

# Physical and Digital Media Strategies For Exploring 'Imagined' Realities of Space, Skin and Light

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## Abstract

This paper will discuss an unconventional methodology for using physical and digital media strategies in a tightly structured framework for the integration of Environmental Control Systems (ECS) principles into a third year design studio. An interchangeable use of digital media and physical material enabled architectural explorations of rich tactile and luminous engagement.

The principles that provide the foundation for integrative strategies between a design studio and building technology course spring from the Bauhaus tradition where a systematic approach to craftsmanship and visual perception is emphasized. Focusing particularly on color, light, texture and materials, Josef Albers explored the assemblage of found objects, transforming these materials into unexpected dynamic compositions. Moholy-Nagy developed a technique called the photogram or camera-less photograph to record the temporal movements of light. Wassily Kandinsky developed a method of analytical drawing that breaks a still life composition into diagrammatic forces to express tension and geometry. These schematic diagrams provide a method for students to examine and analyze the implications of element placements in space (Bermudez, Neiman 1997). Gyorgy Kepes's *Language of Vision* provides a primer for learning basic design principles. Kepes argued that the perception of a visual image needs a process of organization. According to Kepes, the experience of an image is "a creative act of integration". All of these principles provide the framework for the studio investigation.

The quarter started with a series of intense short workshops that used an interchangeable use of digital and physical media to focus on ECS topics such as day lighting, electric lighting, and skin vocabulary to lead students to consider these components as part of their form-making inspiration.

In integrating ECS components with the design studio, a nine-step methodology was established to provide students with a compelling and tangible framework for design:

Examples of student work will be presented for the two times this course was offered (2001/02) to show how exercises were linked to allow for a clear design progression.

**Key words:** analog digital media/interaction, Bauhaus methods, pedagogy of play, visual perception, representation strategies, and environmental control systems.

## 1 Introduction

A format for integrating third year design studio content with environmental control systems (ECS) topics was first introduced in the winter quarter of 2001 and was continued in the winter quarter of 2002. The group of students enrolled in an ECS studio would be enrolled in a corresponding design studio. These two courses, with different instructors, would meet in the studio space on alternating days.

It was up to the individual instructors how and when ECS topics such as day lighting, electric lighting, thermal behavior, acoustics and water and waste systems would be made part of students' design investigations, in particular their articulation of building space and skin. The difficulty of synchronizing activities in the ECS studio, ECS lecture and design studio were formidable, and it was decided by the

authors to link these two studio activities as closely as possible (see table. 1) in order to emphasize to students that ECS issues were fundamental to their design work. Readings (the majority of the studio text was taken from "Questions of Perception, Phenomenology of Architecture", by Holl, Pallasmaa, & Perez-Gomes) discussions and sketchbook "aphorisms response" assignments provided a shared thematic framework, with a focus on how experiential, phenomenological aspects of architecture can be enriched and informed by a background understanding in ECS.

Week	(#)Activity Themes	Reading Themes
01	(1)Analog & Digital Warm-Up Ex. & (2)Conceptual Understandings Ex.	Representation
02	(3)Daylight Precedent Studies	Infrastructure & Water
03	(4A)Space Moods of Day Light & (4B)Spatiality of Night	Light & Materiality
04	(5)Acoustics & Volume	Sound & Senses
05	(6)Volumetric Configurations of Space [MID-Review]	Skin
06	(7)Skintegration (Thermal Optimization - exterior skin)	Space & Body
07	(8)Process Integration	Building Typologies
08	(8)Process Integration	Building Typologies
09	(9)Project Integration	Building Typologies
10	(9)Project Integration [FINAL Review]	Building Typologies

**Table 1** Design & ECS Studios Calendar

Early in the quarter, assignments related to students' own design work followed immediately from 'experiential' group assignments. The group "Day Lighting Precedent" study, for example, led directly to "Space Moods of Day Light", a daylight investigation in individual student design projects. At this time, around the third week of the quarter, students were focusing on the design of an "Interactive Space", and were not informed about the rest of the project program. As a result, the day lighting model and related studies became formative design investigations relieved of constraints such as fitting a space studied in a predetermined place relative to other programmatic elements or a site. The "parti" or concept design for the entire project evolved out of the ideas that were developed for this single space. This is a different model from many studios, where students are given a program and site on the first day of class, quickly develop the parti and devote the rest of the quarter or semester to developing the building in its entirety.

The same methodology for integrating ECS with design was used for all of the students' projects during the two times the course was offered. The studio projects were a 360MW power plant, a cancer treatment research center, and a Recycling Research Center. The power plant and the recycling research center projects were supported by field trips to help students understand the functioning of these facilities.

As in previous instructor's design studios, assignments were crafted for students to develop skills in both digital and analog media tools, to see the advantages and disadvantages of both, and to develop a critical attitude towards media. Early design exercises were exploratory and encouraged the use of the computer for its iterative ability and its facility in generating rich graphic vocabularies that are suggestive of spatial character and experience. Later exercises such as "Skintegration" required students to consider how these vocabularies may be translated into building elements (in this case a building's skin), and how these elements may be transformed or rearranged depending on the thermal consequences of orientation, materials and so on. For the last weeks of the quarter, students in the design studio were required to develop the project in detail. In the ECS studio, students were asked to integrate day lighting and thermal optimization in their projects, and, in addition, they were able to choose one additional topic to incorporate out of those covered in the ECS studios and lectures.

This paper will describe the sequence of ECS and design exercises that were assigned and will conclude with remarks on the assessment, lessons, successes and next steps of this ECS/Design model.

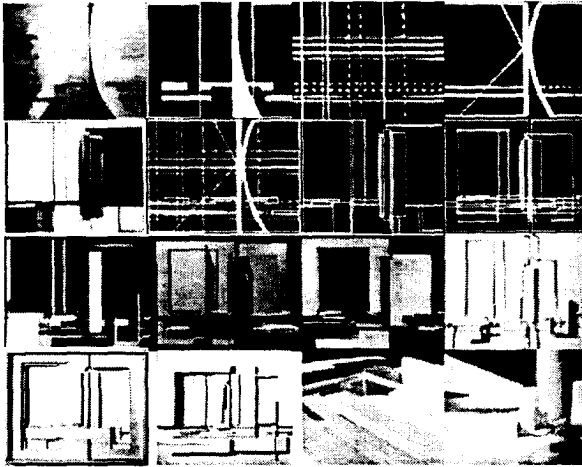


Fig. 1 Physical and Digital Media Warm-Up Exercise

## 2 Exercise One Analog & Digital Warm-Up Exercise (Fig. 1)

A previous workshop titled "Analog and Digital Language of Vision (ADLV)" conducted at Cal Poly in the Spring of 2000 (Bermudez, Fowler, Neiman 2000) provided the foundation principles for this exercise. A previous paper "Between Analog and Digital Civilizations" (Bermudez, Neiman 1997) further defined the basic premise of this approach that introduces students to the advantages of going back and forth between the worlds of analog and digital media to enhance ones ability to recognize and maximize design opportunities. This warm-up exercise (figure 1), an exercise accomplished in collaborative teams of 4 students, provided an opportunity for all students in the studio to come up to speed using a range of digital tools in the context of solving a design problem. In addition, the outcomes from this team project became a foundation kit-of parts vocabulary that each individual student would use for developing their own project vocabulary.

This seven-step analog & digital exercise (fig. 1) is based on Bauhaus principles of craftsmanship and visual perception. A strict set of guidelines applied foundation principles of the Wassily Kandinsky method of analytical drawing that breaks a still life composition into diagrammatic forces to express tension and geometry. Each step alternated between analog and digital media. This exercise started with still life images, then proceeded to acetate overlays, to analog/digital diagrams, analog/digital relief models and ended with a spatial manipulation device. The outcomes from these group projects provided a foundation vocabulary for individual student projects.

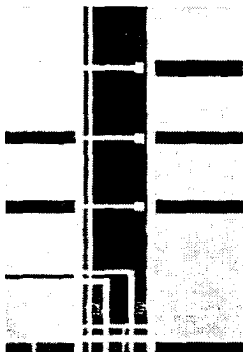


Fig. 2 Team #1  
Traces Section



Fig. 3 Team #1 Traces  
Model

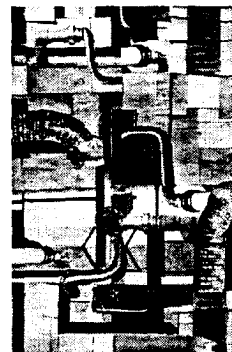


Fig. 4 Team #2  
Traces Collage

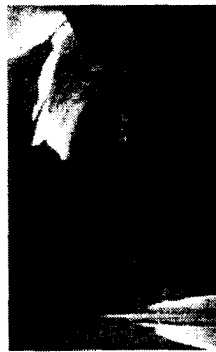
### 3 Exercise Two Conceptual Understandings – Traces of Infrastructure

(Figs. 2 – 4)

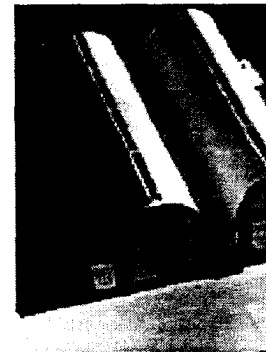
Students were asked to work in groups to “trace” water supply and return - from its point of origin to its final destination - and determine where and how in the life of the system interconnections occur within the building that they have studio in. They made rubbings of materials of the system, and crafted physical relief models, drawings and collages. Students were asked to represent these findings with compelling representations and also with “poetic” written descriptions of the sensory stimuli they experienced. A goal of this assignment was to identify formal and material qualities in infrastructure that is ordinarily out of site and out of mind, and also for students to recognize that buildings are connected to a web of systems that extend well beyond the building footprint.



**Fig. 5** Team #1  
Guggenheim Interior



**Fig. 6** Team #1  
Guggenheim Exterior

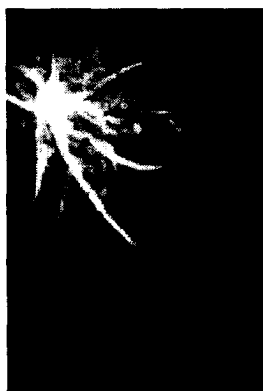


**Fig. 7** Team #2  
Kimbell Interior

**Fig. 8** Team #2  
Kimbell Exterior

### 4 Exercise Three Daylight Precedent (Figs. 5-8)

Student groups studied significant architecture precedent examples by prominent architects (Aalto, Bruder, Holl, Kahn, Le Corbusier, Piano, Wright, Zumthor) as a way to explore daylight as a form generator. After an initial gathering of information on the precedent, students were asked to develop a hypothesis about the impact of daylight on the experience and functioning of the building. A large-scale model of the precedent enabled an accurate study of interior light conditions. Digital images of the interior of the model were taken at different times of day and year and were presented to the class. Students revisited the original day lighting hypothesis based on their more intensive and refined analysis.



**Fig. 9** Marissa  
Rutledge Charcoal  
Daylight Study



**Fig. 10** Marissa Rutledge  
Daylight Model Study



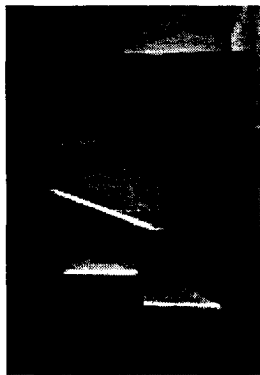
**Fig. 11** Saba Ghole  
Charcoal Daylight  
Study



**Fig. 12** Saba Ghole  
Daylight Model  
Study

**5 Exercise Four-A, Space Moods of Light – use of charcoal media and light box (Figs. 9–12)**

Students were required to generate “initial concepts” in response to design projects. During an in-class charrette, students developed a concept narrative (“catch phrases”) on a predetermined theme and created a charcoal concept ‘light’ sketch of a 48’ wide, 80’ long and 48’ high interactive main space. This space became the form-generating programmatic component of their final design. From these initial studies, and using the daylight precedent study as inspiration, students developed a 1/2” scale ‘double wall construction’ day lighting model of the interactive main space.



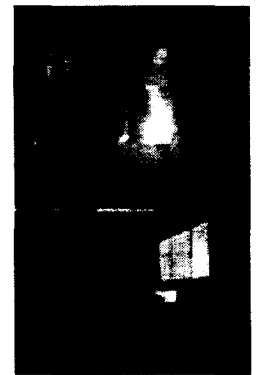
**Fig. 13** Frank Mahan Day Light Study



**Fig. 14** Frank Mahan Electric Light Study



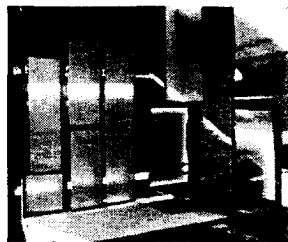
**Fig. 15** Jonathan Lott Day Light Study



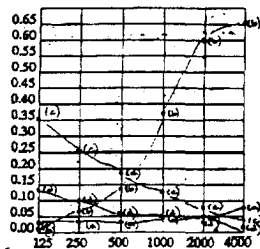
**Fig. 16** Jonathan Lott Electric Light Study

**6 Exercise Four-B Spatiality of Night: Designing with the Effects of Electric Light - an electric expression to mimic daylight scheme (Figs. 13 – 16)**

Students were asked to create “DYNAMIC ATMOSPHERE” with electric lighting working with the same model they generated for the daylight exercise. Electric lighting was simulated in the model using Christmas lights, Plexiglas/acetate sheets, rods, etc., and digital images were taken of the interior and exterior of the space “at night”. The original lighting concept was re-evaluated and refined based on discoveries made with the model. In-class discussions centered on light distribution, the interrelationship of light and the surfaces on which it falls, and the role of electric lighting relative to day lighting. Students were encouraged to ‘mimic’ day lighting after dark through the deployment of electric lighting.



**Fig. 17** Gonzalez's Acoustical Study



**Fig. 18** Gonzalez's Acoustical Cals.

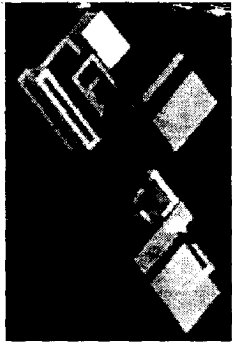


**Fig. 19** Saude's Acoustical Studies

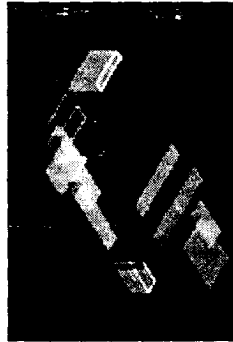
**7 Exercise 5. Acoustics & Volumes (Figs. 17-19)**

Students developed physical models for understanding acoustic performance in their interactive main space. They first calculated the reverberation time (RT) for the space, which required them to make

preliminary decisions about building materials and finishes. In most cases the RT's were high and unsuitable for speech and similar functions. Students reevaluated decisions about materials in an effort to lower the RT. In most cases this led to an enrichment of the palette; perforated panels and fabrics for example were introduced in many projects in configurations that supported the established architectural vocabulary.



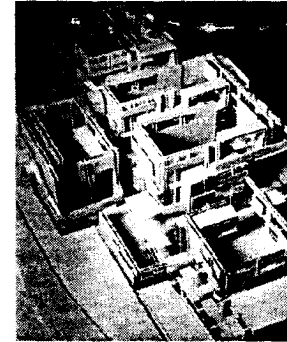
**Fig. 20** Gonzales's Volumetric Study #1



**Fig. 21** Gonzales's Volumetric Study #2



**Fig. 22** Gonzales's Volumetric Study #3

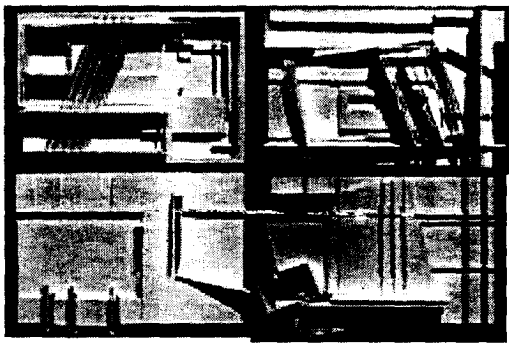


**Fig. 23** Gonzales's Study Model

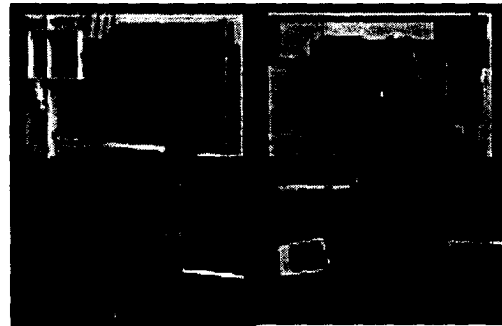
### **8 Exercise Six Volumetric Configurations of Space — expressing the project's concept in the spatial configuration**

(Figs. 20 - 23).

Transforming all of the separate components of the project (e.g., skin, interactive main space, volumetric configurations of space, etc) into an integrated architectural expression allowed students to build on and further integrate lessons learned in earlier exercises.



**Fig. 24** Sam Bermudez Skin Analog Skin Studies



**Fig. 25** Sam Bermudez Skin Digital Skin Studies

### **9 Exercise Seven Skintegration — expressing the project's concept in the skin (Figs. 24 - 25)**

Addressing thermal optimization principles required that each of the students develop four skin model details. Each detail had to embody the concept of the project and at the same time explicitly express the response to each of the four orientations (see figs. 24 & 25) – south (top left of figs.), west (top right of figs.), north (bottom left of figs.), and east (bottom right of figs.).

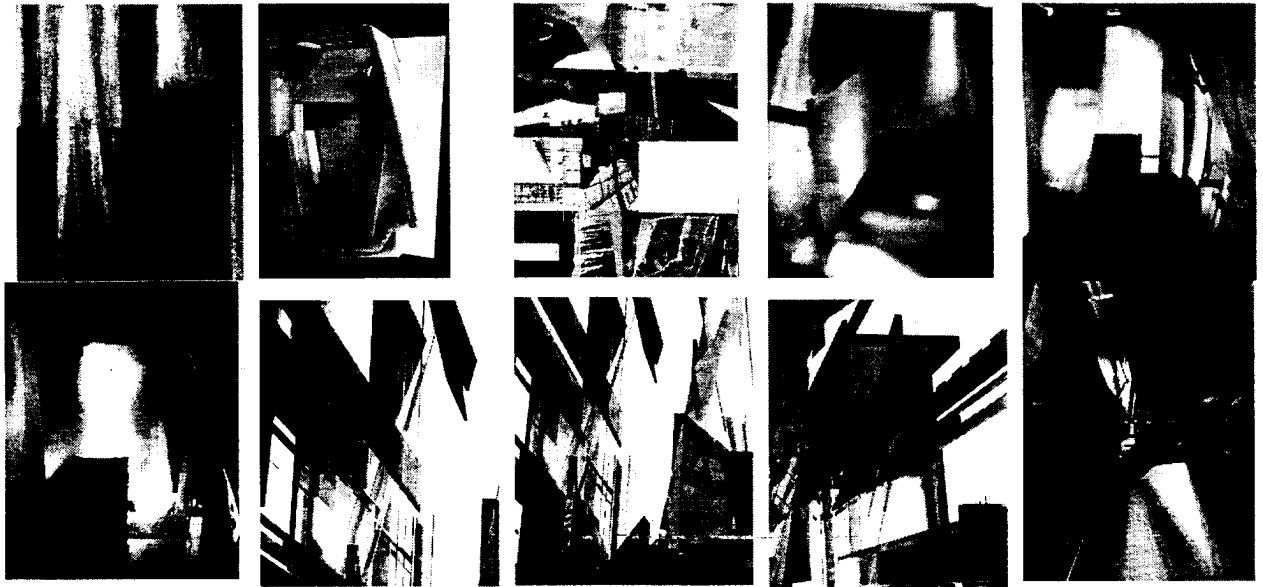


Fig. 26 Maryse Bissonnette's "Cancer Treatment Center" Design Process Sequence – Concept "Structure in Destruction"

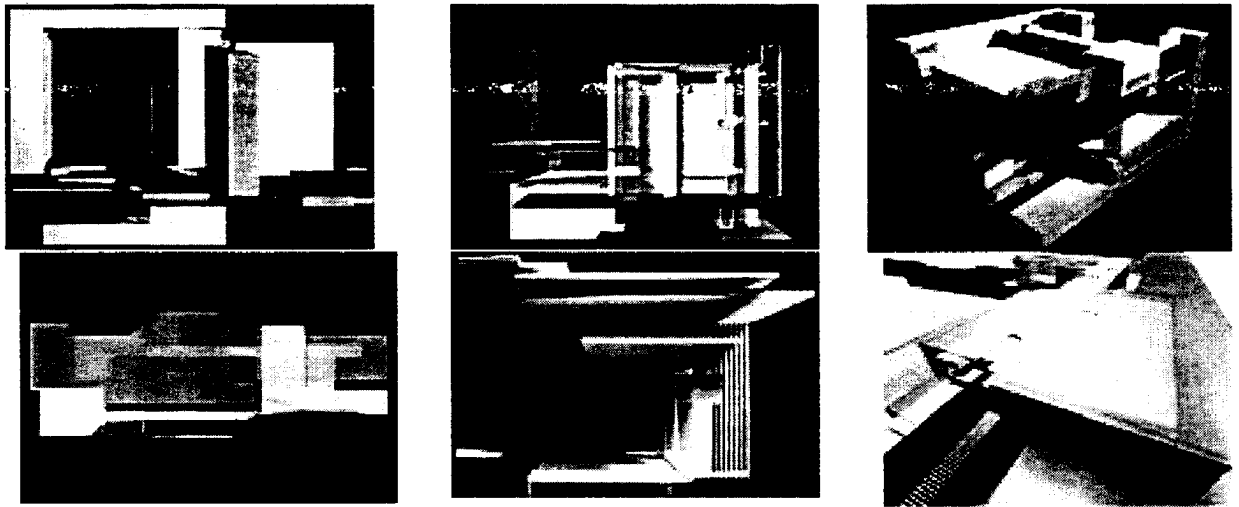
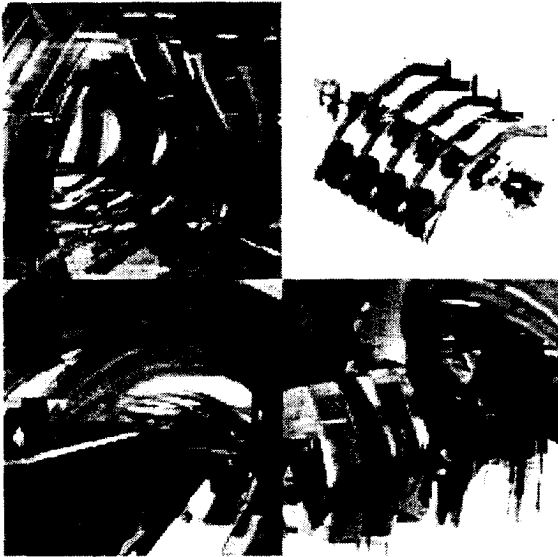


Fig. 27 Stephen Saude's "Resourcefulness Center" Design Process Sequence – Concept "Crescendo"

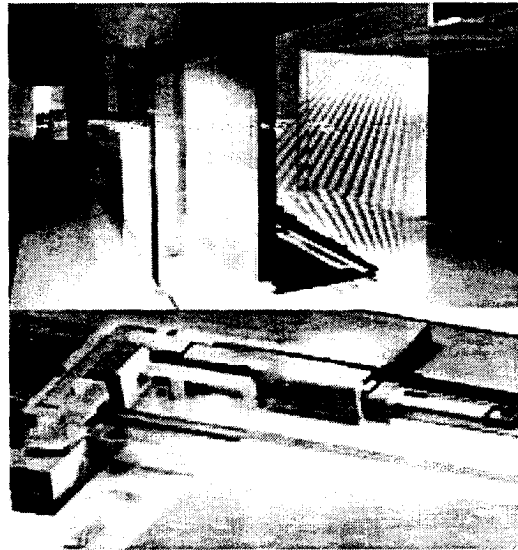
#### 10 Exercise Eight Process Integration (Figs. 26-27)

During the seventh week of the quarter, students completed the last of the specific ECS studio assignments and spent the remainder of the studio (3 weeks) integrating ECS topics in their final design project. Instructors required that students meaningfully integrate day lighting and thermal optimization ("skintegration"). They were also asked to select an additional optional ECS topic to explore out of electrical lighting, acoustics and water and waste. Students' overall performance in the

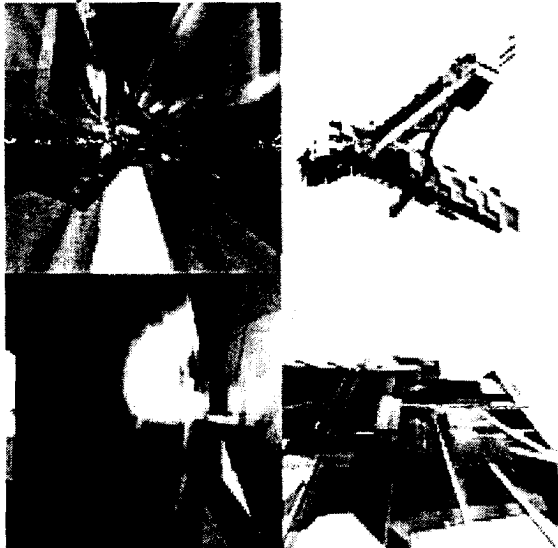
ECS studio was measured in part by their ability to skillfully and beautifully synthesize ECS issues with other design concerns in their projects.



**Fig. 28** Saba Ghole's Power Plant - Concept "Catalyst"



**Fig. 29** Stephen Saude's Resourcefulness Center



**Fig. 30** Maryse Bissonnette's Cancer Treatment Research Center



**Fig. 31** Samuel Bermudez's Resourcefulness Center—Concept "Vulture"

**11 Exercise Nine Project Integration** (Figs. 28-31)  
Final images of a range of studio projects.

## **12 Final Student E-mail Journal Feedback**

"I really enjoyed the ECS/Design collaboration this quarter. I don't think I've ever had a quarter in which the two were so well integrated. I liked the fact that we got to explore the ECS side of design by focusing on the general concepts rather than the number-crunching side."



## ...exploring space, skin and light

"I think the skin is a great opportunity to create spaces that people will find inviting and to create a different relationship with the exterior."

"Also the class showed me the way to include the computer in my everyday work and how it is important to go back and forth from analog to digital."

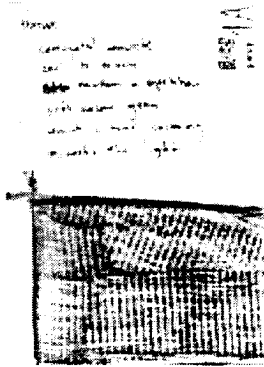


Fig. 32 Johnnathan Lott's  
Power Plant Project  
Material Rubbing #1

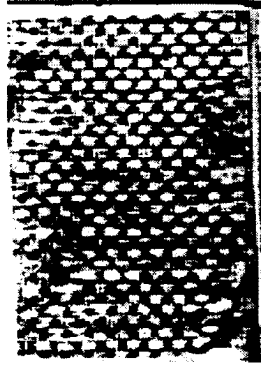


Fig. 33 Johnnathan Lott's  
Power Plant Project  
Material Rubbing #2



Fig. 34 Johnnathan Lott's Power Plant Project  
Study of Electric Lighting

13 Daily & ECS Aphorism Entries (Figs. 32 - 34)

Daily, students were required to make a single entry into a miniature 4" x 6" sketchbook. Instructors developed a total of 42 statements for students' to react to. These statements provided an opportunity to react and reflect on project development with the generation of a range of media representations.

### 14 Conclusion: Assessment, Lessons, Successes and Next Steps

#### 14.1 Assessment

The Bauhaus methods provided the theoretical framework for maximizing design opportunity through the interactive use of analog-digital procedures in developing analytical drawings and models. It's difficult to separate the methods from the procedures to determine which aspect of the framework is more effective, since both work together to provide the clear and strict set of rules for the students to react to throughout the quarter.

The success of developing these Bauhaus methods into an analog-digital framework is that it introduces students to a pedagogy of play and interpretation in which focuses more on the poetics of representation (and not its technicalities) as the driving force to generate architectural understanding. The act of playing (execution) precedes results (conception) or, interpretation follows form and form follows action. This allows for the development of an experimental yet critical attitude towards the value, rationale and logistics of media in architectural design. (Bermudez, Fowler, Neiman 2001). As one student stated, "this process allows no one in the class to be left behind". All students in the class are equally engaged in the design process and all have visibly significant components to develop as a result, which also adds to the dynamically charged nature of the studio environment which does feed into each of the students' project development. Another student best summed up the difference of using both of these mediums along with indicating what happens when these mediums become interactive with the following statement, "(The) ANALOG (medium) states the tangible while (the) DIGITAL (medium) inclines the mood. (The) DIGITAL and ANALOG combine to communicate what sits behind my eye-lid-curtain".

The overall quality of the studio projects — when compared holistically to the other seven third year ECS/design studios both years — was mostly visible in the strength of both the interior and exterior architectural vocabulary of students' projects. There was also an ease of understanding how a student's project (in looking at the documented design process) related to the concept, ECS issues and how project evolved over the duration of the quarter. Both the vocabulary development and the clarity of the process was due to the following: first, the quarter started with the analog-digital warm-up exercise (which established the foundation for design tools framework and architectural vocabulary); second, this same framework was used for the strategy of studying the ECS components for their individual project; and finally, continuing to use this framework for the synthesis of the significant ECS components into total development of project. A few student insights that shed additional light on the quality of projects based on this process include: "The ... process was very integral in developing a design vocabulary, in terms of form and most importantly skin. It provided a firm inspiration for defining that skin, without that it would have proved a difficult struggle to find a foundation to leap from." "(The process) has helped me in creating a strong architectural language that has guided me throughout my project. Thus, I was not distracted by the many issues that faced me, but was able to rationalize and keep my idea(s) clear and strong." "The use of multi media (analog-digital tools) and the intense pace of this studio created a strong and direct process that inspired my design throughout the quarter. While all the parts remain exercises within themselves, it is when you see how they all relate to one another and speak of a unified process that makes this design approach so significant."

#### *14.2 Lessons, Successes and Next Steps*

Going back and forth between digital and analog media has the advantage of revealing more quickly and more clearly weaknesses in a project as well as inconsistencies between a student's original intentions (for example about how light will work in a building) and what is revealed in their work. The most successful students quickly identified shared qualities of images generated on the computer and on paper and a composite idea of the project seemed to emerge as they proceeded. These students committed to a consistent formal language that they could articulate and develop in both digital and analog realms.

A goal as students move from the generation of a graphic vocabulary to a building design would be to have them quickly model the energy and environmental performance implications of their design (such as it is, at that point). This would force a preliminary consideration of building materials, glazing areas and so on. As they proceed they will be able to translate what is in many cases a rich kit-of-parts vocabulary into something that is compelling architecturally and that also makes sense in terms of energy use regarding light quality and so on. A survey of computer energy modeling tools with strong graphic interfaces would be a logical next step in the development of the ECS/design integration model.

An immediate immersion in ECS-related topics in the first few weeks of class set the tone for the quarter. In stressing the importance of understanding acoustics, day lighting, and thermal performance in the creation of meaningful architecture, it is essential to make these topics compelling for students. While the early foundation exercises required measurement (of light levels, sound intensity and so on) and a familiarity with equipment, terminology and concepts related to building performance, this analytical understanding served to enrich a larger experiential and qualitative exploration of architecture (for example how light can be employed to provide atmosphere or make evident a destination, how contrast supports or diminishes desired effects, and so on). This had an energizing effect on the students.

To work in groups and to study the work of others as a way to begin the quarter relieves pressure of immediate creative authorship, or, in other words, the necessity of an "overnight genius solution." Instead, students go through a process where graphics and analyses are quickly developed and become powerful tools for later design work. With the "Daylight Precedent" for example, although it is true the buildings the students studied all have qualities that defy description, they are at the same time tangible and definable. Materials and their reflectances, dimensions and profiles can be measured, and

## ...exploring space, skin and light

natural light in interior space can be studied. Accurate models made by the students help enormously in understanding how light works in buildings, something they began to translate in their own design work.

The flexibility of this model, where an early and intense focus on ECS is balanced by an immersion in design later in the quarter, recognizes time constraints and priorities as the quarter progresses and the desire for a successful and well-developed final studio project. The success of this model depends upon a shared understanding of objectives and a high degree of coordination on the part of the ECS and design instructors.

The power plant project, resourcefulness center, and cancer center promoted a high level of dialogue and critical thinking about architecture as well as broader social, economic, and environmental issues, and provided a political response to current issues – such as energy crisis in California and issues associated with recycling. The magnitude of these projects and the fact that these are non-traditional building program encourages if not forces students to contend with ECS issues. As one example, the power plant requires three million gallons of water per day for cooling purposes. This water needs to be cleansed, and this purification typically occurs through a chlorination process. Students interested in pursuing 'water and waste' as their optional ECS topic to integrate in their design were given an environmentally friendly alternative to investigate, consisting of a 80,000 cubic foot trickling filter, a carbon sink pond and a 2.5 acre constructed wetland. Water became a functional infrastructure that could not be ignored; it also became a design element that helped students mediate the relationship between building and site.

One of the challenges of the quarter system and of design education in general is the difficulty of exposing students to a new topic, acoustics as but one example, having them explore it in a design problem, and expect them to meaningfully integrate the topic in a final project. The ECS/Design integration model and the Bauhaus analog-digital methodology attempted this past winter would benefit from a more rigorous project evaluation of environmental criteria at the quarter's end in addition to feedback about the quality and spirit of their work, time constraints notwithstanding, so students have a clear idea of the extent of their success.

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