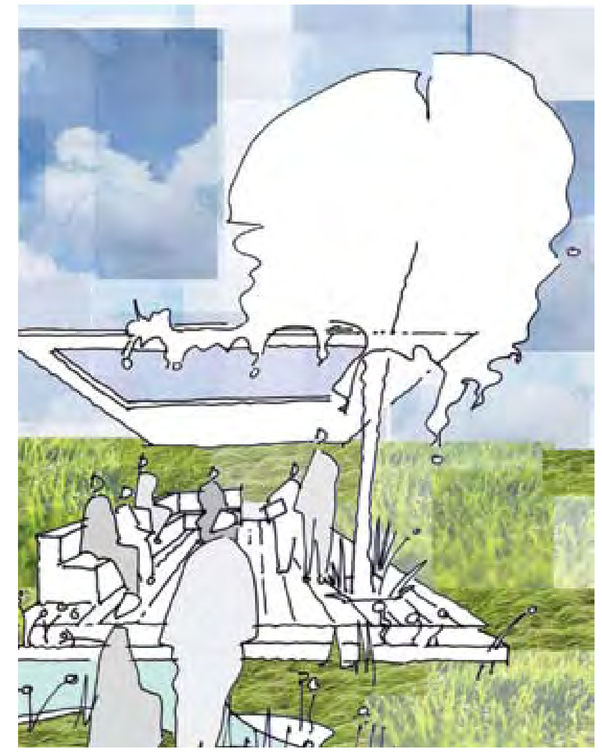
Bideford College

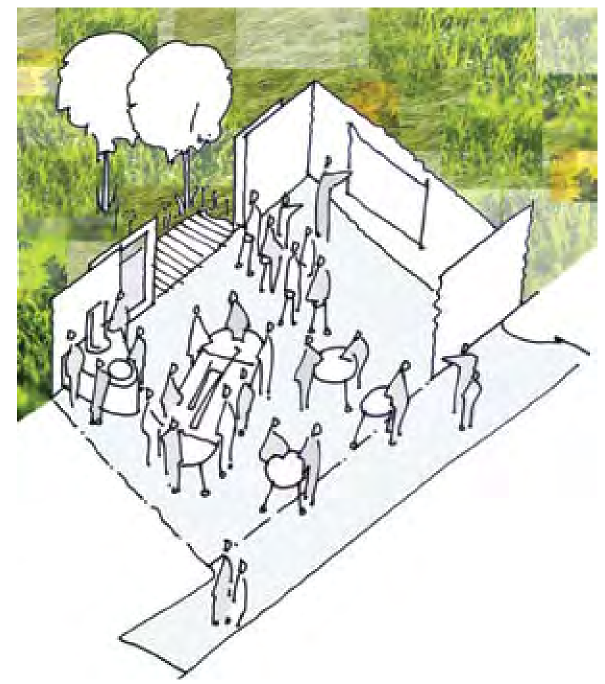
A school with a combined demonstration/theatre space that will benefit the school's community and visiting teachers.

Number of students 1770
Local authority Devon County Council
Age range 11-18
Project Faraday coordinator White Design Associates
School's architect NPS Property Services SW

Site plan of the new school showing the science accommodation (pink)





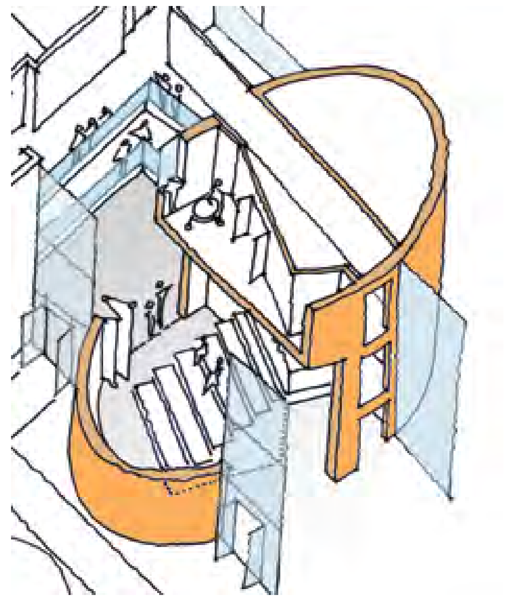


Context

Bideford College is the only science specialist college in North Devon and is a sustainability demonstration school as well as a Faraday demonstration project. The college's science department is involved in leading edge work on primary-secondary transition, through a specialist teacher employed equally in Bideford College and the surrounding feeder schools. The school had started the process of detailed design before Project Faraday began in earnest. Its footprint was therefore largely established and the basic plan of the science department fixed. Project Faraday allowed the school's designers to challenge the conventional breakdown of spaces, at the same time working out how individual rooms would be used, how they would relate together, and how they would be equipped for science teaching. These designs are conceptual designs – proposals continued to evolve after this book was written.

"If science is all work, work and no practical stuff, it's 'Oh no not science again'. We should turn it into something which is really physical and fun."

Student, Bideford College



The demonstration space is on two storeys and allows for raked seating. It opens out onto the teaching theory space for large-scale experiments.

The vision

Bideford College puts great emphasis on collaboration – both internally and with those outside. Internal collaboration means science is often taught through other subject areas. This is part of a vision for science learning that centres on the contribution applied science can make to using scarce resources carefully, managing environmental issues and creating a sustainable future.

The college also believes collaboration is a powerful mechanism for promoting deep learning for students, supporting the school's student-centred approach. The college has a 'lab on loan' for use in primary schools and runs training sessions for local primary school teachers, as well as occasional science weeks for feeder schools.

Early discussions with the college sketched out four critical elements for the new building, which formed the basis of a design brief:

- Extending science learning and teaching opportunities outside (using ICT developments) and linking to sustainability objectives
- Building on past outreach events, increasing the links with primary schools and local science organisations
- Developing a demonstration theatre and teaching theory space as non-timetabled spaces, focused on demonstrating science experiments to large groups and making further improvements to the quality of teaching
- Designing to support better links to the wider science and non-science community outside the school

These elements shaped the research stage of Project Faraday at Bideford College and provided a common thread and purpose.

Design rationale

The Faraday team worked with Bideford College to develop a generic suite of spaces and apply them as appropriate within the context and programme constraints. The spaces were developed around specific principles:

- Challenging the definition of a traditional lab and looking at alternative spaces that can support current and future science learning and teaching, with an emphasis on personalised curriculum and project-based learning that engage students effectively
- Promoting flexible interfaces between internal and external spaces, with single-sided circulation that ensures good levels of daylight, passive ventilation and external views/contact for improved sustainability
- Providing spaces that can accommodate today's curriculum while allowing for future curriculum developments and 'transformation'
- Encouraging external learning and teaching in a range of landscape settings
- Breaking down barriers between young people and adults using the science spaces to encourage positive learning behaviour

The team also developed a new taxonomy, a way of naming and organising science spaces to reflect the range of learning environments where science can take place. This was useful both for designers and the school in imagining what the science department would look like and how to talk about new science spaces.

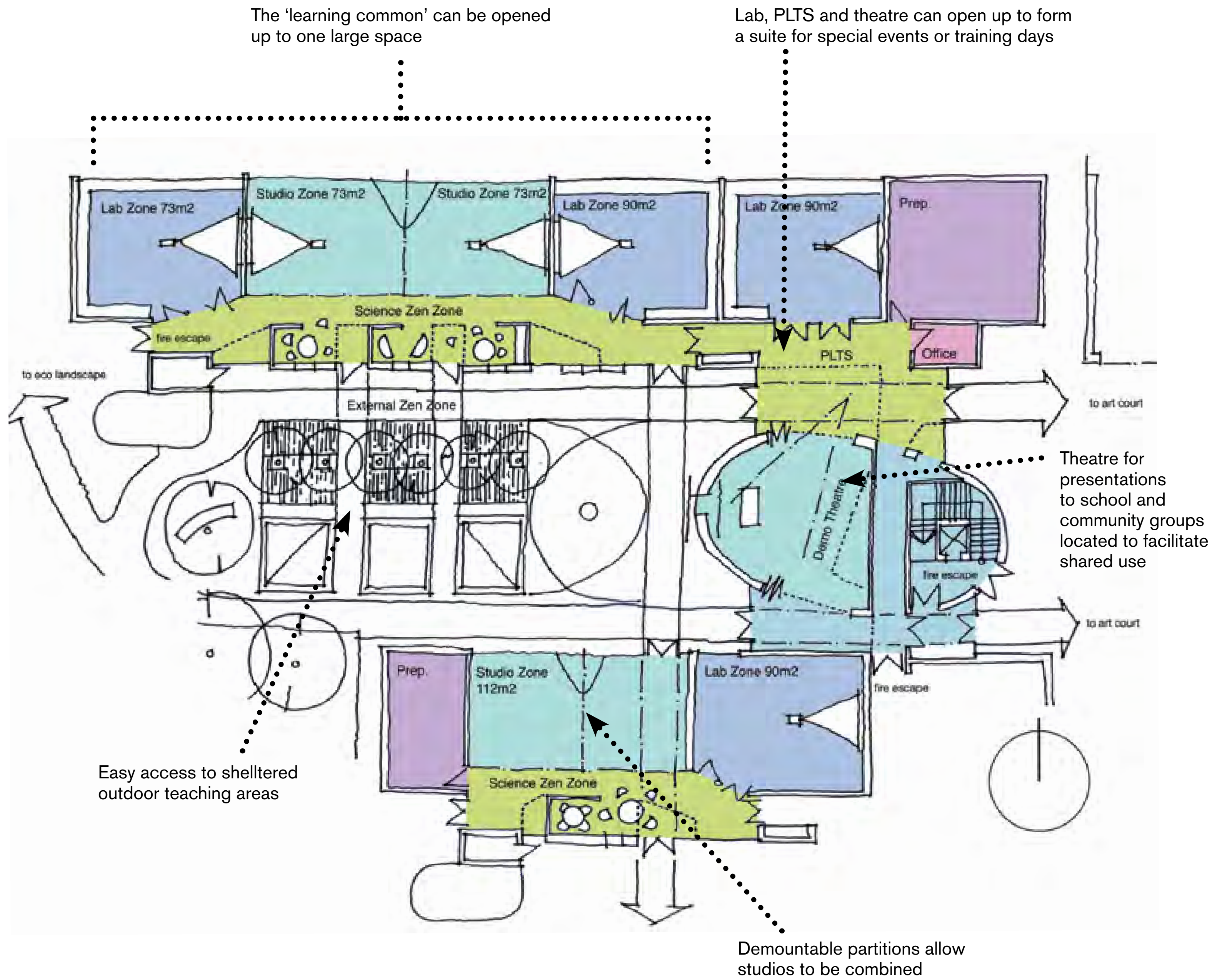
The designs

The core elements of the Bideford Faraday proposals are a demonstration theatre/teaching theory space, and 'learning commons' – combinations of:

- two fully serviced labs
- two lightly serviced studios
- classrooms
- 'zen zones' (small breakout areas)

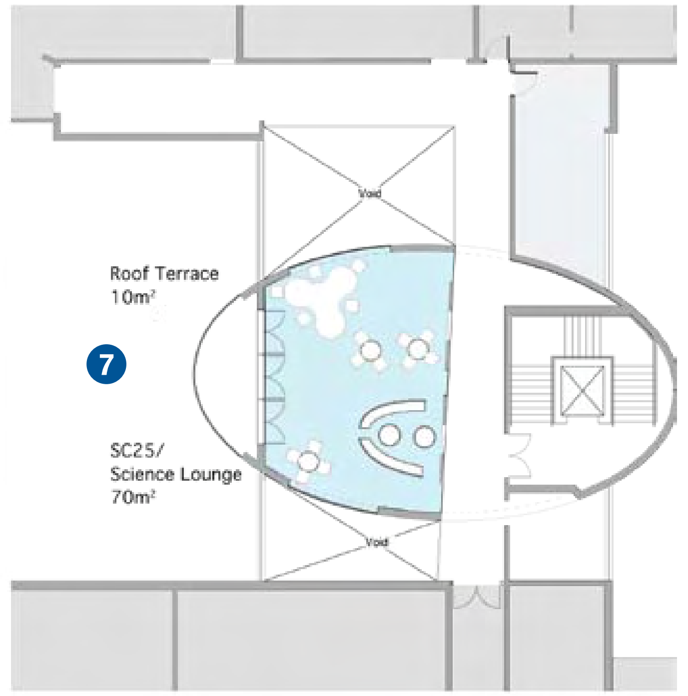
The learning common is equivalent in area to four labs and circulation space in a traditional science facility. The 'common' can be viewed either as a single space with integrated circulation, or as a series of separate spaces.

There are also preparation spaces, staff work areas and a science lounge. How they fit into the broader science facility is shown in the plan on pages 45-46.

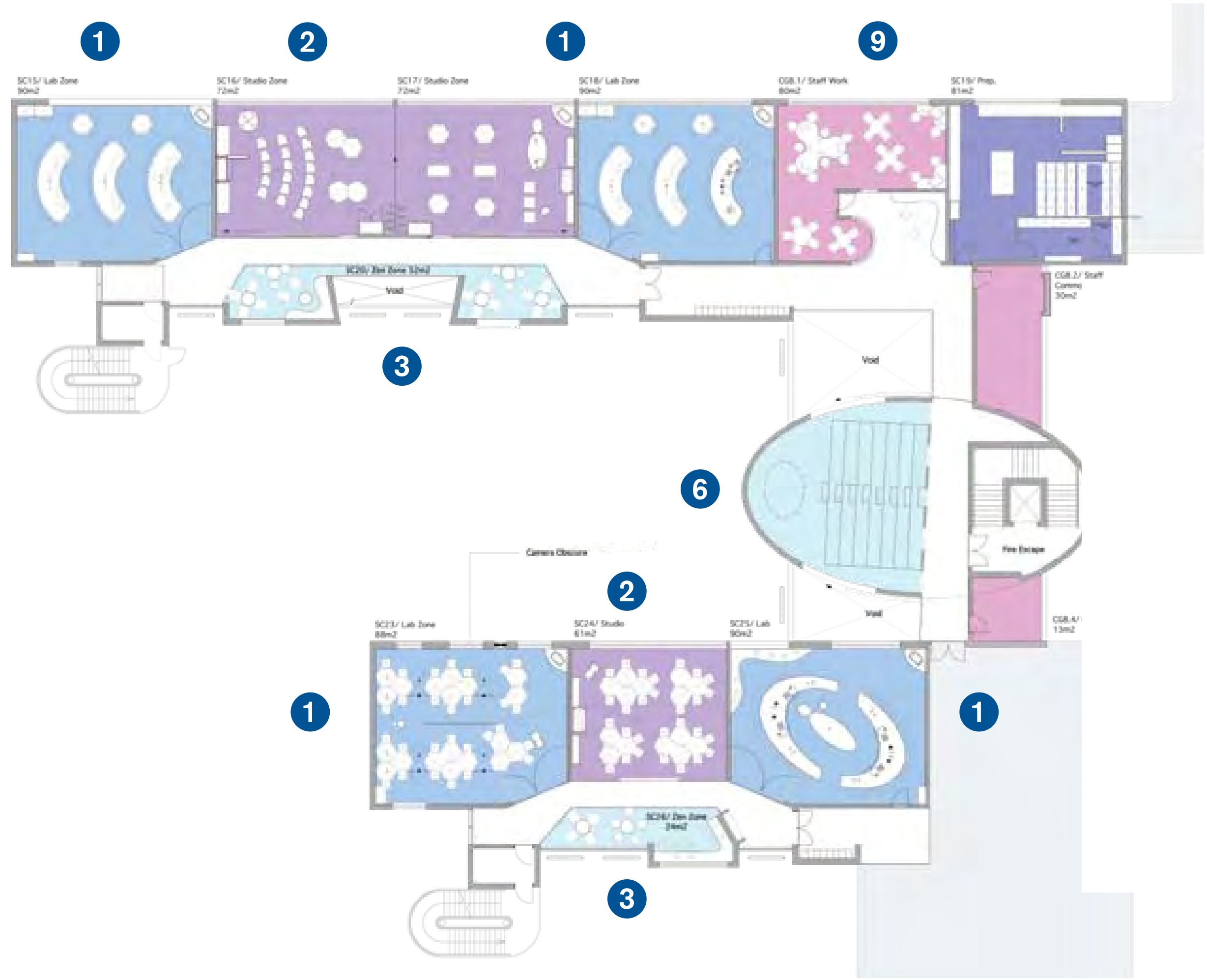


Concept plan showing key features of the design

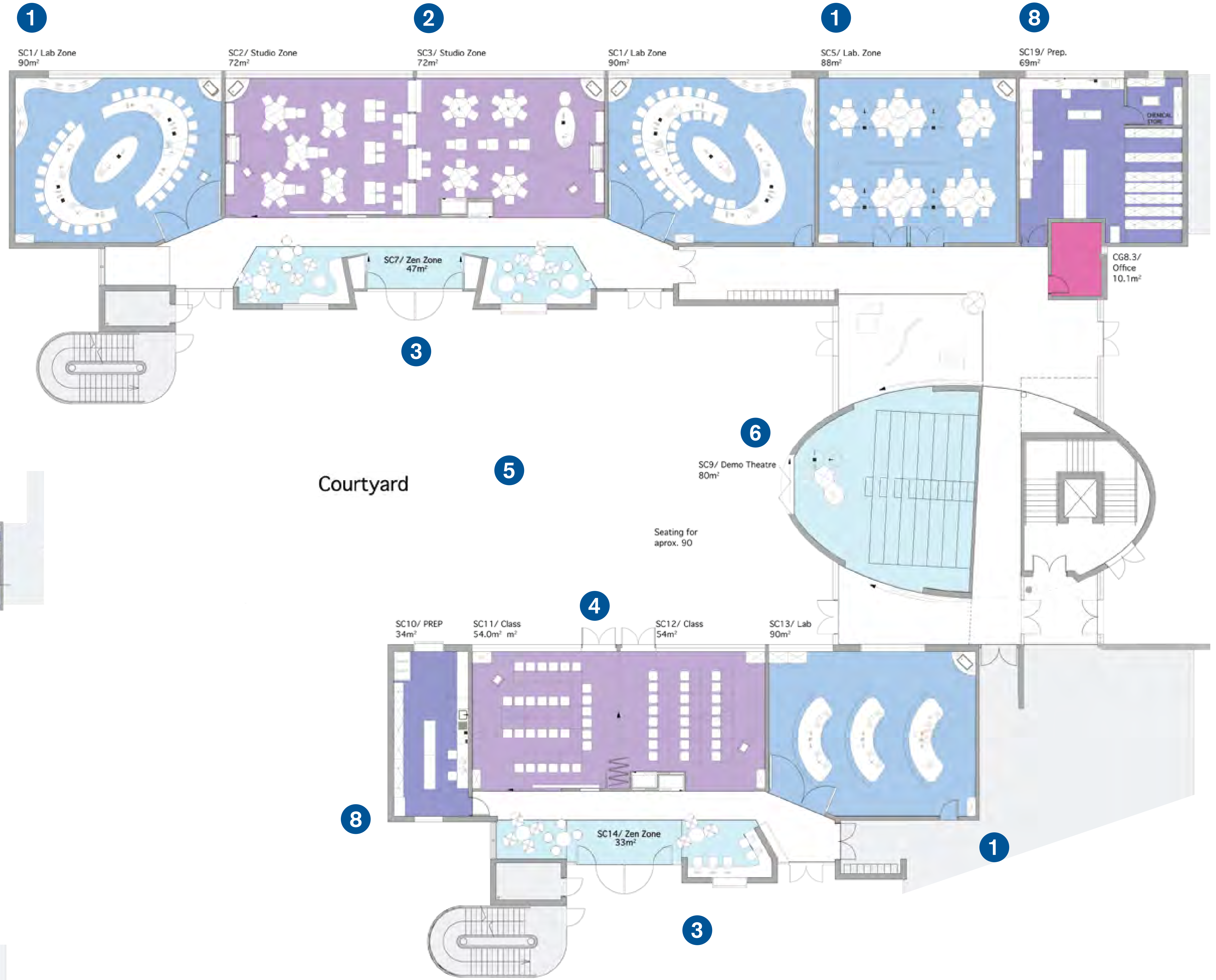
The core elements of Bideford's proposals are a demonstration/teaching theory space and 'learning commons'. The learning commons consist of two labs, two studios and two breakout spaces – zen zones. Taken together, the core elements will serve for practical and theory work, for large and small groups.



Detailed 2nd floor plan



Detailed 1st floor plan



Detailed ground floor plan

1 Eight serviced laboratories (90m²)
The labs' main function is to provide a space for students to engage in rigorous scientific investigation. Access to services like gas, electricity and water is essential. The space is designed for practical exploration and application of science.

Two crescent-shaped benches with full services allow excellent supervision and clear views from students to the teacher and to all other students.

2 Four science studios (72m²)
Used for a range of science activities, with access to a sink and water, power and data, it's not a heavily serviced space, except for one fully serviced demonstration bench. 'Light' science experiments will take place in the studios but the focus will be on analysis, presentation, discussion and debate.

The studios are in the middle of the suite of spaces and can be opened to form a continuous space, screened but not separated from the zen zones. The zen zones are located to allow an easy flow between the three types of space.

The predominantly open plan form allows the zen zones to be monitored from the studios. Moveable screens can separate spaces without sealing them acoustically. The labs at each end may be open to the common but can also be closed off from it, and the learning common provides direct access to an external science courtyard.

These two studios are connected to two screened breakout areas for small group work or individual study.

3 Four zen zones (33/47m²)
Designed as a breakout space for the adjacent studios and labs, they support individual and small group activity, with a focus on informal learning and space for quiet reading and reflection.

4 Two classrooms (54m²)
A general teaching space for learning about theoretical science. This space can be configured for a variety of approaches to learning and teaching, and may be used for theoretical science lessons as well as other subjects as part of an interdisciplinary curriculum.

5 External lab/class and ecological landscape
The courtyard provides external learning and teaching spaces. More infomation is provided over the page.

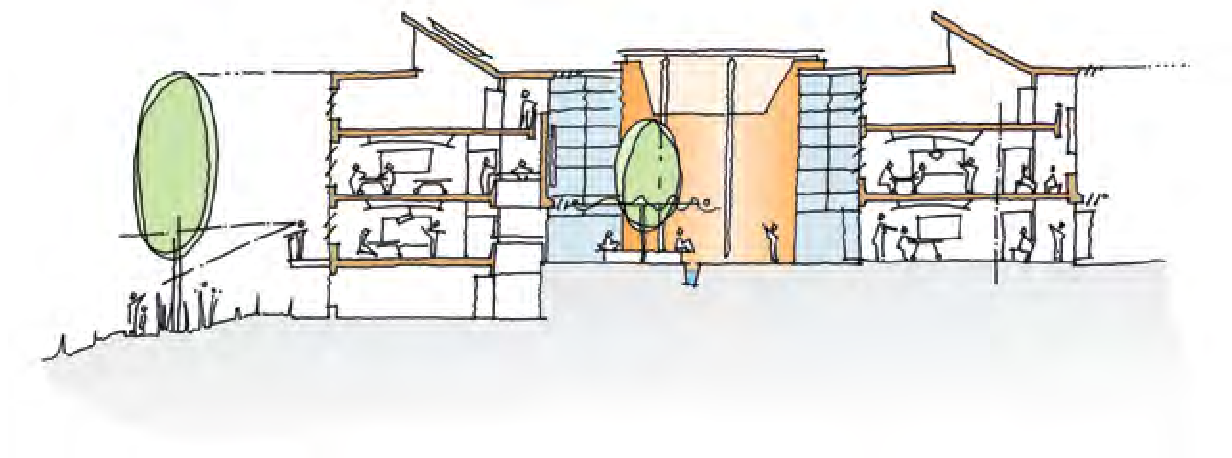
6 Demonstration theatre and teaching theory space ('PLTS', 80m²)
To be used as a common resource for the school and wider learning community, but predominantly for science. The theatre and teaching theory space are focused on demonstration and performance, for lectures and evening use, innovation and sharing best practice. Leading edge teachers can come and perform, observed by colleagues and peers. These are non-timetabled areas, with the expectation that they will be bookable or used in innovative ways to change the curriculum experience.

The areas form the heart of the science department, close to the entrance and opening out onto the science courtyard. The demonstration theatre is two storeys high, allowing the possibility of raked seating. By opening onto the teaching theory space and adjacent laboratory, large-scale experimentation will be possible.

7 Science lounge
This space on the second floor is for informal learning. It has a crescent-shaped roof terrace, overlooking the courtyard.

8 Prep rooms
There is a prep room on both floors and the first floor prep room is adjacent to the staff workroom for easy access.

9 Staff room
The staff room on the first floor has space for group and individual work. It also has a seating area outside where students and teachers can meet informally.



Wide, level-access doors let students get to the outdoor learning area easily.

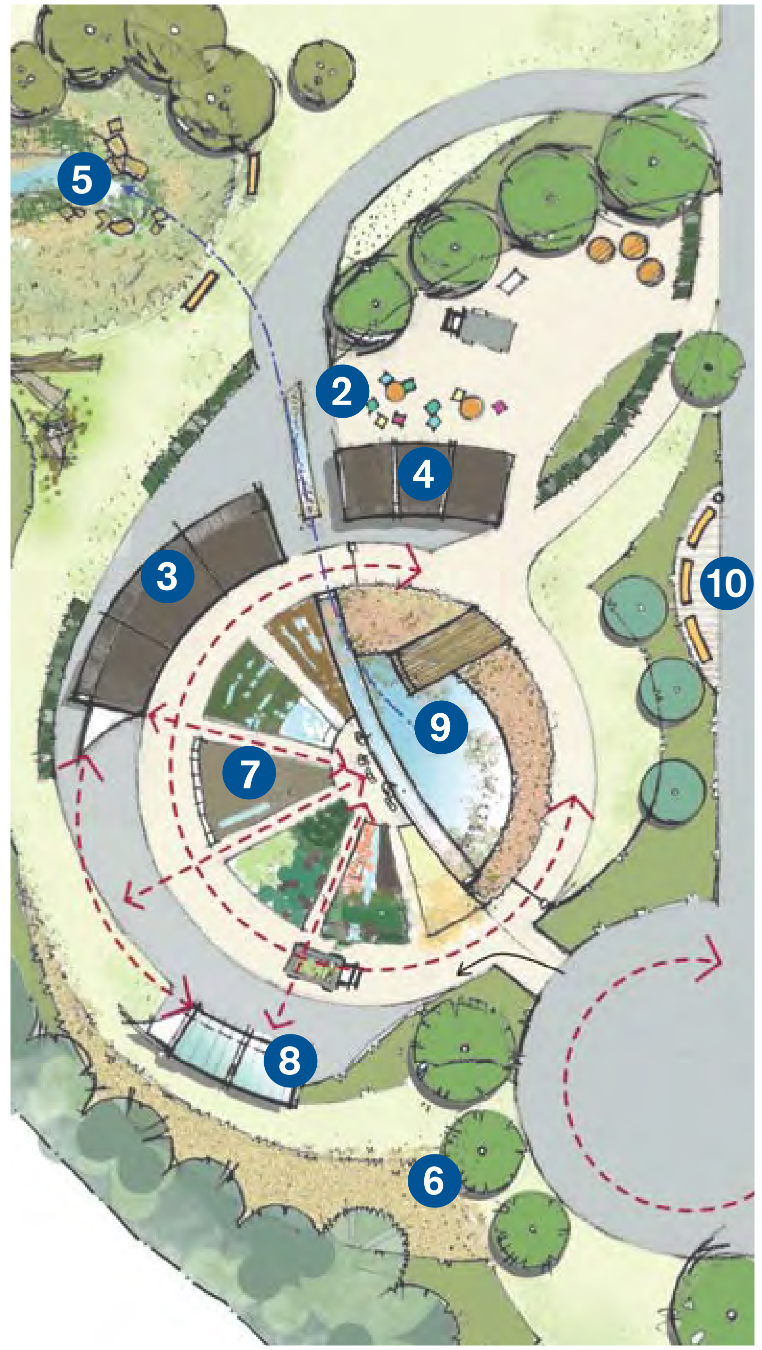
The learning space in the courtyard will be protected from wind and rain.

Using the whole campus

The design reflects Bideford's dual status as a sustainability and science demonstration school. The two aspects overlap in many ways – a narrow plan means there's good summer ventilation, less electrical lighting is needed, and there are good views outside, with a visual connection to the grounds. The views help to emphasise the links between the school and the natural environment, and implicitly remind students of wider sustainability issues.

The department is organised around direct, easy access to an external courtyard designed as an external teaching and learning space. This will be delivered through student design when the building and site works are complete, and when funding allows. Adjacent to the science department will be an ecological landscape with food production areas, an example of a sustainable building and a demonstrable SUDS scheme (see image opposite).

The learning experiences provided by the building fabric and the grounds are enhanced by exposing elements of design – structural, materials, renewable energy generation or landscape – thus turning the facilities themselves into an educational tool.



Plan of the outdoor areas showing the sustainable technologies building, glass house and other outdoor facilities enclosing a circular zone for horticulture. It has radial divisions for different experimental conditions and an irrigation channel running through the middle.

1 Outdoor classroom, with moveable seating and tables, a yard for storage, composting and recycling

2 Sustainable drainage system (SUDS), using a filter and reed bed

3 Sustainable technologies building, built using a frame structure and pleached trees

4 Extra storage and learning space and recycling

5 Wetland habitat and SUDS

6 Wildflower grassland habitat

7 Planting beds offer a range of growing conditions: hydroponic, organic and raised beds

8 Glass house/nature hide

9 SUDS Water collection point

10 Seating cove

Cost commentary

- The main additional costs are due to additional gross internal floor area of 243m^2 associated with the demonstration theatre and science lounge. It's the school's intention that the demonstration theatre will be shared with other curriculum areas, other schools and the local community, as well as being used for teacher training events.
- There are also additional costs due to the folding acoustic partitions between laboratories, screens, enhanced services and services equipment and some non-standard fittings and furniture throughout the layout.
- The extra cost of the conceptual design (compared to a traditional science facility of 15 labs) is £330/m^2 of the gross internal floor area. This is in the middle of the cost range of the extra over costs that have been identified for the six Project Faraday schools.

CLEAPSS comments

- All rooms opening onto a glazed corridor, part of which will be used for small group learning and teaching, has the advantage that pupils waiting outside the lab or science studio at the start of a science lesson will not be crowded (which can lead to misbehaviour).
- Having two chemical stores, one on each floor, is likely to create some confusion, particularly for maintaining and checking stock. A single store for the bulk storage of chemicals would be simpler and more useable. However, a nearby lift allows materials and equipment to be moved between floors.
- The lecturer's bench in the demonstration theatre provides gas, water and electricity. These services will need to be securable, especially since the whole area of the demo theatre will be more fluid in nature, including being opened up to form a single large space. This can be organised through one or more key-locked shutoff switches, but another possibility would be to have services that fold away into the lecturer's bench, so not on permanent display. This would mean they would not impede non-science lectures or events.

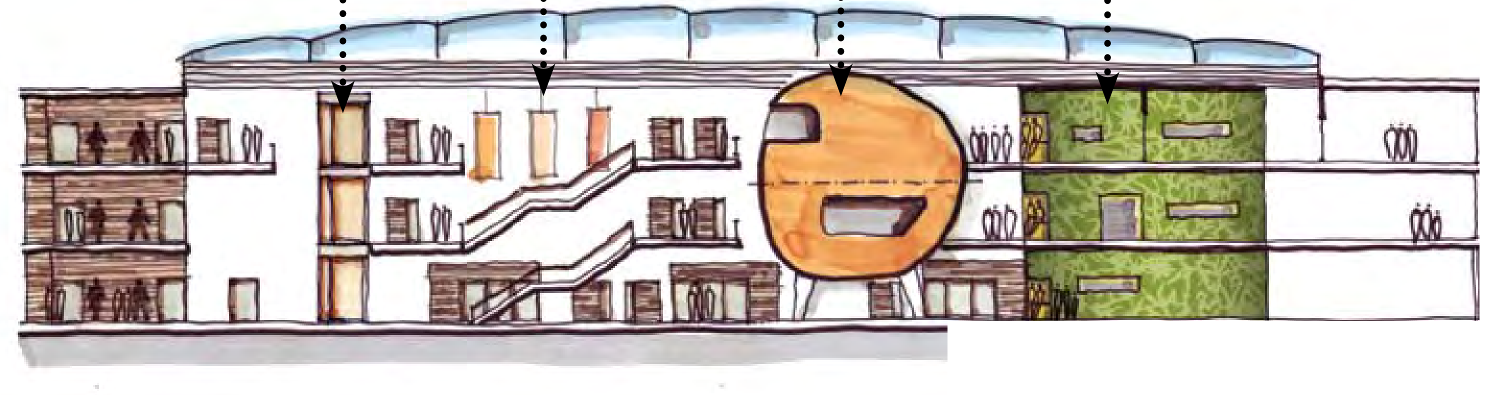
Renewals case study 03

Rednock School

This school offers a true science journey from the entrance doors to the science department with an 'immersive' incident centre as a focal point.

Number of students 1400
Local authority Gloucestershire
Age range 11-18
Project Faraday coordinator GovEd Communications
School's architect cube_design

This aerial view of the site shows science accommodation in the foreground, with a large roof light running along its spine.



Section through the new wing with science on the first floor.

Context

Rednock School is a science specialist school with a catchment area of about 100 square miles. Apart from three or four existing buildings, Rednock will have a completely new school ready to open in September 2009.

Parents and the community view science as one of Rednock's strengths. The school itself sees science and the 'reinvention of science' as a springboard for connecting to other departments, the wider communities, primary feeder schools, and further education facilities, including Bristol University and Explore@Bristol.

The school's provision of a global dimension in all aspects of its curriculum was recognised by the British Council in 2004 and 2007, which awarded the school 'International School' status. Students are presented with many opportunities to learn about the global community, both within and beyond the classroom environment, and pursue this vital aspect of their learning with a wide range of partner schools, both in this country and abroad.

When Project Faraday started, the new school design was already at RIBA Stage D – detailed design was underway. The Faraday team developed design options for the science suite of spaces but their main input related to fit-out, furniture and internal partitions.

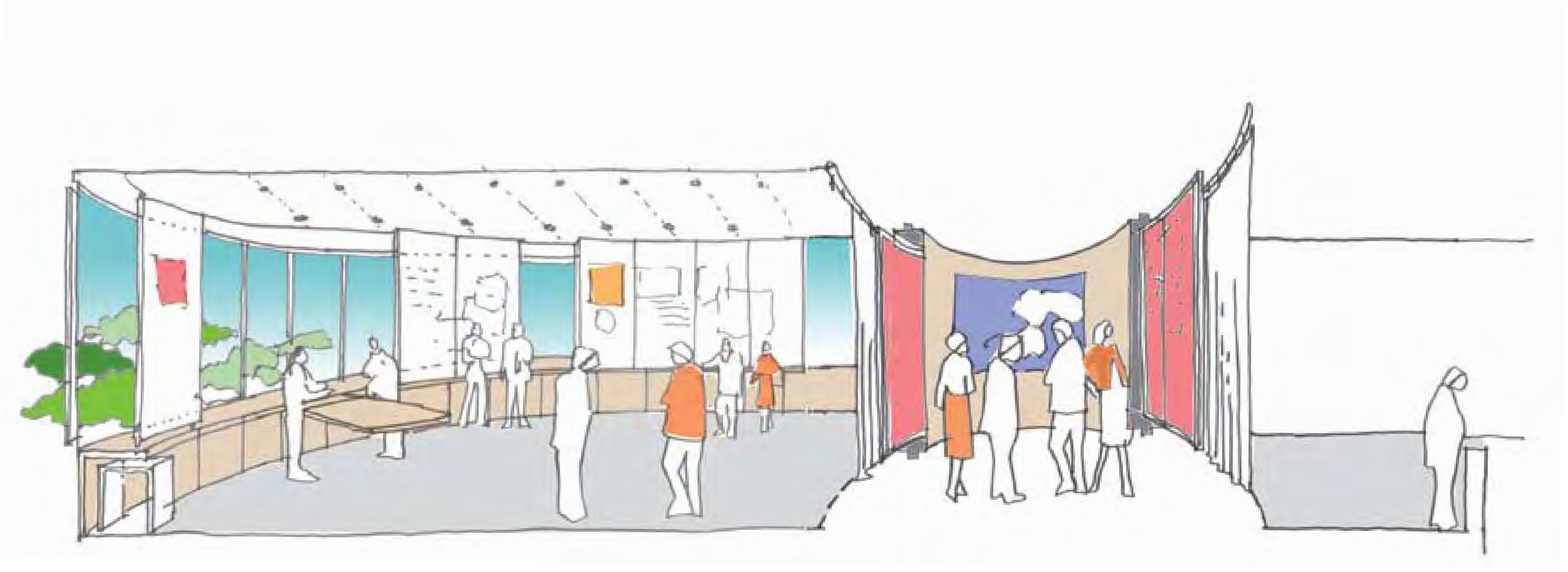
The vision

Science teaching is at the core of Rednock School's educational vision. The school devoted a lot of time to considering how its aspirations can be achieved in the physical form of the building and grounds.

The main principles were:

- The building should reflect the school's concept of personalised and independent learning with a skills-based curriculum crossing disciplines.
- Rednock School should be a sustainable school. This aspect of the brief was influenced by input from the students.
- There should be flexibility to use different learning and teaching methods in classrooms, and the outside environment should be accessible.
- The school has a role as an adult learning centre and the building should be a resource for the entire community – including a performance space for them – since there are few other community facilities in the area. The entrance should welcome the community.
- The science facility will have at its heart an 'incident centre' for problem solving scenarios – for example, future developments in health and disease, linked to climate variations.

The new school facilities had to sustain and reinforce established links outside – including local universities, the BBC and schools in the UK and abroad.

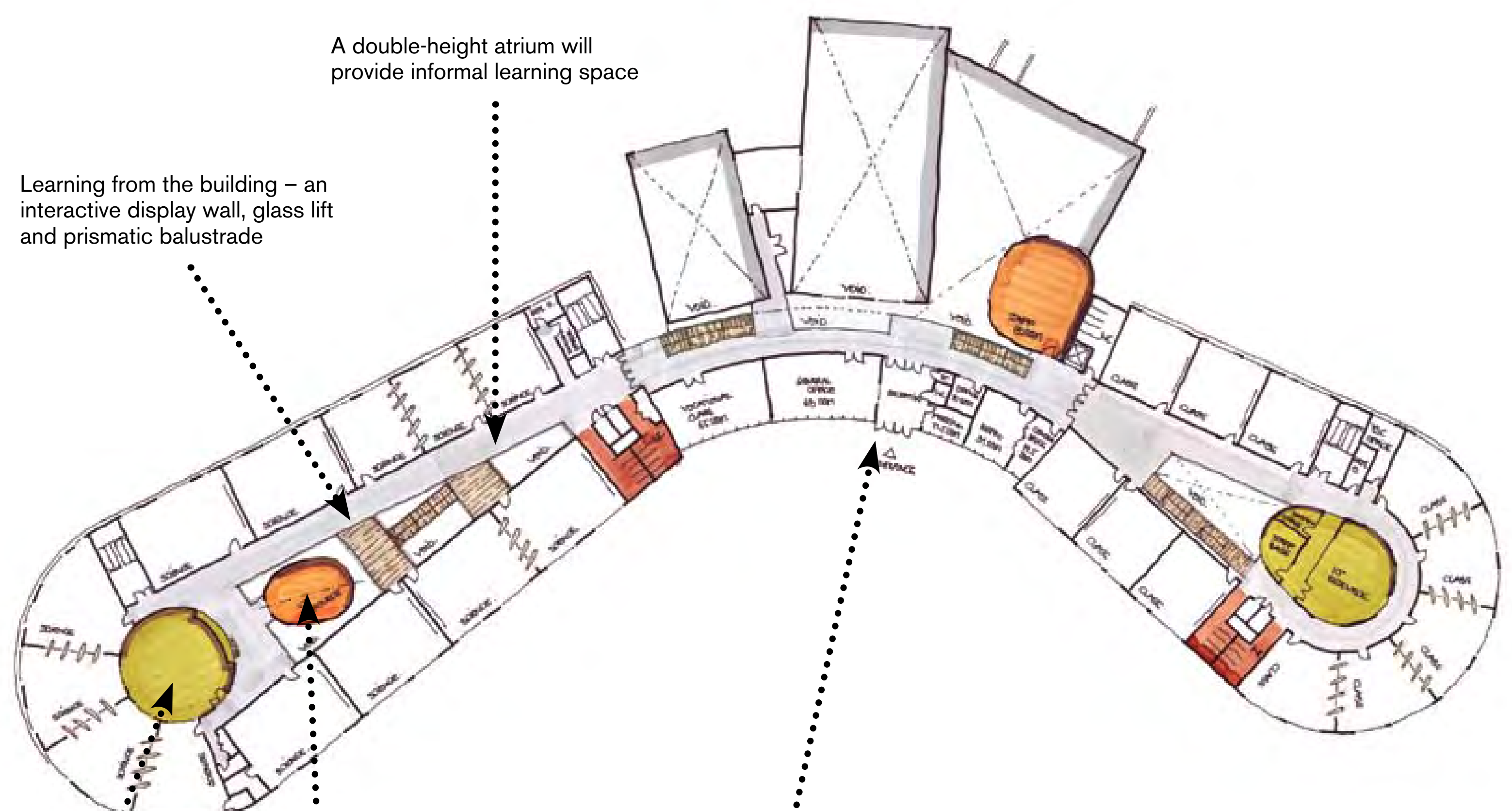


This 'incident centre' at the heart of the facility will be a focal point for problem solving and role play. Moveable screens will allow it to be opened up to the adjacent teaching areas.

Design rationale

Science is at the heart of the school.

- A 'science journey' starts when you enter the school grounds, leading students into the science wing and the incident centre, where they are exposed to real-life science dilemmas and work together to reach solutions to them. The idea is that all parts of the school buildings and grounds can be used as tools for teaching, adding to the learning experience.
- ICT and learning make use of the building and grounds for data collection, particularly as many new technologies are mobile and allow students and teachers to 'roam'. There's a particular emphasis on studying the building and grounds as they change through the seasons.
- The designers focused on meeting two key elements of the brief – personalised learning (which meant providing spaces that would support students in taking responsibility for their own learning), and flexibility (which meant the design team had to think hard about furniture layouts and the sort of furniture they specified for science areas).
- Rednock aspires to using digital technologies creatively for science. The design supports this by providing structures to allow for great flexibility of teaching, and to slot in new technologies as they become available.
- The project team aimed for 'loose-fit' integration of digital technologies, so that the fit-out of the building can be changed over the short or long term to support the technology. A flexible, or at least reusable, approach to buildings will help extend the life span of the building and therefore improve its sustainability.
- The school specifically wanted a central atrium (a glass-roofed internal area) for learning as well as circulation. It's not intended only for science learning, but also for maths, geography and other subjects. The atrium will also be used as a 'spill-out' space for less formal teaching, particularly in science. The students will circulate via the atrium and will always be aware of its 'interactive wall' showing student science work.

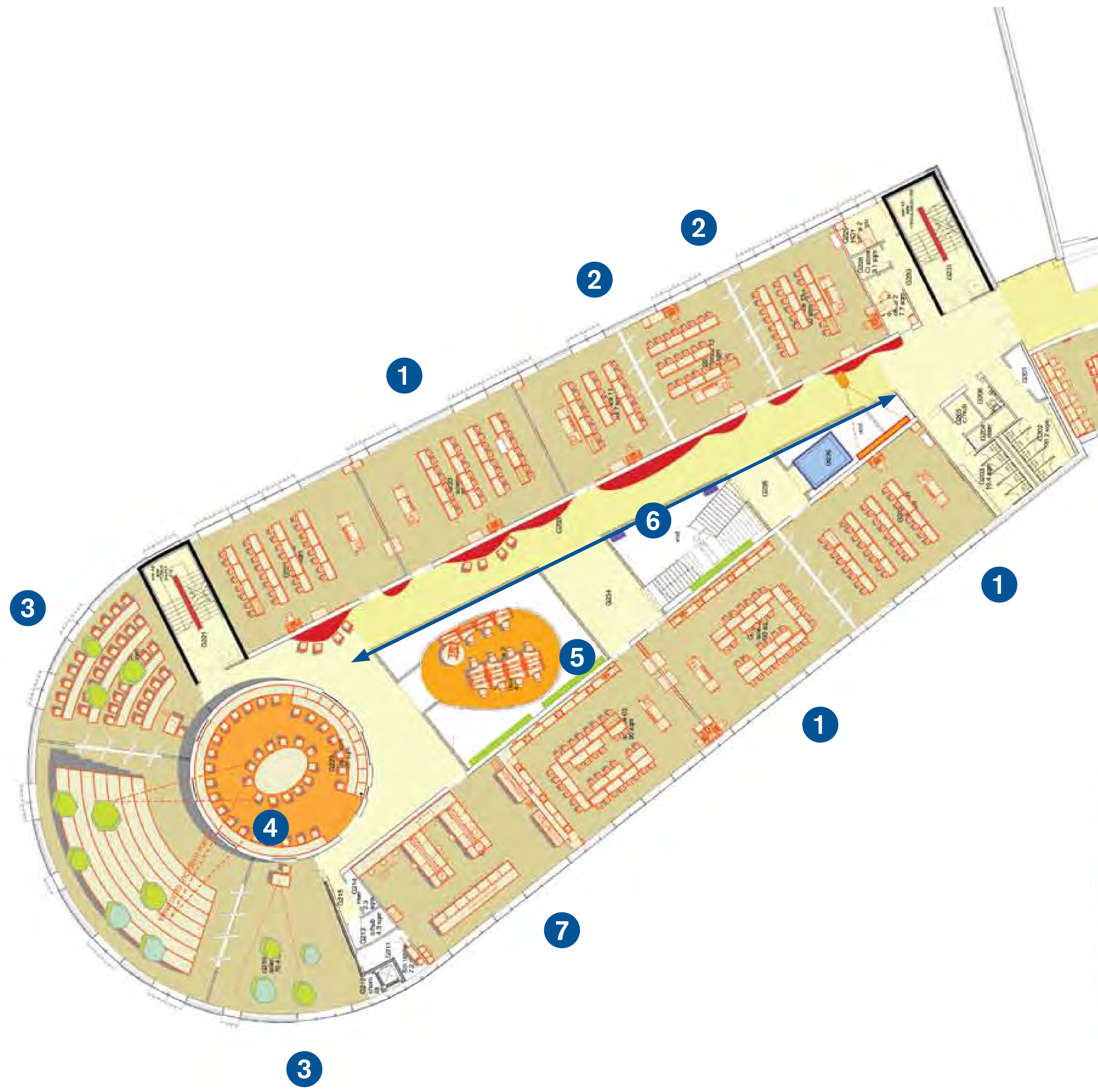


Concept plan showing key features of the design

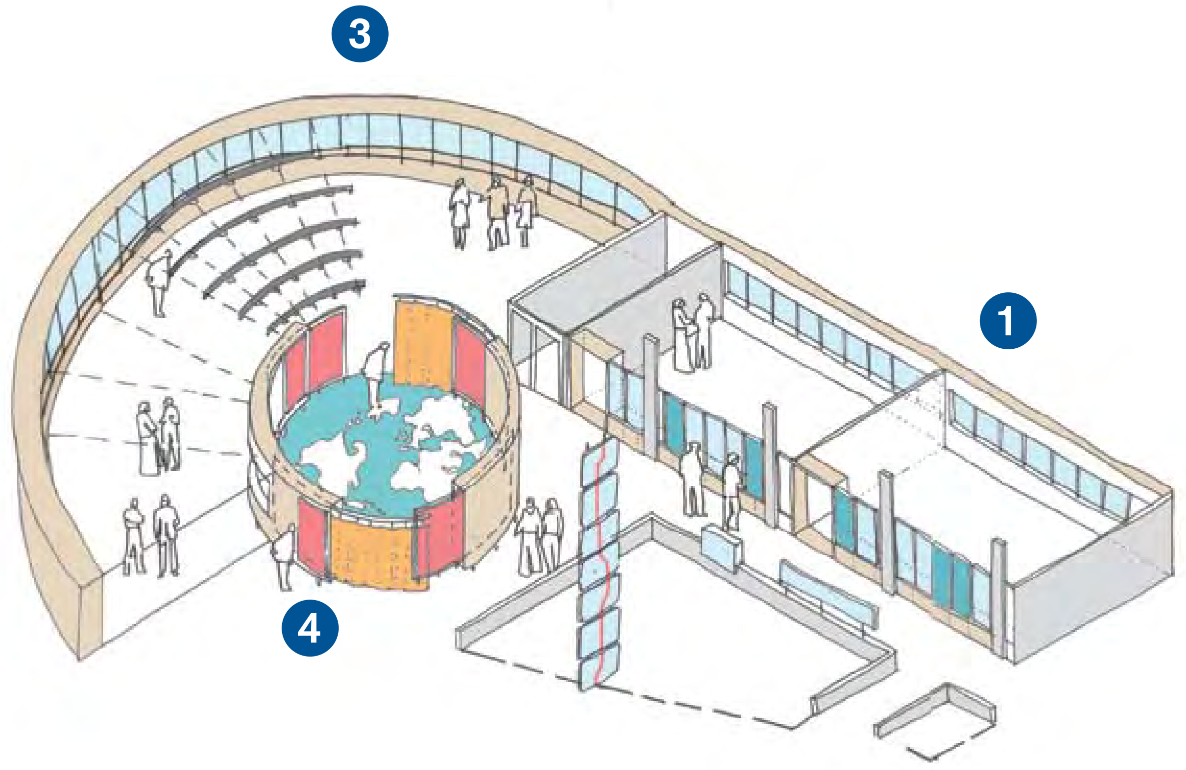
The designs

The science spaces are arranged around a top-lit atrium. There are varying levels of sophistication in terms of services for rooms, and rooms are different sizes according to their function. The whole area is wired for ICT and screens. The approach is to create an environment in which students will lose the sense that they are at school.

Rednock School's proposals consist of six fully serviced labs, two smaller dry labs and three multi-purpose rooms with sliding partitions. There is also an incident centre – perfect for strategic thinking and problem solving.



Detailed floor plan



One of the preliminary sketches for the incident centre

1 Six serviced laboratories (90m²)
A flexible layout, with fixed, fully serviced practical workspaces along the sides of the room, supplemented by mobile practical stations with additional power and data. All teaching spaces have moveable and flexible services, to give maximum potential for adaptation.

2 Three multi-purpose rooms (60m²)
Two sliding walls between them, with acoustic insulation, mean they can be opened for large groups – particularly useful during the school's science festivals and for large group presentations.

3 Two dry labs (70m²)
Intermediate practical work spaces between fully serviced labs and the multi-purpose rooms, not equipped for wet practical work. They will have moveable power and walls and moveable, modular furniture.

4 Incident centre
The dry labs, the auditorium and another larger space will be interconnected, divided by sliding partitions, and linked to a central hub that will form an incident centre, a space for students to carry out decision making, strategic thinking and problem solving – cast as government officials, for example, reacting to an event or situation, such as the Gloucestershire floods.

Budgets permitting, the incident centre will be fitted out as a stage set, with layer upon layer of flexible enclosures and technologies that the school can use in different ways as its learning and teaching evolves. Sliding screens or full height curtains allow enclosures to be defined in more or less formal ways. If funds allow, this incident centre will create different environmental conditions using lighting, plasma screens, ICT and theatrical visual reality elements on the surrounding walls and enclosures. This caters perfectly to the school's plans to maximise cross-disciplinary learning and teaching.

The stage sets will also be able to create and simulate virtual reality spaces, using three-dimensional stereo projection – already used by the military and for entertainment. This can be as simple as having two overhead projectors, set at 90 degrees to each other. For a modest cost, it offers a wide field of view and greater realism for students. It also allows multiple users, and for viewers to move in 3D.

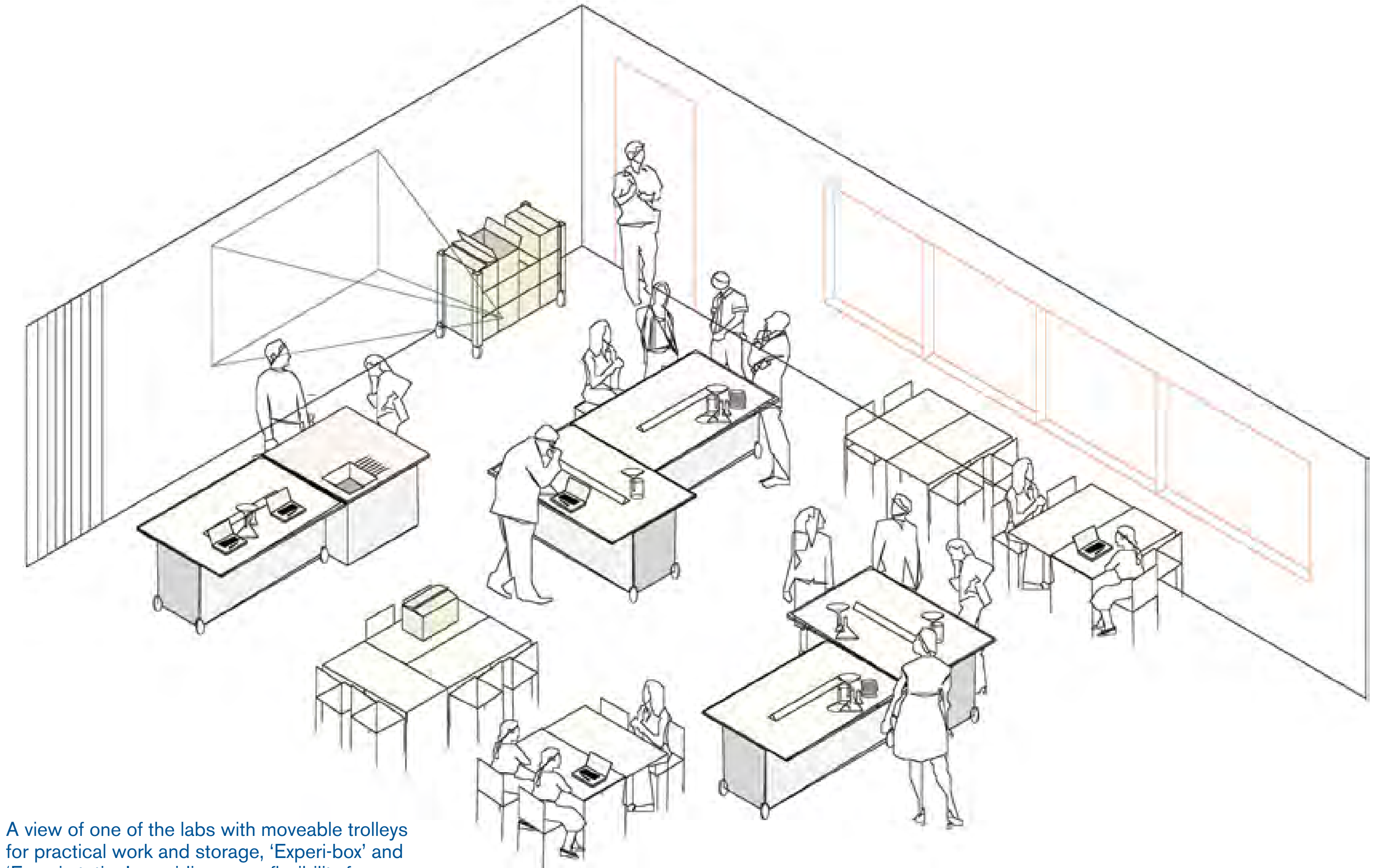
Recessed lockers will be hidden in one of the walls of the incident centre to provide extra storage space.

5 ICT pod
In the atrium near the centre of the science department, the ICT pod will have 12 workstations for students to carry out research on the internet and for other computer-based learning.

6 Learning wall
One of the walls in the atrium will have a series of informal breakout areas, where small groups of students or individuals can work away from the distractions of a larger group. There will also be a large measuring scale on the ceiling. Like the glass lift, rainforest images and a dinosaur fossil elsewhere, this helps to make the building itself useful for science learning.

7 Prep room
A central prep room serving the whole department and well positioned to support the incident centre.

This artist's impression gives a flavour of what the finished science wing will look like.



A view of one of the labs with moveable trolleys for practical work and storage, 'Experi-box' and 'Experi-station', providing more flexibility for science learning.

Using the whole campus

The school plans to use a number of building features to demonstrate scientific concepts including a prismatic balustrade. As well as being a beautiful object and a design feature, the balustrade will help teaching about the way light behaves, showing how different wavelengths of light refract and reflect differently in a prism.

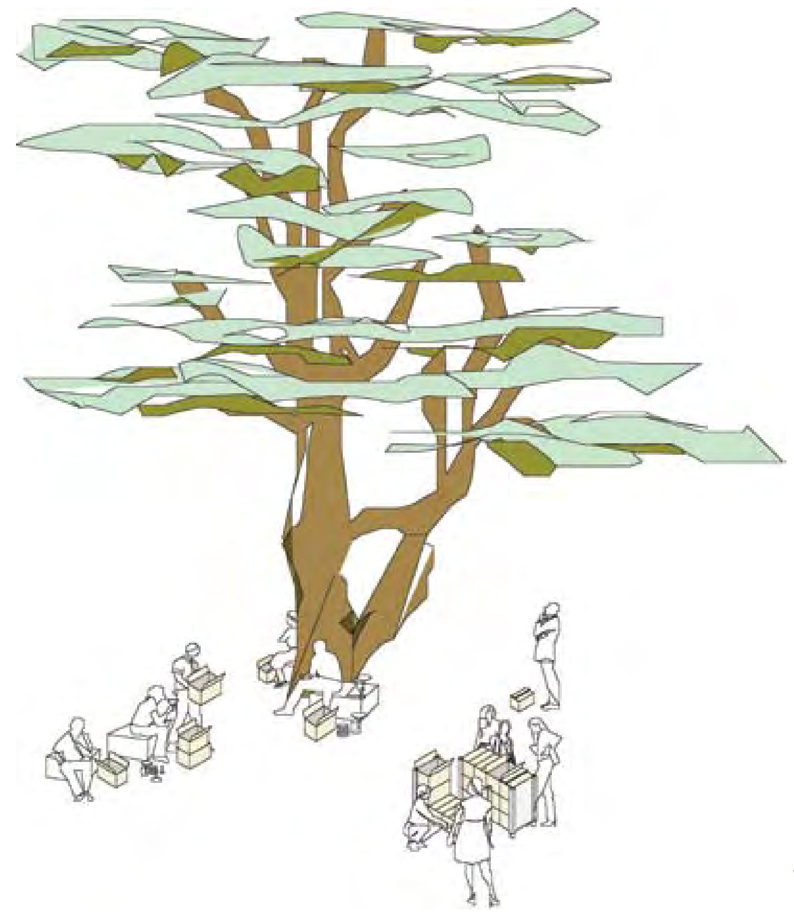
Pupils will learn from the school's sustainability measures. The school was assessed as 'excellent' under BREEAM (the Building Research Establishment's Environmental Assessment Method), and is aiming for carbon neutrality. Sustainability measures include a 15m-high wind turbine, underfloor heating linked to a biomass boiler fuelled by wood pellets, photovoltaic panels (generating solar electricity) on the roof of the main hall, and a sedum roof. The biomass boiler alone is estimated to save 160 tonnes of CO_2 each year.

Rainwater will be collected from the school's roof for flushing toilets, which will reduce the mains water use by around 750,000 litres a year. A SUDS scheme will deal with the remaining rainwater, using swales, permeable paving and a wetland study area.

There are outdoor teaching spaces, with active educational installations tied into the curriculum. For example, there's a weather monitoring station and the rainwater harvesting system can be used in science teaching, both for climate topics and fluid dynamics. Outdoor areas are planted with indigenous plant species, and one of the two existing mature cedar trees is equipped with a growth monitor for long-term experiments.

Flexibilty

The Faraday team considered furniture for the school very carefully, and came up with a series of innovative ideas, from an 'Experi-box mobile trolley' to an 'Experi-station'. The first is a robust trolley with a series of built-in storage boxes, completely independent and suitable for fieldwork and students working in groups. The second, which supports practical work indoors and possibly outside, has a small amount of storage space and incorporates small power and data services. It's suitable for cross-curricular work – for example, transforming a sports hall into a venue for sports science investigations.



Moveable trolleys will allow students to work outside.

"We want to see what happens for real, not reading it from a text book."

Student, Rednock School

Cost commentary

- The concept designs for Rednock School extend beyond the core science accommodation, enhancing the science learning journey from the entrance to the science department. The cost of these items is in addition to the costs stated below.
- The main extra costs relate to the incident centre (feature ceilings and moveable service pods to the lab, projection equipment and plasma screens), interactive display walls, and the scenic lift. In addition there is a GRP pod that is within the science department, although this is part of the overall school design and not particular to Project Faraday.
- The extra cost of the concept design compared to a traditional science facility of 13 labs is £583/m^2 of the gross internal floor area. This is at the higher end of the cost range of the extra costs identified for the Faraday schools.
- The school is planning to phase in the most sophisticated technology as their budget allows

.

CLEAPSS comments

- The demountable walls between labs and around the 'hub' offer many interesting possibilities but must provide adequate sound insulation when closed.
- The design, structure and material used for the partitions must be carefully considered to avoid a fire hazard, particularly where they combine with a run of fixed benches to form the dividing wall between labs.
- Access to perimeter benches should not be hindered by loose furniture when the benches are required for whole class practical work.