NOISE CONTROL IN THE EDUCATIONAL ENVIRONMENT: AN INTERSTATE HIGH-SCHOOL

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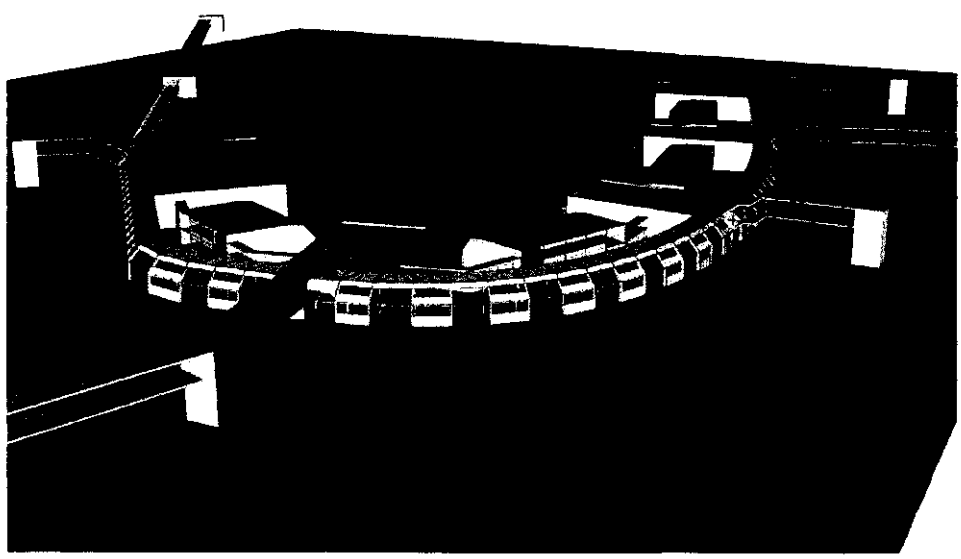

This project began and was completed during the spring semester of 2004.

FORWORD

High schools are too often being built in the wrong places. The tendency is to build in the rural landscape, taking up valuable cropland and making travel to the school cumbersome and time-consuming. Meanwhile, land alongside interstate intersections and railways is becoming more unused. One of the primary reasons for this is the amount of noise that is generated by the traffic. With today's technologies and knowledge of noise control, it can make sense to place our educational environments on the country's main arteries for the resources that they provide. Schools in these locations allow direct access to major cities and educational sites in any direction; and therefore, great learning experiences.

Vehicular transportation is a way of life for Americans. Roadways take up a vast percentage of our landscape and railways, while losing some popularity, still remain an important source of material movement. It is even possible that a newfound use for these railways could revive them once again, and use of roadways show no signs of slowing. These aspects of our landscape are too often deemed undesirable. What is overlooked is the fact that these railways and roadways connect us to one another. Along with connections beyond the complex, the school itself becomes more easily accessible if placed within the main points of the vehicular system.

This project uses noise control as a design determinant. The premise is that by designing a school in a challenging acoustic context it will encourage the placement of our educational facilities in noisy environments. Unwanted noise can be overcome by architectural means. To show a school that is beautiful in form, function, and academic performance while, at the same time, conquering the major concerns of urban building, helps prove that it's possible to utilize this once undesirable land.

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SUMMARY

The design of this Interstate High-School for Dayton, Ohio proves that utilizing the once undesirable land along interstates and railways for our educational facilities is a worthwhile venture. Locating our schools in urban "wasteland" frees up our valuable cropland, effectively utilizes the vacant urban land, and brings our youth into the city where they will one day be living and working. The placement along the major points of our transportation systems makes access to and from the site unproblematic, while directly connecting the students to field trip learning experiences. The auditory downfalls of such sites can be overcome through architectural means.

INTRODUCTION

The learning atmosphere is one in which information can be effectively transferred from one person to another. While many factors are taken into consideration for design of these spaces, noise control and management is among the most important. A successful learning environment involves a mixture of quiet settings, controlled noise settings, and real world noise settings. A quiet setting, such as a classroom, is one in which verbal communication is critical. The ability to speak and hear clearly is of extreme importance for the transfer of information. A controlled noise setting, such as a gymnasium, is one in which noise levels can rise significantly without having a negative effect on the quality of the learning atmosphere. In these spaces, the quality of sound, and its transferability is of no lesser importance than the quiet setting, merely different. The third noise setting is the real world situation, such as outdoor spaces. In these environments, one is exposed to virtually no noise protection. The sounds of today's real world, such as cars, trains, and people, fill the air. This is the environment in which we all live, work, and play.

Each of the three settings may have many subgroups, and there are also times that functions may require multiple settings or vice versa. This is the principle that governs the topic of "Noise Control in the Urban Educational Environment." All

of the settings mentioned are equally important to providing a well-rounded education.

A major problem with building our schools in very rural areas is that one of these auditory situations is absent. Since most of our young will spend their adult lives in the urban environment, part of their daily education should be to expose them to that environment, and present them with a learning, working, urban atmosphere. The population of the earth is growing very rapidly, cities are becoming denser, and it is becoming more important for our schools to seize this valuable urban land. As infants, we were all given the instinct to draw our attention to "noise." Perhaps this is because exciting things happen where noise is present. The successful design of a school in an urban environment allows each of the three noise level atmospheres to take place. The arrangement of these spaces is very critical to the functionality of the facility, and breaking the design down into these categories will allow them to work very effectively for one another.

PROGRAM OVERVIEW

The project used to explore the thesis is the design of a career center/high school (9-12) for Dayton, Ohio. The idea for this project came from a real world problem given to Lorenz Williams Clinton. LWC is an education focused architectural firm in Richmond, Indiana. They were commissioned to undertake the design of a school on the same site. At that time, I was on internship at LWC. After attending the initial site planning charrette, it became clear to me that noise control was going to be a primary issue. I was excited about the problems posed by the site, and more so by the general public's desire to place the school on this site. Although many were not enthused about the potential location, I was intrigued. It made perfect sense. In some way, the rest of the world would be at their fingertips. With direct access to the interstate system and railway, education could easily take place anywhere in the country. The school will be designed to include the core curriculum (Math, Science, English) in today's sense

along with the career technology aspect: students, primarily in their junior and senior years, will participate in post-industrial oriented education preparing them for what lies ahead. The ultimate goal for Dayton is to develop its middle class population. This educational concept is becoming more common in Ohio, but what will set this school apart from other schools will be its dramatic reference to site advantages; and providing a successful quiet, controlled, and real-world auditory settings.

The space summary was compiled using resources from Ohio School Facilities Commission and Lorenz Williams architectural offices in Dayton, Ohio and Richmond, Indiana.

DESIGN OBJECTIVES

Noise control can be dealt with in any, or all, of three ways: designing with mass, designing with distance from source, or by designing with layers. Designing with mass involves using thickness of material to dampen the sound waves, diminishing their energy as they move through the material. The more massive a surface is, the greater the noise absorption will be. Designing with distance simply means creating a maximum amount of space between the most noise sensitive areas and the noise source. This can be done in several ways with the main idea being to force the noise to travel through air space, which provides significant noise control. It does this by reducing force over the distance. For example, if you double the distance, you reduce the sound energy by a factor of four. Finally, designing with layers involves using multiple surfaces, with air space between each surface, to buffer the noise gradually from the exterior to the interior space. Layering is placing the less noise susceptible spaces between the noise source and the more noise susceptible spaces. All three strategies are used in this project to demonstrate a variety of ways to handle the issue.

A major noise problem posed by this site is the proximity to the railway. This is an active track with trains passing

every twenty minutes. More threatening to the site than the air-born noise created by the train engine and the whistle is the noise that travels through the ground and into the educational site. Vibration is a very real issue in noise control since sound waves travel through solid surfaces much better than through air. This plays a major role in the school's design, creating a need for the minimization of contact to the ground in the quiet spaces.

A secondary noise problem involves the interstate intersection that lies directly west and south of the site. While the concrete rails along the elevated roadways absorb much of the engine noise before they reach the school, the constant droning of tires and honking of horns pose a noise problem at all times. This issue informs the use of layers to buffer the noise coming from the elevated sources.

The interstate intersection creates many spaces in between and under its ramps. This space is often treated as uninhabited space, being used merely for drainage and an occasional tree. This thesis utilizes that space for outdoor learning centers, informing the students of various plant and wild life. Plants thrive off of the carbon dioxide emitted by the vehicles. Each sliver of land between the ramps can be accessed from the school by traveling under the on and off ramps to the interstate, taking full land advantage of the site.

The school easily accesses the interstate and the railway systems. Equally important, the interstate and the railway easily access the school. The institution has its own on and off ramps to each of the interstates for the commute in and out as well as the field trip use on a daily basis. The school is visibly a part of that intersection. As anyone drives through this section of Dayton, they notice that they are speeding through an "interstate high school." The school has its own train station where field trip instruction can take place as the students wait for the locomotive. Classroom carts, an idea to go along with the thesis, can be hitched to the train. These are built to provide the

classroom setting while travel is taking place.

COST INFORMATION

The following is an estimate based on square footage and cost per-square-foot. Cost per-square-foot was established using information provided by Lorenz Williams Clinton along with personal educated guess according to high quality design and material usage. This figure does not take into consideration the site preparation work that would take place involving demolition and environmental groundwork.

Net Core/Program Spaces 245570 SF
Mech./Elec. Spaces (5%) 12278.5 SF
Corridors (14%) 34379.8 SF
Total Core/Prog. Spaces 292228.3 SF
Construction Factor (15%) 43834.25 SF
Gross Program Space 336062.5 SF

336,062.5 SF x $125.00 per SF = $42,007,812.50

(Above figures are only an estimate as of Nov. 03)

BRACKETING

The space summary provided was compiled using information from Ohio School Facilities Commission (Ohio School Design Manual Career Tech. Supplement), Lorenz Williams offices in Dayton, Ohio and Richmond, Indiana, and personal adjustments for study purposes. This is merely a quantitative list of spaces with their respective sizes divided into curriculum categories.

ADMINISTRATION

Reception	500
Secretary	500
Director/Principal	300
Supervisor's Office	240
Coordinator Office	360
Conference Room	500
Mail/Work/Copy	250
Administration Stor.	150
Vault	65
Restroom	100
Guidance Council	480
Guid. Records/Stor.	200
Guidance Conf.	200
Parent/Volunteer	200
Health Clinic	400
Itinerant Person.	480
In-School Susp.	275
	5200

MEDIA CENTER

Reading Room	3500
Media Specialist	240
Workroom/Stor.	500
Main Cross-Connect	380
AV Stor.	250
Conference Room	250
Multi-Media Prod.	500
Document Stor.	300
	5920

PERFORMANCE ARTS

Auditorium (1,400 seats)	22500
Dressing Rooms	900
Storage	900
Lobby Space	1200
	25500

ARTS AND COMMUNICATIONS

Commercial Art Lab	1500
Comm. Art Darkroom	250
Comm. Art Office	120
Comm. Art Storage	200
Art Room	1200
Art Material Stor.	200
Art Kiln/Ceramic Room	100
Entertainment Marketing	2000
Ent. Mark. Office	240
Ent. Mark. Stor.	400
Instrumental Music	1800
Inst. Mus. Stor.	400
Inst. Mus. Library	120
Inst. Mus. Uniform Stor.	150
Inst. Mus. Ensemble Room	300
CADD Lab	1200
CADD Stor.	200
Academic Classrooms	4500
Biology	1200
Science Prep.	200
Teacher Prep.	200
Restroom	50
Small Group Instruction	150
Material Storage	75
Resource Room	900
Classroom	600
Classroom	900
	19155

BUSINESS/ MANAGEMENT

Administrative Technology	3000
Office	240
Storage	400
Computer Network Technology	3000
Office	240
Storage	400
Computer Support Technology	1500
Office	120
Storage	200
Culinary Arts/Food Service	2000
Lab	1500
Culinary Arts Restaurant	300
Culinary Arts Dry Storage	900
Classroom	120
Office	200
Storage	490
Changing Room	1200
Life Skills Lab	100
Life Skills Storage	1200
Computer and Business Class.	100
Workroom/Storage	4500
Academic Classrooms	1200
Biology	200
Teacher Prep.	50
Restroom	150
Small Group Room	75
Material Storage	900
Resource Room	600
Classroom	
	24885

ENGINEERING

Electronics	2000
Office	120
Storage	200
Automotive Technology Lab	6500
Auto Tech Eng. Stor.	800
Auto Tech Mach. Lab	900
Flam. Mat'l Stor.	60
Office	120
Storage	200
Changing Room	605
Tool Crib	550
Ref. Room	200

Carpentry Lab	4500
Carpentry Finish Room	500
Carpentry Mat'l Stor.	800
Office	120
Storage	200
Changing Room	605
Tool Crib	550
Ref. Room	200
Manufact. Eng. Tech Lab	3500
Mfg. Eng. Tech CAD	400
Office	120
Storage	200
Changing Room	605
Tool Crib	550
Ref. Room	200
Engineering Technology Lab	5000
Eng. Tech. CAD	800
Office	240
Storage	400
Changing Room	1210
Tool Crib	1100
Ref. Room	400
Classroom	1800
Academic Classrooms	4500
General Sci./Physics	1200
Chemistry	1200
Science Prep.	300
Teacher Prep.	300
Restroom	50
Small Group Room	150
Material Storage	75
Resource Room	900
Classroom	600
	45530

HEALTH AND HUMAN SERVICES

Early Childhood Development	1500
Observation	120
Infants	700
Kitchenette/Breakroom	350
Reception	500
Workroom	150
Toddler Restroom	60
Office	120
Storage	200
Dental Assisting Lab	1500
X-ray Room	80
Darkroom	80
Office	120
Storage	200
Changing Room	490
Medical Assisting Lab	1500
Training Toilet	120
Laundry	120
Office	120
Storage	200
Changing Room	490
Diversified Health Occup. Lab	1500
Exam Room	200
Classroom	900
Office	120
Storage	200
Changing Room	490
Agriscience	1500
Office	120
Storage	200
Academic Classrooms	4500
General Sci./Physics	1200
Chemistry	1200
Science Prep.	300
Teacher Prep.	300
Restroom	50
Small Group Room	150
Material Storage	75
Resource Room	900
Classroom	600
	23225

SPECIAL ED, STUDENT SERVICES, MISC.

Classroom	900
Workroom/Conf.	300
Restroom	100
Resource Room	1800
Storage	150
Material Storage	100
Multipurpose Room	1500
	4850

GENERAL SERVICES/ CUSTODIAL

Custodial Office	100
Workroom	300
Large Group Restrooms	4000
Custodial Closets	120
Electrical Closets	120
Telecom Room	120
Storage	150
Central Storage/Distrib.	1000
Loading/Receiving	120
	6030

FOOD SERVICES

Kitchen	3500
Dietician Office	75
Restroom	50
Locker Room	125
Student Dining	5000
Stage	900
Staff Dining	500
Table Storage	450
	10600

PHYSICAL EDUCATION

Gymnasium	20000
Student Locker Rooms	10400
Student Restrooms/Showers	4800
Physical Ed. Stor.	800
P.E. Office	300
Staff Shower	75
Lobby Services	1500
Training/Weight Room	2000
	39875

Net Core/Program Spaces	245570
Mech./Elec. Spaces (5%)	12278.5
Corridors (14%)	34379.8
Total Core/Prog. Spaces	292228.3
Construction Factor (15%)	43834.25
Gross Program Space	**336062.5**

The Interstate High-School is:

A Just School, **where education, justice, food, shelter, health and hope are fairly distributed and where all people participate in learning;**

A Beautiful School, **where art, architecture and landscape spark the imagination and move the spirit;**

A Creative School, **where open-mindedness and experimentation mobilize the full potential of its human resources and allows a fast response to change;**

An Ecological School, **which minimizes its ecological impact, where landscape and built form are balanced and where buildings and infrastructures are safe and resource-efficient;**

A School of Easy Contact and Mobility, **where information is exchanged both face-to-face and electronically;**

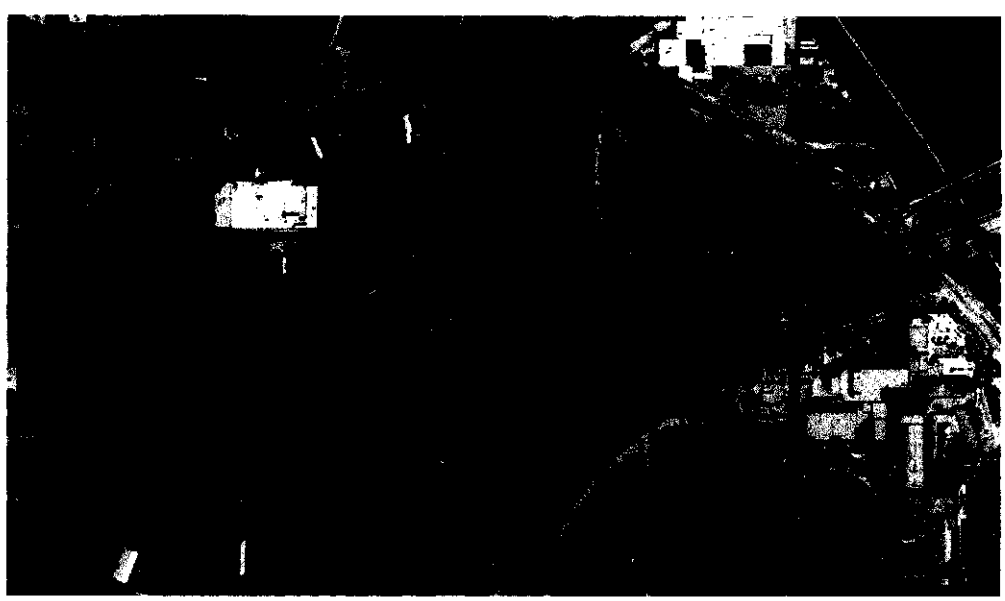
A Compact and Polycentric School, **which protects the landscape, focuses and integrates inner-communities within neighborhoods and maximizes proximity;**

A Diverse School, **where a broad range of overlapping activities create animation, inspiration and foster a vital public life.**

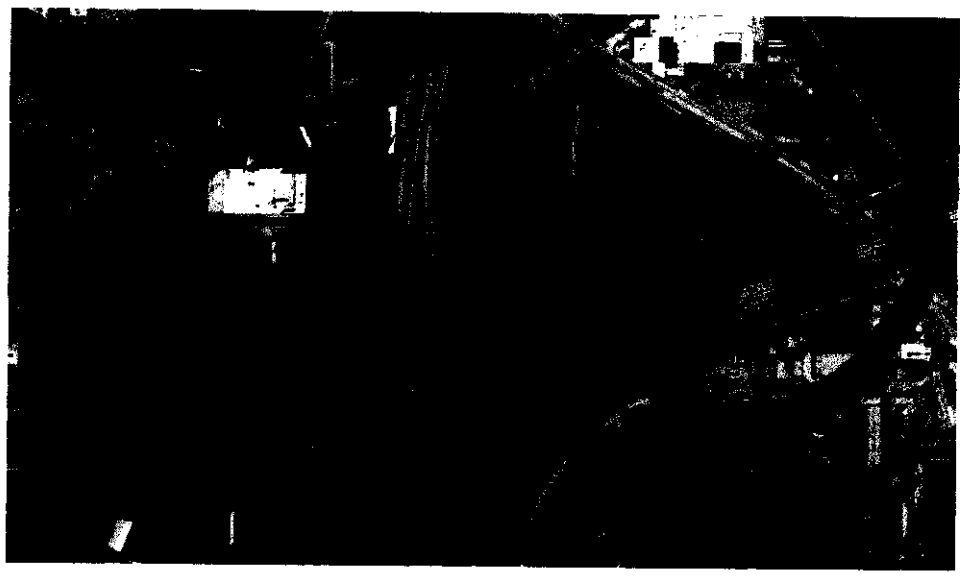
above modified from Richard Rogers

SITE ANALYSIS

school property



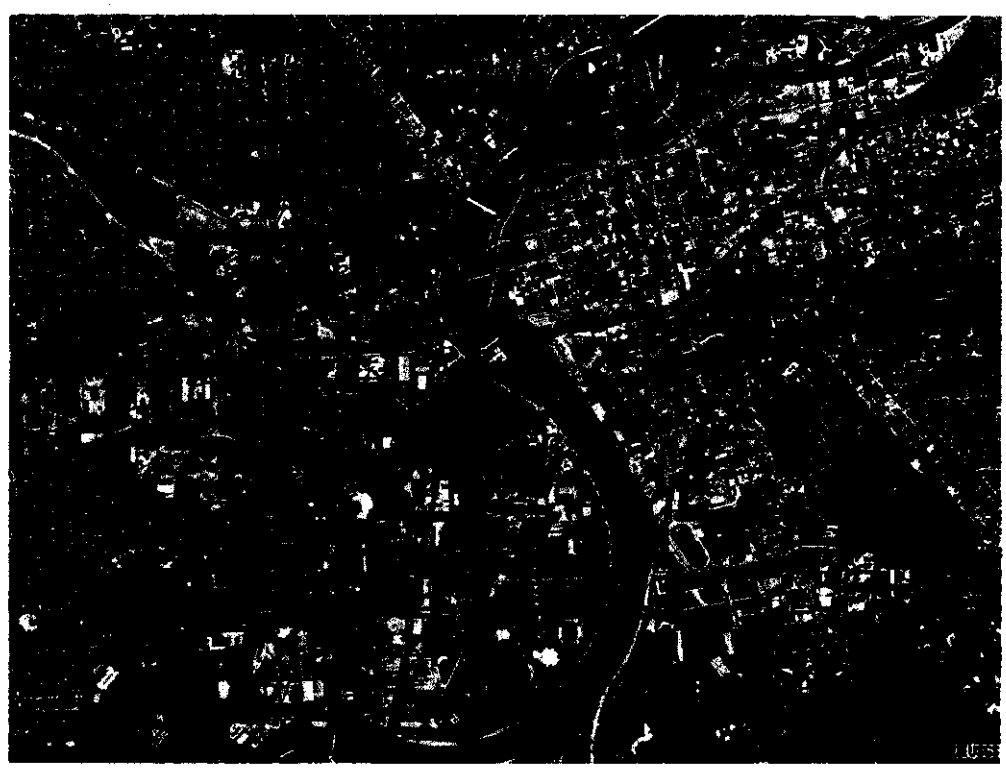
noise flow



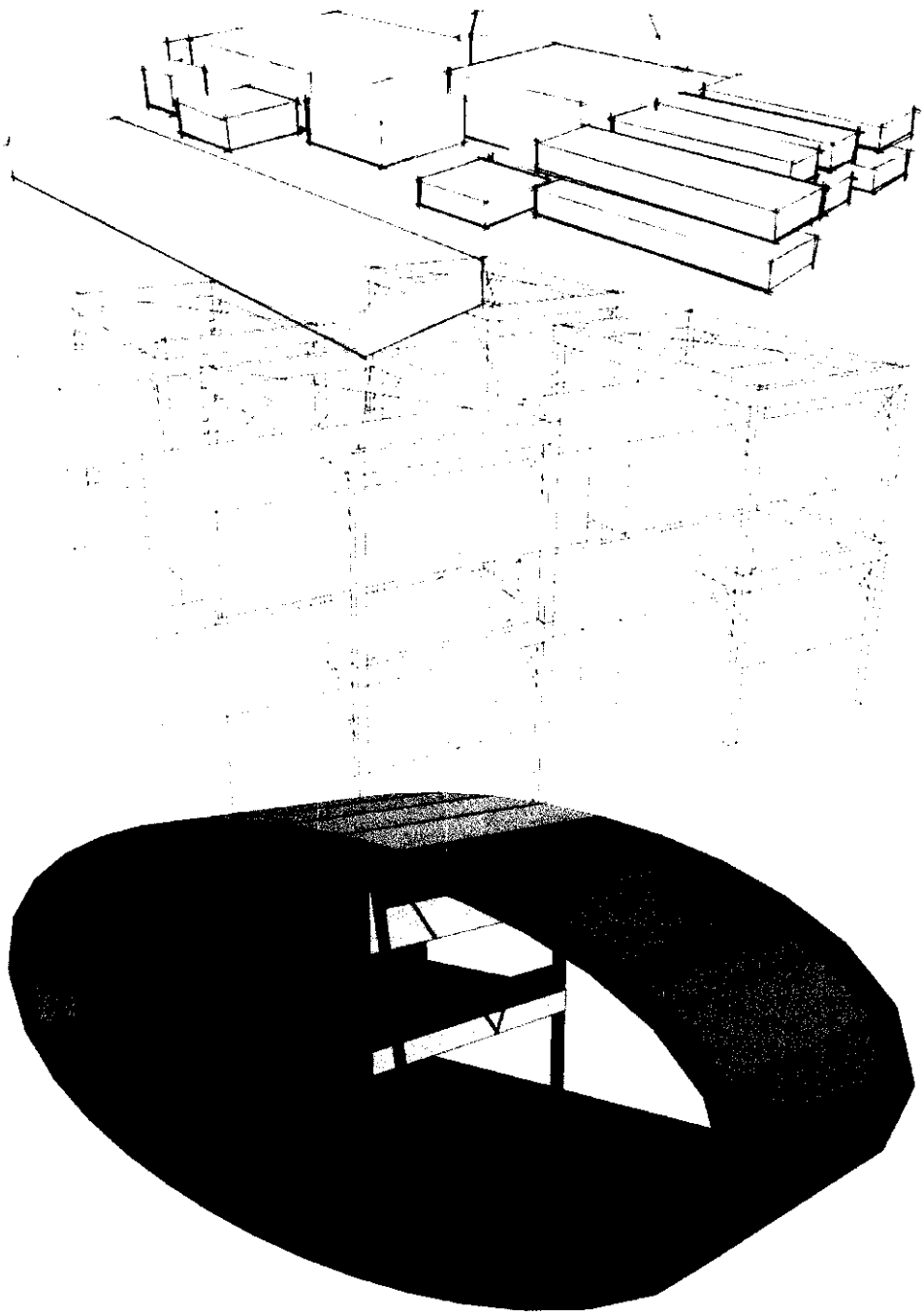
sun pattern

views

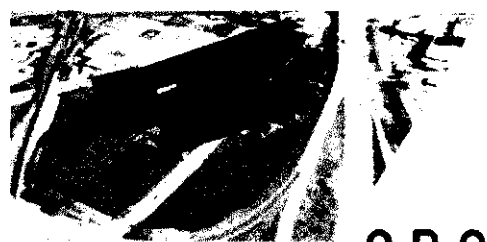
connectivity



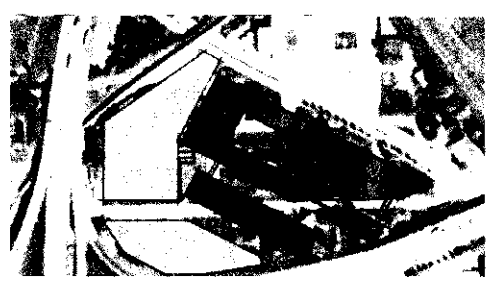
CONCEPTUAL DESIGN

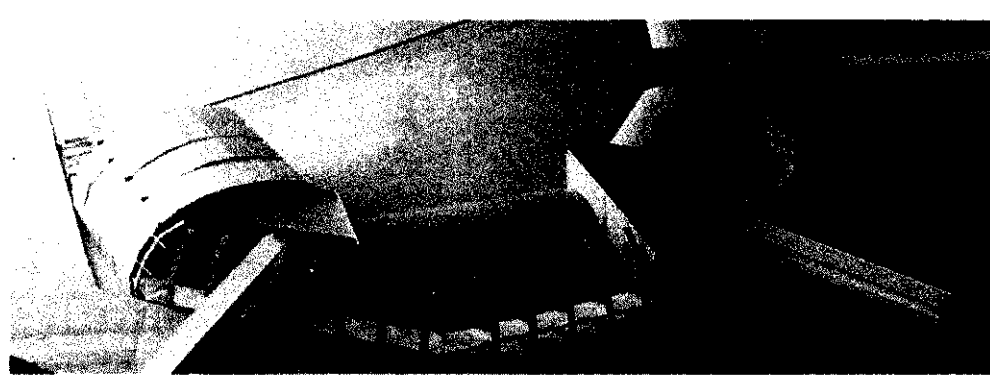


two

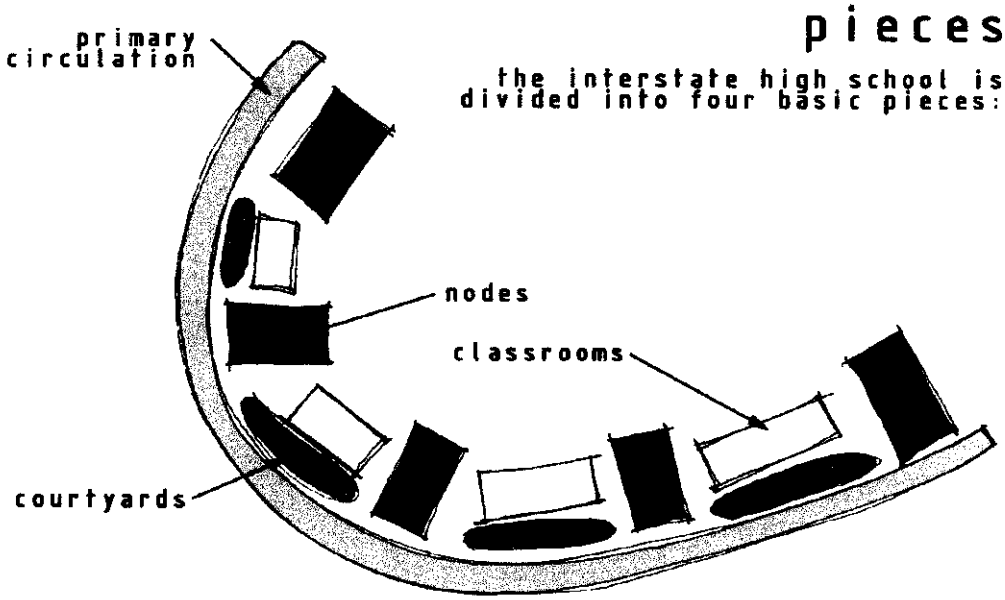


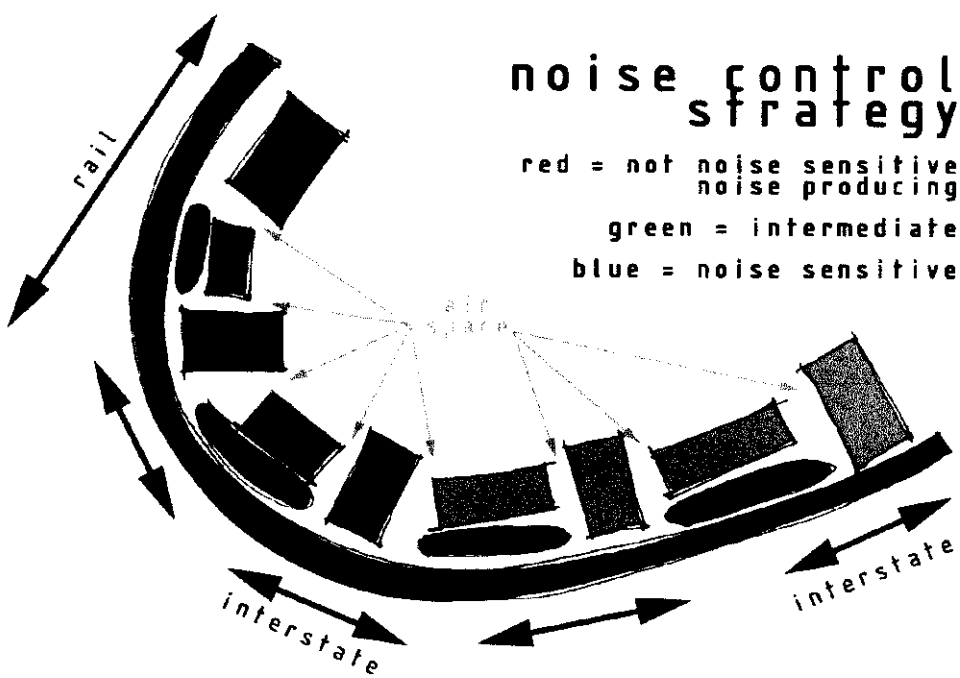
one

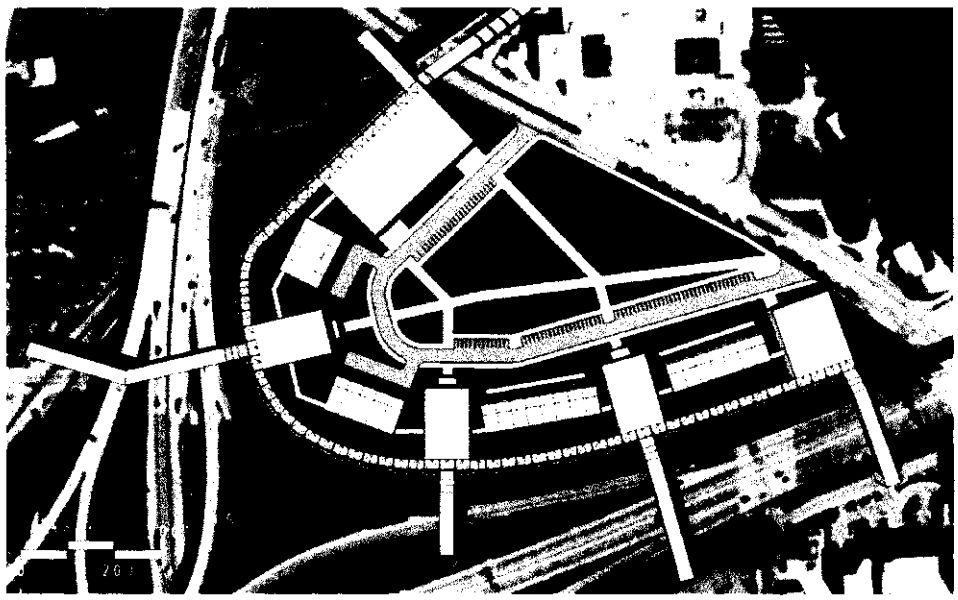




SITE PLAN

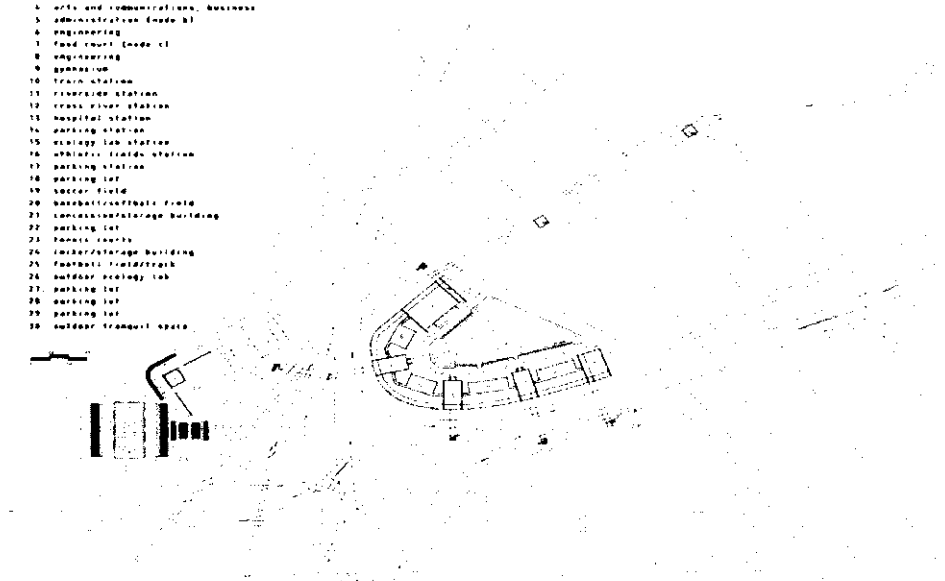

primary circulation
pieces
the interstate high school is divided into four basic pieces:
nodes
classrooms
courtyards


noise control strategy
red = not noise sensitive noise producing
green = intermediate
blue = noise sensitive
rail
interstate
interstate

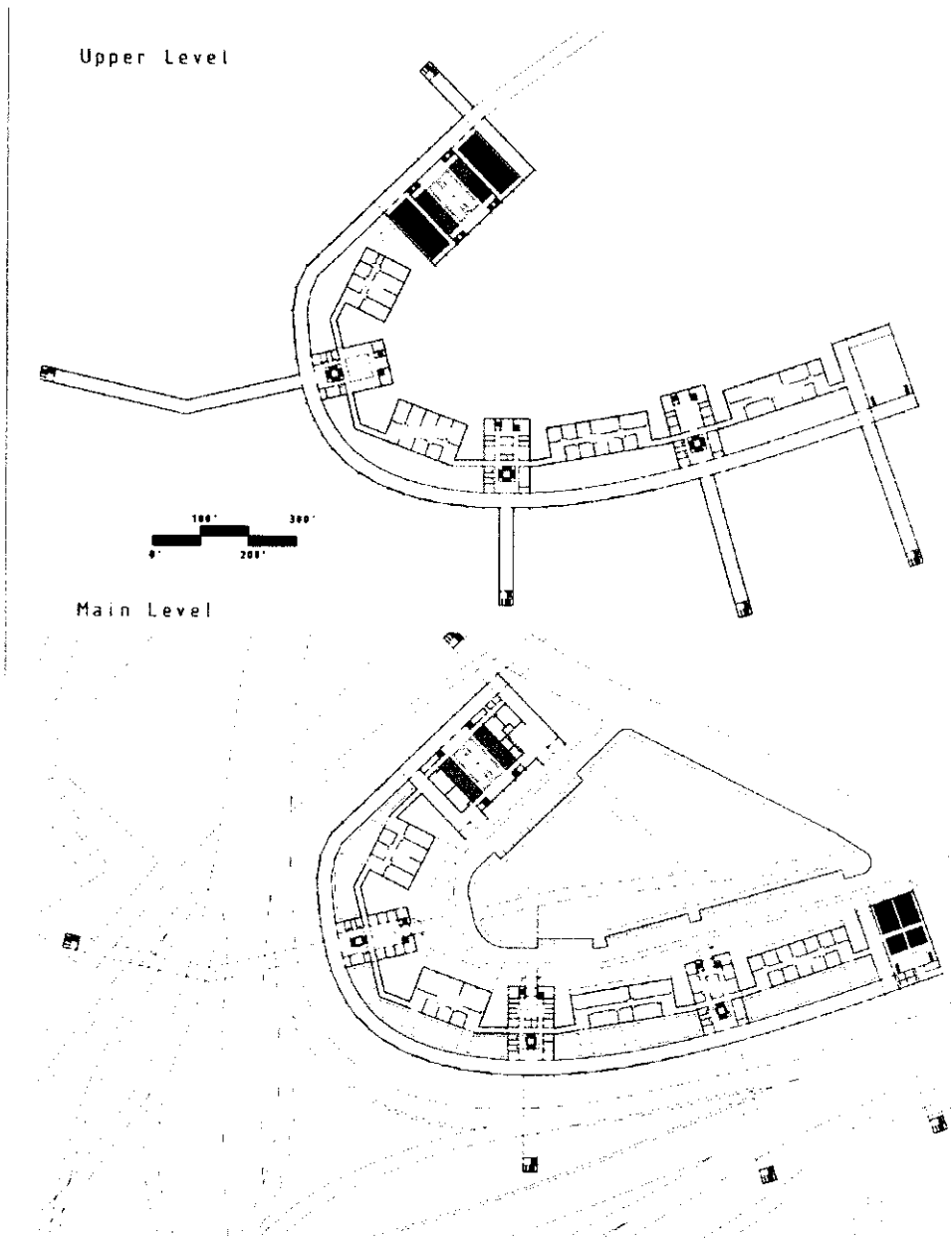


plan key:

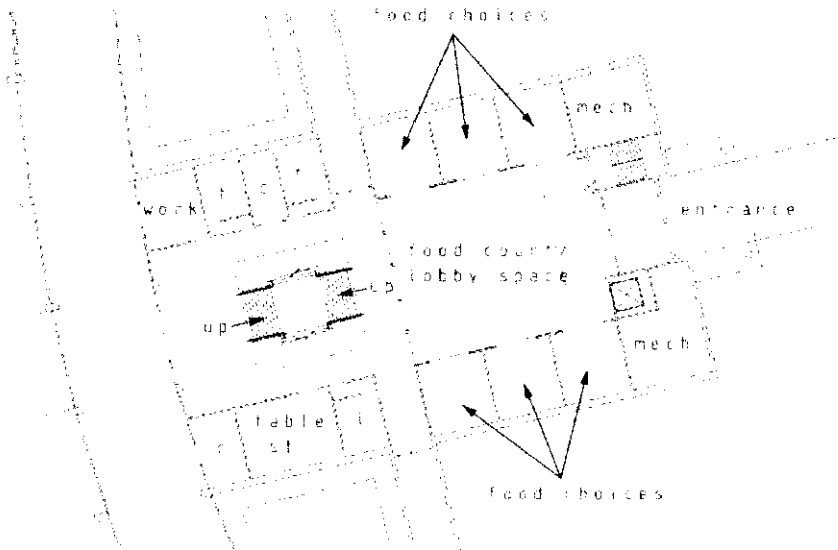
1 auditorium
2 health and human services, business
3 media center (node a)
4 arts and communications, business
5 administration (node b)
6 engineering
7 food court (node c)
8 engineering
9 gymnasium
10 train station
11 riverside station
12 cross river station
13 hospital station
14 parking station
15 ecology lab station
16 athletic fields station
17 parking station
18 parking lot
19 soccer field
20 baseball/softball field
21 concession/storage building
22 parking lot
23 tennis courts
24 locker/storage building
25 football field/track
26 outdoor ecology lab
27 parking lot
28 parking lot
29 parking lot
30 outdoor transport space



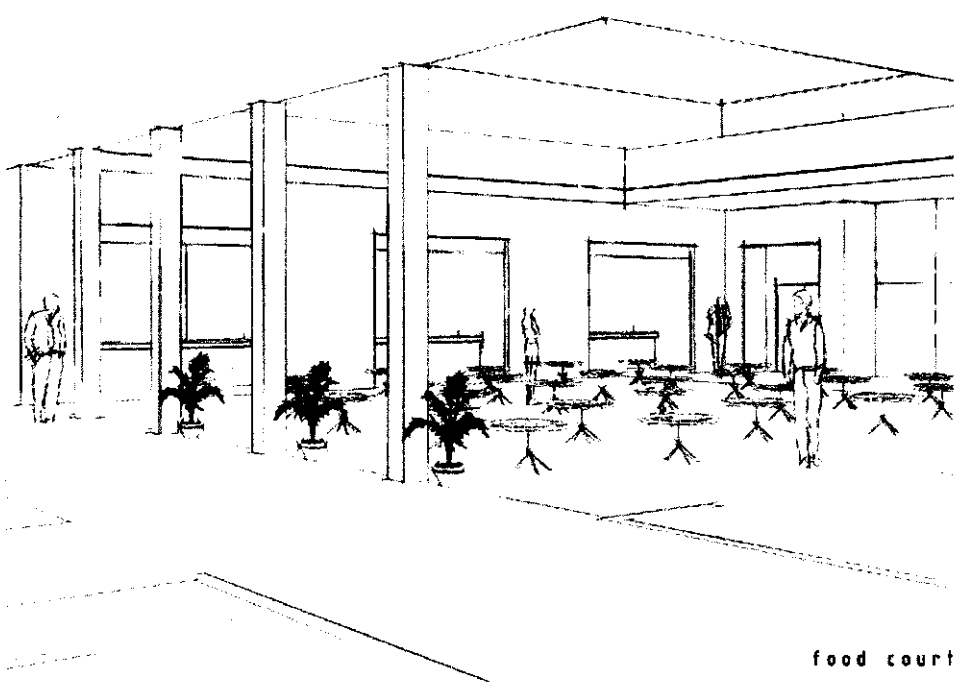
FLOOR PLAN



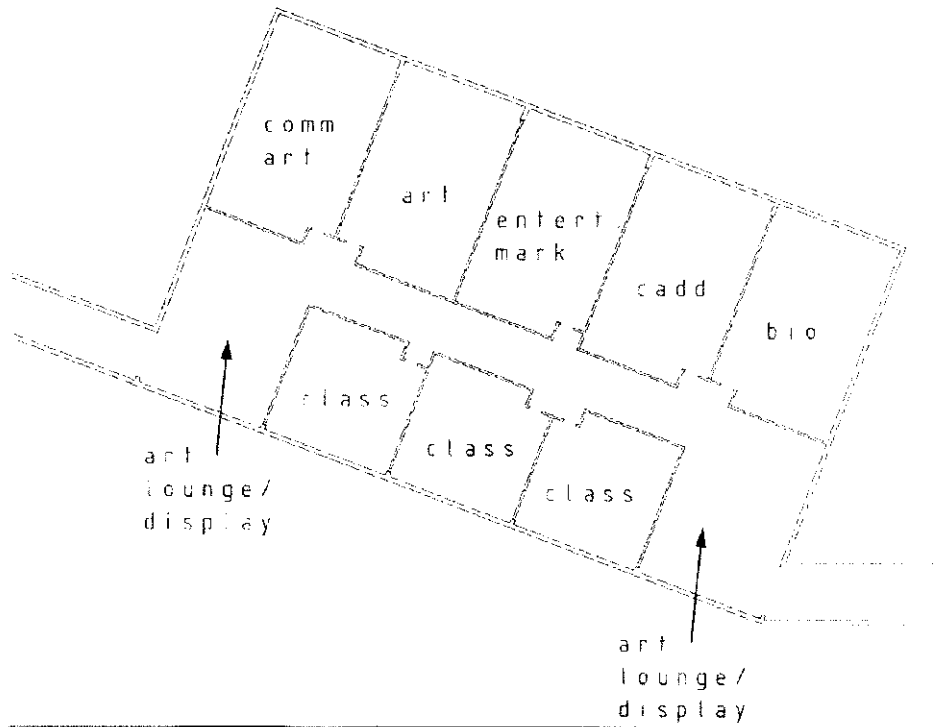
PIECES



typical node



food court


comm art
art
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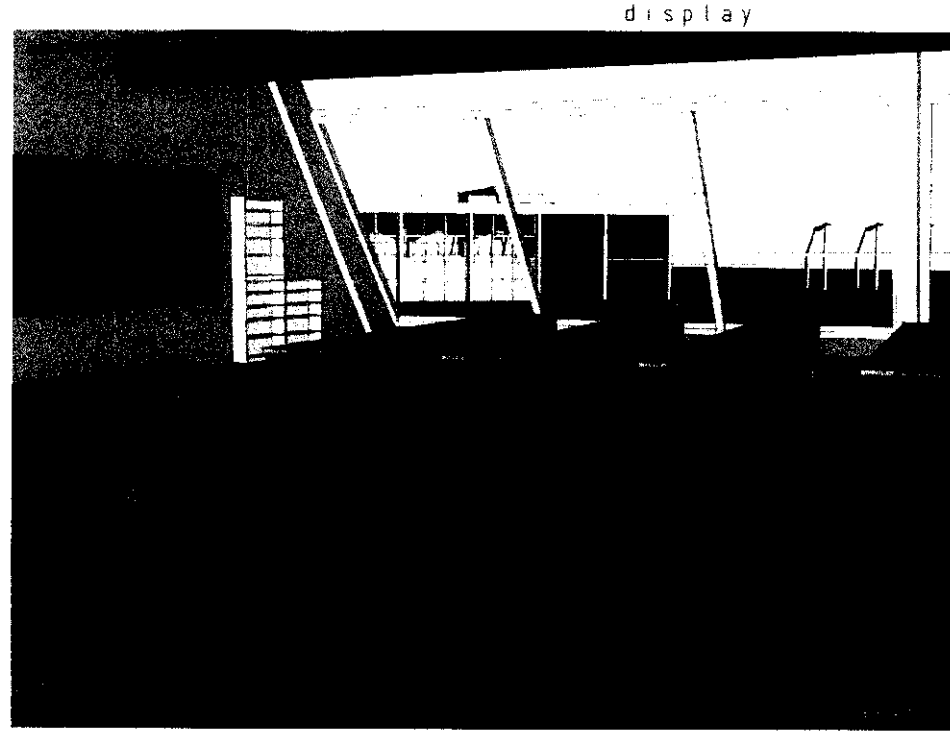
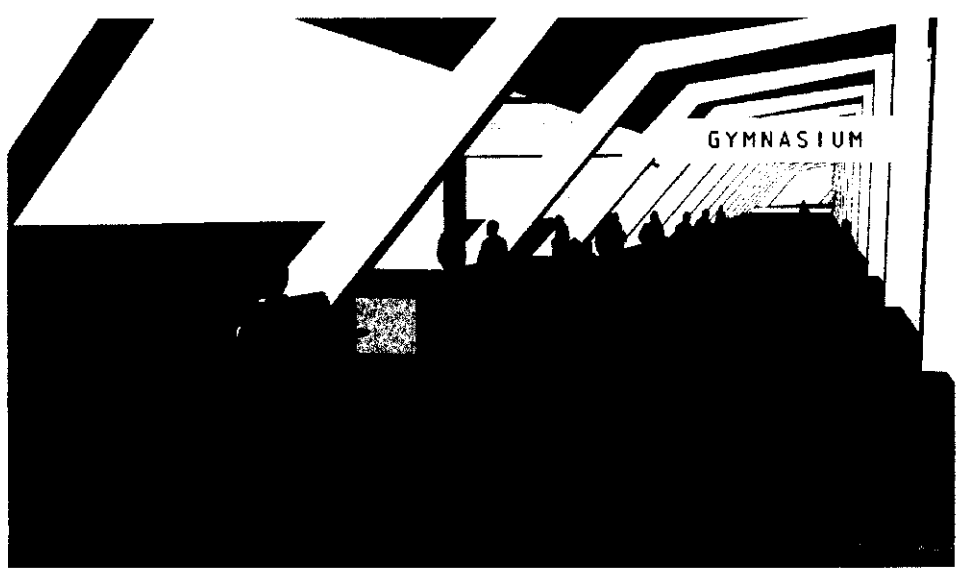
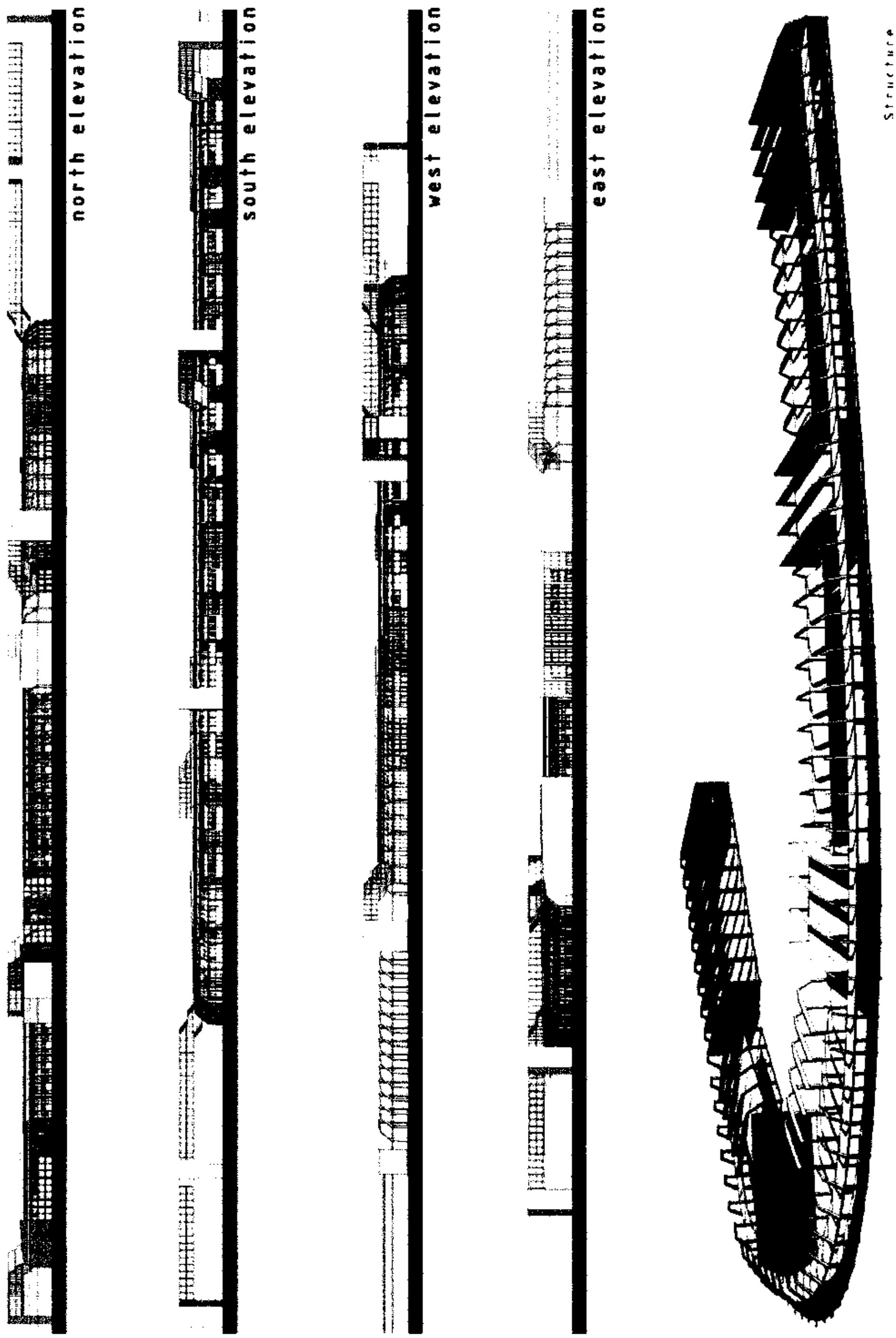
art lounge/ display
art lounge/ display



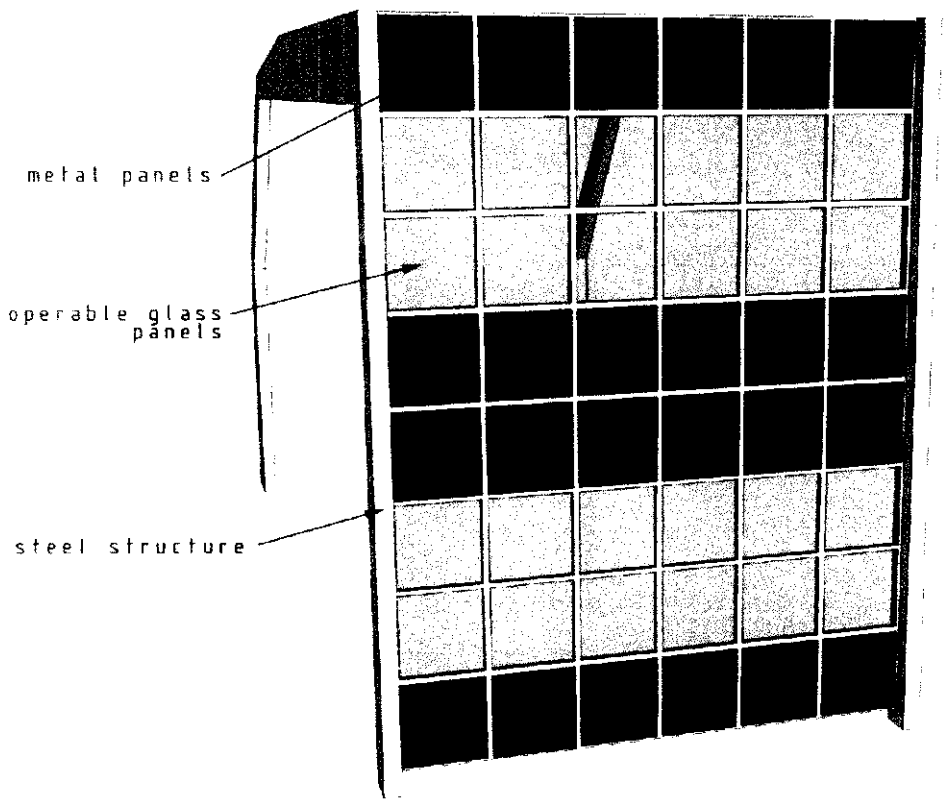

supply stand
locker bay
ecology planter

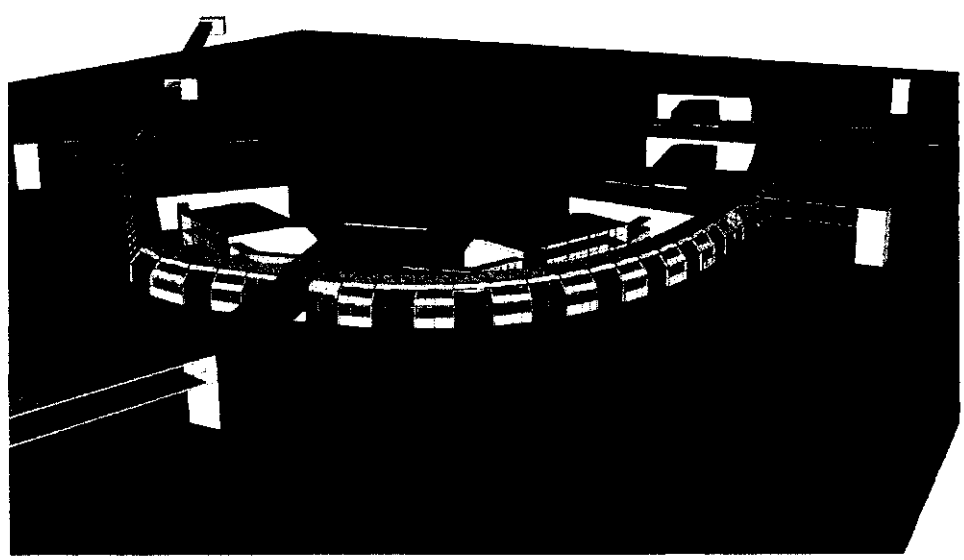

GYMNASIUM

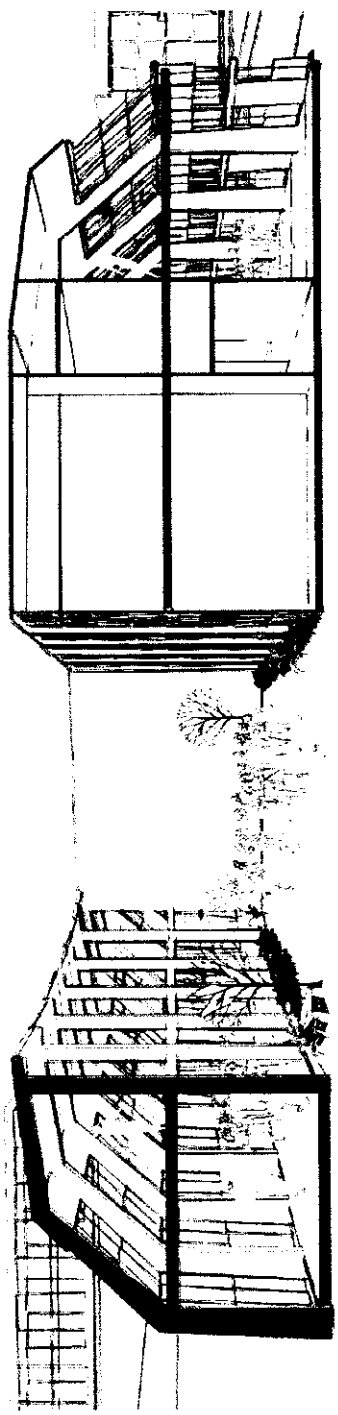
VIEWS

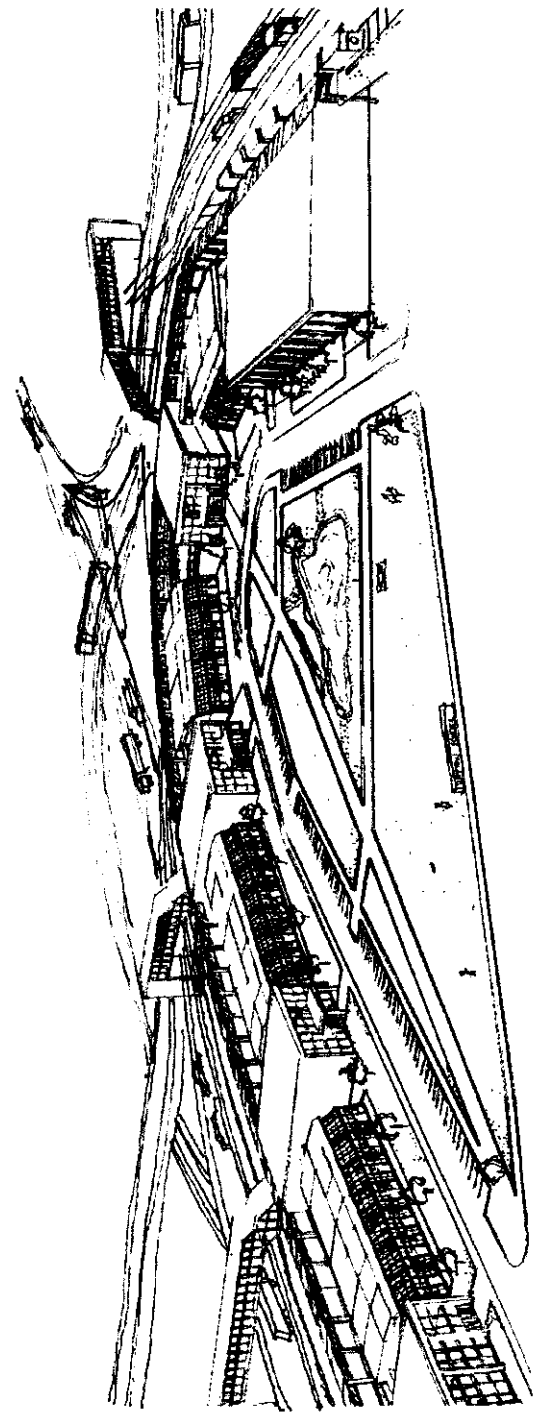


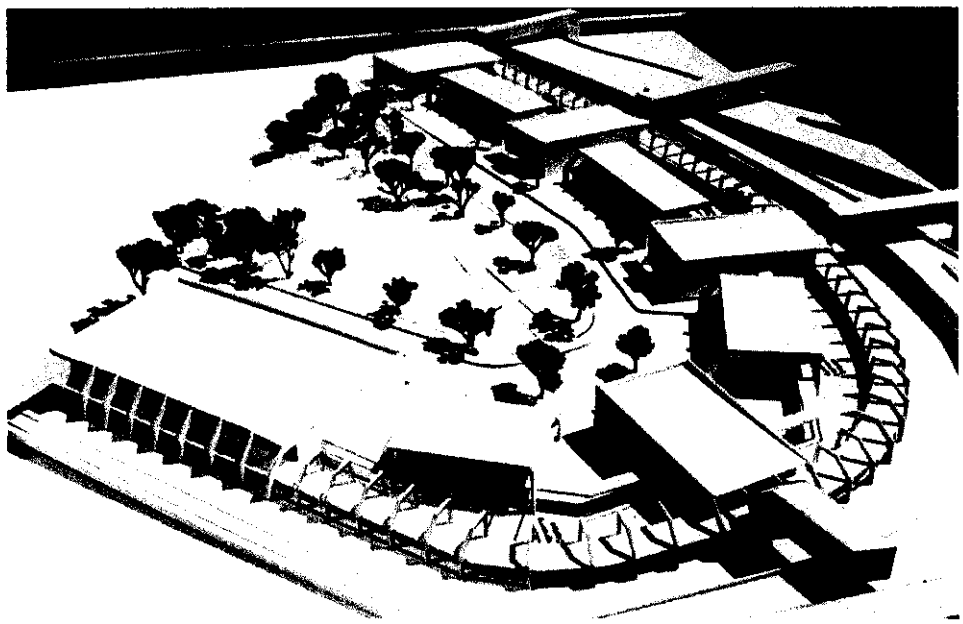
north elevation
south elevation
west elevation
east elevation
Structure

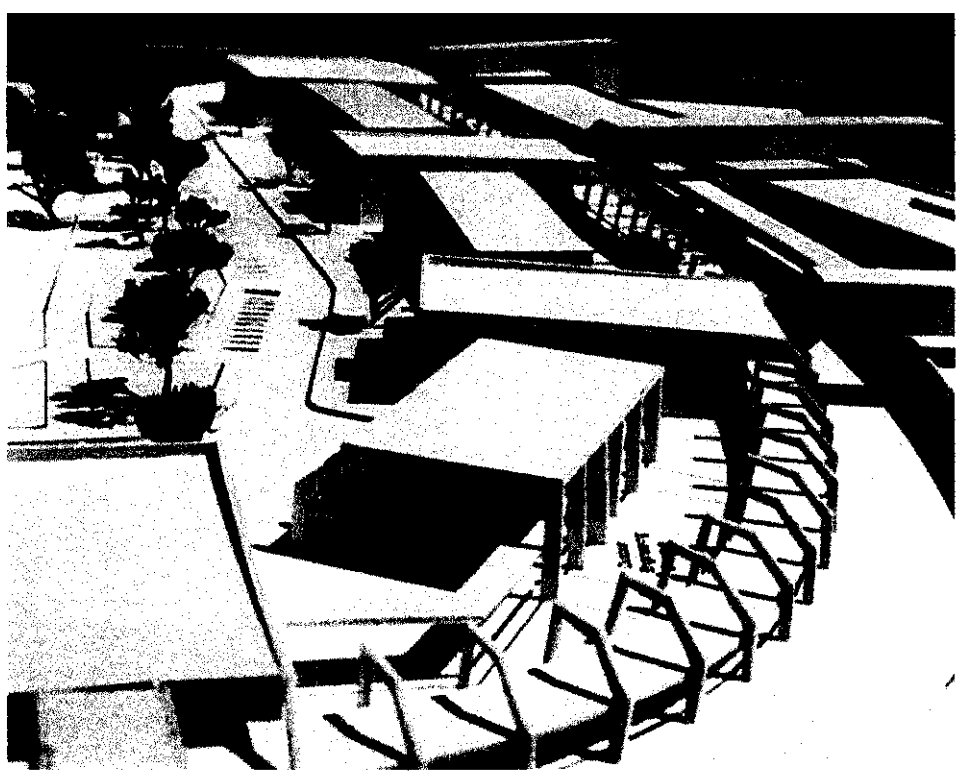

metal panels
operable glass panels
steel structure

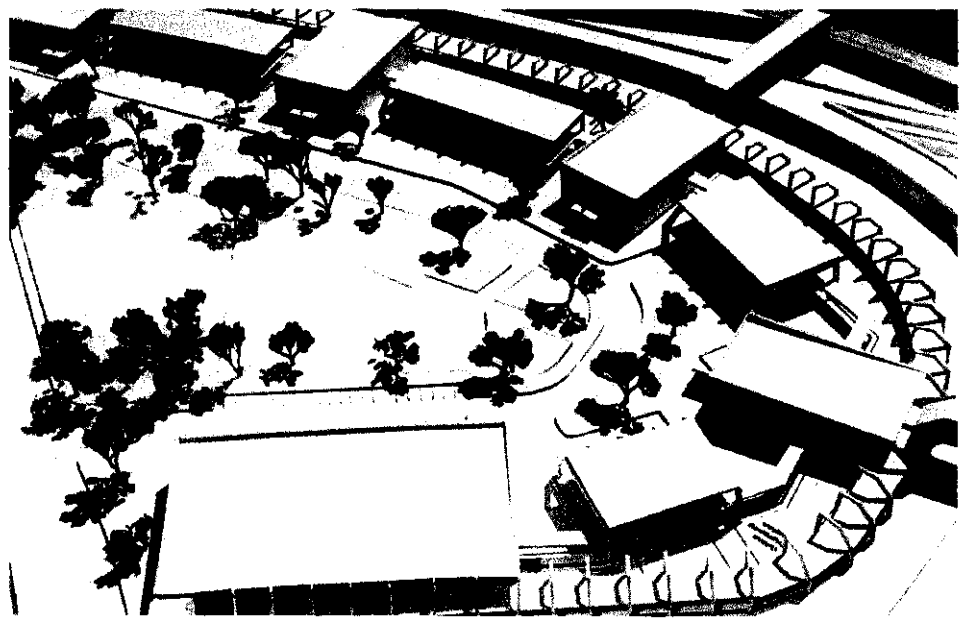


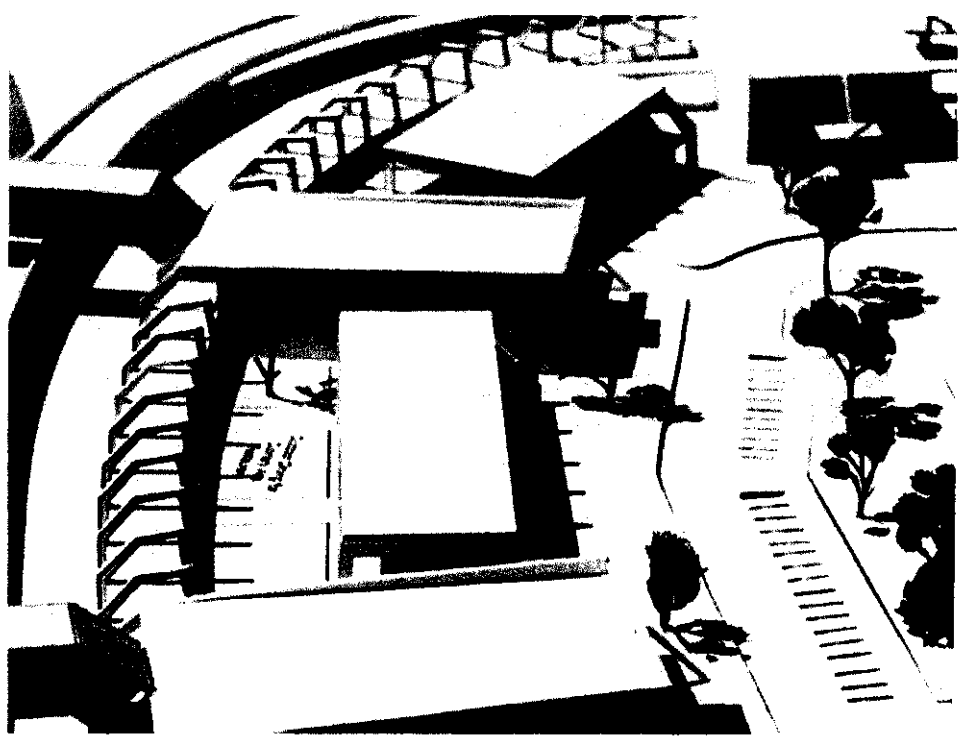


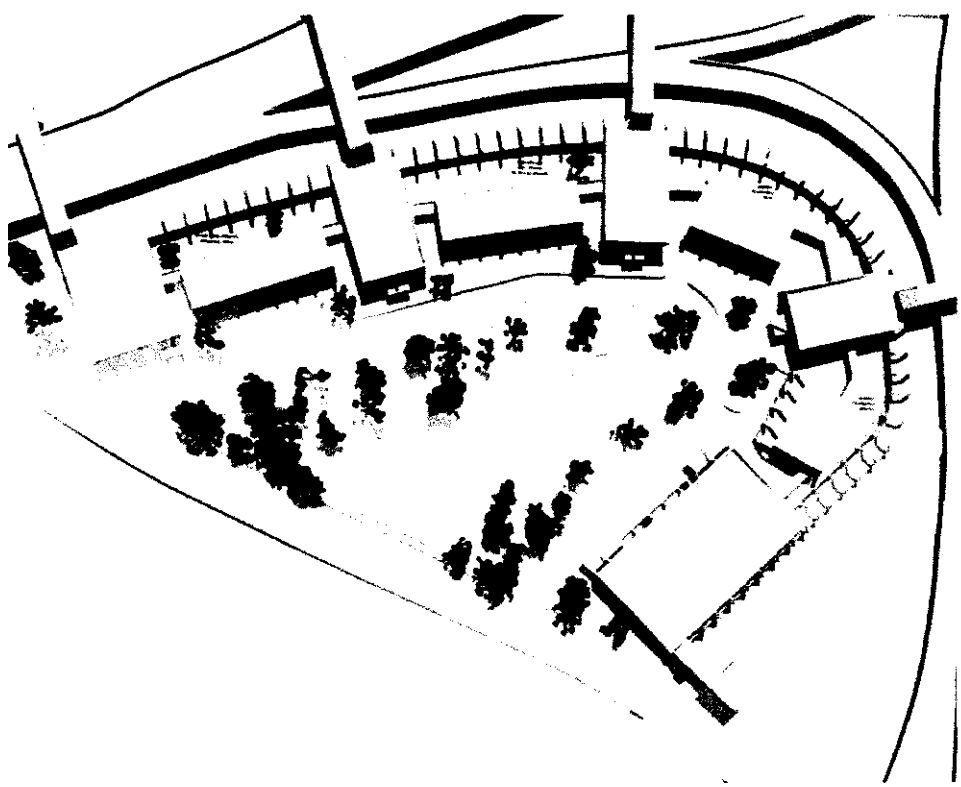












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