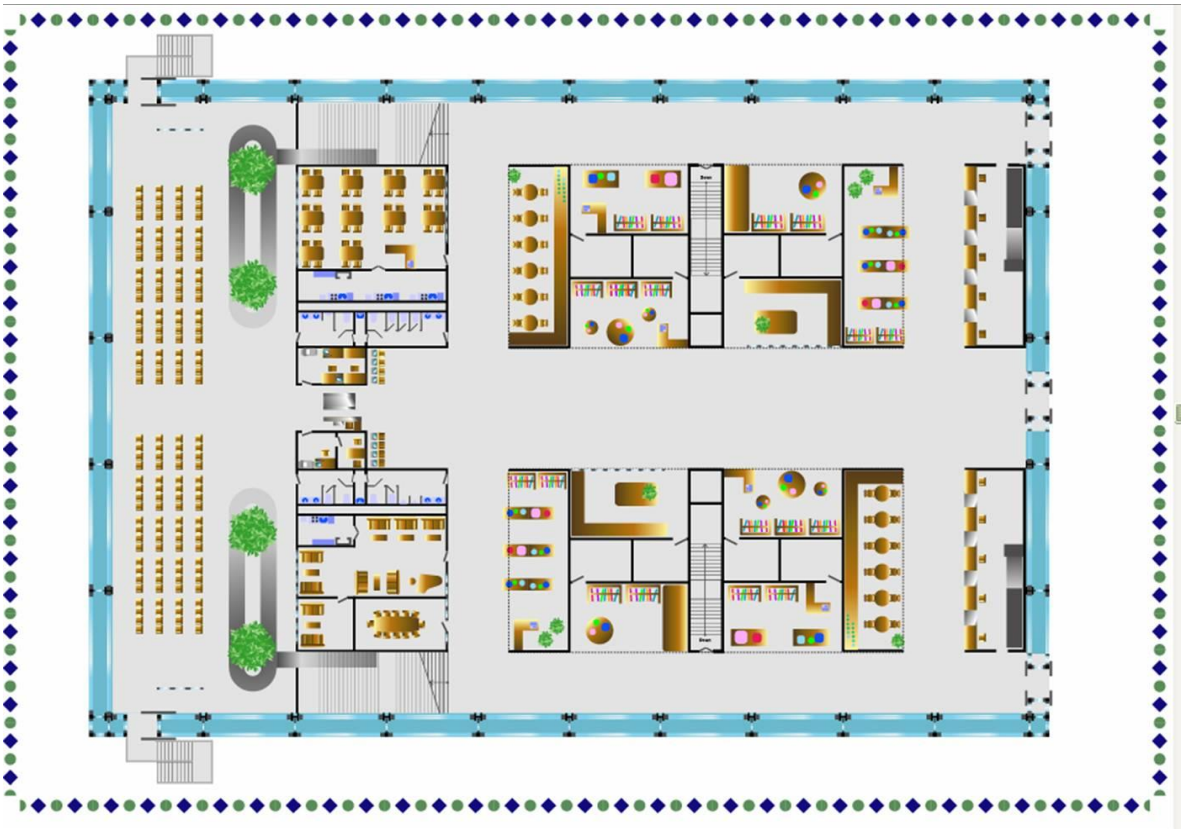
IPRO-335 Fall '04
The Interprofessional Approach to Architectural Engineering Capstone Design

Website: http://omega.cs.iit.edu/~ipro335
December 3, 2004

Table of Contents



Introduction:

Airplanes are without doubt one of the greatest inventions of the 20th century. Air travel has become an integral part of our lives enabling us to travel great distances in less time. With the increase in air travel, airports inevitably evolved over time.

This fall, the IPRO-335 design project involved a design of a small airport to serve several communities in a suburban area. Rather than designing a conventional airport, our team decided to take a project in a unique direction with a concept design of "Airport of the Future."

Background:

IPRO-335: Interprofessional Approach to Architectural Engineering Capstone Design involves a complete design of a building considering all architectural engineering aspects. The project requirements include material selection, structural analysis, design of heating and cooling systems, design of electrical systems, and preparation of drawings.

Objectives:

IPRO-335's objective this semester was to design a small airport serving several communities. This project involved a complete design including:

- Overall layout of the airport
- Structural analysis and material selection for the terminal
- Design of a heating, ventilation, and air conditioning system (HVAC)
- Design of an electrical and lighting system
- Addressing acoustic issues
- Preparation of detailed drawings for the terminal (Structural, HVAC, and Lighting)

Our design concept is "Airport of the Future." This airport will eventually serve as a commercial and business center for the community.

Team Organization/Tasks:

The IPRO-335 team was composed of six students, each with a different area of expertise. Each member focused on a specific component/design of the airport based on their area of expertise.

- Raquib Pramanik – Senior Aerospace Engineering
  Tasks: Team leader, overall planning and management
- John Doles – Senior Civil Engineering
  Tasks: Structural Analysis and Foundation Design
- Mihdi Vahedi – Senior Electrical and Computer Engineering
  Tasks: Lighting, Electrical and Acoustics Design and Webmaster
- Hana Ishikawa – Senior Architecture Major
  Tasks: Architectural design and layout
- Janet Martinez – Senior Architectural Engineering
  Tasks: HVAC Design (Plumbing) and Sprinkler Systems
- Dan Rehberg – Senior Architectural Engineering
  Tasks: HVAC Design (Heating and Cooling Systems), Façade Design

Methodology:

The following lists are the methods that each team used to accomplish their tasks and to overcome any obstacles and barriers.

Architectural Design:

- Came up with concept design
- Designed interior and various components within the terminal
- Developed detailed drawings

Structural Analysis:

- Begin with overall building conceptual design from architectural sketches and team collaboration.
- Determined design loads for local site conditions including:
  - Wind Load
  - Snow Load
  - Earthquake (Seismic) Load
  - Soil Characteristics
  - Frost Penetration Depth

- Determined design loads based on building type and occupancy including:
  - Dead (Unchanging) Load
  - Live (Variable) Load
- Applied loads to building according to specified load combinations:
  - 1.4 D
  - 1.2 D + 1.6 L + .5 S
  - 1.2 D + 1.6 S + L
  - 1.2 D + 1.6 S + .8 W
  - 1.2 D + 1.6 W + L + .5 S
  - 1.2 D + E + L + .2 S
  - .9 D + 1.6 W + 1.6 H
  - .9 D + E + 1.6 H
  - And others if they may control
- Research engineering materials and their suitability for design:
  - Steel
  - Concrete
  - Timber
  - Masonry
  - Aluminum
  - Synthetics / Composites
- Design and proportion overall structural framework, individual members, and their connections to fail in a predictable, "safe" manner:
  - Consider all failure modes (Limit-States)
  - Favor failure modes which allow members to slowly show distress (ductile yielding) over sudden failure / collapse (brittle fracture)

- Design for serviceability conditions not explicitly accounted for in strength design including:
    - Deflection
    - Acceleration
    - Vibration
    - Cracking
- Revise design as required to achieve required:
    - Strength
    - Serviceability
    - Economy
    - Coordination with other design disciplines
- Prepare final reports, calculations, specifications, and drawings

Runway Design:

- Wind Data Analysis
    - Wind data collection and relevance
    - Runway Direction
    - FAA website data

Electrical and Lighting Design:

- Load Calculations
    - Identifying all Equipment to be used in Building
    - Researching wattage for each item in building
    - Approximating usage time and quantity of equipment
    - Calculating Total AC connected Wattage and Avg. Watt Hrs./ Day
    - Adjusting Load Correction Factor
    - Repeating process after consulting with professors
- Lighting Design Layout
    - Researching options (solar lighting)
    - Learning basics of AutoCAD (from team members and tutorials)
    - Designing Appropriate Layout
- Rendering Sample Calculation
    - Learning AGI 32 (from team members and tutorials)
    - Rendering a sample room with lighting and furniture

HVAC (Plumbing, Cooling & Heating, Sprinkler systems):

- Lectures by Professor Megri and Professor Muehleisen
- Collaboration with Electrical & Lighting team to determine loads
- Determine components necessary for calculations
- Calculate dimensions of various components of the HVAC systems (pipe diameter, length, slope, etc.) and analyzing using various HVAC computer softwares
- Researched materials and cooling units using the internet
- Prepare final reports, calculations, specifications, and drawings

Website Design:

- Using Open Source Mambo
- Collecting relevant information and working with team leader

Results:

Architectural:

The floor plans were created for the first, second and cafe floors of the terminal. Also included were the rendering calculations for the above layouts.

Heating Ventilation and Air Conditioning (HVAC):

Cooling Load

3,808,856 Btu/hr

317 tons

Chiller

Three units selected from www.carrier.com

ASHRAE 90.1

Building exceeds code by 1%

Plumbing Analysis:

Total drainage fixture units for the building: **236 dfu**

Diameter of the pipe connected to the city main**: 5 inches**

Slope of the piping: **1/8 inches per foot**

Discharge velocity is from: **1.93 - 2.23 ft/s**

Electrical and Lighting Analysis:

Lighting calculations were carried out in AGI32 where the results were rendered into images. After adjusting Load Correction Factor for losses in the system, following are the approximate final calculations.

Total AC connected Wattage (maximum): **350 kW**

Average Watt Hours per Day: **6000 kW Hrs. / Day**

Approximate cost @ $0.08/kW Hrs. **$14,400.00 per month**

Barriers/Obstacles:

Due to the small team size, a numerical analysis of the acoustics, cost estimates, and designs of other airport structures (such as the control tower and runway lighting) were not performed.

Conclusion/Next Steps:

With the preliminary design and layout completed, the next step is to perform the tasks which were not performed and/or completed. Since our design concept entails a possible expansion, a design of the expanded airport should be considered. Some of the specifics entail:

- Details and further Rendering Options
- Runway lighting
- Implement Message Board on Website
- Get more specific equipment data
- Cost estimation

References/Resources:

Website: www.iit.edu	Hosting Institution
Website: http://ipro.iit.edu	The IIT Inter-Professional Projects Program
Website: www.faa.gov	Regulations, Codes, and Airport Layouts
Website: www.windustry.com	Wind Data Analysis
Website: www.agi32.com	Lighting Rendering Software
Website: www.gettyimages.com	Images Resource Database
Website: www.sl20.com	Security and Protective Equipment
Website: www.pilkington.com	Windows and Panes
Website: www.ashrae.com	Energy Codes and Information Database
Website: www.ada.gov	Disability Access Codes
Website: www.iccsafe.org	Building Codes Database
Website: www.otis.com	Elevators and Escalators

Acknowledgements:

The IPRO-335 team would like to thank Professor Jamshid Mohammadi (Advisor), Professor Ali Emadi (Load Calculation), Professor Ganesh Raman (Acoustics), Professor Joseph Pinnello (Load Calculation), Professor Ahmed Megri (Component Design), & Professor Ralph Muehleisen (Acoustics) for their assistance.