

Mod Name: Spark Lead

Describe your mod in detail and how it changes gameplay.

This mod switches the learning content from a computer science/chemistry focus to an electrical engineering focus. The core mechanics are mainly the same, creating circuits in order to produce a desired effect. However, rather than a chemistry focus, combining atoms to carry a sufficient amount of molecules through the reactor, the goal is to deliver appropriate electrical current through the circuit using a combination of standard electronics parts such as wires, resistors, transistors, LEDs, and so on. Generally electronics are focused on efficiency and delivering the appropriate current without overburdening the load, so the challenge will change in not only delivering current to the load, but also not shorting it out.

The most basic levels will involve making circuits to light an LED with a given power source with DC current (a single-direction flow). Later levels model AC current by having the power source switch directions at some frequency. In addition, the tools that the player can use will start with the simple resistor, but will lead up to transistors, diodes, and transformers, which have more complex properties. Late game levels will be more complex, since later goals will involve not only delivering appropriate current to a single load, but also manipulating the source voltage (power) in order to power up particular components of a bigger system in appropriate ways. This can be modeled aesthetically in game similar to Space Chem, whereby the player is trying to power a robot to do battle and must send power to the appropriate parts for victory.

The gameplay changes in that the player will be managing how the electrical current is flowing - the magnitude of voltage and current, and the direction of the current. Lines have to be careful in not crossing, otherwise there will be short in the circuit and the load will be destroyed. It is less of an exercise of parallel processing for how the current is flowing and more about serial processing in making sure that there is appropriate current and voltage at key junctions of the circuit.

Why did you decide to make this change?

Building the diagrams in Space Chem immediately reminded me of the circuit diagrams that I had to draw in my electrical engineering courses. The same methods of analysis, troubleshooting, and tinkering required to play Space Chem was used when I was studying electronics. Electrical engineering has roots in chemistry as well, so the connection is not too much of a stretch.

What changes in player perception or behavior do you think will result? Why?

The core of Space Chem's experimentation and problem solving should not change that much. However, because the solutions to electrical circuits come from a different workflow than combining and delivering molecules, the problem solving process will be likely different. For example, in electrical engineering, you typically tackle circuits in a

systematic way, making sure that particular sections of the circuit have suitable collective resistance, voltage, current, etc. before moving onto the next section. In a sense, circuit analysis lends itself well to checkpoints in game. Suitable combinations of circuit components can lock when the appropriate value is reached.

What is the new curricular goal? Is it something that can be evaluated, if so, how?

- Systematic problem solving - evaluate how learners segment and tackle complex system problems
- Basic electrical circuit concepts - evaluate by analyzing basic circuit diagrams
 - Current flow
 - Power sources
 - Resistance

(See educator guide reading for example) What does your mod not teach?

- This mod serves as a basic abstraction of electrical engineering concepts, such as serial or parallel distribution and current flow. It is useful for getting a visual of how electrical current functions, but should be used in tandem with proper study and lab work for more realistic examples that come from the imperfection of components.
- Moreover, the actual mathematical relationships between resistances, voltage, power, etc. may not be reached depending on the complexity of the component.
 - $\text{Power} = \text{Current} * \text{Voltage}$, which can be easily represented in-game
 - Power loss through wires may be neglected, for sake of simplicity
- This does not teach the reasons why certain components, such as diodes and transistor work in a unique matter, as they are complex is outside of the scope of the intention of the game.
- For the sake of example and game flow, some components in game have simplified functionality or are imaginary. These components are clearly marked for further discussion.

Describe your experience of SpaceChem's game feel.

Definition of game feel:

“Real-time control of virtual objects in a simulated space, with interactions emphasized by polish...”

...great-feeling games [are games]... that convey five different types of experience to the player:

- The aesthetic sensation of control
- The pleasure of learning, practicing and mastering a skill
- Extension of the senses
- Extension of identity

- Interaction with a unique physical reality with the game"

- *Game Feel*, pg. 32-33; Swanson (2009)

Based on this definition, I didn't get a good sense of game feel from Space Chem. I didn't get a sense of real-time control over the environment. I placed the different components in the reactor, and turned the reactor on to test the setup. Because of the test and response flow of the gameplay, I didn't get a good continuous experience, which inhibited achieving flow during play. Perhaps it was out of frustration of not understanding the mechanics, but I didn't find much pleasure from learning and practicing the skills presented in the game. On the contrary, I didn't like actually applying the mechanics in a new level. It felt like lab work to me, which I would rather do because of the physical nature of lab work.

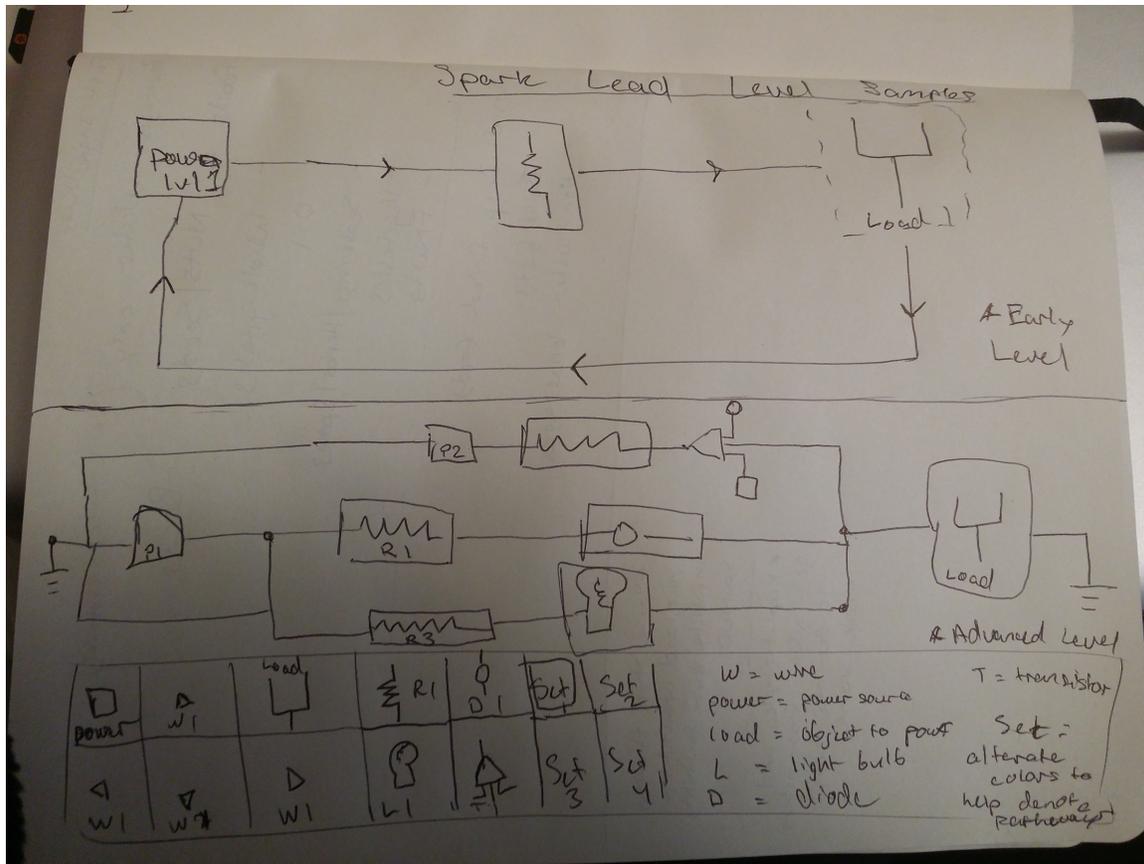
Based on the diagram in the book (pg. 8), the game feel seems to be the intersection between polish and spatial simulation. You get a sense of how atoms interact with each other in the game world, and the polish (aesthetics) of the game provide better context for the game play. This is evident in the later stages of the game (based on the educators' guide) whereby the gameplay mechanics are largely the same, the context by which the player is using the mechanics change because they are building a system to defeat a boss, rather than to build a reactor.

How do you think your mod will change the feel of the game? In what way?

The mod will make the game play a more real-time experience. Since the game is working with electrical currents, electricity is always flowing, and thus the player will be able to see the results of their circuits in real-time. Moreover, even if the player were allowed to switch off the power, allowing for a testing state and a debugging state, the player would immediately tell if the current flows correctly, by whether or not the intended result occurs. This is different from Space Chem is that you don't know immediately if a configuration is correct, but only after letting it run for a few cycles. For me, this created a sense of doubt of my own designs because it was hard to initially trust what I have built. Granted, it is much like programming, but it also contrasts in that you can modularly program and test different functions, rather than have to program the entire system at once.

With the addition of voltmeters and other measuring components, the player should be able to build the solution in a more modular way, also giving the player more of a sense of control over the system and better game feel.

Depending on the type of mod, provide brief storyboard on a supplemental reference page to illustrate any layout, graphic, or mechanic changes (contact me with your idea if you are unsure whether you need to do this)



These are some sample levels for the game *Spark Lead*. This is to demonstrate how the different components can be used. Although electrical currents can have a variance in the flow of current and the magnitude of voltage, this game ignores that for the sake of simplicity. There may be different sets of components, which will allow for further customization and complex solutions, but the actual values attributed to the components will be simple, e.g. set 1 has a value of x ; set 2, $2x$; set 3, $4x$, and so on. Actual electrical components need more complex mathematics to analyze effectively. Nonetheless, the basic points of electrical circuits would likely come across clear enough for illustration.