



IUPUI

**SCHOOL OF INFORMATICS  
AND COMPUTING**

DEPARTMENT OF HUMAN-CENTERED COMPUTING  
Indiana University–Purdue University  
Indianapolis

**NEWM N548**

**3D Prototyping for Application in Medicine**

*Section No.:*

*Credit Hours:* 3

*Time:*

*Location:* IT 255, Informatics & Communications Technology Complex 535 West  
Michigan Street, Indianapolis, IN 46202 [\[map\]](#)

*First Class:*

*Website:* <https://canvas.iu.edu/.../>

*Instructor:* Zebulun M. Wood, MS in Technology, Lecturer

*Office Hours:* Mondays and Tuesdays, 1–5 pm, and/or by Appointment

*Office:* IT 463, Informatics & Communications Technology Complex 535 West  
Michigan Street, Indianapolis, IN 46202 [\[map\]](#)

*Phone:* 317-278-4140 (Office)

*Email:* [zwood@iupui.edu](mailto:zwood@iupui.edu)

*Website:* <http://soic.iupui.edu/people/zeb-wood/>  
<http://www.indianauploaded.org>

*Prerequisites:* NEWM N502 or Equivalent or Instructor Permission

**COURSE DESCRIPTION**

This course covers advanced modeling, sculpting, articulation, and printing of 3D objects for applications in medicine and dentistry. It includes strategies for the collection, evaluation, and editing of data from medicine and dentistry and the creation of prototypes for complete medical and dental applications.

**EXTENDED COURSE DESCRIPTION**

Students develop a set of physical objects and display them appropriately for their intended medical or dental application. They choose from a wide variety of problems involving medical or dental data to evaluate and anticipate applicable solutions using 3D printing. Students concept their proposals in collaboration with campus or community partners and research techniques and references. Students evaluate and analyze medical and dental data to quickly create solutions to issues currently in demand. Students develop two printed objects and display them appropriately for their intended field. One is an experimental medical or dental solution using already collected data; the other project must implement some partnership looking to solve a medical or dental problem.

### **Recommended Texts:**

Bidanda, B., & Bártolo, P. J. (Eds.). (2008). *Virtual Prototyping & Bio Manufacturing in Medical Applications*. New York: Springer. **ISBN-13:** 978-0-387-33429-5 **e-ISBN:** 978-0-387-68831-2

### **Resources for Reference**

[Converting MRI Data](#)

### **Software used:**

[MIMICS](#) – data conversion

[3-Matic](#) – data conversion and manipulation

Autodesk Maya 2015 + **Data Refinement**

Zbrush 4r6 + **Data Refinement**

Adobe Production Suite (Photoshop, After Effects, Premiere,)

### **Equipment needed:**

- Notebook
- Box Account [<http://www.box.iu.edu>]
- Portable Table

### **Core Competencies:**

- Students develop, discuss, and implement from preproduction, to production, to post-production 3D-printed prototypes for use in medical and dental applications.
- Students model, analyze, articulate, and 3D print physical objects using common practices for 3D printing.
- Students setup 3D objects, for watertight printing using .stl and .obj file formats.
- Students create two prototypes for applications in either medicine or dentistry.
- Students analyze, create, collect, manipulate 3D-print prototypes from various datasets.
- Students learn the entire production pipeline for creating geometry that can be printed cost effectively and standards using various data collection methods.
- Students compare, contrast, and defend the value of 3D shapes used to prototype potential solutions used in medicine and dentistry.
- Students anticipate and forecast entire production pipelines for the creation of geometry that can be printed cost effectively in accordance with best practices using various data collection methods.

### **Principles of Graduate and Professional Learning (PGPL)**

Learning outcomes are assessed in the following areas:

- |    |                                     |                   |
|----|-------------------------------------|-------------------|
| 1. | Knowledge and skills mastery        | Moderate emphasis |
| 2. | Critical thinking and good judgment | Major emphasis    |
| 3. | Effective communication             | Some emphasis     |
| 4. | Ethical behavior                    |                   |

## Student Learning Outcomes:

Upon completion of this course, the student will	RBT	PGPL	Assessment
1. Evaluate the workflows of surgeons and dentists who create 3D models;	5	2	Assignment 6 Midterm 1
2. Evaluate critically the templates to ensure accurate production of 3D models for the missing structure;	5	1	Assignment 5 Midterm 1
3. Evaluate and design plans for a production;	5	2	Model 1 and 2 Midterm 2
4. Develop production methods in a 3D printing pipeline;	6	1	Model 1 and 2
5. Evaluate, test, and experiment with various datasets to create applicable solutions;	5	2, 3	Model 2 Assignments
6. Apply self-imposed deadlines and time management to fulfill final project expectations and budget considerations;	3	2	Model 2, Final Prototype
7. Create models that are aligned with their functional and/or cosmetic purpose;	6	1, 2	Model 2 Assignments
8. Develop project presentations in accordance with research interest in medicine or dentistry.	6	3	Final Prototype

RBT: Revised Bloom's Taxonomy

## EXPECTATIONS, GUIDELINES, AND POLICIES

### Attendance:

For success in this class I expect students to attend each class session. I will only allow missed classes if you give me notice a full week in advance. This class has a stringent attendance policy of 1 dropped letter grade for each 2 classes missed. I will take attendance at the beginning of each class.

### Incomplete:

The instructor may assign an Incomplete (I) grade only if at least 75% of the required coursework has been completed at passing quality and holding you to previously established time limits would result in unjust hardship to you. All unfinished work must be completed by the date set by the instructor. Left unchanged, an Incomplete automatically becomes an F after one year. <http://registrar.iupui.edu/incomp.html>

### Deliverables:

You are responsible for completing each deliverable (e.g., assignment, quiz) by its deadline and submitting it by the specified method. Deadlines are outlined in the syllabus or in

supplementary documents accessible through OnCourse. Should you miss a class, you are still responsible for completing the deliverable and for finding out what was covered in class, including any new or modified deliverable. In fairness to the instructor and students who completed their work on time, a grade on a deliverable shall be reduced 10%, if it is submitted late and a further 10% for each 24-hour period it is submitted after the deadline.

### **Midterms:**

There are two midterms.

### **Lab assignments:**

Class tutorials and demos must be completed with the instructor. Failure to do so can result in a detrimental effect on effort and class participation scores.

### **Class assignments:**

I will require homework exercises following tutorials or in class demo each week. I expect these to be completed by the next class.

## **WEEKLY SCHEDULE**

### **Week 1**

Introduction: Syllabus, Student and Instructor Introductions,  
Student Knowledge Inventory  
Lecture: Equipment/Software Introduction  
Goals of class, requirements for application and discovery  
Lab: Go over current models in students' inventory  
Assignment 1: Bring in models to inventory

### **Week 2**

Lecture: Introduce equipment in action, \*things to watch out for  
Lab: Review models, data types, and options for editing  
Assignment 2: Collect resources and network for collaborations

### **Week 3**

Lecture: History and trends in medical and dental prototyping, identify process options  
Lab: Review data, make watertight and to scale, print  
Assignment 3: Research trends and identify possible area of exploration  
Assignment 4: Check for water tightness/ material efficiency

### **Week 4      LAB DAY – Visit with on-campus or community partners**

Model 1: Final .stl ready for print/review  
Create Model 1 from data and prepare it for 3D printing

### **Week 5**

Guest Lecture: Invited guest  
Application of 3D printed models in medicine and dentistry to reconstruct missing parts of the body, Use of imaging software

Midterm 1: Midterm on readings at the beginning of class

### **Week 6**

Guest Lecture: Surgeon and dentists' workflow and processes to construct the template for the 3D objects

Assignment 5: Students are provided with a case report and template made by surgeons. The students need to evaluate and write a report on the template

### **Week 7**

Lecture: Interaction and communication between surgeons or dentists and the individual responsible for 3D printing. What is important?

Assignment 6: Write a communication report with specifics on what needs to be done

### **Week 8**

Lecture: Discussion on applications and trends

Lab: Review Model 2 pitches

Assignment 7: Pitch 2<sup>nd</sup> 3D-printed model

### **Week 9**

Lecture: Cleaning/prepping data with various applications

Lab: Review models and begin printing ready models

Assignment 8: Print approvals check for water tightness and material efficiency

### **Week 10**

Lecture: Editing Accurately, Engineering in design

Lab: Review models and begin print-ready models

Assignment 9: 2<sup>nd</sup> .stl ready for print/review, Pitch final prototype and partnership  
Research of trends for final project: Plan development

### **Week 11**

Lecture: Mold Prototyping for Mass Manufacturing

Lab: Review final prints of Model 2 and pitches for Final

Model 2: Pitch for Final, Collaborative plan

Check all articulated pieces water tightness and material efficiency

### **Week 12**

Lecture: Discuss chosen methods for models and how to tackle implementation

Midterm 2: Midterm on readings

### **Week 13**

Lecture: Visit with oncampus or community partners  
Lab: Begin check and print of final prototypes

#### **Week 14**

Lab: Begin check and print of final prototypes  
Assignment 10: Finish and prep for presentation with collaborators

#### **Week 15**

Final Prototype: Present Final Prototype

#### **Week 16**

Research: Present research

### **ASSESSMENTS**

#### **Weekly Assignments**

All assignments are to be delivered in a folder with your name, class, and week titled, if the assignment is Maya based; with zipped Maya project folders, and will be evaluated through Oncourse within the week.

Weekly assignments will vary in topic and assist in the students understanding and appreciation of how the production pipeline is executed between data and print. Students will adapt to design issues, evaluate data, and integrate experiments in prototyping with current issues in medicine.

- **Model 1** is a preliminary check on pipeline and material efficiency for creating models for 3D printing from medical and dental data. (100 points)
- **Model 2** is a check on the student's ability to create a project problem and solution while understanding production and application of said object within a given medical or dental application. This is the first 3D-printed model. (100 points)
- **Final Prototype** is your final 3D-printed model based on an on-campus or community partnership, medical or dental solution to specific problem, or collaboration with client.
  - 100 points towards model, level detail, quality, and efficiency
  - 100 degree of difficulty, marketability of project
  - 100 points for presentation
- **Research** (100 points) is your research into a specific design problem area will supplement and support the design and experiments towards your final prototype and partnership with a real or simulated client. You will develop and report on the following:
  - Previous solutions to specific surgical or medical issue
  - Present method and creative solution for specific issue

- Anticipate design challenges and opportunities

## ASSESSMENT GRADE BREAKDOWN

	<b>Due Date</b>	<b>Assignment</b>	<b>Points</b>
Assignment 1		Bring in models that you have already	25
Assignment 2		Collect resources and network for collaborations	25
Assignment 3		Research trends and identify possible area of exploration	25
Assignment 4		Check for water tightness/ material efficiency	25
Model 1		Final .stl ready for print/review Create Model 1 from data and prepare it for 3D printing	100
Midterm 1		Midterm on readings	100
Assignment 5		Write report on template	50
Assignment 6		Write a communications report	50
Assignment 7		Pitch 2 <sup>nd</sup> 3D-printed model	50
Assignment 8		Print approvals check for water tightness and material efficiency	25
Assignment 9		Pitch final prototype and partnership Research of trends for final project Plan development	75
Model 2		2 <sup>nd</sup> .stl ready for print/review / pitch final articulated model	100
Midterm 2		Midterm on readings	100
Assignment 10		Check for all articulated pieces Check for water tightness and material efficiency	50
Final Prototype		Delivery of final product/files	300
Research		Supplement Final Pitch with support in review of literature in design issue area	100



## Grading Scale:

A+	97 – 100	Outstanding achievement, given at the instructor’s discretion
A	93 – 100	Excellent achievement
A–	90 – 92.99	Very good performance and quality of work
B+	87 – 89.99	Good performance and quality of work
B	83 – 86.99	Modestly acceptable performance and quality of work
B–	80 – 82.99	Marginal acceptable performance and quality of work
C+	77 – 79.99	Unacceptable work (Core course must be repeated for credit)
C	73 – 76.99	Unacceptable work (Core course must be repeated for credit)
C–	70 – 72.99	Unacceptable work (Course must be repeated for credit)
D+	67 – 69.99	Unacceptable work (Course must be repeated for credit)
D	63 – 66.99	Unacceptable work (Course must be repeated for credit)
D–	60 – 62.99	Unacceptable work (Course must be repeated for credit)
F	Below 60	Unacceptable work (Course must be repeated for credit)

No credits toward major, minor, or certificate requirements are granted for a grade below B–.

## CODE OF CONDUCT

All students should aspire to the highest standards of academic integrity. Using another student’s work on an assignment, cheating on a test, not quoting or citing references correctly, or any other form of dishonesty or plagiarism shall result in a grade of zero on the item and possibly an F in the course. Incidences of academic misconduct shall be referred to the Department Chair and repeated violations shall result in dismissal from the program.

All students are responsible for reading, understanding, and applying the *Code of Student Rights, Responsibilities and Conduct* and in particular the section on academic misconduct. Refer to *The Code > Responsibilities > Academic Misconduct* at <http://www.indiana.edu/~code/>. All students must also successfully complete the Indiana University Department of Education “How to Recognize Plagiarism” Tutorial and Test. <https://www.indiana.edu/~istd> You must document the difference between your writing and that of others. Use quotation marks in addition to a citation, page number, and reference whenever writing someone else’s words (e.g., following the *Publication Manual of the American Psychological Association*). To detect plagiarism instructors apply a range of methods, including Turnitin.com. <http://www.ulib.iupui.edu/libinfo/turnitin>

## Academic Misconduct:

1. **Cheating:** Cheating is considered to be an attempt to use or provide unauthorized assistance, materials, information, or study aids in any form and in any academic exercise or environment.
  - a. A student must not use external assistance on any “in-class” or “take-home” examination, unless the instructor specifically has authorized external assistance. This prohibition includes, but is not limited to, the use of tutors, books, notes, calculators, computers, and wireless communication devices.

- b. A student must not use another person as a substitute in the taking of an examination or quiz, nor allow other persons to conduct research or to prepare work, without advanced authorization from the instructor to whom the work is being submitted.
  - c. A student must not use materials from a commercial term paper company, files of papers prepared by other persons, or submit documents found on the Internet.
  - d. A student must not collaborate with other persons on a particular project and submit a copy of a written report that is represented explicitly or implicitly as the student's individual work.
  - e. A student must not use any unauthorized assistance in a laboratory, at a computer terminal, or on fieldwork.
  - f. A student must not steal examinations or other course materials, including but not limited to, physical copies and photographic or electronic images.
  - g. A student must not submit substantial portions of the same academic work for credit or honors more than once without permission of the instructor or program to whom the work is being submitted.
  - h. A student must not, without authorization, alter a grade or score in any way, nor alter answers on a returned exam or assignment for credit.
2. **Fabrication:** A student must not falsify or invent any information or data in an academic exercise including, but not limited to, records or reports, laboratory results, and citation to the sources of information.
3. **Plagiarism:** Plagiarism is defined as presenting someone else's work, including the work of other students, as one's own. Any ideas or materials taken from another source for either written or oral use must be fully acknowledged, unless the information is common knowledge. What is considered "common knowledge" may differ from course to course.
- a. A student must not adopt or reproduce ideas, opinions, theories, formulas, graphics, or pictures of another person without acknowledgment.
  - b. A student must give credit to the originality of others and acknowledge indebtedness whenever:
    - 1. directly quoting another person's actual words, whether oral or written;
    - 2. using another person's ideas, opinions, or theories;
    - 3. paraphrasing the words, ideas, opinions, or theories of others, whether oral or written;
    - 4. borrowing facts, statistics, or illustrative material; or
    - 5. offering materials assembled or collected by others in the form of projects or collections without acknowledgment
4. **Interference:** A student must not steal, change, destroy, or impede another student's work, nor should the student unjustly attempt, through a bribe, a promise of favors or threats, to affect any student's grade or the evaluation of academic performance. Impeding another student's work includes, but is not limited to, the theft, defacement, or mutilation of resources so as to deprive others of the information they contain.
5. **Violation of Course Rules:** A student must not violate course rules established by a department, the course syllabus, verbal or written instructions, or the course materials that are

rationally related to the content of the course or to the enhancement of the learning process in the course.

6. **Facilitating Academic Dishonesty:** A student must not intentionally or knowingly help or attempt to help another student to commit an act of academic misconduct, nor allow another student to use his or her work or resources to commit an act of misconduct.

## **OTHER POLICIES**

1. **Right to revise:** The instructor reserves the right to make changes to this syllabus as necessary and, in such an event, will notify students of the changes immediately.

2. **IUPUI course policies:** A number of campus policies governing IUPUI courses may be found at the following link: [http://registrar.iupui.edu/course\\_policies.html](http://registrar.iupui.edu/course_policies.html)

3. **Classroom civility:** To maintain an effective and inclusive learning environment, it is important to be an attentive and respectful participant in lectures, discussions, group work, and other classroom exercises. Thus, unnecessary disruptions should be avoided, such as ringing cell phones engagement in private conversations and other unrelated activities. Cell phones, media players, or any noisy devices should be turned off during a class. Texting, surfing the Internet, and posting to Facebook or Twitter during class are generally not permitted. Laptop use may be permitted if it is used for taking notes or conducting class activities. Students should check with the instructor about permissible devices in class. IUPUI nurtures and promotes “a campus climate that seeks, values, and cultivates diversity in all of its forms and that provides conditions necessary for all campus community members to feel welcomed, supported, included, and valued” (IUPUI Strategic Initiative 9). IUPUI prohibits “discrimination against anyone for reasons of race, color, religion, national origin, sex, sexual orientation, marital status, age, disability, or [veteran] status” (Office of Equal Opportunity). Profanity or derogatory comments about the instructor, fellow students, invited speakers or other classroom visitors, or any members of the campus community shall not be tolerated. A violation of this rule shall result in a warning and, if the offense continues, possible disciplinary action.

4. **Bringing children to class:** To ensure an effective learning environment, children are not permitted to attend class with their parents, guardians, or childcare providers.

5. **Course Evaluations:** Course evaluations provide vital information for improving the quality of courses and programs. Students are urged to complete one course and instructor evaluation for each section in which they are enrolled at the School of Informatics and Computing with the following three exceptions: (a) The student has withdrawn from the course; (b) fewer than five students are enrolled in the section (in which case anonymity is impossible); and (c) the section is a laboratory that must be taken with a course having a different section number. Course evaluations are completed at <https://soic.iupui.edu/app/course-eval/>. Course evaluations are open from the eleventh week. Course evaluations are anonymous, which means that no one can view the name of the student completing the evaluation. In addition, no one can view the evaluation itself until after the instructor has submitted the final grades for the course. In small sections, demographic information should be left blank, if it could be used to identify the student.

6. **Communication:** For classroom-based courses, instructor or teaching assistant should

respond to emails by the end of the next class or, for online courses, within two Indiana University working days, which excludes weekends and holidays. The instructor should provide weekly office hours or accept appointments for face-to-face, telephone, or teleconferenced meetings, and announce periods of extended absence in advance.

7. **Email:** Indiana University uses your IU email account as an official means of communication, and students should check it daily for pertinent information. Although you may have your IU email forwarded to an outside email account, please email faculty and staff from your IU email account.

8. **Disabilities Policy:** In compliance with the Americans with Disabilities Act (ADA), all qualified students enrolled in this course are entitled to reasonable accommodations. Please notify the instructor during the first week of class of accommodations needed for the course. Students requiring accommodations because of a disability must register with Adaptive Educational Services (AES) and complete the appropriate AES-issued before receiving accommodations. The AES office is located at UC 100, Taylor Hall (Email: [aes@iupui.edu](mailto:aes@iupui.edu), Tel. 317 274-3241). Visit <http://aes.iupui.edu> for more information.

9. **Administrative Withdrawal:** A basic requirement of this course is that students participate in all class discussions and conscientiously complete all required course activities and/or assignments. If a student is unable to attend, participate in, or complete an assignment on time, it is the student's responsibility to inform the instructor. If a student misses more than half of the required activities within the first 25% of the course without contacting the instructor, the student may be administratively withdrawn from this course. Administrative withdrawal may have academic, financial, and financial aid implications. Administrative withdrawal will take place after the full refund period, and a student who has been administratively withdrawn from a course is ineligible for a tuition refund. Contact the instructor with questions concerning administrative withdrawal.

10. **Emergency Preparedness:** Safety on campus is everyone's responsibility. Know what to do in an emergency so that you can protect yourself and others. For specific information, visit the emergency management website. <http://protect.iu.edu/emergency>

11. **Student Advocate:** The Student Advocate provides assistance to students with personal, financial, and academic issues. The Student Advocate Office is located in the Campus Center, Suite 350. The Student Advocate may also be contacted by phone at 317 274-4431 or by email at [studvoc@iupui.edu](mailto:studvoc@iupui.edu). For more information visit <http://studentaffairs.iupui.edu/advocate>.

12. **Counseling and Psychological Services (CAPS):** Students seeking counseling or other psychological services should contact the CAPS office by phone at 274-2548 or email at [capsindy@iupui.edu](mailto:capsindy@iupui.edu). For more information visit <http://life.iupui.edu/caps/>.

## MISSION STATEMENT

The Mission of IUPUI is to provide for its constituents excellence in

- Teaching and Learning;
- Research, Scholarship, and Creative Activity; and

- Civic Engagement.

With each of these core activities characterized by

- Collaboration within and across disciplines and with the community;
- A commitment to ensuring diversity; and
- Pursuit of best practices.

IUPUI's mission is derived from and aligned with the principal components—Communities of Learning, Responsibilities of Excellence, Accountability and Best Practices—of Indiana University's Strategic Directions Charter.

## **STATEMENT OF VALUES**

IUPUI values the commitment of students to learning; of faculty to the highest standards of teaching, scholarship, and service; and of staff to the highest standards of service. IUPUI recognizes students as partners in learning. IUPUI values the opportunities afforded by its location in Indiana's capital city and is committed to serving the needs of its community. Thus, IUPUI students, faculty, and staff are involved in the community, both to provide educational programs and patient care and to apply learning to community needs through service. As a leader in fostering collaborative relationships, IUPUI values collegiality, cooperation, creativity, innovation, and entrepreneurship as well as honesty, integrity, and support for open inquiry and dissemination of findings. IUPUI is committed to the personal and professional development of its students, faculty, and staff and to continuous improvement of its programs and services.