Designing for the Next Generation of Scientists

SMITHGROUP JJR

Designing for the Next Generation of Scientists

By Irene Monis, AIA, LEED AP

There has been much speculation about what the academic scientific workplace of the future will look like. As young scientists enter the post-doctoral and faculty ranks and recent college graduates enter graduate school, architects and laboratory planners will need to re-think the way we design research environments so that these facilities will best serve the next generation of scientists. An in-depth look at both learning and workplace trends can help identify the guiding principles that will transform laboratory design in the next few decades. Learning, workplace, and technology trends are closely intertwined. The development of emerging technologies and how these technologies will be adopted by the lab users will be important factors to consider. Evolving workplace structures, such as the flattening of the organizational pyramid, will also have an impact on the spatial relationships of laboratory functions.

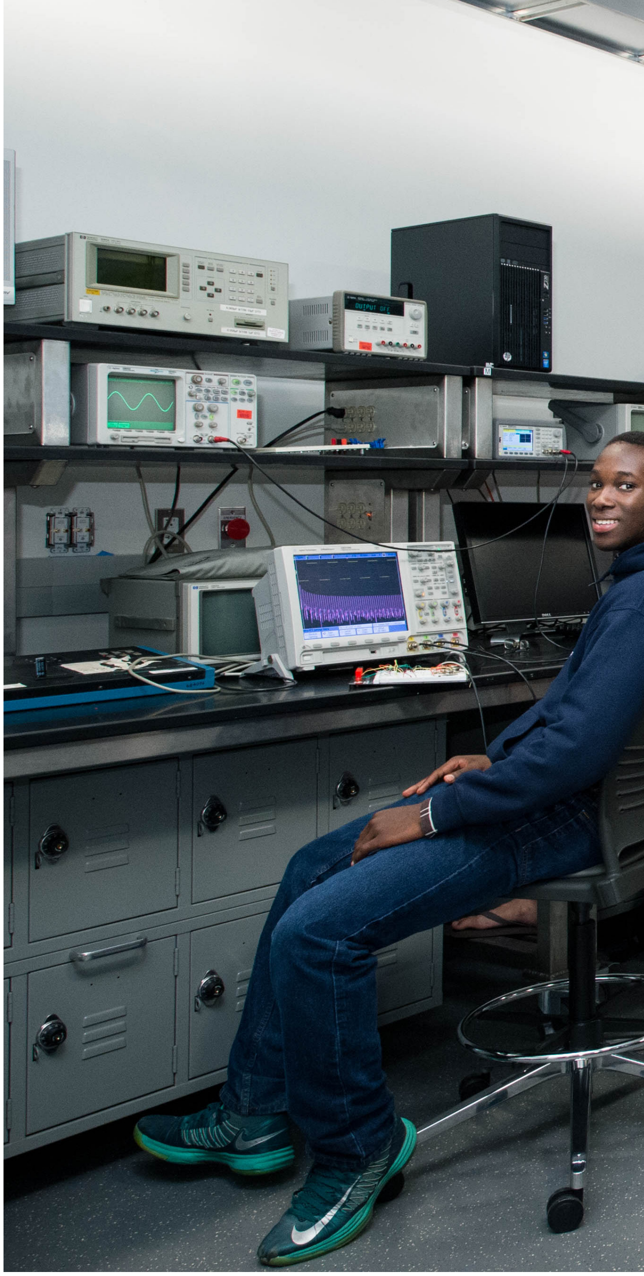
Organizational Structures and Team Work

The next generation of scientists will be a group inclined to collaborate and share ideas. The traditional organizational pyramid will flatten to give place to a more horizontal workplace structure where team work will prevail over old hierarchical structures. To understand what these new structures might look like, it is fitting to examine recent learning trends. Interactive education and a preference for team-based learning hint to evolving workplace structures. In interviews conducted by SmithGroupJJR, students ranked peer to peer interaction as essential. Today's students value collaboration and favor spaces conducive to team-based learning.

Student-faculty interaction also ranks high on their list. According to the American So-

Left:
At the University of California San Francisco's Regenerative Medicine Building, the labs merge into social hubs, allowing for a seamless integration between the interaction and research areas. (Architect SmithGroupJJR with Rafael Viñoly Architects)

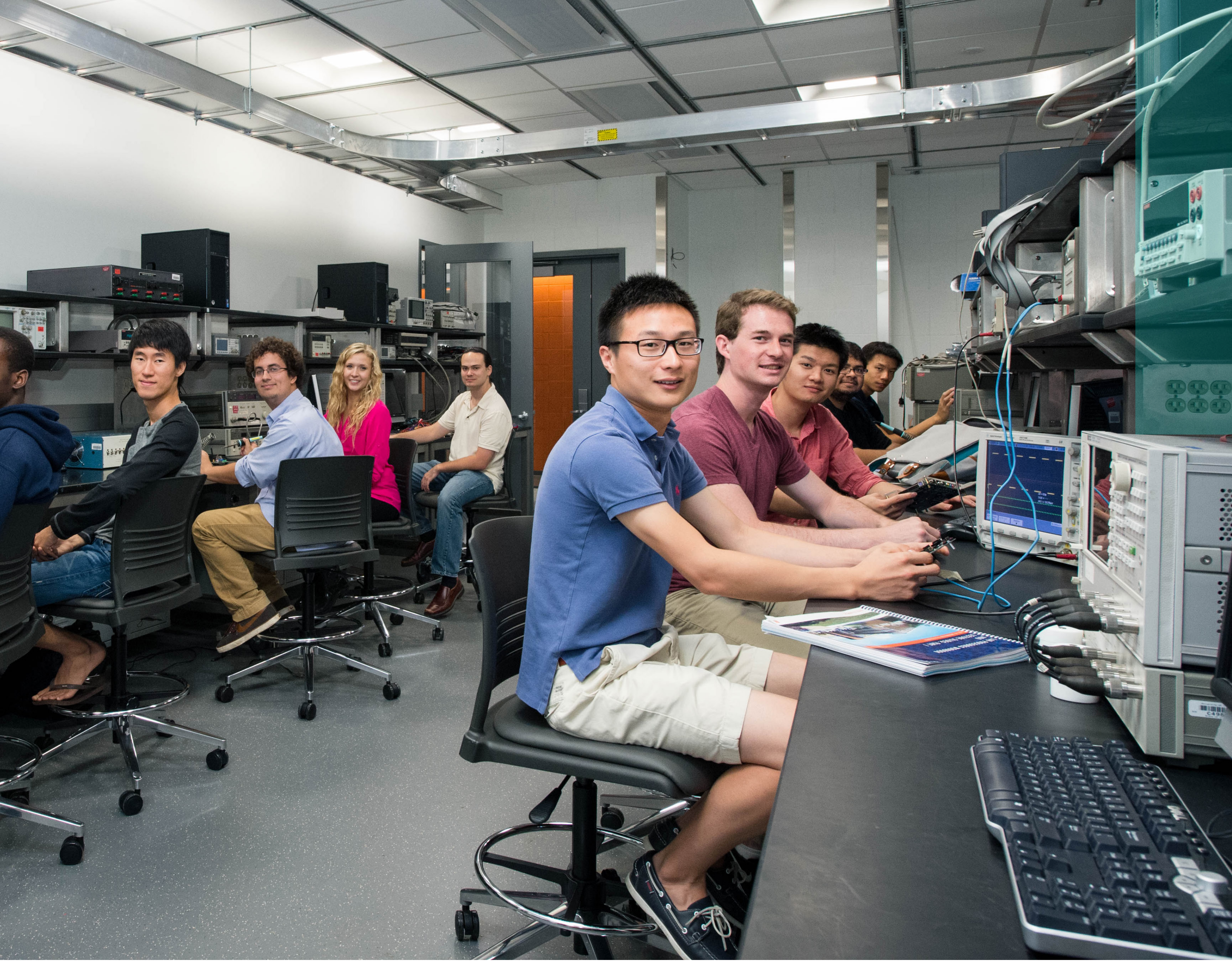
ciety for Engineering Education, two of the most significant factors affecting engineering student engagement and retention are the quality and extent of students' interactions with faculty. Students across American campuses are interacting with faculty in social and informal settings, breaking the traditional boundaries established by earlier generations. It is expected that as recent graduates begin their scientific careers, their influence will lead to a structural re-assessment of the scientific workplace. The new generation of scientists will favor highly flexible work environments where the boundaries between the lab, the office, and the social hub will blur to accommodate spaces that are able to be reconfigured to the needs at hand. The compartmentalization of lab functions will be replaced by multi-functional spaces, with laboratories extending into public and social areas to foster interaction and collaboration. At the University of California San Francisco's Regenerative Medicine Building, the laboratories merge into social hubs, allowing for a seamless integration between the interaction and research areas. At the University of California Merced's Science and Engineering Building II, prototyping laboratories are located on the ground floor. Large glazed folding partitions open to a covered colonnade, which is part of the campus' primary pedestrian system. This planning scheme enables robotics fabrication and testing to "spill" into the colonnade area. Curious students often stop to share ideas and participate on research projects. The trend calls for laboratories that are open to the entire academic and research community to foster interest and participation.



Technology and the Mobile Scientist

The next generation of scientists will be part of a group who views technology as an integral part of their identities. Autonomy, motivation and self-assurance, along with an unhindered approach to technology, will characterize the next generation of scientists.

Academic laboratories have long relied on graduate students and postdoctoral researchers to perform repetitive, tedious experimental tasks. The next generation of scientists will demand more autonomy and



greater opportunities to participate in the creative and intellectual phases of research.

New developments in laboratory automation and informatics, such as Laboratory Information Management Systems (LIMS) and Electronic Laboratory Notebooks (ELNs), will facilitate the cultural shift. While the use of LIMS and ELNs is widespread in the pharmaceutical and biotechnology sectors, adoption by academic laboratories has been slower. According to a recent study conducted by Atrium Research & Consulting, less than 25% of institutional laboratories have adopted some type of laboratory informatics system. The inclusion of ELN content in undergraduate curricula and the availability of systems specifically developed for the academic sector will likely change this trend. An increased level of collaboration between institutional and private laboratories will also help accelerate the pace of ELN adoption. In recent years, major universities, including Yale, Cornell, and the University of Wisconsin, have adopted web based ELNs to serve their research and teaching laboratories. The most basic ELNs replace the traditional laboratory paper notebooks allowing scientists to digitally log, track, and search experimental data. More sophisticated systems can be programmed to set up, run, control, and

Above:
University of Illinois, Electrical and Computer Engineering Building became part of the research environment.

analyze experiments through automated workbenches and to receive experimental data directly into mobile devices.

Widespread adoption of laboratory informatics systems and instrument automation will allow scientists to spend less time on repetitive tasks and more time collaborating and brainstorming. Instrument automation will lead to the miniaturization of lab processes, allowing experiments to run using smaller amounts of compounds. ELNs can be set to track chemical inventories, enabling the reduction of the size of costly chemical storage rooms, and making the lab a safer place to work. Process miniaturization and reduced chemical inventories will free laboratory space for other critical uses. As lab equipment and instruments become smaller and more automated, the laboratory spaces will become increasingly compact, with areas for interaction and idea exchange taking center stage. The use of artificial intelligence on lab processes will lead not only to a shift of open lab, support, and interaction area ratios, but also to new spatial relationships between the computational and the experimental lab. Recent trends indicate that computational simulation and prototyping will not be exclusive to engineering or materials sciences labs. We will likely see an increase in simulation and prototyping in biological labs as well.

> **“The interplay between computational and experimental research will dictate a higher integration between the wet and dry laboratory.”**

Scientists at the University of Minnesota's Center for Cardiovascular Repair "grew" the first artificial beating heart in the lab using a bioreactor that simulates heart physiology. 3D printers are used in biology labs to create prototypes to engineer the architecture of organs. The interplay between computational and experimental research will dictate a higher integration between the wet and dry laboratory. This integration will bring new design challenges. While much of the latest trend in laboratory design has been to separate computational and wet laboratories to attain energy and cost efficiencies, designers will need to figure out how to efficiently integrate these two types of laboratories into highly flexible spaces that can function as dry labs, wet labs, or a combination of both. And it might be precisely emerging technologies that will allow designers to solve this conundrum: Similar to wireless data transmission, wireless power transmission will allow the reduction of fixed utilities in the lab. Advances in the development of ductless fume hoods, which rely on carbon and bonded gas phase filtration to remove chemicals before discharging air back into the room, will enable mobility of a traditionally fixed piece of laboratory equipment. Benches and sinks mounted on wheels, equipped with highly flexible piping allow portions of dry laboratories to be reconfigured into wet labs in a snap. At the Lawrence Berkeley National Laboratory's Molecular Foundry, the laboratory casework

Right:
At Michigan State University's Molecular Plant Sciences Building, the upper three floors are dedicated to creating flexible, open lab environments for students and some of MSU's most productive plant researchers.

Above:
At the University of California Merced's Science and Engineering Building II, prototyping laboratories are located on the ground floor. Large glazed folding partitions open to a covered colonnade, which is part of the campus' primary pedestrian system.

is mounted on wheels and equipped with quick disconnects. Utilities distributed in overhead service carriers allow for a fast reconfiguration of the laboratory spaces to best serve the scientist's immediate needs.

Looking Forward

As the scientific workplace rapidly evolves, one question seems timely: what can architects and laboratory planners learn by deepening our understanding of how the next generation of scientists will engage in the research process? In the last two decades there has been a shift in the approach to laboratory design. The inclusion of important design principles - such as sustainability, access to daylight and views, energy efficiency, and spatial flexibility- contributed to that shift. Moving forward, it will be critical to understand how both evolving trends in workplace culture and emerging technologies will impact building metrics and functional adjacencies. It can be inferred that the scientific workplace of the future will be a highly mobile environment which will accommodate the desire to work in teams, both physically and virtually. We will see a higher integration between computational laboratories and wet laboratories, as well as a growth in multi-functional spaces. It is likely that the new spatial model will include innovation hubs where multiple functions,

such as basic experimentation, computer simulation, prototyping, and interaction, will be accommodated in one space. Transparency will provide desired connectivity when acoustical controls are a must. Movable partitions will provide opportunities for space reconfiguration - from private to semiprivate to open and back - as needs dictate. Flexibility and adaptability will be less about movable casework and "Plug and Play" systems, and more about research processes and the ability of spaces to adapt to evolving technologies and preferred workplace structures.

Irene Monis, AIA, LEED AP

Irene Monis is a principal with the San Francisco office of SmithGroup. An architect and a sustainability expert with over 20 years of experience, Ms. Monis specializes in the design and construction of science and technology facilities. Her expertise involves projects on university and institutional campuses with a focus on green design, LEED® and Labs21. She has extensive experience leading LEED-certified projects and has presented at industry conferences on topics ranging from sustainability to science and technology design.

"Designing for the Next Generation of Scientists" was originally published in *Laboratory Design Newsletter* on December 15, 2014.

SMITHGROUP JJR