

Objective: Create an infrastructure simulation game that will provide insights into the implications of transitioning to alternatively fueled vehicles.

A simulation-games is an analysis tool used to develop strategic options in a low risk environment. A typical modern simulation game is conducted using human players to represent the key stakeholders in a process, a simulation model that computes the results of the collective player actions, and game administrators charged with running and refereeing the system. In many cases the players are actual stakeholders in the process being simulated.

Formal modeling and expert assessment are currently the predominant approaches for strategic planning. Formal modeling makes use of quantitative models of systems. It works best for simple systems composed of transparent, quantifiable relationships. In modern practice these models are highly complex. The assumptions they use are often not completely and explicitly stated, and may be impossible to discover, even if the model builders are available to discuss it (i.e. the model builders may not understand all of their own assumptions or those from sub-model data they have incorporated).

Comparing Operational and Strategic Problems

Problem Attributes	Type of Problem	
	operational	strategic
1) ability to predict	high	low
2) complexity	low	high
3) conflict	low	high
4) risk	low	high
5) clarity of goals	clear	ambiguous
6) information	quantitative	qualitative

(source: Underwood, 1986)

Expert assessment is the other predominant method for formulating policy. Experts are limited by several factors. First off, experts have no effective way to factor uncertainty into a problem in a comprehensive manner. Like models, experts also have biases, many of which can be unconscious. Experts who are hired by the client can feel pressure to bias their advice towards what they think a client might want to hear in order to keep the client's business. Experts tend to want to seek consensus and avoid confrontation (Underwood, 1986).

Military Background

The first simulation games were designed to teach rulers of ancient civilizations how to fight wars. Chess and Go are abstracted versions of those games. Key to success in both of those games is the ability to think through multiple successive moves and counter moves.

Militaries have made the most extensive use of simulation games. The Prussians developed the modern simulation war game in the 19th century in order to respond to the substantial manpower advantages of the French, their long time adversary. The methodology was productive, as evidenced by Helmut von Moltke the Younger's numerous victories in the years 1872-1913 against numerically superior foes. War games are now an essential planning and training tool for all militaries (Caffrey, 2000).

Business Background

Businesses began to employ simulation gaming to enhance their strategic planning in the 1950's. They began with rationalistic assumptions about market behaviors but soon began to incorporate irrational components to provide a more realistic representation of the world. Now simulation-games are most commonly used as a "fun" training tool for businesses, however there are many instances of simulation-games being used by high level executives for strategic planning.

The Harvard Business School's famous case method of teaching business students is a partial simulation methodology. Students at HBS study business "cases," actual business examples in which a management team had make a challenging decision. They then craft their own responses to the situation. Where it falls short of being a simulation is that there is no response to their proposed case responses. In a simulation the players make decisions and receive feedback as to the quality of their response (Mayer, 2002).

Strengths and Weaknesses of Simulation Games

Like other analysis tools simulation games have their own set of strengths and weaknesses. Simulation games are excellent in their ability to bridge the gap between systems that are otherwise disparate. Simulations games can integrate quantitative financial, scientific and engineering models with qualitative models from fields like political science, sociology and marketing. The big picture provided by the games comes at the cost of detail: specific effects can be difficult to determine and hence games are not good for finding statistically significant correlations.

Important hidden relationships between systems can often be found using games. In *Infrastratego*, a simulation game exploring the transition to a deregulated power market in the Netherlands for example, it was found that there were powerful incentives for stakeholders to game the market during the transition phase. This caused consumers to seriously distrust the deregulation agenda (Kuit, 2005). Once these relationships are exposed however the games are less forthcoming on what to do about them.

Simulation games are costly and time consuming to develop. The normal development time for a game is six to twelve months. Once developed the game may only be used a few times. Furthermore it has been suggested that there may be a saturation point at which it will be difficult to get domain knowledgeable participants to attend (Mayer, 2002).

The STEPS Alternative Fuel Transition Simulation Game: Preliminary Summary

The STEPS alternative fuel transition simulation game is in a very early phase of development. The details described here are likely to change. The game, as it currently stands, is made up of players representing consumers, fuel producers, vehicle producers, NGOs and the government. They will interact in a manner similar in structure to *Infrastratego* (Kuit, 2005). The players will be tasked with implementing an aggressive scenario set of fuel economy and GHG regulations over a 40+ year period. Players are scored based on how well they represent their stakeholder.

Player Roles

Player roles may be taken on by an individual or a team. Each team or individual will have a computer equipped with an internet connection, a web browser, spreadsheet software and whatever else the player might want to use (the player can use his personal machine due to the game's web interface). Play is conducted in fifteen minute turn representing a simulation period of several years. There are five categories of player types: Government, Consumers, Vehicle Producers, Fuel Producers and NGOs.

Government players represent relevant agencies charged with regulating issues including energy, the carbon market, emissions, and transit / transportation. In addition to the agencies a judge player will settle in game legal disputes, as was done in *Infrastratego*. Government agencies pursue scenario set agendas such as GHG reductions. They impact the game via taxes, subsidies, legislation and research funding.

Consumers are a composites groups based on similar characteristics (e.g. income, VMT,). Consumers are also a political group that lobby government and manufacturers for actions they perceive to be in their interests.

Vehicle producers create lines of vehicles for consumers to buy. A line is similar to a brand; it is a set of vehicles that are sensibly grouped for manufacturing and marketing purposes. Producers invest in R&D to improve their offerings. In the current design vehicle producers can build four different drivetrains: liquid fuel (petroleum and biofuel), HEV/PHEV, HFC and BEV.

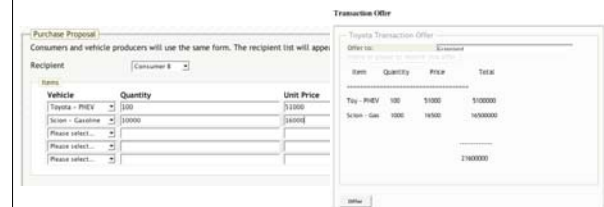
Fuel producers produce fuels for the vehicles. A fuel producer's role extends from well to forecourt. Producers have their own natural resource supplies, transport, refining capability and distribution networks in the consumer regions. The term *liquid fuel* is used to designate all petroleum and biofuel blends. This is done for the purpose of simplicity; it is assumed that optimal choices about actual liquid fuel proportions are being made at a decision level below that of the game. Producers must decide how much biofuel to blend into their liquid with petroleum fuel based on cost and regulations. Fuel producers can build electric utilities in order to serve PHEV and BEV induced (and other) demand if they so choose.

NGOs are lobbying groups that seek to pursue their group agendas. Environment, health, and business groups will be represented. The NGOs work by forming alliances with like minded players. NGO

Game Play

The game is driven by consumers. Consumers seek to maximize their overall utility by making optimal choices about how they will meet their transportation needs. Personal vehicles are the dominant mode however they can increase their usage of transit and non-motorized modes.

Consumers purchase vehicles by negotiating with vehicle producers. Consumers value quantifiable qualities like power, mpg and size along with qualitative characteristics such as style. On every turn consumers must replace vehicles that have been retired from their fleet.



Proposal offer and receipt screens (prototypes)

Consumers purchase fuels based on their desired VMT for the next turn. Consumers are considered to be indifferent to branding. Their purchases will be simulated using a fuel purchase share function like this one:

$$s_{ij} = \left(\frac{100 \cdot d_i}{\sum_r d_r} \right)^{\alpha_j} + \left[\left(\frac{100}{p_i} \right)^{\beta_j} - \frac{1}{n} \sum_l \left(\frac{100}{p_l} \right)^{\beta_j} \right]$$

Fuel proportion scoring formula and example scenario

The score, s_{ij} , is used to calculate the proportion of fuel purchased by *consumer j* from *producer i* given that consumer *j*'s preference for convenience is α_j and his price sensitivity is β_j . The value d_i is the number of distribution outlets for producer *i* in consumer *j*'s region. The value p_i is the price producer *i* is offering the fuel at in that region. A scenario table showing the actual market shares an equally sized set of fuel distribution networks with different prices is shown above.

More game information is available on request.

System Status and Demonstration

This project is scheduled to be ready for testing in Fall 2008. The first gaming event will occur in Winter 2009.

We are interested in discussing the decision model designs and game structure with sponsors and other knowledgeable persons.

Some early demonstration screens can be seen upon request.

References

Caffrey, M. (2000). "Toward a History Based Doctrine for Wargaming" Retrieved April 23, 2008, from <http://www.airpower.maxwell.af.mil/airchronicles/cc/caffrey.html>.

Kuit, M., Mayer, I. de Jong, M. (2005). "The INFRASTRATEGO game: An evaluation of strategic behavior and regulatory regimes in a liberalizing electricity market." Simulation Gaming(March 2005).

Mayer, I., Veeneman, W. (2002). *Games in a World of Infrastructure*. Delft, Eburon Academic Publishers.

Underwood, S., Duke R. (1986). Decisions at the top: Gaming as an aid to formulating policy options. *ISAGA - 17th Intl. Conference*. D. Crookall, Greenblat, C., Coote, A., Klabbbers, J., Watson, D., Pergamon. **Simulation – Gaming in the late 1980's**.

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