Sustainable Land Development Graduate Program

Leading to an MS Degree in Civil Engineering
Fall 2021

Background and Current Situation

Civil engineers focusing in the land development arena are critical in the planning, design, construction, and management of the facilities, developments, and infrastructure required for preserving our high standard of living. According to current census projections over the next thirty years, the U.S. will experience a surge in population of 30%, boosting the population from 325 million to over 425 million. This growth will increase pressures on our Nation's overburdened and aging infrastructure. A new generation will require state of the art facilities for housing, job growth, recreation, commerce, and institutional services that integrate rapidly advancing technologies. These dynamic needs can only be met through an evolving and sustainable approach to land development engineering that is responsive to the ever-changing demands of society and the developing world.

Urban renewal and the urbanization of "edge cities", like Tysons Corner and Reston in Fairfax County, present great challenges to civil engineers–how to create vibrant urban centers and economic growth from older, under-utilized, under-planned, existing communities. There is a great need for modern, sustainable infrastructure including: multi-modal transportation options that are pedestrian friendly; inter-connected street networks; underground, modern, smart utilities; modern stormwater systems that minimize both flooding and environmental impact; more efficient buildings; and supporting green infrastructure. These are just a few of the challenges encountered on both a regional and a site-scale development level. Multiple disciplines are needed in support of these efforts, and we need to understand and influence how communities make sustainable decisions. Technical expertise related to this development relies on the land development engineer, whose job it is to integrate these expansion and redevelopment efforts, as communities evolve, project by project.

The need for adaptive, highly skilled land development engineers with strong communication abilities is at an all-time high. These engineers require multidisciplinary knowledge in areas including water resources, transportation, urban planning, zoning law, land use, finance and marketing, real estate, construction engineering and management, and data-driven decision-making processes. Engineers practicing land development must respond to overlapping needs from each of these areas--a skill that requires the ability to process competing design criterion with a vast array of business and technical knowledge. Despite this pressing need, Civil and Environment Engineering (CEE) graduate curricula lack integration of these various disciplines, focusing instead on individual subject areas. A sustainable land development graduate program will need to provide students with knowledge and skills that span multiple disciplines within and outside of civil and environmental engineering. Like industry, instruction and research in these areas requires faculty that understand the multidisciplinary rules and demands of the field—a skill missing in most Civil Engineering departments across the nation, typically due to faculty specialization in the traditional disciplines.

In an attempt to meet pressing needs of industry, the undergraduate Land Development Design Initiative (LDDI, www.lddi.cee.vt.edu) was created in 2006 as a collaboration between land development practitioners and academics to improve land development design education and increase interaction between practitioners and students at Virginia Tech. The LDDI program has now grown to include 5 separate courses focused on land development, and includes a Sustainable Land Development course focused on sustainability, using rating systems like LEED and Envision. LDDI boasts a 100% post-graduation job placement rate for over 1,000 students since inception, even during the Great Recession. As of late spring 2020, the program has 50

sponsoring companies and municipalities, and involves practitioners in teaching, mentoring, and social activities. The program has expanded to include an enhanced focus on cutting-edge research efforts. LDDI is the only program of its kind in the nation. The uniqueness and success of the LDDI program is an indicator of the need for a graduate program that stresses similar values and objectives, but at a higher educational level and with relevant cross-cutting research.

MS Graduate Degree Proposal

The long term growth and popularity of the undergraduate LDDI program with employers and students has demonstrated the need for this type of educational program. The next logical step is to establish an interdisciplinary, CEE-based Master of Science graduate program which has a goal consistent with the first Fundamental Canon in the ASCE Code of Ethics:

> *"Engineers shall hold paramount the safety, health and welfare of the public and shall strive to comply with the principles of sustainable development in the performance of their professional duties."*
>
> *[In October 2009, the ASCE Board of Direction adopted the following definition of Sustainable Development: "Sustainable Development is the process of applying natural, human, and economic resources to enhance the safety, welfare, and quality of life for all of the society while maintaining the availability of the remaining natural resources."]*

The goal of this graduate program is to allow CEE graduate students to gain a background and perform research in the area of sustainable land development. Students in the graduate program will acquire a unique set of skills that will enable them to more quickly contribute to the sustainable land development needs of industry. Students will not only understand how to integrate basic knowledge of conceptual design, comprehensive planning, grading, erosion and sediment control, and stormwater management but recognize and explain the effects of particular types of development on transportation systems, utility systems, social-economic systems, and environmental systems. The forethought of how these aspects of sustainability are interwoven within the context of the site plan and the larger comprehensive plan are critical when considering how a new development or redevelopment will contribute to community, regional, and societal needs today and in the future. Students in this graduate program will also learn professional and industry norms and standards from a heavy influence of practitioners in the core classes who act as mentors for projects.

Research will focus in the areas of the allied faculty who have a home in the traditional CEE Program Areas, but perform research specifically related to sustainable development. There are three exit options for students in the Sustainable Land Development Program. Students who complete the **course work only track** (Option 1) are required to complete an oral exam that covers course material. Students who complete a **Project and Report** (Option 2) or **Thesis** (Option 3) will work directly with the allied Sustainable Land Development faculty. In addition to their plan of study, students completing a Project and Report or Thesis must provide a one-page summary about how their research is directly related to sustainable land development. Courses will only be offered at the Blacksburg, VA campus but up to 50% of the graded coursework hours may be taken at other universities[1] as part of the degree program.

Requirements include: 3 core CEE courses, 2 additional CEE elective courses, with the rest of the program coursework filled with elective courses from any university department, as

[1]See Graduate school policy for more details:
https://secure.graduateschool.vt.edu/graduate_catalog/policies.htm?policy=002d14432c654287012c6542e38200ca

approved by the student's graduate committee. At least one elective course must be outside of the Civil and Environmental Engineering Department.

Curriculum for Sustainable Land Development Graduate Program:

Required Core Coursework:[2]

CEE 5254 Advanced Municipal Engineering
CEE 5264 Advanced Sustainable Land Development
CEE 5274 Land Development Design Projects
CEE 5944 Seminar

Possible CEE Electives:[3]

CEE 5074 Global Virtual Design & Construction
CEE 5114 Advanced Sustainable Systems
CEE 5204 GIS Applications in CEE
CEE 5334 Quantitative Hydrology[2]
CEE 5440 Instrumentation and Signal Processing
CEE 5624 Transportation & Land Use
CEE 5734 Urban Hydrology and Stormwater Management
CEE 5784 Sustainable Transportation Infrastructure
CEE 5984 Policy Making for Infrastructure[4]
CEE 5984 Transformative Infrastructure Projects[4]
CEE 5984 Smart Sustainable Infrastructure[4]
CEE 5984 Urban Water Sustainability[4]

Possible Electives from Other Departments:[3]

UAP 5184 Community Involvement
UAP 5304 Land Use Planning
UAP 5554 Real Estate Law

Participating Faculty:

Dove, J.
Dymond, R.
Hancock, K.
Little, J.
Paige, F.
Rippy, M.
Sarlo, R.
Shealy, T.
White, C.
Young, K.

---

[2] Students who have already taken the concurrent undergraduate classes (CEE 4254, 4264, 4274, 4304) may not take the graduate level concurrent classes towards fulfilling their course requirement. These students are still required to have a minimum of 5 CEE classes in their Program of Study, excluding the courses taken at the undergraduate level.
[3] This is not a complete list. Electives can be determined by the committee.
[4] Course numbers will change.

Required Background Courses[5]:

The set of courses to require for those grad students without an ABET-accredited Civil Engineering degree would include:

CHEM 1035/1045 – General Chemistry
MATH 1205 or MATH 1225 – Calculus/Single Variable
MATH 1206 or MATH 1226 – Calculus/Single Variable
ESM 2104 - Statics
MATH 2214 - Differential Eqns.
MATH 2224 - Multivariable Calculus
PHYS 2305 - Physics I
CEE 3014 – Construction Management
CEE 3304 - Fluid Mechanics – 4 credits @ Virginia Tech

[5] See Appendix 6.0 in the CEE Dept Graduate Policies and Procedures Manual: https://www.cee.vt.edu/wp-content/uploads/2019/07/Graduate-Policies-and-Procedures-Manual-Departmental.pdf