

COMP 345-Winter 2016 Project Description

General Information

The project is about writing a C++ computer game that allows the user to play a reasonable version of the *POWER GRID* role playing game. The *POWER GRID* is a “Strategy” computer game, the gaming rules are given in [1].

The project is to be undertaken by teams of exactly 4 members and consists of the building of a challenging large C++ program. The completion of the project is divided into two separate components: (1) the *Intermediate Project Delivery* is a first operational build of the software, effectively demonstrating the full implementation of some important software features; (2) the *Final Project Delivery* is the demonstration of the finalized version of your software. During the final project delivery, you also have to demonstrate that your code includes many of the C++ features presented in the lectures. All project deliveries are to be undertaken in the laboratory where the team presents the implemented features to the instructor following a pre-circulated grading sheet. The individual assignments will also be related to the project, but graded individually and separately from the project.

It is important to realize that the project description is purposely incomplete, and that it is one of your duties in this project to: 1) elicit and formulate all the missing details before you start the implementation, 2) limit the scope of the project according to the time that is available, and the required features, 3) determine what design decisions will be made, as well as 4) what tools will be used for the implementation. These activities require some investigations and discussions that are important aspects of software development and this project.

Problem Statement

POWER GRID is a multiplayer board game in which players compete to purchase power plants, expand their power networks into cities, then buy enough natural resources to power those cities. It combines an economic system that simulates supply and demand with an auction round that pits players against each other as they try to buy the latest power plant technology.

In the game, each player represents a company that owns power plants and tries to supply electricity to cities. Over the course of the game, the players will bid on power plants and buy resources to produce electricity to provide power to the growing number of cities in their expanding network.

The object of *POWER GRID* game is to supply the most cities with power when someone’s network gains a predetermined size. The players mark pre-existing routes between cities for connection, and then vie against other players to purchase the power plants that you use to supply the power. However, as plants are purchased, newer more efficient plants become available so you’re potentially allowing others to access to superior equipment merely by purchasing at all. Additionally, players must acquire the raw materials, like coal, oil, garbage, or uranium, to power said plants(except for the highly valuable ‘renewable energy’

wind/solar plants), making it a constant struggle to upgrade your plants for maximum efficiency while still retaining enough wealth to quickly expand your network to get the cheapest routes.

The game is played with a map of a country or province, or state (e.g. Canada, USA, or Quebec, Ontario ...etc.). Each map consists of six regions featuring cities with connections of varying costs between them. The number of regions used is based on the number of players. The map design itself is a key feature in the strategy of game play as some areas of the map feature generally higher connection costs compared to other areas of the map.

The game is played in rounds, with each round consisting of 5 phases:

1. Determining player order
2. Auction power plants
3. Buying resources
4. Building
5. Bureaucracy

The game ends after one player builds a fixed number of cities. The winner is the player who can supply electricity to the most cities with his network. Tie breakers are who has the most money, then the most cities.

Phase 1— Determining Turn Order

Turn order is rearranged each turn according to the number of cities each player has connected. The player with more connections is placed before a player with fewer connections and continues ending with the player with the fewest cities playing last. When players own the same number of cities, a player with the higher value plant is placed before a player with a lower value plant. (Exception: Turn order is determined randomly at the beginning of the game, and then rearranged after power plants are purchased per the normal rules).

Phase 2— Auction Power Plants

Turn order determines who begins the bidding on power plants. The first player begins and may choose to pass rather than bid on a chosen plant, in which case they forfeit the chance to bid on any power plants on a given round. An initial bid must be equal to or higher than the value of an available power plant. After the initial bid, players take turns bidding in clockwise order until every player has passed on a current bid. Once a plant is purchased, a new one is drawn from the deck to replace it, with the available power plants re-arranged in numerical order according to their value. The player with the highest priority turn order (which may still be the first player) then has the option to bid on an available plant. Phase 2 ends when every player has either purchased a plant or passed on their opportunity to bid on a plant. Most power plants require one or a combination of resources: coal, oil, garbage and uranium, in order to supply electricity. Wind turbines and nuclear fusion plants do not require resources.

Phase 3— Buying Resources

In reverse turn order, players can buy resources for their plants. Players may only purchase resources they can use, and each plant may only hold twice the number of resources it needs to run. Thus a plant that uses two oil may hold up to four oil. As resources are purchased, they become more expensive, thus the person who is last in turn order can buy resources at the cheapest prices for that round.

Phase 4— Building

In reverse turn order, players may build into cities. In the first round, a player may choose to build into any city that is not already occupied. A player may continue to expand by paying the cost to build into the desired city slot plus the value of all connections to that city from an already occupied city. No player may build into more than one slot in a city. Slot one costs 10'Elektros' and is the only slot available during Step 1. During Step 2, the second slot is available at a cost of 15 Electros, and in Step 3, the final slot is available at a cost of 20 Electros.

Phase 5— Bureaucracy

During this phase, players expend resources to power their cities and earn more income (Electros) based on the number of cities they power. Resources available to be purchased are replenished at a rate based on the number of players in the game as well as the current Step. Finally the highest value power plant is placed at the bottom of the draw deck (this changes in Step 3).

The game is further divided into 3 "steps".

In *Step One*-8 power plants are visible to players arranged into two rows of four based on their numerical value ranking from lowest to highest. The first row of the lowest numbered plants is available to be bid on by players. In step one, only the first slot of a city may be built into.

Step Two-is triggered when any player builds a set number of cities determined by the number of players in the game. In Step Two the lowest level plant is removed (this is only performed once). In addition, the second city slot becomes available for players to build into. Finally, the resource replenishment rate is changed.

Step Three-is triggered when the Step Three card comes up in the power plant deck. The Step Three card is initially placed at the bottom of the power plant deck. In Step 3, again, the lowest level plant is removed and a new plant is now drawn to replace it. The available power plant pool now consists of 6 power plants that are all available to be bid on. The remaining power plant deck is shuffled to make a new draw deck.

The *POWER GRID* game can be played by 2-6 players. With only 2 players, a lot of the interesting aspects of the multi-player game go away, it works for teaching the rules. With three players it loses some competition elements on the plants, and there is essentially no competition for cities in Step 3. Six players loses part of the middle game, though the extra competition helps make up for it. The *POWER GRID* works best with 4 or 5 players,

A high-level description of the mandatory game features is given below.

Mandatory features

The implementation of the project consists of two components: (1) a configuration component and (2) a game-play engine. The former is used to configure the game by providing the map layout with the different cities, wooden houses, wooden resources tokens, money (in Electro), summary cards, power plant cards, "Step 3" card, etc. The latter enables the actual game play and enforced the gaming rules.

In what follows the mandatory features for each component are listed.

(1) Configuration component:

This component is used for configuring/setting up the *POWER GRID* game and consists of the following modules:

- A player editor that allows creating players' dashboards.
- An editor for summary cards, power plant cards, houses, resources, "Step 3" card, and money objects.
- A map editor that allows creating maps consisting of regions and cities.

This component must include a feature for saving and loading existing game configurations.

(2) Game-play engine component:

The game engine constitutes of the actual *POWER GRID* game. Its implementation should contain the following features:

- Loading of a pre-defined game configuration of *POWER GRID*.
- Players' dashboard: each player has an inventory panel where he can view all his items, area playing in, cities, plants, money, houses, resources etc.
- Players' area, number of cities they control, houses, resources that are on the map.
- Game play for multiple-players must be supported (see requirements of each build).
- A window should be available, where a log of relevant game information are output and can be used to properly demonstrate game rules being followed(e.g. The current stage and phase, and active player. Clarity of the log is of prime importance. All important game information should be appearing in the log window in order to explicitly demonstrate that the gaming rules are being followed as the game is played.

Deadlines	Intermediate delivery:	March 9-11, 2016
	Final delivery:	April 6-8, 2016
Evaluation	Intermediate delivery:	15%
	Final delivery:	20%
Late submission	Not acceted	
Teams	Size of exactly 4 members	

Reference

[1] *Power Grid*, Friedemann Friese, available on the Moodle Course homepage, or under <http://riograndegames.com/games.html?id=5>