

BIM for D.Arch: From Novice to Master

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December 2013

Submitted towards the fulfillment of the requirements for the Doctor of Architecture degree.

School of Architecture
University of Hawai'i at Mānoa

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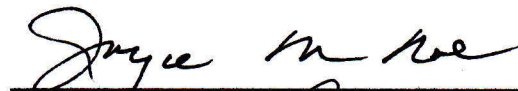
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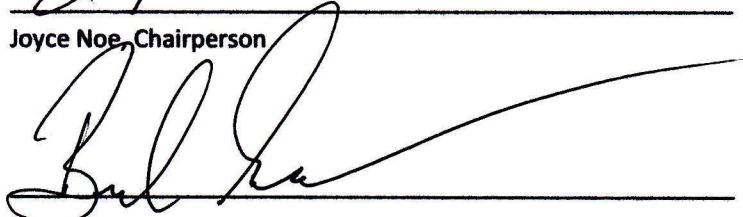
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December 2013

We certify that we have read this Doctorate Project and that, in our opinion, it is satisfactory in scope and quality in fulfillment as a Doctorate Project for the degree of Doctor of Architecture in the School of Architecture, University of Hawai'i at Mānoa.

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I like to dedicate this research and design project to my family, friends and mentors, for their unwavering love, loyalty, support, guidance and inspiration.

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ABSTRACT

This project provides a series of proposed criteria and suggestions for the planning and programming of a Graduate Certificate in Building Information Modeling (BIM) for the Doctor of Architecture program at the University of Hawai'i at Mānoa, School of Architecture. The project proposes a BIM Certificate Program in response to the widening gap between digital technology in practice and what is being offered in architecture education. The goal of this project is to demonstrate the possibilities for an integrated and collaborative approach to BIM inclusion within the D.Arch program in order to maximize the opportunities within the D.Arch program for students to progress from novice to master in the training of BIM tool and practices. Hence, bridging the gap between academia and real world architectural practice. The Graduate Certificate in BIM program criteria and proposal are drawn from the analysis of various learning theories, combined research methodology, and qualitative analysis; including student questionnaire, practitioner interview, BIM inclusion case study, analysis of the University of Hawai'i at Mānoa, Doctor of Architecture degree program.

INTRODUCTION

Overarching Theme and Background

For the last century, balancing professional, disciplinary, and liberal arts emphases in the curriculum of architectural education has been a challenge.¹ This challenge has yet to be resolved. The Association of Collegiate Schools of Architecture (ACSA) frames the common struggle of architecture education in this way, “In every decade, schools have had to conceptualize the skills, modes of thought and methods of inquiry that best prepare graduates for their chosen career. These conceptions have had to be correlated with those of the profession, and calibrated to avoid reducing architecture education to vocational training and to enable students to navigate an evolving field.”²

In a 2009 interview with Zack Mortice, Marvin Malecha, FAIA, Dean of North Carolina State University’s College of Design expressed concerns over the challenges of architectural education, saying, “The distance between what’s happening in architecture schools and what’s happening in practice has never been greater.”³ So what is causing this distance? The ACSA and educators interviewed by Zack Mortice, as well as other educators have identified two key causes for this distance:

1. There is a discrepancy between what architecture education programs offer and what is required in real-world practice.
2. Real world practice is adopting new technologies at a faster pace than educational programs.

Other concerns include:

1. The architecture profession is susceptible to economic conditions and recent changes in graduate student loan terms are leading students to be more focused on finding programs that better prepare them for real-world practice.
2. For architecture programs to remain competitive, it is imperative that architecture education curricula reflect current trends in the field.

¹ Joan Ockman, ed., Rebecca Williamson, ed., *Architecture School: Three Centuries of Educating Architects in North America* (London: The MIT Press, 2012), 6.

² Ockman, *Architecture School*, 7.

³ Zach Mortice, ed., “Insight to Practice is Relevant to Design Education,” *AIArchitect: Volume 16 Practice*, February 27, 2009, accessed May 27, 2012, http://info.aia.org/aiarchitect/thisweek09/0227/0227p_education.cfm.

(Ockman 2012, Mortice 2009, Hopkins 2011, Hopkins 2012)

Dr. Michael Crosbie believes that it is essential to bring students up to speed with current architectural practice, so they can be prepared to compete in the professional world and sustain the architecture field for the future.⁴ Perhaps now is the time to address these issues. Architecture as a profession could suffer if we fail to bring today's students up to speed with the current practice.

The dilemma remains, how do we address these challenges in architectural education mentioned earlier? What are the technological changes that are changing the architecture profession? How can educational programs remain current with technological changes, integrate both theory and practice, and bring students up-to-speed with current realities in the field? Time constraints imposed by required classes for accreditation pose a significant challenge for architecture programs. In order to maintain accreditation, architectural programs must meet 34 National Association Accreditation Board (NAAB) criteria.⁵ It is difficult for programs to include courses in addition to the required classes.⁶

New technologies are continually changing the practice of architecture. Phillip G. Bernstein mentioned that less than 10 percent of U.S. architects had heard of Building Information Modeling (BIM) in 2003, but by 2009, 60% were planning on adopting BIM in their practice.⁷ Based on the Autodesk User Group International (AUGI) survey in 2010, "BIM adoption exceeds 80 percent among the national's largest architecture, engineering and construction industry (AEC) firms,"⁸ while an ACSA survey showed only 61% of architecture education programs adopted BIM in their graduate studio.⁹ As AUGI stated, "Architects, engineers, designers and contractors continue to strive to align their working practices and organizational structures with the principles of BIM."¹⁰ Perhaps architectural education should also align its curriculum to current principles and practice of BIM.

⁴ Michael, Crosbie, Ph.D., FAIA, "Getting Practice in Your Practice: firms Hosting Academic Design Studios," The American Institute of Architects: Practicing Architecture, February 3, 2010, accessed May 26, 2012. <http://www.aia.org/practicing/AIAB089948>.

⁵ "Changes to Conditions," The National Architectural Accreditation Board, access May 31, 2012, <http://www.naab.org/news/view.aspx?newsID=1>.

⁶ Mortice, "Insight to Practice is Relevant to Design Education."

⁷ Peggy Deamer, ed. & Philip G. Bernstein, ed., *BIM in Academia* [Connecticut: Yale School of Architecture, 2011], 6.

⁸ "BIM, a Reality for AEC," AUGI, accessed November 3, 2012, <http://www.augi.com/library/bim-a-reality-for-aec>.

⁹ "2010-2011 BIM/IPD Survey Results- Summary May 2011," ACSA, accessed November 3, 2012, <https://www.acsa-arch.org/docs/resources/bimipdsurvey2010.pdf?sfvrsn=1>.

¹⁰ "BIM, a Reality for AEC."

Initial Arguments

Real world practices such as Building Information Modeling (BIM) should be introduced early on as a part of the architectural curriculum. Adopting these practices in the initial phase of architecture education will bridge the gap between academic preparation and current practice and better prepare graduates to enter the workforce with BIM mastery. This will help graduates gain a competitive edge and also help sustain the architectural profession alongside with the technological changes.

This project examines the issues pertaining to the separation between technological practice and academia. It aims to examine the curriculum and potential of the incorporation of a BIM Certificate Program at the University of Hawai'i at Mānoa, School of Architecture, Doctor of Architecture Degree program (D.Arch). The project proposes to answer the following research questions:

Research Questions

- What is causing the separation between what is being offered in architectural education and real world practice?
- What factors inhibit the adoption and incorporation of current practices into the architecture education program?
- In general, how is the architecture education program currently responding and adapting to technological and architectural practice change?
- In general, what are some current challenges and issues in the incorporation of BIM in architectural education?
- What are the perceptions of practicing architects when it comes to the inclusion of technology training, such as BIM, and its importance in ensuring their preparation for real world practice?
- What are the perceptions of D.Arch students when it comes to the inclusion of technology training, such as BIM, and its importance in ensuring their preparation for real world practice?
- How could BIM be included in architectural education?
- How could BIM inclusion in architectural education enhance the architecture profession?

Project Focus

There are many aspects in architectural education, professional practice, technological training and technological practices worthy of investigation. This project does not intend to address all of these aspects, but aims to consider approaches in architectural education, particularly relating to BIM education, which have potential to better prepare graduates for the professional world and to enhance the architecture profession for the future. The focus of this research project is to examine the potential for bridging the gap between academia and real-world architectural

technologies and practices by proposing a BIM Certificate Program at the University of Hawai'i at Mānoa, School of Architecture, Doctor of Architecture Degree program.

Project Goals

The project aims to develop a proposal for a 'BIM Certificate' for the Doctor of Architecture program as a case study for enhancing the architectural education for students. The goals of the BIM Certificate program are:

1. Increase awareness of the need to bridge the gap between architectural education and practice.
2. Increase awareness that technological changes such as BIM are changing the profession and academia needs to reflect these changes in its curriculum.
3. Provide opportunities and training for students to progress from novice to mastery in BIM technology while pursuing the D.Arch degree.
4. Produce D.Arch graduates that can one day become leaders in the architectural field in the future.
5. Preserve the architectural profession through enhancing academic curriculum.

Audience & Outcomes

The audiences of this project include the Doctor of Architecture program and similar educational programs as it aims to serve as an initial step in bridging the gap between architecture education and real world practice. The aspiration is that other innovative BIM inclusion approaches might emerge as a result, providing balance in professional, disciplinary and technology emphases in the curriculum, while enhancing the process for graduates to begin practice in the profession with mastery or at the very least becoming highly skilled in BIM technology. The research will provide insights on issues pertaining to the gap between architectural education and practice, proposing the implementation of a series of BIM technology Courses to better prepare graduates to enter the workforce with highly desirable skills.

The project will include a proposal for BIM Certificate Program for the D.Arch program, designed to utilize BIM at an early stage of the degree as a viable means to reduce the gap between architectural education and practice.

End Project & Level of Development

An experimental study and program evaluation will not be possible at this time. However, it is hoped that, in the future, a quantitative comparison and program evaluation would demonstrate the effectiveness of such a certificate program, and provide further insight into necessary refinements and further implementation development. Other traditional and

nontraditional architectural institutions could use the D.Arch. BIM Certificate Program as a case study and provide similar opportunities for their students. The end project and level of development includes the following:

1. An analysis of the distinction and challenges between the separation of architectural education and practice.
2. A proposal of using technology such as BIM to bridge the gaps.
3. A proposal of a BIM Certificate Program for the University of Hawai'i at Mānoa, School of Architecture, Doctor of Architecture Degree program.

Enhancement of My Own Educational & Professional Interests

This project enhances my own educational and professional interests in several ways. It helps me better understand the relationship between the architecture profession, education and technology. Understanding the history and trends of these elements will help me better adapt to the changes of the profession in the future. One of my primary professional interests includes the use of new technologies, such as BIM, in practice. This project provides opportunities to further my understanding of the issues and challenges involved in the trends and implementations of BIM in practice and academia.

My other professional interest is in finding ways to enhance the architectural education learning process. I am a LEED AP and Revit Architecture 2013 and 2012 Certified Professional; I went through a long self-taught and self-sought learning process that was at times extremely frustrating and confusing. The frustrating experience made me realize many students are capable of learning this knowledge and these skills while they are in school and do not have to wait until they are working on their Intern Development Program (IDP). The process could be much more efficient and effective if knowledge and skills were a part of the architectural curriculum, allowing educators, practitioners and students to share what they know and inspire each other collaboratively. It is my hope to bring awareness to the need for the inclusion of a track in all architectural programs, making it easier for aspiring architects to adapt to current practice in the profession and not be a novice when they graduate, but be at a mastery or expert level at essential skills like BIM.

Physical & Theoretical Context

The project examines existing competency, learning theories and topics pertaining to BIM and academia. Literature reviews include works from "The Five-Stages of the Mental Activities Involved in Directed skill Acquisition" by Dreyfus and Dreyfus, the Calculative Rationality titled "From Socrates to Expert Systems: The limits and Dangers of Calculative Rationality", the "Conscious Competence Learning Matrix" and the "BIM in Academia" symposium at the Yale School of Architecture.

While the project includes case studies and examples of multiple architectural programs, the

main physical context focuses on the University of Hawai'i at Mānoa, School of Architecture, Doctor of Architecture Degree program.

Other Pertinent Conditions & Parameters

Some pertinent conditions and parameters relating to this doctoral project include:

1. The lack of existing governing theory of BIM's implications and use.¹¹
2. The lack of existing BIM pedagogy in academia.¹²
3. Where the line should be drawn, how much involvement and BIM inclusion is too much for academia?
4. How could academia effectively include BIM training and education?

Although the outcome of the project includes a proposed BIM Certificate Program for D.Arch, an experimental research project or other evaluative research necessary to test the effectiveness of the proposal and suggestions will not be part of the doctoral project. However, it is my hope that the project will lead to further refinement and development in the near future, enhancing the methodology and approaches that could help to bridge the separation between what is being offered in architectural education and what is happening in practice.

¹¹ Deamer, ed., Bernstein, ed., *BIM in Academia*, 1.

¹² Deamer, ed., Bernstein, ed., *BIM in Academia*, 1.

EXTENDED LITERATURE REVIEW

Before suggesting the BIM Certificate Program for D.Arch as a resource in bridging the gap between the separation between architecture education and real world practice, the following literature review provide an in-depth background in the main reason for the separation between the two and theories behind the BIM Certificate Program proposal. The literature reviews address the following issues:

1. The Separation between Architecture Education and Architecture Practice
2. Learning Theory & Competency Theory

I. The Separation between Architecture Education and Architecture Practice

In the 2009 interview with Zack Mortice, Marvin Malecha, FAIA, Dean of North Carolina State University's College of Design expressed concerns over the challenges of architectural education, saying, "The distance between what's happening in architecture schools and what's happening in practice has never been greater."¹³ He mentioned that real world practice is adopting new technologies at a faster pace than educational programs. This literature review examines the reasons for the separation between architectural education and architectural practice and how to bridge this gap. It covers the backgrounds and trends of architecture education, practice and technologies. It also examines changing technologies as one of the reasons for the separation and changes in practice. This literature provides a review of the following:

Part A: Architecture Education and Organizations

1. The history and trends of architecture practice and architecture education.
2. Architecture education in North America
3. Organizational and accreditation influence in architecture practice and education (AIA, ASCA, NAAB, NCARB, IDP, ARE)

Part B: Architecture, Technologies & Practices

1. Architectural technologies in practice
2. Building Information Modeling (BIM)
3. BIM Adoption in the real world
4. Insight into the BIM trend
5. BIM as the emerging a new practice model
6. Integrated Project Delivery (IPD)
7. IPD benefits & challenges
8. AIA IPD case study results

Part C: Main Reasons for the Separation

1. What is changing the practice of architecture?
2. What are the differences between what is being offered in architectural education and what is happening in architectural practice?

In order to understand the separation, it is necessary to understand the history and trends of architecture practice, education and technologies, primarily how different eras and movements affected the structure and organization of both practice and education.

¹³ Mortice, "Insight to Practice is Relevant to Design Education."

Part A: Architecture Education and Organizations

History & Trends of Architecture Practice and Architecture Education

Architecture education was apprenticeship based during the 1700s. Aspiring architects obtained practical knowledge through carpentry and bricklaying craft apprenticeship. The New World did not require Guilds; a structure codified by statute in sixteenth-century England. Instead, the apprentice was indentured to a master craftsman for seven years. During this time, they learned the skills of their profession and progressed to become journeyman who could then charge customers for services. It was also common for masters to gather for educational and fraternal purposes.¹⁴ As early as 1734, the Carpenter's Company of the City and County of Philadelphia offered "instruction in the Science of Architecture." By 1834, the Carpenter's Company opened the "architectural drawing school" five nights a week.¹⁵

With the rise of industrialism and public education in the 19th century, drafting rooms in the firm had replaced the traditional practice of workshop architectural apprenticeships. Two new educational models evolved during the Age of Enlightenment in midcentury---the German Polytechnical school, based on the French Ecole Polytechnique and the French Ecole des Beaux-Arts. Both of these educational models were viewed as highly organized, were subsidized by the state, located in highly reputable institutions, and were seen as more efficient and up-to-date.¹⁶ Formalized institutional training became the standard for future architects.

Architecture Education in North America

The Post American Civil War era brought the emergence of universities; a new form of educational institution in North America. Higher education was no longer only for the religious, nor focused only on Greek and Latin. With a sense of national pride, many aspired to be American intellectuals and pursue in higher education.¹⁷

The American Institute of Architects (AIA), influential in organizing architecture practice and standards, was also instrumental in many aspects of architecture education. AIA started looking into the architecture education in the United States during 1867. Although the organization was unable to secure the necessary funding for the education programs, members were envisioning incorporating "evening classes in drawing, aesthetics, and the history of art and architecture."¹⁸

Unofficial architecture education seminars were common, but the first university-based

¹⁴ Ockman, *Architecture School*, 11.

¹⁵ Ockman, *Architecture School*, 11.

¹⁶ Ockman, *Architecture School*, 12.

¹⁷ Ockman, *Architecture School*, 12-13.

¹⁸ Ockman, *Architecture School*, 12-13.

architecture school became official in the United States in 1876.¹⁹ For aspiring architects, the model of learning implementation by Thomas U. Walter, president of the American Institute of Architects during the early 1880's, has been the primary education model for becoming an architect. Walter was an enthusiastic advocate of professionalization; he described his model as "first pursuing a course of architectural training in a Technical college, embracing Mathematics, line drawing to scale, mechanical drawings, and linear perspective. A foundation thus laid, if well laid would be a proper preparation for entering an architecture's office as a student of the profession; he would there find ample sources of information in art; ample opportunities to practice in drawing, and incentives for devoting himself to the acquirement of an Architectural education, which, if thoroughly attained would eventually put him in the front rank of the Profession."²⁰ In order to understand architecture education as it is today, we must first take a look at the organizations that made architecture a profession and embedded it in university institutions.

Organizational Influence in Architecture Practice and Education

AIA

On February of 1857, Richard Upjohn established the American Institute of Architects in New York City, with thirteen architects as members of the organization. Upjohn became the first president between the years of 1857 to 1876. The organization strived to "promotes the scientific and practical perfection of its members" and "elevated the standing of the profession."²¹ Major changes in the profession of architecture in the United States were about to take place and the organization invited new members and designed new guidelines. The term "architect" became a professional one, and individuals could not be a self-proclaimed "architect" without meeting the guidelines and objectives adopted by the organization.

By 1858, the AIA constitution was amended; the mission of the AIA became "to promote the artistic, scientific, and practical profession of its members; to facilitate their intercourse and good fellowship; to elevate the standing of the profession; and to combine the efforts of those engaged in the practice of Architecture, for the general advancement of the Art."²² In 1867, the mission was modified again to "unite in fellowship the architects of this continent, and to combine their efforts so as to promote the artistic, scientific, and practical efficiency of the profession." Since then, the wording of AIA's mission has been modified occasionally, but the basic objectivities have remained the same. The first AIA conference was held in 1867 and

¹⁹ *Wikipedia*, s.v. "Taubman college of Architecture and Urban Planning," http://en.wikipedia.org/wiki/Taubman_College_of_Architecture_and_Urban_Planning (Accessed October 6, 2012).

²⁰ Ockman, *Architecture School*, 38.

²¹ "History of the American Institute of Architects," The American Institute of Architects, accessed October 15, 2012, <http://www.aia.org/about/history/>.

²² "History of the American Institute of Architects."

official reports and publications followed soon after. The gatherings provided members with “opportunities to network and learn about the latest technologies and products and gain continuing education credits.”²³

By 1887, AIA chapters had been founded in Philadelphia, Chicago, Cincinnati, Boston, Baltimore, Albany, Rhode Island, San Francisco, St. Louis, Indianapolis and Washington, D.C. Currently, AIA chapters are located in the United States and its territories, the United Kingdom, Continental Europe and Hong Kong. The push for licensure accelerated after the merger between the Western Association of Architects and the American Institute of Architects in 1889. Before the merger, members only needed to state their qualifications if they wished to obtain advancement to fellowship in the AIA. In 1897, the State of Illinois became the first state to adopt an architectural licensing law.²⁴

By 1920, a more institutionalized process was in place for those who wished to advance. By 1935, the power of selection was given to the Jury of Fellows, and application requirements included resumes of work. The AIA College of Fellows was established in 1952, since then, the mission statement is to “stimulate a sharing of interests among Fellows, to promote the purpose of the Institute, to advance the profession of architecture, and to be of ever-increasing service to society.”²⁵

ACSA & NAAB

In 1897, the state of Illinois’s medicine and law regulations led legislation to begin regulating the practice of architecture. Dankmar Adler and Nathan Ricker are accredited for introducing this law. The first architecture licensing exam was given in 1898. By 1902, the exam was restricted to “graduates of the state’s approved four-year architecture curriculum.” In one year, this policy was extended to graduates from Cornell, Columbia, Harvard Universities, the Massachusetts Institute of Technology, and the University of Pennsylvania.²⁶

The Association of Collegiate Schools of Architecture (ACSA) was the result of the first attempt to establish a system of equivalency and national standards among national programs. By 1912, to be accredited, schools needed to meet the two years “standard minima,” established by the ACSA. This was the accreditation process until 1932, when ACSA, abandoned the standard minima. The ACSA, the American Institute of Architects (AIA), and National Council of Architectural Registration Boards (NCARB) established the National Architectural Accrediting Board (NAAB). Its founding agreement of 1940 indicated it was established “to create an

²³ “History of the American Institute of Architects.”

²⁴ “History of the American Institute of Architects.”

²⁵ “History of the American Institute of Architects.”

²⁶ “NAAB History,” The National Architectural Accreditation Board, access May 31, 2012, http://www.naab.org/about/naab_history.aspx.

integrated system of architecture education that would allow schools with varying resources and circumstances to develop according to their particular needs.”²⁷

Currently, the National Architectural Accrediting Board (NAAB) is the only authorized agency to accredit professional architecture programs in the United States of America. There are 123 institutions housing a total of 154 NAAB accredited professional programs in architecture. One institution offering the Doctor of Architecture, 95 offering Master of Architecture, 58 offering Bachelor of Architecture degree, and seven institutions in candidacy status.²⁸ Although attending a NAAB accredited program does not guarantee registration and licensure, most state registration boards require applicants for licensure to graduate from a NAAB accredited program. The accrediting process is “intended to verify that each accredited program substantially meets those standards that, as a whole, comprise an appropriate education for an architect.” NAAB aims to ensure graduates are competent in “a range of intellectual, spatial, technical and interpersonal skills” understand the historical, socio-cultural, and environmental context of architecture; are able to solve architectural design problems, including the integration of technical systems and health and safety requirements; and comprehend architects’ roles and responsibilities in society.”²⁹ Today, the American Institute of Architecture Students (AIAS), the Association of Collegiate Schools of Architecture (ACSA) and the National Architectural Accrediting Board (NAAB) are working together with the American Institute of Architects to “ensure the highest quality of architecture education in the United States.”³⁰

It is crucial to understand the NAAB does not restrict or dictate the curricula of architecture schools or programs. NAAB “aspires to be the leader in establishing educational quality assurance standards to enhance the value, relevance, and effectiveness of the architectural profession.”³¹ The mission of NAAB is to “maintains a system of accreditation in professional architecture education that is responsive to the needs of society and allows institutions with varying resources and circumstances to evolve according to their individual needs.”³² As stated in the 1940 Founding Agreement, “The... Societies creating this accrediting board, here record their intent not to create conditions, nor will to have conditions created, that tend toward standardization of educational philosophies or practices, but rather to create and maintain conditions that will encourage the development of practices suited to the conditions which are

²⁷ “NAAB History.”

²⁸ “Architecture Programs,” The National Architectural Accreditation Board, access May 31, 2012, http://www.naab.org/architecture_programs/.

²⁹ “About The NAAB,” The National Architectural Accreditation Board, access May 31, 2012, <http://www.naab.org/about/>.

³⁰ “History of the American Institute of Architects.”

³¹ “About The NAAB.”

³² “NAAB Mission,” The National Architectural Accreditation Board, access May 31, 2012, <http://www.naab.org/about/naabmission.aspx>.

special to the individual school. The accrediting board must be guided by this intent.”³³ The NAAB Conditions for Accreditation emphasize self-assessment and student performance as central elements since 1975.³⁴

NCARB, IDP & ARE

The National Council of Architectural Registration Boards is recognized universally as “the global leader of architectural regulation through its exemplary standards, credentialing requirements and reciprocal licensure processes, and consummate customer service.”³⁵ According to NCARB, “A licensed architect is required to take legal responsibility for all work,” and to become a licensed architect, one must first obtain a professional degree in architecture. Most states requires a professional degree from a NAAB accredited program. Second, one must participate in a period of practical training or internship such as the Intern Development Program (IDP) and earn a total of 5,600 hours of supervised training hours. Third, candidates for licensing must pass all divisions of the Architect Registration Examination (ARE).³⁶

Intern Development Program (IDP)

The Intern Development Program, created in the 1970s by the National Council of Architectural Registration Boards (NCARB) and the American Institute of Architects (AIA), has become a vital path to becoming an architect. Through the comprehensive experience, participants “learn about the daily realities of architectural practice, acquire comprehensive experience in basic practice areas, explore specialized areas of practice, develop professional judgment, and refine career goals.” This is essential for competent practice and prepares participants to practice architecture independently upon initial registration.³⁷

The 5,600 of supervised training hours includes four categories:

1. Pre-Design
 - a. Programming
 - b. Site and Building Analysis
 - c. Project Cost and Feasibility
 - d. Planning and Zoning Regulations
2. Design

³³ “About The NAAB.”

³⁴ “NAAB Mission.”

³⁵ “Our Mission, Vision and Values,” NCARB, accessed October 20, 2012, <http://www.ncarb.org/About-NCARB/Mission-Vision-Values.aspx>.

³⁶ “Overview of the Profession,” NCARB, accessed October 20, 2012, <http://www.ncarb.org/en/Becoming-an-Architect/Overview-of-the-Profession.aspx>.

³⁷ NCARB, *IDP Guidelines*, NCARB Publications-Resources-Guidelines, http://www.ncarb.org/Publications/~media/Files/PDF/Guidelines/IDP_Guidelines.pdf (accessed October 20, 2012).

- a. Schematic Design
 - b. Engineering Systems
 - c. Construction Cost
 - d. Codes and Regulations
 - e. Design Development
 - f. Construction Documents
 - g. Material Selection and Specification
- 3. Project Management
 - a. Bidding and Contract negotiation
 - b. Construction Administration
 - c. Construction Phase: Observation
 - d. General Project Management
- 4. Practice Management
 - a. Business Operations
 - b. Leadership and Service

Architect Registration Examination (ARE)

With the growth of NCARB, standardized testing became a part of the licensure process by the late 1950s. By 1979, the “Task analysis and validation study” became today’s Architect Registration Examination (ARE).³⁸ The ARE is being used in all U.S. states and territorial registration and by various Canadian provincial and territorial architectural associations. It aims to assess a candidate’s “knowledge, skills and abilities to provide various services required in the practice of architecture,”³⁹ and to fulfill the NCARB’s mission “to safeguard public health, safety, and welfare.”⁴⁰ As of 2012, ARE 4.0 consists of seven divisions:

- 1. Programming, Planning & Practice
- 2. Site Planning and Design
- 3. Building design and Construction Systems
- 4. Schematic Design
- 5. Structural Systems
- 6. Building Systems

³⁸ NCARB, *History of NCARB*, NCARB Publications-Resources-Special Papers, <http://www.ncarb.org/Publications/~media/Files/PDF/Special-Paper/history.pdf> (accessed October 20, 2012).

³⁹ *History of NCARB*.

⁴⁰ *History of NCARB*.

7. Construction Documents and Services⁴¹

Upon successful completion of a professional degree in architecture, participation in a period of practical training or internship and passing all divisions of the Architect Registration Examination (ARE), licensure is then granted, and one can legally obtain the title of an “architect” and provide “architecture services.”⁴²

With all of the attention on standards and ensuring that programs adequately prepare architects for entering practice, along with the freedom of how each school can address its needs when it comes to curriculum programming, why is there still a gap when it comes to what is being offered in architectural education and current architectural practice?

⁴¹ NCARB, *ARE 4.0 Guidelines*, NCARB Publications-Resources-Guidelines, http://www.ncarb.org/Publications/~media/Files/PDF/Guidelines/ARE_Guidelines.pdf (accessed October 15, 2012).

⁴² *History of NCARB*.

Part B: Architecture, Technologies & Practices

Architectural Technologies in Practice

Before BIM became the new tool for designing and modeling in the architecture profession, CAD was the tool of choice, replacing the popular drawing board, rotating ink pens, tracing paper, two-dimensional hand drawing and sketching; where the scale of the drawing was the greatest issue for designers.⁴³

Computer Aided Design Software or Computer Aided Drafting software was made possible by mathematician Euclid of Alexandria's work in 350 B.C. "The Elements" are the foundations of the Euclidian geometry upon which CAD systems are built. The world's first CAD software, the "Sketchpad" was created by Ivan Sutherland during his PhD thesis at MIT in the early 1960's. In the 1970's CAD software migrated out of research and into commercial use. Many CAD software programs and vendors emerged, and by 1980's 3D solid modeling CAD software program was included in several commercial uses. AutoCAD became the first CAD software vendor to complete a public offering. Autodesk AutoCAD release 1 came the following year after the rise of IBM in 1981. Powerful UNIX workstations and emerging 3D rendering was inevitably shifting the CAD software market to 3D and solid modeling. By 1985, CAD software became the trend in the industry. Pro/Engineer was the first 3D CAD system to be entirely based on solid models and history-based features and constraints. User friendly features such as user interface with drop-down menus, context-sensitive menus, pop-up option and input boxes, and icons became part of the technology.⁴⁴ In 1986, Graphisoft's ArchiCAD program was the first Building Information Modeling BIM debut in the AEC industry.⁴⁵

By 1990's, the market was driven by cost and 'time to market'. Boeing was succeeding using the 'all CATIA no paper' design strategy, and successfully completed the 777 paperless design, eliminating traditional physical mockups and saving time and cost. This led many other industries to use CAD software as their design tool. By 1992, Autodesk 2D CAD Software Company became the #1 revenue making software. The continued advancements of the computer developments, with SolidWorks releasing its 3D software by 1993.⁴⁶

⁴³ Francisco Silva, "Evolution, Methodologies & Concepts of CAD & BIM Software Tools in the AEC Industry," translated by Google Translate. Loja dos Desenhadores: Projectos de Construção Civil e Programação para Autocad, accessed October 2, 2012.

<http://lojadosdesenhadores.blogspot.com/2012/04/evolution-methodologies-concepts-of-cad.html>.

⁴⁴ "CAD software-history of CAD CAM," CADAZZ, accessed October 15, 2012, <http://www.cadazz.com/cad-software-history-2000-2004.htm>.

⁴⁵ Global Associates, "The History of the BIM and the Success Story Till Date," BIM: Building Information Modeling Blog, entry posted December 30, 2010, <http://bim-modeling.blogspot.com/2010/12/history-of-bim-and-success-story-till.html> (accessed October 15, 2012).

⁴⁶ "CAD software-history of CAD CAM."

Two significant changes came about in the mid 1990's. First was the PC 3D CAD software explosion. Second was an unrelated explosion in PDM (define) systems (streamlining management of drawings). Although PDM accelerated, by 1995 3D CAD software using b-rep solid modeling and NURBS surface modeling started to plateau. The future outlook for 2D CAD became a concern.⁴⁷

CAD's greatest issue was not being able to communicate the design in a virtual environment. Just like the adaption of CAD; BIM requires new practice methodologies and approaches to effectively implement the design process. "Product Life-cycle Management" is an important part of the research for manufacturing databases. The CAD industry has continued to grow through out the 1990's. By 2000, "Global Shape Modeling" was developed; which allows NURBS surfaces to be pushed and pulled.⁴⁸

Building Information Modeling

The National Institute of Building Sciences defined Building Information Modeling (BIM) as "a digital representation of physical and functional characteristics of a facility," serving as a "shared knowledge resource for information about the facility, forming a reliable basis for decisions during its life cycle from inception onward."⁴⁹ In other words, BIM is a "tool and process where one cannot realistically exist without the other."⁵⁰ As of 2012, BIM software such as Autodesk Revit Architecture include 2D, 3D, 4D (schedule), 5D (cost), 6D (Building commissioning), 7D (Construction Safety) and 8D (ongoing operations and maintenance) components.⁵¹

Today, BIM not only allows architects to create virtual environments based on parametric modeling, but "the geometric consistency and integrity of the building model is maintained in spite of any changes or modifications that may have been made to it." Unlike CAD, parametric object consists of "a series of geometric definitions and their associated data and rules," creating non redundant definitions. Storage of data sets are possible within the building model, eliminating countless specification sheets compared to CAD and providing equal changes to data sets associated with the model.⁵² The result is that BIM is faster, providing more precise decision

⁴⁷ "CAD software-history of CAD CAM."

⁴⁸ "CAD software-history of CAD CAM."

⁴⁹ Dana K. Smith, "Building Information Modeling (BIM)," Whole Building Design guide: A program of the National Institute of Building Sciences, Posted July 24, 2008, <http://www.wbdg.org/bim/bim.php> (accessed Aug 29, 2012).

⁵⁰ James Vandezande, Phil Read and Eddy Krygiel, *Mastering Autodesk Revit Architecture 2012* (Indianapolis: Wiley Publishing, Inc, 2011), 5.

⁵¹ Julie Oldbury, "Seeking Clarity-Editing 6D, 7D and 8D BIM from our Vocabulary," The Big Bad BIM Blog, entry posted June 14, 2012, <http://blog.assemblestystems.com/bid/168905/Seeking-Clarity-Editing-6D-7D-and-8D-BIM-from-our-Vocabulary> (accessed Aug 28, 2012).

⁵² Global Associates, "The History of the BIM and the Success Story Till Date," BIM: Building Information

making, high-quality construction documents, prediction of building performance, cost estimating and construction planning.⁵³

BIM adoption among architects, consultants and builders had been gaining momentum. The American Institute of Architects survey released “The Business of Architecture” report in 2009, indicating “34 percent of firms have acquired BIM software, and more than two thirds of those are using it for billable work.”⁵⁴ McGraw-Hill Construction also released a study stating that half of all participants including engineers, contractors, owners and architects are using BIM or BIM-related tools. The study showed 6 out of 10 architects were using the technology.⁵⁵

According to McGraw-Hill, BIM usage in construction companies jumped from 17 percent in 2007 to 49 percent in 2009 to 71 percent in 2012. Currently there are more contractors (74%) using BIM than architects (70%).⁵⁶ The survey showed 49 percent of BIM contractors with five or more years experience using the software; 40 percent of them use BIM on 60 percent of their projects.⁵⁷ The survey and study demonstrate that the technology has been embraced by the building profession.

BIM Adoption in the World

The term “BIM adoption” was first introduced to the Architecture, Engineer and Construction (AEC) industry in 2002.⁵⁸ In an article titled “Around the World with BIM,” Lachmi Khemlani, Ph.D and founder of www.AECbytes.com, talks about various organizations in the world that govern and mandate BIM practices.

The Building and Construction Authority (BCA) in Singapore has implemented a roadmap for

Modeling Blog, entry posted December 30, 2010, <http://bimmodeling.blogspot.com/2010/12/history-of-bim-and-success-story-till.html> (accessed October 15, 2012).

⁵³ Chuck Eastman, Paul Teicholz, Rafael Sacks & Kathleen Liston, *BIM Handbook: A guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors* (New Jersey: John Wiley & Sons, Inc. 2011), 1.

⁵⁴ Joann Gonchar, “Diving Into BIM,” Architectural Record: Continuing Education Center December, 2009, accessed October 15, 2012, <http://continuingeducation.construction.com/article.php?L=5&C=625&P=1>.

⁵⁵ Joann Gonchar, “Diving Into BIM,” Architectural Record: Continuing Education Center December, 2009, accessed October 15, 2012, <http://continuingeducation.construction.com/article.php?L=5&C=625&P=1>.

⁵⁶ Joann Gonchar, “Diving Into BIM,” Architectural Record: Continuing Education Center December, 2009, accessed October 15, 2012, <http://continuingeducation.construction.com/article.php?L=5&C=625&P=1>.

⁵⁷ “New Research by McGraw-Hill Construction Shows Dramatic Increase in Use of Building Information Modeling (BIM) in North America,” McGraw Hill Construction Press release, October 11, 2012, <http://www.construction.com/about-us/press/new-research-by-MHC-shows-dramatic-increase-in-use-of-BIM-in-North-America.asp>, accessed October 15, 2012.

⁵⁸ Lachmi Khemlani, “Around the World with BIM,” AECbytes, May 9, 2012, accessed September 3, 2012. <http://www.aecbytes.com/feature/2012/Global-BIM.html>.

incorporating the use of BIM by 2015. While there are no mandates and regulations to use BIM for all of its building projects, strategies including a library of building and design objects are being developed in collaboration with buildingSMART Singapore. BIM submission templates for architectural, structural and M&E templates are part of the roadmap.⁵⁹

China currently does not have any BIM mandates, but the country has social and economic development initiatives which include “shifting development from urban and coastal areas toward rural and inland areas, enhance environmental protection, and accelerate openness and reform... one of the key construction related initiatives... is the energy-efficient buildings.” To meet this requirement, China is “cracking down on energy-profligacy and setting firm energy targets for buildings to meet.” Khemlani believes that China is “indirectly advocating the use of advanced AEC technologies like BIM, even though it is not mandating BIM outright.”⁶⁰

Unlike Singapore and China, the UK Government is mandating the use of BIM. Khemlani believes “AEC firms in the UK are already quite advanced in BIM implementation.” All Government funded contracts over £5 million (approximately \$8,009,056 US) are to be BIM projects by 2015.⁶¹ In May 2011, the “Building Information Modeling” section in the “Government Construction Strategy” document specifies the mandate that the Government will require full collaborative 3D BIM as a minimum by 2016. It also stated that the government will focus on developing standards to address issues that inhibited the adoption of BIM, due to “the lack of compatible systems, standards and protocols, and the differing requirements of clients and lead designers.”⁶² The AEC (UK) BIM Standard Committee released the standard in Nov 2009. In June 2010, it released BIM standard for Revit, and BIM standard for Bentley Products in Sep, 2011. BIM standards for ArchiCAD and Vectorworks were to follow.⁶³

AEC technology vendors such as Tekla and Solibri are located in the Skandinavian countries of Norway, Denmark, Sweden and Finland. Neighboring Hungary is known for the adoption of ArchiCAD.⁶⁴ The Danish government has recently passed a law that public building projects over \$5million Danish Krone (approximately \$875,960 US) must include BIM models with high levels of information.⁶⁵

⁵⁹ Khemlani, “Around the World with BIM.”

⁶⁰ Khemlani, “Around the World with BIM.”

⁶¹ Carl Collins, January, 2012, comment on Follow Konrad, “Which country’s public authorities have made BIM obligatory for their building and construction projects?” LinkedIn BIM Experts Blog, January, 2012, <http://www.linkedin.com/groups/Which-countrys-public-authorities-have-98421.S.90166057>.

⁶² Khemlani, “Around the World with BIM.”

⁶³ Khemlani, “Around the World with BIM.”

⁶⁴ Khemlani, “Around the World with BIM.”

⁶⁵ Alexander Larsen, January, 2012, comment on Follow Konrad, “Which country’s public authorities have made BIM obligatory for their building and construction projects?” LinkedIn BIM Experts Blog, January, 2012, <http://www.linkedin.com/groups/Which-countrys-public-authorities-have-98421.S.90166057>.

The General Services Administration (GSA) is responsible for the construction and operation of all federal facilities in the US. Currently most BIM mandates and requirements are at the federal level, including “all major projects conducted by the U.S. General Services Administration, the federal government’s real-estate management arm, require spatial program BIMs as a minimum requirement for approval by the federal Office of the Chief Architect.”⁶⁶ Other public-sector U.S. government organizations that are developing programs and mandates regarding BIM include the U.S. Army Corps of Engineers, the U.S. Air Force, and the U.S. Coast Guard.⁶⁷ The use of BIM for spatial programs started in 2007 and required “spaces, areas, efficiency ratios, and so on more accurately and quickly than traditional 2D approaches.” The GSA not only endorses BIM, it is also endorsing other 3D and 4D technologies as a transition from 2D technologies.⁶⁸

Insight into the BIM trend

In the Architectural Record Interview by Bryant Rousseau, Paul Seletsky, director of design at Skidmore, Owings & Merrill and Carl Galioto, partner-in-charge of SOM at New York Technical Group shared their insights on current BIM trends and practices.⁶⁹

Paul Seletsky believes the architectural practice of BIM is more of an “elliptical process” than the traditional linear process of architectural practice, starting from conceptual to early stages of design and into development and so on. “Specifications” is a great example, because traditionally specifications are a post-rational application to the finished design, but specifications are applied in early stages of design because the information is designed to be embedded into the rules of the building information model.⁷⁰

Carl Galioto believes the BIM impact will affect everyone as much as email has had an impact on business over the last 20 years. The shift of how BIM and information are created and shared may become the new way of working. After overcoming the initial hurdles of initial BIM implementation, architects will be able to enjoy the data-rich model and circular process that goes beyond what a virtual building can offer. Implementation of BIM requires changes in attitude by individual professionals, and changes in attitude within the profession as a whole, including “modification of legal guarantees and a movement and a willingness to take on greater

⁶⁶ “Worldwide Market for BIM software, Services Expected to Boom over the Next Eight Years,” WPL Publishing Co, Inc., July 6, 2012, accessed September 13, 2012, <http://constructionadvisortoday.com/2012/07/worldwide-market-for-bim-software-services-expected-to-boom-over-the-next-eight-years.html>.

⁶⁷ “Worldwide Market for BIM software, Services Expected to Boom over the Next Eight Years.”

⁶⁸ Khemlani, “Around the World with BIM.”

⁶⁹ Bryant Rousseau, “The ArchRecord Interview: SOM’s Carl Galioto and Paul Seletsky on BIM,” Architectural Record, March 2008, accessed May 23, 2012, http://archrecord.construction.com/features/interviews/0803som_bim/0803SOM_BIM-2.asp.

⁷⁰ Rousseau, “The ArchRecord Interview: SOM’s Carl Galioto and Paul Seletsky on BIM.”

responsibility.” This will help “regain a leadership position in the entire process of the realization of buildings.”⁷¹

Seletsky believes that smaller firms like large firms could enjoy the same benefit implementing BIM as part of their collaborative process, but it is largely up to the architects and how they view the means and the role of BIM. If BIM is viewed as only a more efficient production of representational documentation, then the architecture profession will not maintain a leadership position in the industry, but may cede leadership to construction-management firms. If BIM is understood as simulation and analytical-per formative analysis of design, the architecture field could seize the opportunity to elevate their stature and responsibility, encouraging innovations in architecture. Some of these innovations have become the standard trends; sustainable features and implementations are part of this trend, such as building envelopes thermal performance, day lighting of interior spaces, life cycle, facility management, etc. BIM also helps lower the financial cost by providing greater efficiency, enhancing the design value to the clients.⁷²

BIM as the Emerging New Practice Model

Building Information Modeling (BIM) technology has become popular among architects, engineers, contractors, owners, and others in the design and construction industries.⁷³

For the purposes of contract drafting and negotiation, it is crucial to understand that BIM is not a single “model” created by the project team. BIM could be defined as a “design model” and a “construction model,” with the ability to exchange information between different software platforms. Design models are usually created by the architect and consultants with standard information such as plans and specifications for construction documents for the permit and bid sets. Construction models are usually created by construction management and its subs with information found in shop drawings and other submittals.

To avoid future conflicts, contracts for BIM-enabled projects need to carefully “define rules for the creation, revision, and use of different models by different members of the project team.” Project delivery systems such as design / bid / build could use BIM as a tool, but BIM is at its full potential when paired with collaborative approaches such as the Integrated Project Delivery method.

⁷¹ Rousseau, “The ArchRecord Interview: SOM’s Carl Galioto and Paul Seletsky on BIM.”

⁷² Rousseau, “The ArchRecord Interview: SOM’s Carl Galioto and Paul Seletsky on BIM.”

⁷³ Jay Wickersham, “Legal and Business Implication of Building Information Modeling (BIM) and Integrated Project Delivery (IPD),” Harvard GSD issues 7212, April 2009, accessed October 3, 2012, <http://isites.harvard.edu/fs/docs/icb.topic552698.files/Wickersham%20BIM-IPD%20legal%20and%20business%20issues.pdf>.

Just like the more streamlined Design-Build method replacing the traditional Design-Bid-Build approach, the Integrated Project Delivery method may become more popular due to its success when paired with BIM.

Integrated Project Delivery

The American Institute of Architects defines Integrated Project delivery (IPD) as “a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to owner, reduce waste, and maximize efficiency through all phases of design, fabrication and construction.”⁷⁴ It is necessary to understand BIM and IPD are two different concepts; BIM is a tool, while IPD is a process, but they are at full potential when implemented together. “IPD is a project delivery method distinguished by a contractual agreement between a minimum of the owner, design professional, and builder where risk and reward are shared and stakeholder success is dependent on project success.” Public and private owners are increasingly interested in alternative methods of project delivery, “including construction manager-at-risk, fast tracking, and contractual clauses to incentivize the minimization of costly change orders.” These fall within the method called ‘Integrated Project Delivery’ (IPD).⁷⁵

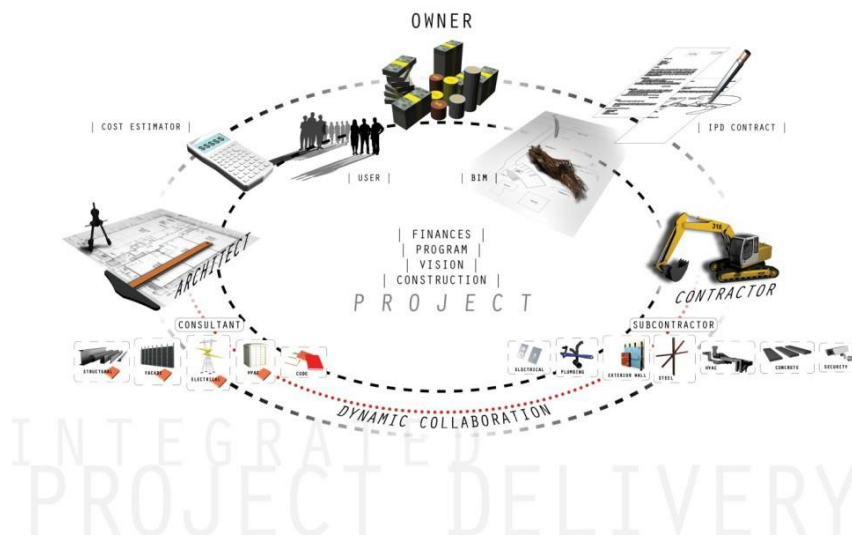
Tim Winstanley from ArchiDaily.com, an online architecture magazine, explains that the fundamental IPD process is to “ensure maximum efficiency and successful project delivery from all parties involved.” It provides quality delivery, uniting owner, architect and contractor on the same level playing field branches out with subcontractors and consultants.⁷⁶ According to Pike Research senior research analyst Eric Bloom, North America, Western Europe and the Asia Pacific region are the forefront for BIM adoption, especially when it is related to building efficiencies such as energy, water, waste and cost of operations. One key factor influencing adoption of BIM in North America and Western Europe is that public organizations such as the U.S. General Services Administration (GSA) is requiring BIM for building and facilities management.⁷⁷

⁷⁴ AIA, “Integrated Project Delivery: A Guide,” The American Institute of Architects, AIA National, AIA California Council, 2007 version 1, assessed September 22, 2012, <http://www.aia.org/aiaucmp/groups/aia/documents/document/aiab085539.pdf>.

⁷⁵ Wickersham, “Legal and Business Implication of Building Information Modeling (BIM) and Integrated Project Delivery (IPD).”

⁷⁶ Tim Winstanley, “Integrated Project Delivery methodology,” ArchDaily, August 2, 2011, accessed September 21, 2012, <http://www.archdaily.com/153953/integrated-project-delivery-methodology/>.

⁷⁷ “BIM Tools Are Becoming a Necessity for AEC Firms, Says Report,” The News, October 9, 2012, accessed September 21, 2012, <http://www.achrnews.com/articles/121106-oct-9-2012-bim-tools-are-becoming-a-necessity-for-aec-firms-says-report>.



(Fig. 1) Integrated Project Delivery

<http://ad009cdnb.archdaily.net/wp-content/uploads/2011/07/1311720028-project-delivery-methods7.jpg>

IPD collaboration could be applied from the beginning of the design project to the project handover between the owner, prime design, and the prime constructor. It consists of two key elements: collaborative design process and sharing of financial risks/rewards. Most U.S. projects and contracts use the collaborative design process without sharing of financial risks and rewards, known as IPD lite. For the architect and construction management (CM), this requires a more intensive collaboration prior to the creation of construction documents. New contractual relations such as the '3-party contract' issued by the Lean Construction Institute or 'Form 300, Tri-Party Agreement for Collaborative Project Delivery' by the Consensus Docs 2007, have changed many expectations of owners, architects and CMs. Currently, AIA offers many forms for various IPD contracts.

- The AIA A195, A295 and B195 Transitional Forms, are designed as the first step for construction manager agreements into IPD.
- The AIA C191 Multi-Party Agreement is designed as a single agreement that the parties can use to design and construct a project utilizing IPD.
- AIA also designed a Single Purpose Entity (SPE) Agreement (C195, C196, C197, C198 and C199) to create a limited liability company for the purpose of planning, designing and constructing the project in a fully integrated and collaborative process.⁷⁸

⁷⁸ AIA, "Integrated Project Delivery (IPD) Family," The American Institute of Architects, Contract Documents, 2012, accessed September 22, 2012, <http://www.aia.org/contractdocs/AIAS076706>.

⁷² Winstanley, "Integrated Project Delivery methodology."

IPD benefits & challenges

Although, IPD has become more popularized with the AIA contract forms, IPD implementation is more of an evolutionary approach and not a revolutionary adaptation within the design/building industry. A three step approach is necessary for the full incorporation of IPD.

- First, the use of BIM software and shared model is becoming the profession and industry standard when it comes to collaboration and uniting project delivery for architectural, engineering, mechanical, construction, costing, scheduling and life cycle management.⁷⁹ But interoperability of systems could still be a challenge; not all subcontractors use BIM.⁸⁰ Even within the conventional design / bid / build process, legal questions will arise and affect the project regardless of whether it employs the IPD process.⁸¹
- Second, in IPD lite, collaborative design process is seen as an evolution of CM-at- risk, but the process includes much more information sharing and decision-making among all members of the project team. Management through committee is often diplomatic, but the decision making process is often democratic and collaboratively managed, while taking into account of multiple parties' expertise for optimal solutions.⁸² Early consultants and specialty involvement can render early clash detection and deficiencies before the start of construction; resulting in lower Request For Information (RFIs) and Change Orders (Cos).⁸³
- Third, full IPD includes sharing of financial risks and rewards; all parties are equally vested. Although, liabilities and independent insurance tangents remain present in a technical sense,⁸⁴ IPD aims to provide incentives to all parties to maximize the collaboration effectiveness, sharing financial rewards and risks based on exceeding cost, schedule and quality goals for the project does pose a far-reaching legal implications for the business profitability, insurability of architects and other designers.⁸⁵ Incentive pool including profits of IPD contingency or percentage of profits for the IPD entity; improving the value of performance and quality across individuals involved in the project. If costs saving measures are achieved, the amount could be applied in another

⁷⁹ Winstanley, "Integrated Project Delivery methodology."

⁸⁰ Jonathan Cohen, FAIA, "Integrated Project Delivery: Case Studies," The American Institute of Architects, AIA California Council, January 4, 2010, accessed September 22, 2012, http://hga.com/sites/default/files/downloads/resources/ipd_casestudies_aiacc_final_010410_0.pdf.

⁸¹ Wickersham, "Legal and Business Implication of Building Information Modeling (BIM) and Integrated Project Delivery (IPD)."

⁸² Winstanley, "Integrated Project Delivery methodology."

⁸³ Winstanley, "Integrated Project Delivery methodology."

⁸⁴ Winstanley, "Integrated Project Delivery methodology."

⁸⁵ Wickersham, "Legal and Business Implication of Building Information Modeling (BIM) and Integrated Project Delivery (IPD)."

part of the project or divided among individuals of the IPD team. The shared Risk/Reward environment also eliminates the traditional methods of passing along blame and responsibility and encourages attitudes that seek project prosperity.⁸⁶ Another critical approach is to use the contract negotiation process to define issues and build mutual trust and respect among team members. BIM and IPD require excellent communication and clear lines of information sharing and decision-making within the project team.

AIA IPD Case Study Results

AIA Case Study Scorecard defines six characteristics identified as fundamental to IPD:

1. Early involvement of participants.
2. Shared Risks and Reward.
3. Multi-party contract.
4. Collaborative decision making.
5. Liability waivers.
6. Jointly developed goals.⁸⁷

Out of the six projects studied, only the Autodesk AEC Solutions Division Headquarters meets all six characteristics. The results of the case studies suggest the following for IPD implementations.

1. The financial incentives could cause unwelcome changes in behavior; the IPD design and build team will want to treat every change as scope change and not an item to be subtracted from the contingency. It is essential to implement scoring excises taken to level of conceptual design, in which everyone works at cost until a deep understanding of the project and a level of comfort around the program and budget is achieved by all parties. A certain level of discomfort will occur, but that discomfort is “the team’s obligation to design the target cost.”⁸⁸
2. Although all key players use BIM, subcontractors might use other specialized software other than BIM. This poses a problem with the interoperability of the systems.
3. Part of the promise of IPD is to deliver to the owner better interoperability among design models; fabrication models and facilities management systems are necessary.
4. IPD could eliminate redundant detailing, reduce time spent on site for architects and minimize RFIs and submittals.⁸⁹

⁸⁶ Winstanley, “Integrated Project Delivery methodology.”

⁸⁷ Cohen “Integrated Project Delivery: Case Studies.”

⁸⁸ Cohen “Integrated Project Delivery: Case Studies.”

⁸⁹ Cohen “Integrated Project Delivery: Case Studies.”

Part C: Main Reasons for the Separation

What is changing the practice of architecture?

From the literature, one can see there is a separation between architecture education and architecture practice, partly because of changes in the practice of architecture. From the apprenticeship-based process in the 1700s, the architecture trade became a profession with the birth of the American Institute of Architects. With the rise of industrialism replacing workshop apprenticeships with drafting rooms, architecture education was divided into two separate parts. First, an education focusing on a course of architectural training with technical foundation including art and sciences followed by obtaining real world practice as an apprentice.

There are many reasons pertaining to the separation between architecture education and architecture practice, as one might see from the history and trends of the practice of the profession, and technological development is playing a vital role in architectural practice. In the past 30 years, drafting tables have been replaced by CAD. Today, CAD is in the process of being replaced by 3D and BIM software. BIM development has given the architecture profession new opportunities to further develop new methodologies such as IPD, but because of the structure of education institutions and other reasons, it is difficult for architecture programs to stay current with real world technological practice such as BIM and IPD. BIM has become the preferred tool in the architecture profession; as a result, other new practices and methodologies will continue to emerge.

According to Dennis Shelden, 'Building Information Modeling and Professional Practice,' the influx of new technical, procedural and organizational innovations in the building delivery process is changing the practice of architecture. The key component of this evolution is BIM, by creating value and incentives for a new approach in conventional practice, from contractual roles and responsibilities to the format and content of project information.⁹⁰ BIM reduces errors of design, improves design quality, shortens construction time and significantly reduces construction costs.

Architects must be flexible to accommodate clients and other stakeholder needs and be open minded towards new methodologies. Architecture practice will continue to change with the emergence of new technologies. The separation between architecture education and architecture practice exists because real world practice is adopting new technologies at a faster pace than educational programs. Perhaps now is the time to better integrate innovative approaches from the field into architectural education in order to address these issues. Dr.

⁹⁰ Dennis R. Shelden, *Building Information Modeling and Professional Practice: In Computational Design Methods and Technologies: Applications in CAD, CAM and CAE Education*, ed. Ning Gu and Xiangyu Wang (Australia: University of Newcastle, 2012), 83-100.

Michael Crosbie believes that it is essential to bring students up to speed with current architectural practice, so they can be prepared to compete in the professional world and sustain the architecture field for the future.⁹¹ Architecture as a profession could suffer, if we fail to bring today's students up to speed with the current practice.

What are the differences between what is being offered in architectural education and what is happening in architectural practice?

BIM in Education

In 2010, the ACSA partnered with Autodesk to conduct a survey on the use of Building Information Modeling (BIM) and Integrated Project Delivery (IPD) content in architecture curricula. 53 schools responded, 37% of which are accredited or candidate for accreditation programs. Of the 53 schools, 28 (49%) offered a degree in B.Arch, 44 (77%) offered a degree in M.Arch and 19 (33%) of the schools offered both B.Arch and M.Arch degrees.⁹²

Use of Software

Revit was used in more than half of the schools, nearly matching the number of schools using AutoCAD. Ecotect Analysis was used in 25% of the studio and elective courses. Maya was used in 25% of elective courses. Approximately 1/3 of the schools used 3ds Max Design in elective or studio courses. ArchiCAD was the most identified non-Autodesk project, followed by Bentley, Digital Project, Rhino, Sketch-up and Vector works.⁹³

Use of BIM

- Studio courses: 75% used BIM in studio courses. 70% for undergraduate design studio and 61% for graduate design studio.
- Non- studio courses: 60% of programs used BIM in non-studio, required courses. 54% for B.Arch programs and 64% for M.Arch programs. 50% focused on computing, digital representation, modeling or related topics while 33% were courses devoted specifically to BIM.
- Elective courses: 63% used BIM in elective courses. 57% for B.Arch and 68% for M.Arch.

IPD incorporation in Studio

A third of the respondents described design studios where multiple disciplines met with multiple participants mentioning real-world projects involving clients, construction or other projects carried on beyond academe. Many participants believed that a philosophical grasp of IPD with a

⁹¹ Crosbie, "Getting Practice in Your Practice: /firms Hosting Academic Design Studios."

⁹² Cohen "Integrated Project Delivery: Case Studies."

⁹³ ACSA, "2010-2011 BIM/IPD Survey Results- Summary May 2011."

focus on case studies to illustrate IPD is needed to better understand the issues of IPD before using the software.

Collaborative Design Strategies

- 77% teamed with architecture students at the same level
- 33% teamed with architecture students at different levels
- 47% teamed with architecture and non-architecture students
- 63% teamed with architecture faculty in the same studio
- 32% teamed with architecture and non-architecture faculty
- 51% used non-architect critics or instructors during the term, with engineers being the most mentioned discipline of these students, faculty or critics.

IPD incorporation in professional practice curriculum

- 68% used case studies or in-depth examples of IPD models beyond basic descriptions such as design-bid-build, design-build, etc.
- 70% discussed contractual issues. 57% only discussed this within the B.Arch program.
- 47% discussed insurance issues. 32% only discussed this within the B.Arch program.
- 68% discussed working in teams. 50% only discussed this within the B.Arch program.
- 60% discussed using BIM software in the office. 46% only discussed this within the B.Arch program.⁹⁴

Architectural Technologies in Architecture Education

Although the technology, delivery methods and practice of architecture has changed; the process of becoming an architect has been essentially the same. The structure of Architectural education has become more organized with AIA, ACSA, NCARB, NAAB and the implementation of IDP and ARE, but architectural education has not changed much since the 1860s. The mission of AIA, ACSA, NCARB and NAAB is not to regulate the specifics about what is being taught within the educational setting; rather their focus is to ensure students receive adequate training to become an architect.

Currently, there is no mandate or requirement for architectural programs to include specific architectural design software within the curricula. The NAAB leaves individual architectural program design and curricula to the institution, allowing each program to be creative and innovative in their method of architectural education.

⁹⁴ ACSA, "2010-2011 BIM/IPD Survey Results- Summary May 2011."

New technologies are continually changing practices in the field of architecture. Building Information Modeling (BIM) technologies offer tremendous potential when implemented in practice effectively. However, where BIM is offered in architectural education programs, it is generally only at an introductory level inadequate to prepare graduates for real world applications. In the symposium by Yale School of Architecture on 'BIM in Academia,' architecture practice is racing ahead in BIM, while BIM struggles to be accepted as a credit worthy subject. For academic institutions to offer BIM education, it has to be either categorized as a skill or knowledge worthy course. Currently, BIM skills are squeezed or linked to building construction information, technology/structures area, environmental courses, fabrication courses and professional practice, but these are often "an awkward intruder in courses."⁹⁵

⁹⁵ Peggy Deamer, ed., and Philip G. Bernstein, ed. *BIM in Academia* [Conneticut: Yale School of Architecture, 2011], 1-002.

II. Learning Theory & Competency Theory

The literature review on the Separation between Architecture Education and Architecture Practice demonstrated that a separation exists between the two and BIM adoption is one of the reasons for the separation. The following literature review will focus on existing learning and competency theories. These theories will serve as the basic guidelines and models for the design and implementation of the BIM Track for D.Arch project, it consist of two parts:

Part A: Five Stages of the Mental Activities Involved in Directed Skill Acquisition

Part B: Four Mental Functions & Conscious Competence Learning Matrix

The literature will address the following questions:

1. How does one define a competent architect?
2. Is being merely competent enough?
3. Is being a competent architect enough?
4. Should architecture education only train students to become competent architects?
5. What are some possible ways to implement this essential skill within the architectural education?

Part A: Five Stages of the Mental Activities Involved in Directed Skill Acquisition

Competency has many meanings, it is a widely used term in management development, organizational and occupational literature.⁹⁶ Competency can be defined by a set of behaviors that “provide structured guide enabling the identification, evaluation and development of the behaviors in individual employees.”⁹⁷ The Oxford dictionary defines “Competency” or “Competence”, as the ability to do something successfully or efficiently.⁹⁸ According to the Carnegie Mellon University, Software Engineering Institute, being competent, means being “capable of performing an allotted or required function.”

How is a competent architect defined? Is being competent enough? Should architecture education only train students to become a competent architect? Is it possible for architectural education to educate and provide training opportunities beyond producing competent architects?

This literature review focuses on the examination of competency development and various learning theories that can be applied to architectural education, particularly in essential software skills.

Is being competent enough?

In order to understand whether being competent is enough, we can study Hubert L. Dreyfus and Stuart E. Dreyfus’s proposed theory developed in the 1980’s on “The Five-Stages of the Mental Activities Involved in Directed Skill Acquisition”.

The paper on Calculative Rationality titled, “From Socrates to Expert Systems: The Limits and Dangers of Calculative Rationality,”⁹⁹ recounts one of Socrates’s earliest dialogues, “The Euthyphro”. Plato tells of an encounter between Socrates and Euthyphro, a religious prophet and expert in pious behavior (virtuous behavior). Socrates asks Euthyphro to define the characteristic of piety (virtue in religious devotion, spirituality or a combination of both). He would like to use Euthyphro’s standard to judge the actions of men. Like many experts, Euthyphro gave him examples from his field of expertise, in mythical situations of gods and men where they do things that are considered pious. He also tells Socrates his rules for

⁹⁶ Collin Audrey, “Managers’ Competence: Rhetoric, Reality and Research,” *Personnel Review*, Vol. 18 Iss. 6, (Leicester: MCB UP Ltd, 1989), 20 – 25.

⁹⁷ *Wikipedia*, s.v. “Competence (human resources),” accessed July 10, 2013, https://en.wikipedia.org/wiki/Competence_%28human_resources%29.

⁹⁸ “Competence,” *Oxford Online Dictionary*, accessed 8/12/2013, http://oxforddictionaries.com/us/definition/american_english/competence?q=competency.

⁹⁹ Hubert L. Dreyfus and Stuart E. Dreyfus, “From Socrates to Expert Systems: The Limits and Dangers of Calculative Rationality,” *The department of Philosophy*, accessed August 12, 2013, http://socrates.berkeley.edu/~hdreyfus/html/paper_socrates.html.

recognizing cases of piety examples, differentiating impious acts from pious acts. However, Euthyphro is unable to state the rules he use to define piety and pious behavior.¹⁰⁰

Socrates ran into the same problem with craftsmen, poets and even statesmen, they could not articulate the principles underlying their expertise. Socrates then concluded that experts knew nothing and he knew nothing also. However, Plato is able to further explicate this issue. He believes that experts, have to disregard the principles they have learned earlier, but these rules are imbedded in the expert's mind unconsciously.¹⁰¹

Drawn from Socrates's conclusion and Plato's explanation, Dreyfus and Dreyfus's suggest that there are four mental functions and five skill level stages when learning a skill by means of instruction and experience. It is a learning process from novice to master. The following are the summaries and descriptions of the "Five Stages of the Mental Activities Involved in Directed Skill Acquisition", focusing on competency development by Dreyfus and Dreyfus:

Table 1 (Dreyfus & Dreyfus Pg19.)

Skill Level/ Mental Function	Novice	Competent	Proficient	Expert	Master
Recollection	Non-Situational	Situational	Situational	Situational	Situational
Recognition	Decomposed	Decomposed	Holistic	Holistic	Holistic
Decision	Analytical	Analytical	Analytical	Intuitive	Intuitive
Awareness	Monitoring	Monitoring	Monitoring	Monitoring	Absorbed

Five Stage Skill Level

1. Novice

- Related to the rule-based behavior. The instruction is given in context-free features, so the performer can apply the task without previous experience.
- The performer simply follows set rules and feels no pressure to perform because each task comes with a rule.
- Example: The student automobile driver learns to recognize and interpret the free feature- speed by speedometer, and is then given a rule to shift to second gear when the speedometer points to ten miles an hour.

2. Competence

¹⁰⁰ Wikipedia, "Competence (human resources)."

¹⁰¹ Wikipedia. "Competence (human resources)."

- The performer is able to incorporate aspects of the situation, by either seeing a sufficient number of examples from real situations or by learning from the instructor pointing out the meaningful aspects of the situation. He/she is able to recognize similar aspects; new situational aspects and non-situational features can now be recognized. This information is brain-state recorded, similar to a “guideline”, treating all aspects with equal importance and the performer is able to use these guidelines for correcting similar conditions.
- If the performer is unable to complete a task, his/her emotions could be detached and therefore he/she would not feel responsible for not being able to complete the task, rationalizing the situation that not enough instructions were given, and hence the result is miss-performance.
- Example: the advanced beginner driver can now use the engine sounds- situational and speed- non-situational in the gear- shifting rules. Shifting up when motor sounds like it is racing and shift down when it sounds like it is straining. From experience, he/she has learned to observe the demeanor, position and velocity of pedestrians and other drivers. He/she is able to distinguish the behavior of a distracted or drunken driver from an alert driver.

3. Proficiency

- With increasing experience, the performer will run into situations in which he/she might recognize too many potentially relevant elements, and the pressure of mastering the skill becomes a daunting task. A specific situation presented at two different times with different perspective is treated as two different situations. Hence, new rules, plan or perspective are needed before the performer is able to restrict attention to only a few of the relevant features and aspects before an easier decision process is complete. These skills could be learned through increased instructions or experiences. It is important to understand that due to the subtle differences in various situations, it is not easy to acquire these new rules. It is impossible to prepare a list of what to do in each possible situation. The competent performer must evaluate each situation and choose the plan with the timing that best fit the particular situation.
- At this stage, it is more stressful than prior stages. Previously, if the learned rules didn’t work out, the performer could rationalize that he hadn’t been given adequate rules, but at the competent stage, the performer will feel responsible for making mistake and hence experience the emotional roller coaster of not being a competent performer. The performer is able to see long term goals and specific aspects of the situation. It will be increasingly difficult for the performer to adopt the detached rule (not feel responsible for not

being able to complete the task by rationalizing not enough instructions were given); the performer is then left with two choices:

1. Resistance to the acceptance of risk and responsibility, which can lead to stagnation, boredom and regression. The performer simply stops progressing, he/she either quits or at a standstill.
2. Continual involvement, which lead to further skill development and advancement. The performer is able to somehow come up with new rules, plans and perspective and continue.
 - Example: A competent driver exiting the freeway off-ramp curve has to take into account of speed, surface condition, criticality of time, etc. He has to decide precisely whether to let up on the accelerator, remove his foot or step on the brake. He will be relieved if the exit was a success without being honked at, or he might be shaken if he begins to skid while exiting the off ramp.

4. Expertise

- Proficiency can be developed only if the experience and intuitive behavior of the performer replaces reasoned responses that the brain relates and combines appropriate plans based on situational discrimination (distinguishes among many situations), without having to sort through each rules and principles before deciding which aspects of the situation are considered more important. This means the performer is able to jump into action involving intuitive responses, with less doubt and with ease, he/she can see clearly what needs to be achieved rather than going through a calculative procedure.
- At this stage, the performer can not only see the goals and aspects of the situation and tasks to be completed, he/she is able to decide how to respond based on recognizing the important features of the situation.
- Example: A proficient driver will not need to spend additional time considering the speed, angle of bank, and feel the gravitational forces before deciding whether to apply the brakes or to reduce pressure on the accelerator while making a turn on rainy day. A proficient driver is able to access the situation and make intuitive responses based on the important features of the situation and respond with ease and without doubt.

5. Mastery

- Although, the mastery level is similar to the expert level in terms of mental capacity, the expert is able to experience intense absorption and transcends to a higher level. He/she is not only able to see what needs to be done and tackles the task by situational discriminations, he/she also have the ability to make more subtle and refined discriminations with the ability to pay conscious

attention and to reflect on his/her performance. With vast experience in many situations, the brain is able to subdivide and sub-classify different tactical decisions, allowing for immediate intuitive situational responses. This immediate response is the characteristic of expertise in the subject.

- Example: The expert driver is able to feel when to slow down on an off ramp, he simply performs the action. What must be done, simply is done.

From Dreyfus and Dreyfus's findings, not only does competency development occur in a five stage progression, it is essential to realize "calculative rationality". Theories and rules should only be viewed as the basics or be the center of reasoning during the beginning process, or the result is stagnation. In order to progress, beyond "deliberative rationality", a detached, reasoned observation of one's intuitive, practice-based behavior combined with continual improvement on intuition, through challenges and reflection, without replacing it by purely theory-based action of a novice is the only progression to expert competency.

Increasingly, today's society exhibits a bureaucratic nature, with the danger of losing many skills and expertise through over reliance on calculative rationality. We must ensure the process of learning continues to progress into the deliberative rationality phase, in which an expert could remain without over emphasis on the expert system.

As mentioned by Dreyfus and Dreyfus, it is important to understand that expert systems (in which rules, principles apply) are never as good as experts, because the expert system requires experts to define rules, therefore forcing him/her to regress back to the level of a beginner and state the rules he/she had learned in school and often times, rules that he/she no longer remembers. The value of these rules and facts are merely important, compared to the knowledge the expert has captured from his experiences of actual outcomes of various situations.

(Brucem, Dreyfus & Dreyfus, Dreyfus & Dreyfus^{102 103 104})

Based on the definitions of the "Five Stages of the Mental Activities Involved in Directed Skill Acquisition", by Dreyfus and Dreyfus, being competent is only being able to apply the skill at a brain-state record; a guideline based response to similar conditions. From this, we can

¹⁰² Brucem, "Dreyfus Model: A richer Understanding of Competency Building," Xraydelta Blog, posted August 1, 2013, <http://xray-delta.com/2011/10/12/dreyfus-model-a-richer-understanding-of-competency-building/>.

¹⁰³ Stuart E. Dreyfus and Hubert L. Dreyfus, *A five-Stage Model of the Mental Activities Involved in Directed Skill Acquisition*, (Berkley: University of California, 1980), accessed August 8, 2013, <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA084551>.

¹⁰⁴ Hubert L. Dryfus and Stuart E. Dreyfus, "From Socrates to Expert Systems: The Limits and Dangers of Calculative Rationality."

conclude that if the required result only requires the performer to respond based on guideline type process, and if it is okay for the performer to exhibit detached emotions, permitting rationalization for not being able to complete the task because he/she was not given enough instructions, then being competent is enough.

Define a competent architect

A competent architect “is one that carries out his/her architecture-related duties competently.”¹⁰⁵ The Perkins + Will Research Journal mentioned the duties and responsibilities of an architect are to follow the legal standard of care, legal and professional obligations under an industry standard owner/architect agreement.¹⁰⁶ The B-Series: Owner/Architect Agreements such as B101-2007 defines the basic and additional services.¹⁰⁷ The bureau of Labor Statistics, Occupational outlook Handbook, suggests Architects spend most of their time in offices, where they consult with clients, develop reports and drawings, and work with other architects and engineers.¹⁰⁸ To become competent in these tasks, one must first master the most basic communication skills in the architectural field; architectural drawing.

Is being a competent architect enough?

If being a competent architect means we only need to perform similar tasks using a standard guideline in following the legal standard of care, legal and professional obligations under an industry standard owner/architect agreement,¹⁰⁹ then, yes, being competent is all we need to be as an architect, because these tasks comes with strict rules, principles and guidelines. However, a big part of an architect’s duties and responsibilities include architectural drawings, methods of delivery, etc., things that are situational and cannot rely on a few simple guidelines. Being a competent architect will not provide the necessary result needed for a successful project.

¹⁰⁵ Paul Clements, “Improving Software Architecture Competence” (presented at the Carnegie Mellon University, Software Engineering Institute, Pittsburgh, PA, May 16, 2007), accessed June 22, 2013, <http://www.sei.cmu.edu/library/assets/Clements.pdf>.

¹⁰⁶ Helena O’Connor, “Architectural Services During Construction: Duties and Liability,” Perkins + Will Research Journal Volume 04.01, 2012, accessed August 19, 2013, http://www.perkinswill.com/sites/default/files/ID%20_PWRJ_Vol0401_01_Architectural%20Services%20During%20Construction.pdf/

¹⁰⁷ American Institute of Architects, “Contract Documents,” accessed September 3, 2012, <http://www.aia.org/contractdocs/aia076745>.

¹⁰⁸ Bureau of Labor Statistics, “Occupational Outlook Handbook: Architects,” accessed December 1, 2012, <http://www.bls.gov/ooh/architecture-and-engineering/architects.htm>.

¹⁰⁹ Helena O’Connor, “Architectural Services During Construction: Duties and Liability,” Vol. 04.01.

Part B: Four Mental Functions & Conscious Competence Learning Matrix

Should architecture education only train students to become competent architects?

If architectural drawing is not part of the architect's duties and responsibilities, then architectural education could only train students to become a competent architect. However, because architectural drawing is an essential part of the architect's duties and responsibilities, architectural education must ensure students obtain architectural drawing skills at a high level, so they can effectively communicate their designs practically.

Architectural drawing is a technical drawing of the building.¹¹⁰ There are many ways to produce architectural drawings. Currently, Building Information Technology (BIM) is a popular process or delivery method that is able to generate architectural drawings and offer other multi-dimensional benefits. Currently, Autodesk Revit Architecture has the most downloads from the National BIM Library, with a market share of 49%, followed by ArchiCAD with 18%.¹¹¹

BIM is a process and Revit is a BIM tool.¹¹² When implemented effectively, it could be beneficial to the architecture industry. Currently, BIM tools are only taught at a beginning level in academia, if it is part of the curriculum at all.¹¹³ Being able to implement BIM tools in architectural education may help bridge the gap between academia and real world practice.

What are some possible ways to implement this essential skill within the architectural education?

From the "Five-Stage Model of the Mental Activities Involved in Directed Skill Acquisition" by Dreyfus and Dreyfus, it is possible to apply the transformation of four mental functions and five stages of mental activity involved in skill acquisition (table 1) in the academic setting, providing BIM tool/Revit training opportunities.

According to Dreyfus and Dreyfus, for the training to be effective, it is important that the training courses are designed with an awareness of the developmental stages and to facilitate the trainee's advancement without introducing "intricate and sophisticated aids..." because although it might improve performance at a particular level, it will delay progression to higher

¹¹⁰ Wikipedia, "Architectural Drawing," Wikipedia the Free Encyclopedia, accessed August 19, 2013, http://en.wikipedia.org/wiki/Architectural_drawing.

¹¹¹ Anna Winston, "Which BIM Software is the Most Popular?" bdonline.co.uk, accessed March 5, 2013, <http://www.bdonline.co.uk/which-bim-software-is-the-most-popular?/5049817.blog>.

¹¹² Autodesk, "Building Information Modeling," accessed November 8, 2013, <http://usa.autodesk.com/building-information-modeling/>.

¹¹³ Renee Cheng, "Questioning the Role of BIM in Architectural Education," AECbytes Viewpoint #26, July 6, 2006, accessed August 27, 2013, http://www.aecbytes.com/viewpoint/2006/issue_26.html.

stage or even encourage stage regression.¹¹⁴ With this in mind, it is important to understand the Dreyfus and Dreyfus's Four Mental Functions as they play an important role in learning development.

Four Mental Functions

1. Recollection

- The performer is able to recollect similar aspects of non-situational conditions and, recognizing the similarity, successfully achieve situational experience-based recognition.

2. Recognition

- The performer is able to perceive the similarity of whole situations accompanied by recognition of salience; recognizing the most noticeable or important aspect of the situation in a holistic manner.

3. Decisions

- The performer is able to intuitively recognize whole situations and come up with unique decisions without the need of conscious calculations.

4. Awareness

- The performer is able to be completely absorbed in his performance analytically, without the nuances for monitoring and evaluating each performance.

The Four Mental Functions are similar to the "Four Stages of Competence", in the "Conscious Competence" learning model, ladder or matrix or the "Four Stages for Learning Any New Skill", developed at Gordon Training International by Noel Burch in 1970's.¹¹⁵ It relates to the psychological states involved in the process of progression from incompetence to competence in a skill and is a useful reminder of the need to learn, and train others in stages.^{116 117} The following is a description of the four stages:

1. Unconscious incompetence

- During this stage, the performer is unaware of the relevance and existence of the skill area, and he/she is also unaware of their own deficiency in the subject. Often times the performer will deny the relevance or usefulness of the new

¹¹⁴ Stuart E. Dreyfus and Hubert L. Dreyfus, *A five-Stage Model of the Mental Activities Involved in Directed Skill Acquisition*, p16.

¹¹⁵ Wikipedia, "Four Stages of Competence," Wikipedia: The Free Encyclopedia, accessed August 12, 2013, http://en.wikipedia.org/wiki/Four_stages_of_competence.

¹¹⁶ "The Conscious Competence Model," College of Occupational Therapists of Ontario, accessed May 1, 2013, http://www.coto.org/pdf/qa_consciouscompetence.pdf.

¹¹⁷ Wikipedia, "Four Stages of Competence."

skill, until he/she becomes conscious of their incompetence, then, it is possible for the performer to begin to develop the new skill.

- It is essential to understand that the goal for the trainer is to help the trainee enter the “conscious competence” stage. The length of time an individual spends in this stage depends on the strength of the stimulus to learn, so it is important for the trainer to demonstrate the effectiveness of the skill or the benefits of obtaining the skill.

2. Conscious incompetence

- The performer is aware of the relevance and existence of the skill. He/she is also aware of their own deficiency in the subject through trial and error or other type of experimentations in relating to the subject. The performer should have a measure of their deficiency, have an idea of the level of skill required and have the commitment to learn and practice the new skill and to move to the “conscious competence” stage.
- The performer might become overwhelmed by the vast knowledge area and might make mistakes. This is normal, however, and making mistakes is the integral part of the learning process at this stage; the trainee is able to understand he/her deficiency through the mistakes in various situations.

3. Conscious competence

- The performer achieves “conscious competence” by being able to perform the skill reliably at will. Although the performer might need to break down the process into various steps with high concentration and calculation, he/she is able to perform the skill without assistance. The performance might be at a slower pace, it is not ‘second nature’ or ‘automatic’ yet, but the performer is able to demonstrate the skill. However, the performer is inadequate when it comes to teaching the skill to another person.
- The trainee realizes that the only way to progress is to apply oneself and do what is necessary and put the time into practice and discover the meaning and result. The trainee should continue to practice the new skill and commit to becoming ‘unconsciously competent’. Practice and continual exposure to a different variety of situations will help in skill development progression.

4. Unconscious competence

- Through continual practice, the performer is able to internalize the skill, able to perform the required skill unconsciously; it is now ‘second nature’. He/she is able to multitask while executing other tasks and be able to perform the required skill with accuracy, precision and with speed. However, the unconscious competent performer might have difficulty explaining exactly how they perform the skill, because the skill is now instinctual.
- It is essential that the unconscious competent performer periodically check against new standards to maintain skill level.

(¹¹⁸ ¹¹⁹ ¹²⁰ ¹²¹ ¹²²)

Often times, trainers commonly assume trainees to be at a stage 2- conscious incompetent level, and focus all the effort towards achieving stage 3- conscious competent level. It is important for trainers to step back and realize most trainees are still at the stage 1- unconscious incompetence level. This is a cause for the failure of a lot of training and teaching. It is essential for the trainer to effectively communicate and help the trainee become aware of the “skill existence, nature, relevance, deficiency and benefit from the acquisition of the new skill.”¹²³ Trainees must first become fully aware of their own incompetence, or he/she will not see the need for learning the skill. By being aware of their own need for it, trainees will respond to the personal benefit they will gain from learning the skill.¹²⁴

Progression is possible when the trainee feels a sense of personal achievement, with a moment of awakening, when things ‘click’ into place. However, it is possible that for some personality types, one might not be able to progress to stage 3 or 4, or might even resist progression to stage 2. Nonetheless, recognizing one’s incompetence is essential before other progression is possible.¹²⁵

The learning theories mentioned above can be applied to the inclusion of the BIM Track for D.Arch program, and they delineate the need for architects to possess skills beyond the competency level. Architecture education could provide opportunities that enable students to obtain skills from novice to mastery while earning their degree. However, before suggesting a BIM Track curriculum proposal, it is essential to understand the current D.Arch program’s focus and intents, the questionnaire responses collected from D.Arch students’ perspectives on BIM inclusion, and interview responses from practitioners on the subject of BIM and practice. The following design and research documentation will provide a review of the topics mentioned.

¹¹⁸ Wikipedia. “Four Stages of Competence.”

¹¹⁹ Jared M. Spool, “The Flexibility of the Four Stages of Competence,” User Interface Engineering, accessed August 29, 2013, http://www.uie.com/articles/four_stages_competence/.

¹²⁰ “Conscious Competence Learning Matrix,” Cumbria, accessed September 2, 2013, <http://www.cumbria.gov.uk/eLibrary/Content/Internet/327/6256/40728132550.pdf>.

¹²¹ “Conscious Competence Learning Model- Stages of learning,” Surgical Assistant Resource, accessed August 30, 2013, http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CC0QFjAA&url=http%3A%2F%2Fwww.surgicalassistantresource.org%2Fweb_documents%2Fconscious_competence_learning_model.doc&ei=-McJUpUfhcG0Bty3gegK&usg=AFQjCNFQIKdOfvZdSBby2ARHnYQL1ayXNA&sig2=khoO73TRRYHXBlSGe5mzKg.

¹²² “The Four Stages of learning a Skill,” Essential Life Skills.net, accessed Aug 12, 2013, <http://www.essentiallifefskills.net/stagesoflearning.html>.

¹²³ “Conscious Competence Learning Model- Stages of learning.”

¹²⁴ “Conscious Competence Learning Model- Stages of learning.”

¹²⁵ “Conscious Competence Learning Model- Stages of learning.”

Research Documentation

Research Methodology

The “BIM for D.Arch” project is a BIM Certification Program designed for at the University of Hawai'i at Mānoa, School of Architecture, Doctor of Architecture degree program. The nature of this research is a combination of applied research and design research. The project uses a basic qualitative case study approach to examine the curriculum of the Doctor of Architecture degree program at the University of Hawai'i at Mānoa, School of Architecture, with the goal of the implementation of a BIM Track program to bridge the gap between what is being offered in architectural education and what is happening in practice. Purposive sampling was used to select participants for questionnaires and interviews. While the Doctor of Architecture degree program at the University of Hawai'i at Mānoa, School of Architecture provides a case sample, it is hoped that other architectural programs could apply the findings. Data were collected concurrently with simultaneous analysis.

Data Collection

Three types of data were collected and used in this study: documents and artifacts, questionnaires and interviews.

Documents and Artifacts: Document analysis include articles, journals, books, newspapers, transcripts, e-mail messages, program curricula, other literatures, websites etc. Primary & secondary sources are both considered. The information and analysis is documented throughout the doctoral project both as background and major part of the research document.

Questionnaire: D.Arch. students enrolled in the 1st and 2nd year studio during Fall 2012 are included in this purposive sampling techniques were used to select participants to respond to the questionnaire.

Interviews: Practitioner interviews are conducted during Spring 2013 during Professional Studio Practicum internship at Perkins Eastman Inc. It focus on the topic of “BIM Technology in Practice.”

The research documentation includes the following:

1. University of Hawai'i System Mission Review
2. Doctor of Architecture Program Review
3. Doctor of Architecture Timeline
4. Physical Location
5. Doctor of Architecture Professional Degree theories of curriculum adoption and Curriculum
6. Historical Preservation Certificate

7. University of Hawai'i at Mānoa, School of Architecture Technology
8. Doctor of Architecture Student Questionnaire
9. Practitioner Interview
10. BIM Inclusion Case Study

University of Hawai'i System Mission Review

Summarized in the *Architecture Program Report* by the University of Hawai'i at Mānoa, School of Architecture, the mission of the University of Hawai'i system is to “provide quality college and university education and training; create knowledge through research and scholarship; provide service through extension, technical assistance, and training; contribute to the cultural heritage of the community; and respond to state needs.”¹²⁶

The system is unique due to its familiarity and orientation in Hawaiian, Asian, and Pacific cultures, it strives to serve international leadership role.¹²⁷ The University of Hawai'i at Mānoa is dedicated not only to academic and research excellence but also to serve the local, national and international communities with the aloha spirit.¹²⁸

With its unique geographic location embracing both East and West, “Mānoa serves as a portal to an exceptional educational experience while striving to improve quality of life in the region through collaborative partnerships that support innovations in education, health care, social development, culture and arts, earth, space, and ocean sciences, sustainable land management, and technological advancement.”¹²⁹

The University of Hawai'i and the Mānoa campus are committed to advancing higher education in the 21st century by:

- development of global perspectives and interconnections
- responsible stewardship of land, water and other shared resources
- preservation and celebration of diverse ideas and cultures
- promotion of a spirit of collaboration and respect
- preservation and celebration of Hawai'i's unique spirit of aloha
- innovative use and development of practical and efficient technologies

(*Architecture Program Report*, March 2012, page 3, The University of Hawai'i at Mānoa, School of Architecture, Honolulu.)

¹²⁶ *Architecture Program Report*, March 2012, page 3, The University of Hawai'i at Mānoa, School of Architecture, Honolulu. (hereafter cited as *Architecture Program Report*, UHM SoA).

¹²⁷ *Architecture Program Report*, page 3.

¹²⁸ *Architecture Program Report*, page 3.

¹²⁹ *Architecture Program Report*, page 3.

Doctor of Architecture Program Review

The *Architecture Program Report* of March 2012 by the School of Architecture at the University of Hawai'i at Mānoa, stated its vision, mission, goals, core values and guiding principles in the 2010-2014 Strategic Plan of the School of Architecture as the following:

Vision:

- The School of Architecture emphasize on global connections.
- The School of Architecture inspires transformative design at the global scale with pre-eminence in the Asia-Pacific region.¹³⁰

Mission:

- Respond to the unique location in the Asia-Pacific region and recognizes the privilege and responsibility to address cultural, environmental, and social diversity.
- Commit to passionate and engaging community participation through teaching, learning, research, professional practice, and service.¹³¹

Goals:

- Integrate Asia-Pacific throughout the School of Architecture.
- The School of Architecture will be a recognized leader on campus, in the state and regionally, on issues of sustainability and environment design.¹³²

Core Values & Guiding principles:

- Knowledge, creativity, passion, environment, respect and community.¹³³
- Reflects the University and School values of “respect, sharing, engagement and innovation.”¹³⁴

Based on the *Architecture Program Report*, the history and description of the Doctor of Architecture program are summarized and shown in the following D.Arch. timeline:

¹³⁰ *Architecture Program Report*, page 5-6.

¹³¹ *Architecture Program Report*, page 6.

¹³² *Architecture Program Report*, page 7.

¹³³ *Architecture Program Report*, page 6.

¹³⁴ *Architecture Program Report*, page 3.

Doctor of Architecture Timeline

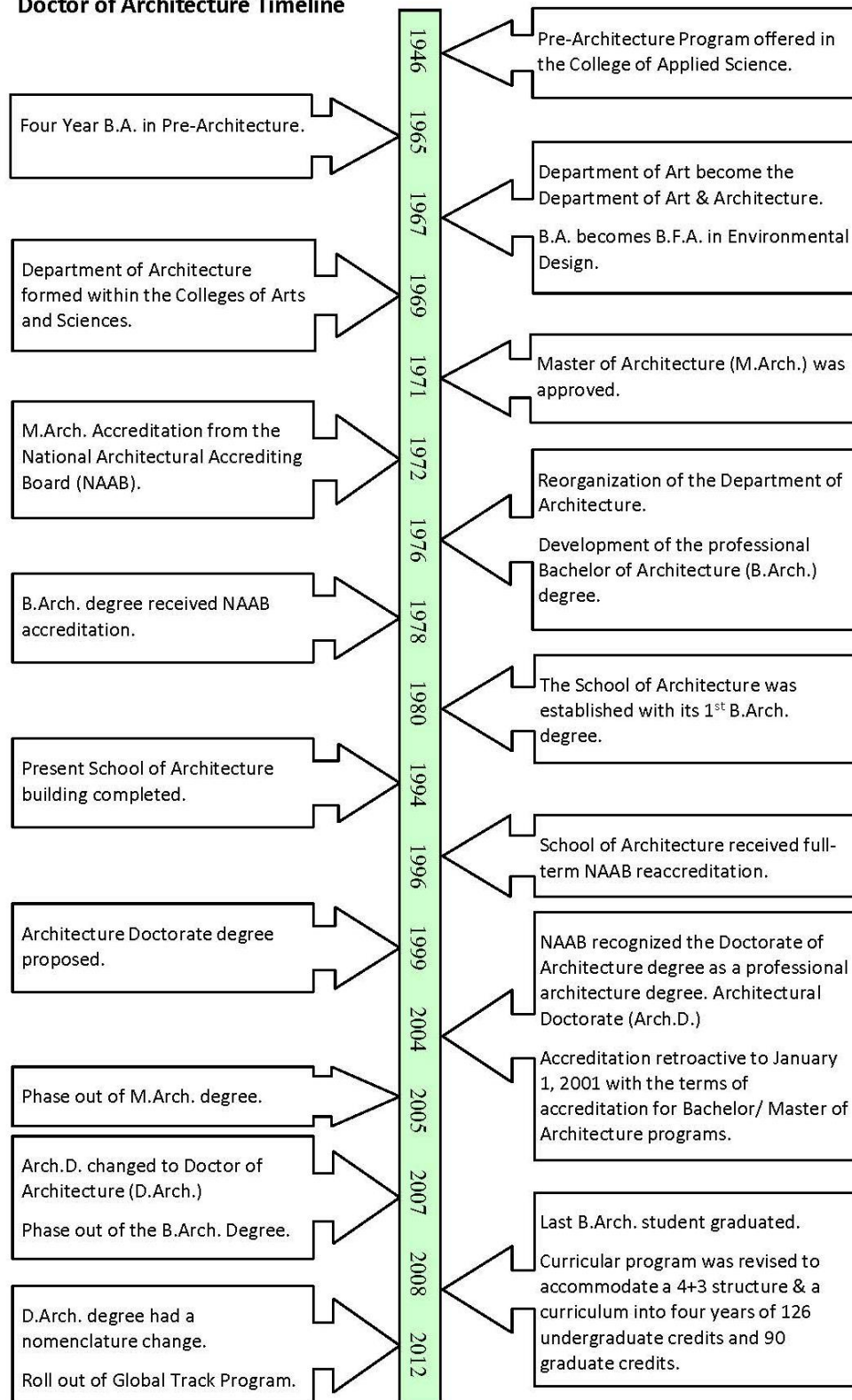


Fig. 2: D.Arch time line

Physical Location

The location of the D.Arch. program is the greatest strength of the school. Being “in the middle of the Pacific, midway between the U.S. Mainland and Asia, results in a diverse faculty and student body which cannot be found anywhere else in the world.”¹³⁵ The location of the program and its exposure of Hawaiian, Pacific and Asian culture provide “interesting opportunities for academic investigation, research and design.”¹³⁶ The University of Hawai'i at Mānoa and the School of Architecture aim to prepare students for the global practice of architecture in the 21st Century.¹³⁷ The School of Architecture believes the position of the program provides a “well-developed understanding of global culture and a well-balanced lifestyle...The school has capitalized on the unique opportunities that result from our unique identity and association between North America and Asia in the 21st century.”¹³⁸

D.Arch Professional Degree theories of curriculum adoption and Curriculum

As stated in the *Architecture Program Report*, “The professional D.Arch. program curriculum has been designed to include the knowledge and skill areas required to proceed from internship to licensure, including each area of expertise. The Professional Practice course and the Professional Studio included in the professional program specifically address the IDP, including application procedures.”¹³⁹

The D.Arch. curriculum includes professional practice and professional studio courses, emphasizing not only research and strengthening of the Asia-Pacific ties, but also to the development of initiatives in sustainability and environmental design.¹⁴⁰ The incorporation of the Professional Studio in the D.Arch. program provides a “monitored, research-oriented professional experience” for each student during the full semester Practicum. Students can pick to go to “an architectural firm, a community outreach project led by a practitioner/educator, or a special professional research project proctored by a research faculty member,” as part of their practicum.¹⁴¹ The goal of the Professional Studio is to better prepare students for the professional field they have selected.¹⁴² The School of Architecture stated “the program integrates course work with professional office practice and provides a capstone project of research and design. Future professionals from this program are well equipped to address regional architectural issues and the Asia Pacific arena.”¹⁴³

¹³⁵ *Architecture Program Report*, page 68-69..

¹³⁶ *Architecture Program Report*, page 3.

¹³⁷ *Architecture Program Report*, page 68-69.

¹³⁸ *Architecture Program Report*, page 68-69.

¹³⁹ *Architecture Program Report*, page 5.

¹⁴⁰ *Architecture Program Report*, page 7.

¹⁴¹ *Architecture Program Report*, page 52-54.

¹⁴² *Architecture Program Report*, page 52-54.

¹⁴³ “Student Overview,” University of Hawai'i at Mānoa, School of Architecture, accessed September 7, 2013, <http://www.arch.hawaii.edu/#student-overview>.

There are two NAAB accredited tracks within the D.Arch degree at UHM:

1. The 108 credit hour track for students with an approved undergraduate degree other than a pre- professional degree. An additional semester or two, consisting of 15-18 credits are required for those without a pre-professional degree.¹⁴⁴ (See appendix B : Doctor of Architecture Degree (D.Arch) 108 hour credits- without pre-professional degree)
2. The 90 credits hour track with an approved undergraduate pre-professional degree.¹⁴⁵ Applicants with a 120 credits pre-professional degree in architecture, or equivalents are eligible to enter the three year duration, 90 credits graduate level professional degree.¹⁴⁶ (See appendix A: Doctor of Architecture Degree (D.Arch) 90 hour credits- with pre-professional degree)
 - a. A dual-Degree Program with Tongji University is the newest subset addition to the 90 semester credit hour professional D.Arch program.¹⁴⁷ The Global Track- China Focus provides a unique experience in which students are able to study in both the United States and China. Students will receive a Master in Architecture from Tongji University's College of Architecture and Urban Planning in Shanghai, accredited by the National Board of Architectural Accreditation (NBAA) of China. Along with the Doctor of Architecture degree from the University of Hawai'i at Mānoa, School of Architecture.¹⁴⁸ (See appendix C : Doctor of Architecture Degree (D.Arch) 90 hour credits + Global Track China Focus)

Besides the two tracks and dual-degree program, the school of architecture also offers concurrent interdisciplinary certificates programs, such as the Historical Preservation Certificate through the American Studies department. D.Arch Graduate students can enroll as a concurrent student and take three core courses (9) credit hours + two elective courses (3) credit hours, that could be double counting as part of the D.Arch electives and a required practicum internship (different from the D.Arch Practicum requirement).¹⁴⁹ (See Appendix D: Graduate Certificate in Historical Preservation) Both NAAB accredited tracks “critically testing and expanding the definitions of, and relationships between the academy and the profession; using research as a basis for the grounding of design and as a primary means to expand

¹⁴⁴ “Student Overview.”

¹⁴⁵ *Architecture Program Report*, page 52-54.

¹⁴⁶ “Student Overview.”

¹⁴⁷ *Architecture Program Report*, page 50.

¹⁴⁸ “Student Overview.”

¹⁴⁹ William Chapman, e-mail to Amy Ling, September 28, 2013.

knowledge in the discipline.”¹⁵⁰

The program encompass one semester of professional studio, students are allowed to choose the practicum program during this semester. “The Practicum Program is a scholarly and research activity integrated into a professional office environment occurring in an off-campus location. The Practicum integrates theory, practice, and research in a comprehensive manner in a professional office study environment...and it is a goal of the course to engage in a critique and an expansion of how professional design may be conceived and practiced now and in the future. Emphasis is given to developing the core skills of leadership, critical thinking and cultural understanding.”¹⁵¹ The program also includes a completion of an individual Doctorate Project. The doctoral project spans two semesters and it provides opportunities for students to advances in architectural knowledge through analysis, research, scholarship, and design.¹⁵²

UHM SoA Technology

The UHM architecture school consists of a three story 32,000 square foot reinforced concrete structure with wireless internet access. Although all students are required to have their own computer laptop for course work, there is an IT laboratory hosting a few computers and scanners. Other equipment such as printers, large-scale plotters, laser cutters, a 3D-printer, and other highly advanced technology are available for students at a cost.¹⁵³

The school does not require students to obtain specific software skills besides technology requirements for various courses. For the past few years, an introductory Rhino and Grasshopper training is offered as an elective class, along with an introductory level course including trainings in Maya, SketchUp and Photoshop. The current D.Arch. curriculum offers many opportunities for students to explore massing and free form design. However, students usually need a certain level of technological skills and knowledge to communicate their design effectively. Design documentations and construction documentations are standard requirements for most of the studio courses and often students find it difficult to learn a new software while trying to meet other project requirements.

¹⁵⁰ “Doctor of Architecture: Overview,” University of Hawaii at Mānoa, Programs + Admissions, accessed April 21, 2013, <http://www.arch.hawaii.edu/#darch>.

¹⁵¹ “Practicum,” University of Hawaii at Mānoa, Programs + Admissions, accessed April 21, 2013, <http://www.arch.hawaii.edu/#darch>.

¹⁵² “Architecture (ARCH),” University of Hawaii at Mānoa, 2013-2014 Catalog, accessed September 8, 2013, <http://www.catalog.hawaii.edu/courses/departments/arch.htm>.

¹⁵³ *Architecture Program Report*, page 24.

Doctor of Architecture Student Questionnaire

The doctoral project focus on the development of a BIM Certificate Program for the Doctor of Architecture degree at the University of Hawai'i at Mānoa, School of Architecture program. The insights and experiences from current architecture students on the topic are essential to the project. The purpose of this questionnaire is to render a holistic understanding of the experiences and challenges facing the University of Hawai'i at Mānoa, School of Architecture students. The questionnaire was confidential and responses were anonymous. It took about 15-30 minutes to complete the questionnaire and the results collected were analyzed at a group level.

Students who were enrolled in Fall 2012 in two studio courses (Arch 541- the 1st graduate comprehensive studio course and Arch 544- the last graduate comprehensive studio course in the curriculum sequence) were asked to participate. Student questionnaires were collected during November of the Fall 2012 semester. Having a better idea of the expectations of the degree and the course, students were able to provide a more accurate response to the questionnaire. The questions were open ended and students were asked to describe their experiences with or perceptions of the architectural education and practice in which they were currently participating. Students from the two studio courses were chosen for the research because they represent the beginning and end of the D.Arch. architectural training.

Arch 541 is the first graduate comprehensive studio; it marks the initial formal training in the graduate program. This studio includes two categories of students; those with and without prior architecture education. For the next two years, students learn the necessary knowledge and skills preparing them for the architectural profession. Students take approximately two to three other studio courses before enrolling in Arch 544; the last comprehensive graduate studio course. Two years and four semesters later, most of these students have fulfilled the program requirements and entered the last phase of the D.Arch. program; the doctoral research phase. The student questionnaire consisted of the following questions:

Category, background knowledge & interests

1. What studio are you currently enrolled in?
2. What architectural software training have you received prior to your enrollment in this degree program?
3. What Architectural Software Training have you Received During to Your enrollment in This Degree Program?

Insights of architecture education and technology

4. In your opinion, do any of the above software training prepare you for real world practice?
5. What other software do you believe will help prepare you for the architecture profession?

Insights on technology education

6. What is your view on architectural education? Do you believe the D.Arch program provides education that reflects current architectural practice?
7. What are the knowledge, skills and trainings, which you believe students must acquire before graduating from formal architecture school?
8. What is your perception on the inclusion of technology training and its importance in ensuring your preparation for real world practice?

Doctor of Architecture Student Questionnaire- Analysis, Interpretations and Outcome

The results of the student questionnaire are presented and analyzed below on a question-by-question basis.

Question 1: What studio are you currently enrolled in?

Arch 541

A total of 35 were enrolled in the Arch 541, 33 of the 35 students were present at the time of the questionnaire research and a total of 19 students participated.

Approximately 60% of those who received the questionnaire responded.

Arch 544

A total of 10 were enrolled in Arch 544, 6 of 10 students were present at the time of questionnaire, and a total of 6 students participated, resulting in approximately 100% of those who received the questionnaire responded.

Analysis

Fewer students are enrolled in 544 architecture studio than 541. This was expected, as there are multiple requirements before students are allowed to enroll in 544. During the two year period between the studios, students receive various training in theory, history, systems, studio courses, etc. Around 54% - 60% from both classes participated and provided responses for the questionnaire.

Question 2: What architectural software training have you received prior to your enrollment in this degree program?

"Prior" training is defined as either self-taught or curricula enrollment prior to Arch 541 of the D.Arch program.

Arch 541

Participants who responded to the research, 68% had prior training in AutoCAD, 37% in SketchUp, 37% Rhino and 26% had no prior training in any architectural software.

Arch 544

Participants who responded to the questionnaire, 67% has prior training in SketchUp, 33% in AutoCAD, 33% in Revit, and 50% had no prior training in any architectural software.

Combined

From the combined total of both Arch 541 and Arch 544, 52% reported having prior training in AutoCAD, 38% reported having prior training in SketchUp, 24% reported having prior training in Rhino and 27% had no architectural software training prior to their D.Arch (the final 3 years) enrollment.

Analysis

The data above shows a shift in what software training trends between students who came in two years earlier have experienced prior to the program compared to those

coming in more recently. In general, those in the first studio course were more likely to have had prior experience in AutoCad, Rhino, Maya, 3dMax, Photoshop, Illustrator, and InDesign than those coming in two years earlier while those coming in earlier were more likely to have had either no experience or experience with Sketchup.

Although, fewer students were exposed to Revit and SketchUp before entered the program, as of 2012, more students entered the D.Arch program with prior architectural software training and more students entered the program with AutoCAD and Rhino training. This could be due to educators and students understanding the importance of basic architectural training before BIM related training.

Software	Arch 541	Arch 544	Combined
None	26%	50%	32%
AutoCAD	68%	33%	60%
MicroStation	5%	0%	4%
Revit	5%	33%	16%
From Z	0%	0%	0%
Grasshopper	5%	0%	3%
Sketch Up	37%	67%	44%
Rhino	37%	0%	28%
Maya	5%	0%	4%
3Ds Max	5%	0%	4%
Photoshop	21%	17%	20%
Illustrator	10%	0%	8%
InDesign	10%	0%	8%

Table 2: Training Prior to D.Arch Enrollment

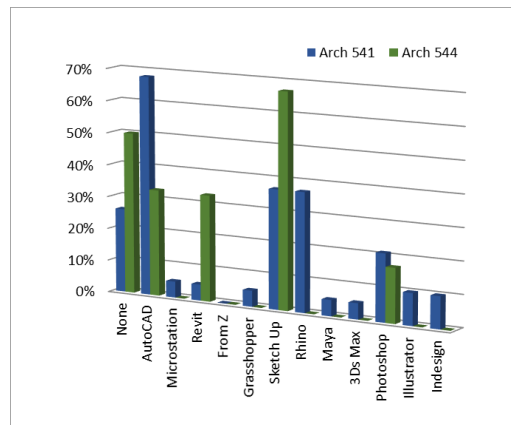


Figure 3: Bar Chart- trainings prior to D.Arch Enrollment.

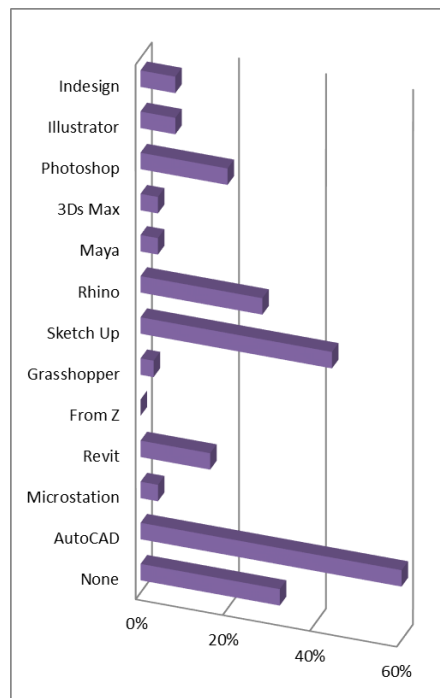


Figure 4: Overall Training Prior to D.Arch Enrollment

Question 3. What Architectural Software Training Have you Received During to Your enrollment in This Degree Program?

“During” Training is defined as either self-taught or training provided as part of the D.Arch program.

Arch 541

89% of the participants responded they had received training in Rhino during their enrollment in the D.Arch program, 84% in Revit and 74% in AutoCAD.

Arch 544

100% of the participants responded to receiving training in Rhino, 83% in AutoCAD, and 67% in Revit and SketchUp.

Combined

From the combined total of both Arch 541 and Arch 544, 83% reported receiving training in Rhino during their D.Arch enrollment, 69% in Revit and 66% in AutoCAD, followed by 48% in Grasshopper and 45% in SketchUp.

Analysis

During D.Arch enrollment, students appear to be exposed to training in Grasshopper and Revit followed by Adobe InDesign, Illustrator, Rhino and Photoshop. Whether self-taught or through program curricula, the data indicate a change of software exposure for students over the two years. Beginning students were more likely to have received some experience in Revit, Grasshopper, Photoshop, 3DsMax, Illustator, and InDesign. Students who were nearing the end of the program were more likely to have received training in Autocad, FromZ, Skethup, Rhino, and Maya. Rhino is the software that most students received during their D.Arch enrollment. Rhino and Grasshopper are the major software officially taught in one of the elective courses in the D.Arch program. Although, AutoCAD and Revit are not the most reported architectural

software training received during their enrollment in the D.Arch program, they are the top most reported software that are not officially taught in the D.Arch courses. With only 10% of the students reported receiving prior training in Revit and 69% reported receiving training during the D.Arch program.

Software	Arch 541	Arch 544	Combined
None	0%	0%	0%
AutoCAD	74%	83%	76%
MicroStation	0%	0%	0%
Revit	84%	67%	80%
From Z	5%	17%	8%
Grasshopper	63%	33%	56%
Sketch Up	47%	67%	52%
Rhino	89%	100%	92%
Maya	16%	33%	20%
3Ds Max	5%	0%	4%
Photoshop	42%	33%	40%
Illustrator	32%	17%	28%
InDesign	16%	0%	12%

Table 3: Training During D.Arch Enrollment

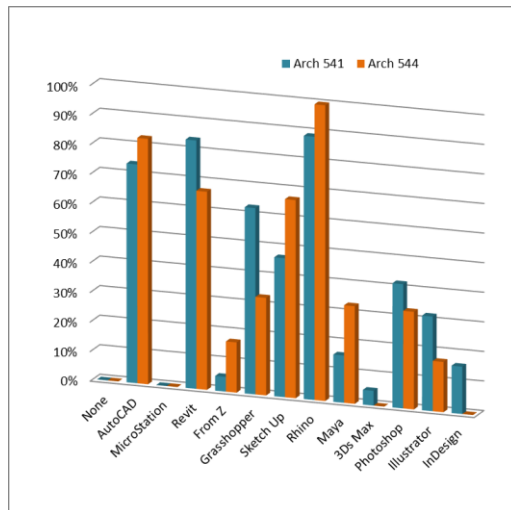


Figure 5: Bar Chart- trainings During D.Arch Enrollment

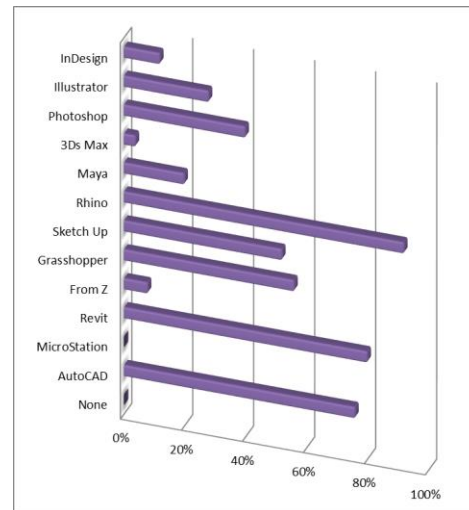


Figure 6: Overall Training During D.Arch Enrollment

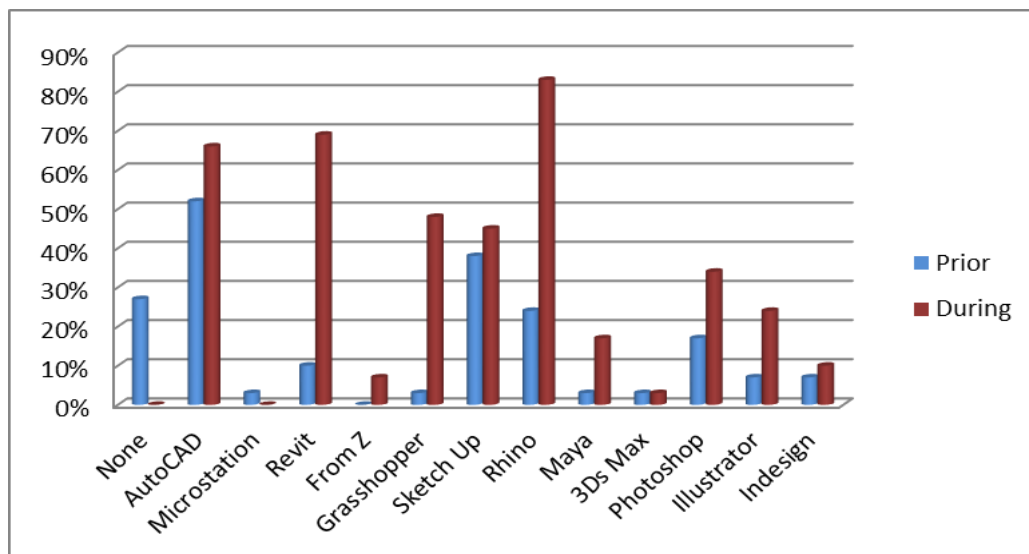


Figure 7: Architectural software training-Prior vs. During D.Arch enrollment

Question 4: In your opinion, do any of the above software training prepare you for real world practice?

Arch 541

95% of the participants listed AutoCAD as the software training that prepared them for real world practice, 89% listed Revit, 55% listed Rhino, followed by Grasshopper.

Arch 544

100% of the Arch 544 participants listed AutoCAD and Revit as the software training that prepared them for real world practice, followed by Rhino, SketchUp and Maya.

Combined

It is interesting in that both groups were fairly consistent in their beliefs about the importance of various software programs with the top listed ones consistent

1. AutoCad
2. Revit
3. Rhino
4. Sketchup
5. Maya

The interesting difference is that newer students were more likely to identify other software programs as important that were not at all mentioned by the students who were further along in the program (e.g. Grasshopper, 3D Max, Photoshop, Illustrator, InDesign). From the combined total of both Arch 541 and Arch 544, 83% and 79% respectively believe AutoCAD and Revit training prepares them for real world practice, followed by 45% in Rhino and 28% in SketchUp.

Analysis

Perhaps as students approach the end of their architectural training they increasingly become more aware of what's happening in the real world of architectural practice. Research results indicate an increased identification of Revit software training as helping prepare them for real world practice, followed by 5% increases in identification of AutoCAD and 1% in SketchUp.

A larger percentage of participants' indicated that AutoCAD and Revit are helpful in preparing them for real world practice. Those students closer to the end of the D.Arch program and closer to entering real world practice were more likely to conclude that Revit and AutoCAD type software reflect real world practice.

Table 4: Student Opinion: Software training that prepares for real world practice

Software	Arch 541	Arch 544	Combined
None	0%	0%	0%
AutoCAD	95%	100%	96%
MicroStation	5%	0%	4%
Revit	89%	100%	92%
From Z	0%	0%	0%
Grasshopper	32%	0%	24%
SketchUp	32%	33%	32%
Rhino	55%	50%	45%
Maya	11%	17%	12%
3Ds Max	16%	0%	12%
Photoshop	16%	0%	12%
Illustrator	11%	0%	8%
InDesign	5%	0%	4%

Figure 8: Student Opinion: Software training that prepares for real world practice

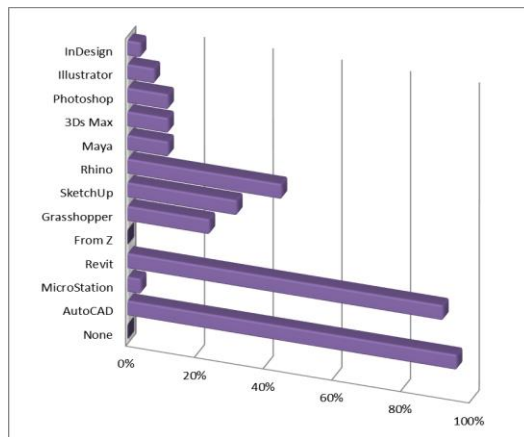
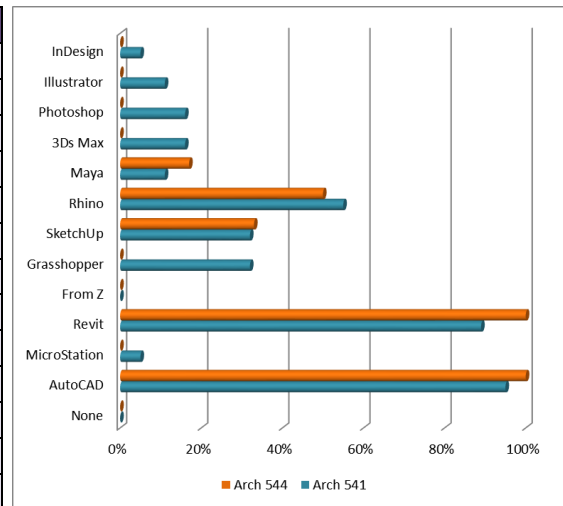


Figure 9: Combined student opinion- software training that prepares for real world practice

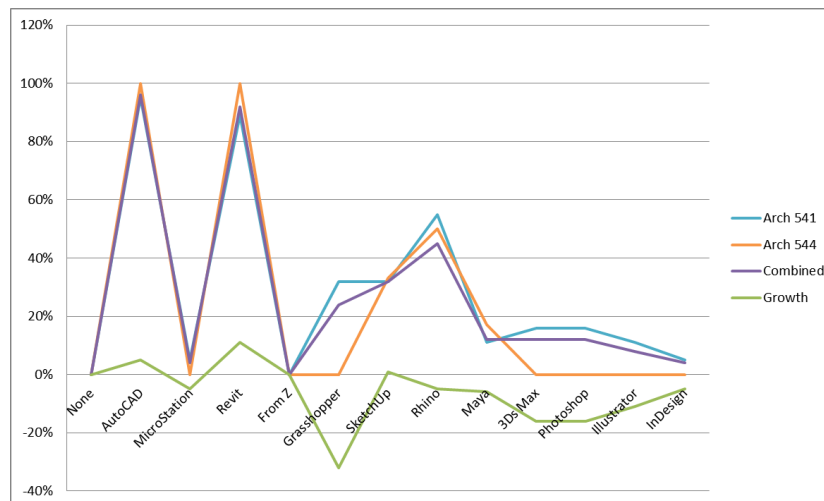


Figure 10: student opinion comparison- software training that prepares for real world practice

Question 5: What other software do you believe will help prepare you for the architecture profession?

Arch 541

Participants listed BIM (26%) as the top software training that they believe will help in preparation of the architecture profession. 21% of Arch 541 participants listed Revit, Photoshop and Illustrator as the other software, while 21% did not know what software would help prepare them.

Arch 544

Participants listed BIM (33%) as the top software training that they believe will help in preparation of the architecture profession. Arch 544 participants listed BIM, Revit and Grasshopper as their top choices, at 33% each. Followed by Photoshop, Illustrator, PowerPoint and other sustainability software at 17% each.

Combined

Both Arch 541 & 544 listed BIM as the top software training that they believe will help in preparation for the architecture profession.

Analysis

Most participants listed BIM as the other software training that would prepare them for real world practice, followed by Revit (21% and 33%). This result is interesting because Revit, SketchUp and FormZ (although neither of the latter two were

Software	Arch 541	Arch 544	Combine
Don't Know	21%	0%	16%
AutoCAD	11%	0%	8%
MicroStation	0%	0%	0%
Revit	21%	33%	24%
From Z	0%	0%	0%
Grasshopper	11%	33%	16%
SketchUp	0%	0%	0%
Rhino	0%	0%	0%
Maya	11%	0%	8%
3Ds Max	5%	0%	4%
Photoshop	21%	17%	20%
Illustrator	21%	17%	20%
InDesign	16%	0%	12%
PowerPoint	11%	17%	12%
BIM	26%	33%	28%
Sustainable	5%	17%	8%
GIS	11%	0%	8%
3D software	5%	0%	4%
3D scanning	5%	0%	4%
Microsoft	5%	0%	4%
Data Manage	5%	0%	4%

mentioned at all by respondents) are considered subsets of BIM software. It is unclear if the participants understand the definition of BIM and the differences between various BIM software components.

Table 5: Student Opinion: Other software training that prepares for real world practice.

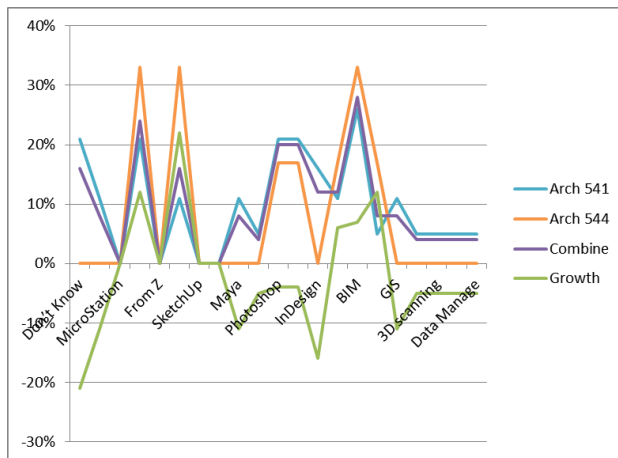


Figure 11: Student Opinion: Other software training that prepares for real world practice

Question 6: What is your view on architectural education? Do you believe the D.Arch program provides education that reflects current architectural practice?

Arch 541

“Architectural education is complex. Much of it must be self-sought and self-taught. Learning how to learn, think critically, ask questions, generate solutions, design, etc. Yes, the program reflects these practices.”

“No, the program does not reflect entirely of the architectural practice, mainly for the reason of having to be self-taught and referencing solutions through online tutorials.”

“Not entirely. The only studio that focuses on professional practice is practicum. The other 6 years of studio is full of *self-discovery*.”

“Yes, I believe the D.Arch program shows connection to relevant design of the moment.”

“Yes, but I would like it to be more practical and based on actual practice, not concept design.” “I think the D.Arch program prepares us in the context of understanding some of our most potent interests. It doesn’t and should not prepare us specifically to work in the profession. Each firm operates differently, we must simply be prepared to adapt.”

“Yes, I believe it is extremely relevant to modern challenges of sustainability and world

relationships.”

“yes, D.Arch provides critical thinking real life situations, and reflects some of the practice. However there are things that student aren’t able to learn in school only, ie. Initiative, appreciation, communication, clientele.”

“yes, the D.Arch program provides education that reflects current architectural practice, though I wish I was introduced to more programs in the first 4 years, we are just learning Revit now in 5th year.”

“No, during this program I have learned many things about design, but the majority of things I will need is how to actually manage a construction program have yet to be taught. I am not competent enough to start to finish on a design yet.”

“Yes, but too short for learning architecture program. Sometimes very confusing.”

“Yes.”

“Yes, the program reflects the current architectural practice. – focus on code issues is important – how to get the permit from city and county for a project- the administrative part is important.”

“I feel that the school provides enough of a base for students to get their “foot in the door.” The education may not be complete, but it’s enough to start working for a firm.”

“Depends on what you want to do. I worked at a firm that didn’t design too much, so programs like Rhino + Grasshopper weren’t necessary. Revit is a must learn.”

“Yes and no. Architectural practice is diverse, not one education can prepare for all possible practice environments.”

“I believe that this degree is highly valuable but even if it can get us a job, I don’t think we are taught the right things or enough structures.”

“Yes, there is a balance between hand and computer work, which are both equally important. As well as structural importance and design approaches.”

“I don’t know if the D.Arch program provides education that reflects architectural practice. I have no had any experience in a current architectural practice to compare

it to.”

Arch 544

“No, it’s missing how and when these programs become important.”

“I think the D.Arch program is continuously improving in terms of the classes it offers. The idea of having a practicum would be beneficial for me as well. However, I think we should have a paid structural professor to help us in studio projects like in the real world. This way we learn more about how structures are applied in our designs.”

“No, I do not think the program trains us properly for the real world because the instructors spend more time lecturing and talking than actual exercises in learning the materials and using the computer programs more.”

“I think this program does not give enough training in technical areas (i.e. structures) and not enough in presentation layout and rendering.”

“no, because it does not mimic the realities of practice and importance of communication in architecture/ articulating/ working with other industries.”

“yes- D.arch program provides good education, but it is the responsibility of each student learn seriously of the information received in the classrooms.”

Analysis

10 of the 19 participants from Arch 541 provided a positive response or indicated that they do believe the D.Arch program reflects current architectural practice; 3 of the 19 provided a negative response or indicated that they do not believe the D.Arch program reflects current architectural practice, while 6 of the participants provided a neutral response.

1 out of the 6 participants from Arch 544 provided a positive response or indicated that they do believe the D.Arch program reflects current architectural practice, 3 of the 6 provided a negative response or indicated that they do not believe the D.Arch program reflects current architectural practice, while 2 participants indicated a neutral response.

A few responses indicated that there is conflicted view on how much of the self-taught, self- sought and self-discovery should take place in architectural education. Most agreed no one education could teach all the necessary skills required to become an architect, but most did mention they believed the program needs to include and address real world practice and real world situations that help train students in order to gain

confidence and be able to adapt to the changes in the profession. Other comments included the needs for more in-depth lessons on structure, presentation, layouts, materials and other technical skills.

Question 7: What are the knowledge, skills and trainings, which you believe students must acquire before graduating from formal architecture school?

Arch 541

14 out of 19 participants (73%) believe technology or software skills and trainings must be acquired before graduating from formal architecture school.

Arch 544

5 out of 6 participants (83%) believe technology or software skills and trainings must be acquired before graduating from formal architecture school.

Combined

76% of total participants believe technology or software skills and training must be acquired before graduating from formal architecture school, followed by teamwork or collaboration skills and leadership skills. Other skills mentioned:

- Communication
- Organization
- Time management
- Structures
- Digital design
- Presentation
- Environmental Stewardship
- Problem solving
- Society Responsibility
- Teamwork
- Code issues
- How to get permits

Analysis

Clearly, participants believe that Technology/Software skills and training are essential to acquire before graduating from architecture school, followed by skills in teamwork and collaboration and leadership. Being able to communicate effectively, time management and project organization are among other skills that participants mentioned.

Most Common Responses	Arch 541	Arch 544	Combine
Technology/Software	14	5	76%
Teamwork/Collaboration	9	3	48%
Leadership	7	0	28%

Table 6: Student Opinion: Knowledge, skills and trainings students must acquire before graduation

Question 8: What is your perception on the inclusion of technology training and its importance in ensuring your preparation for real world practice?

Arch 541

"It must be included. 20 years ago it was hand drafting. Now it is computers to do everything. The industry is going digital; we MUST be prepared and competent."

"Technology training should be included in the D.Arch program because it provides a tool for expressing and fabricating designs, whether in school or in practice."

"it is probably important on some level but we can learn the programs anytime we want even w/out school- quote "don't go to school to learn computer programs. Go to school to learn how to do what paladins did."-Peter Eisenman."

"Technology training should be included in the D.Arch, but also be available when students ought to learn them and NOT BE EXPECTED TO HAVE LEARNED THEM."

"I believe technology is important in architecture but not absolutely essential. What is essential is people who can properly communicate what is in their head and understand design."

"Tech training should be included because it opens up more creative opportunities." "Technology= The Real World."

"Technology literacy is fast becoming a basic requirement in every part of life and the architectural field is no exception."

"It is very important to open doors but I also feel it can pigeon hole you into a back room of the office and miss design and collaboration."

"Some is taught but is not used or emphasized enough."

"Technology should be included because the D.Arch is a professional degree, not a philosophical degree."

"Technology should be included in the D.Arch program because we are growing/living in

an age of technology that is constantly changing/upgrading. "How do we (architects) keep up in this world?"

"Should definitely be included- necessary for successful career in the job world."

"It feel that it is very important to include technology training because it appears that most firms are moving towards technology. By knowing various software it will be easier to market ourselves or adapt to practices already occurring."

"Technology training should be included but should be given in more depth with what the programs can actually do."

"Technology training should be included in the D.Arch program, because it is the future of architect's/ architecture offices; stay competitive!"

"Should be, b/c as the world moves faster, we need technology to keep up."

"Technology training should be included because architecture keeps changing technologically."

"Technology is important in our education. Programs like Revit speed/ add time to the design process, also gives you more opportunities to start working at firms."

Arch 544

"Yes, technology training is highly important and should be pushed more but most of the instructors don't know BIM and don't push it because of the aversion to it, we need to be as proficient as possible in all programs most architects use."

"Technology training should be included in the D.Arch program because it is an important part of the industry. It helps us to communicate design... and get a job."

"T.T. should be included because it's essential to working today, I don't think I would get hired if

I couldn't run any of the software."

"Technology is the driving force for employment today. I think it's important for us to put that as a "must" for education."

"Technology training should be included in the D.Arch program because it is part of our

design communication and it will never go away. It will only get more and more advanced, therefore, students and professors must be aware of what technology is available today and in the future.”

“It’s important, but is not the most important topic. I have noticed that most of the students don’t know nothing about hand drawing and visualize the architecture more as a business than a career.”

Analysis

18 of the 19 participants from Arch 541 provided a positive response or indicated that they do believe the inclusion of technology training is important in ensuring preparation for real world practice. 1 of the participants mentioned that although it is important, technology could potentially “pigeon hole” the design. Another participant mentioned that schools should not only provide technology training, but also teach students how to apply the training.

All 6 of the 6 participants from Arch 544 provided positive responses or indicated that they do believe the inclusion of technology training is important in ensuring preparation for real world practice. One of the participant also mentioned that although it is important, it is not the most important topic, but most provided responses that indicate technology training is essential to architecture profession.

Analysis, Interpretations & Outcome

The results of the student questionnaire demonstrated that technology in architectural education is continually changing; in even just a short two years between these two groups of participants, the prior exposure to architectural technology demonstrated this difference, lower level students (newer to the D.Arch program); generally seem to be more aware of BIM technologies and have a higher chances of having some experience with BIM software comparing to those who are in the higher level (had been in the D.Arch program longer). This shows BIM technology are progressing and becoming increasingly popular, students also see the value in obtaining such skills and have been exploring towards the directions of BIM implementation and practices.

It is clear that both groups believe technology training is an essential part of architectural training. Most participants indicated technology training is important to acquire before graduating from architecture school; they believe the inclusion of technology training in architecture education will ensure preparation for real world practice. From the questionnaire results, most of the participants believe BIM software training would help prepare them for real world practice. This calls for the program to provide more opportunities in which students can obtain BIM and software knowledge before graduation.

Practitioner Interview

This doctoral project focuses on the development of a BIM Certificate Program for the Doctor of Architecture degree at the University of Hawai'i at Mānoa, School of Architecture program. The insights and experiences from active BIM practitioners reveals essential views relating to the topic. The purpose of the interview renders a holistic understanding of the real world architectural practices and challenges, particularly relating to architectural technology and BIM.

The Practitioner Interviews are conducted during the Professional Studio-Practicum course in Spring of 2013. Interview participants include BIM practitioners of a major architecture firm with more than 300 employees, and practitioners from multiple architectural specialties and focuses were interviewed. Each interview took 30-40 minutes. The interview is based on purposive sampling within the practicum firm; focusing on practitioners with more than 5 years of actual BIM practice experience, whom currently serve as leaders and mentors within the firm. To demonstrate participants' credibility while ensuring confidentiality, the name of the architectural firm are kept confidential and interviewees' real name are represented by numbers, and their real name will not be revealed. However, a brief description of their practice experiences and positions are included in the interview responses.

As previously mentioned, BIM is a process and Revit is the tool.¹⁵⁴ However, since Autodesk Revit Architecture is the common BIM software choice and also the choice for this practicum firm, therefore, from here in, BIM and Revit represent and reflect each other in the sense of implementations and process methodologies. The interview questions includes the following.

BIM Practitioners

Background:

1. Please describe your background. (Example: architectural education, work experiences & focuses, how long you've been with this firm, how many firms have you worked before joining this current firm, what is your main job descriptions currently, etc.)

BIM's Pros and Cons:

2. What are the Pros and Cons for this firm to use BIM as a project methodology?

BIM and Firm's BIM Practice:

3. What are the firm's current BIM struggles if any?
4. What are the common struggles for new BIM hires at this firm?
5. To ensure efficient work flow, as the firm's or project's BIM manager, what

¹⁵⁴ Phil Read, Eddy Krygiel and James Vandezande, *Mastering Autodesk Revit Architecture 2013* (New Jersey: John Wiley & Sons, 2012), Kindle edition, location 579.

are your recommendations to the employees working on current BIM projects?

6. What are the firm's current BIM strategies in keeping employees up to date?
7. What are the firm's standard/guidelines? Are these referencing any established BIM guidelines from the profession?

Obtaining BIM Skills and Practices

8. What are your recommendations on BIM management Best Practices?
9. Besides the typical BIM modeling skills, what other essential skills and knowledge are necessary for ensuring an effective BIM project?
10. Besides the resources provided by the firm, what other recommended resources would greatly improve the BIM skills and knowledge of current and future employees? Could you share a few of your personal favorite BIM resources (websites, books, organizations, articles and literatures, professionals, etc.)?
11. What are your recommendations for aspiring students who are interested in entering the BIM profession?
12. In your opinion, what is the best approach/sequence in teaching BIM skills?

BIM Practitioners Interview

Question 1: Please describe your background. (Example: architectural education, work experiences & focuses, how long you've been with this firm, how many firms have you worked before joining this current firm, what is your main job descriptions currently, etc.)

BIM Practitioner 1

A BIM Manager, BIM Practitioner 1 graduated from the 6 year B.Arch program at the University of Cincinnati. The program included internship opportunities. The current firm he is working for was one of the firms he interned at while pursuing his architectural education. He also has experience working in the Washington, D.C. and San Francisco area. By 2002, he returned to this firm and has been here since then. He is currently involved in the construction development and construction administration phase of a current project. The current project is his first Revit project which implemented Revit from the early design development phase.

Although, he has experience working with software such as ArchiCAD, some 10 years ago he did not have the opportunity to experience BIM capabilities that are available with current BIM software. However, his previous experience exposed him to the ideas of collaborative file sharing and 3D elements. With 10 years of experience at the current firm, he is able to give some valuable insights in regards to BIM implementations, managements and approaches..

BIM Practitioner 2

A BIM Manager for one of the highest budget projects in the architectural firm, BIM Practitioner 2 graduated from New York Institute of Technology in 1997 with a B.S. in Construction Management and worked in New Jersey focusing on Educational Design. He returned to New York and obtained his five year B.Arch degree from New York Institute of Technology. During his pursuit of this degree, he worked for several large size architecture firms focusing on healthcare architectural design, which is still his current focus today. He later worked for two other large scale architectural firms before working for the current architecture firm. He has been working at the current firm for the last 2 years.

He started working with BIM seven years ago, but did not have the opportunity to fully utilize BIM until he began working in healthcare design projects. He quickly noticed the technology allowed for greater coordination between Architect, Owner and consultants, and that provided the opportunity for him to utilize BIM. He saw that the software provides Architects with a robust platform to do many things (scheduling, take off, clash detection, energy analysis, etc.). He understood early on that with BIM as with all software, one has to learn how to do it efficiently and he put all his effort into learning how to implement the software efficiently.

During his healthcare design phase, he worked as a Medical Planner, Project Designer and

BIM Manager. His skills in BIM grew and his work using BIM became an integral part of the firms he worked for. The transition into BIM and credibility as an expert in BIM was validated when he began teaching BIM/Revit at City College of New York, in the Bernard and Anne Spitzer School of Architecture in the Fall of 2012, where he continues teaching today.

BIM Practitioner 3

This practitioner is firm-wide CAD/BIM Applications Manager as well as a senior associate for an overseas section of the firm. Practitioner 3 is pushing for Revit/BIM implementation for his firm. He earned his B.S. of Architecture and M.Arch from the McGill University at Montreal in 1981 and earned the Dipl. Arch from Kyoto University, Japan in 1983. He previously worked at five other architectural firms and opened his own firm in Vancouver, Canada in 1990, before joining his current firm in 1998.

Question 2: What are the Pros and Cons for this firm to use BIM as a project methodology?

BIM Practitioner 1

The firm at the current location has eleven studios and each studio works independently with its own BIM managers focusing on specific architectural service types. The firm is focusing on finding ways to combine Revit resources, minimizing redundancy during various project phases and maximizing the BIM process efficiency. BIM coordination is a notable asset. Beginning with good habits and careful initial set up of the project, BIM has the ability to coordinate between plans, elevations, details and other drawings sets. It also provides greater efficiency within the team, firm and with consultants. With a few clicks, sections are cut and other functions are easy to implement. These functions could reduce potential errors. Building commissioning and facility management are other great BIM assets that could benefit the firm. The current industry is pushing for BIM and this firm will see the feasibility in its BIM projects.

Although, BIM has many assets, it is not perfect. Using BIM could present difficulties in ensuring all team members being at the same competency level, or in effectively producing drawings while meeting variance requirements in a fast paced setting, such as most healthcare architectural projects. In order to keep a smooth design project workflow while maintaining project schedule, it is also common to keep two separate files for different sets of documents for variances requirements, but managing and coordinating parallel file sets could be an immensely difficult task. A way to resolve these issues is to keep staffing and training at the same level. But due to the nature of the learning curve of Revit, it is difficult for every team and its members to take full advantage of all of the features of Revit. Another issue is that training might teach one to learn how to use Revit, but one still needs to work in an actual project in order to learn various functions necessary to effectively implement BIM as a deliverable. This process from training to practice takes time and it's often difficult for fast pace firms during the transitional time.

BIM Practitioner 2

For this firm, having a central source of “Information” that pertains to the project is an asset of BIM implementation or using Revit as a tool. Architecture and constructing a building is more than simple floor plans. While there is a graphic part of architecture, there is also the information (specs, materials, documentation) and BIM combines both of these aspects into a useable data base. In return this provides young architects with an opportunity to understand the whole building process faster, which has the potential to create better architects.

The down side of the software is the illusion that everything is modeled (Idea of 3 dimensions X,Y,Z). Modeling is the creation of data that you can test. Revit allows the user to model architectural details for every little thing, and when you do that, you end up potentially losing time and the outcome can be an unprofitable result.

BIM Practitioner 3

The benefit of using BIM as a project methodology includes better coordination, visualization, early understanding of building components, better quantification and scheduling, the ability to imbue elements, components, groups with any amount of data and data linkages.

The down side includes the difficulties experienced in the common transitional period which the firm is currently experiencing. There are difficulties developing BIM skills, learning new project workflows, project staffing, contractual arrangements, and managing client and consultant expectations. The greater reliance on computers and programs often means that other traditional skills are neglected like hand sketching, mental computation, etc.

Question 3: What are the firm’s current BIM struggles if any?

BIM Practitioner 1

The firm’s current practice resources and sharing capabilities are not quite at the level that I am hoping for just yet. The firm has a Revit distribution group email, in which one could reach out to their peers for further support and suggestions. Even with the peer support in place, the firm will need to continually explore better ways to upload and standardize resources and make these information available to everyone and minimize redundancy during the project delivery process.

BIM Practitioner 2

The firm struggles in two areas when it comes to BIM implementation. One, the firm’s lack of BIM users or better yet lack of experienced BIM users, and secondly, hesitation and resistance from other staff thinking BIM is a fad and/or will devalue what an Architect offers. These two extremes create some struggles when it comes to BIM implementation.

BIM Practitioner 3

The firm is still in varying stages of transition and implementation in various studios and offices throughout the firm. This uneven pace is difficult to manage. Like many other firms, this firm is struggling to leverage their BIM skills both in terms of project productivity and project profitability. BIM allows many opportunities for enhanced services as well as a greater range of services which we have yet to really take advantage of. Conversely, some project managers and project proposals may be promising a little more than we are currently able to deliver. It is also difficult to find engineering consultants who are at a comparable level of BIM implementation and this slows down the BIM progress.

Question 4: What are the common struggles for new BIM hires at this firm?

BIM Practitioner 1

The firm is currently transitioning all its projects to use Revit as the deliverable and the struggles between new PE BIM hires and current employees are not that different. The collaborative differences of using Revit in a school setting or when used individually vs. using it collaboratively as a team is the biggest struggle.

Individual users generally have a good understanding of the modeling tools and the way things are set up in Revit, but the whole idea of using work-sets and making what you've done and created in Revit available for others could be a difficult concept to understand for individual users. Revit team collaboration is a different approach to things, something that you would not encounter in schools, training or tutorials. Real world settings and actual project participation is required to realize the power of Revit, in which multiple people working on the same file and same area of the building; altering one element in a view within Revit will forever alter the whole project. One of the common practice issues for new firm BIM hires is when he/she is forced to address it when participating in an actual team project.

BIM Practitioner 2

The common struggles are not knowing the office standards (which does not only apply to Revit/BIM) and the lack of architectural construction knowledge. In AutoCAD, when you draw a line to represent a wall, if it is done wrong, there really is no impact to the model. In the world of BIM, there is a live impact because it impacts something that is happening in the model, whether its repeat information or a wall pushes through a floor above because its limit is incorrect. Hence, it is important to have the basics of architecture and construction to effectively implement BIM.

BIM Practitioner 3

We don't as a rule (at least here at this location) make any "BIM hires". We look at the complete range of skills and proficiencies, which must include BIM skills as a matter of course. Hence, our

hires come in ready and able to work in a BIM environment.

Question 5: To ensure efficient work flow, as the firm's or project's BIM manager, what are your recommendations to the employees working on current BIM projects?

BIM Practitioner 1

Managing file sizes, and keeping track of the number of people working in the same file simultaneously is very important. Trouble shooting between hardware and file management is one of the common tasks with large group projects. Separating the core, shell and fitout (with equipment attached) model for Revit projects would help. However, fitout and equipment should not be separated, because there could be things that are associated with each other and will cause issues when separated. The keys to ensuring efficient BIM project workflow lies in the balance and break between what should be separated and maintaining group sizes.

These settings are largely driven by individual team structure and the distribution of Revit members in various files. Having a large difference in staffing distributions between various Revit files that belong to the same project is not recommended. A bad distribution of Revit members would be having two people in one file while having ten people working in the other file. It is also best to avoid having members switching back and forth between files, since moving file to file could be a time consuming task.

BIM Practitioner 2

Having a solid "BIM Matrix and Execution Plan" are the keys for ensuring efficient BIM project workflow. Similar to completing any tasks, the first step is having an outline or place to start. Both of those documents allow a project team a source to refer to when they have questions on what to model and what the expectations are. In addition to that, one should find tutorials or documentation on how to create various elements, an open forum where people share their experiences using Revit is another good tool.

BIM Practitioner 3

Keep on advancing your BIM skills. There's a wealth of resources freely available and team members should consider advancing those skills as part of career development. Communication at every level is a key component of any BIM project: formal/informal, between team members, inter-office, with other firms, with consultants, etc.

Question 6: What are the firm's current BIM strategies in keeping employees up to date?

BIM Practitioner 1

The firm is transitioning to using Revit for all its future projects. When it comes to evolving software practices, this firm avoided having to evolve as much compared to other firms who

have already transitioned to Revit. Most of the firm's Revit members have already been using Revit, learned it or are learning it through Revit project participation. The firm does provide two kinds of training. One is the general training; which takes place every month and covers different software techniques and how it relates to Revit implementations. The firm is beginning to offer specific trainings tailored to specific groups. Specific group examples include but not limited to: designer trainings focusing on massing, schematic, and façade development; Interior designer trainings focusing on scheduling and other tasks; Project manager trainings focusing on staffing and deliverables.

BIM Practitioner 2

The firm currently is focusing on training and getting the firm to adopt the BIM culture; understanding that BIM is the next step in Architecture, and by doing this, the firm will be moving forward in being innovative with design and technology.

BIM Practitioner 3

The firm offers two or three day basic training for existing staff who are transitioning to BIM. New employees who are assumed to have BIM skills are assigned a BIM mentor, who may or may not be on the current project team. Other in-house technical seminars on single topics occur on an office or studio basis and are often carried firm-wide via webinar.

The firm also strives to keep current information available on the firm's intranet system. The intranet discussion forum and the Revit User email distribution list. A Revit Steering Group, comprised of BIM leaders throughout the firm, discusses current strategies and helps envision short- and long-term goals in boosting skills and techniques. Currently, the firm is negotiating a contract with the Autodesk reseller to provide the firm with a broad assessment of their current procedures. The firm is hoping that this will help boost the depth and quality of the BIM implementation throughout the firm.

Question 7: What are the firm's standard/guidelines? Are these referencing any established BIM guidelines from the profession?

BIM Practitioner 1

Currently, the firm has its own file set up, templates and families. These are located in the firm's server resource drive and are available to all employees. The firm also developed their own families and components developed by previous projects and could be reused for other projects. Employees should utilize these folders to submit recommended standards, guidelines and references. The submitted information will be reviewed and standardized according to various situations. A Distribution group email is also available. BIM/Revit members could seek answers and advice among other firm Revit peers. Online forum and help sites are the first line resources. Sites such as www.revitcity.com, www.forums.autodesk.com, www.youtube.com and google searches.

BIM Practitioner 2

The firm based its standard from the National Standards for BIM, AIA and other organizations, but due to the differences of each project's contract and project type, currently there isn't a standard that applies to all projects.

BIM Practitioner 3

The firm's Revit Project Templates embody all the current graphic standards as well as BIM-related model, view and sheet organization standards. These were originally built off of the existing Firm's CAD standards, and continue the same drawing practices. If both an AutoCAD team and a Revit team are following the firm's standards, it is very difficult to look at a construction drawing and tell which team did what.

The firm's CAD/BIM standards follow for the most part the National Cad Standards (NCS) in the current version (v5), with varying practice between studios or offices. The firm nearly always favors the NCS version when arbitrating the best standard to follow.

For the BIM workflow, there are several emerging BIM guidelines for various parts. In addition to the drawing organization and drafting standards of NCS v5, the firm also pays attention to the National BIM standard which deals primarily with the BIM process, and how the BIM project teams interact with one another. The most practical part of NBIMS v2 is Chapter 5, and in particular Section 5.2, where discusses the BIM Execution Plan. This section is based on the Penn State BIM Execution Plan; the firm's practice is based on the Penn State model document. For Revit family development, the firm references the Autodesk Revit Model Style Guide v2.1, which is available on Orchard. In addition to the above, there are many reference documents in the Revit Resources section of firm's intranet which any BIM user should be consulting for the current standards for BIM modeling, BIM project management, BIM consultant coordination, etc.

Question 8: What are your recommendations on BIM management Best Practices?

BIM Practitioner 1

When it comes to BIM management best practices, it is better to stay away from modeling everything as a 3D element in Revit. Caution in modeling in 3D should be taken, because it is easy to over model and do extraneous work that drains the project budget and prolongs project schedules. It is better to model as much as possible only when it is justified. 2D annotation work should be limited and embedding details should only appear at the fine detail level. Most people might think ceiling plans are only useful in a 2D view, but because elements such as lighting might require ceiling hosts, elements such as ceilings should be modeled as a 3D object. By approaching this correctly the first time and having the understanding of how things are set up in Revit, one might practice efficient BIM management.

Do not model things in details. How detailed an element should be modeled could be determined by thinking how often the element will be referenced in drawing sets. If the element will only be visible once within the project, it is then not worth making a 3D model of it. However, with objects that are location based or ones that contain typical details, it's best to embed them in the 3D model as much as possible. In situations in which the element only requires representations within a view, it is best to create an invisible 3D element composed of 3D views, using 2D lines to create a Revit family containing a plan, elevation, RCP and section view. A good example of this is 3D furniture when the furniture does not need to be visible in the 3D view, but a 3D representation of the furniture is required in other views. These could be modeled with an invisible 3D element which is composed of 2D views with embedded information of the family and that will help keep things organized and could keep a smaller file size.

BIM Practitioner 2

Effective BIM management and best practices of having well created documentation, material and sources will allow for better overall BIM practice. Using those sources consistently helps to develop and allow the practice to evolve at a faster rate. Being aware of the common bad practices is a good direction towards better practices. Continually informing staff of the proper way to do things within the software and provide good explanations of why it has to be done in a certain way will help staff to understand the issues and problem fully, hence with the possibility of more effective BIM management. Each organization has its own standards and reason for those standards. Incorporating National Standards with firm standards will allow the team to develop and tailor a Best Practices reference guide for a particular project.

BIM Practitioner 3

The firm's current Best Practices are found in the two Best Practices documents found on the firm's intranet.

Question 9: Besides the typical BIM modeling skills, what other essential skills and knowledge are necessary for ensuring an effective BIM project?

BIM Practitioner 1

Understanding the 3D spatial sense when using Revit, realizing that unlike 2D CAD, Revit requires deeper understanding of spatial and the interconnected nature of the program. It is important for one to understand the consequences of adding, deleting or moving something in Revit and the ripple effect it can cause within the model. For example, deleting one element in the detail view might delete the element in all other views. Moving a wall in one view will move

the wall in all views and the wall is no longer in the correct location in the project.

It is necessary for Revit users to have better understanding of construction and how things fit together in the construction process; how different elements meet and connect, how they are composed, and the sequence of the construction. Revit should be modeled as the building will be constructed in real life, so that by understanding the layers of a wall and how it connects to a slab, one could model these elements correctly in the first place.

Understanding drawing sets and sheet setup is another essential type of knowledge. One should learn to think the sequence of plan, to enlarged plan, to detail plan, because all information exist in that view has a bidirectional relationship with other views. To prevent losing information, it is important to pay attention to the progression sequence from set to sets; one should be consistent and ensure everyone is on the same pace and work in a logical way.

For Project Managers, it is important to understand Revit production, time management, project scheduling, and organize the team according to the needs of Revit workflow which is different than CAD. Project managers should be familiar with the program enough to have the understanding of project time management, Revit tasks and how much can get done in the team.

BIM Practitioner 2

Continuously look for multiple, better or alternate ways to do the same thing. While you want to be consistent and not deviate, software like Revit allows you to take something built with a primary concept and use it in a different manor, such as using rails to do egress calculations, using curtain walls systems to do custom facades, etc.

Besides the typical BIM modeling skills, other essential skills and knowledge necessary for ensuring an effective BIM project include basic modeling technics such as massing, extrusions, etc., and understanding Excel and conditional formatting to take full advantage of scheduling as well as parametric capabilities of Revit/BIM, Construction knowledge and basic programming because it is a fast growing trend.

BIM Practitioner 3

For the architects and designers on the project team, a sound understanding of building construction is a necessity. Unlike CAD which is in essence a series of lines, a BIM model is a digital representation of a building's construction.

In order to effectively create a BIM model, one must know how a real-world building is constructed. There must also be an understanding of how a construction drawing set is

organized and what constitutes a good construction drawing. This is entirely independent of BIM modeling skills. For the BIM project manager, there is a range of essential required skills, including consultant coordination on a BIM project, contractual issues on a BIM project, staffing modes on a BIM project, etc.

Question 10: Besides the resources provided by the firm, what other recommended resources would greatly improve the BIM skills and knowledge of current and future employees? Could you share a few of your personal favorite BIM resources (websites, books, organizations, articles and literatures, professionals, etc.)?

BIM Practitioner 1

Topic specific conferences and seminars provides good BIM resources, providing an in depth focus relating to different Revit positions. Using books as the main day to day resource is not recommended because technologies are changing so fast that by the time a book is in print, the information has already become outdated. Since there is a high chance someone already has encountered and addressed the same issue in the past, for day to day trouble shooting, one should check with www.augi.com, www.revitcity.com, www.forums.autodesk.com, www.youtube.com and Google searches. For new cases, most likely someone in the Revit world out there will be able to tell you if it is possible to complete the task you are trying to complete in Revit.

Obtaining training is a good start, as one becomes more familiar with the software, what it is capable of, and it will be easier to know what questions to ask and how to look for the answers. Participating in training session, class or tutorials is also useful. Jumping into a project is one of the best ways to learn---experiences such as collaboration and the consequences of making changes has to be learned in a project setting.

BIM Practitioner 2

Personally, I have not read many guides as the internet provides many great sources of information. One recommendation is the book “Mastering Autodesk Revit Architecture” by James Vandezande, Phil Read and Eddy Krygiel. Online resource suggestions:

- Mine of course: <http://paulaubin.com/category/blog/>
- Luke Johnson of Dimond Architects Pty Ltd:
<http://whatrevitwants.blogspot.com/>
- Steve Stafford of AEC Advantage: <http://revitoped.blogspot.com/>
- David Light of Case, Inc.: <http://autodesk-revit.blogspot.com/>
- Zach Kron of Autodesk: <http://buildz.blogspot.com/>
- Aaron Maller of The Beck Group:
<http://malleristicrevitation.blogspot.com/>

- The Revit Clinic (Autodesk):
http://revitclinic.typepad.com/my_weblog/
- Andy Milburn: <http://grevity.blogspot.com/>
- Jeffrey Pinheiro (The Revit Kid)<http://therevitkid.blogspot.com/>
- David Baldacchino and Steve Campbell: <http://do-u-revit.blogspot.com/>
- Rory Vance of KnowledgeSmart: <http://the-knowledgesmart-blog.blogspot.com/>

BIM Practitioner 3

There are many, many great Revit/BIM blogs. Some of my favorites are:

- Rethinking BIM: www.rethinkingbim.wordpress.com/
- (bim)x: www.bimx.blogspot.com/
- Revit OpEd: www.revitoped.blogspot.com/
- All Things BIM: www.allthingsbim.com/
- Malleristic Revitation: www.malleristicrevitation.blogspot.com/
- Do Revit: www.do-u-revit.blogspot.com/
- Do U Revit: www.do-u-revit.blogspot.com/
- The Revit Kid (especially for students): www.therevitkid.blogspot.com/

In nearly every city where the firm has an office there is a Revit Interest Group. Interested BIM users should take advantage of these. Autodesk University is a tremendous learning and networking experience. It maintains an on-line catalog of all past courses given, there are thousands of well-written articles to be found there. Autodesk also conducts Revit (and other software) certification. This is a valuable and respected professional accreditation. For books, there are many well-written training manuals, too many to mention, but one interesting one is "Big BIM and Little BIM".

Question 11: What are your recommendations for aspiring students who are interested in entering the BIM profession?

BIM Practitioner 1

Unlike conceptual firms focusing on renderings, most production based firms focus on producing construction set and building constructions highly prioritize those who have knowledge in the implementation of BIM. Aspiring students should become fluent with BIM software, know how it works and understand the logic of it enough to get started. Other experiences could be acquired by working in a team.

Understanding the power a person holds while using BIM/ Revit like software, in which simple gestures can make large impact---both negatively and positively. Those who are giving the instructions or directions of what to do with the Revit drawing files need to have a good understanding of what they are asking another person to do. The person giving the command, needs to give clear instructions and be clear about what the consequences of the directions are.

An example is someone giving a direction of deleting a line from the file; when using CAD, this line will be the only element being deleted, but in Revit, this line is associated with other items and resulting in the deletion of all associate items.

In Revit, it is much harder to undo things, it is easier to change settings and add information later. An example would be changing wall justification, types, place holders, location lines, etc. One small adjustment could undo a lot of work and it's much harder to get them back in Revit. It is better to avoid situations in which one has to lose many days of work just to get back one hour of changes. One wrong adjustment could break dimensions and lose multiple views. By understanding the spatial sense of construction, it helps one to understand the spatial sense of Revit; of how elements are joined, it's properties and what the consequences are as a result of each adjustment. It is also important to keep backups for possible file corruptions. A successful implementation of Revit boils down to understanding, keeping tabs and making sure that one notices the details within the model.

BIM Practitioner 2

Aspiring students need to understand the capabilities and limits of Revit. To keep in mind that not everything has to be modeled and don't think something that hasn't been modeled before wouldn't benefit from being modeled. Think outside of the box and push the software boundaries. Learn as much as one can with the software and when the software is unable to do what you want, look outside to apps, such as add-ons. Practice building real buildings and understand how Revit's capabilities can benefit you, save time and make one a better Architect.

BIM Practitioner 3

As a rule, this location doesn't hire BIM technicians, we hire architects and designers who as a matter of course must have BIM skills. Architectural schools are, we find, currently giving students a very good understanding of these skills and of profound importance of BIM in the AEC industry.

Question 12: In your opinion, what is the best approach/sequence in teaching BIM skills?

BIM Practitioner 1

First, obtain the basic maneuvering and logic of BIM and BIM software and participate in a project setting. I did not know anything about BIM or Revit two years ago and learned everything about Revit in the project setting. It provided good practice and testing for various troubles shooting experience.

BIM Practitioner 2

The best approach or sequence gaining BIM skills is by getting your feet wet! Do the tutorials but if you worked for a firm and have a project that has been completed, try building it in Revit

and see how long it takes you complete a set of Construction Documents.

BIM Practitioner 3

The typical sequence used at the firm:

Day 1

- Getting Started
- Building Information Modeling / BIM
- Common terms
- Using Autodesk Revit Architecture
- Exploring the User Interface
- Starting a Project
- The Basics of the Building Model
- Getting Started with Walls
- Working with Interior Walls
- Working with Compound Walls
- Adding Doors and Windows
- Working with Levels
- Working with Column Grids
- Using Dimensions and Constraints
- Placing Dimensions
- Working with Constraints
- Developing the Building Model
- Creating Curtain Walls
- Using Building Components
- Loading Component Families
- Modifying Component Families

Day 2

- Developing the Building Model
- Creating and Modifying Floors
- Adding Ceilings
- Working with Roofs
- Working with Stairs and Railings
- Creating and Managing Parts and Assemblies
- Rooms and Areas
- Using Rooms and Areas
- Color Fills
- Area Plans
- Creating Schedules
- Working with Basic Schedules
- Working with Materials and Schedules

Controlling the Appearance of Schedules

Day 3

Detailing and
Drafting Working
with Section Views
Creating Callout
Views Annotations
Detailing
Working with Drafting Views
Locking and annotating 3D
Views Managing Views in the
Project Browser Presenting
The Building Model
Working with 3D Views
Controlling Object Visibility
Working with Title Blocks
Getting Started with Rendering
Sharing the Model
Importing Content
Exporting Content Printing
Working with Project Templates
Getting Started with Work-sets

If Time Allows

Site Basics
Point clouds
Legends
Walkthroughs
Phasing
Massing for Design

BIM Practitioner Interview Analysis

Drawn from the interview responses above, the following are the real world architectural practices and challenges, particularly relating to architectural technology and BIM. The following points are drawn in the order of the interview questions.

1. BIM practitioners all have an extensive architectural and architectural construction experience, although not necessarily BIM focused experience. However, once given an opportunity to implement BIM tools, the practitioners all recognized the benefits of BIM in various architectural projects.

2. BIM offers many assets that could greatly enhance the design process and delivery of the project. However, it is not perfect and could be difficult to manage and maintain data bases, project schedules and implementation during the transitional period. It is important to realize that unlike other architectural tools, if the user is not mindful, alteration in one part of the BIM file could affect multiple parts of the project and result in great difficulties in recovery of lost data.
3. To ensure successful BIM implementation in the practice setting, it is important to ensure ample experienced BIM users and firms need to holistically understand and realize the importance of BIM implementation. The firm also needs to provide in-house support groups for BIM users to freely exchange implementation tips. Leveraging BIM skills in terms of project productivity and project profitability remains a difficult part of the BIM adoption in practice.
4. Having good BIM skills alone should not be the sole hiring purpose. It is essential to have a good understanding of the modeling tools and other BIM set ups and understand the impact of BIM; a line represent more than a line in BIM, it contains multiple types of information that could cause live impact within the project.
5. Good workflow requires efficient BIM project management, including managing file sizes and team managements. Understanding the project will help in decision-making components, organization, and project staffing. One should be proactive in BIM training; seek resources from team members and other tutorials or other documentation.
6. It is important to provide up-to-date BIM strategies for employees. This could be done through hired training sessions, in-house technical seminars or through the firm's intranet system. The key is to provide appropriate staff training in the subject specific to their task.
7. Each firm should have their own BIM standards and guidelines. However, these guidelines should reflect standard from the National Standards for BIM, AIA, National Cad Standards and other organizations. Each project should have an individualized BIM Execution Plan.
8. It is important to realize not all elements need to be modeled in 3D. By understanding the purpose of various BIM elements, one can make the decision of whether to model these elements in 2D or 3D, ensuring feasibility of the project and its file size. Continually informing staff of proper way to utilize the software with clear explanations will help minimize future issues and ensure effective BIM management and practices.
9. Besides BIM modeling skills, one should have a good understanding of 3D spatial sense, being able to think in the progression and sequence of plan, to enlarge plan, to detail plan. Construction knowledge, basic programing and scheduling are some essential skills necessary for an effective BIM project. In order to effectively create a BIM model, one must know how a real-world building is constructed. Project

managers should be able to communicate and understand BIM production, time management, project scheduling and organize the team according to the needs of BIM workflow vs. CAD workflow.

10. BIM staff should continually improve their BIM skills by attending topic specific conferences and seminars. Some online BIM resources that could be helpful includes but not limited to:

- a. www.au.autodesk.com/
- b. www.augi.com
- c. www.revitcity.com
- d. www.forums.autodesk.com
- e. www.youtube.com and Google searches
- f. <http://paulaubin.com/category/blog/>
- g. <http://whatrevitwants.blogspot.com/>
- h. <http://revitoped.blogspot.com/>
- i. <http://autodesk-revit.blogspot.com/>
- j. <http://buildz.blogspot.com/>
- k. <http://malleristicrevitation.blogspot.com/>
- l. http://revitclinic.typepad.com/my_weblog/
- m. <http://grevity.blogspot.com/>
- n. <http://therevitkid.blogspot.com/>
- o. <http://do-u-revit.blogspot.com/>
- p. <http://the-knowledgesmart-blog.blogspot.com/>
- q. www.rethinkingbim.wordpress.com/
- r. www.bimx.blogspot.com/
- s. www.revitoped.blogspot.com/
- t. www.allthingsbim.com/
- u. www.malleristicrevitation.blogspot.com/
- v. www.do-u-revit.blogspot.com/
- w. www.do-u-revit.blogspot.com/
- x. “Mastering Autodesk Revit Architecture” by James Vandezande, Phil Read and Eddy Krygiel.
- y. “Big BIM and Little BIM” by Finith E. Jernigan AIA.

11. Aspiring students need to understand the capabilities and limits of Revit/BIM. To keep in mind that not everything has to be modeled and thinking that something that hasn't been modeled before wouldn't benefit from being modeled. Think outside of the box and push the software boundaries. Learn as much as one can with the software and when the software is unable to do what you want, look outside to apps, such as add-ons. Practice building real buildings and understand how Revit's

capabilities can benefit you, save time and make one a better Architect.

12. The best approach or sequence in gaining BIM skills is by jumping into the project and getting your feet wet.

BIM Inclusion Case Study

BIM and the Development of Collaborative Knowledge

Building Information modeling (BIM) is “a method for organizing information throughout the phases of the design process, and enables computer applications to use this information to perform analytical tasks to gain insight into the design performance.”¹⁵⁵ According to the Case Study on “Educating the Master Building Team: Leveraging BIM to Enable the Development of Collaborative Knowledge”, The authors felt, while the integrating information from BIM could be beneficial for “design authoring, design analysis, engineering analysis, and construction planning,”¹⁵⁶ a single student faces significant limitations when it comes to gaining analytical insights in tasks such as:

1. Energy analysis
2. Day lighting analysis
3. Cost Estimating
4. 4D modeling
5. Constructability
6. Structural analysis

There is no question that BIM implementation changes the design process and it is important for students to learn various analytical software applications. However, it is essential to teach students how to “collaborate, learn and leverage the collective intelligence of a team... which require both a breadth and depth of knowledge across many domains.”¹⁵⁷ To successfully train students in both knowledge in specific domains and depth across various domains, one can look into Thomas Kelley’s “T-shaped concept”.¹⁵⁸ A person that possesses a T-Shaped quality, is a person able to couple empathy across disciplines or domains with deep knowledge in specific domains (see Fig. 12: T-Shaped Person).

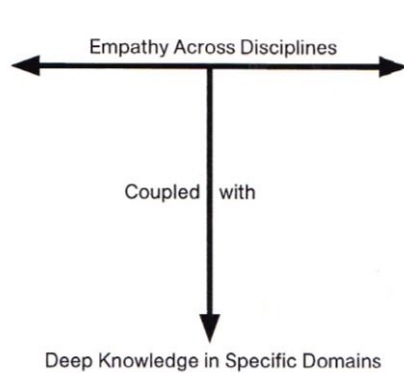


Figure 12: T-Shaped Person

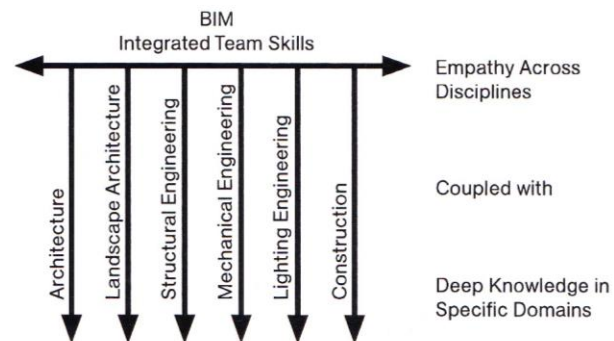


Figure 13: T-Shaped Concept with design program domains

¹⁵⁵ *BIM in Academia*, 57.

¹⁵⁶ *BIM in Academia*, 57.

¹⁵⁷ *BIM in Academia*, 57.

¹⁵⁸ *BIM in Academia*, 58.

The T-Shaped concept could be applied in the Architecture Engineering and Construction (AEC) industry. To successfully plan, design, construct and operate a facility requires collaboration between multiple disciplines such as “architecture, landscape architecture, engineering, construction, and facility management.”¹⁵⁹ (see Fig. 13: T-Shaped Concept with design program domains)

Two: Empathy across disciplines educational approach implement such concept:

1. Typical architectural curriculum & design studios

- Emphasize development in the breadth of knowledge concepts through a curriculum that includes courses related to needed topics that are not directly incorporated into the studio learning environment.
- Example: Design studio focuses on gaining knowledge in architectural design and other multiple separate courses address structural engineering, mechanical engineering, history and theory, etc.
- Pros: Gaining exposure in multiple discipline topics through their own coursework.
- Cons: Difficult to gain extensive experience through collaboration with team members from other disciplines.

2. Integrated design studios

- Emphasize development in the breadth of knowledge concepts through constructivist and experiential approach, emphasizing development through knowledge and experience opportunity.
- Example: Collaborative BIM Studio, in which students work with other disciplines; architecture, landscape architecture, construction, structural, mechanical, and lighting/electrical engineering.
- Pros: Opportunity to learn from team members, about leadership, team dynamics and group management by collaboration experiences.
- Cons: Difficult for most academic institution to organize and provide collaborative opportunities.

(BIM in Academia, page 57-60)

In the book *BIM in Academia*, case studies of collaborative studio and integrative studios are analyzed, one of these is the Penn State program.

¹⁵⁹ *BIM in Academia*, 58.

Penn State- Integrated BIM Studio

Penn State recently offered two experimental courses directed toward multi-discipline collaboration by using BIM technology for sharing and facilitating design-solutions. The first design course, depending on the academic program, includes a junior, senior or graduate-level design course. This BIM Studio Course was implemented in spring semester of 2009 and 2010. It utilized BIM as the design technology or tool. It integrated six disciplines- architecture, landscape architecture, construction, structural, mechanical, and lighting/electrical engineering. The studio project was a real world project and active professionals participated in the design process. The following are the benefits of this integrated BIM studio:

1. Data collection, analysis, design development, data coordination and project presentations.
2. Early planning of model content and workflow.
3. Provided tangible experience in team organization and BIM workflow.
4. Early and continuous feedback and synchronous communication between disciplines.
5. Observable work flow and design actions.
6. Understanding of technical, aesthetic, and social aspects of a collaborative design process.
7. Using BIM as a design process tool; traditional design processes are modified to leverage the benefits of BIM.
8. Integrated design resulting in a more efficient, effective and integrated design process.
9. The ability to compare schedule, cost, and energy usage of their designs to the actual project design.
10. Gain valuable knowledge and increased interest in performing well in studio due to the use of an actual project and participation of professionals.

(BIM in Academia, page 60-61)

The second course is an integrated design course in Architectural Engineering (AE), in Integrated Project Delivery (IPD), and four architectural engineering disciplines. The course focus is around IPD/BIM concepts with multidisciplinary teams. Each team includes one student from each of the four AE disciplines: construction, lighting/electrical, mechanical, and structural. The course was offered in Fall of 2009. The course was split into two semesters:

First semester:

1. Incorporated a case study/ experience-based learning format, studied successful high-rise architecture design and consulted with practitioner experts.
2. Work flow organization, creating BIM Project Execution Plan.

Second semester:

1. Execution of team-specific proposed project design revisions, including: architectural and façade concepts, optimization of structural lateral systems, mechanical and lighting/electrical system design, energy analysis, sustainability, constructability, design and construction coordination.
2. Application of IPD/BIM concepts trends and design in design and construction industry.

(BIM in Academia, page 60-63)

From the above courses, Penn State provided the following insights when it comes to integrating multidisciplinary studio courses in academia:

1. Faculty BIM Champion(s) is essential. Each discipline should have a member with integrative experience in BIM implementation and able to devote significant time to develop the courses and foundation of the courses.
2. Flexible course scheduling and enrollment; it might be necessary to schedule the course at night to avoid course conflicts. A closely managed enrollment is needed to balance student teams.
3. A technologically savvy teaching assistant will aid in technical support and ensure an easier process.
4. Careful selection of project, as it is more appropriate for students to develop the design content for the BIM studio course, but for an architectural engineering project to use an existing building.
5. Leveraging tools for group feedback and faculty intervention to facilitate appropriate team attitudes and processes if needed.
6. Develop institutional knowledge; encourage students to share what they have learned with other students. Example: www.bim.wikispaces.com
7. Recognition for faculty contributions to the courses, as interdisciplinary courses require much time and contributions from qualifying faculties.
8. Clearly define expectations for students, including deliverables and professional team behavior. Team goals and collaborative design process should be discussed early in the process, discussions should continue to address all issues and challenges.

(BIM in Academia, page 63-66)

The experimental studios resulted in positive responses at Penn State. A few challenging issues from the experiment includes the following:

1. The need for early inclusion of foundational BIM instruction in the program; enable students to be productive, domain-focused participants in their group.
2. Maintain and continually expand computing and visualization structure for the courses.
3. Allow for flexibility in existing curricular requirements to include new courses.

4. Define appropriate time and implementation for the new courses, for it to work collaboratively with existing curricula.
5. Provide or maintain training for faculties as needed for the program.

(BIM in Academia, page 66)

After finishing the BIM Studio, one particular student with six years of industry experience felt he still learned lots from the studio. He expressed his view on the integrated design studio courses, demonstrating the success of the curricula:

1. Collaborative learning, based on real world principles.
2. Pushing the boundaries of technology and design process.
3. The studio of potential to solidify each discipline's ideas and methods in the context of a collaborative 'professional' design team.

(BIM in Academia, page 66-67)

Design Documentation

Graduate Certificate in Building Information Modeling for the Doctor of Architecture Degree Program

Using document review, literature review, student questionnaires, practitioner interviews and curriculum studies, and BIM inclusion case study as insights on the key factors and issues pertaining to the difference between architectural education and practice.

The results echo the importance in bridging the gap between architecture education and current practice, and support the inclusion of BIM technologies is an important part of academic education.

University of Hawai'i at Mānoa Certificate Program Overview

Per *Executive Policy E5.205* (see Appendix F: University of Hawai'i Executive Policy E5.205 Academic Minors and Certificate Credentials) of the University of Hawai'i at Mānoa, Office of the Vice Chancellor for Academic Affairs, Certificate programs do not lead to a degree, but “complement degree programs and may provide the training necessary for professional certification.”¹⁶⁰ ¹⁶¹ A certificate program is a designated set of courses that complements a degree program “by enhancing the development of skills and knowledge in a focused area of study, or provides intensive professional training.”¹⁶²

Certificate programs may be offered as:

1. A specialization within a degree program.
2. An interdisciplinary field that combines courses from two or more degree programs.
3. A “stand alone” program designed to develop an area of professional knowledge or practical skills.

Existing classified students who meet University and program entrance requirements may enroll in certificate programs.¹⁶³ Upon completion of the enrolled degree program requirements and certificate requirements, students will then be awarded the academic

¹⁶⁰ “Certificate Programs,” The University of Hawai'i at Mānoa, last modified August 23, 2013, http://manoa.hawaii.edu/ovcaa/planning_approval/certificate_programs.html.

¹⁶¹ “Academic Subject Certificate Programs Procedures and Guidelines,” The University of Hawai'i at Mānoa, Office of the Vice chancellor for Academic Affairs, accessed September 21, 2013, http://manoa.hawaii.edu/ovcaa/planning_approval/doc/Academic%20Subject%20Certificate%20Guidelines.docx.

¹⁶² “Certificate Programs.”

¹⁶³ “Academic Subject Certificate Programs Procedures and Guidelines.”

subject certificate.¹⁶⁴ Certificates must be approved according to guidelines, or it will not appear on University of Hawai'i transcripts.¹⁶⁵

University of Hawai'i at Mānoa Graduate Certificate Program Requirements

Graduate certificate programs may “complement degree programs and may provide the training necessary for professional certification.”¹⁶⁶ A graduate certificate program offers “a distinct program of study and provide graduate students with a concentrated and intellectually coherent set of courses.”¹⁶⁷ The University of Hawai'i at Mānoa allows enrollment of multiple certificate programs or concurrent in an advanced degree programs.¹⁶⁸ According to the *Academic Subject Certificate Programs Procedures and Guidelines*, June 2004 edition by the University of Hawai'i at Mānoa Office of the Vice Chancellor for Academic Affairs (see Appendix J: Academic Subject Certificate Programs Procedures and Guidelines), graduate certificates should meet the following criteria:

Graduate certificate program purposes:

1. To complement the education of students within disciplinary graduate programs.
2. To provide the training necessary for professional certification.

Graduate certificate program requirements:

1. A minimum of 15 credits, of which at least 9 must be at the graduate level (600-700).
2. At least one required courses (3 credits) and a capstone project or experience.
3. A passing grade of B or higher, and a cumulative GPA of 3.0 for all courses counted towards the certificate.
4. Publicized in the catalog of the developed standards and procedures.
5. Consistently maintained the standards and procedures.

Graduate certificate program structure:

1. A director or chair- responsible for the day-to-day operation of the program and for advising students.
2. Graduate faculty responsible for overseeing the program, including assessment of learning, maintenance of quality, monitoring of the curriculum, and admissions. Graduate faculty may include members of the professional community.

¹⁶⁴ “Academic Subject Certificate Programs Procedures and Guidelines.”

¹⁶⁵ “Academic Subject Certificate Programs Procedures and Guidelines.”

¹⁶⁶ “Certificate Programs.”

¹⁶⁷ “Academic Subject Certificate Programs Procedures and Guidelines.”

¹⁶⁸ “Academic Subject Certificate Programs Procedures and Guidelines.”

University of Hawai'i at Mānoa Graduate Certificate Approval Process

Based on the *Academic Subject Certificate Programs Procedures and Guidelines*, “approval of appropriate curriculum committees and dean(s) of the sponsoring unit(s) is required, as well as Graduate Division, Faculty Senate, the Chancellor, and the Board of Regents (if appropriate). Certificates that require Board of Regents approval must receive an approved “Authorization to Plan” prior to submitting a proposal.”¹⁶⁹

The authority to approve a Certificate Program is based on the condition of the Certificate Program:

1. University of Hawai'i at Mānoa Chancellor has the authority to approve certificate programs in specific subjects that represent recognition of work taken within (or among) existing Board authorized programs. Follow the Graduate Certificates Proposal Outline (see Appendix I: University of Hawai'i Graduate Certificates Proposal Outline).
2. University of Hawai'i Board of Regents has the authority to approve Certificate programs that do not meet these criteria and those that require the commitment of new resources by the University. Prior to submitting a certificate proposal, the Board of Regents must approve the “Authorization to Plan” proposal (see Appendix H: University of Hawai'i Authorization to Plan Template); follow the Executive Policy E5.201 Approval of New Academic Programs and Review of Provisional Academic Programs (see Appendix G: University of Hawai'i Executive Policy E5.201 Approval of New Academic Programs and Review of Provisional Academic Programs).



Fig. 14: Certificate Approval Process for existing Board authorized Programs- Certificate Programs (UH Executive Policy E5.205)

or

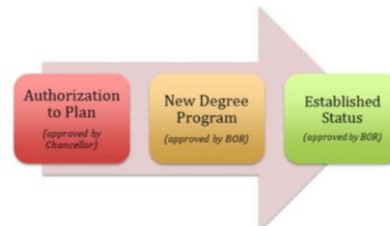


Fig. 15: Certificate Approval Process for non-existing Board authorized Programs- New Degree Programs (UH Executive Policy E5.201)

Graduate Certificate in Building Information Modeling Approval Process

According to the Spencer A. Leineweber, Director of Graduate Program of the School of Architecture, the Doctor of Architecture degree at the School of Architecture at the University

¹⁶⁹ “Academic Subject Certificate Programs Procedures and Guidelines.”

of Hawai'i at Mānoa is a Board of Regents approved program.¹⁷⁰ However, since the BIM Certificate Program will require hiring of new faculty, the certificate will require “new resources” from the University,¹⁷¹ hence, the proposal requires Board of Regents’ approval before a program proposal can be submitted for approval. Per *Executive Policy E5.205* and *E5.201*, the BIM Certificate Program approval process should consist of the following:

1. Authorization to Plan to be submitted and approved by Chancellor.
2. New Degree Program approved by Board of Regents.
3. Established Status approved by Board of Regents.
4. BIM Certificate Proposal approved by Graduate Education Review Committee.
5. BIM Certificate approved by the Vice Chancellor for Academic Affairs.
6. BIM Certificate approved by the University of Hawai'i at Mānoa Faculty Senate.
7. BIM Certificate approved by Chancellor.

Graduate Certificate in Building Information Modeling Focus & Goals

1. Using BIM inclusion as a method to bridge the gap between what is being offered in architectural education and is happening in real world practice while remaining accredited by NAAB.
2. Stress the importance of early BIM education and training.
3. Provide continuous progression opportunities without stifling the learning process.
4. Ensuring students to progress from novice to master within the D.Arch. degree through education, mentoring, self-direction and self-evaluation opportunities.
5. Enable adaption to future technological changes.

¹⁷⁰ Spencer Leineweber, e-mail message to Amy Ling, September 23, 2013.

¹⁷¹ Spencer Leineweber, e-mail message to Amy Ling, September 23, 2013.

SCHOOL OF ARCHITECTURE
GRADUATE CERTIFICATE IN BUILDING INFORMATION MODELING PROPOSAL
University of Hawai'i at Mānoa

Purpose and Objective

The Graduate Certificate in Building Information Modeling (BIM) will provide a specialty focus in real world application of Building Information Modeling (BIM) for interested participants. The certificate will provide opportunities for those interested in obtaining the in-depth knowledge and/or skills needed to effectively utilize and implement BIM tools and practices relating to real world architectural settings. Upon review and approval by the School of Architecture, a Graduate Certificate in Building Information Modeling (BIM) will become available. Interested participants may enroll in one of the two tracks based on their degree level.

Graduate Certificate in Building Information Modeling (BIM) Track A

For students admitted to and in good academic standing with a 3.0 GPA or above at the University of Hawai'i at Mānoa, School of Architecture, Doctor of Architecture degree program, Track 1 or Track 2.

Graduate Certificate in Building Information Modeling (BIM) Track B

The certificate is also available for those previously obtained a professional degree in Bachelor of Architecture (B.Arch), Master of Architecture (M.Arch) or other appropriate degree related to architectural education.

The Graduate Certificate in Building Information Modeling (BIM) objectives include:

1. Addressing the need to bridge the gap between what is being offered in architectural education and real world practice while retaining NAAB accreditation.
2. Recognition that BIM technology is changing the architecture profession and the need for BIM inclusion in architectural education and training.
3. Addressing the need for both students and practicing professionals to stay current with architectural technology such as BIM.
4. Propose early BIM inclusion in the Doctor of Architecture degree program.
5. Building Information Modeling education and training focusing on real world implementation and practice.
6. Provide a balanced learning environment by encouraging progression through various skills/learning development stages.
7. Advance and improve performance without being stifled by overly sophisticated aids.
8. Ensure BIM application skills progression from novice to master through core and elective courses providing training, mentoring, self-direction and self-evaluation opportunities.
9. Gain knowledge and opportunities in obtaining official software certification

credentials along with the Graduate Certificate in Building Information Modeling and Doctor of Architecture degree program.

10. Enable adaption to future technological changes.

Relationship with Existing Degree Program

The Graduate Certificate in Building Information Modeling (BIM) will be directly integrated into the Doctor of Architecture degree program at the University of Hawai'i at Mānoa, School of Architecture. The certificate program courses will be taken in conjunction with existing Doctor of Architecture degree courses which enables students to obtain the certificate while completing the Doctor of Architecture degree's core and elective courses.

Certificate Program Administration

The Certificate program will be administered by the School of Architecture, Doctor of Architecture degree program. All advising will be done by the School of Architecture, either by the Director of Graduate Program for the Doctor of Architecture degree, and or the director of the Graduate Certificate in Building Information Modeling at the School of Architecture.

Certificate Implementation

The Doctor of Architecture graduate program including both Track 1 – 90 credit hours and Track 2 – 108 credit hours, accredited by the National Architectural Accrediting Board (NAAB), will participate in providing the courses for the certificate. Other courses which require Building Information Modeling expertise and specialization will require new hires. This personnel will have recent real world practice experience and/or are currently practicing in the architecture field using BIM software, particularly Autodesk Revit Architecture. Acceptable work experience includes regional, national and international work.

Personnel involved in the planning process and implementation of the program include Amy Ling- D.Arch candidate and the School of Architecture, Spencer Leineweber- Director of Graduate Program, Joyce Noe- Associate Professor, Kevin King- Salt Lake Community College, Architectural Technology Program Coordinator, Burt Goncalves- instructor at City College of New York, Bernard and Anne Spitzer School of Architecture and practitioner at Perkins Eastman, Inc. The School of Architecture, Director of the Graduate Program, Spencer Leineweber and Associate Professor, Joyce Noe, will be actively involved in implementing this certificate program.

Population Served by the Program

Graduate Certificate in Building Information Modeling (BIM) Track A

The Graduate Certificate in Building Information Modeling will serve all part-time and full-time graduate students enrolled in the Doctor of Architecture degree programs at the University of Hawai'i at Mānoa. The certificate program is most relevant to Doctor of Architecture students,

who have a general interest and understand the importance of obtaining such skills before entering the architectural profession.

We anticipate that approximately 60% of all Doctor of Architecture students will earn a Graduate Certificate in Building Information Modeling each year based on the amount of interest demonstrated by current students in obtaining architecture technology skills such as Building Information Modeling.

Graduate Certificate in Building Information Modeling (BIM) Track B

The Certificate will also serve those who received prior professional degrees and appropriate work experiences in the architecture field.

We anticipate those with a B.Arch, M.Arch or currently practicing in the architecture field to participate in the certificate program. Actual percentage will depend on economy and regional demand.

Program Organization

Foundation Courses and Prerequisites

Graduate Certificate in Building Information Modeling (BIM) Track A

Students must be accepted and enrolled in one of the Doctor of Architecture degree program Tracks and in good academic standing with a 3.0 GPA. The Graduate Certificate in Building Information Modeling requires students to declare certificate enrollment before their 2nd year of the Doctor of Architecture program. Students are required to complete the two foundation courses (ARCH 5xx: BIM 1, ARCH 5xx: BIM 2) with grade C or better before enrolling in the Graduate Certificate. Applicants must be approved by the School of Architecture Graduate Director or Graduate Certificate in Building Information Modeling Director prior to enrollment.

Graduate Certificate in Building Information Modeling (BIM) Track B

Those holding a professional degree in architecture (B.Arch, M.Arch or equivalent), must declare as a University of Hawai'i, non-degree seeking classified student at the time of the Certificate enrollment. Applicants must be approved by the School of Architecture Graduate Director or Graduate Certificate in Building Information Modeling Director prior to enrollment.

Fields of Concentration

There are no required sub-concentrations or areas of specializations within the certificate program. However, elective courses are designed to provide in-depth knowledge or specialization in BIM related subjects while offering maximum flexibility in the course of study. Although the certificate allows for elective pairings of two separate subjects, the certificate participants are encouraged to pair electives that provide in-depth knowledge in specialized fields.

Credits Required

Graduate Certificate in Building Information Modeling (BIM) Track A

Required: Minimum 9 Credit Hours + D.Arch Collaborative and Integrative hours

(9) BIM Core Credit Hours + (6) BIM Elective Credit Hours (D.Arch concurrent Electives) +

(6) D.Arch Architecture Studio with BIM Integration Credit Hours + (12) D.Arch Professional Studio with BIM Practice Credit Hours.

In addition to the Doctor of Architecture degree program, students will enroll in Track 1- requires 90 credit hours and Track 2- requires 108 credit hours. A total of 15 credit hours are required for the Graduate Certificate of Building Information Modeling. A total of 9 BIM core credit hours (three core courses of three credit hours each) + 6 BIM elective credit hours (two elective courses of three credit hours each). The two electives could be double counted as part of the Doctor of Architecture elective courses.

The Doctor of Architecture degree program consists of various architectural courses; Doctorate Research, Architecture Studio, and Professional Studio. In addition to the 15 credit hours in certificate requirements, students participating in the Graduate Certificate in Building Information Modeling while pursuing the Doctor of Architecture degree program are required to enroll in one BIM integration focus Architectural Studio (ARCH 544_B: Architecture Studio V Comprehensive). Students are also required to choose from a list of BIM firms or BIM focused experience for the ARCH 547: Professional Studio; that is, they can choose Practicum (P), Community Design (C) or Alternative Experience (E).

The double counted BIM electives, BIM integrated Architecture Studio and BIM focus Professional Studio, provide extensive collaborative experience for the Graduate Certificate in Building Information Modeling participants. This will greatly enhance students' BIM knowledge and real world experience essential for successful implementation of BIM in the architectural profession. However, it will not result in additional financial burden for the student and it ensures the Certificate participant will graduate at the same time as the Doctor of Architecture degree program students.

Graduate Certificate in Building Information Modeling (BIM) Track B

Required: Minimum 15 Credit Hours

(6) BIM Core Credit Hours + (3) BIM Elective Credit Hours + (6) D.Arch Architecture Studio with BIM Integration Credit Hours

The Graduate Certificate in Building Information Modeling Track B is designed for interested participants who have already obtained an architectural professional degree and/or those with appropriate architectural practice experience. Therefore, Track B participants are only required to participate from Phase 1 to part of Phase; a portion of Phase 3 and Phase 4 are omitted.

Required Course Rationale

Certificate courses are organized based on the learning theory “Five Stages of the Mental Activities Involved in Directed Skill Acquisition” by Dreyfus and Dreyfus. The curriculum is structured in four phases.

Phase 1: novice to competent

Gaining knowledge in BIM software application skills is the main focus of this phase. The rationale is to provide the background necessary for students to progress from ruled based skill level to guideline or situational skill level where one is able to apply the task without previous experience and progress to having the ability to recognize and interpret appropriate problem solving skills based on a guideline system.

Phase 2: Competent to Proficient

Gaining implementation experiences is the main focus of this phase. At this stage, students are provided a design studio with guidance. Students are required to complete an architectural design with the integration of BIM, structure, sustainability design, construction process and innovation. Through this process, students will progress from guideline- based to situational experience where one will be able to problem solve and complete and redefine new rules for various tasks or situations.

Phase 3: Proficient to Expert

This phase offers a variety of elective courses with different specialty foci. The rationale for these elective courses is to offer in-depth experiences for students to progress from the situational analytical thought process to an intuitive thought process. As intuitive response achieved, the student will be able to decide how to tackle a BIM task

without the need to sort through all the various rules and previous experiences.

Phase 4: Expert to Master

Students are required or expected to continue applying their BIM skills in either the Professional Studio or other real world settings. This will provide more situational experiences for working with various BIM issues and tasks and it will help the student to progress from having simple intuitive responses to being able to sub-classify and categorize different BIM responses.

Required Courses & Certificate Program Structure

Graduate Certificate in Building Information Modeling (BIM) Track A

Required: Minimum 9 Credit Hours + D.Arch Collaborative and Integrative hours

(9) BIM Core Credit Hours + (6) BIM Elective Credit Hours (D.Arch concurrent Electives) + (6) D.Arch Architecture Studio with BIM Integration Credit Hours + (12) D.Arch Professional Studio with BIM Practice Credit Hours.

Graduate Certificate in Building Information Modeling (BIM) Track B

Required: Minimum 15 Credit Hours

(6) BIM Core Credit Hours + (3) BIM Elective Credit Hours + (6) D.Arch Architecture Studio with BIM Integration Credit Hours

Year 1

Phase 1- Novice to Competent (Rule-based to Guideline-based application)

Required: two (3) CR Graduate Certificate in BIM- Core Foundation Courses

(Required: Track A & Track B)

**Portion of the course objectives below include objectives provided by Autodesk Software marketing.*

ARCH 5xx: BIM 1 (3)

Prerequisites: None

Instructor: New BIM Hire 1 (Autodesk Revit Certified Professional + Professional BIM experience) and Arch__: Student Mentor 1 or Arch__: Student Mentor 2.

- Basic & Intermediate BIM software skills.
- BIM History, Theory & Practice.
- Regional BIM firm visits.
- Regional, national or international BIM firm/ practitioner visiting lectures.
- Gaining training hours suggested by Autodesk Revit Certification.

- Course focus on reviewing topics related to Autodesk Revit Architecture Associate and Professional Certification by using official preparation materials by ASCENT (Autodesk Official Training Guides) and Wiley (Official press).
- Skills & Topics: User Interface, file management, views, levels, walls, doors, windows, component, columns and grids, stairs and railings, roofs and floors, sketching, annotations, schedules, construction document sets, collaboration, documentation, elements, modeling, views, etc. (see Appendix E: Autodesk Revit Architecture: Certified User and 2014 Certified Professional)
- A medium scale commercial design project using BIM/Revit is required as part of the final project.

ARCH 5xx: BIM 2 (3)

Prerequisites: None

Instructor: New BIM Hire 1 (Autodesk Revit Certified Professional + Professional BIM experience) and Arch__ : Student Mentor 1 or Arch__ : Student Mentor 2.

- Advanced & BIM software customization skills.
- BIM best practices & real world implementation theory.
- Regional BIM firm visits.
- Regional, national or international BIM firm/ practitioner visiting lectures.
- Gaining training hours suggested by Autodesk Revit Certification.
- Course focus on reviewing topics related to Autodesk Revit Architecture Associate and Professional Certification by using official preparation materials by ASCENT (Autodesk Official Training Guides) and Wiley (Official press).
- In-depth Skills & Topics: User Interface, file management, views, levels, walls, doors, windows, component, columns and grids, stairs and railings, roofs and floors, sketching, annotations, schedules, construction document sets, collaboration, documentation, elements, modeling, views, etc. (see Appendix E: Autodesk Revit Architecture: Certified User and 2014 Certified Professional)
- In-depth BIM data and design refinements are to be added to the BIM 1 medium scale commercial design project as part of the final project.

- Year 1 covers all Autodesk Revit Certification Topics + Local BIM firm tours & Lectures + Visiting Lectures from international firms + SoA Intranet forum & Community participation.
- Mentoring by SoA BIM Coordinator & Student Mentors.

Year 2

Phase 2- Competent to Proficient (Guideline-based to Situational Experience)

Required: one (6) CR D.Arch Architecture Studio with BIM Integration

(Required: Track A & Track B)

ARCH 544 B: Architecture Studio IV with BIM Integration (6)

Prerequisites: Arch___ (3): BIM 1 & Arch___ (3): BIM 2.

Instructor: SoA Instructor (Professional BIM experience) and Arch___ (1): Student Mentor 1 or Arch___: Student Mentor 2.

- Collaboration & integration with Arch 544: Architectural Studio V, Arch 523 Architecture System II Wood & Steel or Arch 524 Architecture Systems III Concrete and Masonry. Arch 525 Architecture Systems IV Sustainability and Arch 526 Arch System V Integration.
- Focus on strengthening real world implementation of BIM in architecture, structure, sustainability design, construction process and innovation.
- Provide BIM support and advising by qualified BIM professionals and student mentors.
- Studio course work with real world constraints (actual local architectural design project), involving multi-disciplines (architecture, landscape architecture, construction, structural, mechanical and light/electrical engineering).
- Project provides hands-on experience with stakeholders, building codes, BIM project deliveries and team coordination.
- End project design is buildable & feasible with professional quality construction documentation.
- Gaining training hours suggested by Autodesk Revit Certification.
- This course is limited to those whom have declared their enrollment in the Graduate Certificate in Building Information Modeling.
- Real world Integration and incorporation of Studio, Structure, Sustainability, Innovation & Construction Process.
- Support for real world BIM practice.

- Mentoring by SoA BIM Coordinator & Student Mentors.

Phase 3- Proficiency to Expertise (Situational Experience to Intuitive Response)

Required: two (3) CR BIM Concurrent Electives (D.Arch Elective-double count)

(Required: Track A)

Required: one (3) CR BIM Electives

(Required: Track B)

** Electives offer during evenings.*

Construction Management

ARCH 6xx: BIM Construction Process (3)

Prerequisites: Arch___ (3): BIM 1 & Arch___ (3): BIM 2.

Instructor: SoA Instructor (Professional BIM experience) and/or Local BIM Practitioner Volunteers (Specialist or Expert in related BIM topics).

- Overview, construction modeling, estimating, quantification, coordination, prefabrication.
- Software: Autodesk Revit, Navisworks, BIM 360 Glue, Quantity Takeoff, Building Design Suite, Fabrication, Inventor.
- Predict and communicate project constructability more accurately with the ability to virtually construct, test, and validate design intent.
- Increase collaboration with stakeholders by integrating data from multiple sources to facilitate whole project review and construction simulation.
- BIM building process used to facilitate the exchange and interoperability of information in digital format.
- Reduce error-prone manual counting and maintain more accurate budgets with software that calculates material quantities and tracks in-cost estimates.
- Produce more accurate estimates and update the quantification process by extracting quantities, areas, and volumes from 2D and 3D designs.
- Minimize expensive delays by checking model collisions between elements within individual disciplines.
- Reduce waste and minimize RFIs when you find, manage, and resolve conflicts prior to construction.
- Simplify collaboration by giving stakeholders access to BIM models and intelligent data with cloud-based model coordination and clash detection.

- Minimize material waste, improve labor efficiency, and boost field productivity by designing custom building components for fabrication.
-

ARCH 6xx: BIM Construction Management (3)

Prerequisites: Arch____ (3): BIM 1 & Arch____ (3): BIM 2.

Instructor: SoA Instructor (Professional BIM experience) and/or Local BIM Practitioner Volunteers (Specialist or Expert in related BIM topics).

- Planning & logistics, coordination, field management, field layout, commissioning and handover.
- Software: Autodesk Navisworks Manage, Constructware, BIM 360 Field for Contractors & Construction Managers, Point Layout, BIM 360 Glue, Buzzsaw, etc.
- Holistically review integrated models and data with stakeholders to gain better control over project outcomes.
- Transform the delivery and oversight of construction by combining cloud-based collaboration with mobile technologies at the point of construction.
- Reduce contractual, safety, performance, and financial liability risks when you automate issue tracking, quality management, and access to project data.
- Create points in the BIM/CAD model, and export/import coordinate data to the field for faster, more accurate construction layout, QA/QC, and as-built modeling.
- Shorten handover periods with electronic handover documentation that provides the owner with a digital asset.
- Reduce facility downtime by speeding recommissioning with software that tracks key details throughout the commissioning process.

Project Management

ARCH 6xx: BIM Design Process (3)

Prerequisites: Arch____ (3): BIM 1 & Arch____ (3): BIM 2.

Instructor: SoA Instructor (Professional BIM experience) and/or Local BIM Practitioner Volunteers (Specialist or Expert in related BIM topics).

- Using the full potential of BIM and other software to support decision-making from earliest conceptual stages through design and construction, operational life and demolition.
- Software: Autodesk Revit, Formit, Energy Analysis for Autodesk Revit, Green Building Studio, Rendering in Autodesk

360, showcase, 3ds Max Design.

- Use an iPad® tablet to capture building design concepts anywhere, anytime and bring them into Autodesk® Revit® software for further development.
- Sketch freely and manipulate forms interactively with conceptual modeling tools within Revit software.
- Quickly gain insight into energy consumption with cloud-based analysis tools.
- Experience a more seamless design-to-analysis process with design models containing data that can be used for downstream energy analysis.
- Experience a more seamless design-to-analysis process with design models containing data that can be used for downstream energy analysis.
- Work simultaneously with other project team members on the same building information model, in the same office or across geographies.
- Quickly produce high-quality renderings in the cloud to evaluate design options with your project team.
- Better communicate design ideas and options to clients through interactive presentations.
- Bring your ideas to life with cinematic-quality renderings and visualizations that can be used in marketing.
- Incorporate optimized workflows, streamlining information and integrating program data.
- BIM based workflow, Integrated BIM workflow and Integrated Project Delivery (IPD).
- BIM Standards for design, documentation, visualization, and simulation, Industry Foundation Classes (IFCs).
- Create engaging design visualizations to present ideas.
- Use presentation tools to better evaluate design options.
- Access tools to help meet visualization needs.
- Create more efficient buildings with energy analysis tools.
- Gain better insight into constructability using 3D models.
- Help resolve conflicts before construction.

ARCH 6xx: BIM Project Management (3)

Prerequisites: Arch____ (3): BIM 1 & Arch____ (3): BIM 2.

Instructor: SoA Instructor (Professional BIM experience) and/or Local BIM Practitioner Volunteers (Specialist or Expert in related BIM topics).

- Improve communication throughout the project lifecycle by

more securely managing and sharing data with collaborators and stakeholders.

- Role of BIM Manager or Virtual design to construction (VCD).
- BIM object-oriented tasks, measure performance objectives, schedules, take-off and logistics.
- Software: Autodesk Revit, Navisworks Manage, BIM 360 Glue, Vault, AutoCAD WS, Building Design suite Premium, New Forma.
- Work simultaneously with other project team members on the same building information model, in the same office or across sites.
- Reduce change orders by coordinating architecture and engineering designs before construction begins.
- Improve collaboration with internal and external team members with software that offers version control, rollbacks, and tracking to keep you aligned.
- Improve communication and see updated changes instantly by viewing and editing files on your mobile device or the web.
- Real-time navigation, quantification tools, collaborate with manufacturers & fabricators.
- Managing BIM files, families, project files and troubleshoot.

Sustainability

ARCH 6xx: BIM Materials & Fabrication (3)

Prerequisites: Arch___ (3): BIM 1, Arch___ (3): BIM 2.

Instructor: SoA Instructor (Professional BIM experience) and/or Local BIM Practitioner Volunteers (Specialist or Expert in related BIM topics).

- BIM interactions, management and tracking of building materials, prototypes, manufacturers, specifications, BIM families and details.
- Software: Autodesk Revit, 3ds Max Design, Navisworks Simulate, Mudbox.
- High-performance environment and professional-quality tools to help create highly realistic 3D characters, engaging environments, detailed props, and compelling concept designs.
- Integration, analysis, and communication tools help teams coordinate disciplines, resolve conflicts, and plan projects

before construction or renovation begins.

- Comprehensive 3D modeling, animation, rendering.

ARCH 6xx: BIM LEED + Sustainability (3)

Prerequisites: Arch___ (3): BIM 1, Arch___ (3): BIM 2.

Instructor: SoA Instructor (Professional BIM experience) and/or Local BIM Practitioner Volunteers (Specialist or Expert in related BIM topics).

- In-depth sustainable BIM application focusing on various practices for small, medium and large scale infrastructures that support LEED accreditation.
- Utilizing BIM and related software for achieving various LEED categories.
- Software: Autodesk Revit, Formit, Energy Analysis for Autodesk Revit, Green Building Studio, BIM 360 Glue, Point Layout.
- Experience a more seamless design-to-analysis process with design models containing data that can be used for downstream energy analysis.
- Create more sustainable, energy-efficient designs by gaining insight into the energy consumption of design concepts early in the design process.
- Support LEED certification and Energy Star ratings with tools that help you perform whole-building analysis and optimize energy efficiency.

Urban Design

ARCH 6xx: BIM for Landscape Design (3)

Prerequisites: Arch___ (3): BIM 1, Arch___ (3): BIM 2.

Instructor: SoA Instructor (Professional BIM experience) and/or Local BIM Practitioner Volunteers (Specialist or Expert in related BIM topics).

- Complex space planning and construction design of outdoor public areas, landmarks and structures to achieve environmental, social-behavioral, and aesthetic landscapes by implementing BIM, Geographic Information Systems (GIS) and other tools.
- Software: Autodesk Revit, Energy Analysis for Autodesk Revit, Green Building Studio, Google Earth.
- Capture, store, manipulate, analyze, manage, and present all types of geographical data.

ARCH 6xx: BIM for Urban Design & Urban Planning (3)

Prerequisites: Arch___ (3): BIM 1, Arch___ (3): BIM 2.

Instructor: SoA Instructor (Professional BIM experience) and/or Local BIM Practitioner Volunteers (Specialist or Expert in related BIM topics).

- BIM for Urban Design and Urban Planning by implementing Geographic Information Systems (GIS) and other related information systems.
- Software: Autodesk Revit, Formit, Energy Analysis for Autodesk Revit, Green Building Studio, BIM 360 Glue, Point Layout, Google Earth, AutoCAD civil 3D, Infrastructure Design suite, Infrastructure Map Server, InfraWorks.
- Capture, store, manipulate, analyze, manage, and present all types of geographical data.
- Gain more accurate, accessible, and actionable insight throughout the execution and lifecycle of transportation, land, and water projects.
- Accelerate the design process, and streamline decision making. Rapidly generate data-rich proposals to better predict how design alternatives may perform in the existing environment, and more effectively communicate with stakeholders.
- Quickly publish and share CAD, GIS map, and asset information with web-based GIS mapping software.

Practice

ARCH 6xx: BIM Internship (3)

Prerequisites: Arch___ (3): BIM 1, Arch___ (3): BIM 2, Arch 544_B: Architecture Studio IV with BIM Integration.

Instructor: SoA Instructor (Autodesk Revit Certified Professional + Professional BIM experience) and/or Local BIM Practitioner Volunteers (Specialist or Expert in related BIM topics).

- Provide extended Professional Studio experience beyond the Doctor of Architecture requirements.
- Real world BIM collaboration, implementation and individualized experience.
- BIM mentoring by practicing BIM experts.
- This course is limited to those who have declared their enrollment in the Graduate Certificate in Building Information Modeling.

ARCH 6xx: BIM Mentoring (3)

Prerequisites: Arch____ (3): BIM 1, Arch____ (3): BIM 2, Arch 544_B: Architecture Studio IV with BIM Integration.

Instructor: SoA Instructor (Autodesk Revit Certified Professional + Professional BIM experience) and/or Local BIM Practitioner Volunteers (Specialist or Expert in related BIM topics).

- 2nd Year students in the Graduate Certificate of Building Information Modeling are to serve as mentors for the 1st year certificate students.
- Training students in leadership and teamwork, while providing opportunities to further their BIM knowledge and experience through problem solving.
- Gaining training hours suggested by Autodesk Revit Certification.
- This course is limited to those who have declared their enrollment in the Graduate Certificate in Building Information Modeling.

Research

ARCH 6xx: BIM History, Theory, Methodologies & Practice (3)

Prerequisites: Arch____ (3): BIM 1, Arch____ (3): BIM 2, Arch 544_B: Architecture Studio IV with BIM Integration.

Instructor: SoA Instructor (Professional BIM experience) and/or Local BIM Practitioner Volunteers (Specialist or Expert in related BIM topics).

- In-depth history of architectural discipline and progression from 2-D to 3-D, virtual prototype to parametric modeling.
- Theory of BIM practices in different architecture services and how that is different from traditional architecture practice.
- Integrated Delivery Process, lean design, etc.
- Hierarchical of BIM, etc.

ARCH 6xx: BIM Independent Research (3)

Prerequisites: Arch____ (3): BIM 1, Arch____ (3): BIM 2, Arch 544_B: Architecture Studio IV with BIM Integration.

Instructor: SoA Instructor (Professional BIM experience) and/or Local BIM Practitioner Volunteers (Specialist or Expert in related BIM topics).

- Provide independent research or study opportunities with individualized BIM focus.
- Course focus on reviewing topics related to Autodesk Revit Architecture Certification.
- This course is limited to those who have declared their

enrollment in the Graduate Certificate in Building Information Modeling.

Year 3

Phase 4- Expertise to Mastery (Intuitive Response to refined tactics)

Required: One (3) CR Graduate Certificate in BIM- Core Course

(Required: Track A only)

ARCH 6xx: BIM Student Mentor 1 (3)

Prerequisites: Arch____ (3): BIM 1, Arch____ (3): BIM 2, Arch 544_B: Architecture Studio IV with BIM Integration.

Instructor: SoA Instructor (Autodesk Revit Certified Professional + Professional BIM experience) and Local BIM Practitioner Volunteers.

- 3rd Year students in the Graduate Certificate of Building Information Modeling are to serve as mentors for the 1st & 2nd year certificate participants.
- Training students in leadership and teamwork, while providing opportunities to further their BIM knowledge and experience through problem solving.
- Gaining training hours suggested by Autodesk Revit Certification.
- This course is limited to those who have declared their enrollment in the Graduate Certificate in Building Information Modeling.

Required: one (12) CR D.Arch Professional Studio with BIM Focus

(Required: Track A only)

ARCH 547 B (12): BIM (Practicum/Community Design/Alternative Experience)

Prerequisites: D.Arch Program requirements + Arch____ (3): BIM 1, Arch____ (3): BIM 2, Arch 544_B: Architecture Studio IV with BIM Integration.

Instructor: Doctor of Architecture Arch 547 (12): Professional Studio instructor + Onsite or offsite BIM Specialist (approved BIM Mentor or Practicum mentor with BIM expertise)

- Real world BIM collaboration, implementation and individualized experience.
- BIM mentoring by practicing BIM experts.

Practicum and Internships

A (12) credit hours Professional Studio is required by the Doctor of Architecture degree. Students of the Graduate Certificate of Building Information Modeling are required to enroll in a Professional Studio with BIM real world practice. The Professional Studio with BIM Focus will follow the School of Architecture Professional Studio placement process.

Certificate participants can choose an additional (3) credit hours Internship Elective, it is not part of the certificate requirement and no other practicum or internships are required.

Culminating or Integrative Experience

A total of 6 to 24 credit hours of concurrent, collaborative and integrative courses with the Doctor of Architecture degree program serves as the culminating experience. No other integrative experience are required.

Graduate Certificate in Building Information Modeling Track A Culminating experience:

1. (6) Credit Hours of BIM Concurrent Elective (D.Arch Elective double count)
2. (6) Credit Hours in Architectural Studio with BIM Integration
3. (12) Credit Hours in Professional Studio with BIM Focus

Graduate Certificate in Building Information Modeling Track B Culminating experience:

1. (6) Credit Hours in Architectural Studio with BIM Integration

Graduate Certification in Building Information Modeling- Track A Program Chart

AY 2013-2014

University of Hawai'i at Mānoa School of Architecture

Graduate Certificate in Building Information Modeling "Track A"- for D. ARCH. Degree Program Track 1 or Track 2

undergraduate 120 credits

Student Name

ID #

Advisor Meetings

YR	SEM	DESIGN	TECHNOLOGY	PRACTICE	HIST/THEORY	ELECTIVES	CR
1	F	ARCH 541 [6] Architecture Studio II Medium Buildings in Site Graduate Status	ARCH 523 + [3] Architecture Systems II Wood & Steel Graduate Status, PHYS151+L		ARCH 515 [3] Asia-Pacific Arch History & Theory Graduate Status	ELEC 5xx6xx[3] Open Elective University Wide Graduate Status	18
	S	ARCH 542 [6] Architecture Studio III Large Buildings ARCH 523, 533, 541	ARCH 524 + [3] Architecture Systems III: Conc. & Masonry ARCH 523	ARCH 539 [3] Research Methods Seminar ARCH 515, 541		ARCH 5xx6xx[3] Arch Elective Graduate Status	18
2						ARCH 5xx[3] P1: BIM 1 Arch. Elective BIM Cert. Require Graduate Status	6
	S						
3	F	ARCH 544_B [6] P2: Architecture Studio V: Comprehensive ARCH 542, 524		ARCH 545 [3] Advanced Practice ARCH 524, 533	ARCH 516 [3] Arch & Urban Design Theory Graduate Status	ARCH 6xx[3] P3: BIM Elective 1 Arch. Elective and BIM Cert. Elec. Graduate Status	18
	S	ARCH 543 [6] P2: Architecture Studio IV: Urban Design ARCH 516, 526, 538, 545				ARCH 6xx[3] P3: BIM Elective 2 Arch. Elective and BIM Cert. Elec. Graduate Status	15
3				ARCH 547_B [12] P4: Sections: C, P, or E Professional Studio ARCH 543, 545, 548			max 12
	S	ARCH 548 [6] Doctorate Project II ARCH 547C, 547P or 547E				ARCH 5xx6xx[3] Arch Elective Graduate Status	max 12
D. ARCH 90 CR + Grad. Cert. in BIM 9 CR =							99

draft date: Oct, 2013

Track A	Certificate Required Courses	D. ARCH - BIM Integration Courses
Minimum (9) CR in Grad. Cert. in BIM + (6) CR in D. Arch Concurrent Electives + (18) CR in D. Arch Integration	Arch 5xx (3) P1: BIM 1 Arch 6xx (3) P3: BIM Elective 1 (Concurrent) Arch 6xx (3) P3: BIM Elective 2 (Concurrent)	Arch 544_B (6) P2: Architecture Studio V Arch 547_B (12) P4: Professional Studio

Cost: Summer \$3000 Tuition for resident & non-resident Student.

Graduate Certification in Building Information Modeling- Track B Program Chart

University of Hawai'i at Mānoa School of Architecture
AY 2013-2014
Graduate Certificate in Building Information Modeling "Track B"- with Professional Architecture Degree
B.Arch, M.Arch or Equivalent

Student Name _____ **ID #** _____ **Advisor Meetings** _____

SEM	DESIGN	TECHNOLOGY	PRACTICE	HIST/THEORY	ELECTIVES	CR
1					ARCH 5xx[3] P1: BIM 1 BIM Cert. Require <i>Graduate Status</i>	ARCH 5xx[3] P1: BIM 2 BIM Cert. Require <i>Graduate Status</i>
	ARCH 544_B [6] P2: Architecture Studio V: Comprehensive <i>ARCH 542, 524</i>				ARCH 6xx[3] P3: BIM Elective 1 BIM Cert. Require <i>Graduate Status</i>	ARCH 6xx[3] P3: BIM Elective 2 Optional BIM Cert. Elec. <i>Graduate Status</i>
Sum						6
Fall						9

draft date: Oct. 2013

Graduate Certification in Building Information Modeling = 15

Cost: Resident Tuition \$8,516.
 Non-Resident Tuition \$15,095.

Track B	Certificate Required Courses	D.Arch - BIM Integration Courses
Minimum (16) CR, possible (18) CR.	Arch 5xx (3) P1: BIM 1 Arch 6xx (3) P3: BIM Elective 1 Arch 5xx (3) P1: BIM 2 Arch 6xx (3) P3: BIM Elective 2 (Optional)	Arch 544_B (6): P2: Architecture Studio V

Graduate Certification in Building Information Modeling- BIM Electives for Track A & B

University of Hawaii Manoa, School of Architecture

Graduate Certificate in Building Information modeling Electives & Concurrent Electives

Track A: Select TWO Elective Courses from those listed below (*Concurrent D.Arch Elective- double count*)

For students admitted to and in good academic standing with a 3.0 GPA or above at the University of Hawai'i at Manoa, School of Architecture, Doctor of Architecture degree program, Track 1 or Track 2.

Track B: Select ONE Elective Course from those listed below

For those previously obtained a professional degree in Bachelor of Architecture (B.Arch), Master of Architecture (M.Arch) or other appropriate degree relating to architectural education.

BIM PROJECT MANAGEMENT

ARCH 66x: BIM Design Process (3)

- Using the full potential of BIM and other software to support decision making from earliest conceptual stages through design and construction, operational life, and demolition.
- Software: Autodesk Revit, Form, Energy Analysis for Autodesk Revit, Green Building Studio, Navisworks Manage.

ARCH 66x: BIM Project Management (3)

- Improve communication throughout the project lifecycle by more securely managing and sharing data with collaborators and stakeholders. Role of BIM Manager or Virtual design to construction (VDC). BIM object-oriented tools, measure performance objectives, schedules take-off and logistics.
- Software: Autodesk Revit, Navisworks Manage, BIM 360 Glue, Vxair, AutoCAD VPS, Building Design Suite Premium, Revit Forms.

BIM CONSTRUCTION MANAGEMENT

ARCH 66x: BIM Construction Process (3)

- Overview, construction modeling, estimating, quantification, coordination, prefabrication.
- Software: Autodesk Revit, Navisworks, BIM 360 Glue, Quantity Takeoff, Building Design Suite, Fabrication, Inventor.

ARCH 66x: BIM Construction Management (3)

- Planning & logistics, coordination, field management, field layout, commissioning and handover.
- Software: Autodesk Navisworks Manage, Constructionw@re, BIM 360 Field for Contractors & Construction Managers, Point Layout, BIM 360 Glue, Buisness, etc.

BIM PRACTICE

ARCH 66x: BIM Internship (3)

- Extended Professional Studio experience beyond the Doctor of Architecture requirements.
- Real world BIM collaboration, implementation and individualized experience.

ARCH 66x: BIM Mentoring (3)

- 2nd Year students in the Graduate Certificate of BIM act to serve as mentors for the 1st year certificate students.
- Training students in leadership and teamwork, while providing opportunities to further their BIM knowledge and experience through problem solving.

BIM SUSTAINABILITY

ARCH 66x: BIM Materials & Fabrication (3)

- BIM interactions, management and tracking of building materials, prototypes, manufacturers, specifications, BIM families and details.
- Software: Autodesk Revit, 3ds Max, Design, Navisworks Simulate, Mudbox.

ARCH 66x: BIM LEED + Sustainability (3)

- In-depth sustainable BIM application focusing on various practices for small, medium and large scale infrastructures that support LEED accreditation.
- Utilizing BIM and related software for achieving various LEED categories.
- Software: Autodesk Revit, Form, Energy Analysis for Autodesk Revit, Green Building Studio, BIM 360 Glue, Point Layout.

BIM Landscape & URBAN DESIGN

ARCH 66x: BIM for Landscape Design (3)

- Complex space planning and construction design of outdoor public areas, landmarks and structures to achieve environmental, social-behavioral, and aesthetic landscapes by implementing BIM, Geographic Information Systems (GIS) and other tools.
- Software: Autodesk Revit, Energy Analysis for Autodesk Revit, Green Building Studio, Google Earth.

ARCH 66x: BIM for Urban Design & Urban Planning (3)

- BIM for Urban Design and Urban Planning by implementing geographic information systems (GIS) and other related information.
- Software: Autodesk Revit, Form, Energy Analysis for Autodesk Revit, Green Building Studio, BIM 360 Glue, Point Layout, Google Earth, AutoCAD civil 3D, Infrastructure Design suite, Infrastructure Map Server, InfraWorks.

BIM RESEARCH

ARCH 66x: BIM History, Theory, Methodologies & Practice (3)

- In-depth history of architectural discipline and progression from 2D to 3D, virtual prototype to parametric modeling.
- Theory of BIM practices in different architecture services and how that is different from traditional architecture practice.

ARCH 66x: BIM Independent Research (3)

- Provide independent research or study opportunities individualized BIM focus.
- Course focus on reviewing topics related to Autodesk Revit Architecture Certification.
- This course is limited to those whom have declared their enrollment in the Graduate Certificate in BIM.

draft date: Oct, 2013

Additional Resources

The certificate program requires the hiring of 1-2 full-time faculty or lecturers. We also hope local BIM firms will participate and take the lead in courses that require BIM expertise and specialization. Most of the courses will be taught by the School of Architecture instructors and University of Hawai'i System affiliates.

The administration of resources will be done by the Physical Officers and the Dean of the School of Architecture. It is estimated that each faculty will cost \$80,000 a year and be required to teach four courses. Lecturers are estimated to cost \$5000 per semester.

Program Effectiveness and Student Learning Assessment

The effectiveness of the certificate program will be measured by demand for the program, completion rates, ratings on course offerings, and completion interviews with those obtaining certificates.

Assessment of student learning will be done through the examinations, judging of BIM practice decisions, assessment of practicum consulting performance, and feedback from supervisors of students doing Professional Studio.

Appropriateness and Relationship to Campus Mission

The courses offered as part of this certificate program include essential skills, knowledge and training that is not yet offered in our graduate degree programs. This applies to most architecture education nationwide. The implementation of the Graduate Certificate in Building Information Modeling integrated within the Doctor of Architecture degree will be one of a kind in the nation. The courses content offer invaluable experience and is an asset for the students.

The Graduate Certificate in Building Information Modeling is consistent with several of the strategic initiatives of the University of Hawai'i Systems.

1. Provide quality college and university education and training.¹⁷²
2. Respond to state needs.¹⁷³
3. Dedicated not only to academic and research excellence but also to serve the local, national and international communities with the aloha spirit.¹⁷⁴
4. Mānoa serves as a portal to an exceptional educational experience while striving to improve quality of life in the region through collaborative partnerships that support innovations in education..., and technological advancement.¹⁷⁵
5. Committed to advancing higher education in the 21st century by innovative use and

¹⁷² *Architecture Program Report*, 3.

¹⁷³ *Architecture Program Report*, 3.

¹⁷⁴ *Architecture Program Report*, 3.

¹⁷⁵ *Architecture Program Report*, 3.

development of practical and efficient technologies.¹⁷⁶

6. Development of global perspectives and interconnections.¹⁷⁷

The proposal of this certificate program was driven by the University's mission of economic development of our state and the fact that University of Hawai'i Systems at Mānoa serves as a portal to an exceptional educational experience while striving to improve quality of life in the region through collaborative partnerships that support innovations in education... and technological advancement.¹⁷⁸

¹⁷⁶ *Architecture Program Report*, 3.

¹⁷⁷ *Architecture Program Report*, 3.

¹⁷⁸ *Architecture Program Report*, 3.

Graduate Certificate in Building Information Modeling for D.Arch Issues and Challenges

The doctoral project, “BIM for D.Arch: Novice to Master”, proposes a Graduate Certificate in BIM for both D.Arch students and those who have previously obtained a professional architecture degree. The proposed certificate serves as the beginning or gateway to an academic architecture program offering similar professional architecture degrees as the Doctor of Architecture degree program at the University of Hawai'i at Mānoa, and could play a role in bridging the gap between the two.

This doctoral research and design project addresses the primary gap between academia and real world architectural practice; technological developments and advancements such as Building Information Modeling. However, it is essential to understand there are multiple ways to address the gap between academia and real world practice. There are also many subcomponents beyond the scope of the project that are noteworthy of further study.

It is impossible for any research and design project to resolve all pertinent issues relating to the topic, and this doctoral project is no exception. Therefore, it is important to point out the following issues and challenges pertaining to this doctoral research and design project:

1. There are multiple ways to bridge the gap between academia and real world architectural practice. The Graduate Certificate in BIM is only one of the possible ways to address this gap.
2. Although Building Information Modeling has become more popularized, some in the profession still exhibit some hesitation in the adoption of BIM. This could be due to many factors, such as lack of available personnel in the firm and the lack of understanding of the structure and design process of BIM.
3. The Graduate Certificate in BIM requires passing multiple approval processes by the University of Hawai'i Systems, University of Hawai'i at Mānoa and School of Architecture. An Authorization to Plan is required and depending on the review outcomes, the certificate course structure and contents might require some adjustments before the roll-out date.
4. For the Graduate Certificate in BIM to flourish, BIM inclusion needs to be part of the regular course work. This requires some initial adjustments to the existing D.Arch degree program core courses. The BIM inclusion content shall at a minimum introducing how BIM are to be implemented in a particular task or process with real world approach or example. (See Appendix K: BIM Inclusion for Existing D.Arch Degree Program)
5. BIM inclusion in existing courses is not enough for a full range real world BIM experience. For the initial certificate roll-out, at minimum, one Architecture Studio shall focus on real world BIM implementation and real world multi-discipline collaboration. The studio design course will require multi-disciplinary professionals with BIM expertise. The studio course requires expensive preparation and planning,

compared to a regular studio course; requiring involvement of the school, various departments and local practitioners. The coordination responsibility will lie heavily on the school of architecture and its faculty. As the certificate program grows, other architecture studios could also offer extensive real world BIM focus, providing early BIM exposure.

6. Students should have the opportunities to explore varieties of BIM related topics. Well rounded BIM and architectural electives are necessary.
7. Extensive real world BIM implementation opportunities are necessary for students to gain real world BIM practice experiences. Practicum and internship should focus on BIM project experience and practice. This requires the school to set detailed guidelines on practicum or internship requirements. The school will also need to implement a detailed selection process, allowing only qualified firms that are able to provide interested students the appropriate mentoring in specific BIM topics.
8. BIM technology is continually improving. In order for the certificate program to ensure the most up-to-date contents, continual monitoring and adjustments of the certificate program courses are required to ensure appropriate course content. To prevent overworking existing faculty and personnel, new hiring may be required, especially as the certificate program grows larger.
9. For the certificate to gain notability and maintain the highest reputation in real world BIM education, the faculty must have extensive BIM education and real world BIM implementation experience. Continual training and education is a must to keep the faculty up-to-date with new practices and methodologies.
10. University of Hawai'i at Mānoa, School of Architecture's physical location presents some disadvantage in retaining qualifying faculty individuals, as housing and the cost of living are higher than many mainland states. However, Hawai'i has the advantage of being the midpoint between East and West and if the University or School of Architecture is able to offer better incentives for qualified individuals and their families, the school could potentially attract or retain qualified individuals from all over the world.
11. The Graduate Certificate in BIM- Track B will be compared to the less costly learning approach; learning on the job or learning through professional software training centers. However, it is important to understand the value of the full certificate program that focuses on the full spectrum of BIM skills, knowledge, techniques, real world implementation and practices, multidisciplinary integration and collaboration. These experiences could take several years on the job or multiple expensive training sessions through training centers before these experience opportunities are presented, if they present themselves at all. It is better to gain the experience through the Graduate Certificate of BIM and be able to apply that experience learned in future projects.

12. Certificate course contents and teaching methods need to be consistent and follow a set of learning theories, such as the “Five Stages of the Mental Activities Involved in Directed Skill Acquisition,” by Dreyfus and Dreyfus. Although a certain amount of support and guidelines are required as part of the course contents, in order for students to progress from novice to master in BIM, it is essential not to over rely on learning aids and guidelines. The course content must provide enough open room for students to explore and become independent, be able to come up with their own ways of problem solving and developing trouble shooting methods. The focus of the learning process should focus on teaching students to seek appropriate methods on their own with appropriate support.
13. The Graduate Certificate in BIM is currently being introduced as an addition to the D.Arch degree program. However, in the future, the certificate should be integrated as part of the standard D.Arch degree program content; real world BIM focus should become the core program content.
14. To ensure program quality and progression, the program should include regular evaluations and feedback from both faculties and students.
15. Finance is a very crucial part of sustaining and maintaining the operation of the certificate program. Strategic marketing emphasizing the benefits of the BIM certificate could provide stable and continuous participant enrollments. These marketing campaign should include ideas from current D.Arch students with the guidance of faculty and local practitioners.

Conclusion

The Reason for the separation between what is being offered in architectural education and real world practice

From the Gilded Age, the Age of Enlightenment, to the Post American Civil War era, the process of basic architecture practice and architecture education has been the same; with the same goals of training one from apprentice to master. All time periods have striven to set definitions, guidelines and regulations for the purpose of defining the profession. The Post American Civil War brought the emergence of a new form of educational institution- universities. Since then, the process has become more organized. The collaboration of organizations such as the American Institute of Architects (AIA), the Association of Collegiate Schools of Architecture (ACSA), National Council of Architectural Registration Boards (NCARB) and the National Architectural Accrediting Board (NAAB), have come together to create an enriching educational experience and maintain development in the conditions of practices that promote the professional standing of the profession.

With the rise of industrialism replacing workshop apprenticeships with drafting rooms, architecture education was divided into two separate parts. First, an education focusing on a course of architectural training with a technical foundation including the arts and sciences followed by obtaining real world practice as an apprentice. Legally, to be an architect, one must obtain a NAAB accredited professional degree or equivalent, completing the Intern Development Program (IDP) and passing the Architect Registration Examination (ARE).

This doctorate research and design project examines the concerns mentioned by the Association of Collegiate Schools of Architecture (ACSA), in which “The distance between what’s happening in architecture schools and what’s happening in practice has never been greater.”¹⁷⁹ Two key causes has been identified by the ACSA educators:

1. There is a discrepancy between what architecture education programs offer and what is required in real-world practice.
2. Real world practice is adopting new technologies at a faster pace than educational programs.

¹⁷⁹ Mortice, “Insight to Practice is Relevant to Design Education.”

Factors inhibiting the adoption and incorporation of current practices and BIM into the architecture education program

Multiple factors inhibit the adoption and incorporation of current practices and BIM into the architecture education program. From the doctoral project research and analysis, some of the factors include:

1. Currently, governing architectural organizations do not have any requirements regarding BIM curriculum. Educational approach, methodology, course content and subjects are left to the university's discretion.
2. Existing credit hours requirements pose some difficulties for post introductory BIM curricula. Most architecture educational programs are already full with required courses.
3. The lack of defined regulations regarding current practices and methodologies as part of the architecture education curricula result in the lack of further BIM inclusion in education programs.
4. Although BIM is being adopted by many in the AEC industry, BIM theories, methodologies and best practices are continuously being developed. This creates some challenges as to how BIM shall be taught in academia.
5. BIM is not a single "model." It is defined as a "design model" and a "construction model," with the ability to exchange information between different software platforms. This will require more resources from educational institutions to provide a holistic education and experience.

Current response to adapting to technological and architectural practice change in architecture education programs

In general, most architecture education programs currently include little to no BIM training in their programs. For the program that include such training, it is usually limited to one introductory course or a BIM integrated studio, but very few offer an extensive BIM inclusion program with real world BIM practice as the focus.

Dennis Shelden, author of, 'Building Information Modeling and Professional Practice,' suggests the influx of new technical, procedural and organizational innovations in the building delivery process is changing the practice of architecture. Due to the many benefits of Building Information Modeling technologies, BIM adoption among those in the architecture profession has increased tremendously.¹⁸⁰ However, from the 2010 ACSA survey, only half of the 53 schools indicated BIM implementation is part of their

¹⁸⁰ Joann Gonchar, "Diving Into BIM."

core curriculum and only 33% of those courses are devoted specifically to BIM.¹⁸¹ Since there are no mandates or requirements for architectural programs to include specific architectural design software within the curricula, BIM in academia is lagging behind, unable to keep up with current architectural practice and resulting in the separation between what is being offered in academia and what is happening in the real world.

Perceptions of practicing architects when it comes to the inclusion of technology training, such as BIM, and its importance in ensuring their preparation for real world practice

According to Phillip G. Bernstein, new technologies such as Building Information Modeling are continually changing the practice of architecture. Less than 10 percent of U.S. architects had heard of Building Information Modeling in 2003, but by 2009, 60 percent were planning on adopting BIM in their practice.¹⁸²

Through the practitioner interview conducted during the Professional Studio-practicum course in Spring 2013, the responses revealed a few ways students could prepare for real world architectural practice such as BIM:

1. With time comes experience; increased real world architecture experience will help one in the understanding of how BIM could and should be applied in various situations.
2. Architectural practice involves multi-disciplinary experience and practices; besides basic architectural knowledge, one should be familiar with building construction; the sequence of real world construction process and the composed layers.
3. It is essential to understand the sequence of BIM and the 'information' in BIM; even the slightest adjustments could change the entire outcome of the project.
4. Scheduling skills are essential---these could be program skills such as Excel and conditional formatting---to take full advantage of scheduling as well as parametric capabilities of Revit/BIM.
5. Understanding the capabilities and limits of Revit is important; one should understand the appropriateness of either modeling an object in 2D or 3D and spatial sense.
6. In the sense of BIM practice, it is important to first learn BIM modeling skills, then gain experience by building actual BIM projects, continuing to test and seek different methods and approaches in various BIM tasks.

¹⁸¹ ACSA, "2010-2011 BIM/IPD Survey Results- Summary May 2011."

¹⁸² Deamer, ed. & Bernstein, ed., *BIM in Academia*, 6.

7. Practices of good workflow, efficient BIM project management, file size and team management are all practice preparation.
8. Learning about various firm BIM standards and guidelines along with the standard from the National Standards for BIM, AIA, National CAD standards and other organizations will help with preparing for an individualized BIM Execution Plan.
9. The practice of clear communication should be taken seriously---one has to be able to think in the progression and sequence of the project and communicate to team members with clear instructions to effectively manage a BIM team.
10. All aspiring BIM student and BIM professionals should continually improve their BIM skills by attending topic specific conferences and seminars; this includes online resources and other resources.

Perceptions of D.Arch students when it comes to the inclusion of technology training, such as BIM, and its importance in ensuring their preparation for real world practice

The responses of the D.Arch Student Questionnaire reveals although fewer students were exposed to Revit and other BIM software, more students were exposed to some type of architectural software before entering the degree program; approximately 69% reported having unofficial Revit/BIM training, this indicate a shift in software trends.

Both groups are fairly consistent in their beliefs of the importance of AutoCAD and Revit training as a way to prepare for real world practice. Although, the results are unable to indicate if participants understand the definition of BIM and the differences between various BIM software components, Revit is ranked as the top software training they believe will help in preparation of the architecture profession.

A combined 76% of total participants believe technology or software skills and training must be acquired before graduating from formal architecture school, followed by teamwork or collaboration skills and leadership skills. All participants but one believe that the inclusion of technology training is important in ensuring preparation for real world practice; only one participant believed technology could potentially “pigeon hole” the design process.

In general, students are becoming more aware of the important role BIM Plays in the architectural profession. Participants shows interest in BIM inclusion in future curricula and believe such training will help prepare them for real world practice.

BIM inclusion in architectural education and enhancement of the architecture profession

As mentioned earlier, there are many aspects in architectural education, professional practice, technological training and technological practices worthy of investigation. This project does not intend to address all of these aspects, but aims to consider approaches in architectural education, particularly relating to BIM education, which have the potential to better prepare graduates for the professional world and to enhance the architecture profession in the future. The focus of this research project is to examine the potential for bridging the gap between academia and real-world architectural technologies and practices by proposing a BIM Certificate Program at the University of Hawai'i at Mānoa, School of Architecture, Doctor of Architecture Degree program.

The Graduate Certificate in Building Information Modeling at the University of Hawai'i at Mānoa, School of Architecture, Doctor of Architecture Degree program utilizes the learning theory "Five Stages of the Mental Activities Involved in Directed Skill Acquisition," developed by Dreyfus and Dreyfus. The certificate provides opportunities for both Doctor of Architecture degree students (Track A), as well as for those who have already completed the Bachelor of Architecture and Master of Architecture degree program (Track B) to gain specific knowledge in the field of BIM. The certificate focuses on the full spectrum of BIM skills, knowledge, techniques, real world implementation and practices, multidisciplinary integration and collaboration. In the profession, it may take numerous real world working hours before the opportunity presents itself, if it happens at all.

Therefore, the certificate program provides valuable learning opportunities within fast paced time frame to maximize opportunities and minimize time duration required in work settings. The certificate is designed for participants to progress through five stages: novice, competent, proficient, expert and master; and through the four mental functions: recollection, recognition, decision and awareness. Participants also have the opportunity to gain skills and knowledge for the Autodesk Certifications.

The Graduate Certificate in Building Information Modeling is not the only part of the program that will include BIM exposure. The Doctor of Architecture degree program will update some of the core courses with early BIM collaborations. In-depth real world BIM collaborations and integration will be the focus of the architectural design studio, focusing on early multi-disciplinary BIM integration. The professional studio of practicum, community design or alternative experience will focus on real world BIM collaborations and practice, in which participants will be mentored and learn by getting involved in the real world BIM setting.

The Graduate Certificate in Building Information Modeling (BIM) objectives include:

1. Addressing the need to bridge the gap between what is being offered in architectural education and real world practice while retaining NAAB accreditation.
2. Recognition that BIM technology is changing the architecture profession and the need for BIM inclusion in architectural education and training.
3. Addressing the need for both students and practicing professionals to stay current with architectural technology such as BIM.
4. Proposing early BIM inclusion in the Doctor of Architecture degree program.
5. Building Information Modeling education and training focusing on real world implementation and practice.
6. Providing a balanced learning environment by encouraging progression through various skills/learning development stages.
7. Advancing and improving performance without being stifled by overly sophisticated aids.
8. Ensuring BIM application skills progression from novice to master through core and elective courses providing training, mentoring, self-direction and self-evaluation opportunities.
9. Gaining knowledge and opportunities in obtaining official software certification credentials along with the Graduate Certificate in Building Information Modeling and Doctor of Architecture degree program.
10. Enabling adaption to future technological changes.

Current challenges and issues in the incorporation of BIM in architectural education

There are many challenges and issues in the incorporation of BIM in architectural education; due to varying views on BIM inclusion in academia, the lack of governing requirement on BIM inclusion in academia, individual institutional requirements and restrictions. It is impossible to avoid or resolve all challenges and issues in the subject. However, it is clear that the development of technology such as BIM as one of the main reasons for the gap between academia and real world architectural practice. In order to bridge this gap, academia has to adopt and initiate changes in its curriculum to better meet the technological changes and demands.

By proposing a Graduate Certificate in Building Information Modeling at the Doctor of Architecture degree program, it is the hope of this project to bring awareness and bridge the gap of what is being offered in academia and what is happening in the real architectural world and help graduates to progress from novice to master in the BIM sector.

Self-assessment of Doctoral Project

The doctorate project is meant to serve as the beginning of an attempt in bring awareness to the primary reason for the gap between architectural education and real world architectural practice. The project propose the solution of a Graduate Certificate in Building Information Modeling that the Doctor of Architecture degree program could institute to bridge this gap and enhance the learning experience for students. Similar certificates could be implemented in other institutions with the same focus on the importance of BIM education. Although, the project proposes a certificate as an addition to existing architectural curricula, it is necessary for the certificate to phase out and become embedded as the core of the degree program in the future.

The doctoral research and design project has met its objectives, goals and provided a feasible method for addressing the issues mentioned. It is my hope that further analysis and development in the near future could bring the certificate to life, making the University of Hawai'i at Mānoa and School of Architecture, Doctor of Architecture degree program an even more unique program than it already is and provide graduates of the program the opportunity to be leaders in BIM technology and practices.

APPENDIX

- Appendix A: Doctor of Architecture Degree (D.Arch) 90 hour credits- with pre-professional degree
- Appendix B: Doctor of Architecture Degree (D.Arch) 108 hour credits- without pre-professional degree
- Appendix C: Doctor of Architecture Degree (D.Arch) 90 hour credits + Global Track China Focus
- Appendix D: Graduate Certificate in Historical Preservation
- Appendix E: Autodesk Revit Architecture Certified User and 2014 Certified Professional
- Appendix F: University of Hawai'i Executive Policy E5.205 Academic Minors and Certificate Credentials
- Appendix G: University of Hawai'i Executive Policy E5.201 Approval of New Academic Programs and Review of Provisional Academic Programs
- Appendix H: University of Hawai'i Authorization to Plan Template
- Appendix I: University of Hawai'i Graduate Certificates Proposal Outline
- Appendix J: Academic Subject Certificate Programs Procedures and Guidelines
- Appendix K: BIM Inclusion for Existing D.Arch Degree Program

**Appendix A: Doctor of Architecture Degree (D.Arch) 90 hour credits-
with pre-professional degree**

**University of Hawai'i at Mānoa School of Architecture
D. ARCH. PROGRAM CHART - with Pre-Professional Undergraduate Degree**

AY 2013-2014

Student Name _____ **Advisor Meetings** _____

ID # _____

undergraduate 120 credits

YR	SEM	DESIGN	TECHNOLOGY	PRACTICE	HIST/THEORY	ELECTIVES	CR
1	F	ARCH 541 [6] Architecture Studio II Medium Buildings in Site Graduate Status	ARCH 523 [3] Architecture Systems II Wood & Steel Graduate Status: PHYS 151+L		ARCH 515 [3] Asia-Pacific Arch History & Theory Graduate Status	ELEC 5x6xx[3] Open Elective University Wide Graduate Status	18
	S	ARCH 542 [6] Architecture Studio III Large Buildings ARCH 523, 533, 541	ARCH 524 [3] Architecture Systems III: Conc. & Masonry ARCH 523	ARCH 539 [3] Research Methods Seminar ARCH 515, 541		ARCH 5x6xx[3] Arch Elective Graduate Status	18
2	F	ARCH 544 [6] Architecture Studio V: Comprehensive ARCH 542, 524	ARCH 526 [3] Architecture Systems V: Integration ARCH 515, 524, 525, 542	ARCH 545 [3] Advanced Practice ARCH 524, 533	ARCH 516 [3] Arch & Urban Design Theory Graduate Status	ARCH 5x6xx[3] Arch Elective Graduate Status	18
	S	ARCH 543 [6] Architecture Studio IV: Urban Design ARCH 542, 524					max 12
3	F			ARCH 547 [12] Sections: C, P, or E Professional Studio ARCH 543, 545, 546			max 12
	S					ARCH 5x6xx[3] Arch Elective Graduate Status	max 12
TOTAL							90

print date: 28 May 2013

Year 1 (Fall) 18 credits

ARCH 541 Architecture Studio II (6): Design of a medium complexity building and site engaging social, cultural, codes, building systems, and sustainable design. Production of program and schematic design documents. Individual projects. ARCH majors only. A-F only. Pre: 540.

ARCH 533 Advanced Design Communication II (3): An interdisciplinary investigation of design theory as connected to digital technology and its applications to current developments in practice and research within architecture and design. ARCH majors only. A-F only. Pre: 531.

ARCH 523 Architecture Systems II: Wood and Steel (3): Properties, evolution, and range of wood and steel and their use in structural systems and the ability to assess, select design, and integrate structural systems into building design. ARCH majors only. A-F only. Pre: 522.

ARCH 515 Asia-Pacific Architectural History and Theory (3): Study of the history and theory of culture and the built environment with particular focus on the Asia-Pacific region. ARCH majors only. A-F only. Pre: 571. ELEC 5XX/6XX - - (3): Open University Elective

Year 1 (Spring) 18 credits

ARCH 542 Architecture Studio III (6): Design of complex, large scale building and site engaging social, cultural, code, sustainable systems, and acoustic issues. Production of schematic and design development documents. ARCH majors only. A-F only. Pre: 523, 533, and 541.

ARCH 524 Architecture Systems III: Concrete and Masonry (3): Properties, evolution, and range of masonry, concrete and advanced composites and their use in structural systems and the ability to assess, select design, and integrate structural systems into building design. ARCH majors only. A-F only. Pre: 523.

ARCH 525 Architecture Systems IV: Sustainability (3): Qualitative and quantitative investigation of sustainable building systems with emphasis on integrated high-performance building design and operation, innovative mechanical systems, resource conservation, and renewable energy systems. ARCH majors only. A-F only. Pre: 523

ARCH 539 Research Methods Seminar (3): Comprehensive assessment of objectives and

function of research in architecture. Lecture, seminar, independent work with emphasis on doctorate project topic and proposal development. ARCH majors only. A-F only. Pre: 515 and 541 ARCH

5XX/6XX - - (3): Architecture Elective

Year 2 (Fall) 18 credit

ARCH 544 Architecture Studio V Comprehensive Design (6): Design and programming for a moderately complex building and site. Production of design development and partial construction documents describing sustainable building assemblies and construction cost. ARCH

majors only. A-F only. Pre: 515, 524, 525, and 542.

ARCH 526 Architecture Systems V: Integration (3): Properties, evolution, and range of building materials, assemblies, and systems and their applications in integrated high-performance building design with a focus on the role of detail and systems in the design process. ARCH majors only. A-F only. Pre: 515, 524, 525, and 542.

ARCH 545 Advanced Practice (3): Comprehensive study of architectural practice investigating architect's response to global forces, including entrepreneurial practice, office organization, project delivery, compensation, and construction law. ARCH majors only. A-F only. Pre: 524, 525, and 533.

ARCH 516 Architecture and Urban Design Theory (3): Detailed investigation of major theories in architecture and urban design and examination of their impact on contemporary architectural practice in varied geo-political contexts. Open to non-majors. A-F only. Pre: 515.

ARCH 5XX/6XX - - (3): Architecture Elective

Year 2 (Spring) 12 credits

ARCH 543 Architecture Studio IV: Urban Design (6): Urban design focused on Asian cities investigating social, cultural, political, and technological factors; study of historical precedents, building/block typology, circulation, infrastructure, and context response. ARCH majors only. A-F only. Pre: 524 and 542.

ARCH 546 Doctorate Project I (6): Individual development of a doctorate project with an approved chair and doctorate project committee that advances architectural knowledge through analysis, research, scholarship, and design. Repeatable three times. ARCH majors only.

A-F only. Pre: 515, 516, 526, and 545. (Spring only)

Year 3 (Fall) 12 credits

ARCH 547 Professional Studio V (12): Scholarly and research activity combined with professional experience occurring in an off-campus location. (C) community design; (E) alternative; (P) practicum. Repeatable three times. ARCH majors only. A-F only. Pre: 543, 545, and 546. Year 3 (Spring) 12 credits

ARCH 548 Doctorate Project II (6): Individual development of a doctorate project with an approved committee that advances architectural knowledge through research, scholarship, design, and engages theoretical and architectonic propositions. ARCH majors only. A-F only. Pre:

547C or 547E or 547P. (Spring only)

ARCH 5XX/6XX - - (3): Architecture Elective

ARCH 5XX/6XX - - (3): Architecture Elective

(Architecture Program Report, 50-52)

**Appendix B: Doctor of Architecture Degree (D.Arch) 108 hour credits-
without pre-professional degree**

University of Hawai'i at Mānoa School of Architecture
D. ARCH. PROGRAM CHART - with Non Pre-Professional Undergraduate Degree

AY 2013-2014

Student Name					ID#	entry semester		undergraduate 120 credits	
SEM	DESIGN	TECHNOLOGY	PRACTICE	HIST/THEORY					
UG Required	ARCH 101[4] Basic Arch Studio If portfolio inadequate in basic design	MATH 140 [3]	PHYSICS 151+L [4]						Undergraduate credits do not count toward graduate degree
F									
S	ARCH 540 [6] Architecture Studio I: Small Building Graduate Status	ARCH 322 [3] Architecture Systems I: Intro to Systems Math 140 or Concurrent		ARCH 571 [3] World Architecture History & Theory Graduate Status	ARCH 5xx6xx [3] Graduate Status				
Boot Camp									18
1	ARCH 541 [6] Architecture Studio II: Medium Buildings in Site Graduate Status	ARCH 323 [3] Architecture Systems II: Wood & Steel Graduate Status; PHYS 161+L		HIST/THEORY ARCH 515 [3] Asia-Pacific Arch History & Theory Graduate Status	ELECTIVES ELEC 5xx6xx[3] Open Elective University Wide Graduate Status				18
S	ARCH 542 [6] Architecture Studio III: Large Buildings ARCH 523, 533, 541	ARCH 324 [3] Architecture Systems III: Conc. & Masonry ARCH 523	ARCH 539 [3] Research Methods Seminar ARCH 515, 541		ARCH 5xx6xx[3] Arch Elective Graduate Status				18
2	ARCH 544 [6] Architecture Studio V: Comprehensive	ARCH 326 [3] Architecture Systems V: Integration ARCH 515, 524, 525, 542	ARCH 545 [6] Advanced Practice ARCH 524, 539	ARCH 516 [3] Arch & Urban Design Theory Graduate Status	ARCH 5xx6xx[3] Arch Elective Graduate Status				18
S	ARCH 543 [6] Architecture Studio IV: Urban Design ARCH 542, 524								max 12
3			ARCH 547 [12] Sections: C, P, or E Professional Studio ARCH 543, 545, 546						max 12
S					ARCH 5xx6xx[3] Arch Elective Graduate Status				max 12
TOTAL 108									

Effective July 2013.

effective July 2013

Table B-1. 108 credit hours D.Arch Program Chart- without Pre-Professional Undergraduate Degree.

Pre-Entry Fall

ARCH 201 Architecture Studio (4): Development of designs and processes to explore solutions responding to human needs in the built and natural environment with emphasis on analysis and representation architectonic space and form using hand and computer techniques. A-F only.

Pre: 132 and either ART 113 or ART 116. DA

Pre-Entry Spring

ARCH 522 Architecture Systems I- Introduction to Systems (3): Study of building materials, assemblies, and integrated design including structural, environmental, life-safety, and building envelope systems. Development of ability to design, analyze and assess appropriate systems.

ARCH majors only. A-F only. Pre: departmental approval.

ARCH 531 Advanced Design Communication I (3): Exploration of digital technologies, their relationship to design, and their application to architectural analysis, conceptualization, design processes, communication, representation, and construction. ARCH majors only. A-F only. Pre: departmental approval.

ARCH 540 Architecture Studio I: Intro to Design (6): Design theories and systematic analytic and synthetic methodologies applied to creation of building and site spaces responsive to environmental and human needs. Several individual projects. ARCH majors only. A-F only.

ARCH 571 Architecture History (3): Investigation of architectural history and theory in the world from antiquity to present. Examining social, political, technological, material, and environmental forces. ARCH majors only. A-F only.

ARCH 5XX/6XX - - (3): Architecture Elective

Other Pre-Entry Requirements

ART 113 Introduction to Drawing (3): Descriptive, expressive, and formal aspects of visual language through drawing practice.

MATH 140 Pre-calculus (3): Functions, with special attention to polynomial, rational, exponential, logarithmic, and trigonometric functions, plane trigonometry, polar coordinates, conic sections. Credit allowed for either 135 or 140. Pre: 135 or 161 or assessment exam.

PHYS 151 College Physics I (3): Non-calculus physics. Mechanics, wave motion, heat. Pre: A grade of C in MATH 140 or pre-physics assessment.

PHYS 151L College Physics Lab I (1) (1 3-hr Lab): Introduction to experimental analysis, physical observation and measurement, experiments on conservation laws, fluid friction, oscillations. Pre: 151 (or concurrent).

Year 1 (Fall) 18 credits

ARCH 541 Architecture Studio II (6): Design of a medium complexity building and site engaging social, cultural, codes, building systems, and sustainable design. Production of program and schematic design documents. Individual projects. ARCH majors only. A-F only. Pre: 540.

ARCH 533 Advanced Design Communication II (3): An interdisciplinary investigation of design theory as connected to digital technology and its applications to current developments in practice and research within architecture and design. ARCH majors only. A-F only. Pre: 531.

ARCH 523 Architecture Systems II: Wood and Steel (3): Properties, evolution, and range of wood and steel and their use in structural systems and the ability to assess, select design, and integrate structural systems into building design. ARCH majors only. A-F only. Pre: 522.

ARCH 515 Asia-Pacific Architectural History and Theory (3): Study of the history and theory of culture and the built environment with particular focus on the Asia-Pacific region. ARCH majors only. A-F only. Pre: 571. ELEC 5XX/6XX - - (3): Open University Elective

Year 1 (Spring) 18 credits

ARCH 542 Architecture Studio III (6): Design of complex, large scale building and site engaging social, cultural, code, sustainable systems, and acoustic issues. Production of schematic and design development documents. ARCH majors only. A-F only. Pre: 523, 533, and 541.

ARCH 524 Architecture Systems III: Concrete and Masonry (3): Properties, evolution, and range of masonry, concrete and advanced composites and their use in structural systems and the ability to assess, select design, and integrate structural systems into building design. ARCH majors only. A-F only. Pre: 523.

ARCH 525 Architecture Systems IV: Sustainability (3): Qualitative and quantitative investigation of sustainable building systems with emphasis on integrated high-performance building design and operation, innovative mechanical systems, resource conservation, and renewable energy systems. ARCH majors only. A-F only. Pre: 523

ARCH 539 Research Methods Seminar (3): Comprehensive assessment of objectives and function of research in architecture. Lecture, seminar, independent work with emphasis on doctorate project topic and proposal development. ARCH majors only. A-F only. Pre: 515 and 541 ARCH

5XX/6XX - - (3): Architecture Elective

Year 2 (Fall) 18 credit

ARCH 544 Architecture Studio V Comprehensive Design (6): Design and programming for a moderately complex building and site. Production of design development and partial construction documents describing sustainable building assemblies and construction cost. ARCH

majors only. A-F only. Pre: 515, 524, 525, and 542.

ARCH 526 Architecture Systems V: Integration (3): Properties, evolution, and range of building materials, assemblies, and systems and their applications in integrated high-performance building design with a focus on the role of detail and systems in the design process. ARCH majors only. A-F only. Pre: 515, 524, 525, and 542.

ARCH 545 Advanced Practice (3): Comprehensive study of architectural practice investigating architect's response to global forces, including entrepreneurial practice, office organization, project delivery, compensation, and construction law. ARCH majors only. A-F only. Pre: 524, 525, and 533.

ARCH 516 Architecture and Urban Design Theory (3): Detailed investigation of major theories in architecture and urban design and examination of their impact on contemporary architectural practice in varied geo-political contexts. Open to non-majors. A-F only. Pre: 515.

ARCH 5XX/6XX - - (3): Architecture Elective

Year 2 (Spring) 12 credits

ARCH 543 Architecture Studio IV: Urban Design (6): Urban design focused on Asian cities investigating social, cultural, political, and technological factors; study of historical precedents, building/block typology, circulation, infrastructure, and context response. ARCH majors only. A-F only. Pre: 524 and 542.

ARCH 546 Doctorate Project I (6): Individual development of a doctorate project with an approved chair and doctorate project committee that advances architectural knowledge through analysis, research, scholarship, and design. Repeatable three times. ARCH majors only.

A-F only. Pre: 515, 516, 526, and 545. (Spring only)

Year 3 (Fall) 12 credits

ARCH 547 Professional Studio V (12): Scholarly and research activity combined with professional experience occurring in an off-campus location. (C) community design; (E) alternative; (P) practicum. Repeatable three times. ARCH majors only. A-F only. Pre: 543, 545, and 546. Year 3 (Spring) 12 credits

ARCH 548 Doctorate Project II (6): Individual development of a doctorate project with an approved committee that advances architectural knowledge through research, scholarship, design, and engages theoretical and architectonic propositions. ARCH majors only. A-F only.

Pre:

547C or 547E or 547P. (Spring only)

ARCH 5XX/6XX - - (3): Architecture Elective

ARCH 5XX/6XX - - (3): Architecture Elective

(Architecture Program Report, 50-52)

(¹⁸³ ¹⁸⁴ ¹⁸⁵ ¹⁸⁶ ¹⁸⁷)

¹⁸³ *Architecture Program Report*, 50-52.

¹⁸⁴ "Architecture (ARCH)."

¹⁸⁵ "Art and Art History (ART)," The University of Hawai'i at Mānoa, 2013-2014 Catalog, accessed October 2, 2013, <http://www.catalog.hawaii.edu/courses/departments/art.htm>.

¹⁸⁶ "Mathematics (MATH)," The University of Hawai'i at Mānoa, 2013-2014 Catalog, accessed October 2, 2013, <http://www.catalog.hawaii.edu/courses/departments/math.htm>.

¹⁸⁷ "Physics (PHYS)," The University of Hawai'i at Mānoa, 2013-2014 Catalog, accessed October 2, 2013, <http://www.catalog.hawaii.edu/courses/departments/phys.htm>.

**Appendix C: Doctor of Architecture Degree (D.Arch) 90 hour credits +
Global Track China Focus**

Fall 2012

GT2

University of Hawai'i at Mānoa School of Architecture
D. ARCH. PROGRAM CHART - GLOBAL TRACK CHINA FOCUS

Student Name _____

ID # _____

YR SEM		DESIGN		TECHNOLOGY		PRACTICE	HIST/THEORY	ELECTIVES	Pre-architecture undergraduate 120 credits	
		ARCH 541 [6] Architecture Studio II Medium Buildings in Site	ARCH 533 [3] Design Communication II	ARCH 523 [3] Architecture Systems II Wood & Steel	ARCH 525 [3] Architecture Systems IV: Sustainability Seminar	ARCH 538 [3] Research Methods Seminar	ARCH 516 [3] Arch & Urban Design Theory		Tongji Students F13+	UHM Students F12
1	F	Graduate Status	Graduate Status	Graduate Status			Graduate Status			15
	S	ARCH 542 [6] Architecture Studio III Large Buildings		ARCH 524 [3] Architecture Systems III: Conc. & Masonry	ARCH 523	ARCH 541 ARCH 516, 541				15
	Sum					ARCH 547T [6] Professional Studio: China				
Required UHM Students										
2	F	ARCH 543 [6] Architecture Studio IV: Urban Design	ARCH 546C [3] Doctorate Project I: A				ARCH 515 [3] Asia-Pacific Arch History		ARCH 690 [3] English Language Tongji Students Only	Chinese Tongji MArch Requirement
	S	ARCH 544 [6] Architecture Studio V: Comprehensive	ARCH 546G [3] Doctorate Project I: B	ARCH 526 [3] Architecture Systems V: Integration					ARCH 690 [3] American Culture Tongji Students Only	Chinese Culture Tongji MArch Requirement
		ARCH 542, 524	ARCH 547C	ARCH 516, 524, 525, 542					Graduate Status	Graduate Status
	Sum					ARCH 547B [6] Professional Studio: Community Design				
Required Tongji Students										
3	F	ARCH 550G [6] Global Architecture DArch Studio				ARCH 545 [3] Advanced Practice	ARCH 5x6xx [3] Arch Elective	ARCH 5x6xx [3] Arch Elective		8
	S		ARCH 548H [6] Doctorate Project II A			ARCH 555 [3] Advanced Global Practice	ARCH 5x6xx [3] Arch Elective	ARCH 5x6xx [3] Arch Elective		15
			ARCH 546G			ARCH 545	Graduate Status	Graduate Status		15
									UHM Students	Tongji Students
									TOTAL	90 + Tongji 98

Table _ : _ 90 credit hours D.Arch Program Chart + Global Track China Focus.
http://www.arch.hawaii.edu/pdf/program%20chart_Tongji%20GT2.pdf

Doctor of Architecture Degree (D.Arch) 90 hour credits- Global Track: China Focus

Year 1 (Fall) 15 credits

ARCH 541 Architecture Studio II (6): Design of a medium complexity building and site engaging social, cultural, codes, building systems, and sustainable design. Production of program and schematic design documents.

ARCH 533 Advanced Design Communication II (3): An interdisciplinary investigation of design theory as connected to digital technology and its applications to current developments in practice and research within architecture and design.

ARCH 523 Architecture Systems II: Wood and Steel (3): Properties, evolution, and range of wood and steel and their use in structural systems and the ability to assess, select design, and integrate structural systems into building design.

ARCH 516 Architecture and Urban Design Theory (3): Detailed investigation of major theories in architecture and urban design and examination of their impact on contemporary architectural practice in varied geo-political contexts.

Year 1 (Spring) 15 credits

ARCH 542 Architecture Studio III (6): Design of complex, large scale building and site engaging social, cultural, code, sustainable systems, and acoustic issues. Production of schematic and design development documents.

ARCH 524 Architecture Systems III: Concrete and Masonry (3): Properties, evolution, and range of masonry, concrete and advanced composites and their use in structural systems and the ability to assess, select design, and integrate structural systems into building design.

ARCH 525 Architecture Systems IV: Sustainability (3): Qualitative and quantitative investigation of sustainable building systems with emphasis on integrated high-performance building design and operation, innovative mechanical systems, resource conservation, and renewable energy systems.

ARCH 539 Research Methods Seminar (3): Comprehensive assessment of objectives and function of research in architecture. Lecture, seminar, independent work with emphasis on doctorate project topic and proposal development.

Year 1 (Summer) 6 credits (required to be in China for UHM students)

ARCH 547T Professional Studio: China (6): Scholarly and research activity combined with professional experience occurring in an off-campus location. (C) community

design; (E)
alternative; (P) practicum.

Year 2 (Fall) 12 credits (Tongji University)

ARCH 544 Architecture Studio V: Comprehensive Design (6): Design and programming for a moderately complex building and site. Production of design development and partial construction documents describing sustainable building assemblies and construction cost.

ARCH 526 Architecture Systems V: Integration (3): Properties, evolution, and range of building materials, assemblies, and systems and their applications in integrated high-performance building design with a focus on the role of detail and systems in the design process.

ARCH 546C Doctorate Project I (3): China: Individual development of a doctorate project with an approved chair and doctorate project committee that advances architectural knowledge through analysis, research, scholarship, and design. (C) China, (G) Global, (H) Hawaii. CHINESE LANGUAGE- (3)

Year 2 (Spring) 12 credits (Tongji University)

ARCH 543 Architecture Studio IV: Urban Design (6): Urban design focused on Asian cities investigating social, cultural, political, and technological factors; study of historical precedents, building/block typology, circulation, infrastructure, and context response.

ARCH 546G Doctorate Project I (3): Global: Individual development of a doctorate project with an approved chair and doctorate project committee that advances architectural knowledge through analysis, research, scholarship, and design. (C) China, (G) Global, (H) Hawaii.

ARCH 515 Asia-Pacific Architectural History and Theory (3): Study of the history and theory of culture and the built environment with particular focus on the Asia-Pacific region.

CHINESE CULTURE - (3)

Year 2 (Summer) 6 credits (optional for UHM students; required for Tongji students)

ARCH 547B Professional Studio: Business (6): Scholarly and research activity combined with professional experience occurring in an off-campus location. (C) community design; (E) alternative; (P) practicum.

Year 3 (Fall) 15credits

ARCH 550G Architecture Studio: Global (6): Urban design focused on investigating social, cultural, political, and technological factors; study of historical precedents, building/block typology, circulation, infrastructure, and context response; (C) China, (G) Global.

ARCH 545 Advanced Practice (3): Comprehensive study of architectural practice investigating architect's response to global forces, including entrepreneurial practice, office organization, project delivery, compensation, and construction law.

ARCH 5XX/6XX - - (3): Architecture Elective

ARCH 5XX/6XX - - (3): Architecture Elective

Year 3 (Spring) 15 credits

ARCH 548 H Doctorate Project II (6): Individual development of a doctorate project with an approved committee that advances architectural knowledge through research, scholarship, design, and engages theoretical and architectonic propositions.

ARCH 555 Advanced Global Practice (3): Comprehensive study of architectural practice investigating architect's response to global forces, including entrepreneurial practice, office organization, project delivery, compensation, and construction law.

ARCH 5XX/6XX - - (3): Architecture Elective

(¹⁸⁸ Architecture Program Report, 33-53)

¹⁸⁸ "Architecture (ARCH)."

Appendix D: Graduate Certificate in Historical Preservation

Program Courses | University of Hawai'i at Mānoa | American Studies

American Studies

AT THE UNIVERSITY OF HAWAI'I AT MĀNOA

ABOUT US ■ UNDERGRADUATE ■ GRADUATE ■ HISTORIC PRESERVATION ■ MUSEUM STUDIES

COURSES ■ PEOPLE ■ COMMUNITY ■ FORMS ■ NEWS & EVENTS ■ CONTACT



Program Courses

AMST 423 History of American Architecture

(Cross-listed as ARCH 473)

Course description: This is a basic introduction to the history and range of American architecture. Coverage is given to both "designed" and "vernacular" examples of buildings and surroundings, with principle emphasis on well-known American buildings. In addition to buildings and built environments of the continental U.S., the course will also discuss buildings in Hawai'i, the Caribbean and Panama, the Philippines, and other Asian-Pacific countries and islands influenced by North American architectural traditions and practice. Both lectures and readings will emphasize the ways in which cultural identity and aspirations are expressed in architecture. It will also treat the impacts of materials and technology upon architectural forms.

Course Requirements: This course carries an oral communication focus designation (O).

Students will be required to make a significant oral contribution to the class. This will involve active discussion of readings and presentation of ideas as well as a formal oral presentation of their term paper in the context of an "architect/client" presentation. In addition, students will give two short presentations on current events in architecture. The oral communication focus will enable students to prepare for careers in architecture, planning, American Studies and other fields. Students will be encouraged to use audio and/or visual aids to assist in their presentations.

AMST 474 Preservation: Hawai'i, Asia and the Pacific

Course description: This course is an overview of issues in conservation and historic preservation facing peoples of Hawai'i, Asia, and the Pacific. The course covers the range of historic and cultural resources found in the region, steps taken in the past to preserve these resources and

Historic Preservation

THE FIELD

HISTORIC PRESERVATION AT THE UHM

ADMISSION GUIDELINES

PROGRAM COURSES

PEOPLE

SUMMER PRESERVATION FIELD SCHOOLS

COMMUNITY

COOPERATING INSTITUTIONS

ORGANIZATIONS AND PARTNERS

ALUMNI

PROJECTS

RESOURCES

NEWS & EVENTS

DOWNLOADS

2013 EXPERTS LECTURE SERIES

EMPLOYMENT & INTERNSHIPS



<http://manoa.hawaii.edu/amst/historic-preservation/program-courses/>[10/24/2013 10:49:07 PM]

present threats to their preservation. Issues of past colonial interventions, the rights of indigenous peoples to have a say in what is preserved and how, and the means by which traditional cultures might best be saved and recognized are treated in detail throughout the course.

Course Requirements: This course carries an oral communication focus designation (O). Students will be required to make a significant oral contribution to the class. This will involve active discussion of readings and presentation of ideas as well as a formal oral presentation of their term paper. In addition, students will give two short presentations: these are a book report and a "regional report" on the geography and cultural and heritage resources of a particular region in the Asia-Pacific area. The oral communication focus will enable students to prepare for careers in tourism, heritage conservation and management, architecture, planning, American Studies and other fields. Students will be encouraged to use audio and/or visual aids to assist in their presentations.

ANTH 645 Historic Preservation

Course Description: Historic and cultural resources are now covered by a raft of federal and local historic preservation laws. The intent of these laws is to protect and to encourage the wise management and preservation of these significant resources. In the first part of the seminar, the various laws and associated regulations together with their combined impact on historic properties will be presented and discussed. In the second half of the course, we assess and critique the various components of historic preservation, including concepts and ethics as they apply to historic preservation. **Course Requirements:** Students are expected to actively participate in each class meeting. There is a midterm exam following the first part of the course; students undertake a written research project pertaining to historic preservation during the latter half of the class.

AMST 675 Preservation: Theory and Practice

(Cross-listed as ARCH 628 and PLAN 675)

Course Description: This course serves as a basic introduction to the field of historic preservation. Students will be introduced to the language of the field, will come to understand key concepts and assumptions and will become familiar with the overall background of the subject. Emphasis will be placed on the history of historic preservation in the U.S. and in other countries, on basic theoretical precepts and on current practice. Subjects include the role of house museums in historic preservation, historic districts and their regulation, architectural and other resource surveys, the National Register program, historic preservation law, the relationship of preservation to planning, the economics of preservation and landscape and rural preservation. Historic preservation, as students will come to realize, is a many faceted subject, touching upon art, social values, economics and law. However, the discipline remains strongly tied to architecture and planning; and these core interests will continue to take priority in the course.

Course Requirements: The course combines lectures and in-class discussions, together with short field exercises and a research project. Students will be expected to attend class sessions and participate in discussions and question periods. Weekly reading assignments will serve as a basis for classroom discussions; so students are expected to come to class prepared. The course includes a mid-term exam, submission of the results of the field exercise and preparation of a National Register nomination, which will substitute for a term paper, and a Final Exam.

AMST 676 Recording Historic and Cultural Resources

(Cross-listed as ARCH 676 and PLAN 676)

Course Description: The course is intended to familiarize students with the basic techniques used in the recording and evaluation of historic buildings and other cultural features. Emphasis will be on field survey methods, the compilation of inventories, and evaluations of significance and/or integrity. Students will become familiar with State of Hawai'i's own survey and registration process, with both inventories and methodologies for field surveys of cultural resources in other states and countries, and will also be introduced to the requirements of the National Register of Historic Places Program of the federal government. There will be further introductions to basic architectural and other historic resource descriptive terminology, methods of researching the history and contexts of historic properties, and some training in the preparation of site plans.

Course Requirements: Students will be required to complete a short preparatory exercise, either involving the compilation of research materials or a brief synopsis of research (approximately 10 pages); and to participate in a relatively extensive field exercise. As a lecture/laboratory (or studio/practicum) course, students will be expected to devote at least 3 hours a week to the field component of the project. There will also be weekly reading assignments and short exercises, several quizzes, as well as classroom presentations.

AMST 677 Historic Preservation Planning

(Cross-listed as PLAN 677)

Course Description: Local-level historic preservation, with an emphasis on historic districts, design guidelines, regulatory controls and community consensus-building. Methods and approaches in the identification and regulation of historic districts and landmarks. Taught as a combination of lectures, discussions and field exercises, the course will provide students with an understanding of how to survey historic districts, establish boundaries, draft design guidelines and write local preservation ordinances. Emphasis will be placed on legal considerations, community concerns, including the problem of displacement, and the regulatory process.

Course Requirements: The course is delivered in a combined lecture, discussion and field exercise format. Students will be expected to attend class regularly, participate in class discussions and contribute to a class project focusing on a local community. Students will be given weekly reading assignments, research tasks and field exercises. The final product will be a class report to which each student is expected to contribute. There will be also short midterm and final examinations.

Recommended Prerequisites: Historic Preservation; Survey and Theory (AmSt 675) and Recording Historic Resources (AmSt 676). Cultural Resource Management (Anth 645), History of American Architecture (AmST 623), and The American City (AmSt 627) would also be useful prior courses, but are not required.

AMST 679 Elements of Style

(Cross-listed as ARCH 679)

Course Description: The course is an in-depth examination of the manifestations, visual characteristics and social/cultural meaning of "style" in American architecture and decorative arts from the early settlement period through the present. The course covers the basic issues, such as

"what is style?" (or is there such a thing as "style?"), the terminology of architectural description and the persistence of classical tradition in both architecture and furniture and furnishings. Students will be introduced to the full range of "style" terminology and also to specialized terminology for architectural and decorative components. The course will trace not only furnishings but the "assemblage" of parts, particularly for interiors through which a sense of "style" is conveyed. The course is seen as a complement to AmSt 681, American Vernacular Traditions, which treats more persistent formal characteristics of architecture. Nonetheless, the "vernacular" meanings of stylistic expression are not ignored. The course will also introduce students to some of the key architects, furniture makers, and decorators in each period, though the emphasis will remain on more anonymous expressions. One or more field trips will also be scheduled.

Course Requirements: The course combines lectures and in-class discussions with a research project/paper (see above). Students will be expected to attend class sessions and participate in discussions and question periods. Weekly reading assignments will serve as a basis for classroom discussions, so students are expected to come to class prepared. The course includes a short quiz, a mid-term exam, the research project/paper and its presentation in class, and a final exam.

AMST 680 Historic Building Technology

Course Description: History of buildings, building technologies, materials, and finishes, including construction techniques and methods of investigating older buildings, with an emphasis on North American building practices c.1600-c.1960.

Course Requirements: The course combines lectures and in-class discussions with a research project/paper (see above). Students will be expected to attend class sessions and participate in discussions and question periods. Weekly reading assignments will serve as a basis for classroom discussions, so students are expected to come to class prepared. The course includes a short quiz, a mid-term exam, the research project/paper and its presentation in class, and a final exam.

Recommended Prerequisites: Historic Preservation; Survey and Theory (AmSt 675, PLAN 675 or ARCH 628).

AMST 681 American Vernacular Traditions

(Cross-listed as ARCH 650)

Course Description: The course will introduce students to a variety of American vernacular building and other cultural traditions, with an emphasis on early rural architecture and landscapes, regional traditions of the 18th and early 19th centuries, popular transformations of the late 19th century, and finally widespread building practices and other cultural expressions of the 20th century. It will cover the basic history of and current approaches to the study of vernacular architecture and cultural landscapes, provide a list of current literature, including relevant journals and periodicals, and introduce students to methods used in the study and analysis of a range of material, architectural and landscape forms.

The course combines lectures and seminars. Lectures will provide a broad overview of the field, as well as a chronological treatment of the development of American vernacular architectural forms. The seminar portion of the course will emphasize problems and approaches in vernacular architectural studies. Topics will include: diffusionism, environmental factors, and cultural factors. The "linguistic" model for analyzing vernacular forms will also be treated.

Course Requirements: Students will be expected to attend class regularly and participate in classroom discussions; write and present a 5-6 page report and a 8-10 page research paper, short midterm and final examination.

AMST 695 Historic Preservation Practicum/Internship

Course Description: The Practicum/Internship is the final requirement for the Certificate in Historic Preservation. It is restricted to students enrolled in the Historic Preservation Certificate Program and is generally taken as the last course in the sequence of required courses for the certificate, although students may be enrolled simultaneously for the Practicum/Internship and other courses in the program. Students not enrolled in the program may take the Practicum/Internship as part of their other studies, with the permission of the Director, although this is not encouraged.

To enroll in AmSt 695, you must submit a practicum/internship topic and proposal to the Director for approval. Upon receipt of approval, the student will be given a special approval code for registration.

The Practicum/Internship is intended to advance the student's knowledge of the field and to research areas of special interest. Since the project is meant to be of a practical character, students are encouraged especially to take advantage of work-related opportunities in the field. Past Practica/Internships, for example, have included research reports carried out for Cultural Resource Management firms, studies conducted for non-profit organizations, research and exhibits undertaken for museums, and results of on-going advocacy projects. Students should view the Practicum/Internship as an opportunity to explore areas they have never had an opportunity to consider, and to build on and consolidate projects in which they have had prior involvement.

Course Requirements:

Course Options: The course offers two principal options: one, a formal internship with an approved preservation-related organization; or two, a research project, determined in consultation with the Director of the Historic Preservation Program. Briefly, Option One [internship] requires at least 320 hours (eight weeks) of work, either paid or volunteer, for an approved preservation-related organization and a written report of approximately 10 pages (2,500 words) and formal presentation on activities. Option Two can be considered as a "mini-thesis," requiring approximately the same expenditure of time and effort. Those taking Option Two [research project] are encouraged to pick a topic of a practical or "applied" character and are also required to make a formal presentation of their work, along with a substantially longer written report. Typically, an Option Two [research project] would require a paper of approximately 50 pages (12,000-15,000 words).

It must be emphasized that American Studies 695, Practicum/Internship, is intended to represent a substantial contribution to the historic preservation field. Students are expected to carry out the work in a timely and professional manner and to view the process as a rigorous and formal one. In essence, Option One candidates are expected to present the results of an intensive internship in the field. Option Two candidates will complete what might be considered as a short thesis. Students are expected to use slides, overhead transparencies and other visual aids to present their work in a professional manner. All written material submitted shall be neatly typed and illustrated as deemed necessary to the project chosen. Students should consult the Chicago Manual of Style (and various research aids) for this work. All footnotes, endnotes and

bibliographic entries shall be completed in accordance with the Chicago Manual.

AMST 696 Preservation Field Study (offered every summer)

NOTE: This is a "generic" syllabus; it is updated annually for the particular location/area studied to include specific topics, instructors/speakers, dates, times, field trips, etc. The final syllabus for each summer's program is available in the Spring upon request.

Course Description: The 6-credit hour Preservation Field Study (Field School) has offered training in historic preservation focusing on the Pacific region every summer since 1991, examining a different venue's historic sites and other cultural resources.

The Field School is of interest to students and professionals in architecture, art history, archaeology, anthropology, geography, historic preservation, planning and related fields. Previous drafting talent or experience, while desirable, is not required. The program offers students both theoretical and practical experience. The first portion consists of lectures, study tours, exercises, field work and the beginning of the project work, while the final portion is devoted exclusively to project work. The typical schedule features classroom lectures and field exercises Monday through Friday, from 9:00 a.m. to 4:00 p.m., and field-trips on most Saturdays from 9:00 a.m. to 1:00 p.m. The pace of the Field School is necessarily intense and to keep up with and get the most from the program, diligent effort and wise use of time is required.

Course Requirements: Participants are expected to do assigned readings. There will be several short individual and team exercises, as well as group project(s). As noted above, the program is comprehensive and concentrated. Working effectively and harmoniously within a group context and environment is an essential and critical aspect of the course. Students will be evaluated both on their group and individual performance. Drawing and drafting is a significant element of the course. Previous experience is recommended and highly useful, but is not required. While a participant's best effort is expected, experience, or lack thereof, in this area will be taken into account.

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Appendix E: Autodesk Revit Architecture Certified User and 2014 Certified Professional

Autodesk Certification Program

Autodesk® Revit® Architecture: Certified User and 2014 Certified Professional

Exam Preparation Roadmap



Autodesk certifications are industry-recognized credentials that can help you succeed in your design career—providing benefits to both you and your employer. The certifications provide reliable validation of skills and knowledge, and they can lead to accelerated professional development, improved productivity, and enhanced credibility.

Autodesk highly recommends that you structure your examination preparation for success. This means scheduling regular time to prepare, reviewing this exam preparation roadmap, taking a course at one of our Authorized Training Centers, and supporting your studies with Official Preparation Materials. Equally as important, actual hands-on experience is recommended.

The **Revit Architecture Certified User** exam includes both academic and industry requirements designed to confirm that Revit Architecture users have the skills necessary to continue their design careers—whether they attend college, enter the workforce, or work toward additional levels of industry certification. The exam consists of 30 questions combining multiple-choice and performance-based items to ensure students understand and can effectively use Revit Architecture. The exam has a 50-minute time limit. For more information, visit www.certipoint.com/autodesk.

The **Revit Architecture 2014 Certified Professional** exam is aimed at assessing professional users' knowledge of the tools, features, and common tasks of Revit Architecture 2014. The exam is comprised of 35 questions, of which the majority requires you to use Revit Architecture to create or modify a data file, and then type your answer into an input box. Other question types include multiple choice, matching, and point-and-click (hotspot). The exam has a 2-hour time limit (in some countries, the time limit may be extended). Find an Autodesk Certification Center at autodesk.starttest.com.

Certification Program Information

You may take each certification exam up to three times within a 12-month period.

For more information on the Autodesk Certification Program, visit www.autodesk.com/certification.

Recommended Experience Levels for Revit Architecture Certification Exams

Actual hands-on experience is a critical component in preparing for the exam. You must spend time using the product and applying the skills you have learned.

Certified User exam:

Revit Architecture 2011-2014 course (or equivalent) plus 50 hours of hands-on application

2014 Certified Professional exam:

Revit Architecture 2014 course (or equivalent) plus 400 hours of hands-on application

ATC® Instructor-Led Courses

The Autodesk Authorized Training Center (ATC®) program is a global network of professional training providers offering a broad range of learning resources. Autodesk recommends that test-takers consider taking a certification preparation or product training course at one of these centers. Visit the online ATC locator at www.autodesk.com/atc.

Official Preparation Material

The official preparation materials for Autodesk Certification exams are published by ASCENT (Autodesk Official Training Guides) and Wiley (Official Press). These guides are used by Autodesk Training Centers, and are available for direct purchase in various formats from www.ascented.com and www.wiley.com/go/autodeskofficialpress.

Autodesk Education Community

The Autodesk Education Community offers students and educators free software, learning materials, and classroom support. Learn more at students.autodesk.com.

Schools can become Certipoint® Centers to provide the Autodesk Certified User exams in their classrooms. For more information, contact Certipoint at www.certipoint.com.



Autodesk Certification Program

Exam Topics and Objectives

We recommend that you review the topics and objectives during your preparation for certification. The Autodesk Official Training Guides and Official Press for Autodesk certification exams are published by ASCENT and Wiley Publishing. These guides cover the topics and objectives listed below. Please note that not all objectives will be tested during your certification exam.

Autodesk Revit Architecture Certified User

Topic	Sub-Topic
User Interface	Definitions
	UI Navigation/Interaction
	Drawing Window
	Navigation Control
	Zoom
File Management	Definitions
	Project Files
	Open existing Revit project
	Create new Revit project
	Save
Views	View control and properties
	View Types
	Cameras
Levels	Definitions
Walls	Home Tab > Wall
	Options Bar
	Openings
	Join
	Materials
Doors	Home Tab > Door
	Options Bar
	Model in place
Windows	Home Tab > Window
	Options Bar
	Model in place
Component	Home Tab > Component
	Options Bar
	Component Host
	Families

(Continued)

Topic	Sub-Topic
Columns and Grids	Definitions
	Home Tab > Grid
	Grid Properties
	Home Tab > Column
	Column Properties
	Modify
Stairs and Railings	Stair Types and Properties
	Stair Placement Options
	Railing Types and Properties
	Railing Placement Options
Roofs and Floors	Roof Types and Properties
	Roof Elements
	Floors Types and Properties
Sketching	Geometry
	Fillet, Trim
	Snap
Annotations	Text
	Dimensions
	Tags
Schedules	Schedule Types
	Legends
	Keynotes
Construction Document Sets	Sheet Set up
	Printing
	Rendering

To take a Certified User exam, find out more from Certiport:
www.certiport.com/autodesk

For more information: www.autodesk.com/certification

Autodesk Certification Program

Exam Topics and Objectives

Autodesk Revit Architecture 2014 Certified Professional

Topic	Objectives
Collaboration	Copy and monitor elements in a linked file
	Use worksharing
	Import DWG files into Revit
	Create and modify filled regions
	Place detail components and repeating details
Documentation	Tag elements (doors, windows, etc.) by category
	Use dimension strings
	Set the colors used in a color scheme legend
Elements	Change elements within a curtain wall (grids, panels, mullions)
	Create compound walls
	Create a stacked wall
	Differentiate system and component families
	Work with family Parameters
	Create a new family type
	Use Family creation procedures
	Edit room-aware families
Modeling	Assess review warnings in Revit
	Create a building pad
	Define floors for a mass
	Create a stair with a landing
	Create elements such as a floors, ceilings, or roofs
	Generate a toposurface
	Model railings
	Work with phases
	Edit a model element's material (door, window, furniture)
	Change a generic floor/ceiling/roof to a specific type
	Attach walls to a roof or ceiling
	Define element properties in a schedule
	Control visibility
Views	Use levels
	Create a duplicate view for a plan, section, elevation, drafting view, etc.
	Create and manage legends
	Manage view position on sheets
	Move the view title independently of the view
	Organize and sort items in a schedule

To take a Certified Professional exam, find an Autodesk Certification Center:
autodesk.starttest.com

For more information:
www.autodesk.com/certification



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Appendix F: University of Hawai'i Executive Policy E5.205 Academic Minors and Certificate Credentials

Prepared by the Vice President for
Planning and Policy
This is a REVISED policy.

UNIVERSITY OF HAWAI'I

EXECUTIVE POLICY - ADMINISTRATION

March 1996

P 1 of 5

E5.205 Academic Minors and Certificate Credentials

I. INTRODUCTION

This executive policy promulgates broad guidelines for: (1) academic minors, and (2) those certificate credentials that are conferred on the authority of the Chancellors/ Executive Vice Chancellor in accordance with Section 5-2b of the Board of Regents Bylaws and Policies.

II. OBJECTIVES

The purposes of this policy are:

- A. To establish system guidelines to be used by campuses that decide to recognize academic minors.
- B. To bring together and promulgate understandings that have been reached regarding the authorization and use of certificates conferred by the Senior Vice President and Executive Vice Chancellor for UH-Mānoa, the Senior Vice President and Chancellor for UH-Hilo and UH-West O'ahu, and the Senior Vice President and Chancellor for the UH-Community Colleges.
- C. To require the development of campus policies and practices designed to assure academic soundness and consistent practice in the use of certificate credentials and academic minors.

III. POLICY GUIDELINES

A. Academic Minors

1. Authority to recognize academic minors resides with the Senior Vice President and Chancellor/Executive Vice Chancellor of each campus offering baccalaureate degrees and is exercised in accordance with the requirements of Executive Policy E1 .201, "Faculty Involvement in Academic Policy," and the following guidelines.

2. If recognized, academic minors exist in conjunction with academic majors and do not stand alone. Therefore, campuses may recognize academic minors only in Board-authorized baccalaureate degree programs. Classification of students for admission and enrollment purposes will continue to be by academic major/degree objective.
3. Campuses choosing to recognize academic minors are responsible for formulating campus policy that includes, at a minimum, the rationale for doing so and credit and grade-point requirements. If a campus recognizes minors, not all degree programs on that campus must have minors.
4. Campuses choosing to recognize academic minors will note the completion of the minor on transcripts.

B. Academic Subject Certificates

1. Authorization. Authority to confer certificates in specific subjects that represent recognition of **work taken within (or among) existing Board authorized academic programs** resides with the Senior Vice President and Chancellor/Executive Vice Chancellor for each Unit. (The requirements for establishing Board-authorized academic programs, i.e., new programs, are found in Executive Policy E5.201.)
2. Definition. Academic subject certificates are supplemental credentials available to students enrolled in an associate, bachelor's or graduate degree program, i.e., classified students, and to unclassified students already holding undergraduate or graduate credentials. Students enrolled solely for the purpose of obtaining an academic subject certificate will be regarded as unclassified for admission and enrollment purposes. Exceptions to this policy involve new program development and are subject to the requirements of E5.201.
3. Campus Policy. Campuses conferring subject certificates on the authority of the Senior Vice President and Chancellor/Executive Vice Chancellor are responsible for establishing campus policy and procedures specifying, at a minimum, administrative responsibilities, credit and grade-point requirements, and certificate format, acquisition and conferral.
4. Student Record. Completion of subject certificates is noted by the campuses on student transcripts.

C. Certificates of Completion

1. Definition. Certificates of Completion (C.C.) are credentials signifying completion of entry-level training in the community colleges' vocational technical programs.
2. Conferral. Authority to confer Certificates of Completion resides with the Senior Vice President and Chancellor for the UH-Community Colleges.
3. Authorization. The Senior Vice President/Chancellor for Community Colleges may approve the offering of Certificates of Completion: (1) within academic programs that have been authorized by the Board of Regents to offer the Certificate of Achievement, Associate in Science and/or the Associate in Applied Science Degree; or (2) as a sole credential in vocational-technical program areas that do not require Board approval, i.e., areas that do not require the allocation of substantial resources. Authorization of Certificates of Completion in such areas is the exception rather than the rule.

The Board of Regents approves the offering of Certificates of Completion in new program areas deemed to require substantial general fund resources. That is, these programs require the inclusion of a specific request in the Regents' budget for a workload or a program change appropriation; or they require a reallocation of resources so extensive that it is necessary for the Board to act to terminate the program or programs from which the resources are drawn.

4. Title. The title of a Certificate of Completion should be descriptive of the training provided. In those cases in which the Certificate of Completion represents the entire first level of training in a vocational-technical program the name is the same or similar to that for the umbrella C.A./A.S./A.A.S. program, e.g., a C.C. in Drafting within the C.A. and A.S. Drafting Technology program. In other cases, the Certificate of Completion may represent a vertical slice of the first-level of training in a C.A./A.S./A.A.S. program, i.e., the first-level of training may consist of a number of entry level modules. If this is the case, it is acceptable to give the Certificate of Completion a title that describes a specific entry-level module and that title may be different from the title of the umbrella program, e.g., a Certificate of Completion in Pattern Making within an Apparel Design and Construction program. Whether Certificate of Completion titles of this sort are noted on official records in parentheses after the umbrella program title or simply stand alone is left to the judgment of the Senior Vice President and Chancellor.

5. Advertisement. All approved Certificates of Completion can be included in campus catalogs. Except in those rare cases where Certificates of Completion represent stand-alone programs, they are advertised as credentials within Board-approved programs.
 6. Admission. (a) As a rule, students are admitted to Board-approved programs, i.e., the umbrella program area. The CAPIS application booklet will show the Certificate of Completion as an objective within the larger program area and refer the applicant to the catalog for specific program details. For example, students wanting to pursue one of the various C.C.s in the Food Service area (Storeroom, Short-Order Cook, etc.) are admitted to Food Service with a C.C. objective. (b) Students may be admitted directly to those programs in which the C.C. has been authorized as the sole credential. The CAPIS booklet will provide separate entries for such programs. (c) Providing separate CAPIS entries and thus admitting students to program areas other than those outlined in (a) and (b) requires coordination with the Office of Vice President for Planning and Policy.
 7. Reporting the Codes. Upon notification by the Senior Vice President and Chancellor for Community Colleges of the approval of a Certificate of Completion, the Office of the Vice President for Planning and Policy will validate requested codes and include the C.C. in the annual Curricula Offered Report.
 8. Review. Certificates of Completion are subject to Board and Executive Policy on the review of established programs (E5.202) either alone or as part of the C.A./A.S./A.A.S. vocational-technical programs whose faculty and resources they share.
- D. Reporting Requirements
1. The Office of the Vice President for Planning and Policy is responsible for maintaining an annually updated listing of all University curricula including Board- and Senior Vice President conferred credentials.
 2. The Senior Vice President and Chancellor/Executive Vice Chancellor of a baccalaureate degree-granting campus that chooses to recognize academic minors and/or establish subject certificates will:
 - a. provide the Office of the President with copies of campus policies relating to academic minors and/or subject certificates;

- b. provide the Office of the Vice President for Planning and Policy with an annually updated list of Subject Certificates including effective dates; and
 - c. maintain an internal record of those bachelor's programs offering minors, including effective dates.
3. The Senior Vice President and Chancellor for Community Colleges will:
- a. provide the Office of the President with copies of Certificate of Completion and Academic Subject Certificate policies for the Community Colleges; and
 - b. provide the Office of the Vice President for Planning and Policy with an annually updated list of Certificates of Completion and Subject Certificates including effective dates.

Appendix G: University of Hawai'i Executive Policy E5.201 Approval of New Academic Programs and Review of Provisional Academic Programs

Prepared by Director of Planning and Policy.
This update replaces Policy E5.201 dated March 1987.

UNIVERSITY OF HAWAI'I

EXECUTIVE POLICY - ADMINISTRATION

April 1989

P 1 of 13

E5.201 Approval of New Academic Programs and Review of Provisional Academic Programs

I. INTRODUCTION

This Executive Policy directs implementation of Sections 5-1a(1) & (2) and 5-2a(2) of the Board of Regents Bylaws and Policies. The following objectives, policies and guidelines provide for the systematic monitoring of academic program planning intentions, the authorization of new academic program proposals, and the evaluation of provisional academic programs of the University of Hawai'i. The Vice President for Academic Affairs at Mānoa and Chancellors are called upon to specify implementing procedures as appropriate for their campus(es).

II. OBJECTIVES

The objectives of the executive policy are:

- A. To facilitate the advancement and transmission of knowledge resulting from academic program planning and development.
- B. To specify the components of the academic program authorization process and their purposes.
- C. To establish guidelines and procedures for the preparation and processing of authorizations to plan, proposals for new academic programs, and reviews of provisional programs.
- D. To assure the administration and Board of Regents of the academic and fiscal soundness of proposed and provisional programs and their appropriateness to both university-wide and campus missions.
- E. To assure the administration and the Board of Regents that provisions for adequate physical facilities for the programs have been included in campus long-range development plans.
- F. To assure the administration and the Board of Regents that provisions for meaningful assessment of student learning have been included in authorizations to plan,

proposals for new academic programs, and reviews of provisional programs.

III. POLICIES

A. Definition of a Program

For purposes of Board approval, a new academic program is any sequence of courses or instructional activities:

- Culminating in a Board conferred degree or certificate of achievement (requiring a separate notation on any Board-approved credential);
- Requiring a major commitment of general-funded resources to a new instructional area. A new program shall be considered as requiring such resources if: (a) it requires inclusion of a specific request in the Regents' Budget for a workload or program change appropriation, or (b) it involves a reallocation of resources so extensive that it requires a Board action to terminate the program or programs from which the resources are to be drawn.

Board approval is required for non-general funded academic programs culminating in Board-conferred credentials. It is not required for certificates of completion at the community colleges or subject certificates at the four-year campuses which are conferred by the chief executive officers of those units in accordance with Board of Regents policy. An academic program whose sole credential is such a certificate, however, does require Board approval if it meets the definition of a new program as given above.

B. Program Title

The title of the program, including parenthetical information, approved by the Board of Regents at the time of program establishment becomes the official title for purposes of Board-conferred credentials and is used in University publications. A Master List of Board-authorized degree and certificate programs is maintained by the Office of Planning and Policy.

Requests to change academic program titles in order to maintain currency in terminology and involving no substantive change in the program or service group are made to the Vice President for Academic Affairs at Mānoa or to Chancellors, utilizing the

action memo format. Upon approval, such changes are reported to the Board of Regents as an information item. The Office of Planning and Policy reports such changes to other University offices as appropriate.

Name changes that reflect a substantive program change are handled according to the requirements for new program authorizations as outlined in this policy.

C. Authorization To Plan (ATP)

An ATP is a request to plan a new academic program made at the beginning of the formal program planning process before resources are committed to program planning. Current academic/educational development plans include academic program planning intentions, especially approved ATPs.

1. Purposes. The purposes of the ATP are:

- To monitor, coordinate, decide upon, and provide support for academic program planning actions.
- To alert administrators of new academic programs under consideration within the University, providing them with an opportunity for coordination and for appropriate preliminary input.
- To inform the administration and the Board of Regents of long-term academic program planning intentions; the long-term physical facilities requirements of planned programs; and provide opportunities for appropriate feedback.

2. Internal Procedures and Approving Authority. Each Unit establishes internal procedures for preparation, processing, and approval of ATPs, including a time limitation on each approved ATP. At the Community Colleges, Hilo, and West Oahu, the Chancellors establish their own internal procedures for the processing of ATPs, and are authorized to give final approval. At Mānoa, the Vice President for Academic Affairs, in consultation with the deans, other Vice Presidents as appropriate and the Director of Campus Operations establishes internal procedures; deans of the various UHM colleges, schools and the Graduate Division are authorized to give final approval. Also at Mānoa, the Director of Campus Operations shall advise the

Vice President for Academic Affairs, and other UHM Vice Presidents as appropriate, of the ability of the Mānoa campus to accommodate the planned program's physical facilities requirements. At all campuses, it may be necessary to process amendments to campus long-range development plans for Board of Regents' approval if adequate provisions for physical facilities for planned programs are not provided for in existing plans.

3. Information Procedure. At the end of the Fall and Spring semesters, each Unit prepares a report to the President's Office on the ATP activity, utilizing guidelines provided in Appendix A. The President informs the Board of Regents of approved ATPs as information items.

D. Proposal for New Academic Programs

A program proposal sets forth the description of and justification for new academic programs sought by the campuses.

1. Contents. The proposal must contain sufficient information to permit assessment of the academic integrity and quality of the program, to determine its fiscal soundness and efficiency relative to other University activities, and to determine its appropriateness to the mission of the University and the campus. Specifically, the proposal addresses the questions listed in Appendix B. In the case of graduate programs the Board criteria as summarized in Appendix B are addressed. In addition, the proposal must clearly address the physical facilities requirements of the planned new academic program.
2. Procedures and Processing. Each Unit establishes internal procedures for the preparation and processing of new program proposals, ensuring appropriate faculty and student input and attention to the questions outlined in Appendix B. Also, the proposal shall include a "Plan Amendment" request if the campus long-range development plan does not include adequate provisions for physical facilities for the program.

Program proposals are sent to the Vice President for Academic Affairs at Mānoa or to Chancellors according to the procedures established for the Unit. Approved proposals are sent to the President with a recommendation for his approval

in action memorandum format; a copy of the recommendation is sent to the initiating department. The office of the President reviews the proposal and (if it is acceptable) forwards it to the Board of Regents with a recommendation for approval. No commitments (of resources or anything else) may be made to a proposed program until final approval has been granted by the Board. Resources for newly approved academic programs are sought in accordance with standard budgetary policies and procedures.

3. Timetable. In general, program proposals must be approved by the Board in time to permit the commitment of those new or reallocated resources required for the program to be implemented by the desired date.
 - Program proposals that do not require new or reallocated resources may, at the Unit's recommendation, become operational upon Board approval.
 - Program proposals to be implemented through internal reallocation of resources are submitted to the Office of the President five to seven months prior to the proposed date of program implementation. The President submits proposals to the Board for action at least four months prior to program implementation.
 - Program proposals whose implementation is contingent on the acquisition of additional ("new") general-funded resources must be approved by the Board in time to permit the inclusion of the necessary resource requests in the biennium budget preceding the proposed implementation date. Therefore, such proposals should reach the Office of the President by December 1 in the first year of the biennium preceding proposed program implementation (i.e., a minimum of 21 months prior to proposed implementation). The President transmits approved proposals to the Board of Regents by February 1 in time for consideration at the March Board meeting.) In order to respond in a timely manner to extraordinary programming needs, the President may waive the above proposal submission deadlines to his office. In such cases, justification for a waiver is provided by the Vice President for Academic Affairs at Mānoa or the Chancellor concerned.

E. Provisional Programs

1. Definition. All programs approved by the Board of Regents are placed on provisional status during their first cycle of operation. That cycle is defined as two years for programs normally completed in one or two years (e.g., certificate, associate, master's and supplementary programs). For all other programs the cycle equals the number of years students are normally expected to take to complete the program (e.g., four years for the baccalaureate and four to five years for doctoral degrees). Upon Board approval, the Office of the President determines the specific length of the first cycle and the timing of the provisional review in consultation with the respective Vice President or Chancellor. No tenure appointments or tenure commitments shall be made in new programs until the Board of Regents has reviewed the provisional cycle and elected to continue the program.
2. Content and Procedures. Each provisional program is reviewed during the year following completion of the provisional cycle, with the review document reaching the Board of Regents not more than one year after completion of the provisional cycle. Vice Presidents and Chancellors establish procedures for the preparation, review and approval of reviews of provisional programs within their Units ensuring appropriate faculty and student input. The review document forwarded for Board approval shall include a program self-study that considers quantitative information on program activities and resources, utilizing the quantitative profile format of Appendix C, and that provides in general the following information (see Appendix D for specific guidelines):
 - (a) A statement of program objectives. Differences with those found in the program proposal should be explained.
 - (b) An assessment of whether or not the program is meeting its objectives and a summary of the evidence used to reach this conclusion.
 - (c) A discussion of any substantial changes made in the program since its approval and any substantial discrepancies in program indicators or activities from those identified in the program proposal.

(d) A projection of resource needs for the next five years.

Appendix D includes the Board criteria (Section 52a (2)) that must be addressed in the case of graduate programs.

3. Processing. Reviews of provisional programs are sent to the Vice President for Academic Affairs at Manoa or to the Chancellor according to the procedures established for the Unit. Approved reviews are sent to the Office of the President along with an action memo. The action memo summarizes the facts developed in the program review document to support the recommendation to continue or terminate the program. A copy of this memo should be shared with the initiating department. The Office of the President analyzes each review and sends it to the Board of Regents with a recommendation for program continuation or termination. The final decision to continue or terminate the program resides with the Board of Regents.

APPENDIX A

REPORT TO THE PRESIDENT OF AUTHORIZATION TO PLAN (ATP) ACTIVITY

_____ Hilo
_____ West Oahu
_____ Community College
_____ Manoa

Reporting Period: _____ Spring 19____
_____ Fall 19____

Name of ATP	Type of Program (e.g. AA, BS, etc.	Contact Person	Date of Approval	Status	Comments

APPENDIX B

GUIDELINES FOR PROPOSALS FOR NEW ACADEMIC PROGRAMS

The proposal addresses each of the questions below. Parenthetical materials suggest the kinds of information that may be relevant in answering each question.

1. What are the objectives of the Program?
(Objectives should be stated in terms of meeting student, community or State needs, and should devote considerable attention to student learning objectives.)
2. Are the program objectives appropriate functions of the college and University?
(Relationship to University and campus mission and development plans, evidence of continuing need for the program, projections of career opportunities for graduates, etc. In the case of graduate programs attention must be directed to Board criteria, Section 5-2a(2) requiring relevance of the program:
 - (a) To the professional, economic, social, occupational and general educational needs of Hawai'i.
 - (b) To national and international needs where Hawai'i and the University have unique or outstanding resources to respond with quality.
 - (c) To basic education needs for which there is a demand by Hawai'i's population.
 - (d) As a necessary supporting discipline for quality programs.)
3. How is the program organized to meet its objectives?
(Description of curriculum organization, requirements, admission policies, advising and counseling, and other aspects of the program, with reference to its objectives.)
4. Who will enroll in the program?
(Special target groups, if any; number of majors expected by year; expected service to non-majors; evidence of student interest.)
5. What resources are required for program implementation and first cycle operation?
(Number, source, and cost of faculty; library requirements; support personnel; estimated cost of supplies, equipment and CIP; facilities to be utilized; total funds required for

program implementation and operation; expected sources of funds, including sources of reallocated funds.)

6. How efficient will the program be?
(Compare anticipated cost per SSH, cost per major, SSH/faculty, average class size or other quantitative measures with other programs in the college and similar programs on other UH campuses.)
7. How will effectiveness of the program be demonstrated?
(Describe the plan for assessing the quality of student learning. In addition, information should be gathered on projected number of graduates yearly; placement of graduates; special accreditation; student satisfaction; career and employer satisfaction, etc.)

APPENDIX C

Quantitative Indicators for Program Reviews

The following are provided for each of the provisional years. Whenever possible, data are broken down by level of instruction (e.g., lower division, upper division, graduate or C.C., C.A., A.S.).

- (1) Number of majors
- (2) Number of SSHs offered, fall semester
- (3) Number of FTE Course Enrollments (SSHs divided by 15 for undergraduates and by 12 for graduates)
- (4) Number of classes (sections) offered, fall semester
- (5) Average class size (number of SSHs divided by number of classes offered)
- (6) Number of FTE faculty
- (7) FTE student-faculty ratio
- (8) Performance of majors on program-administered assessments of student learning.
- (9) Information on overall satisfaction of majors with the program.
- (10) Number of graduates (annual)
- (11) Budget allocation
- (12) Cost per SSH

APPENDIX D

GUIDELINES FOR ASSESSMENT OF PROVISIONAL AND ESTABLISHED PROGRAMS

The self-study addresses the questions below. Parenthetical materials suggest the kinds of information that may be relevant in answering each question.

The specific information included in self-studies varies with program circumstances.

- (1) Is the program organized to meet its objectives?
(Discussion of curriculum, requirements, admissions, advising and counseling, and other aspects of the program, with reference to its objectives.)
- (2) Is the Program meeting its learning objectives for students?
(An assessment of the quality of student learning as indicated by systematic analysis of student performance with reference to standard expectations, surveys of student satisfaction with instructional aspects of the program, etc.)
- (3) Are program resources adequate?
(Analysis of number and distribution of faculty, faculty areas of expertise, budget and sources of funds, and facilities and equipment.)
- (4) Is the program efficient?
(An assessment of productivity and cost/benefit considerations within the overall context of campus and University "mission" and planning priorities. Include quantitative measures comparing, for example, SSH/faculty, average class size, cost per SSH, cost per major with other programs in the college, on the campus and, as appropriate, similar programs on other UH campuses.)
- (5) Evidence of program quality.
(A qualitative assessment of the program in relation to competing demands for resources by new programs and continuing programs. Accreditation or other external evaluation, student performance [e.g., on external exams], satisfaction, placement and employer satisfaction, awards to faculty and students faculty publication record, evaluation of faculty, etc.)
- (6) Are program outcomes compatible with the objectives?
(Analysis of numbers of majors, graduates, SSHs offered, service to non-majors, employment of graduates, etc., in relationship to objectives.)
- (7) Are program objectives still appropriate functions of the college and University?
(Relationship to University mission and development plans,

evidence of continuing need for the program, projections of employment opportunities for graduates, etc.)

In the case of graduate programs, attention should also be given to the following need factors.

- (a) The direct relevance of the contribution of the field of study to the professional, economic, social, occupational and general educational needs of Hawai'i.
- (b) A "national needs factor" that emphasizes the direct relevance of the contributions of the field of study to national needs and where Hawai'i and the University have unique or outstanding resources to respond with quality.
- (c) An "international needs factor" that emphasizes the direct relevance of the contributions of the field of study to international needs and where Hawai'i and the University have unique or outstanding resources to respond with quality.
- (d) An educational needs factor that indicates the direct relevance of a field of study to basic education needs for which there is a demand by Hawai'i's population.
- (e) The relevance of a field of study as a necessary supporting discipline for quality programs identified by the above criteria.

Appendix H: University of Hawai'i Authorization to Plan Template

Authorization to Plan (ATP)

University of Hawai'i

Effective August 1, 2011

Authorization to Plan (ATP) a New Academic Program

Guiding Principles

- Best interest of the student (demand)
 - Reflects sufficient numbers of interested students
- Best interest of the community (workforce needs)
 - Meets current and anticipated workforce needs of state
 - Responds to changing needs of industry
- Aligned with campus mission and system strategic outcomes/priorities
 - Consistent with campus mission statement
 - Capacity for additional students
 - Capacity to deliver program/courses
 - Stewards resources efficiently.
- Aligned with the University of Hawaii system mission and priorities
 - Supports campuses in developing necessary, sustainable and cutting edge degrees
 - Avoids unnecessary duplication is avoided
 - Encourages collaboration among programs/campuses
 - Maximizes use of resources

Please complete all sections with an emphasis on item 5. The ATP is not to exceed 8 pages.

1. Prior to completion of the ATP, proposers must consult with the Vice Chancellor for Academic Affairs (VCAA) of the interest in proposing a new degree/certificate
2. Identify the campus, school/college and department/division requesting the ATP
3. List the planning committee chair and members
4. Identify the degree/certificate proposed
5. Describe the need for program:
 - a. Provide a program description
 - 1) List the program learning outcomes
 - 2) Justify the program (include, as appropriate, evidence of internal and external factors driving need for this program; completion of needs assessment; number of interested students per year; need for such a program in relation to workforce development, graduate studies, etc.)
 - 3) Discuss how the program will impact campus, island and/or the state's economic development.
 - 4) Discuss how the proposed program addresses workforce needs
 - 5) Demonstrate how the proposed program aligns with system and campus mission and strategic plan and outcomes.

- b. Can identified need be met by existing UH program(s)?
 - 1) List similar degrees or certificates offered in UH System
 - 2) Describe the impact of the proposed program on current courses or programs at the campus and within the system (is it duplicative? Can resources be leveraged? Can a joint program be offered or campuses collaborate to offer one degree?).
 - 3) If a similar program exists, consult with other campuses, identifying, who has been consulted, what campus and date of consultation. Consultation will include:
 - a) The VCAA of the other UH campuses with relevant programs by the VCAA of the campus proposing the degree/certificate
 - b) Colleagues in related disciplines from other campuses have been consulted.
- 6. Planning the new program
 - a. Planning period. Describe the
 - 1) Planning period (not to exceed two years or reapplication is necessary)
 - 2) Activities to be undertaken during the planning phase
 - 3) Anticipated submission date of program proposal
 - 4) Workload/budget implications during planning period
 - 5) How program will be economically sustainable
 - 6) Impact proposed program may have on accreditation
 - 7) How program will fit within campus and/or system organizational structure
 - b. Description of resources required:
 - 1) Faculty (existing and new FTEs)
 - 2) Library resources (estimate of current resources and additional resources required))
 - 3) Physical resources (space, equipment, etc.)
 - 4) Other resources required (staff, graduate assistantships, etc.)
 - c. Five-Year Business Plan. Provide a five-year projected budget for the program that answers the following questions and includes a completed Mini Cost Revenue Template:
 - 1) What will be the annual costs to implement the program?
 - 2) What will be the projected enrollment and estimated tuition revenue?
 - 3) How will be program be funded?
 - 4) Does the current or proposed budget (Department/College/Campus) include funds or a request for funds for the proposed program? Please provide details.
 - 5) Given a "flat budget" situation or if anticipated enrollment does not materialize, how will the proposed program be funded?

ENTER VALUES IN HIGHLIGHTED CELLS ONLY					
YEAR	FY	FY	FY	FY	FY
PROGRAM COSTS					
Faculty w/o fringe					
Other personnel costs w/o fringe					
Library					
Equipment/Supplies					
Other					
TOTAL Expenses					
REVENUES					
Projected Enrollment					
No. of Courses					
No. of Credits					
SSH					
Tuition Rate/Credit					
Total Revenue from Tuition					
Other Sources of Income					
TOTAL Revenues					

7. Describe the impact on current courses or programs.
8. If the curriculum includes courses that are offered at other UH campuses, describe how articulation of these courses will be assured prior to the program proposal submission.
9. If this program is multidisciplinary, provide evidence of commitment for support from the colleges, departments, programs, and/or individuals expected to participate.

APPROVED / DISAPPROVED

Dean

Date

The ATP has completed the campus approval process prior to review by Council of Chief Academic Officers

Reviewed by:

Campus Chief Academic Officer:

____ Recommend

Comments:

Signature

Print Name

Date

Chancellor: _____ *Disapproved*

____ *Approved* ____

Comments:

Signature

Print Name

Date

Council of Chief Academic Officers (Systemwide Consultation):

Comments:

Print Name

Signature

Date

(A copy of the signed document is provided to the Office of the Executive Vice President of Academic Affairs/Provost)

Appendix I: University of Hawai'i Graduate Certificates Proposal Outline

GUIDELINES FOR ACADEMIC SUBJECT CERTIFICATE PROPOSALS University of Hawai'i at Mānoa

June 2004

1. What is the purpose and objectives of the proposed academic subject certificate program, including the relationship to existing degree programs(s), if any?
2. How will the program be administered? Who will be responsible for advising of students (e.g., department chair, program director or staff, individual faculty from the various participating departments)?
3. What units (e.g., programs, departments, schools, colleges) are involved? Who are the faculty involved in the planning process and who will be involved in implementing the proposed academic subject certificate?
4. What population will be served by the program (e.g., graduate students enrolled in degree programs at the University; professionals working in the community who wish to upgrade knowledge and skills, desire a certificate only, and will not enroll in a degree program; undergraduate students enrolled in degree program at the University (full-time, part-time))? What is the anticipated number of students to be served each year?
5. How is the program organized?
 - a. What are the foundation courses and prerequisites needed for acceptance into the program (e.g., graduate or undergraduate status, grade point average; work experience)?
 - b. What are the fields of concentration (tracks, areas of specialization) in the program? If there is more than one concentration, how do the fields differ?
 - c. What are the number of credits required for the academic subject certificate? (Note that the minimum required credits for graduate and undergraduate academic subject certificates are 15.)
 - d. What courses are required for the certificate program? What is the rationale for including these courses?
 - e. What is the structure of the program (e.g., first-semester courses; required or core courses; electives)?
 - f. Will a practicum or internship be required for the academic subject certificate? If so, how will the certificate program arrange for and administer the practicum?
 - g. Is there an integrative experience at the end of the certificate program and if so, of what nature, e.g., scholarly paper, research project, written examination, integrative interdisciplinary seminar?
6. What resources are required for program implementation and operation? How will these resources be obtained? Are additional resources required for the operation of the program?

7. How will the effectiveness of the program be demonstrated and measured? How will student learning be assessed?
8. Are the program objectives appropriate functions of the college and university? (Applies to proposals for all graduate certificates and for undergraduate certificates that involve units in more than one college or that require the commitment of new resources by the University.) Discuss relationship to University and campus mission and evidence of continuing need for the program.

Appendix J: Academic Subject Certificate Programs Procedures and Guidelines

June 2004

Academic Subject Certificate Programs Procedures and Guidelines

An academic subject certificate program is a designated set of courses that does not lead to a degree, but complements an existing degree program by enhancing the development of skills and knowledge in a focused area of study, or provides an alternative to a degree program in the form of intensive professional training or personal enrichment in a focused area of study. Certificate programs are classified as either graduate or undergraduate certificates. They are generally narrower in scope than degrees, and the courses, together with other forms of credited educational experience, are specifically structured to form a coherent specialization. They may be offered as a field of specialization within an existing degree program; as an interdisciplinary field that combines courses from two or more degree programs; or as an area of professional and practical forms of specialist knowledge and skills.

Individuals who may enroll in certificate programs include students who are in existing graduate or undergraduate degree programs or other students who meet University and program entrance requirements. Those who enroll solely to obtain an undergraduate certificate will be admitted as unclassified students; students enrolled solely in graduate certificate programs must be admitted as classified graduate students.

Academic subject certificates are awarded to students either on completion of the degree requirements for the degree program in which they are enrolled or, in the case of students who hold a baccalaureate degree, or who are not enrolled in a degree program, upon completion of the certificate requirements.

UH Executive Policy E5.205 grants the Mānoa Chancellor the authority to approve certificate programs in specific subjects that represent recognition of work taken within (or among) existing Board authorized programs. Certificate programs that do not meet these criteria and those that require the commitment of new resources by the University require Board of Regents approval.

Certificates that are not approved according to these guidelines are not official credentials of UH Mānoa and will not appear on University of Hawai'i transcripts.

Graduate Certificate Programs

Graduate certificate programs have two broad purposes: 1) to complement the education of students within disciplinary graduate programs; and 2) to provide the training necessary for professional certification. Typically, independent admission is accepted but some may limit admission to current graduate students. Students interested in completing graduate certificate programs must be admitted as classified graduate students.

Graduate certificate programs offer a distinct program of study and provide graduate students with a concentrated and intellectually coherent set of courses. They must include at least one required course (three credits) and a capstone project or experience.

A graduate certificate program requires a minimum of 15 credit hours of coursework at UH Mānoa, at least nine of which must be at the graduate level (600-700). Successful completion of the certificate program requires passing required courses with a grade of B or higher, and a cumulative GPA of 3.0 for all courses counted towards the certificate.

Students may enroll in multiple certificate programs or in certificate and advanced degree programs. There is no general prohibition against double counting between certificate and other programs as long as it is permitted by both programs. However, double counting between certificate programs is not permitted.

Graduate certificate programs, like all graduate programs, are administered by their graduate faculty, which may include members of the professional community. The graduate faculty are responsible for overseeing the program, including assessment of learning, maintenance of quality, monitoring of the curriculum, and admissions. Clear standards and procedures must be developed, publicized in the catalog, and consistently maintained.

Graduate certificate programs should have a director or chair who is responsible for the day-to-day operation of the program and for advising students.

Proposals for graduate certificate programs should follow the “Guidelines for Academic Subject Certificate Proposals” and should include course proposals for all new courses. Approval of the appropriate curriculum committees and Dean(s) of the sponsoring unit(s) is required, as well as Graduate Division, Faculty Senate, the Chancellor, and the Board of Regents (if appropriate). Certificates that require Board of Regents approval must receive an approved “Authorization to Plan” prior to submitting a proposal.

New graduate certificate programs are approved for two-year provisional period and will subsequently be subject to regular program reviews. Evidence of lack of quality, low student interest, and/or lack of faculty interest or participation may lead to probation or termination of a program.

Undergraduate Certificate Programs

Undergraduate certificate programs are generally designed to complement the education of students within other existing major programs. They may be offered as an interdisciplinary course of study, as a specialization within an existing major, or in a field that currently lacks a major. In any case, undergraduate certificate programs provide students with a concentrated experience within a defined field of study. They cannot be simply a subset of courses required for an existing undergraduate degree, but must offer a distinct program of study.

Undergraduate certificate programs are based on a series of intellectually coherent courses requiring a minimum of 15 credit hours at UH Mānoa, at least nine of which must be upper division (300-400). There should be at least one required course (three credits) and a capstone project is recommended in order to provide cohesion to the program.

Successful completion of the certificate program requires a cumulative GPA of 2.5 for all courses counted towards the certificate. Students may enroll in multiple certificate programs, but no more than six credits may overlap between any two programs, and they may not overlap between more than two. No more than nine certificate credits may count towards elective course credits in a baccalaureate degree program.

Undergraduate certificate programs should have a director or chair who is responsible for the day-to-day operation of the program and for advising students. There should also be appropriate mechanisms for assessment of learning, maintenance of quality and monitoring of the curriculum. Clear admissions standards and processes must be published in the catalog and consistently maintained.

Proposals for undergraduate certificate programs that (1) represent recognition of work that is not part of existing Board authorized programs, (2) involve units in more than one college, or (3) involve the commitment of new resources by the university administration, should follow the "Guidelines for Academic Subject Certificate Proposals." They should include course proposals for all new courses and will require approval of the appropriate curriculum committees and Deans of the sponsoring units, the Faculty Senate, and the Chancellor. Proposals representing work not part of existing Board authorized programs and requiring new resources will be submitted to the Board of Regents for approval. Certificates that require Board of Regents approval must receive an approved "Authorization to Plan" prior to submitting a proposal.

Proposals for undergraduate certificate programs that are (1) interdisciplinary, but within a single college, (2) offered within an existing major, or (3) in the absence of a major by another single unit, should follow the “Guidelines for Academic Subject Certificate Proposals.” Such proposals will require the authorization of the appropriate curriculum committees and Deans of the sponsoring units and the Mānoa Chancellor.

New undergraduate certificate programs are approved for a two-year provisional period and will subsequently be subject to regular program reviews. Evidence of low and declining enrollment may lead to probation or termination of a program.

GUIDELINES FOR ACADEMIC SUBJECT CERTIFICATE PROPOSALS
University of Hawai'i at Mānoa

1. What is the purpose and objectives of the proposed academic subject certificate program, including the relationship to existing degree programs(s), if any?
2. How will the program be administered? Who will be responsible for advising of students (e.g., department chair, program director or staff, individual faculty from the various participating departments)?
3. What units (e.g., programs, departments, schools, colleges) are involved? Who are the faculty involved in the planning process and who will be involved in implementing the proposed academic subject certificate?
4. What population will be served by the program (e.g., graduate students enrolled in degree programs at the University; professionals working in the community who wish to upgrade knowledge and skills, desire a certificate only, and will not enroll in a degree program; undergraduate students enrolled in degree program at the University (full-time, part-time))? What is the anticipated number of students to be served each year?
5. How is the program organized?
 - a. What are the foundation courses and prerequisites needed for acceptance into the program (e.g., graduate or undergraduate status, grade point average; work experience)?
 - b. What are the fields of concentration (tracks, areas of specialization) in the program? If there is more than one concentration, how do the fields differ?
 - c. What are the number of credits required for the academic subject certificate? (Note that the minimum required credits for graduate and undergraduate academic subject certificates are 15.)
 - d. What courses are required for the certificate program? What is the rationale for including these courses?
 - e. What is the structure of the program (e.g., first-semester courses; required or core courses; electives)?
 - f. Will a practicum or internship be required for the academic subject certificate? If so, how will the certificate program arrange for and administer the practicum?
 - g. Is there an integrative experience at the end of the certificate program and if so, of what nature, e.g., scholarly paper, research project, written examination, integrative interdisciplinary seminar?
6. What resources are required for program implementation and operation? How will these resources be obtained? Are additional resources required for the operation of the program?

7. How will the effectiveness of the program be demonstrated and measured? How will student learning be assessed?
8. Are the program objectives appropriate functions of the college and university? (Applies to proposals for all graduate certificates and for undergraduate certificates that involve units in more than one college or that require the commitment of new resources by the University.) Discuss relationship to University and campus mission and evidence of continuing need for the program.

Appendix K: BIM Inclusion for Existing D.Arch Degree Program

University of Hawai'i at Mānoa School of Architecture D. ARCH. PROGRAM CHART - with Pre-Professional Undergraduate Degree

AY 2013-2014

Student Name _____ Advisor Meetings _____

ID # _____

undergraduate 120 credits

YR	SEM	DESIGN	TECHNOLOGY	PRACTICE	HIST/THEORY	ELECTIVES	CR
1	F	ARCH 541 [6] Architecture Studio II Medium Buildings in Site Graduate Status	ARCH 523 [3] Architecture Systems II Wood & Steel Graduate Status, PH15 151-14		ARCH 515 [3] Asia-Pacific Arch History & Theory Graduate Status	ELEC 5xx6xx[3] Open Elective University Wide Graduate Status	18
	S	ARCH 542 [6] Architecture Studio III Large Buildings ARCH 521, 533, 541	ARCH 524 [3] Architecture Systems III: Conc. & Masonry ARCH 523	ARCH 539 [3] Research Methods Seminar ARCH 515, 541		ARCH 5xx6xx[3] Arch Elective Graduate Status	18
	F	ARCH 544 [6] Architecture Studio V: Comprehensive ARCH 543, 524	ARCH 526 [3] Architecture Systems V: Integration ARCH 515, 524, 525, 543	ARCH 545 [3] Advanced Practice ARCH 524, 533	ARCH 516 [3] Arch & Urban Design Theory Graduate Status	ARCH 5xx6xx[3] Arch Elective Graduate Status	18
2	S	ARCH 543 [6] Architecture Studio IV: Urban Design ARCH 542, 534					max 12
	F						
3	F			ARCH 547 [12] Sections: C, P, or E Professional Studio ARCH 543, 545, 548			max 12
	S					ARCH 5xx6xx[3] Arch Elective Graduate Status	max 12
TOTAL							90

draft date: Oct, 2013

D.Arch Courses Requiring BIM Inclusion	
Year 1	ARCH 533 (3) ARCH 523 (3)
Year 2	ARCH 524 (3) ARCH 525 (3) ARCH 526 (3)

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