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Future Labs
Strategies for designing and building laboratories that adapt, innovate, and thrive

Contents

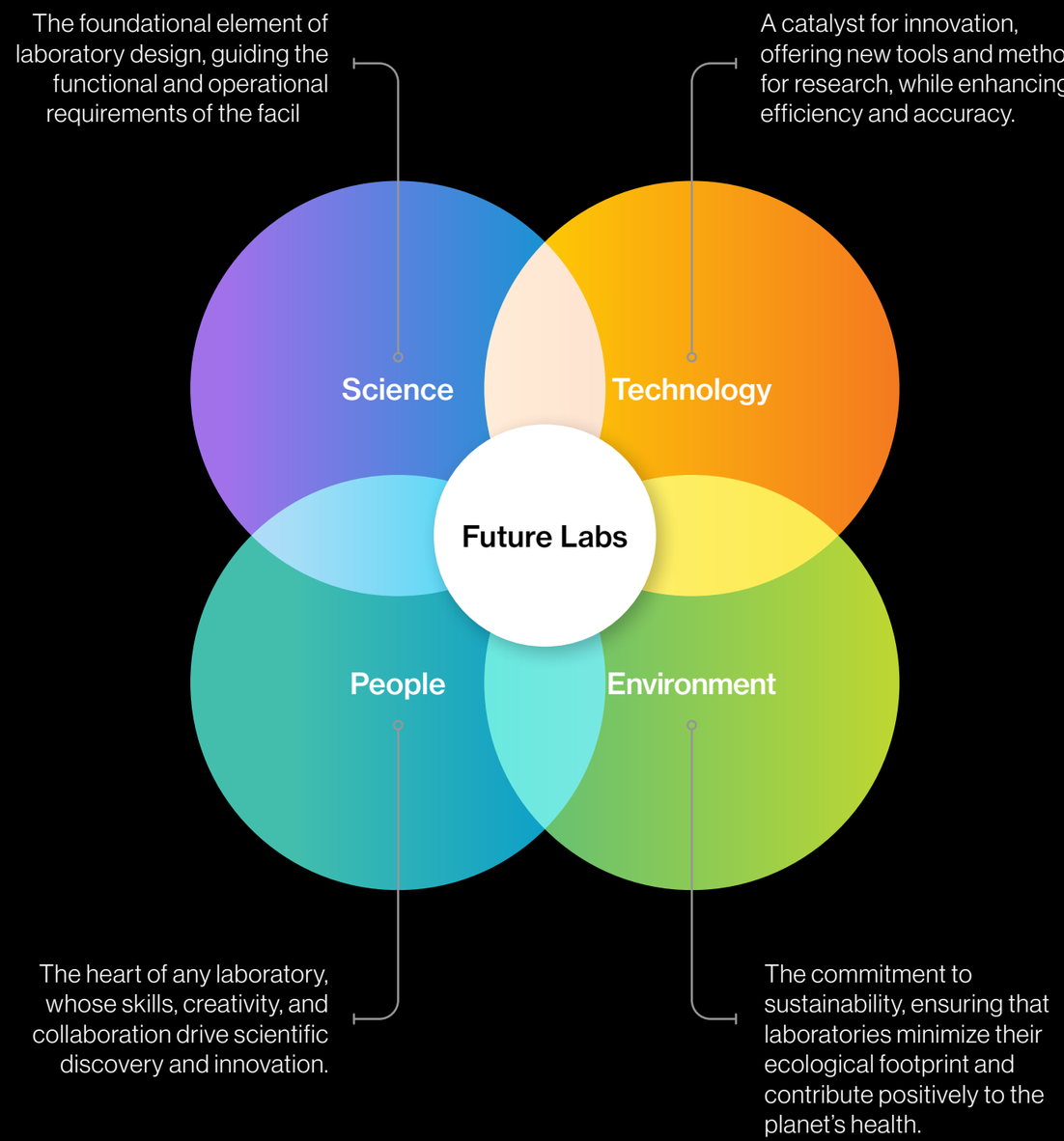
OVERVIEW

The Future Lab framework

The landscape of laboratory design is undergoing a profound transformation, driven by rapid advancements in healthcare research and the increasing importance of sustainable practices. Laboratories serving the fields of biotechnology, pharmaceuticals, and biomedical discovery are at the forefront of this change, requiring a forward-thinking approach that integrates the latest in scientific and technological innovations with a deep consideration for environmental impact and human well-being.

This white paper discusses how **science, technology, people, and the environment** converge in creating laboratories that meet current demands and are flexible enough to face tomorrow's challenges. Each of these topics represents a critical aspect of laboratory design and operation, underscoring the need for a comprehensive strategy that balances cutting-edge scientific research with advancements in technology, workforce empowerment, and sustainable design principles.

The present moment, more than any before, demands a reimagining of how laboratory spaces are designed and delivered. With the pace of change accelerating, designing labs that can stand the test of time and be delivered at speed requires an integrative approach that considers not just the immediate needs but also the near-term and long-term future of scientific research.



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01

Science first

Prioritize the foundation of innovation

In the rapidly evolving landscape of life sciences, the principle of “science first” goes beyond philosophical ideals—it is a critical blueprint for the future of laboratory design and construction. Recognized as the experts in their fields, scientists drive the relentless pursuit of discovery and innovation. **Adopting a “science first” mindset is crucial for the thriving future of laboratory design.**

SCIENCE FIRST

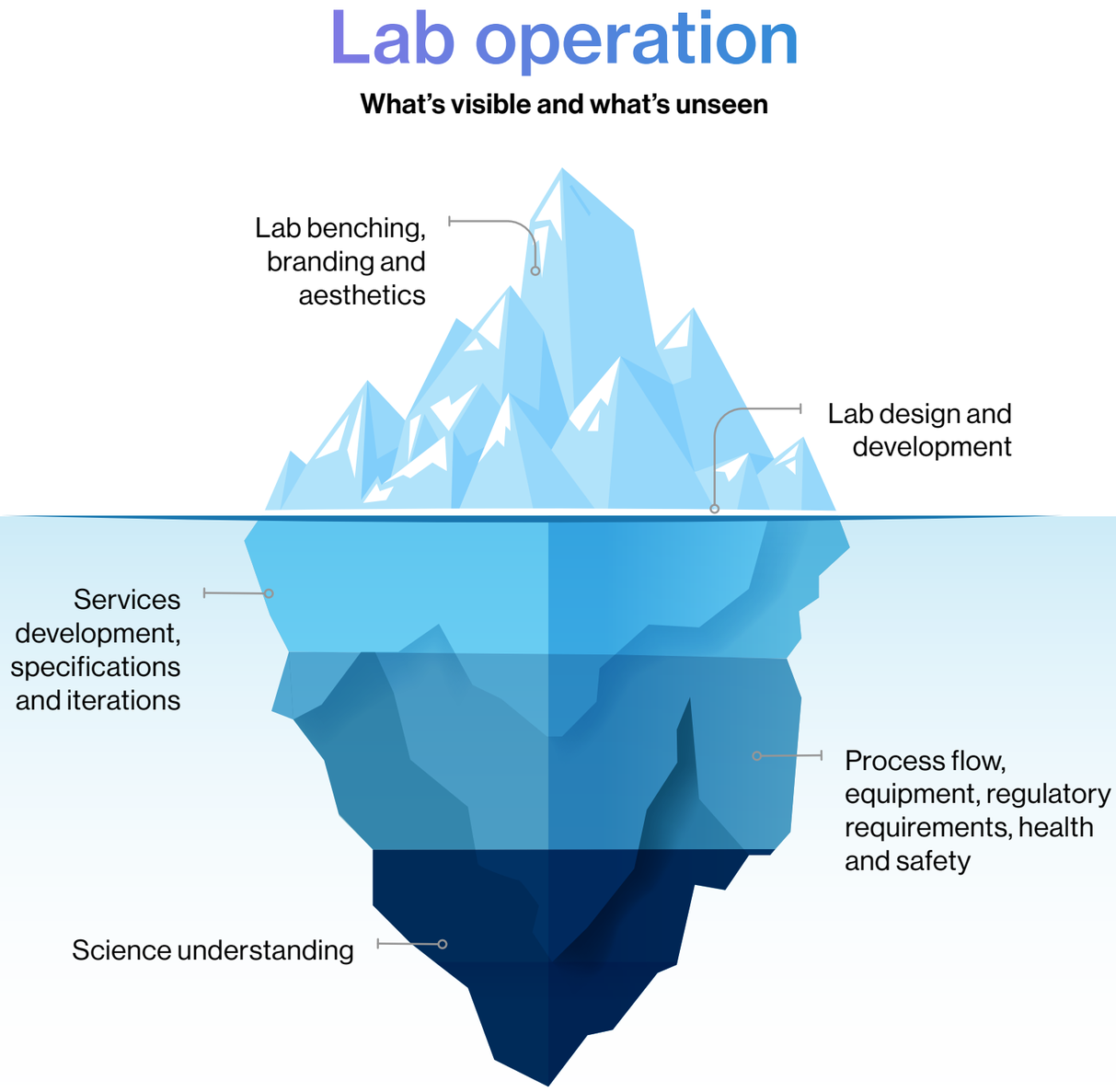
Why “science first” matters

Adopting a “science first” approach in the design and construction of laboratory facilities is crucial to support the demanding and dynamic nature of scientific research.

Much like an iceberg, where only a small portion is visible above the water, this philosophy ensures that facilities are meticulously designed to accommodate complex operations beneath the surface, comply with regulations, and support the technological needs of future research.

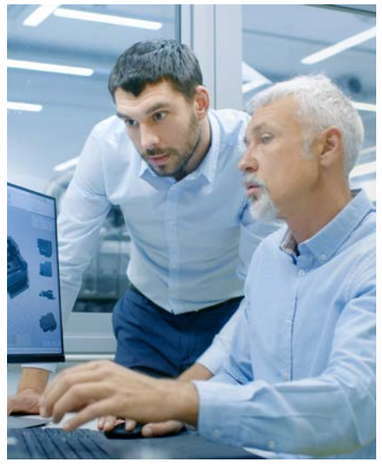
By prioritizing the unique requirements of scientific inquiry from the outset, laboratories can become centers of innovation and discovery, enabling scientists to address global challenges effectively.

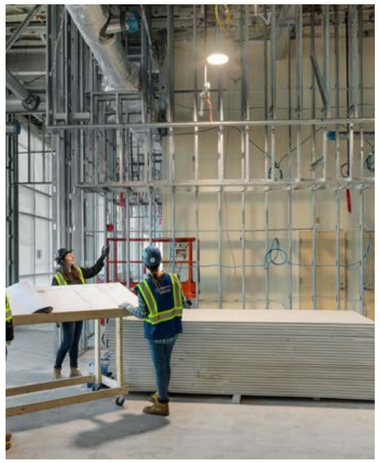
This approach emphasizes strategic planning and collaboration, ensuring that research environments are not only functional for current needs but also adaptable to future scientific advancements.

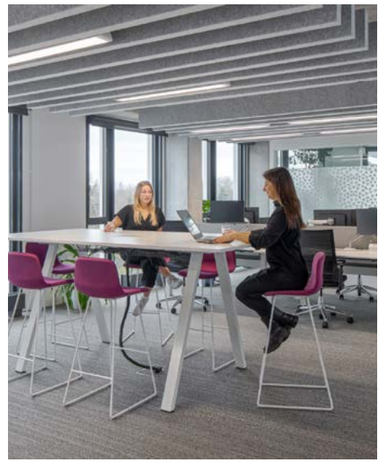


6 tips to prioritize “science first” in future-proofing your facilities

These key considerations emphasize the importance of prioritizing a “science first” approach to ensure your facilities are ready for the future







01

Build trust and understand the vision

Understanding and aligning with the vision and goals of the scientific founders and organization helps build trust during early engagement with the client team and understanding their passion.

02

Engage laboratory users

Clearly define project requirements to build trust, secure buy-in, and facilitate change acceptance, ultimately reducing the fear of change.

03

Involve the construction team

Including a broader construction team from the outset, with a focus on science, enables informed decision-making. This continuous engagement promotes the skill development necessary for creating complex scientific facilities.

04

Integrate with the ecosystem

Scientific research is not an isolated endeavor; it operates within a broader ecosystem that includes supporting industries, regulatory bodies, and academic institutions. This interconnected environment fosters further developments across the sector, demonstrating the communal nature of scientific advancement.

05

Keep up with trends

Staying informed about the latest scientific discoveries, lab design innovations, and industry benchmarks is crucial. These trends directly impact R&D facility design, guiding decisions toward creating flexible and sustainable spaces that can adapt over time.

06

Develop talent

Investing in team members who grasp both the intricacies of science and the practicalities of construction is vital. Such personnel act as bridges, accurately translating facility requirements to suppliers and ensuring that the laboratory infrastructure aligns with scientific objectives and compliance standards.

02

Technology

Design spaces that enable integrated technology

The rapid pace of technological advancement has dramatically transformed the way we work.

The adoption of Artificial Intelligence (AI) and machine learning in laboratory operations stands at the forefront of this change. It serves as a crucial element in keeping pace with rapid technological progress and revolutionizing operational procedures.

By automating tasks that are manual and potentially hazardous, this integration not only enhances safety but also allows scientists to engage in more creative and innovative work.

Looking forward, the realm of scientific research is set to become more collaborative. This shift is driven by the need for increased productivity, knowledge sharing and efficiency, particularly considering the rising costs associated with developing new drugs.

Leveraging technology, especially through automation, big data, and AI, is key to overcoming these challenges. It serves as the cornerstone for making processes more efficient, accelerating scientific breakthroughs, and speeding up the development of new treatments.

10 ways laboratories will adapt to integrate technological advancements

01

Machine learning and predictive analytics

Advanced tools and automation are revolutionizing drug discovery and development, evolving traditional wet labs into efficient dry labs. Virtual models and predictive analytics are transforming animal studies, while automation, such as system reactors and in-process monitoring in clinical development will reduce GMP facility needs. Quantum computing promises to enhance drug discovery with faster data processing. For example, the lead optimization stage can be expedited by simulating molecular structures and drug target interactions.

02

Wet lab spaces

While essential for the drug discovery stages, these spaces will increasingly use automation to boost productivity. This includes continuous operation, data integration, concise analysis, and streamlined presentation to support remote collaboration. Advances in cloud storage will also reduce the need for on large on-site servers and physical lab spaces.

03

Instrumentation and miniaturization

Advances in sophisticated scientific instrumentation for analysis and measurement are being refined. Breakthroughs such as lab-on-a-chip technology are poised to accelerate drug discovery and development by integrating one or several laboratory functions on a few millimeters of single integrated circuits, thus reducing footprint, sample size, and processing time.

04

Reduction in physical lab footprint

An increase in the capabilities of power and data management is leading to the design of smaller, more efficient labs. This evolution is driven by technological advances that support the use of smaller, yet more powerful, equipment, minimizing the need for expansive lab spaces.

05

Geographical flexibility in workforce allocation

Companies need to consider geographical workforce distribution, especially where remote collaboration is common. Lab work traditionally required on-site presence, but advances in remote monitoring and data analysis now enable effective global work, promoting flexible staffing models in life science

Given the rapid technological evolution witnessed over the past two decades, predicting specific outcomes becomes complex. Yet, the involvement of tech giants in healthcare suggests an imminent, significant impact of AI and machine learning on the life sciences industry, reshaping laboratory design and function.

The future of laboratory design is intrinsically linked to technological advancement, requiring a forward-thinking approach that embraces flexibility, innovation, and sustainability.

10 ways laboratories will adapt to integrate technological advancements

06

Varied pace of technology adoption

The rate of technological adoption varies widely between large pharmaceutical companies and smaller biotech firms, largely due to differences in resources and expertise. Larger companies typically have the means to invest more heavily in the latest technologies.

07

Sustainability in instrument and equipment design

Suppliers in life sciences are increasingly expected to deliver products that are technology enabled and designed with sustainability in mind. This is essential for reducing environmental impact and achieving the industry's sustainability objectives.

08

Design adaptable spaces

Lab designs of the future must prioritize flexibility, allowing for quick adjustments in focus based on scientific demands. The ability to efficiently transition activities, whether ramping up for drug development or scaling down projects, is crucial.

09

Smart lab infrastructures

Embracing smart lab technologies from the design stage is vital, despite the challenges of varying global adoption rates and regulatory landscapes. Smart labs integrate automation, advanced data analytics, and remote operation capabilities, streamlining research processes and improving productivity.

10

Enhanced security

In an era where laboratories grow more digitized and dependent on interconnected technologies, ensuring high levels of data protection and system security becomes critical. This includes safeguarding sensitive research data and personal information against cyber threats, emphasizing the necessity for robust security protocols and systems.

CASE STUDY

Preparing for the quantum revolution

One of our quantum computing clients is at the forefront of solving humanity's biggest challenges, from climate change to drug discovery. To support their mission, Unispace engineered a state-of-the-art facility.

How we delivered:

- ISO7 clean room: Equipped with a ducted fume cupboard
- Cryostat rig area: Includes power and data supplier, control units, and cooling pumps
- Compressor plan: Custom-designed with chilled water distribution systems to efficiently cool cryostats and keep the quantum computers functioning

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03

People

Attract and retain talent through thoughtful design

The quest to understand scientists' preferences is foundational to laboratory design. Recognizing that **scientists are the most valuable asset of any research organization, their needs and wants should guide the architectural process.** Our scientific and construction knowledge and experience enables us to fully understand and bridge the gap between science and construction.

Boston Scientific, Clonmel, Ireland

Bridging generational expectations and prioritizing wellbeing

Workplace expectations among scientists differ across generations — from Gen Z and Millennials to Baby Boomers.

Each group exhibits unique working styles, varying degrees of comfort with technology, and distinct attitudes toward change. Furthermore, their views on wellbeing, mental health, and the significance of work-life balance vary substantially.

Wellness should not be viewed as a mere addition but prioritized and integrated into the lab's infrastructure, significantly enhancing the work environment. This strategy not only enriches break times and periods of rest but is also key to attracting and retaining top-tier talent.

The rigorous demands of scientific research include long hours of standing, intense concentration on individual tasks, and working under stringent conditions such as GMP (Good Manufacturing Practice) environments that require comprehensive PPE. As such, prioritizing employee wellbeing is essential in laboratory design.

Consequently, laboratories need to be tailored to accommodate this wide array of needs, creating an environment that is not only inclusive but also inspiring.

Biogen, Baar, Switzerland

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How to design spaces that support your people

To design spaces where your people want to work and that enables them to thrive is a muti-faceted approach. **Not only must you consider the physical space, but you must also think about the people working there and what they need beyond the space.** To do this organizations must allocate a portion of the budget and floor space for enhancing wellbeing.

This commitment shows the organization's dedication to its employees by investing in their health and productivity. **Such investments lead to more productive employees, improved retention, better attendance, heightened motivation morale – all of which positively affect the bottom line.** Furthermore, appointing a wellbeing champion can ensure the successful implementation and sustainability of wellbeing initiatives.

To ensure success organizations must monitor the impact of these wellbeing initiatives and share the results with stakeholders. Data-driven feedback will ensure continuous improvement and help justify the investment.

10 strategies to enhance laboratory wellbeing

01

Balance function with aesthetics

For life sciences and tech firms, balancing lab design with aesthetics is crucial. High material and HVAC costs make labs expensive. Addressing storage early enhances functionality and appearance. In high-containment labs (BSL/CL/PC-3/4 and GMP facilities), using closed-system equipment and digital wallpapers improve the work environment.

02

Create open and collaborative spaces

Design labs with open, collaborative spaces to enhance transparency and innovation. Use writable walls and interactive displays for brainstorming. Ensure the layout promotes collaboration, accommodates specific needs, and maintains visibility between lab and office areas for openness and inclusivity without compromising confidentiality.

03

Include training and educational areas

These areas should be versatile and capable of hosting meetings, town halls, or team-building activities. Features such as tiered seating can accommodate different event formats.

04

Create versatile and flexible spaces

Design adaptable environments with reconfigurable workstations to support diverse research activities. Ensure flexible essential services (power, data, gases) to accommodate layout changes without disruption. Use modular elements and a mix of fixed and mobile benches for versatile lab design.

10 strategies to enhance laboratory wellbeing

07

Keep neurodiversity top of mind

Create an inclusive environment for all neurotypes. Organizations like Harwell Science and Innovation Campus and Advanced Research Clusters exemplify the importance of investing in spaces that enable equity and diversity in science, promoting an inclusive lab for the future.

08

Showcase the science

Displaying science to the public and engaging with the community can give organizations a competitive edge. Accessible science and community involvement can foster a positive organizational image.

06

Integrate shared core facilities

These may include glassware cleaning stations to maintain laboratory equipment, cryostorage for sensitive biological samples, analytical suites with advanced instruments for precise measurements, and waste management services for proper hazardous material disposal. Leveraging these shared resources enhances productivity, reduces costs, fosters a collaborative work environment, and promotes efficient resource utilization.

06

Incorporate green spaces and natural light

A comfortable workspace incorporates green spaces and maximizes natural light in its design. These elements greatly enhance mental and physical wellbeing, fostering creativity, and reducing stress.

05

Consider ergonomic design

Invest in ergonomic furniture and adjustable workstations. Ensuring the lab is ADA/DDA compliant not only supports the health of all employees but also enhances the organization's reputation.

10

Develop comprehensive amenities and wellness programs

Incorporating wellness programs and relaxation spaces for holistic wellbeing, such as exercise/yoga studios, meditation and prayer rooms, and on-site nurseries or nursing rooms. Include free hot meals and on-site cafes, demonstrating a shift towards a supportive work environment that meets the diverse needs of employees and attracts diverse talent, including women researchers. This fosters a collaborative work environment, and promotes efficient resource utilization.

CASE STUDY

Focusing on on-site childcare

One of our UK clients recognized the importance of supporting working parents, particularly young women scientists, in balancing their careers and family life. By investing in an on-site nursery adjacent to their laboratories, they addressed a significant barrier to retaining talented employees facing childcare challenges. Despite the regulatory complexities involved in integrating childcare facilities within a scientific research environment, the firm persevered, demonstrating a strong commitment to employee welfare and diversity in the workplace.

CASE STUDY

World-class facilities in the innovation district spurs success for drug discovery firm

Initially housed in outdated and scattered hospital facilities, our client faced significant challenges. The environment hindered innovation and collaboration, resulting in substantial funding losses. Recognizing the need for change, the firm relocated to a modern building in London's emerging innovation district.

How we delivered:

- Created BSL/CL/PC Level 2 laboratories
- Designed collaborative office spaces for their global scientific team

The improved environment boosted morale and productivity, drawing attention from the pharmaceutical industry. This led to a major investment from a big pharma company, underscoring the importance of an innovative and supportive workspace.

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04

Environment

Craft sustainable environments

Creating laboratory spaces that not only foster innovation but also have a minimal environmental footprint is crucial in today's eco-conscious world. Achieving a positive impact on the planet through laboratory design and operation hinges on two fundamental aspects:

- Environmentally friendly **laboratory design and build**
- **Laboratory operations**, sustainable lab practices, waste reduction, and recycling programs

Laboratories, by nature, are more energy-intensive than typical office spaces using as much as three to five times the energy of offices.

This is often due to the handling of hazardous materials, the need for controlled environments for safety, research integrity, and comfort. Despite these challenges, adopting both environmentally friendly design principles and sustainable laboratory practices can significantly mitigate the environmental impact of these essential scientific spaces.

Sustainability is everyone's responsibility. By rethinking how laboratories are designed, constructed and operated, we can ensure these critical environments contribute positively to our planet's health without compromising their crucial role in scientific discovery and innovation.

Key considerations for sustainable laboratory design and build

Engineering control specifications

Contractors should understand their client's scientific pursuits and the subtleties of their work. This understanding ensures laboratories are neither under nor over-engineered. Inadequate specifications might compromise safety, comfort, or even experiment integrity, while excessive specifications can inflate both initial and operational costs, detracting from sustainability.

01

02

Risk assessment for engineering controls

Conducting an early risk assessment is pivotal. It guides the design of essential engineering controls, including mechanical ventilation (air changes per hour), electrical capacity, lighting, and plumbing requirements, aligning them with the lab's specific needs.

03

Optimizing laboratory process flow

Knowing how research activities flow within the lab can streamline movement and efficiency. Designing optimal routes reduces unnecessary travel distances and conserves resources, contributing to a lab's efficiency and sustainability.

04

Sustainable materials

Choosing sustainable materials for lab benching, flooring, and fixtures not only supports environmental goals but also enhances the lab's long-term viability. These choices reflect a commitment to reducing the ecological footprint.

05

Designing for adaptability and flexibility

Acknowledging research's dynamic nature, incorporating movable benches, modular units, and dropdown services can future-proof labs, allowing them to evolve without extensive redesigns.

06

Incorporating lean methodologies

Applying Lean methodologies in laboratory design improves scientific value, increases resource efficiency, and enhances worker wellbeing. By focusing on reducing waste and increasing value, labs can optimize space usage, share equipment efficiently, and minimize consumables and energy use, aligning with sustainable development goals.

07

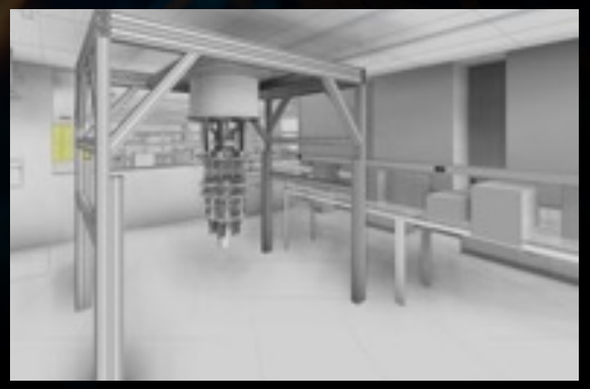
Innovative energy reuse

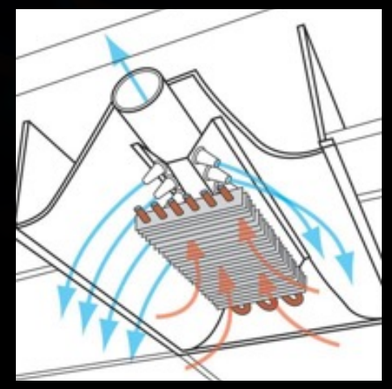
We're leading the way in energy reuse within laboratories by exploring innovative methods to capture and repurpose heat generated from quantum computing. Our goal is to redirect this heat back into buildings or the public energy system, enhancing both efficiency and sustainability.

SUSTAINABILITY IN ACTION

Heat recovery from quantum computing

This project involves adapting chilled beam systems to recover heat exhaust from quantum computing, aiming for energy reclamation. This innovative approach presents a sustainable solution to manage and utilize waste heat.





Essential factors for sustainable laboratory operations

Effective sustainability in laboratories isn't just about large-scale initiatives; small, everyday actions are key in reducing environmental impact. Here are practical tips for making existing laboratory operations more eco-friendly:

Fume cupboard management

Ensure fume cupboard sashes are lowered during use to contain airflows and turned off when not in use to conserve energy.

Solvent selection

Whenever possible, opt for environmentally friendly solvents over hazardous ones, minimizing the ecological footprint of chemical research.

Consumable use

Reduce reliance on single-use disposable gloves and plastic consumables, seeking sustainable or reusable alternatives.

Water and waste

Adopt water recycling methods and on-site waste disinfection processes to reduce the need for external waste transportation and treatment.

Equipment procurement

Invest in laboratory equipment with superior energy ratings and designs prioritizing sustainability.

Equipment maintenance

Perform regular maintenance and servicing on lab equipment to ensure optimal efficiency and longevity.

Solvent recycling

Implement solvent recycling programs and establish a comprehensive waste management strategy to minimize hazardous waste.

Freezer management

Consider increasing the temperature of -80 degree freezers by 10 degrees Celsius, decreasing energy consumption without compromising sample integrity.

Efficient equipment usage

Operate autoclaves and glasswashers only when fully loaded to maximize energy and water efficiency.

Leakage and emissions monitoring

Actively check for leaks in gas and water systems and monitor levels of volatile organic chemicals (VOCs) to prevent unnecessary waste and exposure.

Ongoing training and benchmarking

Engage in continuous researcher training on sustainable practices and compare performance against benchmarks from other labs or industries to identify areas for improvement.

Uniphar, Dublin, Ireland

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Navigating the sustainability imperative

The undeniable impacts of climate change and global warming are influencing everyone. With the rapid acceleration of climate disruption, those in laboratory design, construction and operations must prepare for a future dictated by stringent political and global regulations.

These **regulations are increasingly focusing on sustainability, making it not just an important aspect but potentially a foundational element in the design of future laboratories.** Embracing this change is vital for labs to not only propel scientific innovation but also to make a positive impact on environmental conservation.

CONCLUSION

Shaping the laboratories of tomorrow

Laboratory design has evolved under the influence of factors like business goals, location, budget, market maturity, and political climate, each shaping how modern design and sustainability are integrated into facilities. Business objectives often guide the lab's functionality to align with an organization's mission and research goals. Geography affects design due to climate and resource availability, pushing for energy-efficient and sustainable solutions. Budgets impact the inclusion of innovative and green technologies, while political and regulatory frameworks dictate sustainability and safety standards.

Future Labs will break from traditional layouts, adopting open, flexible, automated, and collaborative spaces. This shift will give scientists the freedom to work more effectively, boosting innovation, creativity, and productivity, and enhancing our understanding of the world.

Marie Curie once said, "Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less."

With this mindset, the scientific community is poised to enter an era of laboratories that not only advance knowledge but also prioritize sustainability and collaboration. The vision for future laboratory design is about creating spaces that inspire tomorrow's discoveries while being sustainable and fostering a culture of eco-conscious research.

Our team includes scientists who guide our lab and workplace consultancy, design, and construction, enabling us to create spaces that support your future research. We work collaboratively with a range of stakeholders from 'conception to completion', anticipating potential issues, mitigating risks, and avoiding any down-time. We are passionate about making our small contribution in delivering the innovative facilities fit for purpose, supporting researchers to focus on their ambitions. With our approach, we make sure to get it right the first time.

CLICK HERE

Reach out to discover how we can help you.

Reference and notes

References

1. https://www.unispace.com/reluctant-returner/generation-z-workplace

Notes

1. Neurodiversity - Creating an Inclusive Lab of the Future: Qualtrics Survey | Qualtrics Experience Management Neurodiversity. - an umbrella term covering a spectrum of neurological differences including autism, ADHD and dyslexia.

2. Glossary

   CL – Containment Level

   PC- Physical Containment

   BSL – Biosafety Level

   GMP – Good Manufacturing Practice

   PPE- Personal Protection Equipment

** Our broad assumption throughout this analysis is centered on laboratories within the sphere of medical research, including life sciences research, biotech, pharma, and biomedical discovery and development. However, the principles and strategies discussed herein are universally applicable across diverse science and technology organizations. Through a detailed exploration of these four pillars, this white paper aims to provide a comprehensive framework for designing and delivering laboratories that are not only equipped to handle today's scientific inquiries but are also adaptable, sustainable, and poised for future advancements.

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