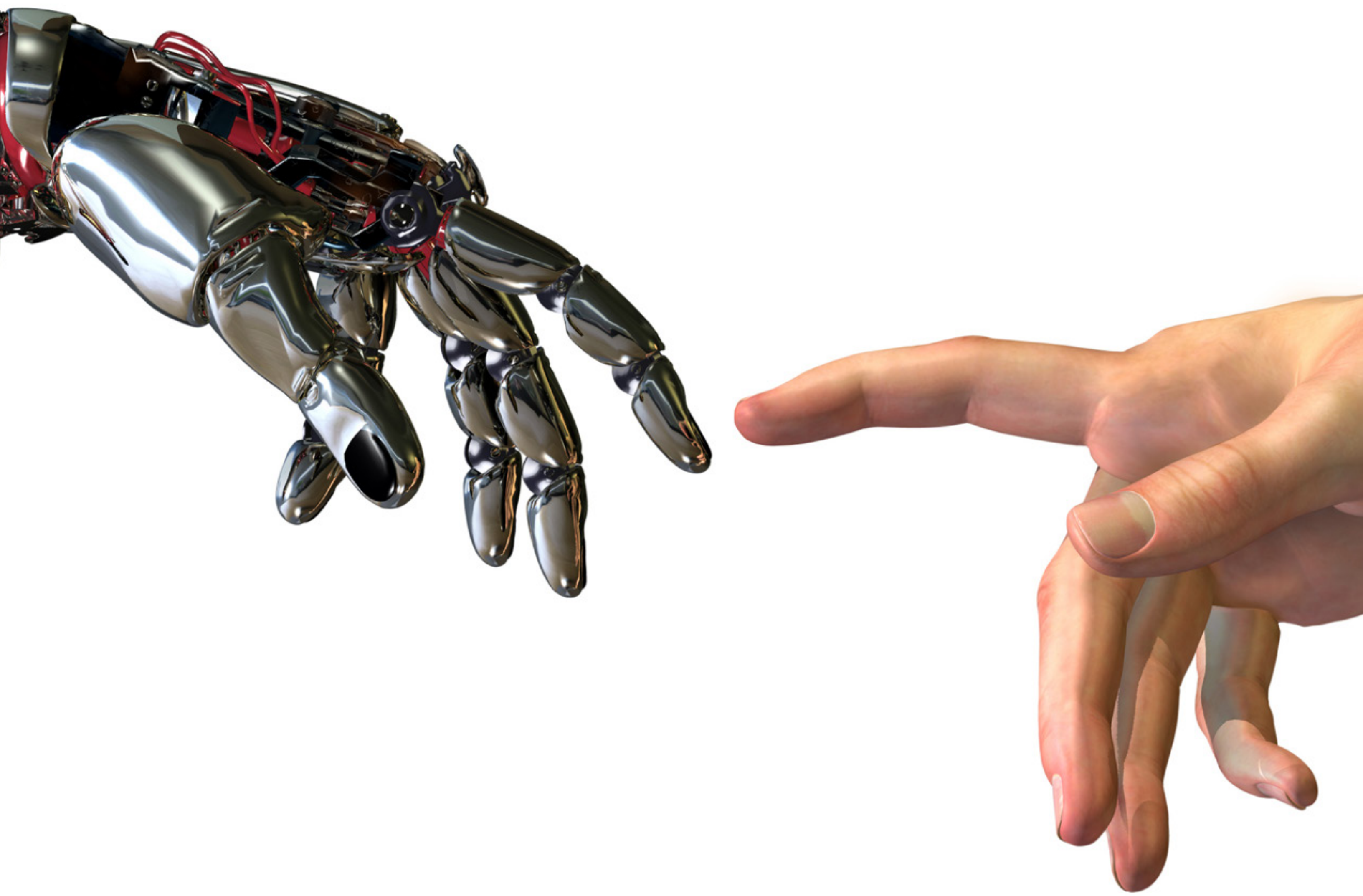


LAB 2050

PHYSICAL MANIFESTATION

What Will the Laboratory of 2050 Look Like?

That is the fundamental question of an ongoing initiative at SmithGroup. The firm's Science and Technology practice periodically takes time to examine the new technologies, scientific trends and economics shaping the research landscape. Since 2001, it has sought out knowledge experts from leading research institutions to better understand their expectations for the future, so that SmithGroup can be optimally prepared to provide transformative programming, lab planning and design solutions. In 2015, it began to focus on the Laboratory of the Half Century, or LAB2050.

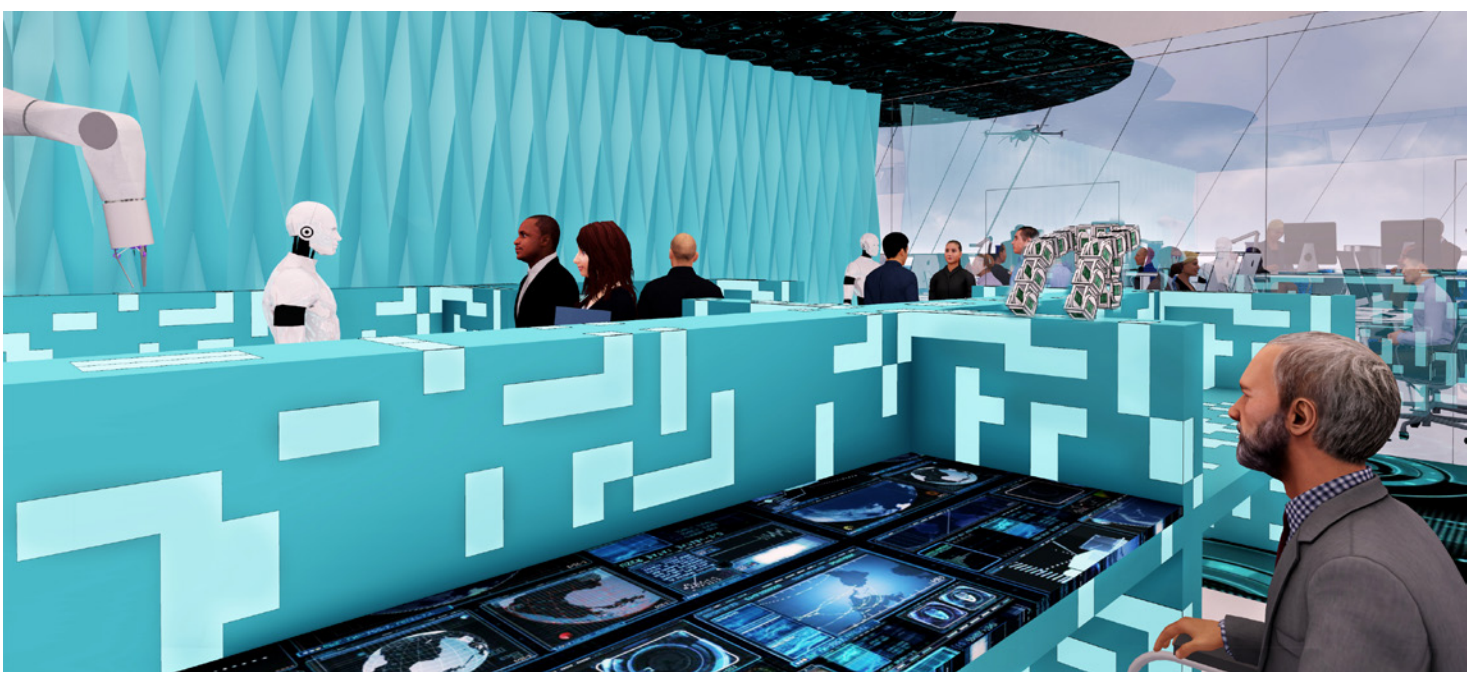
Building on those studies, SmithGroup's Science and Technology Advisory Board gathered at the Lawrence Berkeley National Laboratory in September 2017 to further the discussion of LAB2050. In an interactive design charrette, the Advisory Board envi-sioned the physical attributes and characteristics of LAB2050 that could best advance scientific discovery in the coming decades. Together, they explored what LAB2050 might look like, how it might function, and how to plan for a built environment that supports the transformative scientific endeavors of tomorrow.

About SmithGroup's Client Advisory Board

This esteemed think tank comprises some of the top minds in the research and technology industry, representing some of the nation's most future-focused academic, governmental, corporate and private institutions. The SmithGroupJJR Advisory Board convenes annually to share ideas and insights into the trends, issues, challenges and opportunities facing research facilities throughout the world.

"It's the WeWork model for research: on-demand space for on-demand research."

Niraj Dangoria / Stanford University School of Medicine



Imagining the Future. Three Scales.

The LAB2050 charrette broke into teams and explored the lab of the future on three scales: the environmental spatial scale of the laboratory: the broader building scale of a research facility; and the overall campus and site scale, which looked at how research buildings might fit into a university, corporate or urban context.

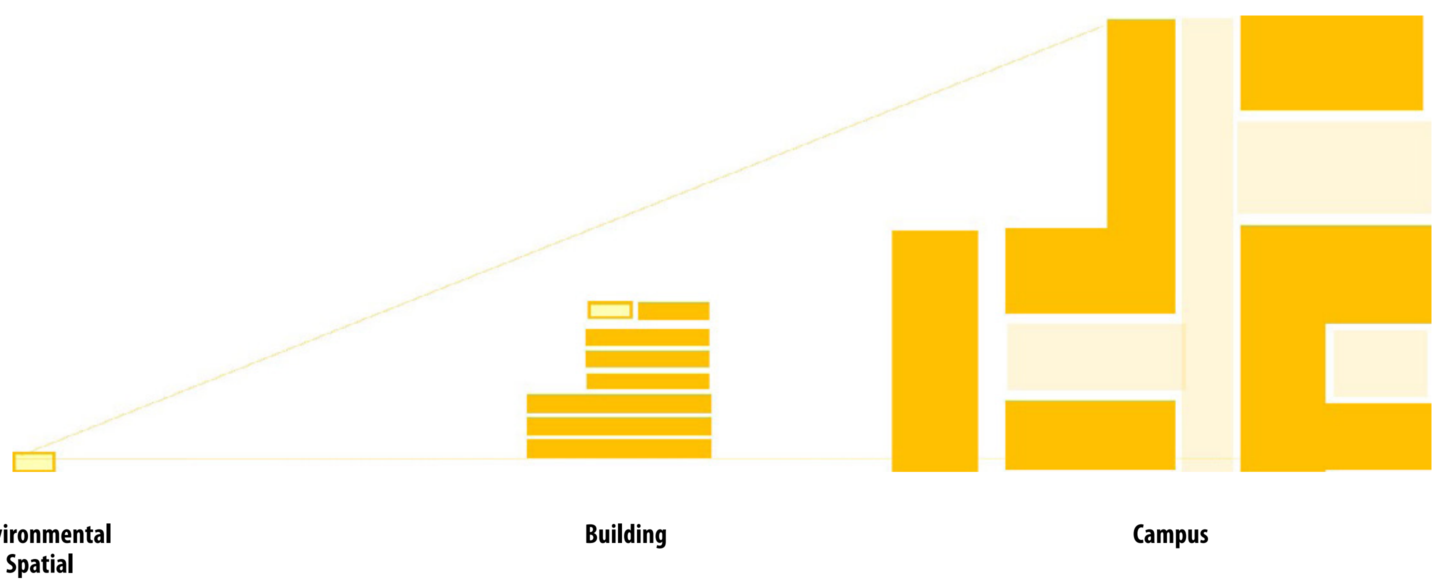
The teams emerged with ideas on how these scales might best intersect, and with some fundamental principles to guide the ongoing discussions of LAB2050:

Key Takeaways:

Factor in the growing role of automation. While humans will still drive innovation, automated technology plays an increasingly useful role in executing tasks. This will improve efficiency, consistent automated processes, and human safety. Laboratory designs will address how to integrate human intelligence and artificial intelligence most effectively.

Consider the building as a modular pod. The research facility of the future must bridge the disparity between traditional building life spans and the ever-evolving technologies that inhabit them. Brick and mortar gets replaced with plug-and-play modular systems that can be swapped out for different types of research, updated technologies, or new partnerships.

Design for "knowledge hub" density. Increased human interaction leads to greater discovery collaboration and innovation. Even with the advantages of new technology, the core mission of the research campus will continue to be as a knowledge hub. It thrives best with social density, permeability and a human scale.



Environmental Spatial: Integrating Automation into the Laboratory

The automation we see in laboratory settings today will continue to increase, with smarter automated technologies becoming an intrinsic part of research functions. Laboratory designs will reflect this interplay of humans and automation, whether it be the interaction of people and automation, or the purposeful separation of people and automation.

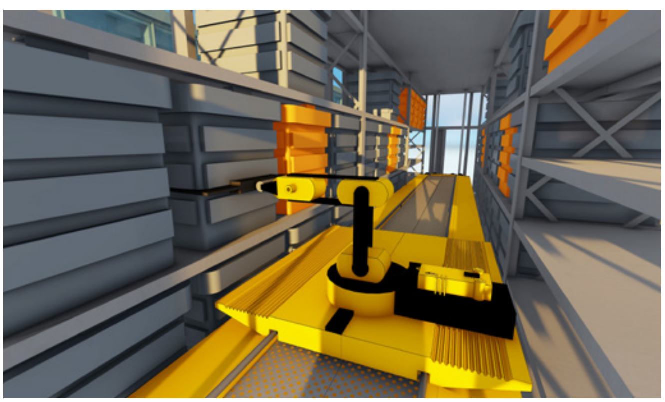
Stack Lab

The Self-Documenting StackLAB.

The traditional horizontal-oriented lab goes vertical, removing the constraints of support services within the research space and creating a more efficient footprint. Research labs and collaborative spaces are optimized for the comfort and efficiency of people on one level, with automated support services provided by drones in the fly zone above, and rovers in another dedicated tech space below. These autonomous technologies document lab activities, and can freely move among various labs and other campus locations.

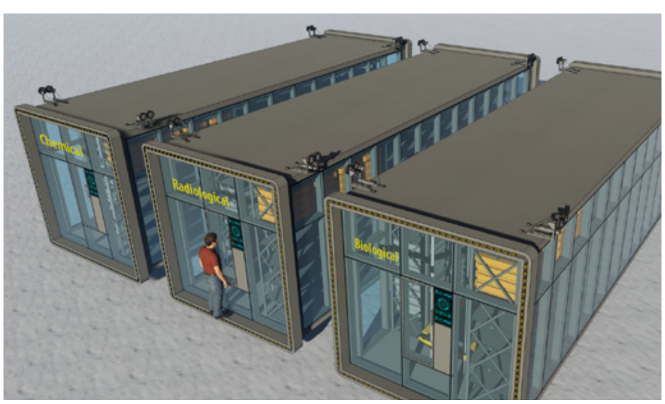
> **“The intelligent infrastructure could actually be like the internet of things for a research lab. You can collect a lot of data about the work being done in the lab, with wonderful side effects of procedure documentation, inventory management and other benefits.”**
>
> Patty Jones / Beckman Institute at University of Illinois Urbana-Champaign

HazPod



Plug-and-Play Pods.

In the HazPod, laboratories become self-contained modules, or pods, that can be installed or removed as needed from a stationary building and infrastructure framework. They are easy to update as technology evolves, and are ever-adaptable to changing research needs. They solve the challenge of space inventory, creating “labs on demand” that can be stored off-site, called into place as needed, and stacked and organized in the optimal layout. Research supplier entities may maintain an inventory of proprietary pods throughout the world, able to plug in to research projects in different locations.



Isolated Hazards.

HazPods significantly increase human safety, by isolating hazardous research environments. Chemical pods, biological pods, radiation pods and the like separate hazards from humans, with robots efficiently performing routine laboratory processes within. Pods also can isolate other lab functions that don’t require regular human intervention, such as electrical and mechanical systems.

> **“A modular system lets you create zones that are monitored and accessed by support systems, rather than humans. When you consider all the things we currently do to keep people separate and safe from chemicals, it’s a big step forward in safety.”**

Suzanne Napier, AIA, LEED AP / SmithGroup

People Space

Inviting People Places.

With auto tech handling routine and repetitive functions, the space occupied by humans becomes rich with amenities and enabling technology that foster interaction and inspiration. These comfortable and soft environments provide researchers with the freedom from processes to provoke thought, explore ideas virtually and allow for discovery.

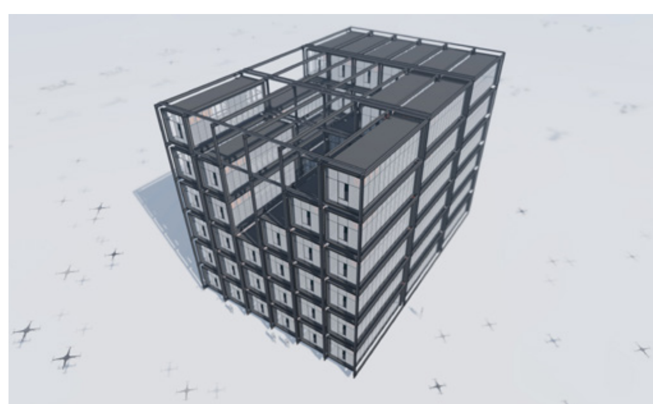
Live/Work Flexibility.

These human-occupied areas also are modular, allowing for the ideal ratio of lab-to-people space. They are designed to provide the types of spaces where people chose where they want to be and can do their best work. Configurations might include collaboration areas and auditoriums; hospitality/residential quarters, such as apartments or capsule hotels; restaurants, retail and other services; and outdoor living spaces, recreation areas and vertical urban farms.

AutoTech Space

Remote Autonomous Labs.

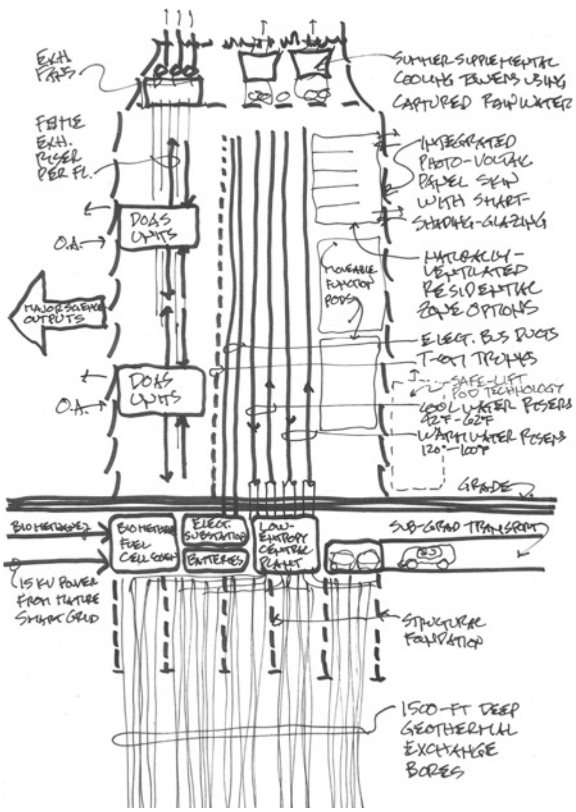
Laboratory modules that operate largely with automated technology can be stacked and stored together in a remote repository. Not constrained by human needs for space, daylight, fresh air and other conditions, these sealed environments are highly energy efficient, with net-zero the norm. With a bi-directional track system, pods can self-organize into space-saving cubes. Obsolete pods are easily replaced with updated technologies.



Building Scale: Creating an Adaptive Infrastructure

The research facility of the future must be hyper-adaptable, able to stay relevant for 50 years even as the technology within them may change every two to five years. Although no one can predict with certainty what science will discover, new building concepts plan for the unknown with an infrastructure designed for nimble versatility and flexibility.

Infrastructural Chassis



Infrastructural Chassis.

The research building of tomorrow isn't as much a building as it is a skeletal framework, or chassis that serves as a docking station for plug-and-play laboratory modules. It allows research organizations to custom tailor the optimum mix of collaborative, bench and automated space. It can also isolate different types of lab functions—wet versus dry labs, for example—in independent modules. The building becomes on-demand space for on-demand research.

Low-Entropy System.

The building chassis is also a self-contained energy chassis. It takes advantage of its vertical orientation with photovoltaic systems and intelligent building skins above ground, and with hybrid geothermal strategies below grade. On-site battery storage reduces peak-hour demands and offers energy back to the grid.

Autonomous Mode

Delivery and Docking.

Laboratory modules will be warehoused in off-site repositories, with just-in-time delivery as needed. To lift and dock these lab pods in place, the chassis will house a sophisticated robotic positioning system that is sensitive to equipment vibration tolerances, chemical compatibility and other challenges.

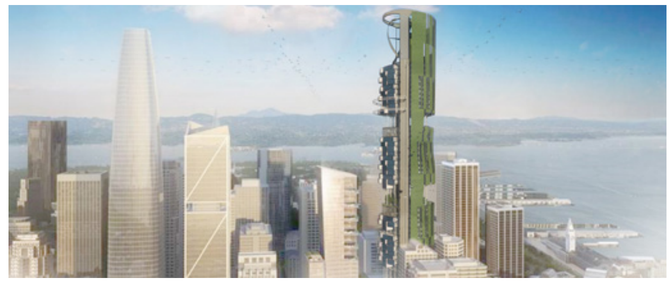
> **"In 2050, we just make the assumption that all buildings are net zero and exporting energy back to the grid."**

Mark Kranz, FAIA, LEED AP BD+C / SmithGroup

Urban Center

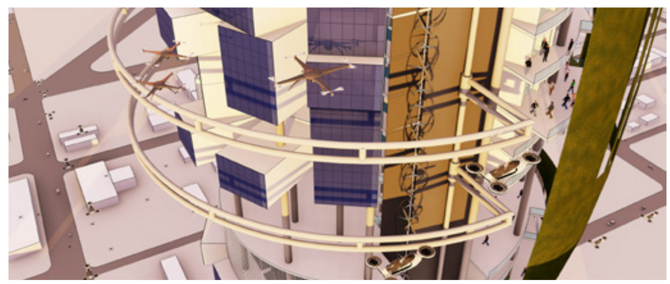
Adaptive to Urban Density.

Research institutions may increasingly migrate from rural campus environments toward highly urban centers to leverage talent. The building chassis adapts well to dense urban environments where space is at a premium. Like the laboratory modules within, it stacks vertically, minimizing its footprint and moving more functions underground.



Self-Contained.

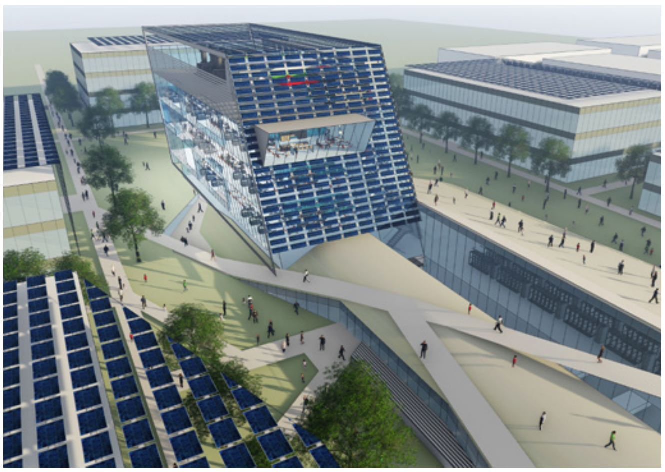
The urban tower becomes an all-inclusive research city, housing all the facilities and support functions needed for scientific study and daily living. Thanks to the plug-and-play modular concept, it contains the optimum combination of laboratory pods, collaborative spaces, living quarters, food sources, parks, daycare centers and other services. Below-grade operations include energy systems and autonomous transit.

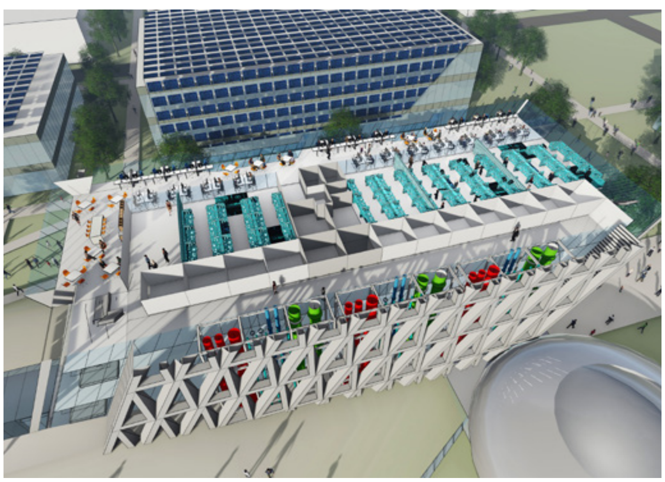


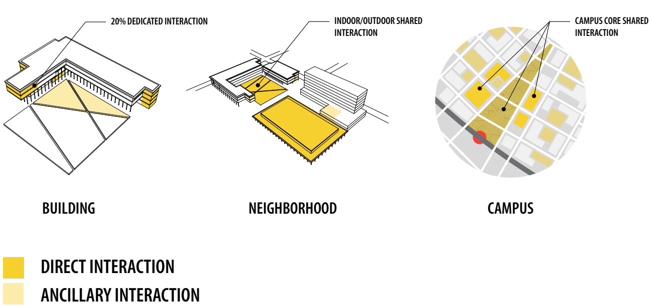
Campus Scale: Recognizing the Need for a Knowledge Hub

While it routinely operates with expansive and ongoing changes in technology, the research community still values human interaction as a vital component of innovation. The campus becomes a central knowledge hub for people to gather and collaborate.

Campus Module







Sense of Place.

Creating a community that nurtures enlightenment and discovery remains the core function of the campus, as it has been for hundreds of years. What will change is how the campus is organized, reflecting the disruptive advancements in research, transportation and communications.

Social Density.

A human-scale, walkable core anchors the campus, fostering the social density that encourages intellectual nodes to thrive. Public visitor centers, science exhibit halls and theaters engage the community and support public-private partnerships that are increasingly important funding sources. Autonomous labs, transit, parking and non-interactive support services move to the perimeter of campus.

Synergy.

As the campus becomes rich with social density, it enjoys a more fluid exchange of intellectual capital. The campus of the future is intellectually permeable, breaking down isolated silos among research disciplines and town-gown barriers. Research communities will organize around specific research problems and innovative product development rather than disciplines

Sustainability.

The campus design that responds to the desire for social density also lends itself to a sustainable centralized energy system. With a campus-wide smart electric grid that can move and store energy, new buildings with geothermal heating and cooling become green energy exporters to older campus facilities. Transit is still needed to bring people together, but its energy impact will lessen with the advent of aerial and autonomous vehicles. Transit solutions that seem fanciful today will become reality within the decade.

The Sea of Change Starts Now

Continued advancements in technology and yet-unimagined scientific breakthroughs no doubt lie ahead for the Lab of the Half Century. Yet as SmithGroupJJR and its Advisory Board have discovered since embarking on their first future lab initiative, Lab 2020, nearly two decades ago, the future is transitional. Changes, however profound they may be, happen not in leaps but in layers.

Preparation for that transitional future must include a critical analysis of how the research community works today. What enables us? What disables us? What are the steps we can take now to stay nimble and adaptable to change as we approach LAB2050 and beyond?

What else have we learned? Although technology disrupts our world and accelerates the rate of change, humans still drive innovation. Our LAB2050 participants believe human intelligence will continue to outpace artificial intelligence. The challenge is to create intelligent infrastructure that integrates new technologies efficiently and effectively, while maximizing human potential. By dovetailing the power of autonomous technologies with the brilliance of the human brain, the Lab of the Half Century welcomes a world of scientific discovery that truly knows no bounds.

> **"Unless there is a Newton-like discovery in the next 20 years, Artificial Intelligence will advance very differently than human intelligence.**
>
> **Artificial Intelligence is not on a convergent path with the human cycle. There will be partnering and teaming, adding embodiment of robotics."**
>
> Alonso Vera, PhD / NASA Ames Research Center

Thank you to our Advisors and Participants

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LAB 2050

Physical Manifestation

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