GATEKEEPER 2013

Educational Overview

Presented by Jubilee BEST Robotics
Mobile, AL
This PowerPoint is ONLY to be used as a reference once the Gatekeeper Game Specific Rules have been read in their entirety.

We hope you enjoy Gatekeeper in your community. It has been our honor and privilege to design and develop the 2013 BEST National Game.

BEST of Luck!

The Jubilee BEST “A” Team
Mobile, Alabama
Educational Goals of Gatekeeper

• Real-world relevance of current technology (the “T” in BEST)
• Critical thinking skills and strategy
• Teamwork between driver and spotter
• Rigorous and educational yet FUN
Introduction to Gatekeeper

• **Squeaky**, the original BEST robot needs upgrades to become Squeaky 2.0
• All upgrades have been complete, but one component is missing: the **BEST CPU**
• We need your help in building the newest and fastest **CPU** on the market
History of Squeaky

• *Ted Mahler* and *Steve Marum*, Co-Founders of BEST, created Squeaky

• Squeaky has appeared over the last 21 years at Official BEST Prototype Games and other BEST events

• *Let’s meet Squeaky!*
Ready to build a BEST CPU?

Let’s begin by asking a few questions...
What is a CPU and what are the components of a BEST CPU?

The CPU (Central Processing Unit) is the part of a computer that performs the arithmetic, logic and control functions.

The internal components are composed of different combinations of logic gates to perform various logical functions for the CPU.
What is a Logic Gate?

A gate is a device implementing a Boolean function. A gate performs a logical operation on one or more Boolean inputs, and produces a single Boolean output. A gate consists of transistors.
A **transistor** is a small electronic semiconductor device having at least three electrical contacts, used in a circuit as an amplifier or switch.

In Gatekeeper, a **dowel** represents a container holding a large number of transistors.
Gatekeeper Transistor Values
--Gate Fabrication Area--

Transistor values for AND, OR and NOT gates

48 transistors
96 transistors

Upper Assembly Line

Lower Assembly Line

24 transistors
48 transistors

Non-painted end
Painted end
Gatekeeper Transistor Values
--Gate Fabrication Area--

Transistor values for **NAND** gates

48 transistors / 96 transistors
Transistors to Gates

Collect large numbers of transistors to make gates (chips)

Gates
• AND Gate = 24 transistors
• OR Gate = 24 transistors
• NOT Gate = 24 transistors
• NAND Gate = 16 transistors

Once enough transistors are collected to create gates, teams will put various gates together to create integrated circuits

Integrated Circuits
• Multiplexer: 2 AND + 1 OR + 1 NOT vs. 3 NAND
• Adder: 1 AND + 1 OR + 1 NOT vs. 2 NAND
• Decoder: 1 AND + 1 NOT vs. 2 NAND
• Data Latch: 1 AND + 1 OR + 1 NOT vs. 1 NAND

Once integrated circuits are complete, teams will begin building their BEST CPU

Core Processor Area
• ALU: 1 Multiplexer + 1 Adder
• 3 Registers: 1 Data Latch each
• 1 Instruction Decoder

Memory Module Area
• 8-bit: 1 Data Latch
• 32-bit: 4 Data Latches + 1 Address Decoder
<table>
<thead>
<tr>
<th># of Gates</th>
<th># of Transistors</th>
<th>Point Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 AND Gate</td>
<td>24</td>
<td>10 points</td>
</tr>
<tr>
<td>1 OR Gate</td>
<td>24</td>
<td>10 points</td>
</tr>
<tr>
<td>1 NOT Gate</td>
<td>24</td>
<td>10 points</td>
</tr>
<tr>
<td>1 NAND Gate</td>
<td>16</td>
<td>8 points</td>
</tr>
</tbody>
</table>

**Example #1**
1 AND Gate
24 transistors
10 points

**Example #2**
4 AND Gates
96 transistors
40 points
What is an Integrated Circuit?

There are four (4) types of integrated circuits in the Stage 2 Fabrication Area:

- **Multiplexers (MUX)**
- **Adders**
- **Decoders**
- **Data Latches (D-Latch)**
A **Multiplexer (MUX)** is a device that selects one of several analog or digital input signals and forwards the selected input into a single line.

![Image](play-hookie.com)

An **Adder** is a digital circuit that performs addition of numbers. The most common adders operate on binary numbers.

![Image](ami.ac.uk)
A **Decoder** is a device which does the reverse operation of an encoder, undoing the encoding so that the original information can be retrieved.

A **Data Latch (D-Latch)** is a latch which has a feedback path, so information can be retained by the device. Therefore latches can be memory devices, and can store one bit of data for as long as the device is powered. As the name suggests, latches are used to “latch onto” information and hold in place.
Building Integrated Circuits

- Gatekeeper: *Clothes hangers* represent gates. To build an integrated circuit, calculations must be made to determine the number and type of gates needed to create each circuit.

*Remember, inventory is required from Stage 1: Gate Fabrication Area.*
Squares represent colored hangers and the number required to build each integrated circuit. Strategy will determine whether a team uses NAND gates or AND/OR/NOT gates.
Gates to Integrated Circuits

Gates
- AND Gate = 24 transistors
- OR Gate = 24 transistors
- NOT Gate = 24 transistors
- NAND Gate = 16 transistors

Once enough transistors are collected to create gates, teams will put various gates together to create integrated circuits.

Integrated Circuits
- Multiplexer: 2 AND + 1 OR + 1 NOT vs. 3 NAND
- Adder: 1 AND + 1 OR + 1 NOT vs. 2 NAND
- Decoder: 1 AND + 1 NOT vs. 2 NAND
- Data Latch: 1 AND + 1 OR + 1 NOT vs. 1 NAND

Once integrated circuits are complete, teams will begin building their BEST CPU.

Core Processor Area
- ALU: 1 Multiplexer + 1 Adder
- 3 Registers: 1 Data Latch each
- 1 Instruction Decoder

Memory Module Area
- 8-bit: 1 Data Latch
- 32-bit: 4 Data Latches + 1 Address Decoder
Integrated Circuits (IC) Point Values
--IC Fabrication Area--

- Manufactured **MUX** 80 points
- Manufactured **Adders** 60 points
- Manufactured **Decoder** 40 points
- Manufactured **D-Latch** 60 points

**NOTE:** Upper assembly line operates twice the speed as the lower assembly line.

**Example #1:** 3 NAND gates on the upper Adder assembly line = 2 manufactured Adders.

**Example #2:** 3 NAND gates on the lower Adder assembly line = 1 manufactured Adder.
Collect large numbers of transistors to make gates (chips)

Gates
- AND Gate = 24 transistors
- OR Gate = 24 transistors
- NOT Gate = 24 transistors
- NAND Gate = 16 transistors

Once enough transistors are collected to create gates, teams will put various gates together to create integrated circuits

Integrated Circuits
- Multiplexer: 2 AND + 1 OR + 1 NOT vs. 3 NAND
- Adder: 1 AND + 1 OR + 1 NOT vs. 2 NAND
- Decoder: 1 AND + 1 NOT vs. 2 NAND
- Data Latch: 1 AND + 1 OR + 1 NOT vs. 1 NAND

Once integrated circuits are complete, teams will begin building their BEST CPU

Core Processor Area
- ALU: 1 Multiplexer + 1 Adder
- 3 Registers: 1 Data Latch each
- 1 Instruction Decoder

Memory Module Area
- 8-bit: 1 Data Latch
- 32-bit: 4 Data Latches + 1 Address Decoder
The BEST CPU Fabrication Area consists of two sub-areas:

- **Core Processor Area** (located on the left)
- **Memory Module Area** (located on the right)
What are the components of the Core Processor?

A **BEST Core Processor** requires:

- **(3) Registers** (made by placing **one D-Latch** into each designated area)
- **(1) Instruction Decoder** (made by placing **one Decoder** into the designated area)
- **(1) Arithmetic Logic Unit (ALU)** (made by placing **one MUX and one Adder** into the designated areas)
A **BEST Memory Module** is capable of fabricating two types of memory modules:

- **8-bit Memory Module** (made by placing one D-Latch into the designated area)
- **32-bit Memory Module** (made by placing four D-Latches and one Address Decoder into the designated area)
CPU Fabrication Point Values
--CPU Fabrication Area--

- **Register** installed: 90 points
- **Instruction Decoder** installed: 60 points
- **MUX** installed in ALU: 120 points
- **Adder** installed in ALU: 90 points
- **8-bit Memory Module** completed: 90 points
- **32-bit Memory Module** completed: 420 points
- **8-bit CPU** completed: 512 points
- **32-bit CPU** completed: 1024 points
Gatekeeper utilizes an inventory system that is independent from scoring values:

- Components fabricated in each stage are placed in a team’s inventory.
- This inventory is NOT represented physically, but is instead maintained by the BEST Scoring Software.
- Hubs will provide a display for viewing team inventory, but it is highly recommended that teams track their own inventory.
What is 5S?

The 5S system is a workplace organization method to organize a workspace to improve efficiency and effectiveness. The five S’s are:

• Sort
• Set in order
• Shine
• Standardize
• Sustain
The 5S Bonus

The **5S Bonus** is awarded at the completion of each match for maintaining a clean and safe work environment:

- **5S Bonus** is calculated at the end of each match but is not finalized until the end of the round.
- **5S Bonus** will be awarded at the end of a match, if no game pieces have been removed from play, and any game pieces in contact with the floor are also in contact with the robot.
- **The maximum 5S per round** is 10% of the scored amount.
Tie-Breaker

- In the event of a tie, the winner will be the team with the **highest notebook score**

- If the notebooks are tied, the winner will be determined by flipping a standard **U.S. Quarter** (preferably from Alabama!)
Good Luck!
Please remember to read the rules FIRST.
Any remaining questions can be addressed on the Official BEST Q&A!