

CE-220: Fundamentals of Civil Engineering

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Lecture 1 - 1/25/22

- Course Description
 - Planning, execution, and interpretation of drawings and specifications for Civil Engineering projects.
 - Sample drawings and specifications.
 - Contractual requirements and sample contracts.
 - Permitting, scheduling, and cost estimation.
 - Basic operations of design and construction firms.
 - Interface with other disciplines on Civil Engineering projects.
- Midterm
 - Likely March 8, before Spring Break.
 - Multiple choice questions (might have multiple right answers)
- Final group project/presentation
- Grading
 - Class participation: 20%
 - Quizzes: 15%
 - HW: 20%
 - Midterm: 15%
 - Final Project: 30%
- Office Hours: 4:30 - 5:00, 8:00 - 8:30, by appointment
- 10 points deducted for each week that an assignment is late.
- Recommended readings: ENR, ASCE, any professional journals of interest
- Abbreviated notes will be posted in teams. Take notes like they won't be.
- Civil Engineering Sub-Disciplines
 - Airport Engineering
 - Architectural Engineering
 - Coastal Engineering
 - Construction Engineering
 - Earthquake Engineering
 - Environmental Engineering
 - Forensic Engineering
 - Geotechnical Engineering

- Highway Engineering
- Ports and Marine Engineering
- Materials Engineering
- Municipal/Urban Engineering
- Railway Engineering
- Site Engineering
- Structural Engineering
- Transportation Engineering
- Wastewater/Water Resources Engineering
- Civil Engineers fulfill society’s needs, a service profession.
- Introduction
 - **The Process** - from Request for Qualifications and Proposal for initial Planning to Opening Day for the Project.
 - * Where it begins
 - * A “Need” is identified
 - Owner needs to develop property purchased to lease for income (return on investment)
 - Inspectors note that deck deterioration is advanced and needs repair/replacement.
 - Traffic demands have grown to regularly “jam” the route and no viable alternates are available.
 - * Scope developed - usually by owner or owner’s representative (program manager for major projects)
 - * Request for Qualifications (RFQ) or Request for Proposal (RFP) for Design issued by Owners
 - Lists *qualifications* needed - (Sometimes 2-step process: RFQ first and shortlisted teams get the RFP second).
 - Objectives and Scope of Work are detailed
 - Schedule is defined
 - Criteria
 - **The Players** - Relationships among Owners, Designers, Builders (and sometimes Financers)
 - * Owner/Owner’s Representative
 - * Designer/Engineer - Develops construction (or contract) Documents (CDs). Supports construction (reviews of Contractor’s alternatives, RFIs, Means and Methods, relays design intent).
 - * Contractor - Bids on work defined in CDs. Lowest qualified bidder (usually) gets awarded the contract.
 - * Resident/Construction Inspector - Assures work is performed in accordance with CDs. Processes pay requisitions. Coordinates submissions to/from designer.
 - * Quality Control/Quality Assurance/Testing
 - * **Design-Bid-Build** Contractual relationships between owner and engineer and owner and contractor. Cooperative support between engineer and contractor.
 - * Roles civil engineers play: Designer, Resident/Owner’s Representative, Contractor, Owner, Maintenance Engineer, QA/QC.
 - **New Construction** - Case Study - Tacoma Narrows Bridge
 - * Timeline for Tacoma Narrows Bridge
 - 1994 - WSDOT Public - Private Initiative Announced
 - 1996 - Major Investment Study

- 1996/98 - Environmental Impact Studies
- 1999 - Project Standards and Criteria Development
- 2000 - Basic Configuration and Initial Design
- 2001 - Determination of Fixed Price
- 2002 - Legislation enacted and bonds shortlisted
- 2002 - Notice to proceed - 9/25/2002
- 2007 - Opening day - 7/17/2007
- * Financial mechanisms for procuring and paying for projects.
 - Buildings v. Bridges
 - Procurement Methods
 - Conventional Design-Bid-Build (DBB)
 - Design/Build (DB) and Progressive Design/Build (PDB)
 - Public-Private Partnerships (P3) and Design-Build-Bid-Operate-Maintain (DBOM)
 - Construction Manager/General Contractor (CM/GC)
 - Last three are called alternate delivery (AltD)
 - Conventional Design-Bid-Build: Owner → Design → contract bid then built
Engineering Oriented: Owner controlled, low risk, low opportunity.
 - Design-Build and P3: Owner → 30-40% Design and RFP → Design/Build teams advance design, bid then final designed/built staged. Also adds finance/operate/maintain in P3.
Construction Oriented: Contractor controlled, managed risk, better opportunity.
 - Progressive Design-Build: Owner → 5-10% Design and RFP → PDB teams selected on qualifications, advance design with owner and owner's representative.
Investor Oriented: Investor controlled, high risk, high opportunity.
 - CMGC - Owner "brokers" the marriage
 - Private public Partnerships, Design/Build/Operate/Maintain and other concepts
 - Bonding/Tolling and its place in financing
 - Federally funded projects - interstate system
 - Real estate and tax implications
- * Contracts for Design
 - General Terms and Conditions: Standard of care, Insurance, Payment terms, other "legalese"
 - Scope of Work
 - Compensation - types of Contracts
 - Schedule for project
 - Special provisions
- * Construction Inspection and Construction Management
- * Contracts for Contractors - General terms and conditions (Division 1). The rest is the construction documents (plans and specifications, usually done by the design engineer)
- **Rehabilitation** - Case Study - Verrazzano Narrows Upper Level Deck Replacement
 - * First phase - Study and design brief
 - Notice to proceed - 12/2003
 - Two viable operations: steel orthotropic and concrete filled steel grid.
 - Traffic studies to determine workable staging
 - Utility survey to evaluate relocation
 - Analyses to "global" impact of each alternative
 - Final recommendations
 - Two conceptual (10%) designs

- Budgetary cost estimates
- * Second Phase - Designer
 - Two main construction contracts (Part A: Utility Relocation and Part B: Deck Replacement)
 - Two prototypes (Trinidad Lake asphalt pavement at throggs neck bridge and orthotropic deck for fabrication “proof of concept” and fatigue tests)
 - Additional Wind Tunnel Testing
 - Value Engineering
 - Constructability review
 - Final Design - VN-90A - December 2008
 - Survey - How Dissimilar might the panels be?
- **Recent Trends**
 - * Sustainability - Going “Green” needs to be part of process early if it will be followed through to completion.
 - * Integrated Project Delivery/BIM
- Homework 0
 - Do one random act of kindness
 - You cannot personally benefit from this
 - You must not tell anyone what it is
 - If the person you did it for finds out, it doesn’t count

Lecture 2 - 2/1/22

- Project documentation
 - Contract/”Boilerplate”
 - Specifications
 - Plans
 - Engineer’s estimate
- Bridges vs. Buildings
- Interdisciplinary projects
- Conflicts and Contradictions - minimizing them
- Civil Engineering Sub-Disciplines
 - Airport Engineering
 - * JFK Terminal 4
 - * LaGuardia Airport re-envisioned
 - Architectural Engineering
 - * San Francisco’s Salesforce tower
 - * Atlanta’s Mercedes Benz Stadium

- * Major coordination with architects and other trades
- * Customers demanding more “bells and whistles” and “moving parts”
- * Facade and structural glass specialties are becoming a “thing”
- Coastal Engineering
 - * Waterfront work: Levees and flood protection, bulkheads, seawalls, scour protection
 - * Beach erosion mitigation: Jetties, groins, sand replenishment, delta preservation
 - * Offshore structures: Oil rigs, wind farms, bridge pier scour protection, wave and tidal generators
- Construction Engineering
 - * Means and Methods: Staging, formwork and falsework, concrete curing plans.
 - * Traffic control plans
 - * Shop drawings
 - * Fabrication procedures
 - * Erection procedures
 - * Sizing cranes for construction: Temporary track driven cranes, tower cranes, gantries
 - * Transportation problem solver
 - * Procurement
- Earthquake Engineering
 - * Seismology
 - * Soil effects
 - Soil-structure interaction - coming up with the springs
 - Attenuation/amplification from intervening soil layers
 - * Tectonics - movement of plates
 - * Monitoring and prediction modeling
 - * Structural analysis
 - Response spectra
 - Multi-modal response spectra
 - Time history
 - Design elements
 - * Research and Development
 - Active/passive damping systems
 - Innovative bearings (isolation, friction/pendulum)
- Environmental Engineering
 - * Water treatment
 - Controls for effluent and runoff
 - Groundwater, settlement basins
 - Desalination
 - Waste treatment
 - Cleanup from spills
 - * Air
 - Air quality effluent control/scrubbers, etc.

- Indoor air Quality: Dust control / filtering, Cleaning chemical pollutants
- * Noise control, indoor and out
- * Soil-structure: Erosion controls (planting, hay bales, riprap, etc.)
- Forensic Engineering
- Geotechnical Engineering
 - * Soils
 - Geotechnical investigations
 - Classifying
 - Soil improvement: Stone columns, Soilcreting/jet grouting
 - Settlement control/preconsolidation
 - Highway and utility work
 - * Foundations
 - Spread footings and mats
 - Pile foundations - many kinds
 - Support of excavation: Tie-backs and sheeting, soil nailing
 - Tunnels, shafts
- Highway Engineering
 - * Alignments - plan and profile
 - * Cross sections
 - * Mass haul optimization
 - * Utility plans and relocations
 - * Pavement boxes
 - * Curbs, sidewalks, paths, driveways
 - * Survey coordination
 - * Drainage
 - * Signalization and lighting
 - * Speed and red-light enforcement
 - * Traffic control
 - * Striping
 - * Signing
- Ports and Marine Engineering
- Materials Engineering
 - * Metallurgy and alloying
 - High performance steels
 - Other metals
 - Corrosion protection - Coatings, metalizing, cathodic protection, etc.
 - * Concrete
 - New mixes and materials: Glassphalt, lightweight aggregates, cements, fly ash, slag, and pozzolans, fiber reinforcement, ultra-high-performance concrete (UHPC)
 - * Asphalts and binders
 - * Research and Development

- Plastics and composites, including carbon
 - Fiber reinforced polymers (FRP)
 - Nanotechnology
 - Reuse of waste materials in new work
- Municipal/Urban Engineering
 - * Utilities/Infrastructure
 - Communications - phone, broadband, cable, cell cites
 - Electric and power generation/distribution
 - Gas storage and distribution
 - Steam
 - Sewage/sanitary
 - Pump stations
 - * Mapping
 - * Geographical Information Systems (GIS)
 - * Parkland development and maintenance
 - * Streetscape
 - * Zoning and city Planning
 - * Maintenance
- Railway Engineering
 - * Railroad design
 - Alignments: Plan, Profile, tolerances get tighter with increased Speed
 - Track work: Rail (continuously welded), frogs and switches, ballast, clamps
 - Signals
 - Platforms and "gaps"
 - Mezzanines and station design
 - Bridge and tunnel design
 - Embankments and retaining walls
- Site Engineering
 - * Permitting
 - * Site plans
 - * Drainage
 - * Sanitary sewers
 - * Parking lots
 - * Survey coordination
 - * Curbs, sidewalks, paths, driveways
 - * Utility plans and relocations
 - * Site and facility lighting
 - * Signing and striping
- Structural Engineering
 - * Buildings
 - * Bridges

- * Retaining walls
- * Tunnels
- * Special structures
 - Guyed towers
 - Blast design
 - Shells and domes
 - Fabric structures
 - Stadiums
 - Oil rigs
 - Wind farms
 - Transfer stations
 - Ports and marine structures
- Transportation Engineering
 - * Transportation surveys
 - * Planning, modeling, and studies
 - * Operations
 - * Highway Systems
 - Traffic projections
 - Toll studies and financing
 - Tolling methods
 - Bike lanes and pedestrian paths
 - * Mass transit
 - Bus Systems
 - Metro and light rail systems
 - Commuter rail systems
 - High-speed Rail
 - Fare collection systems
 - * Carpooling and other alternative transportation
- Wastewater/Water Resources Engineering
 - * Water supply
 - * Testing and treatment
 - * Storage
 - * Distribution
 - * Pumping stations
 - * Maintenance
 - * Fire lines
 - * Desalination
 - * Wells and Aquifers
 - * Irrigation
 - * Hydraulic Studies
 - Dams
 - River backwater studies
 - Flooding studies

- Sub-Disciplines: Wrap-up
 - Lots to choose from
 - Many overlap
 - None are stagnant - continuous developments keep things interesting
 - Plenty of long-term opportunities
- Planning and permitting - Subject overview
 - *Private v. Public*: Who's in charge?
 - * Architects tend to take lead on private work/buildings
 - Contract with the owners
 - Subcontract to structural, mechanical, electrical, and plumbing designers
 - Make decisions on overall configuration
 - Tend to be the “LEEDers” for Sustainability decisions
 - * Civil Engineers tend to take the lead on public works/bridges
 - Many major bridges do not have architectural involvement
 - Geotech, Architects, MEP subs to structural or civil
 - *Planning*: Site selection, preliminary budgeting, feasibility studies
 - * Site selection
 - Owner purchases property, often in consultation with designers
 - Owner objectives = “program”
 - Proximity to utilities/transportation
 - LEED or ENV SP criteria
 - * Preliminary Budgeting
 - Does it make economic sense?
 - Cost/benefit analysis
 - Financing - bonds or loans needed?
 - * Feasibility studies
 - Any fatal flaws in the plan?
 - Work arounds possible?
 - *Environmental Assessment* - Impacts to consider
 - * Water Quality
 - Additional runoff created?
 - Settlement ponds or permeable areas
 - * Air Quality
 - * Dust and noise control during construction
 - * Additional traffic generated?
 - * Wildlife affected?
 - * Parkland
 - * Open Spaces
 - * Cultural Resources

- * Historical Resources
- * Natural Resources
- * Quality of Life
- Major investment studies
 - * Will it pay off?
 - * Depends on: Cost/benefit analysis, Life cycle costs, return on investment
 - * Financing options