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A DESIGN SPRINT TOWARDS A FOUR-YEAR CURRICULUM IN TRANSDISCIPLINARY STUDIES

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In this design case, we describe our design process that resulted in recommendations for a four-year undergraduate curriculum in transdisciplinary studies. The case is centered on a fast-paced, two-week design "sprint" undertaken by the two authors, which involved consolidating and synthesizing program evaluation data and course designs from the three previous years of a novel undergraduate transdisciplinary degree program, creating design blueprints that outlined program-level objectives, and identifying recommendations for future course-level design. In the process of completing these hand-off materials for the incoming team of instructors, we had to work through substantial ambiguity, balancing the needs of identified learner personas, the capabilities of existing instructional team members, and the end goal of producing students that had a flexible, personal transdisciplinary identity. This case describes the design activities we used, the instances of failure that precipitated our design sprint, the instructional and institutional constraints we faced, the blueprints for future instructional design we created on the course and program level, and the ultimate failure of the degree program we sought to support.

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INTRODUCTION

This design case is situated within an effort to experiment with novel approaches to technology education at a large Midwestern US research-intensive university. In the Fall of 2013, a group of Faculty Fellows were recruited to design a novel program that included both technology and humanities content. This evolved into the concept of a competency-based transdisciplinary program with a technology component, located in a College of Technology but architected by fellows from the College of Technology, Liberal Arts, and Education. The program "soft launched" in 2014, and although there was initially no degree offered, students in traditional technology disciplines such as mechanical engineering technology, electrical engineering technology, computer graphics technology, computer informatics technology, or building construction management could opt into the transdisciplinary program experience. The official degree program, a Bachelor of Science in Transdisciplinary Studies in Technology (TST) was approved by state and regional accreditation bodies in Spring 2016, and a small number of students officially transferred to the program in Fall 2016. The first cohort of freshmen entered the program in August 2017 and the program was closed to enrollment in 2019, with only a handful of students ever receiving a degree in TST.

We learned much from the initial pilot years, marked by moments of success but also substantial issues with misalignment of instructors and goals, failure of curriculum, and issues relating to program scale. We were breaking new ground in our efforts to provide a transformative experience for students—in the process, confronting challenges at

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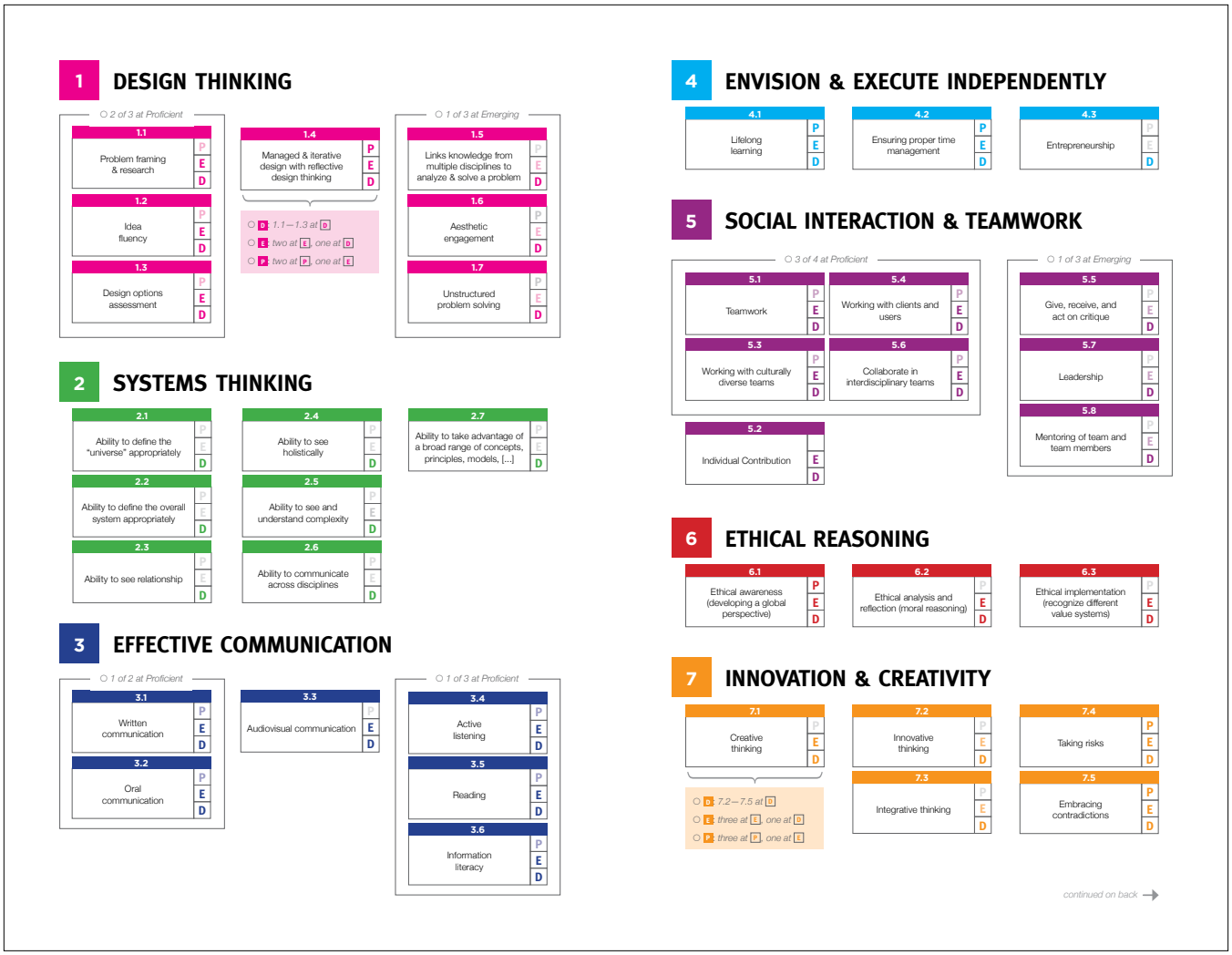


FIGURE 1. Example of the competency map used to track student progress towards mastery.

many levels within the institution (e.g., registrar, scheduling, faculty appointments, competency badging systems) and beyond. The high-level program design was laid out in plans submitted for accreditation efforts, but these plans allowed for a fair amount of flexibility. However, this flexibility, coupled with our push to "build the airplane while it was in flight" resulting in the discovery of many barriers that were experienced by different faculty fellows, resulting in a high amount of variability and a low amount of actual program alignment. Once the program was fully in motion, the team saw the need to create a more unified and detailed four-year program design to build this alignment.

After several attempts to work on a four-year design through committee efforts, the group collectively recognized that this process did not work well, in large part due to difficulty coordinating schedules and time constraints of fellows with many other responsibilities within this program as well as in our respective home departments. Differences in language and philosophy spanning multiple colleges and departments on campus also made it difficult to gain traction, especially in short meetings that were scheduled too far apart. Potentially most importantly, there was consensus on the *need* for alignment, but not all fellows felt that a detailed four-year design was necessary to achieve this alignment. Some team members were concerned that a four-year design would constrain the ability to innovate in the program while others were concerned that the lack of a consistent plan would put students at risk for confusion, result in insufficient scaffolding of learning and inadequate planning for personalized learning plans, and failure to complete on time—concerns also expressed by students.

Therefore, our team of two was tasked with coming up with a proposal with sufficient detail that it could be either implemented directly or used as a "jumping off" point for further discussion and detailed design since we were the only two faculty with educational experience in instructional design. We selected the "design sprint" approach to encourage quick and iterative development, maximizing the amount of time that others could use in the summer to build on our strategic outcomes. From the commencement of this task, we knew

that our proposal was unlikely to be taken up in full by the team, but we had hopes that pieces of the design would prove useful—at the very least in inspiring conversations about alignment that we knew the team greatly desired. In addition, there were multiple other programs being redeveloped or created in the college at this same time, and we knew there was potential for our proposal to inspire program-level pedagogical conversations and downstream instructional innovations in those contexts as well.

To enact this design "sprint," we spent two weeks in intense design discussions, during which we locked ourselves away for several hours at a time, producing a set of materials that included learner personas, a documentation of the learning spiral, identification of ways to enact disciplinary content in course instruction, and providing vertical alignment across course experiences.

Breaking the Rules of Traditional Higher Education

The transdisciplinary program promised a unique combination of the following traits, which had been iteratively designed and iterated on over a period of four years:

- *Use of program-level crosscutting competencies.* Students are expected to move through three levels of 20 competencies (Figure 1) in the following broad areas: communicate; create and innovate; engage in culture, values, and the arts; inquire and analyze; and interact with others. These competencies are not connected to particular coursework; students can submit artifacts gained from core program coursework, other classes, extracurricular activities, or experiences from other sources.
- *Personalized program of study.* Students are encouraged to set personal, professional, and life goals. Each student must select two or more focus areas, including at least one in the College of Technology and one in humanities or another non-technical domain. Students then select courses within these focus areas, moving from introductory to higher level courses in each focus area.
- *Design- and humanities-focused core courses help students develop transdisciplinary understanding and identity.* Core courses are not meant as a place to learn core disciplinary knowledge, but rather a place to foster conversations across, between, and beyond disciplines. The project-based curriculum has a dual pedagogical emphases on design (in a humanistic, human-centered framing utilizing a studio pedagogy) and sociocultural traditions from multiple humanities disciplines (utilizing a seminar pedagogy). Throughout the four years of the program, students are encouraged to become more independent thinkers and to gravitate towards areas of specialization and interest, while also developing skills as generalists that can independently learn, incorporate, synthesize, and build new knowledge from content derived from a variety of traditional disciplines. They are also required to work with other TST students with their own unique profiles in interdisciplinary teams throughout their degree program.

Historical Framing of the Program

In Fall 2013, a group of Pioneer Faculty Fellows was assembled, including both faculty in the College of Technology and faculty from across the university, including liberal arts, sciences, libraries, and education. This group was given guidance to design a program based on a set of core values provided by the leadership team, including:

- Viewing the student as a whole person.
- Welcoming diversity/access for all.
- Student autonomy.
- Risk taking as an important component to learning.
- Openness fostered through sharing, transparency, and collaboration.

The College of Technology leadership team further specified the following goals for students to meet upon completion of the program:

- Technical fluency.
- Lifelong learning skills.
- Empathy and optimism for global stewardship.
- Individual and collaborative learning and work skills.
- Ability to ask big questions and take risks.

The faculty fellow group engaged in reading, visits to inspirational programs at Stanford d-School and Olin College, workshops offered by Olin faculty and by a professional coach who had experimented with alternative pedagogies, and visits to potential employers including IDEO and Electronic Arts. Faculty discussed the current teaching and learning culture and debated the viability of alternative models. It soon became apparent that differing pedagogical approaches and underlying assumptions about teaching and learning varied across disciplines represented by the faculty fellow group. Over time, a subset of the fellows identified a spiral model that we felt would meet our goals, which integrated both seminar and studio components into a holistic transdisciplinary pedagogy. Within this pedagogical framing, we adopted a competency-based assessment approach to encourage students to focus on mastery rather than grades. This initial design and design process are described in Exter et al. (2015).

In the intervening years between the program founding and our design sprint, fellows experimented with many different models of instruction, including bundling of multiple courses together, allowing students to have one "course experience" and get credit for multiple existing courses in the pilot year (2014-2015) and using a parallel and intertwined

set of humanities and technology courses in the intervening years (2015-2017). Both authors were directly involved in the design and iteration of the parallel and intertwined model of coursework, which drew on two primary signature pedagogies:

- The design studio (Boling et al., 2016), with an embedded focus on project-based work and critique as a means of socialization and formative assessment. This pedagogy was operationalized as the *design lab* sequence, where students worked in a custom-built lab with a range of prototyping equipment and collaborative workspaces.
- The humanities seminar (Chick, 2009), with a focus on collaborating and effectively communicating across multiple disciplinary traditions, often through deep discussion and engagement with wicked problems. This pedagogy was operationalized as the *seminar* sequence, where students engaged in deep discussion outside of the design lab.

Colin taught one session of this studio in Spring 2016 and both authors consulted on the creation and evaluation of both course environments in the years prior to our design sprint.

ABOUT THE DESIGNERS

To contextualize the design activities in this sprint, it is important to document some of the authors' educational background, design experiences, collaborative experiences prior to this sprint, and specific design commitments. Both of us had earned terminal degrees in instructional design from the same institution, and we had spent two or more years prior to this design session immersed in the transdisciplinary incubator. Marisa was one of the founding fellows and had been responsible for program evaluation and embedded research since the beginning. Colin was hired in Fall 2015 with a split appointment as a fellow in the incubator, and contributed to evaluation and research activities, as well as co-teaching the studio course during the Spring 2016 semester.

Both of us had contributed substantively to industry projects and program level curricula on the bachelors and/or graduate level, thus bringing skills from industry and academia.

Colin has a background in studio education, earning a bachelors and masters degree in graphic design. They have worked as an art director for an instructional design consultancy, and contributed to the design and development of interactive web experiences, learning-focused conferences, and change management initiatives. Since then, they have studied studio pedagogy and design cognition as a researcher and have focused on bringing humanistic approaches to user experience (UX) design education, particularly in the context of human-computer interaction. They have also conducted research on ways of knowing and competence in design practice which inform their work within the transdisciplinary program.

Marisa has a background in computer science, including bachelors and masters degrees, and 14 years' experience in software design, software development, and day-to-day project management. She has also worked as a lead software designer and instructional designer, culminating in a role as the director of design, development, and testing on educational software. These design and development roles required her to work with individuals with a variety of backgrounds including human-computer interaction (HCI), graphic design, testing, literacy, culture and language education, and social studies education. In addition to research related to transdisciplinary education, Marisa has also conducted research on the knowledge, skills, and attitudes important to professionals in several design disciplines. These studies have pointed to the importance of cross-cutting or "21st century skills," which have informed her curricular design and teaching.

Prior to the design sprint we focus on in this manuscript, both authors actively participated in the design of multiple courses, competency families, and four-year curriculum design sessions. During this collaborative work, we learned more about our personal philosophies of and approaches to design, which shapes the design work we will discuss in this manuscript. Marisa has strong episodic memory of the prior history of this program, starting from the earliest meetings, and her investment in the initial program vision might blindside her at times. In her design work, she prefers to jump between a high-level view and details in order to gain an understanding of the whole. Intense discussion or debate is an important part of her design process, and helps her own thinking along; she is not set in her own viewpoint, but feels she must defend one viewpoint at a given moment in order to fully understand it and opposing viewpoints. Colin is comfortable thinking "on their feet" and bounces equally between abstract/theoretical domains and practical examples. They have a substantial store of mental precedent in relation to design education practices, both from their own teaching and past studio experiences. They like to be efficient with time, leading them to sometimes move quickly through discussions where they already have a solid idea of where the conversation should head without necessarily realizing that others are not yet on the same page or might have valuable alternative perspectives.

Despite these different patterns of work, we have productively collaborated in the past, and have commonly used visual aids as a "boundary object" to visualize what we are doing and thinking, drawing out where we disagree or where our thinking is not yet aligned. We have also become comfortable rewriting each other's work in past

research efforts, which has generally resulted in productive collaboration.

THE DESIGN SPRINT

Our focus in this case is the design sprint itself—including the activities, methods, and visualizations that we used to get at the core of our goals for the four-year experience. We intentionally selected this format to match both practical limitations on our time (2-3 condensed weeks of effort instead of effort spread over the entire summer) and to force us to rapidly and iteratively move from ideation and framing to structural outcomes. The outcomes or artifacts that emerged from this sprint are important, but they will not be explored or explained at the same level of depth as our approach, including the ways in which design failure is intertwined with the design context, our design efforts, and the outcomes of the artifacts we created.

The Challenge

In the academic year prior to the design sprint in May 2017, the fellows had formed a committee to consider the learner experience of the program. We met six times during the fall semester, leading to an initial proposal of transdisciplinary education and program aims at the beginning of December 2016. However, little progress was made during the relatively short committee meetings during the spring semester, leading us to get frustrated at our lack of progress. In a moment of audacity, Colin told our leadership team that if they and Marisa could get a week to truly focus on this problem, we could get our thoughts documented and have a clear path forward. To our surprise, the funding was approved for May 2017, and now we had to get the work done.

> *We committed that we would design and document an approach to a transdisciplinary four-year experience, with guidance for an incoming instructional team, in less than two weeks.*

Our Approach

We planned for most of our work time to be spent addressing the abstract program-level design, with implications for the design of individual courses across the four-year sequence. To do this, we relied upon rapid prototyping of possible course activities and program design mechanisms, constantly working at macro (program) and micro (activity, instructional method, or course) levels to illustrate for ourselves how the design could be implemented. This approach allowed us to clarify and articulate our vision and assure ourselves that the outcomes would form a viable framework for course- and program-level design.

During each of the working sessions, we met in a meeting room with floor to ceiling whiteboards and also pulled a moveable whiteboard into service as well. We knew from past collaborative design experiences that we both needed to sketch ideas out to understand them ourselves and explain them to each other. We also armed ourselves with lots of sticky notes to annotate our sketches and provide more free-form ways of documenting our thinking.

We had limited time, due to requested deliverable deadlines from the dean and the practical needs of the instructional team teaching in Fall 2017. In addition, we had travel limitations and other personal responsibilities which constrained our working times and deliverable deadlines to the following:

- Three primary working sessions of approximately four hours each in May 2017. Sketches and other materials produced during these sessions are included in the text in their original form.
- Documentation of the design in written and presentation form, to be delivered in early June 2017 to the dean and incoming instructional team. This documentation was based on what was created during the work sessions but was refined as we passed the documents back and forth. Additional off-line work resulted in a list of anticipated challenges and recommendations for staffing. Elements from final documentation are reproduced in the text, often located visually in relation to the sketches that inspired them.

Our Guiding Philosophy

We set out from the beginning to focus on the learner experience, rather than traditional instructional design structures such as learning outcomes and assessments. We explicitly drew from and built upon Parrish's notion of designing for felt and aesthetic experience (2005; 2008) from the educational literature, and from McCarthy and Wright's (2004) notion of lived and aesthetic experience in relation to technology more broadly. We also drew on Colin's previous experience working with Elizabeth Boling and Marty Siegel at Indiana University on various studio approaches to education, which were also created or explained through this narrative and experiential approach (Boling et al., 2013).

For us, focusing on the learner experience meant that we did not start with learning objectives or outcomes, but rather with identifying what *experience we wanted the learner to have*. This approach was ideal in our situation, since the core learning experiences within the transdisciplinary program did not have any definitive knowledge or "content" that must be conveyed, and we did not have specific indications of how to balance multiple disciplinary perspectives without somehow pointing towards some core content in a traditional ID process.

There were some constraints to this thinking, however. The incubator environment in which this program was situated was used to being "counter-culture," which frequently resulted in an unintentionally atheoretical or anti-theoretical

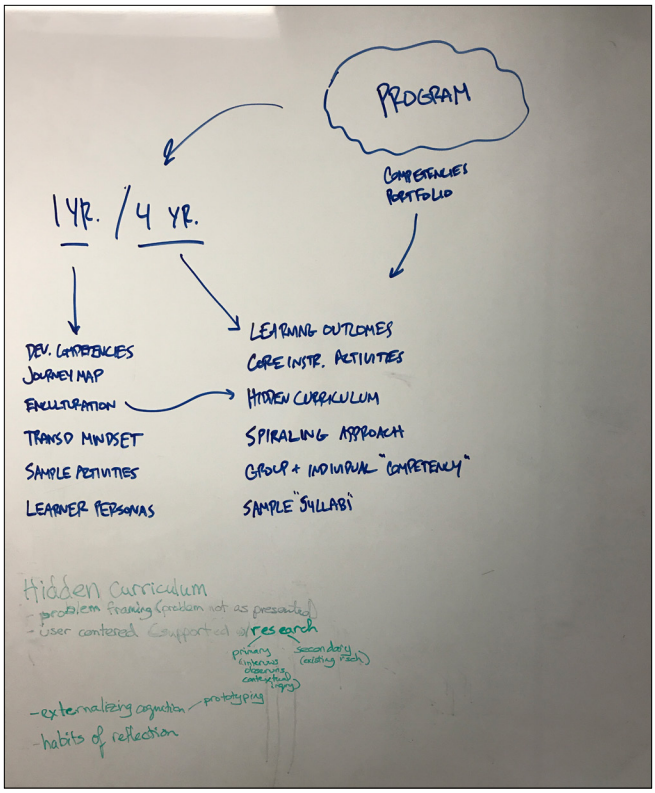


FIGURE 2. An initial list of deliverables, organized in relation to the program at large (4 year) and the first year experience (1 year).

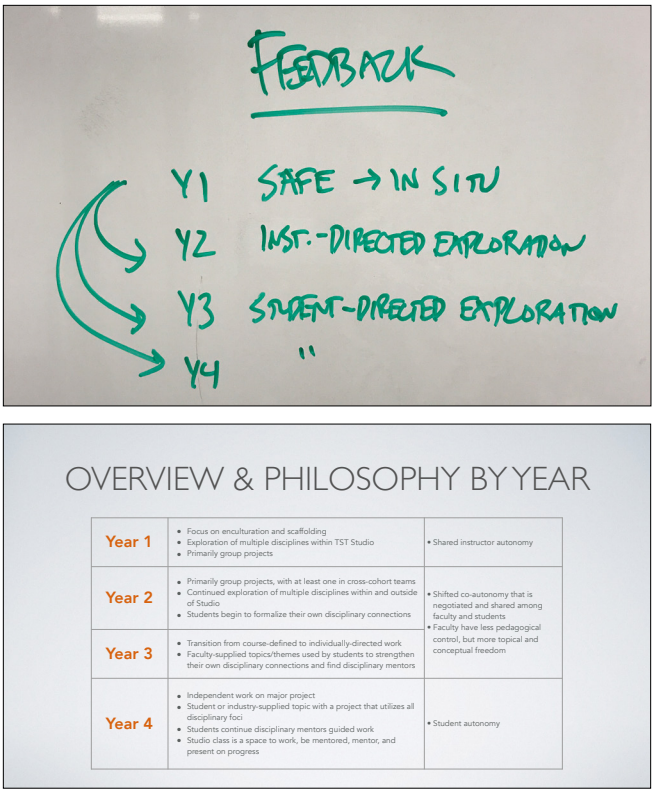


FIGURE 3. Sketches of the kinds of feedback we wanted students to receive by year of the program, moving from "safe" to instructor-directed to student-directed (top). The final documentation included a mapping by year (top), augmented by elements of our philosophy of engagement, originally sketched in Figure 4.

stance among some fellows. There was also a strong desire to allow for continual experimentation by course instructors, causing a fear of imposing too much structure. *This meant that doing "too much planning" was against the founding philosophy of trying to break traditional educational structures, both institutional and disciplinary.* This lack of desire to plan had, in some ways, precipitated the need for this design sprint, but it we knew this tension would also impact the value and eventual use of the deliverables we would create. Thus, we focused our efforts on a program-level vision composed of many linked deliverables as a vision for the team, but with the understanding that only some components might be actually implemented based on the interests and direction of new hires that were planned for the program.

It All Started with a List of Deliverables

To launch our first work session, we brainstormed out a list of deliverables we desired to create by the end of the sprint. These were aspirational goals based on what we expected would need to be completed for handoff of the four-year experience. While these goals were determined quite quickly—in the space of 30 minutes in our first meeting—they served as a continuing reminder of what pieces still needed to be diagrammed or worked out in sticky notes when we got lost in our own thoughts (Figure 2).

These deliverables were thus contingent, and yet a way of providing structure and direction for our sprint. All deliverable goals had substantial history within our program, pointing towards past design efforts, moments of misalignment, implementation failures, or aspirational futures. And thus, while we could have easily spent all our work time narrowing and editing this list, we chose to use the initial brainstorming session as a chosen design constraint, allowing us to quickly move into more constructive design methods that would deliver on these goals.

Thinking and Designing on Multiple Levels

We explicitly worked to engage our design activity at multiple levels of abstraction (in order from most abstract and holistic to most concrete and time-delimited):

- Program-level
- Interaction with competencies
- Year-level
- Course/semester experience-level
- Instructional activity/module-level

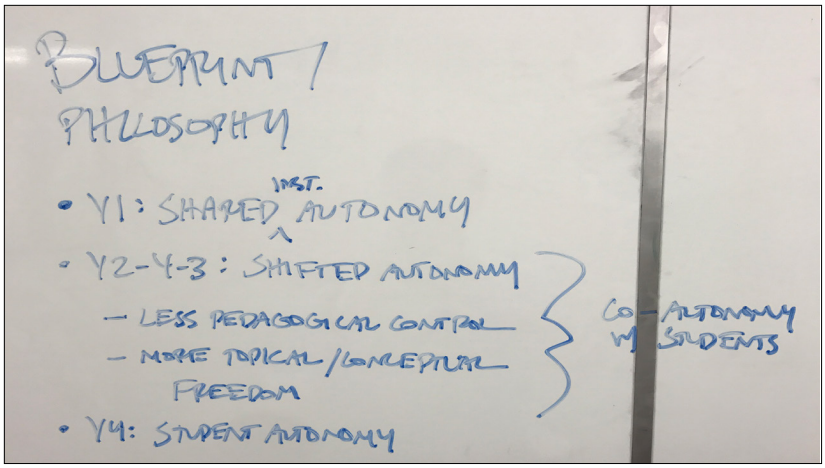
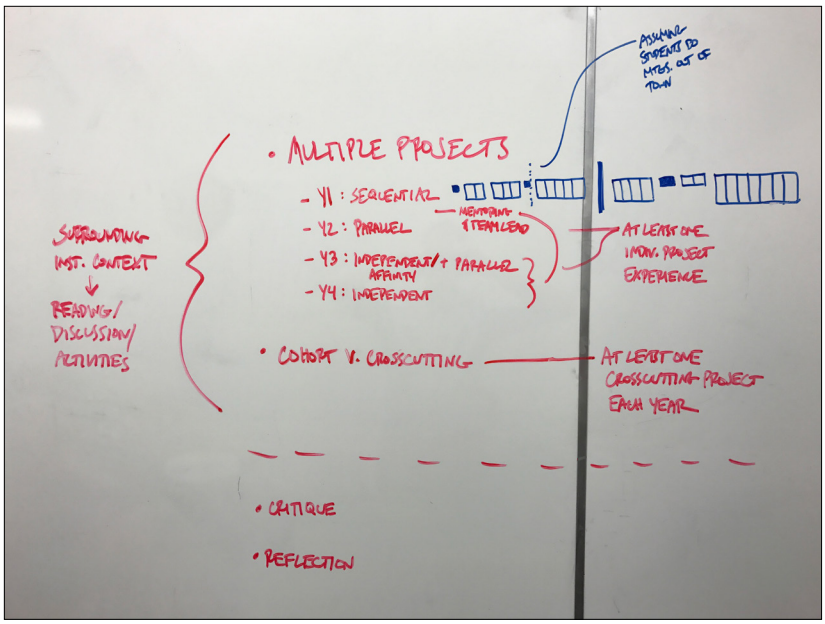


FIGURE 4. A framework for our philosophy of engagement between students and instructors, moving from shared instructor autonomy in the first year to co-autonomy in the second and third year, followed by student autonomy in the final year.



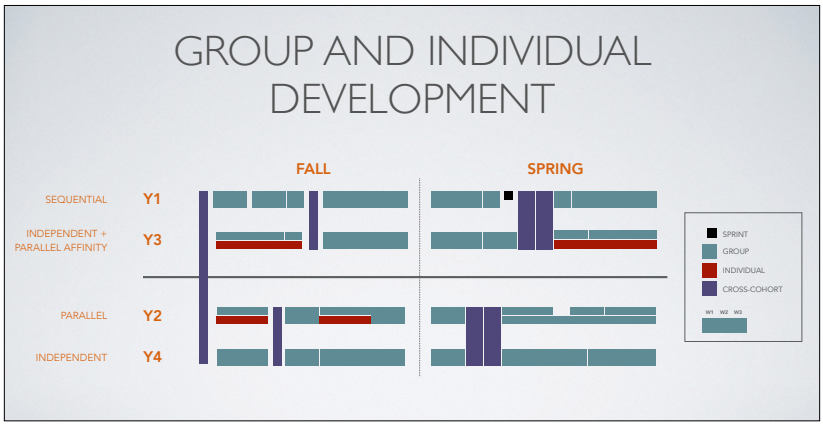


FIGURE 5. Organization of course progression, key areas of commonality, and opportunities for vertical integration. The original sketch (top) included key characteristics of each year along with potential opportunities for cross-cohort interaction, which were concretized in the final documentation (bottom).

While we did not call out the fact that we were using these multiple scales as lenses very frequently, we often proposed ideas on the program level, and then worked downwards to identify what that might look like in a first-year experience. This served as both a "sanity check" to make sure our assumptions were valid and workable, and allowed us to imagine the learner experience from multiple perspectives at once. Throughout our design sessions, this multi-level design approach resulted in a number of schema that allowed us to compare certain aspects of the experience within and across the four years.

For instance, in Figures 3–5 we identified the role of feedback, philosophies of student learning and engagement in coursework, and project orientation and integration across multiple cohorts. In each of these Y1-Y4 progressions, we talked through the kinds of social and emotional scaffolding that would be needed, and the ways in which we could increasingly assure students' agency in the learning process. All of these schema were inspired by various points of actual or potential failure in the existing program architecture, allowing us to focus attention on program-level or structural elements that we anticipated would not scale appropriately or would otherwise result in unintended outcomes.

Each schema became the site to work out different kinds of design complexity (building on ideas we borrowed from Boling & Gray, 2015), employing different kinds of constraints, program elements, and language to make that part of the design space tractable. For instance, in Figure 4 we were attempting to work out the ways in which we could assure program consistency, while also affording control to individual instructors and students. We identified shared instructor autonomy for Y1 to ensure program consistency that would allow for equal enculturation. However, in Y2-Y3 we imagined a space for more instructor autonomy in relation to topics, concepts, and pedagogical approaches. This discussion allowed us to think through two divergent views shared by different sets of faculty that were in conflict at the time of this sprint—should the studio experience serve as an experiment, where any instructor could teach whatever they wanted in whatever way that they wanted, or should there be a shared set

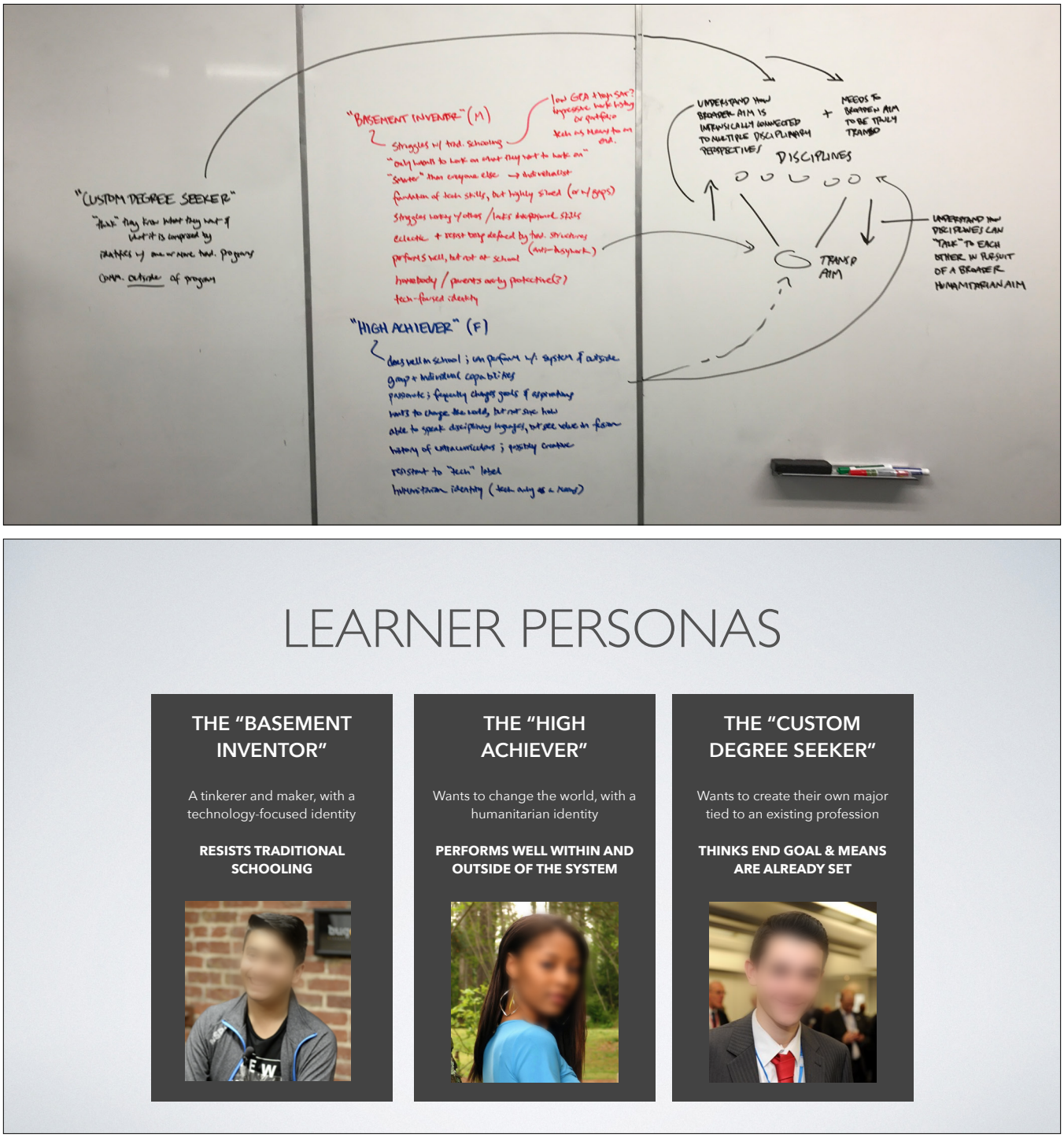


FIGURE 6. A whiteboard sketch of potential learner personas (top) and finalized persona summaries (bottom).

of enculturating experiences that would unite all students? This traversal through the program and year level allowed us to consider the tradeoffs and attempt to satisfy multiple conflicting constraints.

THE PROJECTED FOUR-YEAR EXPERIENCE

Naming Our Learners

We used a well-known user experience method to empathize with and identify our learner population—personas—drawing on previous experiences in the UX program that Colin had contributed to (e.g., Gray et al., 2020; Vorvoreanu & Connolly, 2015; Vorvoreanu et al., 2017). This allowed us to

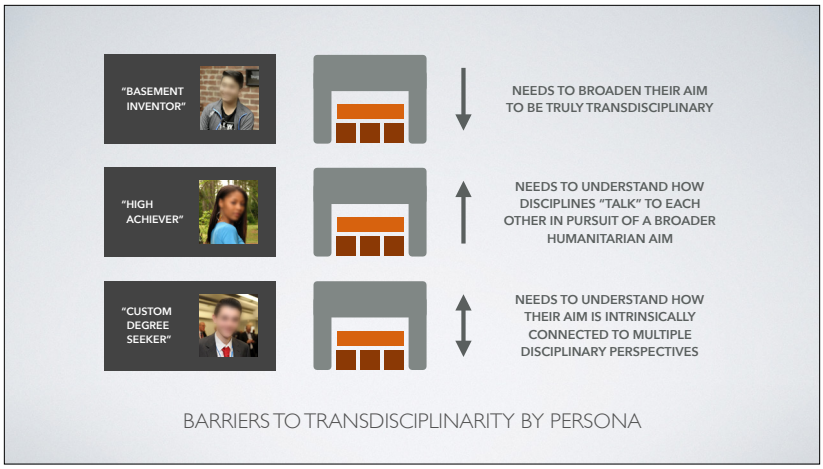


FIGURE 7. Operationalization of the personas in the final report in relation to key learning barriers.

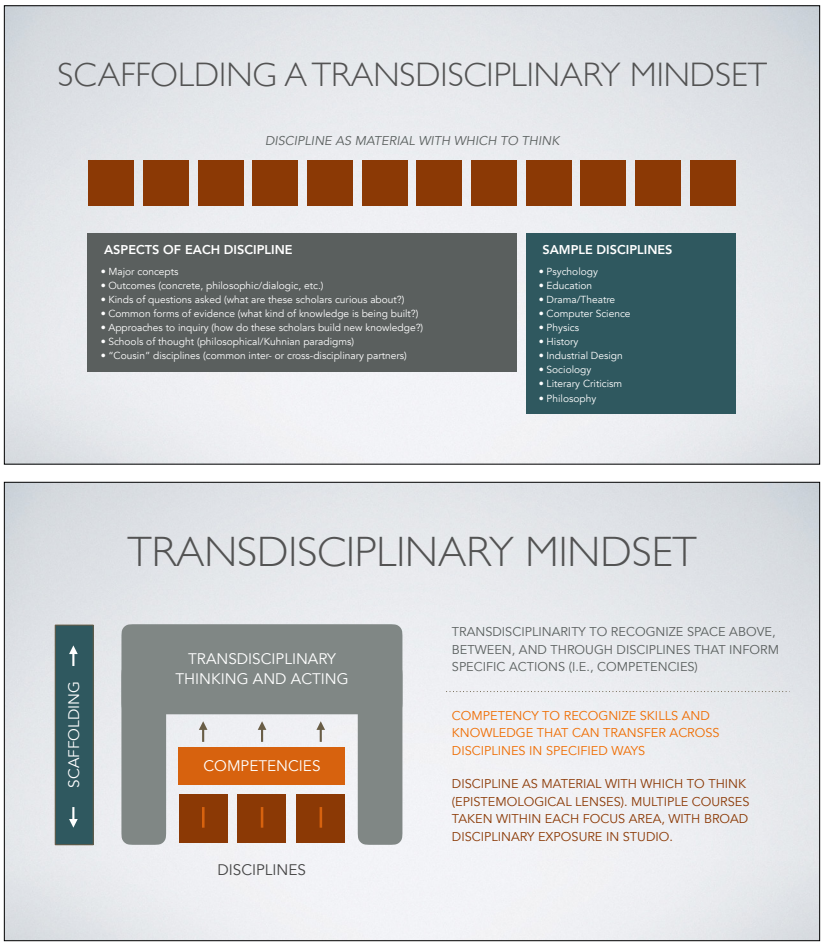


FIGURE 8. Aspects of disciplines that have relevance to a student's creation of a transdisciplinary identity.

think through not only the unusual self-selected population of students we already had, but also some potential types of students we may want to attract in the future.

We began our conversation by thinking of students already in the program or those that the program had been initially designed to serve. Then, we created bullet-point personas which represented idealized versions of these three "typical students" (Figure 6, top). While we began with student traits, we soon began to get a sense of their individual personalities and goals, giving each student a name and tagline to easily remember and refer to them throughout our design activities.

Each of our personas had a different motivation for joining the program, and a different understanding of what the program would be like—just like our actual students. For example, our "basement inventor" was mostly interested in technology and chose this program primarily because he did not do well in a traditional high-school model. He liked the idea of self-directed technical design projects. On the other hand, the "high achiever" did well in both traditional and non-traditional classrooms and was motivated by a desire to change the world. She was genuinely interested in engaging in many different disciplines and didn't want to be tied down to one.

As we continued working, we tested out ideas against each of these personas. How would they react to the experience we were designing? What would we hope each would get out of it and share with other types of learners? For example, our "custom degree seeker" would come in the program hoping to use it to his own end—he may have a particular career in sight but could not find a degree that matched it and saw this as an opportunity to "cobble together" a hybrid degree of traditional coursework. This student may not be as intrinsically interested in our transdisciplinary model or core courses, so we would need to help them see the value of those experiences. The "basement inventor" would be motivated to learn skills, knowledge, and techniques from across technical disciplines that would suit the needs of an immediate project but might resist humanities topics as irrelevant. In contrast, the "high achiever" would be intrinsically interested in learning what could be known from any educational experience, and eager to take courses across a wide variety of disciplines. She may have an intuitive understanding of transdisciplinarity. However, she may need more guidance in determining a professional goal, or at least, initial path, to work towards, while her natural

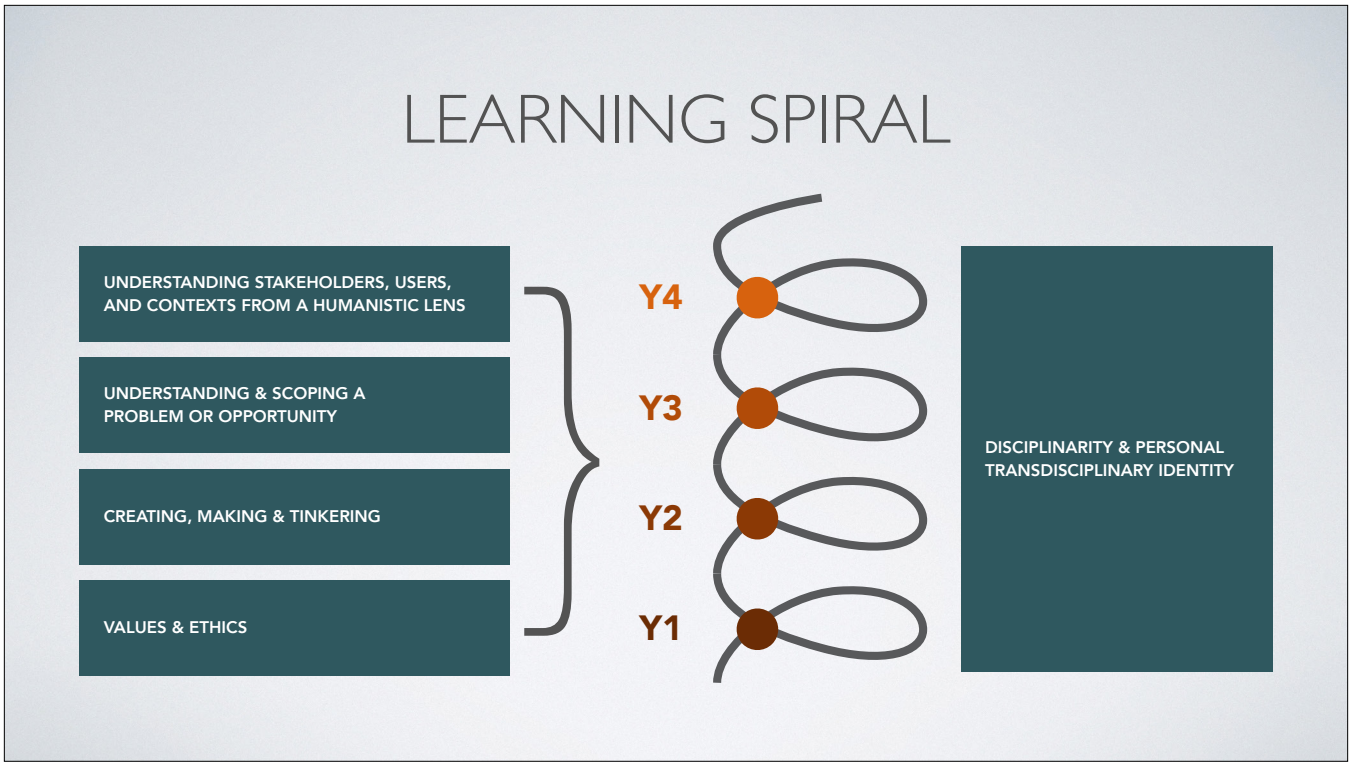


FIGURE 9. A finalized form of the learning spiral with multiple strands that supported a student's development of transdisciplinary identity.

tendency might be a simultaneous desire to move on to a medical degree, legal degree, acting career, or to start her own non-profit.

These conversations and constructed scenarios helped us think through the types of structures we would need to put into place to help these students value learning outside of their immediate areas of interest, and eventually move to a deeper understanding of transdisciplinarity and formation of a unique transdisciplinary identity (Figure 8). We believed that our concept of having students deeply examine several disciplines and identify commonalities and differences across them would be valuable to each of these students, but their approach to the exercise and what they got out of it would differ.

Identifying the "Learning Spiral"

The idea of a spiral curriculum had been part of the program design from the beginning. However, it had been difficult to bring this design to a deeper level because of the intentional lack of specific disciplinary content and desire to bring in instructors with different disciplinary perspectives and therefore different content each semester. Although the competency model provided a rough vision of cross-cutting skills that were not discipline specific, many of the program faculty as well as the leadership resisted discussion of what exactly would be spiralled, leaving earlier versions of the program design with one-to-three word descriptions of the goal of each year.

We realized that we would need to provide a template and examples of what a "contentless" spiral model that encapsulated the major underpinnings of the program vision and what had been done in the course level up till that point would look like.

These are the strands we decided to spiral across all four years:

- Disciplinarity & own transdisciplinary identity
- Understanding stakeholders, users, and contexts from a humanistic lens
- Understanding & scoping a problem or opportunity
- Creating, making & tinkering
- Values & ethics

These strands emerged relatively quickly, but we benefited from more than two previous years of work in identifying transdisciplinary competencies and competency families which were part of the program-level assessment structure. In identifying these five strands, we called back to mind arguments and splintering that had occurred in our group of fellows over the naming of these transdisciplinary competencies, and we sought to find names that did not primarily value any one disciplinary perspective.

Discipline as Material to Think With

One of the major intended traits of this program design was students' development of their own transdisciplinary

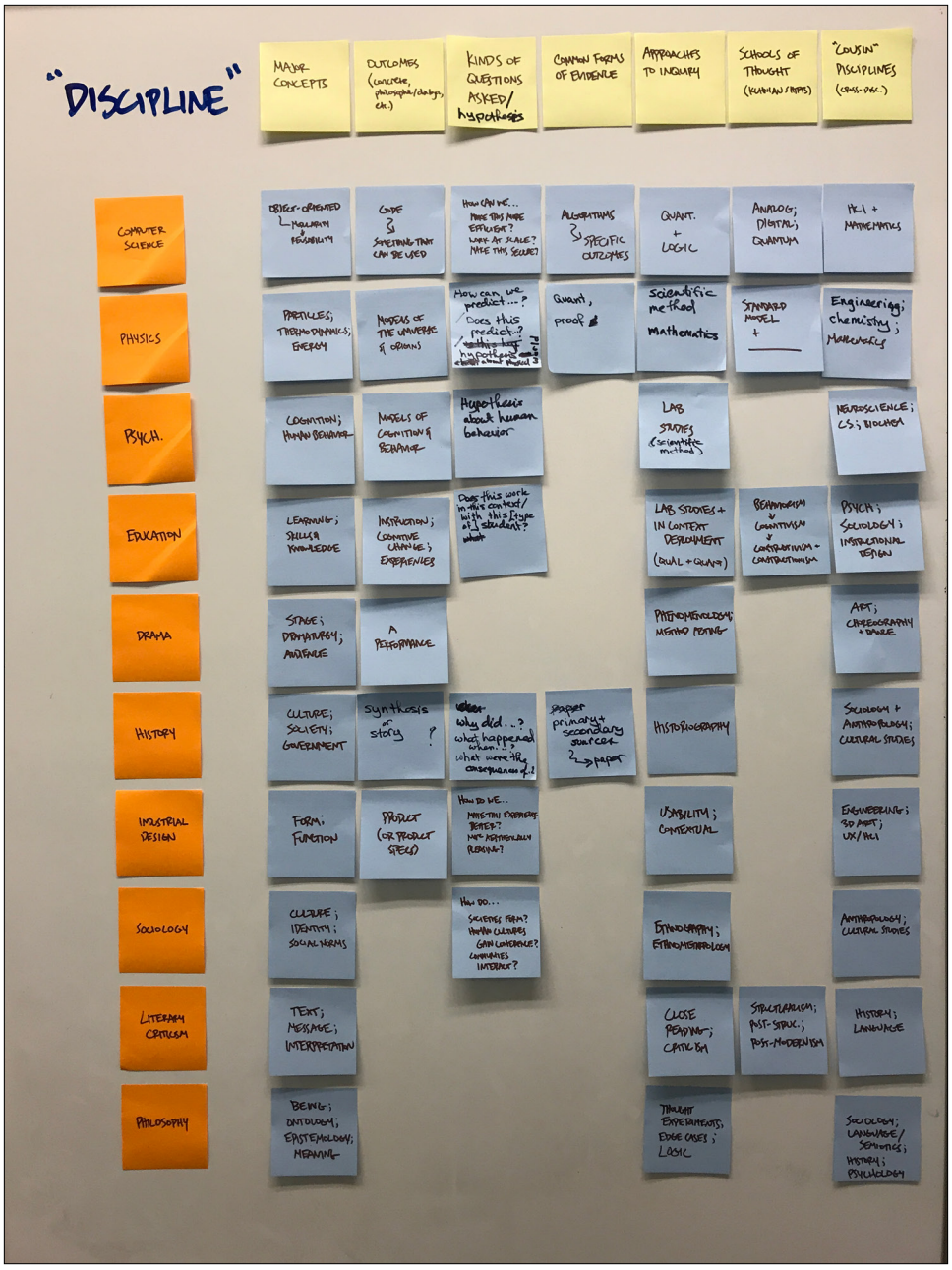


FIGURE 10. Discipline mapping using sticky notes, answering several core questions such as: major concepts, typical outcomes, kinds of questions asked, common forms of evidence and approaches to inquiry, "schools of thought," and "cousin" or related disciplines.

identity—going beyond the use of cross- or multi-disciplinary courses (which combine two or more disciplines into one experience). To achieve what we framed as "true transdisciplinarity" (as described in Figure 8, bottom) we needed to move beyond a "build your own degree" program which allowed students to select coursework from more than one discipline. We realized that our previous efforts to combine technology and humanities topics, and by extension, seminar and studio pedagogies, also didn't go far enough; students realized at some level that they were learning content from more than one discipline, but to a larger extent they had been left on their own to synthesize what they learned and determine how to apply this disciplinary knowledge to their own goals independently. They also received little guidance on how to choose courses that met their goals, and tie what they were learning across their focus areas together.

We began thinking abstractly about transdisciplinarity and how to help students move from being embedded within one discipline, to adjusting to learn disciplinary material in more than one discipline, to grasping the concept of disciplinarity and how to move beyond it. First, we concluded, students would need a way to examine, compare, and contrast across disciplines.

After several attempts to talk more abstractly about how the program and individual students could support and scaffold this type of thinking, we found that our discussions began going in circles. Colin was comfortable thinking abstractly about disciplinary epistemologies, while Marisa found it difficult to discuss at this level, and was skeptical about students' ability to think so abstractly about disciplines, when she herself struggled with the exercise.

We ended up creating a worked example of an exploration of ten disciplines in sticky notes (Figure 10), which was later expanded (with the help of Wikipedia) by Marisa to simulate how a student might explore a new discipline. This started as a way for Colin to think through how they imagined disciplinary epistemologies being compared and contrasted to one another, even though we wouldn't expect an undergraduate student to independently conceive or conduct such an activity on their own.

As we proceeded, we added to the list of disciplines (orange sticky notes) to provide a sampling of the variety of disciplines available at the university. Rather than limiting

Discipline	Major concepts	Outcomes	Questions asked/ Hypotheses made	Common forms of evidence	Approaches to inquiry	Schools of thought	"Cousin" Disciplines
Psychology	Cognition, human behavior, emotion, consciousness	Models of cognition and behavior	Hypotheses about human behavior	Statistical data derived from observation or measurements as part of laboratory experiments	Single-subject and group experiences; lab studies	Behaviorism, cognitivism, humanistic/ gestalt, psychoanalytic, social	Neuroscience, biology, computer science
Philosophy	Being, ontology, epistemology, meaning	Logical premises, statements of ethics, political philosophy (e.g. Confucianism, Marxism)	What is [truth, reality, free-will, etc]? What does it mean to exist? Why is it wrong to…? Is it worse to …or …?	Philosophy may also be based purely in logic and logical inferences, not requiring evidence.	Deductive or logical reasoning, thought experiments, use of evidence to increase confidence in philosophical statements or define edge cases.	Empiricism, rationalism, idealism, positivism, structuralism	History, theology, ethics, mathematics, language/semiotics
Computer Science	Object-oriented (modality & reusability)	Something that can be used (e.g. compliable code that meets requirements)	How can we make this more efficient? Make this work at scale? Make this easier to maintain?	Algorithms that produce specific outcomes	Logic and quantitative measurements	Analog, digital, quantum	Mathematics, human-computer interaction

FIGURE 11. A sample of final mapping of three disciplines from our final report.

ourselves to "technology" and "humanities", which was the verbiage used in programmatic discussions in the past (and had led to both failure and fragmentation of the fellows team), we included a range of disciplines from abstract (philosophy and mathematics) to traditional sciences and humanities topics, to professional disciplines, such as computer science and education.

Working through this process ourselves helped us envision what it would be like for students to answer these questions. Marisa was concerned that students would not be able to understand or answer many of these questions, which led to a more concrete discussion of how instructors could guide students through this process as a group during their first year as part of mapping out their disciplinary areas of interest. We envisioned that students could also go to faculty in their disciplinary focus area classes to help them fill in the information for each focus area, which would have the side effect of encouraging students to make use of office hours and form a relationship with faculty—good habits of successful students. We had some concerns about whether this activity would be feasible, but as a framing activity we felt it was a successful point of departure.

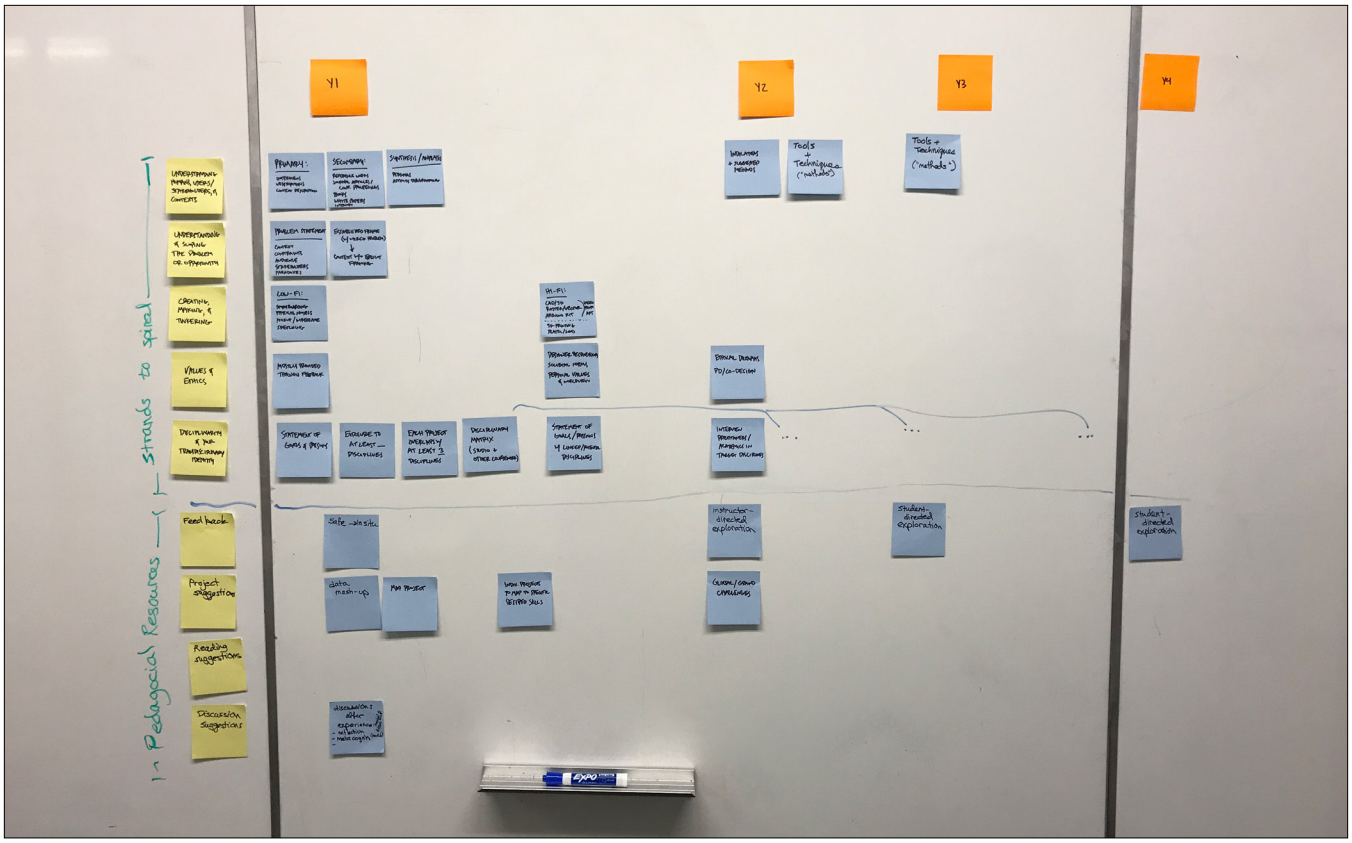
We envisioned that the creation of a tool (such as a worksheet) may help to scaffold students through this process and thought this scaffolded version could be done with several disciplines during the first year (as topical disciplinary knowledge was brought in), and that instructors or mentors would help students through this process during their early years in the program. However, we did not create this worksheet during the sprint.

Cascading Strands and Disciplinary Perspectives over the Four Years

Once we had a draft of the disciplinary perspectives and strands in place, we took a stab at seeing how these elements could cascade over four years (Figure 12, next page). We began by detailing out the first year, then moved on to the next three. Because subsequent years became increasingly student-centered and students were expected to behave in increasingly self-directed ways, most mapping was focused on the first two years. In the latter two years, we used more abstract indications of learning outcomes or evidence, such as "Identify and use appropriate tools & techniques for project needs (group and individual)" for the disciplinary and personal transdisciplinary identity strand or "Engage with paradoxes that reflect tractable framings of wicked problems" for the understanding and scoping a problem or opportunity strand.

Alignment to Specific Instructional Experiences

Once we had a rough outline of what would be focused on across each year, we began to think about what the learning experience would be like, and how each of the five strands could be developed through projects and activities.



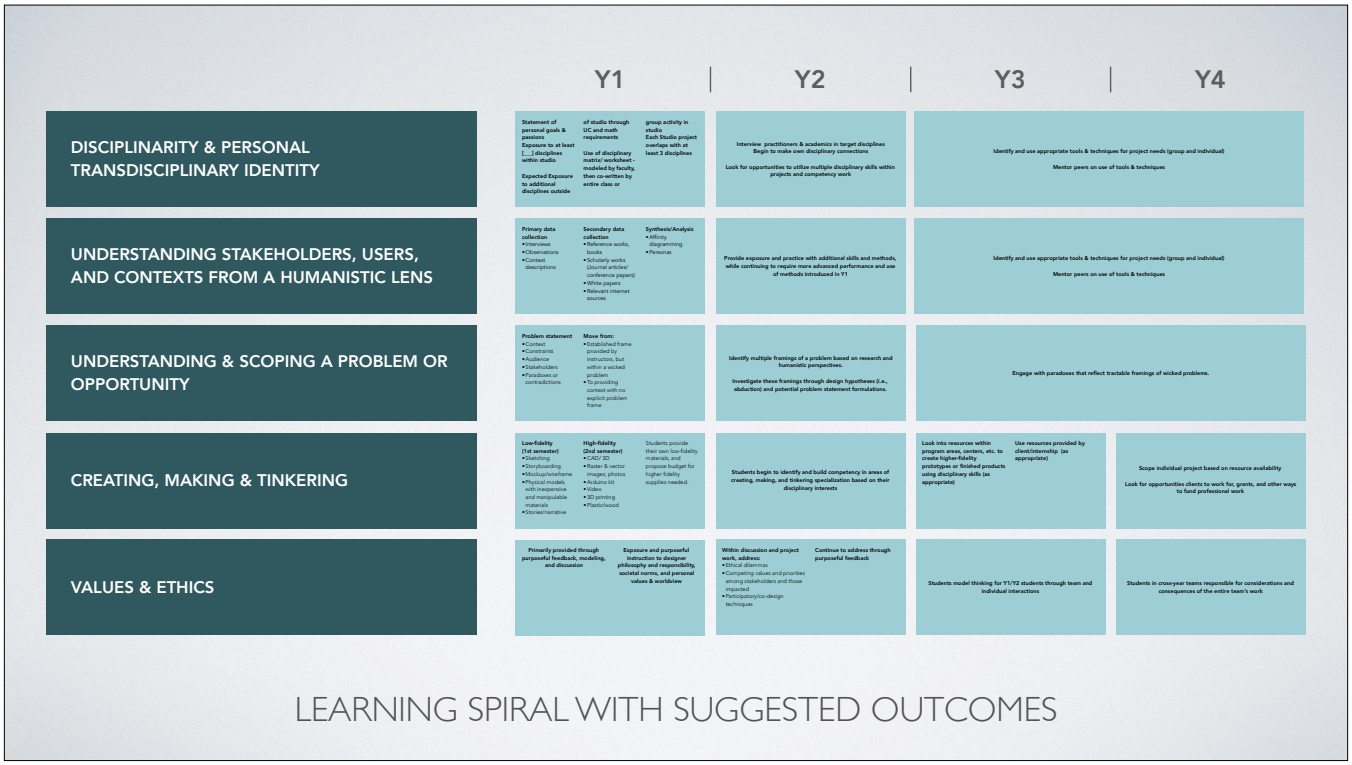


FIGURE 12. Initial mapping of skills by year, including strands we wanted to spiral, pedagogical resources and tactics, and key methods or tools students should engage with (top). This resulted in a final proposed mapping (bottom).

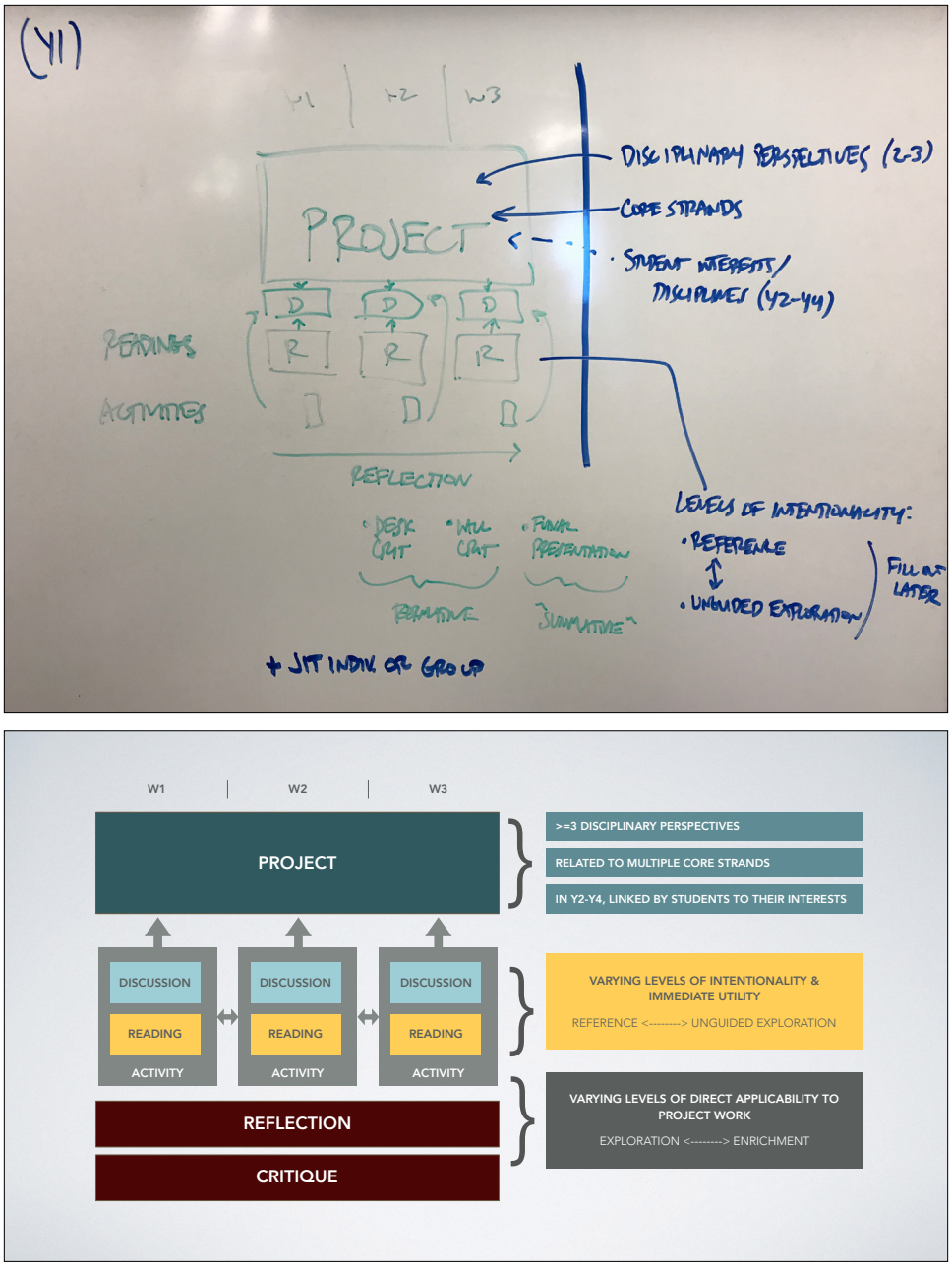


FIGURE 13. A draft of the activity and project framework, which included elements from our previous work such as disciplinary perspectives, core strands, relevant disciplines, and potential readings or activities (top). In a finalized form, this framework provided a mechanism for mapping both the elements of instruction and visual alignment with key program and discipline-related components (bottom).

We envisioned projects of varying length and requiring multiple disciplinary perspectives across the year, moving over time from instructor-provided projects particulated in by all students (year 1) to student-driven projects that required skills from students' own focus areas (later years). Activities, with related readings and discussions would support development of depth of understanding and skills to support project work. Over time, readings and discussions would move from references provided by instructors to unguided (student-driven) exploration. Similarly, reflection and critique activities would help them both to explore the synthesis of multiple disciplinary perspectives and provide a source for interaction.

In order to help ourselves understand what this would look like, we drew out a sample four year sequence (focusing on the first year) including projects of varying sizes (Figure 13, top). We built on our experiences teaching these students and from interviews we had conducted as part of the program evaluation, which indicated that students preferred a mixture of shorter projects and sprint-like activities to break up larger projects. Drawing this draft framework helped us refine our thougths about how to pull together the various strands and pedagogies, and we went back and forth between this design and the project-level design.

In the final documentation, we also included a worked example using the activity and project framework, building on an idea (the "map project"; Figure 14) that had been proposed by fellows representing the humanities portion of the program in a previous four year curriculum committee meeting. We used this example not only to activate the various elements of the program design we had addressed in our design sprint (e.g., elements of the learning spiral, linked disciplines, types of pedagogical support, potential activities) but also to demonstrate our commitment to celebrating the ideas of our faculty colleagues and showing how they would function within our design.

WHAT HAPPENED NEXT, AND THE END OF THE PROGRAM

We presented our final materials in June 2017 to the dean, other college administrators, and others involved in the

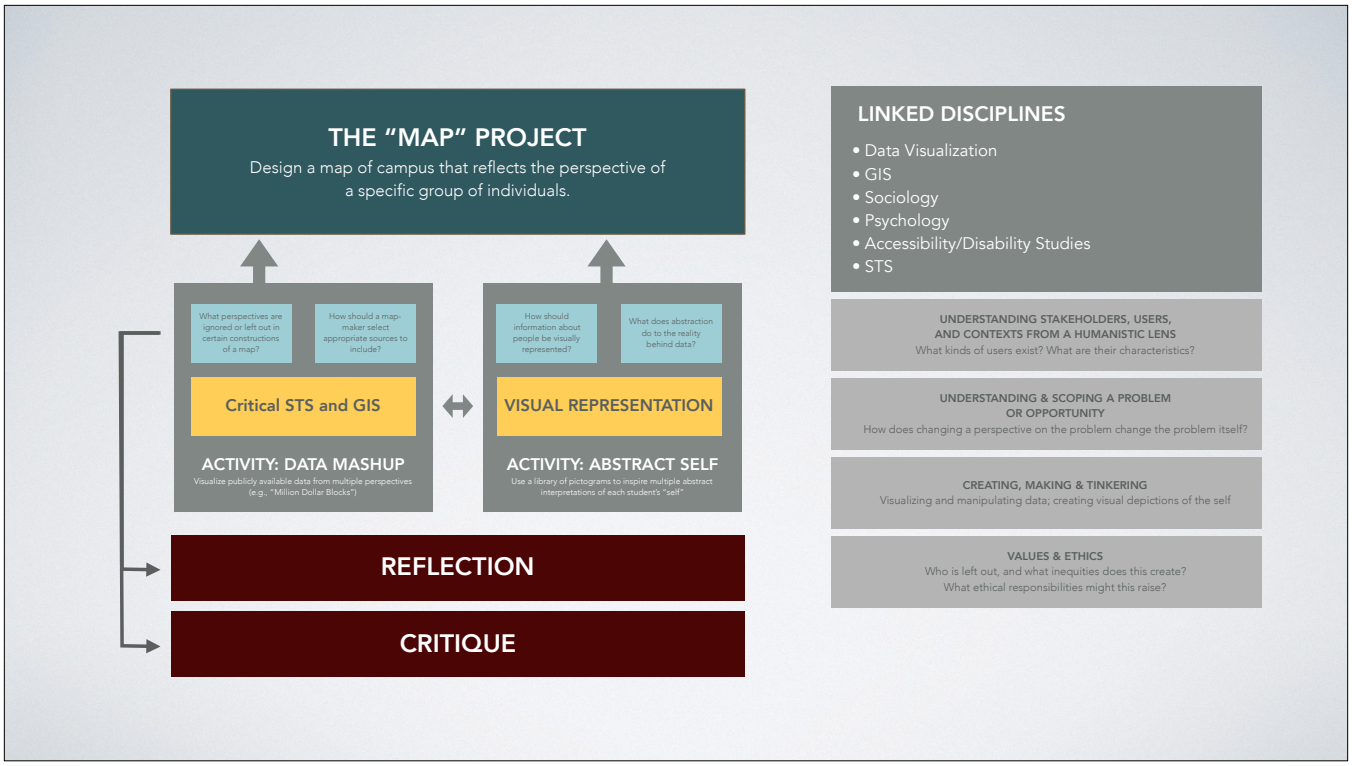


FIGURE 14. A worked example using the project framework, illustrating connections among project goals, linked disciplines, spiral strands, and potential activities.

program. During the period of our design sprint, Colin had officially requested to be unassigned from the degree program due to growth in their own UX design program and by the time of the meeting, this reassignment had been officially approved. In parallel, Marisa had been asked by her home department to limit her time spent on the program, focusing only on continuation of existing evaluation activities. Thus, even though we both cared deeply about the future of the program we had invested so much time in over the preceding years, this handover of a blueprint for future course and program-level activities was now a tangible representation of our "farewell gift" to the future program team and the college at large. Since this material was to be handed off to two new hires that were not yet determined (and the process for onboarding these new hires was not made clear to us as program designers), the exact fate of our recommendations and the degree to which they might impact the evolved program was unknown.

Overall, our work was received enthusiastically, and the stakeholders felt that we had captured key programmatic elements that had potential to address some of the design failures we had set out to solve. However, there were many aspects of the program that our plan did not directly address which impacted the viability of the plan in the semesters that followed. In particular, the program was struggling with recruitment due to confusion over the name and the open-endedness of the degree outcomes. Additionally, even though we had mapped out three different personas to identify the kinds of students we wanted to support, many of the students already enrolled in the program were of the "basement inventor" type, but often without the self-regulation skills needed to effectively and independently build the disciplinary skills they needed to meet their degree objectives. Notably lacking were students in the "high achiever" category, and only a minority of students were of the "custom degree seeker" type that lacked motivation to build the transdisciplinary components to join together their diverse disciplinary interests. Our plan also did not address the fracturing already apparent in the group of fellows, and in many ways, the unresolved tensions over goals to be unconstrained in innovation while also planning for a full four year degree left lasting divisions in how fellows approached each other and the program.

Despite these gaps that we knew would impact implementation, we handed off a 22-page deck of documentation (many of the pages are reproduced in this case) to the administrators and program fellows and hoped that at least some elements of our specification would be adopted. However, in the coming year, program fellows and faculty were realigned, the program was moved to a new departmental unit (from a "floating" program at the college level), and new enrollment continued to stagnate. By the 2018-2019 academic year, it became clear that the degree program—while innovative across a number of measures, including its transdisciplinary focus, mastery orientation, competency-based structure, and integration of technology

and the humanities—was simply unfeasible in its present form, and enrollment was closed for the following academic year.

This marked the formal close of the degree program—which was precipitated by failure on many fronts, only some of which we have addressed in this manuscript. At a high level, this failure was a result of a program which perhaps too "radical" for our institutional context with a name and function that was misaligned with the communication expectations of prospective students. From an instructional design perspective, the program development revealed weaknesses in our knowledge of how to design flexible, "content-less" learning experiences and the means of balancing instructor autonomy and program stability. We describe some of our reflections on this experience of failure as instructional designers in the next section.

WHAT WE LEARNED ABOUT OURSELVES, THE PROGRAM, AND INSTRUCTIONAL DESIGN AT THE "MARGINS"

Through the design of these various aspects of the four-year curriculum, we were able to identify a plausible path forward for the program *design*, but increasingly recognized that—due to a range of social, disciplinary, and institutional factors, these design efforts were unlikely to be implemented. Within two years of these design elements being delivered to the team, the program began the process of being dismantled—resulting in failure to meet our immediate design aims. While the immediate program failed in many ways, this design process was an active site for discovery and reflection, and impacted the delivery and scaling up of the UX design program that Colin led starting in 2017. In this section, we reflect on what we learned through this (failed) design experience engaging with instructional design "at the margins," while also identifying ways in which our design approach has impacted the design of other learning experiences in the years since this design sprint.

First, we learned what we could and could not achieve in two weeks. We knew from the beginning that our plan for the design sprint was audacious, and even though we were successful at a high level in building out the program components we felt were necessary, these components were not specified in a complete design document (as would be typical ID practice) and not all materials were written or visualized in a form that other program fellows without an education or ID background could fully understand.

Additionally, while we did not set out to follow any standardized ID process model—recognizing the limitations of such models, particularly for our specific goals and needs (Gibbons, Boling, & Smith, 2014)—a skeptic might look at our design approach and find gaps or a lack of adherence to key elements of what Yanchar and Gabbitas (2011) have called "orthodoxy," even labeling our work as a failure in some measures. In fact, previous approaches with a more typical ID approach had already failed to work in this environment due to its lack of "core" content (see Gray et al., 2018 for additional details on this particular challenge), plurality of instructional approaches, and uneasy tensions between educational innovation and administration of such a path-breaking program.

Instead, our approach in this sprint was primarily pragmatic, or "eclectic" using the terminology of Yanchar and Gabbitas, drawing on a range of design judgments (Gray et al., 2015) that allowed us to investigate the problem space of the four-year curriculum, which was informed by our substantial precedent knowledge and existing engagement in related problem spaces over the previous two or more years. Thus, while our approach was pragmatic, our process was a result of careful and considered judgments regarding what constraints were relevant, and at what times; where existing precedent knowledge or programmatic structures were useful and when they needed to be replaced with new approaches; and when traditional ID process moves were useful or would "bog us down" in relation to our goals and the short time frame for work. We reinforced our belief through this process that most typical ID processes were not well-suited to programmatic and structural components of the educational approach we were seeking to create, instead finding more resonance with more flexible visualization and analytic methods common in HCI and UX contexts.

Second, we perhaps overestimated the extent of our agreement as two faculty fellows prior to entering the sprint, and many of the sketches and resulting discussions informed our alignment—or areas of remaining tension. We required quite a bit of discussion and movement between design elements at differing levels of the program and course design as we (re)examined and refined our thinking on each. Through these discussions, sketching, and other forms of rapid prototyping, we iterated through many of the program elements we sought to design, using our previous experiences to evaluate or analyze the fitness of these elements for our purposes while also making reasoned judgments about the ecological validity of our approach based on our previous evaluation of learner and program needs.

Important to our approach in this sprint was our ability and willingness to debate, sometimes even having heated discussions, in order to deeply consider what we were trying to do. However, another important ability we recognized was our ability to end the debate when it began to go in circles, or to use prototypes such as whiteboard sketches as a tool to move from an abstract discussion to focusing on specific and concrete examples.

Third, we knew that we were conducting instructional design "at the margins," combining approaches from UX, LX, and ID perspectives alongside our substantial prior inquiry

into inter- and trans-disciplinary educational practices. This inquiry built upon the failure of the group of fellows collectively to identify tractable instructional practices in the previous years of the program, while also representing continued efforts to identify ways to circumvent key learning barriers we had observed through our classroom instruction and assessments of student learning as educational researchers—particularly us as the two fellows invested in the design sprint.

While we had substantial experience working together, we were both aware during the sprint that we were trekking over new ground, and we never knew in advance whether a particular discussion, prototyping approach, or design outcome would end up being relevant to our final package of work. Instead, we grew to embrace this imminent sense of failure or opportunity, "trying out" new approaches that felt right in the moment and seeking to learn from failed prototypes or conversations that ended up in rhetorical "dead ends" more than once. Although we did not have full knowledge of the implications of the sprint while we were undertaking these design activities, many elements of the project framework, disciplinary mapping, and spiral strands were eventually used to inspire program-level discussions within the UX design program that was led by Colin starting in the summer of the design sprint. So while many program elements became abandoned in the TST degree, they served as useful precedent for another program with related goals.

Fourth, we had to reconcile both our felt ownership over elements of the program and the need to motivate other fellows to take up our design ideas and implement them in future iterations of the curriculum. This is perhaps our biggest failure, since we were seeking to identify a path forward for a program that was already fractured, and in many ways, a lack of trust and fragmentation pervaded our work even before the sprint began. We did consider the perspectives of other fellows, with Marisa's historical knowledge of the program serving as both a sounding board for these concerns as well as occasionally miring us in detail that was no longer relevant to the present state of the program. We were also aware that, based on the history of collaborative efforts within the larger team, other fellows might not be amenable to utilizing elements of a design created by only two fellows, and that they were not used to thinking at a program (rather than single course) level—an issue which had precipitated the need for the design sprint in the first place. Thus, we had to consider how to present this work in a neutral way, actively building on concepts already proposed by other fellows (such as the worked example of the project framework) and also anticipating pushback regarding the perceived rigidity that could be interpreted as reducing instructor control over the design of individual courses.

To address these concerns, we presented some elements as coherent tools for mapping existing and future curricular moves (e.g., spiral strands, disciplines, project framework) and other forms of guidance as primarily heuristic (e.g., encouraging vertical integration among courses, providing general advice on levels of student v. instructor directedness). However, it is unclear to what degree, if at all, any of this guidance was used to motivate changes to courses or the program after the delivery of our documentation—and it is likely that our design work was likely forgotten before anyone had the chance to seriously consider it due to a change in instructional staff, among other changes.

CONCLUSION

In this design case, we have detailed the process and outcomes of a two-week design sprint, where we sought to create a new four-year program structure for a novel undergraduate transdisciplinary degree program, building on a multi-year history of design efforts in this competency-based program. Through a range of prototypes at various levels of fidelity, and through conversation, we sought to address key moments of program failure that had precipitated our design sprint, while also anticipating how our materials could inform learning experiences that were better aligned in the program following the conclusion of our sprint.

ACKNOWLEDGMENTS

We express our thanks to the faculty, students, and administrators that nurtured this space to experiment with new educational structures and approaches—many of which have benefitted future generations of students in the Polytechnic and beyond.

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