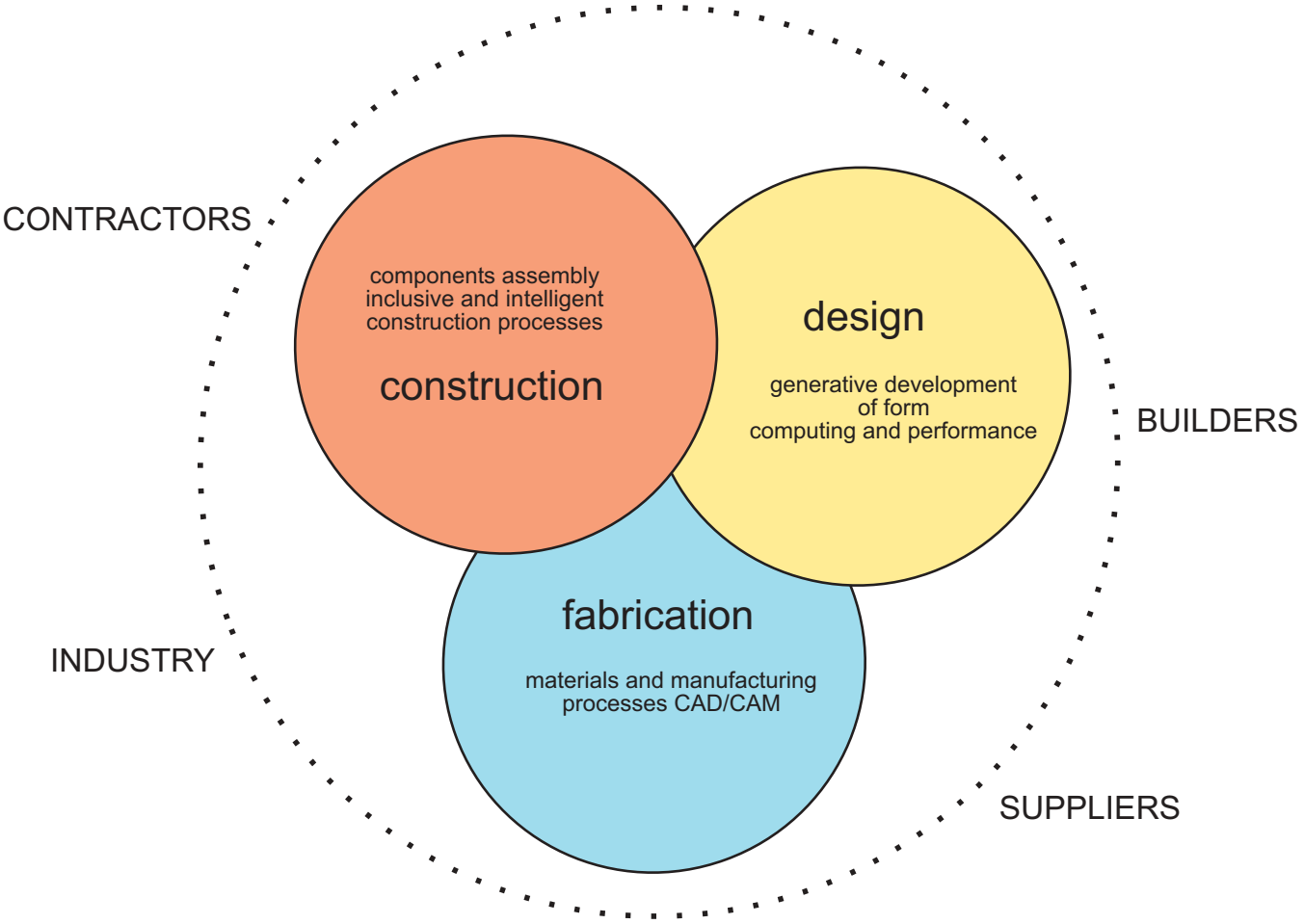
DDF

DDF
Digital Design and Fabrication
College of Architecture
Texas Tech University
Master of Science Program

TEXAS TECH UNIVERSITY
COLLEGE OF ARCHITECTURE

IN COLLABORATION WITH INDUSTRIAL ENGINEERING, MECHANICAL ENGINEERING, CIVIL ENGINEERING
COMPUTER SCIENCE, BUSINESS ADMINISTRATION

DDF
digital design and fabrication
performance and making



Interdisciplinary education forms a network hub
acting as a catalyst for innovation in the industry,
contributes to the *advancement of knowledge*
and forms a *social benefit* to the *community*

Master of Science in Digital Design and Fabrication

The College of Architecture's Master of Science in Digital Design and Fabrication (DDF) is dedicated to advance design knowledge and pursue innovation in the process of making architecture. The program is positioned at the intersection of architecture, engineering and computation with a profound sustainable and interdisciplinary direction. The program expects to develop applied research approaches that concern emerging material issues in a "digital-craft" based professional practice.

With a focus on digital technologies, the program explores new material processes across different fields and the related fabrication and building methodologies. The goal is to form a set of skills, which build up a designer's creative potential through material oriented strategies. Research models and innovative approaches are in direct response to questions of inquiry brought forward through our network of partners in professional practice. The program is intended to prepare students for recent market changes with an exponential increase in digital and information-driven design-build projects.

A change in the process of architecture through the technological evolution of "drawings" is occurring today, but in contrast with the renaissance, it is reconfiguring the whole building industry, involving the architect in an emerging networked team of design and construction specialists. New communication and knowledge exchange techniques supported with information technology (IT) are disrupting time frames and spatial relationships between key players and facilitating inclusiveness and collaborative project delivery. The cyberarchitect in the new role of the integrative generalist or design specialist forms part of the emerging creative class, to use a term suggested by Richard Florida of Carnegie Mellon University.

The new "design+build" process, inspired by the automotive industry, is no more a linear single-event procedure, but instead is focused on collective problem solving in a central 4D digital master model. In this model, simultaneous multi-events are modified and subjected to performance simulations early in the design phase. The emerging common building information model, is universally accessible and parametrically organized in a way to accompany the building from its digital inception through the entire building life cycle.

It is the challenge of the DDF program to stimulate research in new design processes and techniques (from bio-ecological to nano-technological), where the material and product-based outcome is simulated at the industrial fabrication stage through prototyping and the determination of innovative aspects during the assembly phase. While it helps the students to gain experience with the latest manufacturing technologies (in particular the use of computer numerically controlled equipment such as routers, laser cutters, and other machinery) the program provides the additional opportunity to investigate potentially new building systems by way of prototyping small to full scale components. The digital design and build process is based on precise descriptions, which are driving the fabrication of building products through parametric instructions fed directly into the respective machines. Through the exploration of these parametric strategies, this highly informed process can influence the way architects design, in particular because the new techniques allow one to judge the performance of models and their variations in direct response to material implications. Recent concepts of mass customization and variability in manufacturing are therefore issues to be critically reviewed in design research in seminars and studios.

The DDF program consists of 38 hours of course work including design studios and thesis.

The first year consists of courses which provide a theoretical basis and skill development in creative computational modeling, digital design strategies and emergent technologies. Emphasis is on the generative development of form, computing in terms of *formfindung* (formfinding) and extending to the performance and behavior of resulting structures and geometries.

In general, the program focus is on emergent design techniques and a material-based process further developed in the design studio and complemented by specific courses. With the introduction to fabrication concepts, students are given hands-on experience with Computer Aided Manufacturing (CAM) software and computer numerical processes complemented by experiments with state of the art technology in the lab.

The second year consists of courses which provide additional expertise in experimental design techniques related to advanced material research. Students are encouraged to develop and structure their research toward individual thesis design proposals. Courses on materials and innovative methods of assembly work in concert to further develop the individual student's research, culminating in a master design thesis, project, or scholarly paper.

All courses provide the necessary set of skills to be applied in design research experiments. The idea is to create a think tank embedded in strategic, interdisciplinary collaborations with other colleagues and colleges on and off campus in order to incubate new ways of research and engage in projects related to current themes. Students in the program will also engage in and organize workshops, symposia and publications to bring their research findings to the forefront of ongoing debate in the architectural field.

Certificate

Digital Design and Fabrication Certificate: This certificate is an educational component of the Master of Science in Digital Design and Fabrication. Both the Master of Science and the Certificate make up the Digital Design and Fabrication Program. A minor or certificate of specialization can be obtained by graduate students in other programs by taking the 15 hours of core courses in the DDF program. The digital design and fabrication certificate is intended to prepare students for recent market changes with an exponential increase in digital and information-driven design-build projects. Students develop a set of skills geared towards a "digital-craft" based professional orientation with emphasis on design techniques, advanced material processes and fabrication methodologies.

MArch students wanting to earn the certificate are required to complete the 15 core course hours in addition to required courses for completion of that degree. MArch graduates who wish to pursue the MS Degree after receiving the MArch with the certificate may transfer in only six hours from the MArch certification and must the complete 38 hours of approved course work to receive the MS Degree.

BSArch students can take up to nine hours of the certification within the last eighteen hours of undergraduate study. These hours can be transferred toward the MS Degree if these nine hours are not used to fulfill the undergraduate degree requirements. BSArch students can also opt to take these nine hours as undergraduate electives within the last eighteen hours of BSArch coursework as counted elective courses, and complete an additional six hours of certification core courses after graduation, to receive the certificate. If BSArch students wish to pursue the MS Degree later, only six hours of the certificate hours can be transferred and the student must complete an additional 32 hours of course work.

Any student enrolled at TTU in any school or college can earn a certificate, as a Bachelor, Master, or PhD degree candidate under the same guidelines above having been accepted into the certificate program offered by the College of Architecture. The certificate is awarded only after completion of a first degree.

For additional information, please see the DDF webpage at:
http://arch.ttu.edu/wiki/Digital_Design_Fabrication_M.S.

Application Dates:
March 1st for the following fall semester
October 1st for the spring semester (approval by the program director)

Contact:
Program Director
Assoc. Prof. Christian R. Pongratz
Ph: (806) 742 -3136 X226
christian.pongratz@ttu.edu

DDF MS Degree Courses

1st Semester Fall:
AR 5302 Product Design (Flueckiger) *
AR 5301 Smart Materials (Perbellini) *
Elective (3 hrs.)
TOTAL HOURS: 9

2nd Semester Spring:
AR 5352 Design Computing (Park) *
AR 5334 Adv Stds in Construction Tech (Pongratz only) *
Elective (3 hrs.)
TOTAL HOURS: 11

3rd Semester Fall:
AR 5503 DDF Studio
AR 7000 Research (3 hrs.)
AR 5301 Design Process (Pongratz) *
TOTAL HOURS: 9

4th Semester Spring:
AR 5361 Poetics and Digital Tools (Neiman) *
AR 6000 Thesis OR Thesis Project OR Paper (6 hrs.)
TOTAL HOURS: 9

Approved Electives:
IE 5351 (spring) Advanced Manufacturing Processes
IE 5355 (spring) Computer-Aided Manufacturing Engineering
IE 5356 (spring) Biomedical Design & Manufacturing

Degree Plan 38 hrs.
*elective courses for Certificate (req: 15hrs)

DDF Course descriptions:

DESIGN:

1. ARCH 5352 Design Computing (Park) (catalog:Computer Applications to Architecture)
DECO (DEsign COmputing) introduces design as a computational enterprise in which mediating technologies are developed to compose and describe architecture and designs. The course opens with the novel idea of design computing as a creative act in architecture. Moreover, in the course investigators create a design world that is based on language, modern logic, and fundamentals of cognitive science to address the notion of generation in computational design. The course covers topics such as mathematics in design/architecture, design by number, media art, shapes, modern logic, the notion of language, cognitive science, shape arithmetic, symmetry, spatial relations, action & reaction, human & computer interaction, shape computations, shape grammars, and physical computing. Hands-on design exercises and projects are continually framed and examined in the larger context of current digital and physical technologies in computing.

2. ARCH 5301 Design Process (Pongratz) (catalog: Special Problems in Architecture)
This course is an intensive introduction dedicated to advanced computing and parametric modeling. It will explore digital processes of design related to the intellectual conceptualization, development and automation of *formfindung*. Investigating generative natural systems, the history of evolutionary morphological processes of form development and their resulting geometrical changes are explored and put into relationship with emerging computational models of form generation. The object of exploration is the discreet variation and modularization of surfaces. Topics cover questions of *formgebung* versus *formfindung*, difference and repetition, generative design, evolutionary design, genetic algorithms, component assembly in nature and their self-organizing potentials. Authors and architects discussed include D'Arcy Wentworth Thompson, Robert Le Ricolais, G. Bateson

Methodology of inquiry: Recent algorithmic processes introduced with scripting techniques in several software packages (MEL, GH, DP, GC etc.), allow for control, variation and differentiation of design strategies through parametric definition and scheduled intelligence. Instead of linear processes being employed in the design development process as in the past, chance and performance occur simultaneously, which permits us to address current necessities with inclusive design strategies. The exploration of relationships and dependencies of objects with programmed loops and open "what if" conditions maximizes the exploration of a large number of variations within reduced time restraints. The course is intended to explore with small exercises the different steps involved with programming concepts. With increasing competency, individual paths and programs will be developed which experiment with the potential of parameter changes and environmental influences on the system.

3. ARCH 5361 Analog-Digital Constructions (Neiman) (catalog: Architectural Theory Seminar)
This design seminar investigates the strategies, tactics and techniques of form making with a particular emphasis on design fabrication. The work is exploratory in nature and proceeds unfettered by the conventions of practical application in order to discover the unexpected that could radically alter our understanding of the practical. The creative techniques presented give students a procedural foundation for the integrated use of physical material and digital tools in a design process. The course features design discussion and critiques of design and fabrication work, supplemented by procedural demonstrations and workshop sessions. Both analog and digital assignments are completed outside of class time.

The specific objective is for student teams to design, document, fabricate, paint and assemble a series of large-scale, three-dimensional, physical relief models translated from pre-existing two-dimensional compositions. Several overlapping processes are engaged as follows:

1. Design: analog design configurations developed and translated to digital 2D construction templates.
2. Measuring Model: an analog tool for calibration of layered and vertical components.
3. Virtual Model: a working 3D digital model produced from vector-based template files.
4. Fabrication: laser cutting of model parts from vector-based template files.
5. Assembly: laser cut parts are painted and assembled.
6. Documentation: scanning and photography of the entire process.
7. Display: exhibition or publication of models, drawings and process photos.

Required Software: formZ, bonzai3D, Adobe Photoshop and Illustrator.

FABRICATION:

4. Arch 5301 Smart Materials (Perbellini) (catalog: Special Problems in Architecture)

The course will study emerging material practices from building component design to interactivearchitecture and smart design. The focus is on the exploration of properties of materials with the goal to understand the potential for innovation through a “smart application” in contemporary building design. The research investigates material components that may form an intelligent sustainable system by using their physical characteristics. Recent research driven products of the industry like self-cleaning glass, anti pollution pavement, or shape memory alloys will be further explored in their application potential. Students will engage in analysis, research and development of design, engineering and manufacturing of innovative and high performance building components and envelopes. The course will engage in the questions of how materials may have different rarely applied properties and how this changes the range for new applications in building design.

5. ARCH 5334 Building Skins (Pongratz Only) (catalog: Adv Stds in Construction Tech)

The course on building skins will engage students in research and development of fabrication strategies and material processes, and explore the potential for innovation in building components and their assemblies. In addition, it will focus on the workflow between design concept in the generative modeling phases and design output to fabrication, such as the transfer to rapid prototyping and other numerically controlled machines. Students will be introduced to CAD/CAM environments, the concept of file-to-factory, and study the flow of projects in solid modeling and parametric software packages. An initial part of the course is dedicated to the analysis of design, engineering and manufacturing constraints related to innovative and high performance building envelopes. Case studies will explore the design of façade typologies through contemporary manufacturing methodologies and with regard to the materials of various cladding systems. Materials range from high-strength concrete, stone composites, extreme textiles to latest polymer and fiber composites.

Each year the course will focus on a specific topic of material inquiry selected by the instructor. The notion of non-standard production will be explored through a material system driven research in two phases, surface design and assembly design.

Students will be given a hands-on experience from small scale models to large scale mockups in different methods of fabrication, exploring material resistances and employing the equipment of the digital design and fabrication laboratory.

Readings include works by Frei, Fuller, Piano, Sobek and others.

CONSTRUCTION:

6. Arch 5302 Product design Workshop II (Flueckiger) (catalog: Product Design Workshop)

Introduction and development of contemporary product design and prefabricate housing with emphasis on digital fabrication process. Making of a prototypical design product/model applying digital fabrication technology.

F. Prerequisite Product Design I

Approved Electives:

7. IE 5351. Advanced Manufacturing Processes (3:3:0).

Prerequisite: Consent of instructor.

Advanced topics in manufacturing materials and processes, including metallurgical considerations, nonmetallic materials, deformation processes, metal removal theory, and process economics. This course introduces graduate students to research work in the area of manufacturing materials and processes. Upon completion of this course graduate students should have increased their awareness of the multiple phases involved in selecting manufacturing processes based on the functional requirements imposed by part design. Also, graduate students will gain experience in the process of initializing innovative research, and supporting and clearly documenting it for future implementation.

8. IE 5355: Computer Aided Manufacturing Engineering (3:3:0).

Computer usage in manufacturing systems, computer-aided process planning, numerical control, industrial robot applications, flexible manufacturing systems, and integrated of CAD and CAM systems.

9. IE 5356: Biomedical Design & Manufacturing

Introduction to concepts and issues in biomedical design and manufacturing, including, biomaterials and nanomaterials, medical devices, body mechanics, design requirements, manufacturing, quality control, and ethics.

Educational Objectives

This course intends to introduce graduate students to research work in the area of design and manufacturing for biomedical applications. Overall, students will be presented with an overview of the biomedical device industry, basics and issues associated with biomedical design and human factors, selection of biomaterials, fabrication/manufacturing planning and control, and ethical issues that must be considered in the field. Upon completion of this course graduate students should have increased their awareness of the multiple aspects involved in biomedical design and manufacturing. Also, the graduate students will have gained experience in developing multidisciplinary research bridging medicine and engineering in a team oriented environment.

TEXAS TECH UNIVERSITY
College *of* Architecture™

Name_____
SS#_____
Entered Program_____

MASTER OF SCIENCE IN ARCHITECTURE, College of Architecture – 2009-2010
Digital Design and Fabrication Certificate

First Year					First Year				
	FALL					SPRING			
ARCH	5302	Product Design Workshop			ARCH	5352	Computer Applications to Architecture		
ARCH	5301	Special Problems in Architecture			ARCH	5334	Adv Stds in Construction Tech		
		General Elective					General Elective		
			Total	**9 Hours**				**Total**	**9 Hours**

Second Year					Second Year				
	FALL					SPRING			
ARCH	5503	Advanced Architectural Design Studio			ARCH	5361	Architectural Theory Seminar		
ARCH	7000	Research			ARCH	6000	Master's Thesis (6 hrs)		
ARCH	5301	Special Problems in Architecture							
			11	**Hours**				**Total**	**9 Hours**

Total hours: 38

COURSES NOT USED IN THIS CHECK:

TRANSFER CREDIT FROM:

TEXAS TECH UNIVERSITY
College *of* Architecture™

Name_____
SS#_____
Entered Program_____

NAAB ACCREDITED DEGREE PROGRAM:
GENERAL-ARCHITECTURE PROGRAM
BACHELOR OF SCIENCE IN ARCHITECTURE (Pre-Professional Program)
MASTER OF ARCHITECTURE (Professional Program) – 2008-2009
DIGITAL DESIGN AND FABRICATION – CERTIFICATE (Approval of Director required)

General-Architecture Program — Admission to the University. Only courses with a minimum grade of C or better will be accepted for the Architecture Program.

Foreign Language Required? Y N Sem 1_____ Sem 2_____

First Year	FALL: *SEEING*		SPRING: *FOUNDATION*	
ARCH 1311	**Design Environment & Society**	_____	**ARCH 1412 Arch. Design Studio I**	_____
ARCH 1341	**Arch Freehand Drawing**	_____	**ARCH 1353 Digital Media I**	_____
	Core Curriculum See below	_____	**Core Curriculum** See below	_____
	Core Curriculum See below	_____	**Core Curriculum** See below	_____
	Core Curriculum See below	_____	**Core Curriculum** See below	_____
		15		**16**

Pre-Professional Program — Competitive placement based on comprehensive review including student portfolio, written essay, GPA and statement of intent.

Summer	SESSION I		SESSION II	
	Core Curriculum **See below (Nat'l or Phys)**	_____	Core Curriculum **See below (Nat'l or Phys)**	_____
	Core Curriculum **See below**	_____	Core Curriculum **See below**	_____
		7		**7**

Second Year	FALL: *BASIC-INTERNAL*		SPRING: *BASIC-EXTERNAL*	
ARCH 2501	**Arch. Design Studio II**	_____	**ARCH 2502 Arch. Design Studio III**	_____
ARCH 2311	**Hist. of World Arch.**	_____	**ARCH 2315 Hist. 18/19/20 Cent. Arch.**	_____
ARCH 2351	**Arch. Construction I**	_____	**ARCH 2342 Arch. Design Drawing**	_____
	Core Curriculum See below	_____	**ARCH 2355 Environmental Systems**	_____
	+Diversity Elective (3 hrs)	_____	**Elective (3 hrs)**	_____
		17		**17**

Third Year	FALL: *BUILDING ENCLOSURE*		SPRING: *BUILDING SYSTEMS*	
ARCH 3501	**Arch. Design Studio IV**	_____	**ARCH 3502 Arch. Design Studio V**	_____
ARCH 3341	**Digital Media II**	_____	**ARCH 3314 Contemporary Issues in Architecture**	_____
ARCH 3350	**Arch. Construction II**	_____	**ARCH 3352 Building Information Technology**	_____
ARCH 3373	**Environ. Analysis/Site Planning**	_____	**ARCH 3355 Construction III**	_____
	Elective (3 hrs)	_____	**ARCH elective**	_____
		17		**17**

Summer	*URBANISM*	
++ARCH 4601	**Architectural Design Studio VI**	_____ **(Summer I and Summer II)**
		6

Fourth Year	FALL	
ARCH 4341	**Media Elective**	_____
ARCH 4354	**Integrative Systems**	_____
ARCH 4363	**Architectural Theory**	_____
□ARCH 5302	**Product Design**	_____
		12

Total hours: 131

Core Curriculum

ENGL	1301	Essentials of College Rhetoric
ENGL	1302	Advanced College Rhetoric
MATH	1321	Trigonometry
MATH	1350	Analytical Geometry
Phys	1403	General Physics I w/lab (4 hrs)
†Natural Lab Science (4 hrs)		
POLS	1301	American Government Organ.
††POLS	2302	American Public Policy
HIST	2300	History US to 1877
HIST	2301	History US since 1877
** COMS	2300/3358	

++ Optional courses ARCH 4365, 4366 for the Bachelor of Science Degree (Pre-Professional Program) and/or ARCH 4601. ARCH 4601 is a prerequisite for ARCH 5901.
††Or approved substitution.
+ Diversity elective course offerings on ARCH Website (www.arch.ttu.edu).
****Choose from COMS approved courses.**
†Choose from Core Curriculum requirements.

MASTER OF ARCHITECTURE, College of Architecture – 2008-2009
DIGITAL DESIGN AND FABRICATION – CERTIFICATE (Approval of Director required)
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PROFESSIONAL LEVEL PROGRAM: **Requirements for admission to the Professional Program include: completion of all academic course work in the first three years and a threshold score on the Admission Criteria Rating System. Please check the University catalog or College website for admission criteria. In all graduate courses, no grade below a C will be accepted. A 3.0 GPA is required each semester and a 3.0 GPA to graduate.**

Professional Program

		SPRING	
ARCH	5901	Comprehensive Studio	_____
ARCH	5365	Arch. Research Methods	_____
			12

Fifth Year

	FALL	
ARCH 5501	Topical Studio	_____
□ARCH 5301	Smart Materials (Perbellini)	_____
Elective (ARCH 5361	poetics and digital tools (Neiman)	_____
		11

	SPRING	
ARCH 5502	Topical Studio	_____
□ARCH 5334	Adv Stds in Const. Tech-Pongratz Only)	_____
□ARCH 5352	Design Computing (Park)	_____
		11

Sixth Year

	FALL	
ARCH 5503	Topical Studio	_____
□ARCH 5301	Design Process	_____
ARCH 5392	Professional Practice	_____
		11

Total Hours: 176

COURSES NOT USED IN THIS CHECK:

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TRANSFER CREDIT FROM:

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revised 10/08