

# Strategic Planning: Facilities Task Force

Cornell College of Engineering

## Executive Summary

The Cornell College of Engineering is engaged in a comprehensive strategic planning process. This “facilities and infrastructure” report reflects the findings of a subcommittee reporting to the College Strategic Planning Committee. It takes into account the strategic priorities of the College, the strategic plans of units in the college, and the changing nature of research and teaching. Members were Ken Birman (CS; Task Force Chair), Mark Eisner (OR&IE), Cathy Long (Dean’s Office), Ephraim Garcia (MAE) and Bruce van Dover (MS&E). Our major findings can be summarized as follows:

- The College confronts pressing facilities issues. These include a pervasive shortage of space for both existing programs and new research initiatives, aging facilities and infrastructure critically in need of renovation, and the requirement to transform existing space to respond to new styles of research and instruction. A large percentage of the College’s existing space is ill suited for emerging research needs.
- Undergraduates have become distanced from faculty, a consequence of a decades-long transformation of teaching space into office and laboratory space. We must reestablish an environment in which undergraduates and faculty can study and work in close proximity by integrating appropriate teaching space in research-dominated buildings.
- The success of interdisciplinary programs demands that collaborators be situated close to each other, and close to research resources. In particular, Cornell’s Life Sciences facilities will be relatively far from Engineering. Several major research priorities in Biology depend on collaboration between faculty in Engineering, FCIS and Life Sciences. These faculty must be situated as close as is practical to collaborators.
- The College lacks appropriate service and support space for students, faculty, and staff. The Engineering Library is outdated and does not adequately support the learning and study requirements of modern instruction, such as group projects, experiential learning, presentations, and computing. Student services are dispersed. Community space is sparse. Bringing all elements together in settings that could become natural centers of gravity would promote cohesiveness and collegiality, continue the College’s strides in improving climate, and help attract and retain a more diverse community.
- It is time to revisit the College “Master Plan”. The Master Plan is a development roadmap that looks decades into the future and identifies possible building locations and footprints with attention to aesthetics, convenience, program needs, etc. The existing plan is outdated by such events as the construction of Duffield Hall.
- Major investments in new facilities and major renovation of existing facilities should be seen as urgent priorities. The upcoming Cornell campaign represents a unique opportunity to transform the College. Cornell should invest to reestablish an environment that promotes the highest quality educational experience for undergraduates, is able to attract the world’s best students, researchers and faculty members in the most hotly contended research areas in history, and promotes the success of multi-disciplinary research initiatives vital to the long-term health of the institution.

## Summary of Recommendations

- Engage an architectural firm to revise the College Master Plan through dialog with a wide range of stakeholders (including administration, researchers and students, both in Engineering and in the Faculty for Computing and Information Sciences).
- The existing Engineering quadrangle is far too crowded. Expansion (for example, onto Hoy Field) must be explored.
- Construct a new building to house the Department of Computer Science, the Faculty for Computing and Information Sciences, and related programs.
- Participate in the construction of a new Physical Science Building that will house the Department of Applied and Engineering Physics.
- Construct a new space close to the Engineering Quadrangle to house the Biomedical Engineering program. Invest in the Life Sciences facilities to promote collaborative programs in Engineering.
- Construct space adequate to house a new program in Clean Energy.
- Renovate or build to create a College Learning, Library and Service center that can serve as a focal space for use by students, faculty, and staff while also bringing the Library into the 21<sup>st</sup> century.
- Undertake a sweeping renovation of existing facilities, both interior and exterior.
- Invest to upgrade the College networking infrastructure, while also creating a group to study broader computing needs and trends within the College.

## Introduction

Cornell's College of Engineering is a place of powerful influence, unique discovery, world-class research, and exceptional education. Its faculty, staff, students, and alumni are truly world-class; their accomplishments are recognized as Cornell's successes throughout the world. It is not only fitting, but essential, that the facilities of the college catalyze, nurture, and enable the work and study of the college community.

The Facilities Task Force was asked to prioritize College facilities requirements with respect to the upcoming Capital Planning and Fund Raising Campaign. We reviewed Departmental Strategic Planning documents, the Engineering Space Study, the College Library Strategic Plan and other materials. Our assessment of the current state of facilities in the college, the college's research and instructional goals, anticipated emerging areas of intellectual pursuit, and the strengths of our competition, lead us to the following conclusion:

***There is a vital need to create new space, facilities and capabilities, and to dramatically improve the capacity of existing facilities to meet the research, instruction, and community needs of the College of Engineering. Actions to address the shortcomings in facilities must be swift and extensive in order for the College to continue its success into the next century.***

A summary of our working assumptions with respect to current and incremental space within the College is attached to this report as an Appendix. Significant specific findings include:

- Our peer institutions have invested heavily in Engineering facilities over the past decade.
- The appearance and function of most of the College's facilities do not begin to reflect the distinction or eminence of the college, particularly in the wake of two decades of extensive construction throughout the Ithaca campus. The aging facilities do not provide the type of environment that is necessary to support informal interactions and a sense of community, nor do they encourage collaboration. Our peers have created Engineering campuses that are both functionally superior to Cornell's and also strikingly attractive. Cornell must respond to this challenge; failure to do so will make us less competitive.
- The experimental equipment, computing power, and research materials used in modern engineering were not remotely envisioned when the college was constructed. In many cases the infrastructure (exhaust and structural support capacity as examples) has been expanded to maximum capacity. The inability to further expand could prevent Cornell from pursuing vital research priorities.
- Experiential learning, through hands-on experimentation and building, group tasks, and design projects, a required component of modern engineering education, cannot be accommodated in College space the way it is currently configured.
- 70% of the college's facilities were constructed in the 1950's, primarily as classroom space. Conversion of space to research and teaching laboratories has occurred over time, distancing students from faculty members and from research activities.
- Mechanical systems are still in the form originally constructed more than 50 years ago, in part or in full, in 11 of the college's 12 buildings on the engineering quadrangle; 10 of these buildings require communications network upgrades; mechanical and data systems in over 90% of the facilities do not meet the power, plumbing, exhaust, and cooling requirements to conduct modern research and instruction.

## Unifying Themes

We have identified several themes that should guide the College in its facilities planning efforts.

### Transforming the College

- **Renewing the Image of the College** The character of the college's facilities should reflect the innovative and remarkable work of its community members. Although the buildings currently comprising the Engineering College are classics from the period in which they were designed, they are now crowded by new construction and are visibly aging despite some largely cosmetic upgrading. The perception and image of the college are greatly influenced by the character of its facilities and the space within which daily activities are conducted. Externally, the facilities are noticeably outdated and internally college space is increasingly crowded, gloomy and visibly deteriorated. Investment not merely in new facilities but also in a dramatic rejuvenation and upgrading (or in some cases even replacement) of existing facilities offers the College—and University—an opportunity to make a statement about the very nature of Engineering as a discipline. Moreover, such steps will provide an environment that will attract faculty and students who are interested in the subject matter yet dismayed by the increasingly degraded physical environment.
- **Facilitating Collaboration and Community** Research, teaching, and a shared sense of vision depend on space in which informal interactions between students, faculty, and staff can occur. Cornell Engineering prides itself on its collegiality, yet the College lacks the kinds of environments that can foster casual dialog, host receptions and other college community events, and encourage Engineering students, faculty, and staff to perceive themselves as part of a community. Indeed, as the College of Engineering has grown, there has been a steady erosion of space dedicated to these informal interactions. (The atrium of Duffield Hall will respond to some aspects of this concern).
- **Reducing the Distance Between Students and Faculty** The culture of student and faculty interacting, learning, and working together outside the classroom is a hallmark of the student experience in Engineering, reliant on space proximity and design that facilitates these interactions. Appropriately located space can encourage and support a culture of extramural interaction. As research needs have consumed instructional space and teaching has migrated away from

college facilities, we have eroded a critical link between students and faculty.

- **Rethinking the Role of the Library**  
The library was built at a time when its central role was acquisition of printed materials and provision of access to those materials. Today, students access materials electronically, use the library as a space for collaborative learning, to conduct research over the network, and utilize it as a place of study alone and in groups. The library is poorly designed for these activities, and has been judged substandard in quality and space. A major redesign is needed.

### Catalyzing Research

- **New Research Priorities**  
The leadership position of the Engineering College, and Cornell, is predicated on the ability of researchers to create the future through sophisticated, complex experimentation and design, only possible with advanced facilities that enable research in emerging areas of importance. With the growth of interdisciplinary work, research groups have grown in size. The ability to successfully compete in emerging areas of technology for funding, faculty, and students will require additional space, and space equipped with systems and features not found in current facilities. Success will be realized only if the college begins now an aggressive planning, renovation, and construction initiative to transform and create facilities needed to support research in the 21<sup>st</sup> century.
- **Promoting Interdisciplinary Collaboration**  
Interdisciplinary and collaborative approaches are increasingly crucial to progress in research. Cornell has an enviable reputation for fostering a culture of collaboration and Cornell's ongoing commitment is evident in such College priorities as the Clean Energy initiative and the new Information Technologies majors, and is explicit in many department strategy documents. Yet collaboration cannot succeed without physical proximity. Thus College priorities that link Engineering to research in Biology and the Life Sciences, or to Physics, or the Arts demand both new kinds of space and also appropriately located and connected space that can bring collaborators from traditionally separated endeavors together. As we look at tradeoffs between possible sites for new space, or options for renovating existing space to meet the needs of new programs, physical proximity and connection are important considerations.

- Upgrading and augmenting Laboratories  
There is a striking shift underway from theoretical, “pencil and paper” approaches to Engineering back into the laboratory. New researchers who join Cornell will require new kinds of laboratory and instructional space. Completely new research themes are emerging, in areas such as Bioengineering and Biomedical Technologies, Environmental Engineering, and Miniaturized Devices. This theme is repeated throughout the strategic planning documents we reviewed.
- Connectivity  
For better or worse, Ithaca’s weather is a challenge. Transportation of delicate research materials between laboratories has become the norm in collaborative research. Often these labs are located in different buildings. Controlled safe passages to allow effective transportation of materials and equipment is imperative. In addition, the creation of comfortable connections between buildings could greatly reduce the perceived barriers that can arise even when faculty members are housed in adjacent but separated buildings.

#### Responding to Evolving Student Needs

- Rapid Growth of Graduate Programs  
Over the course of a decade the College has created a significant, vibrant Masters of Engineering. Additionally, many Ph.D. programs have grown dramatically. In order to serve these students effectively, the College must provide sufficient new space for offices, laboratories, project, and research space.
- New Teaching Styles  
More and more instruction within the College occurs in hands-on settings or requires substantial work on projects. New learning styles involving self or group driven inquiry, experiential learning via projects, and peer learning are becoming an increasingly important and required part of engineering education. Web based learning via the creation of simulated experiences or web driven laboratory may also have a large impact on how engineering education is performed. New kinds of instruction and project space and computing infrastructure are needed to promote these kinds of collaborative learning experiences.

- Changing Demographics

The Engineering community is more diverse than ever before, and will continue to diversify. Its faculty, staff, and students, from all backgrounds, demand an environment that is supportive of their success in work and study. This includes the physical environment. Additionally, as society's needs change, Engineering is responding to demand for new majors by creating, for example, a major that will be joint between BEE and CEE, focused on Environmental Engineering, and one that will be joint between CS, ORIE and ECE, focused on Information Sciences and Technologies.

These new majors will potentially appeal to a new kind of student, because they offer significant numbers of credit hours in departments and courses that have traditionally had higher percentages of underrepresented student groups (particularly women) than was the case for Engineering when most of its buildings were built. The resulting demographic changes are highly desirable, but have implications for the design of new facilities and the renovation of old ones.

## Priorities and Recommendations

1. We recommend that a building be constructed, jointly with the Faculty for Computing and Information Sciences, to house Computer Science, the Program for Computer Graphics, Digital Libraries and other FCIS programs in areas important to Engineering, such as Computational Biology and Genomics. Relocation of these efforts into new space would free almost 50,000 NSF within Upson and Rhodes Hall, creating the opportunity to respond to severe overcrowding seen in ECE, ORIE and MAE. When selecting a site for this building, attention must be given to the need for proximity between researchers who would be located within it, collaborators throughout Engineering, the Cornell Theory Center, and in the new Life Sciences complex.
2. We recommend that a building be constructed to house the proposed new research efforts in Biomedical Engineering, but doubt that it is practical for these Engineering faculty members to be situated within the Life Sciences complex because they may be too far from the primary Engineering campus and too few (six as now planned) to have the necessary critical mass for an independent program. Accordingly, this space will be needed closer to the primary Engineering campus.
3. We endorse College investment in the Life Sciences and Physical Sciences projects, provided that attention is given to the need for “critical mass” and to the importance of locating major College programs in proximity to collaborators within the College.
4. New space should be constructed to house the proposed new “Clean Energy” program, a cross-cutting initiative that engages many facets of Engineering and would also respond to a national priority in this area. We see this as an exciting concept that could unite a wide range of departments, faculty members and students and also help Cornell achieve national visibility in an important emerging research area.
5. New or renovated space is needed for a College Learning, Library and Service center that would bring a number of student-related activities in an integrated setting while also offering a venue for a variety of social and informal interactions. While the Duffield Atrium should respond to some aspects of the perceived need for a “social” center for life within the Engineering quad, Engineering is too large for a that single space to address the whole need, and Duffield Atrium lacks convenient access to the Library and to various student services.
6. The existing Engineering quadrangle is far too crowded. Expansion (for example, onto Hoy Field) must be explored, and offers possible resolution of our proximity concerns.
7. We strongly favor an extensive renovation of existing buildings, covering both interior and exterior space. Interior renovation is needed to overall an aging and inadequate physical plant. Exterior work could, at modest cost, transform the overall appearance of the Engineering quad.



## Discussion

As part of this construction, it will be important to explore tradeoffs between the demolition of one or more existing College buildings and the other variables that enter the picture, notably the importance of laying the foundations for collaboration by situating new programs in proximity to researchers and resources those new programs should leverage.

The proposed construction should have a secondary benefit of easing the overcrowding evident in existing buildings. When renovating existing facilities, it will be important to upgrade the functionality, improve the overall quality of space, recreate opportunities for undergraduates to work side-by-side with faculty and other researchers, and actively transform the dynamics of College life to deliberately promote the kind of atmosphere that prevails elsewhere on the Cornell campus, but has gradually been lost in Engineering. We identify the Duffield Atrium as an example of the type of investment we believe is vital.

Although a major portion of the engineering quad was built in a coherent (though now outdated) style, too much of the construction in Engineering has been planned opportunistically, and this may be one reason for the sense of overcrowding and the poor aesthetics of some parts of the College. We strongly recommend that the University engage leading architects to develop a new master plan that responds—through the functionality, location, design, and character of College facilities—to these recommendations and to the objectives of

- a) Enabling and encouraging collaborative work across disciplines within the College and across the University,
- b) Encouraging ongoing, informal, year-round interaction within and across student and faculty populations,
- c) Permitting the evolution of research priorities and organizational structures, and communicating to the University and its visitors the fundamental, dynamic, open, and essentially humanistic role of engineering research and education in modern society.

Our committee believes that new construction required will require demolition of some existing Engineering buildings, but also that expansion beyond the existing College perimeter (perhaps onto Hoy Field) represents the only practical way to respond to the various priorities now facing the College and the University in a balanced and “holistic” manner. Moreover, such a step offers the opportunity to transform the appearance and atmosphere of the College, an outcome we see as very unlikely if new construction is limited to the existing confines of the College.

## Further Recommendations

The preceding recommendations focus on major renovation and construction priorities. We also wish to stress a number of priorities that should guide this broader process.

1. Invest to create new kinds of learning environments. We are convinced that a small number of “learning centers” responding to new models for hands-on teaching and group projects would be of tremendous benefit throughout the College.
2. Invest to recreate the Engineering College Library as a state-of-the-art research and study environment, with greatly deemphasized storage space for periodicals and other materials now available online and increased attention to the creation of space suitable for student research, homework, study, etc. The College is sufficiently far from most undergraduate housing so that this type of space is required if our students are to work effectively.
3. Co-locate student support services and make them as accessible as possible.
4. A major part of our recommendations revolves around the need to upgrade the mechanical and data network systems serving all offices, labs, and classrooms. We recommend that every effort be made to ensure that new construction and renovated space is energy efficient, in consonance with the strategic environment and energy initiative, and that the College prioritize these considerations in its Master Plan.
5. Provide appropriate office space for Masters students. In contrast to PhD students (for whom all departments allocate shared office space), the space needs of our expanding MEng program have addressed in a haphazard manner. This space need not take the form of individual offices space, and can be incorporated with project and collaborative learning space, depending on the needs of the field. However, every MEng student should have access to space appropriate for storing materials, studying and doing homework projects.
6. The College has a number of long term student projects underway that regularly garner national visibility and are often cited as some of the most exciting ways for Cornell undergraduates to have a serious research experience. Examples include the Robosoccer team, the Formula SAE automobile project and the Autonomous Underwater Vehicle project. Such projects require a long-term commitment of space and other resources. Up to the present, the College has dealt with them as unplanned contingencies. Space should be set aside for a small number of future undergraduate research efforts in this style, and resources made available to encourage faculty members to propose and develop additional such activities. They should be viewed as an integral part of the Cornell Engineering experience, not as individual faculty initiatives, and they deserve investment commensurate with their value to the College and to the University.

Finally, we note that although our mission did not include examination of the College Information Infrastructure, the need for investment is inescapable. The communication network should be modernized, and we also recommend that an Engineering Task Force be charged with looking at this question broadly and formulating appropriate recommendations.