Jonathan Revtai - Senior Thesis Presentation

BAKERY SQUARE BUILDING 1

6425 Penn Avenue
Pittsburgh, PA

Option: Construction Management
Advisor: Dr. Riley

POINTS OF DISCUSSION

- Introduction
- General Project Overview
- Green Gym Analysis
  - M.A.E Research

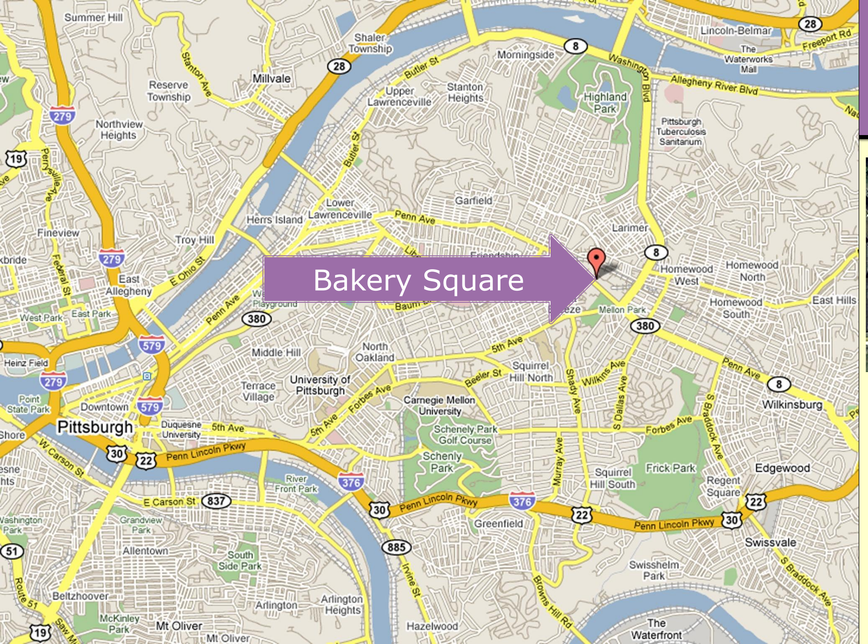
PROJECT OVERVIEW

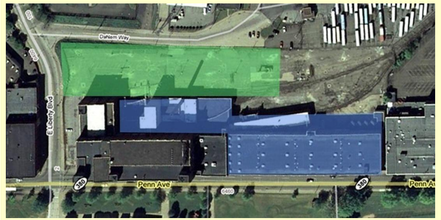
- Bakery Square
  - 5 Buildings Onsite
- Building 1
  - $24 Million GMP
  - 378,000 sq. ft.
  - Multi-use Facility

PROJECT OVERVIEW

- Retail – 42,000 sq. ft.
  - 1st Floor
- Fitness Center - 59,500 sq. ft.
  - 2nd – 3rd Floor
- Parking Garage – 276,500 sq. ft.
  - 1st – 6th Floor
  - 850 Spaces

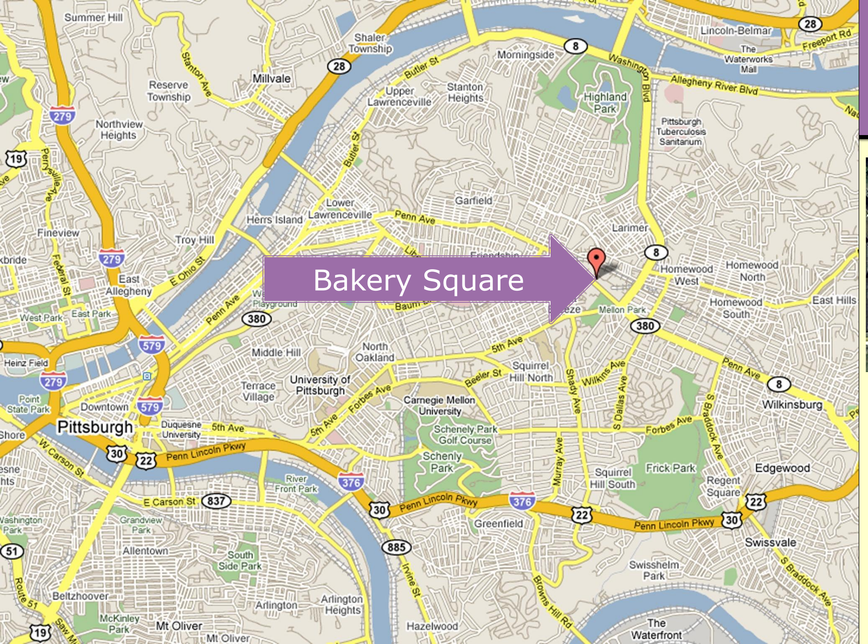
LOCATION



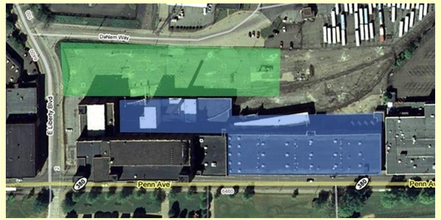


- Located in East Liberty
- Corner of Penn Ave. & East Liberty Blvd.

- Building 1 Footprint Designated by Green

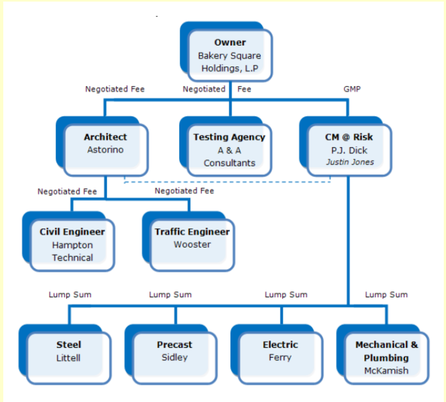


EXISTING CONDITIONS



- Building 1 Footprint Designated by Green
- Blue Areas Required Demolition

PROJECT ORGANIZATION




FITNESS
Bakery Square
FITNESS

GREEN GYM ANALYSIS

GREEN GYM ANALYSIS

- Research Goal
  - Incorporate “green” technology and materials to create a more sustainable fitness center
- Sustainable Design
  - Electric Generating Bicycle
  - Piezoelectric Floor Tiles
  - Bamboo Flooring

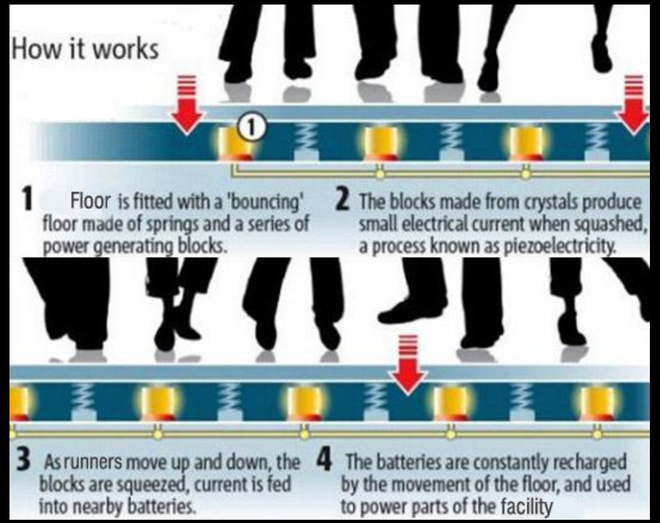
- Gym’s Energy Needs
  - Lighting system mainly fluorescent lights with some incandescent bulbs
  - Calculations based on ASHRAE 90.1
  - Fitness Center uses 42,000 watts

GREEN GYM ANALYSIS

GREEN GYM ANALYSIS GREEN GYM ANALYSIS

- Bicycle Generator
  - Transforms mechanical energy to electrical energy
  - Energy produced by average bicyclist:
    - 150 watts for extended periods
    - 275 watts peak

Description	Cost per Unit	Units	Cost
Equipment	$500	25	$12,500
Inverter	$500	1	$500
Installation	$3,000	1	$3,000
Total			$16,000



GREEN GYM ANALYSIS

GREEN GYM ANALYSIS

- Piezoelectric Floor Tiles
  - Used in Taiwan subway station and London dance club
  - Calculations based on:
    - 132 pound walker
    - 140 steps per minute
  - Walking induced vibrations transformed into electrical energy

- $100 per square foot
- 3,000 square feet of track
- Reduces energy load by 14%

GREEN GYM ANALYSIS

- Bamboo Flooring
  - Use more sustainable materials
  - Bamboo has a shorter harvest cycle than standard maple floors

Evaluated Characteristics of DIN 18032 Part II (1991)	Test Results (Avg. Values)	DIN 18032 Part II (1991) Requirements
Ball Rebound	93%	90% Minimum
Force Reduction	54.2%	53% Minimum
Vertical Deflection	2.80mm	2.30mm Minimum
Area Indentation	15%	15% Maximum

GREEN GYM ANALYSIS

- Plyboo Sport
  - 6,000 square feet of area
  - $7.75 per square foot for material and installation costs
  - Compared to maple floor

System	Cost/ SF	Area	Total Cost
Maple Concord II	$10.50	6,000	$63,000
Plyboo Sport	$7.75	6,000	$46,500

GREEN GYM ANALYSIS

Description	Daily Power (WH)	Yearly Cost	% of Load
Bike Room	5,736	$209	-
Fitness Center	504,000	$18,396	-
Bicycles – 50%	20,280	$740	4.0%
Bicycles – 75%	30,360	$1,108	6.0%
Bicycles – 100%	40,500	$1,478	8.0%
Piezoelectric	69,300	$2,529	13.8%

GREEN GYM ANALYSIS

System	Cost/ SF	Area	Total Cost
Maple Concord II	$10.50	6,000	$63,000
Plyboo Sport	$7.75	6,000	$46,500

- Based on $0.10 per KW-Hr
- Energy prices will double soon
- Efficiencies and material costs should improve

M.A.E. RESEARCH
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- Background
  - Expanded research on sustainable design
  - Focused on Parking Garage
  - Adoption of a LED Bi-level lighting system in place of fluorescent lights

- System Information
  - Replace fluorescent lights with LED which are more efficient and last longer
  - Motion sensing equipment used to lower and raise lighting levels depending on use

M.A.E. RESEARCH
M.A.E. RESEARCH

- UC Davis Case Study

Design	Outcome
Light Quality	CRI 22 to CRI 80
LED Energy Savings	40% less energy
Bi-Level Energy Savings	30% less energy
Maintenance Savings	6 times longer lifespan

- Bakery Square Application
  - Fluorescent lights
  - Lighting Load = 81,000 watts
  - Assumed lights are on 12 hours per day year round

- LED Bi-level System Savings

Description	Daily Power (WH)	Daily Cost	Yearly Cost	% of Load
Parking Garage	977,000	$97.70	$35,672	-
Bi-Level LED	586,400	$58.64	$21,403	60%

MEZZANINE ANALYSIS

- Existing Structure
  - Structural Steel with Composite Decking
- Lightweight Alternatives
  - Wire Rope
  - Precast Concrete
  - Steel Joist

MEZZANINE ANALYSIS

- Goals
  - Reduce costs
  - Reduce schedule
  - Maintain mezzanine layout and aesthetic appeal

MEZZANINE ANALYSIS

- Wire Rope
  - Open space design
  - Requires many precast concrete embeds
  - Concerns of floor vibrations, especially around the track

MEZZANINE ANALYSIS

- Precast Concrete
  - Easily attached with superstructure
  - Cheap alternative
  - Alters floor plan and aesthetic look
  - Requires more crane time

MEZZANINE ANALYSIS

- Steel Joist System
  - Eliminates need for precast crane
  - Easily attached to superstructure
  - Retains open floor plan

MEZZANINE ANALYSIS

- Assumptions
  - Live load = 100 psf
  - Dead load = 57 psf + joists
  - Typical bay size = 34’ x 62’
  - Dead Space in floor plan may be eliminated

MEZZANINE ANALYSIS

- Steel Joist Members
  - Joist – 44LH17
    - 62’ span
    - 83.2 kip load
  - Girder – 36G6N83.2
    - 34’ span
    - 505 kip load

MEZZANINE ANALYSIS

Member	Count	Weight (Ton)	Unit Cost	Total Cost
Joists	60	73.2	$2,898	$212,100
Girders	12	25.5	$2,249	$57,300
Total	72	98.7	-	$269,400

- Cost Comparison
  - Structural Steel - $341,500
  - Steel Joist - $269,400

MEZZANINE ANALYSIS

- Schedule Comparison
  - Reduces precast crane time by 4 days
  - Allows construction of mezzanine to start earlier

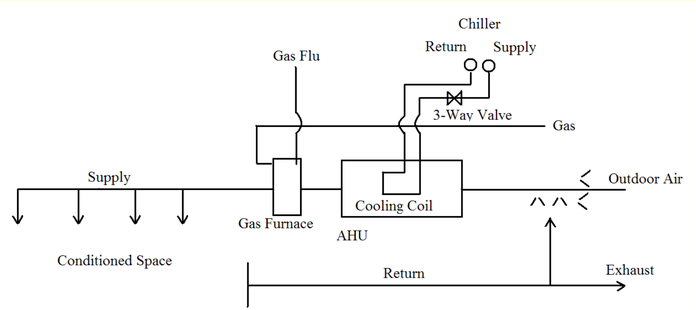
MEZZANINE ANALYSIS

- Summary
  - Reduce mezzanine structure costs by 21%
  - Reduce schedule by 4 days
  - Maintain aesthetic appeal from original design

MECHANICAL ANALYSIS

MECHANICAL ANALYSIS

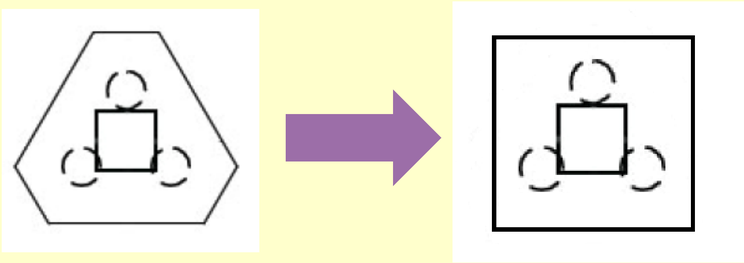
- Mechanical Breadth
  - Relocate mechanical system to open southern façade in fitness center
  - Required redesign of mechanical system
  - Resulted in a higher upfront cost, but reduced operational costs and created better aesthetics



PILE CAP ANALYSIS

PILE CAP ANALYSIS

- Research Background
  - Triangular pile caps had a significantly lower production rate
  - Redesign of the pile cap should reduce costs and schedule length
  - Used as a structural breadth



PILE CAP ANALYSIS

- Load Requirements

Description	Load (PSF)
Floor Live Load	100
Garage Live Load	40
Stairs & Lobby Live Load	100
Roof Live Load	30
Snow Load	25

PILE CAP ANALYSIS

- Assumptions & Calculations
  - Live Load = 106 kips
  - Dead Load = 412 kips
  - Pile diameter = 18”
  - f’c = 3,000 psi
  - Column Dimension = 30” x 42”

PILE CAP ANALYSIS

- Pile Cap Design
  - 6’-6” x 6’-6”
  - 42” deep
  - #11 bars spaced 12” o.c.

PILE CAP ANALYSIS

- Pile Cap Comparison

Description	Triangular	Square
Formwork	$744	$564
Concrete Material	$769	$608
Concrete Placing	$80	$63
Rebar	$318	$393
Total	$1,911	$1,628

PILE CAP ANALYSIS

- Schedule Comparison
  - Productivity of Formwork
    - Triangular – 140 sq. ft. / day
    - Square – 176 sq. ft. / day
  - Multiplied by 31 type PC3 pile caps
  - Reduces schedule by 5 days

PILE CAP ANALYSIS

- Redesign Results

Comparison	Results
Cost Savings Per Pile Cap	$283
Total Cost Savings	$8,773
Schedule Reduction	5 Days

SUMMARY

- Green Gym Analysis
  - Increased costs
  - Reduction in operational costs
  - Successfully incorporates “green” technologies and materials

SUMMARY

- Lightweight Mezzanine Analysis
  - Reduces construction costs by 21%
  - Reduces schedule by 4 days
  - Maintains open floor plan and aesthetic appeal from original design

SUMMARY

- Pile Cap Analysis
  - Reduces costs by $8,773
  - Reduces schedule by 5 days

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QUESTIONS

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