

IMPLEMENTING CONTRACT GRADING IN A PRODUCT DESIGN COURSE TO PROMOTE ITERATION AND LEARNING THROUGH BUILDING

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ABSTRACT

We offer here a rationale for using contract grading in combination with design sprints in an upper-level undergraduate product design project course. Alternatives to grading, in particular contract grading and specification grading, have been gaining popularity in project-based courses across engineering disciplines. While students are highly motivated by grades, the fear of getting a poor grade can make students reluctant to experiment with unfamiliar design methods, and they often then resist building mock-ups early or often enough since they don't yet know the "right" answer. To address these challenges, we have introduced: (1) contract grading based on completing a checklist of design activities to shift the focus from performance outcomes to process engagement and iterative learning, and (2) structured design sprints to require the creation of mock-ups at each stage. We find that combining the two promotes both flexibility and rigor: we communicate that trust in the design process will yield results, but we insist that the steps in the process be followed and documented. We detail the structure of this integrated approach, share insights from its evolution over multiple course offerings, and reflect on its impact on student behaviour, learning outcomes, and project quality.

Keywords: Design, contract grading, alternative grading, design sprints

1 CONTRACT GRADING AND DESIGN SPRINTS IN DESIGN EDUCATION

Contract grading is based on a mutual acceptance by students and instructors of clearly stated expectations for how completion of assignments will translate into grades for those assignments [1]. It can be traced back to the 1960's and 70's and has been applied to all grade levels and many subjects [2]. It is similar to other grading strategies that focus on mastery, such as specifications grading [3]. However, the elements of negotiation and agreement remain distinguishing characteristics. Quintana and Quintana report the application of specifications grading to an engineering design course during COVID [4], and their description of renegotiations of the grading criteria resemble contract grading. Marti notes that while contract grading is underrepresented in the engineering education literature compared to communication, it "is especially applicable in process-oriented courses" [5]. Design sprints, on the other hand, are widely applied in industry and frequently used in design education; Thomas and Strickfaden offer a distinctive example from industrial design, which is less common in the literature than computer science, and assert that sprints promote better collaboration and toleration of ambiguity while helping students overcome design fixation [6]. While both contract grading and design sprints are widely used, we are not yet aware of examples in the literature of a purposeful combination of the two. However, such a combination reveals how the two practices reinforce each other.

2 COURSE CONTEXT

Interdisciplinary Product Design Projects is a two-quarter sequence for undergraduate juniors and seniors enrolled in any degree program on campus. Students work in teams of 3-5, each on a different open-ended physical product design project for an external client. It is co-taught by one instructor with expertise in product design and one with expertise in communication. Learning objectives focus on applying user-centred design principles and methods to real-world problems through research, prototyping, evaluation, project management, teamwork, and professional communication.

Although there is a pre-requisite of an introductory design class, the students enter the course with a wide range of experience in design. Some may have completed only 1-2 design-related classes while

others may have taken several, plus participated in extracurriculars that embrace design methods. As the class focuses on applying design methods over teaching them, this mix of experience creates challenges in getting students to engage in prototyping and other design activities early and frequently enough. Faculty regularly discuss how students seem to resist building physical mock-ups of ideas until they have “figured them out,” rather than using prototyping to do that. Similarly, students seem to resist using design methods they have not experienced before. Both relate to fear of doing something “wrong.” We identified a need to improve engagement with the design process and make it easier for students at all levels of design experience to participate without fear of a low grade on something new to them. We explored variations on contract grading, implemented one with checklists, observed student performance, and evolved the checklists into design sprints. Sprints, with their connections to digital product development and start-up culture, feel more energetic than checklists. This approach has led to more prototyping iterations and design activities completed by teams, reflecting increased engagement.

3 INTEGRATED APPROACHES: CONTRACT GRADING + DESIGN SPRINTS

We combined two approaches: (1) contract grading based on completing a checklist of design activities to shift the focus from performance outcomes to process engagement and iterative learning, and (2) structured design sprints that require the creation of mock-ups at each stage. This combination promotes both flexibility and rigor: we communicate that trust in the design process will yield results, but we insist that the steps in the process be followed and documented.

In the first quarter, 90% of the student’s grade is the contract grade for the design sprints and 10% is for individual contribution. This changes in the second quarter to 50% for design sprints, 40% for final deliverables, and 10% for individual contribution. This shift increases accountability for the quality of final deliverables: a written report (15%), presentation (10%), and the final design and prototype (15%). In both quarters, individual contribution is based on attending and participating in class plus a small number of individual assignments. Students complete peer evaluations twice each quarter that are seen only by the faculty. These help identify issues requiring intervention, especially team work-sharing. If there are significant gaps in contribution to sprint activities, team members may receive different grades. Each quarter has four sprints of 2-3 weeks each, depending on holidays and deliverables. This length allows teams to make meaningful progress while also accounting for scheduling challenges. Teams use an online whiteboard called Miro [7] where the sprints are laid out. Each sprint has a set of deliverables for things any team at this stage should complete, such as mock-ups, journey map, specifications chart, etc. There are also design activities aligned by sprint, but these are more flexible. Teams can move activities between sprints with faculty approval. For example, a team that can’t get to a client site for observations in sprint 1 will move that to sprint 2. In exchange, they would move a sprint 2 activity into sprint 1, such as additional research or meeting a subject matter expert. Checklists for Sprint 1 are shown in Figure 1.

Deliverables	Link Google docs / Miro frames	Faculty comments
Exploratory mockup , a physical model that demonstrates the project challenge		
Journey map reflecting the existing experience that you are addressing		
Team dynamics update		
Plan for next sprint - update Gantt chart & to-dos		
Activity Checklist	Link Google docs / Miro frames	Faculty comments
Draft client interview guide , get faculty feedback, and revise		
Conduct client interview , post summary, get faculty feedback, and revise		
Capture needs on Miro (desirability, viability, feasibility)		
Draft user observation guide , get faculty feedback, and revise		
Create a research plan and document findings		

Figure 1. Sprint 1 checklist

The second quarter is more flexible. There are still deliverables for each sprint, but instead of pre-assigning design activities, there is a reference list to select from and distribute across the sprints according to project needs. The reference checklist is shown in Figure 2.

Testing, Analysis, Feedback - Checklist
Get feedback from your client on mockups and prototypes - Draft interview/feedback guide, get feedback from faculty, and revise - Document results, get feedback from faculty, and revise
Get feedback from two experts on at least two different rounds of mockups and prototypes (outside of design review) - Draft interview/feedback guide, get feedback from faculty, and revise - Document results, get feedback from faculty, and revise
Perform at least FOUR (4) DIFFERENT types of analysis or testing, documenting the approach and the findings (one of these must relate to your DfX topic) - Statistical analysis - Design of experiments (DOE) - Engineering analysis – forces, heat transfer, fluid dynamics, etc. (using hand calculations, finite element analysis, MATLAB) - Manufacturing analysis – tolerance analysis, assembly time analysis, cost analysis, etc. - Physical testing – bending tests, drop tests, crush tests, etc. - User feedback and testing - Materials analysis - Life cycle analysis, carbon footprint calculations

Figure 2. Reference checklist for second quarter (sprints 5-8)

Teams add links to their work in progress and faculty review the work and provide feedback, adding notes to the “Faculty comments” field. Sample comments are shown in Figure 3.

Deliverables	Link Google docs / Miro frames	Faculty comments
2-4 feasibility mockups, partial mockups that show how parts of the design will work	Link omitted	Done!
Updated specs chart	Link omitted	See comments in Google doc
Initial FMEA	Link omitted	Okay for Sprint 5 It will need to be revised and included in your design review brief. Do this early to get feedback from faculty!
Client update email (show draft to faculty first)	Met client in-person	Done!
Team dynamics	Link omitted	Done!

Figure 3. Sample feedback comments on sprint progress

While the emphasis for grading is done/not done, work must be completed to a “reasonable level,” good enough to advance the project. Faculty provide feedback and students make revisions, often including a second iteration. Faculty base the degree of feedback and revision on experience working with teams at this level and factoring in student’s past courses and areas of study. This approach allows faculty to focus on giving feedback and coaching rather than trying to assign numerical values to things that can be difficult to measure. The sprint grade is an A if the team completes all deliverables and activities, and if not, the grade is lowered by three percentage points for each item not completed. Teams can continue to respond to faculty feedback after a sprint is done and their grades will be revised.

4 DISCUSSIONS: IMPACT ON STUDENT BEHAVIOUR

The desired changes to student behaviour include building earlier and more often, engaging in more design methods, sharing work across the team, and making steady progress. We have seen improvements in each, though there are still challenges. We evaluated the mock-ups and design activities of seven teams from two course sections prior to adding contract grading plus design sprints, and seven teams from the two most recent course iterations. There are typically 3-4 teams per section. We excluded the years when COVID-19 impacted the approach for the course.

4.1 Build earlier and more often

Students build more mock-ups with a sprint structure compared to using a course management system (CMS) to assign them. The CMS requires a specific due date for an assignment, but teams may build at different dates due to project variations. Sprints address this by creating a window for completing mock-ups while still providing a deadline. Mock-ups are required in each of the first four sprints and teams share their mock-ups in a class activity. Seeing what other teams create often raises the bar for the next iteration. Tables 1 and 2 show the number of mock-ups made in the first eight weeks (or sprints 1-3), representing the part of the design process with rapid iteration of early concepts. This information is shown graphically in Figure 4. The average number of mock-ups increased from 6.4 to 10.3 per team.

Table 1. Number of mock-ups in the first eight weeks **without** sprints + contract grading

AY 2018-19				AY 2019-20		
Team A	Team B	Team C	Team D	Team E	Team F	Team G
7	7	7	10	6	4	4

Table 2. Number of mock-ups in eight weeks (sprints 1-3) **with** sprints + contract grading

AY 2024-25				AY 2025-26		
Team H	Team I	Team J	Team K	Team L	Team M	Team N
10	6	12	13	14	9	8

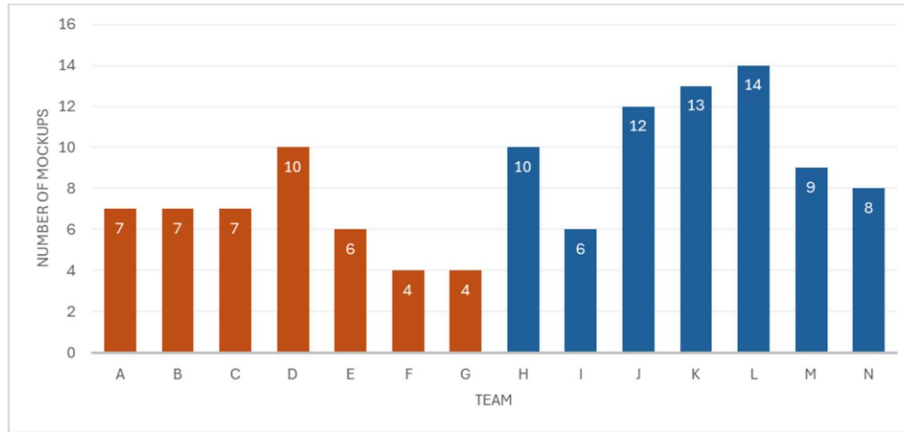


Figure 4. Teams A-F did not have the sprint + contract grading structure; Teams H-N did

Limitations & next steps: When teams build mock-ups as sprint deliverables, sometimes they do just that - build to meet requirements rather than build to learn. Instead of considering how to use a mock up to advance their learning, they just focus on making it. They will learn something with each build, but it would be more impactful if they identified key questions then built mock-ups to get answers. Going forward, we will frame deliverables within the bigger picture, asking students to identify what they need to learn and how they will use the mock-ups, to help them see mock-ups as more than a box to check.

4.2 Use more design methods

The sprint checklists, especially in the second quarter (sprints 5-8), have helped teams apply more design methods. Students entering this class tend to be familiar with the front-end of design, from need-finding through idea generation, as these topics are covered in the pre-requisite introductory design classes and again in design classes at the next level. However, due to time limits of a 10-week quarter, most non-capstone design classes don't cover the later stages of design in detail. In the past, this led to students struggling to identify and apply design methods beyond the initial concept stage. Now, the reference list for sprints 5-8 provides options and faculty help teams pick activities aligned with their project. Faculty also encourage students to consider design activities that they might want to show in a portfolio. Since design activities are not graded, students seem more willing to try new things. They get credit for doing what designers in industry do: identify what needs to be done, put in the effort, and make progress.

Tables 3 and 4 show types of design activities completed in the second quarter. The tables exclude secondary research, design reviews, and other activities required for all teams, such as conducting a Failure Modes and Effects Analysis; nor do they reflect how many of each activity was completed, focusing only on type. After introducing design sprints plus contract grading, the average number of activity types increased from 4.7 to 6.3 per team. In these tables, "functional testing" refers to evaluating performance characteristics specific to project goals, and "physical testing" refers to evaluating durability and robustness, such as drop, strength, and crush tests, corrosion testing, etc.

Table 3. Types of activities in the second 10 weeks **without** sprints + contract grading

AY 2018-19				AY 2019-20		
Team A	Team B	Team C	Team D	Team E	Team F	Team G
User feedback SME interviews Functional testing Simulations	User feedback SME interviews Functional testing Physical testing Force calculations	User feedback Stakeholder feedback SME interviews Functional testing Tolerance analysis	User feedback SME interviews Functional testing Physical testing System calculations Electrical analysis	User feedback SME interviews Functional testing Physical testing Materials analysis	User feedback SME interviews Functional testing Patent analysis	Stakeholder feedback SME interviews Functional testing Physical testing
4	5	5	6	5	4	4

Table 4. Types of activities in the second 10 weeks **with** sprints + contract grading

AY 2024-25				AY 2025-26		
Team H	Team I	Team J	Team K	Team L	Team M	Team N
User feedback SME interviews Functional testing Physical testing	User feedback SME feedback Functional testing Physical testing Thermal analysis Materials analysis Carbon footprint calculation	User feedback Stakeholder feedback SME interviews Functional testing Physical testing Force analysis Simulations	User feedback SME interviews Functional testing Physical testing Tolerance analysis Materials analysis Standards mapping	User feedback SME interviews Functional testing Physical testing Ergonomic analysis	User feedback SME interviews Functional testing Physical testing Precision analysis Force analysis Materials analysis	User feedback SME interviews Functional testing Physical testing Geometric evaluation
4	7	7	7	5	7	5

Limitations & next steps: Sometimes teams select activities without understanding what's entailed and faculty may assume they know more than they do or that they have read the course resources. For example, teams often select "Design of Experiments" thinking it is simply creating a test plan, not realising there is a specific method for identifying variables and for planning, controlling, and analysing results. Without this understanding, teams don't account for time needed to get support from faculty or other resources. Going forward, teams will need to identify not just which activities to put in each sprint but also list 3-4 subtasks per activity, to help teams identify support needed and plan more effectively.

4.3 Enable more equitable team participation

The sprint checklists clarify the types and number of design activities expected. This helps students who have less design experience understand what to do now and what comes next. It also shows many design activities that don't require engineering experience. In the past, students from outside of engineering have struggled to feel they were an equal member of the team due to a perception that design was an engineering-based discipline. Through the checklists, we can show the full breadth of activities, enabling students of different disciplines to identify activities related to their experience and skill sets.

Limitations & next steps: An ongoing challenge is determining if work is shared evenly. Teams are required to use a work-sharing tool, such as a RAM chart, but they don't always maintain it to reflect reality. They also complete reflections on team dynamics and progress and provide feedback on their peers to faculty. These tools help faculty to identify issues, but do not fully meet the need. Faculty rely heavily on student participation in meetings and discussions to assess individual learning. We will continue to revise team-based and individual peer feedback to improve insights.

4.4 Complete work steadily across each quarter

Combining sprints with contract grading helps to even progress across each quarter. In the past, due dates were assigned on the course management site. However, since each project is different, the details of the activity and target dates vary by team. Misalignment between the online system and a given team's

progress makes it difficult for teams to track their work, and they can easily fall behind. In contrast, sprints require a set of activities to be completed within a set timeframe but allow flexibility within that timeframe to align dates to project needs and student schedules. As mentioned earlier, teams can consult with faculty to move activities between sprints. Since teams can see all sprint requirements in one view on Miro, without having to navigate the course management site, they can better plan their work.

Contract grading reinforces adherence to the sprint structure, ensuring teams complete each sprint. As a result, we have generally seen teams doing more work earlier in the project. Some teams still struggle to manage their work and may try to complete all sprint activities just before a sprint deadline, but with four sprint deadlines pre quarter, even that is more distributed than in past iterations of the class.

Limitations & next steps: While grading each sprint encourages teams to take the checklists seriously, we also want to avoid demoralising them if early grades are low as they learn to collaborate. This led us to allow revisions beyond a sprint deadline. However, some teams still delay. In the past two offerings, we announced a final revision deadline part-way through the quarter. This helped, but there should be a clear policy at the start that preserves the importance of the initial deadline. We plan to try a decreasing ability to raise sprint grades. For example, a B could be raised only to an A- after the first deadline, and to a B+ after a later deadline. We have not yet determined the number or spacing of these deadlines.

5 CONCLUSIONS

Contract grading paired with design sprints has meaningfully impacted how students engage with design process in this course. With an emphasis on process over performance and a clear structure for advancing projects, students build earlier and more frequently, apply a wider range of design methods, and distribute the work more evenly across team and project, while faculty focus on coaching over grading. We identified important areas for continued improvement. Some students still treat the project as a series of assignments rather than working toward a goal, and they may commit to design activities without knowing what is involved. Also, while the sprint structure improves work distribution over time, ensuring equitable team participation remains a challenge. These issues are not new to design education, but the current approach gives clearer points of intervention and creates opportunities to adjust to project needs and student learning. Moving forward we plan to:

- Reframe sprint deliverables to more explicitly connect building to the bigger picture.
- Require teams to break complex activities into visible subtasks to clarify scope and distribute work.
- Create a tiered revision policy that preserves flexibility without diluting the initial deadline.

The intent is to further shift from “checking the box” to a more thoughtful and intentional design process. Combining contract grading with design sprints for project-based design courses is a promising approach to promote earlier and more frequent building, a broader use of design methods across disciplines, and steadier progress. It allows more flexibility than typical course management systems, helping faculty and students to adapt to different projects, student needs, and other, unexpected factors.

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