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Message from the Chair

Kevin Devine
Illinois State University

This year's 69th EDGD Midyear Conference placed me in a rather unique position. As the Chair of the division, I strive to look at the "big picture" of the division and maintain the proverbial 30,000 foot view of things. As the 69th Midyear conference chair, I needed stay abreast of many conference details and keep my view at ground-level. My dual role at the midyear conference helped me recognize and appreciate the teamwork, professionalism, and collegiality of the many individuals who make up the EDGD organization. There are many amazing, talented people in the EDGD who are willing to share their talents with others. Many thanks to those who have helped organize this midyear conference, especially Judy Birchman who served as the Program Chair and helped prepare the conference printed materials.

The coming year brings with it many changes for the EDGD leadership team. Nick Bertozzi has left his role as Communications Director and is now the Vice Chair of the division. Many thanks Nick for his contributions as Director of Communications. Lulu Sun is now the Director of Communications and is already working effectively in her new role. I am grateful Lulu has agreed to serve the division in this important office. Long-term executive board members Norma Veurink (Secretary-Treasurer) and Bob Chin (Director of Publications) will see their terms end in June. While we can still look forward to having Norma and Bob serve out their current terms on the executive board, their departure from office will require transition planning. Things that happened "automatically" will take more planning and coordination as newly elected officers learn their new roles.

Last year's EDGD Chair, Dennis Lieu, set our division focus on various aspect dealing with membership recruitment. As a division, we must continue exploring ways to expand our membership. Towards that end, Diarmaid Lane, our Membership Director, is coordinating several recruitment efforts for the division. At Diarmaid's request, time was set aside during this midyear conference to continue the efforts in this regard. Thanks to Diarmaid and his team for leading this important effort.

While we do have a team working on various aspects of recruitment, we must recognize that the responsibility of membership recruitment does not fall on just a few people. We must all explore ways to introduce the EDGD to our colleagues. Perhaps invite a colleague or graduate student to collaborate with you on a research paper that will be published in the EDG Journal. Invite a junior faculty member to co-author a paper that will be presented at the ASEE Annual or 70th EDGD midyear conferences. As I stated earlier in this report, I have come to appreciate the many amazing, talented people in

the division who are willing to share their talents with others. Let's use these talents to position the division for continued success.

Message from the Editor

Robert A. Chin
East Carolina University

Adding to the body of knowledge is the goal of research, the scientific method of inquiry, and other creative activities. The pursuit of new knowledge, however, is dependent on the dissemination and archiving of research findings and the results of creative activities, and ready access to that new knowledge. Ready access, or the ability to retrieve new knowledge, cannot be overemphasized; timely access and ease of access are essential to sustaining the process of creating new knowledge and improving human undertakings. For these reasons, there are abstracting and indexing services and databases.

Abstracting & Indexing Databases

For at least the life of the online *EDGJ*, librarians, members of the Division, annual and mid-year conference authors, and *EDGJ* authors have made inquiries regarding the abstracting and indexing databases that service the *EDGJ*. An abstracting database provides brief summaries of publications, often on a subject or group of related subjects. An indexing database assigns descriptors and other types of access points to documents, such as papers in proceedings and journal articles.

According to Ulrichsweb, an easy to search source of detailed information on more than 300,000 periodicals, the *EDGJ* is serviced by the following abstracting and indexing services/databases:

- EBSCOhost
 - Applied Science & Technology Source, 1/1/2012-
 - Engineering Source, 1/1/2012-
 - ERIC (Education Resources Information Center), 1987-1988, 1990-1991, 1995-
 - Inspec
- Elsevier BV
 - Compendex (COMPUTERIZED ENGINEERING INDEX)
 - Scopus, 2003-
- ERIC (Education Resources Information Center)
 - ERIC (Education Resources Information Center), 1987-1988, 1990-1991, 1995-
- OCLC
 - ArticleFirst, vol.54, no.1, 1990-vol.72, no.3, 2008
- Ovid
 - ERIC (Education Resources Information Center), 1987-1988, 1990-1991, 1995-
 - Inspec

- ProQuest
 - ERIC (Education Resources Information Center), 1987-1988, 1990-1991, 1995-
- The Engineering Index Monthly (DVD)
- VINITI RAN
 - Referativnyi Zhurnal

Services provided by abstracting and indexing services/databases improve the visibility of the *EDGJ* and provides researchers with a means to continue adding to bodies of knowledge. In response, the *EDGJ* is in the process of completing a JSTOR (Journal Storage) publication license agreement and its recent application to Thomson Reuters is under review.

EDGD Calendar of Events

Future ASEE Engineering Design Graphics Division Mid-Year Conferences

70th Midyear Conference – January 24-26, 2016, Embry-Riddle Aeronautical University.
Site Chairs - Heidi Steinhauer and Lulu Sun.

Future ASEE Annual Conferences

Year	Dates	Location	Program Chair
2015	June 14 - 17	Seattle, Washington	Ron Paré
2016	June 26 - 29	New Orleans, Louisiana	
2017	June 25 - 28	Columbus, Ohio	
2018	June 24 - 27	Salt Lake City, Utah	
2019	June 16 - 19	Tampa, Florida	
2020	June 21 - 24	Montréal, Québec, Canada	

If you're interested in serving as the Division's program chair for any of the future ASEE annual conferences, please make your interest known.

The Distinguished Service Award

The 2014 Distinguished Service Award (DSA) recipient is Theodore J. Branoff of North Carolina State University. The DSA is the highest award of merit given by the Engineering Design Graphics Division. It recognizes the significant contributions of the recipient to the Division in terms of leadership, authorship, or support.

The awardee is recognized with a framed citation or plaque, which is presented by the Division Chair or their delegate at the Annual Conference Awards Banquet. Following the presentation, the recipient may address those assembled.

The award description can be found at:
<http://edgd.asee.org/awards/dsa/index.htm>

A complete list of awardees can be found at:
<http://edgd.asee.org/awards/dsa/awardees.htm>

[1] Engineering Design Graphics Division Member, Aaron Clark, introducing the 2014 DSA recipient.

[2] Branoff delivering his DSA acceptance remarks.

[3] Engineering Design Graphics Division Chair, Dennis K. Lieu, presenting the DSA plaque.

Photos from *Theodore Branoff*



[1]



[2]



[3]

Introduction

It is an honor to introduce to the Engineering Design Graphics Division our newest Distinguished Service Award recipient, Dr. Theodore J. Branoff. Dr. Branoff received his degrees from NC State University in Raleigh, North Carolina where he worked his way from Lecturer to Associate Professor. Prior to coming into higher education, he worked as a draftsman in industry and currently still consults outside of academia. He has held many leadership roles in our profession at both national and international levels including President of the International Society for Geometry and Graphics, Chair of the Engineering Design Graphics Division of ASEE, Associate Editor of the *Engineering Design Graphics Journal*, and various other committees for the division including Program Chair and Director of Professional and Technical Committees. Dr. Branoff has worked at the regional level as well, being the past Chair of the ASEE Southeast Section of the K-12 Division, Instructional Unit Division, and the Engineering Design Graphics Division. He continues to be a reviewer for many top research journals in fields related to education and engineering, and has served on over 32 graduate student committees, and directed over nine dissertations and theses. He is one of the few ASEE Fellows within our division, and has won the Division's Editor's Award four times and the Chair's Award three times since he became a member of ASEE. He is a NC State University College of Education Alumni Distinguished Undergraduate Professor, and has been awarded the Outstanding Teacher Award three times within the College of Education at NC State University. Dr. Branoff has countless publications in journals, proceedings, and books related to our discipline, including many national and international presentations. He has been an invited speaker internationally multiple times representing our discipline and our division. Dr. Branoff has served this profession and division with the highest regard to service and dedication. We are fortunate to have people like Dr. Branoff as one of our colleagues and to serve as a great role model for future leaders in our field.

Aaron C. Clark, DTE

**Theodore J. Branoff's DSA Acceptance Remarks
ASEE Annual Conference
Indianapolis, IN, June 15-18, 2014**

Thank you. I am truly grateful to the people in the Engineering Design Graphics Division for the majority of my professional development. Since 1987 the members of this division have pushed me out of my comfort zone and helped me develop as a leader, educator, and scholar. But I also want to take this opportunity to recognize the people who have helped me to get to this point in my career.

Jim & Donna Branoff – Even though we had a very modest household income when I was young, my parents always found a way to make sure us kids were able to participate in extracurricular activities like baseball and hockey. I truly believe that these sports, as well as building things around the house, helped to develop my spatial abilities.

Tom Domagala – When I was about 10 years old I met Tom. Tom is about 9 years older than me. He lived in my aunt's neighborhood, but he became real good friends of my family. He helped coach hockey with my dad, and he also went on some family vacations with us. But the thing that really interested me about Tom was his expertise in drafting. He worked for a company that did contract work for the automotive industry. He would bring by some of the drawings he was working on, and I even got a chance to visit his office once. Tom was the person that really got me fired up about design and engineering graphics.

Mr. Wainwright – Mr. Wainwright was my junior high industrial arts teacher. Junior high was my first exposure to formal instruction with engineering graphics. I remember laying out multi-view drawings from pictorials and pictorials from multi-view drawings in this little area between the wood shop and the metal shop. I think Mr. Wainwright recognized that a couple of us in the class had a special talent in engineering graphics. He allowed us to explore some things that other students didn't find appealing. We also got to build some really cool stuff in his classes that contributed to our spatial abilities and technical skills.

On to high school and a move to North Carolina.

Gail Parker – Mr. Parker was the first drafting teacher I had in high school in North Carolina. He taught me almost everything I know about architectural graphics – and a whole lot about having fun. He also got me involved in VICA. This was the first time I had competed in any academic competition.

Earl Crumb – Mr. Crumb retired from a successful engineering career in New York State to become the drafting teacher at Zebulon High school. As a senior who had been at the school for just over two years, I thought I knew everything. I was prepared to breeze through my senior year in advanced drafting, but Mr. Crumb had other things in mind. He gave me a D on my first assignment, and my whole attitude about his class changed. I knew this guy was going to change the way I saw engineering graphics. I learned more in that year than I did in the previous 5 years in school. We drew things on Mylar with plastic leads and ink. He would randomly tear your drawing to see if you could repair it. That year I won the regional VICA competition and went to the State conference. Not knowing exactly what I wanted to do as a career, I applied and was accepted into mechanical engineering at NC State.

Gordie Dotterer – During high school I worked for my dad's company, Measurements Group, Inc., doing yard maintenance. In the summer of 1981 the drafting department hired me to do printed circuit board layouts of instrument devices in the strain gage industry. Most of my work was ink on Mylar, and it was my first time using a Leroy Lettering set. Gordie Dotterer was my boss. He also happened to be one of my best friend's dad. The few times I did use vellum I can remember Gordie yelling at me for pressing down too much with my pencil. This happened a couple times. I lightened up some to make him happy. Later in college I seem to remember hearing someone say that those who press down hard while writing are very confident in what they are doing. I don't think Gordie would appreciate that explanation.

Garland Hilliard – One of the first classes I was enrolled in at NC State was GC101. I sat through the first class with Ben Webb patiently – recognizing all of the content that would be covered. I talked with Mr. Webb after class about placing out, and he told me I would have to bring my portfolio of work to Garland Hilliard. So I gathered up my high school drawings and headed over to Poe Hall to see Mr. Hilliard. He had a scruffy white beard, ink stained finger nails from his home printing business, and an impressive Southern accent. He intently looked through my portfolio, asked me some questions that I assume came from a final exam, and then awarded me credit for the class. I left thinking that I would not see him again since that was the only engineering graphics requirement in my degree.

Bob Hagavik & Audie Evans – In the summer of 1983 I was able to get a job working for Siemens Switchgear Division in Lizard Lick, North Carolina. Bob Hagavik was my supervisor, and Audie Evans was our low-voltage group leader. The first thing they handed me was a stack of marked up blueprints, the original vellum drawings, and an electric eraser. That was pretty much my job that whole summer – correcting drawings. Eventually they had enough confidence in me to let me do some original drawings. I worked there for three years. Bob was the first person I really watched managing a group of people. We had to meet deadlines, and Bob and Audie were masters at making sure we got things done without being too stressed out. Audie also made sure I understood the relationship between what we were doing and what was going on out on the manufacturing floor. I clearly remember a time when we were trying to meet a

deadline, and the guys on the shop floor would not drill a hole until a drawing was updated. Audie took me out to the floor, we drilled the hole where it needed to be, and then we came back and changed the drawing. We met the deadline.

Joe Clary – In the fall of 1983 I found myself struggling with my coursework in mechanical engineering. That semester I was taking Engineering Economic Analysis, Differential Equations, Dynamics, and Solid Mechanics. Here it was in the first semester of my junior year, and I had not yet gotten my hands dirty in any class. I started hunting through the University Catalog for other majors. I stumbled on one called Technical Education. I made an appointment to talk with the Department Head, Dr. Joe Clary, and he laid out a plan for me for the Spring 1984 semester. Joe later hired me in the Department of Occupational Education and was a big part mentoring me through my graduate work and early career.

Bill VanderWall – One of the courses I took in the Spring of 1984 was Dr. VanderWall's descriptive geometry course. All of the familiar widgets and comfortable mechanical objects were gone. All that was left were points, lines, and planes. It took me a few weeks to feel confident with the material, but it really opened my mind to the possibilities of graphics as a vehicle for problem-solving. I learned quite a few teaching techniques from VanderWall, especially using colored pencils to keep track of different points in space.

John Freeman – In the Spring semester of 1985 I took John Freeman's Furniture Graphics course. I learned quite a bit about furniture in that class – which to this day helps when we buy new furniture. Yes, John, I do still look up under a table to see how things are assembled. I also learned a lot about how to organize my in class objectives and lessons – and how not to organize my office. John has also taught me about how to be a compassionate advisor. He always went the extra mile for our advisees to make sure they understood their options.

Bill Ross – Bill was the first person to get me involved with computer-aided design. I did an independent study with Bill as part of my undergraduate work, and he mentored me through several different CAD programs. Bill made sure we were, as I remember him always saying, on the “bleeding edge” of technology.

John Crow – I don't think I can say enough about what John Crow has done for me. He was my mentor when I did my student teaching and checked my lesson plans to make sure I was on the right track. Today, John is my colleague. Although he retired in 1992, he still teaches two courses each semester at NC State. I can count on him stopping by my office several times each week to have at least a 30 minute conversation about descriptive geometry, visual thinking, religion, marriage, children, the Big House in Lincolnton, or the latest joke he heard.

Nate Hartman – Best doctoral student I ever had. We did some amazing curriculum revisions while Nate was at NC State.

Other Faculty at NC State – Bob Hammond, Ben Webb, Sue Markley, Gaynelle Gull, Eric Wiebe, Walt Kelly, Brian Matthews, Bill DeLuca, Bob Wenig, Dick Peterson, Jim Haynie, Ed Gerler, Alice Scales, and Aaron Clark. All of these people have in some way contributed to my success.

And the folks in the EDGD of ASEE – Mary Sadowski, Frank Croft, Dennis Lieu, Judy Birchman, Bob Chin, Kathy Holliday-Darr, Tim Sexton, Mike Stewart, Pat Connolly, Ron Pare, Ron Barr, Holly Ault, Jim Leach, Nick Bertozzi, Jon Duff, Fritz Meyers, Sheryl Sorby, Barry Crittenden, Norma Veurink, Laverne Abe Harris.

And of course my family – When our boys were young, Darlene took care of them when I was in graduate classes and when I went to conferences. She sacrificed quite a bit to make sure I had a chance to develop professionally. She also was a great sounding board when I needed to vent. She is the love of my life, and I am so grateful for her.

So what is the point of all this besides thanking people? The time you give to help someone is precious, and I believe that is one of the reasons we are on this earth. That could just be helping someone work through a professional issue. It could be writing a letter of reference for someone. It could be encouraging someone to be an officer in a professional organization. It could be taking someone with you when you visit an industrial facility. As we get older, I believe it is our responsibility to help develop young leaders. When I was a young child, or even a teenager, I never imagined that I would be faculty at a university. In fact I was extremely shy in elementary school. I never imagined I would travel around the country and the world talking about research and teaching practices. One year ago I never imagined I would be moving to another state to be a department chair.

So let me end by thanking everyone again for this honor. And I also want to end with a challenge. Give a portion of your day to help someone else.

The Editor's Award

The 2013 Editor's Award recipients are Megan Flanders and Richard C. Kavanagh of the University College Cork, Ireland for their paper entitled Visualizing Compound Rotations with Virtual Reality.

Their paper was published in volume 77, number 3 of the Journal and can be found at:
<http://www.edgj.org/index.php/EDGJ/article/view/388>

The Editor's Award was established to recognize the outstanding paper published in the previous volume of the *Engineering Design Graphics Journal*. The recognition includes a framed citation and a cash award and is presented during the following Annual Conference.

The award description can be found at: <http://edgd.asee.org/awards/editors/index.htm>

A complete list of awardees list can be found at:
<http://edgd.asee.org/awards/editors/awardees.htm>

A Virtual Campus Based on Human Factor Engineering

Yuting Yang
Tourism and Culture College of Yunnan University

Houliang Kang
Tourism and Culture College of Yunnan University

Abstract

Three Dimensional or 3D virtual reality has become increasingly popular in many areas, especially in building a digital campus. This paper introduces a virtual campus, which is based on a 3D model of The Tourism and Culture College of Yunnan University (TCYU). Production of the virtual campus was aided by Human Factor and Ergonomics (HF&E), an application which provided a convenient, comfortable, practical and simple environment for users. TCYU, in Lijiang, China, occupies approximately 800 acres. Set in a parkland environment, it is a modern campus with a rich architectural style based on local Naxi houses with gray tiles and white painted walls. Because it is very large for a virtual campus, the scale and complexity of models have been simplified. They have also been reduced for ease of loading the computer program by three means: Object-Oriented Modeling (OOM), textures and portal-connectors, and many easy-to-use tools have been created which support different input hardware and avatars to help the user tour the campus from different perspectives. Testing results show that the virtual system can run smoothly on the general personal computer.

Introduction

With the development of computer software, 3D virtual reality has become increasingly popular in many areas, especially in building a digital campus. Virtual Campus can display the whole campus based on the geographic information system (GIS) of the buildings and using virtual reality technology. Users can retrieve information, tour the virtual campus and design a real campus through the virtual system. Several studies focus on e-learning or using lower cost methods to build their virtual campus (Fominykh et al., 2008 and Lucia et al., 2009). They emphasize more the potential for supporting learning communities (Lucia et al., 2009 and Prasolova-Førland et al., 2010) and co-construct the virtual campus in a simple, low-cost way (e.g. Building Campus on Second Life (Lucia et al., 2009 and Second Life, 2013) or Active Worlds (Active Worlds, 2013)). However, providing better user experience in the virtual scene and simulating the real world is also important in building a virtual campus. Therefore, in building a system based on Human Factor and Ergonomics (HF&E), it is possible to provide a more convenient, comfortable, practical and highly efficient experience for users and make a virtual campus more user friendly.

Review of Literature

The design of educational virtual world often follows Vygotsky's social constructivist approach (Vygotsky, 1978); following this publication, a growing number of universities have introduced virtual representation in the form of virtual campuses to support a wide range of educational activities. The most famous virtual campus is Nanyang Technological University (NTU) in Singapore (Sourin, 2004) and in Norway, The Norwegian University of Science and Technology (NTNU) (Fominykh et al., 2001 and Prasolova-Førland et al., 2010). NTU built a realistic 3D campus based on blaxxum technology. It provides a very realistic, photographic resemblance of the corresponding NTU campus, with offices and students' rooms. There are also different tools available for students to meet new friends, obtain consultation, follow lectures and complete practical exercises especially in computer graphics. NTNU built a similar virtual campus and introduced the concept of cyber-campus which refers to virtual worlds representing real educational institutions such as universities or schools. They consider virtual campus to be a framework around educational and social activities and have produced a set of tools and resources to support such activities as Collaborative Virtual Workshop (CVW) (Fominykh et al., 2008) and virtual museum (Active Worlds, 2013). NTNU is now in the process of building a virtual campus in Second Life Platform (Prasolova-Førland et al., 2010). In addition, other universities including Zhejiang University, Peking University (Chen et al., 2010), HuaZhong University (Wang et al., 2005), BeiHang University (Hao et al., 2000) and the Chinese University of Hong Kong (Gong et al., 2002) are also building their own digital campuses.

Several studies used various types of platform to create a virtual campus and include VRML, OpenGL, X3D and Second Life. The first three technologies are more complex, but the modeling effect can be controlled and provide more tools for both developers and users. With Second Life (Second Life, 2013) or similar platforms, the development process is relatively simple but the modeling effect cannot be controlled and as such is less extensible and not as ideal as the first three platforms. However, most of these studies focus on learning activities and communication or are interactive with other people in the virtual campus. Here, the discussion is more about e-learning and related tools which can help students to work in the virtual campus. But real virtual modeling and comfortable environment is also very important for users. Therefore, the virtual campus based on HF&E can better reflect the 'human factor' and provide users with a more comfortable experience. Human factors and ergonomics (HF&E) is a multidisciplinary field incorporating contributions from psychology, engineering, biomechanics, industrial design, graphic design, statistics, operations research and anthropology. In essence, it is the study of designing equipment and devices that fit the human and the human body. It can be applied in a variety of ways including the design of safe furniture and easy-to-use interfaces to machines and equipment to provide a comfortable and safe working environment for users (Wiki, 2014 and Zhang et al., 2011).

Through combining virtual reality and HF&E, the virtual campus of TCYU was created based on Crystal Space 3D. The entire system is considered 'user friendly', that is to say the system not only reflects the characteristics of immersion, interaction and imagination of the virtual reality, and is therefore ergonomic with its use of HF&E. Additionally, the functions of people's psychological perception, sense of space, walking, flying and other sensory and behavioral aspects have been considered for human-computer interaction and provide a convenient, comfortable, practical and simple environment for users.

The Design of TCYU

Crystal Space

Crystal Space is used as the basic graphic engine. Crystal Space (Tyberghein, 2013) is an open-source 3D software development kit (3D SDK). It can be used for a variety of 3D visualization tasks including building 3D virtual world and creating 3D applications. It is a portable modular 3D SDK and includes many components for building various applications and games; these are useful for projects that do not involve 3D. Crystal Space also contains many other features; it is not just a game engine and its features are as follows:

- Crystal Space is a package of components and libraries all of which can be useful for creating 2D/3D computer games. The components and libraries are more or less independent of each other in Crystal Space and so can be used independently and create plug-in modules.
- The core of Crystal Space is Shared Class Facility (SCF) and is somewhat similar to Component Object Model (COM), but an easier-to-use and more lightweight mechanism. Thus the whole Crystal Space is a highly modular framework with good extensibility and reusability.
- Crystal Space is written to run under a wide variety of hardware and software platforms, including Window, UNIX and Mac OS.

System Design of TCYU

The virtual campus created is Tourism and Culture College of Yunnan University (TCYU). In order to distinguish from traditional virtual campus and reflect the characteristics of HF&E, this virtual system provides a comfortable, humanized and easy-to-use environment for users and offers a variety of tools to help when entering the system. The different tools offered, allow users to tour the whole campus from different perspectives.

The system consists of two parts: Data and software. The data are responsible for the creation of 3D virtual campus models and actor-models and the Extensible Markup

Language (XML) files describe the exported models. The software is responsible for the interaction between users and the virtual system, including loading 3D models and giving support for touring the campus. Loading realistic multimedia is the basics for building a realistic environment. Therefore two methods are provided to reduce the complexity and scale of the campus model. Additionally, three types of avatars are offered and support different input hardware which can provide a choice of tools, when touring the whole campus from a variety of perspectives. Figure 1 illustrates the system framework.

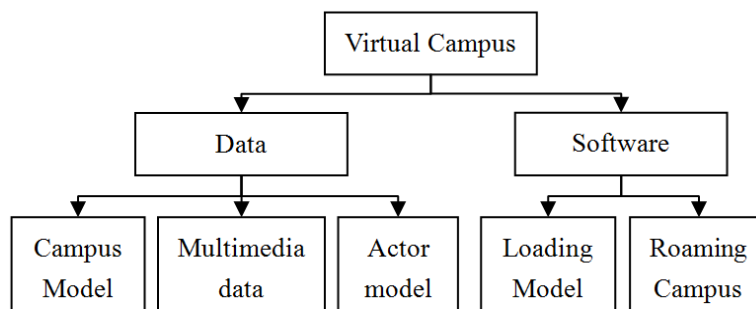


Figure 1. The System Framework.

Creating Models

The realism of the campus model directly affects the quality of the whole virtual campus. The more realistic the 3D model and the greater amount of data included, the slower the system will run but the effect will be better. Furthermore, the model of the whole virtual campus is composed of many buildings and there are many rooms in each; it is large and complex, maybe too heavy for the virtual system, therefore two additional methods are provided to reduce the complexity and scale of the model. One is Object-Oriented Modeling and the other is using texture.

Basic Data Collection

The actual TCYU is a modern campus occupying approximately 800 acres set in a parkland environment. There are about 117 campus buildings of which a great number have a rich architectural style based on the local Naxi houses with gray tiles and white walls. Representing Naxi architectural features is very important because it is one of the major characteristics of the campus. In order to build a realistic virtual campus, first, the position of the buildings was confirmed using a satellite map. Secondly, the 3D models of the architecture were created based on the pictures of Computer Assistant Design (CAD) which are at a 1:1 scale. Thirdly, every kind of texture and material was collected from the real campus and used on the model's surface to make the building look realistic and maintain an authentic style. Finally, the inner structure of the buildings was constructed and decorated. Figure 2 illustrates the satellite map of the main buildings. Figure 3 illustrates the CAD elevation of Wen-Zhi building and Figure 4 is an actual photograph of the Wen-Zhi building.



Figure 2. Satellite Map of the Main TCYU.



Figure 3. Part of CAD Elevation Picture of Wen-Zhi.



Figure 4. The Actual Photograph of Wen-Zhi Building(1:150).

Object-Oriented Modeling (OOM)

Object-Oriented Modelling (OOM) is provided as a method to reduce the scale and complexity of virtual campus. In order to distinguish between the original Object-oriented, the following definitions are provided:

- **Model Class:** Model Class is a “factory” object, which represents model’s structural information and material (for example a tree class).
- **Model Instance:** Model Instance is the copy of model class. It represents the reference to the factory object and their position and rotation. All the model instances will be identical to their class, but they can use different types of materials which distinguishes them from their class (for example a real tree).

In OOM, model class describes the common characteristics of geometries (for example tree class) and model instance only describes the specific characteristics of a single geometry (for example a single tree). That is, the same structural information needs only to be stored once in model class, and model instance only represents the different parts from their own class. Furthermore, in the rendering phase, the model class is invisible and the model instances use the information of their own class to implement the rendering of the virtual objects. For example, if a tree class is created and copied many times, we get a wood. In the wood, the geometrics which compose the tree, actually just need to be stored once as ‘tree class’ and the other trees are the description of the reference to the same ‘tree class’. Thus the scale of the ‘wood’ is a little larger than that of a single ‘tree’. It is very similar to the Object-Oriented therefore it is referred to as Object-Oriented Modelling and the method can help reduce the complexity and scale of virtual campus.

Using Texture

The building includes many windows on the outside walls; this increases the complexity of the model. The reduced visual quality of the model often goes unnoticed by users because it is far away and the details cannot be seen. Based on this premise, texture has been used instead of the original model to reduce the total number of polygons of the building. When comparing the rendering difference between the original model and optimized model of Wen-Zhi building, it can be seen there are only slight differences on the rendering result. Figure 5 illustrates the detailed model of Wen-Zhi building and Figure 6 illustrates the optimized result of the right side wall by using texture. The rendering result is shown in figure 7.



Figure 5. The Detail Model.

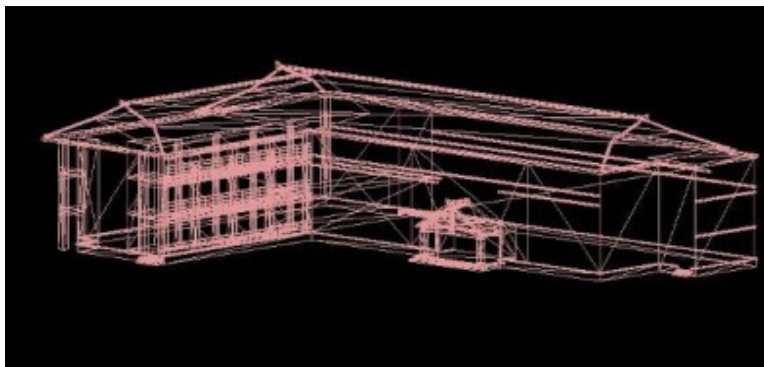


Figure 6. Optimize the Right Side of the Wall.



Figure 7. Rendering after Optimized.

The Implementation of TCYU

Export and Load Models

Extensible Markup Language (XML) has been used to represent the exported 3D models. XML is a mark-up language that defines a set of rules for encoding documents in a format that both the user finds easy to use and also is machine readable. It is a textual data format and is widely used for the representation of arbitrary data structures. Through using XML, structural and organizational forms of 3D models can better be

described. It also makes reading and analyzing model data easier, clearer and faster, bringing convenience for loading models into a virtual system. A simple example of 3D world represented by XML is as follows:

```
<world>      <!--building virtual world-->
<textures>
  <texture name="oldmetal">
    <file>/lib/stdtex/oldmetal.jpg</file>
  </texture>
</textures>
<!-- the detail of building -->
<meshfact name="walls">
  <plugin>thingFact</plugin>
  <zfill />
<params>
  <v x="-10" y="-1" z="10"/>
  .....
  <material>old_metal</material>
  <p name="up"> <v>6</v> <v>7</v> </p>
</params>
</meshfact>
</world>
```

In addition, in order to reflect the ‘human factor’ and provide users with a more comfortable experience in the virtual campus, an avatar start position in front of the gate of the campus is set to help the user understand where they are more easily. Figure 8 illustrates the start position of avatar. Also added is collision detection for the avatar to simulate the real world. Figure 9 illustrates the effect of collision detection for avatar. In addition, the virtual system supports a variety of hardware to control the activities of avatar which includes mouse, keyboard and joy stick. Users can choose a variety of ways to tour the virtual campus.

Portal-Connectors

Virtual campus models are large and complex. During the virtual campus modeling phase, two methods, OOM and textures, are provided to optimize the model. Portal-connectors can also be used to further optimize the virtual campus model and reduce the total geometries at run time.

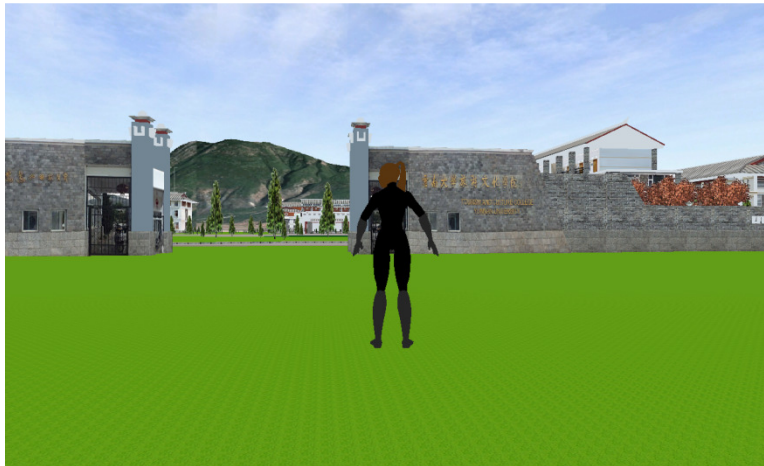


Figure 8. The Start Position of Avatar.



Figure 9. Collision Detection of Avatar.

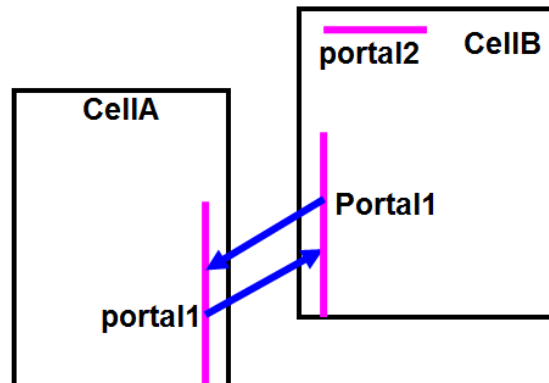
Interactive System

Portals are specific kind of polygons used extensively for accelerating visible determination in complex architectural scenes. They are used to partition a scene into cells such that another cell is only visible if a portal that bounds that cell is visible (Lowe et al., 2005). We created special portals, which have the characteristics of normal portals and can be used as connectors to link different cells called portal-connectors. The characteristics of portal-connectors are as follows:

- Warping transformation is included, so that it may be used in space to connect different cells which are not adjacent to each other; doors and windows are generally defined as portal-connectors.
- Portal-connectors are unidirectional. In order to link cell A and cell B, both cells should define a portal-connector. One is used to identify cell B from A and the other

is used to identify cell A from B; therefore it is possible to see (or go through) each of the cells. The feature provides the basis to further optimize the model. Figure 10 illustrates the characteristics of portal-connectors.

- All cells which are connected by portal-connectors have the same world space coordinate. By getting a current cell reference together with a world space coordinate, we can get our actual position.



Portal-Connector	Source Cell	Destination Cell
CellA.portal1	CellA	CellB
CellB.portal1	CellB	CellA

Figure 10. The Characteristic of Portal Connector.

In virtual campus, many scenes like classroom, study room or student bedroom are the same as each other and these mostly comprise the interior of the building. One classroom only is created and portal connector is used to link the door and classroom. Thus different doors can point to the same classroom and classroom also can point to different doors with multiple portal-connectors. As the appearances of the classrooms are the same as each other, a single classroom only is created, and users consider that they have seen many different classrooms. Even if users believe that different doors correspond to different classrooms, (assuming that a classroom has only one door), the difference will never be seen during walkthrough in virtual campus. That is, there is no impact on the users' experience. Using this method, the same classroom, study room or bedroom can be used repeatedly and a lot of time and resources can be saved during interaction.

Interactive System

Reflecting 'human factor' is the core of this system and many easy-to-use tools are provided compared to other systems. Through choosing a variety of tools, users can obtain different operating and touring experiences. Users can travel the campus in many different ways for instance by car, by plane or on foot. Users can also choose to

walk or fly with first-person perspective for example like playing games and can set their own speed or flight altitude by themselves. Figures 11 and 12 illustrate different ways to travel the virtual campus using first-person. Figures 13, 14 and 15 illustrate different tools to make traveling more comfortable. In addition, a music system has been created, providing background music to assist users learning the basic information of virtual campus and actual campus.



Figure 11. The First-Person Walking.



Figure 12. The First-Person Flying.



Figure 13. Walking Mode.



Figure 14. Driving Mode.



Figure 15. Flying Mode.

Conclusion

The real TCYU campus has a diverse landscape and a great number of buildings with rich architectural style based on the local Naxi houses. TCYU aims to integrate the actual TCYU campus into 3D virtual world and provide users with a real experience on virtual campus. Many methods have been used to reduce the scale and complexity of the campus models and to create the virtual campus based on HF&E. The virtual system supports many easy-to-use tools which provide a simpler, convenient, comfortable, practical and highly efficient experience for the user, therefore making the virtual campus more 'user friendly'. Users can immerse themselves in TCYU through 3D modeling form of avatar and experience virtual campus with different input hardware. Moreover, users can run virtual campus on a normal personal computer that runs MS Windows. During the test, the measured maximum was 265 frames per second; the minimum rate was 221 frames per second and with an average of 240.67 frames per second. Figure 11 illustrates the test frame rate of the system. Further work will focus on supporting multiplayer in the virtual campus for education and communication and even sharing resources, information and knowledge.

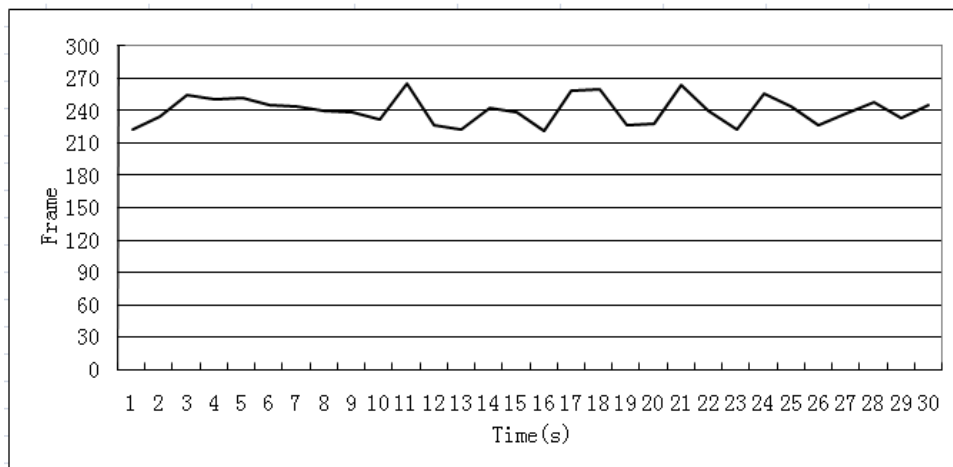


Figure 11. Frame Rate.

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