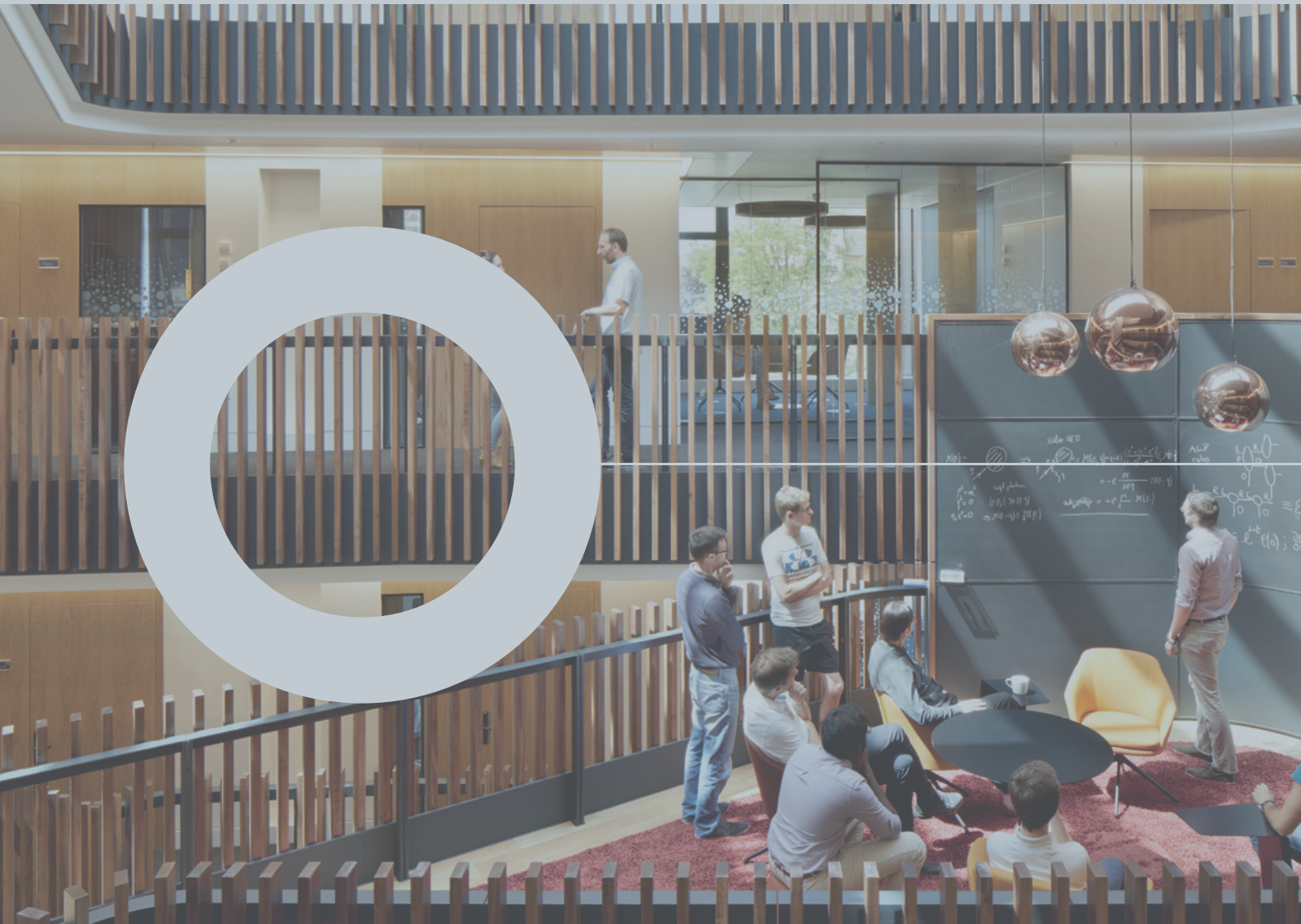
HOARE LEA

A space to innovate. World-class control. Challenge accepted.

HOARE LEA & BEECROFT BUILDING



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It’ll be a unique challenge: extreme close-control laboratories...

Arguably, the most exciting and transformative breakthrough of the 21st century will come from the world of quantum computing. Once thought of as impossible to build, quantum computers transfer information on an atomic scale rather than via silicon chips.

However, quantum computers are incredibly hard to build. With prototypes currently the size of a small room, the race is on to develop useable machines.

Without doubt our most challenging project to date, the Beecroft Building is one of the world’s most demanding facilities, and is where quantum computers will be developed.

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...We’ve never been more ready! Excited to get started.

“Our biggest challenge? Designing a level of vibration control that no other facility around the world could better.”

MATTHEW JONES
PARTNER AND PROJECT LEAD

CLIENT: UNIVERSITY OF OXFORD
ARCHITECT: HAWKINS\BROWN
PROJECT VALUE: £40M

Our approach.
Meet Matthew Jones, Partner and project lead on the Beecroft Building.

"In close collaboration with architect Hawkins\Brown, MEP contractor Crown House, and the University of Oxford, we set out to help deliver one of the most complex projects we'd ever been involved in. Working with some of the brightest people on the planet, and seeing our people really rise to the challenge, was so rewarding."

PLANT PRECISION:
The interstitial plant floor
is designed to remove all vibration.

DEMANDING DESIGN

Manufacturing qubits requires extreme precision: microscopic work that involves imposing information onto a single ion using a laser. Temperature and humidity control is therefore vital in the quantum technology laser labs. Even the smallest change in temperature – just half a degree – could cause the ion to move within its trap or the laser beam trajectory to alter, meaning the experiment is misaligned.

Equally, a single, minimal shudder from a bus driving past the building could affect the work taking place.

The experiments involve scanning tunnelling microscopes (STMs). These highly complex and sensitive instruments use an electrical probe whisker, dragging it across materials to map their surfaces at an atomic scale.

To provide a worthwhile image of the material's surface, extremely tight levels of vibration curve M (VC-M) are required within the STM labs. This standard is well beyond the requirements of even operating theatres and has only been achieved by a handful of facilities around the world.

SERVICES PROVIDED

- MEP
- SUSTAINABILITY
- FIRE ENGINEERING
- ACOUSTICS
- MEP VIBRATION
- LIGHTING DESIGN

A PROJECT DRIVEN BY COMPLEX DEMANDS

INNOVATIVE THINKING

ADDED COMPLEXITY: VIBRATION VS CLIMATE CONTROL

Our biggest challenge was designing the near-impossible close-control climate systems (with high air-change rates) while achieving the ambitious vibration-control targets. This complexity meant it was integral that our experts took a more connected approach than usual.

CONNECTED APPROACH: RESEARCH-INFORMED STRATEGIES

We worked closely with the architect, MEP contractor, the University, and – in particular – the structural engineer and vibration consultant. Together, we agreed on strategies that would help achieve tight vibration control. These strategies ranged from having no rotating plant installed within services spaces local to the STMs, to the ability to shut down services serving the STMs during experiments. We also engaged with suppliers, and visited factories and existing sites in order to obtain vibration data for the plant we were proposing.

Most significantly though, was the use of specialist high-efficiency anti-vibration support systems, which act as shock absorbers for the laboratory spaces – allowing them to remain unaffected when the building moves in response to external forces.

EFFICIENT WORKING: SUSTAINABLE DESIGN

We proposed one solution to meet the close-control climate requirements across all the labs. It was a radical approach: a single large-scale system.

Close-control labs are traditionally not energy efficient so, to minimise the impact of our system, we included the use of low and zero carbon technologies. We designed a variable volume demand-led system that has the ability to turn down when laboratories aren't in use to minimise the system's energy consumption. A Ground Source Energy System (GSES) and a Combined Heat and Power system (CHP) also helped the project meet the requirements of Part L and achieve an impressive BREEAM Excellent rating.

18
keel slabs for vibration control.

2
below-ground laboratory levels.

20
laser labs.

TECHNICAL ACHIEVEMENTS

+/-5%
relative humidity.

+/-0.1°C
temperature stability tolerance.

VC-M.

The laboratories housing scanning tunnelling microscopes (STMs) and laser tables were designed to have the highest possible vibration-control rating – vibration curve M (VC-M).

0-10v signal.

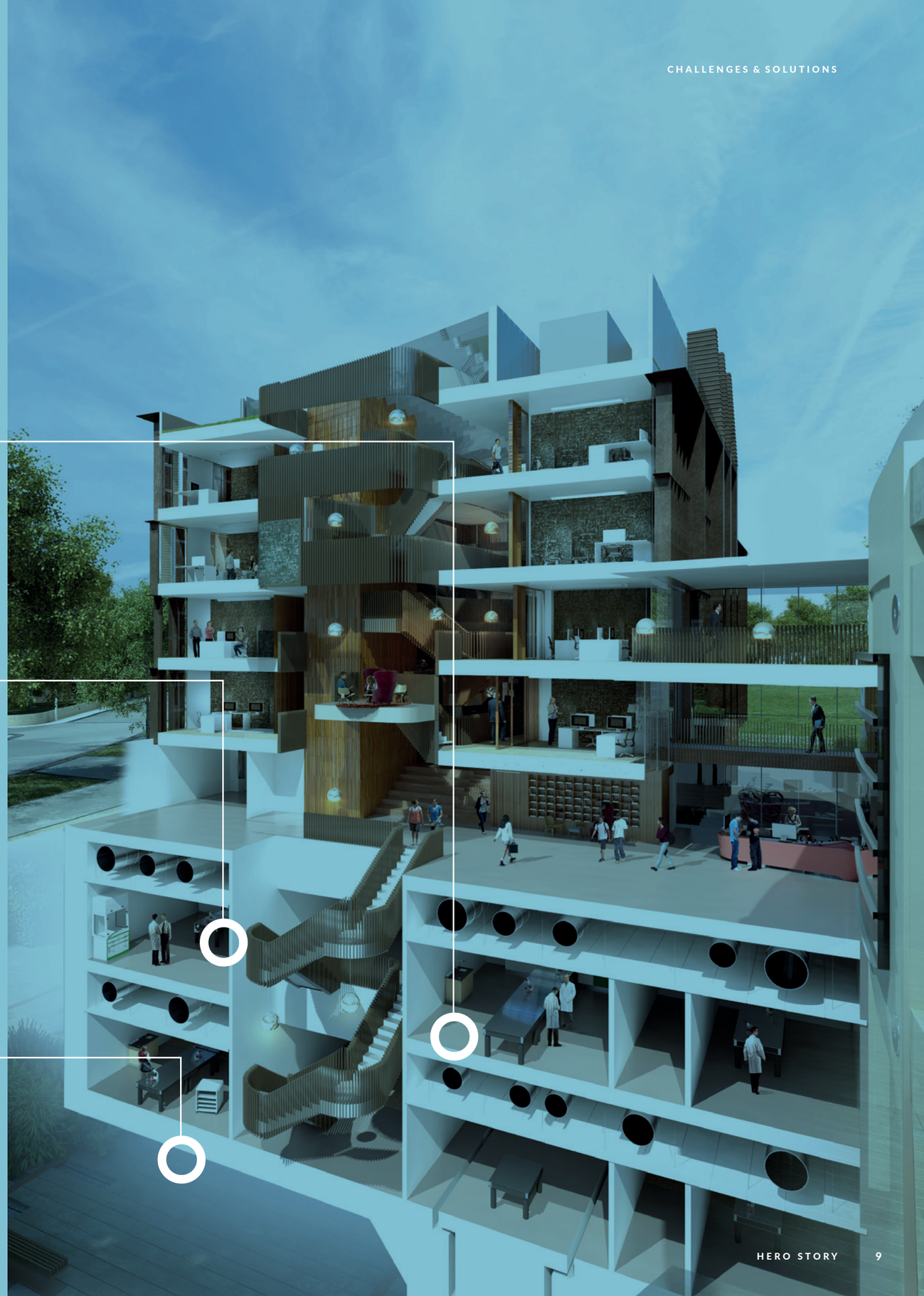
Fast-acting PID-loop control systems are required for each lab. These operate electric thyristor batteries with a 0-10v signal that responds to on-coil and off-coil temperature sensors only.

2 heater batteries per laser table.

The first does a coarse temperature lift and control to within +/- 0.5°C, and the second does a fine lift and control to +/- 0.1 °C.

CHP & GSES.

Low-carbon technologies, such as a Ground Source Energy System (GSES) and a Combined Heat and Power (CHP) system, ensure the building is as energy efficient as possible.



Project impact.
The power of the prototype.

After our teams had reached the best design proposal possible, we made a decision to test the proposed solution even further: with a real-life model. Running the system in this real-world environment meant we discovered it behaved in a way no digital model could have predicted…

THE OLD WITH THE NEW:
Beecroft sits opposite the Grade I listed Keble College Chapel and had to satisfy the demanding planning requirements of such a sensitive site.

A PIVOTAL MOMENT

Probably the most valuable decision we made when working on this project? Asking the project contractor to build a prototype of our close-control solution. Running the system in an Oxford warehouse, we found it wasn't quite meeting the exacting environment criteria we needed.

After this discovery, it was all hands on deck – we brought the entire project team together, and even called on experts with completely different skillsets and techniques. Using the mock-up to test and re-test our new proposals as we developed them, we eventually landed on an innovative solution that achieved the near-impossible levels of temperature and vibration control.

Without the prototype? This valuable process of refinement couldn't have taken place until the time-constrained and costly construction stage. Even more significantly, it gave the people who will work in the laboratories the chance to 'test drive' their system.

It was a process that benefited all parties – germinating ideas, provoking discussions, and creating a better and more honest dialogue with the people it was designed for.

"The prototype enabled us all to gain confidence in a very difficult and technically challenging part of the project."

STEPHEN PEARSON
HEAD OF BUILDING SERVICES, UNIVERSITY OF OXFORD

“Our work satisfied the truly demanding briefs set by the client and planning authority.”

NICK LAWRENCE
PRINCIPAL ENGINEER

SOUND DESIGN

The Beecroft Building isn’t just about world-class laboratories. We also crafted the environments for four above-ground levels that house theoretical research spaces. While a key aim was to promote collaboration between the theoretical physicists using the building, we had to ensure the central open atrium and suspended platforms didn’t compromise the smaller offices. In response, we undertook a number of acoustic measures to ensure the private rooms remain calm, quiet and undisturbed.

TRANSFORMATIVE SPACE

As the physics department’s first new building in 50 years, this project is hugely important. It is hoped that such a step-change in the quality of the department’s infrastructure will equip it for cutting edge science in the 21st century. With the Beecroft Building now housing some of the brightest minds from across the world, we are proud to have played our part in creating the best possible environment for them.

BETTER TOGETHER:
The central space encourages and focuses interaction between researchers.

“This is a building that will provide our world-leading scientists at the Department of Physics with the very best facilities in which to undertake their pioneering research.”

PROFESSOR JOHN WHEATER
HEAD OF PHYSICS DEPARTMENT, UNIVERSITY OF OXFORD

SPACES FOR CONTEMPLATION AND FOCUS

Achievements recognised.

– One of the first science and research developments to achieve BREEAM Excellent.
– The highest possible vibration control rating: VC-M.

COMPLETED WITH PRIDE

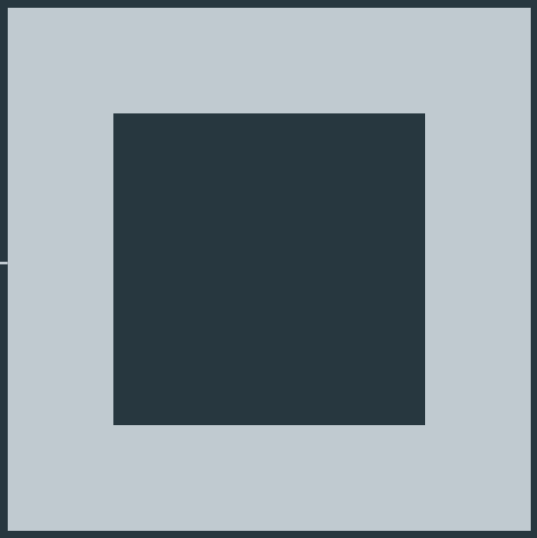
HOARE LEA

Engineers of human experiences.

Hoare Lea is an award-winning engineering consultancy with a creative team of engineers, designers, and technical specialists. We provide innovative solutions to complex engineering and design challenges for buildings.

Irrespective of the scale or complexity of a project, we provide a full range of MEP, environmental, and sustainability services, bringing buildings to life and ensuring that they perform in operation as well as they look.

HOARELEA.COM



Designed and produced
by Hoare Lea