Arch 441 Fall 2008

COLLEGE OF ENGINEERING SIGNATURE BUILDING

GROUP 1 ARCHITECTS

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ARCH 441 – GROUP 1

PROPOSED COLLEGE OF ENGINEERING SIGNATURE BUILDING

LEADING THE WAY TOWARD SUSTAINABLE ARCHITECTURE

EXERCISE #1

THE BRIEF

•A new building is to be built to house the AE Department, the Offices of the Dean of the College of Engineering and The Learning Factory.

•The building will be built in the West Campus and will be known as the College of Engineering Signature Building.

•Sustainability must be at the core of the design.

•The building must be a highly efficient and sustainable building and provide opportunities for research into sustainable design and construction.

UNIVERSITY PARK MASTER PLAN

"…to achieve a model physical environment that exemplifies the University's vision of excellence and enhances Penn State as a distinguished learning community."

Key Principals for Architectural Systems

1A:	***Academic Values***	• High quality learning environment
1B:	Rural Heritage	
1C:	***Accessible Campus***	• Campus edges that are clearly defined but open to the community
2A:	High Quality Environment	
2B:	Student-Oriented Campus Core	
3A:	***Unique Physical Setting***	•Views to surrounding features •"…Campus on the Hill…" •"…Campus in the Fields…"
3B:	***Campus Image***	• Unique character and quality • lawns and tree-lined paths •North-South orientation of Mall structure openings up to the community • Linear circulation routes •Well established grid pattern
3C:	Historic Facilities	
4A:	Campus and Town Relationships	
4B:	***Environmental Stewardship***	• Aquatic and wetland habitats? • Unique local topography
5A:	***Individual Units and Campus***	• Strong community connections between individual buildings • Sensitivity to environmental context • Appropriate integration and balance of buildings and open spaces

THE SITE

The proposed site is in West Campus and is currently used as a car park serving the IST Building

THE SITE

SURROUNDINGS

- On one side the site borders the IST Building.

THE SITE

SURROUNDINGS

- To the other side there is a road, followed by sports fields and then a golf course which borders private land at the edge of campus.

THE SITE

SURROUNDINGS

- At the north east end of the site is the main road N.Atherton St. with the Rec. Hall gym overlooking.

THE SITE

SURROUNDINGS

- Finally there is the south-west end which is currently a car park but is to be the site of a second School of Engineering building.

THE SITE

VIEWS

- The most important views into the site are those from the IST building bridge and from N.Atherton as these will be the main access points for people using the building.

THE SITE

VIEWS

- Also the view of the people working in the offices of IST must be taken into consideration.

THE SITE

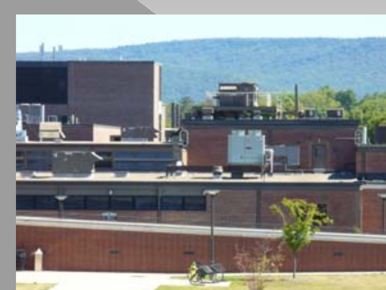
VIEWS

- The views from the site are obviously most appealing towards the north side where there are the green areas.

THE SITE

VIEWS

- Least appealing are the views past the IST building to the south of the Research Building West.



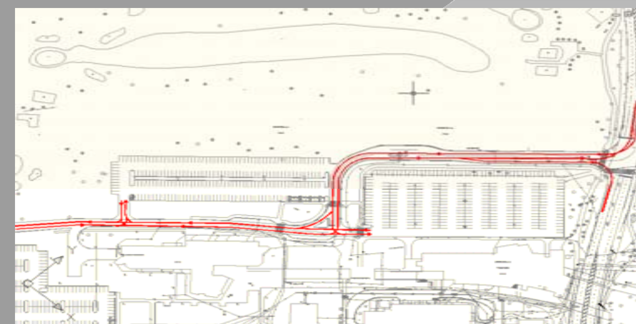
THE SITE

CIRCULATION

- Currently the site is accessible from all directions and from main campus via the IST Building bridge or across N.Atherton.
- Course Drive borders the site on the north edge and currently cuts through the site. This road will be straightened out so it does not enter the site.

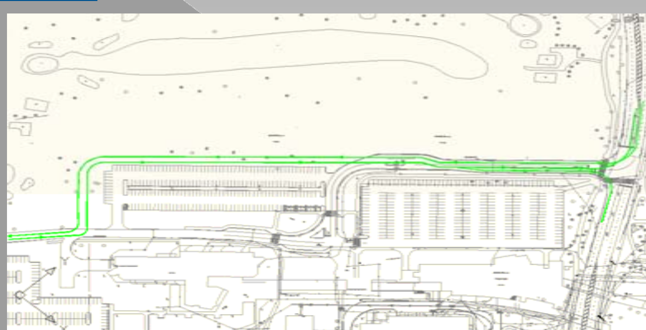
VEHICULAR ACCESS

CURRENT



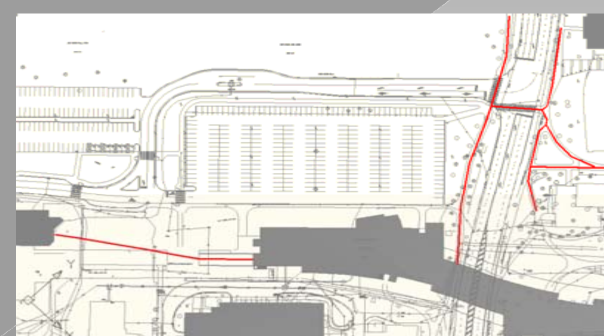
VEHICULAR ACCESS

PROPOSED



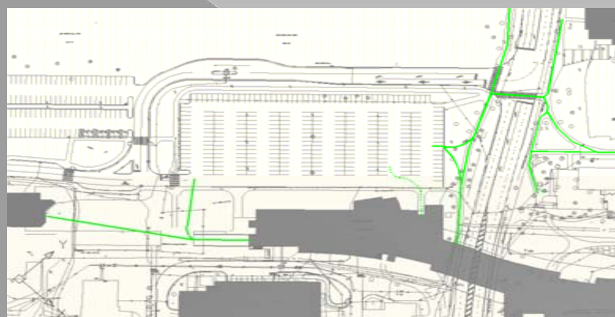
PEDESTRIAN ACCESS

CURRENT



PEDESTRIAN ACCESS

PROPOSED



THE LEARNING FACTORY

•The Learning Factory is a hands-on laboratory and is used for 18 courses spanning six engineering departments.

•The Learning Factory provides modern design, prototyping, and manufacturing facilities. Training classes are offered in shop safety, machining and welding.

•Any engineering student can use the Learning Factory on a walk-in basis for a course-related activity, and instructors can schedule all or part of the facilities for an organized class activity.

• More than 2,500 students use the Learning Factory in a typical year.

THE LEARNING FACTORY

RESOURCES

- Machining
- Welding
- Rapid Prototyping
- Assembly/Test
- Sheet Metal Forming
- Stock Cutoff and Grinding
- Computer Area

THE LEARNING FACTORY

CONSIDERATIONS

- Used by lots of different departments and outside visitors so needs to be easily accessed, preferably with a separate access to the AE department.
- Will create lots of noise so needs to be situated far enough away from the Dean's Offices and classrooms.
- Will need lots of services but these can be on show.
- Needs to be a flexible space to accommodate different projects.

ARCHITECT INSPIRATION

ROBERT A. M. STERN

Darden School of Business

- New faculty building off campus. Echoes original buildings to enhance unity. Provides separate social spaces.

Darden School of Business, University of Virginia, 1996, Robert Stern - http://www.ramsa.com/project.aspx?id=42

ARCHITECT INSPIRATION

ANTOINE PREDOCK

School of Architecture and Planning – University of New Mexico

- Wanted to make a building that inspired and taught students about the potential of architecture. This was achieved by revealing infrastructure and environmental systems such as the cooling tower/solar engine loop.

School of Architecture and Planning, University of New Mexico, 1999/2007, Antoine Predock - http://www.predock.com/NewUNM/Untitled-7.html

ARCHITECT INSPIRATION

ANTOINE PREDOCK

Center for Nanoscale Science and Technology - Rice University, Texas

- Section cuts through the building provide views to visitors and undergraduates so they can see highly sophisticated equipment in use

Centre for Nanoscale Science and Technology, Rice University, Antoine Predock - http://people.seas.harvard.edu/~jones/lab_arch/lab_arch.html

ARCHITECT INSPIRATION

ALFRED WAUGH

Nicola Valley Institute of Technology

- Exceeds ASHRAE standards for energy efficiency by 35% by using strategies including thermal mass, an efficient envelope, natural ventilation and solar control.

Nicola Valley Institute of Technology, British Columbia, 2002, Alfred Waugh - http://www.canadianarchitect.com/Issues/ISarticle.asp?id=150115&story_id=12230105953&issue=05012004&PC=

WHAT IS A LIVING LABORATORY?

- Establish an interface in which the building occupant can interact with the building
- Create sustainable systems that are tangible but not intrusive to occupant
- Allow occupant to be educated about sustainability through interaction with the space

Centre Georges Pompidou by Renzo Piano, 1977, Paris, France

Centre Georges Pompidou by Renzo Piano, 1977, Paris, France

LIVING LABORATORY

SYSTEMS

- Use Wind Power
- Collect Solar Energy
- External Structure

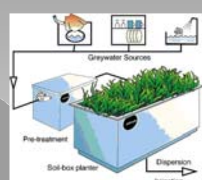
http://www.smh.com.au/ffximage/2007/03/21/macquarie22307_wideweb__470x389,0.jpg

http://myninjaplease.com/wp-content/uploads/2006/11/wind_turbine.jpg

LIVING LABORATORY

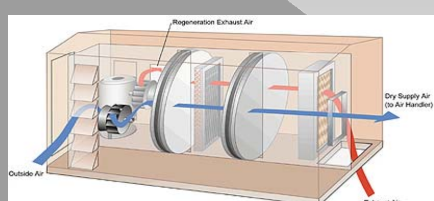
SYSTEMS

- Recycle Water
- Collect Rain Water
- Recycle Heat
- Intelligent Lighting



http://www.savemobile.org/images/graywater-example.jpg

http://www.futurlec.com/Pictures/Photocell.jpg

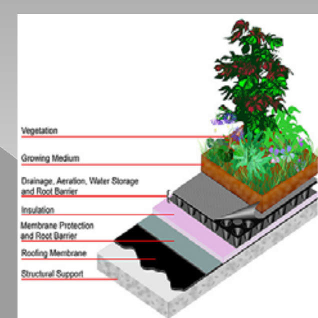


http://cipco.apogee.net/ces/library/graphic/energy.jpg

LIVING LABORATORY

GREEN ROOF

- Counteract Heat Islands
- Excellent Thermal Insulator
- Natural Filter for Gray Water
- Aesthetically Pleasing
- Erosion and Flood Control
- Healthier Air

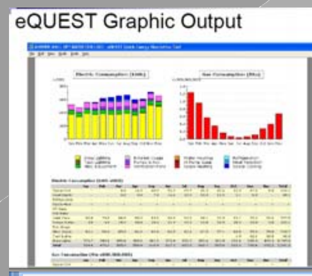


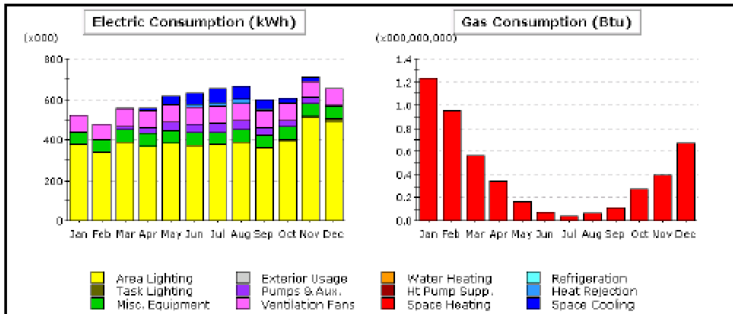
http://sitemaker.umich.edu/section9group1/files/greenroof1.jpg

http://envirostyle.files.wordpress.com/2008/05/virgo-rendering.jpg

ENERGY ANALYSIS

- •Why model?
- •Whole building design
- •LEED EA Credit I
- •Code compliance analysis
- •Utility Incentives
- •Predict operating costs
- •Federal Tax Credits





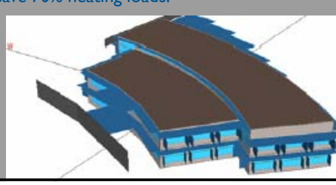
Electric Consumption (kWh x000)

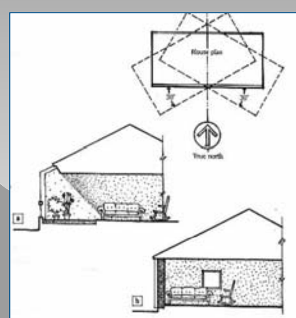
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	4.8	16.5	40.3	52.3	65.9	66.3	42.6	22.3	17.2	0.0	332.1
Heat Reject.	-	-	0.0	0.8	7.8	16.6	20.2	19.9	12.2	2.1	0.3	-	80.1
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	82.0	74.8	84.8	80.3	83.1	82.0	82.0	84.1	79.9	83.1	79.2	82.6	977.8
Pumps & Aux.	3.8	3.4	15.7	30.8	39.3	41.9	42.7	42.5	29.9	25.2	22.0	3.8	232.1
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	62.1	56.4	65.3	62.0	64.8	62.5	62.1	67.5	57.1	64.8	59.3	59.9	743.7
Task Lights	-	-	-	-	-	-	-	-	-	1.3	12.1	12.5	26.0
Area Lights	376.7	342.1	385.4	368.0	381.0	372.4	376.7	385.4	363.8	396.4	508.3	493.3	4,749.5
Total	524.6	476.7	553.9	558.4	616.4	627.7	653.6	666.7	595.4	605.2	708.4	652.2	7,241.2

ENERGY ANALYSIS

- Physical models
- Daylighting/lighting computer simulation
- Computational fluid dynamics(CFD)
- Simple airflow modeling
- Building Geometry
  - Size of surfaces & volumes enclosed
  - What surfaces shade others?

• Orientation- Rotate building 30 degrees East can save 70% heating loads.

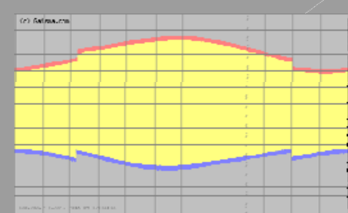


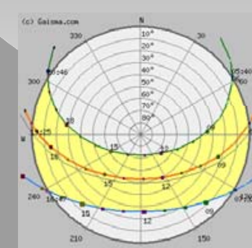


SOLAR ANALYSIS

CHARTS AND DIAGRAMS

- The way the sun crosses the sky can be represented in several ways.
- This is important for orientation, shadow sweeps and photovoltaic locations.

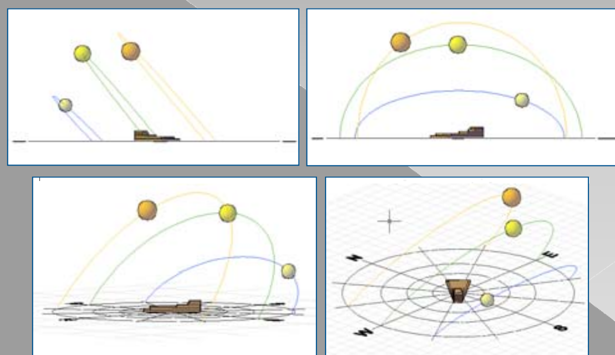




SOLAR ANALYSIS

3D SUN PATH DIAGRAMS

Notice how the winter sun will shine under an overhang, while the summer sun will be blocked



SOLAR ANALYSIS

PHOTOVOLTAICS

- Photovoltaic
  - Building Integrated Photovoltaic
- Tracking Panels
- Use fuel cells to store energy to use during dark periods

Skyscraper Gets Covered In 7000 Solar Panel
CIS Building in Manchester, England (http://www.metaefficient.com)

DC rated at 2340 watts. Single axis trackers with polycrystaline PV cells. (http://en.wikipedia.org/wiki/Solar_tracking)

CENTER FOR SUSTAINABILITY

Technical Data

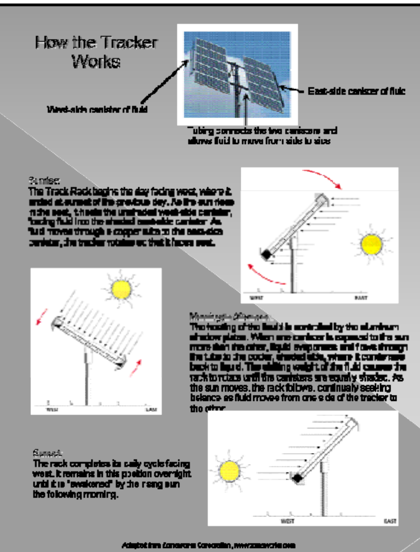
Solar Array 10 Sharp NT-175U1 175 Watt, single-crystalline modules

Inverter: Xantrex GT2.5 Grid-Tied Solar Inverter, 2,500 Watt output capacity

Tracker: Zomeworks UTRF-168 Track Rack

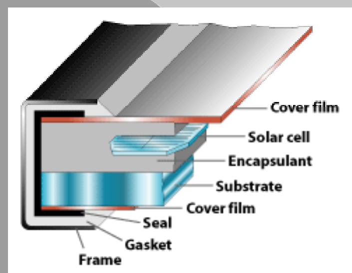
Performance

8.8 kwh/day, 3,200 kwh/year

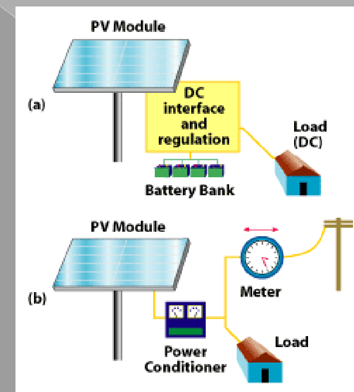


Flat-Plate PV Systems

- These panels can either be fixed in place or allowed to track the movement of the sun.



Balance of System



SOLAR ANALYSIS

SOLAR SHADING

- Exterior or Interior
- Permanent or Motorized?
- Placed on southern and western sides of the building.
- Light shelves – good for summer
- Triple Glazed windows
- PV used to shade windows
- The building is virtually surrounded by "green screen" walls – large
- Trellis structures that support planting – providing natural shade
- Cooling in the summer – and light penetration/heat in the winter.

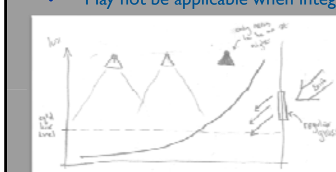
www.avonsolarcontrol.co.uk

www.greenroofs.com

SOLAR ANALYSIS

PSALI SYSTEMS

- Permanent Supplementary Artificial Lighting Interiors.
- Can reduce the amount of energy used by a room during daylight hours.
- Could be improved with the use of different surfaces.
- May not be applicable when integrated with solar shading.



HEATING AND COOLING

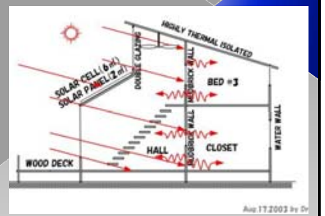
DIRECT HEAT GAIN (WINTER)

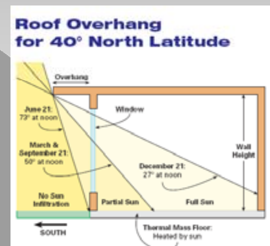
- South facing windows
- Proportion windows to suit thermal mass and size of room(s)
- Convective Air Loop
- Under-floor Rock Beds
  - Trap excess heat during day time.
  - Warm air released at night, cool air forced out.

•Geothermal Heating-

- Air source heat pump
- Ground source heat pump
- Pond Loop heat pump
- Column well heat pump

•Ice storage

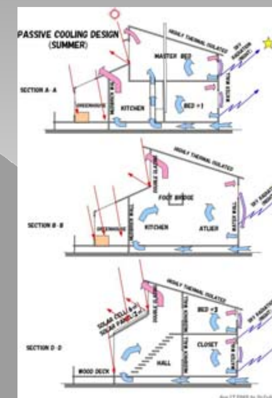




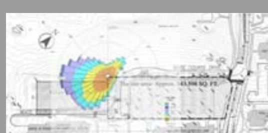
HEATING AND COOLING

PASSIVE COOLING (SUMMER)

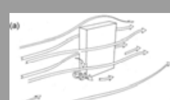
- Ventilation
- Open Space
- Operable windows at low levels with high level clerestory windows to induce stack effect
- Cooler air stored in rock beds at *night.*
- Roof sprays encourage evaporative cooling (used from recycled water).

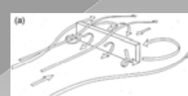


WIND ANALYSIS



Wind Rose of State College
http://climate.met.psu.edu/features/PA_WIND_ROSES/UNVwindrose.php





Wind Flow Diagram
http://www.kuleuven.ac.be/bwf/common/data/JP_2004_JTEBS_Blocken_1.pdf

Wind Flow Diagram
http://www.ansys.com/industries/hvac/images/qfinsoft_lg.jpg

Nano Vent-Skin Syncs Solar, Wind, and CO2 Suckers
http://www.ecogeek.org/content/view/1721/1/

The Helyx (Wind Turbine Helix)
(http://www.metaefficient.com/renewable-power/rooftop-wind-turbines-ready-for-commercial-use.html)

WASTE WATER RECYCLING

- Grey water collection.

•Living Machine - are a form of biological wastewater treatment designed to mimic the cleansing functions of wetlands.

•Black water is treated on site and cycled into the irrigation system

•Solarium/Pond/Water Treatment

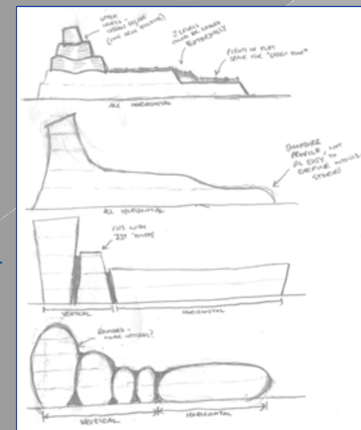
MATERIAL SELECTION

- Natural, recycled, or reclaimed materials.
- Use of fly-ash in concrete.

PRELIMINARY CONCEPTS

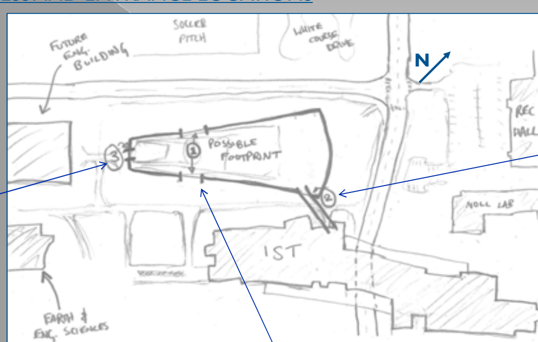
BASIC SHAPE

- "Tower" at south-west end.
- Allowance for views from IST offices.
- Large flatter area for green roof.
- Possible similarities to other surrounding buildings and other buildings on campus.



PRELIMINARY CONCEPTS

ACCESS AND ENTRANCE LOCATIONS



3. Building Link

2. Foot Bridge

1. Lobby Entrances

DESIGN SUMMARY

AIMS

- To create a living laboratory building which uses tangible forms of sustainable design to educate and inspire students.
- To create a building which allows occupants to be immersed in a sustainable environment.
- To allow occupants that are not educated in sustainable technologies to come away with knowledge through their interaction with this space.

ARCH 441 – GROUP 1

PROPOSED COLLEGE OF ENGINEERING SIGNATURE BUILDING

LEADING THE WAY TOWARD SUSTAINABLE ARCHITECTURE

EXERCISE #2

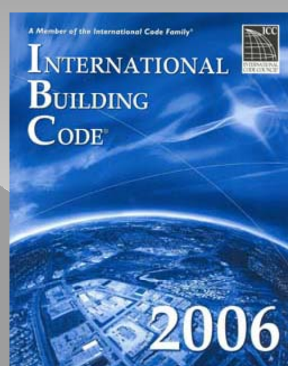
DESIGN SUMMARY

AIMS

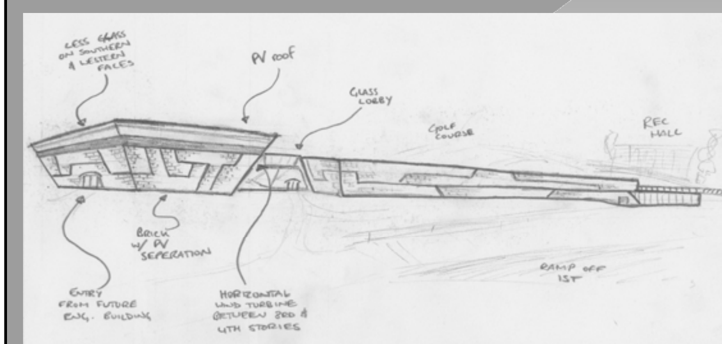
- To create a living laboratory building which uses tangible forms of sustainable design to educate and inspire students.
- To create a building which allows occupants to be immersed in a sustainable environment.
- To allow occupants that are not educated in sustainable technologies to come away with knowledge through their interaction with this space.

IBC CODE CONSIDERATIONS

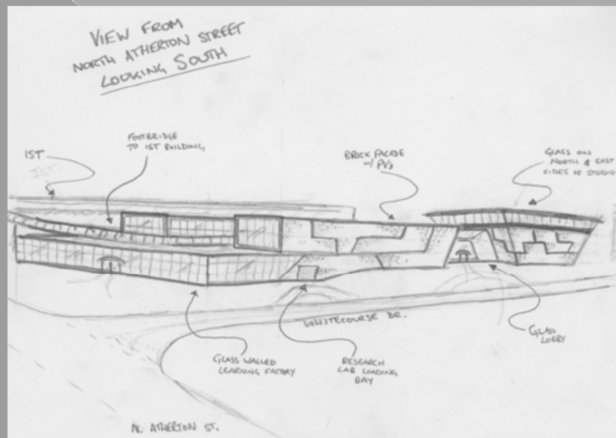
- ✓ Egress Through Hallways
- ✓ Stairwells
- ✓ Area of Refuge
- ✓ Two Ways of Egress
- ✓ Door Swings
- ✓ ADA Accessibility
- ✓ Fire Pull Stations
- ✓ Emergency Lighting
- ✓ Two Hour Fire Rating



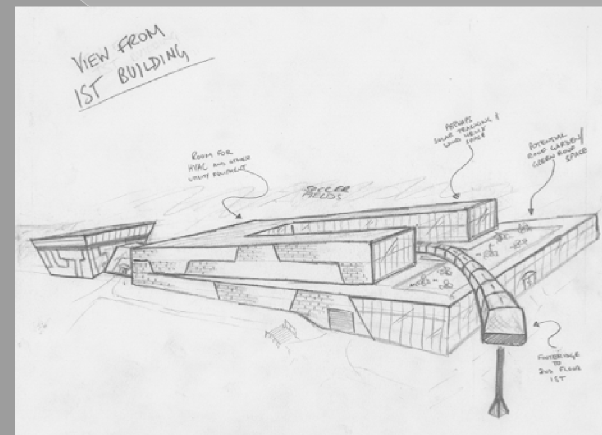
EARLY CONCEPT



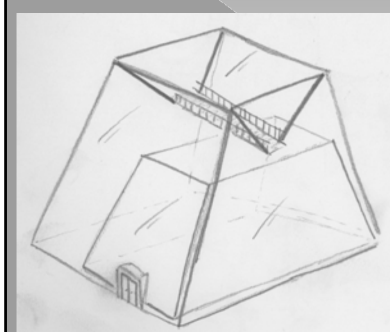
EARLY CONCEPT



EARLY CONCEPT

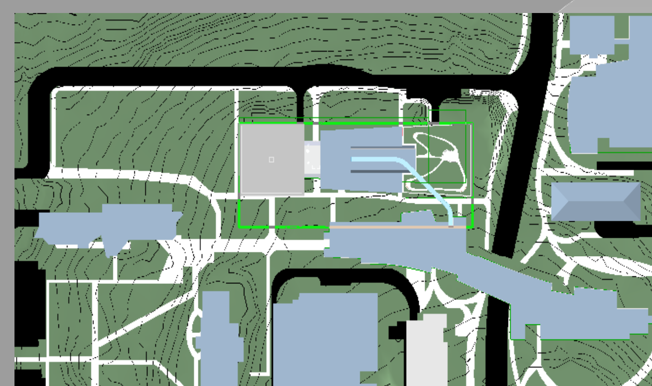


THE LOBBY CONCEPT



- "Box Within A Box"
- Communal Meeting Space
- Living Laboratory Centre Piece
  - Hanging Walkway
  - Structure on Display
- Central Location

SITE PLAN



SITE PLAN

ADJACENCY

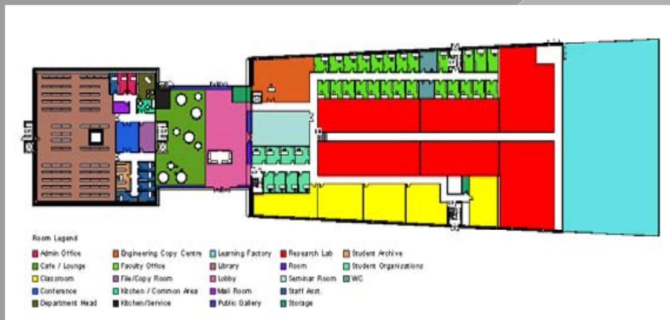
	Adjacencies	Direct Access	Daylight	View	Noise Creation (0-5)	Noise Avoidance (0-5)
A1 Seminar Room					1	4
A2.1 2nd & 4th Year Studio	A2.2		Y	Y	0	5
A2.2 Crit Space	A2.1,A2.3,A2.4		Y		0	5
A2.3 5th Year Studio	A2.2		Y	Y	0	5
A2.4 Graduate Studio/Offices	A2.2		Y	Y	0	5
A3 Research Labs		Y			4	1
A4.1 Design Computing Lab	A2				2	4
A4.2 System Administrator's Office	A4.1				1	4
A4.3 Server Room	A4.1				3	0
A4.4 Technical Workshop/Storage	A4.1				2	1
B1 Faculty Offices			Y	Y	1	5
B2 Faculty Archive	B1				1	2
B3.1 Department Head			Y	Y	1	5
B3.2 Administrative Assistant Offices			Y	Y	1	4
B3.3 Staff Assistant's Office Area			Y	Y	1	4
B3.4 Reception	C1.1	Y	Y		3	3
B3.5 Mail Room/Kitchen/Common Area			Y		3	3
B3.6 File/Copy Rooms					2	2
B3.7 Conference Rooms					2	3

ADJACENCY

	Adjacencies	Direct Access	Daylight	View	Noise Creation (0-5)	Noise Avoidance (0-5)
B3.8 Student Archive					1	1
C1.1 Gathering Space/Lobby		Y	Y		3	2
C1.2 Public Gallery	C1.1		Y		3	2
C1.21 Storage	C1.2				2	0
C2 Café/Lounge/Kitchen/Servi	C1.1	Y	Y		3	3
C3 Engineering Copy Centre	C1.1				3	1
C4 Student Organisations					2	3
DA1 Dean's Office	DB4		Y	Y	1	4
DA2 Assoc. Dean for Undergrad	DB4		Y	Y	1	4
DA3 Assoc. Dean for Research	DB4		Y	Y	1	4
DA4 Assoc. Dean for Admin an	DB4		Y	Y	1	4
DA5 Development and College	DB4		Y	Y	1	4
DB1 Conference Room					2	4
DB2 Storage					1	0
DB3 Lounges			Y		3	3
DB4 Reception/Waiting	A1, A2, A3, A4, A5		Y		3	3
DC Main Engineering Lounge			Y	Y	3	3
Library			Y		0	5
Learning Factory		Y			5	0
Classrooms			Y		3	5

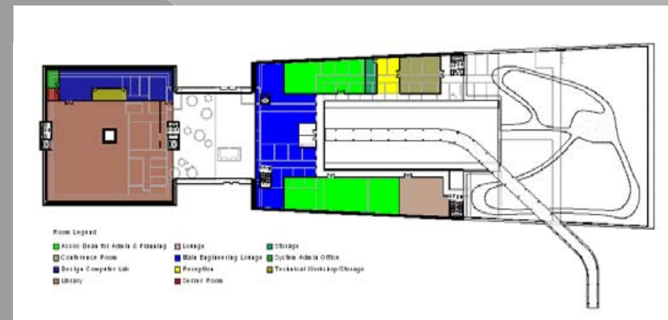
ADJACENCY

FLOOR PLANS



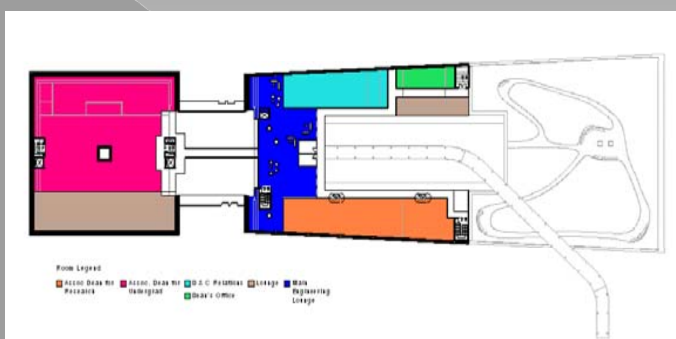
Basement and 1st Floor

FLOOR PLANS



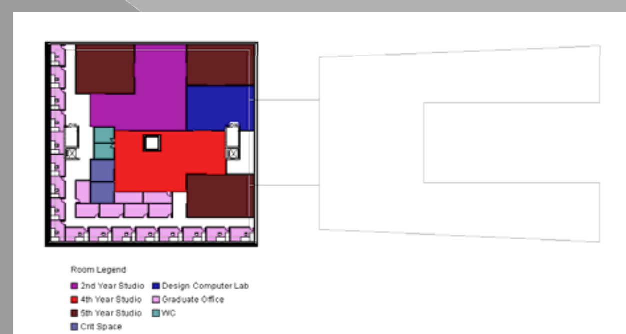
2nd Floor

FLOOR PLANS



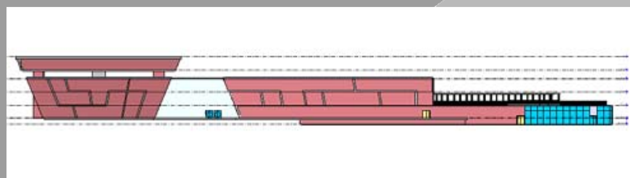
3rd Floor

FLOOR PLANS



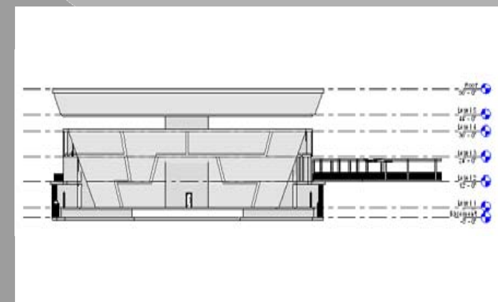
5th Floor

BUILDING ELEVATIONS



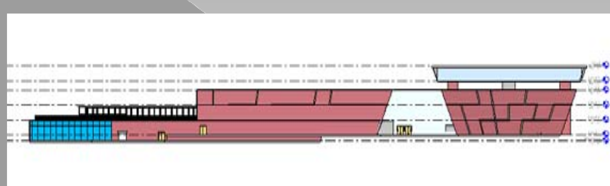
South

BUILDING ELEVATIONS



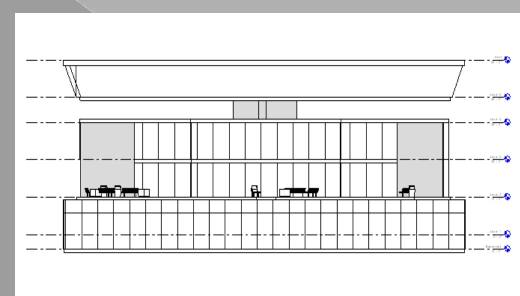
West

BUILDING ELEVATIONS



North

BUILDING ELEVATIONS

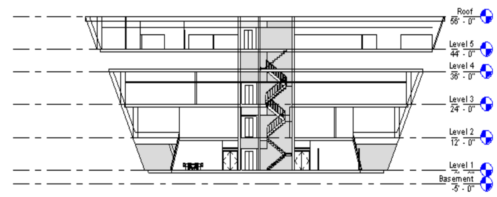


East

BUILDING SECTIONS

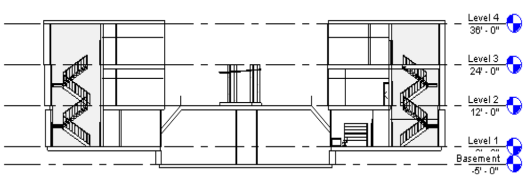
Section Along Length

BUILDING SECTIONS



Section Through Tower

BUILDING SECTIONS



Section Through Wings

SPACE ALLOCATION

	As Programmed	As Designed	Difference
A1 Seminar Room	1200	1294	94
A2.1 2nd & 4th Year Studio	5500	5813	313
A2.2 Crit Space	500	546	46
A2.3 5th Year Studio	4125	4133	8
A2.4 Graduate Studio/Offices	3750	3714	-36
A3 Research Labs	12000	12941	941
A4.1 Design Computing Lab	3000	3640	640
A4.2 System Admin. Office	150	156	6
A4.3 Server Room	100	103	3
A4.4 Workshop/Storage	300	284	-16
B1 Faculty Offices	3500	3674	174
B2 Faculty Archive	200		-200
B3.1 Department Head	300	302	2
B3.2 Admin. Assistant Offices	240	239.8	-0.2
B3.3 Staff Assistants	600	653	53
B3.4 Reception	200	200	0
B3.5	200	196	-4
B3.6 File/Copy Rooms	300	327	27
B3.7 Conference Rooms	400	432	32
B3.8 Student Archive	240	278	38
C1.1 Gathering Space/Lobby	400	2399	1999
C1.2 Public Gallery	450	452	2
C1.21 Storage	200	200	0
C2 Café/Lounge/Kitchen/Service	2610	2868	258
C3 Engineering Copy Centre	1500	1547	47
C4 Student Organisations	1200	1197	-3
DA1 Dean's Office	900	951	51
DA2 Assoc. Dean Ugrad	9200	9529	329
DA3 Assoc. Dean Research	3300	3328	28
DA4 Assoc. Dean Admin	4600	4636	36
DA5 Dev. and College Relations	2000	2360	360
DB1 Conference Room	1000	1024	24
DB2 Storage	250	274	24
DB3 Lounges	8150	5856	-2294
DB4 Reception/Waiting	570	570	0
DC Main Engineering Lounge	5000	8393	3393
Library	14000	14490	490
Learning Factory	10000	11743	1743
Classrooms	5000	4972	-28
Total	**107135**	**115715**	**8580**

SPACE ALLOCATION - GSF

	Required (inc. gross up factor)	Provided	Difference
A1 Seminar Room	1620	1251	-369
A2 Design Studios	18731	18174	-557
A3 Research Labs	16200	16662	462
A4 Computer Lab	4795	4126	-669
B1 Faculty Offices & Archive	5000	5450	450
B3 Adminstrative Office Suite	3348	3345	-3
C1, C2, C3, C4	8586	10200	1614
DA1 Dean's Offices / DB Gen & Shared	39000	39190	190
DC Main Engineering Lounge	6500	8904	2404
Library	16100	15480	-620
Learning Factory	11500	11743	243
Classrooms	5750	6240	490
Total		**140765**	**3635**

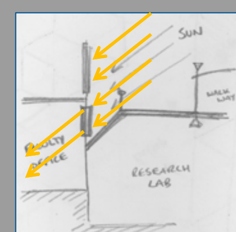
FOOTBRIDGE

- Quick access from the most commonly used route.
- Joins IST building at a quiet/rarely used area.
- Glass roof to keep off rain, otherwise open.
- Leads through/past the green roof.

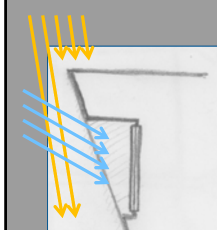
THE GREEN ROOF

- Natural insulation all year round.
- Collect grey water.
- Aesthetically pleasing from the IST offices.
- Multi-purpose space: Studying, Classes, COE functions etc.

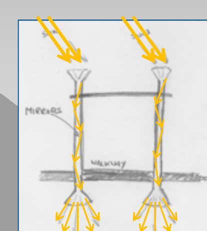
USING DAYLIGHT



Lighting the Faculty Offices



Shading on the Tower



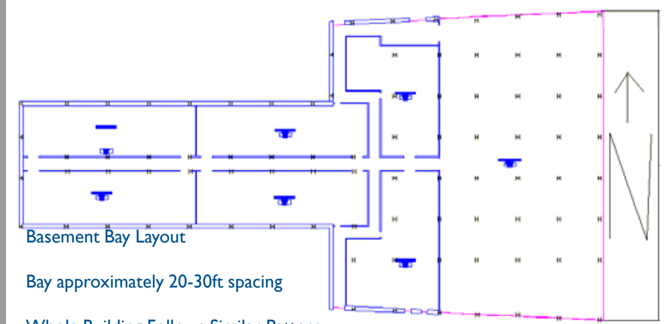
Lighting the Research Labs

SUSTAINABLE WIND & SOLAR ANALYSIS

- Design Will Incorporate Approximately 1,700 Solar Panels
- 4th Floor Incorporates Wind Turbine
- Pay Back time using rates given from Allegheny Power is approximately 40 years
- Max Power Potential: 410,363 kW-H per year
- First Cost: $1,530,000
- Savings Per Year: $36,153

Penn State CFS Photo

STRUCTURAL BAY CONCEPT



Basement Bay Layout

Bay approximately 20-30ft spacing

Whole Building Follows Similar Pattern

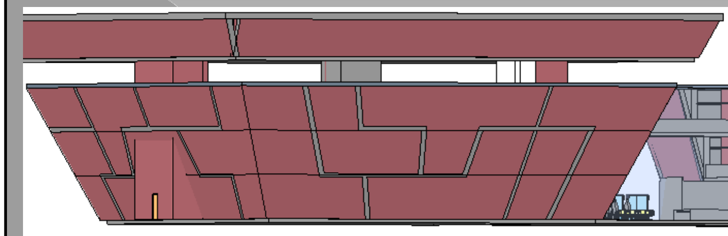
STRUCTURAL CONCEPT – LOBBY

Lobby space will have Larger Columns on exterior Walls

STRUCTURAL CONCEPT – GREEN ROOF

Columns In Learning Factory and Research Labs will be larger to support increased live and dead loading of Green Roof Space

STRUCTURAL CONCEPT – 4TH FLOOR



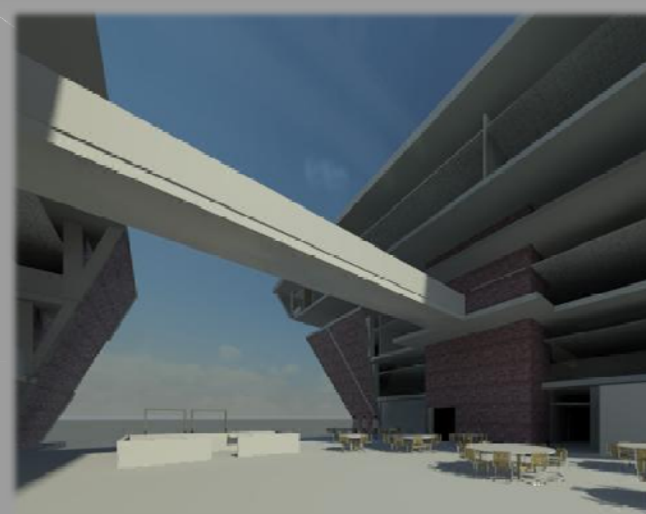
4th Floor supported by central concrete column and by elevator shafts on the East and West Side of the Tower

STRUCTURAL CONCEPT 4TH FLOOR

Conceptual Renderings of Train Station in Naples, Italy

THE NEXT STEPS…

- Organize services and utilities.
- Further develop the sustainability concepts to their optimum productivity.
- Schematic design.
- Further refinement of individual spaces.



ARCH 441 – GROUP I

PROPOSED COLLEGE OF ENGINEERING SIGNATURE BUILDING

LEADING THE WAY TOWARD SUSTAINABLE ARCHITECTURE

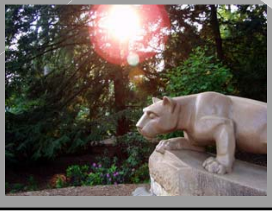
EXERCISE #3

Bailey – Graves – Gray – Hirsch

INTRODUCTION

BUILDING CONCEPTS

- A LIVING LABORATORY BUILDING WHICH USES TANGIBLE FORMS OF SUSTAINABLE DESIGN TO EDUCATE AND INSPIRE STUDENTS.
- A BUILDING WHICH ALLOWS OCCUPANTS TO BE IMMERSED IN A SUSTAINABLE ENVIRONMENT AND LEAVE WITH ENHANCED KNOWLEDGE THROUGH THEIR INTERACTION WITH THE SPACE
- A SIGNATURE BUILDING WHICH EMBODIES THE AMBITION AND COMMITMENT OF THE COLLEGE OF ENGINEERING TO SUSTAINABILITY IN DESIGN



SPACE ALLOCATION – NSF

	Needed	Provided	Difference
A1 Seminar Room	1200	1206	6
A2.1 2nd & 4th Year Studio	5500	5625	125
A2.2 Crit Space	500	491	-9
A2.3 5th Year Studio	4125	4157	32
A2.4 Graduate Studio/Offices	3750	3714	-36
A3 Research Labs	12000	12040	40
A4.1 Design Computing Lab	3000	2990	-10
A4.2 System Administrator's Office	150	156	6
A4.3 Server Room	100	127	27
A4.4 Technical Workshop/Storage	300	284	-16
B1 Faculty Offices	3500	3532	32
B2 Faculty Archive	200	199	-1
B3.1 Department Head	300	302	2
B3.2 Administrative Assistant Offices	240	244	4
B3.3 Staff Assistant's Office Area	600	639	39
B3.4 Reception	200	200	0
B3.5 Mail Room/Kitchen/Commons	200	220	20
B3.6 File/Copy Rooms	300	335	35
B3.7 Conference Rooms	400	458	58
B3.8 Student Archive	240	267	27

C1.1 Gathering Space/Lobby	400	2109	1709
C1.2 Public Gallery	450	452	2
C1.21 Storage	200	141	-59
C2 Café/Lounge/Kitchen/Service	2610	2868	258
C3 Engineering Copy Centre	1500	1507	7
C4 Student Organisations	1200	1125	-75
DA1 - Dean	400	405	5
DA1 - Dean's Conference Room	350	349	-1
DA1 - Admin Assistant	150	154	4
DA2 - UGrad - Assoc Dean	350	352	2
DA2 - UGrad - Assistant Deans	700	699	-1
DA2 - UGrad - Staff Offices	525	548	23
	600	600	0
	1680	1693	13
	700	710	10
DA2 - UGrad - Wage (Students)	360	366	6
DA2 - UGrad - Student Organisations	1600	1652	52
DA2 - UGrad - Academic Assistance Centre	800	807	7
DA2 - UGrad - Instructional Space	1000	1004	4
DA2 - UGrad - Interview Space	600	630	30

SPACE ALLOCATION – NSF

DA3 - Research - Wage (Students)	60	66	6
DA3 - Research - Classroom	1000	947	-53
DA4 - A&P - Assoc Dean	350	350	0
DA4 - A&P - Staff Offices	700	697	-3
	900	910	10
	1320	1345	25
	800	817	17
DA4 - A&P - Wage (Students)	240	241	1
DA4 - A&P - Training Classroom	500	503	3
DA5 - D&C - Director	175	200	25
DA5 - D&C - Staff Offices	900	897	-3
	720	729	9
	200	204	4
DA5 - D&C - Wage (Students)	60	62	2
DB - Reception/Waiting	1600	1600	0
DB - Large Conference	1250	1253	3
DB - Medium Conference	1000	1006	6
DB - Small Conference	900	911	11
DB - Mail Room/Receiving	600	601	1
DB - Central Storage	1500	1500	0
DB - Office Storage	1500	1436	-64
DB - Kitchen/Lunch	800	821	21
DB - Staff Lounge	500	478	-22
DB - Server Room	200	222	22

DC Main Engineering Lounge	5000	4690	-310
Library	14000	13893	-107
Learning Factory	10000	10030	30
Classrooms	5000	4855	-145

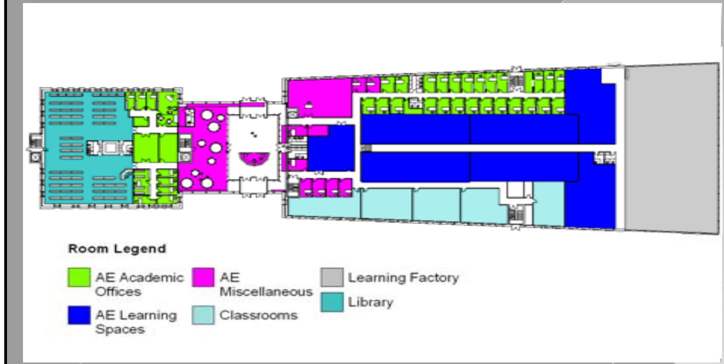
	Needed	Provided	Difference	% Difference
Total	**107035**	**108909**	**1874**	**1.72%**
Total 2	**107035**	**107200**	**165**	**0.15%**

SPACE ALLOCATION - GSF

	Required (inc. gross up factor)	Provided	Difference
AE Department	58273	57565	-708
Dean's Offices	45500	49950	4450
Library	16100	15330	-770
Learning Factory	11500	11534	34
Classrooms	5750	6219	469

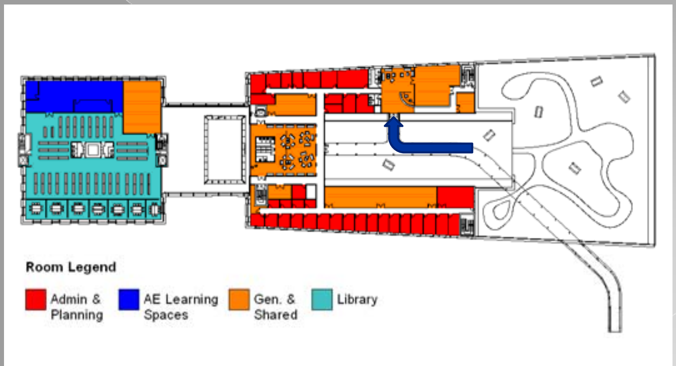
	Needed	Provided	Difference	% Difference
Total	**137123**	**140637**	**3514**	**2.50%**
Total 2	**137123**	**138262**	**1139**	**0.82%**

FLOOR PLANS



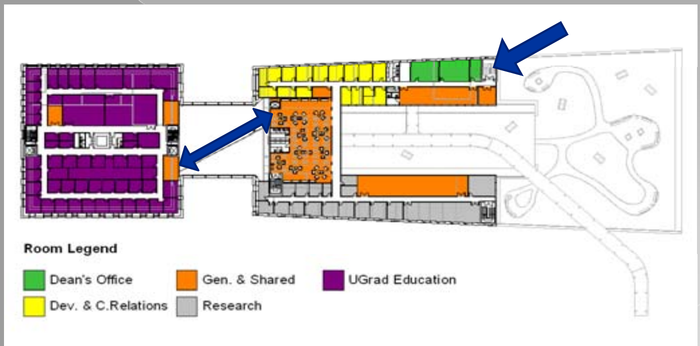
Basement and 1st Floor

FLOOR PLANS



2nd Floor

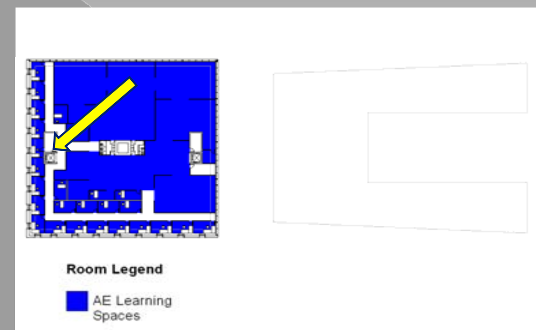
FLOOR PLANS



3rd Floor

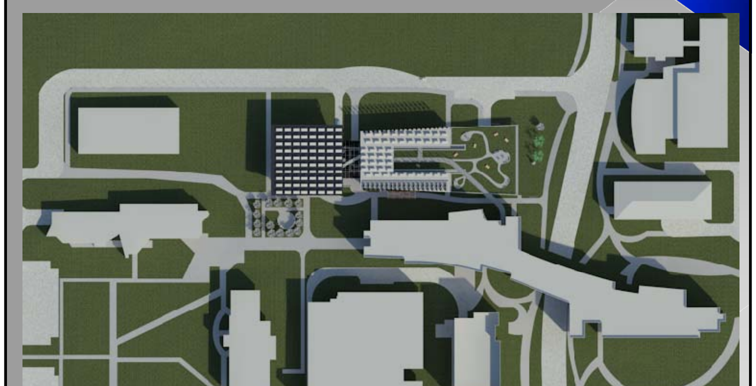
VIEW FROM 3rd FLOOR LOUNGE

FLOOR PLANS



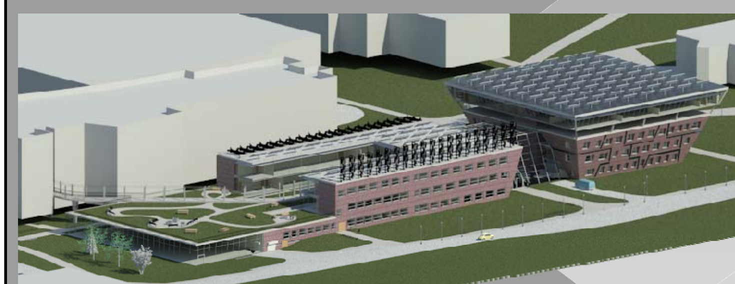
5th Floor

SITE PLAN



Site Plan

EXTERIOR VIEWS



Full Exterior View

EXTERIOR VIEWS

View of Tower and Atrium

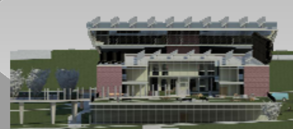
EXTERIOR VIEWS

View from N. Atherton Street

ELEVATIONS

North Elevation

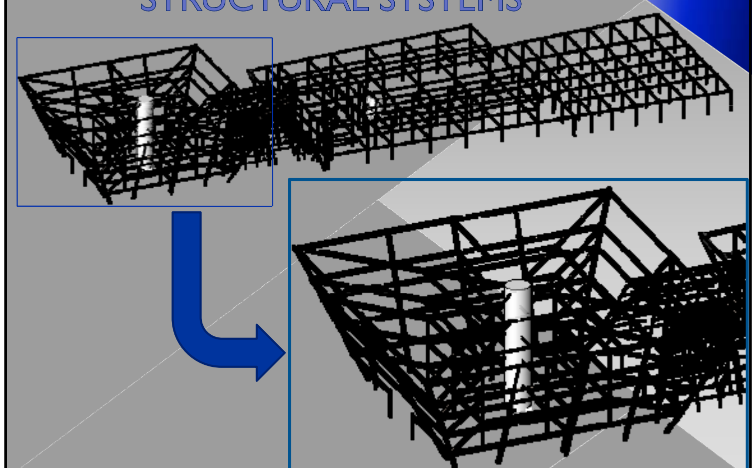
West Elevation



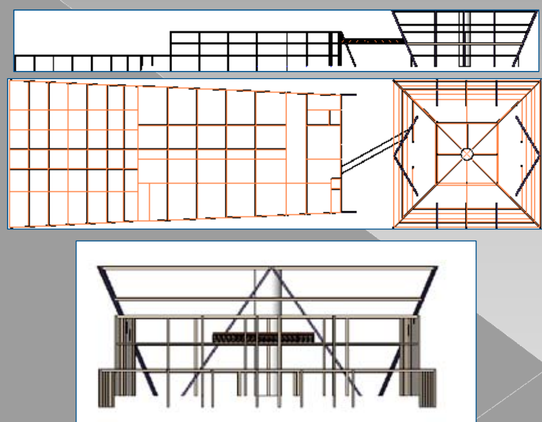
East Elevation

South Elevation

STRUCTURAL SYSTEMS

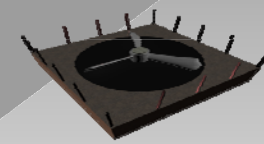


STRUCTURE



SUSTAINABILITY CONCEPTS

- Incorporates Energy Management System
- Solar PV Panels on Roof and Walls
- Wind Turbines
- Rainwater Collection System
- Solar Friendly Design
- Green Roof



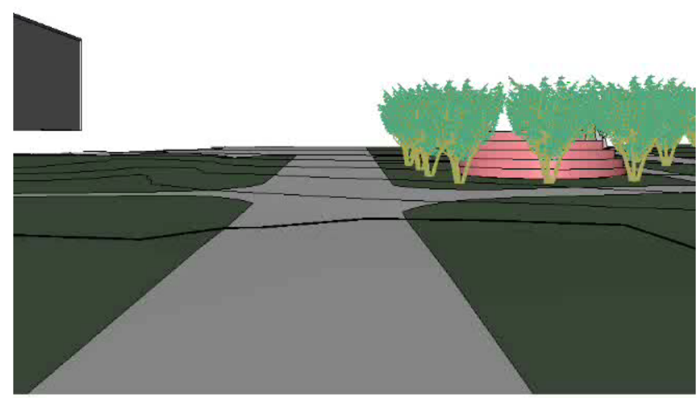
SUSTAINABILITY CONCEPTS

- Building Size = 140,000 ft^2
- Power Consumption = 2,422,000 kW-h/yr (17.3 kW-h/ft^2)
- Sustainability Features Contribute Conservatively **21.4%** of the required energy.
- Monetary Savings of $42,800
- Environmental savings through elimination of power grid

(Calculations based upon Energy Information Administration Commercial Buildings Energy Consumption Survey 2003 (CBECS))

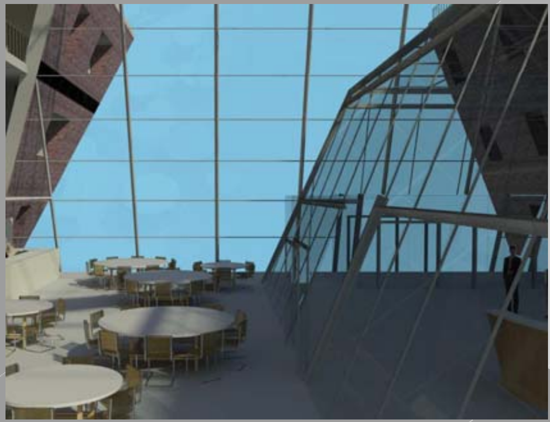
[1 of 400]

VIDEO WALKTHROUGH

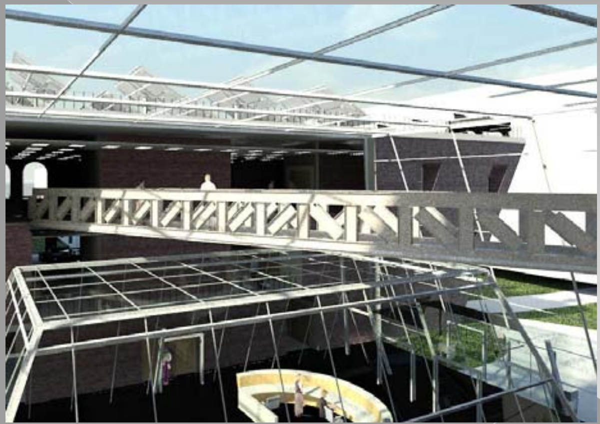


MASS MODEL

INTERIOR RENDERINGS



INTERIOR RENDERINGS



HELIXWIND®
MODEL S594

OUR PHILOSOPHY

Freedom is at the heart of our values – energy independence and autonomy – a freedom fueled by a resource that never runs out. The wind.

Often the simplest and most elegant solutions are the best. We believe that energy self sufficiency is better than the current antagonistic legacy system in decline. However progressive change requires courage, creative and positive innovation and unerring focus on performance. This is the soul of the Helix system.

WHY HELIX WORKS

Inexpensive, reliable, simple, the hallmarks of the Helix system make it the best choice for low wind speed residential and commercial applications. The Savonius turbine based design catches wind from all directions creating smooth powerful torque to spin the electric generator. Mounted up to 35 feet high, in winds as low as 10 mph the Helix system creates electricity to power your home or business.

HOW IT WORKS:

As the wind blows the long helical blade scoops catch wind from all directions forcing it through the turbine. The turbine generator is connected directly to your home and as electricity is generated your home is powered. If the wind isn't blowing your home is powered by the energy grid as usual. If the wind is blowing strongly then your energy produced can exceed your energy consumed and, depending on your local utility, your meter can spin backwards rolling back your energy bill.

Tel: 1.877.2gohelix Fax: 619.330.2627

S594 SYSTEM

The S594 (patent pending) is a commercial scale system for applications on medium to large size buildings. The blade is 16 ft high and 4 ft in diameter with a monopole support for the top bearing. The system utilizes a direct drive permanent magnet generator which reaches rated power at 200 RPM. Power is sent through a Grid tie inverter for use onsite and back into the utility grid for net metering.

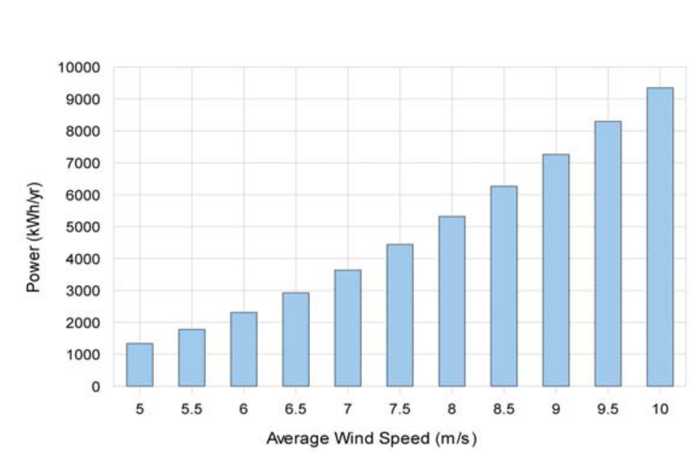
OUR PROMISE

Helix Wind energy systems are designed, engineered and tested at corporate facilities in San Diego and California. Each component is individually tested to ensure the system performs seamlessly as a whole. Our performance data is from real installed working turbines, not a theoretical power curve created on a computer.

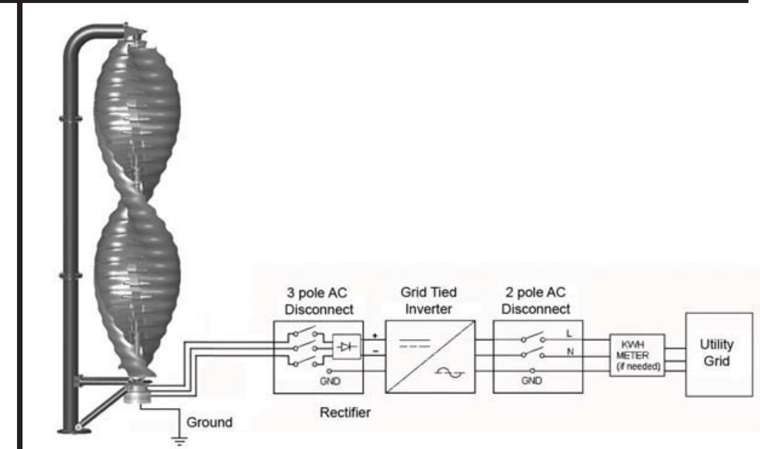
www.HelixWind.com
1848 Commercial St. San Diego, CA 92113

MEMBER

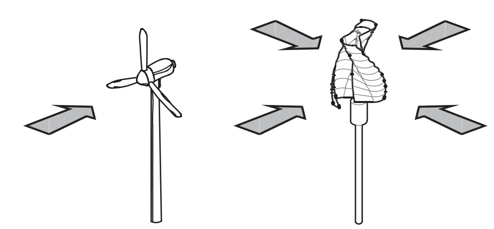
ANNUAL POWER PRODUCTION



S594 ELECTRICAL SCHEMATIC



VAWT ADVANTAGES

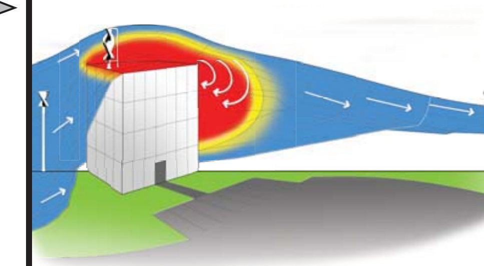


Horizontal Turbine
Must have smooth laminar wind flow from a single direction.

Vertical Turbine
- Functions in wind from any direction.
- Functions in Turbulent or gusty winds.

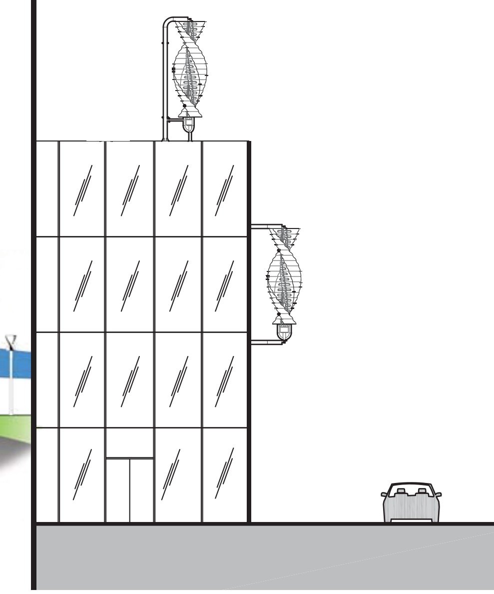
URBAN SITING

Urban structures create turbulence and gusts which are ideal for Vawt applications.



Blue Smooth laminar wind flow
Yellow Turbulence boundary
Red High wind turbulence

MOUNTING FOR COMMERCIAL APPLICATIONS



TECHNICAL SPECIFICATIONS

Rated Capacity - 5 kW

Peak Power - 5.63 kW

Rotor Dimensions - 16' h x 4' w (4.87 m x 1.2 m)

Overall Height - 19.8' (6.0m)

Swept Area - 5.88 m^2

Rotor Construction - Ultra tough Aluminum Alloy

Type - Vertical axis helical Savonius rotor

Cut-in Speed - 8 mph

Braking - No braking needed for normal operation. Manual override for maintenance.

Grid Connection - 110 VAC - 240 VAC, 50-60Hz Grid Tied Inverter.

Weight - 1400 lb (635.029 kg)

Design Life - 30 years

Installation - Roof Top: recommend 2 ft above roof line. *Consult with Helix Wind field engineers for optimum placement guidlines.

Warranty - 5 year Limited Warranty

Generator - 5 kw high efficiency Permanent Magnet Generator

Battery charge systems available

- **Unique patent pending design.**
- **Rugged aluminum and steel construction for any enviro-nment.**
- **Modular, 3D blade for easy assembly and toughness.**
- **Helical turbine for smooth power production.**
- **Ultra reliable Low RPM Permanent magnet generator.**
- **Design gives almost silent operation at less than 5 decibels above background noise.**
- **Completely safe for our friends the birds and bats.**
- **Utilizes turbulent omni-directional air instantly, no yaw control required.**

140,000 ft²   2,422,000 KWh

Annual Bill = $196,000

12,132

Building = 140,000 ft²   Energy USE = 17.3 (140,000) = 2,422,000 Kwh/yr

Annual Bill ≈ $200,000   140,616

Wind Turbines => Avg wind: 6.5 mph

Tower Turbine = 31,938 KWh/yr @ 35% max output => 1.30% => $2,600   @ $80,000 First cost

Helix Turbines = 39 @ 3000 Kwh/yr each = 117,000 Kwh/yr @ ≈ $390,000 initial cost

saves $4,477 => 4.7% of Energy

Solar Panels

12x10x2 + 12x26 + 12x10x8 = 1512 Roof Panels

130 Wall Panels

@ 75% => 1512/10 x 6.6 Kwh/day · 365 day/yr = 364,241 Kwh/yr

=> 15% => $30,000/yr savings for Vertical

Wall panels => 25% => 130/10 x 2.2 Kwh/day · 365 day/yr = 10,439 Kwh/yr

=> .40% => $800/yr

Total Cost of PV System = $1,477,800

SHARP

solar electricity

175 WATT

MULTI-PURPOSE MODULE

NT-175U1

MULTI-PURPOSE 175 WATT MODULE FROM THE WORLD'S TRUSTED SOURCE FOR SOLAR.

Using breakthrough technology, made possible by nearly 50 years of proprietary research and development, Sharp's NT-175U1 solar module incorporates an advanced surface texturing process to increase light absorption and improve efficiency. Common applications include commercial and residential grid-tied roof systems as well as ground mounted arrays. Designed to withstand rigorous operating conditions, this module offers high power output per square foot of solar array.

Multi-purpose module ideal for ground mounted solar systems and the preferred solution for landowners.

ENGINEERING EXCELLENCE

High module efficiency for an outstanding balance of size and weight to power and performance.

DURABLE

Tempered glass, EVA lamination and weatherproof backskin provide long-life and enhanced cell performance.

RELIABLE

25-year limited warranty on power output.

HIGH PERFORMANCE

This module uses an advanced surface texturing process to increase light absorption and improve efficiency.

Sharp multi-purpose modules offer industry-leading performance for a variety of applications.

Improved Frame Technology

SHARP: THE NAME TO TRUST

When you choose Sharp, you get more than well-engineered products. You also get Sharp's proven reliability, outstanding customer service and the assurance of our 25-year limited warranty. A global leader in solar electricity, Sharp powers more homes and businesses than any other solar manufacturer worldwide.

BECOME POWERFUL

175 WATT

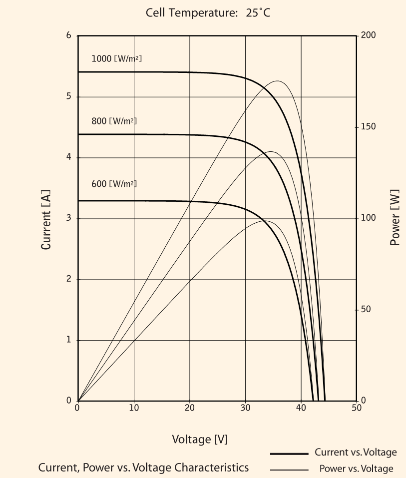
NT-175U1

ELECTRICAL CHARACTERISTICS

Maximum Power (Pmax)*	175 W
Tolerance of Pmax	+10%/-5%
Type of Cell	Monocrystalline silicon
Cell Configuration	72 in series
Open Circuit Voltage (Voc)	44.4 V
Maximum Power Voltage (Vpm)	35.4 V
Short Circuit Current (Isc)	5.40 A
Maximum Power Current (Ipm)	4.95 A
Module Efficiency (%)	13.45%
Maximum System (DC) Voltage	600 V
Series Fuse Rating	10 A
NOCT	47.5°C
Temperature Coefficient (Pmax)	-0.485%/°C
Temperature Coefficient (Voc)	-0.36%/°C
Temperature Coefficient (Isc)	0.053%/°C

*Measured at (STC) Standard Test Conditions: 25°C, 1 kW/m², AM 1.5

IV CURVES

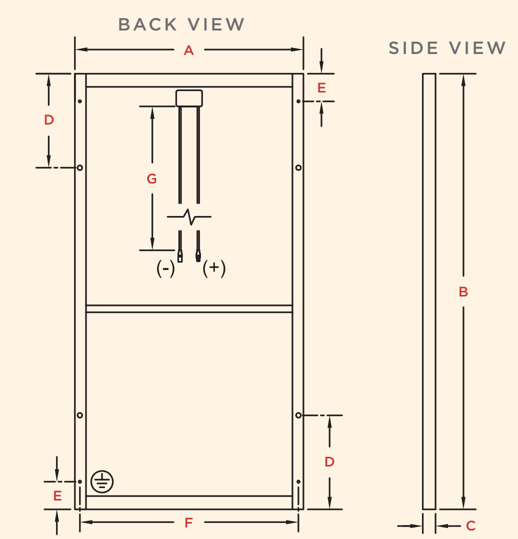


Current, Power vs. Voltage Characteristics

MECHANICAL CHARACTERISTICS

Dimensions (A x B x C below)	32.5" x 62.0" x 1.8"/826 x 1575 x 46 mm
Cable Length (G)	43.3"/1100 mm
Type of Output Terminal	Lead Wire with MC Connector
Weight	35.3 lbs / 16.0 kg
Max Load	50 psf (2400 Pascals)

DIMENSIONS



A	B	C	D	E
32.5"/826 mm	62.0"/1575 mm	1.8"/46 mm	13.4"/340 mm	3.9"/100 mm

F	G
31.1"/790 mm	43.3"/1100 mm

Contact Sharp for tolerance specifications

QUALIFICATIONS

UL Listed	UL 1703
Fire Rating	Class C

c UL us

WARRANTY

25-year limited warranty

Contact Sharp for complete warranty information

SHARP

SHARP ELECTRONICS CORPORATION
5901 Bolsa Avenue, Huntington Beach, CA 92647
1-800-SOLAR-06 • Email: sharpsolar@sharpusa.com
www.sharpusa.com/solar

08F-013 • VP-06-08

Released: Dec 2006
Next CBECS will be conducted in 2007

Table C14. Electricity Consumption and Expenditure Intensities for Non-Mall Buildings, 2003

	Electricity Consumption						Electricity Expenditures		
				Distribution of Building-Level Intensities (kWh/square foot)					
	per Building (thousand kWh)	per Square Foot (kWh)	per Worker (thousand kWh)	25th Per-centile	Median	75th Per-centile	per Building (thousand dollars)	per Square Foot (dollars)	per kWh (dollars)
All Buildings*	202	14.1	12.2	3.6	8.2	17.1	15.7	1.09	0.078
Building Floorspace (Square Feet)									
1,001 to 5,000	47	17.8	11.4	3.8	8.9	20.3	4.3	1.63	0.092
5,001 to 10,000	92	12.4	10.3	3.8	7.4	14.5	8.7	1.18	0.095
10,001 to 25,000	164	10.5	11.1	2.9	6.3	13.4	13.8	0.88	0.084
25,001 to 50,000	439	12.2	11.6	3.8	8.8	16.2	33.6	0.94	0.077
50,001 to 100,000	927	13.1	14.1	4.5	9.9	17.0	68.0	0.97	0.073
100,001 to 200,000	2,181	15.7	12.2	5.3	13.0	23.4	146.4	1.05	0.067
200,001 to 500,000	4,347	15.0	15.4	5.8	12.1	20.7	301.0	1.04	0.069
Over 500,000	17,034	19.0	12.8	10.0	16.6	25.2	1209.8	1.35	0.071
Principal Building Activity									
Education	283	11.0	8.7	4.9	8.9	13.6	21.1	0.82	0.075
Food Sales	276	49.4	43.0	33.4	48.0	77.0	20.9	3.74	0.076
Food Service	213	38.4	20.3	18.8	37.4	70.3	17.4	3.13	0.082
Health Care	564	22.9	11.5	6.1	12.0	18.4	37.9	1.54	0.067
Inpatient	6,628	27.5	14.1	21.8	24.0	35.6	405.3	1.68	0.061
Outpatient	168	16.1	7.8	5.8	11.3	16.5	13.9	1.34	0.083
Lodging	483	13.5	28.0	6.7	11.9	17.7	37.1	1.04	0.077
Retail (Other Than Mall)	139	14.3	17.8	4.3	9.4	18.4	11.6	1.19	0.083
Office	256	17.3	7.5	6.5	11.5	17.6	20.7	1.40	0.081
Public Assembly	179	12.5	20.5	2.2	5.1	11.3	14.4	1.00	0.080
Public Order and Safety	237	15.3	12.4	4.0	7.9	17.6	17.2	1.12	0.073
Religious Worship	49	4.9	10.7	1.9	3.5	6.0	4.4	0.43	0.089
Service	73	11.0	12.0	3.0	6.3	11.8	5.8	0.88	0.080
Warehouse and Storage	154	7.6	16.7	1.4	3.1	6.2	10.8	0.53	0.070
Other	510	22.5	21.4	3.5	7.2	20.3	40.0	1.76	0.078
Vacant	42	2.4	Q	0.4	1.7	3.8	3.9	0.22	0.092
Year Constructed									
Before 1920	83	7.1	8.7	1.6	3.9	9.6	7.3	0.62	0.088
1920 to 1945	122	9.2	9.9	3.2	6.9	13.9	10.3	0.78	0.084
1946 to 1959	125	9.9	10.2	3.1	6.4	14.3	10.6	0.84	0.085
1960 to 1969	168	11.9	11.0	3.4	7.4	14.7	13.5	0.96	0.080
1970 to 1979	239	15.9	13.3	4.4	9.5	21.4	18.1	1.20	0.075
1980 to 1989	275	18.1	12.2	4.8	10.1	20.5	20.8	1.37	0.076
1990 to 1999	250	16.7	12.5	4.7	10.5	22.6	18.8	1.26	0.075
2000 to 2003	288	16.2	19.2	3.1	7.8	18.3	21.4	1.20	0.074
Census Region and Division									
Northeast	208	11.5	9.9	2.4	6.1	14.2	20.1	1.11	0.097
New England	139	10.8	10.0	1.8	4.3	13.2	13.7	1.06	0.099
Middle Atlantic	240	11.7	9.8	2.9	6.9	15.2	23.1	1.13	0.096
Midwest	182	12.9	13.2	3.5	7.9	15.9	11.9	0.85	0.066
East North Central	233	13.5	13.4	4.2	8.3	19.1	15.5	0.90	0.067
West North Central	118	11.7	12.8	3.0	7.2	13.6	7.4	0.74	0.063
South	226	16.5	13.9	4.1	9.2	19.7	15.4	1.12	0.068
South Atlantic	252	17.4	12.6	4.2	9.7	19.7	17.0	1.17	0.067
East South Central	160	15.5	16.4	3.8	8.4	19.8	10.7	1.04	0.067
West South Central	226	15.3	15.8	4.0	9.0	19.3	15.9	1.08	0.070
West	179	13.8	10.6	4.0	9.2	15.2	17.7	1.37	0.099
Mountain	196	15.4	13.1	4.3	8.6	14.4	15.0	1.18	0.076
Pacific	170	13.0	9.5	3.8	9.3	15.7	19.1	1.46	0.112