Preface

Intended Audience

The target audience for this textbook is freshmen and sophomore civil and environmental engineering students. It is assumed that the reader has not yet taken courses in Calculus or Statics.

Goals and Motivation

Over the 15-week period of a typical college semester, the population of the United States will increase by approximately 700,000 people. This is roughly equivalent to the population of Charlotte, North Carolina, the 18th largest city in the U.S. During this same period, the world population will increase by approximately 21 million people, which is greater than the population of New York State, the third most populous state in the U.S. These semester-long numbers correspond to an annual growth in U.S. population of 2 million and an annual growth in world population of 90 million people. Imagine the new infrastructure (the "built environment") that must be constructed and the existing infrastructure that must be modified or expanded to meet the demands of these additional people: roads, rails, hospitals, power supplies, drinking water treatment facilities, schools, bridges, etc. And, even if the population was not growing, the need to build new or maintain existing infrastructure would still be necessary, as people move, the infrastructure ages and deteriorates, standards and regulations change, and user demands change (e.g., vehicle use and water use, on a per person basis).

Albert Einstein said, "we can't solve problems by using the same kind of thinking we used when we created them." This belief has motivated us to write a textbook that not only teaches students the *what* of the infrastructure but also the *how* and the *why* of the infrastructure. In particular, students must be able to view the infrastructure as a system of interrelated physical components, and also understand how those components affect, and are affected by, society, politics, economics, and the environment.

We further believe that studying infrastructure allows educators and students to develop a valuable link between fundamental knowledge and the ability to apply that knowledge. In terms of Bloom's Taxonomy (a classification scheme for learning objectives within various levels of cognitive competence), infrastructure offers a bridge between Level 1 (Knowledge) and Level 3 (Application). Too often, we educators jump from the fundamental knowledge gained in lower level classes into the applications of upper level courses, without spending time to ensure that students grasp the meaning of the knowledge (Comprehension, Level 2) or are able to translate the knowledge into new contexts.

Some have made the analogy that in each course of the undergraduate curriculum, students are given a component with which to build a bicycle. Upon graduation, some students carry a box of parts across the stage, whereas others ride a bike across the stage. The latter have seen how the parts fit together. We feel that the infrastructure is an ideal means of introducing students to civil

and environmental engineering, as it illustrates the interrelationships of the subdisciplines. We fear that all too often, students do not see how all the parts of civil and environmental engineering are interrelated until their senior year (or later). The topics and themes of this book are intended to help students see the "big picture" in the first or second year of the curriculum. Given this established foundation, subsequent coursework will be more meaningful.

Furthermore, engineers are stereotyped as not being holistic. Too often this stereotype holds true, and often results from a technical education that does not incorporate non-technical considerations. A substantial portion of this text is devoted to integrating these non-technical considerations into the design and analysis of infrastructure systems.

Unique Features

Several features unique to this textbook include:

1. **Introductory case studies**—Most of the chapters open with a brief introduction, followed by an introductory case study. These case studies are revisited throughout the chapter in order to emphasize the learning objectives.
2. **Sidebars**—Material is placed in the margins to enrich the content. Sidebars contain examples, definitions, "factoids," and synopses of current events.
3. **Cases in point**—Case studies, in addition to each chapter's introductory case study, are included throughout the textbook.
4. **Conversational style**—Throughout the text, we have chosen to speak directly to the reader, using "we" to refer to ourselves, the authors, and "you" to refer to the reader. We recognize that this breaks with convention, but believe that it makes the material more accessible.
5. **Outro**—An "outro" is the concluding section of a piece of music, and each chapter of this text concludes with an outro. It is intended to serve as a brief summary of the chapter and to introduce students to the next chapter or to the remainder of the textbook.
6. **Extensive graphics**—This textbook includes more than 450 graphs, schematics, and photographs. We have purposely included photographs of some very commonplace components of our infrastructure, as experience has taught us that many first- and second-year students are unaware of the purpose of these components.
7. **Analysis and design applications**—Four chapters are included that describe examples of how civil and environmental engineers analyze and design infrastructure components. Two of these chapters are presented at the introductory level midway through the textbook and two at a slightly more advanced level at the end of the textbook. These chapters are more calculation-intensive than the other chapters of the textbook.
8. **Icons**—Icons are used in margins to alert students to additional information on the textbook website, including videos, articles, reports, photos, etc. Other icons identify the geographic location of places mentioned in the text.
9. **Facebook Page**—A Facebook page, *www.facebook.com/IntroductionTo Infrastructure*, has been formed. Infrastructure-related news items, at the

appropriate technical level for the intended audience of this textbook, will be frequently posted.

Instructor Resources

The following resources are available to instructors on the book website:

Solutions Manual—Solutions for homework problems are provided.

Image Gallery—All figures, photographs, schematics, and graphs from the text are provided in electronic form.

Student Resources

The following resources are available to students (and instructors) on the textbook website:

Image Gallery—Each photograph from the textbook is provided in color at a high resolution to overcome the limitations of the relatively small one-color photographs found in the textbook. Additional photographs are available, many of which are specifically referenced in sidebars.

Web Resources—These are referenced with icons (see example icon to the right), placed in the margins throughout the textbook.

Video Gallery—A variety of brief videos are available on the textbook website.

Tutorials—Examples include rudimentary spreadsheet functions, use of an engineering scale, etc.

Facebook Page—Students can "Like" (i.e., become a fan of, or join) the textbook-companion Facebook page, *www.facebook.com/IntroductionTo Infrastructure*, and receive frequent news updates related to infrastructure.

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Sample Syllabi

Sample syllabi for five possible courses are provided.

One-Credit Introduction to Civil and Environmental Engineering Course

Week	Topic	Readings
1	Introduction to Course	
2	Introduction to Infrastructure	Foreword & Chapter 1
3	History and Heritage	Chapter 8
4 & 5	Construction Engineering	Chapter 6
		Chapter 9 (Construction Engineering Analysis Application)
		Chapter 10 (Construction Engineering Design Application)
6 & 7	Environmental Engineering	Chapter 5
		Chapter 9 (Environmental Engineering Analysis Application)
		Chapter 10 (Environmental Engineering Design Application)
8 & 9	Geotechnical Engineering	Chapter 3 (Foundations)
		Chapter 9 (Geotechnical Engineering Analysis Application)
		Chapter 10 (Geotechnical Engineering Design Application)
10 & 11	Structural Engineering	Chapter 3
		Chapter 9 (Structural Engineering Analysis Application)
		Chapter 10 (Structural Engineering Design Application)
12 & 13	Transportation Engineering	Chapter 4
		Chapter 9 (Transportation Engineering Analysis Application)
		Chapter 10 (Transportation Engineering Design Application)
14	Interrelationships between subdisciplines	Chapter 7
15	Ethics and Sustainability	Chapters 13 & 17

One-Credit Introduction to Infrastructure Course

Week	Topic	Readings
1	Introduction to Course	
2	Introduction to Infrastructure	Foreword & Chapter 1
3	Natural Environment	Chapter 2
4	Structural Infrastructure	Chapter 3
5	Construction Sites	Chapter 6
6	Roads, Mass Transit, and Non-Motorized Transportation	Chapter 4
7	Aviation, Rail, and Waterway Transportation	Chapter 4
8	Energy, Drinking Water, and Wastewater	Chapter 5
9	Stormwater, Solid and Hazardous Waste	Chapter 5
10	Systems View of Infrastructure	Chapter 7
11	Analysis Process	Chapter 9
12	Analysis Applications (Select two subdisciplines)	Chapter 9
13	Design Process	Chapter 10
14	Design Applications (Select two subdisciplines)	Chapter 10
15	Ethics and Sustainability	Chapters 13 & 17

Two-Credit Introduction to Civil and Environmental Engineering Course

Week	Topic	Readings
1	Introduction to Course and Infrastructure	Foreword & Chapter 1
2	Natural Environment	Chapter 2
3	Structural Infrastructure	Chapter 3
4	Transportation Infrastructure	Chapter 4
5	Environmental Infrastructure	Chapter 5
6	Construction Sites	Chapter 6
7	Systems View of Infrastructure	Chapter 7
8	History, Heritage, and Future	Chapter 8
9	Analysis Process and Applications	Chapter 9
10	Analysis Applications and Design Process	Chapters 9 & 10
11	Design Applications	Chapter 10
12	Planning	Chapter 11
13	Sustainability and Environmental Considerations	Chapters 13 & 15
14	Social Considerations	Chapter 16
15	Ethics	Chapter 17

Three-Credit Introduction to Infrastructure Course

Week	Topic	Readings
1	Introduction to Course and Infrastructure	Foreword & Chapter 1
2	Natural Environment and Environmental Infrastructure	Chapters 2 & 5
3	Structural Infrastructure and Construction	Chapters 3 & 6
4	Transportation Infrastructure	Chapter 4
5	History, Heritage, and Future; Systems	Chapters 7 & 8
6	Infrastructure Analysis Fundamentals	Chapter 9
7	Infrastructure Design Fundamentals	Chapter 10
8	Planning and Energy	Chapters 11 & 12
9	Sustainability	Chapter 13
10	Environmental Considerations	Chapter 14
11	Economics Considerations	Chapter 15
12	Ethics; Other Considerations	Chapters 17 & 19
13	Infrastructure Security	Chapter 18
14	Advanced Infrastructure Analysis	Chapter 20
15	Advanced Infrastructure Design	Chapter 21

Three-Credit Capstone Design Course—Supplementary Text

Week	Topic	Readings
1	Introduction to Course	Foreword & Chapter 1
2	Introduction to Infrastructure	Chapters 3 & 6
3	Structural Infrastructure and Construction	Chapter 4
4	Transportation Infrastructure	Chapter 5
5	Environmental Infrastructure	Chapter 7
6	Infrastructure as a System	Chapter 11
7	Planning	Chapter 13
8	Sustainability Considerations	Chapter 14
9	Economics Considerations	Chapter 15
10	Environmental Considerations	Chapter 16
11	Social Considerations	Chapter 17
12	Ethics	Chapter 18
13	Security Considerations	Chapter 19
14	Other Considerations	
15	Open	