

CLIMATE CONNECTIONS CARD GAME

A Major Qualifying Project Report

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ABSTRACT

The project was to create a game to teach climate change to 9-14 year-olds for the FIRST Lego League Challenge.

We designed a card and computer game with 80 unique cards with original graphics and content. We performed extensive play testing with over 40 subjects to guide multiple revisions of game play and rules.

We produced a professional level card and computer game that presents climate change from multiple points of view and is enjoyable and accessible to all ages.

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1 INTRODUCTION

1.1 Overview

For this project, US FIRST has contracted with Worcester Polytechnic Institute to build a game to teach middle school students about climate change. Nine to fourteen year-olds across the nation will use the game as part of this year's FIRST Lego League challenge. The purpose of the game is to teach players about climate change, an issue real scientists are currently working on, in a fun context, and, at the same time promote the development of teamwork and problem solving skills.

1.2 Background

The funding for the project comes from the US Department of Homeland Security (DHS). One of the Department of Homeland Security's current goals is to assure a trained workforce for the future. To that end, they are interested in ensuring primary and secondary school students gain a strong foundation in science. DHS also hopes to encourage students to pursue careers in science. To meet this goal, DHS is collaborating with US FIRST among other organizations to help develop science related educational content that will stimulate students' interest.

The Department of Homeland Security has chosen Hawaii, Alaska, New Hampshire, Massachusetts, and New Mexico to be the pilot regions for the game we developed. Worcester, Massachusetts is the home of WPI and New Hampshire is the home of US FIRST. The Department of Homeland Security selected the other regions because they have a high proportion of students from minority ethnic groups including Hispanics, native Hawaiians, and Alaskan natives. DHS is particularly interested in reaching out to and attracting minority populations to careers in science.

1.3 FIRST

US FIRST (For Inspiration and Recognition of Science and Technology) is an organization devoted to encouraging young people's interest and participation in science and technology. Based in Manchester, NH, the not-for-profit public charity designs accessible, innovative programs that motivate young people to pursue education and career opportunities in science, technology, engineering, and math, while building self-confidence, knowledge, and life skills.(US FIRST) Dean Kamen founded FIRST in 1989. Dean Kamen attended Worcester Polytechnic Institute in the early 1970s and was awarded an honorary doctorate in engineering from WPI in 1992.(Worcester Polytechnic Institute) Dean Kamen's vision for FIRST is *"to transform our culture by creating a world where science and technology are celebrated and where young people dream of becoming science and technology heroes."*(US FIRST)

1.4 FIRST Lego League (FLL)

In 1998, FIRST joined together with The LEGO Group to create FIRST LEGO League (FLL), “a powerful program that engages younger children in playful and meaningful learning while helping them to discover the fun in science and technology.” So far, FLL has reached more than 90,000 kids in 45 countries around the globe. (US FIRST)

FIRST Lego League is an annual robotics challenge and research project for 9 to 14 year-olds. FLL is an eight week-long team experience beginning in September of each year. An FLL team is comprised of three to ten kids, ages 9 to 14, an adult coach, and mentors. Any group – schools, home school groups, churches, neighborhood groups, etc. – can form a team.

Every FLL team first learns about a real-world science issue presented in the challenge. The game we created in this project will fit into this learning and exploration portion of the FIRST Lego League experience. After learning about the topic, teams design, build, and program a LEGO MINDSTORMS robot to carry out certain tasks. Teams must also research and solve a problem faced by current scientists and share their findings with the community.

FIRST Lego League aims to facilitate the learning process and present all sides of an issue, not to teach a specific point of view. In the challenges, FLL does not promote any single solution. Instead, FLL creates a fun environment that entices kids to experiment and generate their own solutions to problems by thinking like scientists and engineers. Through their participation in FIRST Lego League, kids are inspired and empowered to continue learning about and participating in science and technology.

1.5 Climate Connections

Each year, the FIRST Lego League Challenge focuses on a different real world issue. The challenge topic for 2008 is Climate Connections. This September, participating teams will compare the climate in two very different regions of the world and study climate changes over time. As in other years, there will be three parts to the project.

1. **Research:** Teams begin by doing research and identifying a question or problem related to the topic of climate connections that they will investigate.
2. **Innovation:** Teams will find and/or build an answer or solution to the issue chosen in step 1.
3. **Activism:** Finally, teams must become activists, spreading the word about the solution they found. Teams must share what they have learned with their community in some way. That might entail anything from giving a presentation to other students in their school to sharing their findings with the city council.

Climate relates to the robotics focus of FIRST in that robots and other remote instruments are often used to investigate climate conditions, especially in extreme environments such as the Arctic or deep underwater.

2 PROJECT SPECIFICATION

2.1 Goal

The goal of this project is to create a multiplayer game that is both fun and educational. The game should attract and engage its 9 to 14 year-old target audience while at the same time teaching them about climate change. The game should incorporate a teaching style and approach to learning similar to US FIRST's approach so that the game dovetails with the rest of the FIRST Lego League program.

2.2 Requirements

As the game experts in the project, we had control over the choice of genre, platform, artistic style, game play, content, and all implementation details. The following are the few concrete requirements FIRST and DHS stated for this project.

2.2.1 Educational Requirements

The game should

- provide players with a number of decisions and tradeoffs that create a controlled sense of frustration leading to innovation and new thinking,
- present multiple viewpoints and explanations for climate change in a way that lets the players draw their own conclusions,
- offer interesting new information that stimulates the desire to learn more – learning for the sake of learning, and
- afford opportunities for players to cooperate and practice teamwork and “Gracious Professionalism”. Gracious Professionalism is a way of doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community. Gracious professionals compete fiercely while at the same time treating each other with respect and empathy. (US FIRST)

2.2.2 Artistic Requirements

The artwork for the game should

- look “edgy” and contemporary,
- be appealing to our 9-14 year-old audience, and
- challenge players’ thinking as much as the content of the game does.

2.2.3 Technical Requirements

Since classroom environments and computer facilities vary greatly in schools across the nation, the computer version of the game must work in as wide a variety of contexts as possible. To this end, the computer program for the game should

- be self-contained rather than relying on a LAN or Internet connection, and
- be operating system independent.

2.2.4 Distribution Requirements

In order to support FIRST Lego League teams that do not have easy access to a computer, there must be a version of the game that can be offline with cards or other physical game pieces.

The game must be ready to distribute to FIRST Lego League teams by the end of August 2008 so the teams can use it in conjunction with this year's FLL Challenge.

2.3 Target Audience

The target audience for this game is English-speaking children between nine to fourteen years old who live in the U.S. and come from diverse ethnic backgrounds. In the future, the game may be translated into Spanish and other languages and may be distributed in countries outside the U.S.

2.3.1 Audience Characteristics

Age Group	9-14 years
Sex	Both male and female
Culture	Diverse U.S. ethnic groups
Physical limitations	Because they are children, the users will all be much smaller than an average adult. They have smaller hands, shorter reach, and less physical endurance than an adult.
Educational Background	Children will be in the 4 th to 8 th grades. They will have basic reading and arithmetic skills, but we cannot assume any special knowledge beyond that.
Computer/IT use	Some of the children may be very comfortable with computers and other technology. Others may have little exposure to computers at home or in school. Therefore, the interface will need to be easy to learn for children with limited computer experience but consistent enough with other common interfaces (Windows, popular games) so it will not confuse experienced children.
Level of Motivation	The children will likely be motivated to use the system because they will want to have fun and play a game.
Attitude	The children should feel curious, engaged, and entertained by the system. If the system does not engage and entertain them, the children are likely to lose interest and stop using it. Children should also feel challenged by the game – we want to create the feeling of “controlled frustration”.

3 GAME DESIGN

3.1 Genre

The game is a strategy-oriented card game for three to six players. The game play is similar to Magic the Gathering (Garfield, 1993) and other tradable card games. We selected the card game genre because we had limited time in which to build this game and we could develop a complete, polished card game more rapidly than many other types of games such as a role-playing game. In addition, we were able to develop a physical, offline version of the card game for use in classrooms that do not have access to computers. Finally, a card game is relatively easy to adapt or expand to cover other educational topics in future years.

3.2 Overview

This card game allows players to model the interactions between human beings, our built infrastructure, and our natural environment. The game seeks to encourage cooperative play and foster the understanding that when one country or region does something that impacts the climate, it affects everyone on Earth. To that end, the Earth's climate is a shared resource in the game – every player's cards affect the global climate. The object of the game is to build and sustain a healthy population while avoiding catastrophic climate change. The challenge for players is to come up with a strategy that balances the speed of growth with the effects on the environment.

Each player controls a region of the world. At the beginning of the game, each player will get a Role card, for example Political Leader, Environmental Scientist, or Real Estate Developer. The Role cards give each player three unique objectives. The first player to meet any ONE of their objectives wins the game.

As the leader of a region of the planet, players start the game with a pool of 36 Natural Resource tokens. Players can use their Natural Resources to play Building cards. Some examples of Building cards include power plants, farms, and bus terminals. The main purpose of Buildings is to produce Energy to support Citizens in your region. "Dirtier" methods of energy production such as coal-burning power plants create more resources more quickly, while cleaner methods have fewer negative effects on the climate.

Once a player has enough Energy, they can play various Citizen cards, including Scientists, Town Mayors, and Communal Farmers. Each different Citizen has its own ability such as producing more Natural Resources or more Energy. Each Citizen also has one or more votes. Players can use their Citizens to vote on Policies.

Policies are additional rules that have a range of effects on all the other parts of the game. For instance, there are Policies that affect the environment, Policies that cause Citizens to

use less Energy, and Policies that limit the number or type of Buildings players can construct.

As players progress, they will begin having an impact on the climate. The Natural Resources that players start out with will lessen some of the climate impact. However, as players use up their Natural Resources to construct buildings, the Global Climate Level of the planet will start to rise. Every 10 points of increase in the Global Climate Level triggers a climate Event, such as a Hurricane or Wild Fires. Climate Events affect every player. Once an Event card comes into play, the only way to remove it is for players to work cooperatively to drop the Climate Level by passing cleaner Policies, replacing polluting Buildings with non-polluting ones, or conserving more Natural Resources.

3.3 Goal

In the standard version of the game, players have different goals based on their Role. Each player receives a Role card at the beginning of the game. Each Role card lists three different objectives. Players can choose to pursue any of the three objectives on their Role card. The first player to achieve any one of their Role objectives wins the game.

To accommodate educators who want to use this game during a class period and younger players who may have shorter attention spans, we also developed a quick-play version of the game. In the quick-play version, players do not have Roles. The first player to support 10 Citizens in their region wins the quick-play game.

3.4 Key Features

3.4.1 Roles

There are twelve different Roles in the game. We grouped roles into three major types – Eco-Friendly, Industrial, and Political – corresponding to the three main factors in the game dynamics – people, infrastructure, and the environment. Roles give the players objectives focused on one of these three areas. Eco-Friendly Roles focus on minimizing climate change or increasing available Natural Resources. Political roles are interested in growing a large population of Citizens or controlling a large block of Votes (not always the same thing). Industrial Roles center on building many Buildings or producing large amounts of Energy.

Each Role grants the player a special ability to complement the Role's goals. These abilities fall into two styles – ones that grant a player an advantage within their own region (the Congressman gains one additional Vote for every three Citizens that player controls) or abilities that affect other players (the Eco-Activist can prevent another player from constructing a Building).

Each Role card lists three objectives. In general, the first objective concerns playing a specific combination of cards within one's own region. For example, the Real Estate Developer's first objective is to play a certain number of Buildings. The second Role objective focuses more on affecting other players' regions. For example, the Political Leader's second objective is to control the Votes of Citizens in other regions. The third objective for each Role is to pass a selection of policies that are beneficial to that Role.

3.4.2 Building Cards

Building cards represent the infrastructure in a player's region. All Buildings cost Natural Resources to play. Buildings enter play "under construction"; they are not operational until they have been in play for one full round. Once operational, many Buildings require an upkeep cost of Energy or Natural Resources to keep the Buildings in play.

There are three main categories of Building cards: Production Plants, Infrastructure, and Power Plants. Production Plant cards produce Natural Resources. Infrastructure cards represent public facilities such as public transportation or colleges. Power Plant cards produce Energy. Power Plants are further sub-divided into High-, Low-, and Non-Polluting types. High-Polluting Power Plants such as the Coal, Natural Gas, or Biofuel Power Plants produce the most Energy per round. The trade-off is that the High-Polluting Power Plants also require the most Natural Resources to upkeep and have a large Climate Impact. Non-Polluting Power Plants such as the Solar, Wind, and Tidal Power Plants produce the least Energy per round, but have no Climate Impact and no upkeep. Low-Polluting Power Plants fall in the middle.

Players whose Role objectives involve producing large amounts of Energy may prefer to build High-Polluting Power Plants in their region. Whereas players whose Role objectives involve minimizing the negative effects on the global climate may prefer to build Low-Polluting Power Plants.

3.4.3 Citizen Cards

Once players have Energy producing Buildings, they can play Citizen cards. Each Citizen card has an ability, some benefit players receive from having the Citizen in their region. For example, the Home Gardener gives players a small number of Natural Resources each round. In addition to their base ability, each Citizen card also lists an "Educated" ability. If they have a College Building, players can educate their Citizens to receive the educated ability in addition to the Citizen's base ability.

There are three main categories of Citizen cards: Eco-Friendly, Industrial, and Political. Eco-Friendly Citizens have abilities related to Natural Resources. The abilities of Industrial Citizens affect Energy and Buildings. Political Citizens' abilities deal with Votes. Within each category, some Citizens have passive abilities that give the player

more resources and some Citizens have aggressive abilities that allow the player to take resources from others. Amongst the Political Citizens for example, the Town Mayor gives players additional Votes and the Rabble Rouser can change the vote of a Citizen in another player's region.

In general, Eco-Friendly Citizens are most useful to players in Eco-Friendly Roles, Industrial Citizens are most useful to Industrial Roles, and Political Citizens are most useful to Political Roles. However, since all Citizens give players some benefit, players have an incentive to play Citizens even if they do not match the player's Role.

3.4.4 Policy Cards

Citizens inherently possess one or more Votes that players can use to enact a Policy card. Policy cards usually adjust a key point of the game balance. For instance, a Policy may help Buildings produce more Energy, reduce the climate impact of High-Polluting Power Plants, or reduce the Energy requirements of Citizens.

All Policies affect all players equally and must receive a majority of votes (as well as meeting a minimum vote requirement for each policy) to pass.

There are three categories of Policies: Eco-Friendly, Industrial, and Political. Policies in each category are advantageous to players in the corresponding Roles (Eco-Friendly Policies are helpful to Eco-Friendly Roles) but may be neutral or disadvantageous to the other types of Roles. We designed Policies this way so players would oppose or be in favor of different Policies as they try to achieve their competing objectives. This ensures some contention on most votes rather than having Policies pass unanimously.

To add an element of strategy and limit the number of game changing effects, only five Policies may be in play at once. Once there are five Policies in play, any new Policy must replace an existing one. This allows for constant change and evolution without the game becoming too complicated.

3.4.5 Global Climate and Events

Throughout the game, players track the global climate, represented by a number from 0 to 100. The global climate number is cumulative throughout the game. Each round players determine the net climate change for the round and add it to the previous global climate level. Power Plants and some Policies raise the global climate number. Unspent Natural Resources, Infrastructure Buildings, and some Policies lower the global climate number.

For every 10 points increase in the global climate, a new Event card comes in to play. Event cards represent the natural disasters and other events that can occur as the result of dramatic climate changes. Each Event has deleterious effects on the players, costing them resources or cards or limiting their progress. As the climate change grows higher and higher, players must contend with the negative effects of several Events at once,

making it harder and harder for them to achieve their objectives. Events remain in play until players bring the climate back below the level that triggered the Event.

No single card that reduces the global climate number is powerful enough to counteract an Event. Therefore, players generally have to work together to get rid of Events, fostering a sense of cooperation and shared responsibility for the climate.

3.4.6 Resources

This card game has similarities to strategy games such as Settlers of Catan or Starcraft in that much of the strategy involved in playing this game centers around resource management. This game has three primary types of resources: Natural Resources, Energy, and Votes. Players spend Natural Resources to construct Buildings that produce Energy to support Citizens that have Votes. As discussed in section 3.4.1, players attempt to maximize different resources according to their Role's objectives. In a sense, the global climate is a fourth resource that players must balance against their production of the other three resources.

3.4.6.1 Natural Resources

In our game, Natural Resources represent the water, land, plants, animals, and minerals and other resources we obtain from the Earth. Each player starts the game with 36 Natural Resources. Players use Natural Resources to construct and upkeep Buildings. For example, a Coal Power Plant costs a few Natural Resources to build (representing the stone, metal, and other materials used to build the plant) and then some more Natural Resources each round to upkeep (representing the tons of coal burned each day the plant is operational).

There are a few Buildings, Citizens, and Policies that generate additional Natural Resources. However, there are a limited number of these cards because we want players to think about the fact that our planet's resources are finite. We want to teach players that when they use up non-renewable resources, they are gone and they cannot get more. Players who spend too many of their Natural Resources early in the game may find their progress stalled later on.

3.4.6.2 Energy

The Energy resource in the game represents the energy we use to power our homes, offices, factories, cars, schools and so on. Each Power Plant Building card produces some Energy each round. Players use the Energy produced in their region to support their Citizens and Production Plants. Players who do not produce enough Energy will not be able to support many Citizens and thus will not have enough votes to affect the Policies. Depending on which Power Plants they use, players who produce far more Energy than they need may end up having to deal with many negative climate Events.

In our initial design, we planned to have tokens for each different type of resource in the game, including Energy. Early on, however, we began to feel that it was difficult to keep track of so many tokens. In particular, it seemed tedious to distribute tokens for all the Energy produced in a player's region at the beginning of the player's turn only to have the player turn around and spend those tokens to upkeep their Citizens. Therefore, we made the decision to dispense with the tokens for Energy. Instead, players can simply line up their Citizens with the Buildings that support them. Any excess Energy that players do not use to upkeep Citizens or Production Plants goes away at the end of the player's turn.

3.4.6.3 Votes

Each Citizen card has one or more Votes that players can use to support or oppose Policies. Since Policies can significantly alter the dynamics of the game, it is to players' advantage to control enough Votes to be able to enact Policies that help them achieve their objectives.

Unlike Natural Resources, Votes are a renewable resource. When someone plays a Policy, players spend all their Votes to enact or defeat the Policy. Then, the next time a Policy is played, players have all those same Votes available to them again to vote on the new Policy.

3.5 Game Play

3.5.1 Setup

In the physical version of the game, players should first sort the Building cards, Citizen cards, and Policy cards into separate decks and shuffle each one. Then they should place the Event deck in the globe of the climate thermometer and the other three decks in the center of the play area (see Figure 1 Play Area). Each player should draw two cards each from the Building, Citizen and Policy decks for their starting hand.

Each player should take 36 Natural Resources in the form of four 6 Natural Resource tokens, three 3 Natural Resource tokens, and three 1 Natural Resource tokens. Players should keep the rest of the tokens in the center of the play area within reach of all players. Alternatively, one player can act as the "bank" and hand out tokens as necessary.

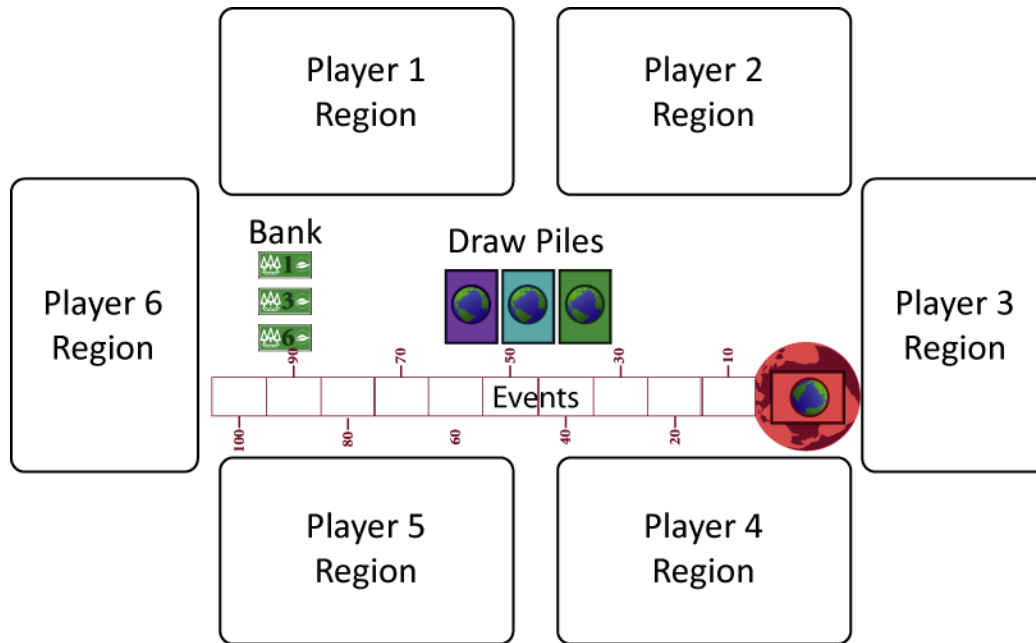


Figure 1 Play Area

At the beginning of a standard game, each player selects a Role card. It is not required, but we recommend that players try to select at least one Role from each of the three main Role types: Eco-Friendly, Industrial, and Political. In a quick-play game, the players do not select Roles but the rest of the game play remains the same.

Each player adds up the total number of votes needed of the Policies in their hand. The one with the highest total goes first. In the event of a tie, the player with the higher Energy output from their Buildings in their hand goes first. Play passes to the left.

3.5.2 Phases of play

After setting up the game, the players take turns.

On their turn, players will:

- a. Draw two cards. Player may draw from any of the three draw piles.
- b. Activate Buildings. Buildings previously under construction are now operational.
- c. Receive Energy and Natural Resources from your Citizens and Buildings.
- d. Then the player may do any of the following:
 - Spend Natural Resources to construct one or more Buildings. Buildings enter play “under construction” and produce nothing for one round.
 - Play one or more Citizens. Player must pay upkeep for Citizens at the end of their turn.

- Put forth one Policy card for a vote. If there are five Policies already in play, the player selects which one they want to replace.

Optionally, the player may also:

- Demolish one or more Buildings and receive half their cost back in resources.
 - Evict one or more Citizens.
- e. Spend the Energy and Resources required for upkeep of the Citizens and Buildings in their region. If the player does not have enough Energy or Resources to pay upkeep, they must demolish the Buildings or evict the Citizens they cannot afford.
- f. Discard down to six cards if the player has seven or more cards in their hand.

At the end of a round, after each player has had a turn, the players evaluate the global climate. During this global phase:

- a. Players determine the new Global Climate Level, using the scorecard to
- add each player's net Climate Impact remembering to subtract 1 Climate Impact point for each 6 unused Natural Resources each player possesses, and
 - add any Climate Impact from Policies, and
 - add this round's total to the previous cumulative Global Climate Level.
- b. If the Global Climate Level has crossed an Event threshold (every 10 Climate points), turn over the next Event card.
- c. Receive Energy and Natural Resources from Policies.

After the global phase, the next round starts and players continue to take turns around the table.

3.5.3 Computer Version

The game play for the computer version is nearly identical to the game play for the physical version. The only significant difference comes from the fact that the computer version is designed to allow all six players to play on one computer. Because they are sharing a computer, the players must switch seats after each turn, giving control of the mouse and keyboard to the next player. Furthermore, if players want to keep the cards in their hand secret, as they would be in the physical version of the game, then only the player whose turn it is should be facing the monitor. However, we designed the game such that knowing what cards other players have in their hands does not significantly affect game play. Therefore, if all the players want to face the computer screen and watch while others take their turns, they can do so.

3.6 Game Design Evolution

3.6.1 Focus on energy choices and natural disasters

Though there are many interrelated aspects to climate change, we decided to focus this game on how our energy choices affect the global temperature and the kinds of catastrophic disasters that a rise in temperature can cause. We focused on these facets of climate change because they seemed the most game-like and the most fun to play with.

3.6.2 Players begin with resources

In our initial game design, we had several types of Building cards that produced various kinds of resources. Players then used the resources to support Citizens. Players had no resources to start with; they had to build the infrastructure to first produce resources before they could do anything else. This made the first several rounds of the game very boring because players were just waiting to draw and be able to play the Buildings that would give them the resources they needed before they could *do* anything. Even when we greatly increased frequency of the cards that produced the important resources in the deck, there was still this period at the beginning of the game where players could not take any action or make any decisions; they simply had to build up resources. Therefore, we decided to give every player enough resources at the beginning of the game to immediately build at least three Power Plants and thus be able to play Citizens during the second round.

3.6.3 Drawing from three decks

The original design consisted of a single deck, containing all the Building, Citizen, and Policy cards. However, we found that sometimes a player would not draw any of the type of card that they needed (e.g., a building card) for several rounds, making it effectively impossible for them to do anything while the other players advanced.

Games like the Settlers of Catan (Teuber, 1996) solve the problem by giving players a “menu” that lists all the things a player can “buy” and lists the resource cost for each. Whenever players have the resources necessary, they simply declare their intention to “buy” whatever they want off the menu rather than waiting until they draw a card. This mechanic completely removes the randomness factor of drawing from a deck of cards and makes it feel like each player is operating much more independently since they are not competing for a limited number of cards. In addition, this mechanic works well for Settlers because there are only five or six different things a player could possibly buy. In our game, players have around fifteen types of Buildings and another twenty types of Citizens to choose from, making a menu much more complicated.

Trading card games that have a similar mechanic where one type of card produces resources needed by other cards (e.g., Lands in Magic the Gathering) solve this problem

by allowing each player to build his or her own deck – literally stacking the deck in their own favor.

Since making enough cards to have separate decks for each player would be beyond the scope of this project, we decided to let the players choose what type of card to draw by having a separate deck for each card type. This keeps the game somewhat random (players do not know exactly what card they will get) yet, at the same time allows players to get the type of card they need rather than waiting several rounds until they happen to draw it.

Allowing the players to choose which kind of card to draw also introduces a little more strategy into the game. Many players choose to draw mostly Building cards for the first few rounds play several Power Plants, building up a large pool of Energy that they can draw on for rapid growth later in the game. Other players however, can choose to draw and play a mix of Buildings and Citizens, which allows them to control the Policy votes in the first few rounds.

Even when players had the choice of what type of card to draw, however, we found the game felt a little slow. Therefore, we decided to allow players to draw two cards each round instead of just one. With that final adjustment, the game seemed to proceed smoothly without a lot of waiting.

3.6.4 Players start with six cards

Most card games seem to start players with between five to seven cards. We started playing with seven, and it seemed to work fine. However, when we decided to allow players to draw from one of three decks, it seemed natural to start players off with two cards from each of the three decks. Therefore, we switched the starting hand from seven to six cards. Starting with two of each type of card also helps to ensure that players will have something they can play immediately. When we had all three types of cards combined in a single deck, it was possible to draw a hand without any Building cards. The new rule guarantees that every player has two Building cards to start with.

3.6.5 Role Win Conditions instead of Victory Points

For the Role cards, we decided to state the objectives as win conditions rather than listing actions for which players receive points towards victory. The idea of victory points appealed to us initially because they would give players a lot of flexibility in finding a winning strategy. Players could choose to get a few points for passing a policy, a few more points for building up their Citizen population, and generally mix and match objectives until they got enough points to win. Ultimately however, we decided against the idea of cumulative victory points in favor of binary win conditions (you've won or you haven't) because keeping track of victory points added yet one more element of

arithmetic to the game when it is already difficult to keep track of all the separate numbers (Climate Impact, Energy production and usage, Natural Resources, etc.).

3.6.6 Number of Cards Played Per Turn

We considered three different alternatives for how many cards players should be allowed to play. The first option was to allow them to play an unlimited number of Buildings and Citizens. The advantage to this option is that it leaves the decisions about managing resources and deciding when to play which Buildings up to the players. The disadvantage to this option is that many first time players may choose to play all the Buildings they can during their first turn and this tends to lead to a very sharp initial rise in the global climate level, from which it may be impossible to recover. This teaches the right lessons from an educational standpoint and will hopefully get players to use more strategy in the future. However, it means the very first game most people play has a high chance of ending with everyone losing.

The second option we considered was to limit players to playing one or two Buildings per turn. This takes the strategy decision away from the players, but lessens the likelihood of a wipeout the first game. This option might also make it harder for some of the roles like the Real Estate Developer to accomplish their objectives (constructing X buildings).

The third option we considered was limiting the number of Buildings a player can play during the first round, then allowing them to play as many as they want thereafter. This option splits the difference between the two other choices. By limiting the number of buildings in the first round, we reduce the likelihood that the players will immediately create a catastrophic situation from which they will be unable to recover. However, for the rest of the game, the strategy is still up to them.

In the end, we solved the issue of playing a limited vs. unlimited number of cards from a different angle, by deciding to have Natural Resources mitigate the climate impact of Buildings.

3.6.7 Natural Resources mitigate Climate Impact

After a round of play testing amongst ourselves, we drew a diagram of the interactions between the different elements of the game and found that most of the interaction between the cards and resources is a purely one-way stream – spend Natural Resources for Buildings that produce Energy for Citizens that vote on Policies. The Citizens and Policies have some effects that circle around and interact with Energy and Natural Resources, but Natural Resources and Buildings do not affect Citizens and Policies.

Thinking about this interaction cycle, and the Roles (Economic Roles concerned with Buildings & Energy, Political Roles concerned with Citizens & Votes, and Environmental Roles concerned with Natural Resources & Climate Impact) and about the

problem that we run into where players raise the Global Climate Level very fast in the first few rounds when there are no mitigating policies in place yet, we came up with the idea of having Natural Resources absorb CO₂, lessening Climate Impact. This makes the Conservationist Role, whose goal is to have many available Natural Resources in a region, much more meaningful and balanced with the other roles. It adds symmetry between Natural Resources, Buildings, and Citizens – now Buildings produce Energy, Citizens “produce” votes, and Natural Resources “produce” negative Climate Impact. Furthermore, it makes Natural Resources seem less of a nuisance and more like an integral part of the game. Finally, it is more accurate to real-life and teaches a better lesson about why we need to conserve our Natural Resources.

We started out with a ratio of 3 Natural Resources = - 1 Climate Impact but found that that made the game a little too easy – it was possible to play an entire game without triggering any Events. Next, we tried 6 Natural Resources = -1 Climate Impact and that seemed to work well.

Once we made the change to having Natural Resources lessening Climate Impact, it was easy to allow the players the full freedom of playing as many Buildings per turn as they want because the Natural Resources everyone starts with counterbalances the Climate Impact of the Buildings during the first few rounds. Players now have a few rounds in which they can get used to the game and play whatever they want before they have to start dealing with catastrophic negative consequences to their decisions.

3.6.8 Distributing Natural Resources during Player Upkeep and Global Upkeep

When we first started play testing the game within our team, we distributed any resources gained from Policies, Citizens, or Buildings during the Global Upkeep Phase. We found, however, that this made the Global Events Phase long and tedious because players would have to calculate how many resources were due to them. Eventually, we decided to continue to distribute any resources gained or lost because of any Policies during the Global Upkeep Phase and to distribute any resources gained or lost because of Citizens or Buildings during each player’s own turn. Since in general Policies affect all players equally, this means that during the Global Upkeep Phase players only have to calculate how many resources to distribute once and then give each player that amount rather than doing separate calculations for each player. Then, within each player’s turn, there is a sub-phase where they receive any resources due to them from the Buildings and Citizens in their region. This sub-phase occurs before the player plays any cards. The timing of the sub-phases means that players do not receive any resources from cards they play this turn until the beginning of their next turn.

3.6.9 Global rather than Local Policies

When we first proposed adding Policies to the game, we had the idea that players could either choose to enact a Policy locally, meaning that it would only affect their own region, or they could enact the Policy globally meaning it would affect all players. Local Policies would require fewer votes to pass and other players could not vote against them. Essentially, this meant that as long as you had enough Citizens for the votes, every Policy you tried to enact locally would pass.

After play testing the idea of local and global Policies, we decided that allowing players to play Policies locally lessens the interaction between the players. Each player could manage their own region essentially undisturbed by and unconcerned with what the other players were doing. Therefore, we decide to change it so that players can only enact Policies globally. This means that all players vote on every Policy card played. In addition, it simplifies game play and the card text because we no longer need to have a separate number of votes and separate rules for playing Policies locally.

3.6.10 Limited number of Policies in play

Initially, we allowed an unlimited number of Policies to be in effect at once. About three-quarters of the way through development, we decided put a limit the game to five Policies in play at any one time. The main reason for this change was that we had found players sometimes seemed to vote for Policies automatically. By introducing a limit on the number of Policies, we added a new trade-off for players to consider in their choices. Now, once five Policies are in play, any new Policy enacted must replace one of the previous five. Players have to decide not only if they are in favor of the new Policy, but also whether or not they prefer the new Policy to one of the old ones. To keep voting as simple as possible, we decided that the player who proposes a new Policy also gets to designate which existing Policy they want to replace.

Limiting the number of Policies in play also makes the calculations easier; fewer Policies means fewer adjustments to take into account.

3.6.11 Limited Number of Cards in Hand

During play testing, we noticed that if a player draws a policy that does not fit their role, then they might keep that policy in their hand the entire game, never playing it. This means such a policy never comes up for a vote and thus can never go into effect even if the majority of the players would vote for it given the chance. We discussed a few different ways of getting around this. One would be to make a rule that whenever a player draws a Policy, they must play it and put it up for a vote. Another would be to change from players drawing two cards, to having players draw one card, which can be either a Building or Citizen and then they have option to draw a second card, which must be a Policy. If the players choose to draw a Policy, they must play it. We felt these

options might make players avoid drawing Policies so they will not be forced to play a card that they may or may not want. A third option would be to continue to allow players to draw any two cards and play whatever they want, however, during the Global Events Phase, they draw a single Policy that immediately goes up for vote. We tried this third option in several rounds of play testing but we ultimately rejected it because players had trouble remembering to draw a Policy during the Global Events Phase.

Instead, we decided to limit players to holding no more than six cards in their hand. This means that if players draw a Policy card that they do not intend to ever play, rather than hold on to it, they will usually discard it back into the deck, giving another player a chance to draw it.

Limiting the number of cards players can have in their hand also makes it easier for younger players with small hands to hold all their cards at once. During play testing, we observed that some children were putting their cards down on the table because there were too many cards for them to spread out and see in their hands.

3.6.12 Citizens require upkeep each round

We argued over whether Citizen cards should have a one-time cost or if players should pay upkeep for Citizens every round.

With a one-time cost, it would be possible for a player to play all the Citizen cards they ever needed using the Energy from a single Building. However, there would still be an incentive to play more than one Building because additional Buildings would allow you to grow your population of Citizens more quickly. Furthermore, some Roles would still have objectives related to producing a high amount of Energy, and so they would want to play many Buildings. The main advantage of having a one-time cost and no upkeep for Citizens is that it reduces the number of calculations players have to make each turn.

In the end, we chose to give Citizens an upkeep cost for the following reasons. First, including upkeep costs seems to model the real world more closely. A person's energy consumption for their lifetime is not fixed at birth. We use energy over time and we can change how much energy we consume at different times. Giving Citizens an upkeep cost, allows us to include Policies in the game that reduce Citizens' upkeep (e.g. Hybrid Cars and Home Energy Efficiency). Seeing how different Policies can affect the Citizens upkeep cost teaches players an important lesson – namely that the choices they make can affect how much energy they use and thus, how much they influence the climate. Finally, from a game play perspective, we do not want to allow players to get through an entire game with only one Building each because it would make the game less interesting. Playing Buildings is what increases the Climate Impact causing Events. If players do not play enough Building cards to trigger an Event, then they never have to deal with any

challenges or obstacles in the game. Having Citizens require upkeep each round teaches a better lesson about climate change and makes the game more fun.

3.6.13 Event Triggered Each Time a Threshold is Crossed

One of the most difficult game play decisions for us to make was how and when Events are triggered. The controversy focused around whether an Event should be triggered each time the Global Climate Level crosses a threshold or only the first time it crosses a particular threshold.

The first option makes real-world sense because if the Climate Level is an indication of the global climate, then when the climate changes a certain amount, we should expect to see effects from that change. The problem with this option is that if an Event is only removed from play when the players meet the Solution condition stated on the Event, then crossing a single threshold multiple times results in multiple Events in play. To solve this problem, we came up with the idea of laying out one Event card for each threshold at the start of the game, then only that Event gets triggered at that threshold. This is still not ideal though because if early on in the game the Climate Level rises a lot and then the players solve several Events and reducing the Climate Level, if the Climate Level later rises once more, players will be faced with the same Events as before. While this may make sense in the real world, it is not much fun in the game to keep seeing the same cards and resolving the same obstacles.

On the other hand, if we opted to only trigger an Event the first time the Climate Level crosses a threshold, players would only ever have to deal with each Event card once. It would also eliminate the problem of triggering multiple Events when the Climate Level vacillates back and forth across a threshold. The downside to this option is that if players get up to a high Climate Level and then drop back down several thresholds, they can start increasing Climate Impact again without any consequences until they have surpassed the previous high level. Not only does this not mimic real-life, it also leaves the players with possibly large stretches of the game where they have no obstacles to contend with.

Eventually we resolved this controversy by getting rid of the stated Solutions on each Event card. Instead, we decided that players automatically solve an Event by reducing the Climate Level below the threshold that triggered the Event. When an Event is solved, it is shuffled back into the deck. This way, if players cross the same Climate Level threshold multiple times, there is only ever one Event in play for that threshold, but it is a different, random Event each time.

3.6.14 Cumulative instead of per round Climate Level

We debated whether the Climate Level should be cumulative throughout the game or if it should reset each round. The cumulative effect relates more closely to how the climate works in real life. However, it is a little bit harder to calculate. We decided that the

educational value of seeing the climate continue to change over time was more important than the inconvenience of having to add the Climate Impact from each round to the previous total.

3.7 Future Possibilities

The following are all ideas we discussed adding to the game, but to avoid feature creep, decided not to pursue for now.

3.7.1 Allowing Players to Trade Cards

The first time we play tested the game at FIRST Place, the children spontaneously started to trade cards from their hand with the other players. After they had selected their Roles and drawn their hands, they just started asking each other “Does anyone want an X card?” Even without any formal rules to govern the trading, there were no fights or disagreements over the trades and they seemed much more satisfied with the game when they had this extra level of control rather than having their cards completely determined by the luck of the draw. We chose not to add the trading of cards to our game at this time because it would have been difficult to implement at this late stage. However, if another team continues to work on this game further, we strongly recommend the addition of a mechanic that allows players to trade cards.

3.7.2 Tragedy of the Common Resources

Observing the children during play testing, we noticed they tended to refer to the Natural Resources as “money”. This led to some poor strategy choices during the first few games because they expected to earn more “money” as the game went on rather than treating their Natural Resources as a limited commodity.

During our discussion of this phenomenon, we came up with the idea of implementing the Natural Resources in a way that would introduce a Tragedy of the Commons style conflict (Hardin).

Tragedy of the Commons refers to a class of problems dealing with the allocation of finite resources where individual interests are in conflict with the common good. In these situations, many individuals have access to a common resource. If all the individuals use the resource sparingly, the resource will continue to be available and everyone will benefit. On the other hand, a single individual can get a greater benefit by taking a larger share or using more of the resource. However, if several individuals take this greedy approach, the resource will run out and no one will be able to use it. A classic example is the Boston Common, which was a public grazing ground until people started over grazing and the Common was closed.

Instead of distributing Natural Resources to each player at the beginning of the game, all the Natural Resources could be pooled in the center of the table. When a player needs

Natural Resources to play a card, they simply draw from the common pool. At the end of each round, a certain number of Natural Resources regenerate or grow back and are added into the pool. The number of Natural Resources that regenerate is exponentially related to the number of Natural Resources left in the pool. Therefore, if all the players use the Natural Resources wisely, everyone ends up with a much larger pool to draw from. However, if even one or two players draw too much from the common pool, everyone's Natural Resources are limited.

Treating the Natural Resources as shared commodity would most likely reduce the tendency of players to think of the Natural Resources as money. It also adds another dimension of strategy and interesting decisions for the players. Players can decide for themselves whether to draw a few Natural Resources from the pool and hope that the other players also choose to play cooperatively. Alternatively, a player can decide to draw a large number of Natural Resources for themselves, giving themselves an advantage over the other players in the short-term, but hurting everyone in the end. A Tragedy of the Commons mechanic also encourages more cooperation between the players by rewarding sharing and thinking about the common good rather than one's own personal good.

3.7.3 Citizen Protests

In the interest of fostering more interaction between the players, we considered giving Citizens the ability to "protest" the construction of a Building once per round. The way we imagined protests working would be that whenever a player plays a Building card, any other player could use one or more of their Citizens to protest it. Any Citizens engaged in protesting this Building could not protest anything else this round. The player who played the Building would be able to use their own Citizens to try to override the protest. Whichever side had the most Citizens would be the winner. If the protestors were successful, the Building would remain under construction for some additional number of rounds.

Since unlike voting on a policy, Citizens can only protest once per round, players would be forced to think more strategically about how many Citizens they want to commit to a protest. If they commit all of their Citizens to protest one Building, they will be unable to do protest anything the next player might put out. On the other hand, if they do not commit enough of their Citizens to this protest, they may lose. In addition, Citizens protesting another player's Building cannot be used to override a protest on one's own Building.

Another, slightly different way we thought of implementing protests was that players could call for a protest against any Building, Quality of Life, or Citizen card. In this case, a protest would essentially be calling for a vote to see if the majority wanted to keep the

card operational or deactivate it. If the protest were successful, the player who owned the card would deactivate it by turning it upside down. While card was deactivated, the player cannot use any of the cards abilities and the card does not count towards the Climate Level or any objectives. The card owner can reactivate it by calling for another protest vote.

We liked the way both of these ideas allowed the players to interact with each other more and we appreciated the additional level of strategy protests would bring to the game. We did add a limited form of protests as an ability for one of the Roles. However, we did not have time to test and refine any protest mechanism on broader scale.

3.7.4 Citizen Satisfaction /Popularity Rating /Quality of Life

Another game mechanic we would have liked to add was something that would represent the conflict between people wanting more luxuries and using up more natural resources and the effect that higher consumption has on the environment. We were looking for some way to acknowledge the fact that people seek out and enjoy many things that have a negative impact on the climate – driving big cars, taking long showers, eating lots of meat, running lots of home electronics, using the heat or A/C as much as they feel like, and so forth. Yet at the same time people suffer when their consumption causes climate change resulting in drought, fuel and food shortages, spreading disease, and so on. In other words, there is a fine balance between consuming enough to be satisfied and not consuming so much that it causes problems. We would have liked to include something in the game that encouraged players to try to find that balance.

One idea we had was to have the Citizens migrate from one region to another based on some measure of their satisfaction with the environment (as measured by Climate Level) in each region. This mechanic greatly appealed to us because it relates the climate back to the people – rather than the Citizens just using Energy and affecting the climate, the climate also affects the Citizens. Such a mechanic would have helped teach students that preventing drastic changes in climate is not just about saving wildlife or preventing natural disasters. It also directly influences where we choose to live, how we make a living, what foods we eat, and other aspects of our daily lives. Unfortunately, we were not able to come up with a simple, fun, and sensible way to implement this mechanic in the time allotted for this project.

We flirted briefly with the idea of adding Quality of Life cards that represent how people are supported. We came up with three different levels of Quality of Life cards:

- Necessity (e.g. Housing, Landfills, Heating),
- Luxury (Sports Cars, Luxury Housing, Flat Screen TVs), or
- Economic (Hybrid Cars, Airplanes, Universities).

The idea was to have the players first play these Quality of Life cards in order to support their Citizens, with the player choosing which level of Quality of Life they wanted for their region. We decided against using the Quality of Life cards because they added an extra delay before players could play Citizens – first players would have had to play Buildings to make Energy, then play Quality of Life cards, and then finally they would have been able to play Citizens. As noted earlier (see Players begin with resources), we found long delays before being able to play Citizens frustrating, so we decided not to include Quality of Life cards.

Another alternative we discussed was to have a 3-point approval system – positive (approve), zero (neutral), negative (disapprove). The consequence for a player having a negative rating might be that it is harder to pass Policies or their Citizens might migrate to another region. The idea was that each Policy would have a binary popularity rating (thumbs up or thumbs down or red or green) and a player's approval rating would depend on the number of popular vs. unpopular Policies a player had enacted in his or her region. (We came up with this idea when we were still thinking of allowing Local Policies.) We discarded this idea because it added two more variables for players to keep track without significantly enhancing the game play.

3.7.5 Board game version

It would have been far beyond the scope of this project to change the game this drastically, however another alternative we discussed was adapting this game to more of a board game genre, similar to Settlers. The main idea was that the game would have different types of land. Certain buildings could only be built on certain types of land. Instead of costing Natural Resources, Buildings require different amounts and types of land. Rather than Producing Energy, Buildings would just indicate a certain number of Citizens that they can support. A system such as this would remove most of the calculations players have to do to keep track of all of their resources. The land slots would show at a glance how much land/Natural Resources players have and Energy would no longer be a factor in the game.

4 CARD DESIGN

4.1 Artwork

4.1.1 Style

Our sponsors at FIRST directed us to make the art “edgy” and appealing to 9 to 14 year-olds. We researched websites, TV shows, and toys that are currently popular with our target audience. The style of the artwork varied from traditional flat, cartoon cell shading, to vector art, to 3D animations. The common features between all these different types of artwork were the bright colors and the simplicity of the shapes and lines. (Mattel, Inc., 2007) (Viacom International, 2008) Images of characters and objects tend to be based on geometric shapes and tend to lack details. Based on our research, we decided to use a vector-art style for all the illustrations on the cards.

In addition to the fact that we felt the vector-art style would be appropriate for and appeal to our target audience, we also had technical reasons for choosing this style. First, we knew that we had only a few months to complete this game and creating unique vector-art illustrations takes a relatively short time compared to making more photo-realistic or more painterly illustrations. Second, vector-art is resolution independent. Thus, we can generate one version of the cards with a resolution appropriate for the computer game and another version with a resolution appropriate for print from the same master file and both versions will look equally clear and smooth.

4.1.2 Color Scheme

In terms of color scheme, our research had shown us that bright, saturated colors would appeal most to our target audience. We decided to make the different types of cards (Building, Citizen, Event, and Policy) each a different color; both to make the game more colorful and to help players quickly distinguish between the types of cards. Because our game centers on the concept of climate change, the first colors we selected for our palette were earthy brown tones for the card borders and blue and green colors for the illustration of the Earth on the back of the cards. We built the rest of the palette to coordinate with these earthy colors – a turquoise sky blue for the Citizen cards, a deep green for Policy cards, a brick red for the Event cards, and a deep purple for the Building cards.

Originally, we planned to make the Event cards purple and the Building cards red, but we decided to switch those colors because that made all the cards that players have in their region analogous cool colors – green, blue, purple – while the Event cards stood out more with the warm red.

4.2 Layout

We designed all the cards to be standard playing card size – 3.5 inches high by 2.5 inches wide. We chose this size because people are accustomed to it and cards this size fit well in human hands (even the hands of 9-14 year olds). In addition, we assume it will be easier to get the cards professionally printed if they are the standard size.

The general layout for the Building, Citizen, Policy, and Event cards is similar to the layout used for Magic the Gathering and other tradable card games (see Figure 2). The cards have an illustration in the upper half of the card and a description of the card's abilities in the lower half. Each card also has a title and type. For those cards that have a cost to play (Building, Citizen, and Policy cards) the cost is indicated in the upper right-hand corner of the card, again similar to Magic the Gathering cards. We chose to place the cost here for two reasons. First, putting the cost in its own spot on every card makes it easier to figure out how much the card costs than if we insert it into the rest of the text. Second, when a player fans out the cards in their hand they can see the cost in upper right-hand corner of all the cards at once and thus, can easily see which cards in their hand they can afford to play.



Figure 2 Magic the Gathering Card

4.2.1 Key Features

The three main types of cards in our game – Buildings, Citizens, and Policies – all share the following key features. Each feature has its own designated position within the layout. Event cards do not have a Cost, Upkeep, Climate Impact, or Category but do have all the other features.

Type

Both the card's color and the type name in the upper left of the card indicate the card's type – Building, Citizen, Event, or Policy.

Cost

To the right of the card type, is the card cost. A number and an icon specify an amount and type of resources represent the cost the player must pay to play the card.

Upkeep

Next to the cost is the upkeep. Like cost, a number and an icon also represent upkeep. The upkeep shows the amount and type of resources the player must spend each round to keep the card in play.

Illustration

Each card has an illustration located between its type and its name. The illustration is a visual representation of the card's name and/or abilities. The illustration serves as a quick, easy identification for the card as well as adding visual interest to the game.

Name

The name written in the middle of each card serves equally as a caption to the illustration and a heading to the abilities and flavor text. Each uniquely named card has a different set of abilities.

Climate Impact/Votes

To the right of the card name is a circular element. If the card has an impact on the climate, a number showing the amount of impact appears in the circle along with the climate impact icon. For Citizen cards, which do not affect the climate, the circle contains the number of votes the Citizen has along with the vote icon.

Abilities

The block of text below each card's name spells out that card's abilities, i.e. how the card affects the game when it is in play. Abilities range from giving a player additional Energy or Natural Resources to changing the number of cards players draw on their turn, to destroying Buildings or Citizens.

Flavor Text

The flavor text appears below the card's abilities. The flavor text is in italics to distinguish it from the abilities text. The flavor text gives players more information about the real world issue that the card represents in a thought-provoking or humorous way.

Category

We subdivided each type of card into three main categories. For Citizens and Policies, these categories are Eco-Friendly, Political, and Industrial. For Buildings, the categories are Power Plants, Infrastructure, and Production Plants. In the bottom right of each card is the name of the category to which the card belongs. We developed the named categories so we could refer to a group of cards concisely by category rather listing the names of several individual cards.

4.2.2 Building Card



1. Cost
2. Upkeep
3. Name
4. Climate Impact
5. Ability
6. Flavor Text
7. Category

Figure 3 Sample Building card

4.2.3 Citizen Card

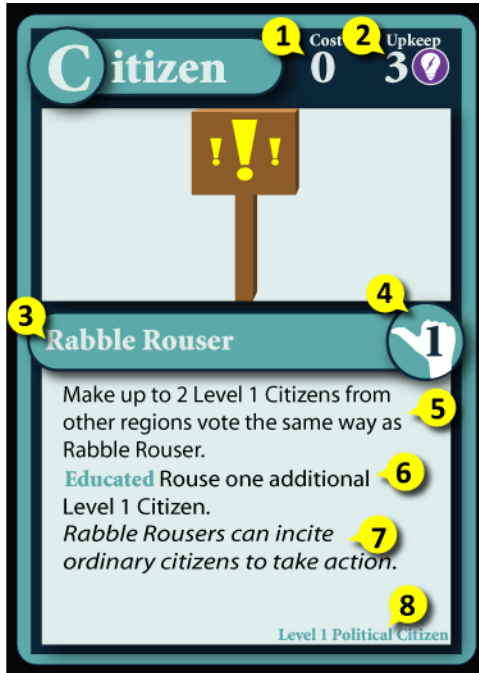


Figure 4 Sample Citizen Card

1. Cost
2. Upkeep
3. Name
4. Vote Count - the number of votes this Citizen possesses.
5. Ability
6. Educated Ability -if this Citizen is Educated, this ability is used in addition to its natural ability.
7. Flavor Text
8. Category

4.2.4 Policy Cards



Figure 5 Sample Policy card

1. Min Cost – the minimum number of votes needed to enact this Policy.
2. Upkeep
3. Name
4. Climate Impact
5. Ability
6. Flavor Text
7. Category

4.2.5 Event Cards

As stated above, Event cards have a Name, Ability, and Flavor Text, but do not have a Cost, Upkeep, Climate Impact, or Category.



1. Name
2. Ability
3. Flavor Text

Figure 6 Sample Event Card

4.2.6 Role Cards

Role cards exist to provide players with a list of information. Players never play Role cards the way they do the other types of cards. Because they function differently, Role cards have a different layout from the other types of cards. We chose to present the Role information in card form to maintain a consistent look and feel with the rest of the card game. However, they could just as easily have been sheets of paper or mini-brochures.

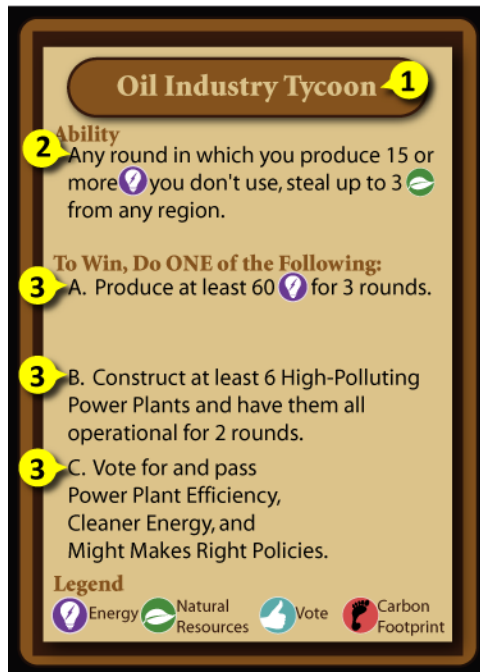


Figure 7 Sample Role card

1. Name: the Role's name.
2. Ability: each Role grants the player an additional, unique ability.
3. Objectives: A player must meet one of their Role objectives to win the game.
4. Legend: defines each of the icons used throughout the game.

4.3 Icon Design

Many trading card games including Magic the Gathering, Yu-Gi-Oh(Takahashi, 2002), and Pokémon(Sugimori, 1998) use small icons to designate certain types of cards or resources within the game. We decided early on that we wanted to do something similar. The advantages of using icons are that they are small and yet people can identify them quickly. There is often a lot of information that we need to convey in the limited space on the front of a card. Small icons allow us to compress more information into a small space than if we were to spell out the words the icons represent. Furthermore, players generally have many cards in their hands or on the table in front of them at once. Using icons makes it easier for players to scan a large set of cards for common features and/or important information.

Given these objectives for how we intended to use icons in the game, it was clear that we needed the icons we designed to have the following characteristics. The icons needed to be simple and clear enough that players could distinguish them even when the icons were very small (as little as 32x32 pixels). The icons needed to be evocative so that images instantly bring to mind the words or concepts they are meant to represent. We went through several iterations of icon designs to find ones that satisfied all these requirements.

4.3.1 Energy Icon



The first icon we designed to represent the Energy resource was a vector art light bulb on a gradated blue circle. While players easily associated the light bulb image with the concept of Energy, they could not discern many of the details of the vector

image when it was printed small.



In the second iteration, we simplified the light bulb to just four clean-edged geometric shapes, without any shading. We made the background the same purple as the Building cards since they are the primary source of Energy in the game. We also experimented with the idea of making each icon a different shape – pentagon for Energy, square for Vote, circle for Natural Resources.



In the third iteration, we returned to using a circular background for all the icons because we found the colors and images made them easy enough to distinguish.

The different shaped backgrounds merely distracted from the main image. For this version of the icon, we also tried a vertical lightning bolt in the middle of the bulb because people tend to picture electricity as a vertical bolt and because the horizontal bolt we were using before looked like the letter ‘M’.



In the final version of the icon, we returned to a horizontal bolt because we can read it two ways: as both “electricity” and as the filament of the bulb. We modeled the bolt on the symbol used to represent a resistor in circuit diagrams.

4.3.2 Natural Resources Icon



Initially we conceived of Natural Resources as building materials. Therefore, our first icon was a vector depiction of wood logs and stone rocks on a gradated blue circle. We found this icon was difficult to identify when it was small, in part because there was relatively little contrast between the image and the background.



In the second iteration, we tried to simplify the icon down to a single flat shape without any shading so it would be clear even when small. We made the background the same green as the Policy cards since Policies are one of the main ways players get more Natural Resources in the game and because the color green is often associated with nature. We rendered the leaf in white because it contrasts well with the green.



While the leaf was very iconic, it made some players think more of “leaves” or “plants” than Natural Resources in general. Therefore, we experimented with a version of the icon depicting several trees and water. Unfortunately, this version tended to look cluttered when small and was less aesthetically pleasing than the leaf.



In the final version of the Natural Resources icon, we tried to combine the organic lines and simplicity of the leaf form with the concept of trees and water.

4.3.3 Climate Impact Icon



The first version of the Climate Impact icon was a footprint (to represent the idea of a “carbon footprint”) superimposed with “CO₂” on a gradated gray circle. This icon was confusing to players because they often mistook it for an exclamation point. In addition, the “CO₂” was too small and too faint to read when the icon was small.



Our next idea was to depict carbon dioxide as a cloud of smoke emitted from a smoke stack. We used the red color from the Event cards as a background because carbon triggers Events. The larger, higher contrast letters made the “CO₂” legible even when the icon was small. However, it was hard to identify the image as smoke stacks, and even when viewers knew what the image was, they did not form a strong association between the image and the concept of carbon dioxide or climate impact.



In the third iteration, we returned to the idea of a “carbon footprint”, but we used an image of a bare footprint that proved easier to identify than the shoe-print in the first iteration. By this time, we had decided that all of the icons should a single image made up of flat shapes on a flat, circular background.



During play testing with the kids at FIRST Place, we found that referring to the Climate Impact as “carbon footprint” or “CO₂” confused the kids when dealing with something like a hydroelectric dam, which strictly does not produce carbon dioxide, yet still has a significant impact on the environment. So, we decided to use the concept of “climate impact” instead of “carbon footprint” and to change the icon image from a footprint to a globe. We initially used the image of the globe that is on the back of the all the cards. However, we found that at 32x32 pixels that globe was not easy to recognize because it has the oceans in the middle and all the easily identifiable landmasses are cut-off. Therefore, we created this globe centered on North and South America.

4.3.4 Vote Icon



At first, we did not have an icon for votes because we were not thinking of them as a resource. However, we eventually realized that just as Buildings produce Energy or Natural Resources, Citizens “produce” votes. We then came up with the image of a hand, extended in a thumbs-up pose to represent voting.



In the second iteration, we reflected the hand on the vertical axis because we wanted players to be able to turn their Citizen cards to make the icon point thumbs-up when voting “yes” and thumbs-down when voting “no” and we found it felt more natural to turn cards clockwise for “yes” and anti-clockwise for “no”. We also decided to make the hand image white to go along with the white images used for Energy and Natural Resources and to contrast with the Climate Impact. This way, we represent all the “good” resources in the game in white and the “bad” carbon in black.

4.4 Evolution of Card Design

As stated above, we based the layout of our cards on the layout used for other, similar card games like Magic the Gathering. Because we used these other card games as a model, we had a reasonably clear idea of what we wanted the cards to look like from the beginning. As you can see by comparing the two images below, the overall layout did not change much from our initial concept to the final version.



Figure 8 Early Building Card Design



Figure 9 Final Building Card Design

Though the colors changed, there is still a large illustration in the upper half of the card while the lower half still contains a text description of the card's abilities. The cards still have a double border and we are still using drop-shadows to set off the various features of the card from the background. That said, we did make a number of tweaks to the card design.

4.4.1 Larger Text Area

We found we needed more room to explain a card's effect and/or abilities in the game. To accommodate the larger text area, we made illustration and the titles for the card type and the card name smaller.

4.4.2 Font Choices

We changed the font used for the abilities and the flavor text to Myriad Pro, a sans-serif font. Though the old-style font we initially planned to use was more attractive when printed out, the sans-serif font was easier to read on the screen in the computer version of the game. We continued to use an old-style font for the card type and title because they are large enough that the serifs are still clear at a 1024x767 resolution on a computer screen. To avoid having too many different fonts, we wanted to use the same font for the cost, upkeep, and climate impact numerals as we did for the card type and name headings. After comparing a wide range of fonts, we selected Minion Standard Black because it has particularly clear, legible numerals.

4.4.3 Different Colored Card Backs

Initially, all the cards were brown on the back and had a brown border around the front. When we decided to allow players to draw from separate Building, Citizen and Policy card decks (see 3.6.3 Drawing from three decks), we changed the colors of the backs of the cards to match the fronts. Thus, Building cards have purple backs, Citizen cards have blue backs, Policy cards have green backs, Event cards have red backs, and Role cards have brown backs. The different colored backs make it much easier for players to quickly sort the cards into the appropriate decks if the different types of cards should ever get mixed together.

4.4.4 Climate Impact/Vote element next to card name

In the first few iterations of card designs, we included the card's impact on the climate in the card's abilities text. However, in our first few play testing sessions within our group we noticed that it was difficult to figure out how much each card influenced the climate during the Global Events phase. Because the climate impact was part of a larger block of text, it was in a slightly different place on each card, making it difficult to scan all one's cards and add up the numbers. In addition, when we looked quickly, we sometimes mixed up the climate impact number with other numbers in the card's abilities.

Therefore, we decided to move the climate impact number to a separate, designated location on all the cards and to make the number larger so it is easier to read at a glance. Since Citizen cards do not have a climate impact we decided to use that spot to display the number of votes each Citizen possesses. To distinguish between votes and climate impact, we superimpose the number on the appropriate icon. We positioned the climate impact/vote element to the right of the card name because putting a large circle there helped to visually balance the large circle in the upper left-hand corner of the card.

4.4.5 Separate Cost and Upkeep in upper corner

Our early card designs had a single number in the upper right-hand corner. For cards that cost Natural Resources, this number represented a one-time cost. For cards that required Energy, the number represented an on going, per round upkeep cost. During the first round of play testing at FIRST Place, we noticed that the students had trouble understanding the difference. One group of students was under the impression that Citizens had a one-time cost the same as Power Plants. After observing the students, we decided to state both the cost and the upkeep explicitly as two separate numbers on each card, even when one of the values was zero.

4.4.6 Category

Displaying each card's category in the lower right-hand corner of the card was one of the last elements we added to the card design. Conceptually, we had already been grouping cards into categories for some time. However, as we play tested, we realized it was useless to refer to "Level 1 Citizens" or "Industrial Policies" in the card text if we did not make it clear to players which Citizens were Level 1 and which Policies were Industrial. It became obvious we needed to clearly identify what category each card belongs to somewhere on the card itself. However, players only occasionally need to refer to a card's category. Thus, we added the category element to the lower right-hand corner, where it is plainly visible if the player is looking for it, but otherwise it is out of the way.

4.5 Implementation of Cards

4.5.1 Working with Adobe Illustrator

We did the artwork and layout for all of the cards in Adobe Illustrator CS2. To avoid duplication wherever possible, we made liberal use of linked files. We constructed the final composite rendering of the front of each card from a minimum of three linked files. There was one file for the background blocks of color and borders. Each card type – Building, Citizen, Policy, Event, and Role – had its own version of this background file. The second linked file was for all the text on the card – the cost, upkeep, name, climate impact/vote, abilities, flavor text, and category. There was one text file for every card in the game. The third linked file was for the illustration. Most cards also linked to one or more icons.

Keeping the various elements that compose a card separate in this way allowed us to make changes to the individual elements more easily. For instance, when we changed the icons from one version to the next, we only had to make those changes in one place (the individual icon files) rather than editing the icons on every single card that used them.

Unfortunately, Illustrator does not seem well designed to handle this kind of project. We ran into a couple quirks in the application that made some of the things we wanted to do with the cards quite tedious and time consuming. One of the most frustrating problems we had was that when you change a linked file, the file that links to it is not updated until you open it and resave it. For example, in the case described above where we changed the icons, we had to open all the card composite files and resave them so that the updated icons would show up. This was far less work than actually editing the icons every place they appear, but it was still a lengthy and tiresome process. Another problem we had with Illustrator is that when one file links to another, that link is a hard-coded absolute path. Thus, if you change the name of a linked file or move it to another directory, you must open all the files that link to that file and manually update the links.

See Appendix E– Editing Cards in Illustrator for more information.

4.5.2 Textures for Java Monkey Engine

In the computer version of the game, we use a simple 3D model of a flat box to represent each card. Again, to avoid duplication and to memory space, all the cards use the same model file with a different texture.

The game engine, Java Monkey Engine (jME), does not support Adobe Illustrator's native file format (.ai). Therefore, to create the textures for the cards, we had to export all of the files from Illustrator into one of the file formats that jME does support. To speed up this process, we created an Illustrator file that laid out a card's front, back, and sides to match up with the UV mapping on the 3D model. Then, we set up an Illustrator variable library with one data set for each card. Finally, we wrote a Visual Basic .NET application that loads each card's data set in turn and exports the resulting file to a .jpeg texture that we can use in jME.

4.6 Future Possibilities

4.6.1 Clearer Illustrations

One of the things we did not have time for in our play testing sessions was to ask the children about individual illustrations to see if the images made sense to them. In creating the illustrations, we used imagery that signifies the concept of the cards to us. However, the images we used might mean something different to our target audience, particularly since many of the concepts we are trying to convey are abstract and do not have a commonly accepted visual representation. For example, we read the illustration

we created for the Erosion Event card, (see Figure 10 Erosion illustration) as four progressive stages of erosion. However, others, particularly if they are not familiar with the concept of erosion might interpret this image differently. Perhaps they see this as an illustration of increasing wind or turbulence.

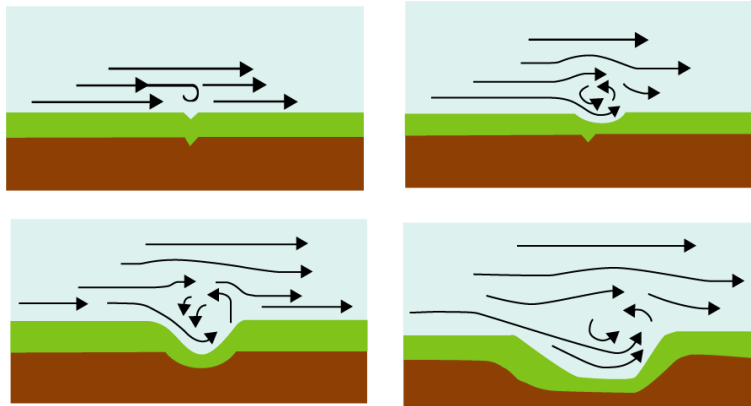


Figure 10 Erosion illustration

Given more time, we would have liked to survey or interview 9 - 14 year-olds about what they visualize when thinking of the various concepts in the cards. Then we could better tailor the illustrations to our audience.

4.6.2 More Consistent Color Palette

Though we had a well-defined color palette for the layout of the cards, we created the illustrations separately and they do not always match the palette. If we had had more time to work on this project, we would have tweaked the colors used for the illustrations to match the colors in the other elements of the cards. For instance, with the Erosion illustration above, we would have matched the light blue color in the illustration to the light blue used as the background for the text on the Citizen cards.

4.6.3 Indicators of Educated Citizens

Several times during play testing, we noticed that players had difficulty keeping track of which of their Citizens they had educated. At this time, there is nothing built into the cards or the rules to help players distinguish between educated and uneducated Citizens. We can recommend that players use some commonly available small object such as a penny or paper clip or scrap of paper to mark their educated Citizens. Alternatively, we could create tokens (perhaps with an image of a diploma or a mortarboard) that players could use. However, we are concerned that any such markers would add clutter to what is already a crowded playing area. With more time and thought, perhaps a better solution might present itself.

4.6.4 Design of Role Cards

While observing the children at FIRST Place, we noticed that they often seemed to put their Role card off to one side and then would sometimes forget their Role ability or objectives or both. Also, having three different possible objectives sometimes seemed to confuse the younger players. They were not sure what they needed to do to win.

To help players keep their Roles in mind, we came up with the idea of making the Role cards 50-100% larger. The bigger size would mean that even if players put their Role cards off to one side, they would still be noticeable and the text would still be legible. We did not have time to test out this idea to see if it solves the problem

We have also noticed that the fact that every player's objectives are visible to every other player can sometimes cause tension or arguments. Sometimes one or more players will take some action specifically to prevent another player from winning. While we designed the game to generate some conflict between the roles, players sometimes take it personally when they know another player is deliberately blocking them. If instead player's objectives were kept secret, it might prevent some bruised feelings because if one player blocked another from winning it would only be by chance or guess, not by deliberate mal intent.

One way we might make the Role objectives secret would be to remove all the objectives from the Role cards. Instead, the objectives could be on separate cards or tokens or sheets of paper. If each objective was associated not with a specific role, but instead with one of the three types of Roles – Eco-Friendly, Industrial, or Political – then players could select a Role and then draw one or more objectives from the corresponding type. Players could leave their Role cards face up on the table so others would know what type of Role they were following, but objectives could be kept secret. Because objectives would be somewhat random, we could simplify things and give each player a single objective for each game rather than giving them three to choose from. Removing the objectives from the Role cards would also leave room to provide a description of the Role, which is something the teachers have requested.

5 SOFTWARE DESIGN

5.1 Platform

We selected jMonkey Engine (jME), “a high performance scene graph based graphics API”(About jME, 2008) as our game development platform. The criteria we considered in making our selection were that the platform should:

- Produce a distributable, executable game that can run on many different operating systems and/or over the Internet,
- Have built-in architecture to support rapid game development (I.e. we did not want to code every part of the game from scratch.),
- Support multiple co-located or networked players, and
- Support 3D graphics.

Based on these criteria, we narrowed our choices down to five platforms: jME, Game Maker(YoYo Games), C4(Terathon Software LLC, 2008), Flash(Adobe Systems Incorporated, 2008) and pygame (Hassey). We rejected Game Maker because it is primarily for the creation of 2D or orthogonal-view adventure games and arcade style games. Trying to use Game Maker to create a card game would require a lot of work to adapt the platform to do something for which it was not designed. Similarly, the C4 engine is a good tool for developing first- or third-person 3D games, but a card game would be a stretch.

From our brief evaluation, we believe either Flash or pygame would have provided adequate support for our card game. Flash in particular seemed like it would have allowed us to create an aesthetically pleasing game with a good user interface in a relatively short period of time. Unfortunately, none of our development team has much experience with Flash ActionScript or Python. We would have needed several weeks to learn the language, if we had selected Flash or pygame as a platform.

Therefore, we chose jMonkey Engine because it provides us with the basics of game control logic and graphics but remains very flexible and extensible for supporting many different types of games. In addition, our team has a good deal of experience with the Java programming platform and jME meets our above criteria.

5.2 Architectural Overview

The jME API determines the basics of the game architecture. jME allows developers to create games as a series of GameStates, corresponding to different stages of the gameplay. jME’s GameStateManager activates and deactivates GameStates according to the flow of the game, passing control from one GameState to the next.

Our game has two top-level GameStates – TitleMenuState and LocalGame. During the TitleMenuState users set the configuration options for the game, including selecting the number of players and entering player names. Then, control passes to LocalGame which runs the actual game. LocalGame is divided into several lower-level GameStates that generally correspond to the phases in the game play (see 3.5.2). There is a PlayerPhase, which we further subdivided into a PlayerUpkeepPhase, DrawPhase, a ProductionPhase, and an ElectionPhase. There is also a GlobalEventsPhase and a GlobalUpkeepPhase.

The jME API also handles the rendering of the graphical representation of game objects such as the cards. In our architecture, we wrap the data representation of the cards, players, and other game objects in a jME Node, which is responsible for the graphical representation. Each graphical element in a jME application is a Node attached to the scene graph. While there is only one scene graph for the entire game, each GameState declares its own root node – the point on the scene graph from which the GameState will be responsible for updating and rendering the graphics. When a GameState is inactive, none of the nodes from its root down are rendered.

The graphic elements of the user interface (GUI), which includes windows, dialogs, labels, buttons, checkboxes, etc.) are separate from the scene graph, which renders cards and players. The game uses the FengGUI API for all GUI elements.

5.3 Key Packages and Classes

5.3.1 game package

The game package is for the main application (Game) and the top-level data structures including GameManager which loads the decks and sets up players and GameWorld which handles the graphical representation of players and cards.

5.3.1.1 Game class

The Game class is the starting point for the application. Game derives from the jME class SimpleGame. It sets up all the base functionality including lighting, mouse, and camera creation.

The main responsibility of Game is to be a time step for the GameStateManager (a jME defined class). The Game class initializes the two main gamestates – TitleMenuState and LocalGame – and starts running the TitleMenuState, the entry point for the game.

5.3.1.2 GameManager class

The GameManager is responsible for the internal model of game data. When it is initialized, it loads all the decks, creates and initializes the players, and deals out the cards. The GameManager also has a PhaseEventHandler (see 5.3.4.4) that handles the events that signal the end of a GamePhase.

There should only ever be one instance of the GameManager. The LocalGame state is responsible for creating and initializing the GameManager.

5.3.1.3 GameWorld class

The GameWorld class handles all the graphics related objects in the game world. It sets up the scene graph, including the placement of players and their cards, and all the regions (areas that can contain cards such as a player's hand or the displayed Event cards). The GameWorld takes the card and player data stored in the GameManager, wraps that data in jME scene graph nodes, sets up the graphical representation of the nodes (location, orientation, etc.), and attaches them to the appropriate spot in the scene graph hierarchy. In order to create the graphical representation of the cards, the GameWorld contains code that loads the 3D card model (a .obj file) and applies the appropriate texture (a .jpg file).

5.3.2 game.gamestates package

This package contains the BaseGameState abstract class and its concrete sub-classes.

5.3.2.1 BaseGameState class

The BaseGameState is an abstract class derived from jME's GameStateNode class. LocalGame and TitleMenuState are concrete classes derived from BaseGameState.

A BaseGameState has a GameManager, a GameWorld, a BaseGUI, and a scene-graph root node.

The update() and render() methods for any GameState (including GamePhases) use the GameState's root node as their starting point. In other words, those methods will update and render the GameState's root node and all its children, but will ignore any other branches of the scene graph. This way, when a GameState is deactivated, all of the Nodes or Spatial's attached to the GameState's root node are automatically hidden.

The BaseGUI contained in BaseGameState manages the GUI components for the BaseGameState and all its sub-gamestates (GamePhases). See 5.3.5.1 for more details.

Our intention was to have only one BaseGameState active at any point during the execution of the game. However, nothing in the code actually limits the number of active BaseGameStates.

5.3.3 game.phases

This package contains the GamePhase class and the sub-package game.phases.gamephases, which contains all the GamePhases. GamePhases are GameStates at a finer-grained level of detail than the BaseGameStates. BaseGameStates delegate most implementation details to the GamePhases, which contain the actual game logic. Currently, all the existing GamePhases are sub-gamestates of LocalGame.

5.3.3.1 *GamePhase class*

The `GamePhase` class is an abstract class derived from the `jME GameState` class. `GamePhase` implements the `GameEventListener` interface, meaning all `GamePhases` are event handlers for `GameEvents`. Examples of `GameEvents` include drawing a card, playing a card, and so on. See section 5.3.4 events package for more details.

`GamePhases` can also handle their own mouse events. Each `GamePhase` can create its own abstract `MouseListener` class providing a custom implementation for handling events such as mouse clicks or releases. While the `GamePhase` is active, its `MouseListener` listens for mouse events on a base node and its children and handles the events accordingly. The base node for the `MouseListener` should be either the root node for the phase or the root node for the phase's parent `BaseGameState` depending on which nodes the user can interact with during this phase. This prevents mouse events related to one `GamePhase` from interfering with any other active phases. As an example, the root node for the `MouseListener` in the `DrawPhase` is the node containing the decks of cards. The user can click on the decks and the `DrawPhase MouseListener` will handle the event, adding the card to the player's hand. While the `DrawPhase` is active, the game ignores any mouse events on any part of the screen other than the node containing the decks.

Each subclass of `GamePhases` overrides the `setActive()` method, which is responsible for turning the phase's functionality on or off. When a `GamePhase` is created, it can be attached to the scene graph as a child of a `BaseGameState`. The parent `BaseGameState` will update and render any active child `GamePhases`.

5.3.4 events

The events package contains the code related to generating and listening for `GameEvents`.

5.3.4.1 *GameEvent class*

`GameEvent` objects represent any of the events that can happen at any point during the game, such as playing a card, calling for a Policy vote, or ending a turn. All `GameEvents` have a source object (the object that spawned the event) and a `GameEventType` (e.g. `DRAW_CARD` or `PLAYER_FINISHED`). Some `GameEvents` also have a data object. The optional data object contains any additional information necessary for processing the event. In some cases, where an event represents one object acting on another (e.g. one card affecting another card), the data object may represent the target of the event. The event handler processing the `GameEvent` should know how to interpret the data object based on the event's `GameEventType`.

5.3.4.2 *GameEventListener class*

The `GameEventListener` and the `GameEventObservable` implement the Observer pattern. `GameEventListener` is an interface that represents the Observer half of the pattern. The `GameEventObservable` class represents the Subject side of the pattern.

Any class that needs to receive notification of GameEvents can implement the GameEventListener interface. In order to start receiving events, the GameEventListener must either subscribe to the PhaseEventHandler or register (addListener) itself directly with a GameEventObservable.

Most GameEventObservables add the PhaseEventHandler as a listener. Most GameEventListeners including the GamePhases (all of which implement the GameEventListener interface) subscribe to the PhaseEventHandler. When the PhaseEventHandler receives an event from a GameEventObservable, it iterates through all the subscribed listeners and passes the event on to them to handle in their own way. The PhaseEventHandler only passes events to *active* GamePhases. This means that any inactive phases will not receive event notifications even though they subscribe to the PhaseEventHandler.

BaseGUIs also implement the GameEventListener interface and subscribe the PhaseEventHandler. This allows the BaseGUIs to add and remove GUI widgets to and from the display appropriately as different GameEvents occur.

5.3.4.3 GameEventObservable class

As mentioned above, the GameEventObservable is the Subject observed by GameEventListeners. This means the GameEventObservable is responsible for actually sending out the event notifications. Any class that generates GameEvents has a GameEventObservable member. Such classes should tell their GameEventObservable what type of events they will be generating. Then, when these classes want to raise an event, they call their GameEventObservable's notifyGameEvents() method, which will send the event to all GameEventObservable's listeners.

5.3.4.4 PhaseEventHandler class

The PhaseEventHandler is a special GameEventListener. The PhaseEventHandler is a listener on most (but not all) GameEventObservables and therefore receives notification of most GameEvents. The PhaseEventHandler keeps its own list of subscribed GameEventListeners, most of which are GamePhases. When the PhaseEventHandler receives an event, it passes the event on to all its active subscribed listeners.

5.3.5 gui.gamestates

This package contains the BaseGUI class described below. The sub-packages gui.gamestates.titlemenu and gui.gamestates.localgame contain all the GUI windows, dialogs, and other components used during the TitleMenuState and LocalGame GameStates respectively.

5.3.5.1 BaseGUI class

BaseGUI is an abstract class that bridges the gap between the FengGUI and jME parts of the game. TitleMenuGUI and LocalGameGUI both inherit from BaseGUI.

BaseGUIs implement the `GameEventListener` interface and have a `GameEventObservable` member variable. This allows them to raise and receive `GameEvents`. BaseGUIs control the display of GUI components, adding or removing them from the screen, in reaction to `GameEvents` generated in other parts of the program. For instance, when a player's turn begins and the game enters the `PlayerUpkeepPhase`, the `LocalGameGUI` receives the event and handles it by opening the `UpkeepPane`. When the players close a window or change some data in the GUI, the BaseGUIs raise `GameEvents` which the `PhaseEventHandler` and other `GameEventListeners` can handle.

BaseGUIs also handle all the internal GUI events for the components in a given `GameState`. For example, when the player selects "Play" from the `MainMenu`, the `TitleMenuGUI` handles that `ButtonPressed` event and opens up the `ConfigWindow`. Since these events only affect GUI components and not game objects, the BaseGUI handles these types of events internally and does not pass them to any `GameEventListeners`.

5.3.6 controller

The controller package contains the `GameController` and `GameEntity` classes. The `controllers.gameactions` package contains all the specific actions derived from `GameController`. Actions perform some manipulation on an attached `GameEntity`. For instance, the `ScaleCardAction` attaches to a `Card` and makes it bigger or smaller.

5.3.6.1 *GameEntity class*

As mentioned in the overview (Section), all the game objects or "entities" have both a data representation and a graphical representation that corresponds to a node on the scene graph. The `GameEntity`, which extends `jME's Node` class, stores the graphical information for the entity along with a reference to the `BaseGameState` that contains the entity. This allows every entity in the game to access to the `GameManager` and the `GameWorld` through its `BaseGameState`.

5.3.6.2 *GameController class*

The `GameController` class derives from `jME's Controller` class. `GameControllers` store a `GameEntity` which it controls and another optional controller (called a `finishAction`) that will take over control of the `GameEntity` when this controller finishes. `GameControllers` also have a `GameEventObservable` so the controllers can notify other parts of the game about the actions the controllers have performed.

Whenever a `GameController` completes its main action, it should invoke its `finish()` method. The `finish()` method sends out notification of the `GameEvents` generated by the controller and passes control of the `GameEntity` to the `finishAction` controller if there is one. The `finishAction` allows us to build up chains of simple actions into a complex sequence. For instance, we can flip a card, then scale it, then move it. Actions linked

using `finishAction` are executed in series, one after the other. To execute several actions in parallel, simply attach more than one controller to the same `GameEntity` at once.

5.3.7 resources

This package contains all the models, textures, card XML data files, GUI themes, and other resources for the game. The GUI themes are XML files that define the appearance of all the FengGUI components used in the game.

This package also contains `deck.txt`, the text file that lists all the cards the `GameManager` should load for all the decks in the game. The `GameManager` also loads the data for each card – name, cost, upkeep, etc. – from XML files, one per card.

All the cards in the game share a single 3D model, `card.obj`. When the `GameWorld` sets up the graphical representation of each card, it combines the model with the appropriate texture for the particular card.

5.4 Future Possibilities

At the time of this report, we have not completed the computer game. Therefore, there are a number of features we still hope to implement in the future including:

- the abilities for every card
- supporting the use of the Charismatic Leader, Rabble Rouser, and Lobbyist Citizens during voting
- allowing players to select a Role
- sound effects for cards flipping and other actions
- 3D models to represent the players
- updated GUI theme in a style appealing to our target audience

In the longer term, if we had more time to complete this project, we would like to research how other card games such as Magic the Gathering Online implement card abilities and game rules. The system we devised works, but we feel with more time and research we could find a more elegant solution.

6 PLAY TESTING

6.1 Methodology

6.1.1 Test Subjects

We play tested the game with three different groups of test subjects: our development team, high school students, and children in our target age range.

All the members of our development team are majoring in Interactive Media and Game Development (IMGD) at WPI. Two members of the team are IMGD Artistic concentrators and two are IMGD Technical concentrators. Two of us are women and two are men. We are all over twenty years of age. At times, when we wanted a few more players to make up a full six-person game, we recruited some of our friends and peers as test subjects as well.

The high school students we play tested with were all participating in Teen Venture Camp, a week-long summer camp at WPI for high school students interested in starting their own businesses. Play testing our game was an optional activity offered to the campers at the end of the day. The campers who volunteered to play our game were all male and ranged in age from 14 to 16 years old.

We play tested with children in our target age range at the FIRST Place camp in Manchester, NH. We visited FIRST Place on two separate weeks with a different group of children each week. Sixteen children (two girls and fourteen boys) ranging in age from 10 - 14 participated in the first week of play testing. Another fourteen children (twelve boys and two girls) participated in the second week of play testing. Most of them were 9 to 12 years old, with one 14 year-old girl.

6.1.2 Protocol

6.1.2.1 *Internal Play Testing*

The play testing sessions within our team were very informal. We met in the library or elsewhere on campus and played with the latest deck of cards. While playing, we took notes about the game. Often we did not play until the end of the game because we would stop to have long discussions whenever something happened that we had not considered before. Sometimes we pulled in our friends to get additional input, a fresh perspective and to see how the game changed with more players.

The main goal of these internal play testing sessions was to allow us to brainstorm about new features and work out the details of game play.

6.1.2.2 Teen Venture Camp Play Testing

One afternoon during the Teen Venture Camp week at WPI, we presented our game to about twenty of the high school students. Unfortunately, about the time we finished going over the rules, many of the campers had to leave. The five students who stayed however, did play a few rounds with one member of our team filling in the sixth spot. While they played, we took notes and answered questions about the finer details of the rules.

The next day, four students returned to play for a longer period. Again, members of our team joined in and played with the teens while also taking notes on the game. Since all of the teens who participated in the play testing seemed to be avid gamers, we had several informal discussions with them about the mechanics as well as their general impressions of the game.

Our primary goal for the play testing during the Teen Venture Camp was to see how well young people who had never played the game before would pick it up. It was an opportunity for us to see what aspects of the game we had started taking for granted that might be confusing to new players. We also wanted to find out whether or not players closer to our target age range would find the game fun and interesting.

6.1.2.3 FIRST Place Play Testing

The play testing sessions at FIRST Place were our most important because the participants were good representatives of our target audience. Since the sessions were so critical, we used a more formal testing protocol.

On the Monday of weak week of play testing, two members of our team gave a brief, prepared presentation describing the main concepts and general flow of the game to the entire roomful of children. After the overview, we sat the children down at three separate tables, each with a set of cards. We talked all the groups through the set up for the game – distributing the initial Natural Resources, drawing their starting hands, etc. Then we let the groups play at their own pace while we monitored them and answered questions. After the children had played for about an hour (a few rounds), we brought them back into one large group and asked them a set of prepared questions designed to gather their impressions of the game.

The children played the game several more times, for two hours each afternoon Tuesday through Thursday each week. During the first week, we were not present after Monday but the children's teacher observed them and emailed us her notes and the children's comments. The second week, we returned on Wednesday. During that visit, we just observed how the children's play styles had evolved since the first day.

Our main goal for play testing at FIRST was to discover how our target audience reacted to the game. In particular, we wanted to know if they thought the game was fun and engaging and if they found any part of the rules or game play confusing or difficult.

6.1.3 Types of Data Gathered

Throughout play testing, we tracked four concrete, quantitative measures – climate levels, length of game, winning role, and number of cards – and three qualitative measures – player enjoyment, understanding, and learning.

It is unfortunate that we could not complete more of the computer version of the game sooner and play test with it. First, it would have been very valuable to get more feedback specifically on the computer version of the game particularly on the interface. Secondly, we could also have used the computer game to track a lot more information about the games and players' choices giving us more quantitative data to work with as we refined the game design.

Still, we were able to gather a lot of good information with just pen and paper.

6.1.3.1 Climate Levels

For each play testing session, we kept a record of the climate levels each round. The climate levels helped us determine if the game was too easy or too hard. Essentially the change in the climate level over the course of the game is a measure of the frequency of the challenges (Event cards). We wanted every game to include some Events. However, the frequency and severity of the Events required careful balancing. The Events should not be too frequent or too difficult, so that if players use good strategy, they are able to overcome the Events and succeed. On the other hand, the Events should not be so infrequent or so easy so that players can ignore them and win.

6.1.3.2 Length of game

We recorded the length of each game in terms of number of rounds and/or actual time played. The length of the games helped us to gauge the balance between the game lasting long enough to be interesting and short enough to finish in one session. This measure proved particularly important when we observed the children at FIRST Place and realized that some of them did not have the attention span to keep playing for more than 30 - 45 minutes.

6.1.3.3 Winning Role

We kept track of which Role won each game and which objective they achieved to win. This helped us to balance all the different Roles, making sure that none of the Roles had a big advantage over any of the others.

6.1.3.4 Number of cards

In some of the play testing sessions, we also noted the number of cards players had in their hand or in their region on the table. This measurement influenced our decisions about the interface design. It gave us an idea of the average number of cards we needed to display on the screen at a time.

6.1.3.5 Enjoyment

Through observation and questioning, we tried to determine how much players enjoyed the game. Were they interested and engaged or bored? We felt that in some ways this was the single most important measurement for gauging the success of the game.

6.1.3.6 Understanding

We tried to measure how well players understood the game both through watching players behavior – seeing which rules they used correctly and which ones they forgot or misunderstood – and through direct questioning – “was anything confusing to you?” Knowing what players understood and what they did not showed us which parts of the game were too complicated, tedious, or onerous and which parts were working well. With this information, we were able to refine the game design, removing or simplifying the parts players had trouble with.

6.1.3.7 Learning

In the play testing sessions at FIRST Place, we tried to determine if the children had learned anything from playing the game. We asked them directly if they felt they had learned anything, and if so what? This data helped us figure out how successful the game is as an educational tool.

6.2 Findings

6.2.1 Climate Levels

In some of the early play testing sessions, we got very high Climate Levels even on the first round. In the 12-Jun session, the climate level was 38 on the first round; 67 by the third round. On 15-Jun, the climate level 32 by the third round, even though the players were trying to play conservatively. These high climate levels meant that Events came into play early in the game and knocked the players back before they had had a chance to progress. This observation led us to add the mechanic that Natural Resources mitigate the climate change (see 3.6.7 Natural Resources mitigate Climate Impact).

In later games play testing sessions at FIRST Place, we noticed that with six players, the number of Natural Resources in play could keep climate levels very low, even negative for several rounds. Combined with our finding that the younger children had trouble adding negative numbers (see 6.2.6), we decided not to let the climate level go below zero.

If we had had the scorecards at the beginning, they would have been useful for keeping track of the climate levels in a more detailed and consistent way throughout the play testing. We did keep track of the total global climate level for each round during most games. However, the scorecards would have helped us record each player's individual contribution and the policies contribution to the total climate level.

6.2.2 Length of Game

In the sessions where we played all the way to the end of the game, games tend to last 5 to 10 rounds. From a game design perspective, that is about the length of game we were aiming for. To win players need to go through enough rounds that they get to apply some strategy, but not so many rounds that the end seems too far away or too hard to achieve. In the games that lasted less than 5 rounds, we found it was usually due to the fact that some Role had an objective that was too easy and we rebalanced the Roles.

With our original rule of drawing one card per turn, we found that games seemed a little too slow. . . progress seemed limited, mainly because we could only draw one card per turn. Therefore, if we did not have any Buildings or Citizens in our hand (which definitely happened for all of us) we could only draw one Building or one Citizen and that was all we could play during our turn. (Summary of 15-Jun-2008 Play Testing)

Thus, we decided to allow players to draw two cards per turn (see 3.6.3 Drawing from three decks). Even with drawing two cards, we found that it took two players who were familiar with the game 1.5 hours to play 10 rounds or 1 hour for five players to play 5 rounds. We were aiming for six players being able to play 10 rounds in 1 - 1.5 hours.

During the second round of play testing at FIRST Place that amount of time required for each round was a significant problem for many of the 9 - 11 year-olds. We observed that 9-11 year-old boys did not have the attention span for a full game. Many of them were getting up from the table and wandering off or playing with things (their water bottles, the Natural Resource tokens, etc.). They had a hard time sitting still for the hour it took them to play through one whole game. They just can't keep their attention on the game while waiting for 5 other kids to take their turns. (Summary of 28 & 30-Jul-2008 Play Testing at FIRST Place)

One child suggested that we should "make the turns a little faster. Maybe on the computer game you could have a time limit like 1 minute per turn."

Based on these findings, we added a recommendation to the teacher's materials that when playing the game with younger children, there should be no more than four players per game. This at least will reduce the time players have to wait before their next turn.

We also developed rules for a quick play version of the game that would not include Roles (see 3.3 Goal).

6.2.3 Winning Role

We changed the Roles and Role objectives several times over the course of the project so it is difficult to draw any conclusions about whether or not one Role consistently won more games. However, by looking at the winning role along with the length of the game we were able to identify times when certain Roles seemed able to win too easily, i.e. within fewer than five rounds. Whenever we found a Role had won too quickly, we adjusted the Role objectives.

6.2.4 Number of Cards

The highest number of cards we recorded in any player's region at one time was 26, which happened during one of the games at FIRST Place. On average, players had around 14 to 16 cards in their region by the end of a game. When we returned on Wednesday of the second week of play testing at FIRST Place, we noticed that many of the younger players did not keep the cards in their region lined up or well organized. This made it more difficult for them to keep track of their progress. We also found that the camp counselor had drawn up play mats with outlines for Building and Citizen cards for the three youngest players. The mats seemed helpful.

Over the course of play testing, we noticed that players occasionally had 10 or more cards in their hand. Observing the children at FIRST Place, we found they had a tendency to put all their cards face down on the table in front of them rather than hold them in their hand. We think this was at least in part because it was difficult for the children to spread out their cards enough to see them all in their hands. In part due to this finding, we decided to place a limit on the number of cards players can have in their hand (see 3.6.11 Limited Number of Cards in Hand).

6.2.5 Enjoyment

We found that most players' initial impression of the game was very favorable. Players said they had fun playing the game. During several of the play testing sessions players asked if the game would be available in stores. They were willing to pay money to buy their own copy of the game. One player said, "I think this game will be very popular. People will buy it. Parents should buy it [to teach] their kids," (Summary of 26-Jun-2008 Play Testing - Overall Observations) which is a good example of the kinds of comments we received.

The children who played the game two hours a day for four days in a row at FIRST Place enjoyed the game initially, but many of them understandably started to get bored by the end of the week. One of the teachers noted on Wednesday that the "First two days were fun playing and now they are starting to say they are bored." On the last day the teacher observed "Today a few students just wanted to end the game, they got off track easily, started to say that the game was boring, but others loved it." However, having the

children play for two hours a day for the entire week is not how we understood the game would be played in the FIRST Lego League Challenge.

In our internal play testing sessions, we felt that the game did not afford enough interaction between the players. As a result, we tried to add more interactive features such as requiring all players to vote on all Policies (see global vs. local policies).

When we play tested with the Teen Venture Camp, they also expressed a desire for a greater ability to affect other players. The kids really wanted to see the Events punish the player who had the greatest Climate Impact. They noticed that two of the five players were responsible for a disproportionate amount of the Climate Impact and they wanted to do something to and/or have something bad happen to the polluters.

The children in the first round of play testing at FIRST Place had several specific suggestions for how add more interaction to the game. They wanted “Invasion cards” that would let one player steal another’s resources and an Assassin card that could kill any Citizen. Between the first and second rounds of play testing at FIRST Place, we incorporated many of the children’s suggestions into new Citizen cards. In the second round of play testing, with these new cards, the children seemed more satisfied with the level of interaction. However, the new cards did have one drawback. The teacher noted that occasionally “the younger kids also take plays personally (for example, one boy quit, knocking all the cards to the floor thinking everyone else was out to get just him!).”

We interpret this as a social problem more than a problem with the game. We cannot prevent the kids from ganging up on one player they dislike nor can we make sure that none of the players are sore losers. We could leave out the cards that allow players to affect each other, making the game more passive and “nicer”, but that would take out a lot of the fun of the game too. Most of the kids seemed to enjoy the opportunity to mess with each other more than they were upset by being messed with.

Another mechanic the children suggested was to allow players to trade cards. In fact, at least one of the groups we observed spontaneously started trading cards during their second game. Due to time constraints, we chose not to include trading in the game at this time. However, it would likely make a fun future addition (see 3.7.1 Allowing Players to Trade Cards).

6.2.6 Understanding

In our early internal play testing sessions, we felt we were doing “too much math” and that it was too complicated to figure out how much Energy, Climate Impact, and Natural Resources we had. (Summary of 12-Jun-2008 Play Testing) Other players found the calculations complex as well, noting, “There’s a lot to keep track of. It would be good if you could have a little digital device to scan all the cards and count everything up for you.” Throughout the game development process, we continued to make adjustments,

from changing the card design so that the climate impact number would always be in the same place to limiting the number of policies allowed in play, all to simplify the calculations required.

For the final round of play testing at FIRST Place, we gave the players scorecards to help them keep track of all the numbers. The teacher told us the scorecards were “a big hit” with the children. By end of the project, with the scorecards and other changes to the game design, even the 9 year olds seemed more comfortable with the math.

The first week at FIRST Place, the teacher observed that the game “NEEDS to be a computer game.”

It is true that in the computer version of the game, the program can handle all the calculations, removing the burden from the players. However, both the computer game and the card game have benefited from the improvements we made to the design and playability.

One of the biggest benefits of play testing was that it allowed us to identify areas where our cards and rules needed clarification. In each round of play testing, we discovered typos, vague statements, or inconsistencies in our card text. Between each round, we addressed these issues improving each generation of cards for the next play tests. As an example, we found the inconsistency in the cost of cards, specifically that some cards had a one-time cost while others have an ongoing cost was confusing to many players. In the next version of the cards, we explicitly stated the cost and the upkeep in two separate fields on each card.

One problem younger players had that older players did not was understanding all the vocabulary used. Young players had trouble understanding and pronouncing words like “charismatic” leader, wetlands “preservationist”, and “mortgage”. Usually the problem words appeared in a title or name of the cards, which do not affect game play. The card title simply helps give the card a connection to real life. A player can use a card as long as they can understand the card’s abilities. In addition, introducing them to new vocabulary such as “El Nino”, “preservationist”, and “EPA” is actually in line with the game’s goal to teach players about climate change.

6.2.7 Learning

We found that the game made players think about the trade-offs between growth and development and climate change. One player said, “The game is interesting and really shows the consequences of carbon. Also, it really presents the tradeoffs of different options.” Another mentioned that “[Cumulative scoring] teaches you how fragile the environment is.”

On the other hand, players, especially the children, did not seem aware of learning any specific facts or concepts. Many of the climate change facts incorporated in the game

appear in the flavor text. Unfortunately, as one child said, he “didn’t really focus on the [flavor] text” and from our observations, that seemed to hold true for most of the younger players.

“It is a very educational game but fun at the same time. So people don’t know they are learning but they are.” (Summary of 28 & 30-Jul-2008 Play Testing at FIRST Place - General Player Comments)

While very positive on some levels, the above quote also illustrates another problem we found – while players may be learning on some level, they are unaware of what they are learning. The teacher from the second week at FIRST Place remarked, “The younger crowd understands the actions enough to play / win the game, but not why the actions are taken. They are missing the big picture, so to speak.” (Teacher Observations from July 28-31 Play Testing)

The camp counselor from the same week had some insightful comments on the issue. He said he had played the game a few times but it wasn’t until he took the time to just look at all the cards and map out the connections that he realized how much everything related to the real world and that everything had a lesson. He noted that the kids, especially the 9 and 10 year olds, tend to get so caught up in the game that they cannot step back and look at the larger picture.

Following his suggestions, we decide to recommend to teachers to stop the children after a few rounds help them to make the connections between the cards they are playing and real life climate change issues. Or, as an alternative to stopping players in the middle of a game, educators might arrange pre- and post-game activities. Such activities might take the form of a quiz or test, which would be useful not just as an assessment tool but also to give players an idea of what they should be paying attention to while they are playing. Other possibilities for activities include reading assignments or class discussions, essentially anything that would provide students with a framework for the concepts, which they can then fill in as they are playing.

We found another obstacle to learning was when the game departs from too far from reality. Initially, we used “carbon footprint” or “CO₂” as shorthand for all effects on the climate. The children found this confusing. For instance, one child asked, “Why does the Geothermal Power Plant produce CO₂?” Others asked the same question for the Nuclear and Hydroelectric Power Plants. When we explained that CO₂ was a catchall, they suggested, “Maybe you should call it something different. Like ‘bad for the climate’.”

6.2.8 Other Findings

One thing we did not expect, during the first week of testing at FIRST Place, we realized we have a second target audience – the educators. As Cindy Randall pointed out to us in

discussion after she observed the play testing that Monday, the children seemed to pick up the game quickly because many of them are familiar with similar style games such as Pokémon and Yu-Gi-Oh. However, most of the educators will not have played these other games. If educators are not comfortable with the game and do not feel like they can explain it well enough to answer the children's questions, they will not use the game, even if the children enjoy it. This led us to expand on the Official Rules document, including more background information for educators and creating a second, one-page Rule-sheet to explain the game as simply and concisely as possible. The Rule-sheet is appropriate for any players, children or adults, looking for a quick how-to to get started playing the game. The Official Rules is more appropriate for educators preparing in advance to use the game in the classroom.

7 CONCLUSIONS

In this project, we have created a fun and educational multiplayer card game suitable for ages 9 and up. We play tested the game with over 40 children, teenagers, and adults and found that players consistently praise the game saying it is fun and entertaining. After playing the game once, almost everyone who participated in play testing wanted to play the game again. Several even expressed interest in purchasing the game if it is ever for sale.

As our sponsor specified in the requirements, our game lets players find their own balance between the environment, growth and industry, and social and political interests. The game does not proscribe a particular solution. It lets players find their own strategies and draw their own conclusions about how best to cope with climate change.

The game is also a useful educational tool containing an abundance of information about climate change. Some of the information is implicit in the relationships between the different factors in the game. For example, Coal Power Plants cause climate change, but they also produce enough Energy to support several Citizens. The Citizens need Energy, but they can adopt Policies that either increase or decrease climate change. The game also contains many explicit facts about climate change in the flavor text. For instance, the Smog Event teaches players that “Recent EPA studies show cleaning up air pollution would change a \$20 billion cost to \$23 billion in savings - a \$43 billion net improvement to society, mostly in lower health care costs and extended lifespans.”

Though we did not have any specific educational requirements in terms of particular terms or concepts that we wanted to teach the kids with this game, our goal was for players to learn something about climate change by playing. In play testing, we found that players often got so absorbed in playing the game that they did not stop to read the flavor text or to think about what they were learning. On one level, this means we succeeded in creating a game that is so fun and engaging that players forget that it is supposed to be “educational”. On the other hand, it means for students to really get the most out of the game, they need other materials and activities to reinforce what they are learning in the game and bring it to the forefront of their conscious attention. Once they take the time to attend to all the cards and form the connections, they are able to see the lessons the game presents. The other activities involved in the FIRST Lego League Challenge, which we designed this game to work with, should help reinforce the lessons in the game.

It is unclear how often our sponsors expect FIRST Lego League teams to play this game. As mentioned above (6.2.5), we found that by the third and fourth days of playing the game for 2 hours per day many of the children at FIRST Place were getting tired of or bored with the game. If our sponsors truly intended for the teams to play this game every day for a week or more, then they should have made that clear up front in the

requirements. When we designed the game, we assumed that this game would be something kids might play once or twice a week during the eight-week program. Played with that sort of frequency, we believe the game would continue to be fun and interesting.

Players enjoy replaying the game because the Role cards allow them to act out different sides of the issues surrounding climate change. Players can explore how their priorities and objectives change when they are playing as an Oil Tycoon in one session and Environmental Scientist or a Political leader in the next. The variety of Roles and objectives make the game fun to play over and over because, as one of our play testers put it, “It means there are new strategies and each time it is different to play. You can get the hang of one [Role] but next time you can switch and it’s new.”

One aspect of the game design that we are not entirely satisfied with is the amount of time it takes players to complete one round. This is especially problematic for the younger end of our target audience, the 9 and 10 year-olds. The younger children tend to have shorter attention spans and consequently, they sometimes become distracted or lose interest while waiting for all the other players to take their turns. The length of time it takes to play one round also means that players may not be able to play an entire game during a single 45 to 60 minute class period. We hope that by using the Quick Game variant of the rule or following our recommendation of having fewer players per game, educators will be able to adapt the game to work within a shorter time span.

In conclusion, though we have many more ideas we would like to explore to further refine the game given more time, in the five months we had, we have designed a successful card game. We have used our technical, artistic, and game design skills to present the complex, technical, and controversial subject of climate change from multiple points of view in a way that is accessible and enjoyable to 9 year-olds. The game looks and feels like a professional product and appeals to a wide range of players even in age groups well beyond our target audience. All in all, I am proud of my part in creating this game and of what we were able to accomplish.

REFERENCES

- About jME*. (2008, May 10). Retrieved August 19, 2008, from jMonkeyEngine.com: http://www.jmonkeyengine.com/wiki/doku.php?id=about_jme
- Adobe Systems Incorporated. (2008). *Adobe Flash CS3 Professional*. Retrieved August 25, 2008, from Adobe: <http://www.adobe.com/products/flash/>
- Garfield, R. (1993). *Magic the Gathering*. Wizards of the Coast.
- Hardin, G. (1968, December 13). Retrieved July 29, 2008, from <http://www.sciencemag.org/cgi/content/full/162/3859/1243>
- Hassey, P. (n.d.). *pygame - python game development*. Retrieved August 24, 2008, from [pygame.org](http://www.pygame.org/news.html): <http://www.pygame.org/news.html>
- Mattel, Inc. (2007). *UB Funkeys Official Site*. Retrieved March 2008, from UB Funkeys: <http://www.ubfunkeys.com/index.html>
- Sugimori, S. T. (1998). *Pokémon Trading Card Game*. USA: Wizards of the Coast.
- Takahashi, K. (2002). *Yu-Gi-Oh! Trading Card Game*. USA: Upper Deck Entertainment .
- Terathon Software LLC. (2008). *C4 Engine Overview*. Retrieved August 24, 2008, from Terathon Software: <http://www.terathon.com/c4engine/index.php>
- Teuber, K. (1996). *Settlers of Catan*. Germany: Catan GmbH / Catan LLC.
- US FIRST. (n.d.). *FIRST Lego League*. Retrieved April 4, 2008, from USFIRST.org: <http://www.usfirst.org/what/fl/default.aspx?id=390>
- US FIRST. (n.d.). *Gracious Professionalism*. Retrieved April 4, 2008, from USFIRST.org: <http://www.usfirst.org/who/content.aspx?id=36>
- US FIRST. (n.d.). *Who We Are*. Retrieved April 4, 2008, from USFIRST.org: <http://www.usfirst.org/who/default.aspx?id=34>
- Viacom International. (2008). Retrieved March 2008, from Nickelodeon: <http://www.nick.com/>
- Worcester Polytechnic Institute. (n.d.). *WPI - About - Profiles in Innovation*. Retrieved from WPI.edu: <http://www.wpi.edu/About/History/Profiles/pump.html>
- YoYo Games. (n.d.). *Game Maker 7*. Retrieved August 24, 2008, from YoYo Games: <http://www.yoyogames.com/gamemaker/>

Appendix A. RULE SHEET

Goal of the Game

The first person to meet one of the objectives on their Role card wins the game!

Game Setup

Place the Building, Citizen and Policy decks and Natural Resource tokens in the center of the play area. Make sure you have a location to track the Carbon Footprint level - a worksheet is included.

Each player then receives:

1. 1 Role card
2. 36 Resources (Four “6” tokens, Three “3” tokens, Three “1” tokens)
3. A hand of cards consisting of: 2 Building cards, 2 Citizen cards, 2 Policy Cards

How to Play

1. On each player’s turn:
 - a. Draw two cards. You may draw from the Building, Citizen, or Policy decks.
 - b. Activate Buildings – Buildings previously under construction are now operational.
 - c. Receive Energy and Natural Resources from your Citizens and Buildings.
 - d. Then you may do any of the following:
 - Spend Natural Resources to construct one or more Buildings. Buildings enter play “under construction” and produce nothing for one round.
 - Play one or more Citizens – be prepared to pay their upkeep at the end of your turn!
 - Put forth one Policy card for a vote. If there are 5 Policies already in play – choose one to replace!

If you wish you can also:

- Demolish one or more Buildings and receive half their cost back in resources.
 - Evict one or more Citizens.
- e. Spend the Energy and Resources needed to upkeep your Citizens and Buildings. If you don’t have enough Energy or Resources to pay your upkeep – you have to demolish Buildings or evict Citizens you cannot afford.
 - f. If you have seven or more cards left in your hand, discard down to six cards.

2. Global Event Turn (After all players have had their turn – we see what’s happened!)
 - a. Determine the new Global Climate Level using the scorecard.
 - add each player’s net Climate Impact,
Remember to subtract 1 Climate Impact point for each 6 unused Natural Resources each player has.
 - add any Climate Impact from Policies, and
 - add this round’s total to the previous cumulative Global Climate Level.

If an Event Level has been reached (every 10 Climate Points) turn over the next Event card.

- b. Receive Energy and Natural Resources from Policies.

Appendix B. TEACHER HANDBOOK

1. INTRODUCTION

This card game allows players to model the interactions between human beings, our built infrastructure, and the environment. The object of the game is to build and sustain a healthy population while avoiding catastrophic climate change.

Each player controls a region of the world. At the beginning of the game, each player will get a Role card, for example Political Leader, Environmental Scientist, or Real Estate Developer. The Role cards give each player three unique objectives. The first player to meet any ONE of their objectives wins the game.

As the leader of a region of the planet, players start the game with a pool of 36 Natural Resource tokens. Players can use their Natural Resources to play Building cards. Some examples of Building cards include power plants, farms, and bus terminals. The main purpose of Buildings is to produce Energy to support Citizens in your region.

Once a player has enough Energy, they can play various Citizen cards, including Scientists, Town Mayors, and Communal Farmers. Each different Citizen has its own ability such as producing more Natural Resources or more Energy. Each Citizen also has one or more votes. Players can use their Citizens to vote on Policies.

Policies are additional rules that have a range of effects on all the other parts of the game. For instance, there are Policies that affect the environment, Policies that cause Citizens to use less Energy, and Policies that limit the number or type of Buildings players can construct.

As players progress, they will begin having an impact on the climate. The Natural Resources that players start out with will lessen some of the climate impact. However, as players use up their Natural Resources to construct buildings, the Global Climate Level of the planet will start to rise. Every 10 points of increase in the Global Climate Level triggers a climate Event, such as a Hurricane or Wild Fires. Climate Events affect every player. Once an Event card comes into play, the only way to remove it is for players to work cooperatively to drop the Climate Level by passing cleaner Policies, replacing polluting Buildings with non-polluting ones, or conserving more Natural Resources.

2. GOAL OF THE GAME

Players win by achieving any of the objectives on their Role card. The first person to meet one or more of the objectives on their Role card wins the game. If two or more players meet their objectives at the same time, the player with more Citizens wins.

The game can also end if the global climate level goes above 100. This represents catastrophic damage to the environment. The game ends, and there is no winner.

3. GAME SETUP

This game is for 3 to 6 players.

The game includes:

- five sets of cards - brown Role cards, red Event cards, purple Building cards, blue Citizen cards, and green Policy cards
- Natural Resource tokens in denominations of 1, 3, and 6,
- a climate counter, and
- a scorecard.

To begin, distribute 36 Natural Resources to each player in the form of four 6 tokens, three 3 tokens, and three 1 tokens.

Keep the rest of the tokens in the center within reach of all players, or one player can optionally act as the “bank” and assign tokens as necessary.

Let each player select a Role card. It is up to the players whether they want to look at the Roles before choosing one or just pull a random card.

Separate and shuffle the remaining four decks of cards: Buildings, Citizens, Policies and Events. Place the Event deck in the red “bulb” of the Climate thermometer and the other three decks in the center of the play area. Leave an area near each deck for a discard pile.

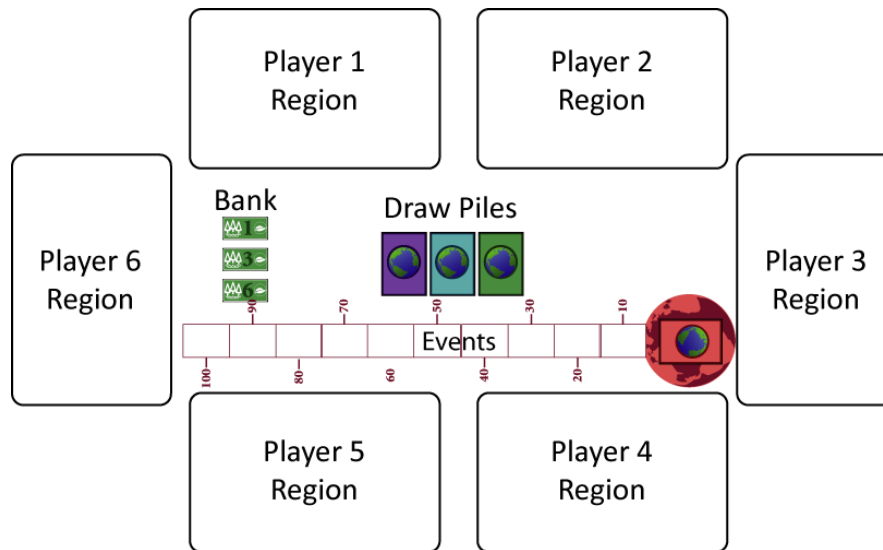


Figure 11 Play Area

Have each player draw two cards each from the Building, Citizen and Policy decks for their hand. Players should keep cards in their hand private and not show them to others.

To determine who goes first, each player adds up the total number of votes needed of the Policies in their hand. The one with the highest total goes first. In the event of a tie, the player with the higher Energy output from their Buildings in their hand goes first.

4. HOW TO PLAY

After setting up the game, the players take turns. Play passes to the left.

On their turn, players will:

- g. Draw two cards. Player may draw from the Building, Citizen, or Policy decks.
- h. Activate Buildings. Buildings previously under construction are now operational.
- i. Receive Energy and Natural Resources from your Citizens and Buildings.
- j. Then the player may do any of the following:
 - Spend Natural Resources to construct one or more Buildings. Buildings enter play “under construction” and produce nothing for one round.
 - Play one or more Citizens. Player must pay upkeep for Citizens at the end of their turn.
 - Put forth ONE Policy card for a vote. If there are five Policies already in play, the player selects which one they want to replace.

Optionally, the player may also:

- Demolish one or more Buildings and receive half their cost back in resources.
 - Evict one or more Citizens.
- k. Spend the Energy and Resources needed to upkeep the Citizens and Buildings in their region. If the player does not have enough Energy or Resources to pay upkeep, they must demolish the Buildings or evict the Citizens they cannot afford.
 - l. Discard down to six cards if the player has more seven or more cards in their hand.

At the end of a round, after each player has had a turn, the players evaluate the global climate. During this global phase:

- d. Players determine the new Global Climate Level, using the scorecard to
 - add each player's net Climate Impact remembering to subtract 1 Climate Impact point for each 6 unused Natural Resources each player possesses, and
 - add any Climate Impact from Policies, and
 - add this round's total to the previous cumulative Global Climate Level.
- e. If the Global Climate Level has crossed an Event threshold (every 10 Climate points), turn over the next Event card.
- f. Receive Energy and Natural Resources from Policies.

After the global phase, the next round starts and players continue to take turns around the table.

5. QUICK GAME VARIATION

If you have only an hour or less to play this game, use this variation.

Do not use the Role cards.

The goal of the game is to be the first player who can upkeep 10 Citizens in their region.

Follow all the other rules as in a normal game.

6. RECOMMENDATIONS

If there are only 3 players, we recommend that

- One player choose an Eco-Friendly role (Environmental Scientist, Celebrity Eco-Activist, Green Architect, or Marine Biologist),
- One player choose an Industrial role (Oil Industry Tycoon, Utility Company CEO, Real Estate Developer, or Retail Store Mogul), and
- One player choose a Political Role (Political Leader, Congressman, Goodwill Ambassador, or Humanitarian).

If this game is being used as an educational tool, we recommend that the educator prepare a pre- or post-game activity or both to give students a framework for the concepts the game introduces and to help them solidify what they have learned. We have observed that sometimes players become so absorbed in playing the game, they miss the larger picture of the climate change issues the game addresses. Pre- or post-game activities should include questions or discussions designed to get students to think about why the actions they are taking in the game matter in the real world.

For younger players and/or players with short attention spans, we recommend either using the Quick Game Variation or having only 3 or 4 players in a single game. The smaller number of players means that each player has less “downtime” where they are waiting for the others to take their turns.

If players are having trouble keeping their cards organized on the table, we recommend creating or having the players create play mats that provide designated spots for the different types of cards. For instance, a play mat might be a sheet of paper with a grid of card-sized (2.5”x3.5”) rectangles. By placing everything within this grid, players should be able to keep better track of their cards.

7. FREQUENTLY ASKED QUESTIONS

When I draw two cards, do they have to be from the same deck?

No. Players can draw two cards from two different decks or two cards from the same deck.

When do Events come in to play?

Every time the climate level reaches a new multiple of ten, a new Event card comes in to play. For example, if the climate level goes from 0 to 16 in one round, players should turn over one Event card and place it in the “10” slot. If the climate level goes up to 20 on the next round, players should turn over a second Event card and place it in the “20” slot.

When do Events go away?

When the climate level drops below the number under the Event card on the climate thermometer, that Event card is shuffled back into the deck. For example, if the climate level drops from 46 to 39, players should remove the Event card in the “40” slot.

Do I have to do everything on my Role card to win?

No. You only have to meet one of the three objectives on your Role to win.

If a Policy passes and is later removed, does it still count towards my objective?

Yes, as long as the Policy passed once it counts.

Who votes on a Policy?

When a player puts down a Policy card all the players must use all of their Citizens to vote on it. Players can turn their Citizen cards clockwise to indicate a “Yes” vote (so the symbol on the right of the card shows is “thumbs up”), and turns counter-clockwise for a “No” vote (“thumbs down”).

Is there an order to who votes first?

Yes. Policy votes happen in two stages. First, going around the table starting with the player who proposed the policy, any players who have a Charismatic Leader, Lobbyist, or Rabble Rouser Citizen card should indicate which Citizens they want to affect for this vote. Players do not say which way they are voting at this stage. Once the Charismatic Leaders, Lobbyists, and Rabble Rousers all have assigned targets,

going around the table again, each player declares whether his or her Citizens are voting yes or no.

What if there are enough “yes” votes to meet a Policy’s Min.

Cost, but there are more “no” votes?

The Policy does not pass. A Policy must receive at least the minimum number of votes AND the number of “yes” votes must be equal to or greater than the number of “no” votes.

Can players vote out a Policy?

Yes. Instead of proposing a new Policy, on their turn any player can request a revote on an existing Policy. The rules for the revote are the same as for voting on a new Policy. If the Policy does not have the minimum number of “yes” votes or if the “yes” votes do not outnumber the “no”s, the Policy is removed from play.

Also, there can only be 5 Policies in play at any one time. If a player wishes to vote in a Policy and there are already 5 policies in play, the player proposing the new Policy must also indicate which of the current Policies they want to replace. Players then have to vote on the new Policy as usual. If the Policy passes, it replaces the Policy indicated. If the new Policy does not pass, it is discarded and the old Policies remain in play.

Can there be two copies of the same Policy in play at once?

No, each Policy in play must be unique.

If a Policy has a Climate Impact, do we add that number to each player?

No. When Policies have a Climate Impact, players should add or subtract that number once per round from the global total, not from each player’s subtotal.

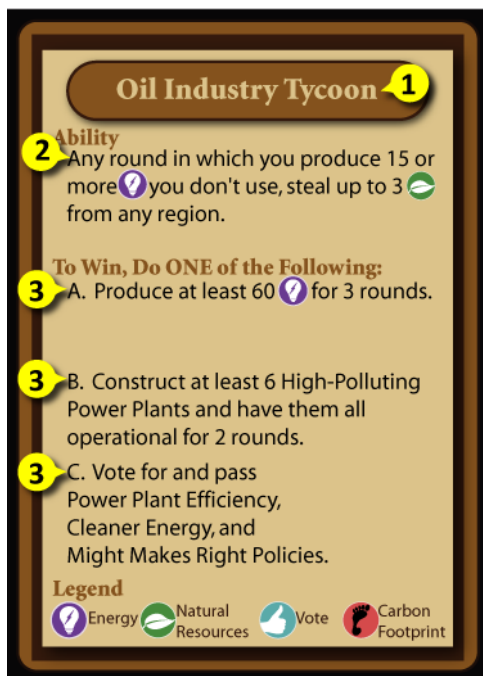
8. ABOUT THE CARDS

Role Cards

There are twelve different Roles in the game, grouped into three major types – Eco-Friendly, Industrial, and Political – corresponding to the three main facets of the game – people, infrastructure, and the environment.

Each Role grants the player a special ability to complement the Role’s goals.

Each Role card lists three objectives. Players must meet ONE of their Role’s objectives to win.



1. Name: the Role’s name
2. Bonus: each Role grants the player an additional, unique ability
3. Objectives: these are the conditions the player must meet in order to win the game. Only one of the objectives has to be met.

Building Cards

Building cards represent the infrastructure in a player's region. All Buildings cost Natural Resources to play. Buildings enter play "under construction"; they are not operational until they have been in play for one full round. Once operational, many Buildings require an upkeep cost of Energy or Natural Resources to keep the Buildings in play.

There are three main categories of Building cards: Production Plants, Infrastructure, and Power Plants. Production Plant cards produce Natural Resources. Infrastructure cards represent public facilities such as public transportation or colleges. Power Plant cards produce Energy.



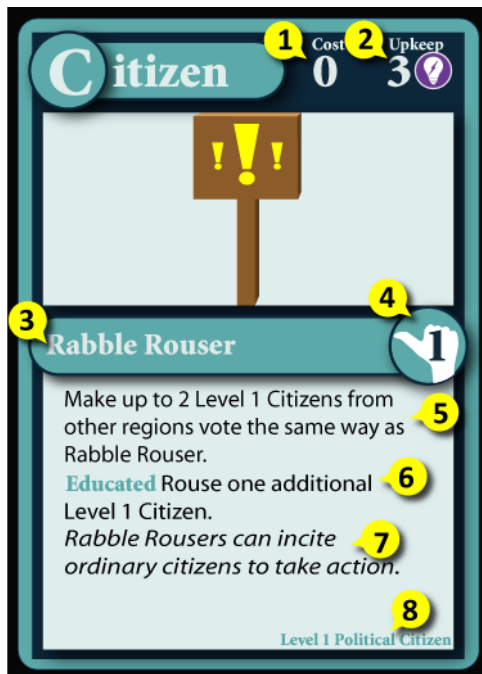
1. Cost : the amount of Energy or Natural Resources needed to play the card
2. Upkeep: the amount of Energy or Natural Resources needed each round to keep the Building in play.
3. Name: the card's name
4. CO₂ Output: the amount of CO₂ the Building produces each round
5. Ability: the ability of the card
6. Flavor Text: additional information about the Building. This has no bearing on the game itself.
7. Category: Buildings are categorized in 3 ways - Power Plants, Production Plants and Infrastructure. Additionally, Power Plants are categorized in 3 ways: Non-polluting, Low-polluting, and High-polluting.

Citizen Cards

Citizen cards represent the people who live and work in the player's region. Players can use their Citizens to vote on Policies.

Each Citizen card has an ability, some benefit players receive from having the Citizen in their region.

There are three main categories of Citizen cards: Eco-Friendly, Industrial, and Political. Eco-Friendly Citizens have abilities related to Natural Resources. The abilities of Industrial Citizens affect Energy and Buildings. Political Citizens' abilities deal with Votes.



9. Cost: the amount of Energy or Natural needed to play the Citizen.
10. Upkeep: the amount of Energy needed each round to keep the Citizen in play.
11. Name: the card's name
12. Vote Count: the amount of votes this Citizen has in each election
13. Ability: the ability of the card
14. Educated Ability: if this Citizen is Educated, this ability is used in addition to its natural ability
15. Flavor Text: additional information about the Citizen. This has no bearing on the game itself
16. Category: Citizens are categorized in 3 ways: Level 0, Level 1 and Level 2 Citizens. The higher the type, the more Energy the Citizen costs, but they have a greater influence on the region.

Policy Cards

Policy cards usually adjust a key point of the game balance.

All Policies affect all players equally.

There are three categories of Policies: Eco-Friendly, Industrial, and Political. Policies in each category are advantageous to players in the corresponding Roles (Eco-Friendly Policies are helpful to Eco-Friendly Roles) but may be neutral or disadvantageous to the other types of Roles.



8. Cost in Votes: the amount of votes needed to pass the Policy in an election
9. Name: the card's name
10. CO₂ Output: the CO₂ effect on the environment, if any
11. Ability: the ability of the card
12. Flavor Text: additional information about the Policy. This has no bearing on the game itself.
13. Category: Policies are categorized in 3 ways: Environmental, Economic, and Social.

Event Cards

Event cards represent the natural disasters and other events that can occur as the result of dramatic climate changes. Each Event has deleterious effects on the players, costing them resources or cards or limiting their progress. As the climate change grows higher and higher, players must contend with the negative effects of several Events at once, making it harder and harder for them to achieve their objectives.



4. Name: the card's name
5. Effect: the ability of the Event that happened when it comes into play. This may be some combination of an instant and an ongoing effect.
6. Flavor Text: additional information about the Event. This has no bearing on the game itself.

GLOSSARY

Building: a type of card.

Citizen: a type of card.

Climate Impact: represents the pollution, greenhouse gases, waste heat, etc. produced by Buildings and Policies

demolish: discard a Building card.

Educated: when a Citizen is educated, it gains an additional ability. Citizens are educated using the College Building card.

Energy: a type of resource.

Event: a type of card.

evict: discard a Citizen card.

Infrastructure: a category of Buildings.

lead: when a Citizen has been declared the target of the Charismatic Leader's ability, and must vote the same way as the Charismatic Leader.

Natural Resource: a type of resource.

operational: when the abilities of a Building card can be used. Operational Buildings also affect the climate.

Policy: a type of card.

Power Plant: a category of Building that produces Energy.

Production Plant: a category of Building that produces Natural Resources.

region: the area in front of a player that they control, where they play their cards.

Role: a type of card.

roused: when a Citizen has been declared the target of the Rabble Rouser's ability, and must vote the same way as the Rabble Rouser.

tap: rotate a card 90° to indicate it cannot or already has been used.

under construction: when a Building card is first played and its abilities cannot be used until the beginning of the player's next turn.

untap: rotate a card to its normal vertical position.

unused Natural Resources: Natural Resources that players must keep and not use for construction or other purposes.

Appendix C.PLAY TESTING NOTES

SUMMARY OF 12-JUN-2008 PLAY TESTING

Summary of the game

Rules used

- Players start with 36 Materials and 2 Building, 2 Citizen and 2 Policy cards.
- Player with the highest vote requirement on the policies in their hand starts.
- Players can play unlimited Buildings and Citizens but only one Policy per turn.
- A new Event is triggered every ten points of CO2.
- Citizens can vote once per turn.

Roles

Karin = Energy Tycoon, TJ = Philanthropist, Tim = Real Estate Developer

CO2 per round

1. 38
2. 57
3. 67
4. 51
5. 35

Winner

None. Karin was completely out of materials and buildings and effectively out of the game by the 5th round. TJ had one building that was not producing anything due to Hurricane. Tim made some progress towards his Role Objectives (passed a few policies, constructed a few buildings).

Overall Observations

We're still doing too much math and it is still too complicated to figure out how much Energy, CO2 and Materials we have.

Discussion Points

Triggering Events

We still haven't decided exactly how Event thresholds should work – whether an Event should be triggered each time a threshold is passed or only the first time and whether the same Event should be retriggered when a threshold is passed more than once or if it should be a different, random Event.

Land slots vs. Materials vs. Buildings that generate materials

In response to the fact that it still seems like we're doing too much math, we discussed the possible ways of eliminating the need for the Materials tokens and keeping track of those numbers. TJ brought up his previous suggestion of having Buildings that cost nothing to play but which can then be "tapped" for materials the same way our other Buildings are currently tapped for Energy. This idea was rejected because it would reintroduce several other problems – particularly the fact that there could potentially be several rounds during which the players cannot do anything until they draw one of these Materials producing Buildings and have enough Materials to construct Energy producing Buildings and then, finally are able to play Citizen cards and start *doing something*.

As an alternative, Karin suggested getting rid of the Materials tokens and instead having "land slots". At the beginning of the game there would be some number (we suggest 4 to 6) slots per player. Instead of costing materials, buildings would take up one or more slots, essentially using/taking up/engaging those resources. Policies that currently give or take materials per round could be rewritten to give or take a land slot. Since this would be a one-time effect and we might even be able to give some sort of visual indicators for the slots, this would reduce the math considerably though we would still have to worry about Energy and CO2.

We also discussed the possibility of having the land slots be a communal resource rather than having designated land for each player. This introduces a bit of extra competition and interaction between the players and also corresponds to real life where, really, we are all building from the same limited resource pool of the planet.

We were generally in favor of trying out the land slots idea in future play testing session.

Decisions Made

Citizens go away at the end of a players turn if the player does not have enough energy to support them.

Card Fixes/Clarifications/Corrections

- All cards need to indicate the type and/or level of the card. Card fronts need to be redesigned to include this information.
- Rabble Rouser – fix hyphenation
- Engineer Wood – replace "Materials", "Energy" and "CO2" with the symbols. Specify "each round".
- Event cards – the "Effect" and "Solution" labels are missing
- Drought – specify if the player can't pay the materials penalty, they must demolish buildings to pay.
- Erosion – specify the effect is "per round"
- All cards should have a common spot for the CO2 effect of that card to make the number easier to find when adding the CO2 during the global events phase.

- Elected Representative – on first glance, the illustration looks like a video game, like Space Invaders
- Level 1 Citizen cards need to say what their Level 2 abilities are if the Citizen is educated.

SUMMARY OF 15-JUN-2008 PLAY TESTING

Summary of the 1st game

Rules used

- Players start with 36 Materials and 2 Building, 2 Citizen and 2 Policy cards.
- Player with the highest vote requirement on the policies in their hand starts.
- On the first round, players can play only one Building. Thereafter, unlimited Buildings and Citizens but only one Policy per turn.
- A new Event is triggered every ten points of CO2.
- Citizens can vote once per turn.

Roles

Karin = Conservationist, Tim = Energy Tycoon, John = Real Estate Developer

CO2 per round

1. 10	9. 11
2. 18	10. 12
3. 32	11. -18
4. 31	12. -47
5. 17	13. -74
6. 9	14. -107
7. 9	15. -130
8. 9	

Winner

Tim (Energy Tycoon) produced over 50 energy for 3 rounds to win.

Observations

It took a rather long time for anyone to win, even though we did not trigger a lot of events.

Karin lost one of her buildings to a Hurricane early on and also had to demolish a building to pay the material cost for some policy and she never really recovered from the set-back.

Our negative CO2 for several rounds was mainly due to the Public Transportation card – it is too powerful.

Karin had a whole lot of cards in her hand that she could not play – the materials, energy, and vote costs were too high after she lost so many materials in the first few rounds. Tim and John on the other hand had very few cards in their hands and seemed to be limited in what they could do by the fact that they could only draw one card a turn.

For UI considerations, both Tim and John had around 15 cards in play in their region by the end of the game.

Summary of the 2nd game

Rules Used

- Players start with 36 Materials and 2 Building, 2 Citizen and 2 Policy cards.
- Player with the highest vote requirement on the policies in their hand starts.
- Every 3 Materials counts as -1 CO2.
- Buildings produce no CO2 while under construction.
- Players can play unlimited Buildings and Citizens but only one Policy per turn.
- A new Event is triggered every ten points of CO2.
- Citizens can vote once per turn.

Roles

Karin = Philanthropist, Tim = Politician, John = Environmental Activist

CO2 per round

1. -17
2. -17
3. -19
4. -12
5. 0
6. 6
7. 2

Winner

We stopped after about 1 hour and 15-20 minutes. We did not take note of the winner, but I think John won by passing 5 or more policies that reduce CO2.

Observations

The mechanic of having every 3 Materials absorb 1 CO2 and having buildings which are under construction not produce CO2 seemed to work. We had a few rounds to build up our regions before worrying about triggering Events. This worked better than simply limiting the number of buildings players can put out the first few rounds. We might have made the negative CO2 effect a little too strong. **For next time, we recommend trying either -1 CO2 per 6 Materials or that buildings under construction do produce CO2.**

Discussion Points

When do Citizens abilities take effect?

We debated whether or not Citizens abilities (for example, giving additional Materials or Energy) happen as soon as the Citizen has been played or at the end of the round or on the

player's next turn. In particular, we did not think players who do not have enough Energy to play a Citizen should be able to play a Scientist or Power Plant Engineer because those cards would give the player enough Energy to support the Scientist or Engineer once they are out. We didn't come to a firm decision, but we suggested that Citizens can vote when they first come out but cannot use their other abilities until the next round.

When are the Materials generated by Policies or Citizens distributed?

In the past, I think we've played that Materials are distributed during the Global Events Phase, but that has never been written down/decided. On the one hand, it's probably easier to keep track of if Materials are always distributed during Global Events. On the other hand, there is already a lot of stuff that happens during the Global Events.

Drawing two cards per turn instead of one

Both games seemed a little too slow. Even discounting all the time we spent discussing things, progress seemed limited, mainly because we could only draw one card per turn. So, if we did not have any Buildings or Citizens in our hand (which definitely happened for all of us) we could only draw one Building or one Citizen and that was all we could play during our turn. The game could go more quickly if we allowed players to draw two cards per turn.

Play one Policy during each Global Events Phase

We discussed the fact that if a player draws a policy that does not fit their role, then they may just keep that policy in their hand the entire game and the policy never gets voted on. We discussed a few different ways of getting around this. 1) We could make a rule that when players draw a policy, they have to play it and put it up for a vote. 2) We could combine this with the idea of drawing two cards and say player can draw one Building or Citizen and choose to play it or not, then they draw one Policy and must play it. 3) Alternatively, players could draw one Building or Citizen and then choose to draw one Building, Citizen or Policy for their second card and if they draw a Policy, they must play it. We thought 3) might put too much pressure to choose on the player though. 4) We can keep drawing and playing cards the same as it is now, but, during the Global Events Phase draw one Policy that is immediately voted on. We liked option 4) because it does not change the game play much, but it allows a chance for some policies to get voted in which might not otherwise have seen the light of day. We tried playing a few rounds with 4) and it seemed to work fine.

Voting recursion/chaining

We realized that with the Rabble Rousers and Charismatic Leaders there is potential for recursive and/or chained voting. We need to make sure we clarify the text and the rules for these cards to avoid that.

Interaction Cycle

We diagrammed how the different cards and resources in the game interact with each other. Currently, the

- average Material cost per Building = 6
- average Energy production per Building = 9
- average Energy cost per Citizen = 9

Starting with 36 Materials = 6 Buildings = 54 Energy = 6 Citizens = averages roughly 7 or 8 votes.

Most of the interaction between the cards and resources is a purely one-way stream – spend Materials for Buildings which produce Energy for Citizens which vote on Policies. The Citizens and Policies have some effects that circle around and interact with Energy and Materials, but Materials and Buildings do not affect Citizens and Policies.

Materials absorbing CO2

Thinking about the interaction cycle above, and the Roles (Economic Roles concerned with Buildings & Energy, Political Roles concerned with Citizens & Votes, and Environmental Roles concerned with Materials & CO2) and about the problem that we run into where players build up CO2 very fast in the first few rounds when there are no mitigating policies in place yet, we came up with the idea of Materials absorbing CO2. This makes the Conservationist Role, whose goal is to have lots of available Materials in a region, much more meaningful and balanced with the other roles. It adds symmetry between Materials, Buildings, and Citizens. And, it makes Materials seem less of a nuisance and more like an integral part of the game. During our second game we actually tested out this mechanic and it seemed to work fairly well.

Role Modifiers

Because all players are basically dealing with the same equation for adding Buildings and Citizens to their region, but the different roles are trying to maximize different parts of that equation, each Role should give the player one or two modifiers that help them achieve their objectives. For instance, all the Citizens in the Environmental Activists region might cost 1 or 2 less Energy. Other examples might be that Politicians get 1 extra vote per Citizen in their region, and Buildings cost 1 or 2 less Materials for the Real Estate Developer.

Adding more Citizen cards

Citizen cards are seen quite often each game. There will be on average 5-8 Citizens per player out on the table by the end of a game. In contrast, there may only be 6-10 Policies total on the board and there may be only a handful of Events. For interest and replayability, more variety in the Citizen cards is a good idea.

Citizens who cost Materials instead of Energy

Perhaps some Citizens who can use Materials for upkeep instead of energy (you don't pay the Materials, just set them aside/tap them for the Citizen). Suggestions might be Forest Ranger, Farmer, Hippie. The idea is that these people are living off the land not the power grid.

Board game version

Definitely not for this round of development, but we talked about how this game might be adapted to sort of a board game style, similar to Settlers, with different types of land. Certain buildings could only be built on certain types of land. Buildings require different amounts of space/land. Instead of Buildings producing energy, they just say how many citizens they can support.

Balancing Issues

The effect of the Public Transportation Policy is too strong. Try -1 CO2 and -1 Energy per Citizen.

It would be nice to have a few more Policies with lower vote requirements so Policies can be played earlier in the game. In particular, Green/Environmental policies should generally cost fewer votes because players in the Green roles will tend to have less energy and therefore fewer Citizens.

Have fewer of the Non-Polluting Buildings in the deck than the High-Polluting buildings because the cost/benefit ratio is much better on the Non-Polluting Buildings.

Decisions Made

For policies that have some sort of cost and/or instant effect like “spend 6 materials”, the cost/effect happens as soon as the policy is voted in.

The Rabble Rouser should only be allowed to control the votes of apathetic citizens (i.e. ones who are not voting on the current policy). The Charismatic Leader on the other hand can force any Citizens, even those who were already voting another way to vote the way the Leader wants. The Charismatic Leader can only do this to 2 Citizens, not 4.

When a Building is demolished, either through player choice or because of an Event (e.g. Hurricane), the player gets back ½ the material cost of the building. The Salvage Construction Policy allows players to get back the full material cost.

When cards give benefits per Building (e.g. Scientist), Buildings which are under construction do not count.

Card Fixes/Clarifications/Corrections

- Hurricane – clarify that the instant effect of destroying a building happens only once. Clarify if players can choose a different building each round or not (suggest not).
- Low Intensity Farming – update to new card design.
- Policy Cards - # of votes cut off on some cards.
- Scientist – clarify under construction Buildings do not count.
- Hydroelectric – change name to “Hydroelectric Power Plant”.

- Nuclear Power Plant – in the size the cards are actually printed, the radiation sign is too small to be recognizable. John thought it was a little man waving his arms.
- Conservationist Role – has the Philanthropist text
- Cleaner Energy – change “Type 1” to “High-Polluting”.
- Carbon-Tax – as written, this policy would probably never be passed. Rewrite so it is more balanced.
- When appropriate, some Policies might specify that they can only be passed by a unanimous vote.

SUMMARY OF 16-JUN-2008 PLAY TESTING

Summary of the game

This game was played with several of Karin's friends who are in the 24-35 age range. They are all technically inclined people (2 programmers, an ECE, a vet tech, and a WPI undergrad).

Rules used

- Players start with 36 Materials and 2 Building, 2 Citizen and 2 Policy cards.
- Every 6 Materials in a region = -1 CO2
- Buildings do not produce CO2 while under construction.
- Players can play unlimited Buildings and Citizens but only one Policy per turn.
- A new Event is triggered every ten points of CO2.
- Citizens voting 'For' are counted first, then Citizens voting 'Against'.
- On their turn, instead of playing a new policy, players can put an existing policy up for a new vote to try to get it voted down. To be voted out, there must be at least as many 'Against' votes as the vote count on the Policy, and the 'Against' must be a majority.
- When buildings are demolished, either by the player's choice or because of an Event or Policy, players get back half the Material cost of the Building.

Roles

All six Roles were played

CO2 per round

1. -19
2. 2
3. 30

Winner

None, we only played 3 rounds.

Overall Observations

Most of the players played their two starting building cards and drew additional building cards and played them as well the first two turns.

In a 6 person game, the last couple people in the round seem to be at a disadvantage the first few rounds because they have not had a turn to put out Citizens yet and cannot vote on the first few policies that players earlier in the round propose. The last player in the round complained of "taxation without representation".

The 6 Materials = -1 CO2 and buildings under construction do not produce CO2 seemed to be a good level for letting players do a couple rounds of building up their region before having to deal with Events.

It took over an hour to get 6 players through 3 rounds. There was of course a lot of time spent explaining the game to the new players and went faster once they started to get the hang of it, but still, it is not a fast game.

The colors of the cards looked good and helped a lot to visually keep track of how many Citizens vs. Buildings were out on the table.

Comments from players

There's a lot to keep track of. It would be good if you could have a little digital device to scan all the cards and count everything up for you. -R

It's not so much that adding everything up is hard. It's hard because the rules keep changing, the way things count keeps changing. -C

The game is interesting and really shows the consequences of carbon. Also, it really presents the tradeoffs of different options. -C

It may be easier for kids who are used to playing games like Pokémon and Flux to play this game than it was for the Gen Xers in this session. -C

Discussion Points

It seems we may need to change the threshold level for Events depending on the number of players. In the third round, only one player was doing a lot of CO₂ – he had +9 CO₂ – but combined with the other players doing small amounts, it was enough to raise the global CO₂ from 2 to 30 in one round.

Balancing Issues

Several of the policies, for example Water Management still don't have any downside.

The Power Plant Engineer could be a little more powerful – perhaps +3 Energy instead of just +1 Energy.

To support the Real Estate Developer role, there should be some policies which decrease building costs.

Decisions Made

To avoid recursion in the voting, we decided that the Charismatic Leader and Rabble Rouser can only affect Citizens which have not been led or roused already. Therefore, if a Charismatic Leader tries to lead a Rabble Rouser who was rousing 2 other Citizens, the Charismatic Leader can change the Rouser's vote but not the other 2 Citizens.

Card Fixes/Clarifications/Corrections

- Political Activist and Rabble Rouser need to be updated to new Citizen front with the vote icon.
- Biofuel – the Energy icon is covering part of the +12.
- Citizen cards – flip the vote icon so that to vote ‘For’ something the player turns the card clockwise. It’s just a more natural movement.
- Drought – this Event came up after the Water Management Policy had already been played, making the solution moot. Need to rewrite the solution to be less specific.

SUMMARY OF 26-JUN-2008 PLAY TESTING

Summary of the 1st game

This game was played with high school students visiting WPI for the entrepreneur summer camp and Gina, the camp organizer.

Rules used

- Players start with 36 Materials and 2 Building, 2 Citizen and 2 Policy cards.
- Every 6 Materials in a region = -1 CO2
- Buildings do not produce CO2 while under construction.
- Players can play unlimited Buildings and Citizens but only one Policy per turn.
- Players draw 1 card on their turn.
- No Policy during the Global Events phase.

Cards

- Included Infrastructure Buildings (3 types of schools, Public Transportation, and Walkable Neighborhoods).
- Included Production Plant Buildings
- 3 of each type of Power Plant
- 3 of each type of Citizen

Roles

All six Roles were played

Winner

None, we only played 3 rounds.

Overall Observations

Two of the kids (Aaron & Aqeel), who seemed to be used to playing lots of games including card games seemed to enjoy the game and be very interested in it. They asked a lot of questions and seemed to grasp the general game play very quickly.

The other two kids (Greg & ????) seemed less interested in the game and perhaps a bit confused. This could just be because we didn't explain the game very well and they only got to play 3 rounds, which isn't really enough time to get the hang of how everything works. On the other hand, these two kids did not come back the next day to play some more whereas Aaron and Aqeel did.

Gina was very enthusiastic about the game. She is a big fan of card games and liked the concept a lot. However, she did not understand the game very well from the limited amount of time she got to play it.

There were far too many school Building cards in the deck.

Comments from players

“The game seems very intricate.”

“Who is your target age group?” [middle-schoolers] “You might want to aim a little older. . . There is a lot of strategy involved in playing the game. It’s like Mastermind – it takes minutes to learn but a lifetime to master. I’m not sure [middle-schoolers] would figure out the strategy.”

Suggestions from players

If a player does not draw any Power Plants to start, allow a mulligan.

The Public Transportation card should be called “Bus Terminal” or something that is actually a building.

Gina suggested having a legend or something passed out to each player which explains what each icon stands for and whether it is good or bad.

Summary of the 2nd game

Tim and Karin played

Rules used

- Players start with 36 Materials and 2 Building, 2 Citizen and 2 Policy cards.
- Every 6 Materials in a region = -1 CO2
- Buildings do not produce CO2 while under construction.
- Players can play unlimited Buildings and Citizens but only one Policy per turn.
- **Players draw 2 cards on their turn.**
- 1 Policy played during the Global Events phase.

Cards

- 2 each of Infrastructure Buildings (College, Public Transportation, and Walkable Neighborhoods).
- 2 each of Production Plant Buildings (Farm, Timber Mill, Recycling Factory)
- More High Polluting Power Plants than Low Polluting Plants
- 2 each Level 2 Citizens, 4 each Level 1 Citizens, 6 Level 0 Citizens

Roles

Tim = Energy Tycoon, Karin = Politician

CO2 per round

- | | |
|-------|-------|
| 1. -9 | 3. -6 |
| 2. -8 | 4. 8 |

5. 24 (El Nino, Ice Caps)	8. 35
6. 30	9. 33
7. 34	10. 29

Winner

Tim won by passing policies.

Overall Observations

Playing 10 rounds with just two players who know how to play the game took about 1.5 hours.

Drawing two cards each turn seemed to work well. It did not speed the game up too much but it made us feel less restricted in our options of what we could play/do.

Having fewer policies that give +/- to each Power Plant or Citizen or each region's CO₂ seems to help make the calculations easier, but we could still stand to simplify the calculations even more.

Being able to Educate your Citizens was a fun addition. Though we had the Education Policy card in the past, since there was only 1 of those cards in the deck, it rarely came up (actually never came up in our play testing). With school Buildings, Educating Citizens becomes an actual part of the game play and adds another strategic decision – educate your citizens or save your limited Materials to use for something else?

The 12 denomination of the Materials tokens seems unnecessary. After the initial distribution of Materials at the beginning of the game, the 12s are almost never used.

Summary of the 3rd game

Tim and Karin played with 3 of the entrepreneur camp kids, two of whom had played a few rounds the day before.

Rules used

- Players start with 36 Materials and 2 Building, 2 Citizen and 2 Policy cards.
- Every 6 Materials in a region = -1 CO₂
- Buildings do not produce CO₂ while under construction.
- Players can play unlimited Buildings and Citizens but only one Policy per turn.
- **Players draw 2 cards on their turn.**
- 1 Policy played during the Global Events phase.

Cards

- 2 each of Infrastructure Buildings (College, Public Transportation, and Walkable Neighborhoods).
- 2 each of Production Plant Buildings (Farm, Timber Mill, Recycling Factory)
- More High Polluting Power Plants than Low Polluting Plants
- 2 each Level 2 Citizens, 4 each Level 1 Citizens, 6 Level 0 Citizens

Roles

Tim = Conservationist, Karin = Political Leader, Alex = Real Estate Developer, Aqeel = Philanthropist, Aaron = Environmental Activist

CO₂ per round

1. -19
2. -10
3. -7
4. 7
5. 29

Winner

None, the kids had to go to dinner before we finished.

Overall Observations

5 rounds with five players, four of whom had played before took about 1 hour.

The game does seem to be fun. The kids seemed to enjoy the game and get very absorbed in it. They wanted to keep playing even when they were supposed to go out to dinner. A friend of the kids came over and watched for at least 15 minutes and also seemed very interested in the game. The kids were interested in obtaining a copy of the game to play later.

The kids really wanted to see the Events punish the player who was producing the most CO₂. They noticed that 2 of the 5 players were producing a disproportionate amount of the CO₂ and they wanted to do something to and/or have something bad happen to the polluters.

They all seemed to dislike the Displaced Populations event card.

Players forgot about their role bonus a few times. We might need to do something to make this either more apparent or make the bonuses easier to apply.

Player Suggestions

On the Role cards, where it lists the policies you need to pass to win, it should indicate the type (Social, Economic, Environmental) of the policies.

Player Comments

“It’s strange that the Hydroelectric Power Plant produces CO₂. But, it’s ok, things are adjusted for the game.”

“Can you email this game to us when it is done?” All three of the kids seemed very interested in getting a copy of the game (either cards or computer version) when it is complete. They were willing to buy it in stores or whatever.

“I think this game will be very popular. People will buy it. Parents should buy it [to teach] their kids.”

Discussion Points

The way we have been playing, we have made players who are voting for a policy vote first, and then those voting against get to vote. However, this doesn't take into account the Rabble Rousers who act only on Citizens who are not otherwise voting. While it does happen that sometimes players are apathetic about a particular policy and don't feel a strong need to vote either for or against it, they may choose to vote simply to prevent the Rabble Rouser from affecting their Citizens. Also, we discussed whether or not there are ever any times when a player does not spend all his or her available votes on a policy. If not, perhaps just to simplify things (especially the interface for voting in the computer game) we should make a rule that players choose if they are for or against a policy and then all their votes go which ever direction they chose.

What are our distribution rights? When the kids started asking us about getting a copy of the game when it is done, we realized that we don't know whether or not we are allowed to distribute the game ourselves or if FIRST or the Department of Homeland Security will own the game completely.

Balancing Issues

In the first game, we had three different types of schools – High School, College, Grad School – one each for educating the three different levels of Citizens. Since there had to be several of each card in the deck (3 each in this case), this resulted in too many school cards. Players were drawing the schools too often when they needed Power Plants. Also, requiring a certain type of school to educate a certain type of citizen lowered the likelihood that players would actually be able to use their school cards. So, we eliminated the High School and Grad School cards and made the Colleges work on any Citizen.

Though the cards have come up in most of the last several games, none of the Grassroots Policies have ever been passed. When players draw them, they don't even usually put them up for a vote. We need to rewrite these policies to make them more useful/attractive to at least some of the players. Alternatively, we could get rid of these cards as separate policies and incorporate their effects as a downside to some of the policies that seem to have no negatives.

There is no reason to play the Scientist Citizen card. The maximum benefit you can get from playing it just cancels out the cost of the card.

Decisions Made

Since there are usually no Citizens in play at the end of the first round, we decided to make it a rule not to play a Policy during the Global Events phase until the second round.

With the addition of the school cards, we discussed whether players should be allowed to educate any citizen or only those in their own region. Since there does not seem to be any significant downside to allowing players to educate citizens in other regions and it seems to add more interesting strategic options, we decided to allow players to educate citizens in other regions. Practically, this option probably won't be used much, but if players want to make agreements between themselves ("I'll educate your Citizen if you vote for my policy") they can.

The "Draw 2 cards per turn" should be an official rule.

Cards cannot have a negative cost. We made this decision to clarify what happens when a Role or Policy reduces the Energy cost of Buildings or Citizens. This was not an issue in the past because all Buildings and Citizens had positive Energy costs. Now however, there are some Citizens and Buildings which do not cost Energy. Rather than add text to every card where this was an issue and/or add sub-types to the Buildings and Citizens, we decided that the easiest thing to do would be to make a blanket rule that cards cannot have a negative cost. The lowest cost possible is 0.

Card Fixes/Clarifications/Corrections

- The icons are a little too small to be easily "read" on the printed cards. Try taking the icon out of the blue background circles and making the icon larger.
- Try to do the CO₂ numbers on the Buildings and Policies in a style similar to the number superimposed on the "thumbs up" voting icon on the Citizen cards.

Role Cards

- Could have a small legend at the bottom of each Role card explaining what the Energy, Material and CO₂ icons mean.
- Political Leader – "Influence 6 Citizens"
- Real Estate Developer – replace "Sustainable Infrastructure" with "Infrastructure".
- Energy Tycoon – add "Policies" to the end of 3rd objective.

Citizen Cards

- Adjust the numbers on the Scientist to make it worth playing.
- Educated Citizen abilities – be consistent that all "Educated" abilities are in addition to base abilities.
- **Illustrations** for the Forest Ranger and Farmer have little bits of solid background behind the silhouettes.
- **Illustration** for the Political Activist – the fist needs to be clearer – outlined or more contrast between fingers and palm. As is, it's hard to tell what it is a picture of.

Policy Cards

- Policies – some say "spend M now" others just say "spend M", make the text consistent.
- Salvage Construction – "Real Estate Policy" should be "Economic Policy".
- Freeze Emissions – needs to state a penalty if players go over the limit.
- Apathy for Sale – Economic or Social Policy?

- Building Sanctions – Economic or Social Policy? Also, clarify “building type”.
- Low Intensity Farming – needs CO2 icon.
- Carbon Tax – needs CO2 icon.

Event Cards

- Frequent Floods – needs CO2 icon.
- Smog – replace “Sustainable Infrastructure” with “Infrastructure”.
- Displaced Populations – remove “Each round”. Maybe rewrite entirely.
- Ice Caps Event has the old card design.
- Loss of Biodiversity – add “policies” to solution text.

Building Cards

- Bus Terminals & Walkable Neighborhoods – replace “Sustainable Infrastructure” with “Infrastructure”.
- Gober Gas Plant – fix typo “odorless”.

SUMMARY OF 14-JUL-2008 PLAY TESTING AT FIRST PLACE

Summary of Games

Players

We had 16 kids between the ages of 10-14 and two camp counselors. We divided the kids into three groups based on age so we could make sure the younger kids understand the game as well as the older kids.

Age 10-11 – 5 kids (4 boys and 1 girl) + 1 Counselor (Tim)

Age 12 – 5 kids (4 boys and 1 girl) + 1 Counselor (Anna)

Age 13-14 – 6 boys

Rules used

- Official Rules_080714.
- Natural Resources received for demolishing buildings gets rounded up.
- [Age 10-11 and Age 12 game] Citizens cost is paid once instead of as an upkeep cost. (They interpreted the rules this way because we did not explain well enough.)
- [Age 13-14 game] 1st player looks at all Role cards and selects which one he wants to be, then 2nd player gets to choose and so on. (They suggested this rule after the first game and implemented it in the second game.)

Cards

- Charismatic Leaders and Rabble Rousers were accidentally omitted from the deck.
- 2 copies of each Policy

CO₂ per round

Age 10-11

1. -20 2. 1 3. 4 4. 16

Age 12

(Unfortunately I didn't get the final numbers from this group, but much like the 10-11 Age group, they kept their CO₂ levels very low through the game.)

Age 13-14

1st game:

1. -26

2nd game:

1. -15

Winner

Age 10-11

Game was ended before there was a clear winner. Players had an average 6-7 cards of both Buildings and Citizens in their region.

Age 12

Real Estate Developer won by having 9 Buildings in his region.

Age 13-14

1st game: Environmental Activist won in 2 rounds by reaching the “-10 CO2 in your region” objective. He drew both the Walkable Neighborhoods and Bus Terminal.

2nd game: Ended before there was a winner.

Overall Observations

The kids seemed to enjoy the game quite a bit. They played for over an hour without taking a break and were excited and interested in playing more.

The math aspect did not seem to bother them at all. They had no trouble adding up all the numbers and did not seem to get impatient or confused with it. However, the adults - Cindy Randall and Michelle, the teacher – seemed to have a hard time following the game. We discussed this with Cindy afterward and decided that unlike the kids, most of the educators won't have experience playing this style of card game and therefore, we need to make sure we provide adequate materials for the educators so they do not feel lost or silly in front of the kids.

Because Tim and I (Karin) were the only developers available to monitor the play testing, we had to divide our time between the three groups. The Age 12 group ended up getting the least of our attention and they were the most confused and least excited about the game. This may indicate that we need to make sure the instructions are better written and/or that the rules are a little simpler because we will not be able to explain the game in person once it goes live.

The one main area of confusion seemed to be about the inconsistency in the cost of cards, specifically that some cards have a one-time cost while others have an ongoing cost. The Age 12 group which we did not monitor as closely was under the impression that Citizens had a one-time cost the same as Power Plants and. Some of the most frequent questions I had to answer in the Age 13-14 group were related to cost. There seemed to be confusion over when cards cost Natural Resources to build versus when they required you to conserve (rather than pay) Natural Resources (for example the Forest Ranger and Farmer cards).

Another issue that presented a bit of a stumbling block to the kids was when the game departs from direct correlations to the real world. For example, see the comments below about Geothermal Power Plants producing CO₂. We may want to adjust the CO₂ numbers for some of the Buildings and/or rename the “carbon footprint” to something more generic like “environmental impact”. Several of the kids also wanted to some sort of “money” in the game in addition to Natural Resources. They seem to understand that things cost money and they wanted some way of representing that and wanted to be able to do things like buy another player’s Natural Resources or Buildings. It may be too late to add money into the game at this stage, but it’s something to keep in mind for the future.

Player Comments

Age 13-14

“It’s kind of like the European Union. All the countries are so close together and affect each other.”

“You should add in money too [in addition to Natural Resources].”

“Can we trade cards?” [Note: They spontaneously started trading cards in the second game. They just decided they really wanted to do it and made deals with each other. The trading worked rather well in conjunction with them choosing their Role cards. Once they had selected their Role and drawn their first hand, they traded Buildings to better match their Roles.]

“Can we buy a Power Plant from someone else after it has been developed?”

“Why does the Geothermal Power Plant produce CO₂?” The same question was asked for the Nuclear and Hydroelectric Power Plants. Each time I explained that we are using CO₂ as a catch all measure of any kind of effect on the climate. “Maybe you should call it something different. Like ‘bad for the climate’.”

“You should have more Citizens. Like maybe a Scuba Diver or Marine biologist and they could have water-based abilities.”

Discussion Points

Is the game fun?

Yes. Lots of kids asked if they could buy the game.

“The cards look pretty.”

Which features of the game did you like the best?

Voting on policies; liked that everyone had to vote.

The least?

Didn't like the Policy that limited how much CO2 you could produce [Freeze Emissions] because it meant you could only build 0 CO2 Buildings.

The directions were vague. [This comment was from the Age 12 group which we didn't get to monitor as closely.]

Was gathering resources (Natural Resources, Energy) too difficult? Too easy?

If you pay a lot of Natural Resources at the beginning it's hard.

There should be more cards that give you Natural Resources.

A war card could let you take someone's resources or region.

[Some players in the Age 10-11 group wanted to give/trade their Natural Resources to other players]

Was playing cards (Citizens, Policies) too difficult? Too easy?

Didn't like that with some Policies you had to spend Natural Resources. Policies should only be about votes not Resources. [Though they didn't say it explicitly, it sounded a little like they were complaining about how everyone has to pay Resources if a Policy is passed even if they didn't vote for it.]

There weren't enough votes to pass policies.

Was meeting your goals (Roles, generic win conditions) too difficult? Too easy?

Too easy. [This was from the Age 13-14 group that had the Environmental Activist who was lucky enough to draw the Walkable Neighborhoods and Bus Terminal allowing him to win in just 2 rounds.]

As the Philanthropist, it was hard to meet the objective for educating Citizens if you didn't have a college.

Would like more Role cards.

Were too many Event cards too much to handle at once?

The Age 10-11 group never got to an Event. They played very cautiously.

Was your play strategy disrupted too much by other players? Did one player dominate? Was one player not able to do much of anything? Do you think each role had an equal chance of winning?

The Politician controlled the policies [in the Age 13-14 group].

Did you learn anything about climate change?

I didn't really focus on the [flavor] text.

"I learned algae absorb CO₂."

If you could name this game, what would you call it?

- CO2 Control
- SimCountry
- Global Warming Game
- Nations
- Drop the CO2
- Divided We Play
- Leaf
- Game of Many Nations
- Try not to die of pollution

Balancing Issues

Might want to have more low vote cost policies so policies can be passed in the first few rounds.

Natural Resource levels might need tweaking – either adjust Building costs downward, or increase the number of cards that produce Natural Resources.

We decided to include 2 copies of each Policy in the deck this time to make it easier to achieve the policy passing objectives. However, having 2 copies of each of the Policy meant that one group (Age 10-11) had 2 copies of Algae and 2 copies of Low Intensity Farming in play at once, making it easy for them to avoid triggering any events. If we are going to include multiple copies of the Policies in the deck, we may either need to impose a limit on the total number of Policies that can be in play at one time (something we've discussed before) or make a rule that only one copy of a given Policy can be in play. A third alternative might be to impose a limit on how many of each type of Policy can be in play (i.e. only 2 Environmental Policies at one time). Or specific high-powered cards, such as Algae, might have additional restrictions in the text of the card.

Decisions Made

When buildings are demolished, the player gets half *rounded up the nearest whole number* of the Natural Resource cost of the building back.

Card & Instruction Fixes/Clarifications/Corrections

- We need some sort of gauge or counter for keeping track of CO2
- It would be good to have more Citizen cards.

- It would be good to have more Role cards.

TEACHER OBSERVATIONS FROM JULY 15-18 PLAY TESTING

By Michele Brezovec

Comments from Tuesday, July 15, 2008

These are from the kids. Spent the first 40 minutes making new Citizen Cards

Age Group 9- 11.5

- Money should go to person who put up the college and not to the bank
- Real Estate Developer – Objective is too easy, maybe add Carbon Footprint can't be more than 10 or maybe have the buildings for two rounds
- Another brown card says 10 power plants and two rounds
- Have a Citizen Card that can be a Rouser and have more than one vote
- Want a digital reminder – sliding scale to keep track of energy, one per person
- Brown Card: too many options, confused with policies vs. votes

Today this group had a winner in the third round, played everything needed to win by the second round. (40 minutes)

Age Group 12

- Citizen Card: “Educated” – maybe say, “when educated” because the kids thought they were ALREADY educated
- College: does it apply to other regions? We played it that way and paid the leader to educate citizens of other regions
- Make it easier to have an event
- On the CO2 thermometer, put some kind of symbol so we know when to pull an event card
- Game moved slow
- “NEEDS to be a computer game
- 4 out of 6 enjoyed the game today
- For Role Cards: especially, “Philanthropist”, “Conversationalist” include job description so we know what these people do in real life
- Events: group liked all events except: Erosion, Displaced Population, Drought and Loss of Bio
- What does log symbol on erosion event card mean?
- Building Timber Mill: why does it generate +3? A timber mill destroys forest
- Real Estate Developer – Objective – “construct 8 buildings” – too easy
- Need more brown cards (equally easy or hard)
- Freeze Emission: can't build anything zero or lower – (maybe – freeze but can still build zero or lower) -- (trade carbon credit for ability to keep building for profit)
- How much is needed to have an event? Didn't have an event.

This group ended the game in round four or five in about an hour.

Age Group 13

- Contradictory cards
- Energy Tycoon: too hard to win (60 per round) Bonus – improve should be by +3 instead of +1
- Kids thought that when voting, if the card said 9 to pass that they just needed 9 even if 17 may have voted negatively. (Discussion was held here for about 20 minutes between the kids)
- Make a Marine Biologist as a Brown Card
- Pay others so your citizens can get educated
- Don't like that someone can change a vote
- Other citizen cards to think about having: vet, doctor, zookeeper and videogame programmer
- Make it harder to have –energy consumption
- Why does geothermal make pollution?
- Nuclear – pollution is 3, it doesn't increase carbon level, nuclear waste is the problem
- Many players wanted CO2 to increase
- Make own citizen each game (one for each player?)
- Ganging up to bring carbon up to sabotage someone from winning
- Make deal to use another person's college?

This group had someone win the game in the third round in about 70 minutes. They also had some heated arguments over the above issues. They didn't get mad and one camper said it was nice having those discussions.

Comments from Wednesday, July 16, 2008

The campers were mixed up today and not playing the game in age groups.

- Older students had traded cards in the game, so when they were mixed into the other two groups it was a different game for them. Are they allowed to trade cards.
- Should players know who everyone is and how they can win or should it be blind? After playing for awhile students will know all of the brown cards and will be able to figure it out eventually, should there be more brown cards created.
- Not sure what the Event card that is Erosion is all about.
- One camper who is 10 did not understand the meaning of the Citizen Rabble Rouser that stated: Select up to two citizens who are not voting and make them vote the same way as Rabble Rousers.
- Some of the students are just playing all of their cards at the first chance they get.
- Create new cards: "Invasion Cards" – the ability to steal
- Assassin cards: Once every three turns, kill any citizen in any region
- Should there be a higher scale for keeping track of events? One team went above the 95 and they decided that everyone died.
- First two days were fun playing and now they are starting to say they are bored.
- It's more fun to end the world apparently.
- Farm = +3, do you get the resources

- With one group of students, the attention of the members started to wonder when it wasn't their turn.
- Two students who got the Political leader card today were confused about the objectives. One was 12 and the other ten.
- One group had two events and another had nine events.
- Winners today were: Real Estate Agents (25 minutes), Environmental Activist (15 minutes), Energy Tycoon (30 minutes), Real Estate Developer (one hour), Environmental Activist (20 minutes), one group all got wiped out.

Comments from Thursday, July 17, 2008

Campers in age level groups.

- Global Phase – arguments and math mistakes
- Today a few students just wanted to end the game, they got off track easily, started to say that the game was boring, but others loved it
- Voting: the option not to vote was not made clear
- Event: El Nino (Kids didn't know what that was)
- Like having to pay for Citizens each turn: reflects reality and slows game
- Confusion on number of policies a player can present per turn
- Many players refuse to believe that someone else won

Winners today:

Philanthropist

Environmental Activist

Political Activist won in two rounds

SUMMARY OF 28 & 30-JUL-2008 PLAY TESTING AT FIRST PLACE

Summary of Games

Players

We had fourteen kids (two girls, twelve boys) aged 9-14 play test the game at FIRST Place. They moved around and played in different groups throughout the week.

Rules used

- The kids used the Quick Rules_080728 supplemented by the Official Rules_080729.
- Limited to 5 Policies in play at one time.

Cards

- Included 12 role cards: Marine Biologist, Green Architect, Celebrity Eco-Activist, Environmental Scientist, Oil Industry Tycoon, Utility Company CEO
- 1 copy of each Policy except 2 each of Reforestation, Population Boom, Construction Boom, and Salvage Construction

Overall Observations

Fun

Once again, the kids seemed to really enjoy the game and think it was fun. On Monday they were all very intent on learning the game and it was a little hard to tear them away at the end to ask them questions.

Short Attention Spans

However, when we returned on Wednesday, it was clear that some of the kids, especially about 8 of the 9-11 year-old boys didn't have the attention span for a full game. Many of them were getting up from the table and wandering off or playing with things (their water bottles, the Natural Resource tokens, etc.). They had a hard time sitting still for the hour it took them to play through one whole game. In fact, though six boys started playing one game, by the time it got to the end only 3 of them were still paying attention and taking their turns. One boy let another play for him. Another was technically still playing but was more interested in telling stories and jokes and would go through his turn so quickly he would forget to even draw cards.

Yet, when I asked all of the boys after the game was over if it was fun, they all still said yes. So, they seem to enjoy it they just can't keep their attention on the game while waiting for 5 other kids to take their turns.

The camp counselor, Zack, played a smaller game with three of the youngest kids (two 9 year olds and one 10 year old) who had been having trouble learning the game. In the smaller group, the younger kids seemed to do much better. One of the 9 year-olds quit the game after about half an hour, but the other two kept playing. Even after Zack won the game, the other two kids

continued to play for the rest of the afternoon trying to see who would come in second. They were very intent on the game and seemed to enjoy themselves a great deal.

The older kids, 11-14, stayed focused and played quietly the entire afternoon.

Need for a Quick Game

So, overall, I think we need to recommend that when playing with younger kids, make the groups smaller - four at the most – and, if we can develop a quick version of the game that can be played in 30 minutes, that would also work better for the younger kids. Perhaps one way the quick game could work would be to leave out the role cards and perhaps don't let Natural Resources absorb CO₂. We could make the goal of the quick game simply being the first to get to 10 Buildings or 10 Citizens. If getting to 10 takes too long, we can lower that number.

Player Interaction

The new Citizen cards we added this time around seemed to afford enough interaction between the players to satisfy the kids. Last time we play tested at FIRST we had a lot of comments from the kids that they would like to see Soldier cards that could steal another player's Natural Resources or an Invasion card that would let them take over another player's region, etc. This time we got only one comment that there should be even more such cards. But for the most part, the kids seemed satisfied with the current level of interaction.

Global Policy Rule

I'm not sure about the group of older kids, but when I observed the other two groups on Wednesday, I noticed they were not playing a Policy during the Global Phase. Perhaps it was just too much to remember; perhaps we didn't explain it well enough on Monday. I'm not sure. Whatever the reason, we might want to revisit this rule. I still think it's a good idea to have something that gets policies out in play that would otherwise just sit in a player's hand, but maybe we need to come up with something different than playing a policy during the Global Phase.

Maybe we could make the rule that you cannot ever have more than 2 Policies in your hand at any time. If you have more, you have to discard them to the bottom of the Policy deck. Actually, we could make that rule for Buildings and Citizens too as it would keep the number of cards in your hand from getting too big. Large numbers of cards in one's hand might be causing problems for the younger kids (see Physical Layout below.)

Score cards

This time around, we provided the kids with score cards to keep track of the CO₂. The score cards we provided on Monday only had one line per round – just enough to keep track of the total, cumulative CO₂ each round. I noticed on Monday and again on Wednesday though that when they did use the score cards, they also tried to write down a lot of additional numbers – each player's CO₂, the total for the round, and then finally the cumulative CO₂. Writing everything down let them do the addition on paper instead of in their head. Even the teacher was

writing down all these extra numbers. Also, on Wednesday we noticed that the kids would often forget to take Policies into account when calculating the total CO₂. So, after Wednesday, I provided them with a different score card (see below) to help them keep track of everything. Jen, the teacher, said the new score cards were a big hit on Thursday.

		Global Carbon Level
Round 1	Player 1	
	Player 2	
	Player 3	
	Player 4	
	Player 5	
	Player 6	
	Policies	
	Round Total	

Observations from Camp Counselor (Zack)

Win with 10 Citizens rule

The rule allowing anyone to win by getting up to 10 Citizens in their region is not in the Quick Rules. I explained we were thinking of getting rid of that rule, but Zack thought we should keep it, just raise the number from 10 to 15 or so. He mentioned that one of the campers (Simon, age 11) had had over 23 cards in his region and was gaining so many Natural Resources per round that the bank was running out, yet he could not meet his role (Oil Tycoon?) objectives for several more rounds. I'm not sure if we should continue to keep the rule allowing anyone to win with X Citizens, or if we just need to adjust the role objectives so they are more obtainable, but one way or another, we should look into it.

One other option to consider might be to use X Citizens wins rule only with the quick version of the game. Perhaps in the quick version we might leave out Roles entirely and just have the single, generic win condition.

Break to absorb lessons from the game

Zack strongly recommended that we advise teachers to stop the kids after they have played a few rounds of the game and help the kids to make the connections between the cards they are playing and real life climate change issues. He said he had played the game a few times but it wasn't until he took the time to just look at all the cards and map out the connections that he realized how much everything related to the real world and that everything had a lesson. He noted that the kids, especially the 9 and 10 year olds, tend to get so caught up in the game that they can't step back and look at the larger picture. Having a teacher coach them through how what they are

doing in the game relates to the real world would increase the educational value of the game. I suggest we add this as an instruction/recommendation to teachers in the long version of the rules.

Physical Game Layout

In terms of the physical layout of the game on the table, Zack made several observations. First, the Climate Thermometer is too long and takes up too much space. The kids end up putting it off to one side and forgetting to take into account the Events that are in play. Zack suggested turning the Event cards sideways along the thermometer, which reduces the overall length by at least 10 inches. Zack also suggested putting the numbers inside the boxes for the cards. Doing so would allow us to cut off the white space around the thermometer saving even more space on the table. I made both changes and sent the revised thermometer to the teacher for the last day of play testing.

Zack also observed that the kids keep forgetting about their Roles because after selecting them at the beginning of the game, the kids just put the Roles off to one side to make room for their Buildings and Citizens. I suggested that perhaps we can make the Role cards much larger – around 5”x7” – which would allow us to increase the text size so they would be readable even if the kids push them off to one side of the play area.

The younger kids had a hard time keeping their cards organized. For Wednesday, Zack actually drew out a mat with designated spaces for Natural Resources, Role card, Buildings, and Citizens for the three youngest kids. He said that seemed to help them keep track of everything. Even for the slightly older kids (10-11 years old), I noticed that they tended to keep their cards face up on the table instead of in their hand. This might be because they have relatively small hands and it is difficult for them to hold 6+ cards spread out in one hand, or maybe it was just because that was how we showed them to play the first game on Monday so we could help them. Whatever the reason, having the cards in their hand down on the table sometimes made it difficult to tell which cards had already been played and which were still in their hand. So, perhaps we want to include an optional play mat and recommend that teachers use it with the younger kids.

Math

The math is difficult for the younger kids. In particular, Zack mentioned that it seems difficult for the younger kids to keep track of how much Energy they have since there is nothing tangible to count. He suggested providing the kids with dice and letting them turn the dice to represent how much Energy they have left.

Jen also mentioned that the younger kids are not yet comfortable with integer math (adding negative numbers). She is a math teacher and said that kids often don't use negative numbers much until the 6th grade. The main place the negative numbers comes into play is at the beginning of the game when the Natural Resources can make the global CO2 level negative. One quick fix might be to just say the CO2 level cannot go below 0. This might even make a lot of sense from a game balance perspective because one of the things we've noticed is that the

more players you have, the more Natural Resources are out absorbing CO₂, so it's actually harder to trigger Events early in the game with 6 players than with 3.

General Player Comments

“It is a very educational game but fun at the same time. So people don't know they are learning but they are.” Seriously, one boy said this word for word. Go Us!

“Make it harder for the environmental [roles] to win.” I believe this was referring to the objective a couple of the roles have of having their region produce -10 CO₂.

“I think you should make it more for everyone. For six year olds and up.”

“Make the turns a little faster. Maybe on the computer game you could have a time limit like 1 minute per turn.”

“Trading cards should always be allowed.” Talking about letting players trade the cards in their hands to other players.

“For the Policies, instead of carbon, maybe they could have some punishment. We kept forgetting to add the carbon from the Policies.”

One boy mentioned that the titles/names of the cards don't always seem to match the description and the pictures. He said it seems like sometimes the picture matches the description better and sometimes it matches the name better. He would like it if they all went together.

Comments about the demo of the computer version

The kids had lots of suggestions about what they would like to see in the computer version, which mainly boiled down to a lot of animations.

“Instead of showing a Building card, show the actual Building.”

“Maybe while a Building is under construction, actually show it being built.”

“You could have animations for when the Events happen, like a hurricane.”

“Play music for dramatic effect.”

“For the Event with the mosquito and the rat [Epidemic], you could maybe show a person getting swarmed by mosquitoes and rats.”

“Show people walking around.”

Discussion Points Monday

Is the game fun?

“Yes” chorused every kid in the room.

Which features of the game did you like the best?

One camper (Simon, 11) who had participated in the previous round of play testing liked that there were more cards to pick from (I believe he was referring to Role cards).

“I like that it relates to the real world.”

“The whole thing.”

“I like the different roles with different goals. It means there are new strategies and each time it is different to play. You can get the hang of one [Role] but next time you can switch and it’s new.”

The least?

There didn’t seem to be much the kids didn’t like, at least on the first day.

Was gathering resources (Natural Resources, Energy) too difficult? Too easy?

“You should start out with more resources, maybe 10 more.”

One kid suggested we add a Cement Plant card to give more resources. That might be more understandable to the kids than the Engineered Wood Plant.

“It should stay as it is.” From Simon who had played for a week last round. He said that the only players who ran out of resources were those who didn’t play smart and build a Farm or something.

Was meeting your goals (Roles, generic win conditions) too difficult? Too easy?

“Kinda hard”

“Voting for specific policies was hard.”

“Having 6 High-Polluting Power Plants [for the Oil Industry Tycoon Role] takes a lot of resources.”

“You should make it 10 Buildings instead of 8 for the Real Estate Developer [to win]”.

Was your play strategy disrupted too much by other players? Did one player dominate? Was one player not able to do much of anything? Do you think each role had an equal chance of winning?

Three of the four players in Tim’s group ganged up on the fourth and kept him from doing much of anything. He could not defend himself from their attacks. They used multiple Emissions Inspectors to drop one of his Power Plants to effectively 0 Energy.

Did you learn anything about climate change?

If you could name this game, what would you call it?

- Planet Earth
- Climate/Pollution Control
- Resources to the Rescue

Discussion Points Wednesday

Is winning too easy, too difficult, or just right?

“10 Citizens is a little too easy to win. 15 would be better.”

Do you think Events happen too often, not often enough, or just enough?

Is there anything about the game that is confusing or unclear?

“It was confusing to learn at the beginning, but now it’s pretty fun.”

Is there anything in the written [Quick] rules that is confusing or unclear?

“You should include that you can win by getting 10 Citizens.”

Is there anything you would like added to the game?

“More of the [Political] Citizens with more than one vote in the deck.”

“There are not enough High-Polluting Power Plants in the deck.”

“More Infrastructure Buildings in the deck.”

“More votes for Citizens.”

“Even more cards that let you mess with other players.”

“Cards that can only be used when the carbon is at a certain level.” The boy suggested a “fire fighter that puts out the forest fires.” I assume he was referring to the Wild Fires Event.

“Maybe you could have a Cop or Police officer. And like how upkeep is like rent, maybe when the Cop is out you would have to pay double rent.”

Is there anything you would like us to take out of the game?

“Not really.”

If we took out Colleges and educating Citizens, would that be good? Or would that make the game less fun?

There were nods and they seemed to think it would be a good thing.

“If you keep education, make it cost more.”

“You can’t tell when Citizens are educated.”

What have you learned about climate change?

“A lot of carbon footprint can raise the temperature.”

“I learned more about what causes global warming.”

“[The game] teaches a lot about business.”

“[Cumulative scoring] teaches you how fragile the environment is.”

Wording Issues

Jen (the teacher) and the older kids seemed to think that the names of some of the Citizen cards were a problem for the younger kids. While I agree the younger kids probably don’t know what some of the words mean, interestingly none of them mentioned it as a problem.

“Town Mayor” could become “Governor”

“Mortgage Loan Officer” => “Banker” or “Bank Officer”

Jen has additional suggestions on names and wording in her notes which she has promised to type up and send to us.

Balancing Issues

Role objectives maybe need to be a little easier to accomplish in fewer rounds/less time. We definitely need to look through all the roles and make sure each one can win in a similar amount of time.

We need to look at exactly how many of each type of card should be in the deck, particularly with respect to making sure there are enough cards of the types needed to meet various role objectives. For example, Real Estate Developer needs 5 Infrastructure Buildings to win and there may only be 6 in the deck.

We may have made it a little too easy to get Natural Resources now. We should look at the numbers on the Production Plants and the Citizens that give Natural Resources.

Make Events come out a little sooner – with 6 players, it’s a lot of Natural Resources soaking up CO2. Again, just making it so that the global CO2 cannot go below 0 might fix this.

Card & Instruction Fixes/Clarifications/Corrections

Try adjusting all the numbers to multiples of 5 instead of multiples of 3.

Citizens

- Get rid of “educated” abilities.
- Miner/Engineer/Scientist – make it clear you don’t get the + Energy on the first round they are out and/or give them an Energy cost. The intention is that you must produce X Energy before you can play them.
- Gardener/Farmer/Forest Ranger – give them some minor energy upkeep – 1 Energy? So players still have to build at least one Power Plant.
- Emissions Inspector – make it clear that you cannot use multiple Inspectors to affect the same Building.

Policies

- Population Boom & Construction Boom – clarify whether player who proposed Policy gets to draw another card or if the effect starts with the next player.
- Carbon Tax – when is tax paid? When policy comes into play or at the end of the round? It could be a different player depending on timing.

Roles

- Real Estate Developer Ability – how long does other player have to keep the Building you put in their region?
- Real Estate Developer – for the “Construct X Buildings” objective, clarify whether Buildings that have been demolished count or not. Probably they should not count.
- Real Estate Developer – make the first objective “Construct 10 Buildings” instead of 8 Buildings.
- Oil Tycoon – change from 6 to 5 High Polluting Power Plants for 2 rounds, maybe even less.

Rules

- Clarify/Specify/Emphasize each player can only play 1 policy on their turn. Or should we change the rule?
- Explain when Events are solved in the Quick Rules.

PrintCardSheets

- Eliminate the white space between the columns of cards, so we only need 1 cut instead of 2
- Make tokens a different shape – 2” square? – bigger, easier to handle, less like dollar bills.

TEACHER OBSERVATIONS FROM JULY 28-31 PLAY TESTING

By Jen ???

What was observed as the most difficult part of the game was the scoring – adding scores (especially later in the game) gets difficult, not helped by attention span, bigger #'s, etc. The biggest issue for the younger kids (age 9 – 11) was the integer addition!! Kids aren't normally exposed to integer addition until middle school. 9 – 11 is a tough age range to be adding things like -27 & 13... they don't (won't) understand integer rules for addition/subtraction for years (I still have 8th graders that don't grasp the concept). There needs to be an easier way for them to keep score. Some kids seemed to dread the scoring part (sometimes skipping it all together!) as it was too confusing for them. If they don't score correctly (or at all), they wouldn't ever get to the "event" portion of the game!

Questions and comments (from the kids) that came up:

Algae policy – is 6 carbon dioxide deduction per person or overall for the entire group?

Need a way to indicate (or some playing marker / piece) to show when citizens have been educated.

Events – duration of some is unclear. Ex – hurricane & flooding cards: when does the event end? Does it return? (get below the threshold then again cross it... does the event reactivate or is it finished?) Do events coincide?

Common agreement that some tasks are too easy for everyone (which isn't necessarily a bad thing!) BUT the descriptions can be too difficult for some players because of their respective reading levels. Words and overall concepts over some heads.

Revisit the age limit? Some words very difficult to pronounce (even for the older kids) and younger kids can't grasp some concepts of definitions (nothing tangible / in their lives to make some real connection).

Some better word choices? Ex. Troubled words: "charismatic" leader, "preservationist" (pronouncing & understanding!), "mortgage" (no one really knew what the word meant or how it worked). Unpopular names / roles / characters: Retail Store mogul, EPA lobbyist (didn't understand EPA or lobbyist!), corporate raider (least favorite as most kids don't want to be the bad guy and the role made it sound like a business was literally attacking to injure). Maybe have a sheet explaining "exotic" citizens? The Political Activists or Elected Representatives – any other powers other than their votes?

One player wanted to make note of a "serious imbalance" – He had 26 cards played on the field and still couldn't meet his role card's winning obligations. He needed too many policies to be passed but the cards he needed either wouldn't come up or couldn't get passed. Policy cards are

not played as often (or are avoided pretty much all together) and need a group vote whereas no one (usually) needs permission for building requirements or citizens. Disadvantage to roles requiring passed policies to those without that requirement. Makes it much more difficult for some roles to win, so those roles may be passed over for those with “easier” requirements. For required policies, maybe get 2 out of 3?

Time to play the game? Younger kids lose interest very quickly. By the end of the week, most of them didn’t want to play at all (bored with it!). Too much downtime between rounds. Game could go on for hours and their attention spans just don’t last that long. Some players requested a time limit or some kind of timer.

When asked Wednesday afternoon about the game, I noticed that one boy in particular, had lots of “positive” feedback. This boy played on the first day (Monday) and refused to play on the other days, yet he said he loved it (after telling me Tuesday how bored he was...). Some of the younger kids were giving misleading feedback... pretty much telling the adults what they were hoping to hear. (they know how to play that game pretty well, too!) I listened pretty intently as he described just how useful the game was and how much her was learning, without knowing he was learning. It would have been much more believable had he played every afternoon, but this boy had only played for a short time on Monday, giving up early out of “boredom”.

The younger crowd understands the actions enough to play / win the game, but not why the actions are taken. They are missing the big picture, so to speak. The game could be about any topic with the same point system (which, incidentally, most pointed out the similarities to another popular card game... very similar in almost all aspects... doesn’t this infringe on the original game’s copyrighting or licensing?). The younger kids also take plays personally (for example, one boy quit, knocking all the cards to the floor thinking everyone else was out to get just him!). They don’t “get it” as hoped.

Appendix E. EDITING CARDS IN ILLUSTRATOR

ILLUSTRATOR TECHNIQUES

Linking one Illustrator File into Another

To Link(Place) one file into another,

Open the Illustrator document into which you want to place the artwork.

Choose File > Place, and select the file you want to place.

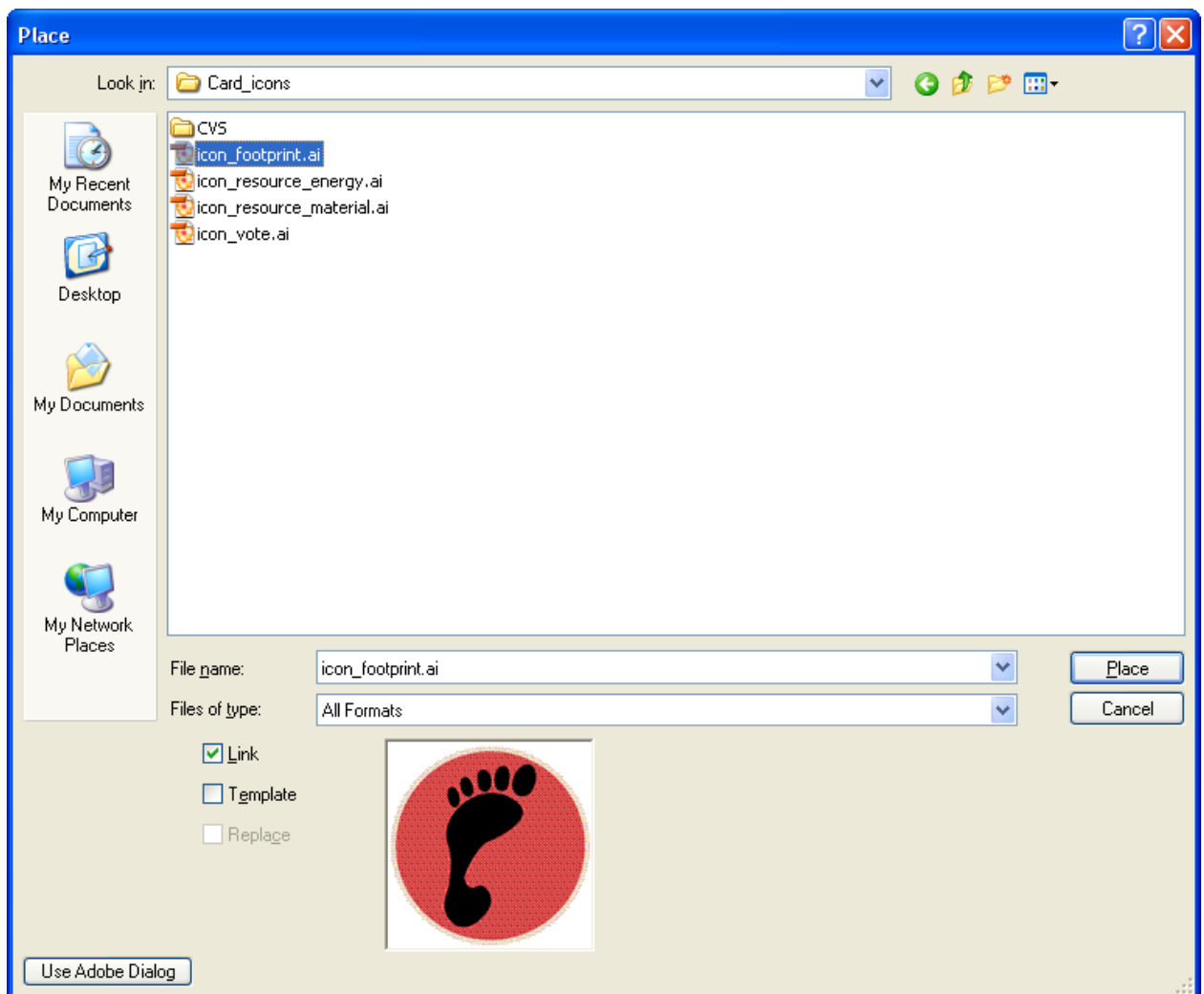


Figure 12 Place a file

Make sure the 'Link' box is checked to create a link to the file. If 'Link' is not selected, a separate copy of the file will be embedded into the current document instead of linking to the original file.

Click Place.

Crop to Art should be selected by default. Leave it and click Ok.

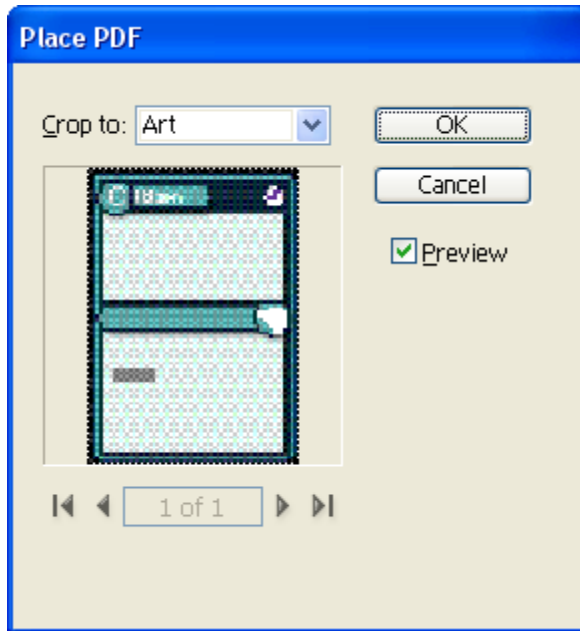


Figure 13 Crop placed PDF

WORKING WITH CARDS

Card Directory Structure

Adobe Illustrator uses absolute paths when linking files, so when checking out the FIRST_Art module from CVS, the local working directory must be C:\FIRST_Art.

The following is a description of the contents of the subdirectories under C:\FIRST_Art\Cards

Card_fronts

Contains one file for each card type (Building, Citizen, Event, Policy, and Role). Each file has all the common elements for the fronts of the cards – borders, card type, background for illustration and text, etc.

Card_backs

Contains one file for each card type (Building, Citizen, Event, Policy, and Role). Each file has all the elements for the backs of the cards.

Card_Text

Contains one PDF file for each card in the game.

DO NOT EDIT THE PDFs MANUALLY.

Source

Contains the Illustrator files used to generate the PDFs, one file for each card type. These files have multiple data sets. Each data set contains all the text for a single card.

Card_Icons

Contains the icons (Energy, Natural Resources, Carbon, etc.) that many other files link to. DO NOT RENAME THESE FILES

If you must rename them, you will have to open ALL the files that use that icon (card_composites, card_Text, etc.) and re-link the icons to the new filenames.

Resources

Contains the illustrations used to represent the various resources (Energy, Votes, Natural Resources, Carbon) throughout the game. These illustrations are separate from the icon files because other files also link to these illustrations. For instance, citizen_front.ai links to the vote illustration and the tokens link to the natural resource illustration.

Building, Citizen, Event, Policy

Contains the illustrations for all the cards of the given type. Generally, one illustration goes with one card_composite file.

If you rename any of these files, you must go into the corresponding card_composite file and re-link the illustration to the new illustration file.

Card_composites

This directory has one composite file per card in the game. Each composite links to the appropriate card_front, card_text, and card_icons files as well as the illustration for the card from the Building, Citizen, Event, or Policy directory.

PrintCardSheets

Contains one multipage PDF file for printing each type of card plus one PDF for tokens. DO NOT EDIT THE PDFs MANUALLY.

Source

Contains the Illustrator files used to generate the PDFs. These files link to the card_composites and card_backs .

Tokens

Contains the files for the Natural Resource tokens.

TexturesForGame

Contains all the textures for the computer game.

DO NOT EDIT ANYTHING IN THIS DIRECTORY.

Everything in this directory is generated by scripts. When exporting the textures to the computer game, just copy the entire contents of this directory to the appropriate directory within the program.

Scripts

Contains the VB code to generate the textures and XML card data for the computer game.

How to Add a New Card

To add a new card, you will need to create 3 separate files – 1 for the card illustration, 1 for the card text, and 1 composite file that links all the parts together.

Card_Text

As an example, say you wanted to add a new Citizen card. First, you would need to

Open Card_Text\source\citizen_text.ai.

If the Layers Window is not open, select Window -> Layers.

Expand the Text layer and select and edit each element of the card text in turn (Votes, CardName, Cost, etc.)

As an alternative, if you prefer to input the text in a text editor instead of in Illustrator, you can save the variable library to an XML file, edit the XML file in a text editor and then load it back into the Illustrator file.

Anywhere icons need to appear in the text, type in the first letter of the type of icon (e.g. E for Energy, C for Carbon footprint) and 3 spaces as a placeholder for the icon.

The CardAbilities text that appears below the card is a special field used by the computer game. It should list the names of the Java objects representing the cards' abilities in the game. This field does not appear on the printed cards because it is outside the artboard area.

When you have input all the text for the new card,

Select Windows->Variables to open the Variables Window.

The name of the current Data Set in the drop-down at the top of the Variables Window should appear in italics, indicating that the Data Set has changed.

Select Capture Data Set from the Variables option menu.

Name the new data set. The naming convention is cardtype_subtype_cardname (e.g. building_infrastructure_college).

While the new Data Set is still active, Save A Copy as . . .

Select PDF as the file type

Go up one directory to Card_Text

Save a copy of the file with the name [data set name].pdf

Save and close citizen_text.ai.

Card Illustration

This is the least complicated part of adding a new card. Just open a new Illustrator file, draw the illustration you want and save it in the appropriate directory for the type of card you're adding – Building, Citizen, Event, or Policy. Give the illustration a file name related to the name of the card.

Card Composite

Create a New Illustrator file. Set the Document size to 500 pixels wide by 700 pixels high.

Place (Link) the appropriate card front from the Card_frons directory into the new composite file. See (Illustrator Techniques

Linking one Illustrator File into Another).

Move the linked card front so it is exactly centered. The easiest way to do this is to

Open the Transform Window by selecting Window->Transform.

Select the Linked card front and change the X and Y coordinates in the Transform Window to 250 px and 350 px respectively.

Place the newly created text file from the Card_Text directory into the composite file. Again, make sure the linked file is exactly centered.

Place the newly created illustration into the composite file. Resize it and move it as necessary so it fits in the illustration space at the top of the card.

Place any icons needed into the composite file.

Resize the icons to 32x32 pixels and move them so they cover over the placeholder initials ('E', 'C', or 'N') in the text.

Save the composite file to the Card_composites directory.

The name of the file MUST be [card text data set name] _front.ai.

The script which generates the textures and data files for the computer game relies on the fact that the composite files have the same names as the data sets in the text source files. If the names are different, the script will not be able to match the cardData.xml file (generated from the text source data sets) with the card_texture.jpg (generated from the composite file).

Updating Links

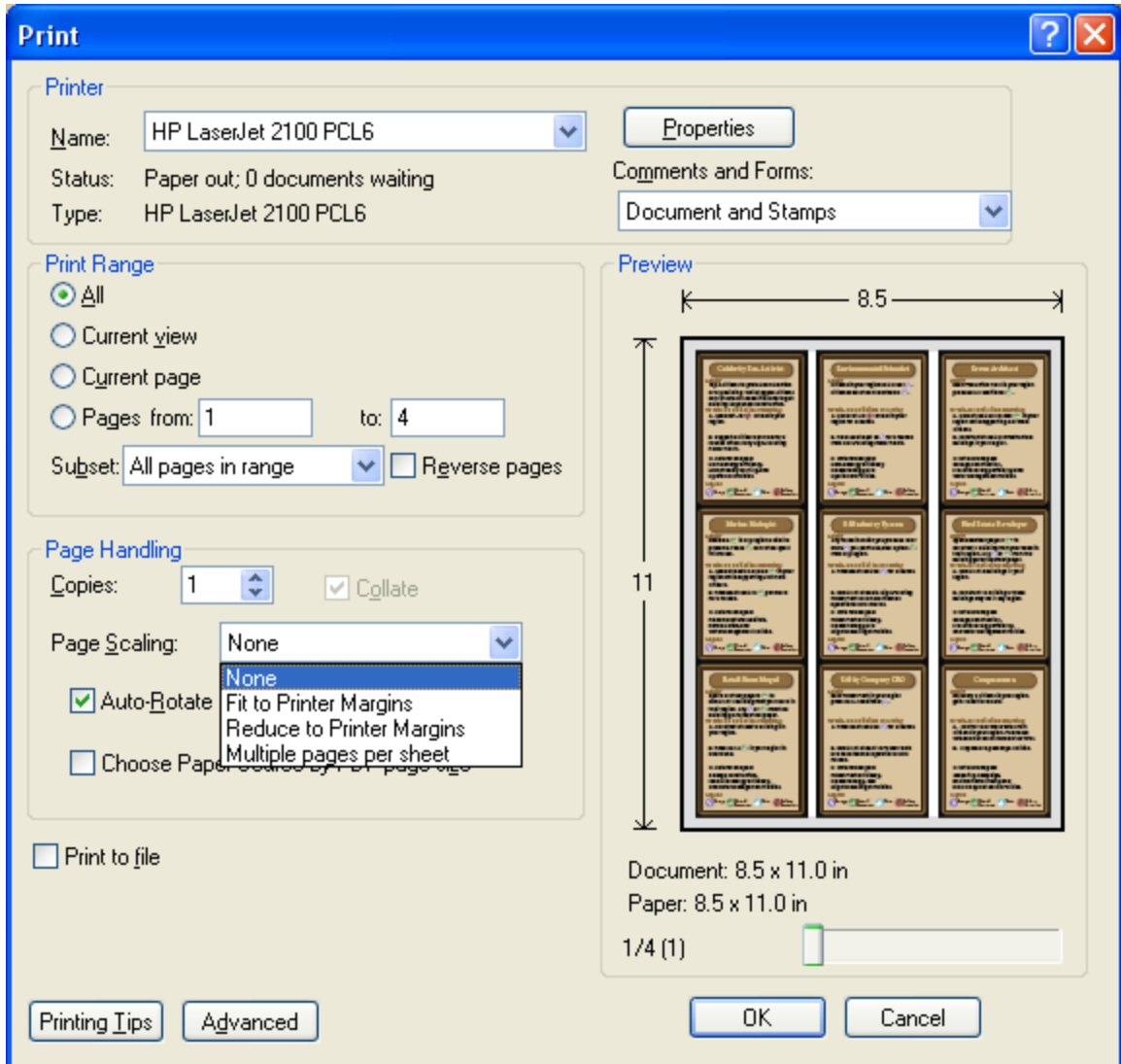
If you change files in . . .	You must also update and resave/regenerate files in . . .
Resource	Card_Icons Card_Text (because the icons are changed) Card_frons Card_composites Tokens
Card_Icons	Card_Text Card_composites
Card_frons	Card_Text (only you also need to move text) Card_composites
Building, Citizen, Event, Policy	Associated Card_composites
Card_backs	None unless you changed filenames, then PrintCardSheets Scripts that generate TexturesForGame
Card_composites	None
Tokens	None

How to Print Cards

Unchanged Deck

If there have been no changes to the cards since the last time they were printed out, simply get the latest PDFs from **C:\FIRST_Art\Cards\PrintCardSheets** and print them out.

Select Page Scaling: None, and
Print Double-Sided



Changed Deck

If there have been changes to one or more cards in the deck, you will first have to generate new PDFs.

Go to C:\FIRST_Art\Cards\PrintCardSheets\source

If you made changes to the text, illustration, or layout of an existing card or cards, all you need to do is

Open the file(s) for the type of card(s) that have changed.

Save a copy . . .

Select PDF for the file type.

Go up one directory to **C:\FIRST_Art\Cards\PrintCardSheets** and select the old PDF to overwrite it. Click Save.

Select Compatibility Acrobat 6. (This gives slightly smaller files than Acrobat 5)

Check Create Multi-page PDF from Page Tiles. Uncheck all the other options.

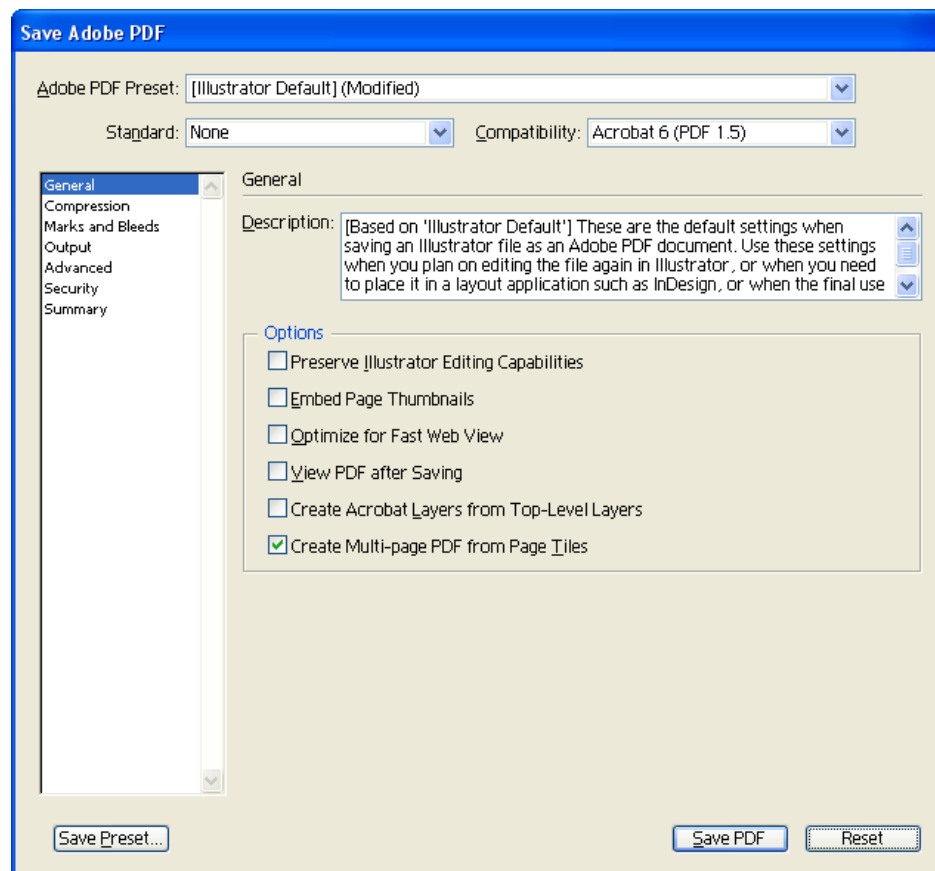


Figure 14 Save a Copy . . . PDF Options

If you need to add card(s) from the deck, you will need to

Open the file(s) for the type of card(s) that have changed.

If all the pages are full,

File->Document Setup

Add 11 inches to the Height of the document (this gives you room for 1 more sheet of 9 cards).

Once there is room to add the new card(s),

Link the new card(s) from C:\FIRST_Art\Cards\card_composites on one of the odd (left side) pages of the file. **Tip: Select View -> Show Page Tiling to see the page numbers and margins.**

Link the appropriate card back from C:\FIRST_Art\Cards\card_backs on one of the even (right side) pages of the file.

Save a copy . . . as a multi-page PDF (see above)

Print the PDF (see above)

If you changed the name of any of the card_composite files or replaced one or more cards with new ones, you will need to

Open the file(s) for the type of card(s) that have changed.

If you have renamed one or more card_composite files, you will get a message saying Illustrator could not find the linked file.

Click Replace

Choose the replacement card from C:\FIRST_Art\Cards\card_composites

If you do not get a message when opening the file,

Select the front of the card you want to replace.

Open the Links Window by selecting Window->Links

Click Relink (the first icon on the left at the bottom of the Links Window).

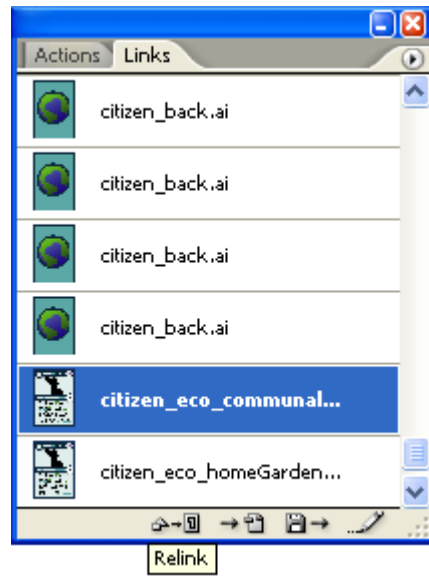


Figure 15 Relinking a card composite

Choose the replacement card from C:\FIRST_Art\Cards\card_composites

Save a copy . . . as a multi-page PDF (see above)

Print the PDF (see above)