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ARTICLE
Facilities Planning for the Neuroscience Curriculum at a Primarily Undergraduate Institution: St. Olaf College's Regents Hall of Natural and Mathematical Sciences

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Planning for new science facilities at your institution is an exciting, challenging, and rewarding endeavor. Perhaps most significantly, it also embodies a rare opportunity to provide new infrastructure to support a programmatic vision for the future. Here, we describe St. Olaf's new Regents Hall of Natural and Mathematical Sciences, beginning with an outline of the planning/design process, then an overview of the features of the building - with particular regard to the Neuroscience Program facilities - and finally a discussion of lessons learned. We hope our experiences may benefit those engaged in the facilities planning process at their own institutions.

Key words: neuroscience facilities; science building; laboratory design

St. Olaf College is a mid-sized Liberal Arts College enrolling approximately 3,000 undergraduates. The Faculty of Natural Sciences and Mathematics at St. Olaf consists of five departments - Biology, Chemistry, Physics, Psychology, and MSCS (mathematics, statistics, and computer science). Majors are offered in biology, chemistry, computer science, environmental studies, mathematics, physics, and psychology, and students can pursue Concentrations (the equivalent of a Minor) in biomedical studies, biomolecular science, statistics, or neuroscience.

St. Olaf's Neuroscience Program was formally established in 2000. Initially driven by student demand, the creation of the Neuroscience Concentration resulted from the hard work and dedication of a small, core group of faculty from Biology and Psychology in the late-1990's. Importantly, this founding faculty group was also successful in securing funding to support a neuroscience course, lab, and startup funds for a neuroscience faculty appointment. More recently, St. Olaf has solidified and broadened the program with three neuroscientist hires in Psychology and Biology (one each year during 2003-05) and the added involvement of neuroscience-interested faculty from other disciplines. Student demand for the program has continued to grow and it currently enrolls over 50 declared Concentrators.

Figure 1. Regents Hall of Natural and Mathematical Sciences.

It became apparent by the mid-1990's that new science and mathematics facilities needed to be on the horizon at St. Olaf College. A feasibility study was conducted in 1999, which in due course led to the launching of a concerted design process in 2002 for what eventually came to be known as Regents Hall of Natural and Mathematical Sciences (Figure 1). This timing was fortuitous for our emerging Neuroscience Program, for it meant that the program/space aspirations of our neuroscientists were manifested throughout design.

Regents Hall of Natural and Mathematical Sciences consists of a 195,000 gross square foot new building for the natural sciences (biology, chemistry, physics, and psychology), 18,000 gross square feet of renovated space in the existing mathematical sciences (mathematics, statistics, and computer science) building, and an 8,000 gross square foot link between these two buildings (see www.stolaf.edu/regentshall for details). The natural sciences and link portions of Regents Hall opened in Fall 2008; renovation is currently underway on the mathematical sciences building in preparation for occupation in Summer 2009.

In hope that our experiences will prove helpful to other neuroscientists contemplating new/renovated spaces, this paper first describes our design process and the general building features of Regents Hall. We then offer a more detailed description of the neuroscience spaces in Regents Hall followed by a discussion of lessons learned.

DESIGN PROCESS

The design of Regents Hall was an integrated, collaborative and vision-driven design-build process that involved faculty, students, facilities personnel, campus-wide representatives, architects (Holabird & Root, LLC), and construction managers (Oscar J. Boldt Construction Company). For us, design-build (as opposed to design-bid-build) was the right decision, as we benefited greatly from the presence of contractors and subcontractors at the table throughout the design process and it allowed us to be relatively nimble as we moved through the challenges associated with a tight design/construction schedule.

The design process was driven by a programmatic vision that we packaged into our "Seven I's." Throughout design, we continuously asked whether Regents Hall would:

- Promote ***interdisciplinary*** work.
- Encourage an ***investigative*** approach to the natural and mathematical sciences.
- Support the ***interactive*** nature of modern science.
- Accommodate the ***innovations*** that bring technology into the classroom and laboratory.
- Be ***inviting*** to students, faculty, staff, and visitors.
- Incorporate ***interconnections*** between the sciences and other distinctively St. Olaf strengths.
- Embody the ***integrity*** characteristic of St. Olaf College.

FEATURES OF REGENTS HALL

At a glance, Regents Hall:

- Provides 119,000 net assignable square footage, including 26 teaching labs, 7 tiered classrooms, 11 flat-floored classrooms, 8 seminar rooms, and 4 computational rooms.
- Has 13,000 square footage of student-faculty research space, much of it shared to foster collaboration, enhance access to common equipment, and minimize duplication of laboratory services.
- Includes a 7,000 square foot science library with technology-based information access, numerous individual/group study spaces, and multiple points of access.

The general layout of Regents Hall can be understood by a description of the second floor (Figure 2). The second floor was chosen for illustration both because much of the Neuroscience Program is housed in the west half of the second floor (described in more detail later) and because the single-story link between the new building (Regents Hall of Natural Sciences) and the renovated building (Regents Hall of Mathematical Sciences) is located on this level. In general, offices are located on the south side of the new building, teaching labs are on the north side, and research labs and support spaces are located centrally. Flat-floored classrooms are dispersed throughout while the larger tiered-classrooms are located at the east and west ends. In addition to serving as a passageway between the new and renovated portions of Regents Hall, the link contains classrooms, two computer science labs, and our statistics-based Center for Interdisciplinary Research.

Several building features illustrate the implementation of our programmatic vision. First, to embody the increasingly interdisciplinary nature of the natural and mathematical sciences, Regents Hall is organized in a fashion that fosters interdisciplinarity while sustaining disciplinary foundations. Beyond the Neuroscience spaces, other deliberately designed interdisciplinary areas include spaces for the Biomedical Sciences (biochemistry, genetics, physical chemistry, molecular biology, microbiology, cell physiology) and the Environmental Sciences (ecology, analytical chemistry, biogeochemistry, molecular systematics, evolution, plant science, environmental chemistry). Second, by grouping faculty with overlapping research interests, we were able to design shared research spaces; this model enabled efficiencies to be realized in terms of utilities and square footage, a tangible benefit beyond the primary goal of fostering investigative learning in a collaborative and interdisciplinary environment. Third, a central crossroads atrium (with coffee shop on one level) and naturally lit

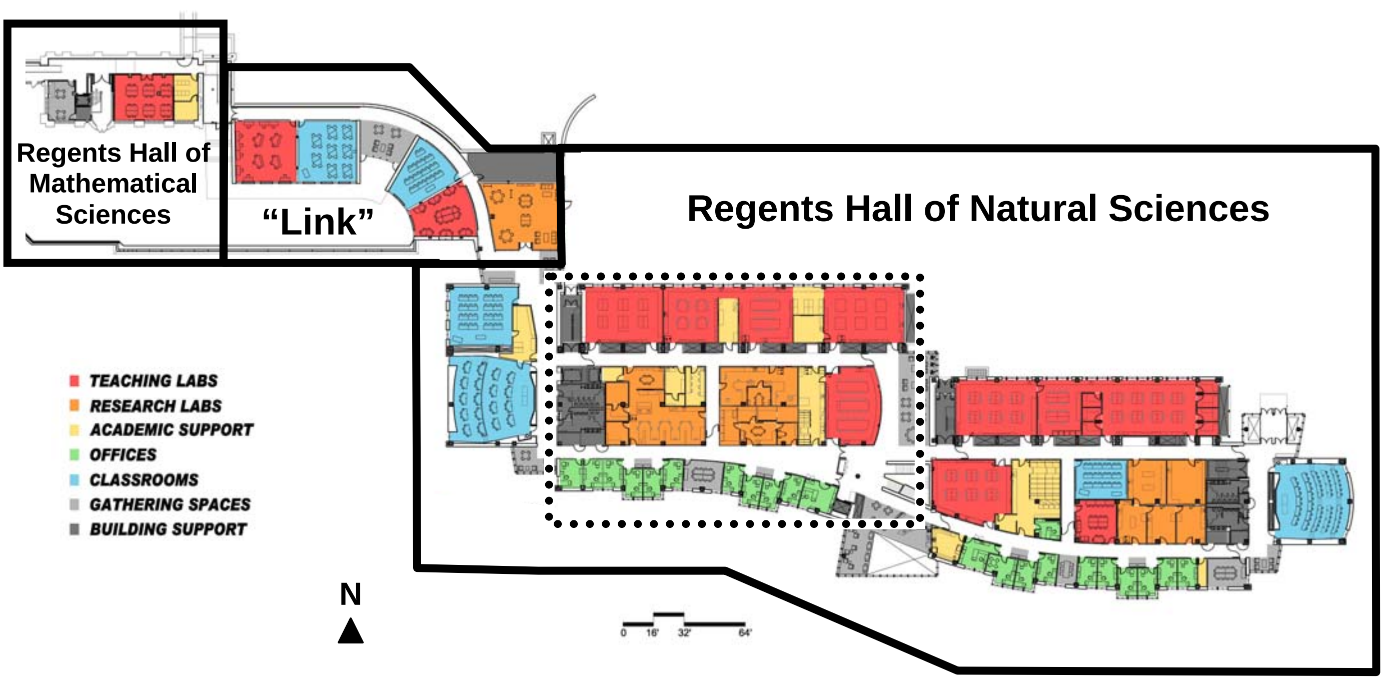

Figure 2. Second Floor of Regents Hall. Spaces are color-coded by function. Neuroscience research spaces and some neuroscience teaching labs are indicated within the dotted line in the central West Wing of Regents Hall of Natural Sciences.

gathering spaces at the ends of hallways provide abundant informal spaces for interaction. Fourth, a variety of different table styles in the tiered classrooms facilitate interactive learning while preserving the ability to deliver formal lectures. The layouts range from rooms filled entirely with movable half-round tables to those with fixed tables, but all enable a class to turn quickly from individual listening to group work. Fifth, windows into five "showcase" teaching labs that flank the central atrium and hallway windows into research spaces make the practice of science a visible and inviting part of the learning environment. Finally, Regents Hall is a thoughtfully designed sustainable building shaped by a commitment to green chemistry and highlighted by natural light penetration deep into the interior spaces, plentiful views to the outdoors, an accessible rooftop terrace containing a "green roof," and site and systems considerations that have us awaiting final LEED certification at either the Gold or Platinum level. A green building was not only consistent with the integrity of St. Olaf's values, it also provided the impetus to incorporate monitoring systems and other features that enable Regents Hall itself to be a laboratory for learning, particularly in regard to sustainability.

NEUROSCIENCE IN REGENTS HALL

Since its inception, one of the guiding principles of the Neuroscience Program has been an emphasis on the interdisciplinary nature of neuroscience, and this emphasis has been reflected in the design of the new neuroscience facilities in Regents Hall.

One major advantage Regents Hall facilities provide for the Neuroscience Program is the bringing together of core neuroscience faculty in Psychology and Biology – departments previously in separate buildings – thus providing the program with a physical "home." Having the offices and research labs of Neuroscience faculty located in one region of the building invites students with neuroscience-related questions/issues to come to this "home," and also promotes interaction between faculty with related interests that might not otherwise have occurred. For example, the majority of offices are arranged in clusters of four around what was informally termed a

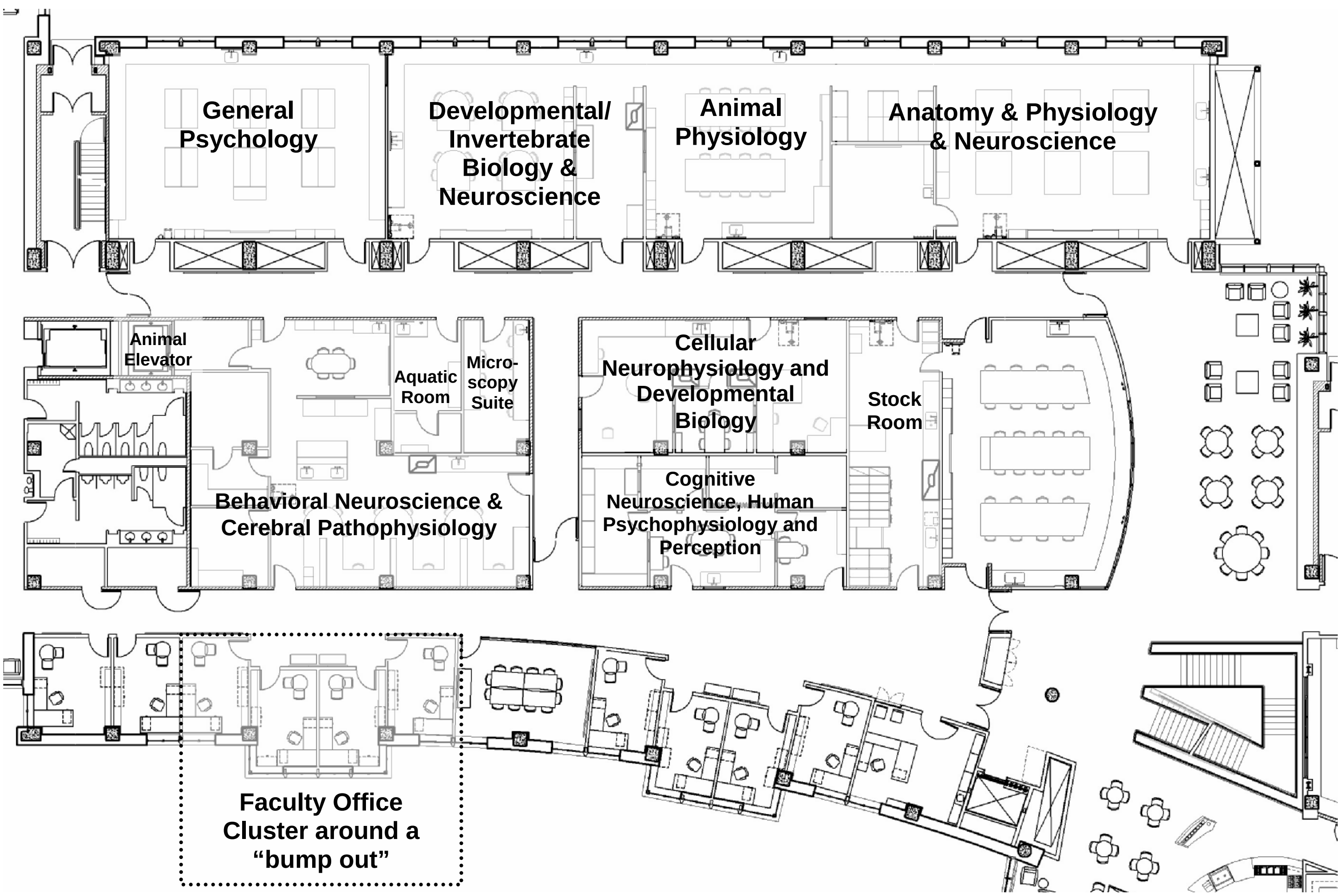

Figure 3. Detail of neuroscience research and teaching spaces (as indicated in Figure 2). Research spaces occupy the central areas, teaching labs the northern wall, and faculty offices the southern wall.

"bump out" on the south wall (see Figure 3). One such cluster of neuroscience faculty consists of a physiologist in Biology with interests in mechanisms of neuroprotection; a behavioral neuroscientist in Psychology who examines the effects of alcohol on place-preference conditioning in adolescent mice; a systems and computational neurobiologist in Biology who studies the leech nervous system; and a cognitive/behavioral neuroscientist in Psychology examining the neural basis of spatial cognition and navigation. Since moving into the building, conversations between these faculty with diverse but overlapping interests have already resulted in ideas for novel collaborative research projects.

St. Olaf has always been a strong proponent of providing students with the opportunity to conduct research as a means of teaching science. New facilities for neuroscience research have been designed to foster this emphasis on investigative and interactive learning. For example, three of the four faculty in the aforementioned office cluster share a single research space (see Figure 3: Behavioral Neuroscience and Cerebral Pathophysiology lab). The fourth faculty member sharing this space is a Biologist who studies animal behavior. Individual areas were designed to accommodate specific faculty research needs (e.g., shielded rooms for electrophysiology in freely-moving animals) but with an eye to maintaining the future flexibility of the space in the event of personnel changes or shifts in faculty research interests. Benches were included in the plan to provide large, flexible areas where shared (e.g., chemical stations) or specific (e.g., electrode making) activities could take place.

A design feature common to all shared lab spaces shown in Figure 3 (and in several others throughout the building) is the inclusion of a small conference area for student meetings, journal clubs, etc. This feature came as the result of faculty input on the relative importance of such spaces to their research programs involving undergraduates, even though it required a loss of "hard" lab space.

Arguably, the most significant improvement to neuroscience facilities is the new animal facility. The old facilities were spread over two buildings and consisted of approximately 500 square feet containing a general holding room, one rat holding room, one mouse holding room, and washing/storage space where cages needed to be washed by hand or in the domestic dishwasher. In stark contrast, the new Regents Hall vivarium covers 1,830 square feet and contains two large and two small animal holding rooms, a large and a small procedure/surgical room, a dry storage room, and a cage wash room complete with cage washer and ventilated dump station. In addition, a dedicated animal elevator allows transportation of animals from the 1st floor vivarium to the research labs on the 2nd floor (see Figure 3: Animal Elevator). Both the animal elevator and vivarium require keycard access. An additional benefit of the new building layout is the proximity of the loading dock to the animal facilities, allowing arriving animals to be quickly and easily transferred to the adjacent vivarium.

A number of teaching lab spaces have been designed with particular regard to neuroscience applications (see Figure 3, north wall). For example, the Animal Behavior teaching lab adjoins the vivarium on the 1st floor (not shown in Figure 3). One notable feature of this room is the ceiling-mounted Nederman exhaust arms above each table for ventilation during work with fixed tissue. The Anatomy and Physiology/Neuroscience lab on the 2nd floor has similar ventilated work spaces created by downdraft benchtops. In addition, this lab also has computer workstations at each bench that are invaluable for having students conduct investigative research utilizing the internet or for running computer simulations such as the neuron simulator "MetaNeuron" (http://www2.neuroscience.umn.edu/eanwebsite/metaneuron.htm) used in our Introduction to Neuroscience course. The cadaver room is located adjacent to the Anatomy and Physiology/Neuroscience lab. The General Psychology lab contains computer workstations around the outside of the room with BioPac equipment that allows students in pairs to record and analyze psychophysiological and EEG data. Another lab of note is the Developmental/Invertebrate Biology and Neuroscience lab which has bullet–shaped benches designed to facilitate small-group microscopy work (e.g., histology).

LESSONS LEARNED

In a project of the complexity of Regents Hall, the lessons learned, both positive and negative, are numerable. Perhaps the most challenging lesson to learn was patience. From earliest planning to completion, the project spanned four St. Olaf presidents over more than 15 years. Hence, the project had several pauses along the way. While these delays created occasional disappointment, in the end the time was crucial to many of our sustainable initiatives as it provided an opportunity to be more thoughtful about emerging technologies. These pauses, in conjunction with clearly articulated principles and a compelling programmatic vision, also helped with the acceptance of features such as the interdisciplinary layout or the shared research spaces, both of which were significant changes from our existing culture.

Success requires a team effort. The users must be involved throughout, the architects must listen carefully to the programmatic vision, the contractors and subcontractors must provide ongoing feasibility and cost analysis, and all must be willing to allocate far more time than imagined to allow for creative solutions to emerge and practical challenges to be solved.

Communication is essential. This is especially important with a design-build process where design changes sometimes need to happen quickly during construction. There may be compelling reasons for a design change (e.g., engineering/construction concerns or excessive costs), but if it has programmatic impact and the user is not informed, frustration is likely. Good communication is also essential to achieve ongoing faculty understanding and to manage faculty expectations. Fortunately, dissatisfaction with spaces in Regents Hall is minimal, but where it occurs there is usually an element of poor communication – inadequate coordination of the various aspects of a space, failure to discuss design changes with users, or ambiguity in the translation of conversations into drawings.

When encouraging the users to contemplate change, affirm early in the process that the open-minded imaginative thinking being asked for may in some cases lead to the conclusion that change is unwise and unnecessary. Granting permission to think this way helps those who at first blush are opposed to change. There are many features in Regents Hall that represent significant change from previous practices, but there are also aspects where we decided to essentially keep the status quo in the face of options for change.

The importance of process is directly related to the difficulty of the decision. It is inevitable that there will be differences of opinion on a project of this magnitude, so decisions need to be grounded in a process that allows all voices to be heard, carefully weighs the consequences of various alternatives, has an agreed to mechanism for decision making, and communicates the outcome to all stakeholders.

Finally, create an atmosphere where all ideas, regardless of whether they turn out to be good or bad, are welcome; innovation flourishes best in this kind of environment. The saying “fail often in order to succeed sooner” was certainly true in our case. Many times, someone would find a nugget of something intriguing in a “bad” idea, spin the idea differently, and then someone else would add a new insight, and pretty soon something really interesting had emerged. Some of our best spaces came to realization this way.

CONCLUSIONS

In conclusion, we in the natural and mathematical sciences at St. Olaf College feel extraordinarily fortunate to find ourselves in new facilities that are the fruit of an integrated design process strongly driven by a programmatic vision for the future. Our Neuroscience Program has clearly been strengthened by the interdisciplinary nature of the new building and the proximity of our neuroscientists. To the extent to which we can be helpful to the broader neuroscience and scientific community, we are pleased to share our experiences and insights.

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