TELLING DESIGN STORIES FOR ENGINEERING DESIGN ENTREPRENEURING

Keywords: engineering design team education, story, aesthetics and leadership, collaboration

Introduction

I am riding Caltrain and twirling a water-filled paintbrush into a compact box of watercolors to plan my afternoon class. I take the train during the week from San Francisco—newly transplanted from Boston—to Palo Alto where I am a visiting professor. During the first weeks of the commute I used a computer for this purpose, then books; finally I turned to what makes time stand still for me—painting. Today I am trying to figure out a way to structure exercises to access story as a methodology and explorative form for a graduate engineering and design methods class. To do this I reflect back on what I already know, what I am learning from graduate student co-creators, and how my participant observation as instructor for the class will impact the developmental stages of their projects.

We know that collaborative design thinking is a social activity [1]. Members work together in teams in the workplace and increasingly in engineering schools in project-based design courses. While these courses give an experience of working in teams, the elements of how insights help individuals create new approaches, sustain engagement and inspiration well into a project and appreciation for new emerging teams are often not emphasized. How will "story" as an explorative form help the graduate student participants who interact with one another to generate and prototype ideas into artifacts? How will the instructor and the students balance leadership as a variable in the process, and artfully influence the transformative connection results of the class?

The nature of personal interaction appears to have an empowering symbiotic energy when guided by a strong connection among members. The possibility for collaboration has a positive result on impact and the development of individual research projects. What is the explicit nature of the interpersonal connections in design groups that facilitate breakthroughs [2]? To what degree are the participants aware of the push-and-pull dynamics [3] of interpersonal behavior as positive or corrosive to the team process, which in turn artfully affects the design team's performance?

"Artistic desire drives my design process." This comment came from a graduate student—named Sangbae—developer of the famous stickybot, as he participated in the design methods seminar. Sangbae's gift is not only contained in his ability to build and deliver a robot that will climb and stick with hundreds of sharply tapered synthetic fibers, it is also in his capacity for connection and deep reflection within the group. We will return to his story, and his willingness to use connections to reflect on sustaining inventive actions with the class, in a later section. Before learning from his and other story elements, it's important for you first to consider why we believe in story as a powerful artistic medium and a useful explorative form. Stories can create a transfer of energy and balance leadership connections. Fusing the parallel between creative desire and creative delivery across each developmental stage of a process 'story' transforms individuals in the class. In order to lay the groundwork for looking at Sangbae's and other telling stories, we briefly discuss the artistic "balancing act" of leadership and connection. Then we consider the meaning of transformative connections, with examples from the class where the students and leader participants explore, evolve, excite, and deliver their project "story," discuss the beginning and middle of our co-developed methodology, closing with what this tells us about the idea of engineering design *entrepreneuring*.

Entrepreneuring refers to inventive actions that are characterized by a symbiotic energy flux within the collaborative connections of a group. Entrepreneuring may be observed in the behaviors of leading entrepreneurs and contained in the collaborative conditions of a group.

The central focus of the current work is a parallel between the artistic desire that drives the design process and how telling stories drives new design elements. Students live their project stories within

the collaborative connections and evolving dynamics of the class just like entrepreneurial leaders live their stories in the evolving dynamics of their companies.

One question organizes the current work: "What if students experience and live their story within the collaborative connections and evolving group dynamics of the class and become more effective at moving forward through the developmental stages where they ideate, prototype, synthesize and deliver by using the design thinking process?" In order to improve the quality and experience of collaborative design performance the class as an engineering design entrepreneuring experience will:

1. Use 'story' as the explorative form for accessing internal process, developing design elements and delivering new designs.
2. Create class as a unique space where students spanning academia and industry redefine the bridge they inhabit and their methods of interaction. Thus, the prototyping environment itself is also a prototype being studied and redesigned from within.
3. Observe in the moment incidents of student insights and appreciations for design work and emerging collaboration. Identify the balanced leadership connections that occur through the vectors of emotion, idea and representation.
4. Intervene with the intent to utilize the developed methods and tools to improve collaborative design thinking and confidence and set the stage for 'entrepreneuring' behavior.
5. Include entrepreneurial leader guest guides with telling story responses to make explicit the developmental stages in the design process through the implicit narrative impact.

The Art of Balanced Leadership and Connection in Telling Design Stories

Engineering project teams are well studied [4, 5, 6], and discussions of story as an art has been well established [7]. Connection as a concept is a well documented way of knowing [8] and unknowingly considering relational leadership in teams [9]. But the suggestion that the success of engineering design work and a balanced leadership intersect because of the connections to a story as the explorative and artful form is new.

But what kind of connection is it? Is it a connection because of leadership within the group? Is it a connection because of how we feel about meaning and the creative power of group genius in directly working relationships [10]? Or is it a sense of a felt meaning around symbols and ideas of discovery [11] when individual within group viewpoint frames and contributes to a developing narrative and designed artifact. Table 1 summarizes connection measured by behavioral dimensions of leadership [12,13,14] and felt meaning [15, 16] and sensing [17, 18].

Table 1
Connection Measured as Behavioral Dimensions

Balanced leadership among members	Uhl-Bien, 2006; Heifetz,2005; Baum et al, 1998
Felt meaning, Directly work the relationships	Perl, 2004; Karanian, 2007;
Sensing around ideas, symbols of discovery	Taylor&Carbone, 2008; Karanian, Skogstad, Taylor,2008

Table 2
Connection Measured with Story as an Artful Approach

Expression of connection as aesthetic form	Taylor and Karanian, 2009; Csikszentmihalyi, 1990
Belonging and responsiveness to 'story' that connects	Ramirez; 2005; Bourriard, Smith&Berg, 1987
Prototype Representation as the explorative form moving forward	Edelman,2008; Eris,2006

Working Transformative Connections

Table 2 summarizes story as connection measured with story as an artful approach. Story as an artful approach and expression of aesthetic form creates connection between humans. Building on previous work [19, 20] it's important to consider aesthetics the way Ramirez puts it. He says that aesthetics is that branch of western philosophy that deals with the future of understanding, perception, cognition, and experiences which we qualify (often after the fact) with adjectives such as 'beautiful', 'ugly', 'elegant', or 'repulsive'. Aesthetic knowledge depends largely on sensing and feeling, on empathy and intuition, and on relating conception to perception [21].

Not all thinking occurs in the heads of team members or one extraordinary leader. The problem facing cross-functional design teams is one of distributed cognition and interpersonal behavior. Much of the thought in a team can be said to reside in a shared representation that leaders create with and for one another. Relevant here is the Knowledge-Concept (K-C) transit—movement of an idea from one space to another—since effective collaboration on a team requires multiple forays between the theoretical and concrete instantiations of a project [22]. Research has shown that team performance is improved when characterized by many movements between the theoretical space and the use of hardware [23]. This supports the notion of prototype representation as the explorative and artful form moving forward across the developmental stages of a project.

The Background for the Preliminary Investigation
The stories included in the observations are a blended combination of two iterations of a graduate seminar in engineering design methods at Stanford University. While the 10 week course seminar has been offered for more than a decade, the two iterations featured in the discussion are new experiments offered in the Spring and Fall Quarters of 2008. A course description and syllabus is distributed, along with an overview of assignments and the core vision for the class. A unique feature is that students are informed in the getting-started ("warm-up") phase for the class that the evolving dynamics of the class impact course curriculum. Each class has an organizing question received in advance, a question added during the class, a practice exercise, and a design challenge.
The seminar uses 'story' as an explorative form approach, with one lead instructor, a consulting instructor, at least one graduate student participant observer, and invited industry guest guides. This story-telling group interaction brings coherence to student perspectives across the stages of the individual design process, the type of coherence that one might observe in an entrepreneurial leader. The students and the instructors are reflective of multiple cultures and geographic locations. All but a few have a background in engineering.
The process relies on spontaneous yet thoughtful restructuring of class assignments, writing and painting practice exercises. Successful completion of the class requires participating by attending class, completing short cycle prototypes, experiencing projective exercises, two minute presentations, and a final paper and presentation.
The current discussion considers class examples and preliminary reflections from iteration I, "Telling Your Research or Project Story," and iteration II, "Telling Your Research or Project Story: What Matters for You and Makes Sense to Industry." (Note: Analysis is in on-going compilation and iteration III is in process, "Telling Design Stories: Do We Design to Create Stories or Do We Create Stories to Design?")

Planning Phase I
A three month exploratory phase examined the significance of story for the purpose of considering a seminar as a collaborative group experiment. A discussion of whether or not to move in the direction of hypothesis driven research resulted in three hypotheses from the three co-authors. Work and rework attempted to synthesize the three hypotheses to one hypothesis. Two similar concepts emerged: balanced connections, and a transfer of energy.
Planning for the next phase of the preliminary investigation included a review of ways to qualitatively prototype, observe, deliver a designed 'story' and recognize the impact of the participant observer researchers and instructor.

Planning Phase II
The observation of two separate iterations of the seminar was qualitatively considered by the Instructor and reviewed in chunks by two co-authors. Elements of student stories were considered from concept to delivery across the developmental stages of ideate, discover, evolve and prototype, and delivery of results. Six entrepreneurial leader guest guides telling response stories were also considered. Drawing, and paintings painted, with projective cue prompts, and other artifacts left behind were also part of the data gathered.

Phase III Model
A novel method for uncovering and coding 'story' results was explored through the development of an equation in the recognition of a personal and scientific truth. While metrics exist for story considered as an archeology and through a well established latent semantic time analysis (LSA, 1988), recent developments [3] suggests a need for a novel exploration of variables that does not rely on a computational, Bayesian, or fuzzy analysis.
A list of variables emerged as energy from: words spoken, words written, questions asked, sketches drawn, photos/videos taken, physical objects created or shared, text messages sent or received, laptops open, phone calls taken, interruptions from outside of group individuals or events, other group events like laughter, applause, non-verbal cues. A generalized energy theory evolved with a two part breakdown. These variables contribute either "positively" (e.g., sketches drawn) or "negatively" (e.g., outside interruptions) to the overall energy of the group. The variables are combined to result in a numerical characterization of a team's total transfer of energy among members; in turn, this numerical result can be compared to other teams to gauge (or judge) the relative engagement of team members. Initial data-gathering has been conducted by filming a class, observing team connections to a story with the participant observer/videographer as a variable in the study.

First-person methodologies were also considered as a way to distinguish one's personal truth from science. Our discussion was not only to recognize a science which includes first-person, subjective experience as an explicit and active component (25) but also to offer a non-traditional and unexpected way to deliver academic work and a relevant promise to the formative nature of engineering education.

METHOD

Intergy is defined as a "shared energy" between collaborative group members. A fluid transfer of enthusiasm, emotion and information visualized as an "energy flux." Intergy can be internal to the group and also shared to engage non-members (participant observers). Figure A depicts "intergy flux" as the symbiotic movement of energy contained both inside and outside of a collaborative team. Entrepreneuring teams are characterized by a highly symbiotic energy flux between both the outside and the inside of a team.
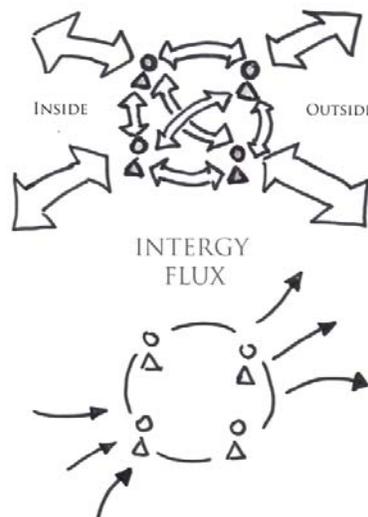

Figure A

Rather than as impartial and disconnected researchers, we approach each situation as "participant observers." So whether we are studying an individual or a group of individuals, we allow them to engage us directly in their activities. This allows us to directly experience and observe Intergy as it is generated by the individual or individuals. We have two primary methods which seek to address the following three Hypotheses:

1. Collaborative groups are characterized be Intergy.
2. Intergy is observable by outward variables in team interactions.
3. Entrepreneuring leaders epitomize Intergy.

The first method is participating observation of a seminar class. Video and audio recordings were made of the session in an attempt to explore Hypothesis 2. In these recordings, the voice of the recorder can often be heard as he is actively participating. Observations of the group's "outward variables" (such as gestures, interruptions, etc.) could ultimately be entered into an equation to obtain a numerical representation of Intergy level. Due to the nature of the seminar, the primary vehicle for Intergy in this case was the sharing of personal stories. See framing of story as intergy in Figure B.
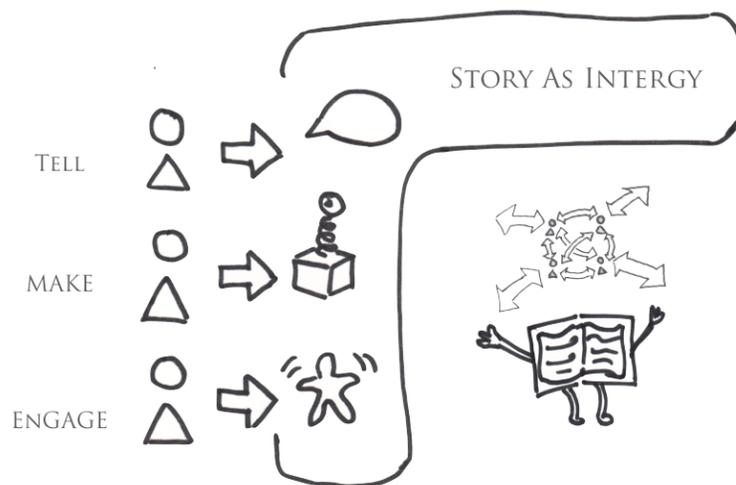

Figure B

Subjects
Students and industry leader guest guides ranged in age from twenty-something to fifty-something in the classes. Some took the class for credit while others participated and visited on a regular basis. Each class group had 8-12 participants. Each group had at least one female participant.

i. Design as Organizing Questions for Each class
Organizing questions for the seminar were formulated based on factors of motivation, imagination, perception and cognition across the seminar project phases of explore, express, evolve and excite (see Table 3). While many of the questions were part of the pre-planning for the course curriculum, some questions emerged based on the evolving dynamics of the class. All the questions for the Excite Artfully category illustrate curriculum that was impacted by the class dynamic.

Table 3
Organizing Questions for the Seminar

	Motivation	Imagination	Perception	Cognition
Explore ; Engage	What matters to you about your project? What do you 'need' as you move forward?	How would you tell your 8th grade self the title and first two sentences of your project?	How is sensation and the ways we organize perception grounded in physiological processes?	How do we make sense out of what is confusing about our designs and research project?
Express Internal	What are the collective unconscious factors that influence your view of your story? What happens when someone else tells your story?	How do you remain inspired and excited 2 or 3 or sometimes 6 years into a 'story' project?	What are your personal 'readiness' factors that will facilitate your moving forward?	If you return to the discovery phase of your story, where are you now in the arc of your work?
Express External	Does it matter if your story is 'like' others who hear, listen or ask about your story?	Imagine and paint a picture of where you are in your story…how do the stories of others inform?	Where is the energy in you? In this group? How is it useful in moving forward on your project?	How do you tell your story to varying audiences—academia or industry or both?
Evolve redesign	Where are you in the arc of your story? Beginning, middle, end?	What is it about being in the middle that is immobilizing or floating	What engages you about your work? How did others prototypes help you move forward?	As you reflect back on the quarter what one question do you have for yourself about the current state of yr story?
Excite Artfully	What are the images and themes of motivation in your picture test stories?	How does artistic desire impact the way you design your story?	Why is it an art to leave gaps? Why not give the beginning, the middle, the end—whole story?	What did your drawing of you inside your project inform your currentstory perspective?

ii. Analysis of Content and Measures

Design as 'story' and the transformative connections are considered descriptively. In the preliminary analysis, four dimensions of telling design stories are featured from a developing verbal, non-verbal and picture narrative: balanced leadership conditions, working the relationships, transfer of energy as emotion and truth, and an artful approach across the developmental stages of project level—from the ideating and motivating stage—through discovery of story form, to the evolution of a prototype to the results (see Table 4).

The intent of the preliminary exploration is to lay the groundwork for next phase analysis to explore a novel way to develop a metric for story as a transfer of energy that not only brings coherence to a developing individual design but also frames how story viewpoints characterize new design elements for leading team success.

Table 4
Story Results and Project Level

	Ideate and Motivate	Discover Story Form	Evolve and Prototype	Results
Leadership and Collaborative Conditions	Successful ideas conveyed	Enhanced by the story as form from self and others	Class evolves with artifacts from moments and prototypes	Balanced transfer of leadership by the delivery phase
Working the Relationships in the evolving story	Motivating conditions are encouraged by the influence of story	Personal story form changes over time as the class changes	Participating with others in similar or different phases facilitate new	Challenges impact transformative connections and story delivery
Transfer of Emotional Energy , Truth	Most empowering when students are present and ready	Telling the true and real adds possibilities	Never faking being present is powerfully clear	Transformative connections evident in truth
Artful Approach	The 'hope and desire' in the beginning phase	Influences the story and explorative story form and influences the actions of surprise	Play with ideas in personal and collaborative space. Find the fun and the flaw.	Find the un-detected beauty in connections with others who help you move forward

The second method, intended primarily to address Hypothesis 3, was to meet one-on-one with leading entrepreneurs. In these meetings, observation took place while the observer was also participating in conversation. One method applied at each of these meetings included having the entrepreneur paint a picture. This method incorporates the "element of surprise" with a generative aspect to create a real artifact. In so doing, we hope to gauge an Intergy level from this interaction as well.

Procedure for Projective Paint a Picture Test
The conversations with the leading entrepreneurs were requested in advance and conducted by the same author each time. Although requests for meeting times time were framed as "no more than 18 minutes" all interview conversations lasted at least one hour. The locations were either in a neutral off company site or at the leader's company. The "element of surprise" was preserved in each case since the same water filled paintbrush, small compact box of water colors and standard sheet of heavy bond paper was hidden away in a large carry-all, leather case. All participants received the same set of directions when the author reached into the case and removed the painting materials and delivered the following directions:
"Imagine that you can paint your self in the middle of your collaborative company or work place. Please be sure to leave a space. Be as creative as you like. If you ask me what I would like to you do I will only repeat the same directions."
Every participant gasped or audibly expressed surprise when the painting materials appeared and a 'paint a picture of yourself request' was delivered. Although all participants used the water-filled paintbrush for the first time, one participant had extensive design experience. The painting exercise lasted 8-10 minutes.

By applying these dual methods, we hope that the validation of Hypotheses 2 & 3 will, in turn, lead to the acceptance of Hypothesis 1 as a useful metric. This would allow us both to represent the Intergy of a group consistently, repeatably and numerically, as well as identifying a group of individuals whose Intergy level has directly contributed to their success in industry.

RESULTS

Results were considered first as anticipated story results and assessed as preliminary concepts in a grounded theory approach across four dimensions of telling design stories (see Figure 4). Any one observation of the presence or absence of transformative connections was observed and reported in word and picture form, across the ideating and discovery, prototyping, and, in-process, delivery phases of 'story' work with:
1. Balanced leadership and collaborative conditions for connection occurred through all participants.
2. Working the relationships within the evolving dynamics and story of the class.
3. Transfer of energy and depth of emotional presence for students and visiting guest guides.
4. Artistic approach as a desire and driving connection for the story and explorative form.

Results were then considered as a reflection on the authors as co-developers of the work and collaboration. We discussed three big ideas that emerged from the steps we had taken and the data we collected. Discussion and reflection turned to focus on the 'one thing' that was central to three ideas, something about energy transfer or a transfer charge. We talked about a sensed dynamic, pieces of contained inside/and contained outside transfer of energy. We were searching for words that described a flow flux, an energy synonym, and began presenting first impression associations to the 'something' about energy. We were chasing an equation, an infinitesimal measurement. Quantum? Other words flowed—perfume, sex, chemistry with characterizations about high energy flux, or symbiotic energy flux, amplification, magnification—all of these conversations led to one word. Intergy.
We define intergy as a shared energy level between collaborative group members. A fluid transfer of enthusiasm, emotion and information visualized as an "energy flux." Intergy can also be internal to and contained inside the group and also shared to energize non members (participant observers).

Results as Three Ideas

1. Collaborative groups are characterized by Intergy. One vehicle for this is story-telling, as observed in the iterations of the graduate methods seminar.
2. Intergy is observable by outward variables in team interactions. Gathering video data of the group at work, as completed in the test case of the class, will allow us to code for these variables. These variables can then be fed into an equation to output a numerical Intergy level.
3. Entrepreneuring leaders epitomize Intergy. These individuals can harness the power of story-telling, with the test case of painting responses for generative means, with the test case of artifacts.

DISCUSSION
Let's return to the story of Sangbae joining the seminar when the question was: "What happens when someone else tells your story?" How he told his story and the group response became very important to the group and meaning for future iterations of the class. "Our discussion today," he stated, "And

your comments and questions after watching my television interview featuring Stickybot, makes me realize that I have returned to the very beginning—all the way back to years ago…where there was a hope and wish (in me) to make a robot that would climb and stick to the wall, like the gecko lizard. "This is that robot." The class was quiet in the kind way that groups support extraordinary work. Then when the graduating student expressed disappointment the class broke their silence. They offered personal connections in the form of ideas, appreciation, and questions when they learned that despite long distance travel from the west coast to New York, Sangbae had been personally excluded from the television audience, while both the robot and the lizard that inspired the climbing sticking action were depicted. The words of wisdom and care from the class appeared to energize and delight Sangbae. It reset the previously viewed t.v. show disappointment and salvaged what happened when someone else told his story because it helped him return to the past, and feel again, like the very first time, the earliest stage wishes of his design process.

The meaning of hope in discovery, irreverently and incorrectly memorialized on that syndicated morning talk show was different for all of us. But one single thread connected the group with balanced similarity during the class discussion. We were riveted by the artful truth in Sangbae's fulfilled desire to move from ideating to discovery to prototype to delivery. We were present for an historical emotional moment in the design innovation process and we knew it. His story-telling became the vehicle for a collaborative connection of energy—Intergy.

The transfer of ideas as intergy is the beginning for so many breakthrough incidents. We still talk about the organizing questions for each class—like when the introductory question was, "How do you tell your story in two sentences?" The group was stunned when the response from a vulnerable, shy, yet poised and award winning woman student was so low her barely audible words trailed off, "The title of my research is…." They mostly male group stared in supportive disbelief. They all knew her from a distance. Many had previously seen the excellence in her mechanically engineered and inspired skin and medical device experiments. She was in the last stages of research experiments and ready to defend her thesis and didn't even know it! "Do you have any idea about what an impact you have made on us?" we asked. The group was so excited and energized that she remembered to be confident again in her work. "Wow," she smiled. "I guess that this is pretty interesting stuff that I am working on. I almost forgot to enjoy what I have been trying to create." Months later, following her successful defense she remarked to the seminar students, "More than you know, your attention and appreciation, really helped me complete my work."

Participants were unaware of some questions in advance. Take the projective-story cue prompt, "Revisit the past, and tell your 8th grade self the topic and first sentence of your story?" Playful results ensued with titles like, "The 17th grader;" and "Where Cool Design Rules the Planet." Or surprise resulted when an entrepreneurial leader's stunning response was, "But I was never in 8th grade. I went from 7th to 9th." He added, "Well if it was 7th grade then it was like a message was coming in from another dimension and nobody was there to receive it!"

Or consider the question, "How do you remain inspired and excited 2 years into a sometimes 5 or 6 year project?" when the guest guide was the founder of a Hollywood production company who had developed a revolutionary film-cutting discovery. His words stayed on the whiteboard where class was held for months, no one wanting to erase the reality of what shivered us to the core: "We failed our way to where we are today," or, "I work with people who see what I say."
The founder responded to a student complaining while asking if his work just 'sucks' since no one on the teaching team appeared convinced by his intricately woven product design story, "It's possible that your work sucks," the founder said. "…but it's more likely that you are giving them too much of the story…never tell the beginning the middle and the end." He added, "It's an art to leave gaps." Silent at first, the student awkwardly recognized the truth in a later presentation. Lest we give a romanticized or incorrect view that all was happy and cheerful in the individual story telling and class connections, awkward silence occurred another time when the founder told more of his personal story. "We never read the manual that said to separate the creative people from the technical people. In fact, our industry doesn't get it. They don't believe us or know what we do. They think it's impossible to artistically collaborate the way we do."

More dramatic, a combative vibe occurred when a student said he reset his first story sentence to, "Why engineers suck," and again when a visitor claimed that the class reflections were misplaced after a design challenge when he responded, "The problem with you students in this place is…"

Illustrative of disparate background setting the stage for team type interactions or teamwork from the class occurred more than once. One example was when a unique duo of young industry guests, friends since 4th grade, walked into the room. First the computer software designer, a self proclaimed geek, smiling and easily connecting and his partner of their joint start-up equity company venture following—comfortably taking the front seats at the head of the seminar table. The organizing question, "What happens when you tell your story to varying audiences—academia or industry—or both at the same time?" was prophetic and a pivotal question for the class. We learned through their unmistakable cohesive bond, often with comedic twists. Engineer to venture analyst, "…is it in the red or in the green when the cash flow is not a problem?" They showed us how the power of a true cross-functioning team could be a force for change, whether the audience was in academia or in industry, and that helped us tell our individual story. More important, we began to see the luxury of what we saw and felt and participated in the not quite academic, not quite industry space of the class. We realized that under other circumstances, we would not know each other, nor have the opportunity to appreciate telling design stories and sharing insights.

Another class scenario began when we prepared for an industry guest guide by pretending that we were 'pitching' our research or projects as a movie title to a motion pictures movie mogul—inspired by a favorite movie, documentary, video game or other virtual depiction. It was the only time we used the word 'pitch' yet had some interesting results. "Honey I shrunk the accelerator!" was the movie title from the post graduate student/physics lab director after he received feedback from other students. This stretched the boundaries for the group, not only for the ideas behind the work, but for the imagination contained within each student moving forward. A student may have been stuck in the middle of a project constraint or research method bound rules.

In the class we talked and painted, reflected on carefully chosen readings and took non orchestrated turns telling our stories. Not just a story for the beauty of the story sake—but a story connected to personal discovery or a product or a development. We responded with care and, sometimes elegantly spoken insight, to where each graduate student, guest, or visiting guest guide, was in the arc or a spiral of the behavioral narrative—the beginning and the new, the middle and the sometimes immobilized and stuck, to worries about what's next.

Intergy was observable in outward variables in group interactions. One class session was recorded on video and audio in an attempt to capture group interaction. The participating observer's voice is heard frequently in the recording as evidence of his participation. Examination of the video after the fact showed that, in fact, several outward variables were clearly observable. Among these were dramatic changes in gesture (leaving the table to make a point while standing), indicators of engagement or disengagement (eye contact, reading printed material, etc.), and large shifts in speaking volume. Many observed factors were obviously influenced by the presence of the recording equipment, which is consistent with the "participant" role of the observer. In this particular instance, much of the influence was negative; students tended to become increasingly shy, lowering their speaking volume and avoiding eye contact with the observer. This tendency away from "engaging" the participant observer demonstrated an apparent lack of Intergy in this case.

Artifacts in the form of an object built or a painting painted illustrate another form of outward variable. One approach was to encourage the creation of a shared object in the moment, thereby stimulating Intergy among group members and providing a lasting piece for reflection after the fact.
During a final class experiment for each test class, students took turns using the same water-filled paint brush, sharing palettes previously filled with a myriad of water colors and painted one picture that was prompted by: "…and now let's end the seminar with a silent paint." In this exercise, the students engaged each other in a generative act, so their level of Intergy should be readily apparent.

The hope with this exercise is that the artifact itself (i.e., the painting, see Figure C) would serve as data from which this Intergy level could be discerned afterwards.

Figure C

A second iteration of this exercise was applied in meetings with individuals (who work with groups). The setup was similar, though unexpected. The prompt in this case was: "Paint yourself in the middle of the collaborative work of your company. Be as creative as you like, and be sure to leave a space." The hope was that, though the individuals were painting solo and without the engagement of their group, the space they chose to leave would be indicative of how that individual perceives the contributions of his group members to his own personal story. This method was used when meeting one-on-one with entrepreneurial leaders, as well as in the class setting. One particularly interesting example is an interviewee who chose to leave the "space" directly between his eyes and hair, in effect blanking out large portions of his face. He specifically explained the space as thinking space—indicating his own special brand of collaboration. He leaned back thoughtfully, as he hesitated when he finished the painting, and then he leaned in and signed it (see Figure D). "I thought about it," he said as he explained his reluctant response, "…and was trying to decide if I should sign it or not, because I never sign my work...because it's always about 'our' work, and I don't want to get in the way of the design."

By forcing a generative state, this exercise makes apparent Intergy as it is manifested in a lasting, physical artifact. Just as the chemistry which carries strangers from the first whiff of perfume to the intimate actions of love, Intergy is the transformative medium by which individuals become generative groups.

Figure D

So we see the participants of the class, along with the instructor, balancing leadership and working the collaborative conditions for connection, in the space between the story and the people. Perhaps the most significant and ambiguous findings were the transformative story connections that occurred because of the participants being present in the moment and telling the uncalculated truth. Connections in this context are most like pure art and are about formativeness for the sake of formativeness [24] in an engineering and design world that doesn't always recognize the transformative power or take the time to form true new connections.

Implications for why telling stories make explicit how entrepreneurial leaders create amazing cross-functional team environments will be explored in the on-going compilation of the current work. Limitations exist in the current small sample size and the in-process exploration of a systematized approach to the analysis of a story. Deciphering variables that contribute to when individual story telling is characterized and energized by a group viewpoint that frames the developing narrative and designed artifact will be a next step focus. Is telling design stories the result or the preliminary investigation?

If we bring these ideas together, the success of engineering design work and a balanced leadership intersect because of the connections to a story as the explorative and artful form.
We are painting a picture to tell a story prototype so we may imagine next steps.
By picturing a more extensive story system we make explicit the implicit transformative connections of intergy that set the stage for *Design Entrepreneuring*. Future work has implications for engineering design education in a not quite academia, not quite industry space-- where every creative thinker wakes up early and runs to work --to lead and design ways for sustaining inventive actions.

We face the challenge of analyzing that which is observable but intangible, obvious but often ineffable. Surely collaborative groups of humans are among the most complex systems ever to be studied, and to extract knowable and repeatable results from the infinite subtleties of their interactions is no small task. Ultimately, we should hope to establish Intergy as that "thing" that is neither inspiration, creativity nor communication, but is the foundation for all of them.

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