Hofstra University

Final Project Report

AMC Model

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CSC132

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**Abstract:**

The AMC Roosevelt Field 8 Theater is currently screening several movies. The movies presently being shown consist of the following:

1. *Ralph Breaks the Internet*
2. *The Grinch*
3. *Creed II*
4. *Fantastic Beasts: The Crimes of Grindelwald*
5. *Instant Family*
6. *Robin Hood*
7. *Widows*

Each of these films are being shown in one of the screening areas within the larger theater. In addition to knowing what movies are being shown we also know the following:

1. Each of the Screening Area has a Total of 150 Seats
2. The Total Number of People Seeing a Given Movie Can be Determined by the Following Formula –
3. The Percentage of People Going to See Movies is Determined in Part by the Show Time

|  |  |
| --- | --- |
| **Times** | **Percentage** |
| 9:00 am – 12:00 pm | 80 % |
| 12:00 pm – 4:30 pm | 60 % |
| 4:30 pm – 8:00 pm | 80 % |
| After 8:00 pm | 90 % |

1. The Arrival Time for Customers for Each Movie is Determined by the Genre

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Time** | **Drama** | **Romantic** | **Horror** | **Action** | **Family** | **Other** |
| 30 Minutes Early | 40 % | 30 % | 50 % | 60 % | 30 % | 25 % |
| 15 Minutes Early | 25 % | 50 % | 30 % | 20 % | 40 % | 25 % |
| 0 Minutes | 10 % | 20 % | 10 % | 20 % | 10 % | 25 % |
| 15 Minutes Late | 25 % | 0 % | 10 % | 0 % | 20 % | 25 % |

1. The Genre of Movie Also Determines the Group Breakdown for Customers

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Group Size** | **Drama** | **Romantic** | **Horror** | **Action** | **Family** | **Other** |
| 2 | 50 % | 70 % | 30 % | 40 % | 20 % | 25 % |
| 4 | 30 % | 20 % | 40 % | 30 % | 40 % | 25 % |
| 6 | 10 % | 10 % | 30 % | 10 % | 30 % | 25 % |
| 8 | 10 % | 0 % | 0 % | 20 % | 10 % | 25 % |

1. The Genre of Movie Also Determines How Much Food a Customer Buys

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Items** | **Drama** | **Romantic** | **Horror** | **Action** | **Family** | **Other** |
| 0 | 40 % | 15 % | 50 % | 40 % | 20 % | 25 % |
| 1 – 2 | 50 % | 70 % | 40 % | 30 % | 40 % | 25 % |
| 3 – 4 | 5 % | 15 % | 10 % | 20 % | 30 % | 25 % |
| + 5 | 5 % | 0 % | 0 % | 10 % | 10 % | 25 % |

1. Half of Customers Get Tickets Online and Half Get Them in the Theater
2. People Who Buy Tickets Online Must Get Their Tickets Scanned at One of Two Kiosks
3. If the Person is Buying the Ticket in the Theater, They Either Can Purchase It from One of Three Electronic Kiosks or From a Human Kiosk Which is Always Staffed by at Least One Person
4. There are Always Ten People Working at the Concession’s Stand

It was through the information provided above that a model of the theater could be constructed of the theater to serve the following three purposes:

1. How Many Customers Come to the Theater Through the Course of the Day
2. Determine If There is a Way to Reduce Cost of Operations with a Reduction in Quality of Service
3. Would it be Cost Effective to Install Some Electronic Vending Kiosks Instead of Just Having Ten People Working at the Concession’s Stand

**Data / Analysis:**

Prior to the construction of the theater’s model, I first had to calculate the number of people who would attend each movie and their individual arrival times. To accomplish this task, I split up the calculations into three phases, the first part being to calculate the number of people who would fill each screening room based solely on the time of day this data is represented as follows:

|  |  |  |
| --- | --- | --- |
| **Times** | **Math** | **Number of People** |
| 9:00 am – 12:00 pm |  | 120 |
| 12:00 am – 4:30 pm |  | 90 |
| 4:30 pm – 8:00 pm |  | 120 |
| After 8:00 pm |  | 135 |

With the number of maximum number of people that would be in each showing determined only by the time of day, I could then go deeper into the number of people who would arrive for each movie showing, this was accomplished by finding the audience score from Rotten Tomatoes for each movie playing. The results were as follows:

*Ralph Breaks the Internet* – Audience Score = 68 %

|  |  |  |
| --- | --- | --- |
| **Showings** | **Math** | **Number of People** |
| 9:50 am |  | 82 |
| 12:55 pm |  | 61 |
| 3:05 pm |  | 61 |
| 3:50 pm |  | 61 |
| 6:00 pm |  | 82 |
| 9:00 pm |  | 92 |

*The Grinch* – Audience Score = 59 %

|  |  |  |
| --- | --- | --- |
| **Showings** | **Math** | **Number of People** |
| 10:30 am |  | 71 |
| 12:40 pm |  | 53 |
| 4:50 pm |  | 71 |
| 8:20 pm |  | 80 |
| 9:50 pm |  | 80 |

*Creed II* – Audience Score = 88 %

|  |  |  |
| --- | --- | --- |
| **Showings** | **Math** | **Number of People** |
| 10:45 am |  | 106 |
| 2:00 pm |  | 79 |
| 4:45 pm |  | 106 |
| 6:45 pm |  | 106 |
| 8:00 pm |  | 106 |
| 10:00 pm |  | 119 |
| 11:10 pm |  | 119 |

*Fantastic Beasts: The Crimes of Grindelwald* – Audience Score = 64 %

|  |  |  |
| --- | --- | --- |
| **Showings** | **Math** | **Number of People** |
| 10:15 am |  | 77 |
| 1:10 pm |  | 58 |
| 5:10 pm |  | 77 |
| 7:20 pm |  | 77 |
| 10:45 pm |  | 86 |

*Instant Family* – Audience Score = 83 %

|  |  |  |
| --- | --- | --- |
| **Showings** | **Math** | **Number of People** |
| 11:30 am |  | 100 |
| 2:30 pm |  | 75 |
| 5:35 pm |  | 100 |
| 8:35 pm |  | 112 |
| 11:30 pm |  | 112 |

*Robin Hood* – Audience Score = 49 %

|  |  |  |
| --- | --- | --- |
| **Showings** | **Math** | **Number of People** |
| 10:15 am |  | 59 |
| 1:20 pm |  | 44 |
| 4:10 pm |  | 44 |
| 7:00 pm |  | 59 |
| 10:30 pm |  | 66 |

*Widows* – Audience Score = 62 %

|  |  |  |
| --- | --- | --- |
| **Showings** | **Math** | **Number of People** |
| 10:00 am |  | 74 |
| 1:30 pm |  | 56 |
| 4:35 pm |  | 74 |
| 7:40 pm |  | 74 |
| 11:00 pm |  | 84 |

With the total number of people that would see each movie at each showing calculated, then I moved on to calculate their arrival times and how they break into groups; wheatear they be a group of two, four, six, or eight, with the over flow from those categories being said to be going by themselves. The arrival times and group breakdown are determined by the genre of the movie. The results were as follows:

*Ralph Breaks the Internet* – Genre = Family

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Time in Minutes** | **Math** | **Number of People** | **By Self** | **Group of Two** | **Group of Four** | **Group of Six** | **Group of Eight** |
| 20 |  | 25 | 5 | 6 | 8 | 6 | 0 |
| 35 |  | 33 | 7 | 6 | 8 | 12 | 0 |
| 50 |  | 8 | 2 | 2 | 4 | 0 | 0 |
| 65 |  | 16 | 2 | 4 | 4 | 6 | 0 |
| 205 |  | 18 | 4 | 4 | 4 | 6 | 0 |
| 220 |  | 25 | 5 | 6 | 8 | 6 | 0 |
| 235 |  | 6 | 4 | 2 | 0 | 0 | 0 |
| 250 |  | 12 | 0 | 2 | 4 | 6 | 0 |
| 335 |  | 18 | 4 | 4 | 4 | 6 | 0 |
| 350 |  | 25 | 5 | 6 | 8 | 6 | 0 |
| 365 |  | 6 | 4 | 2 | 0 | 0 | 0 |
| 380 |  | 12 | 0 | 2 | 4 | 6 | 0 |
| 380 |  | 18 | 4 | 4 | 4 | 6 | 0 |
| 395 |  | 25 | 5 | 6 | 8 | 6 | 0 |
| 410 |  | 6 | 4 | 2 | 0 | 0 | 0 |
| 425 |  | 12 | 0 | 2 | 4 | 6 | 0 |
| 510 |  | 25 | 5 | 6 | 8 | 6 | 0 |
| 525 |  | 33 | 7 | 6 | 8 | 12 | 0 |
| 540 |  | 8 | 2 | 2 | 4 | 0 | 0 |
| 555 |  | 16 | 2 | 4 | 4 | 6 | 0 |
| 690 |  | 28 | 2 | 6 | 8 | 12 | 0 |
| 705 |  | 37 | 5 | 8 | 12 | 12 | 0 |
| 720 |  | 9 | 1 | 2 | 0 | 6 | 0 |
| 735 |  | 18 | 4 | 4 | 4 | 6 | 0 |

*The Grinch* – Genre = Family

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Time in Minutes** | **Math** | **Number of People** | **By Self** | **Group of Two** | **Group of Four** | **Group of Six** | **Group of Eight** |
| 60 |  | 21 | 3 | 4 | 8 | 6 | 0 |
| 75 |  | 29 | 3 | 6 | 8 | 12 | 0 |
| 90 |  | 7 | 1 | 2 | 4 | 0 | 0 |
| 105 |  | 14 | 2 | 2 | 4 | 6 | 0 |
| 190 |  | 16 | 2 | 4 | 4 | 6 | 0 |
| 205 |  | 21 | 3 | 4 | 8 | 6 | 0 |
| 220 |  | 5 | 3 | 2 | 0 | 0 | 0 |
| 235 |  | 11 | 1 | 0 | 4 | 6 | 0 |
| 440 |  | 21 | 3 | 4 | 8 | 6 | 0 |
| 455 |  | 29 | 3 | 6 | 8 | 12 | 0 |
| 470 |  | 7 | 1 | 2 | 4 | 0 | 0 |
| 485 |  | 14 | 2 | 2 | 4 | 6 | 0 |
| 650 |  | 24 | 6 | 4 | 8 | 6 | 0 |
| 665 |  | 32 | 6 | 6 | 8 | 12 | 0 |
| 680 |  | 8 | 2 | 2 | 4 | 0 | 0 |
| 695 |  | 16 | 2 | 4 | 4 | 6 | 0 |
| 740 |  | 24 | 6 | 4 | 8 | 6 | 0 |
| 755 |  | 32 | 6 | 6 | 8 | 12 | 0 |
| 770 |  | 8 | 2 | 2 | 4 | 0 | 0 |
| 785 |  | 16 | 2 | 4 | 4 | 6 | 0 |

*Creed II* – Genre = Drama

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Time in Minutes** | **Math** | **Number of People** | **By Self** | **Group of Two** | **Group of Four** | **Group of Six** | **Group of Eight** |
| 75 |  | 42 | 0 | 22 | 12 | 0 | 8 |
| 90 |  | 27 | 5 | 14 | 8 | 0 | 0 |
| 105 |  | 10 | 0 | 6 | 4 | 0 | 0 |
| 120 |  | 27 | 5 | 14 | 8 | 0 | 0 |
| 270 |  | 32 | 2 | 16 | 8 | 6 | 0 |
| 285 |  | 20 | 2 | 10 | 8 | 0 | 0 |
| 300 |  | 7 | 3 | 4 | 0 | 0 | 0 |
| 315 |  | 20 | 2 | 10 | 8 | 0 | 0 |
| 435 |  | 42 | 0 | 22 | 12 | 0 | 8 |
| 450 |  | 27 | 5 | 14 | 8 | 0 | 0 |
| 465 |  | 10 | 0 | 6 | 4 | 0 | 0 |
| 480 |  | 27 | 5 | 14 | 8 | 0 | 0 |
| 555 |  | 42 | 0 | 22 | 12 | 0 | 8 |
| 570 |  | 27 | 5 | 14 | 8 | 0 | 0 |
| 585 |  | 10 | 0 | 6 | 4 | 0 | 0 |
| 600 |  | 27 | 5 | 14 | 8 | 0 | 0 |
| 630 |  | 42 | 0 | 22 | 12 | 0 | 8 |
| 645 |  | 27 | 5 | 14 | 8 | 0 | 0 |
| 660 |  | 10 | 0 | 6 | 4 | 0 | 0 |
| 675 |  | 27 | 5 | 14 | 8 | 0 | 0 |
| 750 |  | 48 | 0 | 24 | 16 | 0 | 8 |
| 765 |  | 30 | 0 | 16 | 8 | 6 | 0 |
| 780 |  | 11 | 1 | 6 | 4 | 0 | 0 |
| 795 |  | 30 | 0 | 16 | 8 | 6 | 0 |
| 820 |  | 48 | 0 | 24 | 16 | 0 | 8 |
| 835 |  | 30 | 0 | 16 | 8 | 6 | 0 |
| 850 |  | 11 | 1 | 6 | 4 | 0 | 0 |
| 865 |  | 30 | 0 | 16 | 8 | 6 | 0 |

*Fantastic Beasts: The Crimes of Grindelwald* – Genre = Other / Adventure

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Time in Minutes** | **Math** | **Number of People** | **By Self** | **Group of Two** | **Group of Four** | **Group of Six** | **Group of Eight** |
| 45 |  | 20 | 2 | 6 | 4 | 0 | 8 |
| 60 |  | 19 | 3 | 4 | 4 | 0 | 8 |
| 75 |  | 19 | 3 | 4 | 4 | 0 | 8 |
| 90 |  | 19 | 3 | 4 | 4 | 0 | 8 |
| 220 |  | 15 | 1 | 4 | 4 | 6 | 0 |
| 235 |  | 15 | 1 | 4 | 4 | 6 | 0 |
| 250 |  | 14 | 0 | 4 | 4 | 6 | 0 |
| 265 |  | 14 | 0 | 4 | 4 | 6 | 0 |
| 460 |  | 20 | 2 | 6 | 4 | 0 | 8 |
| 475 |  | 19 | 3 | 4 | 4 | 0 | 8 |
| 490 |  | 19 | 3 | 4 | 4 | 0 | 8 |
| 505 |  | 19 | 3 | 4 | 4 | 0 | 8 |
| 590 |  | 20 | 2 | 6 | 4 | 0 | 8 |
| 605 |  | 19 | 3 | 4 | 4 | 0 | 8 |
| 620 |  | 19 | 3 | 4 | 4 | 0 | 8 |
| 635 |  | 19 | 3 | 4 | 4 | 0 | 8 |
| 795 |  | 22 | 4 | 6 | 4 | 0 | 8 |
| 810 |  | 22 | 4 | 6 | 4 | 0 | 8 |
| 825 |  | 21 | 3 | 6 | 4 | 0 | 8 |
| 840 |  | 21 | 3 | 6 | 4 | 0 | 8 |

*Instant Family* – Genre = Other / Comedy

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Time in Minutes** | **Math** | **Number of People** | **By Self** | **Group of Two** | **Group of Four** | **Group of Six** | **Group of Eight** |
| 120 |  | 25 | 5 | 6 | 8 | 6 | 0 |
| 135 |  | 25 | 5 | 6 | 8 | 6 | 0 |
| 150 |  | 25 | 5 | 6 | 8 | 6 | 0 |
| 165 |  | 25 | 5 | 6 | 8 | 6 | 0 |
| 300 |  | 19 | 5 | 4 | 4 | 6 | 0 |
| 315 |  | 19 | 5 | 4 | 4 | 6 | 0 |
| 330 |  | 19 | 5 | 4 | 4 | 6 | 0 |
| 345 |  | 18 | 4 | 4 | 4 | 6 | 0 |
| 485 |  | 25 | 5 | 6 | 8 | 6 | 0 |
| 500 |  | 25 | 5 | 6 | 8 | 6 | 0 |
| 515 |  | 25 | 5 | 6 | 8 | 6 | 0 |
| 530 |  | 25 | 5 | 6 | 8 | 6 | 0 |
| 665 |  | 28 | 6 | 8 | 8 | 6 | 0 |
| 680 |  | 28 | 6 | 8 | 8 | 6 | 0 |
| 695 |  | 28 | 6 | 8 | 8 | 6 | 0 |
| 710 |  | 28 | 6 | 8 | 8 | 6 | 0 |
| 840 |  | 28 | 6 | 8 | 8 | 6 | 0 |
| 855 |  | 28 | 6 | 8 | 8 | 6 | 0 |
| 870 |  | 28 | 6 | 8 | 8 | 6 | 0 |
| 885 |  | 28 | 6 | 8 | 8 | 6 | 0 |

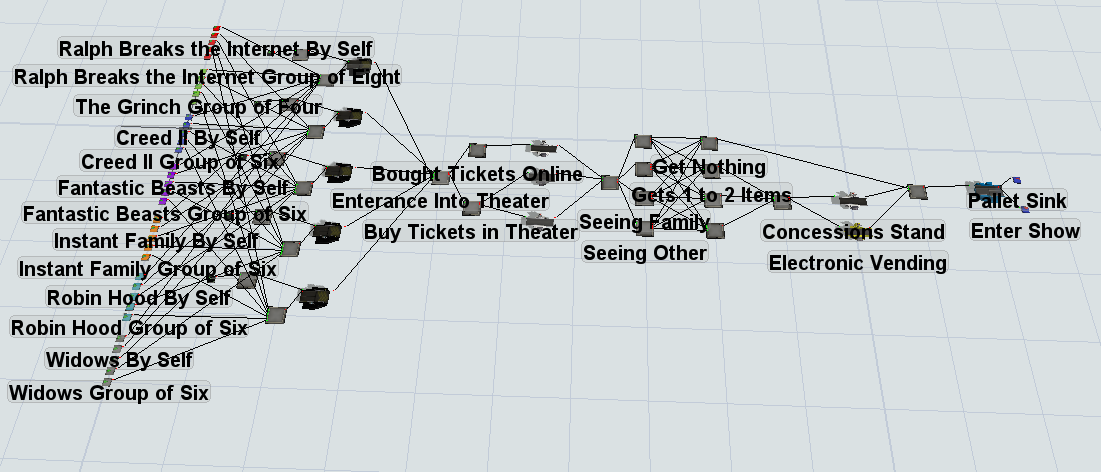
*Robin Hood* – Genre = Action

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Time in Minutes** | **Math** | **Number of People** | **By Self** | **Group of Two** | **Group of Four** | **Group of Six** | **Group of Eight** |
| 45 |  | 35 | 1 | 14 | 12 | 0 | 8 |
| 60 |  | 12 | 4 | 4 | 4 | 0 | 0 |
| 75 |  | 12 | 4 | 4 | 4 | 0 | 0 |
| 90 |  | 0 | 0 | 0 | 0 | 0 | 0 |
| 230 |  | 26 | 0 | 10 | 8 | 0 | 8 |
| 245 |  | 9 | 1 | 4 | 4 | 0 | 0 |
| 260 |  | 9 | 1 | 4 | 4 | 0 | 0 |
| 275 |  | 0 | 0 | 0 | 0 | 0 | 0 |
| 400 |  | 26 | 0 | 10 | 8 | 0 | 8 |
| 414 |  | 9 | 1 | 4 | 4 | 0 | 0 |
| 430 |  | 9 | 1 | 4 | 4 | 0 | 0 |
| 445 |  | 0 | 0 | 0 | 0 | 0 | 0 |
| 570 |  | 35 | 1 | 14 | 12 | 0 | 8 |
| 585 |  | 12 | 4 | 4 | 4 | 0 | 0 |
| 600 |  | 12 | 4 | 4 | 4 | 0 | 0 |
| 615 |  | 0 | 0 | 0 | 0 | 0 | 0 |
| 780 |  | 40 | 4 | 16 | 12 | 0 | 8 |
| 795 |  | 13 | 3 | 6 | 4 | 0 | 0 |
| 810 |  | 13 | 3 | 6 | 4 | 0 | 0 |
| 825 |  | 0 | 0 | 0 | 0 | 0 | 0 |

*Widows* – Genre = Other / Crime

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Time in Minutes** | **Math** | **Number of People** | **By Self** | **Group of Two** | **Group of Four** | **Group of Six** | **Group of Eight** |
| 30 |  | 19 | 5 | 4 | 4 | 6 | 0 |
| 45 |  | 19 | 5 | 4 | 4 | 6 | 0 |
| 60 |  | 19 | 5 | 4 | 4 | 6 | 0 |
| 75 |  | 18 | 4 | 4 | 4 | 6 | 0 |
| 240 |  | 14 | 0 | 4 | 4 | 6 | 0 |
| 255 |  | 14 | 0 | 4 | 4 | 6 | 0 |
| 270 |  | 14 | 0 | 4 | 4 | 6 | 0 |
| 285 |  | 14 | 0 | 4 | 4 | 6 | 0 |
| 425 |  | 19 | 5 | 4 | 4 | 6 | 0 |
| 440 |  | 19 | 5 | 4 | 4 | 6 | 0 |
| 455 |  | 19 | 5 | 4 | 4 | 6 | 0 |
| 470 |  | 18 | 4 | 4 | 4 | 6 | 0 |
| 610 |  | 19 | 5 | 4 | 4 | 6 | 0 |
| 625 |  | 19 | 5 | 4 | 4 | 6 | 0 |
| 640 |  | 19 | 5 | 4 | 4 | 6 | 0 |
| 655 |  | 18 | 4 | 4 | 4 | 6 | 0 |
| 810 |  | 21 | 5 | 6 | 4 | 6 | 0 |
| 825 |  | 21 | 5 | 6 | 4 | 6 | 0 |
| 840 |  | 21 | 5 | 6 | 4 | 6 | 0 |
| 855 |  | 21 | 5 | 6 | 4 | 6 | 0 |

With the arrival times calculated we known that the theater will receive a total of 3,046 people through the course of the day. I could then move on to creating the actual model. Which in the end looks like this:



To create this model, I first started with a total of 35 sources: 5 for each film, representing arrival times for people arriving by themselves, to form a group of two, four, six, and eight. On each one of the patron’s creation I would have them have an item type tagged to them based on the movie they were going to see; example *Ralph Breaks the Internet* = 1 and *Robin Hood* = 6. After the sources for the customers were made, I had each one sent to a combiner which placed each one into its corresponding group size; the time this takes I sent to zero minutes under the assumption that the customers who are going to see a movie in a group came together. Once the groups were formed, they are sent to the Entrance to the Theater Queue which splits them 50 / 50 for those who bought tickets online and those who chose to buy their tickets in the theater. If the person bought tickets online they would have to go to one of two kiosks to have there tickets scanned which has a time distribution of johnsonbounded(3.12956, 5.43887, -0.24789, 0.67414, getstream(**current**)). If the customer goes to buy a ticket in the theater they could either buy it from a human kiosk which always has at least one person working it and at most three, this has a time distribution of johnsonbounded(3.38572, 12.12971, -0.03885, 0.65504, getstream(**current**)) or the customer could get it from one of three electronic ticket kiosks which has a time distribution of beta(0.00205, 13.65796, 6.33031, 12.51746, getstream(**current**)). Once the customer has had their ticket scanned or bought their ticket they can enter the main theater lobby and decide whether or not they want to buy food and if so how much, this was done through sending the customer to a queue to represent the genre of movie they are seeing and then by percentage select if they are getting food or not and if they are assign a new item type to them; example 8 if they are getting 1 – 2 items or 10 if they are getting 5 or more items. If the customer is getting food they are sent to a processor which h can support up to ten people at a time and depending on what they are getting could have a time distribution of weibull(0, 2.87945, 2.76283, getstream(**current**)) if they are getting 1 – 2 items, weibull(0, 4.95070, 2.32190, getstream(**current**)) if you are getting 3 – 4 items, and weibull(0, 7.96499, 2.00407, getstream(**current**)). Once done with purchasing food customers would go through a separator and enter their given show. Once the model was completed I ran it and found that in its default design provided that most everything worked properly however, people who bought a ticket online and had to have it scanned by only one of two ticket kiosks had to wait an excessive amount of time averaging around 260 minutes, this would be greatly rectified by increasing the number of available kiosk to scan tickets from 2 to 4 which drastically reduces the wait time to being around four minutes. Beyond that if you let the system run with ten people working the concession’s stand, three electronic ticket kiosks to buy tickets and a human kiosk to buy tickets always operated by three people everything can run smoothly. But while the system does run well, costs could be greatly cut at the concession’s stand. If the theater was to purchase just one electronic vending machine at a cost of $25,000, they could afford to only have three human workers to stay in concessions, this is going under the assumption that each worker earns minimum wage and works a 40-hour work week, which would average to about $22,880 per employee for their yearly earning. Installing just one machine would be able to remove seven employees saving a total of $160,160 per year if the machine is purchased.