Adapted Hungry, Hungry Hippos Board Game

Alternative Design 1:
In this design, the adapted Hungry, Hungry Hippos board game will allow for full control and playability, without the need to exert much force on behalf of the client. A mechanical control system will be implemented, and will consist of a small electric DC motor, and push button switch. When the push button is activated by the user the motor will supply the necessary force to the board game’s levers and the user will be able to play.

The assistive device will be a separate unit that can be attached and detached to multiple Hungry, Hungry Hippo board games. The device will also be battery operated which will allow for multiple playing locations, and it won’t have to be tethered to a wall outlet. In order to supply the necessary force to the control levers, the motor will incorporate a swing arm which will spin about the motor axis and come in contact with the board game. Once the motor is activated, this swing arm will continuously hit the operating lever (see Figure 1). Figure 2 shows an example motor which can be used.

Figure 1: Mechanical system setup for design 1

Figure 2: Sample DC electric motor

The benefits of this design are that the client will require very little force in order to play the game, and will have a large degree of independence. In order to complete this design the required torque of the motor will need to be evaluated in order to determine whether it can supply the required force. Also the spin speed of the motor needs to be determined so that the game will provide the correct level of responsiveness. Because there will be continuous contact
between the motor’s swing arm and the board game levers, wear and tear will be present. The material for the swing arm needs to be strong enough to withstand repeated use, but should also be kept to a minimum weight. Because this design is rather simplistic it will require very little maintenance, if any, and will also be very user friendly.

**Alternative Design 2:**

In this design, the adapted Hungry, Hungry Hippos board game will also allow for full control and playability, without the need to exert much force on behalf of the client. A mechanical control system will be implemented, and will consist of a small electric linear actuator, and push button switch. When the push button is activated by the user, the actuator will supply the necessary force to the board game’s levers and the user will be able to play.

The assistive device will be a separate unit that can be attached and detached to multiple Hungry, Hungry Hippo board games. As in the previous design, the device will be battery operated. In order to supply the necessary force to the control levers, the linear actuator will be positioned above the board games lever, and, once activated, will push with a downward force. Figure 3 below depicts the mechanical system setup for this design. Figure 4 shows an example linear actuator for use in the design.

![Figure 3: Mechanical system setup for design 2](image)

![Figure 4: Sample linear actuator](image)

The benefits of this design are that the client will require very little force in order to play the game, and will have a large degree of independence. In order to complete this design the
necessary force of the actuator will need to be determined, as well as the speed at which it operates. There will be minimal wear and tear utilizing this design because the moving parts are directed in a linear manner, and the only concern would be weakening over time for the board game levers. Also, this design will be maintenance free, and, because of its simplistic nature, if a problem were to arise, it could be easily repaired.

Alternative Design 3:

This last design will also be a separate unit which attaches onto the Hungry, Hungry Hippos lever arms. It will incorporate a mechanical control system to minimize the force required from the client to play the game. In order to allow the client a higher degree of independence, the adapted board game will use a pulley system and lever. When the push lever is pressed, the pulley will act to reduce the force needed, and the board game levers will operate. By having the assistive device as a separate unit, the client will be able to use multiple Hungry, Hungry Hippo board games, and will also be able to use the device on any one of the four board game stations. Because this design calls for a purely mechanical control system, there will not be a need to have any power source, and thus the board game will be playable in all suitable locations.

The mechanical system will use a large push paddle that the client will easily be able to navigate to, and this will then be attached to the board game levers through a pulley system. They pulley system will act to reduce the load necessary to push down on the board game levers, thereby reducing the force needed from the client. A mechanical setup for this design can be seen in Figure 5.

![Figure 5: Mechanical system setup for design 3](image)

The main benefit of this design is that there will be no electrical activity required, and the client will be very hands on and engaged while playing. The concern however is that because there will still be some force required to push down on the levers, the client may not be able to operate the device. Also, some regular maintenance may need to be applied in order to keep the pulleys lubricated and functioning smoothly. The device will also need some initial setup, by being physically attached to the board game levers before being played with.
Adapted Sled

Alternative Design 1:

In the first design, a purchased full support swing seat will be bolted to a sled, which Joey’s mother provided to the team, through a quarter-inch plywood. The seat will be tall enough to provide good back and head support with a full harness, strapping both his waist and shoulders to the seat. Figure 6 below is a picture of the exact seat the team plans on purchasing if this design is implemented, and Figure 7 is a picture of the sled to be used along with its dimensions.

Figure 6: Full support swing seat

Figure 7: Joey’s sled
Alternative Design 2:

The second alternative design for an adapted sled involves manufacturing a completely new sled and seat, instead of using the one provided by the client. The advantage of building the sled from the ground up is that it allows for the most customized solution to the client’s needs. The downside is that this is the most expensive design. This design is similar to the first design except that the sled will be made of three large skis on which the seat will be mounted. Using skis rather than the provided sled will provide added stability as the sled will have a wider base, as well as make it easier to mount a wooden base on which the seat can be mounted. The wooden mount has two purposes: to secure the three skis together making up the sled, and to provide a mount for the seat. The same seat used in design one would be used in this design as it meets the client’s specifications. Figure 8 below describes this alternative.

![Figure 8: Adapted sled for alternative design 2](image-url)
Alternative Design 3:
The third alternative design for an adapted sled involves modifying an existing product. The advantage of this design is that it would be the cheapest design. The downside would be that the design will be limited by the existing product. The sled would have to be modified in order to meet the project specifications, as most of the existing sleds for young children are not secure enough for Joey’s unique needs, as discussed in the Proposal. An adductor would need to be added to the seat in order to prevent the client from slipping out. An extension would have to be placed on top of the backrest in order to support the client’s head while riding. Finally a new harness would have to be installed to secure the shoulders and waist. Figure 9 depicts an existing sled design that could be modified as described.

![Figure 9: Toddler Taxi Sled](image)

**Device Control Panel**

**General Description:**
All three designs for the control panel involve the use of microcontrollers, receivers, transmitters, and, in some cases, an IR-RF extender. Also, the design for the outer casing will be the same, regardless of its internal design. It will utilize touch-sensitive, jelly-bean style buttons in order to control three or four different functions for the client’s CD and DVD players and turtle light. The difference in the designs is comprised in the arrangement of the connections for these devices or in alternative ways of supplying the same circuit or functionality within the system.

**Alternative Design 1:**
The first design, as in the other two to be presented, will utilize a microcontroller hooked up to a transmitter, in the control panel, to communicate between the user and the devices he/she wants to control, utilizing radio frequency (RF) waves. The CD player and the turtle light will, in turn, each be hooked up to a shared microcontroller, which will process the data received by the receiver from the transmitter. Serial communication will be utilized in

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order to accomplish this. Serial communication “involves changing voltage of an electrical connection between the sender and receiver at a specific rate.”\(^2\) It is a series of binary 1s (high) and 0s (low), 1s usually corresponding to an input voltage (high) and 0s corresponding to no voltage input (low). Of course, the opposite could be true and depends on the designer’s choice of logic. However, for this project, the conventional 1s-high and 0s-low protocol will most likely be used. Therefore, in order to accomplish the wireless serial connection, each device’s switches of interest (on/off, play, stop, and maybe some color buttons for the light) will be tested for the pulse protocol to which they are designed to respond by the manufacturer. The signaling protocol involves the pattern of 1s and 0s in the signal, the frequency and timing between pulses, and any type of header or tail attached the beginning and end of the signal, which may indicate start, stop, or the address of the device\(^3\). All of these things will have to be taken into consideration when programming the microcontrollers to send and receive serial data. Most likely, since both the CD player and the light will be responding to the same microcontroller and receiver, a device address will be important to include in the signal, so each device knows which signals to respond to and which to not respond.

In terms of the physical jelly-bean buttons, which the client will push to control the devices, these switches will act as bridges between a 5-9 V power source and an input pin on the microcontroller in the panel. Each switch will be hooked up to its own digital I/O pin. When a switch is closed (the user pushes a button), the input will be connected to the power source and will receive a high input at the pin. This will initiate the serial communication between the microcontroller and transmitter in the panel and their receiving counterparts attached to the devices. Depending on what button is pushed by the client, the microcontroller will be able to determine which of its pins received a high input and will then determine what message must be communicated to the receiver. Figure 10 below depicts the microcontroller-transmitter setup in the control panel. A PIC1684 microcontroller is depicted in the figure, but this is not necessarily the exact module which will be used in the design. It is sufficient enough at this point, however, to clearly illustrate the intended design, as all microcontrollers have the same basic features—input, output, power, and ground.

\(^2\) Making Things Talk by Tom Igoe, 2007

\(^3\) Making Things Talk by Tom Igoe, 2007
Input switches for light and radio connected to buttons on control panel. When one of the switches is closed, a pin from the microcontroller is connected to the power source to activate signaling.

Radio: On/Off, Play, Stop
Light: On/Off, Blue, Green, Auburn

In the case where the DVD player would share the microcontroller, the last three switches would be connected in the same way.

**Figure 10: Control panel's transmission setup**
(The blue wires indicate the CD player’s input and the green wires indicate the light’s input)

Figure 11 is an image which illustrates the setup for the microcontroller and receiver connected to the CD player and light. The basic idea is the same as described above for the transmitter, except that there are no switches for the user to control. The microcontroller and receiver will be placed inside a plastic receiving hub. The receiver hub can probably be powered by an adapter, rather than a battery that must be charged, since it’s not necessary that the hub be as portable as the panel.

**Figure 11: Receiver setup for CD player and light**
The DVD player will have its own separate receiving setup. The team thought that having a separate setup would be beneficial to the client, since it’s meant to be a portable DVD player and the screen is only seven inches in diameter; therefore, a separate setup will make it easier for the client to transport the player around. Since the DVD player includes its own infrared (IR) remote, the team intends to utilize the remote control’s circuitry within the panel and use an extender to “convert” these signals to RF to be transmitted. In this way, the trouble of signal replication and modulation can be avoided. In this design, NextGen’s Wireless RF Remote Extender will be utilized. The extender can be purchased for between $49-$60.

According to the patent for this extender (US Patent # 6,400,480 for a Battery Module Transceiver for Extending the Range of an Infrared Remote Controller, filed April 4, 2002), the device consists of a battery-sized transceiver and power supply. Figure 12 below is a diagram taken from the patent which describes the design. As stated in the patent, “It is noted that a radio frequency (RF) signal 4 of about 30-50KC accompanying the emission of the IR signal 3 will be radiated all around the IR remote controller 1 which is representative of the IR signal.”4 (The numbers 1, 3, and 4 refer to the corresponding numbers in Figure 12.) Therefore, unlike most other IR-RF extenders, the IR signal is not “converted” in the conventional sense, rather it utilizes the remote’s equivalent RF pulses and uses its transceiver to detect these pulses, modulate and amplify them, and finally transmit them as an RF signal. The transceiver and its rechargeable battery supply are placed in a casing and then inserted inside the IR remote’s battery cartridge in place of one of its AA or AAA batteries. The transceiver’s battery powers both the remote and the transceiver.

In the team’s design, however, the extender will not be placed inside the battery cartridge of the remote, since the remote’s casing will most likely be removed to be used within the panel. To limit the amount of batteries to be charged, the remote’s circuitry, and hopefully the extender, will all be powered by the panel’s one rechargeable battery supply. The team doesn’t anticipate a problem in the transceiver’s ability to detect the RF pulses from the remote by placing the extender near rather than in the remote, since the module acts as any other RF receiver, and the inventor’s placement of the extender seems to be more for the purposes of convenience and aesthetics rather than functionality. In place of the remote’s own buttons acting as switches for the remote, the control panel’s buttons will be wired to the remote’s circuitry to control the switch functionality.

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4 Free Patents Online: All the Inventions of Mankind at http://www.freepatentsonline.com/y2002/0105698.html
Figure 12: Overall view of the extender’s design, as taken from its patent

Once the first transceiver has transmitted the RF signal, a second transceiver picks up this signal and then converts it back to the original IR signal. An IR emitter is included with this part of the setup to communicate with the IR photodiode on the DVD player. Figure 13 below is the inventor’s description of the second transceiver.

Figure 13: Setup of second transceiver, as taken from its patent

In terms of the microcontrollers to be used for this project, a specific type has yet to be decided on. BasicStamp, Microchip’s PIC, or Arduino microcontrollers are all possibilities.
Alternative Design 2:
A second design differs only in the way the DVD player’s extender is implemented. Everything else remains the same, including using the DVD remote’s circuitry within the panel. Rather than buying the extender from NextGen, the team can create its own IR-RF converter. The benefit of this would be that the team would have more control over the extender’s circuitry and the price may be somewhat less than buying the whole device; however, the down-side is that creating the “guts” of a circuit adds to the tedious detail of the design process, especially debugging, as well as to the ordering process because several small parts will have to be purchased.

Figures 14 and 15 below are examples of IR-RF conversion circuits, which could be utilized in the team’s design. In these designs several pre-made chips are utilized to perform specific functions. Figure 14 describes the part of the circuit which would be placed in the control panel. The IC1 IR Receiver Module would be receiving its signal from the IR remote control’s circuitry in the panel. Then the signal is sent through four NAND gates to convert the IR signal to RF by inverting the logic. For infrared signals, a logic high is 0 and a logic low is 1; therefore, by inverting this logic, a high is 1 and a low is 0. The RF receiver and transmitter can then respond to this logic convention. After this conversion, the IC3 RF transmitter module can then transmit the RF signal at 315MHz. Figure 15 is the receiving half of the circuit, which then converts the RF signal back to IR using the IC2NE55 chip and emits an infrared signal via an LED.

The capacitors in the circuit are meant to reduce noise, and the circuit itself works for remotes which emit IR frequencies between 36-38 kHz. This is an acceptable range since most

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IR remotes emit signals between 38-40 kHz. The circuit’s frequency range could probably be adjusted by buying different receiver and transmitter modules.

**Alternative Design 3:**

The last alternative design to be discussed involves wiring the DVD’s transmitting system in the same way that the CD player and light are wired. It would still have a separate receiving hub, so the DVD player could still be moved around more easily without having to transport all three devices. As mentioned in Figure 10, in this design, the last three switches on the panel would be wired to three more inputs on the microcontroller. Using the remote’s circuitry in this design would be unnecessary. However, the difficult part would be to replicate the current signal going into the DVD player from the transmitter. There are two possibilities: The receiving end may still have to have circuitry, as described in Alternative Design 2, which would convert the RF signal back into its equivalent IR signal. Otherwise, the microcontroller, when controlling the DVD player, may have to send out signals with inverted logic, which may complicate the design process, since the other devices respond to the conventional logic form. In other words, this design is a combination of the previous two designs, so the above figures should be adequate in understanding this alternative.