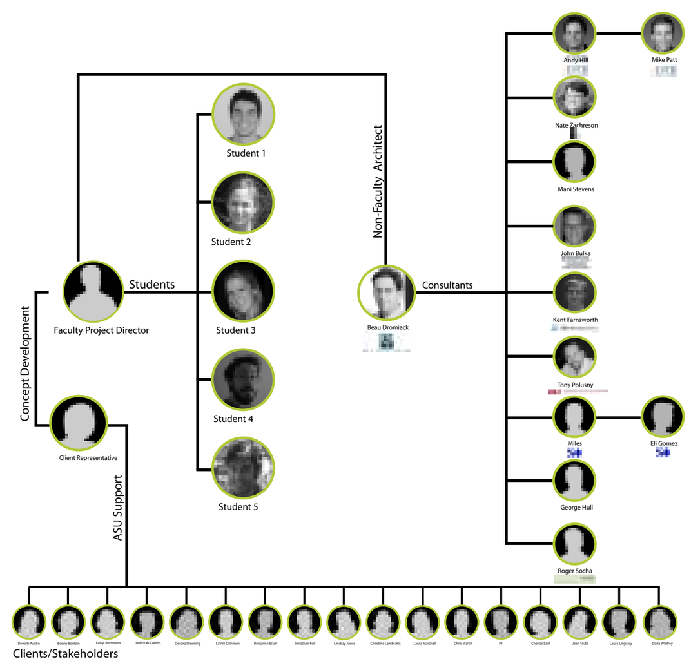
"POLYSHADE"

Polyshade demonstrates a new pedagogical model that applies parametric design to the traditional design-build studio. This approach aims to establish a fully associative collaboration across a professional team established for the construction of a small building. In working with local architects Polyshade aims to create a "proto practice" studio environment that furthers the mutual concerns of education and practice.

The specific goals of the Spring 2010 session centered on creating an actively cooled, shaded environment for a community garden within university campus housing. The project extends the sustainable practice of an existing grad/faculty housing organization by proposing an outdoor learning/gathering space that mitigates heat stress in extreme temperatures. The students worked within the constraints of a stakeholder client base, a specific site, budget and an agreed collaboration with local architects (chosen for their experience and vested interest in the site).



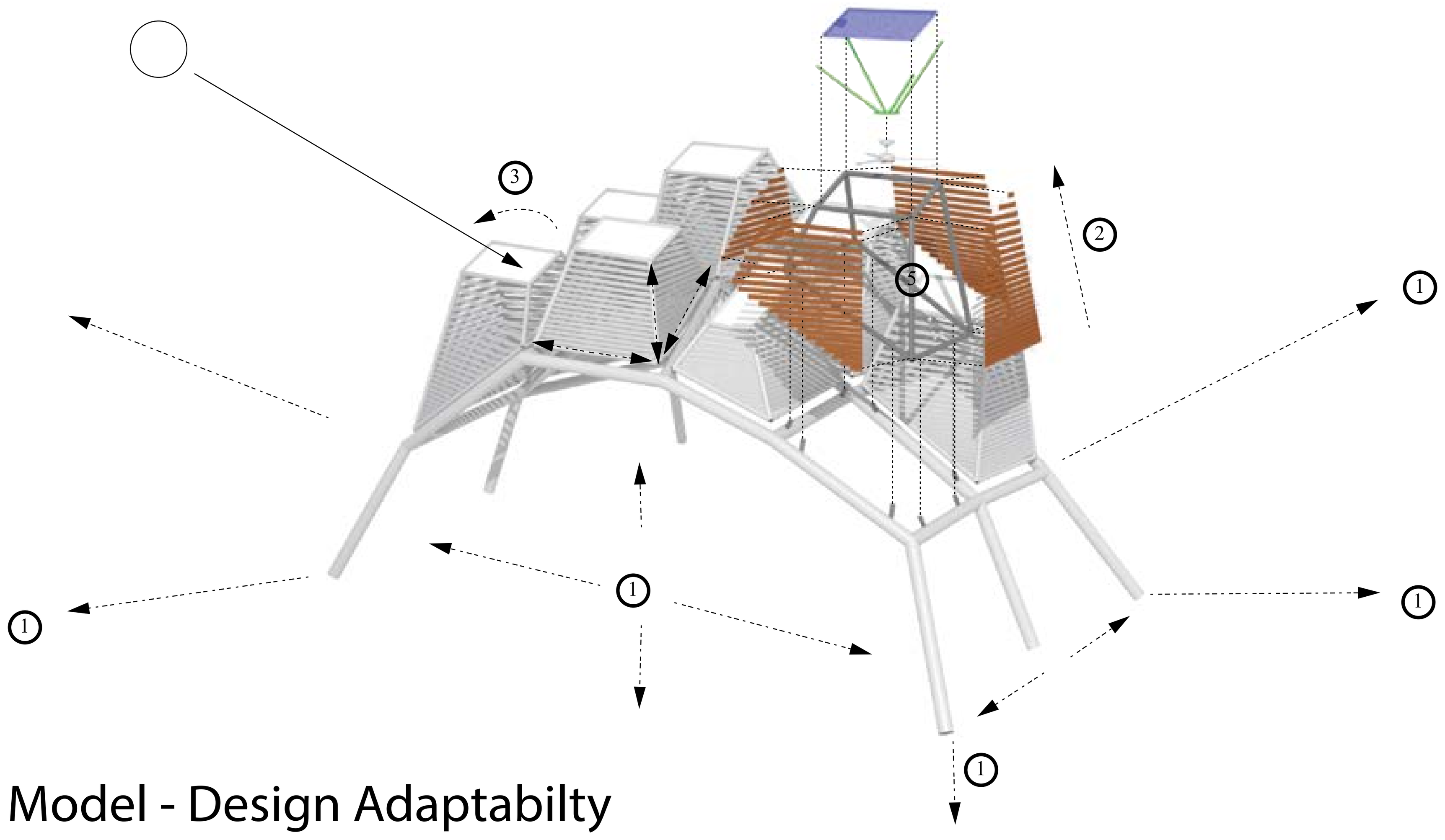
This collaborative experience extended to the architect's consultants as the project developed. Consultations were carried out at strategic points during the project with structural engineers (Tony Polusny MBJ), pre-project costing (Andy Hill DPR), PV/Solar (Nate Zachreson ESD) among others.

Collaboration/Cooperation

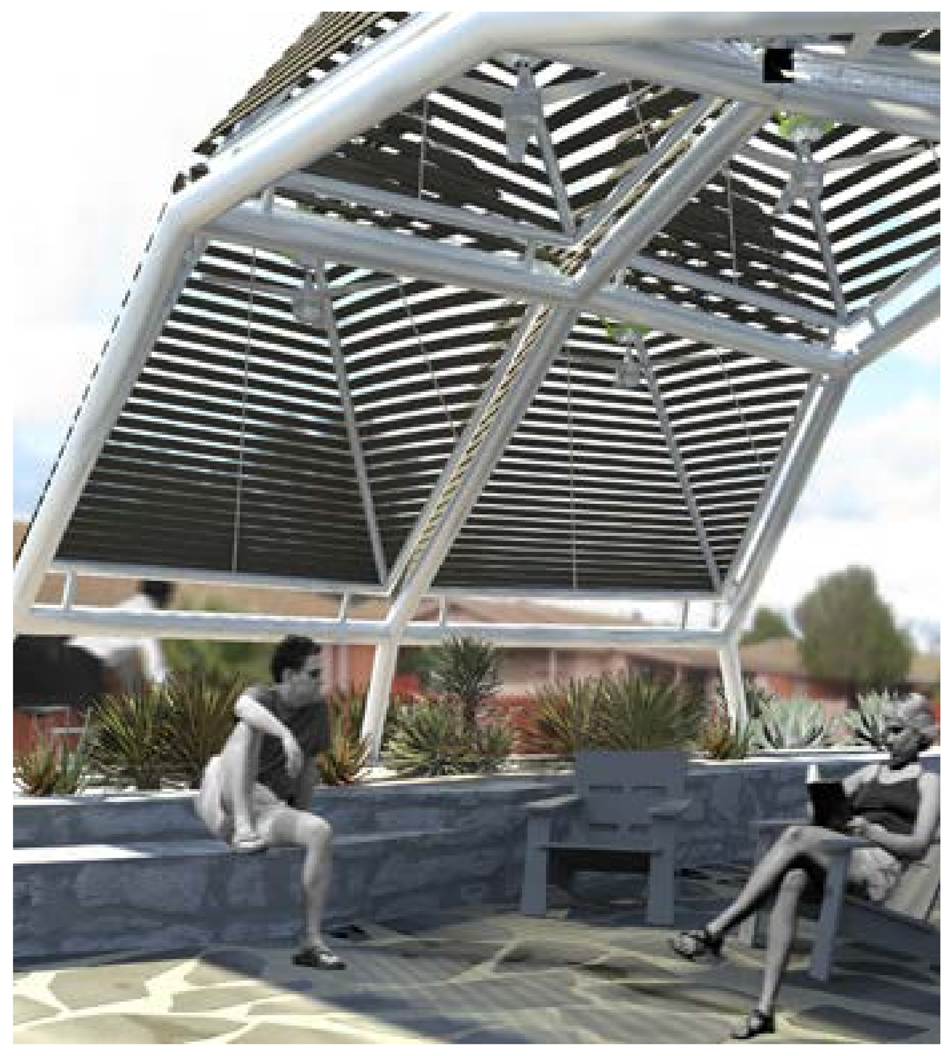
Div No	Description	Quantity	Unit	Unit Cost	% Reduc.	Subtotal
1	Demolition					
	Misc. Site Demolition	800	sf	1.5		$1,200.00
						$1,200.00
2	Site Work					
	Cut to Fill at Seating Area	88.8	cy	40		[illegible]
	Back-fill and Fine Grading	8	hr	175		$1,400.00
	Existing Utility Relocation					
	Debris Box	1	ea	350		[illegible]
	Site Temporary Fence	350	lf	4		[illegible]
	Protect existing to retain plants	1	LS	500		[illegible]
	Patch back existing landscape	200	sf	6		$1,200.00
	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
	Fill dirt	40	cy	15		[illegible]
						[illegible]
3	Substructure - Site Concrete					
	Footings (24" x 6" x 18")	14	cy	375	75%	[illegible]
	#5 double each way rebar	190				
	Waterproofing	1	LS	1200		$1,200.00
						[illegible]
4	Superstructure					
	Main structure frames	3	ea	4500	75%	[illegible]
	Cross members	10	ea	1000	75%	[illegible]
	Hat structure top rings	4	ea	563	75%	[illegible]
	Hat structure bottom rings	4	ea	563	75%	[illegible]
	Hat structure verticals	4	ea	563	75%	[illegible]
	Hat structure standoffs	8	ea	80	75%	[illegible]
	Cladding (doug. fir) assume: 2" gap between each 1x4	300	lf	1.1		[illegible]
	Dry-fit	1	ls	950		[illegible]
	Shop labor	240	hrs	62		[illegible]
	Engineering	40	hrs	96.8		[illegible]
	Transport	3	hrs	250		[illegible]
	Erection	1	LS	16,685		[illegible]
	Paint steel	1	LS	2500	75%	[illegible]
						[illegible]
5	Electrical					
	Solar Panels	8	ea	0		[illegible]
	Industrial Fan	8	ea	150		[illegible]
	Inverter (Morningstar Sunsine 300W 12v	8	ea	250		[illegible]
	10in x 10in x 6in enclosure and backplate	8	ea	55.54		[illegible]
	Heavy duty safe switch (12Vac, 20A)	8	ea	16.34		[illegible]
	T Bussman JLLN fuse and fuse holder w/ termination lugs (12Vac, 100A)	8	ea	12.75		[illegible]
	T Bussman JLLN fuse and fuse holder w/ termination lugs (120Vac, 3A)	8	ea	12.75		[illegible]
	5/8in x 8ft copper grounding electrode	8	ea	11.12		[illegible]
	6 AWG	80	ft	0.51		[illegible]
	8 AWG	80	ft	0.36		[illegible]
	12 AWG 500ft spool	1	ea	68		[illegible]
	16 AWG 500ft spool	1	ea	35.51		[illegible]
						[illegible]
6	Jobsite Management					
	Project engineer	4	wk	2400		[illegible]
	Project accountant	10	wk	95		[illegible]
						[illegible]
7	Jobsite Office					
	Computer	1	mo	475		$475.00
	Cell Phone	1	mo	110		[illegible]
						$585.00
8	Vehicles/Travel					
	Truck rental, small	1	mo	900		$900.00
	fuel- trucks, cars	1	mo	300		$300.00
						$1,200.00
9	Temporary Services					
	Temp. toilets	1	mo	125		$125.00
	Construction signage	1	mo	200		$200.00
						$325.00
	Project Subtotal					$92,511.17
	Subguard Insurance	1%				$925.11
	Payment and Performance Bond	1.25%				$1,156.39
	Construction Contingency	10.00%				$9,251.12
	Contractor's Insurance	1.75%				$1,618.95
	GC Fee	4.33%				$4,005.73
	Sales Tax	5.24%				$4,847.59
	Project Total					$114,316.05

Students were regularly involved in construction budget estimation for full-fabrication. In this instance the students were involved in four stages of estimation carried out with the architects recommended consultants (Andy Hill. DPR preconstruction management). Students establish a parametric model based on quantitive information required by the consultants i.e. excavation, length and diameter of pipe sections, linear length for Trex cladding, areas for paintwork and required electrical and solar equipment.

Project Budget Managment



Parametric Model - Design Adaptabilty



Legend

1. Primary Structure span and height (linked to diameter pipe section).
2. Distribution of shading slats according to solar orientation.
3. Orientation of solar panels fixed to south at an angle of 22 degrees.
4. "Hat" adjustments according to fan cooled zones.
5. Secondary structural section diameter.

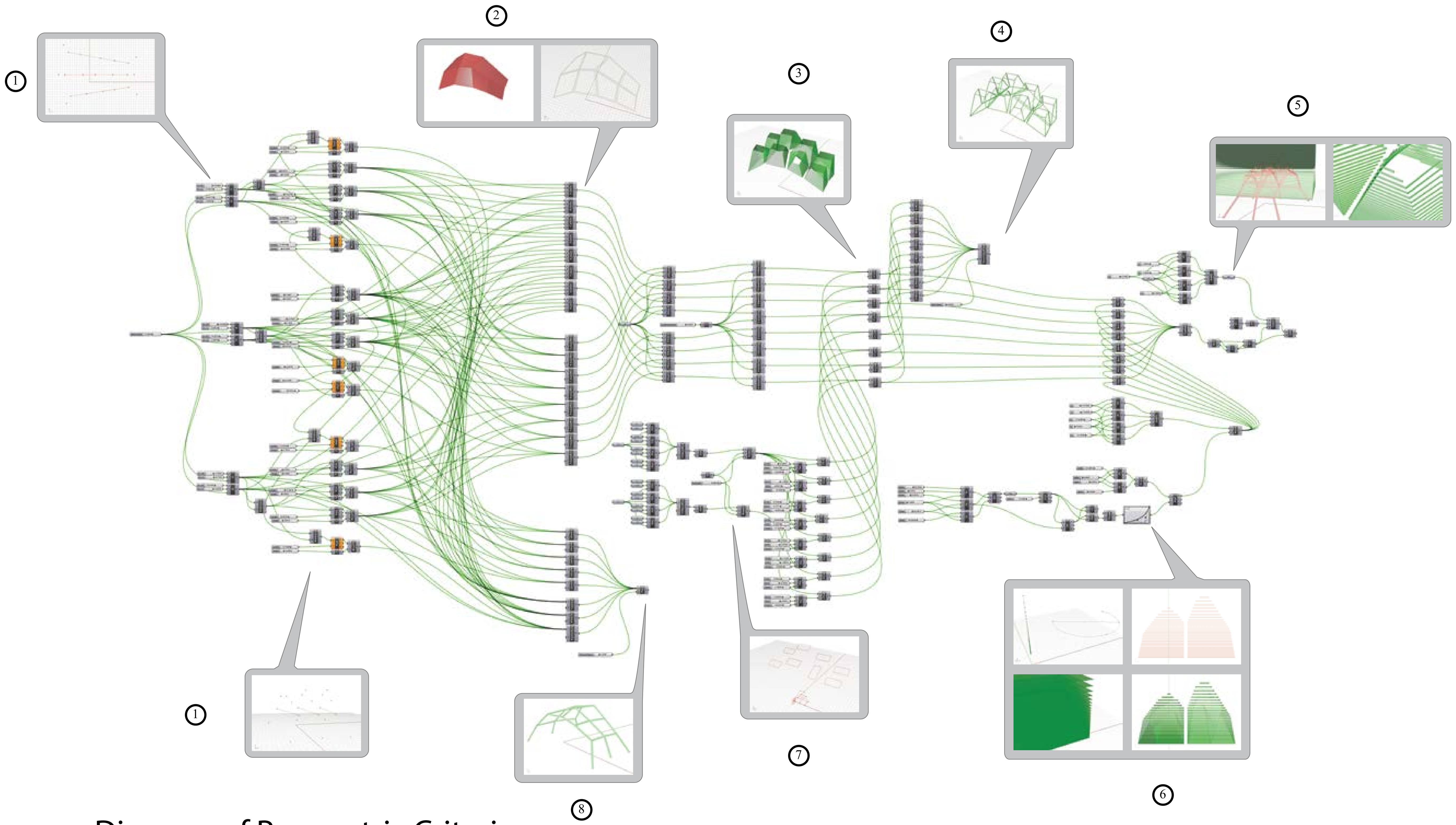


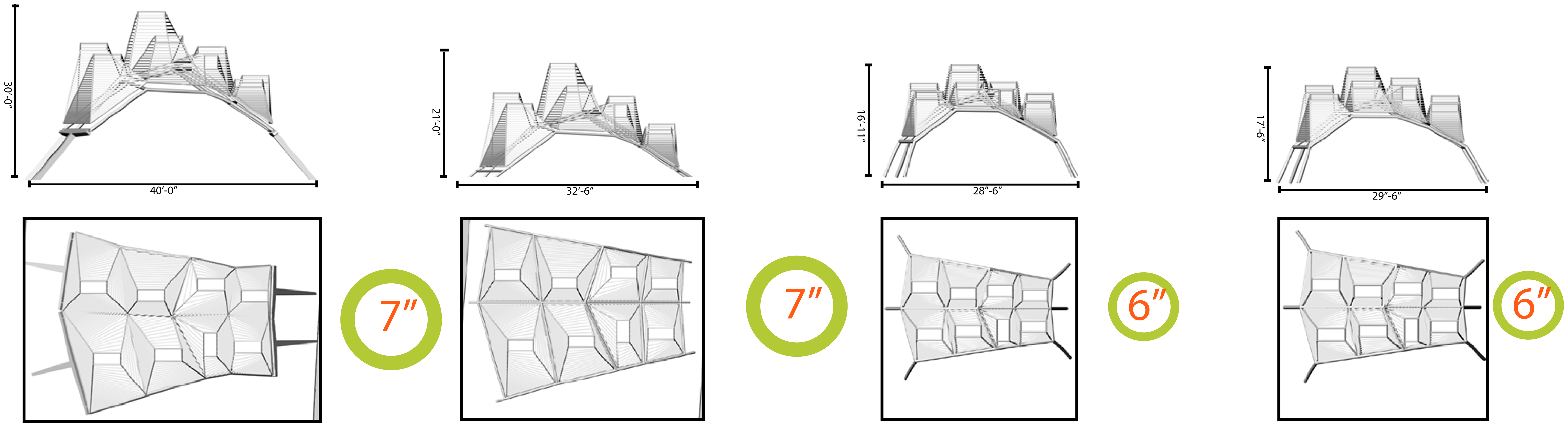
Diagram of Parametric Criteria

Computers/Technology

Polyshade provides an understanding and development of advanced roles of "Computer/Technology" in providing information for costing and construction. Particularly an understanding of practice of parametric design. (Boyer Table 8). From the outset the students were encouraged to is to build a fully parametric model that connects associatively to cost, structural and environmental considerations. Our aim is to provide an efficient understanding of the consequences of adjustments to the design through the practice of mass-customization and delayed differentiation. In this case we developed a Rhino/Grasshopper parametric definition that would provide quick updates to design modifications. The choice of these programs instead of Revitt/Archicad lay in the grassroots learning of associative links and how to visualize and create them. This provides an "inside the box" experience we felt was crucial to the student's ability to judge why and when they should use industry-standard BIM programs when they became practitioners. It also served to introduce the Rhino/Grasshopper parametric model to the architects.

Legend – Parametric Diagram

1. Intersection points for primary structure modified individually (u and v direction).
2. Ceiling cell diagram
3. Hat height modified individually.
4. Secondary structure – pipe thickness and overall length (quantities measured for costing).
5. Slat section (quantities measures for costing).
6. Slat distribution according to solar orientation. In some cases this slats are distributed in an algorithmic sequence (quantities measures for costing).
7. Fixed solar panel orientation - south at an angle of 22 degrees. In some cases this causes shear in the "Hat" profile that can be accommodated up to the bending tolerance of the shading slats.
8. Primary structure - pipe thickness which varies according to span (quantities measures for costing).



$196,000

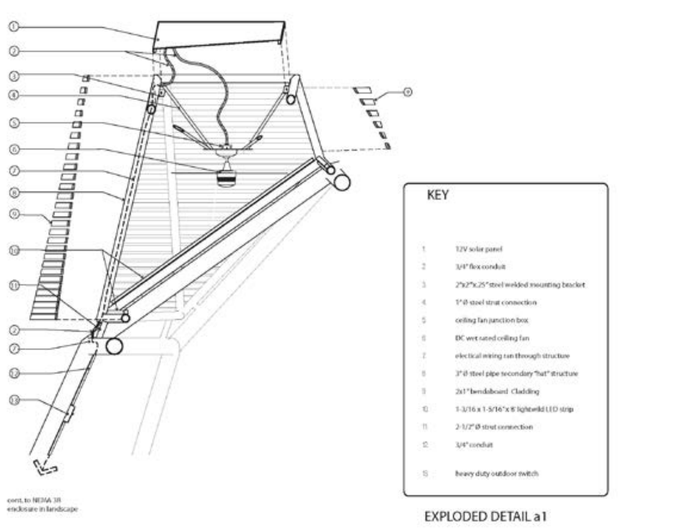
$136,830

$125,770

$116,630

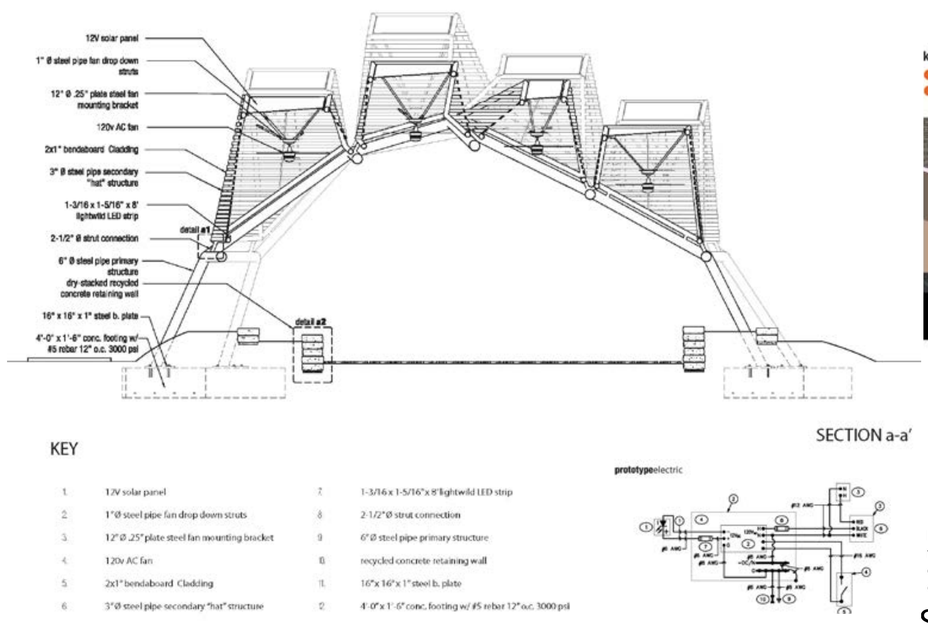
Developments of Costing According to Adjustments in the Parametric

Approach Sequence - Polyshade Builds Upon the Exiting Sustainable Practice of the Community Garden



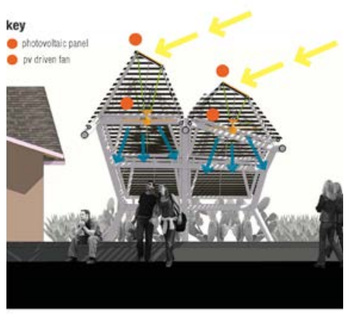
Throughout the project students (particularly those involved in the development of the digital model) developed a set of CD's for construction.

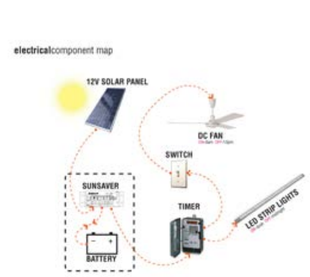
Construction Drawings -"Hat" Section

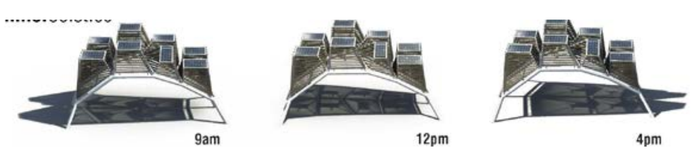


KEY

1.	12V solar panel	7.	1-3/16 x 1-5/16"x 8' lightwild LED strip
2.	1" Ø steel pipe fan drop down struts	8.	2-1/2" Ø strut connection
3.	12" Ø .25" plate steel fan mounting bracket	9.	6" Ø steel pipe primary structure
4.	120v AC fan	10.	recycled concrete retaining wall
5.	2x1" bendaboard Cladding	11.	16"x 16"x 1" steel b. plate
6.	3" Ø steel pipe secondary "hat" structure	12.	4'-0"x 1'-6" conc. footing w/ #5 rebar 12" o.c. 3000 psi

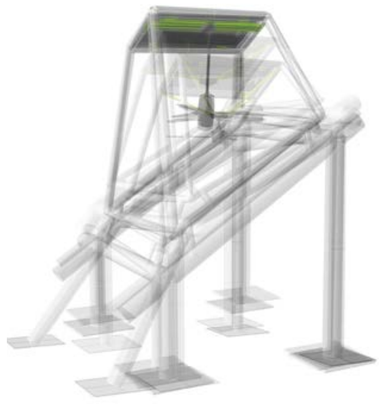


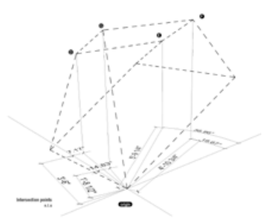




Engage in sustainable practice (solar) through consultation with PV/Solar specialists ESD providing technical learning. This based on a wider necessity to provide solutions to arid-zone shade and mitigation of heat stress in extreme temperatures. The provision of actively cooled zones promotes the use and engagement of outdoor public space.

Sustainable practice (solar) - PV Arrangement.



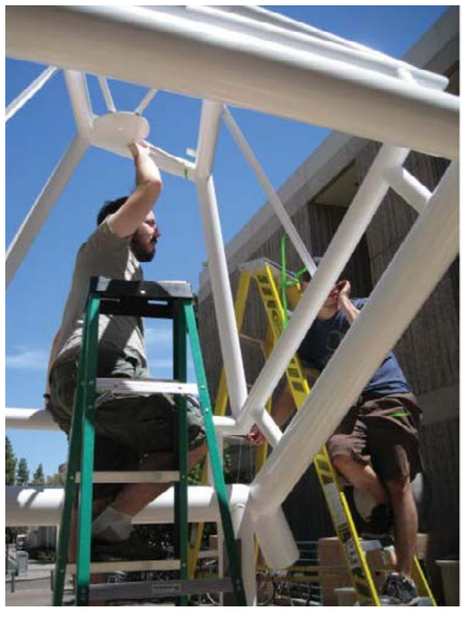


Prototype - Cost Control and Construction

10	**Prototype Hat**				
	6" x 21 sch 40	1	ea	211.34	$211.34
	3" x 21 sch 40	3	ea	82.91	$248.73
	2 1/2" x 21 sch 40	1	ea	64.18	$64.18
	Cladding (bendaboard) assume: 2" gap between each 1x4	5	20ft	22	$110.00
	Solar Panels	1	ea	0	donated
	Industrial Fan	1	ea	180	$180.00
	Inverter (Morningstar Suresine 300W 12v	1	ea	268	$268.00
	16in x 12in x 6in enclosure and backplate	1	ea	58.54	$58.54
	Heavy duty spst switch (12Vac, 20A)	1	ea	16.34	$16.34
	T Bussman JLLN fuse and fuse holder w/ termination lugs (12Vdc, 100A)	1	ea	12.76	$12.76
	T Bussman JLLN fuse and fuse holder w/ termination lugs (120Vac, 5A)	1	ea	12.76	$12.76
	5/8in x 8ft copper grounding electrode	1	ea	11.12	$11.12
	6 AWG	10	ft	0.51	$5.10
	8 AWG	10	ft	0.36	$3.60
	12 AWG 500ft spool	1	ea	68	$68.00
	16 AWG 500ft spool	1	ea	35.91	$35.91
					$1,306.38

Cost -control also included full-scale fabrication of prototypical section of the project. In this instance students were responsible for coordinating the construction of one of the eight bays of the overall structure. This bay needed to be fully costed taking into account primary structure, cladding, PV and fan arrangement. It also encompassed finishes, an estimation of labor, delivery and assembly. While students were involved in some aspects of this construction it was important that they made an assessment of their own value to provide a practical evaluation of cost that could be pro-rated for the complete structure.

In this instance students developed a method of communicating fabrication drawings for steelwork fabricator (S. Diamond Steel). They learnt to interpret the digital model in terms of the appropriate information for the fabricators i.e. 3D positioning of intersections, four-way pipe intersections and "birds mouth" profile. This involved a close working relationship with S-Diamond and learning the importance of hardcopy and electronic fabrication information. This was particularly associated with connection details and the structural diagram. Several students we actively involved in shop visits and quality control.



Construction Conflict and Risk Managment

Construction Administration - Students developed a set of CD's for the construction of the prototypical unit of a single bay of the shade structure. This involved a close working relationship with S-Diamond steel and learning about the importance of hardcopy and electronic fabrication information. This was particularly associated with connection details and the structural diagram. Several students we actively involved in shop visits, quality control and managing the construction on site.

Students had additional experience in resolving and coordination the fabrication sequence that also involved electrical and solar installation by professional engineers. The gained experience resolving negotiations with university campus health and safety and acquiring permission for campus installation. This involved risk assessment for delivery and installation on two sites.