By All Means: Multiple Media In Design Education

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ABSTRACT

This paper describes how to combine media to maximize understanding in CAD education. Advantages such as synergistic communication, clarification of common concepts and awareness of media characteristics are illuminated through digital and traditional projects. Learning computer media through communication exercises is discussed with examples from networked collaborations using the World Wide Web. Language teaching shows how to use these exercises to encourage critical thinking in a CAD curriculum.

1. Introduction

Throughout the design process, architects generate many kinds of artifacts which represent ideas. Traditionally, a heterogeneous mix of sketches, models, and renderings have been used for communication with colleagues and clients. With computer media, the range of tools keeps expanding and the time to learn them seems to contract. In this setting, how can we exploit the range of visualization tools to create the best quality designs with the most efficiency? How can the educational process equip graduates for this task?

One way to prepare students for new challenges is to familiarize them with a range of digital and traditional tools. Working in more than one medium: 1) shows the individual advantages and disadvantages, 2) allows insight into the interplay between method and content 3) reveals how translating between media can enrich the process.

This paper incorporates ideas from related arts and media into computer aided design (CAD) education for architects. The phrase CAD is used in its broadest sense to include all forms of digital design tools. Examples are drawn from teaching of elementary CAD, design studio and architectural representation at the University of Hong Kong (HKU).

2. Synergy with multiple media

2.1 EACH MEDIUM HAS ITS OWN CHARACTERISTICS

Each medium in which a designer works is like a musical instrument, with its own characteristics and idiosyncrasies. Digital tools in particular are defined to excel in specific, well-defined ways, even as their number and diversity grow. Because media and content are inextricably related, certain ideas will only emerge with specific tools. Designers must be taught different media to give access to lateral thinking. A well-informed designer needs to act as a conductor, knowing exactly which voice to call on for a particular kind of expression. Appreciation for excellence, as in masterworks recordings, and basic operational understanding, as in how brass instruments differ from strings, will equip a designer to make the right choices.

2.2 START WITH ONE MEDIUM AT A TIME

Introductions to individual mediums provide the preparation necessary for later combining media. At the Univ. of Hong Kong, first year undergraduates have a required

class which introduces a spectrum of applications. Topics have included system basics, network communications, /image manipulation, desktop publishing, 2D and 3D modelling, databases, rendering, and animation. The class covers basic computer concepts and gets students started with using software to solve simple creative exercises.

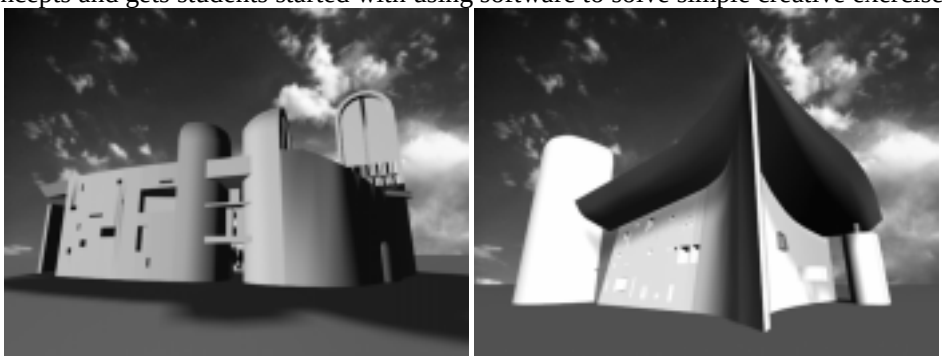


Fig. 1. First year CAD renderings of Le Corbusier's Ronchamp by Wai Man Cheung.

The class format consists of a weekly two-hour large-group lecture which includes conceptual explanations, software demonstrations and visual examples. Software procedures are learned through self-guided tutorials, in both computer-based and book form, and through additional weekly small group help sessions led by a teaching assistant (TA).

Adding things up

After introducing areas for further exploration, we must show how tools can work together as an ensemble. Students need to try using different kinds of digital tools together to understand particular possibilities of each. Taking a project through a series of applications emphasizes the portability of data. Simple examples include taking the outline of a manipulated scanned image into an illustration program, using a desktop publishing tool to layout separately created text and graphics, and importing CAD renderings into image-manipulation software. These examples can additionally demonstrate file dependency and clarify how files can be hierarchically linked.

Working in multiple digital media reinforces common principles

Introducing a series of programs can reinforce understanding of common organizational strategies that are used in many programs. For example word-processing and drafting programs both have elements with attributes which may be controlled by independently-stored style format definitions. Types, transformations, hierarchy and inheritance can be introduced in simpler programs to make more complex programs seem easier. Different manifestations can clarify an abstract concept.

2.3 Different media for different objectives

After the students have practiced combining the media serially, then they combine them in parallel. At HKU, CAD skills learned in the introductory class are complemented by traditional visual studies and design studio practice so that the students are ready to combine media in their second year. We require them to try different methods in the design studio, where a variety of techniques can spur creative shortcuts.

Parallel media: Physical models and CAD models

Combining traditional media with digital media provides a contrast between the different properties of each. For a second-year undergraduate design project, we modified a formerly all-CAD requirements to require both CAD and physical models. This Assembly Project requires the students to design components for hierarchical

assembly, first into modular units and then into a building. It shows them how a building's organization can be mirrored in its CAD data structure. When the students worked on this project solely with the computer, they had difficulties understanding the structural weaknesses of their projects, particularly instability and member sizing.

In Spring 1995, we changed the problem to include wood and metal models. These models were used to study historical precedents, create new modular bay designs (1:50) and find site massing strategies. A computer model was then used to develop a building design and construction details. This approach gave them a more intuitive feel for instability, deflection and modes of failure through the study models and showed how the computer excels at geometric transformation, structural analysis and hierarchical design. (Cheng 1995) To reduce redundancy, representation should explore a specific aspect or scale.

A good example of the synergy that can develop from working in two modes came out of this exercise. After admiring one classmate's model of Nicholas Grimshaw's Waterloo International Terminal, a student adapted part of the structure for his own bay design. Using the computer, he modelled a sculptural 3D truss element from Grimshaw's design and then manipulated the geometry to create a new paired rhythm. By extending the arcs of the ends of the paired trusses, he was able to generate a completely different kind of pier condition. The computer made it was possible to find a form that would have been very difficult to shape accurately in cardboard or wood.

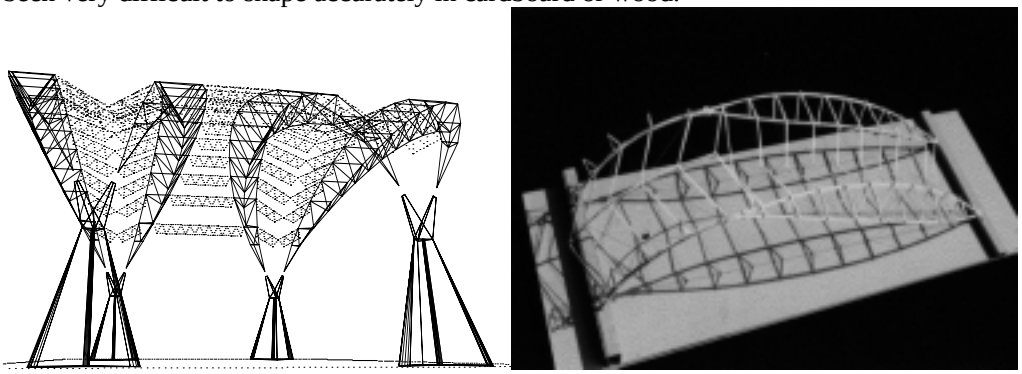


Fig. 2. Wan Chuen Ng (left) used the computer to adapt Grimshaw's model by Charlotte Hagg (right).

Working in multiple media is critical because each media enforces its own rigor or demands upon the development of an idea. (McLuhan 1964) CAD drawings force a precision in defining geometry and require an abstract understanding of design organization. Physical models demand less precision, but require spatial coherence in a way that 2D drawings do not (as shown by elevations which do not meet correctly at a corner).

3. Translating between media

3.1 Multiple channels reinforce understanding

Most artists and artisans work directly in a medium such as clay, fiber or paint. But since architects must rely on paper and digital substitutes for the final masonry or steel materials, they must become adept at visualizing their designs through a variety of channels. Taking a project from one medium to another can lead to new directions and encourage refinement. Robin Evans explains the way that this enrichment process can work for architects in translating from drawing to building. (Evans 1986) He says that by drawing on paper, architects don't get the immediate feedback that comes from manipulating bricks and mortar. Instead, we get the precision and abstract nature of

drawing. Drawings, particularly digital ones, allow us to project and manipulate complex geometry in ways that would not occur by pushing around stone columns or I-beams.

3.2 Multiple media can mean thoughtful translation

Not only does the medium of drawing empower our imagination, but also the conversion process itself provides opportunity for reflection and refinement. The transition can be as simple as switching from pencil to marker or as involved as planning how to organize a computer model from a sketch design. While gliding fluidly fosters spontaneity, changing gears in a more laborious way can improve the project by encouraging re-assessment. When the transition is not seamless and automatic, it requires consideration of essentials.

In the case of translating from drawing to building, there is usually a negotiation between the contractor and the architect so that the design intent is realized most effectively. It takes years of experience for a designer to truly understand how his drawings could be built. In his mind, lines are automatically decoded and missing information is imagined. But ideas developed with the abstraction of lines need to be modified according to construction practices and field conditions. While compromise can reduce the quality of the design, the need for it creates an opportunity for improvement.

This enrichment can take place when re-articulating into any new medium. The process of re-articulation accelerates the design process's cycle of creating, re-assessing and refining by forcing consideration of what is essential and what is vestigial. When this re-assessment requires the presentation in a new medium, it requires us to think the idea in a new way that fits the medium's constraints. To take a project from one medium to another requires understanding of both media; the boundary accentuates differences.

These differences are critical to understanding new media which have less-developed conventions. As the technology matures, new symbols and analogies need to be assimilated in the way we have accepted "links" and "nodes". We can often make the digital depictions more vivid by creating parallels in familiar media. For example, carving and gluing forms are analogous to Boolean operations. Until virtual reality systems become more accessible, working in a second medium can anchor new conventions.

3.3 Parallels in second language acquisition: Learning universal principles

Knowing one medium of expression gives direction for learning others. Learning one language provides the skills for mastering a second. (Bialstok 1994) Second language learners understand verbal communication from their first language, so experienced designers see how to use graphic and spatial elements in many media. Distinguishing unique features from more general principles accelerates fluency.

A medium like painting brings us into the realm of color as well as the realm of the pigment's vehicle, whether it be oil, acrylic, water or egg yolk. The world of additive color is the part which remains invariant across different media, whereas the exact stiffness of the paint and the brush is very dependent on the exact type of paint. Skill in laying a watercolor wash is useless in layering up gobs of acrylic. But the lesson of how a light patch of yellow ochre looks in a field of cobalt blue will be useful in many fields.

Understanding color theory and studying color experts like Cezanne gives relevant lessons for image-processing tools. Ideas about color may be gained from cutting and pasting Pantone papers or by sliding Hue Saturation and Brightness controls. The method of finding and using color will depend on the tool, but the fact of how certain colors appear together may be re-used. Similarly, principles about rhythm, contrast, connections, and dynamics can be found through one medium and applied to others.

4. Why focus on communications in computer media studies?

4.1 COMMUNICATION GIVES A SOCIAL MOTIVATION TO COMPUTER WORK

Whereas discovering new principles is rewarding, learning technical means to find them can be arduous. Focusing on design communication can make media learning compelling. Communication exercises in computer classes can humanize a potentially cold and intimidating subject by providing human feedback. For students who are intimidated by strict procedures, sympathetic and encouraging peers, penpals, or coaches can be a welcome antidote. Knowing that their work will be displayed and discussed can make students work hard, whether out of personal pride or fear of embarrassment.

Encouraging the class to be a networked community can mitigate the anonymity of a large class size. E-mail democratizes the classroom by putting professors, teaching assistants and students on more equal footing. (O'Donnell 1994) It gives accessibility to tutors in times of frustration. FTP sites can be homework hand-in sites, archives for student works, repositories of good examples and sites for discussions.

4.2 DEEPER UNDERSTANDING THROUGH CREATIVE EXPRESSION

Conveying an idea to others requires competency in using a medium as well as some understanding of its expressive possibilities. The incentive of a social relationship can stimulate creativity in crafting a missive, whether to impress, amuse or merely inform. In particular, since young adults are often very keen on impressing their peers, they will be more inventive when they have an audience. While theatricality can substitute gimmicks for content, this is mitigated by the fact that creating a compelling presentation requires control of the media.

5. Media learning through communication exercises

5.1 ROLE-PLAYING AS RECIPIENT OF INFORMATION

Getting students to use computers for communication means setting up different kinds of situations for sharing work-in-progress. In our introductory courses, students' weekly or bi-weekly assignments are often reviewed in class. Group sizes range from pairs to the whole class so that students can develop work in relative privacy and present it in more formal situations.

Whatever the format, the key is to the exercises is role-reversal: making students the recipients, readers, or interpreters of work similar to their own. Critiquing each other's work forces them to see the assignment through other eyes.

Situations for this can be set up in different ways. Small-group in-class brainstorming exercises can provide a break from lecturing and engage the students in using ideas from the lecture. This can be as simple as having students take five minutes to identify possible CAD symbols and operations in building facades. By working in a group, the student is removed from isolation, getting feedback and giving opinions.

The instructor can make the sessions more productive in several ways. By setting ground rules such as balancing criticism with praise, avoiding personal attacks, and emphasizing strong points; the sessions will be constructive rather than contrary. By monitoring remarks or summary comments and then correcting or adding ideas, the teacher can avoid the risk of inexperienced students misleading each other.

Levels of comprehension

In language learning, the highest cognitive skills are required in understanding and creating a cogent argument. Understanding argument requires attention to abstract ideas and the ability to recall structures and relationships. (Brown 1994) Putting forth an idea or an argument requires critical thinking, mental organization and rhetorical skill. Collecting, organizing and analyzing material to apply it to specific contexts exercises reasoning abilities. Responding to others' arguments develops discrimination about quality and flexible thinking. Delivering an argument requires development of persuasive

presentation skills in orienting to a listener's viewpoint, in using language accurately and expressively. (Byron et al. 1993)

5.2 Debate: Making students voice ideas formally

Formal debate forces participants to perform these tasks in a way that architects would do well to emulate. In Hong Kong, because debate's structure provides permission for culturally reticent students to articulate and dissent, it has been seen as a useful teaching tool. (Byron et al. 1993) The abstract thinking and mental organization that is required in debate is what we need in applying computer media. Thesis projects show how difficult it is to make architectural form demonstrate an idea while addressing functional and aesthetic issues. But even if the form does not express a polemical argument, it is useful to discuss design intentions, development, and representation. In CAD, the organizing structure shows an individual's priorities and how they interpret the subject. Choices about media and techniques verbally defended in a structured discussion or recorded asynchronously in a listserv forum.

5.3 Formalizing multimode communication through network projects

Collaborative networks provide an appropriate venue for these discussions because they impose their own structure on communication exchanges. Compared to face-to-face interactions, digital links require a conscious choice of channel. In person, gestures and tone of voice are unconsciously combined with words, but with mediated communication, choosing the modes of transmission, such as text, graphics, audio, video, hypertext, etc., requires a conscious decisions. Since participants must structure the way that they communicate, the content can be easily guided as well. Certain sessions can operate as debates, requiring presentation, rebuttal and defense.

WWW as Virtual Design Studio medium

Through a series of networked design collaboration, called the Virtual Design Studio, we have tried different ways to involve student critiques into the process. (Wojtowicz 1995) In previous years, students from the University of Hong Kong (HKU) have worked on the same architectural design brief as others around the world using network communications (e-mail, ftp, telnet, whiteboard, video-conferencing) to share design strategies. (Cheng 1994)

This year's project used separate World Wide Web sites, rather than a centralized server, as the repository for information. Students documented their on-going designs for a Japanese religious center into evolving HyperText Markup Language (HTML) presentations. They incorporated CAD drawings, scanned sketches and models, CAD renderings, sound and animations to describe both themselves and their projects. While the initial intent was to concurrently design and publish, within a six week span students were only able to update the material a few times.

To intensify the exchange, we supplemented the HTML postings with real time sessions. Bandwidth limitations from Hong Kong meant that network audio and video communication were not practical. But even simple real-time Internet "talk" (simultaneous text) brought emotional immediacy to the project which was lacking with merely posting information and waiting for a response. The interaction made students from our partner school, Univ. of British Columbia (UBC), come alive in a way that still photos could not convey.

Role-playing: Students read, present and critique other's ideas

Since we could only use synchronous video via phone lines (AT&T PictureTel) for the final video-conference, we created our own kind of Virtual Critique as an intermediate review. Each of our students was assigned a project from UBC to present and defend. Navigating and explaining required them to examine these projects in a

much deeper way than merely browsing them. They enjoyed verbally emulating the tough comments of their own critics.

The resulting diplomatic e-mail criticism about the difficulty of orientation helped improve final presentations. Since the UBC groups created CAD perspective renderings early in the design process, they created unrelated views which were difficult to follow. Disorientation was compounded by individuals rendering delegated parts of the site separately to save time. But after the HKU feedback, students successfully added key plans and site information to give context. Simply collaging an ocean or mountain background photo clarified orientation as well as enriching the imagery.

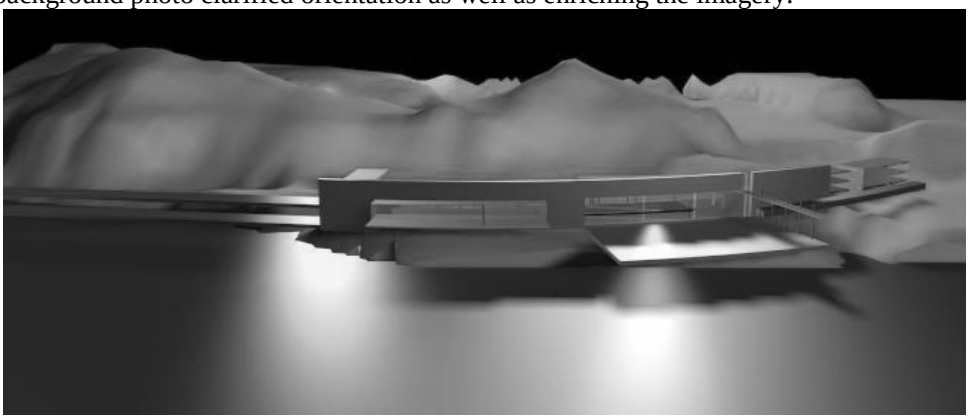


Fig. 3. Virtual Design Studio rendering by HKU student Falk Kagelmacher shows site for orientation.

VR Walk-through Critique

A more sophisticated version of the Virtual Critique was provided by a group led by Jim Davidson of Univ. of Washington's Human Interface Lab. Rather than participating in the design project themselves, they acted as outside consultants. They imported digital models created at UBC and HKU into their virtual reality system (Silicon Graphics Onyx Reality Engine) and gave feedback from the walk-throughs. UBC was able to use CU_SeeMe to get black and white frames in real-time, while the HKU students had to be content with e-mail feedback. Despite not getting to experience the walk-throughs, our students were delighted to get the new response to their buildings.

Throughout the exercise, the main goal was always to get the idea across to the other people: to tell the story about the design in a way that would entice them into responding. The lure of getting a person from across the globe to see our ideas gave a motivation for putting in the extra effort required to work with all the media. We even joked about the kinds of relationships we were building as we called the e-mail penpals "shotgun weddings" or "blind dates".

5.4 TRANSLATING A PRESENTATION FOR DIFFERENT PURPOSES

The Virtual Design Studio's final presentation goals pointed out the need to master the translation process to address different kinds of audiences. Because an ACSA competition was used for the project, the students had to create: 1) a hyperlinked presentation for individual browsing, 2) a linear tour through this hypermedia document for the video-conference and 3) a static boards for the competition. In this case, it was difficult for a single project to meet all three divergent goals. For example, the multiple links for individual exploration are extraneous in a linear group presentation.

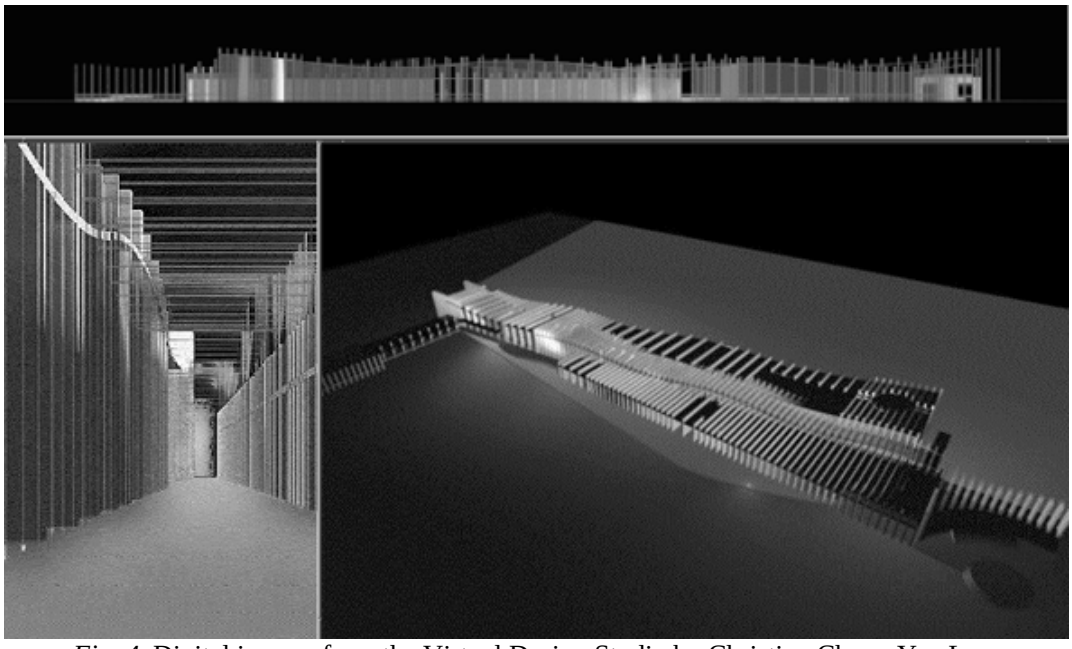


Fig. 4. Digital images from the Virtual Design Studio by Christina Chung Yee Lee.

The difficulties pointed out the need for architects to bring their concepts fluidly between formats to address different kinds of audiences. Networked communications can involve different kinds of communities and require advanced planning so that the communication channels used are appropriate. For example, full 3D models are suitable for design team members whereas carefully guided animations would be more suitable for marketing.

6. Conclusion: Curriculum of skill-building followed by practical use

Basic skills followed by content-based learning

At HKU, we teach computer design skills the way many schools teach writing. First-year English composition classes give basic skills which are then practiced in different subject areas. Essays from these writing-intensive courses are graded according to how well form and content work together.

The parallel in CAD education is to start with a technique-oriented courses and then offer design studios and support courses which require the intensive application of these skills. The methods courses should start with an overview of principles, show how these principles can be used creatively via different software applications. At the intermediate level, in-depth exploration of computer methods should require the use of several media used synergistically for design. Advanced courses can rely on computers as tools for researching and communicating ideas in specialty areas such as history, environmental issues, management, etc., or they can explore extending computer tools through customization and development.

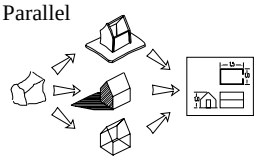
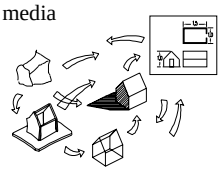
LEVEL	BEGINNING	INTERMEDIATE	ADVANCED
MEDIA USE	Basic Concepts ! Individual Media A Media in Series	Media in Parallel 	Fluid mix of media 
PROJECT TYPE	Short Exercises	Design Projects	Design & Research
FOCUS	Technique and Communication	Technique & Content Relationships	Content- Oriented

Fig. 5. Stages of a CAD curriculum

Incorporating different kinds of challenges into CAD curriculum

A CAD curriculum can build on student's creative ability, analytical ability and architectural knowledge as well as technical savvy. Staging the work with increasing levels of technical complexity is important for fostering feelings of accomplishment. However, at any level of technical difficulty, different levels of analytical or creative skills can be required, making the problems more interesting and allowing people of different aptitudes to shine.

For example a simple assignment for learning to use symbols requires students not only to design a set of building elevations using parametric variation and element substitution, but also to describe the character of each elevation and to explain which one was the most successful. In doing so, the students practice the computer design procedures, exercise their aesthetic judgement, and put their ideas into written form. Using these different skills for a single problem trains the student to become self-reliant in finding resources for new challenges.

Goal is multi-lingual fluency

The goal of our program is to equip students with underlying principles which will continue to be useful. They should come away with a broad knowledge of many media and a deep experience of a few which fit their design process. Working in multiple media allows for comparison and contrast which leads to a deeper understanding and communication exercises give the motivation for learning these media. By seeing CAD as an expressive language, we can use strategies which have been effective teaching other kinds of communication. A curriculum based on multimedia communication equips students with the self-reliance needed to face changing technology, the ability to solve problems in different ways and the expertise to convey ideas effectively.

Communication skills are particularly important since architects play a pivotal role in conveying and interpreting information between clients, colleagues, consultants and contractors. Since computers are increasingly useful in organizing, processing and publishing information throughout the design & construction process, using computers as communication tools is key to being an effective architect.

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