**Concept Paper for Bachelor of Science in Civil Engineering**
**from the Kate Gleason College of Engineering**

I. **Title/Department/College:** Bachelor of Science (B.S.) in Civil Engineering / Department of Civil Engineering / Kate Gleason College of Engineering (KGCOE)

II. **Description of goals and justification for proposed program**

Civil engineers apply mathematical and physical science in order to improve and protect the environment; design facilities for the community, industry, and transportation; and provide infrastructure for society (American Society of Civil Engineers (ASCE), 2008). One indication of the importance of civil engineering is its prominence within nearly all of the nation's top engineering colleges. All of the top 20 engineering colleges in the U.S., and 46 of the top 50, offer B.S. degrees in civil engineering (U.S. News and World Report, 2015). Consistent with its plan to be among the nation's most prominent engineering colleges, the Kate Gleason College proposes to create a B.S. degree program in civil engineering that will provide students with the education and experience they need to become immediate contributors in the field. By providing civil engineering as a career option, the Kate Gleason College will attract a new group of students to RIT, broaden its base of faculty and industry partners, and further strengthen KGCOE's national reputation for outstanding career-oriented undergraduate engineering education. It will also better position the College to provide that next generation of individuals who will be well prepared to address the "grand societal challenges" that will impact the quality of life for humanity in the future.

In his 2011 State of the Union address, President Barack Obama cited the near-failing grade given by ASCE to the nation's physical infrastructure, and implored the nation to support the restoration of our roads, bridges, and rails as a critical step in achieving economic growth. ASCE estimates that the U.S. will need to invest $157 billion per year in the coming decade in order to raise the quality of our nation's infrastructure to an acceptable level. The National Academy of Engineering (NAE) has also emphasized the urgency of addressing this issue by including "Restore and Improve Urban Infrastructure" as one of its 14 Grand Challenges that our society must face in the years ahead (www.engineeringchallenges.org). Civil engineers are vital to improving infrastructure, so it is not surprising that employment opportunities for civil engineers are currently strong and are projected to grow 20% from 2012 to 2022 (U.S. Bureau of Labor Statistics, 2015).

The importance of civil engineering in our global society continues to grow as the population rises. ASCE projects that every nation will face a water supply challenge within 20 years and that civil engineers will be at the forefront in facing this challenge (ASCE, 2007). Already, one of six people do not have adequate access to clean water, which is why the NAE has included "Provide Access to Clean Water" as another one of its Grand Challenges (NAE, 2015). Society also faces the threat of rising ocean levels and the massive impact this will have on infrastructure. The challenge of this far-reaching problem is monumental and society will rely on the civil engineering profession to provide adequate and sustainable solutions to the impact of this and other consequences of climate change.

Civil engineering's contribution to world stability demands that modern civil engineering students be educated on issues such as globalization, sustainability, and policy-making. The creation of a new program provides the perfect opportunity to carefully consider these evolving needs of the profession and develop a curriculum that is well-aligned with these demands. KGCOE is nationally recognized for preparing

students to make an immediate and sustained impact in their engineering careers, and the addition of civil engineering will allow us to expand our portfolio of industry partners as well as strengthen our connection with existing partners who already recognize the value of a degree from KGCOE.

## III. Description of the new program

In 2008, ASCE established a Body of Knowledge (BOK) that articulates the knowledge and experience that a civil engineer needs to attain prior to entering the profession. The BOK, included in the Appendix, outlines a set of 24 outcomes organized into three categories: foundational, technical, and professional. These outcomes are mapped to levels of achievement specified by Bloom's Taxonomy in order to define the minimum cognitive levels of achievement. The BOK essentially provides a framework that we will use to construct the civil engineering curriculum. A critical component of the BOK is civil engineering work experience which, through the KGCOE co-op program, will be integrated into the five-year plan of study.

The development of a new engineering program also requires consideration of the criteria established by the Accreditation Board of Engineering and Technology (ABET) for the accreditation of civil engineering programs. Along with specifications regarding general math and science, the ABET criteria for civil engineering requires that students "apply knowledge of four technical areas appropriate to civil engineering." Traditionally, the civil engineering profession has been characterized by six sub-disciplines of engineering: structural, environmental, transportation, geotechnical, hydraulic, and construction. Because of the impending B.S. program in construction management within the College of Applied Science and Technology (CAST) at RIT, the proposed civil engineering program will not focus on this sub-discipline.

The proposed B.S. program in civil engineering will follow closely the general framework that is used in all the other undergraduate engineering programs at RIT. All engineering students must take a significant amount of fundamental math and science courses in their first two years of study. Mixed in with these math and science courses will be other general education (liberal arts) courses and at least two introductory civil engineering courses. Beginning in their third year, students will take core courses in civil engineering and will integrate academic terms with co-operative education experiences. In their five years at RIT, students will earn one year of practical work experience in civil engineering, along with their four years of academic study. Students will choose from a variety of professional electives that will allow them to specialize in one or two sub-disciplines of civil engineering or obtain breadth across several areas. In the fifth year of study, students will be required to participate in multidisciplinary senior design, which is a two-semester sequence in which students work on multidisciplinary teams to address a project that is inspired by one of our industry or municipal partners.

## IV. Description of new program's fit with RIT academic portfolio blueprint characteristics

The proposed program will be closely aligned with RIT's academic blueprint characteristics:

- **Scholarship, Research, and Creativity –** Significant external research funding is available in support of civil engineering research; faculty will be expected to develop scholarship plans, pursue external funding, and engage students in their research, where appropriate. Research in civil engineering requires significant investment in the laboratory facilities necessary to support it.
- **Innovative Teaching and Learning –** KGCOE has earned a reputation for excellence in engineering education. As it has done with its new programs in chemical and biomedical engineering, the College

will develop state-of-the-art laboratory facilities for this new program and draw upon industry-standard computer-aided design software to complement instructional modalities.

- **Experiential Learning –** Along with the integration of co-op throughout the academic plan of study, civil engineering courses will emphasize hands-on laboratory experiences. Co-op and experiential education are essential elements of all KGCOE programs.
- **International and Global Education –** Curriculum will emphasize the importance of civil engineering in our global society. Several of the broad-based challenges that civil engineers will address in the coming decades are inherently global in nature (e.g., rising sea levels, clean drinking water, and infrastructure of developing nations).
- **Synergy and Interdisciplinarity –** Along with synergy among other KGCOE faculty and students (e.g., Ph.D. in Engineering), the civil engineering program will provide an opportunity for KGCOE faculty to collaborate with colleagues in the civil engineering technology program in CAST, particularly through joint research projects and the teaching of specialized electives.
- **Inclusive Excellence –** The civil engineering program will allow us to attract a new and diverse set of faculty, staff, and students. Of the bachelor's degrees in civil engineering awarded in the U.S. in 2013, 21% were awarded to women and 11.5% were awarded to AALANA students (ASEE, 2014). Furthermore, the percentage of women faculty in civil engineering (15.4%) is greater than the average across engineering disciplines (14.5%) (ASEE, 2014). KGCOE has a proud tradition of inclusive excellence in recruiting faculty and students from underrepresented groups, and we would strive to surpass these percentages.

## V. Synergy with other programs

The most obvious synergy this new program will have is with the civil engineering technology program in CAST. An ad hoc committee of KGCOE and CAST faculty has been established to identify specific opportunities for collaboration and synergy. Given the projected enrollment for civil engineering and the already strained resources that CAST faces with respect to laboratory space, we don't expect a substantial sharing of existing laboratory resources. However, in developing new laboratory space, there will be opportunities to create facilities that are mutually beneficial to the two programs along with the impending program in construction management. We also expect that research collaborations will naturally take place among the faculty in the two programs as well as opportunities for students in both programs to select elective courses from the collective offerings of both programs.

The proposed civil engineering program will also be synergistic with the new Ph.D. in Engineering program, which welcomed its inaugural class in 2014. A unique feature of this Ph.D. program is its focus on four key application domains; two of which, transportation and energy, are well-aligned with civil engineering. The addition of civil engineering faculty will provide opportunities for undergraduate students to participate in research initiatives associated with the faculty who support the civil engineering curriculum.

## VI. Administrative structure for the new program

The administration of the program will closely resemble the organizational structure of the other KGCOE programs. A department head will be appointed to lead the department and several staff will be appointed to support advising, technical laboratory support, and general administration.

**VII. Enrollment management expectations and sustainment**

To project enrollment figures for a B.S. in Civil Engineering, we benchmarked enrollment data from peer institutions that offer an undergraduate civil engineering degree (Clarkson, Carnegie Mellon, RPI, Penn State, WPI, Drexel, Cornell, University at Buffalo, and Syracuse). RIT already competes with all of these schools in other high-enrollment engineering programs, including mechanical and electrical engineering. Because enrollment trends in civil engineering seem to be synergistic with enrollments in mechanical engineering, the projected increase in enrollment from a civil engineering program was based on the ratio of civil engineering to mechanical engineering enrollment in each of these schools. Across these peer institutions, undergraduate civil engineering degrees awarded were on average, 52% of the mechanical engineering degrees awarded (range: 38.1% - 76.0%). Based on this average value, we estimate an additional 80 students per graduating cohort at steady state. (RIT awarded 154 Mechanical Engineering B.S. degrees in 2012-13.) This projection is consistent with the ratio of students who graduate from the corresponding technology programs at RIT. In CAST, CET has consistently graduated approximately 55% of the number of manufacturing and mechanical engineering technology (MMET) graduates over the past five years.

Enrollment Management agrees that the demand for civil engineering is strong and supports the consideration of a B.S. in Civil Engineering. However, they estimate that a new civil engineering program will also result in a decrease in the entering class of civil engineering technology students such that the net gain of students to RIT is likely to be approximately 50 per year. This projection is what has been used for the cost model analysis. That said, RIT has had for many years "competing" programs in MMET and Mechanical Engineering, Electrical Engineering Technology and Electrical Engineering, and Computer Engineering Technology and Computer Engineering, and all three sets of programs have flourished thanks to the strong brand that RIT has sustained in technology and engineering. Furthermore, many of our industry partners see RIT's degree programs in technology and engineering as complementary, and they routinely seek graduates from both programs to meet their specialized needs. Thus, we have good reason to anticipate similar outcomes with respect to civil engineering and civil engineering technology.

**VIII. Impact on resources including utilization of existing resources and cost model analysis (1/2 page)**

Development of a new engineering program requires investment in infrastructure, capital equipment, and human resources. However, with the anticipated growth in enrollment, the preliminary cost model projects that a financial surplus will be realized in the third year of the program. In particular, the program will require approximately 21,000 sq. ft. of space (33,280 gross sq. ft.) to accommodate the labs and classrooms needed for instruction and project work, together with the offices for faculty and staff. Although the plan is to enroll a cohort of 80 students per year at steady-state, the cost model assumes revenue generated from 50 incremental students because of the potential erosion in the enrollment in Civil Engineering Technology (as explained in the report from the Office of Enrollment Management). The program will require hiring 8 incremental faculty and three staff, who will be phased in over a six-year period. Thus, we anticipate that this five-year degree program will achieve steady-state within six years. The cost model illustrates that the annual contribution margin, once steady-state is achieved, is approximately $1.1 million.

## IX. Conclusion

The demand for civil engineers remains very high and the need will continue to grow. A civil engineering program will complete the KGCOE portfolio of traditional engineering disciplines and will enable us to attract an even wider pool of outstanding applicants. With the recent addition of programs in chemical engineering and biomedical engineering, we have demonstrated that new undergraduate programs in engineering present tremendous opportunity for growth of the college and university.

## References


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# Appendix

| ***Outcome Number and Title*** | ***Level of Achievement*** | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| | ***Knowledge*** | ***Compre-hension*** | ***Application*** | ***Analysis*** | ***Synthesis*** | ***Evaluation*** |
| ***Foundational*** | | | | | | |
| 1. Mathematics | **B** | **B** | **B** | | | |
| 2. Natural Sciences | **B** | **B** | **B** | | | |
| 3. Humanities | **B** | **B** | **B** | | | |
| 4. Social sciences | **B** | **B** | **B** | | | |
| ***Technical*** | | | | | | |
| 5. Materials science | **B** | **B** | **B** | **B** | | |
| 6. Mechanics | **B** | **B** | **B** | **B** | | |
| 7. Experiments | **B** | **B** | **B** | | | |
| 8. Problem solving | **B** | **B** | **B** | **B** | | |
| 9. Design | **B** | **B** | **B** | **B** | **B** | |
| 10. Sustainability | **B** | **B** | **B** | **E** | | |
| 11. Contemporary issues and historical perspective | **B** | **B** | **B** | **E** | | |
| 12. Risk and uncertainty | **B** | **B** | **B** | **E** | | |
| 13. Project management | **B** | **B** | **B** | **E** | | |
| 14. Breadth in civil engineering areas | **B** | **B** | **B** | **B** | | |
| 15. Technical specialization | **B** | | | | | |
| ***Professional*** | | | | | | |
| 16. Communication | **B** | **B** | **B** | **B** | **E** | |
| 17. Public policy | **B** | **B** | **E** | | | |
| 18. Business and public administration | **B** | **B** | **E** | | | |
| 19. Globalization | **B** | **B** | **B** | **E** | | |
| 20. Leadership | **B** | **B** | **B** | **E** | | |
| 21. Teamwork | **B** | **B** | **B** | **E** | | |
| 22. Attitudes | **B** | **B** | **E** | | | |
| 23. Lifelong learning | **B** | **B** | **B** | **E** | **E** | |
| 24. Professional and ethical responsibility | **B** | **B** | **B** | **B** | **E** | **E** |

**Table 1. Summary of the learning outcomes described in the ASCE Body of Knowledge needed for civil engineers.**

## BS in Civil Engineering
## SUMMARY REPORT

| Fiscal Year | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 6 yr Total |
|---|---|---|---|---|---|---|---|
| Avg Enrollment: Students (FT + PT) | 40 | 88 | 115 | 136 | 171 | 179 | 728 |
| | | | | | | | |
| Part-time Faculty expense | $ 36,720.00 | $ 37,454.40 | $ 38,203.49 | $ 38,967.56 | $ 39,746.91 | $ 40,541.85 | $ 231,634.20 |
| Full-time faculty expense | $ 406,169.74 | $ 966,683.97 | $ 1,126,877.31 | $ 1,293,091.72 | $ 1,758,604.74 | $ 1,793,776.83 | $ 7,345,204.31 |
| Total Expenses | $ 1,616,593.27 | $ 2,476,314.25 | $ 2,986,084.18 | $ 3,310,259.32 | $ 3,863,184.60 | $ 4,104,781.98 | $ 18,357,217.60 |
| Revenue (Net of Aid) | $ 981,944.82 | $ 2,225,725.23 | $ 3,015,488.01 | $ 3,693,414.00 | $ 4,819,482.72 | $ 5,215,873.44 | $ 19,951,928.22 |
| CONTRIBUTION MARGIN Surplus/(Deficit) | $ (634,648.44) | $ (250,589.02) | $ 29,403.83 | $ 383,154.68 | $ 956,298.12 | $ 1,111,091.46 | **$ 1,594,710.62** |

**Note : This sheet is password protected to maintain the formulas.**