An Application Study of the CAD Tools in Architecture Basic Design

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Abstract

The purpose of this paper is to present the application of automation tools in architectural basic design courses and the relationship between the design with consequent courses. This research is based on the inter-relationship occurring between architectural basic design and other courses provided in the department of architecture of various universities. Basic design, which consists of visual communication in multi-media, is an important training course in aesthetics. Related training facilitates students with more representational varieties in architectural basic design and allows them to apply their acquired knowledge and experience to other courses. The study shows that computer-aided basic design (CABD) will provide a new learning standard for design environments. In order to familiarize students with the management ability of design information, computer-aided architectural design should be integrated with basic design as a fundamental design tool. This paper includes course contents of universities, tool planning the application between basic design and consequent courses, the match between design contents and the function of tools, and the implementation, observation, and evaluation of basic design contents. Research results include the establishment of a course content database, a matrix of design contents and computer applications, the setup of learning environments, new course contents, computer-oriented operation patterns, and the exemplification of planned subjects.

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1. Introduction

The purpose of this paper is to present the application of automation tools in architectural basic design and the relationship between the design with consequent courses. This research is conducted based on the inter-relationship occurring between architectural basic design and other courses provided in the department of architecture in local universities. This research investigates the feasibility of tools, in terms of computer applications, in assisting students of basic design. The research includes the observation and result of an independent study for two semesters. The study included collected information like the topic or content of exercises from various universities. Reference also added detailed description and comparison of six universities to this research. However, the inter-relationship between CAD and other architecture courses in vertical orientation cannot be proven within this limited period of investigation. Potential influence can only be addressed from the inter-relationship matched between course contents and the items computers can assist.

Basic design, which consists of visual communication in multi-media, is an important training course in aesthetics. For most local universities, students have to study for four or five years before earning a degree of Bachelor of Science or Bachelor of Architecture separately. The course of basic design usually has three credit hours and is offered as an elementary course before architectural studios (Shih & Shen 1995). The course starts form the first semester in freshman and related practice is usually extended to the second semester. Course contents and exercises are categorized based on specific goals which are arranged as modules. The exercises will specify students with a range of materials and representational methods as the fulfillment of a design goal or topic. Students usually apply all kinds of materials and skills to facilitate the representation of their design concepts.

Architectural basic design is considered as a basic training of design tools. The evolution of tools inevitably improves the effectiveness and efficiency in design representation (Herbert 1990). The contents of basic design change from time to time due to the influence of different tools and media on visual preferences and representational form. The changes deserve a detailed study. Since computer-aided design has been applied in architectural design and almost in every subspecialty, the knowledge and training of CAD in architecture should start as early as possible, for example, during basic design courses. Computer-aided basic design (CABD) should be considered as a pioneer course which provides integrated training of design information. The purpose of CABD is to provide a new manner of data manipulation for the design environment, a new learning experience, and a new information management ability in a computer era.

2. Related Studies

Studies were made to some universities in local and North America (Cornell 1993, UM 1987, Princeton 1992, Univ. of Oklahoma 1990, Washington Univ. 1992) to collect course outlines. The outlines can be categorized into common topics which include the composition of lines, points, lines, volumes, or spaces. Composition related manipulation like balance, rhythm, or proportion are usually given as student exercises. Appearance-related attributes like color, texture, or light and shadow are also among those basic practices.

The relationship between basic design and consequent courses was also studied. Based on a study made to the CAD-related courses of local architecture schools (Shih & Shen 1995), "introduction to computers" is usually offered prior to all computer-related courses. The contents mainly include computer programming and introduction to applications. Following courses include computer-aided drafting, three-dimensional modeling, and computer animation which are offered as special studies and can be directly applied to generate drawings or models. The application of tools is influenced by the teaching sequence of course contents. In general, tools are taught and practiced to handle 2D drawing information prior to 3D volumetric modeling. The arrangement of CAD-related courses is usually purposely designed to meet the drafting demand in architecture practice after students graduate. Although applications which can integrate 2D and 3D data exists, few schools and firms use them for low market sharing.

Some interviews were conducted of students regarding their learning experience of basic design and CAD-related courses. An opportunity for learning CAD tools in the early years of design education is usually missed due to course design. Fig 1. shows the traditional sequence of design data manipulation in a studio is a 2D to 3D process. Although the main part of design representation is 3D objects, most schools choose 2D drafting as the principle CAD training courses when students start to work with real building projects as sophomores. This course design causes a deficiency in the analysis of 3D forms. Instead, traditional cardboard models or perspective drawings are utilized.

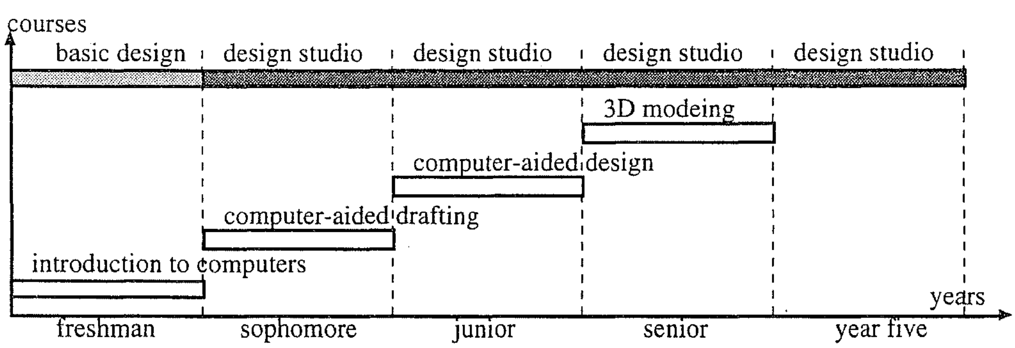

Figure 1. A general arrangement of CAD-related courses (Shih & Shen 1995)

3. Basic Design

CABD, which is the first design-related course for freshmen, features part of a continuous training curriculum. The training of observation, manipulation, and analysis in basic design is just a beginning compared to subsequent design courses. The training will promote students' design aesthetics and facilitate the application of appropriate tools. Related training will facilitate students with more representational varieties in architectural basic design and allow them to continue applying their knowledge and experience learned to other courses.

The pedagogical goal of basic design can be categorized as follows, based on previous research result(Shieh & Wu 1995):

* establishing a learning framework capable of accumulating design experience;
* developing the ability in space imagination;
* facilitating the ability in precise and creative representation.

In relating CAD to the first goal, the manipulation of design data can be considered as an important part of design experience, since the related capability usually ensures the support for the completeness of an architecture student's learning framework. In relating CAD to the second goal, three-dimensional geometries can be built by applications (CAD systems) to facilitate the visualization of abstract or physical spaces. The stimulus of visualization can facilitate following design development, consequently, helps to develop the ability in space imagination. Some universities consider design as a kind of training in representing design concept. Design studios is conducted to encourage precise and creative representation. In relating CAD to the third goal, previous mentioned visualization applications actually can assist the construction of spaces with particular attributes. Design contents can be addressed with substantiated geometry data. As a result, design contents can be described or represented more accurately.

In course contents database, this paper has collected exercises from 5 professional colleges. Similar contents of additional 6 universities can be referred from reference. Some exercises come with detailed description. Course contents usually start from graphic design. From the manipulation of points, lines, faces, to volumes, exercises are related to architectural design in terms of the inter-relationship between design elements, such as repeat, gradient, symmetry, balance, proportion, rhythm, coherence, contrast, unity, and pure. Exercises are also extended to the manipulation of attributes like color, texture, light/shadow, and mass. In order to prevent being isolated from real design projects, exercise contents are usually taken from real examples. It depends how students transform the abstraction of exercises.

The collected data can be categorized by types and contents as follows.

* experiencing space: e.g. representation of spaces from movies, reconstruction of childhood ' space, re-representation of visual elements

* construction of geometric elements: e.g. construction of points, lines, faces, volumes. Editing and assembly of geometric elements are also included.

* composition: manipulating the inter-relationship between shapes through repeat, symmetry, balance, etc. to meet certain exercise requirement. Exercises include fundamental composition of forms, components (points, lines, faces, volumes), basic architecture elements. Examples can be found like the pictorial representation of pleasure, anger, sadness, and happiness.

* attributes: including color, texture, light/shadow

* 2D and 3D transfer: analyzing the transformation between 2D and 3D geometric elements. A common example is to transform from 2D collage, relief sculpture, to 3D objects with the goal to experience all the possibility of 3D configuration based on the interpretation of 2D projection.

* relating spaces and objects to real objects: e.g. design of environmental subject, such as showroom, overline bridge, square in front of architecture department, and waiting area next to a bus stop.

In general, all exercises are concluded with a final project, which usually refers to most of previous practice, to purposely integrate different design criteria.

4. The Relationship between Basic Design and Tools

CAD tools can assist basic design with functions for visual communication, training, generating design data, and establishing a new manner of data manipulation. Traditional training manner lacks efficiency and effectiveness in data manipulation, due to the limited capability of tools. In order to provide training necessary to freshman, many universities purposely plan the contents of exercises in basic design to handle the conceptual transfer between professional 2D drawings and their 3D representation (Shieh & Wu 1995). Traditional training with hands-on operation is still important in developing the awareness and response to physical objects. However, the efficiency and effectiveness should be enhanced to increase student's ability in data manipulation.

4.1.Architectural basic design is a multi-featured visual communication activity

Visualization acts as a kind of stimulus to assist design development (Herbert 1990). From the contents of exercises of various architecture departments, it can be shown that the training is conducted with tools which can facilitate the representation of a student's concept (Shieh & Wu 1995). Design itself is an activity of visual communication (Lawrence 1993). In addition to representing design intention, the contents of communication have been extended to multimedia instead of a single type or format of data. CAD tools are effective to visual communication in transferring different types of data format and integrating all kinds of data for presentation. The new type of visual communication has proven its feasibility in many fields. Traditional basic design, which only applies drawings or a model to represent design results or to stimulate design thinking, becomes very self-restricted.

The contents of basic design have been updated for a long period of time. Related study will lead to the influence of tools and media on visual preference and representational form.

4.2.Architectural basic design is a fundamental training of design tools

Almost universities listed architectural basic design, or similar courses, as the first or introductory course of design (Shieh & Wu 1995). Architectural basic design can be considered as a basic training of design tools. The evolution of tools inevitably improves the effectiveness and efficiency in design representation. Tools come with many types which serve different purposes in the manipulation of design data (Shih & Shen 1995). Automation tools include software and hardware for CAD, DTP, DBMS, multi-media, communication, etc. It is necessary to extend the scope of application beyond drafting. In addition, the multiple aspects of design data in basic design provide students with a good opportunity to be exposed to various kinds of tools. Student's experience of tools and corresponding knowledge of representation can be established from the practice of real projects. The experience will establish a profound knowledge foundation and complete learning environment for further application in studios.

The types of tools are listed as follows (Shih & Shen 1995).

* CAD: drafting, modeling, rendering, analysis (scheduling, interference checking, building codes, bill of material, structural analysis, energy analysis, light simulation)
* Geographic information system (GIS)
* Word processing: application & tools, OCR, style checkers
* Desktop publish (DTP)
* Multi-media: animation
* Graphics: utilities, clip art
* Business software: desktop presentation, integrated applications, project & time managers, database managers (data, calendar), charting/graphing & statistics, spreadsheet
* Finance & accounting
* Database management system (DBMS)
* Communication: net-working, connectivity, terminal emulation, dial-up services
* Programming language
* Utilities: virus protection, security, back-up software, macro generators, screen savers, system utilities

Students have different preferences of tools. Survey shows that pastel, watercolor, pencil, markers, and other tools are used as the media for representation. This coarse survey of the preferences of tools was made by interviewing about 15 students from 11 different universities or professional colleges. The interview included individual experience and the observation of classmates (about 40 students) regarding drawing tools applied in basic design exercises. In general, tools are chosen according to the requirement of exercises. The number of types may be limited. However, some exercises (like the practice of colors and textures) encourage students to try all possible manners of representation. The encouragement of specialty meets the teaching emphases of some universities as long as pedagogical goals are still followed.

Tool preference is also influenced by the schedule of drafting course. If course schedule starts from color pencil, watercolor, pastel, spray color, to multi-media, previously learned tools and skill will influence what students are going to use in exercises.

Interview showed that color pencil was preferred by most of the students (86%), since it is unlikely to make mistakes. Even mistakes are made, it can be erased. Some type of pencil can generate watercolor effect by applying water on it. Some students chose watercolor if large area of even color was to be painted. Few students chose spray color as presentation media.

The various texture and visual effects of traditional tools now can be substituted by a single painting application. Although differences exist between real and simulated pens, an integrated painting function can help students to develop their ideas more freely.

4.3.Different tools can facilitate the generation of design data from different approaches

The role of tools in generating design data can be classified into a tool-oriented approach and a goal-oriented approach. The former depends on the application of a single type of tool in a design process. Traditional design approach usually develops different alternatives of a project with the same tool. Whether the design goal is achieved or not heavily depends on what can be provided by the functions of the tool. The tool-dominated application can be categorized as a tool-oriented approach. As seen in Fig. 2, an assignment is given to represent the abstraction of a concept by composing a number of squares with different textures and color. A tool-oriented approach would depend on the functions of arrangement to distribute squares to different locations with various numbers of duplication. This approach emphasizes the arrangement of data generated from the same type of tool.

A new application method, which is a goal-oriented approach, can generate data under the same requirement. The goal-oriented approach emphasizes the method data are created. There are many possible methods to help accomplishing design goal. For example, there are functions like wave or contrast can meet the requirement of an exercise (see Appendix). This approach is different from using a single tool (arrange and paste watercolored square, for example) by the number of varieties. Although computer applications are also considered as tools, different functions or filters (special effect functions in a normal imaging application) are conducted with various algorithms. From the viewpoint of tools types, the functions or filters can be considered as the type of tool application which is to meet design goal.

A goal-oriented approach should lead the application of design tools. The merit of traditional basic design will not be ignored as long as the goal-oriented approach is also applied. With the tool approach, traditional training purposes of basic design can be achieved in greater success with the assistance of computer-aided tools.

As seen in Fig 3. and Appendix, the final result is generated by applying different "filters" to change the attributes of an image or a color. More detailed explanation can be found in Appendix. Another representation of the same example, which is the 3D mesh of the pictorial image, tries to introduce another viewpoint of the final result. The mesh representation extrudes each pixel in different heights: the bright the color is, the higher the point is located in the mesh. The example tells that an assignment can be conducted from many different approaches. Students should be encouraged to explore all possibilities with all tools available.

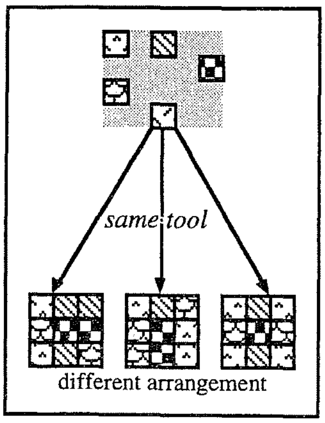

Figure 2. Tool-oriented approach

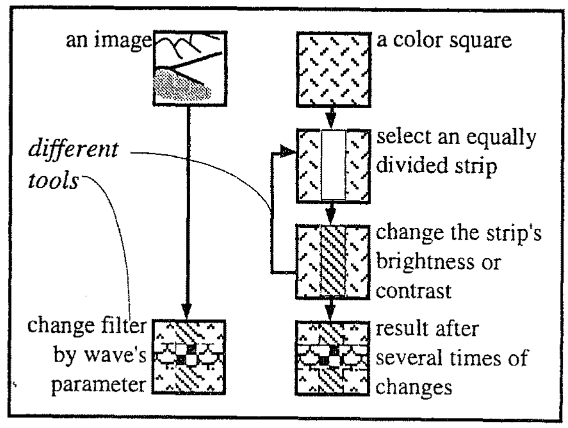

Figure 3. Goal-oriented approach

Pedagogy certainly has it influence on goal- or tool-oriented approach, since some exercises have already addressed expected training of tools and their applying method. But in accumulating design experience, students should use all kinds of resources which leads to the differentiation of goal- and tool-oriented approaches.

4.4.A complete training of computer-aided architectural design should start from basic design

From previous research (Shieh & Wu 1995), all basic exercises try to explore student's experience in different data generation. Computer, which is also considered as a tool, should not be excluded.

CAD tools come with different functions. The application of individual tools and the integration of them is a good exercise. Some basic design exercises should be directly involved with real design projects which are assigned in moderate scale. The size of the assignment should allow students to explore various CAD tools without bearing an extra burden. Under a teacher's planning of assignments and the involvement of potential tools, students will have hands-on experience of tools and the integration of them within one or two semesters. This length of practice is usually sufficient to develop a personal approach and preference of applications. In other words, the practice helps students to discover the most appropriate and efficient control pattern of tools based on personal experience. Since basic design is always offered during freshman, a combined training or exercise of CAD and basic design surely will make the CAD-related education more useful for later manipulation of design data. CABD then becomes a pioneer course in data manipulation and management for consequent design tasks.

4.5.The CABD will also provide a new manner in design data manipulation

The CABD provides students with a new manner in design data manipulation for the design environment, since a new approach for the manipulation of design data and a new learning experience is involved. For example, students can generate a great number of alternatives for evaluation by merely changing attributes. The difficulty in modifying brightness, color, and contrast of watercolors after a stroke is made can be alleviated. In addition to the feature control of contents, new types of definition like color mode, layer, or channel are added to facilitate the representation of data. Painting watercolor will no longer be managing colors in one layer.

The new definition of data type and representation manner will change a student's cognition while perusing the result of an assignment. The result of learning a new definition of data type and representation manner becomes a perfect pioneer and integrated training for the management of design data.

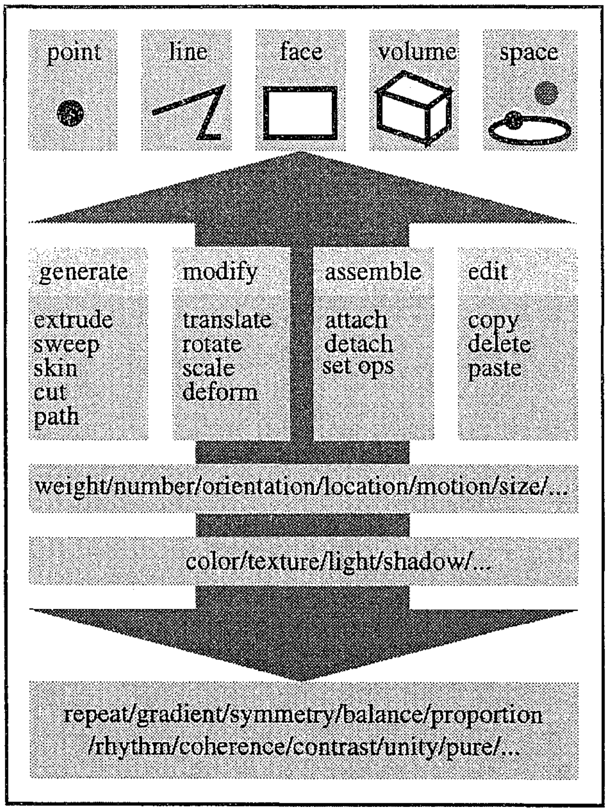

Figure 4. Relation between design contents and related applications

5. Contents of CABD

5.1.A matrix of the contents of basic design and the functions of CAD applications

As seen in Fig. 4, the basic design elements include points, lines, faces, volumes, and spaces. The double-headed arrow represents the items located in the middle are influential to the items on both ends. The manipulation of the elements involves one or more operation of generation, modification, assembly, and editing. For example, an object can be generated by extruding a polygon, sweeping a line, covering a skeleton with skin, cutting through an existing object, and extruding along a path (Foley 1990). Each object has its characteristics like weight, orientation, location, size, configuration, etc. After an object is generated, the appearance of the object can be assigned with color or texture. The characteristics and attributes of a number of objects can be arranged to display a group appearance like balance, contrast, coherence, etc.

Table 1. The main matrix of geometric elements (left), manipulation (top), inter-relationship (right), and attributes (bottom)

	generate	modify	assemble	edit	
point					repeat
line					gradient
face					symmetry
volume					balance
space					proportion
					rhythm
					coherence
					contrast
					unity
					pureness
	color	texture	light/shadow		

Course types and contents of basic design can be categorized into four matrixes based on the definition of geometric elements, composition, inter-relationship, and attributes. Referring to Table 1, the four parts are generate/modify/assemble/edit (to the top of Table 1) and color/texture/light/shadow (to the bottom of Table 1) in horizontal arrangement, and geometric elements (to the left of Table 1) and the inter relationship among them (to the right of Table 1) in vertical arrangement. Four sub-matrixes can be generated by pairing two neighboring axes from the original matrix. Basically, the items included in the left, top, and right axes are used to generate objects. The attributes included in the bottom axis can be assigned before, in the middle, or after the objects are generated. Take the exercise of colors, textures, and light/shadow for example, their practices are separated if exercises are given as individuals.

Most applications support the description of points, lines, faces, and volumes, although various 3D computer applications may define geometric elements differently and provide distinguished data structure for data storage and retrieval. Matching functions can always be found in applications regarding the manipulation of geometric elements through rotation, translation, extrusion, etc. As a result, the definition and construction of geometric elements can be supported by applications accordingly. The support also includes the adjustment of the inter-relationship between elements and the assignment of attributes. Previously established data can be duplicated, modified, and then assigned with different attributes as alternatives to compare the trade-off among many solutions.

5.2.A learning environment for basic design

A learning environment has to be established and accessible by all students before actually offering CABD. The environment includes the hardware and the learning program of CAD tools. Detailed tasks include the demonstration of operation procedures, input/output procedure, distribution of resources, and tutorials.

It's better to locate computers in studio, instead of in a computer room. Required hardware and software are:

* hardware: combining traditional tools and computers to assist the input, output, and storage of design data

* software: emphasizing the integration of design data and application environment. Tools for automation should be used to assist the creation, representation, transmission, modification of design data.

5.3.Course contents and emphases

New course contents are mainly planned based on the modification of current exercises. The handling of computerized design data is included to emphasize the creation and share of the data and to explore different alternatives. One of the exercise, the pictorial representation of emotion through colors, is listed in Appendix. Some exercises can be seen in Table 2.

Table 2. Course contents

Exercises	Required functions	Emphases
pictorial representation of emotion through colors	image processing (Photoshop ®)	color
texture	image processing(Painter ®)	texture
light/shadow	3D simulation-composition of geometic objects, setting light sources (StrataStudio Pro ®)	light/shadow
re-design of building facade (incl. Advertisement panels)	image processing, 3D simulation(StrataStudio Pro ® , Photoshop ®)	composition of basic architecture elements
billiard table design	3D simulation 3D simulation-composition of geometric objects, animation (StrataStudio Pro ®)	composition and interaction between objects
Transfer of billiard table-square in commercial area	image retrieval, 3D simulation (digit camera, StrataStudio Pro®)	experiencing environment, transformation of design elements

A set of tutorial examples, which clearly states the tools applied and the functions used, is provided so that students can learn through stepwise practice. An example is illustrated in Appendix. Images and final results are also displayed.

The additional course contents need to emphasize following issues.

* a top-down data manipulation process:

Based on previous research, the introductory training of freshman emphasizes spatial experience and considers 2D drawing as a tool for design recording or stimulating (Shieh & Wu 1995). The emphases usually lead to the development of a series of exercises from interpreting 2D drawings to experiencing 3D spaces. This type of exercise series is a bottom-up process, if drawings are considered as media used to record 3D objects which are built before.

As a matter of fact, students can direct construct and experience 3D objects, and leave the production of drawings to application interface (Shih 1995). 3D data can provide design decision-making with more realistic spatial information. (Badler 1993 and Samet 1990) The data operational procedure of 2D plans to 3D mass prevents a coherent study of elevations and the study between forms and plans. In fact, it has been an issue whether design should be conducted from 2D to 3D or vice versa. The result should not be influenced no matter which kind of tools are applied. Students will experience a two-way design experience if both top-down and bottom-up data processing manners are combined. The experience, as stated in design goal "establishing a learning framework capable of accumulating design experience," actually can be benefited from hands-on manipulation of computer data.

* multiple and sequential application of design data:

* sequential application of design data: Exercises of basic design are usually related to previous practice. For example, the composition of volumes would include the exercises, such as colors, textures, or transformation to real objects. From the viewpoint of sharing design data between different exercises, data can be duplicated for later use. Comparing exercises in a chronicle sequence would be beneficial to both students and instructors.

* exploring alternatives: Traditional exercises usually emphasize hands-on manipulation of real materials. Since most of students have very limited experience in drawing or model making, try-and-error always occurs to the control or test of final result. Problems are frequently encountered during making design prototype before final works are turned in, let along conduct additional task like creating, modifying, and comparing alternatives. The manipulation of design data through application is very efficiency and can be conducted with traditional operation manner to reduce the effort in try-and-error.

* The variety of representation: CABD conducts visual communication in multiple types of media. Traditional basic design finishes an assignment with a single drawing or model. The narrowed representation result can be expanded by using various tools in a new environment. The efficiency of CAD tools in visual communication can not only provide functions to transfer different file formats, but also integrate various files into an attractive and interactive presentation (Maguire 1990).

5.4.A continuous application of tool application afterward

All the experience of data manipulation can be extended afterward. The knowledge and preference can improve the efficiency and effectiveness of design process. Compared to Fig. 1, Fig. 5 shows the modified sequence of course arrangement. Taking 3D modeling as an example, the created models can not only be used to simulate building mass, but the modeling skill can be used later in year four or five. Both the experience of using tools and data manipulation can be extended.

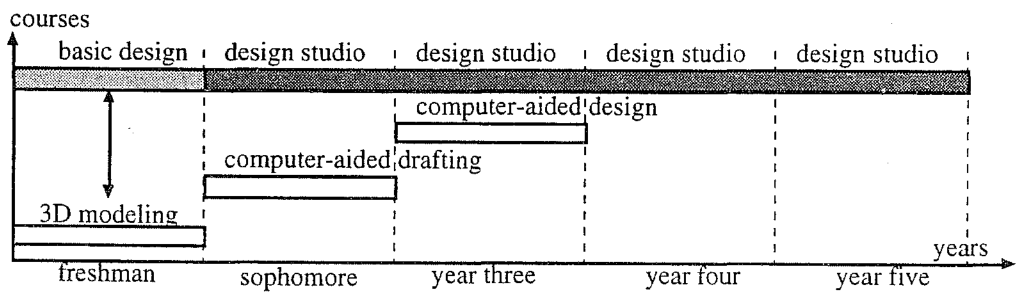

Figure 5. Suggested arrangement of CAD-related courses

"Introduction to computers" is an introductory course which has broader aspect. "3D modeling," a relatively special topic, emphasizes 3D simulation which includes the operation of texture, light/shadow, motion of geometric objects. The two courses consist of different perspectives in contents (Shih & Shen 1995). The reason 3D modeling is useful is because 3D spatial data can be applied to architectural courses in either horizontal or vertical sequence.

The inter-relationship between CAD and other architecture courses in horizontal orientation can be exemplified by the application of spatial data. The 3D spatial data can be used to connect different fields as basic supporting information. For example:

* Design studios: Spatial data are usually used to perform volumetric study, estimate quantity, or construct the scene for an animation.

* Physical environment or energy conservation: Spatial data are usually used to construct physical environment for acoustics calculation, lighting simulation, or heat transfer estimation.

* Facility management: Plans of spatial data are usually referred by management task and used to combine with staff or equipment data for inventory.

6. Student Response

The response of students can be categorized in the following:

* Achieving more control of variation: Taking coloring for example, the proportion or brightness of each color can be controlled with great precision. The stroke of any kind of media (chalk, watercolor, pencil, etc.) can also be simulated. More control of variation is achieved with the application of computer program.

* Preventing a task from redoing: What the most students are afraid of is the lack of control of a design. Final result may be far from the expected. If any mistake is made, an assignment may have to be started from very beginning again. Storing design data in computer format ensures a backup of previous effort,

* Reducing the period of a decision-making cycle: The speed of illustrating design contents by computer application is increased. Consequently, the period of a decision-making cycle can also be reduced.

* Facilitating design adjustment: Correction, adjustment, duplication, comparison can be easily conducted to design contents with the risk of ruining previous effort.

* Reducing real-world feeling of operation: Traditional tools (like watercolor) give users real contact with media. Some students prefer this type of interaction instead of procedure-like operation or pre-defined thinking pattern of computer program, which prevents them from "direct control" with media.

The response of other instructors from consequent courses is not included in the scope of this research. Although the inter-relationship between the training of tools in basic design and consequent courses is addressed in this paper, the relationship is yet to be proven through years of observation. The scope of this paper is limited to the source of basic design.

7. Conclusion

This research is conducted based on the inter-relationship occurring between architectural basic design and other courses provided in the department of architecture in universities. Traditional basic design training is still valuable, but the CABD is applied to expand the traditional approach with more possibilities. Final result is yet to be seen in next few years, nevertheless, related training will facilitate students with more representational varieties in architectural basic design and allow them to continue applying the knowledge and experience learned to other courses. In order to better provide the students with this new learning experience and the management ability of design information, an integrated computer-aided architectural design should be introduced in basic design courses as a fundamental design tool.

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Appendix:Four seasons practice

*exercise: pictorial representation of four seasons - spring, summer, autumn, winter

*purpose: coloring practice, including the modification of all related attributes

*requirement: using square as unit shape to constitute 4 sets of nXn collage

*final works: must represent a link between a collage and a season

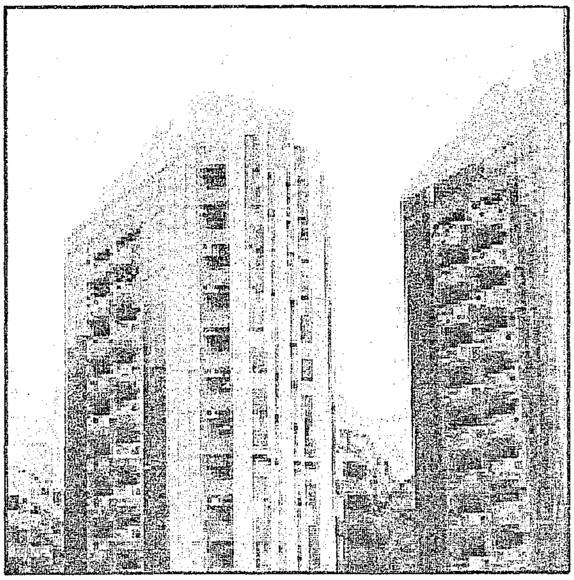
*tools:

*Harware: Mac Quadra 900,

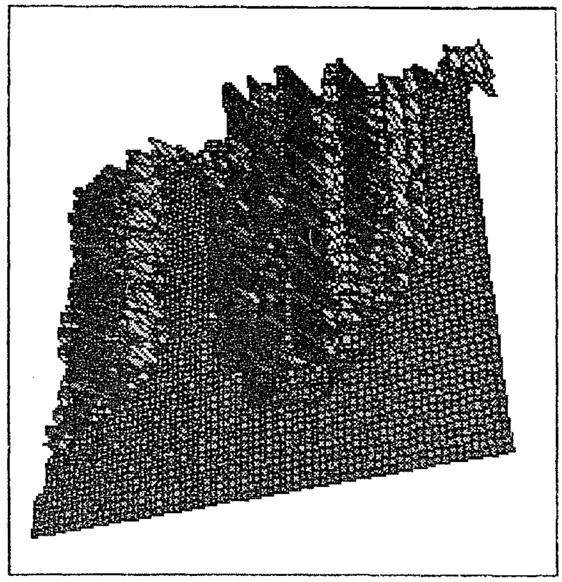
*Software: Photoshop 2.5.1 (image processing),

Cybermesh (Photoshop plug-in used to extrude gray-scaled image into 3D mesh)

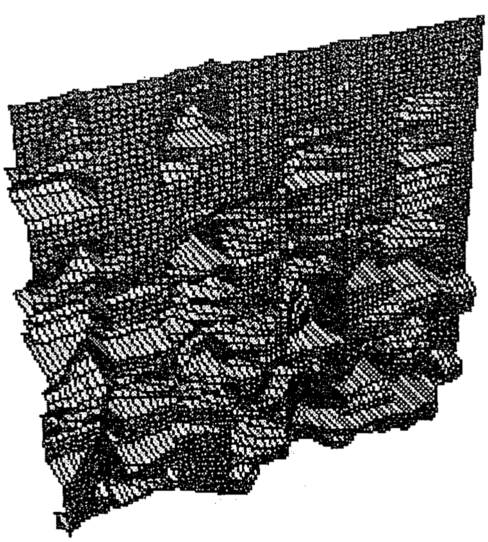
Note: The "wave"in Appendix is a build-in "distort" menu from Photoshop®. "Wave" is used to generated special wave effect. When wave's parameter is carefully set (wavelength:min=1,max=100;amplitude:min=1,max=100;type=square),square-like pattern will be generated. The pattern is similar to the arrangement of small piece of colored paper. The commands selected before "wave" are also build-in functions of Photoshop ®.



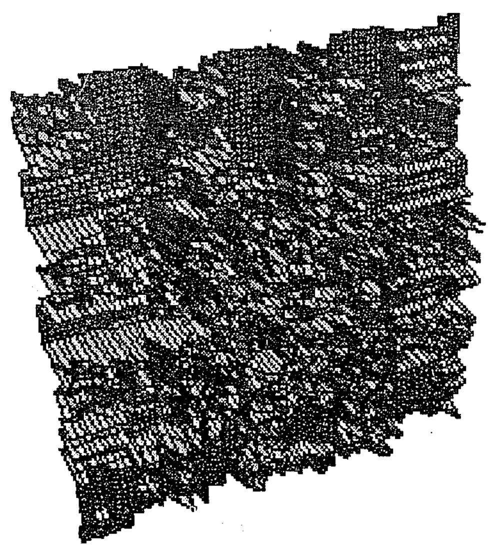
Original image image



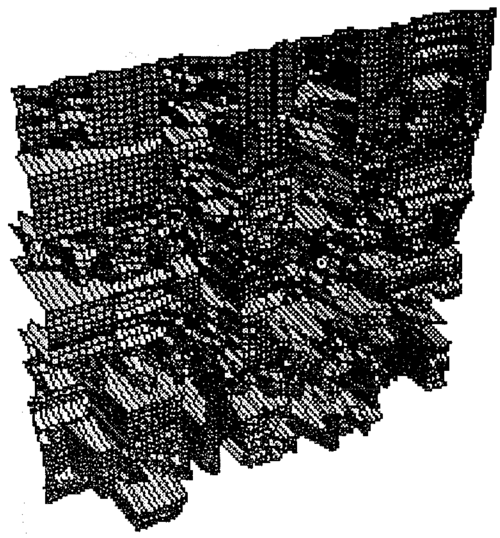
Extruded surface from gray-scaled original



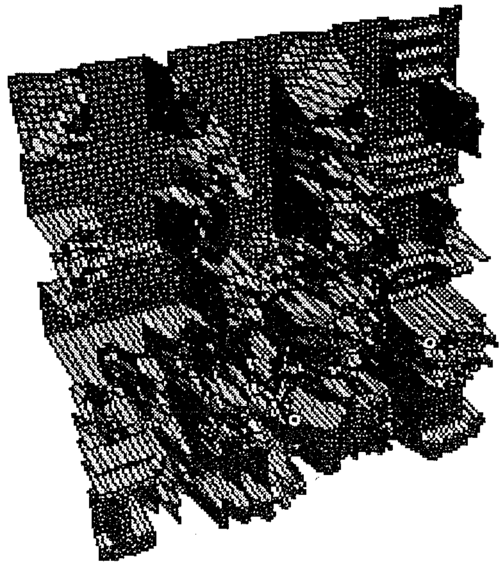
Spring's mesh representation



Summer's mesh representation



Autumn's mesh representation



Winter's mesh representation

建築基本設計課程使用電腦輔助工具之研究

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摘要

本研究係以基本設計與整體建築設計間之關係爲基礎，目的在探討自動化工具在建築基本設計之應用及與後續設計課題應用之關連性。建築基本設計是一多樣性之視覺溝通活動，是不可或缺的設計基本美感能力培養課程，使用電腦輔助之基本設計課程可爲設計環境提供一新的學習標準。爲因應資訊、電腦時代所應培養之新的學習經驗與資訊處理能力，完整的電腦輔助建築設計應始於基本設計，以達設計工具之基本訓練。本研究內容包括現有基本設計課程內容資料蒐整理、基本設計與後續設計課程間延續性之工具應用規劃、設計表內容與電腦輔助工具功能之對應、設計題目之設計、實例推演、試作、觀察與評估等項目。研究成果包括建立國內建築系基本設計課程內容資料庫、建立建築基本設計表達內容與電腦輔助設計相關工具對應關係矩陣、建立建築基本設計課程學習環境、規劃電腦輔助建築基本設計課程內容、建立傳統建築基本設計之電腦工具應用操作模式及建立建築基本設計至建築設計實例推演。希藉本研究提升建築基本設計內容表達之多樣性，及延續由基本設計所獲得之經驗及知識應用至其他設計課程。