Syllabus

Special Topics in Computational Design and Fabrication — Fall 2026

Introductory Information

This course has two central goals: to teach the fundamental concepts behind computational design and fabrication systems, and to teach students how to conduct and communicate research in this area. The course is designed to sit somewhere between a traditional assignment-based class and a fully open-ended research seminar, with the goal of getting the best of both worlds: students learn and implement core technical concepts while also developing an original idea into a working system and research paper.

Students pursue both goals through a semester-long team project. Each team will design and build a **computational design system in a domain of its choice**. The project follows a sequence of milestones aligned with the lectures: teams will (1) define a design representation and design space, (2) build an interactive tool for direct design, (3) develop a fabrication pipeline, (4) introduce computational methods for automating parts of the design process—often through optimization—and (5) evaluate the resulting system. This structure allows students to immediately apply concepts from lecture while progressively building, testing, and refining a system that works.

In parallel, students will learn how to position and communicate their work as research. Writing milestones will accompany the system milestones, with feedback throughout the semester, and lectures will also address research writing and presentation.

The goal is for students to finish the course with both a working computational design system and a paper that can serve as the basis for a research publication. Projects from recent offerings have subsequently been published at ACM SIGGRAPH and the ACM Symposium on Computational Fabrication (SCF), leading venues in the field. We hope that multiple projects from this offering will likewise develop into publishable research.

Learning Goals

By the end of the course, students will be able to:

- Develop computational models to automate design processes.
- Implement algorithms for shape generation and optimization.
- Bridge digital design with physical fabrication workflows.
- Apply algorithms to evaluate design performance.

- Create domain-specific abstractions for interactive design exploration.

Instructor: Adriana Schulz, She/Her
Office hours: Fridays 10:20-11AM, CIT 405
TA: Xiaoyi Liu ("Jason"), He/Him

Prerequisites

- A good working knowledge of Python programming
- Basic linear algebra (matrices and vectors)
- Some mathematical sophistication
- No prior knowledge of manufacturing is assumed

Communication

- See website for updates on lecture topics, calendar and lecture slides: `https://www.computationaldesign.group/courses/csci2952y-fall2026`
- We will use Ed for a discussion board and direct messaging with instructors

Course Materials

- A laptop on which students can run Python code (either locally or through Google Colab) is required for completing homework assignments.
- Students should also be able to install software used in lab sessions, such as OpenSCAD and other free or open-source tools provided during the course.
- Students are responsible for obtaining any additional resources required for their chosen final project, which may involve higher computational power, specific software, or fabrication materials beyond those used in labs. For example, if a student selects a project that involves a specific fabrication technique for which resources are not available through the course, they may need to acquire materials on their own. It is up to students to choose their projects based on the resources they have access to.

Credit Hour Expectations This course is designed to align with Brown University's credit hour expectations. The total expected workload is approximately:

- 14 weeks $\times$ (2.5 hours of class + 2 hours of reading) = 63 hours
- Final Project Writing (4 deliverables, 8 hours each) = 32 hours
- Final Project Presentations Prep (5 Presentations, 3 hours each) = 15 hours
- Final Project Implementation = 100 hours

Total: 210 hours

1 General Policies

This syllabus is designed to be a guideline for the course and these policies are subject to change.

Grades

- 50% Project Milestones (10% for each of the 5 Milestones)
- 30% Final Project Writeup
- 20% Participation
- No final exam

2 Course Project Policies

The course project is the central component of the course and accounts for **80% of the final grade**: five project milestones worth **10% each** and a final paper worth **30%**.

Students will work in teams to design and implement a computational design system in a domain of their choice. The goal is to learn not only how to build a computational design system, but also how to formulate, execute, evaluate, and communicate a computational design research project. By the end of the semester, each team will produce a research-style paper describing its work.

Producing publishable research within a single semester is an ambitious goal. A key part of making this possible is choosing an exciting design domain in which there is room for new computational tools and ideas. We will therefore devote class time at the beginning of the project to selecting domains and forming teams, and then develop the projects incrementally through five in-class milestones.

Project Teams and Domain Selection

All projects will be completed in **teams of exactly three students, with no exceptions**.

We will select project domains collaboratively as a class. First, we will brainstorm a broad set of interesting domains for computational design. The class will then select the top K domains, where K is chosen so that there is one domain for every team of three students.

Once the domains have been selected, we will have an in-class group-forming activity. Students will be able to indicate both which domains they are most interested in and which classmates they would particularly like to work with. The goal is to form teams of three while taking both project interests and collaborator preferences into consideration.

The group-forming activity is ungraded and will take place on **September 25, 2026**.

Project Progression

The project milestones are designed to move from understanding a design space, to building a direct design tool, to fabrication, and finally to an automated computational design system and its evaluation. In the early stages, students will build a system in which a user directly specifies a design, typically through an interface, and the system converts that design into something that can be fabricated. Automation is added later: the final system should allow the user to specify higher-level goals or objectives and use computational methods—often including optimization—to help generate a fabricable design.

Each of the following five milestones is worth **10% of the final course grade**.

Milestone 1: Intro, Related Work, and Design Space — October 2, 2026

Teams will give a short in-class talk introducing the project. The presentation should explain the design domain, motivate what the proposed computational design system will enable, describe the initial design space, and contextualize the project relative to related work.
Paper submission: Submit a draft of the **Introduction and Related Work** sections.

Milestone 2: Direct Design Demo and Fabrication Proposal — October 16, 2026

Teams will bring a working demo of a direct design tool for their domain. At this stage, the system should not automate the design process: the user should be able to directly specify a design, typically through a UI, within the design space the team has defined. Other students will have an opportunity to interact with the demo. Teams should also explain how the output of the design tool will be converted into something that can be fabricated and present their fabrication plan.
Paper submission: Revise the Introduction and Related Work based on feedback and add an **Overview** section describing the system and design space.

Milestone 3: Fabricated Results and System Proposal — October 30, 2026

Teams will fabricate examples produced using their direct design tool and present the fabricated results in class. They will also present a concrete proposal for the end-to-end computational design system they plan to build, including which parts of the design process will be automated and the computational approach they plan to use.
Paper submission: Revise the existing draft and add an outline of the **Method** and **Fabrication** sections.

Milestone 4: End-to-End Design Automation — November 20, 2026

Teams will present a working end-to-end version of their computational design system, including the automated component of the design process. The presentation should explain the algorithms or optimization methods used and demonstrate how the system turns higher-level user objectives into designs that can ultimately be fabricated. Teams will also propose an evaluation plan, including the experiments, comparisons, and ablations needed to assess the system.

Paper submission: Revise the existing draft, develop the **Method** and **Fabrication** sections in detail, and add an outline of the **Experiments and Results** section.

Milestone 5: Final Results, Ablations, and Comparisons — December 4, 2026

Teams will present their final results and evaluation. This should include the strongest examples produced by the system as well as appropriate comparisons, ablations, and other experiments that help establish what the system contributes and how well it works.
Paper submission: Revise the complete draft and add the **Experiments and Results** section, including the final comparisons and ablations.

Paper Development and Final Submission

The intermediate paper submissions associated with the project milestones are **not graded**. The course staff will read them carefully and provide feedback so that teams have time to improve both the research and its presentation throughout the semester. Teams are expected to submit each draft on time and incorporate feedback into subsequent versions.

After Milestone 5, teams will have the reading period to incorporate feedback from the final presentation, complete any remaining experiments, and revise the full paper.

The **final paper is due December 11, 2026** and is worth **30% of the final course grade**.

Paper Development and Feedback

The paper will be developed incrementally throughout the semester. The intermediate paper submissions associated with the milestones are **not graded**. Their purpose is to ensure that teams receive feedback while there is still time to act on it.

The course staff will read these submissions carefully and provide feedback. Teams are expected to incorporate this feedback into subsequent drafts. Although the intermediate drafts do not receive a numerical grade, submitting them on time is an important part of the project process and gives teams the best opportunity to produce a strong final paper.

Final Paper

After the fifth milestone, teams will have the reading period to incorporate feedback from their final presentation, complete their evaluations, and revise the paper.

The **final paper is due December 11, 2026** and is worth **30% of the final course grade**.

The final paper should present the project as a complete research contribution, including its motivation, relationship to prior work, system and methods, fabrication process where applicable, results, evaluation, and conclusions.

3 Participation Policies

- Engaging in class discussion is essential for one of the key learning objectives of this course: to reflect on computational solutions that will enable the next generation of design tools for manufacturing and fundamentally change what can be made, and by whom. **Since there are no scheduled exams and the project alone cannot reflect all of the topics discussed in class, the participation grade is designed to reflect this key learning objective.**

- **Each lecture is worth 0 or 1 participation point, and the lowest 5 scores will be dropped.** This allows students to miss up to 5 lectures without penalty. In cases of extenuating circumstances, students may recover a participation point for an additional missed lecture by submitting a report on that lecture. See details under **"Don't Suffer in Silence"** below.

- Students will be awarded one participation point for every lecture in which they are *actively* present. Participation is measured using "Duck Points."

Participating Ducks, or "Duck Points" Each student will receive one rubber duck at the beginning of the semester, which they should keep and return by the end of the semester. During each class, the student can throw the duck to the lecturer when they engage in class discussion—engagement means either asking or answering a question. The lecturer will keep the "participating ducks" at the front of the classroom until the end of class. At the end of class, the TAs will take note of all the ducks that are up front and give their owners a participation point for that lecture.

Note: Adriana is known to have no chance at a career as a catcher. You will get your participation point whether or not she is able to catch your duck on the first throw, but she will be very excited if she is able to do it, so you should try to make it easy on her ;)

There is no extra credit for participation. Students can keep track of their participation grade on Canvas. Please check Canvas from time to time and let the TA know if there is a mistake, as these can happen with ducks flying around :).

4 Academic Honesty

Please review the Brown University Academic Code: `http://www.brown.edu/academics/college/degree/policies/academic-code`. All work submitted for grading should reflect your own individual effort. Discussions with other students or the instructors are allowed, but copying is not acceptable. Sharing, copying, or obtaining information from unauthorized sources during any assessment activities in this class are violations of the code. Misunderstanding of the Academic Code is not accepted as an excuse for dishonest work.

4.1 Use of AI Tools Policy

Students are **encouraged** to use AI tools throughout the course when they help make the research and development process more effective. These tools can be extremely useful, but

students remain responsible for the correctness, quality, and integrity of everything included in their project.

Literature and Related Work AI tools can be used to help discover relevant papers, summarize papers, and navigate a large body of related work more efficiently. However, AI-generated summaries and citations are not necessarily complete or correct. Students are responsible for verifying references, reading the papers necessary to understand their project area, and making sure that the final paper accurately represents prior work.

Programming and System Development Students are encouraged to use coding assistants and other AI tools of their choice to accelerate implementation. In particular, these tools can be very helpful for quickly building prototypes, user interfaces, and other supporting infrastructure so that students can focus their time on the central ideas of the project.

At the same time, projects in this course are developed incrementally over the entire semester. Code written early in the project will often need to be extended, debugged, and modified substantially in later milestones. Students are therefore responsible for understanding and maintaining their systems. AI tools should make development faster, not create code that becomes a barrier once the system grows in complexity.

Writing Students are welcome to use AI tools to support the writing process. Useful applications include brainstorming, reorganizing ideas, identifying unclear explanations, receiving feedback on a draft, and improving grammar and readability.

However, producing a strong research paper requires substantial thought about what to say, how to structure an argument, and how to communicate ideas precisely. Students should spend time actively developing and revising their writing rather than simply accepting generated prose. The final paper should be clear, specific to the project, and reflect a thoughtful understanding of the work rather than generic or low-quality AI-generated text.

Responsibility for the Final Work Regardless of how AI tools are used, students are responsible for everything they submit. This includes the accuracy of technical claims and citations, the correctness and maintainability of code, and the clarity and quality of the final paper.

In summary, students should use AI tools in this course the same way they would use them in a research lab: as tools to accelerate their work, while remaining responsible for understanding, verifying, and communicating the results.

5 Supporting Students: "Don't suffer in silence!"

We recognize that our students come from varied backgrounds and can have widely-varying circumstances. Our ultimate goal is to help every student be successful in the course. Extenuating circumstances can include physical or mental health and wellness, work-school-life balance, familial responsibilities, military duties, unexpected and unavoidable travel, or anything else beyond your control that may negatively impact your performance in the class.

While we want to make sure all students feel comfortable reaching out to the staff under extenuating circumstances, we have two important concerns:

1. People come from diverse backgrounds and therefore may be more or less likely to feel comfortable asking for special accommodations. Policies that set up harsh deadlines but then are flexible to all students who reach out to ask for special accommodation lead to students not being treated equally and can impact students from diverse backgrounds negatively. To this end, we have decided to make policies for handling extenuating circumstances explicit as part of the syllabus. We also designed this policy so that students do not have to disclose specifics of their circumstances to the staff, which may cause additional discomfort.

2. Students who are suffering from extenuating circumstances often require additional support. Brown has many resources in place to support such students and it is our duty as instructors to make sure that students who are struggling do in fact reach out to those resources so that they can get the support they need. Therefore we clearly outline what types of exemptions we are willing to make directly and which ones cannot be granted without the supervision of staff dedicated to supporting students.

We outline such policies below.

Policy for accommodating a missed project milestone

We strongly encourage teams to plan ahead so that they can present each project milestone on the scheduled Friday. Because milestones are an important part of the class experience, including giving and receiving feedback from other teams, missing a milestone should be rare and should only happen when unforeseen or unavoidable circumstances make presenting on the scheduled date impossible.

Each team may reschedule **at most one milestone during the semester** due to unforeseen or extenuating circumstances. If a team misses a milestone, the team will present the following Friday during Adriana's office hours (10:20–11:00 AM), approximately one week after the originally scheduled presentation.

To request a milestone make-up, one student should email the course staff, **cc'ing all members of the team and the TAs**, and write:

> "Our group is dealing with extenuating circumstances and will not be able to present Milestone [X] on [date]. We would like to use our one milestone make-up and present during office hours on [following Friday]."

Students do not need to disclose the details of the circumstances in the email.

Teams should **not plan to miss Milestone 5**. Because this is the final in-class presentation and there is no later class opportunity to make it up, teams should make every effort to have the project presented on the scheduled date. If one team member is unable to attend, the other team members should present the work on behalf of the group.

If a team needs to miss Milestone 5, or needs accommodations for more than one other milestone, we recommend that the students contact their academic advisors, Student Support Services (SSS), or Student Accessibility Services (SAS) so that we can work with the appropriate Brown resources to support them.

Policy for accommodating missed lectures

If you have to miss lectures and want to make up for participation grade, you can submit a report on the lecture that you missed. Please note that we cannot guarantee that recordings will be available and you may need to reach out to colleagues or the TA for help understanding the lecture you missed. In case of unforeseen or extenuating circumstances, student should email the staff mailing list, and say: "Because of personal circumstances, I had to miss class X and I would like to submit this report (attached) to show that I understand the material that was covered." Please *include* the TAs and do *not* disclose the specific circumstances in your email. All reports must include all topics discussed in the class, and must be submitted by March 13. We will accept up to 5 reports. If you need to submit more that 5 reports (that means you will miss more that half of the semester), we recommend you contact advisors, SSS or SAS.

Accessibility and Accommodations

Your experience in this class is important to us. If you have already established accommodations with student accessibility services (SAS), please communicate your approved accommodations to the instructor at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through SAS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but are not limited to: mental health, attention-related, learning, vision, hearing, physical or health impacts), contact SAS directly to set up an Access Plan. SAS facilitates the interactive process that establishes reasonable accommodations.

Lecture Recordings

This course is scheduled to be fully in-person, but lectures will be recorded. Because technical issues with recordings may arise, we cannot guarantee that all lectures will be made available offline and therefore students are strongly encouraged to attend classes unless they are unable due to extraordinary circumstances.

Privacy Note: The recording will capture the presenter's audio, video, and computer screen. Students' voices during lecture will be captured in the recordings.