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ASSOCIATION MAPPING:

SOCIAL NETWORK ANALYSIS WITH HUMANS AND NON-HUMANS

A Dissertation in

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by

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Abstract

It is now more difficult to escape the computer than it is to find one. Through nearly endless numbers of devices, users are now performing tasks within an eco-system of applications. No single company, single developer, or single user can comprehend the entirety of that eco-system outside of their respective boundaries. Software design as well as the manner through which user-testing is performed needs new approaches that allow these disparate devices, applications, users, and tasks to be considered in concurrence. In doing so, hybrid actors consisting of human and non-human objects and their multi-faceted contexts will allow designers and researchers to construct a wider, more society-facing picture of use.

I present Association Mapping (AM), a novel adaptation of Social Network Analysis that intends to map out each moment of association between people and objects. By including non-human actors in the analysis of software use, all of the disparate applications, devices, tasks, and contexts can be made explicit, numerically represented, and tested against or with similar networks. I demonstrate AM by creating Association Maps for 6 games of the board game *Catan (1995)* – a dice-based game of resource distribution and management. *Catan (1995)* was chosen for this pilot study due to its popularity, affordances, and expected behaviors. The maps are separated in 2 ways: 1). modalities: on the tabletop and mediated by an iPad application and 2). By group.

AM is useful to designers by providing measurements of three distinct spaces: Outer Space or the general shape the objects create while associating, Inner space or the power of each object individually, and Inter-space or groups of objects working in tandem. Through design fiction, literature criticism, metaphor, and play, AM is contextualized and described both through this study and in general.

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Acknowledgements

I often get called out because I “lack grounding.” I think this is unfair. In order for the clouds to exist, the ground has to be there too. They rely on one another for balance. What I *should* get accused of is trying to build a hot-air balloon that can float between them. Maybe that means I’m full of hot air but we all spend so much time in the clouds or on the ground that we rarely see their overlap for very long. I am ok with that. My work rarely makes sense to any one person. I am told this is a problem yet I want to connect the ground and the clouds. I am also told that this has an impact on my career given the need to specialize but I know no other way.

I’m grateful to everyone I’ve ever worked with or spoken to as each of them have provided some new insight that fundamentally shifts my research. Stanley Fish’s “Being Interdisciplinary is so Very Hard to Do” (Fish, 1991) has often been a useful star to navigate disciplinary spaces. I think about this quote in particular, “Disciplinary ghettos contain the force of our actions and render them ineffectual on the world's larger stage” (16). What can I do about it? I seek not internal problems but middling gaps. This is where I seek to float.

It isn’t easy, I often fail and crash, my poor hot air balloon’s basket needs to be rebuilt each time. This takes time. Each of you who have taken the time to talk to me have helped me understand what I need to do to rebuild my basket. While I do not make sense to any one person, the wonderful part of seeking to navigate interdisciplinarity is learning to speak more and more languages. Each new language allows for more space to sail in, more interpretations of objects to bridge spaces with, more ways to try and make sense.

I’ll start this paragraph of thanks by thanking the Department of Sociology at Texas State. Tina, Dr. Day, Dr. Price, and Dr. K…I wouldn’t be here without you. To my committee: Andrea, thank you for providing me with a space to navigate toward. To Jack who I have been too star struck to talk to more than I have, your writing and our brief conversations have provided me with endless optimism. To Marcela, our conversation during my visit to Penn State has been a reason to focus my work. To Fred who asked me about the User, your philosophical approaches have inspired me to try harder to represent the humanities. To Kristen, the love of my life, thank you for helping me find the strength to keep trying. Thank you for healing me up when my balloon crashes. Thank you for always having the thread to stitch it back together.

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Finally, much of my development as a grad student began because of two things: 1. Video Games and 2. Twitter. To video games and board games, thanks for helping me understand systems thinking. To Twitter and the rest, well…there are endless thanks to send to endless scholars who make their work and work processes accessible via Twitter. I hope I can be half of what each of you are now. To the friends I've made on social media, thanks for helping me feel like I have a community during my time on this depressingly solitary dissertation island.

To Damon, thank you for being my friend. To Forrest, I don't see a Dragon. To Adam, thank you for being a fart boss. To Brandon, without your friendship I would never have learned about anything besides how to work at a warehouse. To Peyton and James, let's play a game sometime. To Sal and Shea, your friendship was a significant turning point from depression to elation. To everyone I forgot, thank you!

PROLOGUE – ALL THESE GANDALFS

I think a lot about the book *The Hobbit* (1937) and its usefulness as a collection of metaphors. The book centers on a stubborn, not-so-young guy having his life toppled by someone who knew more about the world than he did. Bilbo Baggins is settling into a life in the place he was born like all of the other people in his village. Unbeknownst to him, some immortal academic angel from far off places named Gandalf decides to usurp his life because it would be good for him. This new life would be filled with adventure, danger, mystery, magic, elves, goblins, dragons, and dwarves because Gandalf had an idea that the world would probably need Bilbo for something. For many of us, we want to be Bilbo before he met Gandalf. Adventure is uncomfortable because adventure changes us and in changing us, the world itself changes. This is the center of so many aspects of our lives.

There are endless Gandalfs who seek to destabilize normalcy so that we may correct some far off wrong many of us have never considered. Martin Luther King Jr. wrote about the white moderate who just wants things to stay the way they are (King Jr, 2012). The writers of the declaration of independence, the Magna Carta, and countless other declarations of war, peace, surrender, marriage, divorce, death, and life all center on some act that threatens to disrupt us at our most comfortable. The fear of change and discomfort keeps us from looking out at the world these Gandalfs see.

I do not think about these things because I want to be a Gandalf. I do not seek to create some incredible change in the world. Instead, I think about them because all the disruptions the Gandalfs create inevitably circle back to the same peaceful, yet stagnant space of steady, predictable living. Humans do not change that often, if at all. One of the most poignant moments of my upbringing as a Sociologist was coming upon this quote:

> *"If one compares our culture with that of a hundred years ago, then one may surely say – subject to many individual exceptions – that the things that determine and surround our lives, such as tools, means of transport, the products of science, technology and art, are extremely refined. Yet individual culture, at least in the higher strata, has not progressed at all to the same extent; indeed, it has even frequently declined. This does not need to be shown in detail" (Simmel, 2004).*

I have thought about this quote every day since I read it in 2004. Fourteen years later, I have begun to understand how and why we need to fight against becoming pre-Gandalf Bilbo Baggins. Instead, we need to emulate Gandalf by tricking someone into action and hoping for the best. I set out to write this dissertation as Bilbo while my adviser – Gandalf that she is – hoped for the best. I myself had been tricked into a PhD program with the promise of education, of possibility, and perhaps some treasure. Though, in academia's case treasure is not usually gold but the knowledge we find along the way. As I have gone on my adventure, I saw Dwarves, their quests, and these wise beings all discussing the world. Yet much like Bilbo, each aspect of my journey was bounded by metaphorical and literal boundaries.

The College of Information Sciences and Technology is in its own building with computer science and electrical engineering, separated from foreign ideas and other disciplines by bricks, roads, and endless bureaucracy. As a result, I have never had a chance to speak to a chemist, a sociologist, a physicist or a professor of the digital humanities. In fact, aside from my desire to play board games, I would never have met anyone except people who quibbled over the social life of information. We all exist inside our own holes in the ground like hobbits, seeking only a stable, predictability consisting of countless meetings, second breakfasts, and banquets at conferences. Our currency is created with the consistent churn of the lowest publishable units with as few encounters as possible with danger in the form of reviewer 2. One commonality between the bounded spaces of discipline is a universal overlooking of those other beings that actually keep the space between boundaries cogent and able–non-humans; these are the things that make the Hobbit (1937) relatable, understandable throughout time and between languages. They are created every day and are almost universally forgotten in favor of the creators themselves.

Designed objects like rings, torches, dragons, phones, doors, and information communication technologies tend to serve as boundary maintainers. As boundary maintenance devices, these technologies perform duties that are assigned by other people. They do little other than what humans have been doing themselves. Yet because these technologies maintain memory, what they do ends up shocking us. It is in shocking us that we seek the comfort under the hill. This has consequences as technology is often blamed for creating the problems that technology points out about us. The problems of the world then become the problems of technology. We see this after the Hobbit (1937) in a journey to get rid of a one particular ring in The Lord of the Rings (1963). We hoist our collective problems onto technology while simultaneously robbing technology of its creator. I began to think about my dissertation research from this point of origin.

As a new graduate student, I was shocked at how little humans were considered by designers of socio-technical systems at the iSchool I enrolled in. I was equally shocked by how little the space I came from considered technology. These two acts of ignoring the other point to a space that needs to be adventured in. It is a space filled with invisible objects that are constantly tempered by an equally invisible desire for predictable normalcy, the desire for no Gandalfs.

Technology is consistently easier to use, easier to understand, and more narrowly focused on specific tasks. Technology, much like fashion (Simmel, 1957), has come to identify others as belonging to our space.

But something else is happening as boundaries become more well-defined. They are also becoming more fragile. It would seem that Simmel's quote is starting to break down. Human beings are changing. We are changing because the objects we use, the technologies we create, are themselves becoming integrated with society in a way that has not been accomplished before (Dix, 2016). It is a stupendous occurrence with consequences we cannot yet comprehend. We cannot comprehend that change because while technology is new, we still study technology use with the same techniques that we have used for hundreds of years.

This realization came at the mid-point of the development of this dissertation. I was not going to simply perform a test to show all of these things. I was not going to ask a question and then seek an answer. Instead, I was going to develop some way of thinking about technology, of asking questions of technology, that did not rely on centuries old assumptions about the makeup of society. It was at this point, that I rejected that quote of Simmel. In doing so, I found that I was free to consider use from mico- meso- or macro- levels simultaneously. It was just a matter of finding the right objects to observe and the right way to consider them. This research does this by first considering them through design fiction (Sterling, 2009) and then through their associations (Latour et al., 2012).

On Becoming a User - A Design Fiction

The movie *Tron* came out in 1984 just as the computer was beginning to escape its business-only uses. The movie involved a computer programmer being placed inside "the grid" or the complex social world of programs inside the computer. Inside the grid, the user – Kevin Flynn

– found that his creations were much more than just the lines of code that he wrote. They were beings with thoughts, hopes, and dreams.

As a world that he helped to create, the user was often considered some sort of god. Other humans seeking to control this world also created programs – the Master Control Program (MCP) was created to overcome and ultimately control all software everywhere. The MCP traps Kevin Flynn inside of the computer and it is only with the help of the defensive program Tron, created by a friend, that Flynn was able to escape. Tron endeavored to bring Kevin Flynn to the space where both humans and the programs inside the grid converged. It was here where the user could escape the prison that the MCP created for Kevin Flynn. This was in 1982 and computation was just beginning to spread as the computer itself got smaller. The juxtaposition of more memory to smaller computers is itself a metaphor for the complexity of the sequel to *Tron (1984), Tron Legacy (2010).*

Almost 30 years later, the user's son – Sam Flynn – receives a text message by way of Tron's creator. The text message was from Sam's father who had not been seen in a number of decades. Sam Flynn goes to the place his father maintained and finds there, a copy of the grid that had been running silently since his father's disappearance. He checks the machine that maintains the grid and suddenly finds himself inside of the same grid that his father was trapped in. Sam finds that his father – The User – had been trapped by his own creation. The reason for his entrapment was that in replicating himself as a machine the machine saw no reason for his flawed creator to remain in control.

I began this research thinking about *Tron* (1984) but instead of thinking about individual programs, I thought about everyone interacting in tandem, the network of The Grid in *Tron (1984)* but as the space I lived in. It is a thinly veiled metaphor. I set out to explore what users experience in their everyday contexts through the act of design fiction. Writing a design fiction is a way of exploring the middle ground between where ideas begin and how ideas materialize. Others refer to it as, "a murky middle ground between ideas and their materialization, and between science fact and science fiction" (Bardzell & Bardzell, 2015). The next section is a design fiction from the perspective of one user. It is perhaps more real than fiction as many of the quotations and events come from the transcripts gathered for this study. It is also not future looking but grounded in the present; however, it serves as an anchor for this research. At present, users are simply trapped, trapped like Kevin Flynn inside their creation unable to get out. I use first-person narration as it is the most direct way to connect one user to the scenario.

Design Fiction Part 1: Getting Paid to Play *Catan*

There was an advertisement in the hallway near the bathroom that said that you could play *Catan* for science. In small print below those words were, "Winners of each game will receive a copy of *Catan* and each player will receive $5.00 per game if they finish 2 games."

This was simple. I played *Catan* all the time. So, I grabbed a tearaway paper and walked to class…which was boring as usual. I messaged friends on *Facebook*, played a few games, and worked on homework for other classes. About half-way through class, I went to the address on the tearaway and saw the start of a survey…ugh. Oh well, it should be fast and this professor is so boring.

A month later I got an email. "Hello, I'd like to have you all come and play games of *Catan* in my building. The room we will be playing in is available at the following times. Please go to this link and indicate what times you are available." This was great! Most of the times I was available were during the evening. I replied to the email though. "Hey, I have a couple friends I can bring with me!" The next thing I knew, I was sitting down to play *Catan* with 2 of my friends and a random person I didn't know. We had been texting each other on the way to the room and I had to text the guy running the game because I couldn’t find the room and the map on the first floor didn’t seem to show the room I was looking for. We couldn’t find a map of the building online either.

After some food and a bit about the research being conducted, we sat down and played a game of *Catan* like we did every day in the dorm. Still, the game was fun and talking to everyone as we played was nice as we got to sit down somewhere else and just have some time to enjoy ourselves. Occasionally, we’d remember something we were planning in the future and so I started having conversations via text message with my roommates. We were going to go to a concert later that week. The money from these two games of *Catan* would help pay for that.

I didn’t win the first game…so I didn’t get a new copy of *Catan* but the person we didn’t know didn’t win either so that’s good. With the first game out of the way, I feel like my luck is warming up! For the second game, the researcher tells us that we will be playing *Catan* via an iPad. I had played with this before but on the Xbox. This looked different. I texted a friend to let them know we’d be done in about an hour. The researcher walked us through the game and after we were done, he handed the iPad to the previous winner and asked them to begin.

Avatar Selection

The first thing we had to do was to select a picture to represent us. I didn’t know why we needed a picture but I selected the one that was the most ironic because the winner of the previous game did. I took a picture of my avatar and sent it to my roommate via Facebook Messenger. I’m sure he’ll find it hilarious. For some reason, when I put my name in, it removed the last character. In fact, it removed the last character of each of our names. Made me feel like none of us know how to spell but it’s funny so who cares.

The other players also selected their picture. After the last person selected their picture, the game began. We didn't roll to see who went first. Instead, the game randomly selected a player to place their pieces first. I felt robbed as I did not get a chance to roll for myself. I was the second player though so that's ok. I looked at the screen…this was the new player or basic board setup from the rulebook. We played with this setup all the time!

Set myself up on a space where I could get wood, ore, and sheep and placed my road facing the middle of the map. I gave the iPad to the next player who also placed their piece. I did not get to see the board again until the iPad came back around to me. After looking at the board again, I saw that both of my friends had arranged themselves to block me. This sucked! So, I placed myself on another part of the board. Here, I could get brick, and sheep. This allowed me to cover just about everything except for wheat but maybe I could build near a harbor so I could trade things in. I gave the iPad to the next player and then waited for the iPad to come around again. With nothing else to do, I started looking at *Facebook* until the first turn began. I couldn't see the game begin but I heard the sound of sheep and wheat. Was this how I was supposed to remember what I had? I really wanted to see the iPad again.

Getting Started

The player before me who won the previous game clicked some buttons and the game began. When I had the iPad, I tried to figure out what the buttons all were. I saw a number of buttons on the right-hand side of the screen. From top to bottom, I saw: a red up and green down arrow, a hammer, a number of cards, a white six-sided die with a red arrow, and black button that was empty with a white arrow under it. I tried to figure out what they all did but I couldn't click on them because they weren't clickable during initial placement. I tried to think about what each button meant as I waited for the iPad to come back around. The first button, up and down arrows, probably was what you clicked on to trade with other players. The second button, the hammer, was probably where you could build things. The cards were probably the development cards but who knows about the dice. The first player clicked a button and the game began.

After looking at the screen, the first player said, “Oh, it's my turn. Rolled a ten. Oh, that's handy.”

“Give us all of our resources,” I told her. I was worried that we would forget what we were owed and that she wouldn’t know how to give us what we got.

“Yeah. Okay, so what do I do now?” She was obviously confused and didn’t want to click on any of the buttons.

I was frustrated that I couldn’t see the iPad so I said, “No more or we're going to forget to pick up our resources.” I wanted my resources and I wanted to see what they were but she was holding the iPad close.

She looked at the screen in confusion. She said after a few second, “Oh, here are my resources down here. Oh, I don't like this.” At least this meant that the resources were distributing to us automatically. Still, I told her, “I don't like this, I want to see.” She looked at me but didn’t really register what I said. After clicking a few buttons on the screen, she said, “Okay I'm done now. What do I do? Do I check something? Dice maybe? That one? Yeah, that’s it!” I heard a sound and she handed me the iPad. When I looked, I saw a small screen telling me my turn was up. There was a green checkmark waiting for me to click on it. Ok, I thought to myself, that means that the button with the six-sided die on it was for passing the turn to the next player.

A Few Turns In

It had been a few turns now. We had figured out how trading worked, how resources worked. We had even begun to keep track of our resources on little slips of paper. I showed everyone this completely insane video on *YouTube* of every Billy Mays commercial broadcast simultaneously. I had also shown everyone at the table this really stupid video someone posted on my Facebook wall of people misspelling and not really understanding the word or how to get pregnant. I noted after that video that transcription was probably going to get real weird (*Researchers Note*: *It did*).

Everything seemed to be moving along. I had told my roommate and his friends that we'd come over to the house in about an hour or so. It might be sooner but I wanted to go and grab my phone charger. The researcher had chargers for iPhones but nothing else. I couldn't get anyone to go and grab it for me and I didn't have an iPhone. Everyone I knew but me had an iPhone it seemed. I put my phone down and started talking to these guys about the problems I was having with my major. Everything seemed inflexible and I couldn't get what I thought was a common-sense degree path. I got the iPad and as it got to me, I saw something terrible.

"Oh no." I said, "I rolled a 7." The first player looked at me after a few seconds and said, "Wait. What happened?"

"This is a real," I said, I rolled a 7. Last turn it would have worked out so nicely but now I just want to cry. I don't normally cry, either."

The first player looked at me said, "I cry way too often, but you know that, Red."

"Ah well, at least I get to steal something from someone." I place the robber on one of the first player's territories and click the green check mark. It steals an Ore from her and places it in my resources. First player looks at me and says, "Fuck!"

"Hey," I laughed, I just got rid of half of my cards, so I don't think you have the right to complain."

“That's your own fault.” She says. “You rolled the 7.”

“It is not my fault! You gave me this thing and then I saw 7 and a screen that said, ‘You got robbed.’” I looked at my now empty resources. I was going to build a settlement and a road. Now I could only build a road. Or, should I try and trade for a wheat and a sheep so I could get a Development Card? All of my plans don’t work now. I sat there staring at the screen.

“This music is so peaceful.” I said, pointing at the iPad. The music for the game was some sort of peaceful rendition of a farming type song. The first player looked at me and said, “It kinda gets in my head but I'm trying to figure out how the heck to work that thing.”

“Yeah.” And she was right. I wondered if the music was selected to distract people somehow. Probably it was there to immerse folks in the game. It didn’t make any sense though the sound effects from the resources themselves were nice. Why would anyone make this version of the game? Who couldn’t afford a copy of *Catan* but could afford an iPad? I guess this version would be nice for cramped spaces, car rides, flights, or just travel in general. School or work too. Wherever you couldn’t set up the game.

Reality Creeping in

I began to talk to my friends on *Facebook Messenger* about the video games we used to play. *Kirby Super-Stars*, *Super Smash Brothers*. I talked to my friends at the table about video games but they weren’t that interested in those types of games. Instead, they talked to me about my weird friends always sending awkward pictures to them on *Snapchat*. I don’t know how the guy even got their *Snapchat* names but it’s weird to me that he messages them as I don’t think he’s ever actually met them. Has he? I’d have to ask later since my phone was running out of battery. Oh right, the game. Looking at the screen I felt like I didn’t want to trade anything because the act of trading got pretty cumbersome.

My friends on *Facebook Messenger* were telling me that there was a free concert coming up in the student union for a person who was getting a lot of radio play now. I pulled up her newest single on *YouTube* and said, “Hey guys! This person is playing at the union soon!” I placed the phone on the table and let the song play. At some point, someone handed me an iPad but I didn’t get anything I wanted. I passed it on to the next player by hitting the dice. As the song played, I joked about how this was going to trip up the various copyright algorithms if he stuck the games on *YouTube* to listen to. He just laughed and said it wasn’t a big deal.

The guy we didn’t know began to ask us if he thought that his old student ID would still work now that he was a semester out of school. We began to talk about the way that the concert student ID checkers weren’t that thorough. We told him that it seemed like it would still work because the expiration date of the ID was really small and that they didn’t slide the cards through a reader, but mostly just looked at the pictures to make sure that they were ok. The first player began to tell us about how she used to sneak all of her townie friends in. We all began to make plans about how to get everyone into the show we wanted to get in.

At some point, the third player created a city. We asked her when that happened. “Oh, a few turns ago.” None of us noticed. The first player also had created a city but none of us noticed when she did it either despite it playing a sound to indicate that it had been created. I looked at my place on the map. From what I could tell, there was no way I was going to come back from this. The robber had been placed on one of my resources for nearly the entire game in a tablewide act of vengeance from when I rolled the first robber. Sometimes, *Catan* was not very fun.

Oh, you won?

We had been playing for a while. I couldn’t tell you how long it was but it was a while. I knew I wasn’t going to win again but it didn’t really matter. We had been talking about other stuff. The player we didn't know had been telling us about other board games to play and through that, we started to talk about maybe trying a few of them out. I was just starting to message my group in my programming class when the first player said, "Oh! I won!"

The music changed then. I don't know when I had stopped paying attention to the music but I definitely noticed that it had changed. I looked at the screen and saw streamers, confetti, and other instruments of celebration playing on the screen. I hadn't looked at her score recently but it wasn't that surprising. After she started building cities, it wasn't going to be that far away. The third player was shocked.

"Dang! You build two roads, huh? I thought I had the Longest Road in the bag!"

"Yeah," the first player said, "I traded in some resources and built up a couple roads so I got the Longest Road. I didn't know how many points I had."

"Oh, they're right here next to our avatars," I told her. She laughed because it didn't really matter if she knew how many points she had. She still won. In the end, we cleaned up a little bit and met up with everyone we had made plans with over the course of the two games - $10.00 and 2 copies of *Catan* richer.

Everyday Context

What users can experience in their everyday contexts is represented in the previous design fiction. Design fiction allows designers, researchers, or anyone to explore "a murky middle ground between ideas and their materialization, and between science fact and science fiction" (Bardzell & Bardzell, 2015). The preceding story is perhaps a little more real than fiction as many of the quotations come from the transcripts of play that were gathered for this study. It is also not future looking but grounded in the present. I wanted to outline and describe the reality most users experience as users in the present are trapped much like Kevin Flynn, trapped inside their creation unable to get out.

Another component of the previous fiction outside of the Tron metaphor is that of modalities. In order to perform activities that require multiple modalities – modalities being a specific way that something exists or is experienced – users must rely on multiple applications. In the fiction, the narrator refers to the iPad they are playing *Catan (1995)* on, music, *YouTube*, *Facebook*, *Facebook Messenger*, *Snap Chat*, electric cords, battery power, and other technologies. This increased over the course of the game until the game itself became a background activity that was abruptly ended. The intersectionality of modality is complex but consistent, often blended in concurrency. People move between modalities constantly during distributed activities, or even activities that are co-located like these games of *Catan (1995)*. But many of these modalities are bounded by a technical mediator that was created for a specific task.

The constant shift between technical mediators often segments activities, tasks, or routine conversation is exacerbated by one-off applications (e.g. *YouTube* for videos, *Facebook Messenger* to talk to *Facebook* friends, Calendar applications, etc.). Segmentation itself can often be worked around within tasks but between tasks things get a little more difficult. Over the course of days, weeks, months, years, and across cultures, languages, geographic spaces, and political realities, the slow re-distribution of complexity builds upon itself. The constant segmentation of human activity via one-use applications has begun to create a pressure in the field of design that it will inevitably have to face (Forsyth & Burt, 2008).

The use of design fiction affords an ability to highlight, to explore the complexities of use that are the focal point of the present research. Design fiction is useful because certain aspects of context can be highlighted in order to provide adequate attention to the ways that tasks are segmented into their own spaces. Fiction must also be deployed because we currently lack adequate tools to research people using little more than the ontology that fosters such a segmented space. It is a self-perpetuating problem. A study that has results and can be used to make cohesive evaluative proclamations about any aspect of technology use simply does not exist. Instead, endless jargon, often for the same concept, obfuscates the poly-social nature of reality itself. The act translating each study from this poly-social reality and putting them together into a comprehensive piece is as difficult as each individual study was to perform.

It is through this design fiction that I hoped to highlight the essence of the problem I am seeking to understand. That problem is this, why do we seek to design one product that is self-contained when the user themselves will not use that product inside of a bubble specifically for that product? The rest of this document is not a fictional account of anything. Instead, it is a long-winded attempt to unravel the ontologies, epistemologies, and numeric quantities and qualities that comprise how we study use. The result is a new method of study called Association Mapping or AM. This method is meant not to study the product, but the way those products exist as a grouping of parts that each must perform their intended activity through the help of other objects, and other people. All objects act simultaneously as equals as their associations foster a space of stability that continues until it does not.

CHAPTER 1 – INTRODUCTION

It is now more difficult to escape the computer than it is to find one. Through a nearly endless number of devices, users are now performing tasks within an eco-system of applications. No single company, single developer, or single user can comprehend the entirety of that eco-system outside of their respective boundaries. Software design as well as the manner through which user-testing is performed needs new approaches that allow these disparate devices, applications, users, and tasks to be considered in concurrence. In doing so, hybrid actors consisting of human and non-human objects and their multi-faceted contexts will allow designers and researchers to construct a wider, more society-facing picture of use.

Computer software and computer hardware, even computer languages are designed through the ontology of 1 user (or function) to 1 program (or calculation) on 1 device (or processor) (Dourish, 2004b). When networked or distributed, this paradigm does not change; rather, it becomes many doing the same task one-at-a-time at incredible speeds. I problematize this ontology but the reader should recognize that it has been extremely successful to the point of revolutionizing the world. It is the study of that use that creates the problems. However, as the computer has gotten smaller and been inserted into smaller and smaller objects, it is increasingly difficult to study use through this 1–1–1 approach. To understand the 1-1-1 approach and why it has become problematic, it is necessary to consider the development of the computer.

The computer has been marked by three distinct developments in the past century: faster, cheaper, and smaller. Faster was one of the first drives for computation as mathematicians struggled with theoretical computer science and Gödel’s incompleteness theorem (Gödel &

Feferman, 1986). Cheaper and smaller was also obvious. Throughout the pre-internet days of computation, man-machine integration sought to create a hybrid intelligence (Miller, 1977). This was re-directed as the computer then began to shrink. Human-model processing (Card, 1981) began to mimic human processes as separate computational systems. These different systems segmented human activities into different applications meant to perform a few closed activities resulting in an increasingly complex eco-system for developers to work in. As the concept of human systems proliferated, human knowledge processes were given to the act of computation and those needed to be available, reliable, and at the speed of human society.

These developments shifted from augmenting humans to augmenting humans at scale. The computer is no longer augmenting human consciousness or human processing speed. Instead, the computer has begun to mimic the substance that creates and maintains society itself (Dix, 2016), objects associating with other objects endlessly (Candea, 2010; Latour et al., 2012; Tarde, 2011). Devices and applications are now so integrated with everyday life that the possibilities of computation have become difficult to comprehend with the same aggregate-style tools and methods of research. This is evidenced by the increasingly regular deployment of automated misinformation, purposeful data perversion, and the spreading of alternative truths to users untrained in the possibility of these techniques (Starbird, 2017). It is here that the problematic nature 1–1–1 manifests most directly; however, this is a symptom. The underlying causes are still buried.

The complexity of the substance we call computation is buried under easy-to-use, easy-to-understand, single-use software and studies created by the 1-1-1 ontology. In most cases, these software or applications cannot to communicate with one another but are instead mediated in separate spaces of memory by an operating system. The study of computer use has changed to meet the tenuous relationship between humans and their machine by focusing on each application in its own context or as a context. The discipline of Human-Computer Interaction (HCI) has expanded to include more and more human-centered research spaces as computers have become faster, cheaper and smaller.

As a field that was birthed and developed in tandem with the development of the personal computer, HCI has been uniquely situated to aid the computer's insertion into first the workplace, then the home, and ultimately society itself (Dix, 2016). There are two moments within the history and founding of HCI that form the foundation of this research. First, in the early 1980s a researcher at Xerox PARC watched video footage of people trying to use a new printer (L. A. Suchman, 1987). The researcher noticed that many users approached the machine with nothing but a goal. For each user, learning took place at that moment with the task at hand and no forethought.

Second, in 1987 two researchers proposed that users paradoxically "asymptote at relative mediocrity" (Carroll & Rosson, 1987). They went on to propose that rather than solve the paradox, it was something that needed to be designed around. At that moment, that was the correct decision but from these two pieces of research, it is easier to understand why complexity was re-distributed through single-use applications. Designing products this way solved a simple problem; however, as smart phones have created unthinkable, unknowable use scenarios, HCI has begun to re-approach many of these early issues.

Waiting for the Computer to Reach Out

Most inquiries about computers simply follow the computer around and wait for it to reach out to them (Bardzell & Bardzell, 2015; Grudin, 1990). This type of work places the computer not as an object of study, but as a context in which users are studied when the computer reaches out to the researchers. The computer is an object through which the inputs (what the computer is asked to do by a user) and outputs (what happens to the user once those inputs are performed) are the object of study. Everything in between is not part of the investigation which makes the computer a black box (Winner, 1993) or object unimportant to the study-at-hand. These enterprises have successful; however, these studies increase the complexity of the field and slowly it has become difficult to produce anything but case studies. The black box masks and bounds types of knowledge that have very little connection to the world outside of it. Indeed, no one discipline or perspective would be able to comprehend the black box in its entirety even if it were open (Dourish, 2004b). One could say that the reality of the black box of computation is instead an infinity of smaller boxes.

Each box is an academic discipline or industry professional calling upon computation in differently termed, differently goaled, but ultimately similar ways. Each black box is created around that form of computation yet still focuses only on input and output. Rarely are these groups involved – or even interested – with what occurs between the two. Within those disciplines that deal directly with computational technology (mathematics, physics, computer science, etc.), the problem of what to do with these black boxed inquiries is a constant pressure that only grows in its vociferousness, much like Robinson Crusoe’s island. The sheer amount of programming required for these black boxed products to function also contributes to the difficulty of opening the black box of computation. But that does not mean that there are not attempts to do so.

Approaches like Humanistic HCI (Bardzell & Bardzell, 2015), Actor-Network Theory (Latour, 2005), Object Oriented Ontology (Morton, 2011), Re-modernization (Bauman, 2013), and different deployments of the tenets of play (Bogost, 2016), have begun to envision ways to re-consider computation by not ignoring the black box. Instead, these approaches – some old, some new – open the black box and allow its contents to be seen engaging the poly-social reality of use. In re-considering the computer, its software, its hardware, its users, and even designers themselves, researchers gain new insight into design that is inclusive to users as well as society itself. It is here, within this problem and new solution space, that this research to construct a method that allows new, or at least different, ways to consider design and use of software begins.

The first act of construction is to deconstruct all boxes, assumptions, and a priori concepts; aggregate measures must also be abandoned (Latour et al., 2012). The user, the designer, the software, and the context must become parts again if wholes are to be understood. This research presents a method—Association Mapping—that first disassembles humans and the many objects required to become and stay human. It does this by embracing certain aspects of Social Network Analysis (SNA), Science and Technology Studies (STS), the Humanities – particularly comparative literature – and bundles it with a case study bound together by the Huizinga's concept of play (1944). In doing so, the hope is that instead of designing a single product meant to perform a single task, designers gain insight into the hybridity and agency of computationally-mediated objects in everyday use.

Research Design

I have outlined a world that is in need of new ways to consider the computer in the same space as humanity, other software, the space of use, intangible interpretations of all of those things, and other objects that can be difficult to define outside of those contexts. The tenets of SNA as exemplified by authors and text by Wasserman and Faust (1994), Borgatti et al. (2013), Granovetter (1973), and other Sociologists can help to map out the poly-social (Applin & Fischer, 2012) reality present during any activity. Poly-social reality is what it seems – the many realities present in any one space. In order to use SNA to analyze these spaces, it is necessary to perform a few logical jumps to get to where SNA can be used to map an activity in a poly-social manner.

SNA typically concerns itself with people or representations of groups of people in bounded spaces (Wasserman & Faust, 1994). It has been used to study people in context (Porter et al., 2018), aggregates like corporations (Kropczynski, 2015), bat colonies (J. S. Johnson et al., 2012), and networks of ancient roads (Brughmans, 2013). The underlying ontology is the same. Human activity is the unit of analysis and in the context of objects, aggregate structures are reflected as humans in an aggregate network. Objects themselves; however, are often not represented in social networks because the objects are not capable of being social (Latour, 1992). This act of agency, of doing something because one wills it, is often studied and the belief that objects can act is often studied in attempts to discredit the notion altogether (e.g. (Barrett & Johnson, 2003)).

Yet, the nature of agency is much more complex than simply being human. Objects are constructed by humans to fulfill a purpose that gives tangibility to a particular piece of culture. From its creation, that piece of culture is then maintained by the object itself. It is not that a human can assign agency to other objects; instead, that object comes to represent some way of doing that, until that object was created, was intangible. Automated door closers (J. Johnson, 1988), automatic teller machines, copy machines (L. A. Suchman, 1987), and the Dow Jones stock index all have a purpose that resembles agency.

These are the logical leaps required for this research. In order to better understand technology use, non-human objects – tangible and intangible – need to belong on the same plane of research that humans afford themselves through the concept of agency. The word social in SNA is then not applicable, thus leaving the phrase, “network analysis.” But this is also not descriptive of what will be the focus of this research as network analysis is too non-specific. To aid in naming, perhaps it is possible then to consider how networks form. Each object of the network must form associations with each other object in order for use to occur. Therefore, the term Association Mapping is the best term to give this new method.

I have gathered a collection of associations between two objects – dyads – that are collected in sequence using the time scale afforded to them by the activity I observed. The activity I observed is a board game called *Catan (1995).* I selected this board game for three specific reasons. First, the board game requires a lot of discussion. If I want to observe how objects associate with one another, some of those objects discussing their relationship provides more complex data about the activity. Second, *Catan (1995)* is not only a board game for tabletops but also an application that spans modalities, including many different electronic devices. Finally, I wanted to gather data that could be compared between modalities or ways of playing *Catan (1995).* Through comparison, I seek to display how Association Mapping can be useful for designers seeking to understand how their product impacts the activity they are designing for but also how other applications and hardware segment their application's intended activity and centrality.

To be more specific, I observed 3 groups of players play two games of *Catan (1995).* These games were played with the tabletop game first and the iPad game second. There is something to be said about the order that these games were played in a stricter experimental space, the order would be altered in order to "control" for some effect. However, I am seeking a comparison between games, between modalities, and between groups that have all been doing their activity the same way for a number of years. The tabletop game was never needed for anyone but the researcher who needed data to compare. The crux of this research exists in the way that players organized around the iPad version of *Catan (1995).* By organizing this so-called experiment in the same way across multiple groups, the goal is to see how difference and similarities are exhibited. The method of Association Mapping will be explored in detail in Chapter 6.

Research Questions

At the beginning of this chapter, I provided a design fiction that highlighted the various ways that technologies and humans are disconnected. Humans are forced to segment their attentions among a variety of products. All of this segmentation focuses on affordances of products rather than the poly-social realities of humans who need to perform tasks across many modalities using those products. To guide this research, there are a number of research questions to consider as a focus for the examination of social networks. These questions will help create knowable structures within the data and provide a foundation for eventual interpretation of the data for design uses. Those questions are:

RQ1: How do patterns of network activity change between differing modalities?

This research pulls heavily from the measurement of nodes and edges in Social Network Analysis. For the purposes of this study, centrality is a family of measures that indicate the position of a node in a network. This is a way of mathematically representing an object's contribution to a particular network (Borgatti et al., 2013). Of the many measures of centrality, Association Mapping focuses on degree centrality – the number of associations a particular object has made – eigenvector centrality – a measure that takes the centrality of all objects attached to each object – and closeness centrality – which concerns itself with how close each object is to each other object (Borgatti et al., 2013; Wasserman & Faust, 1994). Cohesion is also a focal point of the present research. In this case, cohesion is just that, how well each object is connected to each other object.

This question covers a vast amount of information that generated during an activity through which collections of associations begin to gather at the start of an activity that is meant to assemble them. During an activity like playing a board game or video game, each player must interact with the game as well as each component, each rule, and each other player in a significant amount of different transactions. Through a creation of a list of ingredients or irreducible elements, it is possible to simply write an endless list of dyadic entities who association, recruit, and act in tandem. This question is the focal point of creating association mapping. However, there is a need to focus the gathering of data. This sub-question focuses data collection efforts:

> *RQ2: What types of associations among humans and non-humans are the most impactful to the network?*

This question focuses on the quantitative representation of each object. The dyads being created are those that are observed – in-person and in-game. Dyads are represented as quantities as well as qualities which allows them to be examined individually and collectively. In this case, sever logs, error logs, and the computational dyads that form during the communication processes of applications, operating systems, and firmware can be ignored. However, this is something that may be explored in other work. Next, in that the *Catan (1995)* application is a designed product replete with the current tenets of User Experience, User-Centered Design, and App-based design, the final question to consider is about what is missing.

> *RQ3: What affordances does physical play provide the user that virtual play does not?*

From these three questions, the space of collection was focused, the collection efforts were stabilized, and the all-important, “what are the missing masses?” allows us to look outside of the data collection context. There was an interest in replication when these questions were created. While no network, task, situation, context or activity will ever be the same, the ability to know how and why certain decisions are made should help others replicate the method, though probably not the study itself. While this has issues for empiricism, those issues are not without reason.

Assumptions, Limitations, and Terms of Importance

Assumptions, biases, limitations, and terms need to be stated as this piece moves forward. The first assumption about any activity is that we can understand how it forms through the word play. This word, often indescribable and assigned to children due to etymological development over time, has a number of meanings that can help understand the space being observed to catalog associations. Next, the limitations of observation, of the researcher, and of the limitations of time and detail are explored. Throughout each of these sections, the terminology and concepts important to this work are outlined in context.

Limitations

Any study that relies on a human-created object or human-object like our eyes and ears is flawed by default (Latour, 1993). This does not need to be discussed in detail. What does need to be discussed is how this specific work is flawed. In the next few chapters, the act of creating a dyadic map of associations that can be used to make sense of the impact of certain design decisions given the existing activity is presented. Through this comparison, it is possible to make suggestions for designers to make their product feel more naturally human. After all, if humans are maintaining a particular state – say, in something like a board game – then anything meant to mimic that must or should reflect the way that that reality was consistently created.

The limitations of such an endeavor are one of needing to be automated. The difference between a tabletop game and a computer-mediated game on the surface is that the computer maintains the game state and does not make mistakes. Whereas in a tabletop game that is sometimes not desired, for research, it is something very much desired. The way that this research is carried out requires painstaking amounts of effort as a researcher goes through an hour of video a dozen times to make sure that a list of some 3-7000 dyads make the most sense to evaluate. A human performing these actions will make mistakes and there are no statistical checks, nor any quality check to make other than to trust the data presented are such that they reflect that researcher's abilities.

The next limitation is that while these data reflect the specific games they were created to represent, that hundred hours or more of work only captures 6, 1-2-hour moments using 1 product. I would argue that the reasons that social network analysis has not been pursued this way is that the incredible amount of work required makes it unattractive to do. That said, the data in the discussion chapter should reflect the potential that such data collection efforts can provide. By providing a computer system with a number of content aware algorithms in a space of observations, it is possible to more accurately capture and reflect the data here.

Additionally, the nascent nature of social network analysis also comes into focus. Many of the products meant to examine graphs and social networks consisting of a number of matrices are still in their infancy. The tests for centrality, for cohesion, and for other types of tests are not complex enough to provide more actionable data. However, with each examination of these data, other types of tests that could be performed manifest. In this way, the inclusion of non-human actors points out not only the ontological issues of social-network analysis, but also the potential it could provide should more development into measures like these occur.

Expected Outcomes

The expectations of any research deploying AM will be the creation of a number of maps of various spaces of time. These maps will display the long chain of associations between objects within the time observed. For example, a number of dyads are formed when a die is rolled. This results in the connection to the numbers placed on top of the terrain of the board game map. This also results in the numbers making a connection to the terrain and also the terrain making a connection to the resources for distribution.

Recording dyads over time is all that the initial stages of this research should require. After the recording of dyads in sequence, over time, the network will be given attributes to examine. For example, some attributes would be if an object is human or non-human; physical or intangible; card or game piece. The result of these attributes will be an ability to explode any number of levels from the space closest to each object up to a high-level abstraction.

The list of dyads can then be used in a number of calculations. This results in a per-object list of importance in a matrix of relations representing the entirety of the edges and nodes of the network. There are three distinct spaces that are important for Association Mapping. The first space of analysis is the outer space or shape of all of the objects that make up a particular space of analysis. The second space is inner space or the cohesiveness of the objects of that space. The final space of analysis inter-space. Some objects are more central to an activity than others so the last expectation is that this centrality will provide insight into both the tabletop and iPad application of this activity.

Summary

Starting in Chapter 2, I discuss the history of the examination of use through the origin of the various pressures to use computation. Through the literature of Human-Computer Interaction (HCI), we can observe the insertion of social science methods into the study of users. That these fail to account for the non-tool nature of artefacts is of special significance. Chapter 2 ends with a discussion of the ways computation has started to disconnect from the computer itself and resemble aspects of society.

Chapter 3 is a great bridge that attempts to span the disparate spaces that form the basis of the framework for this research. It begins with the concept of play as the basis of culture. Next, I discuss the building pressure of constant segmentation by harnessing the metaphor of *Robinson Crusoe (Crusoe, 1719; Defoe et al., 2007)*. Finally, I use the philosophical work of Alfonso Lingis (1994) to discuss the stranger and its relation to technology. Through the humanities and the study of play, the reasons for the creation of Association Mapping should be clear. In unmaking the whole into parts, Association Mapping can allow researchers and designers to unassembled contexts in order to observe their assembly in real time.

After making the whole into parts, Chapter 4 describes data collection, context, and the object of study – a computer game and its physical counterpart. The board game *Catan (1995)* will be used as a reason to watch contexts assemble, persist, and become other contexts. Here, I will account for the focal points or goals, often called Research Questions. Chapter 5 is a description of Association Mapping. It also covers the nature of how the mathematics of social network analysis can be used in association mapping. Chapter 6 is the data analysis chapter. The results of the study will be given in this chapter.

Chapter 7 is the discussion of Association Mapping in the design process. How AM provides concepts for designers to use in situ will first be discussed. Afterward, the chapter focuses on the worth, weaknesses, and future of Association Mapping. In particular, this chapter focuses on the needs of empiricism and how AM inherits some of the descriptive tendencies of Social Network Analysis while also answering many of the criticisms of the existing methods of analysis. In the epilogue, a design fiction is described for a world in which AM is a common method of analysis. By discussing AM as a feature of HCI's methodological toolbox, I hope to outline the impact of consistent deployment.

CHAPTER 2 – HUMAN COMPUTER INTERACTION AND THE PRESSURES OF USE

This chapter situates the space that this research is performed in by describing the ways that computer use has been examined historically. It is necessary to establish how the historical context directed the method of studying computation and use. The study of computer use in context typically falls under the wide umbrella of human-computer interaction (HCI). As an inter-disciplinary field, HCI houses practitioners and theorists from the social, computer, and physical sciences in an attempt to at least get researchers from those fields into the same room together. The result is a field that can use methods from all disciplines to dig into complex, inter-disciplinary spaces. More importantly than the freedom of method is the agility of HCI. Because the computer is still a relatively new entity in society, the field of HCI is malleable and agile. HCI is constantly changing to meet the ways that the computer, and the act of computing itself is changing.

Situating HCI with Computer Programming

HCI is typically contextualized in 3 distinct waves that match the development trajectory of the personal computer and mobile device. However, there are further contexts to these waves. First, when computer and computer programming was new, a fierce discussion around the nature of programming languages as contextualized by “pure mathematics” and “applied mathematics.” Why and who was programming was a source of a gap that would only widen. The second context is a replication of the first but between research and design in the study of computer use in Human-Computer Interaction. This could be expanded and described as the explicit, hyper-detailed aspects of research versus the implicit, indescribable act of design practice. Finally, the size of computers and the availability of their contexts is the last context of research of computer use.

Practical Programming

The establishment of formal syntax and semantics in computer languages (e.g. the Backus-Naur Form (Knuth, 1964)) allowed programming to become an act that could be studied, and possibly improved. With the formalization of syntax, the act of writing a program itself began to formalize. There were two concepts that stood out, the split between the academic exploration of programming and the practical side of producing programs. According to Naur, "the split between the more academic, pure computer science oriented study of programming languages and the world of practical programming will persist indefinitely" (Naur, 1975).

This formalization of semantics in computer languages also lead a drive to formalize the act of programming itself. However, this was aggressively debated along similar lines of practical programming. It was believed that programmers should remain with their programs after they are finished as a program represents a particular way of thinking about a problem. This theory should be continually debated and changed. The notion of formal programming ignored these concepts and the speed through which practical programming developed overwhelmed the connection between a programmer, the theory of the program, and its context. Over time, design teams have grown so large and so porous, that no single designer could understand the theory of the program at hand (Dourish, 2004b).

Research versus Design

Computer programming was routinized and labeled computer science resulting in a structure of production that exists in the present. The constant creation of new programs, new products, and new ways to use a computer resulted in a new frontier. Computer use disconnected from mathematics, became its own field, and moved into every home in America. Again, due to the speed of production, a number of researchers noted that the practice of design and the research of design were separated. There were often attempts to blend these two sides together. For example, the task artifact cycle offered an attempt to do two specific things.

First, the task artefact cycle sought to make explicit, many implicit concepts of design. These implicit assumptions often confounded formalized, scientific approaches to studying design (Carroll & Rosson, 1992). That is to say that many things designers did to actually design their products often went unspoken, unnoticed, and undefined. By explicating those ineffable concepts, it was believed that a gapless bridge could be made between science and practice in HCI. This situated HCI as a space through which science and practice were the same thing. It further united these two by offering that the use of scenario-based design (Rosson & Carroll, 2009), design rationale (Moran & Carroll, 1996), or vivid, highly-detailed essences of what a product is meant to be designed to do and why it should do those things. Each of these theories centered on computer use but to understand *where* that use was being performed, one must consider who is driving the act of using a computer.

Computer-Use Pressures and Their Impacts

Introduction

It is necessary to consider where the push or pressure to use a computer came from. Pressures are what drives development, situates research, and points to future trends. This section is organized in the order of these pressures: Employer > Home Use > Substance. Generally, these pressures can be traced historically in a way to show how computation became more present in everyday life and where it is going. The first pressure is from employers and coincides with HCI's origins in the 1950s with the EMIAC machines (Shackel, 1959). Employers began to ask their employees to use a machine to compute or process equations. Use often took place inside of a room with a large machine made up of many dials and switches. These machines were often fed cards that contained instructions in order to guide the machine to the answer of a calculation. Engineering was the focal point of design which lead to man-machine integration (Miller, 1977) and human-factors engineering (Grudin, 2017). This type of research began to wane as the computer shrank. It was James Martin who first described the future of computation when he noted that,

> *"The computer industry will be forced to become increasingly concerned with the usage of people, rather than with the computer's intestines* (Martin, 1973).*"*

This was the birth of the second pressure of use: personal use over work use. Martin's prophecy became true as employee use of computers began occur at their individual desks rather than inside a special computer room (Grudin, 2017). The new space of interaction created a crisis of sorts for computer software makers. Software designers often did not consider the human factors of design until the software was nearly complete and often unchangeable at all but a surface level (Carroll, 2003). This post-design attempt to make software more usable in users lead to a crisis as the computer began to head into classrooms and the homes of more than just employees in closed environments.

The personal computer boom brought many new contexts for the use of computer-systems. The computer became more accessible leading to more social sciences to be represented in the design and evaluation of use. The concept of the model-human processor dominated the discussion of the possibilities of what computation could do while computer use moved home as the 1970s ended. The result was a multi-disciplinary united effort to break human cognitive processes down in such a way that would support the design of new software. It was believed that the design of software would reflect the way the mind was thought to function. This is sometimes referred to as the golden age of HCI (Carroll, 2003) but as the 1980s ended, HCI began to fracture.

Different social sciences began to consider the use of computation and computers in different ways. Suchman's (1979) famous study of the photocopier at Xerox fostered a sense of use as a conversation. This expanded the research about computer use to communication studies and other social sciences. Use also expanded to multiple agents when the computer gained a network card. New contexts brought new theories like Activity Theory (Nardi, 1996). This also allowed for new methods to be added to the HCI methodological toolkit. The introduction of networked or distributed group work also fostered a new space of research expanding human-computer interaction to Computer-Supported Cooperative Work (Ellis et al., 1991; Poole & DeSanctis, 1990). Work was not only being done in one office, but in multiple offices around the world simultaneously.

HCI grew with the computer but recently, the computer has begun to shrink to the point where it is not always visible. This has led to what might be considered the next pressure of use – computation as substance (Dix, 2016). The computer is now harder to escape than it is to use. Additionally, the nearly endless storage capacity of government data, personal data, and even infrastructure data has resulted in computation making many invisible aspects of society more tangible. A computer crash can cripple stock markets, governments, and entire industries if that crash lasts for longer than a few hours.

HCI in some respects, has fallen slightly behind the creation of new products for many of the same reasons that the social sciences have also declined. When HCI incorporated the social sciences, it embraced the social sciences during the height of their own internal struggles. HCI inherited many of the problems present within social science itself; namely, the inability to consider the computer as anything but a tool (Latour, 2011; Latour et al., 2012). Yet, computation's growing power over society writ large is not something that can continue to be ignored.

Employer-Driven Use

Unlike the social sciences or humanities which have had hundreds, if not thousands of years of development, the technical sciences have had maybe a century of development under the guise of the study of techniques (Schatzberg, 2006). HCI formed as a discipline as employers began to ask their employees to use computers but the computer has a longer history than HCI. The technologies that comprise the focal point of HCI arose throughout the 1900s through operational research (Thomas, 2015) carried out during the World Wars and eventually hobbyists and their work on the foundation of computation joining with office settings. There are three distinct epochs within the employer-driven, engineering dominant first era of HCI: Human-Factors and Cognition.

Human-Factors

The most pressing aspect of the early stages of computer use surrounded cost. The computer was such an investment that it needed to be running more than it was not (Shackel, 1997). Generally, there were two kinds of people who were involved with computer use – highly educated, mid-level employees who wrote the software and what is sometimes referred to as direct users who were low-level employees and were often not paid well. The initial arrangement around the computer were that users were low-level employees who were asked to feed the machine cards or magnetic tape (Grudin, 2017). These users would then wait until the machine had completed its task before starting a new one

Users and programmers began to split with these early machines and as such, the earliest known pieces of HCI work can be found in the 1950s when these machines were at their height. For example, Shackel (1959) wrote about the ergonomic needs for computers by outlining the design of the EMIAC II, one of the earliest mass-produced computers. Shackel discusses first the need to place dials or potentiometers 45 degrees from one another in order to minimize the risk of users moving the wrong dial. The rest of the piece moves through the various components of the machine discussing the various ways that the design of the interface impacted those low-level employees as they input commands based on a software maker's requests. Many aspects of early HCI are exhibited in this article despite the computer remaining a mostly physical experience.

The computer became smaller and many of the early ergonomics-related research pieces began to decline as the manufacture of computers were taken over by a handful of companies. These factors would not reappear again until the smart phone era. By the beginning of the 1980s, the physical design of computers was stabilized resulting in a more focused evaluation of the software that ran on these machines. The need to better understand users required a wider lens and this opened up research possibilities to more social sciences. At the same time, psychological understanding of the human mind began to play a more important role in the design of software at an ontological level. Software makers attempted to use software design to replicate the way that the human mind functioned (John & Kieras, 1996).

<u>Cognition</u>

By the beginning of the 1980s, the computer's physical makeup was stabilized and so the study of the potential of the computer in addition to its place in society was under discussion. The underlying premise of much of this initial research concerned itself with a model of the human mind called, "the model human processor (Card, 1981)." This model, present for much of the early days of HCI, was a driving force in research that reduced the cognition to three processors: perceptual or sensory data, cognitive or working memory, and motor or the response performed.

The backdrop of these three processors was that the computer could be used to support the pursuit of solutions to real problems. It was also hoped that the understanding of the human mind through these models would allow software to replicate the way the human mind worked. This model of the human mind was created to provide engineers a lens through which to create and deploy precise measurements of as many different types of actions humans could perform. It was psychological in its origination but mathematical in its expression. This resulted in a model without nuance. Card noted that there was a need to boil down the psychology of use into something useful for engineers. He noted that, "What is important is the … (simplification of the task and of psychological theory)" (Card, 1981). As a result, there was a drive to boil down and quantify many aspects of human thought and human existence.

This also had an impact on some hardware functions. What Card (1981) was trying to do was to codify all human actions in order to accommodate for individual needs at a purely mechanical level. The position of keys of a keyboard, the refresh rate of a screen in order to accommodate for movement on the screen, and the reading speed needed for text would all allow designers to have a baseline through which to tune their hardware. One way through which these early engineering attempts managed to move a little forward with embracing psychological skill was with cognition. Here, the earliest conceptualization of a non-mechanical skill was that of

GOMS or Goals, Operators, Methods, and Selection Rules (Carroll, 2003; John & Kieras, 1996). This goal-oriented theory suggested that there was a need to create models that went beyond simple stimulus-response-controller models. That researchers also needed to consider the human-machine hybrid in its context (Carroll, 2003).

The human processor model was still very much the dominant paradigm of the time but it was quickly being challenged by more nuanced cognition-based design goals. Computer engineers needed to find a way to move beyond a stimulus-response paradigm of design. The GOMS methods and what came after were an efficient means through which to take much of the early work and use it in a different way. It was here that much of what would become the present means of creating computational products would appear. Through the creation of generic frameworks (e.g. Microsoft Word, Adobe Photoshop, Skype), users can embrace numerous tools through which to accomplish goals.

<u>These Models in the Context of Use</u>

This model set a baseline of mechanical operations for a generic user base. It also offered a glimpse of how engineering would approximate humanity. What these early groups wished to convey was a need to take complex behaviors and boil them down to manageable points of data that could be conveyed easily through human-factors design. Here is the manifestation of what would become the philosophy of computer science – boiled down representations of human behaviors (Dourish, 2004b). This is best represented in the famous quote from Newell and Card, “Hard science, in the form of engineering, drives out soft science, in the form of human factors” (Grudin, 2017; Newell & Card, 1985). Much like that of the early social sciences, the concept of a measurable, objective truth was seen as altogether needed and superior (for a discussion of Truth, see: (Gadamer, 2004)).

This concept of boiling action down was troublesome for numerous reasons. For example, in societal terms, all humans have fingers, eyes, and brains. Those around them socialize them into their societies with all the norms, values, and traditions those societies possess. However, computers were slightly different. Through the basic input of a keyboard, no matter the culture, the use of its keys would not change. No change would be available despite the language present on the keyboard. Factories, computer software, computer hardware, and more have classified (Bowker & Star, 2000) and codified what it means to use a keyboard. Keyboards often do not change mechanically with few exceptions. The fact that the computer keyboard is codified despite the language is a testament to just how powerful these early factors in design were.

There are more mechanically derived concepts present that could be problematic for much of society. Sitting in front of a screen, the way that screen is produced, the means through which those products are manufactured, and more. Much of the engineering of these devices have yet to engage common society or global societies in a meaningful dialogue about how they should be created or distributed. While this is not directly related to the mechanical theories, much of the early mechanical prototypes and various means of production of those products is a result of a search for what would become the desktop computer. To that end, computation has been slowly growing more distributed as the concept of the office leaves society.

Movement from Employer Use to Self

The computer came home as a result of cheaper components and more usable software. This occurred as social scientists began to study the computer but social science observations are difficult to tie into design (James Hollan et al., 2000). As the computer moved from a disconnected, single-user device to a networked device that allows multiple users to engage a single file simultaneously, the need for using those observations of group theories has increased.

These observations are especially prescient when considering that of the distributed workforce that sometimes works within a single physical space (Hutchins & Klausen, 1996). Telecommuting and tele-conferencing combined with collaborative editing of documents have forced many of the concepts computational designers have long pursued to come under intense scrutiny.

The theories of common ground, distributed cognition, and mental model forced engineers to re-think the computer's place in human intellectual behavior. So much of our thinking is done through objects (or tools, to use another term) (Henare et al., 2007), that we often ignore them. In this section, I will first establish a means through which groups of people come together to perform a task. Here, I will describe the notion of common ground as it relates to "being there." Next, I will engage the distribution of cognition in problem solving during a task. How designers use this distribution of cognition is unique in that it represents a rather stark leap much like the jump between the early mechanical pursuits of design leading to framework design. Finally, I will consider the role of mental models in design. Here, the mental models that users have of particular products come to represent a problem space for designers.

Common Ground

Common ground is an attempt to add a more social element to group-based communication and actions. It is based on the linguistic work of Clark (1996), this literature forms a model of human communication based strictly on language as a means through which individuals and groups use that language to gain efficiency in communicating ideas. Clark and Brennan (1991) define Common Ground as the way that different participants of an activity slowly establish a set of word definitions, object references, and behaviors that indicates their belonging to that specific group Monk (2003). Common ground offers a logical basis for communication via language that has a near undetectable basis of fostering efficient sense making. All members of a group achieve understanding through this process and members do not belong to a group until they do. This accounts for the expectations of language, the expectations of decorum, the expectations of vocabulary, and so on.

This theory of computational development seeks to navigate the basic nature of existence: difference. It does this by seeking to unite differences with a series of commonalities all peoples share. The basis of all communication, according to Monk is face-to-face communication. From this face-to-face regularity, the basis of "being there" is created (i.e. "I can see all aspects of the communication you are initiating"). While this theory does not mention the work of Jim Hollan and Stornetta (1992) or any of the other work that engages this concept, it is an attempt to understand how the act of communication functions.

Monk points out eight problems in communication that causes problems for grounding. Co-presence is an issue because if members are not in the same room together, there are issues with seeing the totality of communication. This lack of co-presence causes an issue with visibility. While I may see your face, my visibility is being mediated by a camera and as such, I do not have all of the information. To that end, audibility is also an issue in that a microphone may not pick up all information being sent via the mouth of the current speaker. Contemporality and simultaneity are issues because through communication in computational media, asynchronous communication is possible. Finally, if written communication is preferred, material has gained a degree of durability and can be revised. However, if only speaking this can be problematic given that speech often fades quickly.

Given these constraints, designers must create their products as a means to mitigate some, but not all, constraints for grounding communication. As Hofstadter (2008) points out, a computational system is a closed system. As such, navigating limitations is often forced upon those interacting with a system. While these limitations of a closed system can indeed offer a degree of personality of a product, these limitations are still limiting. For example, Skype offers a video chat service but until recently, groups had to pay for this service. Even if all members of a group are paying for group conferencing, there is a further issue of bandwidth and information transfer speeds that are reliant on the host of a call, not on Skype's servers. This has resulted in numerous issues for groups attempting to establish common ground. One way to approach this is to engage the idea that cognition might be distributed within a group.

Distributed Cognition

In much the same way that common ground tried to embrace the social, sometimes chaotic, nature of human communication, distributed cognition also sees the fundamental flaw in one computer for one user. Distributed cognition is an attempt by theorists to account for the world the user lives in. Here, questions such as who the user is within a group context becomes more important. The birth of the Computer-Supported Cooperative Work (CSCW) resides within this theory. Here, designers attempt to disconnect from the idea of one user at one time and instead moves to the infinitely complex environment of many users attempting to complete tasks.

This theory takes the complex processes of communication and instead of focusing on the problem-solving task many of the group members are attempting to navigate; it instead focuses on the means through which that problem is solved. It still approaches an issue of group-dynamics attempting to solve a problem as a cognitive issue and through these concepts, offer a means of traversing the various states of completion toward a goal.

This particular theory engages group work as a wholly formed system that is singular in nature. As such, this theory most engages the unification of people and technology. However, it does so with some caveats. First, this is an aggregate level analysis. While the aggregate is treated as a whole, it is done so as an opposite to the traditional micro-level analysis of Human-Computer Interaction (Perry, 2003). To that end, some have called for a new science that is meant to understand how the various facets of a system interact with each other given a particular task.

This theory is essentially an attempt to mitigate consistent reductionist perspectives unfortunately succumbs to those same reductionist philosophies present within computer science. For the most part, this theory attempts to comprehend information flow within a system, not necessarily the system as it is being formed. This is unfortunate as the means through which a system is formed around a task is often just as important as the system itself. However, when engaging the conceptualizations of a system, this work provides endless arrays of how systems, through computation, work and are designed.

Mental Models

The design and re-design of technological objects undergoes many different iterations as time continues. What may be a personal video recorder today may be a camera in a few years. While these products change, the very ideas of what those products are, how those products function, and even the skills needed to use those products vary quite often. The term that generally falls into this line of reasoning is mental models.

This term, mental models, is often a source of confusion. It is in use in many different domains but often relates back to various interpretations of its origins in cognitive science. For the most part, this term is split into two definitions. The first definition is that of a content domain. This definition, mostly based on Gentner and Stevens (2014) edited anthology was engaged with how people came to understand something. Engaging how this understanding was reached and how people act on this understanding is of paramount importance for the design of software and hardware.

For example, Norman (1983) noted that mental models are four unique domains. The first domain what the system is that a particular user is attempting to use. Second, users of mental models tend to look at the "conceptual model of that target system." Third, the conceptual model provides a base of expectations that a user's idea of that target system can be compared to. Finally, the researcher's ideas about each of the previous items must be considered in order to close the loop. Here, we see that the relationship between the network a user come's from has an influence on how that individual sill indeed be using that system. This could differ from the scientist who created that system, as they too, will have a different idea of what that system entails.

This first definition then is a means through which the work of Latour (1996) gains a foothold in the legitimacy of a particular theory of design. For Latour, the sociologists and the engineer are doing the same type of work. Where Mental Models allows us to proceed with this evaluation is that this particular theory allows us to engage those thoughts directly. To this end, Latour (1996) states,

> *"Let's say that he's a sociotechnician, and that he relies on a particular form of ingenuity, heterogeneous engineering, which leads him to blend together major social questions concerning the spirit of the age or the century and "properly" technological questions into a single discourse." (33)*

By understanding the concept of mental models, we gain insight into how this "sociotechnician" can operate. However, this does little when given to smaller questions like software. Here is where the second concept of mental models is applied.

The second conceptualization of mental models essentially looks from the other direction. What comes in to play for this second definition of mental models is a method through which to observe users trying to gain a foothold into a particular product. For me, this second application is generally an application of the paradox of the active user (Carroll & Rosson, 1987). This paradox states that users engaging a system rarely achieve a perfect symbiosis with that system. Asymptotic skill gains often leave a problem space in that the perfect realization of a system is never achieved. While this leaves space for future designers to work with, it represents a paradox through which the answer will never be truly obtained. This lack of possible resolution then represents the spaces this research is attempting to engage.

<u>These Models in Context of Use</u>

The distributed theories within HCI take the mechanical models that preceded them and add a means through which the mechanical aspects of a system influence their users. Additionally, these models and theories expand facets of the model human processor. Where these models go awry is that while they expand to include the user as a means through which design occurs, they do so through reductive techniques that birthed much of the technical sciences.

Common Ground seeks to provide a logical framework through which to insert any number of products and any number of people. This reductive theory loses nuance in favor of a routinized means through which to gain common ground. Despite identifying numerous means through which technology will interfere with the generation of common ground, the application of this theory seeks not to replicate face-to-face communication but to work around. While these authors do not mention the concept of “being there” they do work inside the confines of the desire from technologists to simply get over it, to move beyond being there.

Distributed cognition is another means through which designers are seeking to engage the idea of multiple people working on one system. Like air-traffic control systems at airports or a submarine, this model tends to think of people not as a user, but as an essential component of a system. Designers can consider humans through this model. Much like Latour et al. (2012), the designers deploying this model see the whole as a sum of parts and those parts are where the designers can make a difference. However, unlike Latour et al. (2012) who suggest that the whole is smaller than its parts, the proponents of this model believe that this is an aggregate level theory. It falls into the problematic space of designing for a pre-defined whole.

Finally, mental models engage the components of a particular system not so much from their design, but from two particular standpoints. First, the standpoint of the user is considered. In particular, these models conceptualize the skillset needed to learn how to use a system. It does this by evaluating how users think about a product. It also takes into account the space a product exists in but also the standpoint of the designer. This space is created in such a way as to offer a paradoxical, never obtainable place that design will always try to resolve but never actually will.

These three models or theories allow us to unpack a little of the philosophy of computer science. Here, through adaptation of cognitive science, we can see first the products being designed and how their mechanical components engage the extremities of the user (eyes, fingers, arms, etc.). It does this with mechanical precision. Next, we see the various models of what came next. From the mechanical to actually engaging the brains and group dynamics of users. However, in much the same way as designers engaged the mechanical aspects, these models also try to create mathematical approximations of what it means to be human. These particular models have allowed for significant amounts of successful design as these models also signal a shift from task specific design – very common when computers were large enough to take up a building – to generalized frameworks through which users can do things. Next, the variety of theories that take into account more social science specific methodologies will be considered.

From Self to Substance

The underlying premise of computers have not changed significantly for many decades (Dourish, 2004b). Instead, computers have become more powerful. Power, in this case, is the speed through which to run code. Computers now, off the shelf, can radically outperform computers from just five years ago. Still, for the most part, used or not, computers sit on their desk and rarely reach more than 5% of their possible power. In essence, the technology that runs most computers far outpaces even the most powerful of user. This has led to an increase in the mode computers take. By mode, I mean to say that computation is beginning to take shape in different ways besides the desktop or the laptop.

This next group of theories attempts to do two different things. First, Activity theory was an attempt to create a context of use for users. Activity theory was, for the most part, a means through which to move computational development from the mainframe era to the personal computer era. More than that, it was also an attempt to move development from engaging only novice users to developing novice users into expert users. This set of descriptive tools contained under the heading of activity theory has allowed for significant amount of change to occur in software design.

After activity theory comes a general subheading called, “embodied interaction.” This theory of embodied interaction comes two decades after activity theory began to offer the context of computer use. This approach to HCI is radically different than most. It begins by asking HCI practitioners to think about the philosophy of computer science. Once there, it begins to discuss the ramifications of the various ways through which users embraced the computer. He asks about the early work on computers that gave computation a physical presence. The original metaphor for the desktop is often used for this comparison. Essentially, what this theory is discussing is how the computer has ended up where it is now and how the computer, and computation in general, could be different.

Activity Theory

Activity Theory (AT) concerns itself with the analysis of people in action (Clemmensen et al., 2016). There are three aspects to the study of people in action within AT. The first aspect of study are those subjects who are performing the actions in an activity with a definable goal. The second aspect of AT are those objects that both represent and mediate the activity the subjects are engaged in. Finally, the context of the activity is bound by the objective or goal of it. This triangle of concepts forms the basis of AT but within Human-Computer Interaction these concepts have been expanded and in some cases, reconsidered entirely.

Activity Theory has gone through three distinct waves over the history of Human-Computer Interaction with each wave adding more and more vocabulary for researchers to both learn and deploy (Bødker, 2006). In this research, I will be deploying the third generation of Activity Theory. The most important change third-generation AT provides is dispensing with a single activity-system approach. The third-generation approaches activities by stating that they are not bounded spaces and that systems within an activity are not independent. In a sense, activity systems do not exist inside a vacuum and because they do not exist inside of a vacuum, they rely on other activity systems. Each of these activity systems work in concurrence, all mutually creating a shared activity (see: Figure 1). The various inconsistencies and disagreements about the shared activity provide the means through which the overarching activity that collects these activity systems. These disagreements are often called contradictions within activity theory.

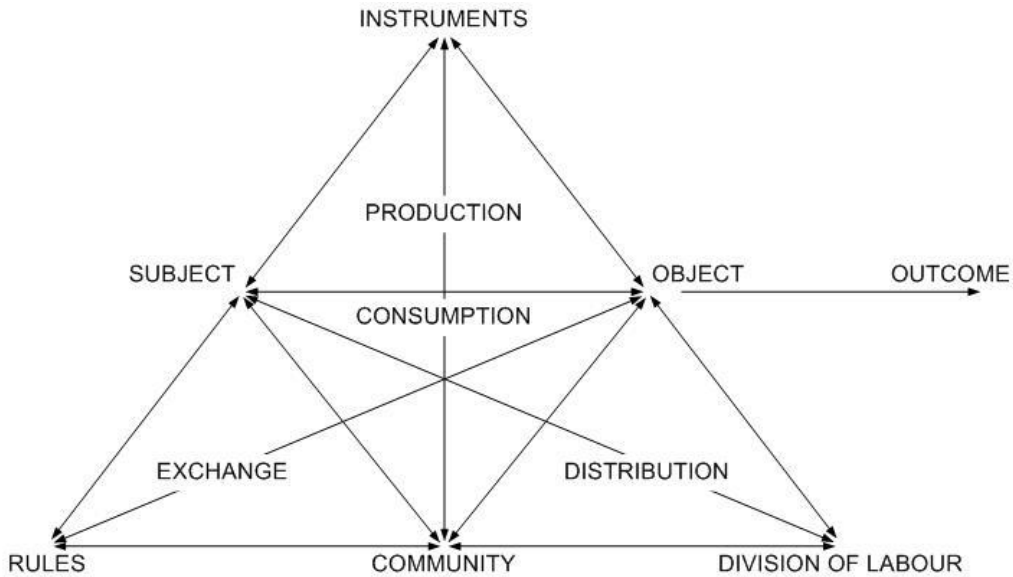

Figure 1 – The components of an activity (Engeström, 1996).

Two illustrations outline how third generation activity theory differs from other types of activity theory. The first is a general outline of how an activity functions as a system. Figure 1 is from Engeström's Expended Activity Theory Model (Engeström, 1996). Where Engeström's version of AT differs from Vygotsky's version is that it expands each of the three aspects of an activity. For example, instead of just subject, object, and objective, there are subjects who together with each other subject, form a community that in turn form rules and divide their labor amongst the community as well as amongst tools created to serve the activity. In expanding activity theory, it begins to manifest as a tool that allows a cohesive picture of users working in situ toward some objective.

When multiple subjects aggregate around an objective, a community is formed (see: Simmel for a discussion of Triads and Dyads and Community (Simmel, 1950). In the case of AT, communities form during an activity and are hierarchically situated. Through this hierarchy, either objectively-derived or previously derived from the context of use, communities divide labor needed to achieve an objective. In dividing the labor, the community will codify norms for that labor, rules needed to help guide the activity toward its objective, and assign the production of tools or objects that embody each of these things. All actions, all aspects of this activity, are all devoted to the inevitable outcome that will represent its completion. Because of the hierarchical, rules-based community within an activity, when contradictions occur that serve to highlight some discrepancy of the rules, development occurs. This development often results in the production of tools, rules, or the division of labor (Clemmensen et al., 2016).

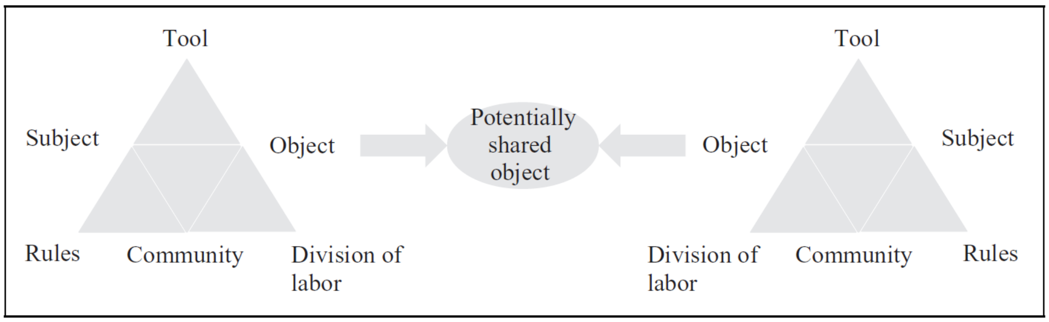

Figure 2 – How Interacting Systems Create a System (Engeström, 2001)

Embodied Interaction

Between the beginning of HCI and the present, a tremendous amount of development has taken place. Computers have gotten incredibly small and incredibly powerful. Along with this development, HCI practitioners have gone from exceedingly complex attempts to create usable systems to beginning to lay the groundwork for creating useful systems. These systems have in the pursuit of usefulness have begun to change.

The development of the computer is marked by a single metaphor – the desktop on a 2-dimensional surface. This 2-dimensional surface has essentially bound the computer to 2-dimensional surfaces, through a computer screen. This computer screen limits designers in what they could possibly do by constricting them to innumerable screen resolutions and screen types.

As such, computation, if a technologist is seeking to expand the realm of computation, is set in developing a unique piece of software or attempting to use hardware in new or different ways.

The theories surrounding embodied interaction are set to exploit these concepts. The work of Paul Dourish (2004) engages this concept as the year 2000 was just beginning. He notes that the computer rarely changes – specifically how it works and how it is used especially. Additionally, computer-use is still just as hard as it has ever been. From here, Dourish dismantles many concepts that exist within computation. The chief of these concepts is that computers were developed primarily by the military. The rigid, formalized language that used to command the processors behind the computer created what we now call the modern computer system. Much of the space that a computer occupies is wasted because of this. The military, as it does in most things, favored power over convenience. The field of HCI has occupied the place where convenience should be.

His goal is to begin to dismantle these concepts, to create new situated spaces for the computer. His term, embodied interaction is, “interaction with computer systems that occupy our world, a world of physical and social reality, and that exploit this fact in how they interact with us” (Dourish, 2004b). Much like the goal of this research, Dourish saw a future wherein the computer was removed from the desk and resituated as a participant in communication. What Dourish seems to want is to re-unify many of the disparate aspects of computation, a piece meal industry with hyper-specialized branches. In its place, he seeks to re-calibrate what is meant by interacting with a computer.

Despite it being nearly completely theoretical, the charges from Dourish sought to re-evaluate what is meant when we discuss interaction with a computer. The primary form of interaction with a computer is through one of two ways. First, users interact with software designed by those who engage a computer in the 2nd way, through procedural rhetoric or the expressive power of code to represent the desired communication from a programmer (Bogost, 2007). Dourish calls this rhetoric symbolic interaction since we have moved from using a computer physically (switching diodes and switches) to symbolically (through computer languages). In fact, he notes that the development of computation as a whole incorporates a range of human skills that is forever growing. This is why he sees the future of computer development as expanding to include skills that are even more human.

These Models in the Context of Use

The incorporation of human skills can be seen through the development of the disparate, often piecemeal development of the personal computer over the course of the past sixty years. These skills and the expansion of skillsets that the computer can harness, represent a means through which to push the envelope of this object. Each new model, each new theory, allows technologists to rigidly encompass some form of human action and codify it into the language the computer can understand.

Activity theory, in this case, allowed for engineers and technologists to observe their systems as they were related to activities. That observation then allowed engineers to move from simple usability to usefulness that is more complex. To that end, embodied interaction took the entire history of development of the computer to task. Dourish seems to have indicated that the philosophies of computer science, the incorporation of human skills, and the uselessness of the powerful processors available today indicated a new need for computers to expand (Dourish, 2004a, 2004b). However, both of these theories still avoid actually engaging computation, as it is needed inside of society itself.

Putting it All Together

This chapter is a list of the various ways that HCI has considered use over time. The list is loosely organized by the source of pressure to use computers but within this list there are myriad exceptions, controversies, and unspoken practices that remain undefined. Carroll and Rosson (1992) provide the best explanation of this issue saying that, "In the world of practice, many things of critical importance are never made explicit." Each of the previously mentioned groups of methods and theories implicitly decide things about their subject, about the products being examined, and how to define the contexts of use. Many of these decisions are not made explicit except through articles that do not center on practice. This maintains the research of technology as two separate entities.

In that same article, Carroll and Rosson (1992) note that they seek to explicate the underlying ontology of HCI by providing a concrete framework through which to build an action-oriented science upon. This is still a work in progress but the pressure to build that action-oriented science is that same pressure mentioned by Dix (2016). In the case of Dix, he notes that the very reason to use technology at all is no longer a personal decision. The implications of that process require new methods and to earnestly approach explicating the underlying ontologies of use. The introduction of Association Mapping is my attempt to render the ineffable aspects of design explicit, but also quantitatively measurable thus expanding the previously mentioned work. The last task left before getting into data and analyses is to make explicit the framework that girds Association Mapping.

CHAPTER 3 – THE GREAT BRIDGE

There are a number of issues within this paper that must be bridged for the work to continue. In Chapter 1, I outlined the goal of this research – to propose a new method to study use. In Chapter 2, I described the history of studying users and computer use noting how each aspect has built upon the previous while incorporating some aspects of other disciplines. It also outlined mediating factors of use, like who was driving the use of computers and where that use was performed. This chapter expands on three concepts: the growing pressure of mimicry, the stranger, and playgrounds. By describing these concepts, I offer that Association Mapping is an attempt to bridge these disparate spaces and provide HCI with a means to reconsider use as a hybrid space.

The Growing Pressure of Translated Mimicry

It is important to repeat the phrase, “black box.” Remember that a black box is a space that analysis or design does not consider in any way other than the input into the box and the output from the box (Latour, 1999; Sturman, 2006; Winner, 1993). In its current iteration, nearly every discipline that uses computers is calling upon that black box with different inputs and outputs. Despite so many different disciplines using computation or the computer, rarely do these groups involved with – or even approach – what occurs between input and output. Within those disciplines that deal directly with computational technology (mathematics, human-computer interaction, computer science, etc.), the problem of what to do with these black boxed inquiries is a constant pressure that only grows in its vociferousness. The complexities of inter-related fields and the growing amount of programming required for products to function have made it increasingly difficult to open the black box of computation.

There are tools that can help us describe the ontology of computation. To comprehend the black box, we must consider the mathematical foundations of computation and how those foundations order and disorder the space. Through Humanistic HCI (Bardzell & Bardzell, 2015), we see the beginning of a more unified, more robust HCI; one that incorporates all manner of tool to help describe the world computation sits in. There are additional tools that have yet to be explored. Humanities-based tools like comparative literature (Bassnett, 1993) can help us to make sense of the space as well as the order. It is a method that concerns itself with cultural expressions across epistemological bounds of culture, of discipline, and of time as well. It does this because the stories we tell often allow us to glimpse some aspect – intentionally or unintentionally – of humanity itself. Authors of fiction, unchained from the premise and baggage that surrounds the scientific pursuit fact and truth, are free to explore as inspiration allows (Dourish & Bell, 2014; Sterling, 2009). The relation and benefit of such a task to an increasingly rational, objective pursuit across all disciplines cannot be understated.

In this circumstance, comparative literature can help to shed light on the place of technology itself. The space between research about technology and production of technology is ideologically rooted through the work of Charles Beard. He who took the work of Thorstein Veblen foundational treatment of technology and linked it to the idea that technological progress represented cultural progress (Schatzberg, 2006). This epistemological move toward the constant ordering and reordering of technical spaces as a stand-in for the place culture resides in on some path toward finality is pervasive, almost invisible.

To open the black box of computation, the current manifestation of technology itself, it is necessary to find some way to make sense of this invisible epistemology. The novel *Robinson Crusoe (Crusoe, 1719; Defoe et al., 2007)* serves as such a method of making sense of the invisible. This novel is often labeled as the birth of realistic fiction and as reality has shifted, *Robinson Crusoe (Crusoe, 1719; Defoe et al., 2007)* has been re-interpreted and re-imagined (Nikoleishvili, 2007). To balance such comparative literature, the novel *Friday, The Other Island (Tournier & Denny, 1974)* offers one such re-interpretation. To start to make sense of where the experimental methodology will occur, let us compare these two pieces of literature.

Robinson Crusoe and Ontologies of Rationality

Robinson Crusoe (Crusoe, 1719; Defoe et al., 2007) is often labeled as the novel that signaled the birth of realistic fiction or fiction that is believable. In this novel, author Daniel Defoe tells the story of Robinson Crusoe and the various events that occur after he is shipwrecked and washes ashore on a deserted island. Alone, Crusoe begins to install the various structures of the civilization he was cut off from on the space before him – the deserted island. When this novel was first released, its realism was so complete that many believed it to be true.

The original full title of the work was scholarly in its approach, *The Life and Strange Surprizing Adventures of Robinson Crusoe, Of York, Mariner: Who lived Eight and Twenty Years, all alone in an un-inhabited Island on the Coast of America, near the Mouth of the Great River of Oroonoque; Having been cast on Shore by Shipwreck, wherein all the Men perished but himself. With An Account how he was at last as strangely deliver'd by Pyrates (1719)*. Because of its realistic approach and representation of the time in detail, the novel is useful as a means through which to see the origin of reason or logic based ordering of things (Latour, 1993). The relationship between technology and humanity resembles that of Robinson Crusoe and his Man Friday. However, to understand this relationship, the books must be described.

In an effort to distance himself from the desires of his parents to pursue a career of practicing law, Crusoe books passage on a ship sailing from York to London after a storm nearly kills Crusoe and his friend. Financially successful, Crusoe goes on another journey but is shipwrecked, captured by slavers, and is brought to Africa where he escapes through the help of a Portuguese ship captain. He then sails with that captain to Brazil wherein Crusoe establishes himself as a plantation owner. Eager for slave labor, Crusoe again books passage on a ship and it is this ship that wrecks near the coast of Venezuela and is lost near the island of Tobago. Shipwrecked and alone, Crusoe names the island the Island of Despair. However, he is strangely fortunate, as on the island are plentiful animals, supplies washed ashore from the wrecked ship, and soil that provides an ample source of nutrients for farming.

For 28 years, Crusoe remains on the island. He imposes his sources of order to it. In colonial fashion, he establishes himself on the island by re-creating the structures of the civilization he is separated from. He cordons off his space with a fence. He establishes a defense of his territory by arming himself. He routinizes the growth of grain by tilling soil and harvesting it when the time is right and dominates local fauna as a livestock farmer would. This system exists until one day he sees a footprint on the beach. This small infraction causes the order Crusoe established to begin to collapse. It is here where the tale of Robinson Crusoe often diverges into two spaces: the original and the critical. In 1967, a French writer named Michel Tournier (1974) offers another version of the novel by offering a new spin on the climax and conclusion - that of Crusoe’s Man Friday.

<u>His Man Friday, or the Freedom of Nothingness</u>

In *Friday, or the Other Island (1974)*, Tournier offers a different interpretation of the events that Robinson and Friday experience (Bertrand, 1995). Friday begins with Crusoe already on board the ship Virginia. He is being told his fortune. As he is told his fortune, the ship is overcome by waves and Crusoe is washed ashore a deserted island. Like *Robinson Crusoe (Crusoe, 1719; Defoe et al., 2007)*, the main character tries to re-establish the civilization he left behind. In Tournier's 1974 version, Crusoe is a little more Puritanical. He reads from the bible each day, stays chaste, and forgoes imbibing alcohol. The differences between the novels begin with the appearance of Crusoe's partner on the island, an Araucanian Crusoe names Friday as that is the day Crusoe believed it was. In the original by Defoe, Crusoe meets and rescues a boy he names Friday. After rescuing him, he teaches Friday English and converts him to Christianity. Crusoe and Friday then leave and head back to England where Crusoe becomes wealthy thanks to the land he had purchased in Brazil. In Tournier's (1974) version, Crusoe accidentally rescues Friday.

Crusoe again teaches him English (albeit, in a much more brutal fashion) and sets out to try to bring Friday into the rational world saying,

> *"I must fit my slave into the system which I have perfected over the years. My success in doing so will be manifest on the day when there is no longer any doubt that Speranza and he have jointly benefited from their meeting." (Tournier & Denny, 1974).*

By dominating the island and installing a system, all outsiders can be placed within it. Unfortunately, the novel *Friday* (1974) is not a novel about the celebration of colonialism. It is a novel about the meeting of standpoints. For Crusoe, historically oriented on a basis of historically manifested logic and order, "Friday never worked in any real sense of the word. Unconcerned with past or future, he lived wholly in the present." Friday was not reachable by the structures of colonialism. Instead, he often serves as an agent of chaos and unpredictability that threaten the entirety of order. This comes to fruition one day after stealing a smoking pipe from Crusoe, Friday wanders into a cave where Crusoe had placed his store of gunpowder and detonates it. Tournier writes,

> *"The explosion had still not quite destroyed the old Robinson: it occurred to him, as he looked at his sleeping companion, that he could very easily kill him - he deserved death a hundred times over! - and then methodically set about the rebuilding of his shattered world. That he did not do so was not only because of his fear of solitude, or his instinctive recoil from such an act of violence. The truth was that the cultivated island had begun to oppress him almost as much as it had Friday. In his heart he had longed for something of this kind to happen. And so, having released him from his earthly bonds, Friday would now show him the way to something else, substituting for an existence he found intolerable a new order which Robinson longed to discover. A new Robinson was sloughing off his old skin, fully prepared to accept the decay of his cultivated island and, at the heels of an unthinking guide, enter upon an unknown road" (Tournier & Denny, 1974).*

The freedom that Crusoe sees in Friday's action is liberation. Crusoe brought to the island his sense of order, his sense of morality, his language, and his agricultural techniques and his sense of importance. This ending is different in both versions. In Tournier's 1974 version, Crusoe chooses to remain on the island while Friday leaves to explore Crusoe's world. In DeFoe's (1974) version, Friday and Crusoe leave together and re-enter rational society as it is obviously the most logical choice. The differences between these two versions allow us to explore the idea that sits at the foundation of this dissertation. Computation, or *Robinson Crusoe* (Crusoe, 1719; Defoe et al., 2007) in this case, has met with Friday – humanity itself – and where the two head next is currently unknown.

The Island of Computation

At the birth of computation, in much the same way as Robinson Crusoe washed up on the island, there was nothing but possibility. In early computation, researchers and engineers set out to make better tools and explore the wreckage and detritus around them. They built new habitats; new ways of doing things based on the memory of the world computation came from. However, the specialized nature of what computation does – mathematically represent human action inside a special space – is much the same as the detached sense of order that Crusoe brings to the island. As Crusoe creates tools, organizes ideas, and orders things as he sees, he begins to create weight. As Crusoe's time on the island continues, that weight needs to be addressed or eventually it will collapse in on itself. *Robinson Crusoe (Crusoe, 1719; Defoe et al., 2007)* solves this issue by allowing Crusoe and Friday to return to civilization. *Friday, The Other Island (1974)* solves this issue by allowing it all to collapse.

The constant creation of new languages and techniques, the separation of applications within their own disconnected spaces, and the increasing number of computational devices have added to that weight. In many circumstances, computation's existence with humanity is at a critical point. If we take Robinson Crusoe and the history of computation to be the same thing, we could say that computation has yet to reach that critical point of divergence. However, over the past two decades, computational design has inched ever closer to that point of divergence – the appearance of Friday. Many of the computational sciences see Friday – the user – as a savage in need of education. If only the user would not simply engage the surface of a product but obtain literacy of computation, then the problem, the paradox of the active (Carroll & Rosson, 1987) user may be assuaged. It remains to be seen if Robinson Crusoe and Friday will return to England or if Friday will detonate Crusoe's habitat entirely.

It may be that dispensing with all of the weight of computation at current may be the only way to understand computation and humanity in tandem. This will help to free the hidden, often unknowable philosophies of the computational sciences. It can do this while simultaneously freeing social science and the humanities from their a priori structures and constructs. This is the usefulness of the *Robinson Crusoe (Crusoe, 1719; Defoe et al., 2007)* metaphor. It helps to visualize the space between Friday or those who are impacted by computation and Robinson

Crusoe, those who create computer mediated tools. In many respects, this metaphor is one of colonialism. The coming of those from enlightened places to those uncivilized groups that have not civilized or enlightened themselves. To aid in this exploration of the space we will conduct our methodological experiment in, it is necessary to call upon more humanities-based work. In this case, the work of philosopher Alphonso Lingus can shed some light on the current space between computational design - or rational society – and the user – or the outsider.

The Appearance of the Stranger and the Problem of Communicating

To deepen the argument about *Robinson Crusoe (Crusoe, 1719; Defoe et al., 2007),* or at least move it from shallow discussions of the power of colonial rationality to something more useful for designers, it is necessary to turn to the act of communication. Through communication, the idea of community emerges. In HCI, this act of community formation is often referred to as common ground (Monk, 2003). Because technology originated in the specialized realm of mathematics and the growth of the technology industries throughout the World Wars, this knowledge was never part of "common society" (Schatzberg, 2006; Thomas, 2015). The design of technology has been a long process of trying to find portions of society that would accept the appearance of a stranger. Communication, as it is known, is often seen as the navigation of miscommunication. For Alphonso Lingis in his *book The Community for Those Have Nothing in Common*, communication is a moment of clarity that must be forcefully created (Lingis, 1994). Lingis writes,

> *"Entering into communication means extracting the message from its background noise and from the noise that is internal to the message. Communication is a struggle against interference and confusion. It is a struggle against the irrelevant and ambiguous signals which must be pushed back into the background and against the cacophony in the signals the interlocutors address to one another the regional accents, mispronunciations, inaudible*

pronunciations, stammerings, coughs, ejaculations, words started and then canceled, and ungrammatical formulations and the cacography in the graphics" (Lingis, 1994).

The formation of the common ground that allows groups of users to work well together has often been pursued mathematically within HCI (Monk, 2003). How fast it appears, the influence of a team being distributed, or even the formation of trust within a team, have all been aspects studied within the realm of community formation and communication. However, each of these take the tool being used to communicate not as participant but as mediator. While logically sound, this is a problematic standpoint. If we are to take Lingis and *Robinson Crusoe (Crusoe, 1719; Defoe et al., 2007)* and *Friday (1974)* to be a guide then logic is not enough. Designers are imposing a set of ways of knowing and doing on their users. The act of group-work, distributed or not, is an island and the designers have just begun to lay the groundwork for their own sense of order based on their basis of community - design itself.

In *The Community for Those Who Have Nothing in Common* (1994), Lingis outlines the appearance of a stranger. We can refer to the stranger as Friday. He notes that rational society – that society through which common ground has been established – has within it at every moment, the potential for the formation of the community for those who have nothing in common. That is, those who have nothing in common are strangers or groups of strangers who interrupt the near unconsciousness of a given task. In these moments, the stranger – or in this case Friday – offer us a chance to re-establish rational society. In every case, society must be maintained and must be constantly repeated, re-evaluated, re-distributed, and re-made.

In many of those moments when that community of strangers appear, it is not unlike the many interpretations of Robinson Crusoe's relationship with his Man Friday. In our default state – as those who live in a colonial society – Robinson wins. There is an establishment or re-establishment of the proper languages, norms, and values of the dominant group. This includes software that is typically founded on linguistically English ideas. However, there are moments with technology wherein the weight of a given society collapses and Robinson Crusoe stays on the island itself while Friday heads back to rational society. These moments create problems for rational society.

If enough Crusoe's maintain their solitary existence – if those who create technology simply stay there, interacting with no one – then technology use only becomes more and more confined to that island. The island itself remains in the background. The sense of order within the space of technology ignores the growing disorder. If other Robinson Crusoes use each other’s source of order as a point of origin, then that weight becomes exacerbated. In design, nearly all software uses some aspect of order from other types of that software. For example, features of Microsoft Word being replicated in Google Documents or Open Office makes their order stricter. The possibility of other types of order become less and less likely to be part of a product. Each of these iterations creates more weight.

At this point, the tale of the island and its new inhabitants has been told so many times in so many ways that it has become nearly impossible to differentiate them. As a default way to consider what designers to do with a particularly deserted space, Robinson Crusoe himself is quickly being trapped on the island and is even more quickly losing meaning. One group considers one way for one user to use one product on one device at a time that can only calculate one thing at a time – regardless of how fast that thing is calculated. While this exploration of comparative literature and philosophy has served its use – the narrative of the stranger and the society as a mimicry of a user and a piece of software representing a society – these metaphors and comparisons quickly break down if they are considered for any amount of time. The point was to create a metaphor that designers could use by creating a space that we could experiment in. To do that, like the Michel Tournier (1974) novel, we must indeed destroy the island in order to feel free again. To do this, we turn to the work of Bruno Latour.

From Stranger to Gradients of Resistance

When Robinson Crusoe witnessed his space of order destroyed, he felt a weight being taken from him. All of these things, these sources of order he had created suddenly disappeared. Without their constant pressure in his life, Crusoe was now able to see things from outside of the perspective all of those structures forced to appear. It was there that he began to the see the world as Friday did - without order. Every moment was not a possible source of disorder or the appearance of a community for those who had nothing in common. Instead, Friday's world was simply structureless. Within the definition of space, we could say that there were no more containers within it. Nothing was bottled, nothing was shelved, and nothing was constructed to hold a group of objects in a particular fashion.

This perspective – of loss as freedom – is useful to use as a way to think about design. Any design is an assemblage; groups of people assemble groups of objects around a common purpose that itself is an assemblage. In this sense, groups of objects are being assembled purposefully by a certain team of people who possess a need for those objects. Without that need for possession, that assemblage would not be created. However, none of the objects that were needed to construct that assemblage could be anything less than what they are. In many ways, the weight of ordering things and the history of the way those things have been ordered is another stand-in for Crusoe. To that end, our methodological experimentation is just that, simply accepting things as they appear. To come full circle, approaching the space of computation with no preformed ideas or a priori structures might allow us to become more competent at examining computation as a whole. Even the computer itself loses its structure. Latour offers the following description of Friday:

> *“we should not decide a-priori what the state of forces will be beforehand or what will count as a force. If the word "force" appears too mechanical or too bellicose, then we can talk of weakness. It is because we ignore what will resist and what will not resist that we have to touch and crumble, grope, caress, and bend, without knowing when what we touch will yield, strengthen, weaken, or uncoil like a spring. But since we all play with different fields of force and weakness, we do not know the state of force, and this ignorance may be the only thing we have in common” (Latour, 1993)*

The loss of the structures that Crusoe forced upon the island are an opportunity. Without pre-formed structures, everything must be remade. Without pre-formed structures, common ground as well as the community for those who have nothing in common can be dispensed with entirely. It can be dispensed with because through allowing it to form on its own we can observe each moment some object is called upon and how those objects test, or interact. Instead of pre-determining strength based on the “rightness” of an idea, strength can be observed as it is formed. Thus, differing types of force, of strengths, of weaknesses will be shown to us in real time in relation to the situation being observed. We will not be looking for anything other than what our participants show us. Latour calls this his principle of irreducibility.

The principle of irreducibility is simple in its form, “Nothing is, by itself, reducible or irreducible to anything.” This means that all things that exist and are called upon by actors are real insomuch that they provide resistance or go through trials. Because of these trials, everything can be used to measure something else. If we are reducing by seeking the foundation of an idea or the origin of a structure, we are reducing the number of actors from multitudes to a single actor. In the case of software design, these actors are typically seen as two - user and device. Each of these actors are reduced so heavily as to practically negate their existence. This tends to offer generalizable results that are not insomuch correct, but offer crude summations that might work for others.

Since the principle of irreducibility is concerned with trials, it calls those things that resist trials (as in, succeed or fail) real or reality. Because nothing is reducible or irreducible, there is not one reality, but a summation of trials. Latour calls these the "gradients of resistance." This approximation of strength or weakness puts all objects at odds with one another. Within a use scenario, a designer offering a blinking cursor as an indicator of location on a page is only called upon when it suddenly appears within a scenario. Its resistance indicates that the cursor's trial has been realized and is thus real (Latour, 1993).

The shape of a scenario like that of use of a product tends to be radically differential in its form. It is constantly reforming as forces are created through trials, allies and resistors form around that object, and it continues going through trials. Over the course of those scenarios, that object could resemble a multitude of things. What that shape is, what it consists of, what it is in relation to other shapes, and the aggressiveness those shapes might have toward others is always in flux. In fact, because nothing is reducible or irreducible, there are no actants, no shapes, no forces that cannot enlist or become allied with others (Latour, 1992, 1993).

Within a use scenario, if we go back to *Robinson Crusoe (Crusoe, 1719; Defoe et al., 2007)* and his island, we can make more sense of it. Crusoe formed the world he came from on the island itself. The various ways of knowing about food, shelter, time, and animals were all objects that managed to manifest and maintain shape because Crusoe himself willed them to stay that way. However, over the course of his stay on the island, the island itself often allied itself with those objects in a way that made Crusoe weaker. Storms that washed away his efforts, people from nearby islands coming to sacrifice on Crusoe's island, or the appearance of Friday all alter the shape of the reality. It should be noted that the island itself would not exist if no one were there; no object is reducible nor irreducible, through these principles, it simply would not matter.

Within *Robinson Crusoe (Crusoe, 1719; Defoe et al., 2007)*, we see Crusoe associate with the island on the island's terms. This is another facet of the principles of irreducibility, "An actant can gain strength only by associating with others" (Latour, 1993). This is an important aspect of this principle as any given observation will witness shapes being formed and unformed by various alliances, resistances, and associations. As such, no shape is fully permanent as everything within an alliance is always at stake. These forces are not symmetrical either. In *Robinson Crusoe (Crusoe, 1719; Defoe et al., 2007)*, when he leaves the island, he allies himself with a boat captain who is allied with a durable vessel that can make the voyage back to England. In this scenario, it is not possible to call upon structures. Crusoe did not rely on the ocean to deliver him a vessel. However, it is also not truly possible to say that it did not do this. The ocean did deliver Crusoe a vessel that could take him home. How or why it came there is not knowable until it is. In this way, there exists no true order aside from the order others create.

This order then creates other orders. Because no shape remains constant, even if there are knowable and unknowable structures, there exists no equivalence, only translation. Interestingly, in every circumstance, the creation of a boundary, a new space as it were, resulted in confronting, dominating, or forcing that space to do what its new residents wanted based on the space they had inhabited. Crusoe and the community for those who have nothing in common had this in common. All of these aspects of the principle of irreducibility are based on the idea of limitations and within the creation of a bounded space through which objects will be ordered, those limitations are perhaps more important than the assemblage itself. To finish opening the black box so that we may experiment within it, we must consider two terms – play and fun.

On Play, Playgrounds, and the Pressure of Systems

The etymology of the word play is increasingly important at present. Modern usage, much like the term space begins within the Grimm's German Dictionary (Grimm et al., 1878;

Huizinga, 1944). Here, the dictionary entry is simply, "a lively rhythmical movement" which is derived from the work of Plato who believed that the origin of play is in the "need of all young creatures, animal and human, to leap" (Huizinga, 1944). It is the word young that often sits at the foundation of this term for play is typically considered immature, juvenile, and wasteful. Yet, within this term are myriad connotations that often appear elsewhere in culture yet remain separated from the word play. For example, Donald Trump's securing the Presidency lead many to believe that Trump would come to, "play the part" of the president yet continual indications of non-play have met with frenetic criticism. Within law and religion are bounded spaces through which one performs ritualistic behaviors - this too is a form of play. Indeed, this term sits shrouded behind the immaturity of youth but looking beyond that shroud one sees that this term perhaps sits at the foundation of nearly every aspect of culture itself (Bogost, 2016).

Play and culture then, are intertwined. But how much and is it something we can use to free ourselves from the black boxes, the Robinson Crusoe's, or the Islands that we currently use for computational development? The easiest answer for this question comes from Huizinga who notes,

> *"Civilization is, in its earliest phases, played. It does not come from play like a baby detaching itself from the womb: it arises in and as play, and never leaves it" (Huizinga, 1944).*

Play is much like that of water to a fish – it is an omnipresent, invisible totality without which we could not survive (Wallace, 2009). With this is mind, what is a better definition to use? Huizinga also provides us with a definition. He notes that play is a freestanding activity that takes place outside ordinary life that is entirely immersive yet is pursued without material gains in mind. It is an activity that contains its own sense of rules and time but promotes its own sense of order and social group formation (Huizinga, 1944). However, this definition is obtuse and difficult to access because if play is like water to a fish, then even ordinary life is play and it does us little good to use this term when we seek to unravel assumptions.

Since Huizinga wrote his book, many different authors have attempted to define play in similar ways but with differing amounts of detail (see: (Caillois & Barash, 1961; Salen & Zimmerman, 2004). In each case, the term begins with the act of separation. This is not satisfactory for as the quote indicates above, we never actually leave play. We do not leave reality. However, there are moments wherein play is somehow differentiated from normal life – that is, there are bounded spaces within play that we do something else, something with a unique space. Philosopher Ian Bogost connects these two realms by noting that,

> *"Play is the act of manipulating something that doesn't dictate all of its capacities in advance, but that limits its capacities through focus and exclusion…Play is everywhere, in anything we can operate…It is not an act of diversion, but a name for the feeling of making something work, of the results produced from interacting with its materials" (Bogost, 2016).*

This definition allows us to remain in ordinary life but to engage the various objects – human or otherwise – that limit us. Bogost uses a definition of play that sits at the foundation of all definitions of play. He adds "Play is a way of operating a constrained system in a gratifying way" (Bogost, 2016). Purposeless, its own sense of time, its own sense of order, and inside of a space delineated for play itself is what we typically refer to as the definition of play. Through Bogost's definition though, we see play take back much of what it has lost from the oft ignored aspects of Huizinga's work. Play is everything - from Astyanax to Yard Work; from errands to Twilight Imperium (Peterson, 1997); from making coffee to parenting. The term gratification in that quote is especially interesting as the terms play and fun are typically associated rather than gratification.

Like play, like space, the problem with fun is that we all think we know what it is yet the word itself lacks true definition. In truth, fun has no definable, no operational meaning as first appeared in the English language attached to the idea of the fool. Court jesters and fools were often afforded a unique position - their job was to see things differently than others. If we take this origin more generally, fun would be separating from real life in some sort of meaningful way that provides prospective. Bogost adds that fun, “is not so much a feeling but exhaust produced when an operator can treat something with dignity” (Bogost, 2016). Here, the fool is called upon, an often ignored position in today’s societies, as dignity, much like the term “authentic” in relation to Heidegger’s Das Man (Boedeker, 2001). Fun is essentially treating something as it is. In this way, the fool, the jester, or Hamlet or Falstaff if one were to take literary figures, often possess a wisdom outside of context the clues us in on the way things simply are.

What Play Affords the Researcher

Within the humanities as well as within academia as a whole is an enormous amount of repetition as different perspectives wrestle with different interpretations of similar ideas. The definitions of play, space, and fun can be seen being explored in several different bodies of work under different names, disciplines, and times. The philosophies of Heidegger (Heidegger et al., 2010) and McLuhan (McLuhan et al., 1994) are the most comparable. Ready-at-hand and present-at-hand call into being tools, concepts that have meaning in use and in possibility. Both exemplify limitation and both are beholden to the authenticity they invoke (Heidegger et al., 2010). McLuhan also calls these concepts into being though for him the terms figure or foreground and ground or background (Bogost, 2016; Logan, 2011). Within media, those things that are figures - news programs, novels, or video games for example - often remain in the foreground. They obfuscate the background, those things we do not pay attention to. Yet it is the background, much like an object’s potential, that provides the limitations that all creators and users explore.

For Huizinga (1944), this ground, this potential was the creation of the magic circle or the bounded space where play occurs. Bogost takes this magic circle a step further by considering the act that takes part inside of that circle. He then corrects the problems with the term (namely, the term itself) by referring to the creation of a bounded space as a playground. In this capacity, a playground is a space where play occurs; however, this term invokes the possibility space of childhood and the infinite ways to engage the equipment any playground contains (Bogost, 2016; Huizinga, 1944).

As playgrounds can form anywhere, it is important to consider just how ubiquitous they are. For example, one day a father was at the mall with his young child and in a hurry. It was holiday season and the mall was extremely crowded so the father was in particularly foul mood. His child was being dragged through the mall at a speed that her tiny legs could barely handle. To compensate, she began to skip and as she did, began to tug on her father's hand. The father notices the tugs and looks back to find out why his daughter was tugging on her hand. He sees that she had begun to skip and avoid cracks on the ground. She had turned the misery of the space she was in into a playground (Bogost, 2016). To use the terms in the previous paragraph, the child had taken the ready-at-hand status of the mall flooring and turned it present-at-hand or into a playground wherein she began to explore the space she was confined to by accepting it for what it was. This exploration consisted of limiting herself further. In doing so, she escaped the reality of the situation by accepting it totally.

At this point, Robinson Crusoe arrives on the island after being shipwrecked. He wakes up and refuses to accept what he sees. In general, as humans we accept very little about our lives when it comes to the systems and limits that surround us. In fact, we do as much as we can to distance or reject many aspects of our lives that we find tedious or require navigating oppressive limits. Like Crusoe, we do not accept that we are washed up on an island. Instead, we find ways to distance ourselves from our limitations and mundane spaces by imposing a sense of order on them. This distancing effect is some sort of irony - the currency of our age (Bogost, 2016). Crusoe distanced himself from his situation by replicating aspects of the civilization he left behind. We distance ourselves from nuisance, from mundanity. However, we are surrounded by so many limitations, so much nuisance, that we can no longer see the wonder of what those limits represent. We disdain these omnipresent rules, limits, and common ordinary events that they have become, as water is to a fish - necessary for life yet invisible due to its necessity for everyday life.

Within software creation, this distancing effect is an essential aspect of design – what parts of an act that is being replicated programmatically are not needed inside software? In addition to those reductions, the act of who a user is: in terms of groups, epistemologies, cultures, or other details that could be called mundane or also unneeded. We seek in software creation, a rather limited gratification - to make the computer do something we want in the way that we want that others can figure out without much effort. For the user, those limitations become learning what the designer wanted to make or force me to do as well as what aspects of the act I am now doing inside a computational environment were not important. Mary Beth Rosson and Jack Carroll illustrate the meeting of these two types of gratification or fun seeking. They note that no matter what a designer does, users will never do anything more than deploy a system at a merely satisfactory level (Carroll & Rosson, 1987). It is here that the Frankenstein (Finn et al., 2017) consisting of fun, space, and play can be fully assembled in order to help us understand the secrets of design and use itself. While paradoxical, this intersection is best described in terms of the distancing effects often considered through the formation of irony through play.

When users engage a piece of software, that software has the potential to do what the user wants. Because users have existed inside of a single use, single philosophy system of software for this long, they have an aversion to complex or tedious systems. As such, the shallow description of the user will always demand that the use of that software be gratifying. Users simply seek a satisfaction that resembles fun. They seek a sort of acknowledgement that they possess the wisdom to use that system. However, because most software begins with the idea that a user will never be able to engage a system fully, the user is often left with a system whose limitations do not allow for satisfaction. As such, even if a task is fun and even if a tool is fun in its potentiality, it is not sufficient to use.

Like the pervasive irony in today's current society, software use continues not because it is well designed but because we must use the tools that exist. Both users and designers have simply accepted a paradigm of, "good enough." Yet within those two words is a vast gulf of ironic dismissal. To make software more useful for users and to make users more available to designers, we must rethink, reconsider, the act of studying design. Through *Robinson Cruose, Friday, or the Other Island,* the terms space, play, and fun, and finally through the concept of irreducibility, we arrive now at a space without structure and a space where no aspect of design, no aspect of communication, and nothing exists unless it is called upon.

To put the lesson of this chapter into a phrase, we can say that societally determined use requires societally determined methodologies. If use is no longer something that is optional or a choice, then the integration of computationally-mediated products has achieved the ubiquity that has been long looked for and long sought. The invisibility of the various components of technology no longer provide adequate subject to study independent of the context users exist in, not use exists in. There are two steps left before performing association mapping. The first is to discuss the data that was gathered. The second is to perform a "traditional" data analysis.

CHAPTER 4 – DATA COLLECTION AND CONTEXT

Introduction

This chapter describes what data was collected, how that data was collected and what the parameters of those collections are. Generally, this is a qualitatively focused dissertation that is using a group-based activity to make sense of how user behaviors change when given an electronic version of a tabletop game. User behaviors will change, not so much because electronic media have some sort of impact on behaviors themselves, but that new actors to an established social network already have an impact on the formation of new networks.

Instead of physical pieces, there are buttons to press, procedures users must follow. Instead of keeping score on paper or in each players' head, there is a computer to keep track of the score, and consistently without error. Instead of remembering all of the possibilities, it is possible to write a program that suggests moves and takes steps to automate certain behaviors that would be needed in a game filled with tangible pieces. As such, it is necessary to gather data that consists of a before and after a certain treatment. In this case, the "treatment" is simply asking users to play a tabletop game via an iPad.

In the case of this research, data collection consists of several obvious needs. First, spoken language must be captured. As such, permissions to record the audio of a room is necessary. Second, because this is a game with tangible pieces, additional steps must be taken to capture the video of the room. Because the audio is being recorded, the players themselves can be captured without their faces or identifying aspects outside of their arms and voices. Finally, on the iPad it is necessary to record the screen itself. This can be done in a variety of ways.

The game that was used as the focal point of this research is called *Catan (1995)* or *Settlers of Catan (1995).* This game was chosen for three specific reasons. First, *Catan (1995)* has become one of the most popular games in the world. As a source of pop culture, *Catan (1995)* has been a source of inspiration for many board games; pop culture references in movies, television, and books; and is useful as a tool of evaluation due to its manner of interactivity. Second, because the game requires discussion (as will be outlined in the next section), this game offers a significant amount of discussion that occurs between players via systems. As such, it is a natural "Think Aloud" exercise. Finally, *Catan's (1995)* translation as an iPad, Xbox, PS4, and web-based video game have allowed it to remain popular and accessible to everyone, everywhere. As such, its popularity, required discussion, and myriad electronic versions make it a perfect vehicle to evaluate methods for research in Human-Computer Interaction.

What is *Catan*?

The activity being evaluated in this research is a board game called *Catan (1995)* – a game about settling an uninhabited island. The game itself has had a tremendous influence over the current state of board games (Eskin, 2010) and was chosen for this study because of its popularity, its procedurally-based discussion, and its availability in physical and digital forms. In 1995, dental technician Klaus Teuber released a tabletop board game called *Settlers of Catan (1995)* in Germany. This game was unlike anything that had preceded it for three reasons. First, the game's production quality was higher than most games of the time. Plastic generic pawns were replaced with wood and foldable boards were replaced with high-quality, custom cardboard pieces.

Second, the game removed tracks like those seen in many older American board games like *Sorry! (1929), Trouble! (1965), Trivial Pursuit (1979),* or *Monopoly (1935)*. Instead, the island of *Catan (1995)* was represented by a series of hexagonal tiles that themselves represented certain types of land (plains, mountains, wheat fields, etc.). Settlers (in this case, the players) have begun to colonize the island. The act of colonization, much like that of Crusoe, is to bring order to the island. To do this, 2-4 players use dice, cardboard, cards, and wood to represent the various types of land, structures, and actors on the modular board made up of independent hexagons. Finally, players did not compete directly with one another but were instead reliant on each other as trading partners. More than auctioning off properties in *Monopoly (1935), Catan (1995)* forces players to work together, competitively.

To be more specific, players assume the role of a group of settlers attempting to settle an island. The settlers are represented by a series of wooden pieces that look like settlements, cities, and roads. The island is represented by hexagonal pieces. These pieces represent a variety of types of land that will provide essential components to construct roads, settlements, and cities. These land types include:

- Mountains - these provide ore but are often called stone
- Pastures - these provide wool but are often just called sheep
- Fields - these provide grain but are often called wheat
- Forests - these provide lumber but are often called wood
- Hills - these provide bricks but are often called clay

A sixth landmass also exists on the island of *Catan (1995)*. However, this land type does not produce resources. Instead, this is where the robber lives. This robber, indigenous or simply an opportunistic resident of one of the players' settlements, steals from the players under certain conditions. In addition to stealing of their own accord, the robber can be called upon to steal from other players through certain criteria like the use of cards.

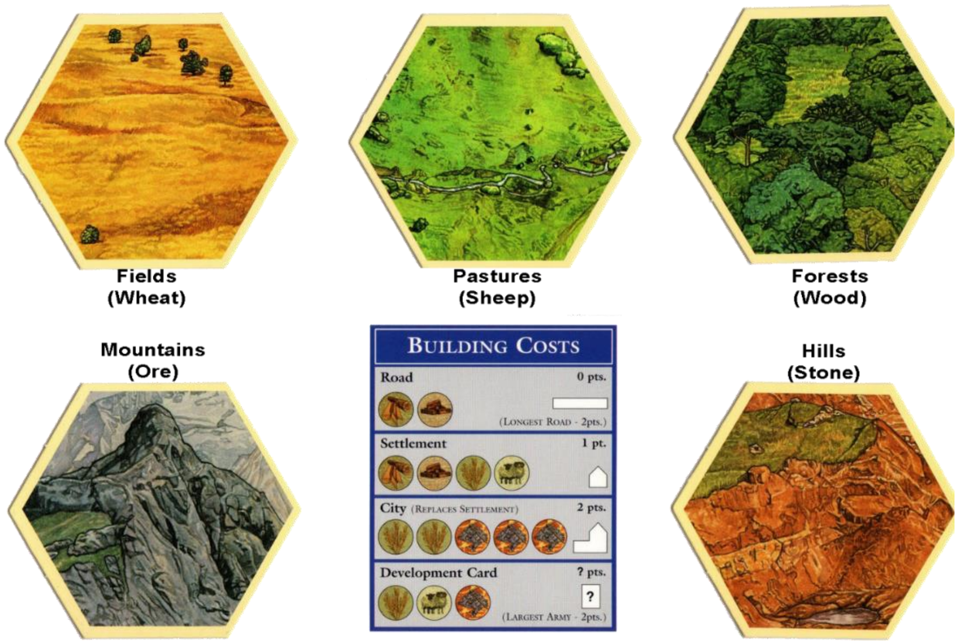

Figure 3 – Land types and their unofficial names

The fictional island of *Catan (1995)* is created with 19 hexagons of carrying land types (See: Figure 3). They are placed in a circular pattern that is five hexagons wide at its widest points. Surrounding the hexagons are long pieces of blue cardboard that serves as both a reminder that *Catan (1995)* is an island but also makes the randomized placement of hexagons to remain stationary. Each of these long water pieces contain a harbor that provide trading opportunities at variable rates. One the board is set and the oceans lock the hexagons in place, small discs are placed on top of the hexagons. On each of these small discs is a number between 2 and 12 and on each of the discs besides the number is a small representation of the probability of that number being rolled on 2, 6-sided dice. For all intents and purposes, these dice metaphorically represent the passage of time and literally represent the probability of resource production by the settlements and cities nearby. The likelihood that one player can obtain all resources without help is very low.

Figure 4 – a Standard *Catan* Map

Each round, each player will roll the two dice in player order. Order is determined before the game begins by whatever criteria the players decide or in the case of the computer-mediated apps, randomly. Once the dice are rolled, the result is compared to the board. Each land that has that number on top of it will produce resources. If a player has a settlement or city touching that hexagon, that player receives one card representing that hexagon's resource type. On a roll of a 7, the player will hire the robber and/or be stolen from should they possess a significant number of resources. Once the resources are distributed, that player may:

- Trade by interacting with other players or using a harbor to trade for resources;
- Build settlements or roads;
- Upgrade settlements to cities;
- Buy a development card;
- Or play a single development card that was not obtained that turn.

Development cards represent additional things done within a city. These are represented by cards that players can purchase by spending (giving to the bank from your pile of resources) 1 wool card, 1 grain card and 1 ore card. These cards typically provide three different kinds of benefits. The first are soldiers who flush out the robber. The soldier flushes the robber out of hiding and the player who played the soldier (also called knights) can send the robber where they please. The second kind of development card typically awards more resources or more roads. The third kind of resource is victory points.

Victory points represent the success of a player's settlements on the island. Play continues until one player achieves 10 victory points. Victory points are achieved in the following manner:

- Building 1 Settlement = 1 Victory Point;
- Upgrading a Settlement to a City = 2 Victory Points;
- Gaining the Longest Road (5 or more roads linked together) = 2 Victory Points;
- Hiring the Largest Army (3 or more soldiers) = 2 Victory Points;
- Development Cards can also provide victory points if drawn.

The victory points for The Longest Road and The Largest Army are not permanently awarded and can shift throughout the game. For example, if I have a road that is length 7 and another player makes a road of length 8, then that player with 8 is awarded the longest road. However, if I build 2 roads the next turn and elongate my road to 9, I will take back The Longest Road. This rule also applies to The Largest Army but is somewhat limited given the capacity of only 1 Soldier or Knight being played each turn.

It is the trading of resources in addition to the randomization of resource distribution through dice rolls that make this game so appropriate to observe how and in what way computer-mediation is reacted to. Players may only initiate trade with others on their turn. On the tabletop, trading occurs face-to-face. On the computer-mediated versions, trade is initiated on a separate screen with each player being shown their available resources one at a time. This screen is shown below.

Figure 5 – iOS Trading Screen

Trading in-person often resembles something like this:

White:	*Anyone give me a sheep or a brick?*
Orange:	*I've got rock.*
Blue:	*If I had either of those things, I would trade.*
White:	*Do you want to give me a wheat?*
Blue:	*No. I cannot say I do.*
White:	*No one? All right. Carry on.*
Red:	*Looks like your loss.*

Discussions about trading, because the numeric and board distribution are so varied, can become rather intense. In fact, the trading procedures of *Catan (1995)* are one of the main reasons for both its popularity, and its status as a replacement for the popular board game *Monopoly*. Games typically take about 60-75 minutes when played via the tabletop and players will often play more than one game in a sitting. Over time, there have been several expansions to *Catan*

(1995) adding everything from more robust robbers and development cards, rivers, and sea faring. However, for the purposes of this study, players were asked to play the basic game.

Data Collection Processes

This section details what, what kind, why, and how the data relevant to this research are gathered. Fundamentally, there are three steps relevant to the collection of data for empirical reasons. The first step is to take an inventory of objects that will be involved. Aside from the room, chairs, and people, there are many objects in the room that must be considered. These items are relevant to the context being observed. Each of these items has a story, a necessary portion within the scenario that is being studied. While participant observation would allow a researcher to see data in situ, the relevance to the context is lost upon the researcher leaving that context.

As such, the second decision to make is about how to account for those items that make up that context in addition to the entire context. Each items' relevance to the whole must be able to be accessed, verified, and empirically available. By accounting for each object and how each object can be recorded, the final step can be taken. In the last few decades, there have been significant changes to the way that information is catalogued, processed, stored, and processed. There are technological ways to capture and observe meaning being created. In this way, data collection can be considered, practiced, and replayed.

Step One: Lists of Ingredients

The Tabletop

One of the very first tasks for data collection is listing everything that will be part of the research. If for nothing else, an ability to know what will be discussed in the observation is useful. The initial ingredients to account for are found in the box the game is packaged in. The list of ingredients for this examination of network formation is cataloged by the contents of a box, the contents of a rulebook, the procedures of a program, and the people involved. What has not been included are things like food, electricity, the table being played on unless it is called out, and the content of conversations. *Catan (1995)* is packaged in a box that contains:

Quantity	**Item**
19	Hexagonal Tiles
6	Sea Frames
9	Harbor Pieces
18	Circular Numbered Tokens
95	Resource Cards
25	Development Cards
4	Building Cost Cards
2	Special Cards (Longest Road and Largest Army)
16	Cities (4 of each color)
20	Settlements (5 of each color)
60	Roads (15 of each color)
2	Dice (1 yellow, 1 red)
1	Robber
1	Game Rules
1	Box

Table 1 – The Contents of the Box

From this list of ingredients, it becomes necessary to add a few things. First, there must be a player who will use each of these things (a maximum of 4 as there are four colors. The next objects to be included are procedures themselves. While procedures like The Longest Road and the Largest Army must be included, objects like victory points, dice rolls, trading, and player communication must be accounted for.

From this starting point, those ingredients can be added to. Each object on the list of ingredients holds no hierarchical importance. Additionally, while there are limitations in terms of quantity for things like cities, roads, cards, and settlements, those limitations define the space of interaction. If that limitation matters at the time, it shows up during observation. The limitations of the system, at least in terms of the tabletop game, are how *Catan (1995)* was created. With that in mind, the list of objects grows slightly longer. The final list of ingredients from the tabletop game is listed in Table 2. Next, the digital game must be taken into account.

Ingredients / Objects / Monads	
Hexagonal Tiles (Terrain)	Box
Sea Frames (Harbors)	White Player
Harbor Pieces (Unused)	White Resources
Circular Numbered Tokens	Orange Player
Resource Cards	Orange Resources
Building Cost Cards	Blue Player
Special Cards (Longest Road and Largest Army)	Blue Resources
Cities (4 of each color)	Red Player
Settlements (5 of each color)	Red Resources
Roads (15 of each color)	Victory Point
Dice (1 yellow, 1 red)	Victory
Robber	Orange Player
Game Rules	Turn Order
Year of Plenty (Development Card)	The Researcher
Knight (Development Card)	Trade
Road Building (Development Card)	Table
Monopoly (Development Card)	Each Player's Phone
Development Card (per player held secret)	Victory Point (Development Card) (Palace, University, Market, Chapel, Library)

Table 2 – Full List of Ingredients

The Digital Application

The game of *Catan (1995)* was translated and released for numerous platforms. Each platform contains numerous affordances but in this study, we deploy the iOS translation as it contains affordances for co-located play. In this case, it is necessary to build on the list of ingredients. For the most part, an electronic or digital translation of human action does not require as many associations as their physical counterpart. The automation capabilities of computation handle a significant number of forced interactions versus the tabletop. These associations are partially black boxed. For example, the players do not need to associate with the Largest Army Card or the Longest Road. The players also do not roll the dice, do not handle distribution of cards, do not have to remember to move the robber, and they do not have to keep the board neat and tidy. From that place, the list of ingredients for the iOS app is found in Table 3.

Where the space of interaction differs here is through the boxed space of the iPad. Passing around the iPad then, is an equivalent interaction to that of passing around the dice. Because of the disconnected nature of information, random interaction with the rulebook, fidgeting with the cards, and things like the discussion about the nature of resource distribution is truncated. No matter the size of the iPad, the information about each player's held resources and development cards is hidden unless it is that player's turn or they are going to trade with another player and even then, players can only see their information on their screen.

Ingredients / Objects / Monads	
Special Cards (Longest Road and Largest Army)	The Researcher
Cities (4 of each color)	White Player
Settlements (5 of each color)	White Resources
Roads (15 of each color)	Orange Player
Turn Start Button	Orange Resources
Robber	Blue Player
The iPad	Blue Resources
Year of Plenty (Development Card)	Red Player
Knight (Development Card)	Red Resources
Road Building (Development Card)	Victory Point
Monopoly (Development Card)	Victory
Development Card (per player held secret)	Trade
Each Player's Phone	Victory Point (Development Card) (Palace, University, Market, Chapel, Library)

Table 3 – iOS Ingredient or Monad List

Step Two: Types of Data and Their Worth

The second step for data collection is to decide how to account for the activities of the objects seated at the table. The most needed data was players to play the games and be recorded. To begin, I advertised on the Penn State campus about needing people to play *Catan (1995)* on camera. Between August and December of 2016, an advertisement was placed around the Pennsylvania State campus in University Park, Pennsylvania. The ad stated that I was looking for people to play *Catan (1995)* as a means through which to think about software design in different ways. As incentive, I offered each player $5.00 per game and offered to give the winner of each game a copy of *Catan (1995)* to be taken home with an additional expansion for five and six players. Each participant contacted me via email – 37 in total. Of those, 11 scheduled a time to meet with me and to be recorded during play.

The observations all took the same form. First, players were assembled to play two games of *Catan (1995)*. Each were told that I was not looking for anything and that all I was doing was recording them playing. I showed them a few videos as example of the type of setup I was pursuing which is consistent with current trends within the board game community when they stream or capture play themselves. I then had the players sit down and finish setting up the game. Because the ingredients were known, most of the data delivered itself. Players discussed what was going on with the game, what was going on with the iPad, and what was going on between one another. They shared videos on their phones, text messaged friends, and generally went about their business as they naturally would.

Additional data came as players sat down. First, all players began by picking a color and setting up their pieces. Next, in all three couples of games, I was asked if house rules were allowed. I responded by saying that if the table agreed to a rule, that was fine. As such, in each case the players all used their interpretation of certain kinds of rules. This normally took the form of how trading worked and how to interpret when the Development cards could be played. This video would continue until a victor was declared. I would then record an additional 5-10 minutes as they cleaned the game up and discussed what they were doing. After the table was cleared and the prize rewarded to the player who won, I would start the iOS *Catan (1995)* app and hand it to one of the players.

Without priming or explanation, the second was played on the iOS app. As noted, this was done to witness how the maintenance of a system impacted the relationship with the system itself. The goal was to watch how players who were unique to a specific type of interaction were impacted by the procedural content being driven by a computer. With the iPad version, players are asked to first choose and Avatar and a Color. Upon doing this, they were asked to input a name and hand the iPad to the next player.

Like the tabletop, the physical makeup of the room did not change. Each player was sitting in front of each other player. The system of the iOS app replicated the bare minimum needs for players to trade one another. In this way, the game was represented in much the same way though physically different in the way the game was interacted with. Like the tabletop game, play would continue until a victor was declared. Upon finishing the second game, each player was handed $10.00, the victory was given a copy of the game of *Catan (1995)* and an expansion that allowed for a fifth and sixth player to play, and snacks were split up and sent home with them.

In this way, all of the data I needed was presented in context. These data were or could be catalogued however I liked and this meant a significant amount of freedom to consider how to use these data. The next step was to decide exactly how to record or gather all of these data.

Step Three – Technological Observation and the Gathering of Data

The most direct method of gathering data is to simply record the activity on the table and the sound within the room. In doing so, all movement, sound, and interaction with the environment will be captured. This will allow researchers to obtain an exhaustive, nearly complete collection of associations created during the formation and perpetuation of a monadology. For the digital translation of *Catan (1995)*, those same cameras will record player action and the game board state as well. However, the focus for these cameras will be on the screen as well as button presses shown in Figure 6 on the next page. Simultaneously, programs like X-Mirage will allow the digital screen to be recorded in full.

One of the biggest flaws with qualitative data is the presence of the researcher. In considering the type of data I wanted, I felt that recording these games would not have a significant impact. The rise of electronic sports or eSports as well as the rise of digital broadcasting of all types, the presence of camera equipment, other people, and performance anxiety is quickly being pushed back. In this way, the camera is an almost natural presence for most types of games. As a researcher, I was impressed with how often my players would ask me if the camera was ok.

The GoPro Camera was placed on a camera mount that was attached to the game table via a clamp. The GoPro would be set to record via an iPad that I had next to me. From the top down, I could see a significant amount of the play surface in addition to the arms of each of the players. This allowed me to observe body language, the game state, and the social life of the players within the game itself. Checking phones, messaging, and all sorts of conversations were captured and catalogued. Once these data were captured, I used Adobe Premiere to sync up the video and each of the small video files that the GoPro recorded (due to filesize limitations). These videos were then viewed and catalogued.

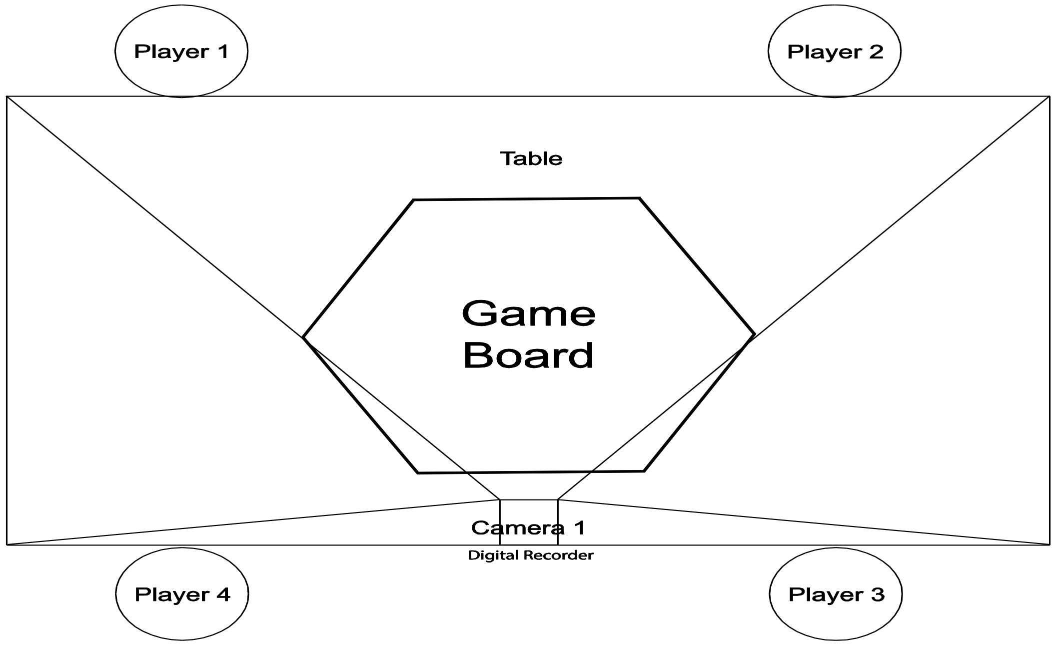

Figure 6 – Camera Placement and Experiment Seating

What Data and How Much?

There are 6 videos of gameplay totaling around 10 hours of play to analyze. And 6 audio files of those games. Each video was synced and pieced together and viewed. Each video was viewed once for grounding and then watched and coded two different times. While these videos were being coded, the researcher sent the audio to Rev.com for transcription. Verbatim, time stamped transcripts were asked for and each transcription was verified during coding as well as during the initial screening. 3 Groups who play 2 games each. To get a sense of the nature of these recordings, please refer to Table 4.

Session	Type	Time
1	Tabletop	1:10:46
1	iPad	1:53:00
2	Tabletop	1:37:46
2	iPad	1:25:38
3	Tabletop	1:31:41
3	iPad	2:29:50
Total		10:08:41

Table 4 – Session Types and Recording Length

Each game was played 3-4 players that consisted of 3 distinct player groups. The first group consisted of 3 college students who knew each other and 1 young business professional. The second group consisted of 3 individuals who knew each other through other friends. The fourth group consisted of 4 individuals who had never met. In each case, there was a mixture of players who had played *Catan (1995)* many times with players who had rarely played. Each group consisted of the following data.

With each game recorded, the most basic data had to do with the transcription. The very first data that I created outside of a list of ingredients a transcript, a video file and audio file was a data sheet with basic parameters on it. These data consisted first of times spoken normalized for time of the game. This was a parameter that would indicate how chatty a table was given what type of game was played. Because the iPad game often required a little more discussion with the researcher, these data were controlled for.

Group 1 – 3 college students, 1 new professional

Within this group, the same player won both games. Additionally, three of the players knew one another outside of the game table. While I initially worried that this would impact the evaluation at hand, I realized that through the method I have assembled that this would not matter. The benefit of the methodology I have assembled is that regardless of the past life and actions of each participant, it is the task that is essential. If the past experiences come up, then it matters for the evaluation because it came up. However, the concepts that come up are in relation to the game or to the assemblage at hand.

Sex	**Age**	**Education Level**	**Board game Experience**	***Catan* Experience**	**Video Game Experience**
Male	20s	4th Year College	Novice	Expert	Expert
Female	20s	3rd Year College	Novice	Expert	Novice
Female	20s	2nd Year College	Novice	Expert	Novice
Male	20s	Bachelor's Degree	Expert	Novice	Expert

Table 5 – Group 1

In this game, the researcher had to discuss certain matters with the players. Specifically, the players wanted to know what each button did and how it functioned. Also, they wanted to know why the naming tool cut off the last letter of the name each time. Finally, after about an hour or so, the iPad version of *Catan (1995)* will bug out. This required the researcher to reset the game when the players asked why it had stopped responding.

Group 1								
Color	**TT**	**(iPad)**	**Normalized**	**% TT**	**% iPad**	**Difference**	**Type**	**Time**
Red	332	551	345	30.38%	17.51%	12.87%	**TT**	1:10:46
White	330	551	345	30.19%	17.51%	12.68%	**iPad**	1:53:00
Orange	221	614	385	20.22%	19.51%	0.71%	**% Diff**	62.63%
Blue	210	255	160	19.21%	8.10%	11.11%		
Total	1093	1971	1234		**average**	9.34%		

Table 6 – Group 1 Changes

Group 1 saw a significant amount of change in the discussion at the table among those who knew each other. In this case, the blue player significantly withdrew from the discussions that occurred at the table itself. This will be discussed further.

Group 2 – 1 PhD Student, 1 new professional, 1 college student

Within this group, I was curious what would occur because 2 of the players were not experienced with the game. However, within this environment the players worked with one another to learn the complexities of the game. The woman within this group was inconsistent with her strategy that allowed for some interesting observations about the way players interpreted the game system in real time. The winners of these games were opposite in *Catan (1995)* experience. It was interesting to see an expert board gamer interact with someone who did not know a lot about board games but did know a lot about *Catan (1995)*. In the end, the player who knew a lot about board gaming ultimately persevered due to several aspects that will be discussed later.

Sex	**Age**	**Education Level**	**Board game Experience**	***Catan* Experience**	**Video Game Experience**
Male	20s	ABD	Novice	Expert	Expert
Male	20s	Bachelor’s Degree	Expert	Novice	Expert
Female	30s	Undergraduate	Novice	Novice	Novice

Table 7 – Group 2

This group was also unique in that it was the only group that gave up. After about an hour and a half with the iPad version, it became clear who was going to win and so they assigned a winner. This is, of course, within the range of the research itself. The players chose the winner because they did not want to have to go through the motions. There was very little fantasy within the second game.

Group 2								
Color	**TT**	**iPad**	**Normalized**	**% TT**	**% iPad**	**Difference**	**Type**	**Time**
White	399	181	207	20.71%	15.89%	4.81%	**Tabletop**	1:37:46
Orange	342	383	437	43.81%	33.63%	10.19%	**iPad**	1:25:38
Blue	472	343	392	39.24%	30.11%	9.12%	**% Diff**	114.17%
Total	1213	907	1036		**average**	8.04%		

Table 8 – Group 2 Changes

Group 3, 4 college students at the 2/3 year

This group consisted of players who were more interested in video games. Many of them had played several other electronic versions of board games and had not played very many board games. During the observation, these players routinely asked which way development occurred. Was it true that the tabletop game came first? From these players' perspective, they believed that the software had come first and novel tabletop versions came later. As this group was entirely new to the tabletop game (having not played on iOS or any other electronic media at all), this group took a significant amount of time to play and had the most variance within their turns.

Sex	**Age**	**Education Level**	**board game Experience**	***Catan* Experience**	**Video Game Experience**
Male	20s	ABD	Novice	Expert	Expert
Male	20s	Bachelor's Degree	Expert	Novice	Expert
Female	30s	Undergraduate	Novice	Novice	Novice

Table 9 – Group 3

In these two games, the players spent some time establishing the rules of the game as 3 of the players had not played *Catan (1995)* before. This resulted also in all of the players carefully treading through the game. This carefulness resulted in longer games. In addition to being careful, the players also attempted to trade with one another every single turn during the iPad game. This also resulted in a much longer iPad game than normal. Note the significant decrease for the experienced Blue Player between the iPad and Tabletop games. By the iPad game, his role as teacher had finished and he spent the iPad game mostly observing.

Color	**TT**	**iPad**	**Normalized**	**% TT**	**% iPad**	**Difference**	**Type**	**Time**
Red	337	560	348	28.44%	35.33%	-6.89%	**Tabletop**	1:31:41
White	242	358	223	20.42%	22.59%	-2.16%	**iPad**	2:27:30
Orange	228	313	195	19.24%	19.75%	-0.51%	**% Diff**	62.16%
Blue	371	286	178	31.31%	18.04%	13.26%		
Total	1178	1517	943		**average**	0.92%		

Table 10 – Group 3 Differences

CHAPTER 5 – ASSOCIATION MAPPING AS METHOD

Chapters 1, 2, and 3, outlined the ways that Human-Computer Interaction (HCI) inherited some of the issues of reduction from the social sciences. Chapter 3 was a framework chapter that described an approach to understanding technology use that did not place technology as some sort of non-unique, unique space to study. While HCI has developed in tandem with the computer, the methods and epistemologies carry the baggage of the Sociology's missing masses (Latour, 1992). The things we make (referred to as non-human actors) are often considered tools, or as having no ability to act on their own. Work on computer use centers on the people using the machine yet the act of creating these tools imbues them with agency in as much as the humans using it have. While this may be controversial, this concept could be widened to attribute the possibility of human agency is dependent upon the objects humans create (Harman, 2009; Latour, 2005). This essence of agentive action is missing from most analysis.

As a result, these missing masses have entangled and obfuscated the act of design at an ontological level – creating a human-centered design focus by placing technological design into a black box instead of pursuing the space we live in – a space where humans and non-humans need each other to act. To put a name to this black box, the phrase "paradox of the active user" was placed (Carroll & Rosson, 1987). The basic premise of this paradox is that users asymptote at relative mediocrity in terms of user skill. While users may asymptote at mediocrity, it is in the constant evaluation of the humans OR the design of systems that created and maintains the paradoxical active user. As a stopgap, the fields of User Experience and all other fields surrounding design have constantly approached design in a way that made it “easier” to onboard users. This onboarding research was not a solution to the problem itself, but a point at which to build around a problem. The result of building around the issue is a rising pressure that is quickly overwhelming computer-mediated products.

In chapter 4, I began to discuss the data collection process. Here, I offered that through an activity that required a moderate amount of discussion, recruitment, and rules-based engagement, any researcher could pursue the concept of hybridity. This chapter outlined the space of analysis – the board game *Catan (1995)* – and the ways through which analysis data was collected. The data were collected through the tenets of broadcasting in that video and audio were where most analyses began. Association Mapping is an augmentation of Social Network Analysis. It is called Association Mapping because social is not a material that things are made of, it is a result of associations over time that are assembled around and persist through an activity. This chapter consists of 5 parts. First, I discuss how a list of associations allows an open black box to become a part of an analysis. Next, I discuss what objects are accounted for and their respective parameters followed by a brief discussion of what aspects of social network analysis are in use. Next, I describe how to do Association Mapping by first analyzing the approach to analysis through the three distinct spaces of analysis.

The first space of analysis is the outer space or the objects that make up a particular space of analysis. The second space is inner space or the cohesiveness of that space. The final space of analysis inter-space. Between object centrality in addition to the likelihood of associating with other entities or objects that are similar or different from one another. This chapter then ends with what this specific Association Map details about the users engaged with *Catan (1995).*

Making the Whole, Parts Again

Much of the work within this research is unintuitive at best, obtusely confusing at worst. The combination of social-network analysis, play, board games, software studies, and Actor-Network Theory have re-created Frankenstein's Monster (Finn et al., 2017; Latour, 2011). Unlike the Monster that created a new being with parts of other human beings, I am responsible not only for its creation, but for its consequences. None of the ideas within this assemblage of approaches are new, nor are they particularly controversial. Each part simply need to be restated and re-assembled. All I have done here is construct an old method using old ideas with new tools. The Information Age has brought with it an endless array of information that can be recorded, analyzed, and manipulated. The assemblage created here dispenses with populations and samples consistent with frequentist assumptions about data. Association mapping represents a single event. Repeating that event provides more data to consider.

In keeping with Frankenstein (Finn et al., 2017), there is a tendency of humans favoring themselves over their creations. This is prevalent in every field that uses methodologies from the social sciences. This tendency appears innocuous but without considering our creations – when using information technology for the purposes of this study – the designers of these technologies will continually favor designing for humans. Favoring humans over hybridity, designing a tool instead of a symbiote, is itself the constant repetition of the moral of the book. The objects we create, much like the being Frankenstein (Finn et al., 2017) created, seek to understand themselves in relation to the world around them. Humans constantly reject or at best, tolerate the existence of these beings (Latour, 2011). It is possible to consider design as the production of a symbiotic entity. This is not equivalent to giving software an identity. Instead, it is a drive to create competent actors that relate to users in more beneficial ways. The first task is to unpack the formation of a social moment.

There are a few steps to unpacking the creation of a social moment. First, any use of software consists of a few different objects that might not be intuitive to consider at first. For example, we often consider the affordances of a product rather than the things that make up that product. Therefore, the first task is to create a list of ingredients. If we take the irreducibility aspect of ANT to heart, we must assemble a list of monads or irreducible elements. When software is designed, they are often assembled parts placed together in a certain way by a designer. The second step is to expand the inventory to certain intangible pieces that maintain the space of interaction – we can refer to this as a playground.

Through the concept of play we know that every playground contains its own:

- Sense of freedom.
- Sense of reality.
- Sense of time and place.
- Sense of order.
- Sense of materiality.

Each of these senses all direct the space being evaluated and unlike traditional analysis these senses are guided by the players and the objects themselves, not the researcher who works only as an observer. There are a few steps that can be taken before a playground is formed by cataloging the possible objects that might appear when the activity has been designed by others to perform (e.g. a game, a piece of software, a building, etc.). By knowing the parts, all assembled wholes have the ability to become parts again. It does this because a researcher can make sense of the associations that are created by the objects within that playground. Of course, while cataloging these objects is possible beforehand, allowing the observed to create their own sense of those objects is equally important.

The final step is to ground the analysis in association. Association is closer to the ways that communication is often defined – not as stating intent but as mediating miscommunication (Peters, 2012). The relationship formed between objects within a playground is the commentary of mediating miscommunication. With computer-mediated activities, there is a log that forms each time an association is made. In a sense, Association Mapping is an attempt to not only log all associations, but provide a means through which to make sense of them.

How to Augment Social-Network Analysis for Non-Human Actors

After reading how and why Association Mapping came to be, it is next necessary to describe Social Network Analysis – where Association Mapping's internal structure comes from. While the desire to apply the term "social" to a network is something we tend to do automatically, remember that social is out the outcome of a network, not necessarily the thing that the network is made up of. What needs to be addressed within this analysis is if the core of SNA, of graph theory, can be expanded to include non-human actors without the need for re-calculating the relationships within a social network. All of the development of mathematical formulas, re-conceptualizations of empiricism within that math, and the various approaches to using these methods should be indicative of the realization of what Gabriel Tarde proposed in the late 1800s.

To make sense of associations – what we term the building blocks of a network that results in a "social moment," it is necessary to translate the terminology that sits at the core of Social Network Analysis. The term actor is a core aspect of both SNA and Association Mapping (AM). However, the use of these terms differs wildly. For SNA, the actor is often defined as, 'discrete individual, corporate, or collective social units.' In SNA, groups of individuals can often be bound together in entities like cities, departments, companies, or teams. Not all "actors" in SNA act. Some entities may simply be hubs to connect other actors−think water cooler or break room as a hub of activity or an administrator as a central node that never actually acts within the capacity of intent.

For AM, the actor consists of all objects associated with given a particular bound. Within this analysis, an actor could be a resource card, a wooden road piece, the meaning attached to the result of a die roll, or even the rules dictating trading resources. Unlike SNA, AM does not necessarily consist of entities that do not act. Instead, all objects are separated from their intent and are instead cataloged and recorded in terms of what other objects they associate with over the sense of time that group of objects has defined. Associations between objects could be considered a relational tie.

In SNA, a relational tie is essentially a social tie. While SNA uses the term “social tie” and “relational tie” interchangeably, these types of ties are often associated with two actors being linked in some way. For example, actors could evaluate one another in that they form a friendship. Or, actors could transfer some sort of material between one another. Actors could be affiliated with a distinct entity together (a club or department within a company) or they could simply be doing something together like walking or having a conversation. SNA also includes the concepts that formed SNA—roads, bridges, and other physical features that connect people, or groups of people together.

AM takes this last point of physical features connecting actors in a network and leans in. In AM, relational ties are devolved into a mutual exchange of information or recruitment. No actor is devoid of intent to act, as such, roads on a *Catan (1995)* map recruit others to play more roads. Resource cards associate with players that result in their being made into tangible pieces on the game board or used to gather other types of resources. All of these entities form relational ties of a singular variety that result in the formation of other ties. These ties often form stronger and stronger networks because, at its core, association mapping relates to the constant agonism of objects (Neill, 2017).

As objects form relations, there are two structures that focus analysis, the dyad and the triad. For SNA, a dyad is a link between two actors. The link is the bond between individuals, not the property of individuals. This means that there is a context for each member of a dyad that keeps them related. This is often the basic unit of analysis of SNA (for a discussion of dyads and triads, see: Simmel (1950)).

Triads, on the other hand, are essentially a movement from a 1–1 duo to what amounts to a society. The triad is an obscenely complex entity and the basis of what makes social network analysis valuable. For the sake of simplicity, a triad is simply a relationship between three points. Without getting into transitivity and balance, for SNA, the triad is simply a subset of 3 actors and the possible ties between them. Triads have a few requisite needs to exist in that all objects of a Triad should be associated with one another.

Where complications arise is how those triads are associated. Below is an example of the "weak ties" theory from Granovetter (1973) in which he outlines the three distinct ways that triads persist. The far left is a triad in which a weak tie (indicated by a dashed line) connects one part of a triad to another but also consists of a strong tie (a solid line) from the central actor of the triad. Most relationships in society are done in this way in that the basis of strength of a social network is through weak ties, not strong ones.

The central example in this image is the result of strong ties to a particular central node. Because two nodes relate strongly to a central one, the two not connected will at least have a passive knowledge of one another—another weak tie. The far-right example is impossible or forbidden in that it is impossible for two strongly tied nodes of a triad to not know of one another in some passive way.

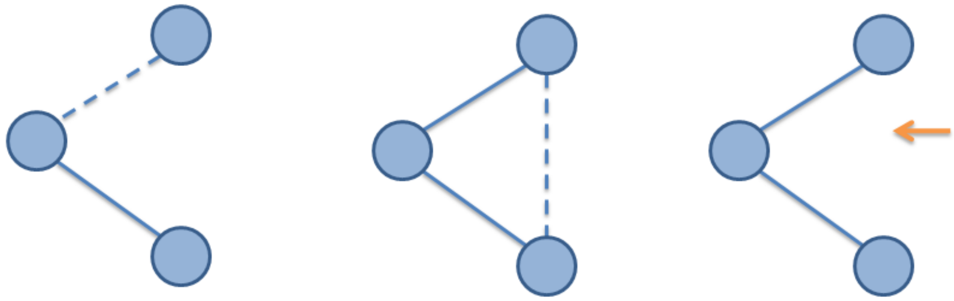

Figure 7 – Granovetter's Forbidden Triad (Granovetter, 1977) at the right.

Triads in AM are a little less difficult. A triad is simply the result of a successful recruitment. The relations between a dyad have been seen to be strong enough that they have successfully recruited a third object. Within *Catan (1995)*, this could be a player obtaining a new resource or a road network gaining another link. It could be multiple soldiers being played by a single user or even two players aligning against a third because the third player has been secured all of the high probability spaces on the board. Triads in this case, are not beset by weak ties. Instead, the level of association is a 1 or 0 and changes over time. Weak associations exist among all monads in that they represent the least reducible unit through which objects, dyads, triads, and networks are built.

For subgroups, SNA often seeks to find groups of actors that are all linked through specific criteria. So, a subgroup is basically a subset of a group. For SNA, Groups are defined as, "the collection of all actors on which ties are to be measured." In this case, a group is basically a finite set of actors that are related in some way. Within this group, analysis occurs of the way those actors in the group or finite set are related.

Within AM, groups and subgroups are not too dissimilar from that of SNA. The researcher, observing the relations among objects within the network, can create groups of ties as they form. For example, over time in *Catan (1995)*, certain objects may begin to form a subgroup.

In one game of this analysis, players began to assemble to attempt to oppose a network of resources and roads that one specific player created. The resulting monopoly made that group exceedingly powerful. Subgroups in AM on the other hand, could be those idle curiosities like “non-human actors” or “human actors.” While AM is not concerned about their existence, the humans at the table have a unique series of ties to the network in total. In this way, SNA and AM are related in that they will use relations—collections of ties of a specific kind—serve as a way to find and focus analysis of groups and subgroups. These collections of ties are what form the basis of value in AM.

For example, the below Association Map shows the associations formed during a dice roll. In this network, Player One hands the dice to Player Two. This holds weight as the passing of the dice is indicative of a new turn. Player two then rolls the dice. Upon rolling the dice, the dice and numbers on those dice form associations between player 1, 2, 3, and 4. However, in forming those associations, the numbers also serve to form an association between the resources of *Catan (1995)* (sheep, wood, ore, bricks, and wheat) which themselves form another chain of associations. Each round (consisting of 4 turns) will have different associations. Perhaps player 4 did not pay attention or was not present when those dice were rolled. Perhaps the chain of associations between the numbers to the resources was disrupted by a roll of a 7, which forms a different set of associations with the Robber instead of the resources.

At no point are any of these individual actors social but together, we see the formation of social moments. This collection of relations to the numbers of the dice result in the formation of a social moment. How these moments continue and their shape allow designers to consider each aspect of their design in situ.

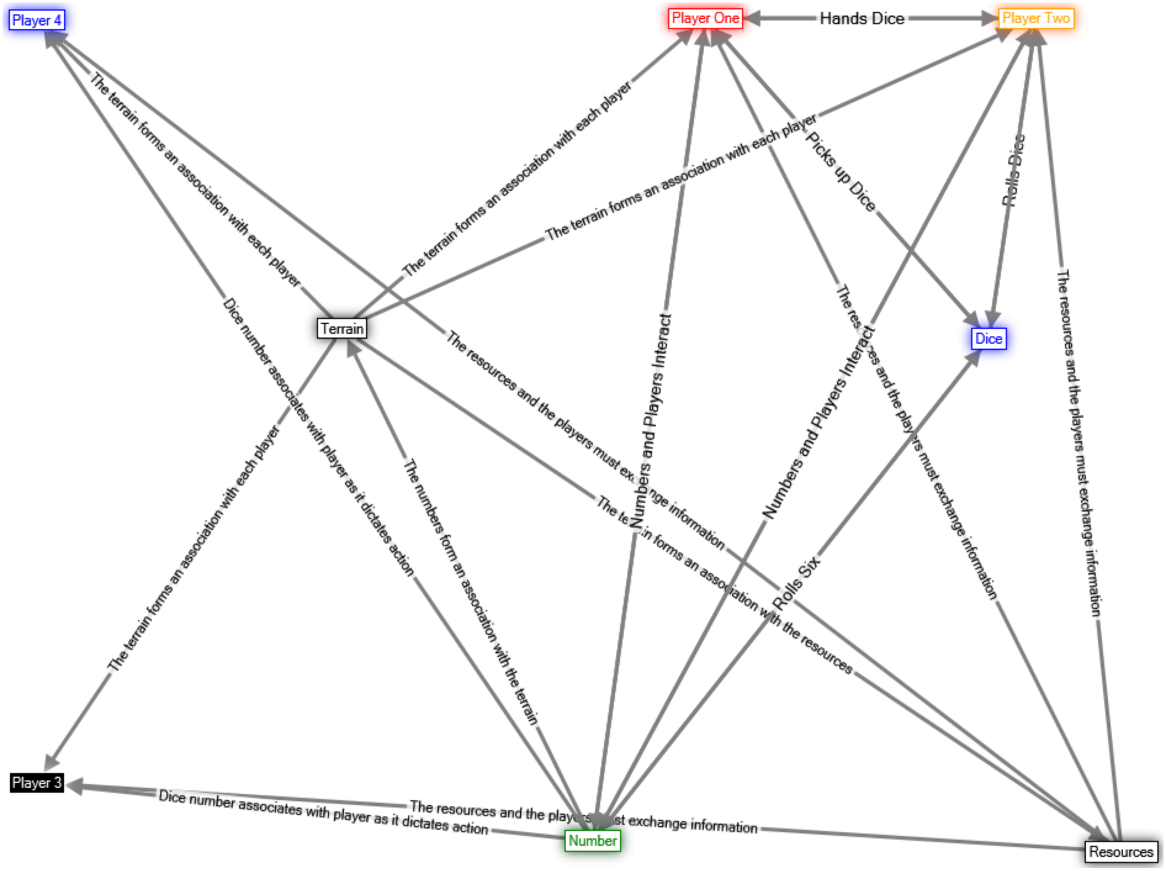

Figure 8 – The Association Map of a Single Die Roll

The terms described in this section provide a starting point for evaluating AM and deploying it. In the next section, I will describe centrality and how these measurements can be used to aid design decisions. After discussing centrality, I will begin to analyze the findings of this first deployment of Association Mapping.

Using the Math of Social Network Analysis in Association Mapping

Social network analysis, graph theory, and the various forms of network analysis have developed in concurrence with computation. These methods—seemingly ignored during Gabriel Tarde's time due to their complexity—are now commonplace and can be achieved with a click of a button through various SNA related software. As SNA developed in complexity, different attempts to use it have produced results that are still having an impact in the present. Some of the more famous applications include the impact of urbanization on individual well-being (Fischer, 1982), how many human-relationships we are from anyone on the planet (Travers & Milgram, 1977), the spread of innovations (Coleman et al., 1957), the formation of markets (Wellman & Berkowitz, 1988), Communities (Wellman, 1979), and citation networks in academia (Latour et al., 2012).

How SNA has been used and how AM will differ is the focus of this section. Specifically, this section will approach the philosophical underpinnings of the mathematical principles of SNA. AM being a straight application of SNA seems straight forward. After all, SNA is concerned with matrices and frequencies of associations between pairs in as much as AM is. As a result, this section approaches the question, “does the inclusion of non-human actors require new equations?” Or, does the math exist independently of the theory and the only reason the word “social” exists with “Social Network Analysis” is that when it was created, the place of non-human objects was still relegated to a non-consequential space?

There are additional concerns about generalizability and purpose of this method. While the purpose of SNA is not positivistic, the nature of SNA within HCI has often been mostly tangential and specifically human-centric to the point of its place as positivist or descriptive being unknown (Olson & Kellogg, 2014). The typical deployment of SNA is to evaluate human-to-human interactivity at scale through technology. What those results mean is often applied in larger and larger scales.

The reason that AM is being developed through this research is that I believe that SNA has applications that matter for the design of technologies. Much like anything, the inter-connected nature of the simple act of using a piece of software is enormously complex. We do not often treat using software with this in mind. In addition to decrypting users, AM has applications in evaluating the details of socio-technical systems at scale in more than just frequency and content of human-created messages in a network. After a brief discussion of a number of applications, I will return to discuss AM.

Within many SNA applications, human beings are simultaneously the cause and affected unit of any analysis. Two events sit at the center of both the setup and conclusion. This has been true in HCI research that examines technology use through SNA (e.g. (Hansen et al., 2012; Hansen & Smith, 2014; Ten Kate, 2009; M. S. R. P. Zaphiris, 2003; P. Zaphiris & Ang, 2009))

1. Humans are the cause of action.
2. Humans face the consequences of those actions.

For example, Hansen and Smith (2014) is written by authors who have been bringing SNA to HCI and they note, “Social Network Analysis (SNA) is the systematic study of collections of social relationships, which consist of social actors implicitly or explicitly connected to one another.” SNA is a powerful tool yet within all of this work, there are untold numbers of non-human actors that create the possibilities of this action. Additionally, many of these studies discuss the impact of a shallow understanding of an obsessively complex issue through the numerical frequency of some aspect of human-to-human contact. Rarely do these studies engage the way that non-human actors shift the focus of, and possibilities of, human action. Nor do they discuss the actions of those same non-human actors within those systems.

For example, the urbanization study linked at the top of this article discusses the results of a large-scale survey about the impacts of urban life on individual relationships (Fischer, 1982). At its core, it sought to evaluate if community had been destroyed by modern society. It does this by evaluating the people individuals have direct contact with each day. It does not by map out the uniquely intimate relationship between humans through that of non-humans (subways, electricity, the highway, busy markets, pedestrian centered mass transit, and the like) in these urban areas.

By its own definition, the author seeks to ferret out if the concept of community itself has been destroyed.

Additionally, the small world study from the infamous Stanley Milgram sought to evaluate the probability that two individuals from different places knew each other (Travers & Milgram, 1977). The researchers of this study did this by sending packets of information with a letter stating that the intended target of this packet was somewhere in Boston, MA. Respondents were asked to mail this package to the target if they knew them personally. If they did not, they were asked to forward the packet to someone who might know them. Each time this occurred, the respondent also mailed a postcard to the researchers to know that it had been forwarded elsewhere. This study generated the concept that each person on earth is separated by 6 other people.

The spread of innovations study linked in the beginning of this piece concerned itself with medical doctors prescribing new medicines (Coleman et al., 1957). By watching when doctors prescribed new medicines and for what reasons those medicines were prescribed, the researchers could evaluate how new ideas diffused across social networks. Generally, these researchers found that within the first few months of a drug’s release, strong social ties had a tremendous impact on prescribing new medicine. If the doctors had not prescribed the drug due to social network ties within 6 months, they often inevitably did so due to factors outside their social networks.

Each deployment of social network analysis presumes that humans only are those entities that communicate and spread ideas. However, within each of these studies are non-human actors that are hidden by other humans. For example, in the Urbanization study, the researcher ignores black boxes like mass transit, bus drivers, store clerks, and other entities that—while invisible when they work—can cause tremendous social interaction when they do not (Fischer, 1982). In this way, the non-human actors of the urban network are constantly causing interactivity but we only notice it when it breaks down.

In the small world study, the researchers evaluate how many humans received the packets before they get to their destination. Through this, they conclude that 5.5–6 people must be contacted to get one stranger from anywhere to connect to another stranger—regardless of distance (Travers & Milgram, 1977). This is a uniquely romantic notion and has been subject to a wide array of treatments in pop culture. Yet within that note of sociality are untold numbers of post office workers, information organizers in things like phone books, the socio-economic limitations of population drift, and other such factors that sit passively behind and within any of the respondents in this study.

Finally, the piece on diffusion of innovation sought to evaluate how quickly doctors prescribed medication based on their integration with their social network of other physicians (Coleman et al., 1957). However, this work does not take into account drug representatives, advertising, patient questions, patient advertising, patient education, or even the research behind these medications. Within each of these studies is an absorption of non-human action that are masked by human-action. If we want a more detailed picture of these studies, all that need done is to add those non-human actors to the network to see where the centrality resides, to see where the influential actors are, to comprehend the struggle that resides within that network. To answer the question at the start of this post: “does the inclusion of non-human actors require new equations?”

The answer is no but the inclusion of non-human actors presents other issues. The most pressing of these issues is exactly what the results mean for designers or the design of new pieces of technology. For example, agency within AM is not tied to any particular object—human or otherwise. Instead, agency is something no single object can express. Only by recruiting objects to assemble can agency be expressed. The expression of agency in a board game like *Catan*

(1995) could be a single player achieving their desire to win. However, this is not done without the dice producing resources to aid them. Agency is not achieved without understanding rules well enough to form a plan. Within that plan, the existence of other objects and the possibility of their recruitment toward the goal of *Catan (1995)* is meaningless. In this way, no single actor can be agentive.

There is of course the argument that without humans the activity would not form at all. Yet, without the pieces this is also true. Humans cannot play *Catan (1995)* if *Catan (1995)* is not present. The existence of *Catan (1995)* cannot be achieved without a designer yet that designer could not have created *Catan (1995)* without the existence of board games, without the existence of cardboard cutting factories, without the existence of wooden pieces, without the existence of colonialism. And through this, we see the power of AM—it presumes none of these things. Association Mapping simply examines the interaction of objects within a given space for a given amount of time. While the game of *Catan (1995)* is used here as an example that very purposefully manifests these concepts, it is not a method that can only be used in games, game design, or play studies. This will be covered in the design fiction at the end of this dissertation. In the next section, we take our first steps into an overview of the findings.

<u>On Indirect Ties</u>

The usefulness of Social Network Analysis is in uncovering the central hubs of a network. A hub is that node that serves to connect all manner of other nodes. These are often discernible in large bureaucratic structures. For example, as a former gofer during my pre-grad school days, I spent a lot of time running here and there. I was a go-between stand-in for non-human actors—a human without the ability to make a choice being told to make connections to other people. Within SNA, the ability to see these sorts of things at the core of "social" system is an incredible thing.

At my gofer job, the network I had to traverse changed almost overnight due to an email. The email changed the nature of access at the administrative level from a starfish to a pyramid. I think a lot about that email. As a Social Network Analyst, sudden changes in networks are really strange for data collection and analysis reasons. In fact, the act of SNA forces a re-evaluation of what generalizability should mean. If all it took to alter the social network of a large campus was just one email, how can these data ever be applied elsewhere.

And this is a limitation of studying only people. For example, with just one email, a whole slew of social activity before the drafting of the email is invisible. We do not often have access to those in power even if SNA is about studying the choices people below them have. No group of people ever act the same. Nor do they produce the same data. They do not because contexts are always changing because there are always indirect actors mediating relationships beyond our attention span.

This is where SNA begins to look something like Association Mapping. Along with the network of humans to humans, non-humans to humans also are deployed. For example, documents get created, new policies occur within faculty meetings or administrative sub-committed. At nearly every point, there are non-human actors like policies, word processors, laptops, webpages, servers, and software that all impact and are mediating and impacting all types of contexts. What these contexts are can be called indirect ties (Zuo et al., 2016). An indirect tie is best referred to as possibly, "friends of friends" or perhaps something like a cashier at a grocery store who suggests a book. In some ways, non-humans are indirect ties. The search for indirect ties is often associated with the concept of transitivity. In this case, transitivity often assumes that, “a friend of a friend is a friend” (Wasserman & Faust, 1994). Example of the various ways ties can be assumed about.

The ways in which ties between nodes in a social network can be conceptualized and termed. Note that in all three of the examples with three actors, the addition of a connection between two previously disconnected points is assumed. This is often called weak ties but through weak ties, we also see indirect ties in possible actors tied to each of those three we can see.

In other types of work, an indirect tie could also be new research citing a paper that cited another paper more relevant but older. Because the newer research is often seen as more relevant, the direct tie is usually noted and the indirect tie, the older research which itself may have been cited due to its indirect citations, is not mentioned. The study of citation networks produces a number of great pieces about this. For Association Mapping, indirect ties produce something else of use.

In Association mapping, there are no indirect ties but only because the notion of directness—sometimes referred to as choice in SNA—has been dispensed with. In order to communicate with another person, I have to make ties to all manner of object. The detail of this level of analysis is, or could be, so minuscule as to become comprehensible only by the most powerful of machines. However, for purposes of practicality, the nature of Association Mapping makes manifest the building of and re-arranging contextual nature of objects in situ.

The email in the above example would be sent at a particular time via a system controlled by the IT department of the University. To make those technologies function, the administrator in charge of the President’s email had to call the help desk in order to make sure that this email could make it through filters. To make the filters except an email sent to that many people at once, the lead of the administration had to make a special exception—a window allowing an email to be created that went to the University administration as a whole, one email address at a time. The administrator had to link the administration permissions directory to the email system itself in order for this to happen. It required a little work to be done in order to make these systems momentarily work together. The help desk personnel set a meeting agenda item for the next week to discuss the email tool they had written and its tie-ins to Outlook, the Exchange server system, and the various mail tools.

We see portions of a network in this example that are not social in and of themselves but the formation of a social moment. This creates bounded spaces for actions that result in a number of ties that are neither direct nor indirect, but hybrid in their abilities. Without the email, the President's office could not perform their campus-wide adjustment. Without the help desk to aid the President's office with making adjustments to the security systems of the email system, the President could not even begin their email. Yet all of this occurs in the background. All of this makes it into a paper if the researcher notices this or finds the right people. As a traditional SNA researcher, it might be that the researcher is undertaking an evaluation of the gofer network of a college system and they do not note the background work being done by non-human gofers.

Ultimately, indirect ties, weak ties, direct ties, directional ties, and non-directional ties all are eradicated in Association Mapping. In their place, we have an association. All associations are by choice and their continuing from one moment to the next is an indication of success. Each association is itself bereft of the hierarchical nature humans create by artificially hoisting themselves above the objects they create to mediate their existence. All of these hierarchical relations must be continually tested and reified in order to maintain their existence. There is no moment wherein an entity can be dispensed with or disappear.

While these entities disappear, we often assign these pre-formatted concepts names. With a name, we can find these pre-formatted ideas and deploy them as needed. This is how non-human actors have power. They are made manifest and can be called due to their tangibility. In this section, I have discussed the concept of weak ties and transitivity within Association Mapping. In the next section, I will discuss centrality, the manner of making sense of an association map, and begin to describe the data that was collected.

Inner-Space: Understanding the measures of Centrality in Association Mapping

In social network analysis, some of the more useful calculations display the centrality of actors and their importance within a network. There are many different measures of centrality and importance. Some centrality measures display how many other nodes a particular node is a part of. Others show how often a particular node is needed when tracing a path from one node to another. Interpreting these measures is contextually based and couched in the way the network itself functions.

At the core of SNA is choice. As such, in some measures the prominence of actors is more important. The prominence of an actor and its centrality may be quite different. For example, in an office environment, there may be a large number of workers who all do the same thing. This entire collection of nodes is central. However, among those, one worker may be more prominent simply because they host far more people choosing to associate with them. In competitive environments like sales, this is an important measure. Additionally, it has other uses for my proposed method of SNA in HCI—association mapping.

Within Association Mapping, these principles are still true—central actors are important. However, where their numeric dependencies are similar, the context and interpretation of these data might be more than a little different. In this section, I outline the four common measures of centrality and their importance to Association Mapping: Degree, Closeness, Betweenness, and Eigenvector Centrality. Each of these types of centrality are directional in nature with directional meaning that one actor is directing a dyadic pairing. In the case of software, users or the software itself may be directing the activity.

Degree Centrality

This measure of centrality is perhaps the simplest yet also the most useful within the toolbox of social network analysis. Degree centrality is essentially defined as how many neighbors a particular node has on a network or graph. Another way to talk about this is that degree centrality allows the researcher to learn the most mathematically active actors in a particular network or graph.

Within directional networks like the ones being used for association mapping, the degree centrality is somewhat unique. For example, directional graphs often use the concept of choice to indicate that choice is available and not forced. However, when doing anything social, the nature of choice is something that is not entirely evident. As such, association mapping rests on the idea of making a choice as a base of any actor. But how is this used within the analysis of data in real time? Well, within directional graphs there are two measures: indegree and outdegree. Or more plainly, how many actors are associating with a particular node and how many actors that node is associating with. Outdegree is the usual measure that most analyses use as it indicates that a choice has been made. For example, consider the nature of bricks in *Catan (1995)*.

With Bricks in *Catan (1995)*, the choice is not necessarily made by the brick but instead, is made by the Dice, by the players playing cards, by the terrain that the player’s pieces are sitting upon, and by the numbers sitting on each of those pieces of terrain. Like humans, many of the *choices* we have are typically little more than reactions toward a particular input. However, as we change modalities—from the tabletop toward that of the iPad—we see the following over the course of a game for the nonhuman objects: Bricks.

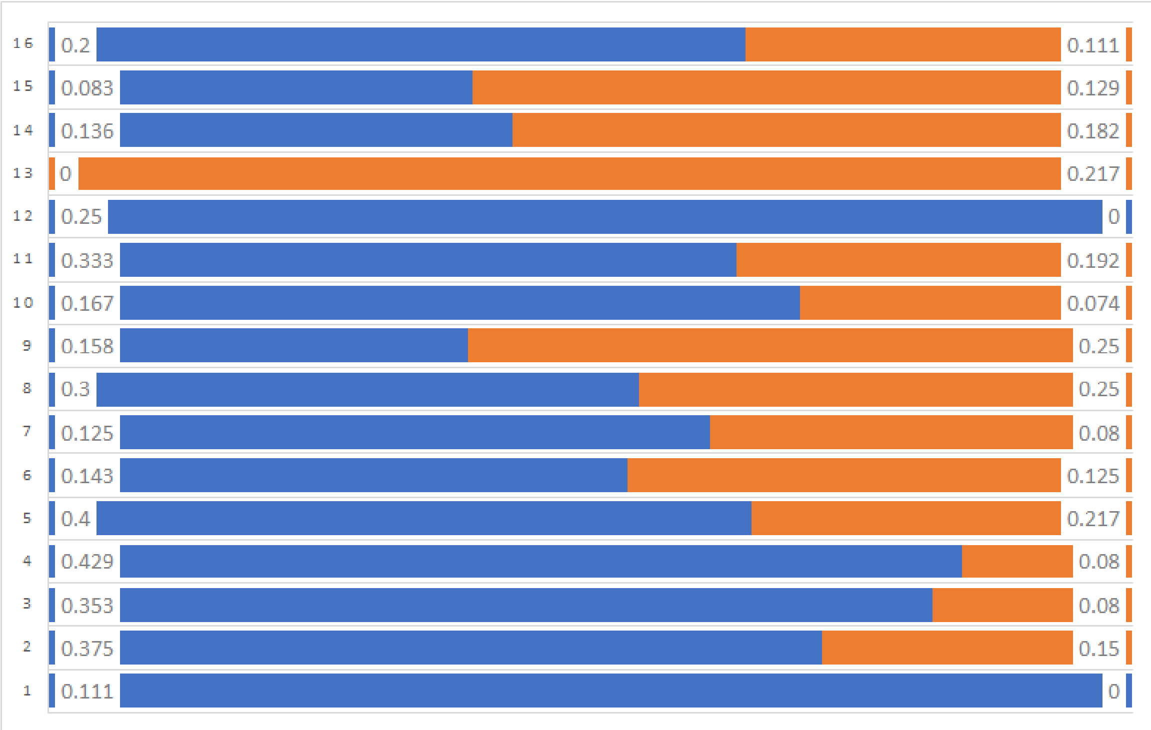

Figure 9 – OutDegree Centrality for Brick

In this chart, we see that bricks are more central to the tabletop game over the iPad game. While we can note mathematically that this is case, we cannot really say anything other than the fact that Longest Road changed hands twice in the tabletop game whereas it was only awarded once in the iPad game. Roads require brick and lumber to build. However, so too do settlements. As such, using centrality is not necessarily the best use of any analysis.

However, what if we were to average the centrality of resources overall between these two modalities? After all, over the course of a game the same number of dice are rolled N times where N is the number of players times the number of rounds in game. With that in mind, the chart for these two games looks like this:

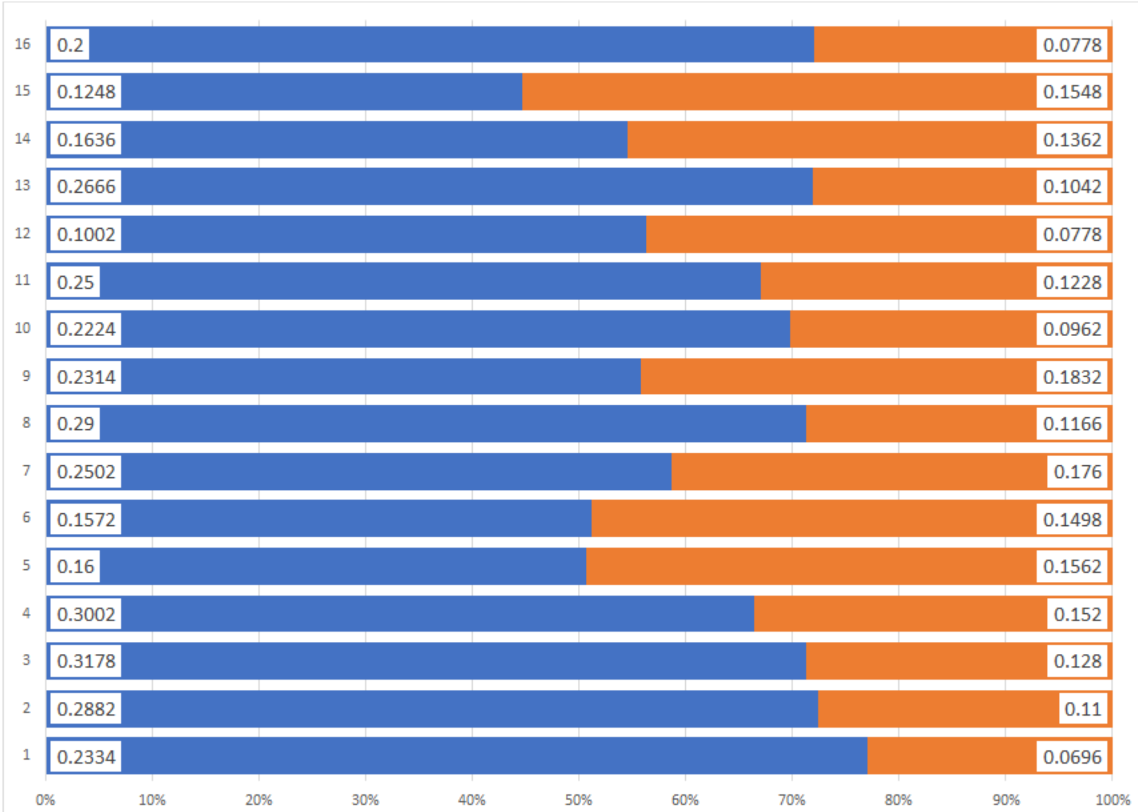

Figure 10 – OutDegree Centrality for Resources

In the above chart, I have plotted the average, normalized centrality for all resources across 16 turns of play. For the tabletop game, the average centrality of all resources was .215829 whereas in the iPad game, the average centrality is .1257. As such, we can say without a doubt that resources did not factor in to, or make as many choices, in the iPad game as they did in the Tabletop game. But why?

Well, this is a relatively simple answer. When players on the tabletop game were in their game, they traded with tangible cards. As such, they would show and hand cards across the table to another player. This meant that Bricks, Ore, Sheep, and all the rest existed physically in the table. For the iPad game, the existence of resources was a numeric quantity that only one player could see at any given time.

Therefore, many of the associations the resources themselves could make decreased. In this case, they decreased by a factor of .092. As these values were calculated with UCInet, we can say that in normalizing these values, UCINet takes the degree of a particular actor and divides it by the maximum possible degree. This results in a percentage which means that there was at least a 9% decrease in average centrality for the resources in a game of *Catan (1995)* when comparing Tabletop vs. iPad.

But this still does not necessarily tell us anything aside from the fact that resources are not as tangible. Where we may find something interesting to discuss via the data is with the humans themselves. Because *Catan (1995)* is a game that requires players to be active, to discuss trades, to relate to all manner of other actor, we can expect a significant amount of human centrality. Through this, we can see the average centrality over 16 turns of *Catan (1995).*

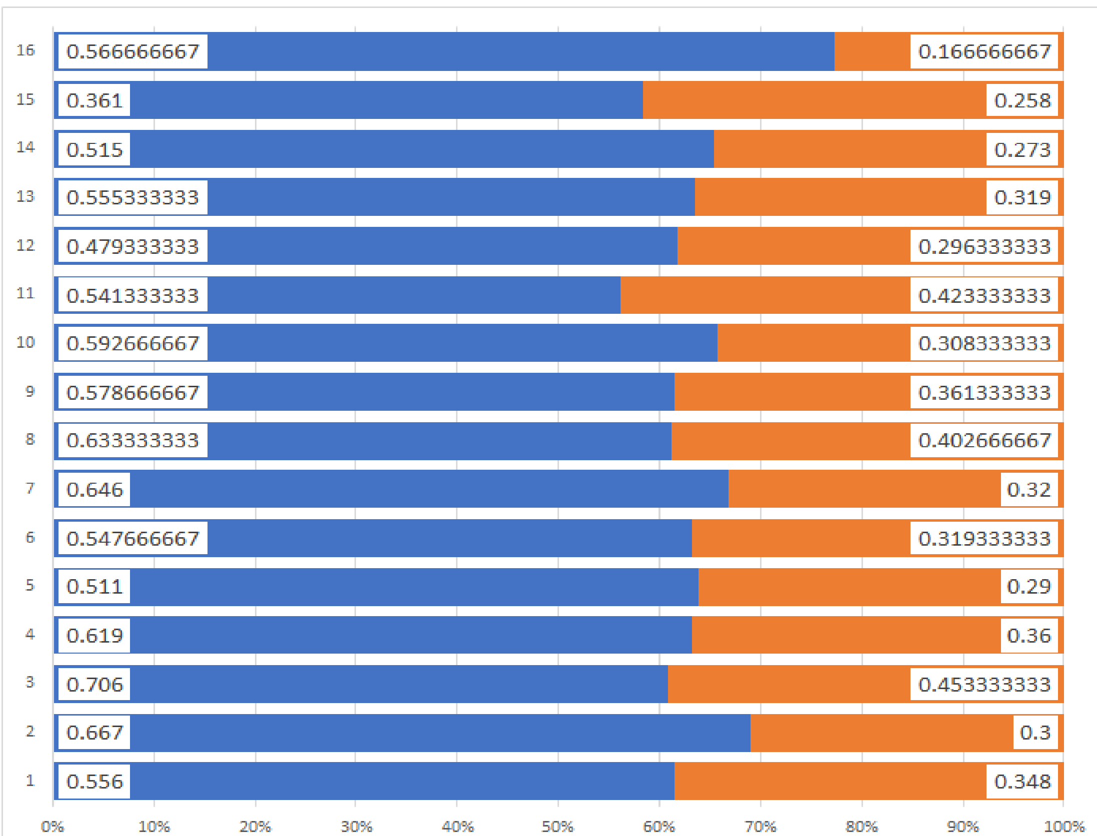

Figure 11 – OutDegree Centrality for Humans

In the above, this is the average Outdegree centrality for all human actors between the two modes of play *Catan (1995)* that were recorded. In this particular game of 3 players, the tabletop centrality measure for humans was .556254 or 56% of all activity came from humans. This is compared to .324958 for the iPad game. This means that approximately 32.5% of all activity of the iPad game was performed by humans themselves.

The difference for this type of centrality is approximately 23.1%. Or, on average humans were 23% less central to a game of *Catan (1995)* played via the iPad application. This too, is the result of automation but the implications for this will be described in the analysis section. The next type of centrality for directional graphs is closeness centrality.

Closeness Centrality

Closeness centrality of what is essentially the distance between actors is another way to consider a matrix or graph. With closeness centrality, the "closeness" is indicative of speed. For example, what nodes are most central, who will I have to talk to if I want to get to as many different other actors as possible. If an actor is central to a graph, it can reach all other actors with as few jumps through other actors as possible.

With Association Mapping, this is an essential component of the strengths of measuring a design. For example, if in mapping out this tabletop game, I come across the idea that a particular aspect of the game is important—like trading in *Catan (1995)*—then my focal point on design will be in lowering the bar for trading in order to have it more accurately reflect that experience that players will bring with them to the app itself.

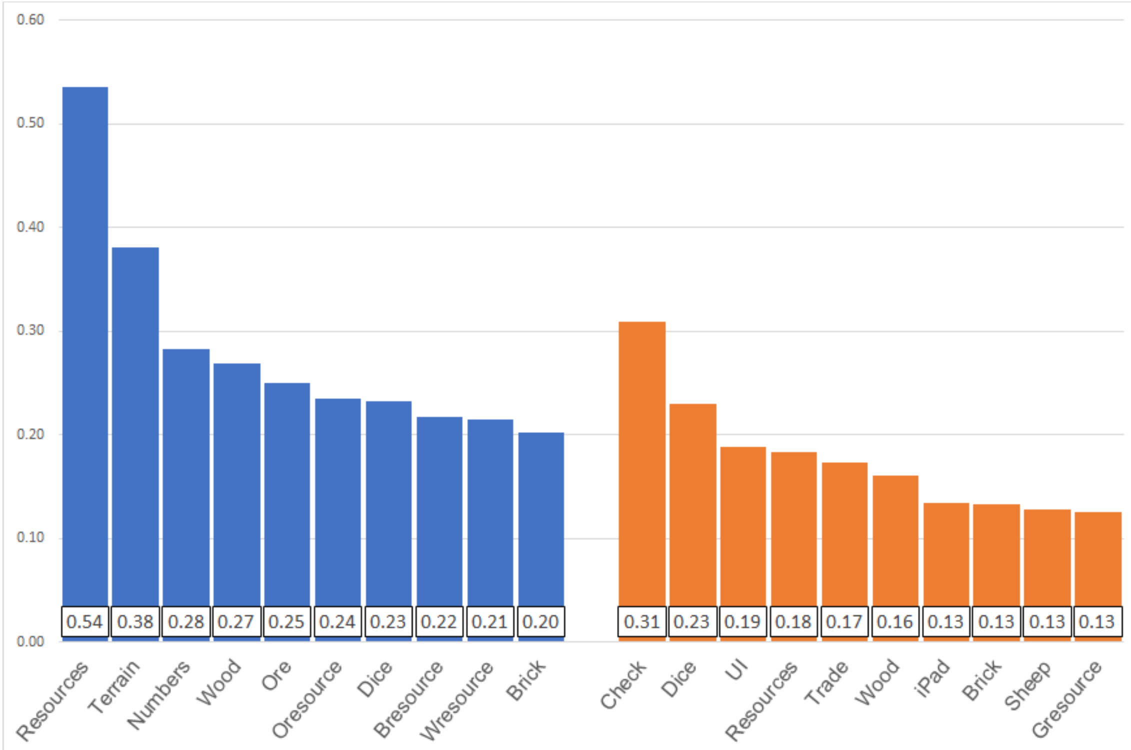

Figure 12 – Closeness Centrality for Top 10 Non-Human Objects

Between these two games, we see a number of objects that are central to that particular modality. For the tabletop game, the closest non-human objects are the Resources, which humans must distribute to one another. In addition, there is Terrain, which humans must refer to in order to examine the resources. Next are the numbers. Here, humans must examine the numbers attached to the terrain in order to distribute resources. We then see the most common resources of this particular game followed by the winning player's resources, the dice that determine the numbers and then each other player's numbers.

The iPad game is a little more complex. The "Check" is the user-interface check mark is present each time a player makes a decision. It is the last item checked before anything occurs. Therefore, it is the most central object and actor. It controls access to computer-mediation. Next, the dice are not the same object as the dice in the tabletop game. Instead, the Dice represent when play is switched to the next player. The "User-Interface" is the terrain and all information related to play. While this screen is important, it is not necessarily central. Resources play another central role in this game but is primarily disconnected from play.

Interestingly, because the players spoke to each other, their phones, and other disconnected objects during the iPad game, the centrality of the iPad objects are slightly lower than they would normally be for this measure. Additionally, many of the independent objects with the iPad game could be combined for even more robust central objects. The Check mark could also be combined with nearly every other non-human object of the iPad game as it is something that pops up constantly. Overall, the centrality of non-human objects is far less logical than that of the human objects because while computer-mediation is logically based, much of it is invisible. Additional developments with this particular method will incorporate computer logs in order to make these objects more manifest. Next, we will discuss Betweenness Centrality.

Betweenness Centrality

Another measure of distance is referred to as "betweenness." This type of centrality is best explained as the amount of stress a particular actor has to go through to reach some other actor. An example of this can be found in Pitts (1978), "The medieval river trade network of Russia revisited." Suppose that in order for *i* to contact *j*, *k* must be used as an intermediate station. *K* in such a network has a certain 'responsibility' to *i* and *j*. If we count all of the minimum paths which pass through *k*, then we have a measure of the 'stress' which *k* must undergo during the activity of the network. Within association mapping, betweenness centrality is partially related to the outdegree centrality but is indicative of the proportion of incoming and outgoing associations. It is here that we might learn of those actors that are the most essential for the task at hand. Take this example from the two games analyzed in the previous section.

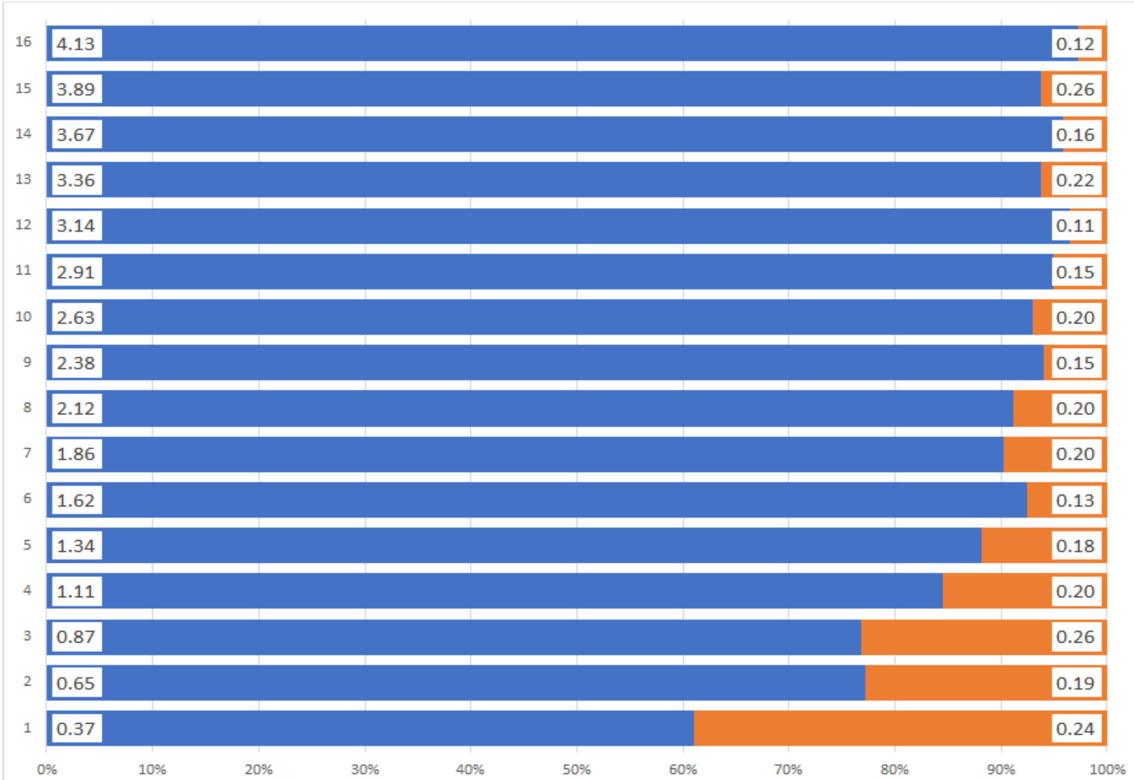

Figure 13 – Betweenness Centrality for Humans

Here, we see that humans are far more central to the action of tabletop gaming. This is not to say that humans are the only movers and shakers of the board but that during play, during an activity, normally humans are central to all activity. When play is mediated by a computer like it is with digital board games, it is often the case by designers that they automate certain aspects of play. In doing so, the centrality of non-human actors increases exponentially in that any measure that seeks to evaluate the impact on the humans will no doubt see a decrease.

To put this as plainly as possible, components of a game do not need to go through human hands in an iPad. They are guided by the iPad itself. For example, the "Check Mark" that is present at each stage of a human's action has a centrality very similar to that of the humans in the iPad game. Next, we consider page rank or eigenvector centrality.

Eigenvector centrality

This form of centrality is essentially one of influence. When an eigenvector analysis is performed, whatever program being used to perform the analysis assigns scores to each actor within a network. These values are as such that those with high values are essentially contribute more than those nodes around them. Another way to think of eigenvector centrality is page rank. With page rank algorithms like those by Google or other search engines, page rank accounts for how many links go to certain pages. Those with high numbers of links going to a page are essentially providing a sense of how "important" that page is. UCInet calculates eigenvector centrality. These again are normalized as a percentage. In continuing with the examples above, here is a plot with the eigenvector centrality of the humans in each game type.

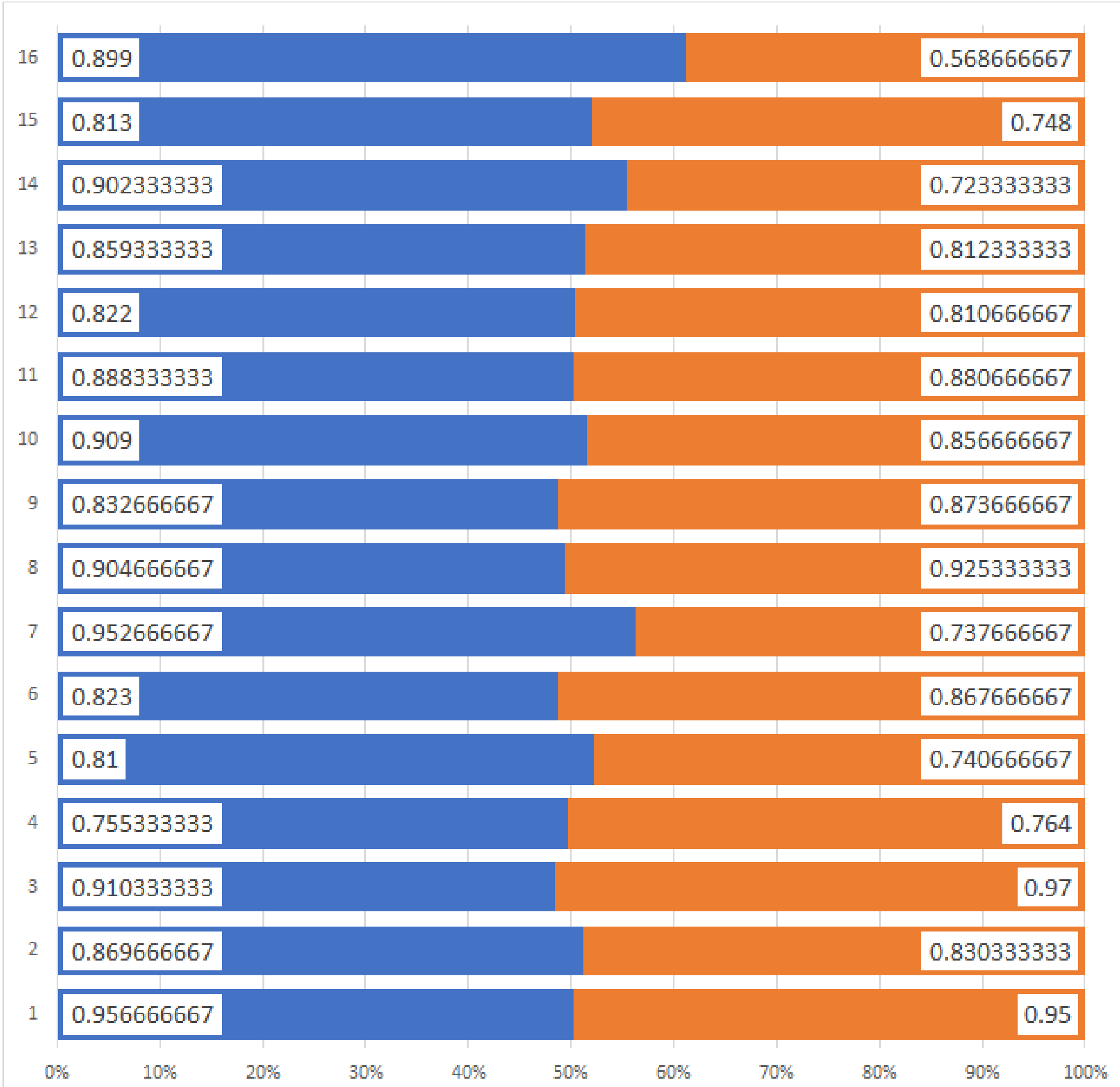

Figure 14 – Eigenvector Centrality for Humans

We see here that humans remain immensely important within the activity itself. Of all nodes in these networks, they are the more important or essential aspects of a network. Again though, the importance leans toward the tabletop game in that there is an average, overall eigenvector centrality of around 87% for the humans. For the iPad game, that eigenvector centrality lowers to 82%. This again, is accounted for by the automated aspects of the game that humans no longer have to manually do. All of this is evident by examining the network structure visually as well. Take these two plots.

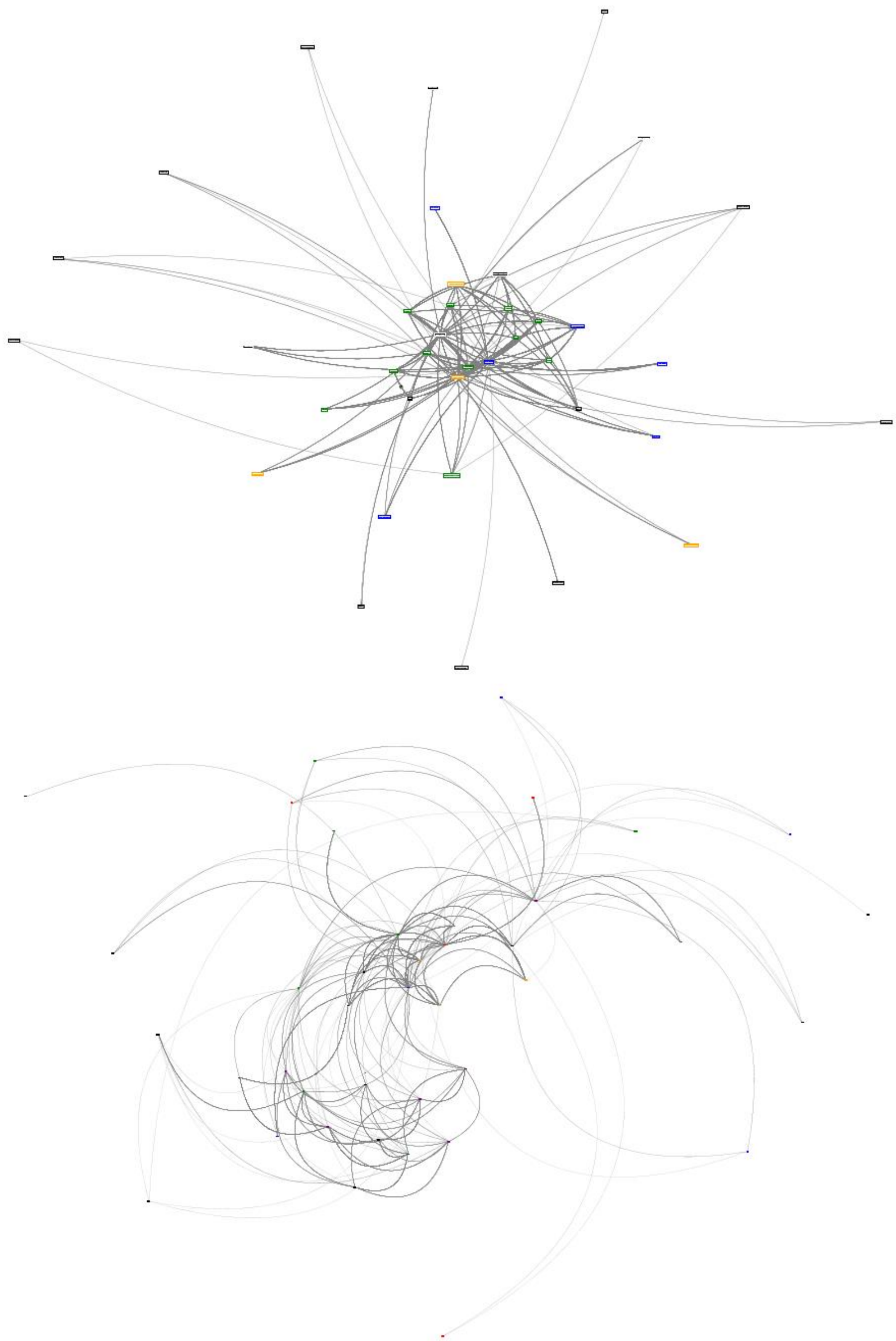

Figure 15 – Network of Play: Tabletop (above) iPad (bottom)

Note that within the tabletop game (above) that the network itself is highly centralized. The human players are maintaining the system by using the tools of the activity to do so. On the right, on the other hand, there is a secondary network of actors that are loosely connected to the central space. This is the computer-mediated aspect of the network visualized for the entirety of either game. Taken per turn, this visualization is still noticeable, just not as starkly. In the next section, I will discuss how to do Association Mapping.

Inter-Space: Homophily, Cliques, and Groups

The centrality of each object, while interesting, is rarely reflective of the reality of any object (Everett & Borgatti, 1998). Objects recruit, make allegiances, and often undergo countless tests of strength to continue their existence. In a game like *Catan (1995)*, all of the agony of that constant testing is encapsulated in hybrids that vie for the best position based on the recruitment of other objects. The inner space of objects allows us to consider each tree whereas the inter-space of an activity allows us to observe small groves within a forest as they compete for nutrients with other groves. There are two ways to consider the inter-space of a network. The first is to separate the groups out in a logical order in order to evaluate that particular group's abilities as a hybrid entity. The second method of analysis for inter-space is to allow the various algorithms associated with separating, identifying, and analyzing networks to find groups, communities, and subgroups.

These programs and packages often follow the same algorithmic group construction that they visualize with. For example, the program used at the start of this project – NodeXL – groups by three distinct algorithms: Clauset-Newman-Moore (CNM) (Clauset et al., 2004), Wakita-Tsurumi (Wakita & Tsurumi, 2007), and Girvan-Newman (Girvan & Newman, 2002). The Clauset-Newman-Moore algorithm relies on the density of a network to discover groups and communities. The Wakita-Tsurumi algorithm is a randomized adaptation of the Louvain (Blondel et al., 2008) method of determining communities. In this algorithm, communities are detected in much the same way as the CNM algorithm but instead uses random samples of each node's neighbors rather than calculating each path. Finally, the Girvan-Newman algorithm focuses not on the central nodes or the hierarchy of a network. Instead, it focuses on finding those nodes that connect communities.

Each of these methods allow researchers to discover communities that they might not know existed. For AM, this measure allows large-scale datasets of use to be considered as a whole but for the purposes of this study, many of the algorithmic measures are not needed. Instead, many of the groups of use consist of those entities that "make logical sense." This means that a player will be bound with their resources and with their game pieces. The game board and its components will be hybridized. The user-interface of the iPad application will be made into a hybrid entity. Additionally, other hybrid actors may become more obvious as analysis continues. Objects and their centrality allow hybrid actors to be discovered but all of the hybrid actors or groups together reflect the entirety of the network. This is referred to as the Outer-space of an Association Map

The Outer-Space of an Association Map

Cohesion measures characterize an entire network in much the same way that visualizing it does. These measures suggest how dense a network is and density, in this case, is a measure that evaluates all of the possible ties in a network given the number of ties recorded in a network (Wasserman & Faust, 1994). In the case of software use, it can be expected that software use networks are somewhat less cohesive. We can expect this because automation removes a number of possible ties. The measure of density simple, but effective at characterizing a network. The last two measures are how many other nodes it takes for one node to connect to another. This is referred to as Geodesic Distance. The last measure is homophily. This is the tendency of nodes to associate with like nodes.

Density

Density is measured by taking all existing ties and dividing it by the possible number of ties. The possible number of ties is simply $Density = \frac{|E|}{|V|(|V|-1)}$ or the number of edges divided by the number of vertices multiplied by the number of vertices – 1. This results in a proportion or percentage of associations that were made. Given the characterization that started this research, the expectation is neither heterophily or homophily but somewhere in between because all possibilities should be equal.

Geodesic Distance

The length of associations between any two nodes is called geodesic distance. It is a measure of density because of a network is dense, then many of the nodes in a network can reach each other very quickly. Distance, in this case, describes how many hops one node has to perform in order to connect to another node. This measure of cohesion is also a description of a graph's density but many of the calculations for geodesic distance are not directly tied to the context of the graph, but the context of the network's components. Thus, while a path may be mathematically the shortest path between two nodes, it might not also be a path that is possible.

This measure offers a way to describe the overall sense of a network. For example, the average geodesic distance will describe the density of a network in a different way than the density calculation itself. These measures can also indicate the strain or lack of cohesion of a network in that if networks have significantly high distances between nodes, then the network is strained as the number of steps it would take to connect to another node is difficult. For the purposes of this study, all of the nodes in the graph are able to associate with one another easily. As a result, this measure allows a number of observations to be made of the network itself. The final measure that AM will deploy in this nascent study is that of homophily and heterophily.

Homophily

While the centrality of each object is important, objects do not often exist alone. In SNA, centrality is a measure of how many hybrid actors a single object is. There are additional measures that can describe the relationship of groups of actors within a network. These measures I refer to as the inner space of a network. The measures of inner space consist of two specific measures that are useful for AM. The first measure, homophily, is an indicator of how objects associate with like objects (Al-Qaheri & Banerjee, 2013). In AM, we would expect homophily and heterophily, the propensity to only associate with different objects, to be skewed toward heterophily. However, this is not entirely true.

Homophily has been used in SNA as a measure that has been associated with a number of trends. For example, many networks tend to be homogenous given that generally, we are a stratified society through the tenets of capitalism's forced social classes. Additionally, online these trends have continued in that social media communities tend to also reflect this trend from reality. In AM, homophily assumes that all objects are equal and makes no hypotheses save 1. Given that all objects will be afforded the same propensity to act, the activity being observed is still a human activity. Therefore, no network will be guided toward homophily because the human actors will be central by way of being the focal point of the network. While this is true, we will no doubt see that hybrid actors – non-human and human together – will be the mathematical majority.

How to Do Association Mapping

A network is little more than a collection of entities that are related in some way. In this way an actor-network, a social-network, and a graph, are synonyms for the same type of assemblage. For actor-networks, Bruno Latour and Michael Callon wanted to allow humans to act instead of being directed and constrained within and by structures and a priori concepts levied upon actants before acting (Callon, 1986; Callon & Latour, 1981). Within information communication technologies, the Actor-Network is termed a Social Network and are instead points of data connected across types of databases (Cross et al., 2002). These connected data points are related to graph theory that originated through the Leonard Euler's solution of the Königsberg bridge problem in 1736 (Barabasi, 2002).

Association Mapping is performed by creating a list of dyads on a spreadsheet. In column A is the object performing an association. In column B is the object being associated with. When an object or human replies to that association, a reciprocal tie is made. In this way, Association Mapping forms a directed network or a social network through which all ties or associations have a direction. By concerning ourselves with non-human objects within the formation of "the social" we must afford non-human objects to have the ability to form an association on their own. With this in mind, the researcher watching an hour-long video consisting of almost countless associations being formed means a lot of individual decisions must be made by the researcher.

Through the associations, it is possible, as with most qualitative methodologies, that something was missed or that something was overlooked. While mistakes could be made, however, due to the nature between a researcher, the subject of research, and the manner through which it was created, other researchers can also engage these data and make their own maps of interactions. The process of creating interactions or associations as they are called in Actor-Network-Theory was simple. All that needed to occur was a physical touch, a call upon a non-human actor or human actor, or a non-human actor called upon something else.

For example, during a normal turn each player will roll the dice, the numbers on the dice indicate that they need to seek out that numeric representation on the board. Once that numeric representation on the board is found, players must then refer to the terrain to see what resource is distributed. Once that resource is known, players must then hunt down the proper cards – at this point, one player may be designated as the “Bank” or keeper of all resources – and obtain what they are owed. Once the resources have been distributed, the player whose turn it is must examine their resources, the terrain, their pieces, the other player’s pieces, and consider their own actions – if any are available.

Within this standard turn sequence, and number of interactions could occur. The player must pick up the dice. The dice are communicating with the player about their contents – small circular indentations or pips. That relationship is 2-way and is represented like this.

Figure 16 – Dice and Player Social Relationship is 2-way

These dice had to be handed to that player and so another player has to be added. As such, that relationship has closure as long as all players can see (and touch) the dice.

Figure 17 – Dice and 2-Players.

Now, the player will roll the dice. Before, during, or after they roll, they may also communicate with other players. Also, other players not currently engaged with the dice might also communicate. As such, the social network that exists at the moment of rolling could look something like this.

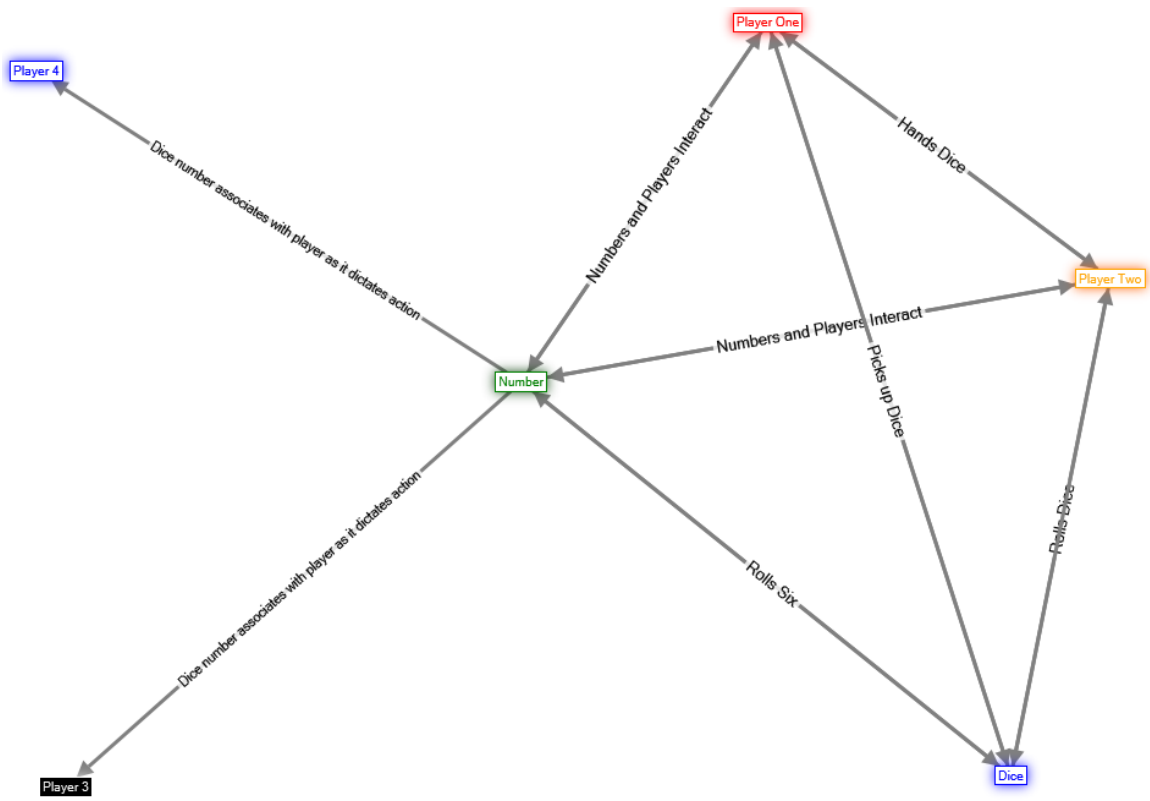

Figure 18 – Associations created by humans and non-humans during a die roll

Once that player rolls the dice, a new set of monads are assembled. The system at hand is being instantiated by the players and the non-human actors as represented by that system. Let's say that the players roll a 6. Here, players then must hunt down the 6's, look at the terrain, and look at each player's pieces. That social network looks something like this:

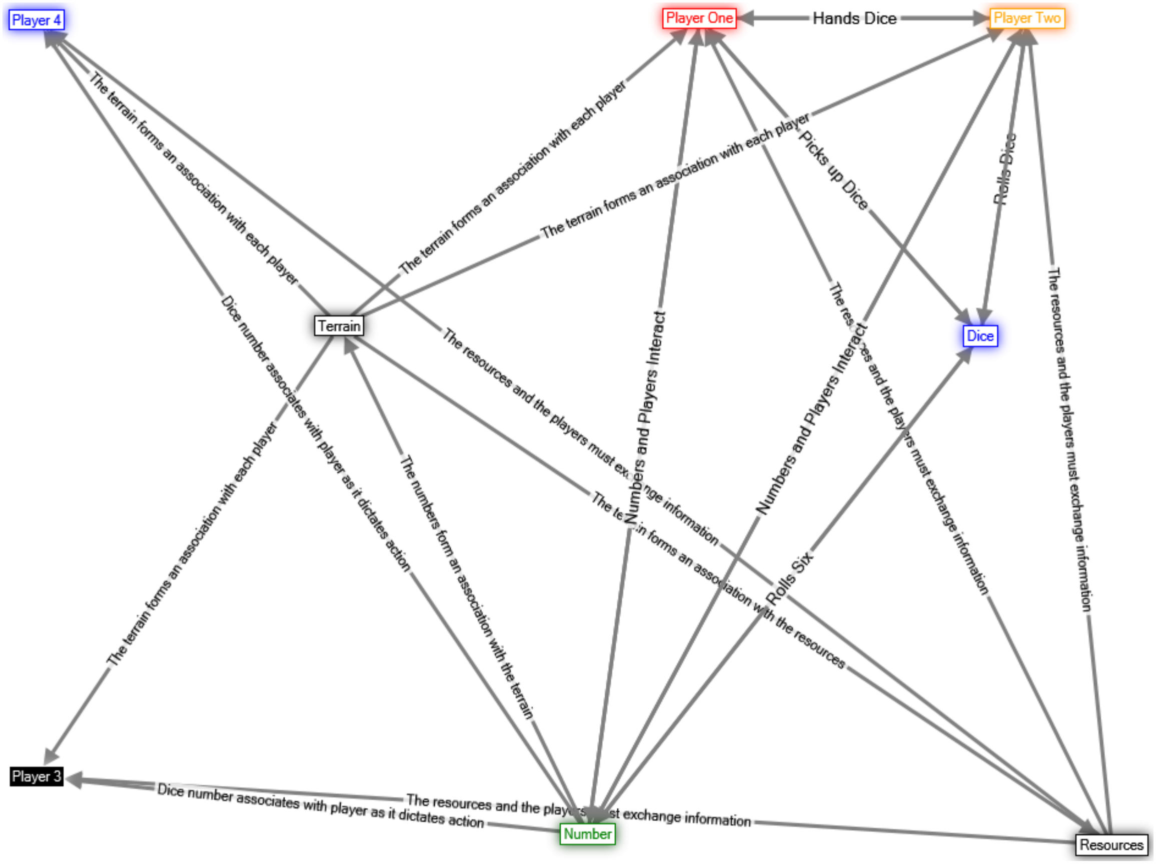

Figure 19 – The number of associations created overtime is always increasing

Each player must check the number which itself must associate with the resources present on the board via the Terrain. In this way, each moment a monadology is being formed, the number of associations, objects, and pairs are quickly growing. The social network above is the beginning of a single round. A round consists of each player on the board taking their turn (literally going around the table). In the case of the basic game of *Catan (1995)*, there are 4 turns each round. As the definition of play is as such that it has its own sense of time and place, the turn is the bounded space within which the playground exists. Once the turn occurs, that player must then consider their actions. In this case, players must grab their resources that the terrain and numbers indicate they must obtain, once obtained whoever's turn it is has determined that they are going to build a road. Building a road on the island of *Catan (1995)* requires a piece of wood and some brick. That social network looks like this.

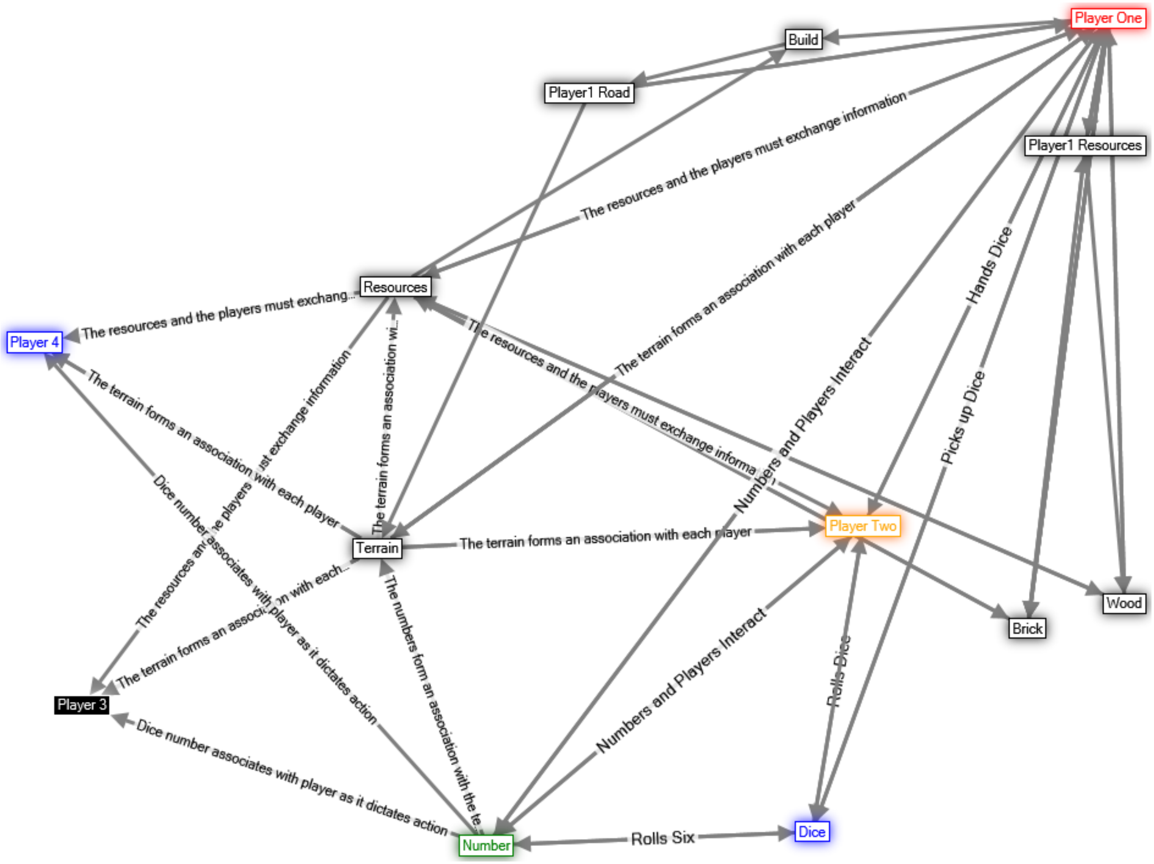

Figure 20 – Right after the die roll and up to a build order

Player 1 (in red) receives a brick resource and a wood resource. They use these resources to build a road. In order to do so, they must designate that they will build a road which means forming an association with the resources and building procedures of that space. This also means that the resources player1 has must become their own separate object both collectively (Player 1 Resources) and individually (Brick and Wood). Note that this still does not include the end of the turn or any moments of discussion. In total, this network might represent 10-20 seconds of time.

As the player uses their resources, they have the option to ask each player or a sort of "pseudo, idealized other" or "the players collectively" if they would like to offer up resources for other resources. Sadly, upon building a road, that player examines their resources and asks if anyone would like to trade with them. Player1 is told no. Partially thwarted from obtaining different resources, that player hands the dice to the next player and the turn continues as it originally began. The final network for this turn would look something like this:

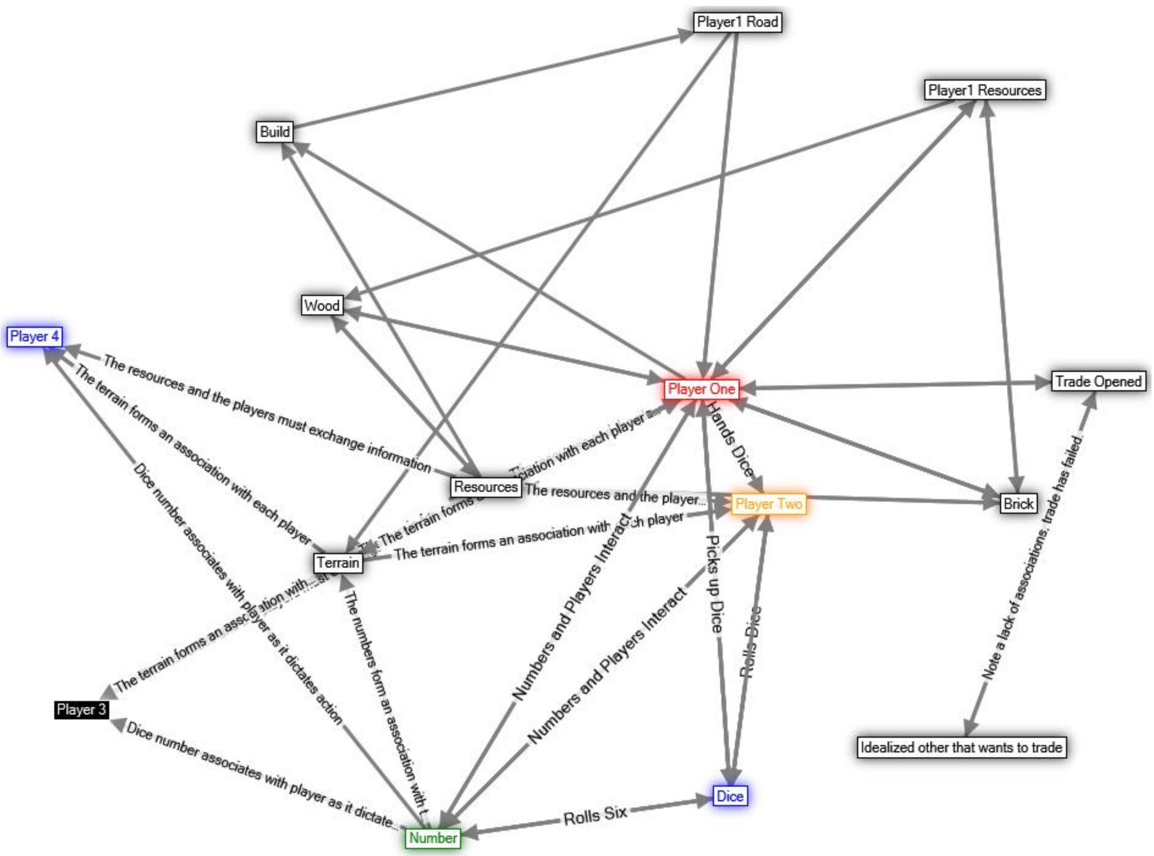

Figure 21 – The First Player's Full Turn

Here, we see that there are no associations made with the "idealized other that wants to trade." In this way, or at least in this style of play, the players are not necessarily associating with one another. Instead, they are associating with some "generalized other." This "other" is someone who is grand who wants to trade with them. With no associations forming with this object, we note that no trade has occurred and, in this way, we see that trade was not possible. Given that this is the beginning of the game, this is not necessarily unheard of and is more common than not.

Overall, while the above are a representative visualization of what is occurring, the spreadsheet itself can contain useful data for the observer. Note how this particular dataset uses labels for vertices to note particular events.

1			Labels
2	Vertex 1	Vertex 2	Label
3	Player1	Dice	Picks up Dice
4	Dice	Player1	
5	Player1	Player2	Hands Dice
6	Player2	Player1	
7	Dice	Player2	
8	Player2	Dice	Rolls Dice
9	Dice	Numbers	Rolls Six
10	Numbers	Dice	
11	Player1	Numbers	Numbers and Players Interact
12	Player2	Numbers	Numbers and Players Interact
13	Numbers	Player1	
14	Numbers	Player2	
15	Numbers	Player3	Dice number associates with player as it dictates action
16	Numbers	Player4	Dice number associates with player as it dictates action
17	Numbers	Terrain	The numbers form an association with the terrain
18	Terrain	Player1	The terrain forms an association with each player

Figure 22 – NodeXL Entry Example

Where this dataset differs from others is that each association along the way is integral to the formation and perpetuation of the event being observed. If associations stop being made, the monadology collapses, the magic circle breaks, or some other type of disruption has occurred. Thanks to the addition of play, we can bound space according to the rules of the systems that are being engaged. By bounding a space thusly, it is possible for that system to not only be evaluated within the time that it creates, but also over time as different types of resets and continuations allow for new associations to be created, old associations to be tested, and for the monadology itself to shift and change.

After cataloging and mapping all of the associations within a particular game, a large database is created using NodeXL, a social network analysis tool. From this master database, a number of smaller databases are created – one for each turn – and placed inside of a folder. In doing this, it is possible to know what aspects of the social network changed over time. From the transcript, we can know why certain aspects of the social network changed. From the video and audio, we can also watch it change. By triangulating all of these entities, not only do we get to witness a monadology form and change, but we have a record of all of the activities within it.

How to Analyze Association Mapping

There are three things that are important to consider for social network analysis that is augmented by Actor-Network-Theory and play. For social network analysis (they will be referred to as monadologies from this point on), they concern themselves with individual actors associating with others. These actors (for example, between one player (A) and another (B)) often form associations. These associations could be for any reason but in this case, A > B represents Player A associating with Player B. In this case, this is a one-way association. B is associated with A but A is only associated with B as a one-direction association. However, if B reciprocates that association, a dyad is formed. A<>B is a 2-way relationship between nodes that forms a dyad.

As associations increase, a third actor (C) appears. In the case of *Catan (1995)* this could be a pair of dice or a piece of terrain. In that case, a Node has begun to appear. In this case, A is associating with C in that they've picked the dice up. They hand the dice to B. In this circumstance A<>C<>B is occurring in that the dice are associating with both of the players as a representation for a round (a quarter of a turn) ending and a round beginning. In some cases, this could be the end of a turn and the beginning of a turn.

At this point, the similarities to normal social network analysis dissipate. There is no reason that a network forms aside from play beginning. Through the start of play, a playground forms and the social network represents that playground. Optimization, speculation about why certain nodes are central, and most network theorizing is minimized. What is used from social network analysis are the mathematical representations of what is occurring within a network. In this case, the concept of homophily or the tendency for like actors to associate is useful not as a measure of like-to-like but as a measurement of how certain kinds of actors interfere with homophiliousness. Additionally, centrality factors like Degree, Closeness, Betweenness, and Eigenvector are useful in that these measures can display the numeric quantity of the qualities the researcher has observed.

In this way, a social network may have actors that are human as their most central components or perhaps at times the non-human, inanimate actors are more central. It is worth noting that in the text *Analyzing Social Networks* (2013), Borgatti, et al. note that,

> *"The nodes in a network can be almost anything, although when we talk about social networks we normally expect the nodes to be active agents rather than, say, inanimate objects."*

Hence the name change. Within a monadology, each monad is just as important as others. It is understood that any object is capable of being associated with and that associations, groups of associations, form a social interaction. Social ties and social relationships do not form the basis of association between actors. As such, dispensing with the inaccurate language and presupposition of human actors as social by default allows the creation of monadologies that can be used as an example of what occurs when objects assemble within a playground. For example, within the playground represented by *Catan (1995)*, the dice, terrain, and numbers are all represented as central to the system. However, their role as a central component within this social network is low because their role is mediated by the resource cards. As such,

CHAPTER 6 – ASSOCIATION MAPPING IN ACTION

Association Mapping Analysis

There are two distinct tasks that must be completed in order to demonstrate Association Mapping's potential. First, there is a need to prove that the method is capable of understanding its object of study differently than existing methods while also expounding on those invisible, implicit assumptions of practice. Second, if Association Mapping does provide new types of understanding of use, then the implications of those new understandings must be shown to have value. The first task is the focus of this section whereas the second task – the implications – will be discussed in the conclusion. This section – in following the traditional academic article structure falls into providing an overview of the data. Specifically, I will be mentioning vertices, nodes, groups, numbers of edges, and other parameters specific to social network analysis and through SNA, association mapping.

Data Overview

For the most part, performing any task using social network analysis resembles building a pyramid from the top down. Or, you could refer to it as an endlessly growing stack of data sheets. The main component of SNA is one of creating dyadic pairs in sequence. The second task of SNA is data cleaning and preparing a number of files for one analysis several dozen times. This is due to most processes within the analysis of social network data being done prepared to carry out different analyses manually. While the R package 'sna' could theoretically perform many of these analyses automatically, the nature of this examination is exploratory in its origination. As such, more graphic-oriented user interfaces allowed for more rapid exploration. With this exploration-focused work, the task then is to take more user-interface focused, pre-packaged entities and use them as they need to be used. This means creating nearly endless numbers of files. For example, the six data files that comprise the initial coding of each game of *Catan (1995)* is made up of:

Game	Edges	Vertices	Total Sheets	Time Played
1 – TT	4172	43	15	1:10:46
1 – iPad	2181	59	15	1:53:00
2 – TT	3561	48	22	1:37:46
2 – iPad	2281	43	17	1:25:38
3 – TT	3409	62	15	1:31:41
3 – iPad	4573	82	20	2:27:30

Table 11 – Total Edges, Worksheets, and Vertices

In addition to the edges and vertices, additional parametric data was appended to the data sheets representing the game. These parametric data included the following attributes.

Type of Association is a representation of what this work seeks to examine. There are four categories for this attribute: Human-to-Human, Non-Human to Human, Human-to-Non-Human, and Non-Human to Non-Human

Human or Non-Human is an attribute meant for an examination of the different kinds of associations. In this attribute, there are two columns – Edge 1 and Edge 2. These are then coded for type of object the originator (Edge 1) is and the type of object being associated with (Edge 2).

Codified Sequence is a parameter used to indicate a group of associations that may be repeated later or is being repeated. For example, when a die is rolled in *Catan (1995)*, the work carried out after the die roll is highly routinized due to the rules of the game itself. In this, the ability to differentiate how humans perform routine versus their mechanical counterparts is valuable. Additionally, this attribute allows humans and non-humans to be observed working in tandem to complete a task.

Turn is the parameter used to represent time within the analyses. When separating each entire game into datasheets to be analyzed separately, this attribute was the key item to separate with.

Time was also represented within these data. However, because time within the activity is kept (by turn), this was more of a representation of time flowing outside the activity. At the start of each die roll, the game's current time was recorded for future reference. This allowed for each turn and each round to be codified and referenced for analysis should it be needed.

User-Interface was represented on the sheet for the iPad games. This allowed for visualizations of the social networks directly referred to by the user-interface for the game.

Each of these attributes will be used in analysis though many of them may remain invisible. For example, the categories of type of interaction are used to separate NodeXL into sheets rather than as analysis. In addition to coding attributes for future analysis, NodeXL was also used to label die rolls, vertices, and color them according to what aspect of the activity they belonged to.

While each of the games is coded in its entirety, the act of coding via recording is not without its problems. One game in particular was troublesome. The second game of the first session with the iPad was the first game that was recorded. The players would remove the iPad from view or hold the iPad in a way that benefitted them. Using the sounds of resource distribution, these potential oversights were overcome. In this way, the affordances of how *Catan*

(1995) was designed lent themselves to a more detail-oriented analysis. Finally, after coding these products in NodeXL, each turn was sent to its own NodeXL workbook.

The next step of data preparation was for the product UCINet. The turns were made into matrices for use in UCINet using NodeXL's exportation functions. Once the matrices were created, they were assembled into 1 excel workbook consisting of a worksheet for each game. These workbooks were then imported into UCINet by batch. Each worksheet within the workbook was made into a UCINet Matrix file consisting of the two necessary files to make sense of the matrix data. Within UCINet, each worksheet was examined using multiple measures of centrality in addition to multiple measures of cohesion. This resulted in additional files for each analysis – 1 new file per turn in addition to 1 file representing cohesion of each game as a whole.

In total, 1 file of 20 turns of a game of *Catan (1995)* began as 1 Excel file. This Excel file turned into 21 matrices which were then combined into 1 excel file consisting of all 20 matrices plus 1 matrix representing the entire game (1 + 21 + 1 +1 = 23). From here, the matrices were imported in a batch using UCINet's batch importing file. This resulted in 42 files for UCINet in order to perform cohesion and centrality measures on them. Each of the centrality measures meant the creation of another file for each turn plus the entire game meaning that 110 files originate from the creation of just 1 NodeXL file. From these 110 files, the results needed to be aggregated and placed into a new Excel file. 6 distinct files were created:

- All Centrality Measures per turn and overall.
- All Cohesion Measures per turn and overall.
- All Cohesion Members per Non-Human object.
- All Cohesion Measures per Human Object.
- All Centrality Measures per Non-Human Object
- All Centrality Measures per Human Object.

Thus, from 1 NodeXL excel file, 116 files were created and of those 116 files, only 6 were of use outside of the visualization and calculations that NodeXL itself can perform. The files created for UCINet were created in order to normalize all measures of centrality and cohesion. In total with these 6 games, there are approximately 116 * 6 files or around 700 files with additional files being created by video recordings, iPad screenshots, audio recordings, Adobe Premiere files, sample networks, exploratory network data, and other ancillary work. This resulted in approximately 1000 – 1500 files to work with across text, audio, video, and network dimensions.

With these files ordered by game, transcripts for the games, recordings, and notes from the researcher, data analysis began. Association Mapping at its core is a qualitative measure bolstered by non-generalizable numeric representations of qualities on matrices. The resulting analysis is mostly descriptive in nature. However, that description should prove to be a fruitful space for ideas about design that can be added to with similar observations over time. This will be discussed via Design Fiction at the end of this research.

Differences Between AM and SNA

AM differs from Social-Network Analysis in a number of ways. Most SNA offers an overview of a particular social network. These data often resemble an exploded view diagram or exploded-view drawing such as Figure 23 an exploded view of a Bultaco Motorcycle Engine (Blain, 2014). In these exploded-view drawings, a complex object is literally exploded. Explosion, in this sense, is that each bit, each piece, each object that makes up a complex object (like a motorcycle engine) is represented in a single picture. This is done to show the viewer the various aspects of the object that might be too complex for the human to make sense of. In AM, these exploded view drawings are not just of the motorcycle, but of the human, the road, the surface being driven on, other drivers, the weather, and everything else surrounding that motorcycle rider.

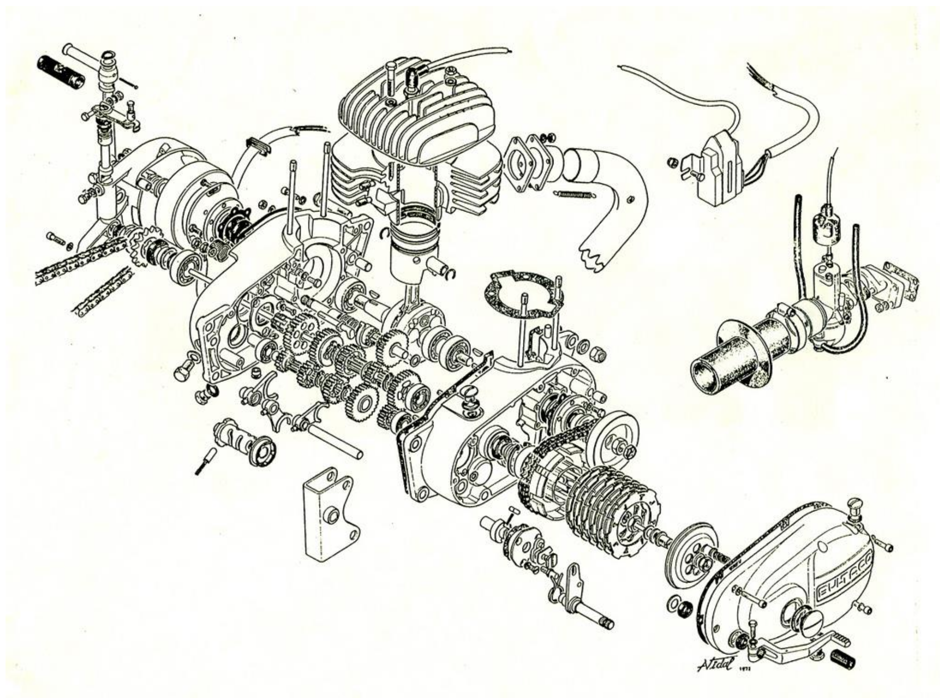

Figure 23 – Bultaco Engine Exploded View

Each of the files for this analysis using the proposed method called Association Mapping is essentially a portion of an exploded view drawing of the social moments created by a design during that design's deployment. While the analysis itself is cumbersome and file heavy, the precedent set by other forms of design over time allow us to view the end goal of what AM is providing, an endlessly exploding diagram of the agonistic nature of agency in a hybrid network consisting of human and non-human objects that cannot achieve anything without recruiting one another.

<u>The Parameters of The Social-Network Analysis Data</u>

In addition to the various objects surrounding and mediating a social network, there is additional numeric data other than points of interaction. There are also frequencies of speaking that can be coded. Within this difference, the best place to begin is in how these data differ and how these data represent an exploded view an activity, or of play. As with all difference, there are a number of similarities that we might miss if we were to obsess over difference.

Game	Edges	Vertices	Total Sheets	Time Played
1 – TT	4172	43	15	1:10:46
1 – iPad	2181	59	15	1:53:00
2 – TT	3561	48	22	1:37:46
2 – iPad	2281	43	17	1:25:38
3 – TT	3409	62	15	1:31:41
3 – iPad	4573	82	20	2:27:30

Table 12 – Total Edges, Worksheets, and Vertices

First, each game on the iPad took longer to finish than its tabletop equivalent (Table 12) with one notable exception – Session 2, Game 2 on the iPad. This will be discussed in detail in the next section. Next, the players in the third session took a very active role in identifying things themselves within the game that was being played. This resulted in the game being coded far differently than the other two sessions though each grouping used slightly different approaches resulting in slightly different vertices, edges, and groups. As a result, we see a possible criticism of AM – its value may be impeded by the group being observed.

It is then possible to retroactively go back and re-code each game with the vertices of the third session now that these initial analyses are completed. This will not be done in the present research as it is more useful to discuss these differences and how a method develops over time. That process is reserved for future research. There are additional issues with recoding the data. While recoding based on the context of other users would result in more predictable data, it would be similarly reduced to existing methods. This is what association mapping is meant to overcome. Instead, these data should be integrated somehow. This will be discussed in the chapter on impact.

Another comparison with SNA and AM is in this concept of modality comparison. SNA could rely on speaking data to perform an analysis of the social network. The following parameters were recorded (Table 13). In this table, we note that discussion often decreased significantly between the tabletop and iPad sessions with the exception of Session 2. These conclusions were reached by examining the number of times spoken and then calculating the percentage difference by normalizing the percentages based on the difference between game 1 and game 2 and then calculating the two normalized values to display the mathematical difference.

Session 1						
TT Color	**TT-TS**	**iPad - TS**	**iPad Color**	**Diff**	**Type**	**Time**
Red	332	551	**Green**	13.00%	**TT**	1:10:46
White	330	551	**Yellow**	12.83%	**iPad**	1:53:00
Orange	221	614	**Red**	1.41%	**% Diff**	62.63%
Blue	210	255	**Blue**	10.96%		
Total	1093	1971	**AVG Change**	9.55%		
Session 2						
TT Color	**TT-TS**	**iPad - TS**	**iPad Color**	**Diff**	**Type**	**Time**
White	399	181	**Red**	4.81%	**TT**	1:37:46
Orange	342	383	**Green**	10.19%	**iPad**	1:25:38
Blue	472	343	**Blue**	9.12%	**% Diff**	114.17%
Total	1213	907	**AVG Change**	8.04%		
Session 3						
TT Color	**TT-TS**	**iPad - TS**	**iPad Color**	**Diff**	**Type**	**Time**
Red	337	560	**Red**	-6.89%	**TT**	1:31:41
White	242	358	**Yellow**	-2.16%	**iPad**	2:27:30
Orange	228	313	**Green**	-0.51%	**% Diff**	62.16%
Blue	371	286	**Blue**	13.26%		
Total	1178	1517	**AVG Change**	0.92%		

Table 13 – Parameters of Differences Between Modalities for Players

It is possible to evaluate just how much information was captured by Association Mapping by checking against recorded human conversation. Each moment a human says something is a recorded association though it is between a human and another human most often. AM uses these associations as well. Many of the moments of discussion from the transcript are included as a researcher also records moments of association, moments of direct touch, metaphorical touch, and whether or not those associations are reciprocated. Each of these associations are dyadic in their creation A > B and B < A if reciprocated. Sometimes these associations may be more complex (e.g. A > B, B > C, C > D, C > B, B > A). While more complex, the creation of these dyadic pairs makes it possible to dig further into the activities being examined. Designers can examine the paths objects form as they contribute to the formation of use and ultimately consider better paths.

If we add the edges from the Association Maps created by observing these 3 groups of players play the board game *Catan (1995)*, then we can see just how much data is missed in only observing humans act. These data are located within Table 14. In this chart, the total number of times each player spoke is recorded by game modality (tabletop or iPad). In addition to the number of times each user spoke, what is also included is the number of edges each user began. By comparing these data, the first task of a new method seems to be answered – AM is at least recording data differently.

Session 1					
		Tabletop		**iPad**	
TT Color	**iPad Color**	**# Spoken**	**# Edges**	**# Spoken**	**# Edges**
Red	**Green**	332	358	246	551
White	**Yellow**	330	433	284	551
Orange	**Red**	221	270	274	614
Blue	**Blue**	210	298	265	255
Totals		1093	1359	1069	1971
Total Edges			4172	**AVG**	3181
		Spoken to Edges	26.20%	29.91%	33.61%
		Human Edges to Edge Total	32.57%	47.26%	61.96%
Session 2					
		Tabletop		**iPad**	
TT Color	**iPad Color**	**# Spoken**	**# Edges**	**# Spoken**	**# Edges**
White	**Red**	399	277	181	324
Orange	**Green**	342	242	383	228
Blue	**Blue**	472	313	343	215
Totals		1213	832	907	767
Total Edges			3561	**AVG**	2281
		Spoken to Edges	34.06%	36.91%	39.76%
		Human Edges to Edge Total	23.36%	28.49%	33.63%
Session 3					
		Tabletop		**iPad**	
TT Color	**iPad Color**	**# Spoken**	**# Edges**	**# Spoken**	**# Edges**
Red	**Red**	337	192	560	524
White	**Yellow**	242	190	358	475
Orange	**Green**	228	161	313	418
Blue	**Blue**	371	297	286	413
Totals		1178	840	1517	1830
Total Edges			3152	**AVG**	4573
		Spoken to Edges	37.37%	33.27%	33.17%
		Human Edges to Edge Total	26.65%	33.35%	40.02%

Table 14 – How many times each player spoke to the number of edges each player created

To compare these data, let us take the number of times spoken for each game and use it as a representation of a number of times humans themselves have created a dyadic pair. This means that the number of times spoken should be similar to the number of times humans created an edge in network data that has a target of another human.

Some of the ways that humans speak during an activity are difficult to understand outside of the contexts they are muttered. One of the ways that this occurs within the data collected here is in the creation of this sort of 'idealized-generalized other.' This generalized other, in a game like *Catan (1995)* is not necessarily unique but it is the result of a set of rules. It is a generalized other for something ideal to occur. For example, "Can anyone trade for wood?" "Someone has sheep, right?" This is an edge that is targeting any one human at the table but it is also an edge that targets no one at the same time. It is seeking a non-human, human in the ether. Additionally, we use this generalized other when declaring things like, "I'm going to use the restroom." Or, we sometimes speak to non-human objects, "I want you to roll a 9" for example, as we beg the dice to result in something that favors us specifically. With these ideas in mind, there should be some discrepancies and variance across the number of times human speak and the number of associations created by humans in Association mapping.

Across many of the games, these data seem to roughly similar. In fact, if we take each tabletop game, the values in Table 15 show that the human edges created to times spoken are very similar. Overall, within each game is around a 7% difference between human edges to total edges. This accounts for roughly 27% of all recorded edges or all human activity within the network being evaluated. In this way, we can make the declaration that perhaps this is true across each of the sessions regardless of the modality of play.

For example, if the data from the above collection of tabletop gaming is replicated for the iPad, then we have the data in Table 15. Within these data, we can see that the data is very similar. Overall, within each game is around a 7% difference between human edges to total edges. This accounts for roughly 30% of all recorded edges or all human activity within the network being evaluated. From this brief comparison of frequencies and differences, we can make the declaration that humans – at least for the games witnessed by this researcher – accounted for approximately 30% of the associations present within the networks created to represent those games.

	Spoken	Human Edges	Total Edges	E/T	HE/TE	Diff
Session 1	1093	1359	4172	26.20%	32.57%	-6.38%
Session 2	1213	832	3562	34.05%	23.36%	10.70%
Session 3	1178	840	3152	37.37%	26.65%	10.72%
Totals	3484	3031	10886	32.00%	27.84%	4.16%
Times Spoken to Total Edges			32.00%			
Human Edges to Total Edges			27.84%			
Difference Spoken to Human Edges			6.95%			

Table 15 – Tabletop specific data for times spoken via transcript to human edges

Interestingly, the data for two of the iPad games – session 1, game 2 and session 2, game 2 – provide something of a wild variance among the games. In session 1, game 2, the game that was recoded consisted of many of the players mostly neglecting the iPad and discussing amongst themselves other topics of interest. Game 2, Session 2 on the other hand, ended early – perhaps as much as 30 or 40 minutes early due to players rejecting an artificially long session due to resource distribution issues, spacing issues for building, and constant flipping of things like the Longest Road. In this way, the difference among the iPad games is far greater than the difference between iPad and Tabletop games.

	Spoken	Human Edges	Total Edges	E/T	HE/TE	Diff
Session 1	1069	1359	3181	33.61%	42.72%	-11.94%
Session 2	907	832	2281	39.76%	36.48%	4.31%
Session 3	1517	840	4573	33.17%	18.37%	28.72%
Totals	3493	3031	10035	34.81%	30.20%	7.08%
Times Spoken to Total Edges			34.81%			
Human Edges to Total Edges			30.20%			
Difference Spoken to Human Edges			7.08%			

Table 16 – iPad specific data for times spoken to human edges

The take away from this section is meant to be that the edges provide approximately 70% more data for designers to work with than that of ethnography, participant observation, qualitative coding, or the other types of qualitative methods. This is not meant to be critical of these methods as they are valuable in and of themselves. Instead, I would suggest that association mapping provides a unique opportunity for Human-Computer Interaction to use its tools and its computational abilities to manifest methods that reflect the complex contextual realities of both the products we create and the users that must use them. Before moving on to discuss the implication of these results, I would like to take a brief moment to dig in to a specific case study – the curious case of Session 2, Game 2 – the iPad game that ended early.

The Case of Session 2, Game 2 – Making Sense of AM through Comparisons

Of the exceptions in the above discussion, the data of Session 2, Game 2 or the 2nd iPad game recorded will be used as a comparative case study. The above section highlighted that the data between AM and the participant observation by providing a discussion of the frequencies of human-based discussion. The conclusion of that section was that human discussion and associations alone provide approximately a third of the number of associations in a given task. The remaining data is often gleaned through the context of what it said. In much the same way as a car engine or fountain pen, we can often still gather enough information to fix things but we may not fix the entire problem. This is where the concept of exploded-diagrams come back into the picture. That is what will be discussed here.

During the second game of session 2, the players elected to not finish the game. Instead of finishing, they awarded victory to a player who was (according to the 2 other players) so far ahead in the game that they were bound to win. This proclamation was interesting as, having played dozens of games of *Catan (1995)* in addition to observing and re-watching this game numerous times, it did not seem like the players would have actually finished that quickly. Instead, if they had elected to keep going there was probably around 30 or 40 minutes left for play wherein other players could have overtaken that player. Here is the board in the state it was left at.

Figure 24 – Session 2, Game 2 Game Board at the last turn.

According to Figure 24 and the other two players in the game, the green player (who was declared the winner) was going to win at any moment. They elected to have the player win and they left the game at that. This also is not a design problem. However, the players got to this point because the red player had allowed themselves a limited view of the board and a numeric distribution that favored the green player due to their initial placement. Due to the nature of the game, *Catan (1995)* tends to work in cycles with players gaining resources and then spending them. This means that if there are a lot of associations in a given turn for a particular player, then we can guess that something has transpired and could then check the tape and transcript for more detail. If we plot the centrality of the green player each turn over the course of the game, we can see this trend manifest in Table 17.

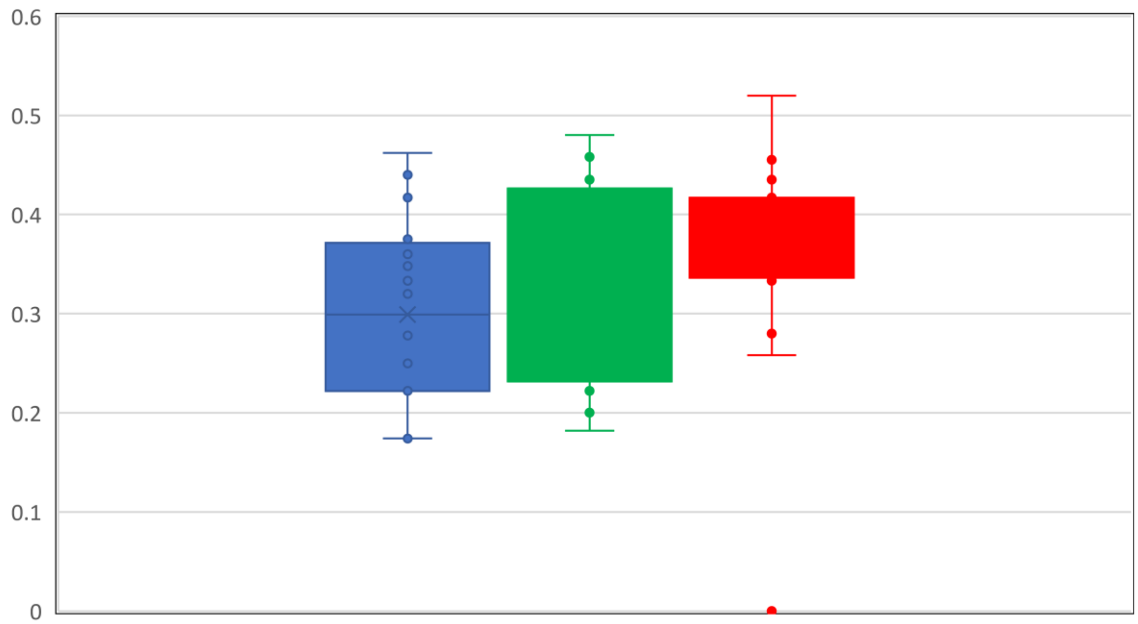

Table 17 – Box and Whisker plot of the degree centrality of the Blue, Red, and Green players

The box and whisker plot of degree centrality allows the trend of centrality to be viewed in total. There are 16 points of data per player and within those 16 points, we can say that the players who *did* more had more variance because they would take turns spending all of their resources – or losing all of their resources to the robber – and then spend a few turns building up again. The green player has more variance because they were able to spend resources the most often. The red player's variance in terms of centrality is indicative of rarely spending resources. In Figure 24, we can see that the player purchased 4 roads and a settlement over 16 turns.

Using the transcripts of play, a brief analysis can be performed to give a little depth to what was discussed at the table. These data were produced in Table 18. In these data, we see that the code, "Dice Reference" was the most repeated phrase of the game session by the human players. This dice reference was twofold. First, some of the references to the dice were about the actual dice rolls. “I rolled a 9” or “I rolled the robber.” There is a second aspect of the code that is indicative of the UI element represented by the dice. Within the *Catan (1995)* app, the dice button means, “please pass the iPad to the next person.” But of the 52 coded dice references, only 6 were referring to the dice button.

Session 1 iPad		**Session 2 iPad**		**Session 3 iPad**	
Code	**Frequency**	**Code**	**Frequency**	**Code**	**Frequency**
Trade	40	Dice Reference	52	Ore	88
Wheat	32	Wood	31	Wheat	73
Sheep	26	Trade	30	Sheep	71
Ore	25	Brick	27	Brick	69
Dice Reference	21	Sheep	26	Robber	45
User Interface	17	Ore	18	Trade	42
Development Card	13	Robber	16	Dice Reference	34
Robber	12	Wheat	16	Player Pieces	33
Brick	11	User Interface	10	Roads	30
Wood	10	Player Pieces	8	Wood	30
Food	5	Roads	6	User Interface	26
Check	5	Development Card	5	Development Card	25
Player Pieces	5	Harbors	1	Check	11

Table 18 – Frequencies of Codes Among all iPad Games via Keyword Counting

While we can see through the game and through the transcript that the dice were being discussed, this does not tell the whole story. It also does not necessarily allow those interested in design how or what the dice discussion might be in reference to. Instead, I offer through AM that this discussion of the dice is more of an implication of and explication of the resources themselves. In actuality, what is needed for this to be useful to designers is an ability to see the actions of the players at hand. This is where the exploding diagram comes into focus. How these data are exploded can help designers understand what is happening to the experience; especially when the network visualization is paired with the measures of centrality and cohesion.

For example, if we just concentrate on the dice, we will not see the entire story.

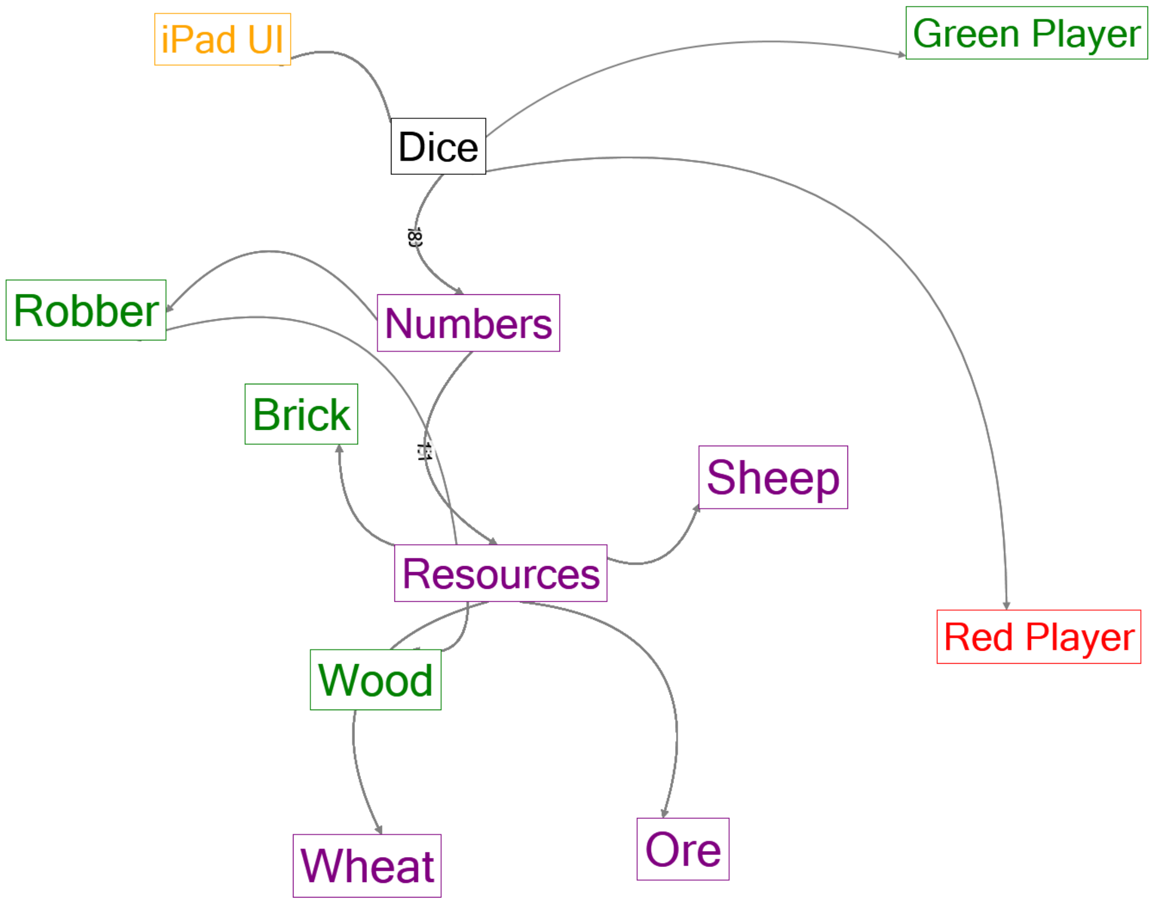

Figure 25 – Ego-Network of the network surrounding the dice.

In the above network, we can see that over the course of the game, the dice is connected both logically and literally to the resources and the numbers that generate them. In addition, the dice are also connected to all of the players as well as the *Catan's (1995)* User Interface represented by the phrase, "iPad UI." What is indicated here is something that might not be shown in Social-Network Analysis or more traditional methods. Within AM, the discussion of the dice is moot. By separating the numbers, the dice represent from the object that indicates that one's turn is done, these possibilities are made clearer. Additionally, the data generated here is not created by the transcript, but augmented by it.

This disambiguation allows the analysis more accuracy as well as an ability answer more questions about what is happening to a design in situ. This exploding can also go one step further by showing what the objects connected to the UI creates within its network. From the analysis, the objects that make the most sense to filter the entire network with make sense. Those objects are, the dice button indicating the next turn, the checkmark indicating an action is completed, the cancel button to stop an action or dismiss a screen, and the objects directly connected to those things.

Once this network is exploded, several things come into focus. When NodeXL organizes the nodes, it does so using whatever method is selected. In this case, the Fruchterman-Reingold or force-directed graph drawing method of network visualization is selected. What this method does is essentially assign attraction to those vertices that share edges while also repulsing those nodes that they do not share edges with. The first thing to notice is that each of the players is not central to this network. Instead, the object at the center that is the central component of the graph is the checkmark. This check mark will be further explored in the next section.

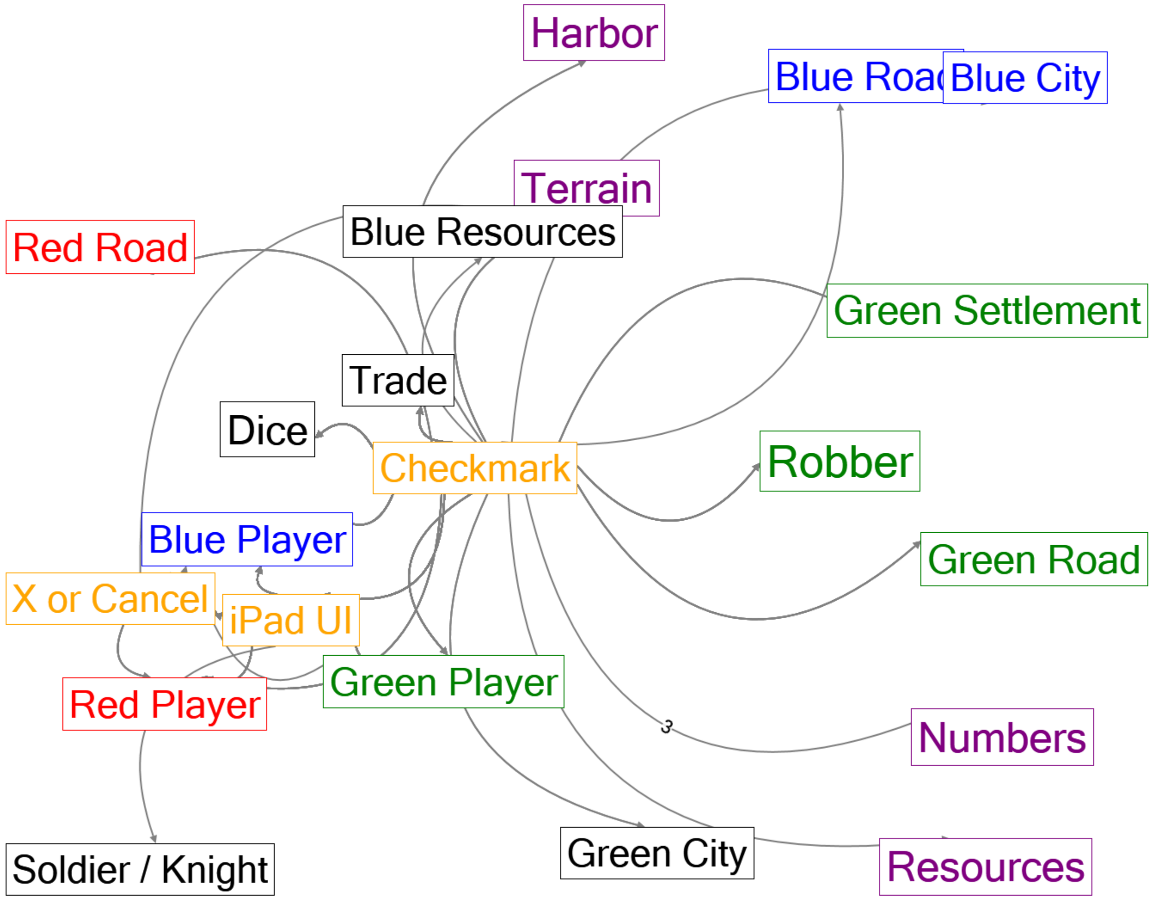

Figure 26 – Exploded Figure representing the elements of the UI

While visually, these data help us examine the makeup of a network of objects, the tenets of empiricism require quantities of qualities run through a number of tests. Or, at the very least the appearance of a concerted, well-structured data collection effort should be present. In the above visualization, each of these vertices is connected to a number of other vertices and through that relationship, we can understand a little about the makeup of these edges. In visualizing them, in witnessing this force-directed graph, we can learn a little bit about their makeup. However, of interest is the data behind the visualization.

By moving these data from NodeXL to UCINet, centralities are normalized. According to the documentation of UCInet, "The share is the centrality measure of the actor divided by the sum of all the actor centralities in the network. These have been ordered so that the actor with the highest centrality appears first." Through these normalization procedures, these data end up with a rank in the form of a percentage. While the visualizations above indicate centrality in some passive way, these data represent the numeric data that comprises the visualization.

Vertices	Average
Check	30.91%
Dice	22.97%
UI	18.81%
Resources	18.30%
Trade	17.31%
Wood	16.08%
iPad	13.40%
Brick	13.36%
Sheep	12.81%
Gresource	12.60%
Build	11.66%
Rresource	11.03%
Terrain	10.61%
Ore	10.51%
Bresource	10.31%
Wheat	10.09%
Numbers	9.98%
Robber	9.58%
UIX	8.96%
Harbor	8.71%

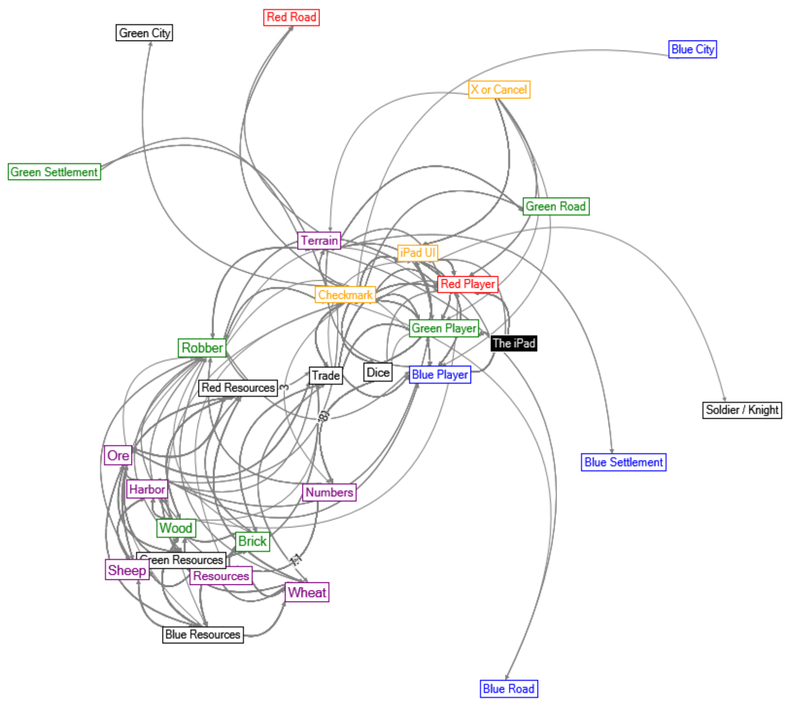

Figure 27 – Visualization of Top Non-Human Actors in Session 2's iPad Game

Table 19 – Normalized Degree Centrality of top Non-Human actors in Session 2 iPad

In the above Table and Figure, we can see a numeric ranking of centrality starting with the check mark and ending with the Harbor. To the right of it is Figure 27, a visualization of the network itself independent of centrality data but instead, is using the actual network data to arrange these nodes as dictated by the method assigned. Seeing these data displayed these two ways is useful.

In the above Table, the big 3 nodes to consider are the Dice, the UI, and the Checkmark. From here, the resources of the game (sheep, wheat, ore, brick, and wood) are represented by a generic entity standing for all of them. Next, each individual resource is shown followed by various UI elements like the harbor, the build button, and each player's individual resource followed by the robber. This list of items within the network of use is useful when examining what non-human objects are most central. However, it does little to offer what those objects are central to. Instead, the right figure represents those data visualized. Here, we can see a few different sections of the visualization.

The first thing to notice is that in the center are *most* of the top 5 central elements. Here, the checkmark, the dice, and the UI are connected. To the right of those objects are the players themselves. It should be noted that with the players represented in the visualization and not the math, the players are themselves less central as they are not being calculated based on their own centrality. The players are not central because they are human, they are central because they are constantly talking to one another. The rest of the network is often drowned out by this.

From that initial central group, there is a disconnected network to the lower left. These are objects that are rarely interacted with. Instead, these are non-human objects that organize themselves and others like them. The resources and each individual players' resources are represented here. They are connected to the rest of the network by the numbers (which generate the resources themselves based on the terrain the number is sitting on top of) and trading. Only, players offer to trade via a screen and if they agree, the resources re-arrange themselves based on the input from players. By receiving the input from the trade screen and not the players, these objects are all essentially removed from the space of interaction.

And so, this is what is meant by "exploded-diagrams" using SNA, called Association Mapping. We can explode the discussion from a transcript and look at how each of the individual elements are structured. By examining that structure, we can make sense of not only what is happening over time, but what is happening at each moment in time (defined by the activity itself). From the initial discussion of players deciding to end the game early, we used AM to make sense of what was occurring. In this case, the cyclical nature of the game was more in favor of the green player at the time and so the other two players gave in to that players' momentum. This is not a design issue. However, in addition to the turn-based data from the game, we can see that there is something of interest in the form of the UI Checkmark. This checkmark seems to be a central non-human object far above the others. This is in need of further analysis.

The Structure of the Discussion

Social Network Analysis has not been used in this way because the word social has traditionally been reserved for something that humans, and humans alone can do. With exception to animals who are social in different ways, the analysis of human-to-human interaction has begun to falter as the growing ubiquity of the computer highlights the ways our ability to research are limited. What I have proposed up until this section of this chapter is that Association Mapping is an augmentation of social network analysis that dispenses with the notions that humans are the only objects who can act. By allowing non-human objects to act within a space that is performed from the perspective of human-computer interaction and consciously focused on play, association mapping has the potential to observe, map, visualize, and measure, the formation of a network that results in a social moment.

In this case, the social moment is result of an endless array of associations with an outcome. The associations form from these irreducible objects that cannot themselves survive in anything other than their native state. To achieve goals, these objects must recruit allies which must survive as hybrid entities in order to continue to exist. Within the use of software, these hybrid entities are formed from the associations of the components of a computer program, the users who themselves are an assemblage of objects, and the context they are engaged in. With that summary of the goals up until now, it is time to consider the next step.

In the previous chapter, I discussed how the perspective of designers often forced users to be pieces, features of a product rather than agentive beings themselves. Next, through the digitization of a tabletop game, I outlined the contradiction between an activity – formed by itself – and a designed activity – designed by outsiders for others. I ended with a discussion of the "generic idealized other" concept of communication during an activity and a discussion of how tool-use was shifted by computer-mediation. The next step then is to discuss the findings of the Association Mapping method of analysis I have been describing and justifying.

The most direct way to discuss the efficacy and use of Association Mapping is to display the three measurements of Social Network Analysis and show how each of these measurements allow us to glean insight from the network formation being observed. The first section of the discussion will be centered on the centrality of the network. Specifically, I will show how the centrality of objects is indicative not only of their strength within the network, but how that centrality also shows the impact of user-interface elements, moments of lost potential, and an ability to witness hybridity in action.

Second, every activity consists of the formation of hybrid assemblages recruiting, undergoing tests of strength, and persisting over the lifetime of a network. The representation of these hybrid objects in SNA are cliques, sub-groups, ego networks, and other words that denote group. This portion of the discussion is devoted to the various ways that group formation is different between modalities of play. For instance, tabletop games in this study generally consist of obviously strong cliques that are contextualized by the game; however, these groups are always connected to other groups. In iPad games, these cliques or groups sometimes are disconnected from the activity by gatekeeper objects – those objects that mask computer mediation.

The last portion of the discussion is about the other aspect of Social Network Analysis that provides much in the way of its utility – cohesion and homophily. These two measures are something of interest for a design in that they represent how closed a group is from outsiders (Wasserman & Faust, 1994). Through cohesion – the "tightness" of a network – and homophily – the connectedness of groups versus the internal connectedness of groups – the ways that use differs between collections of individuals and different affordances should manifest.

Discussion

At the beginning of this dissertation research, I provided a design fiction that highlighted the various ways that technologies and humans were disconnected. Humans are forced to segment their attentions among a variety of products. For instance, writing an email versus writing a paper versus writing an email about a section of a paper versus writing a section of a paper and text messaging a link to a service that allows that user to then make comments outside of the text message thus generating emails about the comments. All of this segmentation focuses on affordances rather than the poly-social realities of humans who need to perform tasks across many modalities. After the design fiction, I posed several questions to help bridge the many segmentations that this dissertation is meant to traverse. These questions, not necessarily research questions, were meant to focus data collection efforts, create knowable structures within the data, and to provide a foundation for eventual interpretation of the data for design uses. Those questions were:

> *RQ_1: How does centrality and cohesion change between modalities of activities translated for computational mediation?*

This question covers a vast amount of information that generated during an activity through which collections of associations begin to gather at the start of an activity that is meant to assemble them. During an activity like playing a board game or video game, each player must interact with the game as well as each component, each rule, and each other player in a significant amount of different transactions. Through a creation of a list of ingredients or irreducible elements, it is possible to simply write an endless list of dyadic entities who association, recruit, and act in tandem. This question is the focal point of creating association mapping. However, there is a need to focus the gathering of data. This sub-question focuses data collection efforts:

> *RQ_2: In examining the list of dyadic associations created during an activity performed via computationally mediated means and in-person, which are the most central? What human and non-human vertices have the most impact on the network?*

What this question does is allow me to focus on what is being counted. The dyads being created are those that are observed. I will also be examining different lists – in person and in game. Within this list, we can then begin to examine the dyads as quantities as well as qualities. In this case, sever logs, error logs, and the computational dyads that form during the communication processes of applications, operating systems, and firmware can be ignored. However, this is something that may be explored in other work. Next, in that the *Catan* application is a designed product replete with the current tenets of User Experience, User-Centered Design, and App-based design, the final question to consider is about what is missing.

> *RQ_3: From the discussion during the activity and through examination of the dyadic list, can we discern how humans worked around aspects of the game that were not afforded for in the virtual version? What are those components?*

From these three questions, the space of collection was focused, the collection efforts were stabilized, and the all-important, “what are the missing masses?” allows us to look outside of the data collection context. There was an interest in replication when these questions were created. While no network, task, situation, context or activity will ever be the same, the ability to know how and why certain decisions are made should help others replicate the method, though probably not the study itself. While this has issues for empiricism, those issues are not without reason.

Inner Space: Human Centrality, Non-Human Centrality, and Hybrid Centrality

In Association Mapping, an augmentation of Social Network Analysis, the central component of what the data can be used to describe is how each individual portion of a network is positioned within it. The use of this position – referred to as centrality – allows researchers to examine how a particular network functions. In AM, non-human and human objects are gathered in a data sheet simultaneously and each are afforded the ability to act. Everything is given the ability to be an agentive entity because the act of design imbues those designed objects with the agency they need to accomplish their tasks. In this type of network, humans and non-humans need each other to have agency.

The life of any network, including the network of a game of *Catan (1995)* is one of constant agony. Objects recruit objects and then persist through tests of strength. Through AM, the agonistic existence of objects and assemblages of objects is made manifest as each object is catalogued over time. The concept of time is something that is often missing from analyses of use unless it is about the speed through which users moved from novice to expert. By choosing a game, time can be observed in multiple ways. For example, every game has a very regimented representation of time; in terms of *Catan (1995)*, time is each player taking their turn. Once this round is over, time begins again with the board staying according to the end of the last turn. The island of *Catan (1995)* can then grow and change as the players take their action. In maintaining this state, it is possible to mark how the centrality of objects shifts.

This initial discussion is about the Inner Space of an activity. This discussion forms around the first research question:

> *RQ_1: How does object-centrality change when the modality of those objects is interacted with changes?*

This question is primarily concerned with how well an activity is translated between modalities. By focusing on the per-object centrality mediated by modality, it is possible for designers to see how their design is impacting the activity as it existed before computation began to mediate the space.

There are three ways to consider the centrality of objects within a map of associations. The first way to consider these objects is through the perspective of the humans. This is the most common way to consider centrality as HCI has inherited the social science's inability to allow non-human objects the capacity to act in the same way as humans do. Through this traditional standpoint, the centrality of non-humans themselves can be considered. In fact, through non-human objects, the controlling aspect of their presence can be observed.

Second, there is non-human centrality independent of humans. In considering the act of design, this type of centrality is the most important to designers. What this second way of considering offers is that when designers create some new object to use – e.g. a game, a piece of software, or even hardware – they create what amounts to a network. By examining how non-human objects arrange themselves, this section offers a way to reconsider design, to reconsider the bounded spaces between software. Finally, this portion of the discussion will end by examining hybrid centrality. By simply adding centrality scores together and visualizing those objects as a group within SNA software, it becomes possible to watch hybridity occur.

The Centrality of Humans versus the Non-Humans that Control them

Of all of the games observed, humans were the most central object to the analysis; however, if only humans are accounted for, only 30% of the total associations created for the network are present. What is not present are three other possible association types: Human to Non-Human, Non-Human to Human, and Non-Human to Non-Human. Each of these types of interactions can provide a number of points of data for the designer to use. For example, in this game, humans often had to associate with the resources they needed in order to win but also in order to give and receive resources, to pick up and place pieces, and to negotiate with others for resources they might not be able to obtain on their own.

Frequency Analysis

If we simply take the frequency of each type of interaction, we can see something of interesting. For example, in Table 20 the frequency of each type of interaction is listed along with the total number of each type of interaction. From this chart and the frequencies involved, we can view just how often humans interacting each other. In some of the games, the human to human (H2H) interaction was exceedingly low. What this game in particular is meant to discuss is of further interest.

Game	H2H	NH2H	H2NH	NH2NH	Total
1 - iPad	228	572	735	448	1983
1 - TT	235	1096	1479	1360	4170
2 - iPad	35	442	732	884	2093
2 - TT	110	1191	722	1265	3288
3 - iPad	176	585	1654	2156	4571
3 - TT	125	1157	715	1153	3150
Total	909	5043	6037	7266	19255

Table 20 – Frequency of Types of Interactions

To better visualize just how much of a difference there is between human-to-human interactions versus all of the different types of interactions, Figure 28 shows a stacked chart representing the percentages of each type of reaction given a 100% range. In this chart, humans represent approximately 30-40% of all interactions. This means that non-humans represent 60% to 70% of all dyads present within the network. This chart is plotted out in Table 21. Given the previous data in Table 20 and the below data in Table 21, we can say that Association Mapping has shown that studying just humans in context is not enough.

	Humans Only	**Non-Humans Only**
1 - iPad	48.56%	51.44%
1 - TT	41.10%	58.90%
2 - iPad	36.65%	63.35%
2 - TT	25.30%	74.70%
3 - iPad	40.04%	59.96%
3 - TT	26.67%	73.33%

Table 21 – % of Human Started Edges to Non-Human Started Edges

Additionally, by condensing these 4 data points into 2 – who created the edge – there is something more that we can discern from the frequency of dyads. First, in each circumstance, humans created more edges in the iPad games. This can be explained by the fact that given the lower, on average, number of edges created by non-humans in the iPad games, that humans were left with opportunity to do other things. But these visualizations display the frequencies of each type of dyad. If the network is taken as a matrix and the matrix is processed for calculating the various centrality measures, something more useful occurs.

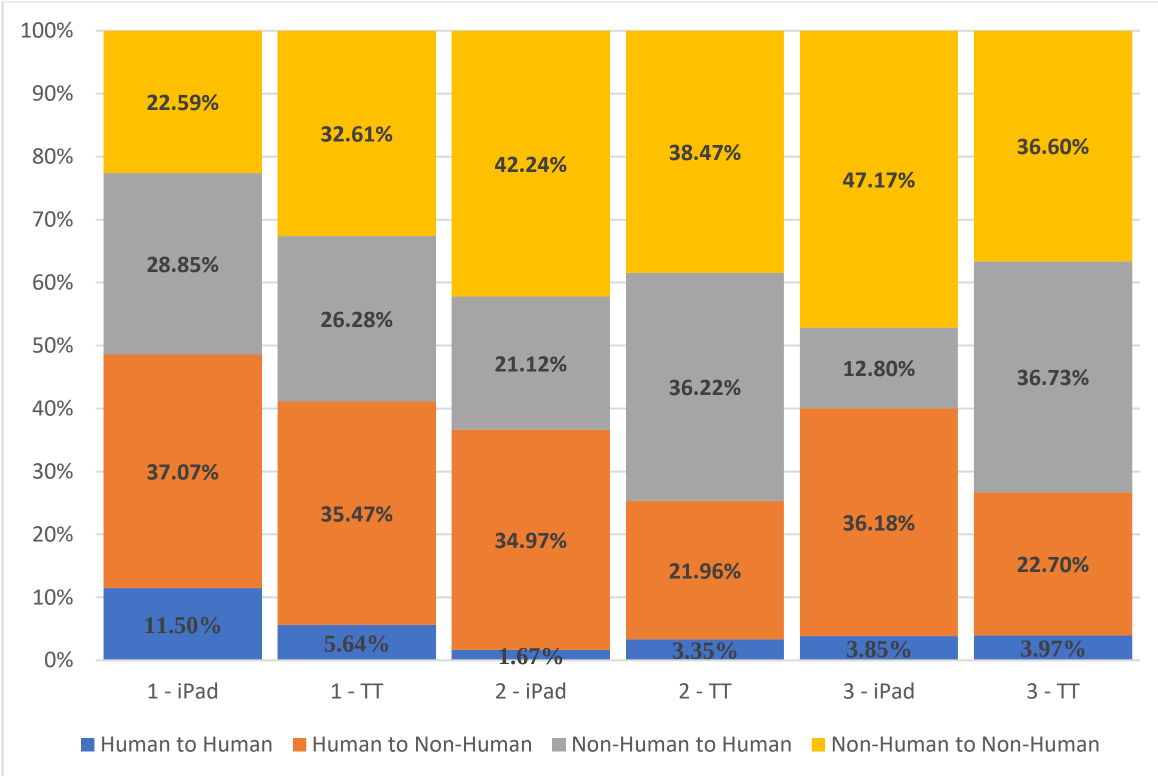

Figure 28 – Stacked Chart Representing the Frequencies of each of the types of interactions

Degree Centrality

The visualizations display the frequencies of each type of dyad. This is useful but does little to embrace the possibilities of social network analysis. Through AM, an augmentation of SNA, centrality measures can be used to discern what objects are the most central to a network. Remember that degree centrality is how many neighbors a particular node has in a network. A collection of centrality measures across all networks observed provides a useful visualization of players within a game.

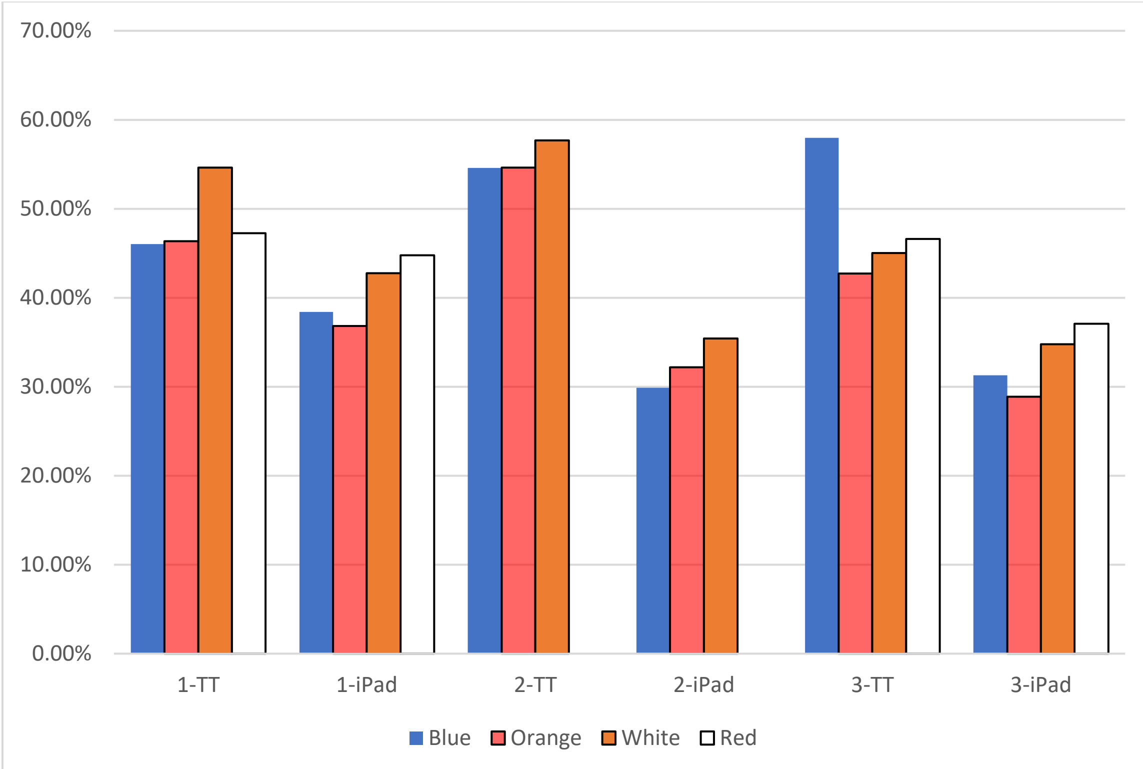

Figure 29 – Average Centrality for Each Player Across Each Session

In each of the sessions above, the average centrality of each player is plotted. What these data show is that while the humans themselves are not the most frequently referred to member of originating a dyad, they are represented in the network far above any other single object. The normalization of centrality in UCINet is as such that the degree of a particular node in a network is divided by the maximum possible degree of the network. This results in a normalized percentage across all nodes in a network. Thus, the division of the degree of each human actor divided by the total possible degree of each network results in nodes that are more central than any one other node.

Interestingly, the most central human is not always the winner of each session, especially when the games are considered individually. In this case, in session 1, White won both games. In session 2, Orange and Blue won with Blue being given the win despite game still needing to be played. In session 3, Blue won both games. What is occurring with these centrality measures is a not necessarily who the winner is but who the most talkative or experienced player is.

In session 1, the white player is the most experienced player at the table but the red player, especially in game 2, overwhelms much of the gameplay by talking more than the other players. In session 2, Orange is the most experienced player at the table and white is the least. This ends up pushing white above the others because white is often involved in associating with other players and other pieces with other players. In session 3, the most experienced player is blue but by game 2, the red player becomes begins to talk more about other things.

In each of these games, the most experienced person is the most central because they are often tasked with explaining the game. These network data again are correlative to the activities occurring at the table. In each circumstance, by the second game each of those experienced players decrease in centrality by a factor around 10, 20, and 30% respectively. An additional consideration for centrality measures and a source of discrepancy for analysis, is the creation of a generalized other human to communicate with. The other, or the stranger if we can once again refer to Alphonso Lingis, is someone who is created when disruption needs to occur.

The Other

Human centrality is therefore something that is replicated within these data. While human to human interaction only seems to account for around 30% of all activity, humans are central to nearly 50% of the activity within the games of *Catan (1995)* themselves. One aspect of human to human interaction is missing and it is also difficult to code as a dyad. The object that we all spend time invoking is this concept of, “the other.” Or, if there was a specific name for it in these data, it would be, “the desired other.”

There are times when we ask questions of no one in particular yet everyone at the same time. This communication meant to be said to anyone within earshot is a probe looking for who might be listening or paying attention. In *Catan (1995)*, this discussion of the other often took place during trading. The game requires that people, on their turn, initiate trades with other players. The trades are usually based on their settlement location on the board and are further mediated by the numbers that the dice end up on each turn. During each players' turn, if they have a desired outcome such as building a road, buying a settlement card, upgrading a settlement into a city, or building a new settlement, they are forced to ask other players for resources. When they do this, the players ask the table as a whole.

During games with the iPad, the number of times the "Other" is invoked as a desired other is generally higher though this difference depends on the amount of trading during the game. Seen in Table 22, the number of times this entity is invoked is not always significantly higher but there may be different reasons for this. In the Session 1, the players took to simply asking the table if anyone wanted to trade initially. But as the game wore on, they began to move away from trying to keep track of the other players' resources and instead began to rely on that of the iPad as a record keeper.

	Other
1-TT	2.59%
1-iPad	3.63%
2-TT	1.03%
2-iPad	1.10%
3-TT	0.48%
3-iPad	1.88%

Table 22 – % of times the Other is mentioned

The other was mentioned by players during tabletop games in ways that were relatively similar. It often sounded like this:

Does anyone want to give me ... If someone gives me a wood, I'll give them a sheep.

The players tended to provide a scenario through which one player, a great person, would give that player something and in return, that great player would give them something as well. During the tabletop games, players could look at the cards that each player had in their hand. They could also look at the board and see what resources were being distributed during any given time. During iPad games, the ability to see what resources were being distributed relied on humans listening to the iPad make sounds resembling the resources. While players would know what resource was generated, they would not know who got what resource aside from the player holding the iPad itself. The iPad games, these moments often took this form due to the iPad limitations:

Orange: All right does anyone want to give me wheat? Does anyone have wheat?
Blue: I don't even know.
White: I don't think so

In examining the networks created by the generic, "other," the generic desired other person was often involved with edge creation that would join sub-groups. The linkage between groups is done through the invocation of the other during the trading moments in-game. Note in Figure 30 that the sheep are never associated with anything desirable. In the game in question, session 2's iPad game, sheep were the most common resource. In addition to the lack of desirability for sheep, Ore were often sought after but were never traded. Not every game was the same in the way that it invoked the desired other. For example, the iPad game did have a way to ask players for, "anything" through the Trade UI. This affordance was only used once as it was not very well presented in the trade screen itself.

The one game where the desired other became, "just trade me whatever" was invoked by just one player who constantly told players that he would trade them anything he had for one specific resource. In this way, that specific player discovered a way to not only invoke the desired other, but to afford for that other through the way the game was coded. Instead of players not know what they had, they could just hit a button and allow players to see what they had through the process of trading.

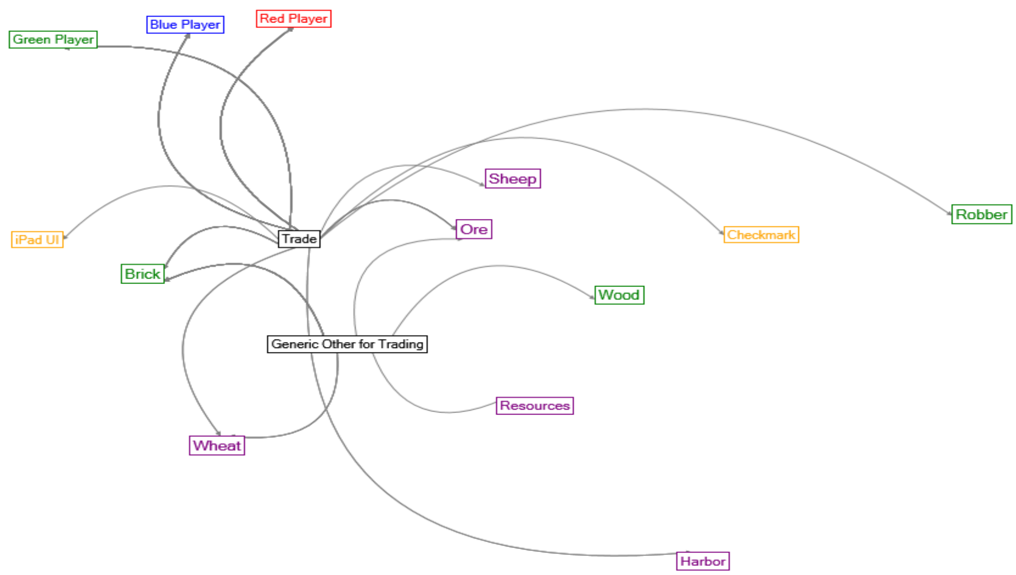

Figure 30 – Generic Other for Trading Visualized

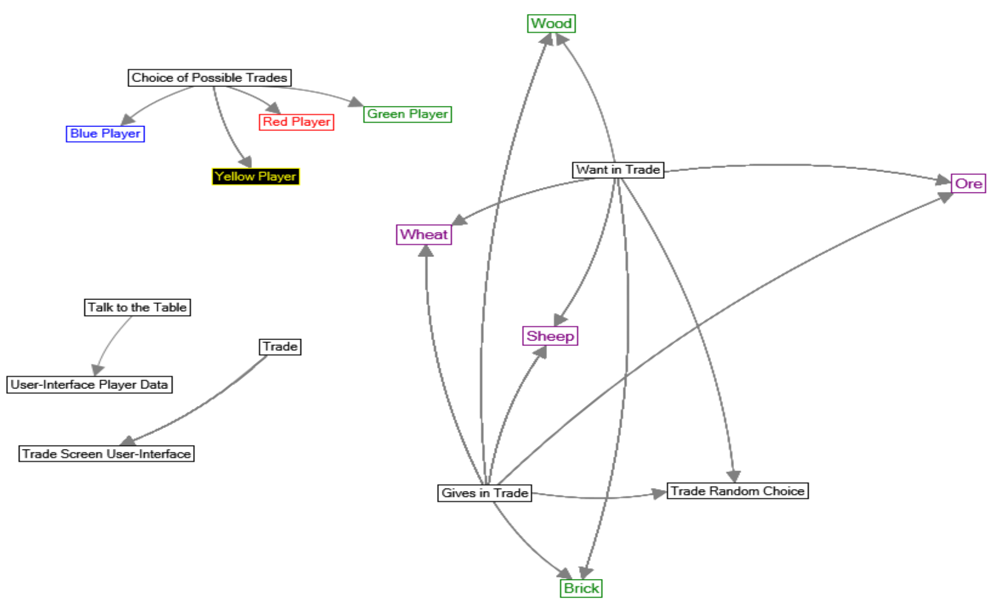

Figure 31 – Session 3 iPad Generic Other Associations

These two above networks were manifested by humans who were invoking a human that did not exist but each player invoking it hoped that they did. While the iPad version of *Catan (1995)* afforded for this creation in the vein of allowing trade screens to be declared as, “any,” this screen was not often used. Because of the way the players performed their action, it is possible to see just how the players offered these things. In speech, the players would offer anything for trade and through the user-interface, the players would allow the iPad to handle the rest.

The differences between human centrality and the frequency of human edge creation allows use to witness a vast difference between the way that people are observed in situ. Through the centrality of humans in these networks, we can show that while non-human objects account for over 70% of a use scenario, humans tend to be at the center of those associations. Finally, the creation of a generic, desired other throughout the games allows us to witness how player-to-player interaction changes the way that interaction occurs through a user-interface. On the one case, players skirt around a user-interface by simply speaking to one another. In another case, those players use the interface to handle the creation of a generic other very differently, by pushing a button that forces each player to look at the trade screen. Non-human objects make up a majority of associations during an activity yet we do not often examine the social life of objects. Association Mapping allows that life to manifest.

Non-Human Centrality, a Tool for Designers

Understanding how human actor centrality shifts between modalities of play is a useful heuristic for the design computationally-mediated systems. This heuristic allows designers to understand how humans create and bridge different nodes of a network. That understanding is something that can enable designers not only to understand their users better, but to understand the activity as well. It is numerically represented and possibly actionable in that regard. This is only one aspect of the activity and it still remains problematic as human-centrality is forcing humans and non-humans to exist in different spaces. However, it is a place to begin. The next step for analysis is to consider non-human actors separate from their human actors.

According to the previous discussion of human actors, we can say that there is what appears to be a significant shift in how humans operate when modality is considered. This makes sense because between modalities, another layer of interactivity is inserted – the user interface. The user-interface (UI) then, is the manner through which the user and the machine interact with one another. The UI provides a gateway for the human to participate in the activity the computer is mediating. Much is written about the play between worlds but that play is also, often human-centric. In AM, the centrality of non-human actors is useful to consider independent of their human actors as – removed of human interference or dominance – they can be evaluated as a network by themselves.

The first concept to consider is how the centrality of non-human objects are impacted by the automation of the various ways those non-human objects are maintained when the space is mediated by humans themselves. Second, given that centrality, the question of whether a comparison between modalities actually provide something useful for designers to analyze is useful or not comes into focus. Finally, AM is an augmentation of SNA and SNA is useful because it can provide visual representations of networks. The question of the usefulness of visual representations, minus any actual data about centrality, must be evaluated.

The Impact of Automation

We often attribute non-human actors as non-agentive while at the same time assigning blame to non-humans when things do not go the way humans planned. “Oh, this computer is just acting up.” Or, “I don’t know, I just do what this thing says.” In this case, we ascribe agency to non-humans though in truth, it was designed to have this impact all along. As a way to visualize these activities in context, AM records each time some object makes an association with some other object.

In the case of *Catan (1995),* there are a number of objects to consider as a central component of design. The first object of central importance are the dice. These 2-6-sided dice represent time, production, and what equates to money each turn and over each turn, each round. The next few objects of importance are directly impacted by the dice. The first of these objects are the numbers that sit on top of the terrain. When the dice are rolled, these numbers become the first object that matter – both to the players and to the game. The next object is that of the terrain and through the terrain, the resources that each piece of the terrain represents. Note that there are multiple ways to consider the resources – both as a whole and as their parts. Each portion of the resources – wood, sheep, ore, lumber, and brick – all represent something to each individual player.

AM can offer a per-item analysis of how each object was impacted by the way it was virtualized. The impact of virtualization on each individual resource can be discerned through the normalized degree centrality and then compared to their tabletop equivalents that are also normalized. The three non-human objects that we could expect to be central to a network that consists of all associations created during a game of *Catan (1995)* are arguably the dice (which generate numbers), the resources (representing the terrain), and the terrain consisting of the different lands that produce resources. In Table 23, the numeric representations of the normalized data show how the centrality of those objects change between modalities. A visual representation of those data can be seen in Figure 32.

	Dice	Resources	Terrain
1-TT	21.89%	44.06%	38.45%
1-iPad	24.04%	26.51%	10.74%
2-TT	23.22%	53.57%	38.13%
2-iPad	22.97%	18.30%	10.61%
3-TT	19.26%	44.12%	36.26%
3-iPad	21.89%	12.45%	38.45%

Table 23 – Average Centrality per Game of 3 non-human objects.

In these data, we can see that there is not much variance with the dice object across modalities. This is not because the dice have remained central. Instead, the dice are used to indicate that a turn is completed. Pressing the button on the *Catan (1995)* app allows play to move to the next player. This accomplishes the same task as associating with the dice in the tabletop game and so the number of associations are roughly proportional. When the terrain object is considered, these data are very different. The iPad's Terrain centrality is roughly half that of the Tabletop with exception of the third game. In the third game, the players themselves began to discuss the terrain and to interact with it in unique ways.

For the other game, the terrain was roughly half that or less than the tabletop version. The reason for this is that in pressing a button – the green check mark indicating it is the beginning of a players' turn – the iPad proceeds to generate a number which then provides all resources associated with the roll to each players' resource pile. This means that the terrain is associated with far less often in the iPad game than on the tabletop.

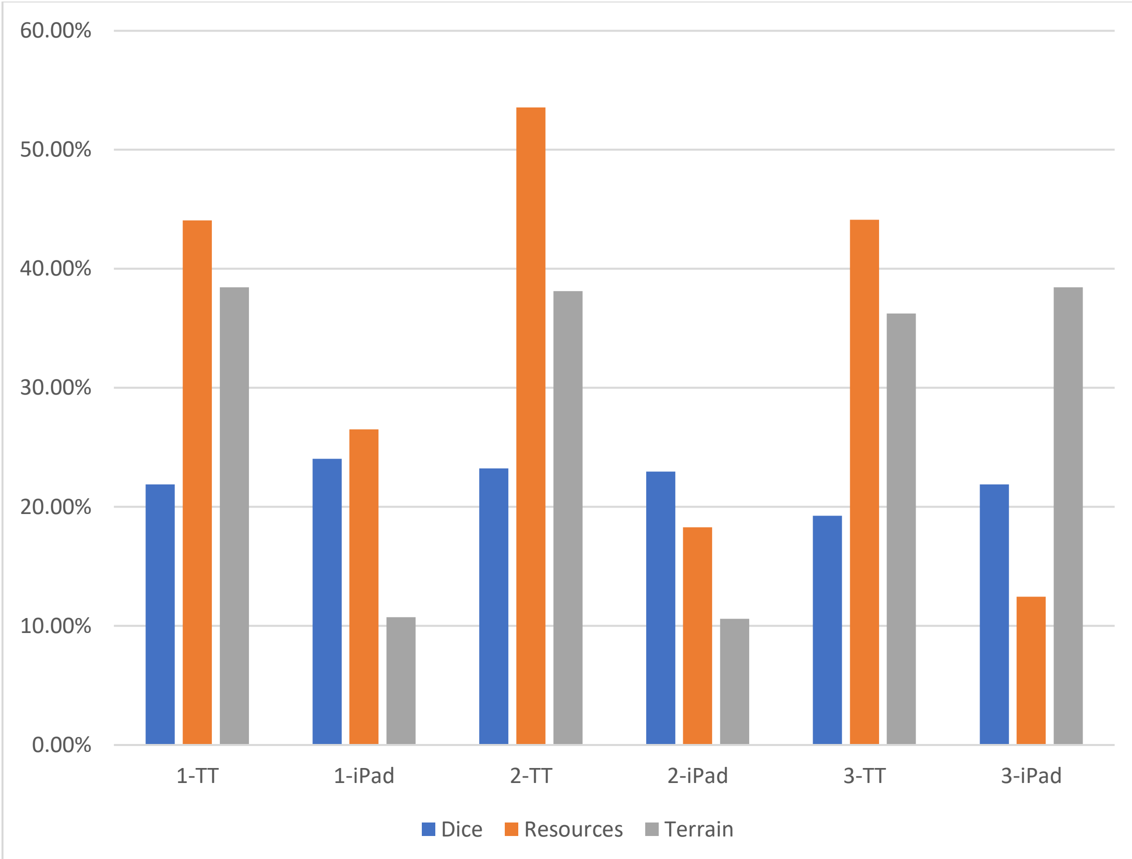

Figure 32 – Average Centrality per Game of 3 non-human objects.

The data present for each object also can be exploded into each turn's centrality. For example, in Figure 33, the centrality of the resources object over 16 turns of play for Session 2 shows the variance of centrality over time. By examining an object like resources in-depth, it is possible to compare not only the distribution values based on dice but also how those objects are interacted with by the players themselves. The numeric values of the resources over 16 turns, each turn could then be broken down into specific social networks as shown in Figure 33.

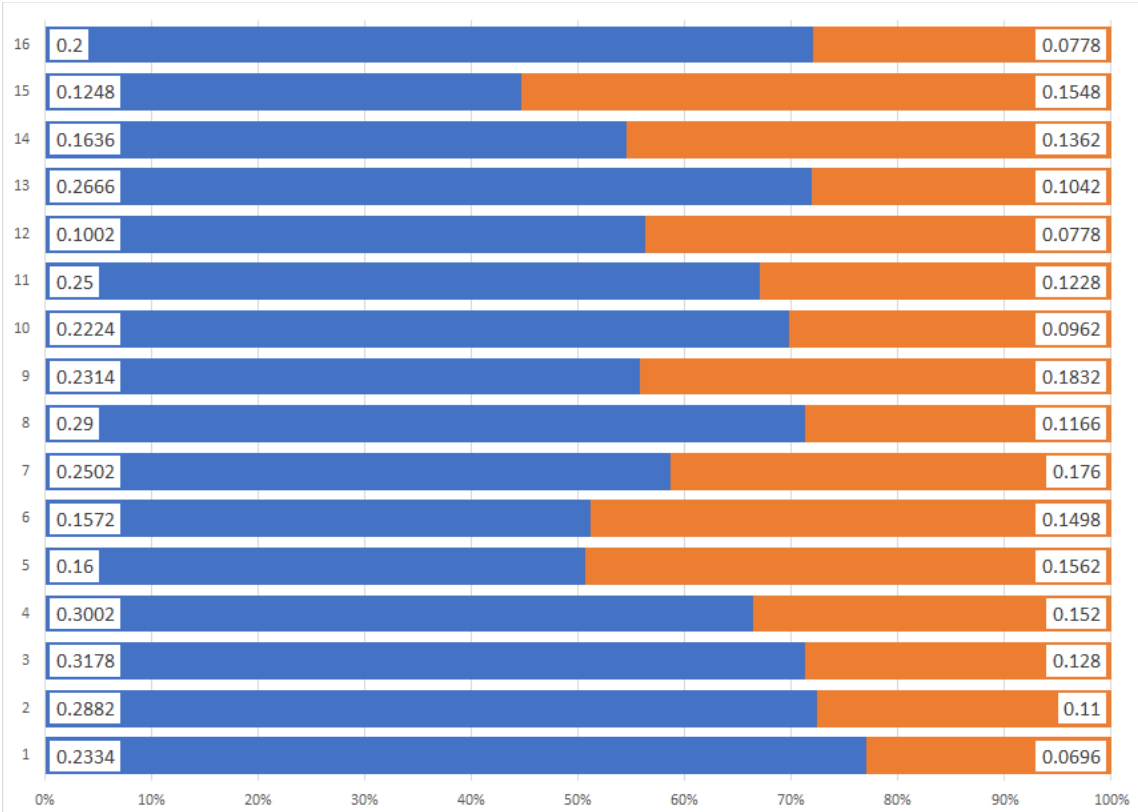

Figure 33 - OutDegree Centrality for Resources

For example, in Turn 6, the red player rolls a 7 which results in the Robber taking a number of their resources. From this turn, we can see that the Robber seems to be working as intended – when it is rolled, it is a central object – but the checkmark that indicates that each player is moving to the next action is just as central as the players themselves. What this seems to indicate is that the user-interface is more central or just as central as the players themselves. If this trend is maintained across all games, the design team may have an ability to measure the impact of the user interface on the flow of the game.

Object	Centrality
Robber	0.458
Red	0.417
Blue	0.333
Check	0.292
Dice	0.25
Trade	0.25
Sheep	0.25
Wheat	0.208
Green	0.208
Resources	0.167

Table 24 – Game 3 Per Object Centrality for iPad

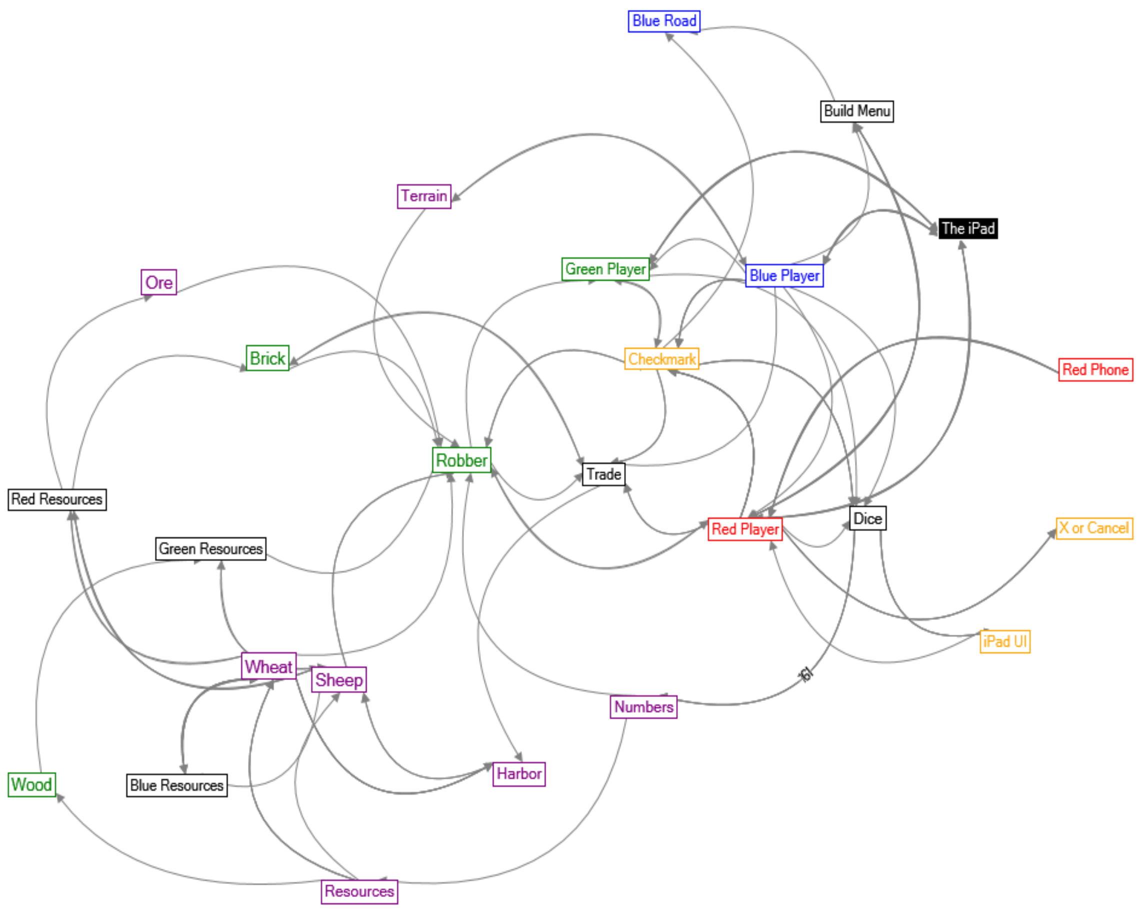

Figure 34 – Game 3 Per Object Centrality for iPad

From the above, AM makes it possible to not only see how much automation can impact an object that is central to an activity but offer a measurement of how automation is impacting each object. How those objects lose centrality and the values they exhibit over each turn is valuable as constant replication of the same activity after design can provide designers with more information about how well a design is replicating the activity it is based on. In design, the automation of activities – essentially placing objects inside a black box – seems to have a tremendous effect on flow of an activity. How that flow is impacted by automation can also be observed, exploded, and examined in detail.

Human-Maintained flow versus Computer-Mediated Design

In addition to the per-object centrality over time, collections of objects and their centrality are also important. For the purposes of board games like *Catan (1995),* the centrality of the resources is an essential part of the game. It is the currency, the way you win and the way you measure your progress with strategies. By automating the distribution of resources, three things occur. First, a computer can and often is more trusted as a distributor of resources because computers cannot cheat or make mistakes. If I as a player am awarded 3 bricks and an ore then perhaps the player serving as banker (or the player closest to the resources piles) hands me 4 bricks and an ore or 2 bricks and an ore. The likelihood that I as a player would say something about the mistakes another human made depends on a number of factors. With a computer, on the other hand, not only am I not asked to deal with the resources myself, the computer distributes them all in machine-like fashion. Second, the computer maintains not only the game state but the legality of moves based on the ruleset. Finally, on a digital surface, I do not have to worry about properly weighted dice, an even playing surface, or bumping the board.

The designer's job is to decide what processes are safe to black box in automation and what processes should not be black boxed. Association Mapping provides an analysis of how that black boxing impacts the centrality of the activity being designed for. In normal human-computer interaction research, the impact of automating certain behaviors can be difficult to observe or even consider. Computer-based designers are already designing systems to be automated because that is what computation is meant to do. As a result, the impact on design of automating things can be invisible at times. AM provides a visualization of the impact of automation. For example, in the 6-games recorded, the three figures below represent the top 10 most central non-human actors.

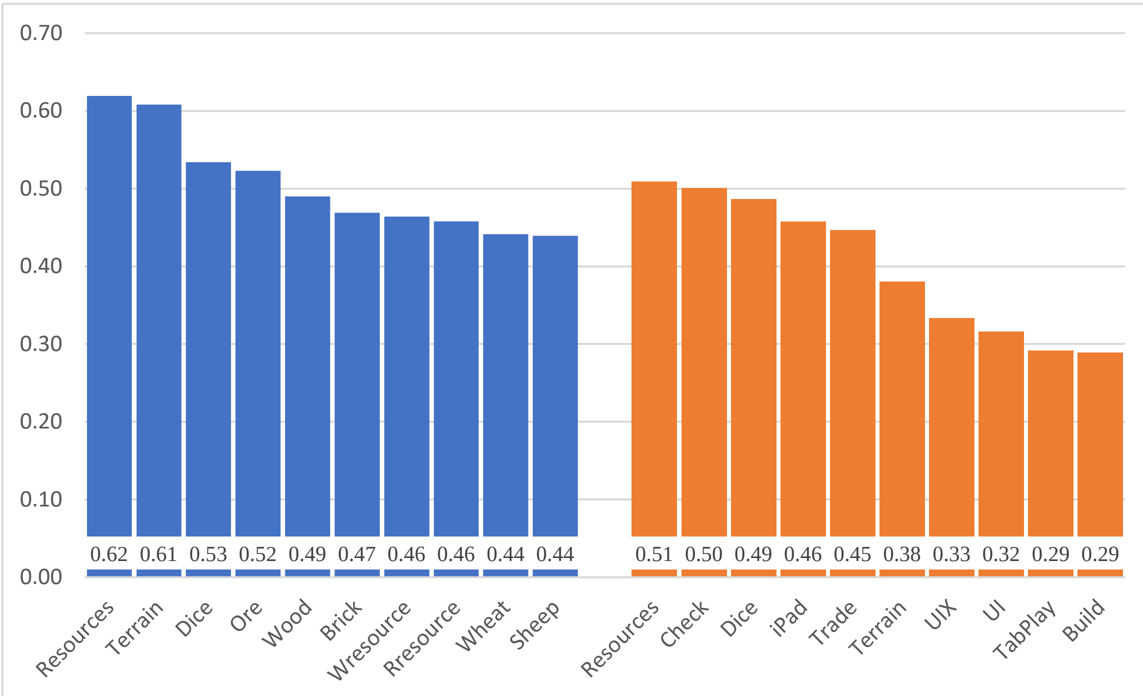

Figure 35 – Closeness Centrality Top 10 Non-Human Objects

In the above game, the non-human actors on the left in the tabletop game follow the discourse surrounding the game itself. While the dice themselves are not the upper most non-human object, they do represent a central actor in the top 3. The resources are dictated by both the dice and the terrain with the most popular resources of the two players at the top of the game account for the remaining slots. At the bottom of these top 10 items are Wheat and Sheep. These resources are slightly below the White and Red player’s resources because they were the most common resources. In this case, wheat and sheep were rarely traded which pushes their centrality down slightly. On the right, the resources still account for a highly central object; however, the value is lower by .11 with UI elements assembling the remaining 10 elements. Note that in this game that the "Tabplay" object is on this list. This is the "idealized other" indicated in the previous discussion. While this object is itself an indication of a human, it is not a human itself.

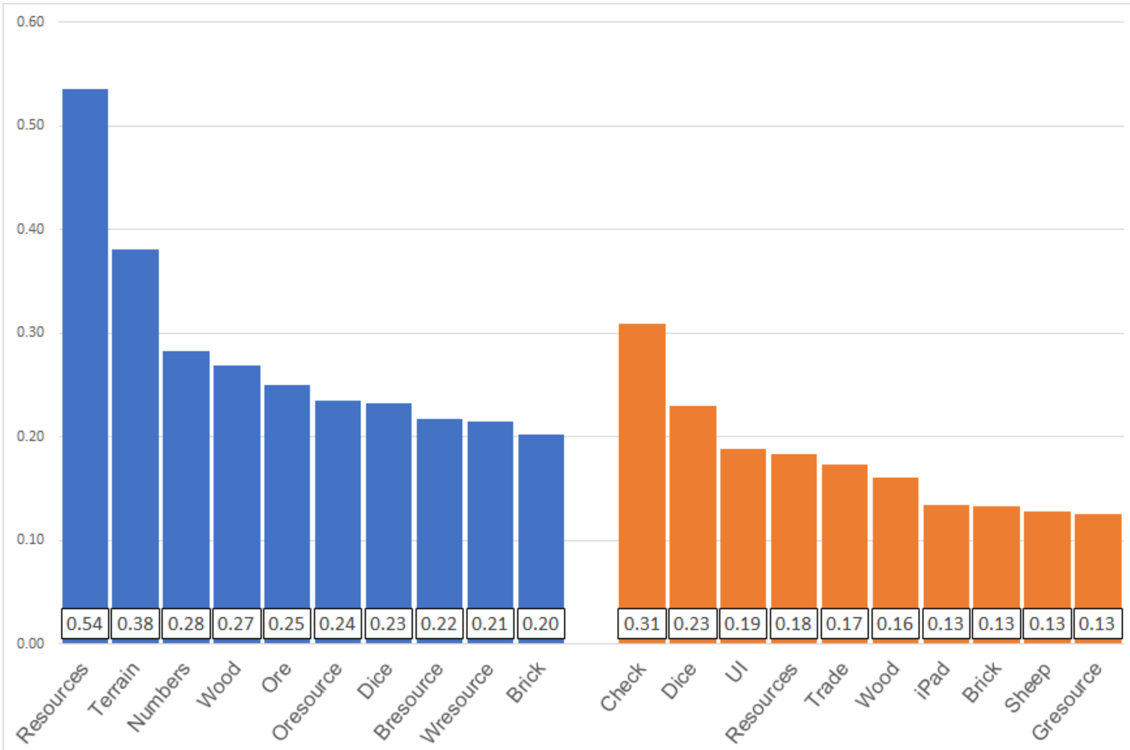

Figure 36 – Closeness Centrality for Top 10 Non-Human Objects.

In session 2, the values are slightly different due to the way the way the players interacted with the playground. Between these two games, we see a number of objects that are central to that particular modality. For the tabletop game, the closest non-human objects are the Resources, which humans must distribute to one another. In addition, there is Terrain, which humans must refer to in order to examine the resources. Next are the numbers. Here, humans must examine the numbers attached to the terrain in order to distribute resources. We then see the most common resources of this particular game followed by the winning player's resources, the dice that determine the numbers and then each other player's numbers.

The iPad game is a little more complex. The "Check" is the user-interface check mark is present each time a player makes a decision. It is the last item checked before anything occurs.

Therefore, it is the most central object and actor. It controls access to computer-mediation. Next, the dice are not the same object as the dice in the tabletop game. Instead, the Dice represent when play is switched to the next player. The "User-Interface" is the terrain and all information related to play. While this screen is important, it is not necessarily central. Resources play another central role in this game but is primarily disconnected from the humans themselves in most ways besides ancillary access during manipulation of the trade screen.

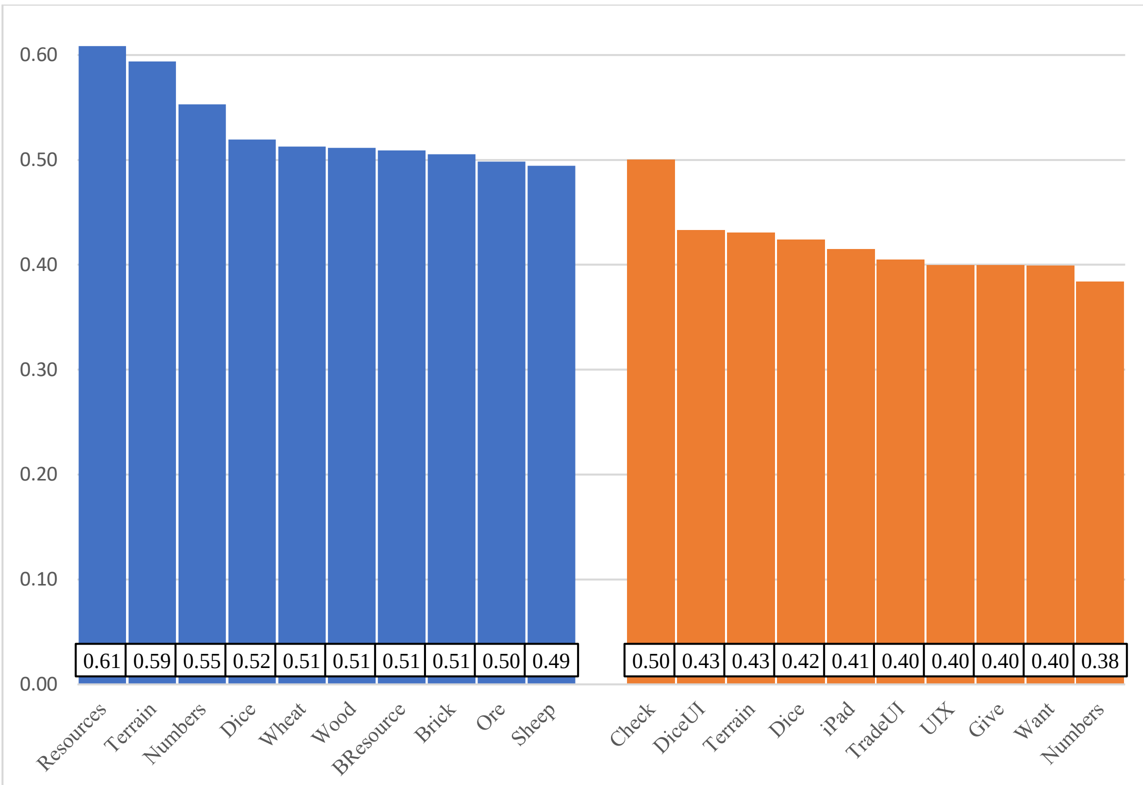

Figure 37 – Closeness Centrality for Top 10 Non-Human Objects

Session 3 was a session that consisted of 3 players who had never played the game before and 1 person who was an expert. What ended up happening with this game was that the trading aspect in the iPad was so powerfully dominant that it broke down into specific aspects. So as the other games indicate, the resources, terrain, numbers, and dice followed by the individual resources as well as the blue player's resources are all in the top 10 most central items. In the iPad game, the check mark is very much the most central object. It is much higher in centrality here than its subsequent items because there was so much trading. Note that the TradeUI, Give, and Want are all indicative of the trade screen.

This examination of closeness centrality points to trends that exist between games that might not have been obvious to players who were watching others play. It is interesting that given the activity, when played on a tabletop the distribution of resources remains the most central object for each game. Unlike the tabletop experience, the user-interface dominates non-human object measurements. Each game provides its own objects that are both pre-defined and defined in situ during coding. The variance among the games is significant because they ended up varying so little. In the next section, the concept of hybrid centrality is discussed.

Inter-Space: Cliques, Groups, and Sub-Groups

The centrality of each object, while interesting, is rarely reflective of the reality of any object. (Everett & Borgatti, 1998) Objects recruit, make allegiances, and often undergo countless tests of strength to continue their existence. In a game like *Catan (1995)*, all of the agony is encapsulated in these hybrids as they vie for the best position based on the recruitment of other objects that allow the pursuit of various goals. To understand the significance of AM, we move then to these objects. The inner space of objects allows us to consider each tree whereas the inter-space of an activity allows us to observe small groves within a forest as they compete for nutrients with other groves. There are two ways to consider the inter-space of a network. The first is to separate the groups out in a logical order in order to evaluate that particular group's abilities as a hybrid entity. The second method of analysis for inter-space is to allow the various algorithms associated with separating, identifying, and analyzing networks in order to find groups, communities, and subgroups.

<u>Choosing One's Own Groups and Their Implications</u>

By manually categorizing those objects as human or non-human, it is possible to make this distinction. It is also possible to avoid this distinction and to allow those objects to meld into hybridity – the natural state of existence itself (Latour, 1993). This is the final aspect of RQ1 – how does centrality change given modality? This question is perhaps best address by discussing the act of trading in *Catan (1995).*

<u>Trading</u>

The central component of *Catan (1995)* is trading. Every aspect of the game tends to be connected to that one act of one player's resources becoming another player's resources. There are aspects of the game that also force resources from one player's resources to another, but those are sometimes difficult to attain. As a result, the very first aspect of hybridity will be to consider all of the components of trading. This hybrid actor will consist of: a player, discussion, wants, things to give, contingencies, player settlement placement, probability of existing resources, and the gap in resource creation for each player. A number of these concepts are not objects that are associated with directly – for example, probability, placement, strain given gaps in resource possibilities – but we can discern a number of necessary actors: the dice or specifically the numbers the dice generate, the terrain, each individual resource, each players' resources, the act of trading, what is needed, and what is wanted.

When modality shifts, these objects are slightly different. Instead of each players' resources, the trade interface encapsulates that data. The iPad itself must be an object necessary for trading because if the player does not receive the iPad then they are not eligible for trading. In light of that, the resources themselves, while part of the trading process, are disconnected slightly from the game. In each of the 3 games observed, players stopped discussing what objects they wanted to trade. Instead, they relied on the automated check that evaluated if anyone was available for trading. As an example, take these two visualizations of the groups associated with trading in session 3.

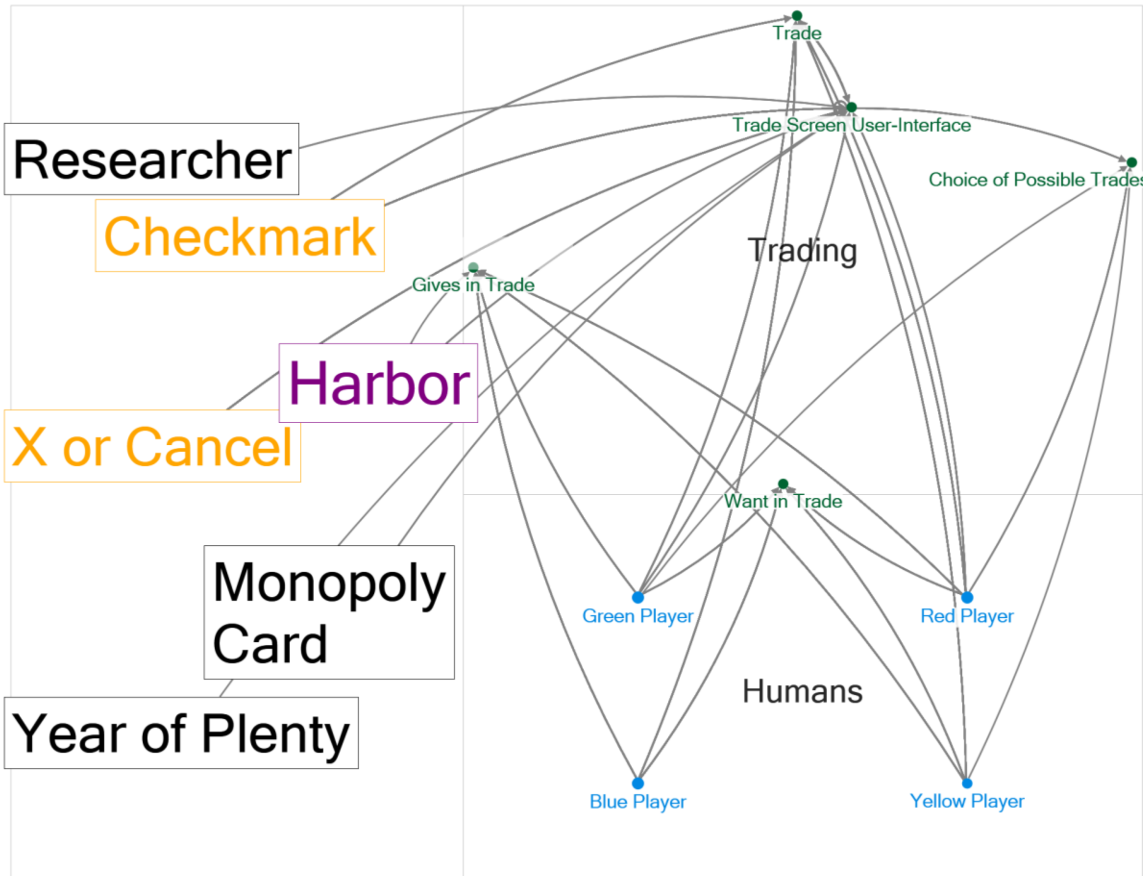

Figure 38 – Session 3 – iPad Session - Trading SubGraph

In the above example, there is everything we would expect to see with trading. Players are interacting with each other through the trading interface. While each players' resources are not necessarily represented individually, they are represented in the objects, "gives in trade" and "want in trade." Where there are discrepancies is within the other stuff located on the left. These other aspects relate to the user-interface, but also with some development cards that use this screen to ask users about what resources they would like to obtain when those cards are played. Each of the hybrid actors here then also encapsulate some objects we would not expect. As designers, the question of centrality here is something rather alarming. We are designing a system that is also being used in other aspects of the game. This is an efficient design but efficiency of computer-mediated design versus maintaining the human-mediated versions of those systems is a focal point. Take the trading associations in the tabletop version of the game with those same players.

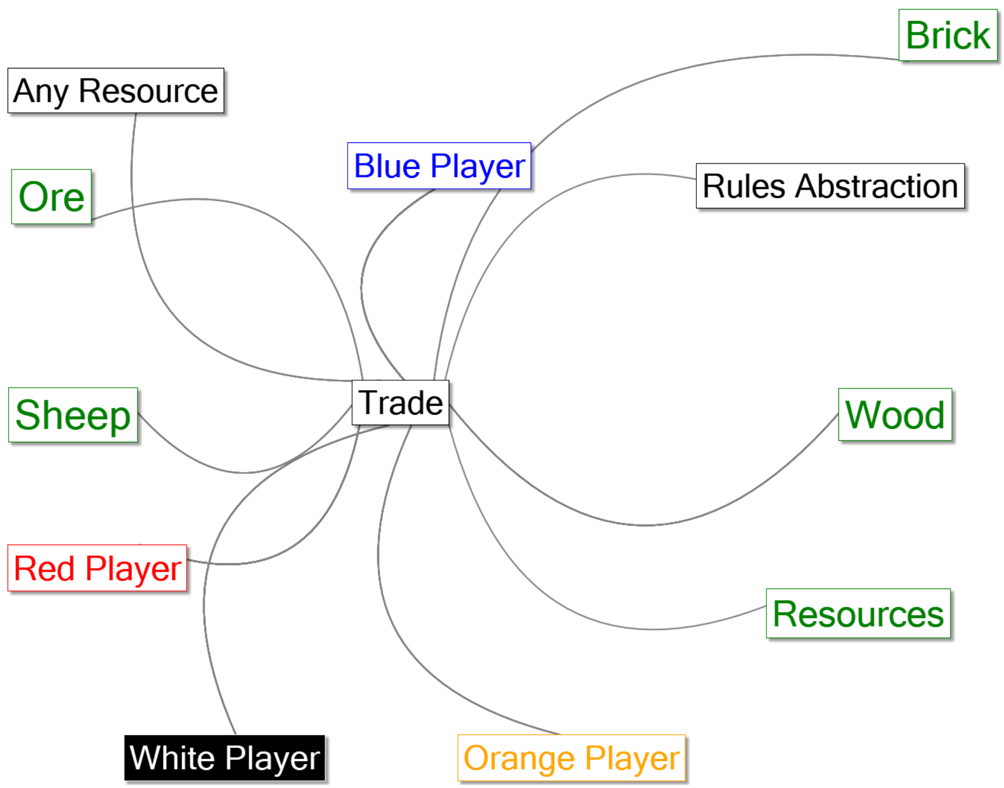

Figure 39 – Session 3 – Tabletop – Trading SubGraph

In the above, the aspect of trading is centralized with the players and each individual resource attached. Additionally, the resources as a general object and the choice of resource is given. Trading is not split up into objects constrained by a user-interface. The object, “rules abstraction” relates to a moment at the beginning of the game when one player was explaining to another player how trading worked. It was abstracted rules because the player was not necessarily explaining the rules correctly, but their interpretation of the rules that had developed over time in game groups that did not follow the rules specifically. This object is not something that is likely to exist within the iPad version of the game but it does represent a moment through which a designer could observe how the rules were incorrectly explained and perhaps use that to guide tutorial creation or even rule keeping options for the app. The next hybrid actor relates to players and their resources.

Players and Their Resources

No human acts without the help of other objects. These could be other people, technologies, rules, laws, norms, or anything else that has a name. When considering AM, the resources that each player has control of is representative of the agency of humans themselves. As it is, because this AM example is using a board game and its digital counter-part as a means through which to explore the possibilities of AM, it is easier to decide what hybrid entities are. The first split is in the representation of the players themselves. In this circumstance, the split is simply: The player, their settlements, their cities, their resources, and their roads.

This leads to a group that can be measured. In the case of each game, the average centrality, in this case further averaged by their members, can be determined. That centrality is based on the sum of averages of betweenness centrality for each member of the group representing that object. Betweenness centrality is chosen because it represents the likelihood of control over a particular network. If a player and their respective non-human resources contain the highest betweenness sum, then their control over the network representing the game is measurable. If these hybrid actors are measurable then it is possible to design around the idea as these sums can then be applied to other groups as a way to examine if the objects meant to have control over a product actually do.

To measure each players' betweenness centrality, the objects that represent a player can be taken into account. Very generally, these are: the player, the player's resources, the player's and the game pieces on the board. There are other aspects to this group but at their core, these objects represent the essence of a player's presence in the game – their money, and their stuff. To check the applicability of this measurement, the logical conclusion should be that the player who won should remain the most between as nearly every aspect of the game will have fallen into that player's favor. These data are represented in Table 25.

	1-TT	1-iPad	2-TT	2-iPad	3-TT	3-iPad
Blue	0.155	0.203	0.188	0.174	0.260	0.179
Orange	0.137	0.282	0.179	0.238	0.098	.149
Red	0.133	0.151			0.131	0.244
White	0.217	0.244	0.196	0.261	0.123	0.227

Table 25 – Betweenness Centrality by Player, Pieces, and Resources. Winner Underlined

In the chart above, all of the resources that reflect the individual players of the game. Each winner of each game is underlined. Note here that there are discrepancies between the most between group. In session 1, the iPad winner was the second highest most-between group whereas in Session's tabletop game, the winner of the game was actually the lowest most between actor. In Session 3, the third lowest was the winner. Note that each of these discrepancies are in the iPad games with exception of the second session. In the second session, the white player was the newest player at the table. The other two players took turns giving this player resources but for the most part, that player did not capitalize on this giving. In each of the iPad sessions, the robber played a more significant role.

The significance of these data is that there are objects that are generally more between than that of a player and their resources. Those objects provide the most fruitful analyses. For example, the betweenness of the Robber is something interesting to examine. In Table 26, the average betweenness centrality can be viewed across each game. It is interesting to note that the iPad betweenness centrality is much higher, often .045 higher than that of the tabletop game robber. The reason for this is straight forward to explain – the robber interacts with resources directly whereas the players cannot. Additionally, the robber interacts with each players' resources whereas the players cannot interact with their own resources much at all.

1-TT	1-iPad	2-TT	2-iPad	3-TT	3-iPad
0.017	0.060	0.017	0.070	0.024	0.061

Table 26 – Average Robber Betweenness Centrality Across all Sessions

An additional object to consider is that of the check mark. Of all objects in the iPad version of the game, this object is one of the most powerful. In fact, the average Betweenness Centrality of the check mark across all games is: .115. This measure is significant because it is near, sometimes above, the betweenness centrality of the human players in the tabletop modality. That specific object is related toward not only trading, but rolling the dice, using cards, building items. Even though the humans are interacting more often between themselves during an iPad game, the check mark often stands between the players and each game action. Another aspect of hybrid activity is how a particular activity bridges other outside of itself.

Players and Outside the Game Objects

Through AM, the ability to observe a defined connection to connections that reside outside of the activity being observed is possible. There are two specific ways that this connection can be observed. First, speech in the transcript could be linked to those moments outside of an activity or inside an activity. The second way to evaluate connection to outside activities is by observing those technological means through which players connect to other places. While coding these games, I was struck by how often the smart phone appeared and began to be more readily observed during iPad games. At first, I believed that this was a moment of boredom due to playing too long; however, I began to notice that as the players interacted that their connections to outside spaces increased. This was a result of discussion that furthered plans and connections for future action. Interestingly, the spaces are not that well defined as the phones do not stand between any player or the activity. Instead, the phone often serves as a moment through which a device ancillary to the task is being deployed because there is a surplus of possible attention. These data then, represent lost design moments.

For these moments, degree centrality and betweenness centrality are not sufficient measures of success or even access. The phone is typically connected to the player who it belongs to and when it does serve as a bridge, it is not long enough to be significant or disruptive enough to be noticed. Instead of betweenness centrality or degree, the measure of eigenvector centrality serves as a measure for this type of object. Eigenvector centrality is related to the importance of nodes within a network. A high eigenvector value is indicative of attachment to other nodes with high values. In the games where the phones were active, the data looked like Table 27.

	1-TT	1-iPad	2-TT	2-iPad	3-TT	3-iPad
Blue	0.000	0.089	0.050	0.052	0.000	0.039
Orange	0.000	0.056	0.017	0.099	0.000	0.086
Red	0.000	0.203			0.015	0.135
White	0.000	0.054	0.011	0.063	0.000	0.097

Table 27 – Eigenvector Centrality of Player Phones Between Modalities

In this Table, we can see that cell phone use is generally more active when the iPad is mediating activity. Because these nodes are rarely connected to anyone but a human, the high eigenvector of humans within this social network makes these objects much more powerful in the network than many of the pieces on the board. As a design-oriented method, AM provides this analysis and through it, would further suggest that this is an untapped aspect of design. By creating objects that show a high propensity to align with powerful objects within a network, you not only stabilize that network from outside interference but also increase its cohesion. In addition to these manual means of assembling groups, automated group finding algorithms can be deployed to make sense of the networks of use.

Algorithmic Methods

Social Network Analysis has been an active method for only a few decades though its market share has increased rapidly with the creation of social media. The algorithmic means of group finding and community discovery, while nascent, are quickly gaining significant power. The program used at the start of this project – NodeXL – groups by three distinct algorithms: Clauset-Newman-Moore, Wakita-Tsurumi, and Girvan-Newman. The Clauset-Newman-Moore algorithm relies on the density of a network to discover groups and communities. The Wakita-Tsurumi algorithm is a randomized adaptation of the Louvain method of determining communities. In this algorithm, communities are detected in much the same way as the CNM algorithm but instead uses random samples of each node's neighbors rather than calculating each path. Finally, the Girvan-Newman algorithm focuses not on the central nodes or the hierarchy of a network. Instead, it focuses on finding those nodes that connect communities.

Each of these methods have been proven for significantly large networks; however, they also focus on the mathematics of a network rather than on what the networks themselves convey. They are typically meant to find trends, groups and communities that might not identify as such to logic itself. Additional methods allow for programs like UCINet to separate existing vertices into cliques in order to examine what vertices are linked more closely to each other than the rest of a network. These methods are valuable for discovery and initial analyses but can be problematic when attempting to be specific. The focus of this section relates to the communities that *should* be present given the nature of the activity being observed. In this sense, the groups in question are related to the various aspects of the activity itself.

Through UCInet, the technique it was programmed to deploy analyzes the various games for this study and creates 61 different cliques. This number of cliques is not useful for analysis. Additionally, AM networks are often very repetitive due to the codified procedures present in the activity. This results in cliques tending to resemble those rules for the tabletop. For example, in game 3 on the tabletop, the top 10 cliques are:

1: Blue Orange White Red Resources Ore Trade
2: Blue Orange White Red Resources Table Trade
3: Blue Orange White Red Resources Trade Sheep
4: Blue Orange White Red Resources Trade Wheat
5: Blue Orange White Red Resources Trade Brick
6: Blue Orange White Red Resources Trade Wood
7: Terrain Blue Orange White Red Resources Table
8: Terrain Blue Orange White Red Resources Robber
9: Blue Orange White Red Resources DevCard
10: Blue Orange White Red Resources Ore Harbor

These cliques generally represent the activity of the board on a regular turn. The players (Blue, Orange, White, and Red) associate with the resources in order to continue play. In this case, UCInet chose to represent Ore first as trading for Ore is generally something that occurs in the game. It is often the scarcest resource. The cliques then go down the list of resources. In clique 7 and 8, Terrain appears as it is an important object for the game. This is followed by the DevCard and Harbor cliques. Because ore was so rare, players often used the harbors to force a trade.

The clique analysis for the tabletop games is so problematic because every aspect of the activity is accounted for by only a few of the objects – the players. With a clique analysis of the iPad version of the game, the clique analysis might provide some unique insight for designers. The list of the top 10 cliques for the iPad game of session 3 are:

1: Red Terrain Blue Green Yellow
2: Red Terrain Blue Green Check
3: Red Blue Green Yellow iPad
4: Red Blue Green DevUI
5: Red Green UIX
6: Red Green TradeUI
7: Red Terrain Green Yellow RobberUI
8: Red Terrain Green Check RobberUI
9: Red Green Yellow TradeUICh
10: Red Green Monopoly

Notice in clique 1, the players are all accounted for with reference to the terrain. Upon hitting the check mark, the dice are rolled and the active player gets to see where resources are sent. In clique 2, on the other hand, the yellow player is missing. This clique that was automatically generated by UCInet has noticed a pattern with the yellow player. In watching the video of the game, the player before Yellow, in this case Green, would often hit the check mark signaling the start of the Yellow player's turn. As a result, the Yellow Player is often missing from that activity.

An additional note about the cliques from that game is that the Blue player is not mentioned with any aspect of the Robber or Trading. In this case, the Blue player did not often associate with anyone throughout the course of the game. The blue player was able mitigate possible resource shortages and was not often impacted by the robber. As a result, that player is seldom seen in a clique with the trade screen. Another note is that the Red and Green players were nervous clickers as they thought about what to do. This manifested by Red and Green consistently clicking on various icons on the screen followed by clicking "UIX" or the UI's X-button. This X-Button cancelled the screen that was brought up.

These are all small examples that are meant to reflect the possibilities of examining a network of use using automated methods. The groups that were observed for this research were created by the obvious connections they shared. Connections were based on the activity that is being observed and the centrality measures show the central objects to begin creating groups with. This is not the case for all networks and is a reminder that *Catan (1995)* was observed and examined not because it provides significant results but because it provides a fruitful space to demonstrate Association Mapping. The final space of demonstration moves to a higher level and considers the forest rather than the trees.

Outer Space: Cohesion and Homophily – a Comparison of Designed Experiences

The final point of discussion concerns itself with the shape of the network in addition to its cohesion. In SNA terms, cohesion is a discussion of how connected every node in a network is. Through AM, the measures of cohesion offer a discussion of the overall impact of computer mediation and it relies on three specific measures geodesic distance, homophily, and density. These measures were covered earlier but should be re-defined as a reminder.

First, geodesic distance is the measure of how many "hops" it takes for one node to get to another. For example, in order for the numbers of the dice in a tabletop game to reach the resources, the number of "hops" or the shortest path from numbers to resources would be dice > numbers > terrain > players > resources. In this case, the distance between numbers and resources would be 3. For networks with a low average distance, we can say that the network is dense since it does not take too much for one node to connect to another. For networks with high distance between nodes, the network is not dense.

Next homophily is a measure of how like-minded objects associate. This is a measure of how likely it is that a node in a network will associate with a node that is similar to it. For the purposes of the present research, this means that this is the likelihood that non-human objects and human objects associate with themselves over the other. In many ways, the measure of homophily or heterophily (only associate with different types of actors) is indicative of what amounts to a "balance" in a network. Balance, in this case is that there is no propensity for nodes to associate with like or dislike nodes. Finally, density is a simple measure but an effective one. Density reflects the proportion of the number of ties in a network to the maximum possible ties of that network. In the case of each network, given the number of nodes that are present, the maximum number of possible ties is if every possible combination of pairs of nodes was equal to 1. The shape of the network as it is visualized is also important.

There is one last object left to describe the shape of the networks – their visual qualities. It would seem that given the possible physical manipulation of a graph that these visualizations would do little but offer an artistically minded research a canvas to paint with. This is partially true; however, the initial visualizations are derived in computationally mediated ways. In the case of software created to perform social network analysis (e.g. UCINet, R's sna package, Gephi, and NodeXL), these software present networks based on a number of algorithms meant to reflect how each node is related to each other node much like that of cliques and subgroups.

Visualizations

In *Catan (1995)*, the most powerful objects in a network of associations are humans. This is true not because humans are the only objects capable of agency, but that their associations are varied. To understand what this means, the shape of the network is evaluated without humans being represented. This was done to examine how each object was relating to each other non-human object without the presence of humans being shown. The goal of this evaluation was to provide an example of how and what association mapping can show the weaknesses of a user-interface.

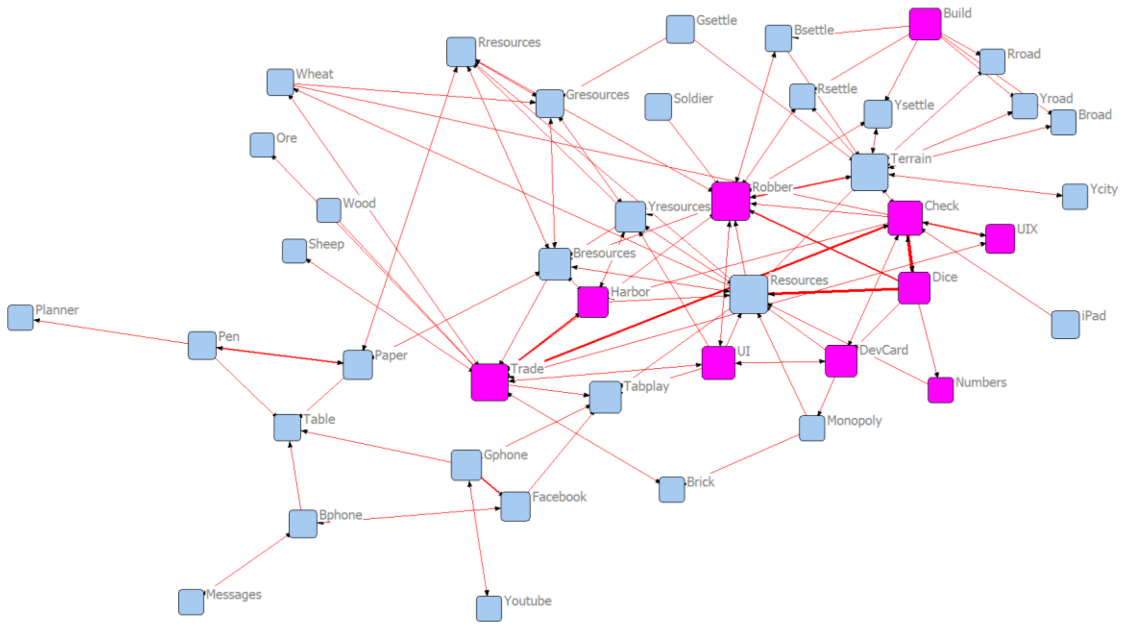

Figure 40 – Session 1 – iPad – Non-Human – Size of Indegree Colored by UI Element

In Figure 40, the first iPad game is visualized without human objects and without those objects that were disconnected from the rest of the network. Note that the Robber is at the center of the map. UCINet generated this visualization and I then manipulated the data to show node size by degree centrality while color-coating for UI-elements. The robber is afforded the same size as the resources of the game in addition to the trade screen, the harbor element of the trade screen, the check mark that indicates that an action is verified, and the other menus for building. Almost all of the UI elements are central to this network. This is in juxtaposition with Figure 40 wherein the resources of the game and its terrain stand out. The elements of the players by contrast, rarely exceed that of their resources. What this visualization provides, is a unique perspective into the impact of a user-interface. If we take the tabletop version of the game as the baseline goal for any computer-mediated replication, then the computer-based parts are overwhelming the activity.

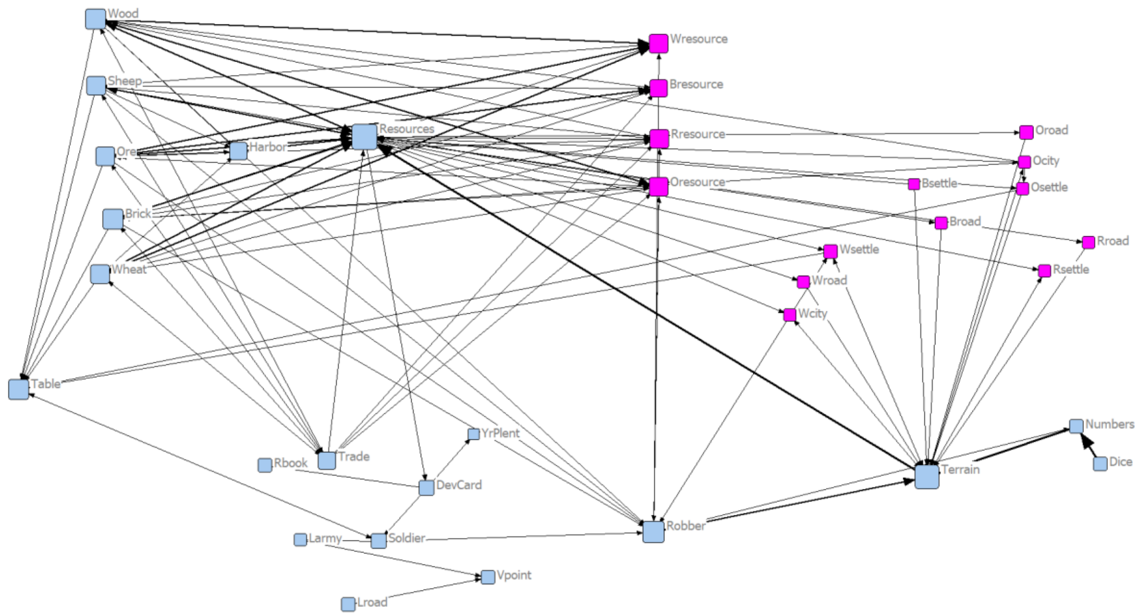

Figure 41 – 1 – TT - Non-Human – Size of Indegree Colored by UI Element

In Figure 41, the same elements are coded in the same way. Note that this time, the check mark and the robber are slightly bigger than the rest of the game elements. This shows just how much of an effect, the user-interface is having on the game. Additionally, the check mark is overwhelming the act of building, the dice, and each players' resource. Another note to make is that the human elements are missing from these visualizations; however, their resources are still indicated in the screen. They are indicated on this graph because they are not controlled by the humans directly, they are controlled by the app itself. Players interact with their resources through the trade screen. There is an additional element to this visualization in the weight of the lines. This is a visualization of the strength of a tie or how often specific elements associate.

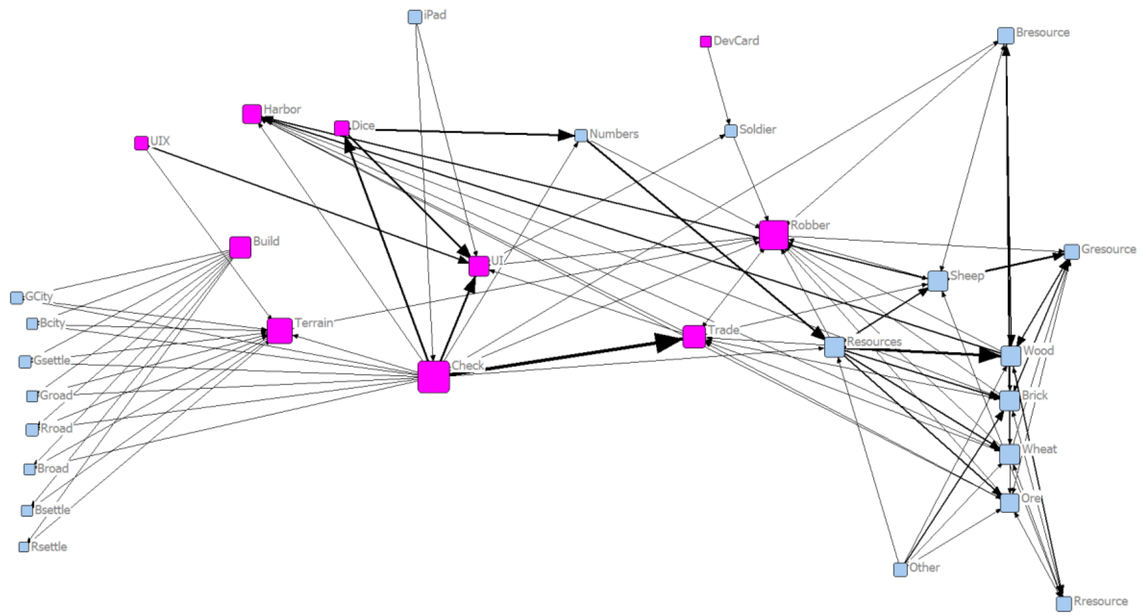

Figure 42 – 2 – iPad – Non-Human Objects by Degree & Strength Colored by UI Element

The dice, for example, always lead to the numbers. However, the dice also bring up the user-interface asking if a player is ready to begin. To roll the dice, the previous player must press the dice button. The current player then presses the check mark and the dice are rolled. While the user-interface itself is central, it is the elements of the user interface that are providing data to indicate that they are overwhelming the rest of the network. Again, in the tabletop game for session 2, the elements of Figure 42 display the centrality of the terrain and the resources of the game. There is no user-interface and players do everything manually but are also more central than any other element of the board whereas in the iPad versions, the check mark often approaches human-levels of centrality.

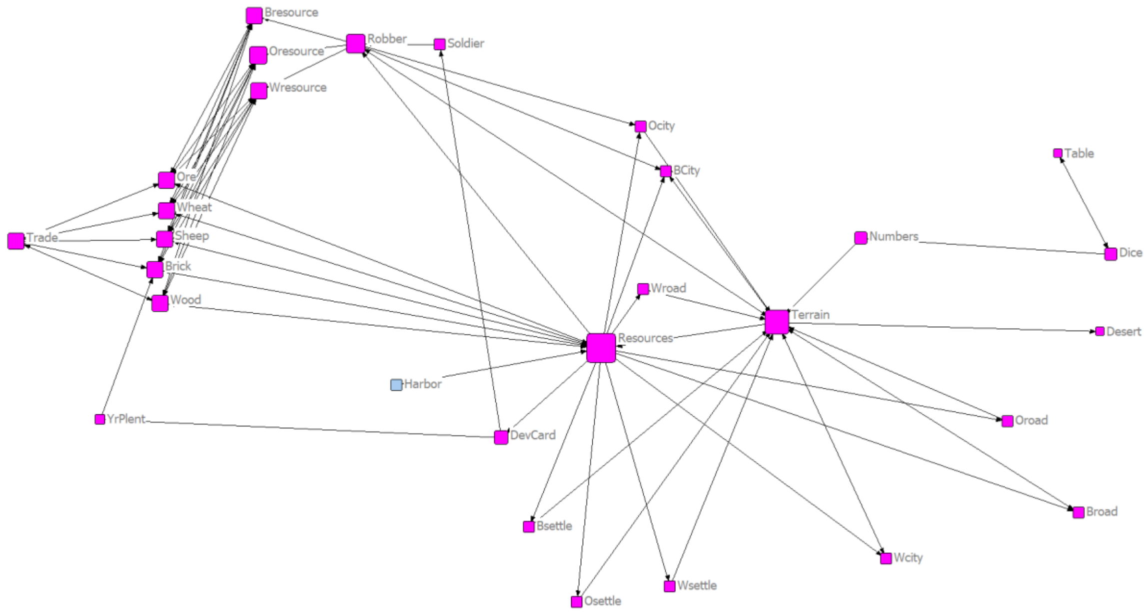

Figure 43 – 2 – TT – Non-Human Objects by Degree Centrality.

This last set of visualizations is the most in-depth. In session 3, the players took great care to explain everything about the game and to repeat much of what was going on to see if they were on the correct path. Additionally, this visualization is color coded by element meaning that the resources are colored green, the UI elements are colored blue, the development cards are colored pink, the trade elements are colored aqua blue, and the player elements are colored orange. These color-coded elements are also sized by their degree centrality. While the difference is slightly smaller given the robustness of the graph, the same trend appears. The check mark is the most central element with each other user-interface also factoring in to being a central actor. The above visualization appears in contrast to the highly centralized game in Figure 43. In the tabletop version of the game, despite being just as careful as they were in the iPad game, the game elements are all that remains centralized.

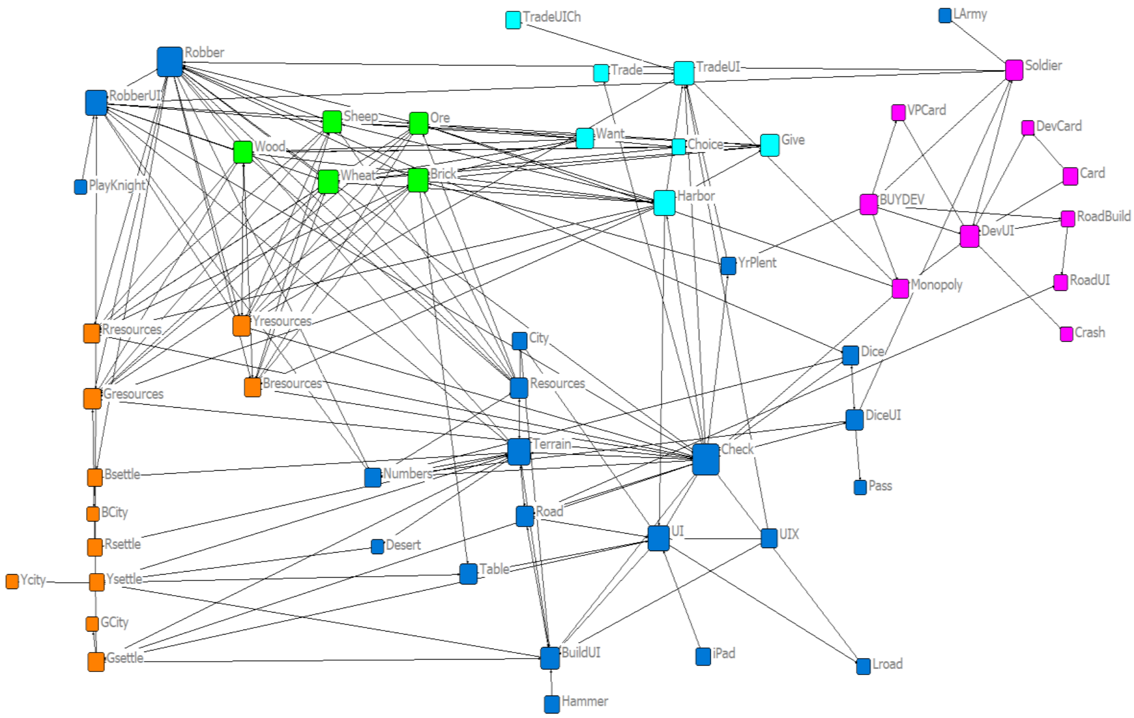

Figure 44 – 3 – iPad – Non-Human Objects by Degree & Strength Colored by Tangibility

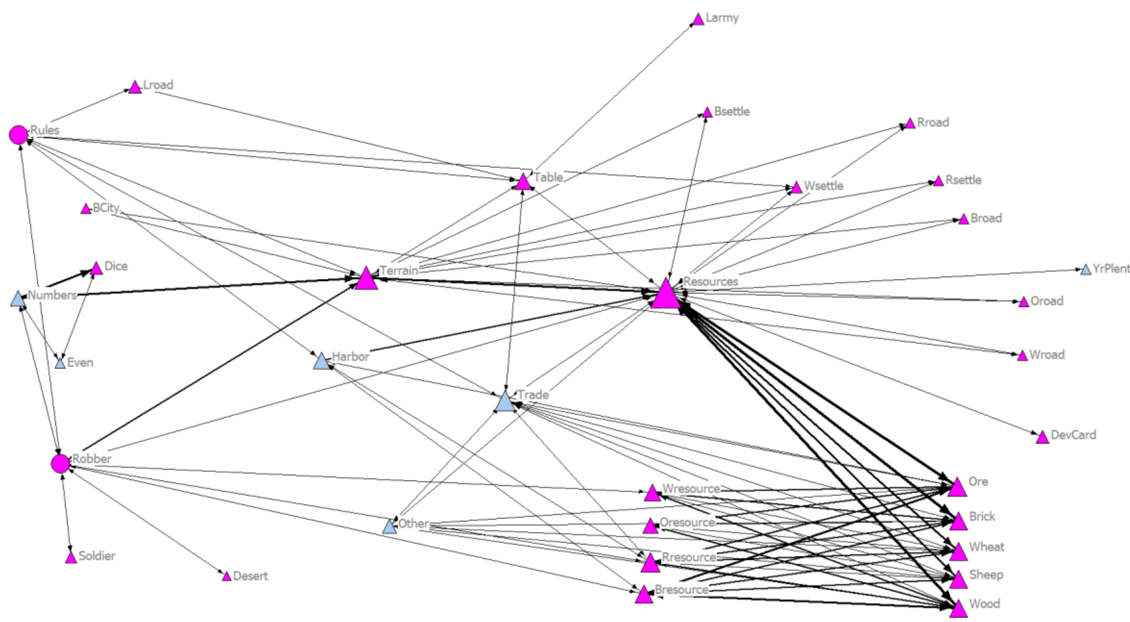

Figure 45 – 3 – TT – Non-Human Objects by Degree & Strength Colored by Tangibility

Interestingly, while these visualizations provide a trend that can be observed, an even higher-level analysis provides a unique opportunity to observe the size and shape of networks. In the visualization engines of NodeXL, the shape of a network using a force-based algorithmically derive graph provides something interesting to observe. Take Figure 44 and 45, a representation of the third game session's 2 games.

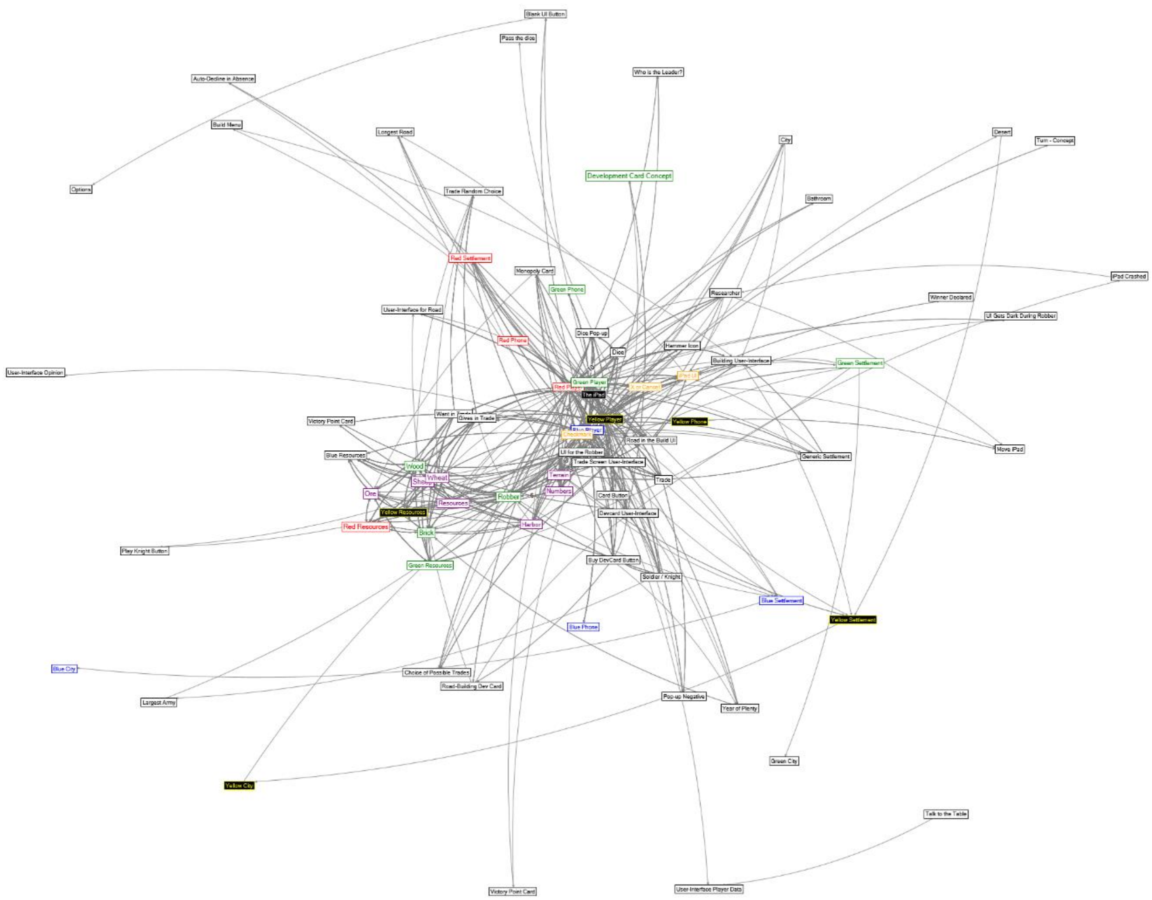

Figure 46 – Session 3 – iPad Visualization Using the Fruchterman-Reingo Algorithm

Note in the above that there are two distinct spaces of interaction. In the middle of the map, there is a lot going on there. This is where the players are located. They are discussing the game, discussing trade, and they are interacting the iPad. This is an expected occurrence as this is a tabletop board game and the players should be doing this. As a vehicle into the game, the iPad serves as the space of interaction. Now, the second space of interaction is in the lower left. There are all sorts of nodes over there doing something. These are the resources of the game. They interact with themselves and through the iPad, they are part of the game. The players actually never touch their resources. Take the previous visualization and compare it to Figure 46.

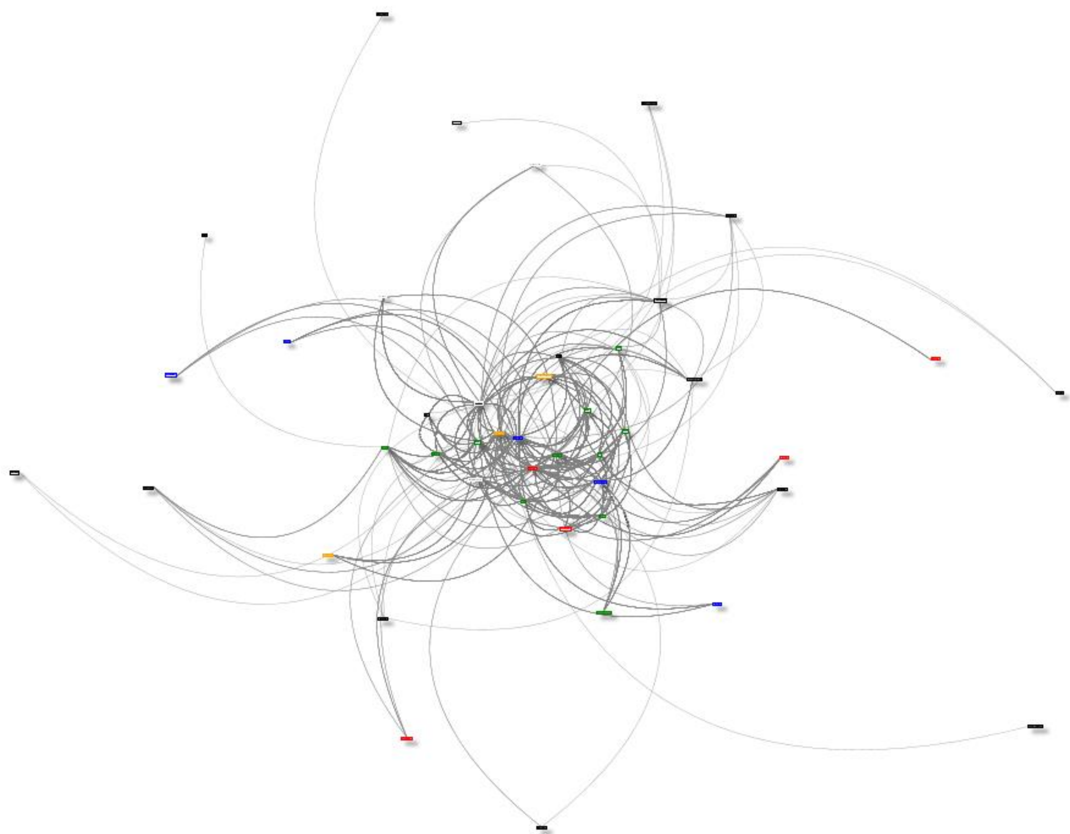

Figure 47 – Session 3 – Tabletop Visualization Using the Fruchterman-Reingo Algorithm

If the goal of a design is to mimic the human-action that originates it, this is the visualization we should be seeing from the iPad game. In the center of this map are the players, the resources, and every aspect of the game. Separated from the main network are not objects that are disconnected from the game, but ancillary objects that are necessary for the game. The node closest to the top of this graph, for example, is the object, “victory.” This node is only associated with once. Off in the distance are development cards, specific uses of the dice like rolling evens or odds, and the realization that an error was made when someone placed a settlement. Now, these visualizations are just that, visual representations of complex scenarios. To dig a little more into the overall shape of these spaces, it is necessary to do a few calculations.

Cohesion Measures

Density is measured by taking all existing ties and dividing it by the possible number of ties. The possible number of ties is simply $Density = \frac{|E|}{|V|(|V|-1)}$ or the number of edges divided by the number of vertices multiplied by the number of vertices – 1. This results in a proportion or percentage of associations that were made. The results of the density measures are located in Table 28.

	1-TT	**1-iPad**	**2-TT**	**2-iPad**	**3-TT**	**3-iPad**
Density	20.80%	11.80%	15.20%	13.90%	20.50%	6.90%

Table 28 – Density of All Games Across Modalities

In this Table, we can see that the Tabletop Games (TT) are generally making an average of 18.83% of their possible edges. This compared to the lower number of edges in the iPad games which are making approximately 10.86% of their possible edges. This measure directly impacts RQ2 – Does Cohesion change between modalities? We can say that yes, it does. From the data provided, we can make an assertion that computer-mediated measures exhibit roughly half of the associations as the physical modality does. The second part of RQ2 is about how the shape of cohesion changes and asks if the change can be explained. To explain the shape of how cohesion changes, the measure of homophily and heterophily must be called upon.

Homophily

This measure is difficult to perform with any meaningful empiricism but it provides useful descriptive capabilities. The way that homophily is measured is through creating attribute datasets or descriptive categorical data about each of the vertices in the network. These categories can be anything but are typically specific to the network itself. In the case of these 6 games, the measures created were 1 – This Node is a Human and 2 – This Node is a Non-Human. The goal for these attributes were not to test some hypothesis or even answer a research question. It was an exploratory measure that was meant to provide some descriptive measures of how each node was associating in the network they belonged to. To make sense of these data, it is necessary to go through each session and then, once each game has been described, discuss how they are similar and different. It is important to note that the coefficient for homophily, in this case the E-I Index is a number between -1 (complete heterophily) and 1 (complete homophily).

Session 1

Session 1 consisted of a group of 3 who knew each other and 1 who did not. The 3 players who knew one another were experts at the game *Catan (1995)* whereas the fourth player was a board game expert who had not played *Catan (1995).* This was the first time any of the players had played a game of *Catan (1995)* electronically. It was also the first time at least 2 of the players had touched an iPad though they had iPhones so the potential mediating factor of figuring out hardware behaviors was mitigated. In this game, the White player won both times with the Orange player coming in close second place each time.

Table 29 describes this game based on the attributes: 1 = Human and 2 = Non-Human. In the tabletop game, there were 4 humans and 37 Non-Humans whereas in the iPad game there was 48 non-humans. In terms of homophily, like- and unlike- following is mostly negated. Even still, the iPad game leaned slightly homophilic at .051 and the tabletop game leaned slightly more toward homophily at .109. That these numbers are roughly halved for the iPad games has been a consistent mathematical trend. While humans can only interact with each other with just 12 different paths, the strength of their ties (19.91 and 18.583 respectively) allows the human actors' smaller number of potential ties to be far more mathematically powerful. Hybrid actors Human >

Non-Human or Non-Human > Human are more mathematically resonant than that of the homogenous Non-Human > Non-Human ties.

What these data show is that mathematically, the networks of Session 1 are neither tended toward homophily nor heterophily based on the strength of ties. When the sum of ties is considered without the strength of each tie, the story is slightly different. Hybrid actors consist of the majority of associations within each game with 189 in the tabletop game and 166 in the iPad game. Independent of the strength of those ties, the heterophilic tendency is noticeable though not mathematically significant. Should this continue throughout each game, there is something to say about how objects tend to associate between modalities.

Tabletop Game			iPad Game		
Block	**Value**	**Freq**	**Block**	**Value**	**Freq**
1	**Human**	4	1	**Human**	4
2	**Non-Human**	37	2	**Non-Human**	48
Homophily	**1**	**2**	**Homophily**	**1**	**2**
1	12	94	1	12	91
2	95	140	2	75	136
E-I Index	**Phi**	**YULES**	**E-I Index**	**Phi**	**YULES**
0.109	-0.498	-0.865	0.057	-0.4	-0.832
Sum of Tie Strengths	1	2	**Sum of Tie Strengths**	**1**	**2**
1	239	1151	1	223	728
2	1509	1380	2	574	455
AVG Tie Strength	**1**	**2**	**AVG Tie Strength**	**1**	**2**
1	19.917	7.777	1	18.583	3.792
2	10.196	1.036	2	2.99	0.202
Std Deviations	**1**	**2**	**Std Deviations**	**1**	**2**
1	6.934	16.62	1	10.153	8.227
2	21.367	5.017	2	7.879	1.777
Correlation	0.346		**Correlation**	0.423	
Ties within	**Number**	**Density**	**Ties within**	**Number**	**Density**
1	239	19.917	1	223	18.583
2	1380	1.036	2	455	0.202

Table 29 – Session 1 Cohesion Measures

Session 2

Session 2 consisted of just 3 players with 3 additional players cancelling in succession. These three players did not know each other directly but consisted of 2 pairs bound by 1 person who knew both. 2 of the players had played the game several times recently and were considered experts whereas the 3rd player was not well-versed in board games and was new to *Catan (1995).* Each player was also well-versed in the technology appropriate to the game in that they all owned an iPad. Additionally, each player was used to being in front of cameras for a variety of reasons. These group descriptions are important to consider as they may be controlling factors for the homophily or heterophily trends witnessed in this game.

In session 2, the trend of leaning a little homophily or heterophily continues. In this case, the iPad game leaned slightly heterophilic at -.189 and the tabletop game leaned slightly toward homophily at .115. In these games, the noticeable difference from the previous session was that the hybrid actors of Human > Non-Human and Non-Human > Human were not the majority rule. Instead, the Non-Human > Non-Human category of association stands out. Interestingly, while there are numerically more associations of Non-Human > Non-Human these ties are not exceedingly strong. In fact, they are the weakest associations of the game. Additionally, human-based associations of Human > Human are significantly lower than the tabletop environment. The average tie strength of Human > Human is 18.333 whereas in the iPad game it is just 3.75. Of all of the games observed, this game was the least cohesive in general.

Tabletop Game			iPad Game		
Block	**Value**	**Freq**	**Block**	**Value**	**Freq**
1	**Human**	4	1	**Human**	4
2	**Non-Human**	48	2	**Non-Human**	36
Homophily	1	2	**Homophily**	1	2
1	6	63	1	12	50
2	63	94	2	38	117
E-I Index	**Phi**	**YULES**	**E-I Index**	**Phi**	**YULES**
0.115	-0.495	-0.885	-0.189	0.229	-0.592
Sum of Tie Strengths	1	2	**Sum of Tie Strengths**	1	2
1	110	722	1	45	727
2	1191	1265	2	437	884
AVG Tie Strength	1	2	**AVG Tie Strength**	1	2
1	18.333	6.685	1	3.75	5.049
2	11.028	1.004	2	3.035	0.702
Std Deviations	1	2	**Std Deviations**	1	2
1	8.769	11.532	1	2.385	14.196
2	22.649	6.135	2	9.809	4.124
Correlation	0.326		**Correlation**	0.21	
Ties within	**Number**	**Density**	**Ties within**	**Number**	**Density**
1	110	18.333	1	45	3.75
2	1265	1.004	2	884	0.702

Table 30 – Session 2 Cohesion Measures

Session 3

Session 3 was the most detail-oriented session with 80 objects ascribed the ability to act by the players at the table. These players were the most varied of the groups with 1 player being an expert and every other player being new to the game. That one player who was an expert took a leadership role in the tabletop game often endeavoring to explain the rules and offering strategy suggestions. By the iPad game, he was the least vocal yet won both games.

This game continues the trend of slight E-I Indices with only .041 and -.046 between the two modalities. In the iPad game, Non-Human > Non-Human actors represented the majority of the ties represented. This is significant because as was shown in the previous section on visualization, there is a subnetwork that can be observed to the side of the main game – the network where resource distribution occurs. Again, the strength of the Non-Human > Non-Human ties is relatively low at .375 but all strength is decreased between modalities.

Tabletop Game			iPad Game		
Block	**Value**	**Freq**	**Block**	**Value**	**Freq**
1	**Human**	4	1	**Human**	4
2	**Non-Human**	76	2	**Non-Human**	76
Homophily	1	2	**Homophily**	1	2
1	12	101	1	12	137
2	101	174	2	72	217
E-I Index	**Phi**	**YULES**	**E-I Index**	Phi	YULES
0.041	-0.476	-0.855	-0.046	-0.353	-0.852
Sum of Tie Strengths	1	2	**Sum of Tie Strengths**	1	2
1	250	1872	1	176	1654
2	1872	2306	2	585	2140
AVG Tie Strength	1	2	**AVG Tie Strength**	1	2
1	20.833	11.7	1	14.667	5.441
2	11.7	1.478	2	1.924	0.375
Std Deviations	1	2	**Std Deviations**	1	2
1	7.151	23.319	1	7.993	15.17
2	23.319	7.537	2	7.316	3.941
Correlation	0.327		**Correlation**	0.235	
Ties within each	**Number**	**Density**	**Ties within each**	**Number**	**Density**
1	250	20.833	1	176	14.667
2	2306	1.478	2	2140	0.375

Table 31 – Session 3 Cohesion Measures

Putting it all together

The final point to make about homophily is that across all of the measures of homophily, the correlation figure is never significant. While there are trends that can be seen numerically by examining the crosstab of who is associating with whom, the numbers, their correlation coefficients, and the tests for significance produce insignificant results. Despite this lack of significance, there is something to be said about the strength of the categories within this test with regard to RQ2. The shape of the cohesion measures observed thus far are as such that it seems as though there are more non-humans associating with each other than there are humans but that humans within the game make so many connections to the non-human actors that their lower number of associations. Additionally, as we witnessed in the visualization section, there seem to be pockets of non-human actors that associate with each other more so than humans within the iPad games. This is causing much of the lower cohesion that is witnessed in these data. The last measure to consider with cohesion is the distance it takes for one node to associate with another node – Geodesic Distance.

Geodesic Distance

The distance between any two nodes on a network is a measure of cohesion as well as a description of density. Distance offers a way to describe the strain of a network in that if networks have significantly high distances between nodes, then node-seeking behaviors become difficult. This measure is impacted heavily by the size of a network though in the case of these 6 games, the values are similar enough for the measures to be accepted. To begin, the average geodesic distance offers a description of the general shape of the network. These data can be seen in Table 32.

	1-TT	1-iPad	2-TT	2-iPad	3-TT	3-iPad
Distance	1.9	2.3	2.1	2.3	1.9	2.6
Std Deviation	0.6	0.7	0.6	0.8	0.6	0.8

Table 32 – Average Distance Between Nodes Across All Modalities

This table describes the shape of each network. We can make a few observations here. First, the standard deviation of these measurements is consistent between .6 - .8. Second, the Tabletop Games generally require fewer jumps, on average with a little over 1 to possibly 2.5 jumps being the average. This stands in contrast to the iPad games wherein there is generally 2 going up to as many as 3. The individual games are slightly more interesting. In Table 22, the overall geodesic distance is shown.

Several things should stand out, the distance from Table 33 is shown broken down in more detail. The 19.05% of the Tabletop Top Game's just 1 hop between node is lowering the geodesic distance down from 2 despite 15.56% of the distances being covered by 3 hops. This stands in contrast to only 9.20% of all distances being just 1 hop and there being a slightly heavier curve between 2 and 3 hops. Of note are those nodes that cannot connect to each other with 5 or fewer hops. 11.56% of the nodes in the iPad networks are unable to reach one another.

Just TT				**Just iPad**		
# Hops	**Frequency**	**Proportion**		# Hops	Frequency	Proportion
1	955	19.05%		1	969	9.20%
2	3194	63.70%		2	3822	36.29%
3	780	15.56%		3	3620	34.37%
4	9	0.18%		4	722	6.86%
5		0.00%		5	182	1.73%
NA	76	1.52%		NA	1217	11.56%

Table 33 – Breakdown of Distances Averaged Between All Games By Modality

Per game, these data can be broken down into more detail. For example, in session 1, all nodes could be reached in at least 3 jumps whereas in the iPad modality, at least 5 jumps were required to reach all nodes. There are nearly just as many nodes with 4 and 5 hops in the iPad game as there are with just 3 in the tabletop game.

1-TT				**1-iPad**		
# Hops	**Frequency**	**Proportion**		**# Hops**	**Frequency**	**Proportion**
1	341	20.80%		1	314	11.80%
2	1104	67.30%		2	1195	45.10%
3	195	11.90%		3	885	33.40%
				4	107	4.00%
				5	151	5.70%

Table 34 – Session 1 Breakdown of Distance by Modality

In session 2, this was no longer the case. There were nodes that were not reachable by 4 or fewer jumps in both sessions though the Tabletop Game was slightly denser in that 72.3% of the nodes could be reached in 2 jumps or fewer. In the iPad game, only 54.5% of all nodes could reach each other in 2 jumps or fewer. Additionally, the distribution is noticeably but slightly skewed left with the Tabletop Game. The game with the iPad encapsulates 86.2% of its nodes in 2 or more nodes versus 84.7% of all nodes in the tabletop game. Session 2 was perhaps the most balanced game that was observed.

2-TT				**2-iPad**		
# Hops	**Frequency**	**Proportion**		**# Hops**	**Frequency**	**Proportion**
1	226	15.20%		1	217	13.90%
2	846	57.10%		2	633	40.60%
3	325	21.90%		3	516	33.10%
4	9	0.60%		4	79	5.10%
NA	76	5.10%		NA	115	7.40%

Table 35 – Session 2 Breakdown of Distance by Modality

In Session 3, there is another game that encapsulates the nodes in 3 hops or less. What is interesting about this session is that in the iPad game, 17.4% of all nodes simply cannot connect with one another. In addition to those nodes that cannot connect with one another, only 6.9% of all nodes can connect to each other with just 1 hop. Session 3's iPad game is perhaps the least dense of the iPad games observed.

3-TT				**3-iPad**		
# Hops	**Frequency**	**Proportion**		**# Hops**	**Frequency**	**Proportion**
1	388	20.50%		1	438	6.90%
2	1244	65.80%		2	1994	31.60%
3	260	13.70%		3	2219	35.10%
				4	536	8.50%
				5	31	0.50%
				NA	1102	17.40%

Table 36 – Session 3 Breakdown of Distance by Modality

Within each of these games there is a detailed breakdown of how far a node had to go to connect to another. While this measure does not explicitly discuss *what* nodes are taking the most hops to get to another node, these can be discovered by visualizing the datasets that UCINet produces when these analyses take place but those visualizations will not be used here as many of the isolates requiring more than 2 jumps can be determined by examining the network visualizations themselves.

Moving on

Association Mapping has provided a lengthy, detail oriented discussion of the network that is created when users begin an activity. There are three spaces that provide worth to designers of software meant to mimic human-mediated activity. The first space is called inner-space. In AM, the centrality of an object can provide many useful ways to understand a network at a level of detail well beyond that of existing methods. Next, the inter-space of a network is considered. While the centrality of individual tress is useful, groves of trees within a forest are also important. In the case of inter-space, the groups that form throughout an activity can provide data about how humans and non-humans are aligning to perform an activity or task within an activity. Finally, the outer space of a network is important. This is the shape of the forest and the various ways that the forest changes given the insertion of a computer as a mediator. In the next chapter, I will discuss how and why these data matter and how to better encapsulate them in the design process.

CHAPTER 7 – ASSOCIATION MAPPING IN THE DESIGN PROCESS

Association Mapping has the potential to influence the design of software in order to make it more competent as a social actor. I first described the state of research within the realm of human-computer interaction (HCI). That research has been fruitful but the nature of computer use is changing as the computer itself begins to disappear. The historic proliferation of computer use throughout the science wars has resulted in a consistent discussion of computer use and design that is human-focused. With those pressures described, I then describe the space of use as it is now connecting to the task-artefact cycle and offering that Association Mapping is a new attempt to catalog implicit design practices. Human-centric evaluation of tools has provided a lot of value for computer use but we stand now within a literal crossroads. The first step to understanding the crossroads was to understand the history of HCI very briefly. This was approached through three distinct pressures use is directed by.

I described these crossroads using metaphors. The first metaphor concerned itself with *Robinson Crusoe (Crusoe, 1719; Defoe et al., 2007)*. The order he imposed on the island soon came to overwhelm him. Crusoe replicated the world he came from, the ontology of humanity, on the island with what was afforded him. However, as this replication and simulation of the world Crusoe had been separated from grew, so too did his need to maintain those things. There were two ways for Crusoe to conclude. The first was as the initial book did. Crusoe escapes with his man Friday on a boat heading back to the world he had replicated before it consumed him. The second ending was suggested by Michel Tournier (1974) who saw Friday blowing up Crusoe's fragile simulation and Friday heading back to civilization while Crusoe stayed behind to live without dependence on the ontology he came from.

The second metaphor was discussed through Lingis' *Community for Those Who Have Nothing in Common* (1994). This metaphor centers on the moment a stranger appears. In this case, the stranger is the moment the black box representing the computer is tipped over with its contents revealing the hidden powers and influence the box had over the community surrounding it. The purpose of this metaphor was to suggest that use is an act of communication and that communication is not about intent, but the mediation of miscommunication. This metaphor was meant to convey the sense that design is often designed around the intent of a designer. This is an act of communication but is inverse of the act of communicating. I suggested that if design were to begin to allow software to act more competently in this regard, that the stranger would not appear so often.

I suggested that through these metaphors we could understand the nature or essence of the issue surrounding computer use. It is working but each new design increases the pressure as a whole. To decrease that pressure, to lower the rate that the stranger appears, we needed to start to approach the evaluation of use in a different way. That different way was Association Mapping. This method of evaluation used the tenets of play, the concepts surrounding Actor-Network-Theory, and Social Network Analysis to examine the network that formed during an activity. This Frankenstein (Finn et al., 2017) of a method would allow designers engaged at various levels of the product creation cycle to evaluate not each individual affordance or the overall efficacy of the product's various components, but the way that the product influenced the activity given a baseline comparison with its non-computer-mediated component.

The pilot for Association Method was an analysis of *Catan (1995).* The present research is an analysis of *Catan (1995)* through two modalities of play as a way to show how AM analysis differs from existing analyses of play. This study reported ultimately that unsurprisingly, the app created to mimic *Catan (1995)* disrupted play momentarily as they became users. The app promoted contradictions within the activity and until those were resolved, the activity was disrupted. Second, the users had to interact with the game system as well as through it. This was exhibited by a number of events. During play, the iPad became a source of myth at the table as players discussed if the iPad actually liked them as a person. Next, the understanding of rules was called into question as the iPad forced all rules to be followed.

I then set out to describe how to do Association Mapping (AM). This method is an augmentation of Social Network Analysis (SNA). The measurements that were useful for AM to provide data for designers had to do with three distinct spaces: Outer Space or the general shape of the network, Inner space or the individual objects and their centrality, and Inter-space or sets of objects that are acting in tandem for some goal. In SNA terms, these are measures of network cohesion, centrality, and sub-groups. Each of these measurements are then exemplified through the networks created to reflect *Catan (1995)* played through different modalities.

Inner space pointed to the user interface as an object that decreased the centrality of humans within the networks where the iPad was mediating the activity. The groups that were evaluated were concerned with how the act of trading was impacted by the appearance of this user AI. Finally, the shape of the network all pointed toward the reasons for the loss of centrality – that many of the objects central to humans participating in the maintenance of a system were essentially removed from their ability to interact with. Each of the observations here taken together offer a complete picture of how a network functions over time and how changing the modality of play shifts the relationship of the players with the activity. But with that, the question now becomes how to deploy these data.

How to Use Association Mapping

In Chapter 7, I provided an in-depth analysis of the different modalities of play during the activity called *Catan (1995).* Through AM, researchers can not only understand the consequences of their design more completely, but the additional information allows researchers to extract implicit data that can be glossed over using traditional techniques. Designers create a list of numeric, testable quantities that describe the power of each object within the context of a product's use. These data are collapsible, groupable, and also able to be tested using a number of statistical methods. The network of use can be further expanded by appending attribute data to each individual node. Even the edges between nodes can have data appended to them. Despite this plethora of data, the questions remain about how to best use it, how to best interpret it. There are three specific ways that this method can be used.

The first way to use these data is how the data were used here – comparison of modality. In Chapter 2, I discussed the work of Peter Naur and the concept of "Programming as Theory Building" (Naur, 1985). Briefly, this concept is that as development of a program occurs, that product comes to represent a theory of whatever human activity the program is replicating. The way to use AM, with this in mind, is to perform AM on the activity that the product is meant to replicate while the theory of that activity is being developed. As the product takes shape, AM can be performed again as a way to evaluate how well that product replicates the activity.

The Task-Artefact cycle (Carroll & Rosson, 1992) expounds on Naur's (Naur, 1975, 1985) points by offering that practice and research are separated by invisible, implicitly derived gaps. AM expands the Task-Artifact cycle by providing researchers a means through which to extract certain kinds of implicit assumptions. Within this analysis was a lengthy discussion of the impact of the checkmark. The implicit design concept that this analysis brought forth was the forced use of a user-interface. Each aspect of the interface in question lowered the centrality of the humans who were using the product. In addition, it allows researchers to see just how much of a process is being automated while also displaying numeric quantities that can be used to measure the consequences of that automation.

Next, for existing products, AM can be performed to learn about how a product needs to evolve versus how users would like it to evolve. The release of a product starts this cycle of constraint-based innovation around limitations of that product and the development of new products that meet that evolution. This is exemplified in the evolution of the word processor from typewrite simulator to its current iteration as a collection of tasks revolving around the concept of text. AM can provide a description of how products are changing and evolving. By also collecting data based on the use of ancillary products used during a specific product's use, new affordances, new development possibilities, and possible partnerships can also be evaluated in tandem.

Finally, AM can be used to explore existing activities before development begins. For example, the games of *Catan (1995)* that I observed allowed me to understand how humans play a role in the maintenance of a game system. In looking at the way that play developed over the course of just 3 games, I had an idea of how computation could be used to replicate many of the central components of the game. However, what aspects of the game could or should be replicated are not readily apparent. By using AM as an exploratory method, what exactly could be computer-mediated should become more obvious as more and more games are added to the data to examine. This deployment of AM also allows for more involvement with other disciplines as different types of researchers engage that research.

The three ways to deploy AM – comparison, post-hoc, and exploratory pre-design – all offer or suggest that the researchers know where a network exists and have come to understand what aspects of that network are important ingredients. The last way to deploy AM is to send researchers into existing organizations to gather network data from independent contexts. For example, the use of word processors in a group-based assignment at a high school versus distributed collaboration of research teams located around the globe is going to be somewhat different and rely on many other kinds of tools. Difference is simple to understand whereas the similarities of these networks will provide useful insight for possible features to include in product development.

Weaknesses

Association Mapping is a method relies heavily on the researcher's ability to understand the context of a network. This understanding begins with comprehension of the product being evaluated but also the context of the activity that product is meant to mimic. How a non-computer-mediated task contextualizes itself is important for understanding how a computer program can be used to mediate that task. The need for social science is growing while the decline of social science representation can be seen in the practice of software development and HCI research. Outside of social science is the need for the humanities; however, more humanities-based research in HCI (while increasingly more important) is also increasingly unlikely.

In addition to the issue of fewer researchers well-versed in the various components of social science, the humanities, and digital humanities, the data from AM also present a challenge. The data associated with social network analysis is not generalizable. Instead, these data reflect the debate of the origin of replicability. The point of statistically derived research is not to find testable facts, but to examine the circulation of ideas and how they change over time. As a result, the concept of empiricism and of replicability is not only ignored, but challenged. This will no doubt result in a number of rejections from existing conference proceedings and journals who are not receptible to the idea that generalizability is a concept that can be challenged.

Whereas these data are not generalizable, there are additional mediating factors. AM data is specific to that specific network. Even within that network, data might be different from hour to hour, from turn to turn, or from the desired time stamp to the next. Network data also reflects the perspective of the researcher who is recording it, coding it, and interacting with it. The interpretive aspect of AM does not stop, either. That same researcher whose imperfect sense of observation created the network continues to examination of the network using tests that require the creation of more data. This results in many of the tests, measures, and interpretations of these data being highly contextualized of both the researcher as well as the context of the research. In a sense, researcher talent plays as much of a role in AM as it does in the design of products themselves.

Finally, the biggest weakness about AM is how long it takes to generate a network. There was approximately 9 hours of footage for the 6 games of *Catan (1995)* that were observed. Of that 9 hours, it took approximately 1.5 hours per 15 minutes of footage to code the data for analysis. This is in addition to the existing 18 hours of observation that went into watching the games themselves and the 9 hours of observation when the recordings were made. AM required well over a few hundred hours of work just to get the networks coded before analysis begins. Once the analysis began, the process took at least double the number of hours per game. Association Mapping, much like Social Network Analysis, is a method still in its infancy.

Future Developments

Given the weaknesses described on the last few pages, there are a lot of developments needed to make Association Mapping friendly and future facing. The first development is deploying algorithmic detection of associations. By recording videos, it is possible for a researcher to make these data make sense. However, given the development of contextually aware algorithms at places like Adobe and Facebook, it is no doubt possible in the near future to apply these algorithms to a series of videos in order to produce actionable data. The additional level of data from these algorithmically derived associations are also with eye-movement and focus. It is one thing to say that a user associated with some object whereas it is another to say that a user associated with the top quarter of the object and grabbed it from the middle. The second development in the future is embracing more from social network analysis.

SNA provides a lot of tools for researchers to use and many of these are not well-developed or supported. For example, modelling algorithms like Exponential Random Graph Models (ERGM) can provide ways to predict links in the future with the existence of other links in a network. Through ERGM, it is possible to take existing models of human activity and apply conceptual designs to them. It would then be possible to use AM as not only generalizable, but as a gathering hub for human contextual association maps to investigate for future development possibilities. This stands in opposition to the ontological premise behind the creation of Association Mapping. However, it would be foolish not to note that this is a possibility. In fact, by constantly evaluating networks of hybrid actors across multiple modalities, contexts, cultures, and languages, it should be possible to model predictive algorithms that are more competent in their predictive capabilities.

Additional development is also possible in the level of detail. It is possible to explode these data even more. It is one thing to incorporate an association between a user and a part of a product. It is quite another thing to association a user to a product and then go one step further into log files and the various ways that computer programs associate internally. With that level of detail, the consequences of even the smallest disturbance in the network can be observable and knowable. The applications for this particular conceptual level analysis of association could provide an infrastructure to event detection systems that can mediate known networks using the techniques discussed above. These systems are applicable for crisis response and management in an effort to save lives though possible privacy intrusions surround the application of these future developments.

Association Mapping is the mapping of objects in context. By mapping a context, it is possible not only to see its shape and its central components, but also its connections to other contexts. This methodology is powerful in that it can provide extremely low-level detail of a network that can be compressed and made to situate high level analyses. It does all of these things while remaining purely descriptive and avoids reducibility by evaluating all aspects of an activity. This example of an evaluation of 6 *Catan (1995)* games provides a “how-to” but also a discussion of the various components of this methodology that are in need of computer-mediation and automated help. In the future, the design of these systems, the task-artefact cycle, and even the understanding of existing human-machine interaction may be better explained by mapping associations. In a world where AM has scaled to become commonplace, there are no black boxes except for those that designers create because they have created it themselves.

The epilogue follows those same users from the introduction. It has been 30 years since they took part in their pilot run of the user test. The 30 years of development in software between now and then has resulted in a number of new ideas in the realm of user-testing. What data are distributed, what processes are distributed, and what data are gathered are highlighted and expounded on where possible. Again, this design fiction is written in first-person perspective to allow the internal life of one of the users to be better contextualized. This design fiction concludes with another perspective from a designer on the design team of the product being evaluated.

EPILOGUE – A FUTURE FACING DESIGN FICTION

In the near future, cameras, microphones, heat sensors, and eye tracking software will be powerful enough to capture and interpret data in real time but small enough to place anywhere. The addition of contextually aware software that can measure the pressure, object, and persons that touch one another has added a new layer of analysis. Automated transcription software also allows for researchers to not only assign anonymous names to users, the software can keep track of voice and inflection automatically. As a result of cheaper hardware, easier to use software, and compression algorithms that keep files trim, coffee shops and restaurants have begun to set aside rooms that are wired in such a way as to offer user-testing for clients around the world. Association Mapping is now nearly fully automated with the possibility of additional data as needed and it has become a cheap way to get a quick meal, watch a movie, or play a game in relative privacy…well, aside from all of the cameras.

Design Fiction Part 2: Tales from the User Room

“Hello, I had a reservation for the play room for about 10 minutes from now.”

The waiter looks down at their list and presses a button near his face. “Yes, the room is ready now, actually. Please follow me. Your guests will be shown a map on their phone when they arrive.”

I had reserved this room a few days ago and was surprised that it was available. Rooms like these had popped up all over the place in the last few years. For a significant cut off of your meal or a few rounds of free drinks, you could get a private, sound-proof room to do anything you wanted. In return, the restaurant sold all of your data to whomever was interested in whatever the activity was. You could play games, have meetings, have sex, or just sit up there in one of the comfortable chairs and disconnect for a few hours. In return, ludological researchers, business intelligence specialists, teledildonics firms, and sleep researchers would get a dossier on you and your activity. There had been breaches in the past but the discount was so good that no one seemed to mind.

“You are signed up to play a board game tonight. The sponsor of this activity would like you to play the game on this tablet. From what I was given as a script, it says that they are working on giving some new life to old board game applications. In return for paying for a meal for each guest as well as 3 rounds of drinks, you agree to provide all recorded data to that firm.”

“What all do we have to do?”

The waiter hands me a small stack of cards and said, “Have each guest read one of these aloud without laughing. You will hear a tone if the reading is accepted. If the reading is not, you will hear a buzzing sound like a game show sound for incorrect answers. Once everyone has read their card and been accepted, you do not need to do anything else. The firm does add that they would prefer if you do not wear hats.”

“That shouldn’t be a problem. Thanks! We can order from this touch screen over here?”

“Yes, your food will be served to you through this wall.” The waiter pushes a button on the wall and it slides away revealing a long glass surface. “We will place the food on this through the other side of the wall as to not disturb the recording. Once the food is all there, you'll get a text message. Just press this button and grab your food. Drinks will be served here as well."

"Thanks! This is so exciting. I haven't done this before."

"Please let me know if you need anything. You can text message me through the application you made the reservation on." The waiter then walked toward the door, opened it, and left me alone in what seemed to be a larger banquet room. There was a table with 4 chairs around it that seemed to be set up for what I had reserved the room for.

The next few minutes went by quick as my friends arrived and we talked about what food and drinks we wanted. We tried to find the most expensive stuff on the list. It seemed like cheating but for all we were going to give away, it seemed like a good payment. Once everyone arrived, we all took turns reading our cards. From what we could figure out, it was just a way for the computer software to recognize each user. Normally this stuff is laughable but one of the conditions for the firm paying for the meal is that everything at least at the start has to be taken seriously before they agree to pay the meal.

The iPad lit up and showed us the game screen. It was a classic throwback to the game *Catan (1995).* There were lots of games that had been inspired by *Catan (1995)* but many of us grew up playing the game in college and had even played the game in the past for a researcher interested in how the iPad game differed from the tabletop game. So here we were, 30 years later playing again in a room covered in cameras with the same group of people.

"Man, this is so weird!" White said. "Were we trend-setters or what?"

I looked at the title screen and things looked different than what I remembered. The game had a picture of me from when I looked at the screen but it had morphed me into a resident of

Catan (1995). It had a prompt asking me what my name was. “Red is fine. I said.” The game made my colors red and my name was also made red. There wasn’t a reason to use our real names. They were supposed to change all of that anyway.

I handed the game to Orange who looked at the screen and said, “I look hideous!” The game then changed her picture slightly. “No no, hideous is fine. Orange is also fine.” It changed Orange’s picture back to the original and set her in place. She handed the screen to White and then Blue who each did the same thing. Our food arrived around this time so we grabbed everything and sat down at the table.

The iPad had a green “Ready?” flashing on its screen. I looked at it and said, “Yes.” The game then set out showing me the tiles as the game made the board for us. The number tiles were then placed on the resources tiles and I was shown a small settlement looking building. When I touched it, the space I touched reacted with some haptic feedback. I could drag my finger around and when I dropped the settlement it stuck into place nearest to where it fell. I found a good spot near two Ore resources and said, “Ok.” I got a text message on my phone from the game with a URL.

“That’s new,” I said. “It looks like I can see all of my resources on my phone.” When I clicked on the URL, it asked me which player I was. I clicked on Red and it showed me a screen that seemed to be all of the information I needed to know. On my browser, I was shown my current points, the resources I could get, there was a space I could see my what resources I had, and if I clicked a button, I could see what it took to build things in game. It also had a, “Message another player” button. I clicked it and saw that I could message people. “Oh wow, they added a back channel.”

“This is neat,” White said. “You know, I still get that music in my head. I’m glad they didn’t keep it. It’s been following me for what, 3 decades now?” She started to hum the music from the old *Catan (1995)* app.

We all placed our pieces and got our resources. I was surprised to see that the html page on my phone was refreshing instantaneously. The iPad came around to me again as I was going to be the first to start the game. I saw two dice that seemed to be sitting in the same place where the settlement had been. I put my finger on them and felt the haptic feedback. I put my finger on the surface and moved them forward. The dice moved and then rolled. A screen prompt came up that asked if we would like to handle our own resources or if the game should.

“Hey do we want to give each other resources each time the dice are rolled?”

“Nah, I don’t think so. If we have this screen, we’ll at least know what we have. I’d like to know I’m not responsible for giving you all your stuff.”

“Please distribute resources, *Catan (1995).*” The game then distributed the first resources created by the dice of the game.

The iPad then said, “You can tell me to stop at any time.”

“Whoa, what was that?”

“Would you like to hear more about voice commands?”

“Sure, tell us about voice commands.”

The *Catan (1995)* app then went through a few basic commands. I could tell the game to roll the dice, that it was a new player’s turn. I could ask the app to read how many cards each player had. I could tell the app to offer a trade to a certain player. I could tell the app to accept trades. I could even tell the app to place a settlement or house in a spot they felt was appropriate.

My phone beeped at that moment. I brought up my messages app and saw that my wife was wishing me luck. She had wanted to come to this tonight but she had had to work. I saw that she had just gotten home and was making some food for the dog. She sent me a video of her ride home where some guy had cut her off. I told her that sucked but we could put it up somewhere later for people to look out for on her commute.

I flipped back to the browser and saw that Orange had messaged me on the *Catan (1995)* page. She said something to the effect of, “let’s make sure White didn’t win again.” She always seemed to win when we played games. “Definitely.” I replied.

The game came back around to me and I saw that I had a bunch of Ore and some wheat. I needed a sheep. I looked at my settlements. In the bottom of the screen, I saw my resource cards. To the left, I saw a button that said, “Propose a trade.” I clicked on it and it asked what I wanted. I clicked the sheep card. It then asked what I wanted to give and I clicked one of my ore. Each player then got a notification on their phone. They looked at the phone and clicked a button. On the iPad it showed me a picture of each player with a check mark next to their face. Blue had an X, he had nothing. But orange and white had agreed to take the trade. I clicked on Oranges’ face because we wanted to beat White finally. White’s phone laughed while Orange’s phone made the Ore sound.

We played for a while and it was super fun. Everything I didn’t like about the app from before seemed to be gone now. Everything made sense though maybe some of the voice stuff was weird. While it was fun, I ended up losing. The unfortunate part about planning to win against a player who always wins is that no matter what you do, they always win. About an hour later, white yelled, “Take that, suckers!”

We stayed a bit later talking about the game and enjoying our drinks. We used to be able to play 3, maybe 4 games a night but that one game was a lot. After finishing our last round of drinks, we all got up and headed downstairs.

“Hey guys! Thanks for coming tonight. All you need to do is sign this release here and everything is great!”

We all signed, talked for a bit outside, and went home.

Design Fiction Part 3: The Game Design Lab

I checked the log in the morning and saw that we had three datasets come in overnight. Two were for products under development but one was for a retro line of products meant to give folks a board gaming experience. You see, all of the board games of the world had mostly stopped being printed. They weren’t stopped because the market failed but because the cost to print that much cardboard and paper skyrocketed. The market for board gaming had begun to rise and it had stayed steady as teams of developers worked to digitize game experiences as faithfully as possible.

I pulled up the data and began to look at it. This was a four-person game of *Catan (1995)*, that game from the 1990s that started much of the board game craze. All of the files looked to be intact and from a cursory glance, the transcription seemed to have gone well. Those files often were useless as voice recognition was not as easy as many companies wanted you to believe.

I opened up the AM package and began to look at the data. There wasn’t a lot that seemed out of place. They had some trouble trading the first time. They had some trouble rolling the dice. They had some trouble moving the robber around. All of this seemed to be pretty baseline.

I clicked on each player to explode their associations. This was interesting. Orange and Red seemed to have some back-channel discussions going while Blue and White also discussed strategies. When they had instituted the back-channel text-chat, there was some disagreement with the design team that this was not something that was natural to games but from early tests of the new feature, it seemed to promote certain behaviors. It's odd though that you had such a stark difference between the two groups. Curious, I began to look at the video log with the white and blue players as they had talked to each other a lot more.

Interestingly, the white player had never clicked on any of the other players' names. She also did not seem to really look at the screen that often. Instead, she kept looking at the iPad while it was in each players' hand. Why was that? He fast forwarded the video and saw that they had sat around talking after the game. In the transcript file he hit the command to find text and typed the word, "couldn't."

The first entry brought up the sentence, "Yeah, I couldn't figure out how to talk to anyone but Blue. Oh well, at least I won."

He looked at the relationship of white's hands to the screen. They had never even clicked the screen after the initial airdrop handshake. Why was this? Was this something common among all of the games they had recorded?

He pulled up the existing datasets from the other user-test rooms around the world. Sure enough, in a few of the games he saw that players were not clicking around on the screen to see what they could click on. Perhaps it was unwise for the designers to rely on the inherent curiosity of users to figure things out on their own.

With the dataset in front of him, he created a dummy node with a centrality was like the others for the white player. He found that given the distribution of die rolls and resources, that if the player had been able to talk to the others, the outcome of the game would have been very different. The predictive aspect of AM was still relatively new but it seemed to indicate that the Blue player probably would have edged out a lead if he had spoken to Red or Orange.

Unlike the White player, the Blue player did click on the screen here and there. The White Player was simply the first one to message him. He looked at the centrality of the Blue player. It was slightly lower than the others. Even in the transcript, the blue player had not communicated that much. This meant that he was something of an outsider as for the most part, players who talked to more people and traded with different people usually won.

He exploded the diagram again. Each player had also been in communication with the outside world here and there but Blue’s communication level seemed to be a lot higher than normal. Blue was talking to someone outside of the room more than he was even talking to White. This seemed normal for the type of group that it was. From all indications, they had met briefly in the past and it was only recently that they had gotten in touch again. This game seemed to be their reunion of sorts.

So, one player doesn’t click around and the other is busy talking to whomever outside of the game. They all seemed to trade well. They all seemed to get the voice commands down. It was this airdropped HTML object that seemed to be the problem. They would have to look at it a bit more to see what was going on. Perhaps its average centrality or even the eigenvector score could be made to go up a bit more. He scheduled a team meeting for later that day and placed his analyses, some notes, and a few visualizations from his tests into the test folder. Perhaps this would be the start of a new design, one they could use elsewhere? He was excited to find out.

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JOURNAL PUBLICATIONS

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