Public Works Engineering and Management Practices for Undergraduate Students

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Abstract

Public works is one of the largest and most diverse fields of public service. It involves the nation's infrastructure which includes the planning, analysis, design, construction, operation, maintenance and management of physical systems essential to economic and social development of communities, cities, counties, regions and nations. Public works facilities, which are referred to as the urban infrastructure and include transportation, communication, energy, water treatment and distribution, waste-and-storm water collection and disposal systems, determine the quality of life in the urban environment. In major metropolitan areas, many components of the infrastructure have deteriorated badly, while others have become severely overloaded. The existing infrastructure is inadequate to accommodate current and future growth. Stringent environmental and safety standards have placed additional pressures on existing facilities.

Decision-making about public works in the American Federal System is a complex and fragmented process, involving the participation of federal, state, and local governments. This process is also similar in other countries with a democratic government.

A three-credit hour, undergraduate course in public works engineering and management practices is proposed in this paper to introduce civil engineering students and coastal and environmental engineering students to basic principles of organization, including organization policies and the engineering code of ethics, along with other topics including personnel management; planning, finance, risk management and legal review; communications; records; emergency management; safety; municipal engineering; engineering design; the bid process; construction; right-of-way permits; utility coordination; buildings, equipment, and grounds; solid waste management, collection, processing, and disposal; streets; and, snow removal and ice control.

This paper details the first attempt to develop such a course in the Department of Civil Engineering at the University of Florida. This subject matter could be very useful to the national and international audience.

Introduction

Most public works professionals are still civil engineers. In spite of having excellent technical training, these professionals often are unable or unwilling to advocate technical policy. Therefore, we are witnessing the emergence of the "generalist administrator". The generalist may not have the technical expertise of the engineer, but he or she advocates policy and applies relevant methodology¹.

The American Public Works Association (APWA), in cooperation with the National Association of Schools of Public Affairs and Administration (NASPAA) and the American Society of Civil Engineers (ASCE), has developed detailed curriculum guidelines/formats for effective public management, personnel, finance, and technology. Several institutions have adopted these guidelines/formats for graduate study in public works. The APWA recommends that an appropriate public works engineering/administration graduate program should consist of 33 semester credit hours. Course work should be flexible, including 12 to 18 hours of technical courses and 12 to 15 hours of management courses. A program may or may not require a six-credit hour thesis and some require 2 to 3 hours of special public works topic study. Some may require a three- to six-credit internship assignment, especially for those students without public works experience².

The APWA Education Foundation has recognized graduate programs at various U.S. universities including University of Florida (UF), Illinois Institute of Technology, University of Missouri, George Washington University, etc. The APWA and International City Managers Association (ICMA) also have workshop series programs which provide information on all levels of management. A typical one-year master's graduate program might include the following plan of study¹:

Construction Planning and Scheduling Public Works Management Public Works Planning Construction Cost and Economic Analysis Introduction to Air Pollution Municipal Refuse Disposal Water Quality Management Financial Accounting Principal of Organization Transportation Engineering and Planning Master's Thesis or Master Report

The following presents a proposed undergraduate public works engineering and management practices course for junior and senior engineering students.

Proposed Undergraduate Public Works Engineering and Management Practices (CGN 4xxx)

A three-credit hour, elective undergraduate course in public works engineering and management practices will be offered to junior or senior civil and environmental engineering students.

Educational Objectives

The general objectives of the course are to:

- 1) introduce students to the meaning of "public works" and its distinction from private works;
- 2) introduce students to the history of public works, outstanding public works projects and the attributes of the engineers responsible for accomplishing them;
- 3) acquaint students with the functions of local, state, and national public works organizations;
- 4) introduce students to the processes of public participation and legislative decision-making as they relate to public works projects;
- 5) introduce students to the concept of land development and its relationship to public works, including the restraints imposed by political, environmental, social, and economic conditions;
- 6) alert students to their professional responsibilities as public works engineers to protect the public health, safety, and welfare (emphasizing the high level of trust and expectation that the public has in its public works officials);
- develop a strong conceptual base and specific problem-solving skills, applying knowledge gained from previous civil engineering courses to solve actual public works engineering problems; and
- 8) acquaint students with fundamental concepts, tools, and techniques used to implement and manage public works projects.

The remainder of the paper details a proposed course syllabus including homework assignments and sources for term paper topic selection.

University of Florida

CGN 4xxx - Public Works Engineering & Management Practices

Course Syllabus - Fall 1998

Instructor: Office:	Dr. F. T. Najafi, Associate Professor Room 202, Weil Hall	Graduate Assistant: Office: Room 202, Weil Hall
Phone:	392-1033 (o) 335-8583 (h)	Phone: 392-9531 (o)
Note:	We have an open-door policy and you are w	elcome at anytime.

Text: *Management of Local Public Works*, International City Management Association, Washington, DC, 1986

Class	Date	Reading Assignment Before Class	Homework Assignmen t	Due	Lecture (Class)
1	12/28	Ch. 1, What is Public Works and its infrastructure? (pp. 3-21)			Course organization & scope - What is public works?
2		Ch. 1 (continued) Decaying infrastructure problems			
3		Ch. 1 (continued) History of Public Works and the Roles of the Public Works Manager			The roles of the public works manager and the future of public works management
4		Ch. 1 (continued)			Guest speaker: "What is Public Works? Problems, issues, and the Roles of the Public Works Manager"
5		Ch. 2, Public Works Organization (pp. 22-36)	#1		Organization of the public works department, relations with county, state and federal agencies
6		Ch. 2 (continued) Outstanding Public Works Achievements			Past examples of public works projects
7		Ch. 2 (continued) Decaying Infrastructure Problems and Funding Constraints to Repair and Build			

Class	Date	Reading Assignment Before Class	Homework Assignmen t	Due	Lecture (Class)
8				#1	Guest speaker: "Funding Constraints and Development of Informed Consent from the Public"
9		Federal Agencies: Federal Highway Administration (FHWA), U.S. Corps of Engineers (USCOE), various federal land management agencies	TPT* Selection		Various department functions, utilities (private vs. public), Department of Community Affairs, Department of Transpor- tation, etc.
10		Ch. 3, Information Systems (pp. 37-55)			Data processing versus manage- ment information
11		Ch. 3 (continued) Computer Use	#2		Guest speaker: "Computer Use in Public Works"
12		Ch. 4, Public Works Finance (pp. 56-67)			Revenue, budgeting
13		Ch. 4 (continued)		TPT* Outline	Accounting, local government borrowing
14		Review for Test #1		#2	Test #1
15		Ch. 5, Public Works Planning (pp. 70-95)	#3		Planning
16		Ch. 5 (continued)			Zoning, land subdivision regulations
17		a) Typical City and CountyOrdinancesb) Minimum Design Standards forHighways & Streets			
18		City and County Road and Street Design Standards			
19		Water and Waste Water Design Standards			
20		Ch. 5 (continued)			Growth management capital improvements program

Class	Date	Reading Assignment Before Class	Homework Assignmen t	Due	Lecture (Class)
21		Ch. 6, Managing People (pp. 96-115)		#3	Organization of the personnel function, position classification and job analysis performance appraisal
22		Ch. 6 (continued)	#4		Guest speaker: "Legal Aspects of Public Works"
23		Ch. 7, Communication Manage- ment (pp. 117-130)		#4	Working with elected officials (public works manager vs. com- mission meeting)
24		Ch. 7 (continued)			Interpersonal communication, listening to citizens, working with media
25		Introduction to Rules, Codes, Ordinances, and Statutes Applicable to Regulation and Procurement of Public Works			
26		Code of Federal Regulations, Occupation Safety & Health Administration (OSHA), Environmental Protection Agency (EPA), Federal Emergency Management Administration (FEMA)			
27		Florida State Statutes (e.g., trans- portation, and procurement of property and services)			
28		Review for Test #2			Test #2
29		Ch. 10, Engineering and Contract Management (pp. 167-189)	#5		The planning and design process; Contract bidding and awards
30		Ch. 10 (continued)			Retention and use of consultants
31		Ch. 10 (continued)			Guest speaker: "Construction Management"
32		Ch. 11, Equipment Management (pp. 190-205)			Total equipment management

Class	Date	Reading Assignment Before Class	Homework Assignmen t	Due	Lecture (Class)
33		Ch. 12, Buildings and Grounds Management (pp. 207-220)			Centralized maintenance
34		Ch. 12 (continued)			Energy conservation
35					Field trip: UF building and ground management
36		Ch. 13, Transportation (pp. 221-265)			Transportation planning
37		Ch. 13 (continued)			Traffic management
38		Airport Planning			
39		Review for Test #3			Test #3
40		Ch. 14 (continued)			Drainage
41				#5 Final Term Paper	Guest speaker: "Waste Water Systems"
42		Ch. 15, Solid Waste Management (pp. 318-333)			Storage and collection Field trip: Alachua County Landfill
43					Field trip: UF waste management

FINAL EXAM SCHEDULE:

Section xxxx (period ____), Exam _____, Final Exam given _____

GRADING STRUCTURE:

Homework (including term paper)25%3 Exams (each 20%) (see Final Exam section in "Our Contract") 75%

100%

EXAMS:

The exams will be based on lecture notes and the textbook.

HOMEWORK ASSIGNMENTS

Individual Assignments

Assignment 1 (5%). Analyze any outstanding transportation or water resources public works project that was completed anywhere, within the years 1850 to 1940, its benefits and costs, compare it to a similar project of recent vintage.

Assignment 2 (10%). Prepare an agenda item to the City Commission of Gainesville for approval to construct: 1) a new four-lane divided highway; 2) a water tower; 3) a wastewater treatment plant; 4) a fire station; or 5) a park. You can choose one of the topics above and you must follow all policy and format requirements of the City of Gainesville. The project will likely be hypothetical, but site characteristics must be real and all justifications must demonstrate compliance with the current published *Comprehensive Plan*. Note: You may select an existing public works problem that is currently under consideration by the City of Gainesville or Alachua County.

Group Assignments

Assignment 1 (10%). Review any approved or pending planned unit development from any Florida municipality or county for consistency with all codes and ordinances and propose an alternate site layout that will also meet code.

Assignment 2 (10%). Based on a search of literature and the Internet, find and describe new, innovative and potentially cost-effective technologies to: 1) treat storm water; 2) treat wastewater; 3) rehabilitate flexible and rigid pavements; 3) construct short-span bridges; and 4) rehabilitate sanitary and storm sewers. Case study sites must be cited.

Term Paper Topic (TPT) Assignment (25%). This is a group assignment of either: 1) a practical design problem assigned by Alachua County Engineering, the Florida Department of Transportation (FDOT), Gainesville City Engineering, or Gainesville Regional Utilities in cooperation with the Department of Civil Engineering; or 2) a public works engineering topic involving service demand estimates; water, wastewater, and solid waste collection systems; storm water management; pavement management; public street design standards; code interpretation; or development of informed consent from citizens as selected from a list of alternative projects, such as follows. The problem assignment must be approved by the instructor and include an engineering report, design calculations, detailed, constructable plans and specifications, and a cost estimate.

Example of Internet Sources

http://www.umkc.edu/umkc/catalog/htmlc/engineer/ce/c363.html (University of Missouri-Kansas City)

http://info-civil.tamu.edu/undgrad/courses/cven451.htm (Texas A&M University) http://www.curtin.edu.au/curtin/handbook95/units/04395.html (Curtin University, Western Australia)

http://www.ce.gatech.edu/~kmolenaa/CE4043/syllabus.htm (Georgia Technological University) http://www.engr.wisc.edu/cee/courses/cee365.html (University of Wisconsin-Madison) http://www.engr.wisc.edu/cee/courses/cee562.html (University of Wisconsin-Madison)

LIST OF ALTERNATIVE TERM PAPER TOPICS

Case Studies in Solving Typical Public Works Problems

- Water main and wastewater line extensions
- Street and intersection improvements
- Correcting drainage and flooding problems
- Traffic studies
- Corridor studies
- Bridge and culvert replacement
- Pedestrian safety and traffic-calming issues
- Rigid versus flexible pavement design and management
- Life-cycle economic analysis of public works projects and value engineering principles
- Dealing with over-budget projects and bids
- Various project delivery methods
- Drainage law issues
- Eminent domain proceedings

Introduction to Land Development

- Site and environmental planning; field surveys and office designs for subdivision, including public improvements and utilities, storm water management systems; site plans for buildings, structures, institutions, shopping centers, and industrial districts; layouts for transportation terminals, motor vehicle parking, parks, and recreational facilities.
- Water and wastewater engineering, water-quantitative control. Sources of surface water. Sources of groundwater. Distribution. Qualitative control. Treatment processes. Wastewater-quantitative control.
- Planning processes; procedures and forces that shape urbanization.

TERM PAPER ASSIGNMENT:

- <u>Background</u>: Note on your homework assignment sheets, "TPT*" (Term Paper Topic), indicates that you should begin selecting your term paper topic (from the list shown).
- <u>Assignment</u>: Prepare an original term paper of 1,500 to 2,000 words pertaining to a significant method, material relevant to topics in the list as shown. All term papers must be submitted at the beginning of the class period on ______, 199_, as a double-spaced, typewritten original.
- <u>Term Paper Topic Selection & Approval</u>: Each student is to choose a topic from the list provided. Other term paper topics may be chosen, but must have <u>prior approval</u> by the instructor.

An outline for the paper is due as shown on the assignment sheet on ______, 199_. The outline is critical and essential. It should define the topic of your paper, indicate the general approach you expect to follow in the presentation of the paper, and provide a reasonable indication of references you expect to use. The outline is expected to be in good form.

The returned outline is to be submitted with the term paper but is not to be considered part of the length of the paper. The term paper is due at the beginning of class, ______, 199_. It is expected that the final paper will be not less than 5 pages in length, typed, double-spaced, and written in good technical form. Final paper margins should have a 1.5inch left margin and 1-inch right, top, and bottom margins. A minimum of 5 references should be used in submitting your term paper.

Missing the deadlines for both the term paper topic outline and the final term paper will cost the student term paper grade points.

<u>Contribution to Grade</u>: The term paper will count <u>approximately</u> 50% of the homework grade. The total homework grade will count 12% of your final grade. Therefore, the weight of this paper is approximately 13% on your pre-final or final course grade. Each test counts 25%.

Term Paper Grading: A typical grading approach would consider:

- Topic being finalized on time
- Term paper being submitted in accordance with instructions
- Introductory statements
- Quality of development of the topic
- Concluding statements
- Grammar and spelling
- Format and attention to normal paper preparation rules
- Before writing your paper, you must ask yourself the following questions and then begin writing your paper in answer to the same questions.
 - Why have I selected this topic?
 - What is the problem that I am so concerned with?
 - What is my objective and how will I approach this project?
 - What solution do I propose?
 - What are my conclusions and recommendations?

"Our Contract"

HOMEWORK:

Homework, besides your listed reading assignments, will be assigned during the class periods indicated and will be due at the beginning of the class period of the due date. Late homework counts $\frac{1}{2}$ if one class late, less after one class late, unless excused for legitimate reason. Incompletes are not recorded. Homework should be submitted on the assignment sheet provided; or, if no sheet is provided, use $8.5" \times 11"$ paper, with untorn edges, written on one side of the sheet only, folded lengthwise, with name, assignment number, and CGN 4xxx written on the outside. Neatness and legibility are expected. A term paper will be a part of homework set score. The homework set grade counts the same as a 1-hour test. If you have any questions concerning the grading of tests or homework, please see the professor within one week after the graded material is returned to you. <u>All homework must be completed in order to receive a course grade, without penalty</u>.

<u>GRADES</u>:

Based approximately as follows: Each of the four tests and the homework set will be equally weighted to determine pre-final grades. Tests missed due to unexcused absences will be graded zero. Grading will typically follow the pattern:

91 and above	= A	67 - 69	= D+
87 - 90	= B+	60 - 66	= D
80 - 86	= B	less than 60	= E
77 - 79	= C+		
70 - 76	= C		

FINAL EXAM:

Based on pre-final grades of A, B+, and B, students are exempt from taking the final exam. Students with B+ or B grades may take the final to attempt to raise their course grade. <u>Students</u> with C+ or below grades must take the final exam. When taken, the final will be substituted for the lowest test score to determine course grade.

ABSENCES:

Requests for excusable absences must be considered with the professor at the earliest opportunity prior to the absence. If absence for a test is not approved in advance (emergencies excepted) the grade will be a zero. Unexcused absences may be reflected as a reduction in your final grade average. Class attendance is expected and an attendance record will be kept. Your class attendance is essential, since it deals with the following important considerations for you to: 1) participate and listen to other classmates' points of view; 2) participate in the discussion and offer support, raise new issues, ask for clarification, and express your own ideas; and 3) enrich the class discussions with example cases and/or personal experiences, etc.

References

1. Whitney, M. M., "Education," *American Public Works Report*, American Public Works Association, Chicago, Illinois, April 1987, p. 22.

2. American Public Works Association, "Public Works Graduate Education," American Public Works Education Foundation, Chicago, Illinois, 1987, pp. 1-12.

Biographical Information

FAZIL T. NAJAFI earned his BSCE from the American College of Engineering, Kabul, Afghanistan, and his BSAE, MS and PhD in Civil Engineering from Virginia Polytechnic Institute and State University. He has worked for over 25 years in government, industry and education, and, currently, is a tenured associate professor of civil engineering at the University of Florida. Dr. Najafi is a member of several professional societies and has a number of refereed and nonrefereed publications having presented numerous technical papers to national and international organizations.

SAL G. ARNALDO is Program Engineer for the City of Tallahassee, Florida, since 1994 and earned his BS in Civil Engineering from the University of Florida in 1975. During the previous 19 years he also worked as Assistant City Engineer for the City of Tallahassee and as Civil Engineer for the City of Tallahassee, an architect/engineer firm and the USDA Forest Service. Mr. Arnaldo is a registered professional engineer in the State of Florida and is also a member of the American Society of Civil Engineers.