Digital Media in Architecture and Interior Design - Curriculum Framework
REPORT FOR THE SIGGRAPH EDUCATION COMMITTEE

Version 0.1, August, 2009

Glenn Goldman and Andrzej Zarzycki, New Jersey Institute of Technology

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INTRODUCTION/BACKGROUND

Both **Architecture** and **Interior Design** are licensed and/or certified professions in the United States requiring degrees accredited by profession-specific bodies, national examinations, and supervised internships - all of which are regulated by individual states charged with protection of the health, welfare, and safety of their citizens and general public.

The licensing of architects is close to uniform throughout the fifty states, requiring degrees from programs accredited by the National Architectural Accrediting Board (NAAB) and national examination administered by the National Council of Architectural Registration Boards (NCARB). National certification of individuals and state-by-state reciprocity is generally administered by NCARB. NAAB was founded in 1940 to "produce and maintain current a list of accredited schools of architecture in the United States and its possessions…" and since 1975 modified its role to the accreditation of professional degree programs rather than schools or universities. The licensing and registration of interior designers is a comparatively newer phenomenon and varies from state to state, some of which accepted licensed architects as interior designers when certification became prevalent in the 1990s. In general, the right to use the title of Certified Interior Designer requires a degree in Interior Design accredited by the Council for Interior Design Accreditation (CIDA) and passage of the NCIDQ (National Council for Interior Design Qualification) examination. CIDA requirements include non-professional courses defined as liberal arts and sciences but "programs located in an institution accredited by a regional accrediting body recognized by the U.S. Department of Education do not need to provide additional proof that they meet CIDA's liberal arts and sciences requirement." [p. II-4, CIDA Accreditation Manual].

Each profession has associated organizations in the United States: the American Institute of Architects (AIA) for architects, and the American Society of Interior Designers (ASID) and the International Interior Design Association (IIDA) for interior designers. The appellations "AIA" or "FAIA", "ASID" or "FASID", and "IIDA" or "FIIDA" may be used by professional members of their respective associations. While professional membership in the AIA and ASID are restricted to their respective disciplines, the IIDA accepts professional members who are either NCIDQ (interior design) or NCARB (architecture) certified.

Although the National Association of Schools of Art and Design (NASAD) includes interior design as a discipline within its purview, neither NAAB nor CIDA require accreditation by NASAD. However, schools must be accredited by an accrediting body recognized by the U.S. Department of Education and Council for Higher Education Accreditation (e.g. Middle States Association of Colleges and Schools/Middles States Commission on Higher Education, New England Association of Schools and Colleges Commission on Institutions of Higher Education, Northwest Commission on Colleges and Universities, Southern Association of Colleges and Schools Commission on Colleges, etc.).

Performance criteria and standards evaluated by both inputs and outputs are focused on those items deemed critical for designers of our built environment. In addition to design, specific expertise is required in a variety of technical subjects that include mechanical and environmental systems for both architects and interior designers, detailed (architects) or general (interior designers) knowledge of, and the ability to incorporate, structural systems into a design, and so on. Consequently, the use of information technology and computer graphics have subsidiary roles in service of design, design development, and production of contract documents. In particular, graphics are used to communicate - to ourselves as designers, to clients, to peers and in an academic context critics, to regulatory agencies having jurisdiction and approval rights for projects, to consultants (e.g. mechanical and structural engineers), and to the contractors who will bid on, and ultimately create, the physical manifestation of the design.

ACCREDITATION REQUIREMENTS REFERENCING OR INCORPORATING (COMPUTER) GRAPHICS

Interior Design/CIDA:

Student work MUST demonstrate *competence* in:
a) drafting and lettering, both manual and computer-aided techniques.
b) illustrative sketching.
c) presentation of color, materials, and furnishings (for example, sample boards, collages, mock-ups, digital representations).

Students MUST:
d) express ideas clearly in oral presentations and critiques.
e) communicate clearly in writing (using correct spelling, grammar, and syntax) in specifications, schedules, and contracts and other business-related documents such as project programs, concept statements, reports, research papers, resumes, and correspondence.

Student work MUST demonstrate the ability to:
f) render by any medium, manual or computer-generated, that successfully communicates the design intent.
g) communicate 3-dimensional space and form, such as in perspectives, paralines, and *models* (computer-generated or manual).

Student work SHOULD demonstrate the ability to:
h) apply the metric system to design work.
i) communicate through alternative presentation techniques (for example, audio, electronic, film, photography, slides, video). [II-13]

Outcomes of student work may be evaluated by CIDA by looking at student work that includes, among other items "CAD drawings [and] Perspectives". [III-6]

Architecture/NAAB:

Student Performance Criteria 13.3 - Graphic Skills
Ability to use appropriate representational media, including freehand drawing and computer technology, to convey essential formal elements at each stage of the programming and design process.

Student Performance Criteria 13.26 - Technical Documentation
Ability to make technically precise drawings and write outline specifications for a proposed design.

Student Performance Criteria 13.28 - Comprehensive Design
Ability to produce a comprehensive architectural project based on a building program and site that includes development of programmed spaces demonstrating an understanding of structural and environmental systems, building envelope systems, life-safety provisions, wall sections and building assemblies and the principles of sustainability.
In order to be able to fully utilize information technology in service of architecture and interior design, it is necessary for students to learn, at the very least, basic principles of computer graphics and be able to creatively utilize a variety of applications. In order to accomplish their tasks architects and interior designers both need an array of tools that include raster graphics/paint programs, three-dimensional modeling and visualization software (including the ability to animate or create walk-throughs), technical drawing applications, image processing software, illustration and compositing applications, building information modeling software, and a bevy of analytical tools to study design implications of lighting, structure, energy use, acoustics, etc.

CURRICULAR IMPLICATIONS

Professional programs in the twenty-first century should include the use of information technology in both design studios and support courses. However it may be inappropriate to dictate exactly how those tools are integrated. Although prescriptive criteria (i.e. the elucidation of particular courses and syllabi that must be taught) are easy to judge from a distance by accrediting bodies, this can stifle innovation and may not always be the most appropriate match for particular institutions, available faculty, or a particular student group. Comprehensive projects by both architects and interior designers (including detailed design proposals, outline specifications, schematic structural design for architects, material and furniture selection for interior designers, etc.) should illustrate proficiency in the use of information technology. While visualization can certainly occur with traditional media, the quality and quantity demanded by professionals can be most effectively accomplished with digital media. Criteria for accreditation and curriculum development should be sufficiently rigorous to establish a de facto standard of use of information technology. Certain "products" (in some professional contexts referred to as "deliverables") like contract documents with building information models or "walk-throughs" illustrating proposed designs can only be created using computer graphics.

It is possible that some programs may choose to deliver skill acquisition via discrete courses. Some may choose to integrate virtually all of the computer graphic skills within the design studio. And a number of programs are likely to have a combination of introductory and advanced courses along with reinforcement and instruction in the design studio context. What is most effective in all cases, and consistent with the findings and discussion held at the Computer Graphics Educators Workshop in Eurographics 2009 (Munich, Germany), is that the instruction in computer graphics will be done in the context of the design disciplines. There are successful cases even in the same university where the graphic communication course is coordinated lock-step with the design studio and also when communication courses are completely independent. What is consistent, however, is that students are given assignments that are relevant to their particular discipline and then required to complete a specific and often discipline-related task, thereby creating a need-to-know for a particular application or skill. In architecture, there is an emerging trend to combine technical and "sustainable" design courses with computational performance simulation and analysis. These courses include computer graphics as an important visual communication tool for simulated data in a manner that becomes useful to architects and students as they seek to integrate this feedback into design proposals. Advanced, optional material may also be studied in separate courses or within advanced "option studios" commonly offered to upper level students.

An incomplete web survey and anecdotal evidence indicate that there are a few discrete required courses in computer graphics available within many architecture and/or interior design programs. Where programs have courses in discipline-specific graphics, the work tends to be digitally created. While most schools continue to teach and require the use of freehand drawing with traditional media, most (although not all) have eliminated traditional t-square and parallel rule drafting. These general and architectural graphic and visual communication courses have supplanted the "computer graphics" courses previously required. Nevertheless, there are a number of schools whose commitment to pushing the boundaries of digital media and the use of information technology in architecture and interior design are evident in a broad array of elective and required courses dealing with computer graphics (examples of online catalog descriptions follow). Many schools have a "special topics" course or equivalent that allows for a variety of classes to be offered, many of which deal with different issues related to and involving computer graphics and other information technology uses, and are offered on an ad hoc basis depending on student and faculty interest as well as available resources.

Despite the fact that many schools offer few electives or discrete courses in computer graphics, it is clear that the material is taught. In order to provide students with the knowledge to enter their chosen professions, schools are obligated to see that there is some level of proficiency in the use of computer graphics and information technology. (Although it must be stated that it is equally clear that the level(s) of graphic proficiency vary from student to student, school to school, and between programs due to many variables - from available resources to faculty interest to the local demands of industry, and so on.) Furthermore, given the packed nature and requirements of accredited programs, it is evident that graphic communication and the use of digital media are reinforced (and sometimes introduced) in the design studio and technical support courses. Therefore it must be assumed that virtually all programs integrate information about computer graphics directly in the design studio. In some instances, programs do not even offer discrete graphics classes that reference any medium whatsoever. Yet these students learn to design, produce design

projects, and document these projects with a variety of media. Every architecture and interior design program requires multiple terms of design studio and almost every program, including those with discrete classes about computer graphics, teach and utilize computer graphics within those studios. Consequently, any additional accreditation requirements dealing with computer graphics should look at the output side - what students can produce in comprehensive and integrated products rather than on the input side requiring a specific course or group of courses, and allow for institution and program-specific decisions on how to deliver the required content.

Moreover, since outcomes are important, curricular and accreditation requirements should not focus on particular programs or even platforms, but on the abilities, image type(s), and uses and needs of particular applications of computer graphics. For example, there are multiple programs - some of which are Windows-based, others Mac-based - that will give a student experience and abilities in the use of Building Information Modeling. Curricular standards should merely specify that students develop the ability to create building information models and understand their uses in a design context. Since available programs can change (some disappear, some are acquired by competitors, etc.), are updated at irregular and varying intervals, and have different associated costs and learning curves, the decision to use one application or platform over another may not only differ from institution to institution, but change over time*. In fact, given the constant of change, it may be more important for curricula and syllabi to guarantee that students become comfortable with a variety of programs, and easily move from one application to another with an understanding of what each application can do best, and most efficiently.*

It is important to at least note that there are multiple programs of study that deal with architecture and interior design, each with its own particular focus. While the concern in this particular document is with professional programs, there are also degree programs in architectural technology, architectural history, architectural engineering, interior architecture, and interior decorating for which computer graphics play an important role. However, while these programs may be used as preparatory programs for eventual entry into professional programs and licensure and/or certification, they do not, in and of themselves, constitute required professional programs. In fact, a number of these may be considered as subsets or specialties of the professional programs. (For example, an individual who wants to design the structure of buildings as a licensed engineer may find it to be more beneficial to study civil engineering. A student may be more efficient in his or her course of study to make a choice between architecture and interior design rather than study interior architecture which, given the time constraints of an undergraduate education, may not cover everything that either profession requires.) There are courses offered by universities in these alternate programs that are relevant to the professional programs and should not be excluded from discussion or consideration merely because they are listed by a different course of study and/or do not lead to a required accredited professional degree.

Rather than propose specific courses, sequences, applications or platforms for curricular integration a list of skills/tasks/image types/information technology uses/etc. that are appropriate for graduates of architecture and interior design programs (along with some examples) who want to enter their chosen profession are proposed. Recognizing that minimum standards should not be a match for level of aspiration, examples of optional and/or advanced and/or experimental courses are also listed with attributions the universities from which they came. These “extra” courses are important because the history of digital media shows that the “optional” courses of today become integrated as the standard courses of tomorrow. At one point (not that long ago) using a computer for design and presentation in a studio was not only optional, but criticized and frowned upon by architectural and design educators. In 2009 digital fabrication is making the leap from optional and esoteric applications into mainstream studios. In most cases the optional courses available are actually within the same department or college as architecture and interior design. In some instances, there are courses in other departments within the university but there seems to be few, if any, barriers for students to take those classes and make the contextual link to architecture and interior design.

DIFFERENCES BETWEEN ARCHITECTURE AND INTERIOR DESIGN PROGRAMS AND OFFERINGS

Because the history of licensing and professional certification for interior designers is shorter than that of architecture, there is greater fluidity in those programs. Although many architecture programs were slow to adopt and adapt to the integration of information technology into their curricula, interior design programs have proven to be even slower. (Note that CIDA still requires competence in hand "lettering" - an attribute jettisoned by architecture programs years ago.) It is important to note that there are differences in both the educational requirements of the two programs as well as the professional duties. Not all tasks studied by architects are required of interior designers - and consequently the use of computer graphics (or anything else) in those applications is not needed. So, for example, while architects are responsible for evaluating thermal transfer through the exterior building envelope - and use computational methods to calculate and visualize design proposals, this is not needed by interior designers. On the other hand, interior designers often take on tasks ignored or not addressed by architects and they do have responsibilities that are well-suited for study with computer graphics like lighting, and need the same analytical and visual tools that are used by architects during the design and presentation processes.

Interior design programs have typically developed from two tracks: architecture and home sciences or art. Those programs that have developed in parallel or conjunction with architecture programs tend to have dedicated studio spaces for their students and are in a position to share (or take advantage of) resources available to architecture students. Programs that are completely independent, that are housed within the derivative of home economics programs or art programs in the absence of other building science disciplines, may not have the history and culture of utilizing technology as extensively or diversely as other programs. While this is not meant to imply any lack of comprehensiveness, it does reflect a difference in curricular utilization of information technology in general, and computer graphics in particular. The use and value of computer graphics is particularly acute for interior design students. They deal with the design of spaces for the human experience. They, at least as much architects if not more so, deal with detailed organization of space and surface for habitation. Given this task, it is important for interior design students to be able to pre-visualize the spaces they are designing. In this context, three-dimensional modeling, walk-throughs, and detailed rendering are all important for interior designers and students. Furthermore, the use of two-dimensional planning that requires drawing and diagramming helps interior designers to organize spaces in logical and effective ways. A non-comprehensive survey of digital media requirements for interior design programs indicates that there is a greater emphasis on design and graphic communication use of digital media than there is for analytical simulations. While this may also be true for some architecture programs, the distinction is more pronounced for interiors.

There are various courses utilizing digital media offered by different interior programs that go beyond the basic applications one would expect to find. At least one program (Cornell) offers a facilities management course within an interior design program that investigates "the use of computer-aided facilities management software in facilities management" with a focus on "building a space inventory database, occupancy data, asset management, and strategic planning." Another program (New Jersey Institute of Technology) requires a discrete course in Building Information Modeling for all interior design students and introduces students to BIM graphic software as part of freshman foundation studies. And another program (Rhode Island School of Design) also introduces BIM to interior design students and cross-lists some courses with the Digital + Media Department to introduce students to virtual space and media-based environments.

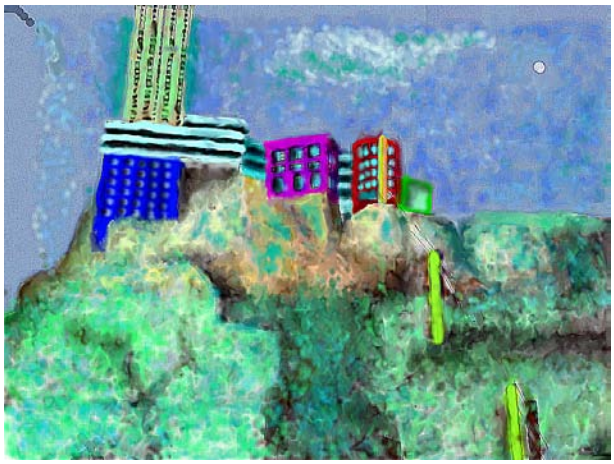
As interior design programs develop and licensing and/or certification becomes more ubiquitous, it seems inevitable that the need for computer graphics will be comparable to the need of architecture programs. So while there is some differences in the needs and uses of information technology between the two programs - especially in the need for analytic applications, it is not unreasonable to assume that the overall graphic requirements are comparable and that the need for accurate pre-visualization during the design and presentation processes are virtually the same.

REQUIRED SKILL SETS/ABILITIES FOR THE INTEGRATION OF INFORMATION TECHNOLOGY

NOTE: Below a number of the image types or skill sets listed are graphic examples. These are for illustrative purposes only and do not represent either a comprehensive exhibit of all graphic image types needed nor are they meant to be prescriptive. They are a subset of image types and graphic information that architects and interior designers could be expected to produce as professionals and in which students should develop some level of proficiency. Furthermore, although the skill sets are listed as discrete, some of the examples shown represent work in more than one group. For example, in order to show rendering and visualization it was necessary for the student or designer to create the three-dimensional model. And it was equally necessary for the student designer to render a three-dimensional model with materials in order to get visual feedback during the design process. Nevertheless, the groups are listed in a way that could represent instructional units.

Basic understanding of file types, storage, computer software and hardware types. A fundamental understanding of the tools used places the student and designer in a position to direct the use of the computer in a way that will facilitate best practices of architecture and interior design. Everything from the influence of RAM vs. processor speed (and type) to file types and sizes for saving and communicating work for different audiences. (For example, understanding the difference between lossy JPG files for online use and email communication vs. lossless TIF files for printing is arguably as important as an English course that distinguishes between technical writing and creative writing.) Intellectual underpinnings of computer graphics (including its history) helps students accommodate inevitable changes in the use of information technology in the design professions.

Raster paint programs. Students can (and need to) use paint programs for a variety of applications, most notably to avoid computer program defaults (including "out of the box" filters) for personal expression of design proposals. The use of non-photorealistic imagery may sometimes be a better way to communicate design intent than a highly rendered image of an inadequately detailed or considered proposal. Paint programs not only help students personalize their visualizations, they are (at least for now) a direct analog to traditional media used since childhood. They avoid over-reliance on computer defaults and provide a mechanism for students to create their own materials libraries with a precision that can more accurately depict proposed finishes and surfaces than generally available within standard rendering and modeling programs routinely available to architects and interior designers. Interior designers often create wall coverings and two-dimensional surface designs that are suitable for exploration with paint programs.

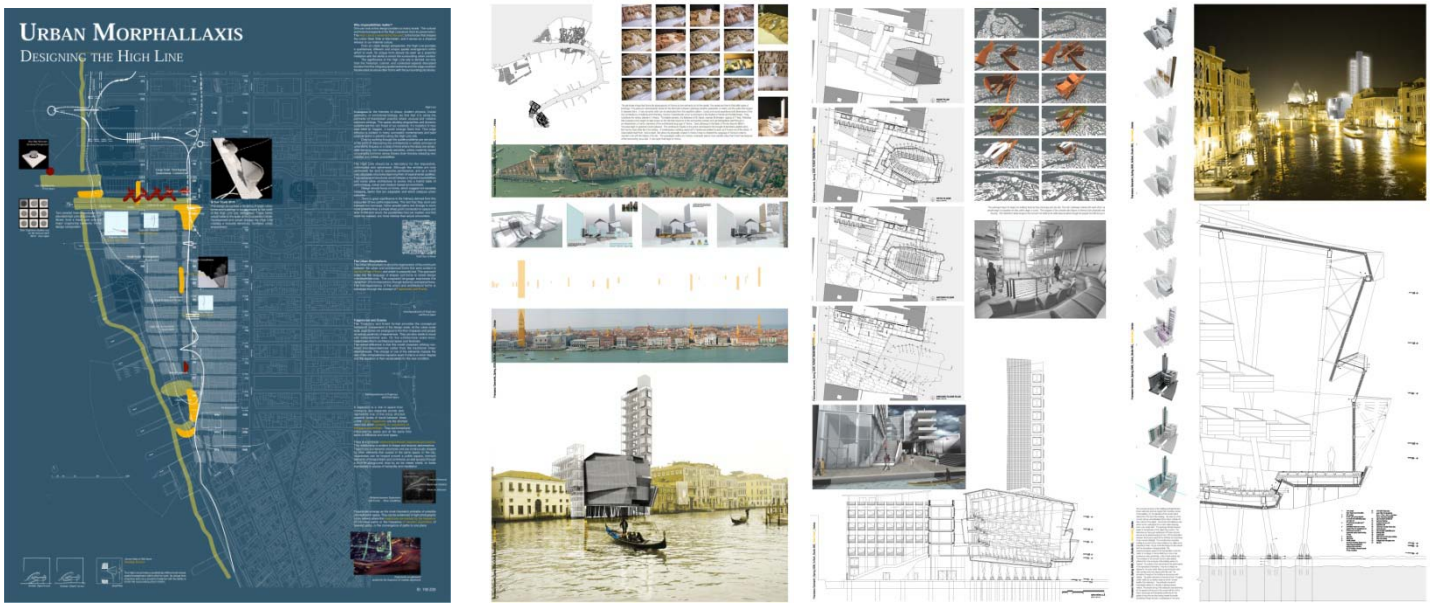


Paint programs may be used to create evocative and personal renderings when applied to three-dimensional models, or may be used to analyze and re-create art in a manner analogous to the way students used to go to museums or galleries and sketch "old masters" locally available.

Image manipulation and digital photography. The ability to collect site data and utilize contextual components in a design is critical for both architects and interior designers. In fact, one of the first tasks any design professional does is document existing conditions for a project. Designers and students must be able to perform this task for any project. The ability to manipulate images is also important for showing “before and after” possibilities and to explore different design options in context. Finally, image processing, like paint programs, are used to improve visualizations from the defaults provided by rendering software, prepare for different output devices and formats, and to personalize evocative visual expressions to accurately reflect design intent. Students need to be able to correct lens distortion, splice images, and understand basic compositional aspects.

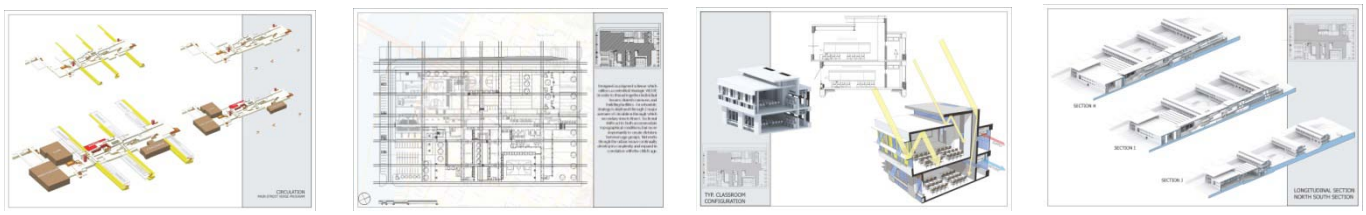
Modeling and site superimposition: Jay Tsai (fourth year) and Rosanna Collars (first year)

Still-image compositing. Students and professionals need to create images suitable for printed display or distribution (as well as electronic distribution) which often require the production of single images that incorporate multiple images and views of a particular project for both clarity and efficiency of communication. Compositing is also used to create packaging and marketing materials for products produced by architects and interior designers.



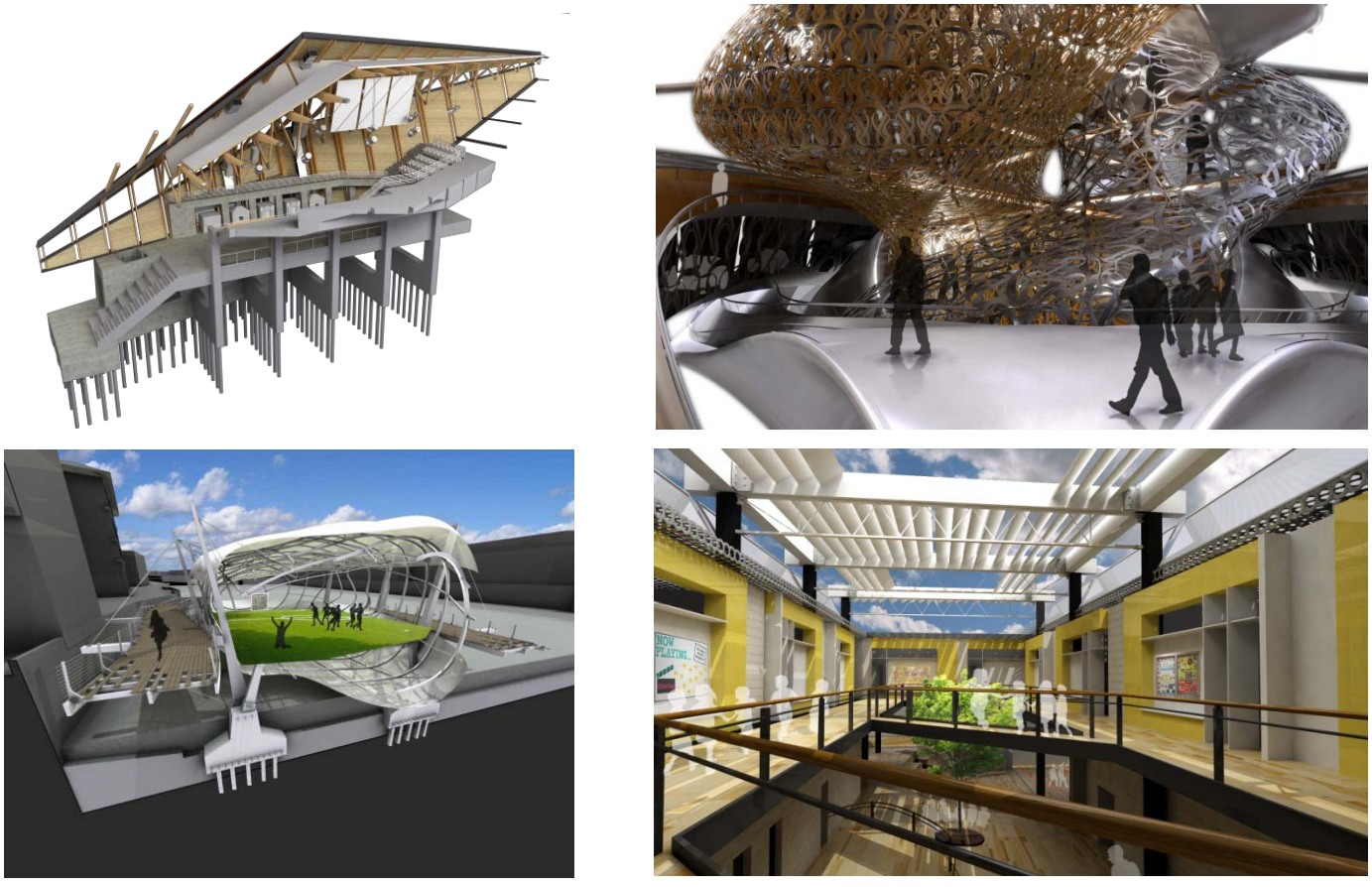
Presentation composites (left - Andrzej Zarzycki, remaining by Francisco Gennarini as a partial presentation)

Technical Illustration. Architects and interior designers, as well as students, need to create technical diagrams and annotate those diagrams to explain various phenomena and requirements to different audiences. Assembly instructions are prepared by interior designers for contractors in small-scale projects. Analytical and illustrative diagrams are prepared by architects for presentation to planning boards and other legislative bodies when seeking approval of projects. Building sections with notes are used for both contractors Even two-dimensional plans that represent data stored in three-dimensional models (either in a single or across multiple software applications) are used to communicate information about building and spatial organization as well as construction processes. Students routinely perform and present the results of case studies of building types as preliminary research when starting a new project. Technical illustrations - diagrams and text - are common produced by both students and professionals.



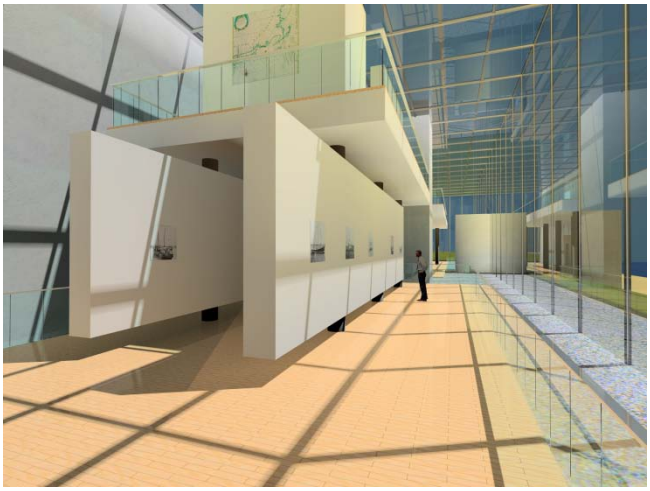
Plans and diagrams by Brian Novello

Digital three-dimensional modeling. Architects and interior designers create proposals for objects and space. Although there is surface design (especially for interior designers), most work is three-dimensional and spatial. Students need to understand the difference between , and be able to use, programs that have a predilection for polygonal models and NURBS models so they can select the application most appropriate for their design intents. Also, any space designed with one type of program often contains objects, furniture, and fixtures that could be more appropriately modeled with a different program and then imported into the primary model. There must be sufficient facility with the use of these programs so that they can be used comfortably in the design process. And hardware must be sufficiently robust so that the creative thought process is not interrupted by intermittent delays due to screen redraws or slow rendering times for visualizations.



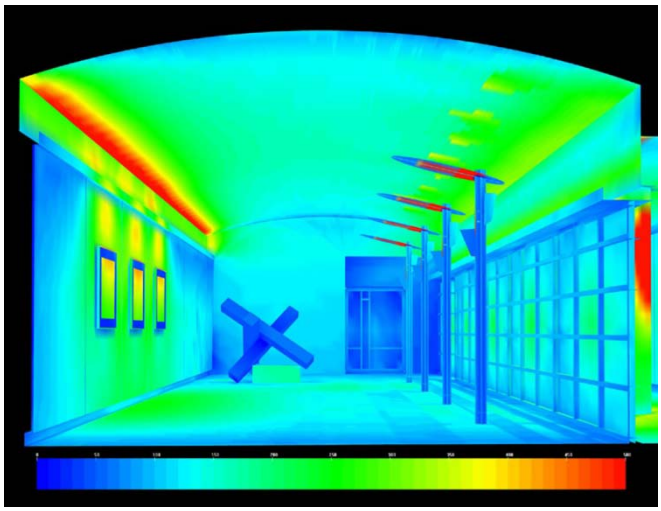
Three-dimensional models used for design investigation (Brian Novello - top left, Pietro Rosato - bottom left, Jai Tsai - right/top and bottom)

Rendering and visualization. The ability to understand and utilize high-quality rendering programs (or components within three-dimensional modeling programs) is critical to the visualization process. Without an ability to represent the space and surfaces that are being proposed, it is difficult to evaluate the design quality either during the design process, or at the end of a project when being reviewed by visiting critics/surrogate clients. This is also the opportunity for students to learn about the differences between rendering methods (e.g. ray tracing and radiosity) and how light is reflected by different materials/surfaces. This skill will also allow students to study materials and provide multiple color and material scenarios for evaluation (important for architects, critical for interior designers).



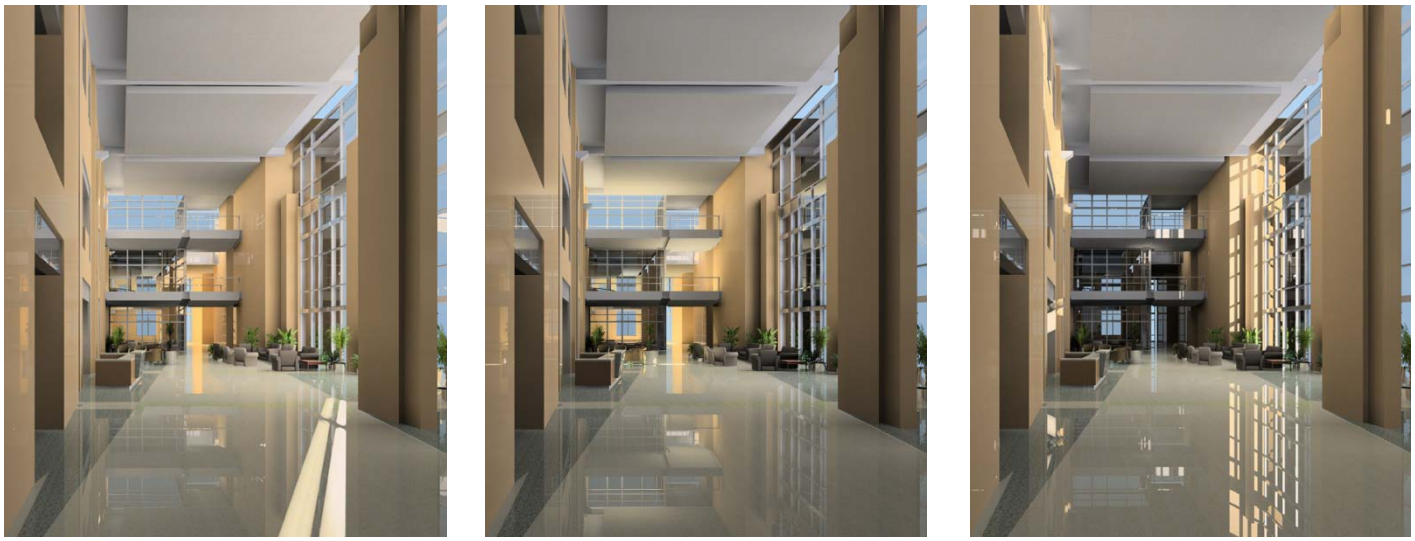
First year interiors (library and research center by Frank Gurdak and café by Cezar Nicolescu

Interior and exterior light studies using photometric light simulations. Photorealistic images require understanding concepts of light design as well as light physical properties. For the daylight simulation students need to specify correct parameters for sunlight illumination (intensity and color). For electric lights, photorealistic imagery involves a light fixture selection from a manufacture's database (web site) and incorporating fixture specific photometric data (IES file format) into digital model. Successful design requires students to formulate lighting design intent for desired illumination levels (foot-candle or lux) as well as to understand code requirements. Based on this information students need to calculate appropriate desired light intensity (lumens) and finally specify types and number of light fixtures.



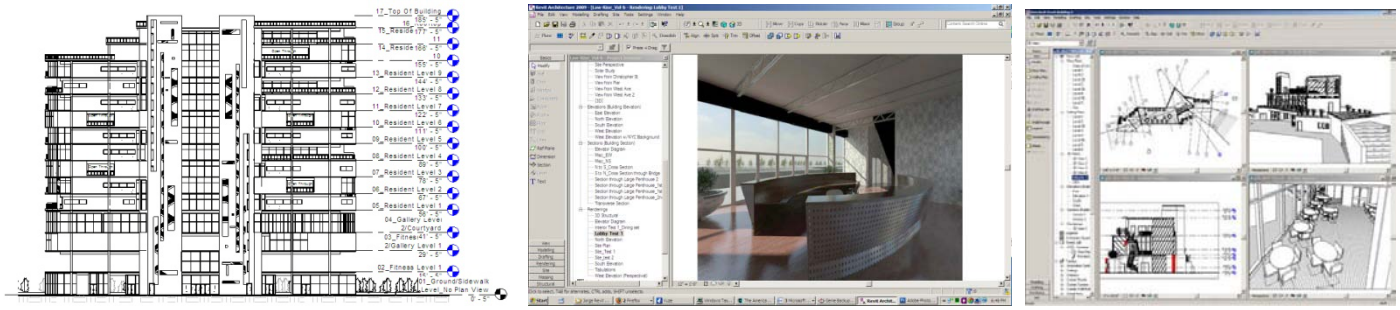
Interior rendering with electric lighting and luminosity map (Andrzej Zarzycki)

Sun and shadow studies (primarily for architects). As part of site design and analysis students should be able to develop sun and shadow studies and evaluate their impact in the site and surrounding properties. These studies include researching geographic site specific data (latitude and longitude) and use of data to develop physically-real imagery.



Daylight studies and renderings for architects (Andrzej Zarzycki)

Building information modeling. Among the construction documentation architects and interior designers produce are what is colloquially described as “working drawings.” Students need to be able to create two-dimensional representations of their three-dimensional models in such a way as to be able to obtain accurate bids that will then lead to construction. Students in upper level design studios and technology courses should be able to create a portion of these documents. With the introduction of building information modeling (BIM) - essentially a three-dimensional model with an associated database - students should be able to develop three-dimensional construction detail that illustrate element assembly and spatial integration of building components. Facility with BIM software implies a basic understanding and an ability to use three-dimensional modeling software and knowledge of building systems and construction methods.



Building information models by Jorge de la Rosa and Bruce McConnell

SELECTION OF ELECTIVE/ADVANCED/OPTIONAL COURSEWORK

Following are examples of courses that are used to deliver content about computer graphics and information technology as used in architecture and interior design. Unless stated otherwise, all courses listed are offered by the design department (not IT or CS) and teach computer graphics in the context of another discipline. More often than not, the individuals teaching these courses have at least part of their education in the field of architecture and/or interior design. *This selection excludes design studio and most traditional architectural or design graphics classes which reinforces via instruction and iteration computer graphic skills on a need-to-know basis. All course descriptions were obtained from the respective educational institution websites July 2009.*

Massachusetts Institute of Technology

4.351 Introduction to Video
Prereq: None U (Fall, Spring) 2-4-6 HASS
Introduction to video recording and editing, presenting video as a tool of personal apprehension and expression, with an emphasis on self-exploration, performance, social critique, and the organization of raw experience into aesthetic form (narrative, abstract, documentary, essay).Enrollment limited to 12.

4.352 Advanced Video
(Subject meets with 4.353) Prereq: 4.351 or permission of instructor U (Fall, Spring) 2-4-6 HASS
4.353 Advanced Video
(Subject meets with 4.352) Prereq: Permission of instructor G (Fall, Spring) Units arranged H-LEVEL Grad Credit
Introduction to advanced strategies of image/sound manipulation, both technical and conceptual. Pre-production planning (storyboards, scripting), refinement of digital editing techniques, visual effects such as chroma-keying, and post-production and audio are covered. Context provided by regular viewings of contemporary video artworks. Additional work required of graduate students. Enrollment in each subject limited to 12.

4.430 Daylighting
Prereq: 4.401 or permission of instructor G (Fall) 3-0-6 H-LEVEL Grad Credit
Provides the tools necessary for an efficient integration of daylighting issues in the overall design of a building. Fundamentals of daylighting and electric lighting are introduced and their relevance to design decisions emphasized: benefits and availability of daylight, solar radiation and sun course, photometry, vision and color perception, daylighting metrics, visual and thermal comfort, electric lighting. More advanced topics are presented and practiced through the design project and homework assignments, such as primary and advanced lighting design strategies, and design and assessment tools for lighting management.

4.501 Architectural Computing and Construction
Prereq: 4.500 U (Spring) 2-2-8
Investigates the use of computers in architectural design and construction. Uses a pre-prepared computer model to test and process investigation and construction. Explores the process of construction from all sides of practice: detail design, structural design, legal and computational issues. Limited to 10 with priority given to Course 4 majors and minors.

4.502 Design Scripting
Prereq: 4.500 U (Spring) 3-2-7
Introduces fundamental ideas of programming and demonstrates their application to the process of visual and spatial design. Students are taught methods for algorithmically modeling visual and spatial forms, evaluating their conditions, building interface, and processing formal data for prototyping, manufacturing rendering and other design tools. Proceeds through a sequence of scripting exercises in application programming environments. Each exercise requires a student to articulate computational tasks in the context of a design, and to write codes that produce graphic solutions.

4.505 Computation Design Workshop
Prereq: 4.501, 4.502, 4.503 3-3-6
Project-based subject that provides opportunities to explore and integrate the various skills, theories, and technologies introduced in prerequisite subjects. Strategies and computational tools for rule-based and parametric design are introduced, critically examined, and explored through application to practical design tasks. Students gain experience with techniques of design synthesis, performance analysis and simulation, visualization, fabrication, and assembly, and with strategies for collaboration and coordination. Emphasis on creative response to challenging design problems.

4.510 Digital Design Fabrication
Prereq: 4.560 or 4.500 G (Fall) 3-3-6 H-LEVEL Grad Credit
Introductory subject in advanced computing, rapid prototyping, and CAD/CAM fabrication for architects. Focuses on the relationship between design and various forms of computer modeling/CAD/CAM tools as output material. Presents the process of design and construction, using CAD files for construction. Taught in phases, starting with CAD/CAM and ending with rapid prototyping of building components fabricated from CAD files. Limited to 36 students.

4.520 Computational Design I: Theory and Applications
(Subject meets with 4.521) Prereq: None U (Fall) 3-0-9
4.521 Computational Design I: Theory and Applications
(Subject meets with 4.520) Prereq: None G (Fall) 3-0-6
Introduces design as a computational enterprise in which rules are developed to compose and describe architectural and other designs. Topics include shapes, shape arithmetic, symmetry, spatial relations, shape computations, and shape grammars. Focuses on the application of shape grammars in creative design. Teaches shape grammar fundamentals through exercises with abstract shape grammars. Discusses issues related to practical applications of shape grammars.

4.522 Computational Design II: Theory and Applications
(Subject meets with 4.523) Prereq: 4.520 or permission of instructor U (Spring) 3-0-9
4.523 Computational Design II: Theory and Applications
(Subject meets with 4.522) Prereq: 4.520, 4.521, or permission of instructor G (Spring) 3-0-6
Introduces advanced topics in shape grammar theory and applications. Includes an introductory component on shape grammars for students new to the area. Discusses generalizations of the shape grammar formalism that permit greater flexibility in computing designs. These include parametric grammars and parametric design, parallel grammars, and color grammars. Introduces color grammars through exercises. Discusses the generative and expressive powers of grammars in relation to other computational design systems. Additional work required of graduate students.

4.540 Introduction to Shape Grammars I
Prereq: None G (Fall) 3-0-6
4.541 Introduction to Shape Grammars II
Prereq: 4.540 G (Spring) 3-0-6 H-LEVEL Grad Credit
An in-depth introduction to shape grammars and their applications in architecture and related areas of design. Shapes in the algebras Ui j, in the algebras Vi j and Wi j incorporating labels and weights, and in algebras formed as composites of these. Rules and computations. Shape and structure. Designs.

4.542 Background to Shape Grammars
Prereq: 4.541 or permission of instructor G (Spring) 3-0-6 H-LEVEL Grad Credit Can be repeated for credit
An advanced examination of the shape grammar formalism and its relationship to some key issues in a variety of other fields, including art and design, philosophy, history and philosophy of science, linguistics and psychology, literature and literary studies, logic and mathematics, and artificial intelligence. Student presentations and discussion of selected readings are encouraged. Topics vary from year to year. Can be repeated with permission of instructor.

4.543 Special Problems in Shape Grammars
Prereq: 4.520, 4.540, or permission of instructor G (Fall, IAP, Spring) Units arranged H-LEVEL Grad Credit Can be repeated for credit
An opportunity to use shape grammars or related algorithmic devices to characterize detailed designs in a historical corpus or original designs conceived from scratch. Projects may have their focus in architecture or in any other area of design (e.g. product design) where there is a strong interaction between form and function. Questions of style and stylistic change, type, and value stressed in relationship to shape grammars and the algorithmic processes they encourage. Project work may extend over multiple terms.

4.560 Geometric Modeling
Prereq: Permission of instructor G (Fall) 2-2-8
Introduces the fundamentals of three-dimensional geometric modeling and associated computer-aided design as well as visualization applications in architecture, urban design, and computer graphics production. Provides a theoretical foundation to a selection of current hardware and software tools. Extensive opportunities to develop practical skills through lab sessions and regular practical exercises. Background in computational skills is an advantage, but not required. Students acquire the skills necessary to undertake independent CAD projects in design studios or other professional settings.

4.562 Architecture in Motion Graphics
Prereq: 4.560 or permission of instructor G (Fall) 2-2-8 H-LEVEL Grad Credit
Provides an opportunity to undertake advanced projects in architectural visualization with an emphasis on the use of computer graphics animation and video production media. Introduces students to advanced visualization software and teaches them to explore spatial expressions in motion graphics format. Selected literature and video materials on architecture and film reviewed to initiate discussion sessions. Previous experience in 3-D modeling software essential. Workshop format.

4.564 Formal Design Knowledge and Programmed Constructs
Prereq: 4.560 or permission of instructor G (Spring) 2-2-8 H-LEVEL Grad Credit Can be repeated for credit
Provides practical and theoretical foundations to explore computational issues relevant to representation of architectural forms and design knowledge. Students learn basic concepts in a computer programming language and acquire practical skills to develop their own software tools for architectural design. Topics include parametrized objects, procedural representation of form, typology and architectural grammar, shape recognition problem, constraint propagation, inter-application communication, and internet-based distribution interface.

4.566 Advanced Projects in Digital Media
Prereq: 4.562, 4.564 or Permission of instructor G (Spring) Units arranged H-LEVEL Grad Credit Can be repeated for credit
Develop independent projects in the study of digital media as it relates to architectural design. Students propose a project topic such as digital design tool, modeling and visualization, motion graphics, design knowledge representation and media interface.

4.580 Inquiry into Computation and Design
Prereq: None G (Fall) 3-0-9
Explores the varied nature and practice of computation in design. Different computational approaches for understanding and thinking about design, and for doing design, are introduced through lectures, readings, discussions, and guest visits by Computation group faculty and others. Topics may vary from year to year. Aims to develop a critical view and awareness of assumptions about computation in design beyond the specifics of techniques and tools, and to open avenues for further research.

New Jersey Institute of Technology

AD 112 - Communication in Art and Design - Digital Media (1-5-3)
This course will help students develop a critical attitude and analytical language to explore 3D and 2D issues involved in the study of design ideas but work will be focused primarily on digital techniques and modes of expression. It will cover drawing basics and digital modeling and extracted drawing techniques and critical analysis of these techniques and other methods of graphic (and architectural) representation. [The course is an introduction to vector graphics, architectural graphics, three-dimensional modeling, and time-based expression. Students are given formal analytical exercises and design assignments requiring the use of *AutoCAD Architecture*, *3D Studio MAX*, *Revit*, and *Rhino.*]

AD 150 - Color and Composition (3-0-3)
A multiple media course combining (primarily 2D) composition, a study of color in art and design, and raster computing applications. Includes principles of color theory such as color interaction, psychology of color, color mixing, color models and palettes, and color reproduction. Course includes lectures, readings, videos, in-class analyses and lab work, and homework/design projects requiring both traditional and digital media. Recitation/review sessions may be offered outside of class time. [The course is an introduction to raster graphics, paint programs, compositing and illustration programs. Students are given formal analytical exercises and design assignments requiring the use of *Corel Painter*, *Corel Draw*, *Adobe Photoshop*, and *Adobe Illustrator.*]

DD 284/ARCH 584 - Video & Animation (3-0-3)
Prerequisites: ARCH 363 or all of the following: AD 111, AD 112, AD 150 or ARCH 334, AD 161, and AD 162. Presents the concepts of 3-D surface modeling, rendering (and modeling vs. mapping), key frame animation, and video production in the context of the design process. Emphasizes the underlying geometric principles of surface modeling, the components of color theory and texture mapping, the principles of key frame animation, and video production.

DD 334/Arch 434 - Simulated Environments (3-0-3)
Prerequisites: AD 112, AD 150 and DD 284 or equivalent and instructor's permission. This course will explore the application of desktop, non-immersive virtual reality to the representation of architecture. Course exercises and projects are designed to uncover both advantages and limitations of this emerging technology, on both practical and theoretical levels. The major focus of the course will be personal evaluation of these tools in the design of both object-specific and the spatial in architectural problem solving. The collaborative nature of the toolkit will inform design decisions vis-a-vis observation of participant behavior and open discussion with interactive critics.

DD 405 - Digital Audio/Music (2-2-3)
Prerequisite: DD 302 or equivalent. Principles of architectural acoustics are presented as a precursor to understanding how sound can be used in virtual environments. Fundamental concepts of music theory are reviewed. Both objective and non-objective sound are considered. Basic recording and editing techniques are introduced for incorporation into video and web-based productions. Student projects will be created and critiqued during class and laboratory time.

DD 415 - Web/Exhibit Development (2-2-3)
Prerequisites: DD 284 and DD 364. Overview of exhibit design dealing with issues of graphic identity and elements; design graphics and typographic styles; venues for small, large, and on-line exhibits; brand identity issues; interactive communication; and the relationship between coordinated physical and digital exhibits. Exploration of exhibit types include educational symposia, trade shows, and museums/galleries. Student analysis and creative lab projects are part of the course.

Arch 335 - Digital Tectonics (3-0-3)
This course uses 3D modeling tools to investigate the relationship of digital models to physical construction. The term digital tectonics refers to an idea regarding the qualities of works of contemporary architecture that seem to be influenced by the use of digital tools. In this course, students are asked to investigate this hypothesis by testing structure, skin, assemblage, form and space making methodologies that are aided by digital tools and rationalized through digital operations.

Arch 337/INT 337 - Building Information Modeling (3-0-3)
This course explores both technical and philosophical approaches to the use of the computer in architectural analysis, design development, information management, and document delivery. Autodesk Building Systems and Autodesk Revit Building will be used for 3D modeling and 2D documentation employing a systems-approach framework for spatial allocation, energy analysis, and structural considerations. The workings of the foundational information databases of the respective software will be thoroughly explored. Projects requirements will include building program resolution, solar analysis, asset scheduling, document layout, and design visualization. Understanding of general CAD principles is a required prerequisites.

Arch 432 - P3 Post Presentation Processing (2-3-3)
The project is deemed Architecture, with a capital A, but there remains nagging questions: What would the project be like if viewed stereoscopically? If it were rendered as a 360 degree panoramic view, what would the space be like? If it was accurately superimposed into the site (lighting, color, texture, camera angle), does the design improve when in the context? Would rendering styles using "natural media" be more descriptive? What would the architecture be like at night?

Arch 433 - Cinematic Literacy for Architects & Urban Designers (3-0-3)
This course will use the digital video camera, digital compositing, and interactive DVD to introduce alternate means of communicating architectural ideas. The course will explore narrative techniques, linear and random-access sequencing and will cover critical analysis of film technique, storyboarding, and the authoring of short vignettes. The final project will be a digital image set on authored DVD expressing an architectural case study of a chosen building, site analysis, and/or urban issue.

Arch 588 - Architoons (3-0-3)
Prerequisite: Arch 364 or AD 112 and AD 150. Through the medium of film, applies literary devices to architectural contexts, including caricature, parody, lampoon, satire and farce. Studies historical and contemporary animations and short films for their treatment of meaning, story line and sequence, timing, environmental and psychological mood, atmosphere and emotion. Using 3-D modeling and animation software, each student produces an animated short subject illustrating an architectural principle or providing a humorous look at architectural history and theory. [

INT 322 - Contract Documents (3-0-3)
Prerequisites: INT 221, INT 222, INT 264, and INT 321. The study of the creation, organization, and management of construction documents (drawings/models/specifications) necessary for the realization of residential and commercial interiors projects. Students will create (portions of) a construction document set. Business procedures, professional ethics, and professional interior design concerns are included in the course. Digital media will be utilized to create technical illustrations, three-dimensional models, and building information models to communicate construction information to contractors and fabricators.

University of Southern California

ARCH 207 Computer Applications in Architecture (2, FaSpSm) Introduction for the non-programmer to the uses of the computer in architecture, including the application of existing programs and their implications for design. Overview and use of software types. Lecture and laboratory. (Duplicates credit in former ARCH 207*a*).

ARCH 307 Digital Tools for Architecture (2, FaSpSm) Main topics include building information modeling, geometric and analytical modeling, among other applications in digital design. Lecture and laboratory. (Duplicates credit in former ARCH 207*b*.) *Recommended preparation:* ARCH 207 or equivalent computer experience.

ARCH 315 Design for the Luminous and Sonic Environment (3, Sp) Ideas, problems, and computations related to the design of buildings in response to the luminous and sonic environment.

ARCH 507 Theories of Computer Technology (3, FaSp) Fundamental theories and meanings of computation as a technique in architectural design. Lecture/discussion.

NOTE: University of Southern California also contains the School of Cinematic Arts which has courses of instruction in Cinema-Television, Animation, Critical Studies, Interactive Media, Production, Writing, and Motion Picture Producing which all contain courses that, at other institutions, may be found within an architecture, interior design, or art and design program. Some courses that may be appropriate for architecture students include:

CTAN 101 Introduction to the Art of Animation (2, Fa) Theory and practice of graphic imagery in all its ramifications with emphasis on self exploration. Open to freshman animation majors only.

CTAN 102 Introduction to the Art of Movement (2, Sp) Theory and practice of graphic imagery using short animation projects including Zoetrope, drawing, painting and flipbooks. Emphasis on the frame by frame/frame to frame relationships. Open to freshman animation majors only. *Prerequisite:* CTAN 101.

CTAN 201 Introduction to Animation Techniques (3, Fa) Theory and practice of analog frame by frame time based media. Exploration and examination of ideas generated in the creation of animated media. Open to sophomore animation majors only. *Prerequisite:* CTAN 102.

CTAN 202 Advanced Animation Techniques (3, Sp) Examination of representational aspects of animation generated through character using short animated projects. Open to sophomore animation majors only. *Prerequisite:* CTAN 201.

CTAN 301 Introduction to Digital Animation (3, Fa) The fundamental principles of working in 2-D digital software with an emphasis on animation, story, sound, timing and execution. Open to junior animation majors only. *Prerequisite:* CTAN 202.

CTAN 302 Introduction to 3-D Computer and Character Animation (3, Sp) The fundamental principles of working in 3-D computer software with an emphasis on animation, performance, lip-syncing, timing and execution.

CTAN 330 Animation Fundamentals (2, Sp) An introduction to the fundamentals of animation, covering such topics as timing, anticipation, reaction, overlapping action, and metamorphosis.

CTAN 336 Ideation and Pre-Production (2, Sp) Emphasis on lateral thinking working across boundaries to find underlying principles in terms of ideation: the act of becoming an agent of ideas. Open to junior animation majors only.

CTAN 432 The World of Visual Effects (2, Sp) Introduction to the expanding field of visual effects; topics include magic lanterns shows, stop-motion fantasies and animation combination films employing the latest digital technologies.

CTAN 436 Writing for Animation (2, Fa) Workshop exploring concept and structure of long and short form animated films through practical writing exercises.

CTAN 443L 3-D Animation and Character Design (2, max 4) Principles of 3-D animation and character design combining lectures, aesthetic concepts and techniques demonstrating the use of 3-D animation software and puppet animation. (Duplicates credit in former CTAN 543) *Prerequisite:* CTAN 452.

CTAN 448 Introduction to Film Graphics — Animation (4, FaSp) An introduction to methods for creating analog animation through experimentation with imagery, concepts and materials. Emphasis on basic timing principles and hands-on techniques.

CTAN 449 Advanced Production in Film Graphics (2 or 4, max 8) Concentration on one area of graphic concept or advanced exploration of media and techniques. *Prerequisite:* CTAN 448.

CTAN 450abc Animation Theory and Techniques (2-2-2, FaSp) *a:* Methods for creating animation blending traditional techniques with contemporary technologies; *b:* instruction in methods for planning and executing a short animated film. Topics covered include storyboarding, visual development and production planning; *c:* practical completion of a short animated film.

CTAN 451 History of Animation (2, Fa) In-depth survey of historical developments, styles, techniques, theory and criticism of animation as an art form.

CTAN 452 Introduction to 3-D Computer Animation (2, max 4, FaSp) Lecture and laboratory in computer animation: geometric modeling, motion specification, lighting, texture mapping, rendering, compositing, production techniques, systems for computer-synthesized animation.

CTAN 462 Visual Effects (2, FaSp) Survey of contemporary concepts and approaches to production in the current stage of film and video effects work. Digital and traditional methodologies will be covered, with a concentration on digital exercises illustrating modern techniques.

CTAN 463L Creative Workflow in Visual Effects (2, FaSp) Spherical panoramic photography, 3-D digital environment techniques and a range of visual effects work while providing the stage for the student's storytelling. *Prerequisite:* CTAN 462.

CTAN 464L Digital Lighting and Rendering (2, FaSp) Concepts, tools and techniques used to create cinematic lighting and rendering in computer-generated imagery (CGI). *Recommended preparation:* familiarity with Autodesk Maya and Apple Shake strongly suggested.

CTAN 501 Experiments in 2-D Digital Animation (2, FaSp) 2-D Digital animation exploring the art form as a fertile terrain for experimentation, exhibition and activism. *Recommended preparation:* 2-D digital experience.

CTAN 502ab Experiments in Stereoscopic Imaging (2, Fa; 2, Sp) *a:* An in-depth exploration of aesthetics and techniques involved in the conceptualization, design and creation of stereoscopic imaging. *b:* Review of techniques and aesthetic issues pertinent to immersive virtual reality and stereoscopic animation. Students realize an original project proposed in CTAN 502*a*.

CTAN 503 Storyboarding for Animation (2, FaSp) Focus on film grammar, perspective, and layout, staging and acting as it relates to storyboarding for animation.

CTAN 505 The Business of Animation (2, FaSp) Professional knowledge and application of fundamental business skills associated with working in the animation industry, academia or the arts.

CTAN 508L Live Action Integration with Visual Effects (2, FaSp) Survey of the digital techniques required to successfully marry live action shooting with CGI elements and green screen footage. *Prerequisite:* CTAN 462.

University of Pennsylvania

L/R 201. Visualization I: Representation. Prerequisite(s): This course is not open to students in their first or second freshman terms at Penn. Students must be rising sophomores to advance register for this course. Introduces technical drawing and explores its thematic possibilities, through both an analysis of antecedents and the production of new works. These complimentary studies serve both to establish an understanding of representation as the foundation to visual communications and to develop the ability for seeing through drawing.

202. Visualization II: Fabrication. Prerequisite(s): ARCH 201. Continues research into visualization with a special emphasis introducing the fabrication shop, tools and techniques. The capacity of materials, their manipulation and the consequences of their inter-relationships are explored as a fundamental issue in making. Through the analysis of precedents and the production of new works, visualizing these relationships compliments drawing with a material imagination and vocabulary.

440. Introduction to Computers in Architecture. This course provides an introduction to computer graphic technology in the context of current architectural practice. We use AutoCAD's latest release as the basic software for the course. AutoCAD is the most widely-used architectural software and provides a good grounding for exploration of other programs. Topics include basic vector graphics, two-dimensional drawing and drafting and basic three-dimensional modeling. The course is organized around a series of structured exercises that illustrate basic principles and enable students to develop greater facility with the software. The modeling emphasis is placed on quick study models as part of the design process. There is also a field trip to the offices of Venturi, Scott Brand and Associates to see the use of computers nin their practice. No experience with Auto CAD software is required.

748. Advanced Digital Media. Technique: a method of accomplishing a desired effect. Media: the material/virtual means of transmission of the desired effect. This seminar will investigate specific media-based techniques and their latent ideologies through the analysis of selected paintings, photographs and films. Lectures and discussions of selected texts will examine how these techniques have impacted architectural culture in the modern period. A critical study of learned perceptions and conventions of seeing and of the media that stand between that which we believe to be real and the image will serve as the basis for creative investigations into depictions of space and material using digital media. By introducing themes that outline intersections between media-specific techniques and architectural practice, the course will enable the creative exploration of new methodologies and techniques related to digital media and its implications on the representation and formation of space. There will be a required presentation that will be developed into a final paper or project.

SM 061. (CINE061, FNAR661, VLST061) Video I. This course provides students with the introductory skills and concepts needed to create short works using digital video technologies. Students will learn the basics of cinematography and editing through a series of assignments designed to facilitate the use of the medium for artistic inquiry, cultural expression and narrative storytelling.

SM 062. (CINE062, FNAR662) Video II. Prerequisite(s): FNAR 061. Video II offers opportunities to further explore the role of sound, editing and screen aesthetics. Through a series of three video projects and a variety of technical exercises, students will refine their ability to articulate more complex and creative projects in digital cinema. In addition, advanced level production and post-production equipment is introduced in this course.

SM 063. (CINE063, FNAR663) Documentary Video. Prerequisite(s): FNAR 061. A digital video course stressing concept development and the exploration of contemporary aesthetics of the digital realm, specifically in relation to the documentary form. Building on camera, sound and editing skills acquired in Film/Video I and II, students will produce a portfolio of short videos and one longer project over the course of the semester. Set assignments continue to investigate the formal qualities of image-making, the grammar of the moving image and advanced sound production issues within the documentary context.

SM 064. (CINE064, FNAR664) Interactive Video. Prerequisite(s): FNAR 061, FNAR 062. This course explores the concepts and technologies behind non-linear storytelling through mediums like DVD's and the world wide web. Students will learn to make interactive DVD videos as a form of expression and explore the possibilities of streaming videomaking.

SM 065. (CINE065, FNAR665) Cinema Production. Prerequisite(s): FNAR-061. This course focuses on the practices and theory of producing narrative based cinema. Members of the course will become the film crew and produce a short digital film. Workshops on producing, directing, lighting, camera, sound and editing will build skills necessary for the hands-on production shoots. Visiting lecturers will critically discuss the individual roles of production in the context of the history of film.

SM 066. (CINE066, FNAR666) Sound Seminar: Sonic Measures. Prerequisite(s): FNAR062. Sonic Measures is a comprehensive introduction to the theory and practice of digital audio design, including sound for video, sound installation, composition, and sound art. Projects and demonstrations will familiarize students with all aspects of recording and synthesis of sound using Apple's Logic Pro software. Assignments will combine technical issues alongside an ongoing conceptual development individual to each student's interests. No musical knowledge needed.

SM 067. (CINE067, FNAR667) Advanced Video Projects. Prerequisite(s): FNAR 062. This course presents students with an advanced level investigation into various forms of digital video projects as well as non-traditional presentation formats. Structured to create a more focused environment for individual projects, students will present and discuss their work in a series of group critiques. Lecture topics, screenings, and technical demonstrations will vary depending on students' past history as well as aesthetic and theoretical interests.

SM 068. (CINE068, FNAR668) Cinematography. Prerequisite(s): FNAR 061. This course will be a technical, practical and aethetic exploration of the art of cinematography as it pertains to film and digital video. Through screenings, in-class excercises and assignments, students will increase their Video I skills in lighting and cinematography as a form of visual expression. Topics covered include shot composition, camera movement, lenses, filtration and color, exposure, lighting techniques, location shooting and how to use grip equipment. Discussions, demos and lectures will include relevant and illustrative historical motion picture photography, current digital video technology, and examples that explore interactions between film and video.

235. (FNAR635) 3-D Computer Modeling/Digital Sculpture. Prerequisite(s): FNAR 123 and FNAR 264. Students will develop a facility with fundamental 3-dimensional design concepts through the application of both computer graphics visualization and physical construction. The course will offer students a technical understanding of Polygonal and Spline based modeling, alternative and standard methods of 3-D input/output, and will cover regulations for creating models that will function properly for animation, video games and CMC/laser output.

236. (FNAR536) Digital Figure Modeling I. Prerequisite(s): FNAR 235. Recommended FNAR 243 or FNAR 280. 3D computer figure modeling is a course which will emphasize the modeling of the human figure on the computer. Students will be studying anatomy as it relates to an understanding of the human bone and muscle structure. This understanding will be implemented in constructing models which could be used for still images, medical illustrations, animation, computer games, 3D output and motion capture.

241. (FNAR541) Hand-Drawn Computer Animation. Prerequisite(s): FNAR-123 and FNAR-264 or Permission of Instructor. The student will learn to conceptualize and produce animation design ideas with an eye on the possibility of making the art of animation a future career. The student will be introduced to the workings of hand-drawn digital 2d animation design using a Wacom tablet and software Mirage, specializing in this type of production. Emphasis will be placed on: 1) the development of drawing skills particularly related to the creation of paperless animation in a quick and effortless style: 2) the finesse of representing a sense of drama and motion within a single frame; 3) storytelling skills fulfilling a mission of urgency and purposefulness; 4) the pursuit of originality in a world where almost everything has already been done- or so it seems; and 5) passion!- for the sense of responsibility to serve others; to follow direction and honor deadlines without compromising one's drive for creative independence. Students are required to buy their own Wacom Intuos2 pens.

264. (FNAR636, VLST264) Digital Design Foundations. This course explores the elements and principles of design and composition. It is an introduction to the intentional organization of traditional and digital image-making. Emphasis will be placed on understanding compositional relationships through experimentation, iteration and critique. Students will create imagery using hand skills and the software programs Adobe Illustrator, Photoshop, and InDesign.

266.(FNAR566) Graphic Design. Prerequisite(s): FNAR 264. Graphic Design emcompasses many forms of visual communication that are disseminated in print, on screen and in the environment. In every design, the meaningful use of text and/or image is what communicates a message to an intended audience. Through a series of different projects, students will gain an understanding of visual problem-solving concepts. Professional design software will be used.

267. (CINE267, FNAR567) Computer Animation. Prerequisite(s): FNAR 123 and FNAR 264. Through a series of studio projects, this course will focus on 2D and 3D computer animation. Emphasis is placed on time-based design and storytelling by developing new sensitivities to movement, cinematography, editing, sound, color, and lighting. Compositing software covered in the course will be used to combine 2D graphics, 3D animation, and sound. Recommended materials: Wacom Pen

268.(CINE262, FNAR568) Interactive Multimedia. Prerequisite(s): FNAR 264. Interactive multimedia design in art, education, entertainment, and business has extended from the primitive state of CD-ROMS, and Laserdiscs, to the web, public interactive installations, and applications for hand-held computers. Through a series of studio projects, this course will focus on sound design, animation and graphic interface design for interactivity. Authoring and editing applications will be introduced including Flash and Pro Tools. Recommended materials: Wacom Pen

Virginia Tech

Arch 5064 - Computer Applications in Design
Computer system fundamentals. Introduction to programming. Emphasis on computer graphics in 2 and 3-space geometry and graphics-related topics employing several languages. Computer usage in architectural design and production. Exploration of available hard and software through advanced design issues. Topics target the processing of various kinds of information related to architecture, including vector modeling, light simulation, digital imaging, and data exchange. The exploration takes place through architectural design issues. The course seeks to introduce the computer as a medium for visualizing the consequences of design decisions in architectural applications. A computing environment based on multiple platforms, software, and data formats addresses the current diversity of information handling related to architecture. Exercises are designed to aid a student in the initial comprehension of construction, manipulation and representation of data or information sets as they relate to architectural design.

ARCH 5115, 5116 - Media and The Environment Workshop
The role of various media of visual communication as tools of documentation, analysis, and creation in the designed visual environment. Skills in photography, film, video techniques, and printmaking graphics will be developed in specific relation to environmental design study and presentation.

University of California - Berkeley

ARCH 122 (FORMERLY ARCH 132) PRINCIPLES OF COMPUTER-AIDED ARCHITECTURAL DESIGN (4)
Three hours of lecture and 1.5 hours of supervised laboratory per week. Prerequisites: none. This course introduces students to the principles of CAD, the theories and methods on which it is founded, and some of its basic and advanced applications (drafting, modeling, rendering, generating, and evaluating design solutions). Students will learn how to use a Building Information Modeling (BIM) software and game-based modeling to develop an interactive, "walkable" and data-rich model of a building.

ARCH 129 (FORMERLY ARCH 138/139X) SPECIAL TOPICS IN DIGITAL DESIGN THEORIES & METHODS (1–4)
Course may be repeated for credit as topic varies. One hour of lecture/seminar per unit per week. Prerequisites: Consent of instructor. Topics cover advanced and research-related issues in digital design and New Media, related to architecture.
Advanced Computer-Aided Rendering & Animation
This course is for advanced students who have a research agenda or specific project involved with computer representation, visualization, or rendering. The course is run as a lab/seminar where individuals are responsible for their own research agenda and its fulfillment. The course provides a forum for serious discussion and exploration of emerging fields in computer rendering, painting, modeling, animation, multimedia and design as well as issues related to those fields. Emphasized are specific interests in human user interfaces and how designers, artists and other graphic thinkers use and develop necessary tools. Students will discuss the uses computers have been put to in support of design as well as the drawbacks of these uses and will explore the potential of the future. Needed is a familiarity and experience with principles of CAAD, the theory and methods on which it is founded, and its principle applications in practice (generating, evaluating, modeling, drafting and rendering design solutions). Students must have previous computer and software experience and to be able to compose and sustain a research plan.

ARCH 133A - TWO-DIMENSIONAL COMPUTING TECHNIQUES IN ARCHITECTURE (2)
Three and one-half hours of lecture for eight weeks. Four and one-half hours of lecture for six weeks. This course looks at the principal 2-Dimensional CAD techniques used by architects to create presentations, schematic drawings, and working documents. Emphasis will be placed on the generation of 2D architectural graphics, the integration of those graphics with nongraphic data, and the uses of disparate graphic approaches.

ARCH 133B - THREE-DIMENSIONAL COMPUTING TECHNIQUES IN ARCHITECTURE (2)
Three and one-half hours of lecture for eight weeks. Four and one-half hours of lecture for six weeks. This course looks at the principal 3-Dimensional modeling techniques used by architects to create computer models, rendered images, and animation. Emphasis will be placed on the generation of 3D architectural graphics and their presentation.

Iowa State University

Arch 432. Advanced Computer Lighting and Rendering. (3-0) Cr. 3. Repeatable. F.S.*Prereq: 230, 301.* Exploration of the computer as a design and communication tool. Emphasis on lighting and rendering techniques.

Arch 433. File to Fabrication. (3-0) Cr. 3. Repeatable. F.S.*Prereq: 230, 301.* Exploration of the computer as a design and manufacturing tool. Emphasis on fabrication techniques and rapid prototyping including laser-cutting, 3-D printing and CNC routing.

Arch 434. Computer-aided Architectural and Environmental Design. (1-4) Cr. 3. S.*Prereq: 334.* Emphasis on application of the computer as a design tool, topical applications and computer graphic methods, development of computer software for architectural and environmental problem solving. Nonmajor graduate credit.

Arch 436. Advanced Design Media. (2-2) Cr. 3. Repeatable. F.SS.*Prereq: 230.* Special topics in design media applications.

Yale

667b, Craft, Materials, and Computer-Aided Artistry 3 credits. This course reviews materials and computer-aided manufacturing (CAM) processes especially suited for digitally crafting inspired and unique architectural components. Students use 3-D modeling programs, including a digital environment that mimics carving actual materials, and then translate their designs into tangible prototypes using a wide range of CAM equipment. Required projects feature increasingly complex geometry as the course progresses.

851b, Survey of Digital Media 3 credits. (Required in M.Arch. I third term.) This course covers the fundamentals of 3-D digital media techniques and representation. Through various projects, students utilize digital media tools and techniques available in the creation and representation of complex forms and spaces. This includes digital image montages, proportional and measured 3-D computer models, fabrication and rapid prototyping technologies, animation sequences, and final representation through nonlinear interactive presentation.

853a, Computation Analysis Fabrication 3 credits. (Required in, and limited to, M.Arch. II, first term.) This course investigates and applies emerging computational theories andtechnologies through the design and fabrication of a full-scale building component and/or assembly. This investigation includes various static, parametric, and scripted modeling paradigms, computational based structural and sustainability analysis, and digital fabrication technologies. Students work in pairs to design, analyze, and fabricate a full-scale constructed piece.

[**860b, Web Design and Interactive Media** 3 credits. This course investigates the use of the Web and interactive media in architecture with an emphasis on design and communicating information effectively. The course begins with an investigation into the way architects can utilize the Web as a tool through online portfolios, presentations, and archives. Students then create a series of short projects focusing on these uses. The course concludes with a final Web project. The course covers standard HTML, Dreamweaver MX, Flash MX, Digital Video, Sound, VRML, QTVR, and Java Script. Dreamweaver and Flash are used as the primary design tools with Photoshop, Premiere, and 3-D Modeling as support applications. Limited enrollment.

[**866a, Modeling, Animation, and Fabrication** 3 credits. Recent advances in modeling, animation, and rapid prototyping allow a design to be investigated, tested, and assembled in the computer and then fabricated directly from data generated by this process. This course investigates this process through the design, animation, and fabrication of an architectural assembly. The first half of the course focuses on advanced modeling technologies. Rhino 3D, Maya, and 3D Studio Max are used to create a complex assembly. The assembly connections and sequencing are tested through assembly animation techniques using Maya and 3D Studio Max. The final assembly is constructed from actual materials, fabricated using rapid prototyping and CNC technologies, and assembled for final review. Limited enrollment.

Rhode Island School of Design

INTAR 2331 **INTRO TO COMPUTING FOR INTERIOR ARCHITECTURE**
The objective of this class is to learn basic digital techniques in spatial design. Students successfully completing this course should be able to develop sophisticated digital layouts with image processing software (Photoshop), create CAD based 2D architectural drawings and 3D models (VectorWorks), and develop a 3D visualization of a design (Cinema 4D). In this course, we will also discuss the integration of 2D and 3D data (BIM), digital materials, as well as the basics of digital lighting and camera work. *Required for BFA, BIA and MIA3-year program; Elective for MIA two-year program INTAR majors only*

INTAR 2367 **ADVANCED COMPUTING**
This course builds upon the knowledge of applications gained during the "Intro to Computing" class, and will introduce students to the capabilities of programs for the advanced user. In addition to expanding on VectorWorks knowledge, students will be introduced to Form-Z and Cinema 4D while expanding their modeling skills, students will also gain advanced understanding of animation, lighting, materials, and rendering techniques which can be utilized in any of the 3-D computer modeling applications. *Prerequisite: INTAR 2331*unless in *MIA two-year program Elective for BFA, BIA and MIA INTAR majors only*

D+M 7150 **INTERACTIVE AND REACTIVE MEDIA ENVIRONMENTS**
Technologies not only change "external reality" but also change our internal consciousness and shape the way we experience the world. The everyday technological apparatus tends to understand space as the void left behind when no objects are present. Unfortunately, once we see space in this way, we are unable to understand the role it plays in our everyday experience. In this course we will examine ways of 'materializing' space–infusing it with life–through the combination of computational and critical tools. As installations, performances or architectural interventions, students will design and build responsive media environment events combining material and plastic arts with real-time computational media. A combination of technical, practical and conceptual skills will be covered with the goal of creating experientially rich spaces. A theoretically diverse approach will be taken, with ideas from art, architecture, neuroscience, phenomenology and computer science surfacing throughout. Technical topics will include real-time audio/video synthesis, media choreography, sensing, active materials and computer vision, explicitly for the design and implementation of large scale, real-time responsive media environments. [NOTE: A number of Digital + Media courses are popular with interior architecture students.]

D+M 7035 **3-D MODELING FOR ARTISTS + DESIGNERS**
Digital 3D modeling is a versatile tool that can be used by painters and printmakers to create perspectival imagery, by sculptors to manipulate form, by architects and interior architects to mockup spatial ideas and explore materiality, and by film and video artists to quickly create animations. This course is an introduction and an overview of 3D modeling for artists and designers. The course will look at various 3D modeling techniques as well as different methods of outputting or presenting 3D models, including rendering images, creating animations, or using fabrication techniques such as laser cutters and rapid prototyping machines to produce physical models. The main goal of the course is to help students develop a working methodology for integrating 3D modeling into their own practice, through a series of exercises. One of the main ideas that will be explored in the course is the versatility of 3D modeling. Students will be encouraged not only to explore 3D modeling as it relates to their own discipline, but to explore digital modeling as a bridge to other disciplines and as a new way to explore space and spatial representations. The course will not focus on a single software, but will examine the relative strengths of various 3d modeling packages, including Maya, 3D Studio Max, Rhinoceros 3D, and Google Sketchup. The course is open to both beginners and students with experience in 3D modeling looking to expand and diversify their skills. [NOTE: A number of Digital + Media courses are popular with interior architecture students.]

Art Institute of Chicago

Design Communication
This course teaches introductory design communication skills. Studio exercises focus on analog methods of drawing and modeling design ideas and introduce the range of digital tools that can be used to make visual representations of ideas at various stages in the design process. Instruction covers the use of 2D digital communication tools, specifically the Adobe suite - Photoshop, Illustrator, In-design and Acrobat; and time-based presentation media such as I-movie, PowerPoint, Keynote or Flash. This lab helps students develop a basic vocabulary of techniques and approaches for visualizing concepts and making compelling visual and oral design presentations.

Spatial Computer Imaging
Drawing, painting, drafting, modeling, and rendering skills are practiced in reference to spatial imaging and manipulation. Beginning digital skills are established in two-dimensional and three-dimensional exercises. Internet access, flatbed scanning, and printing are included. File size management and storage is covered. Weekly exercises guide digital development in spatial exploration.

Spatial Parametrics
Investigates the new field of parametric design, which involves making 3D computer models that have embedded simultaneous equations that modify parts of the model when other parts are changed. Includes the sketching of potential parametric relationships at the beginning of the parametric design process.

GFRY Design Studio
The GFRY is a collaborative, trans-disciplinary design and fabrication studio that actively cooperates with industry to explore how new technologies, social forms and materials can be integrated to produce innovative objects, media, environments and experiences for the challenges of an increasingly complex world. The studio produces work for targeted public opportunities such as art, design and technology expositions, design competitions and topical research publications. Participating in this prestigious atelier offers students a highly visible venue for the exhibition of work and the chance to be involved in the development of public work from concept through fabrication, installation, promotion, and review. Students are admitted via an application reviewed by the faculty.

R**ESOURCES/REFERENCES:**

CIDA Accreditation Manual
http://www.accredit-id.org/accredmanual.php [referenced/downloaded 28.June.2009]

NAAB Procedures for Accreditation
http://www.naab.org/accreditation/2009_Procedures.aspx [referenced/downloaded 28.June.2009]

Teaching Computer Graphics in Context: Computer Graphics Education '09 Workshop organized by Colleen Case and Steve Cunningham
http://education.siggraph.org/media/reports/CGE09-Workshop-Report.pdf [referenced/downloaded 07.July.2009]