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Designing from a Blank Slate – The Development of the Initial Olin College Curriculum

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(with grateful acknowledgement of the Olin College Faculty)

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Olin College Overview and Background

Olin College is an entirely independent institution conceived and primarily funded by the F.W. Olin Foundation, formerly of New York, NY. The College, located in Needham, MA, on about 70 acres of land adjacent to Babson College, was chartered in 1997 by the Massachusetts Board of Higher Education to offer B.S. degrees in Mechanical Engineering, Electrical and Computer Engineering, and Engineering. Conceived as a residential undergraduate institution focusing on the education of engineers, it was charged by the foundation to explore, test and implement innovative engineering curricula and address what the NSF and others had identified as systemic issues with existing engineering education. The College currently is entering its third year of teaching programs for credit; this period was preceded by two years in which faculty worked full-time on inventing the curriculum. The short-term enrollment target is 300 students, with the campus designed for an ultimate enrollment target of 600-650 students. A fundamental objective of the F.W. Olin Foundation is for Olin College to offer all of its admitted students a four-year merit-based tuition scholarship, not just for the first few years but also in perpetuity. Admission to the College is highly competitive, and a better than 10-to-1 student/faculty ratio will be maintained (a much lower ratio will be supported in the early years). Although Olin College is completely independent from nearby Babson College, the two institutions have established strong collaborative relations that enable the sharing of certain facilities and services. Olin students take routinely take a variety of courses in the liberal arts and business at Babson, as well as a wide range of courses through cross-registration agreements at nearby Wellesley College and Brandeis University.

Olin College is distinctive in several ways. First, the College is not organized with traditional academic departments. Instead, the faculty operate as a single interdisciplinary group; faculty offices are assigned with no regard to discipline, so there is a mix of faculty backgrounds on every hallway to encourage interdisciplinary thinking. The steady state faculty count will approach 40 in the near-term. In addition, faculty employment relationships are based on renewable contracts rather than a traditional tenure system. A primary objective of Olin College is to develop a new culture of innovation and continuous improvement, with enhanced entrepreneurial focus. In the fall of 2000, (prior to arrival of the first students) the College established a two-year strategic plan in pursuit of this objective (Invention 2000), which centered on a comprehensive effort to rethink all aspects of an educational institution, including curriculum, student life, administration and finance, admission, development, and college governance. In each of these areas a deliberate four-stage plan consisting of a period of discovery (investigation of best practices), invention, development, and test was executed. One particularly important aspect of this plan was the Olin Partners Program.

In order to establish the initial curriculum, Olin College decided that it would be beneficial to involve a group of students to help brainstorm and test different concepts. These students were considered in some respects as partners with the faculty in the development of portions of the curriculum and student life programs. A group of 30 Olin student Partners were recruited in the spring of 2001 and arrived on campus on August 23, 2001. They were involved in a unique academic program consisting of development and testing of components of the curriculum, student life, community service, and relations with nearby colleges. Their program was organized into six modules of either 4 or 5 weeks each, and included a 4-week trip to France to investigate international aspects of the program on the campus of Georgia Tech Lorraine in Metz.

Each of the four 4-week modules were used to test some aspect of the curriculum. The Partners received "non-degree" credit for the year.

The first freshman class of 75 arrived in fall 2002. This class consisted of the 30 Olin Partners (who will spend a total of five years to complete their B.S. degree), another 15 "Virtual Olin Partners" who received deferred admission from the Partners program, and 30 additional new students.

Even before the first employee was hired at Olin College, the F.W. Olin Foundation began planning an entirely new campus consisting of about 500,000 square feet in eight new buildings. The first four buildings were completed in the fall of 2002. These four buildings include Olin Center (faculty offices, administrative offices, library, computer center, and auditorium), Campus Center (dining hall, student life offices, central heating and cooling plant), the Academic Center classroom/laboratory building (including 27 major classrooms, teaching or research labs of about 1,100 square feet each, as well as numerous smaller teaching and laboratory spaces), and the first Residence Hall (188 beds, in double rooms, each with a private bathroom), a total of about 300,000 square feet of new construction. The second phase of construction will be phased as needed, and will include additional residence halls, and another academic building. The second residence hall is under construction and is scheduled to be completed during the coming academic year.

In early 1999 the foundation hired the founding president, Richard K. Miller. President Miller hired the founding leadership team in the spring of 1999, including David V. Kerns as Provost, Sherra E. Kerns as Vice President for Innovation and Research, Stephen P. Hannabury as Vice President for Administration and Finance, and Duncan C. Murdoch as Vice President for External Relations and Enrollment.

The founding faculty were recruited by the Provost with the explicit charge of leading the development of the new curriculum. The College sought faculty with a passion for undergraduate teaching and innovation in engineering education. However, Olin College is not just a teaching institution and faculty are expected to maintain a high level of intellectual vitality through research, innovative curriculum development, entrepreneurship, creation of intellectual property, or other appropriate creative activity. This intellectual vitality will assist in keeping a faculty member current in their field.

The characteristics sought in recruiting Olin faculty are: (from Sept 6, 1999, Characteristics of Founding Faculty, D. Kerns):

1) A passion for teaching, education, and a strong commitment to improving student's lives.
2) Strong evidence of creativity through research, publications, inventions, entrepreneurship, commercialization of technology, new course or curriculum developments, innovative engineering pedagogy, etc.
3) Evidence of integration of creativity (as identified in 2) into the classroom.
4) A willingness to team, to accept other's ideas, to partner, to lead or to follow.
5) A desire to stay current, and to reflect currency in teaching and in creative endeavors.
6) The potential for "nationally visible achievements" through any of the creativity channels above.
7) Willingness to take reasonable risks to make significant impact.

INVENTION 2000

INVENTION 2000 was proposed by President Miller as a blueprint for developing all academic and operational aspects of the Franklin W. Olin College of Engineering from a clean slate. The plan outlined an intense two-year project of unprecedented scope intended to produce innovative educational processes for preparing the next generation of leaders in a technological society and institutional policies which would establish a commitment to continuous improvement and innovation. Intense efforts were focused on all aspect of the College, however only the academic curriculum development section will be discussed here. The project was funded by support from the F.W. Olin Foundation, as a part of the founding gift. As a result, the faculty and staff were able to devote two full years of effort without the distraction of simultaneous teaching responsibilities.

The following is excerpted from the INVENTION 2000 document, available on the Olin website:

This project will involve the founding faculty, educational consultants, and students in the creation of innovative engineering curricula, which simultaneously address all major challenges identified by the National Science Foundation. These, together with several additional features, will distinguish Olin College

from other engineering colleges. These anticipated distinctive features of the curricula include the combination of a rigorous science and mathematics core, an integrated project-based design component, a firm grounding in the fundamentals of business and entrepreneurship, a strong international component, a vigorous co-curricular component which makes good use of strengths in humanities and social sciences at nearby colleges, and an emphasis on student service to society and a lifestyle of philanthropy.

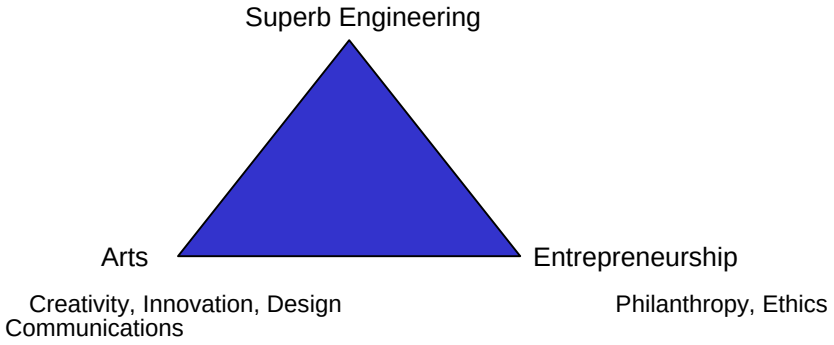
The project will be addressed in four sequential stages. For brevity, these stages will be referred to as (1) discovery, (2) invention, (3) development, and (4) test. The general nature of the activities intended to occur during each phase is as follows. During the ***discovery phase****, research into "best practices" at other institutions will take place. Deliberate efforts will be made to visit other campuses, host visitors from other campuses, obtain advice from knowledgeable consultants, and obtain broad knowledge of the various successful approaches in use today. During the* ***invention phase****, knowledge of best practices will be applied in a creative way to the problem of inventing an overall vision of the four-year educational experience. This will begin with a fundamental evaluation of educational goals and objectives and end with a comprehensive concept for obtaining balance in the overall curriculum. During the* ***development phase****, further refinement of the newly invented curriculum will take place in which the needed detail for the freshman year experience will be developed. This will result in a set of specific courses or educational experiences for teaching the freshmen in Fall 2002, as well as textbooks, laboratory experiments, reading materials, etc. Finally, during the* ***test phase****, the specific educational materials will be tested with the help of a small group of student "partners" who will be recruited specifically for this purpose and will help with INVENTION 2000 as part of a unique one-year experience at Olin College. Each of these stages will take from four to eight months, with the first (discovery) beginning in Fall 2000 and the last (test) ending in Summer 2002.*

Development of the Curriculum

The execution of the INVENTION 2000 plan for curriculum development was initially conducted primarily through faculty teams assigned to various activities. Faculty groups of two or three studied and reported on curricula at a wide range of institutions, and 31 colleges or universities were visited. The faculty also visited (or hosted) over 23 corporations and government agencies to explore corporate learning models while assessing corporate needs and values in engineering education. In addition, various consultants were brought to campus for specific topics. The results of the NSF coalition programs were reviewed in detail. These data were compiled and discussed in a series of faculty meetings and off-campus retreats. With the arrival of the Partners, faculty were able to begin testing various teaching and learning concepts developed during the previous year with "real" freshman-age students.

Several founding principles emerged that have stood the test of time, and are still used in guiding curricular discussions today.

The "Olin Triangle" was first proposed as a visual expression of Olin's goal to "educate the whole person" and "open doors to student possibilities". The Olin Triangle displays the three major dimensions to an Olin engineering education: superb engineering, and a strong emphasis on art, design, creativity and innovation, balanced by basics in business, entrepreneurship, ethics and a spirit of philanthropy.



The “Bold Goals” were developed by the founding faculty at one of the first off-campus retreats, in the fall of 2000. They summarize the curricular objectives at that time, and are still used to guide curriculum development. The Bold Goals are:

- Hands-on design projects in every year
- Authentic, ambitious Capstone senior/advanced student project (representative of professional practice)
- Experience working independently, as a member, and as leader of a team
- Performance before an audience including experts
- International/inter-cultural immersion experience
- Substantial constructive contribution to society
- Ability to communicate logically and persuasively in spoken, written, numerical and visual forms
- Development of self-sufficient individuals able to articulate and activate a vision and bring to fruition

All accomplished within an environment of personal attention and concern

Additional Curricular Objectives include:

- Demonstrated significant creative artistic expression
- Significant work experience in a corporate or business culture
- Ability to apply basic business practices necessary to bring a product to the marketplace

The many ways in which these goals could be implemented in real curricula were openly and widely debated for months. One of the realities of starting a college with a clean slate is that faculty groups are small, and there is a natural tendency for the groups to drive for consensus. The College leadership was concerned that consensus often truncates the truly innovative ideas and the creative (sometimes wild) concepts “outside of the box”. From the wide menu of curricular possibilities, a selection of the choices had to be made that met the realities of a 4 year time constraint, ABET accreditation, reasonable cost, and many other factors, while remaining true to the founding principles. To move the selection process forward, the Provost established the “Curriculum Decision Making Board” (CDMB), a group of 5 faculty and one student Partner. This group was charged with the task of describing the first Olin Curriculum. The five faculty members of the CDMB were chosen as follows: 3 elected by the faculty using a Copeland ballot and two appointed by the Provost. The student was selected by the student government group. The CDMB consisted of Professors: Steve Schiffman and Mike Moody (co-chairs), Rob Martello, Joanne Pratt, Mark Somerville, Jon Stolk, and Brian Storey; the student member was Sean Munson. This group put forward the first detailed proposal for the Olin Curriculum.

In the fall of 2002, Michael E. Moody joined Olin College as Dean of the Faculty and assumed direct leadership of the development of the Olin Curriculum. Dean Moody created a successor group to the CDMB called the ARB (Academic Recommendations Board), which currently oversees curricular modifications and changes. While the faculty are now introducing modifications to the curriculum described below, most of the fundamental concepts and structure remains valid.

The Initial Olin Curriculum

Over the last twenty years, the National Science Foundation and the engineering community have called for systemic changes in engineering education, including

- a shift from disciplinary thinking to interdisciplinary approaches;
- increased development of communication and teaming skills;
- greater consideration of the social, environmental, business, and political context of engineering;
- improved student capacity for life-long learning; and
- emphasis on engineering practice and design throughout the curriculum.

This section describes the “first fruits” of Olin’s effort to rethink engineering education—a vision for the first Olin curriculum, which was implemented in the fall of 2002. Within this vision, Olin combines best practices from many other institutions with new ideas and approaches. Since Olin is committed to continually innovating and improving, the curriculum described in this document represents only the “initial conditions” for a trajectory of continuous curriculum review and refinement that will never really end. As expected, there have been recent improvements and adjustments.

Curricular Philosophy

The founding principle of Olin College of Engineering is to prepare leaders able to predict, create and manage the technologies of the future. Students who will become such leaders must have

- A superb command of **engineering fundamentals**;
- A broad **perspective** regarding the role of engineering in society;
- The **creativity** to envision new solutions to the world's problems; and
- The **entrepreneurial skills** to bring their visions into reality.

The Olin Curriculum addresses these outcomes. Rigorous technical courses and hands-on projects throughout the curriculum require students to apply engineering concepts to real problems. Interdisciplinary courses and projects make explicit the connections both within the technical world and between engineering and society. Extensive design experiences, significant work in the arts and humanities, and an emphasis on original expression encourage students to develop and to apply their creativity. Continuous use of teamwork, communication skills, and entrepreneurial thinking give students the tools they need to take their solutions from the research lab to the world at large.

As shown in Figure 1, the Olin curriculum consists of three phases: ***foundation***, which emphasizes mastering and applying technical fundamentals in substantial engineering projects; ***specialization***, in which students develop and apply in-depth knowledge in their chosen fields; and ***realization***, in which students bring their education to bear on problems approaching professional practice. In all three phases of the curriculum, students are engaged in interdisciplinary engineering projects that require them to put theory into practice, to put engineering in context, and to develop teaming and management skills. As a student progresses, these projects become increasingly open-ended and authentic. Students have significant flexibility in charting their path through the curriculum, but all students are responsible for demonstrating mastery of required material through regular assessment.

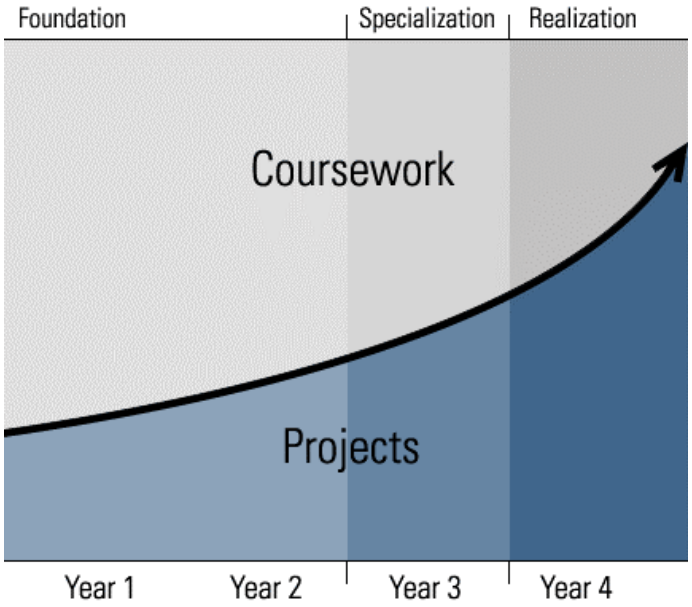


Figure 1: *Structure of the Olin curriculum. Projects are present in all four years, and occupy an increasing proportion of effort as the student progresses from foundation to specialization to realization*.

The Foundation

Figure 2 illustrates the basic structure and requirements of the foundation, which encompasses approximately the first two years of a student's education. A central building block is the **cohort**. Here cohort refers to a large course block (equivalent to three conventional courses) taught by a multidisciplinary faculty team. The block combines two disciplinary topics with a large interdisciplinary project. These cohorts enable tight coordination between the *understanding* of underlying disciplines and the *application* of this disciplinary knowledge to real engineering problems. Cohorts also provide a logical environment for students to develop *entrepreneurial skills*, such as opportunity assessment and teamwork. Finally, cohorts address *student choice* by allowing them to relate material to an application of their choosing – in any given semester, students can opt for one of three "flavors" of the cohort. For example, a student particularly interested in entrepreneurship might opt to pursue a given set of physics and math learning objectives while

doing a related product design and development project, while an artistically inclined student might enroll in a cohort that uses kinetic sculpture to motivate and reinforce the same physics and math objectives. In some cases, cohorts combine two technical subjects (e.g., physics and mathematics); in other cases, cohorts emphasize context by combining the technical with the non-technical (e.g., materials science and business). In all cases, cohorts provide a way to make connections between subjects, and to bring theory into practice through a project.

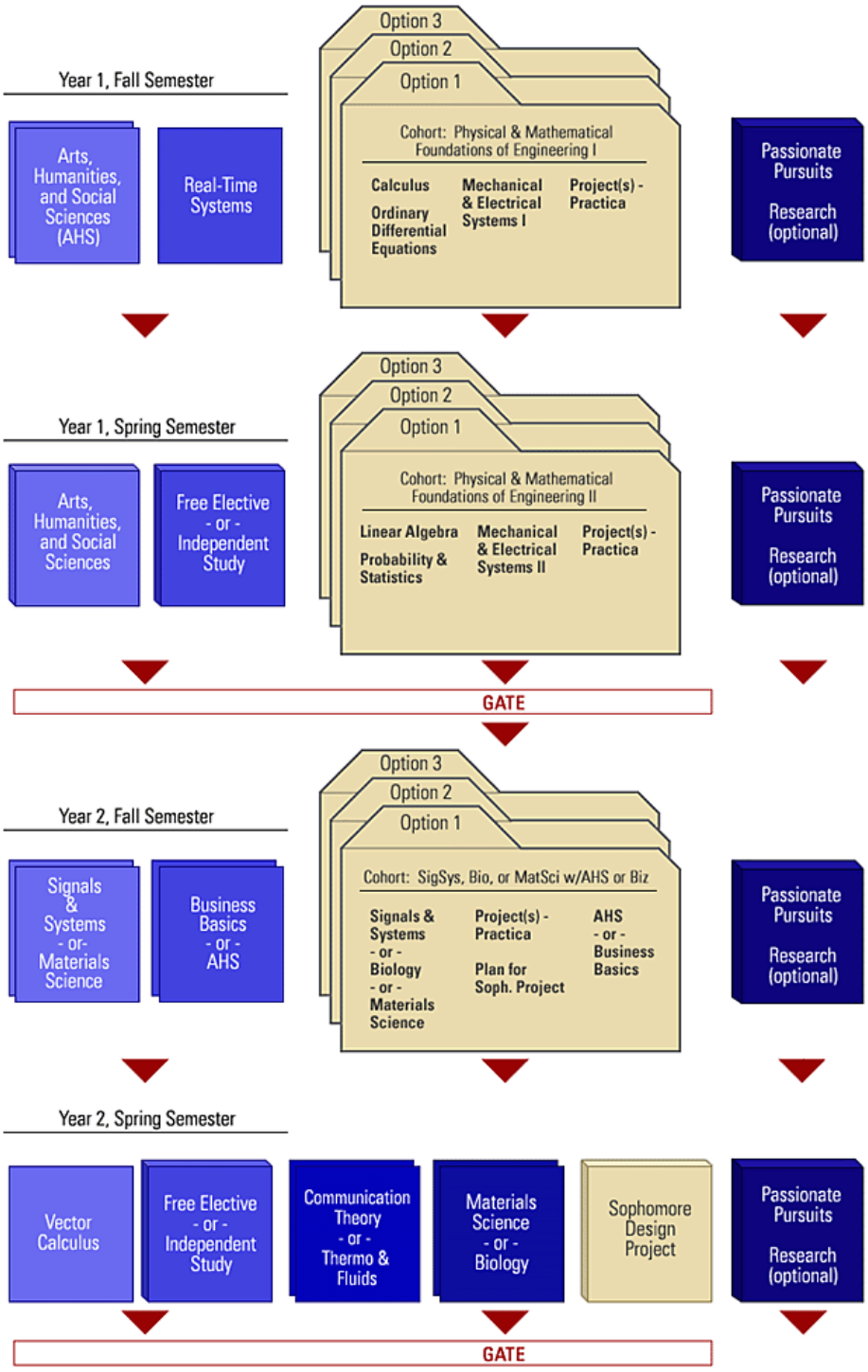


Figure 2: *Illustration of the foundation. Although all students are responsible for the same learning objectives within the foundation, students have many choices, due to the presence of free electives and the option structure within the cohorts*.

Another prominent feature of the curriculum is the **sophomore design project** occurring in the second semester of the sophomore year. While students will be engaged in design throughout the first two years within the cohort projects, the sophomore design project offers a significant opportunity for students to conceive an idea on their own, develop a project implementation plan, and manage the process of bringing it

to fruition. Planning (i.e., team formation and proposal writing) for this design project begins in the first semester of the sophomore year.

Throughout their time at Olin, students will study the **arts, humanities, and social sciences** in order to provide context for their engineering studies. In addition, projects, practica (short, just-in-time learning experiences) and a required course on the basics of business provide grounding in **business and entrepreneurship** each semester of the foundation. In some cases, this work will connect directly with the technical via projects – for example, students might combine study of signals with a course on music theory and a project that focused on building musical instruments; alternatively, signals might be combined with study of business and a project on opportunities in low-cost image processing. All students will graduate with some background both in business and in the humanities; furthermore, students have enough flexibility to choose to emphasize either area.

Students' command of both theory and practice is evaluated at the end of each year during **Gates**, a week-long, institution-wide assessment period which includes not only written examinations but also oral examinations, team exercises, and other forms of authentic assessment. Interdisciplinary by design, Gates force students to synthesize material among classes and across terms. Importantly, Gates assess institutionally defined learning objectives, rather than objectives determined by one instructor. By defining a desired outcome, but not the means by which it is achieved, Gates allow faculty great flexibility in designing courses. Such criteria-based assessment provides invaluable feedback to inform curricular innovation, and ensures that students have met the learning objectives for the year.

To further student creativity and initiative, Olin encourages students to undertake **passionate pursuits**. Olin implemented this program to recognize that students have passions – be they technical, artistic, or entrepreneurial – that play a role in a student's personal and professional education and development. Some Olin students might use this opportunity to start their own business with the support of an Olin/Babson hatchery; others might form a string quartet. Olin gives students the opportunity to pursue these passions independently by providing resources and formal recognition via non-degree credit. Students can also opt to pursue **independent study** and **research** within the Olin Curriculum; space is provided for these activities both with free electives every year, and under the auspices of passionate pursuits.

Specialization and Realization

In Figure 3 we show the current concept for the third and fourth years of the curriculum, specialization and realization. As in the foundation, cohorts play a significant role. **Specialization cohorts** might revolve around different application areas of interest. Each cohort option will link one course with a project, with additional optional courses to add "flavors" to the project. For example, a BioTech specialization cohort could connect a biology course with a project. Some students might take Computational Science as the optional elective and focus their project on BioInformatics. A second group of students might take Entrepreneurship as the technical elective and focus on BioTech startups. Such projects are compelling both for students and for prospective faculty, and provide a logical opportunity for corporate involvement.

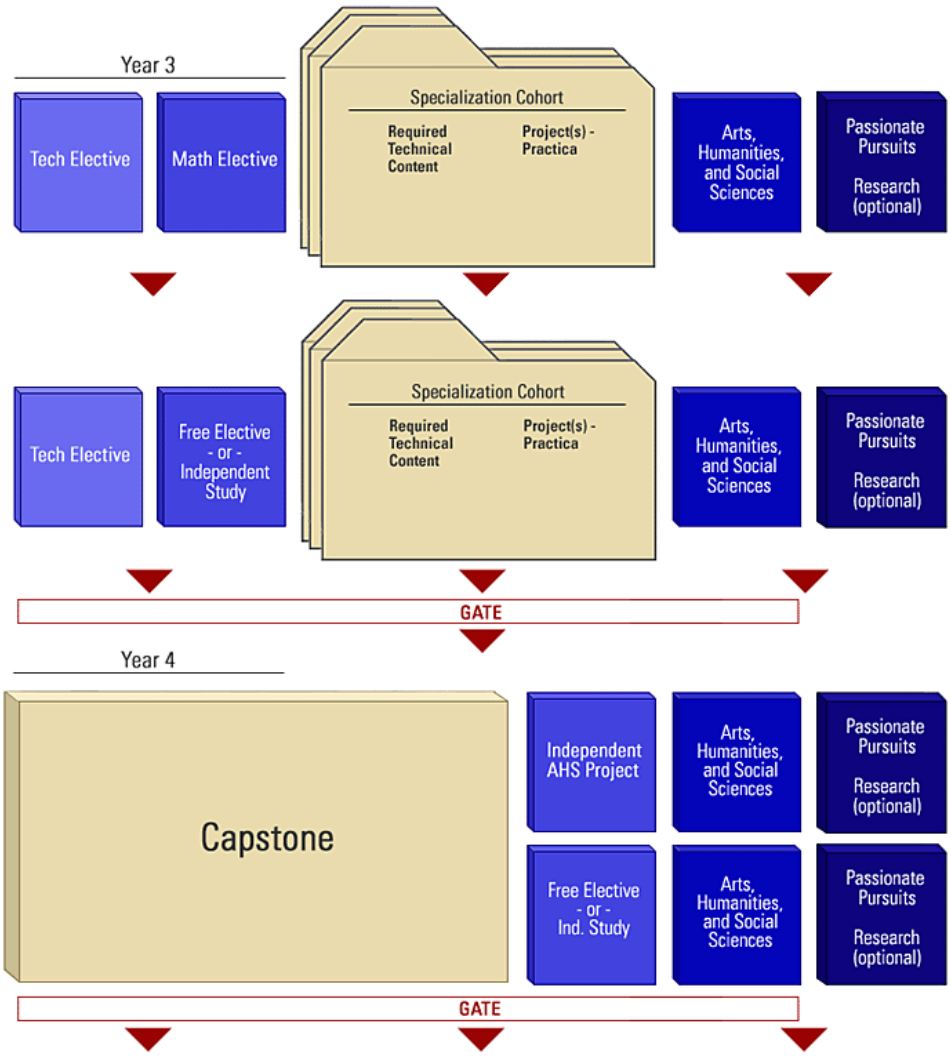


Figure 3: *Illustration of concept for specialization and realization. Student flexibility during these years is very high.*

The junior year will be the ideal time for **international study** and **corporate experience**; since content in the specialization and realization is defined by institutionally determined learning objectives and measured in Gates, students can easily design non-traditional means of achieving those objectives.

A student's final year at Olin will center on an ambitious **capstone** project that occupies at least half of the student's time for the semester. The precise structure of this capstone is not entirely defined, but it will certainly look quite a bit like professional practice. Also appearing in the final year is a **culminating project in the humanities**. In many cases we imagine this will be connected with the capstone. Olin students are encouraged to pass the **Fundamentals of Engineering (FE) exam**. This is designed to encourage development of self-study skills, open the door to professional practice for those interested, and to provide an important external validation of students' proficiency.

ABET Requirements

The Olin curriculum is designed to satisfy the accreditation requirements of the Accrediting Board of Engineering and Technology (ABET). In particular, we believe that our focus on institution-wide learning objectives, and our use of gates both to assess whether courses achieve desired outcomes and to drive improvement of the curriculum are entirely consistent with ABET's philosophy of assessment, evaluation, and improvement. Furthermore, our emphasis on interdisciplinary, hands-on design projects throughout the curriculum concretely addresses ABET criteria. Finally, the curriculum is also designed to satisfy

Mechanical Engineering and Electrical and Computer Engineering program requirements of ABET, as the specialization cohorts will address precise learning objectives.

Key Features of the Olin Curriculum

A number of recurring themes within the Olin curriculum merit amplification. In particular, the Olin Curriculum

- **Emphasizes engineering design with substantial projects (20% - 60% of student time) every semester**. These projects require students to apply math, science, and engineering principles to real problems, to consider engineering in social context, and to develop entrepreneurial skills and thinking. Such hands-on, integrative, interdisciplinary work is a defining feature of the Olin curriculum, and will help Olin produce students who can apply their theoretical knowledge to real problems.
- **Is objective-driven and based in assessment**. Olin's curriculum delivers institutionally defined learning objectives, which are assessed every year by the *institution* and by *outside evaluators* – *not* just by the instructor for a given course. Such a commitment is critical to Olin's mission of innovation and improvement.
- **Breaks disciplinary boundaries**. Interdisciplinary courses and projects emphasize the value of thinking outside the traditional. Olin's explicit decision not to have academic departments furthers this goal.
- **Emphasizes teamwork.** Faculty work on teams within the cohort system and via other team teaching opportunities; students learn teaming both formally and through extensive teamwork in projects.
- **Provides flexibility and accountability**. The objective-driven cohort system provides flexibility with accountability for instructors. Students shape their educations through learning plans, which provide a mechanism for students to determine their short and long term learning goals, and to make sure that they are meeting these goals. Students also have flexibility in their choice of subject matter, in their passionate pursuits, and also in their choice of projects.

In summary, the initial Olin Curriculum was created to address the call for change in engineering education; the initial curriculum is already undergoing enhancements in the spirit of continuous improvement, and will constantly be evolving. The freedom of a blank slate, combined with excellent students, faculty, leadership, and resources provided Olin a unique opportunity to develop new ideas and a culture that welcomes innovation. By teaching entrepreneurship, social context, creativity with design, and superb engineering, Olin intends to provide an environment well suited to the acquisition and development of knowledge, skills, and attitudes that will enable its graduates to be productive contributors throughout their lives.