McGill

McGill - Otto Maass 121, photo from Vezina Architects

Design of Research Space

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Introduction

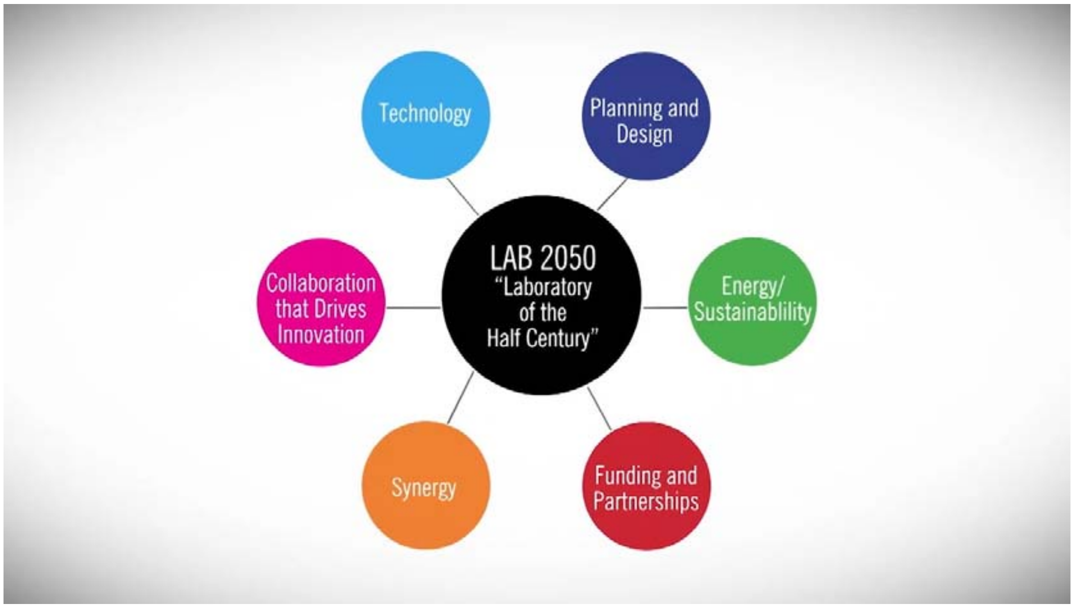
This document aims to provide guidance for the Design Process for future research spaces at McGill. It is written for lab PIs, users, Project Managers, Professionals and Operation & Maintenance people, who will execute a lab project from the Initial phase to the end of the project and who will maintain the spaces after its construction.

Photo from Flad Architects, *Beyond LEED, Sustainable Laboratory Design*

This guide is directly related to one of the five Principal Susanne Fortier's priorities, "Unleashing McGill's Full Research Potential", and which defines as following:

"Today's research landscape is global, interdisciplinary, focused on excellence, and rooted in collaboration with partners of all types (including industry, non-profits, governments, and other universities). This priority area focuses on laying the foundation for McGill to excel in this increasingly competitive and challenging environment."

Recognizing the importance of this statement and the constant evolution in every spheres of Lab Design, whether it is regarding lab organization, technologies, sustainability or health & safety, FMAS wishes, by the adoption of this document, to face the future and adopt the best practices in designing future Research Spaces.



From presentation *Lab2050 : The Future and Science and Laboratory Spaces*, by SmithGroupJJR

Consultation Process

The consultations leading to the Vision, the guiding principles, the design process and the standards to design research spaces of the future took place from June 28, 2017 to December 14, 2017. In total, more than 50 professionals from various sectors participated to the seven meetings that were organized. The consultation process was spearheaded by McGill Design services, in close collaboration with the Office of Sustainability and Environment, Health and Safety.

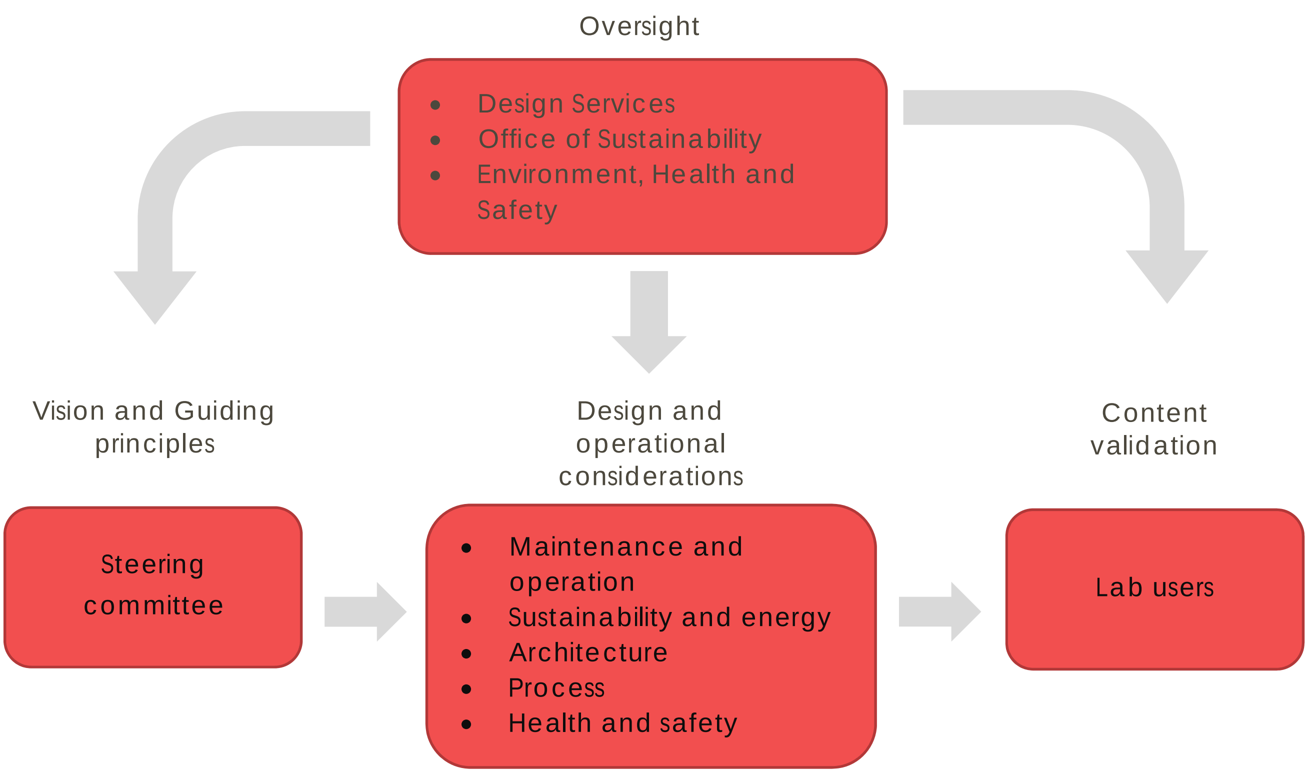
The consultation sessions were meant to address the main design and operational considerations of the labs of the future, and gather the opinions and feedbacks from professionals who are either planning, using or operating labs at McGill.

The seven meetings tackled the following topics:

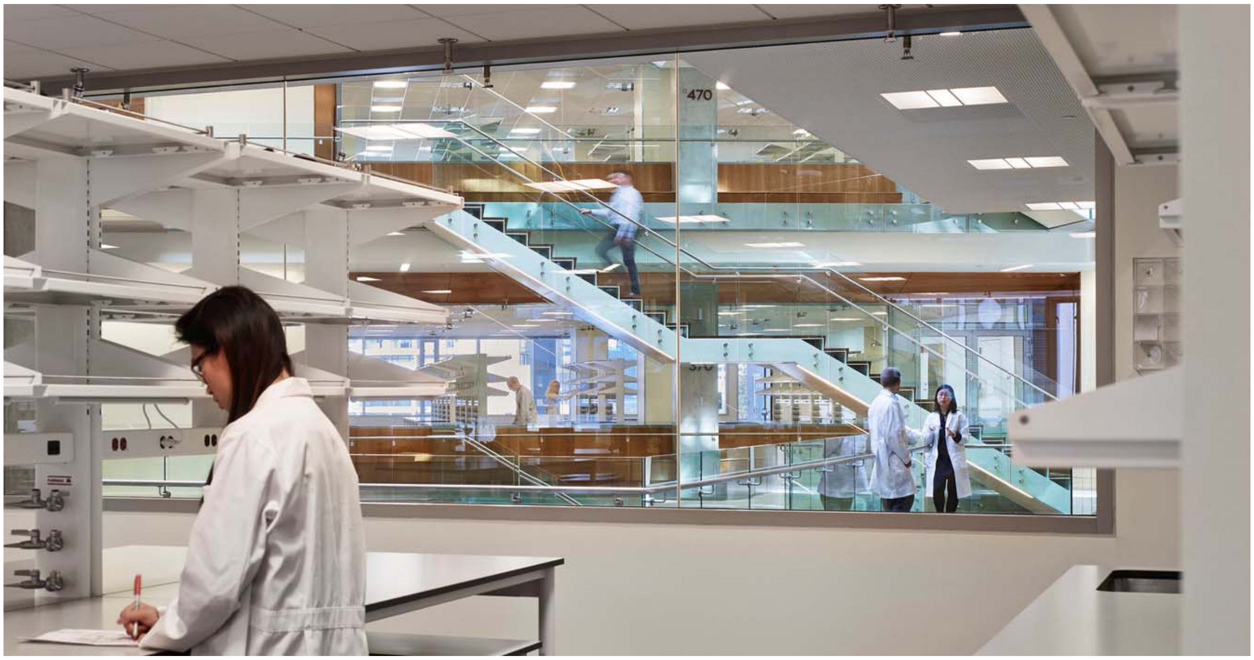
- Steering committee – Vision and Guiding principles (June 28, 2017)
- Maintenance and Operation (October 24, 2017)
- Sustainability and Energy (November 9, 2017)
- Architecture (November 15, 2017)
- Process (November 20, 2017)
- Health and Safety (December 12, 2017)
- Lab Users (December 14, 2017)

The focus groups of these topics contributed to the overall approach, and had a precious input on the principles, the process and the standards to design research spaces at McGill.

Overview of the consultation process



Vision



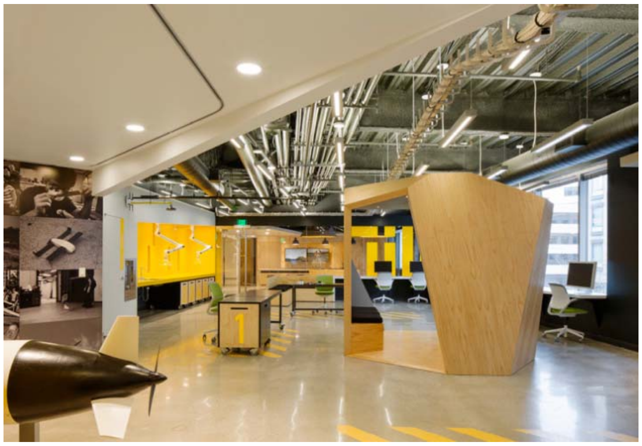
Allen Institute, Perkins+Will, photo from archdaily.com

“The University research spaces will support collaboration, innovation and foster creativity with cutting-edge design that is adaptable, safe and sustainable, thus strengthening McGill’s role as a world leading institution”

Center for Science and Technology, Chapman University. photo from AC Martin

Guiding Principles

1. Creativity, Innovation & Technology



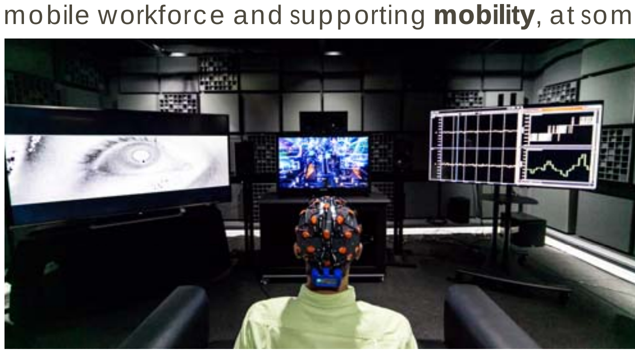
MIT Beaver Works, photo from retaildesignblog.net

The primary goal of the laboratory remains the same: Experimentation. However, the path to discovery, and the way scientists work and interact, are being revolutionized by **emergent technologies** including smaller, more powerful instruments, robotics/automation, computer analysis and advanced communication systems. In a recent Laboratory Equipment reader survey, 48 percent of respondents said instrumentation improvements will expand their research capabilities in the next 10 years. The most significant changes in technologies expected are likely to be **automation systems**, **data acquisition systems**, **detectors**, and **sensors**.

Stargate 3D printer, photo from Relativity Space

360-degree video, photo from Medtronic Applied Innovation Lab

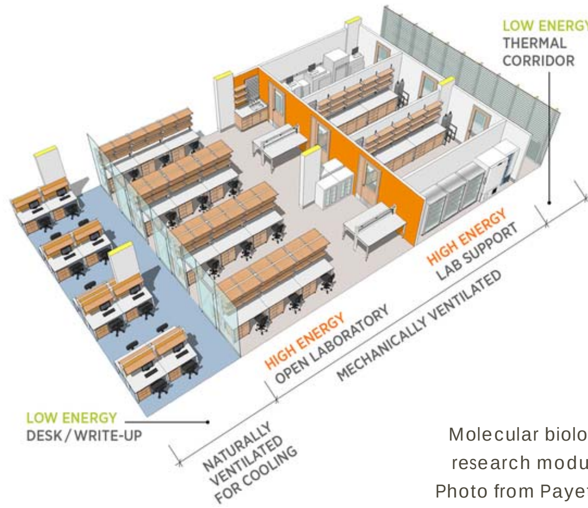
Emergent technologies will reduce the physical footprint of laboratories and free up time for scientists to engage in more collaborative and idea-based endeavours. The future laboratory will need to reflect this change, with a choice of **working environments** replacing the space that was previously dedicated to traditional laboratories. The future laboratory will also provide **flexibility** in the **physical** and **operational aspects** of the laboratory to allow for **emergent technologies**. Additionally, it will provide collaborative **hi-tech tools** such as video and virtual conferences to accommodate a more mobile workforce and supporting **mobility**, at some level, for all employees.



Sensory Immersion Lab at Dolby Laboratories, photo from Business Wire

2. Planning & Design

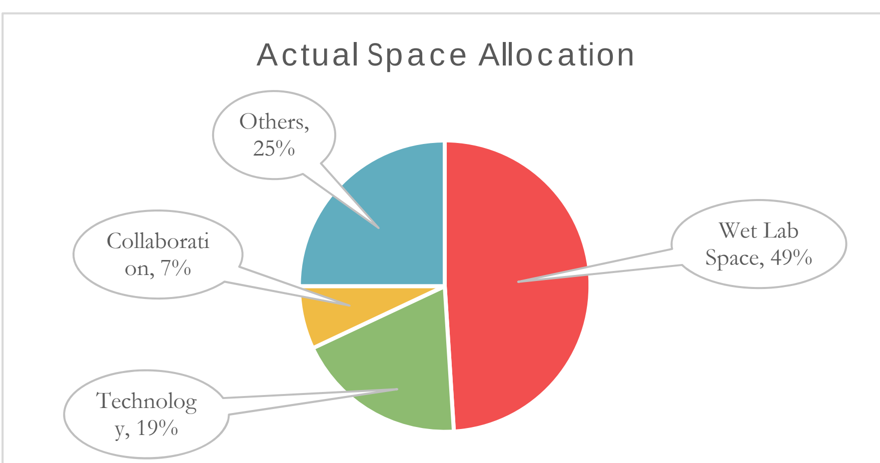
The ultimate goal of laboratory design is to foster innovation, support science and keep scientists safe. Laboratories are designed as units, compartmentalized, self-contained and not collectively. Scientists are separated from each other in formally arranged and rigid layouts, reflecting linear processes and static functionality.



Molecular biology research module, Photo from Payette

The nature of laboratory work requires **distinct** workspaces, and a defined, but permeable barrier between them. Scientists working in these spaces need an area that allows for both **focused concentration** and **easy engagement** with colleagues. Design should use acoustic technologies and visual cues to bring these different spaces as close together as possible. **Adjacencies** and **visual connections** should be created to allow for spontaneous interaction and collaboration between disciplines. Design should focus on workplaces that promote innovation, the transfer of knowledge, collaboration and effectiveness while still providing a beautiful environment which is desirable to occupy. Another consideration to take into account is the integration of **flexible laboratories** that would allow **rapid reconfiguration** based on scientific needs.

Photo from CO architects

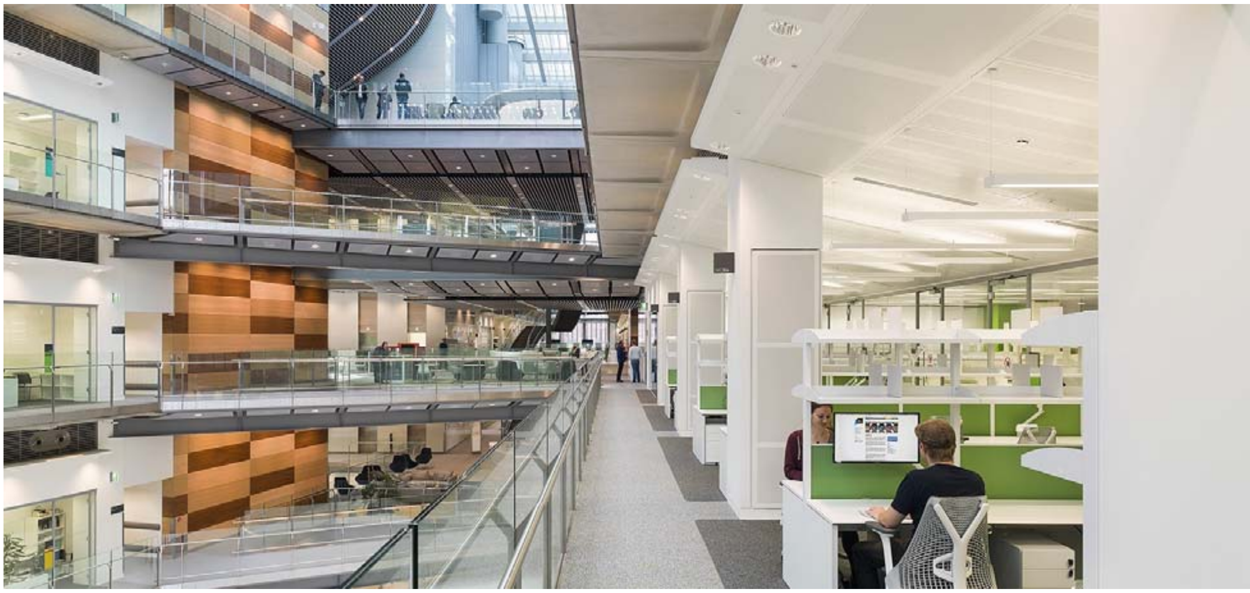


A study done in 2014 by CBRE, demonstrated that a "typical" laboratory in life science industry devotes only 7% of its square footage for collaboration with almost no dedicated space for thinking and contemplation. (Source: CBRE Life Science Practice)

3. Interaction

Challenging researchers to **collaborate across disciplines**, despite their initial reluctance, has led to the creation of new fields of study not defined 20 years ago.

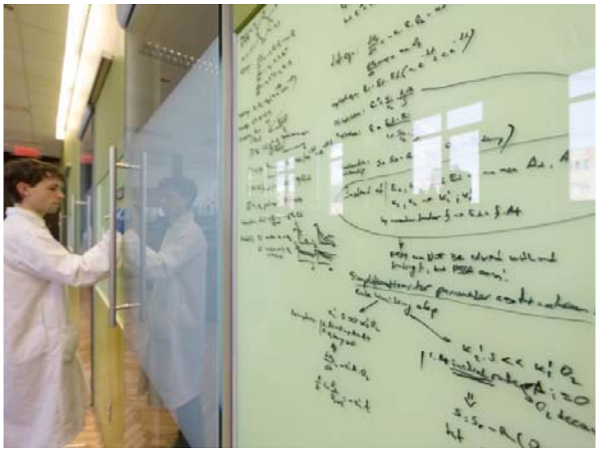
Interdisciplinary collaboration has become paramount to academic and corporate-based research. Fixed benches and utilities limit scientists to their individual workstation and hinder them from working in teams.



Francis Crick Institute, HOK architects, photo by Paul Grundy

The sharing of personnel (and equipment) may prove to be a highly effective measure to counter realities such as budget restrictions.

Collaboration spaces, venues and pathways for chance meetings are seen as critically important means to foster an innovative culture. A **variety** of meeting rooms with video conferencing, informal social/working areas with a place for laptops, whiteboards on every surface and glass walls are the norm. Design efforts will look to the creation of spaces **that promote collaboration** across more disciplines and further **multidisciplinary and transdisciplinary** research. Design will also promote core facilities that create the opportunity to allow mixing of users from multiple locations based on synergies between groups around an area of study, as opposed to within a specific discipline. Other design considerations include the possibility to provide open spaces creating more **visual connections**, the use of technology to untether and connect people and the integration of virtual communication.



McGill - Mac Eng lab, photo from Vezina architects

Photo from Electronic Visualization Laboratory

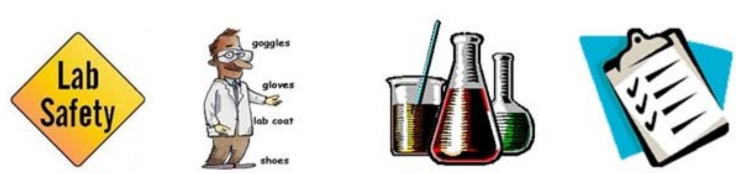
4. Health & Safety

Health and safety means, first and foremost, **protecting** the health and safety of our community and guests and fostering an environment that is conducive to a **productive learning and research environment**. It also encompasses protection from material losses or events that can negatively impact on the continued operation of the institution. Compliance with health and safety legislations is a **complex challenge**, with **jurisdictions** at the municipal, provincial, national and international levels. Research granting agencies also impose health and safety conditions as a part of the research granting process. Health and safety is a moving target, with **new hazards** emerging from new research, coupled with a steady stream of new regulatory requirements.

Overhead Utility Connections, photo from presentation by James Schreyer, *From Afterthought to Forethought: Designing an Optimal Analytical lab*

Safety shower & eye wash, photo from presentation by James Schreyer, *From Afterthought to Forethought: Designing an Optimal Analytical lab*

Meeting the compliance requirements of health and safety in the research lab is commonly viewed as an obstacle to progress, however the ultimate goal is not to put up obstacles, rather it is to **effectively manage risks** and avert situations which can impede progress. The aim in the lab design process is to make sure the safety components are **"right-sized"** i.e., able to meet the demands of the present and flexible enough to also do so in the future. On one hand, an under-designed lab can result in retrofits that usually cost more than they would have if included in the original design, while on the other hand, and an over-designed lab can include expensive safety features that are never used, thereby diverting valuable financial resources that could have been used on more important items.



Review registered labs and workers | Review personnel safety training records | Enter and update chemical inventory | Respond online to EH&S safety assessment items

5. Adaptability

Flexible furniture with overhead service carriers, photo from Waldner Laboratory Systems

Science and technology change rapidly, and the facilities used for them do too. Therefore, new laboratory must be **flexible** and **adaptable**. Maximizing adaptability has always been a key concern in designing or renovating a laboratory building. Adaptability can mean several things, including the **ability to expand easily**, to **readily accommodate reconfigurations** and other changes, and to **permit a variety of uses**. Adaptable labs allow universities to meet changing needs in the future while reducing renovation costs and lab downtime. Core facilities and campus amenities are resources which enable flexibility and adaptability in general research space. They strengthen the campus community and **foster the exchange** of ideas by serving different departments, which may not have otherwise interacted. Adaptability features allow lab space to be **leaner** and **increase efficiencies** in layout.

Adaptable lab furniture, photo from New England Lab

6. Sustainability

Sustainability means meeting our own needs without compromising the ability of future generations to meet their own needs. In addition to natural resources, we also need social and economic resources. Sustainability is not just environmentalism. Embedded in most definitions of sustainability we also find concerns for social equity and economic development. In the context of a lab, it means developing new approaches (technical, operational and behavioral) to enhance the environmental performance of a space that feels safe, inclusive and connected, with a sounds economic approach.

Tufts University Science and Engineering Complex, photo by Payette

Photo from labconco.com

Laboratories are places of discovery and scientific progress, housing both the research that matters and the researchers, and equipment responsible for it. All that science, though, takes **energy**, and many facilities—especially those with significant ventilation needs—utilize it in **high volumes**. To combat this issue, it is important to implement strategies in the workplace that will **minimize the environmental footprint** of our labs and make them environmentally friendly homes for the science of tomorrow. In a lab that embodies the principle of sustainability, people collaborate across disciplines to inform and advance solutions to contemporary problems. They are aware of and responsible for the **environmental**, **economic** and **social implications** of their research.

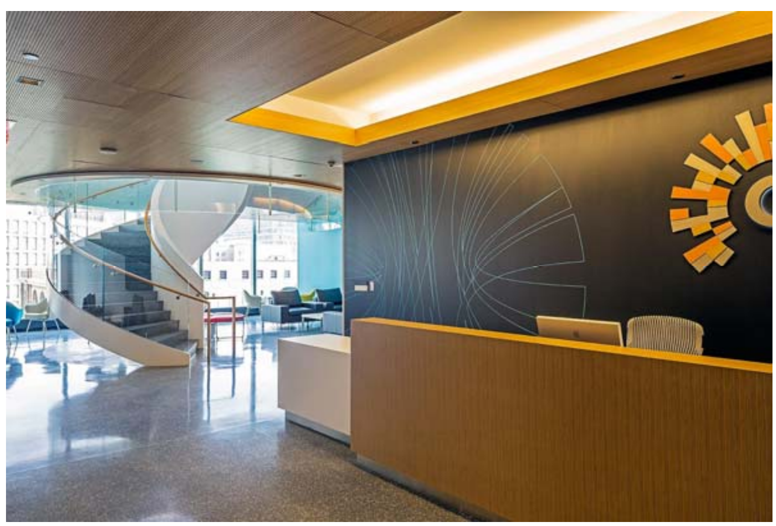
The Well Living Lab, photo from Delos Ventures and Mayo Clinic

7. Ownership & Governance

In a large institution where responsibilities are widely dispersed the question of ownership is a subject of ongoing debate. Who actually **owns a lab**? The PI, the department, the faculty, and central administration can all lay claim to ownership in some respects, but who is responsible for the space allocation, the design, construction, and choice of materials; the operation of the lab and its maintenance. What about safety surveillance, emergency preparedness, and the responsibility for reporting and correcting problems? When does a deficiency become an extra? Who pays?

OICR's Research Laboratory, Diamond Schmitt Architects, photo from architecturelab.net

Ownership of laboratories, responsibility for **maintaining** them and **accountability** for what goes on inside the laboratory should be clearly defined and well understood by all stakeholders. New laboratories do not always require new space if existing spaces are optimized. To achieve this, laboratory spaces should be allocated on the basis of the **needs of the University**, **irrespective of inter-departmental or inter-faculty** differences over ownership. This will also go a long way towards accommodating inter-disciplinary research.



OICR's Research Laboratory, Diamond Schmitt Architects, photo from architecturelab.net

Design criteria

A survey was conducted December 12th 2017 through January 10th 2018 to gather input from lab users regarding laboratory design.

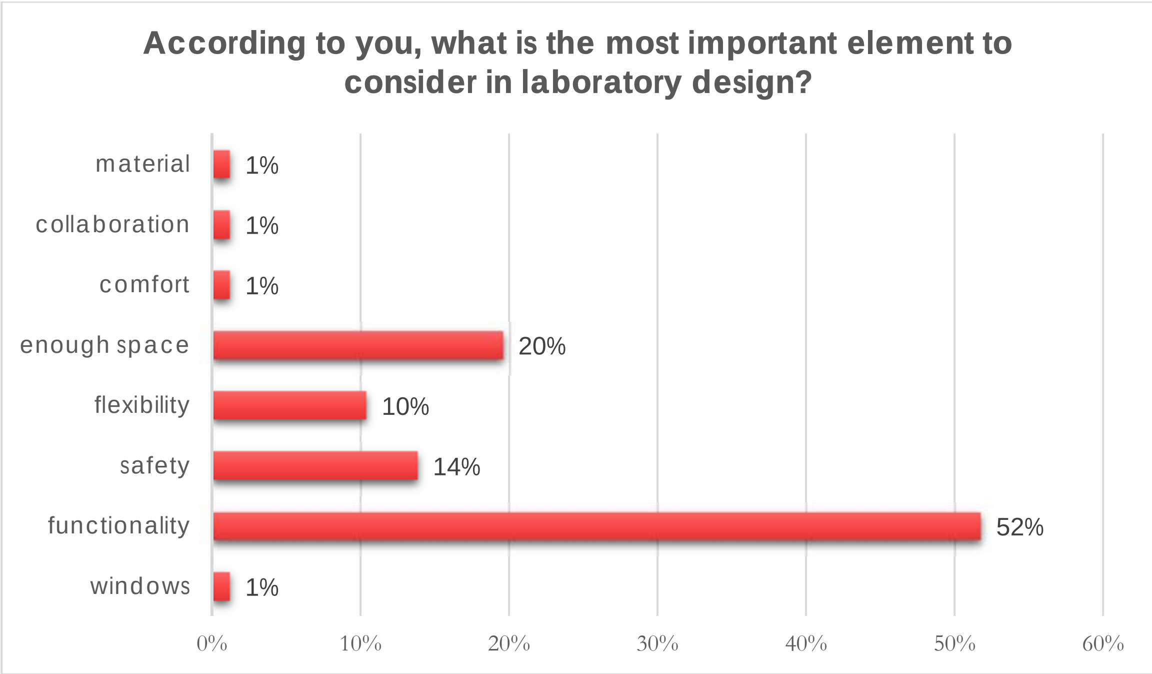
In total, 87 responses were received from users with various functions in various fields of study:

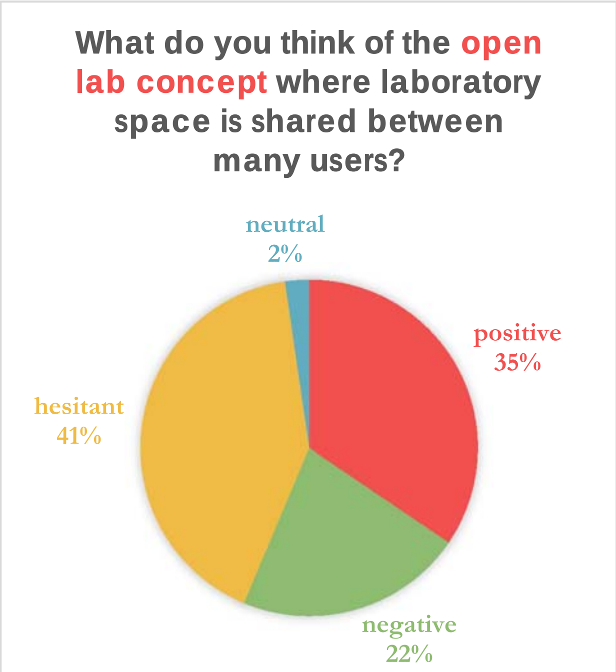
DEPARMENT	#user
Biochemistry	6
Biology	18
Cognitive Neuroscience	2
Food Science & Agricultural Chemistry	1
Building Management	1
Human Genetics	2
IPN	3
Kinesiology & Physical Education	7
Integrative Neuroscience	1
Medicine	3
Microbiology & Immunology	4
MNI	8
Natural Resource Science	1
Neurology & Neurosurgery	10
Neuro-Immunology	1
Oncology	1
Pathology	1
Pharmacology & Therapeutics	1
Physics	6
Physiology	2
Plant Science	1
Psychology	4
Redpath Museum	3

FUNCTION	#user
Academic associate	1
Academic staff	1
Assistant professor	9
Associate professor	12
Building director	1
Chair	1
Chief research technician	1
Course technician	1
Engineer	1
Grad student	6
Lab coordinator	2
Lab manager	2
Lab technician	2
Masters	4
PhD	11
Postdoc	3
Professor	10
Program manager	1
Project officer	1
Research assistant	9
Research associate	5
Researcher	1
Technical assistant	2

Questions were asked about general laboratory design, open lab concept, sharing of spaces and equipment, safety issues, collaboration, technologies, flexibility of lab layout and furniture, storage, space types, aesthetics and sustainability.

The primary criteria in laboratory design according to the users' opinion is functionality. An appropriate layout respecting the laboratory's needs can allow for a smooth work-flow dynamic between users, ensuring at the same time an efficient use of space and an adequate level of safety.

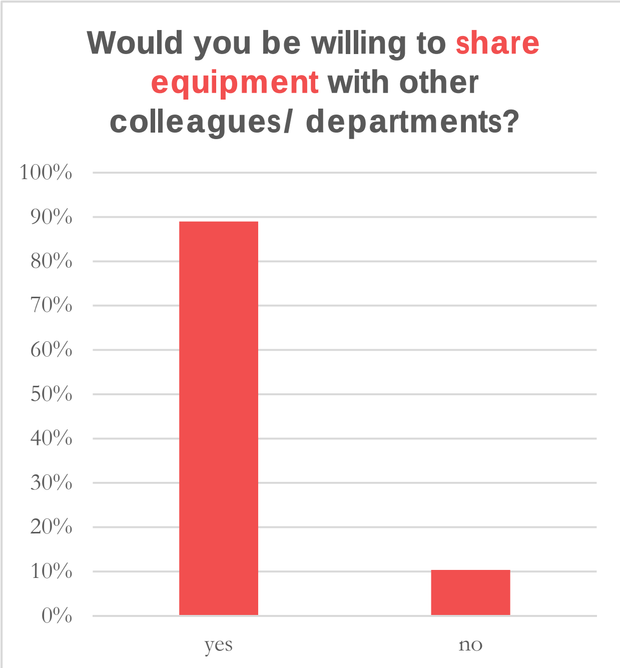




When asked about the open lab concept, 41% of the users were hesitant. They have indicated that the following requirements would have to be fulfilled in order for open lab concept to work:

- Clear rules establishing responsibilities (cleaning, schedule, access)
- Fair sharing of equipment costs, material costs, maintenance and operation costs
- Mutual trust and respect between users
- Proper layout for convenient access
- Sufficient space must remain for non-sharable specialized equipment and experiments, independent work space and personal storage

The complexity of achieving these same requirements were why 22% of the users believe that an open lab concept cannot work. In addition, they believe that open labs can hinder concentration, have inadequate acoustics, and lack confidentiality for certain labs.



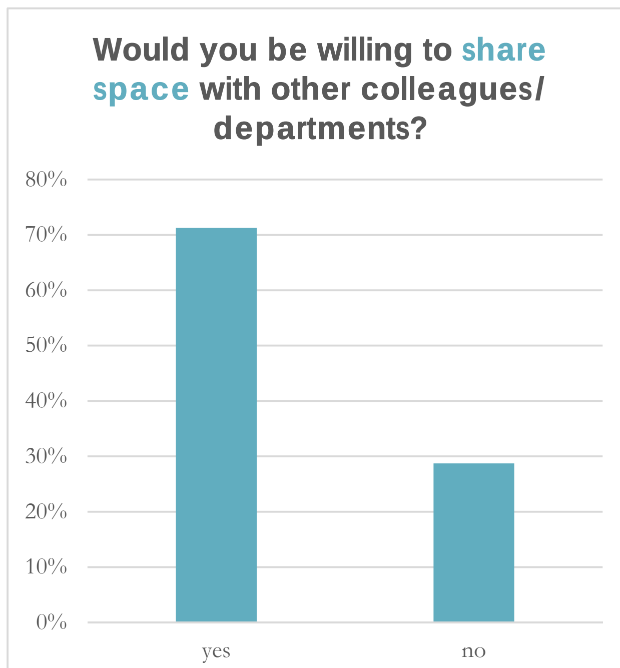
Equipment users are willing to share:

- Low-usage equipment
- Expensive equipment
- Common equipment
- Large equipment
- Core facility equipment
- Equipment not requiring personalized setup

Some sharable equipment listed by the users: centrifuge, ice machine, autoclave, shaker, balance, fume hood, BSC-hood, drying oven, incubator, freezer, fridge, robot, computer, microscope, flow cytometer, printer, motion caption system, imaging software, spectrophotometer, PH meter, dishwashing machine, gel imaging, etc.

Spaces users are willing to share:

- Lab space
- Bench space
- Equipment room
- Storage room
- Meeting / conference room
- Student space
- Office space
- Kitchen / lounge



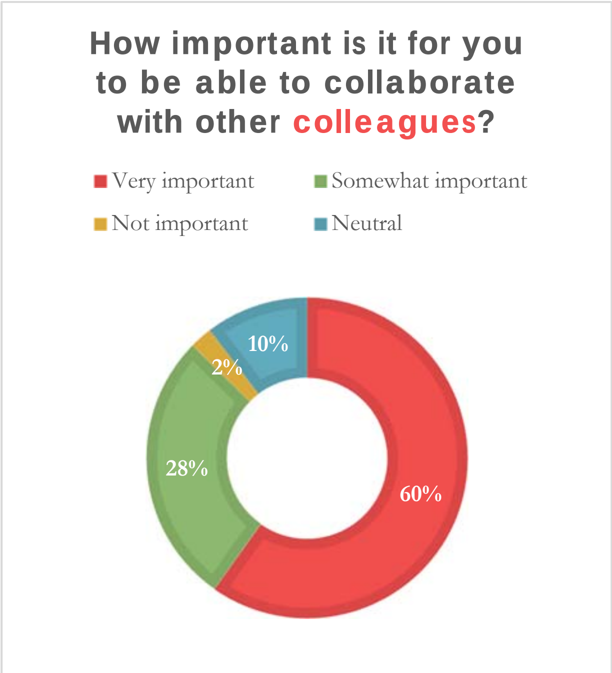
52% of the users had safety concerns regarding open labs. These concerns are mostly focused on human behavior.

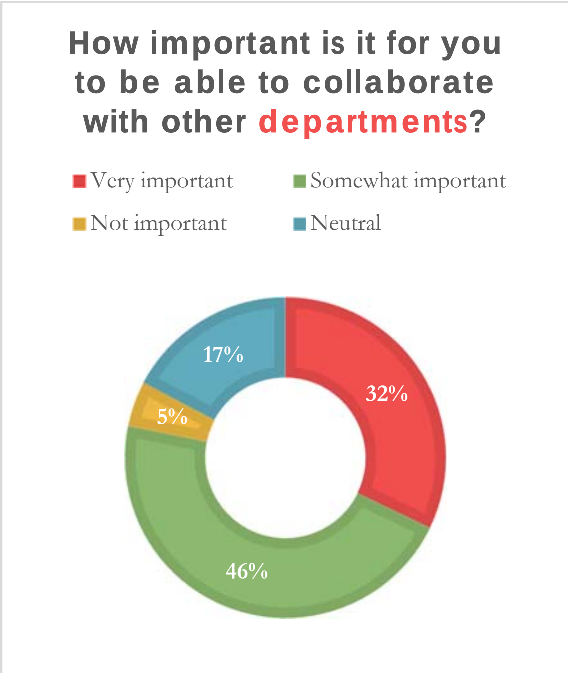
In general, the users are worried about the potential disrespect of safety guidelines, negligence, unauthorized use, the lack of communication, and the lack of accountability. Other safety issues raised are on waste management, spill containment, and possible contamination.

Proper safety training are therefore compulsory for everyone who will be using the shared spaces and the shared equipment in the open lab setting.

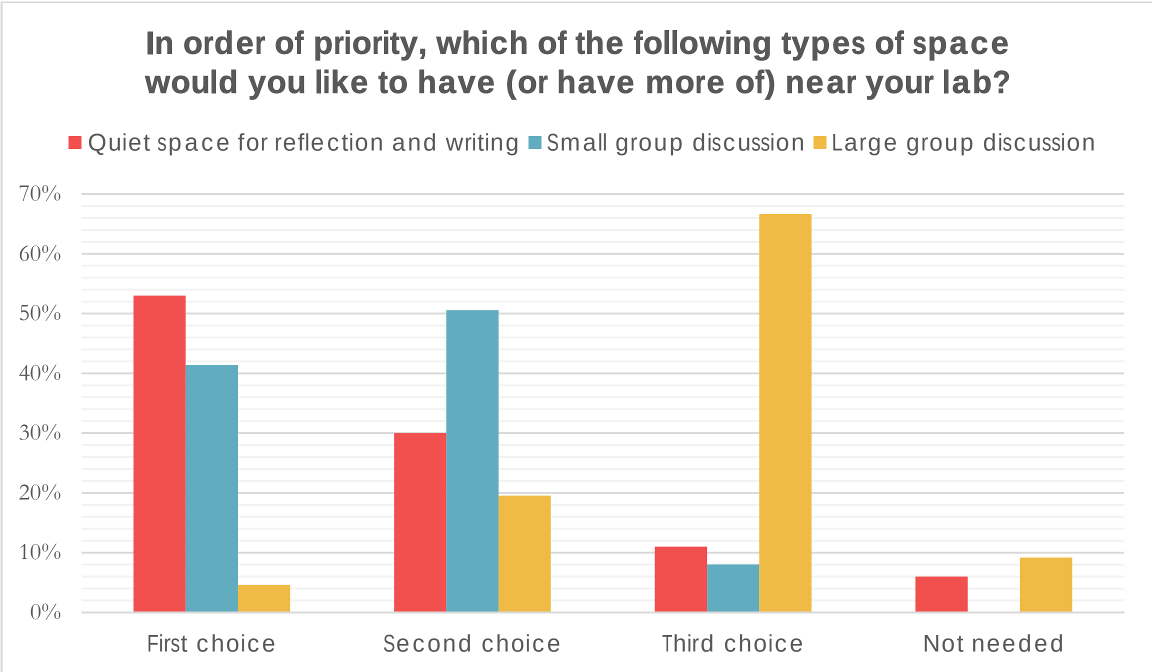
Certain equipment or experiments with high security protocols may therefore be inadequate in an open lab setting, such as lasers, animal allergens, and radioactivity.

An effort should be made in lab design to provide collaboration spaces to allow lab users to exchange ideas and encourage interaction that can lead to innovation.



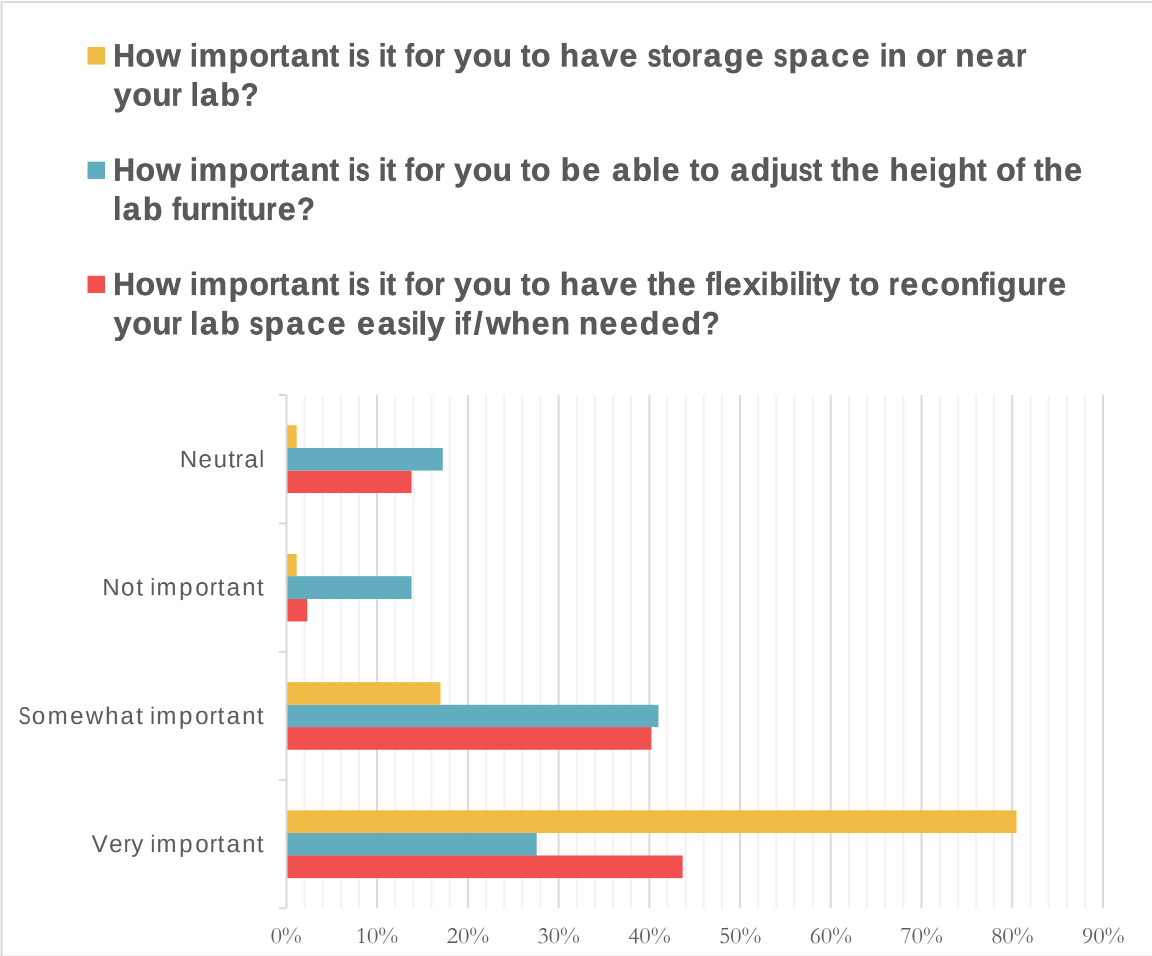


A proper balance should be provided between collaboration spaces for small and large groups, and quiet spaces for individual reflection and writing.



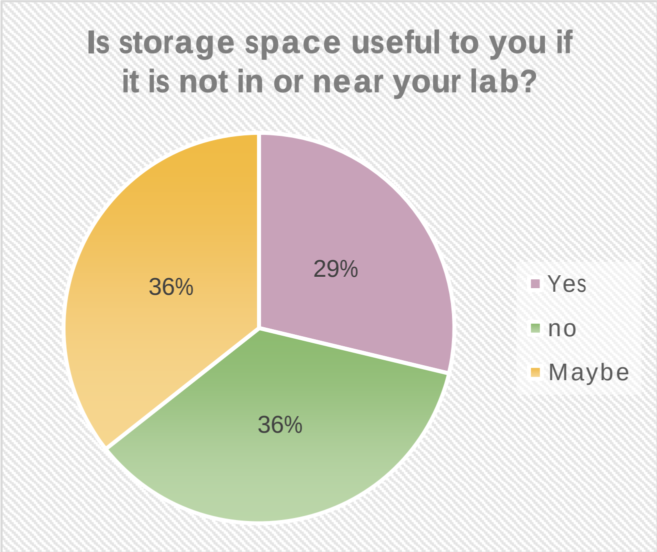
According to the survey results, there are significant needs for quiet individual workspaces and break-out spaces for small group discussions. This requirement should therefore be taken into consideration when planning research spaces.

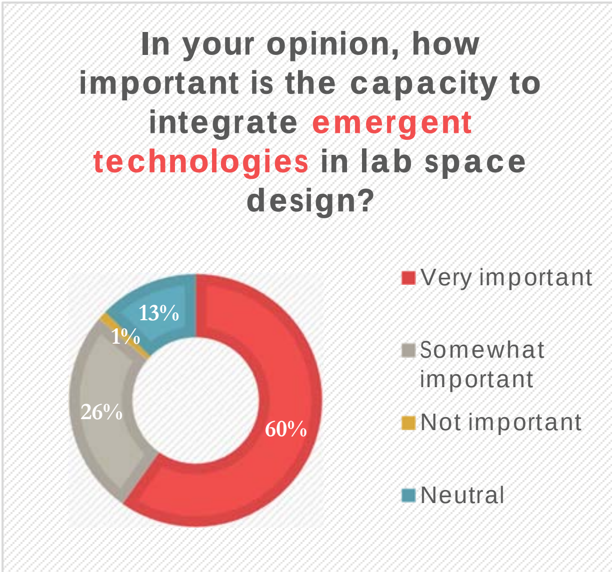
Since laboratory furniture and storage occupy a large footprint in many laboratories, users were asked to grade the level of importance of these elements in their lab spaces.



The results indicate that storage is primordial, and it would be best if storage spaces can be in proximity of the lab spaces.

Flexibility and adaptability of the laboratory furniture are also important. Being able to adjust the height and the configuration of the furniture easily and quickly according to the users' needs should be considered a basic feature of the laboratory of tomorrow.



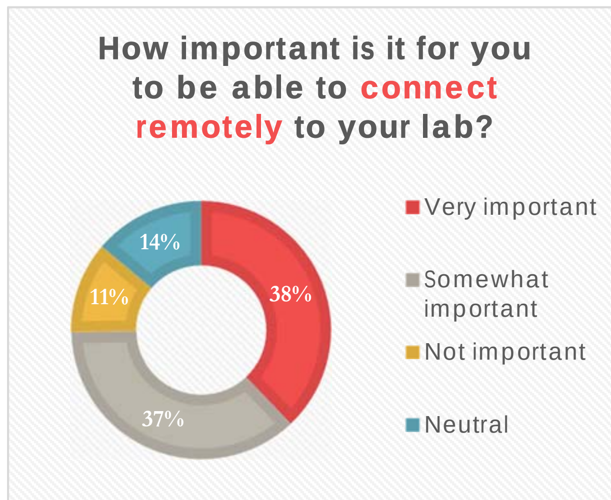


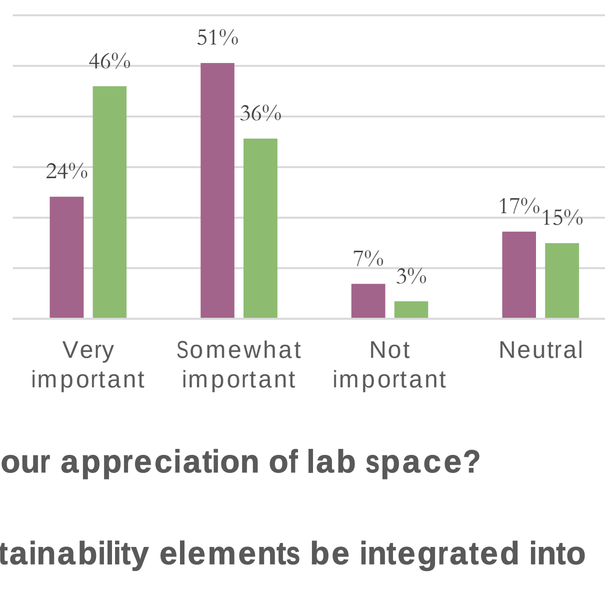
Most laboratories are heavily technology-focused. As technology advances, 86% of the users agree that laboratory design should take into consideration the capacity to adapt and integrate these emergent technologies.

At the same time, as workforce has become increasingly more mobile, lab users do not necessarily have to be physically inside their lab spaces to perform or monitor experiments. 75% of the users responded that being able to connect to their lab remotely is somewhat important to very important.

The kind of information that users would like to access remotely are:

- Computer data
- Cloud storage for data / data saved on a lab server
- Data recording and filing
- Monitor long term experiments
- Experiment results
- Lab status (Temperature/humidity)
- Equipment status
- Remote control of equipment
- Space booking system
- Online lab tools
- Software, computer programs
- Inventory lists
- Schedules for equipment use
- Real-time monitor of who is using the equipment (log-in's)
- Communication to other lab users (videoconferencing)





Finally, we asked the users to elaborate, based on their previous lab renovation and construction projects, on the most important oversights <u>to avoid</u>:

- Lack of communication between Design team and users. Design has to be consulted with all the users, including TAs and lab coordinators
- Lack of basic supplies (vacuum, CO_2, network, air conditioning)
- Not sufficient power (variety and number of electrical and data outlets)
- Interference with lab research (downtime and disturbance to adjacent spaces)
- Low ceiling height, inadequate circulation space, lack of natural lighting
- Inadequate separation of student offices from PI offices (hamper productivity)
- Inadequate acoustics for offices
- Loud and inadequate HVAC system
- Lack of space for equipment room, storage, meeting space, and lunch room
- Lack of functionality and flexibility
- Lack of appropriate equipment
- Bad quality of material

Conclusion

In conclusion, in order to have a proper laboratory design, it is important to involve key stakeholders such as the lab users throughout the design process. Since a lab has generic areas that can be common with other labs, but also function-specific areas that are unique to it, an in-depth needs analysis is required at the early stage of Design.

At this needs analysis, key questions to ask would be regarding infrastructure requirements and also space requirements in order to achieve functionality and flexibility.

Design criteria such as aesthetics, quality of material, quality of space, and access to natural light should be inherent to all design.

Other design criteria and objectives

In addition to the criteria mentioned in the survey, during the different focus group sessions, various key design elements were raised (some of which are already listed in the survey). These design elements should be taken in consideration whenever possible in the planning of new labs or in the renovation or redesign of existing labs.

- Promote the international reputation
- Place Human at the center of the project
- Ally “WELL” principles for the well-being of the users
- Use materials with a beneficial life cycle
- Plan for Universal Access
- Apply ergonomic principles

- Biofilia: Bring in nature, promote connection with nature
- Install vegetable walls (plants, natural colors, water elements)
- Plan for users and not for the equipment. Privilege the use of windows for users.
- Promote Visibility, views of outside
- Plan for low stress, safe & social spaces, noise control, privacy, art
- Plan for resource sharing. This should become interdepartmental (property management)
- Plan for management of residual materials, spaces for garbage cans, bins etc., Consider flow analysis and sorting at source
- Plan for data management: centralize servers (Burnside) or elsewhere, heat recovery (Otto Maass), redundancy, promote "virtual machines"
- Spatial planning
- General orientation: avoid closed rooms along windows, favor high occupancy rate, shared spaces. Glass wall, transparency, and light breakthroughs, light impact analysis, light wells, fiber optic applications. Traffic flow: research process to understand
- Place offices near laboratories, plan for universally accessible technical corridor, subsidized collaborative common spaces of central offices.
- Building Dashboard
- Exhaust and ventilation
- Commissioning
- Promote sustainability : zero waste, safe
- Promote adaptability : flexible, transformative, accessibility, inclusive, evolving, mobile, design for all, modularity
- Consider human factors: living spaces, social spaces, human focused, inclusive, healthy spaces, ergonomic
- Consider community factors: interactive, interdisciplinary, innovative, build around community
- Ownership
- Potential energy saving: freezers, fridges, autoclaves, glassware washing, etc.
- Meeting places + team based labs: open spaces, visual connection, co-beneficial for students with mental health issues, meeting rooms, natural light, pleasant place, kitchen not in circulation, comfortable furniture, writing and display surface, natural light. Acoustic transparency, maintained inside the lab, shared spaces. Collaboration space. Confidentiality elements to respect. Conference rooms.
- Flexibility, modularity, mobile case-work (anti-slip floor, researchers are replaced often)
- Modulate the furniture according to the needs, flexibility in the infrastructure, equipment zone. Mixture of furniture type: Generic: fixed - sink – hood and Specialized: modular. Modular equipment room 100%. Storage space for furniture to reuse.
- Include proper lighting controls: task lighting + reduce lighting density
- Install proper lab exhaust: containment, hoods at the lowest possible flow, analysis system
- Consider the use of chilled beams : heavy infrastructure, advantage for new building
- Design all basic BSL2 labs

Applicability

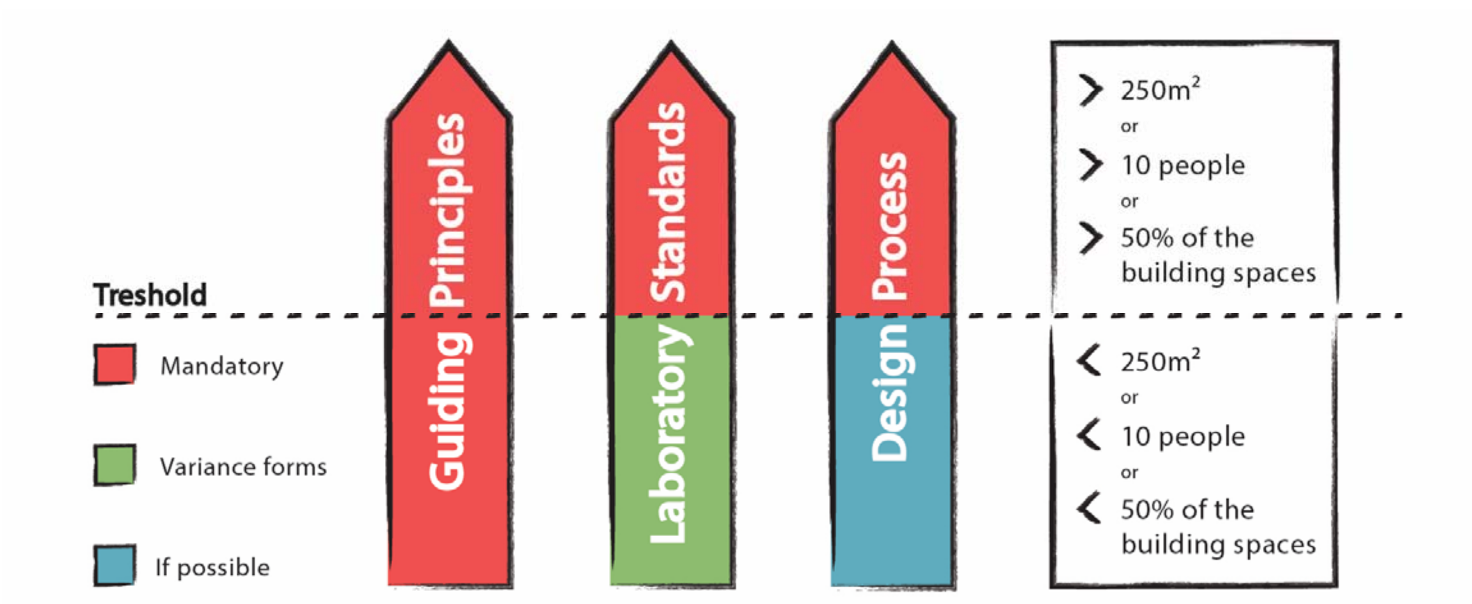
In order to assist the Design team in the vetting of future labs process goals and objectives, McGill has identified two levels of design requirements for projects based on their scope of work.

New Construction and Major Renovations

For all new building or building-wide, full-gut renovation projects (**more** than 50% of the building spaces), or for all fit-outs and partial building interior fit-outs of **more** than 250 m² and/or 10 people and of at least one building story and multiple building systems, the Guiding Principles, the Building Design Standards for laboratories and the Design Process shall apply.

Minor Renovations and Improvements

For all minor renovation (**less** than 50% of the building spaces), or for all fit-outs and partial building interior fit-outs of **less** than 250 m² and/or 10 people, the Guiding Principles shall apply. Variances to the Building Design Standards must be approved at the Design phase according to the procedure of the "Design Standards Conformity" and the "Variance Request" forms. Whenever possible, the Design Process shall apply.



Laboratory Design Process

Research Facilities are complex and need to be built as controlled environments that ensure efficiency and a safe environment for workers and best integrate emergent technologies and equipment. The process for designing and building these facilities requires thoughtful design, takes into account the unique needs of each facility, and develops solutions that lead to the best possible space to perform the research. The construction should take into consideration the sophistication and the sensitivity of the nature of the work done inside the lab.

An Integrated Design calls for an early involvement of stakeholders and a collaborative decision-making.

Owner	Project Management Team	Primary Consultants	Specialities Consultants	Local Stakes	Equipment Vendor	External
• Investigators • Researchers • Staff & laboratory users		• Architect • Engineers (structural, mechanic, electric, plumbing)	• Vibration • Acoustics • Lighting • Building code	• Health & Safety • Operations • Energy • Sustainability • Network and Communication Services (NCS) • AAC • Campus Safety • Building & Grounds • Campus Planning & Development Office • Research & Innovation		• Permits • CCU • MCCU

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Appendix

Appendix 1: Participants

Steering committee - Vision Workshop (June 28, 2017): Robert Couvrette, AVP, FMAS Jim Nicell, Dean Faculty of Engineering Jean-Marc Gauthier Carmen Lampron Annaëlle Perez Alexander Munro Amelia Brinkerhoff François Miller Wayne Wood Lorraine Mercier	**Focus Group – Maintenance & Operations (October 24, 2017):** Luc Roy, Director Fabrice Lebeau Denis Mondou Dominique Gagnon Carmen Lampron Pierre-Luc Baril Alexander Munro Kevin Wade François Miller Wayne Wood Mariette Becchara Lorraine Mercier
Focus Group – Sustainability & Energy (October 24, 2017): Robert Couvrette Fabrice Lebeau Denis Mondou Jérôme Conraud Stéphanie Leclerc Carmen Lampron Pierre-Luc Baril Alexander Munro Kevin Wade François Miller Wayne Wood Mariette Becchara Lorraine Mercier	**Focus Group – Architecture (November 15, 2017):** Robert Couvrette Michael Sullivan (NFOE) George Lazaris Annaëlle Perez Carmen Lampron Maxime Gagnon Philippe St-Jean François Miller Wayne Wood Mariette Becchara Lorraine Mercier
Focus Group – Process (November 20, 2017): Anna Bendix (CDPO) Jim Nicell Jean-Marc Gauthier Sylvain Letarte Luc Roy	 Wayne Wood Jean-Pierre Mallette Mariette Becchara Lorraine Mercier

Focus Group – Health & Safety (December 12, 2017):	Focus Group – Lab Users (December 14, 2017):
Fabrice Lebeau	Isabelle Gamache
Carmen Lampron	Claire Trottier
Jim Gourdon	Alvin Shrier
Jozef Zorko	Linda Pelletier
George Lazaris	Hicham Benslim
Annaëlle Perez	Bennett Smith
Carmen Lampron	Matt Kinsella
Philippe Gerald Raecke Baro	Robert Morawski
Philippe St-Jean	Carole Verdone-Smith
François Miller	Jennifer Wallace
Wayne Wood	Marie St-Laurent
Joseph Vincelli	Julie Fortier
Christian Bouchard	François Miller
Christine Jarabek	Wayne Wood
Ruth Blanchette	Jean-Pierre Mallette
Mario Badilo	Annaëlle Perez
Jean-Pierre Mallette	Mariette Becchara
Mariette Becchara	Winncie Leung
Lorraine Mercier	Lorraine Mercier

Appendix 2:

Building Design Standards, Special Building areas - Laboratories