Wood Cut Optimization

1.0 Summary

The program was run for 4 different test cases with input wood length of 120, and 168, and for house quantities of 1, 2, 4, and 10.

From the 4 results we found that as the number of houses built at the same time goes up the relative waste generated decreases by ~1%. When 1 house is built then there is around ~5% of total waste; however, when 10 houses are built there is ~4% of total waste.

On average, the program's result has 4-5% waste of original product. This 4-5% was accounts for both reusable and unusable (ie. wood pieces smaller than the smallest size useable for the house) wood pieces. Reusable wood pieces account for around 80% waste and unusable waste accounts for around 20% of the waste.

The program when run asks for inputs for the wood sizes that will be put in, and the quantity of houses that need to be built. The program then returns a text file that contains the cutting information and other details that are useful for buying and storing the wood pieces.

The instructions for how to interpret the files are shown below.

2.0 Interpreting Output Results

```
Preprocessed Wood Size [168, 120]
Quantity of Houses 10
Quantity of needed boards {125: 100, 120: 400, 108: 260, 99: 50, 60: 100,
49: 100, 43: 240, 34: 120, 30: 50, 12: 260}
```

The first 3 lines of the output files are to show the configurations used to generate that file.

```
The number of boards utilized: 892
The number of boards with perfect cuts: 682
Wood Size: 168 x265
Wood Size: 120 x417
The number of boards with wasteful cuts: 210
Wood Size: 168 x210
----- Total Boards Needed -----
Wood Size: 120 x475
Wood Size: 168 x417
```

The next 10 lines indicate key characteristics such as size and quantity of wood boards used so that ordering boards or separating total boards needed is easy.

```
----- Cutting Patterns -----
Cutting pattern format: {size1: quantity1, size2: quantity2} x boards
```

The line under cutting patterns heading indicates how the results should be interpreted. The size and quantity in brackets indicate the sizes of the wooden pieces that need to be cut and how many pieces of that size need to be cut from that board. The final “x boards” indicates the number of boards this pattern should be used on.

```
--- Perfect cuts (no waste) ---
Wood Size: 168
{125: 1, 43: 1} x100
{120: 1, 12: 4} x65
{108: 1, 60: 1} x100
Wood Size: 120
{120: 1} x335
{43: 2, 34: 1} x70
{30: 4} x12
```

The perfect cuts section then gives the cuttings that result in zero waste. The lines highlighted in green indicate which board size is being used below.

```
--- Imperfect cuts (some waste) ---
Wood Size: 168
{108: 1, 49: 1} x100
{108: 1, 34: 1} x50
{108: 1, 30: 2} x1
{108: 1} x9
{99: 1} x50
```

The imperfect cuts section then gives the cuttings that result in some waste. This section is read the same way perfect cuts section is.

```
--- End of cutting patterns ---
Unusable waste produced: {11: 100}
Amount wasted: 1100
Usable waste produced: {26: 50, 60: 9, 69: 50}
Amount reusable through further cutting: 5290
```

The end of cutting patterns heading signifies that all wood pieces should have been cut. The lines below show how much waste was generated and how much waste is usable and how much can't be used.

The reusable waste shows the waste sizes but not how to cut them to allow for flexibility in cutting according to pieces required in the future.

3.0 Results

3.1 1 House (Wood Sizes 120, 168)

```
Preprocessed Wood Size [120, 168]
Quantity of Houses 1
Quantity of needed boards {125: 10, 120: 40, 108: 26, 99: 5, 60: 10, 49:
10, 43: 24, 34: 12, 30: 5, 12: 26}
The number of boards utilized: 101
The number of boards with perfect cuts: 84
Wood Size: 120 x84
Wood Size: 168 x0
The number of boards with wasteful cuts: 17
Wood Size: 168 x17
----- Total Boards Needed -----
Wood Size: 120 x84
Wood Size: 168 x17
----- Cutting Patterns -----
Cutting patters to get inventory: {size, quantity}
--- Perfect cuts (no waste) ---
Wood Size: 120
{120: 1} x40
{108: 1, 12: 1} x26
{60: 2} x4
{60: 1, 30: 2} x2
{43: 2, 34: 1} x12
Wood Size: 168
--- Imperfect cuts (some waste) ---
{125: 1, 30: 1} x1
{125: 1} x9
{99: 1, 49: 1} x5
{49: 3} x1
{49: 2} x1
--- End of cutting patterns ---
Unusable waste produced: {}
Amount wasted: 0
Usable waste produced: {13: 1, 43: 9, 20: 5, 21: 1, 70: 1}
Amount reusable through further cutting: 591
```

3.2 2 Houses (Wood Sizes 120, 168)

```
Preprocessed Wood Size [120, 168]
Quantity of Houses 2
Quantity of needed boards {125: 20, 120: 80, 108: 52, 99: 10, 60: 20, 49:
20, 43: 48, 34: 24, 30: 10, 12: 52}
The number of boards utilized: 202
The number of boards with perfect cuts: 168
Wood Size: 120 x168
Wood Size: 168 x0
The number of boards with wasteful cuts: 34
Wood Size: 168 x34
----- Total Boards Needed -----
Wood Size: 120 x168
Wood Size: 168 x34
----- Cutting Patterns -----
Cutting patters to get inventory: {size, quantity}
--- Perfect cuts (no waste) ---
Wood Size: 120
{120: 1} x80
{108: 1, 12: 1} x52
{60: 2} x7
{60: 1, 30: 2} x5
{43: 2, 34: 1} x24
Wood Size: 168
--- Imperfect cuts (some waste) ---
{125: 1} x20
{99: 1, 60: 1} x1
{99: 1, 49: 1} x9
{49: 3} x3
{49: 2} x1
--- End of cutting patterns ---
Unusable waste produced: {9: 1}
Amount wasted: 9
Usable waste produced: {43: 20, 20: 9, 21: 3, 70: 1}
Amount reusable through further cutting: 1173
```

3.3 4 Houses (Wood Sizes 120, 168)

```
Preprocessed Wood Size [120, 168]
Quantity of Houses 4
Quantity of needed boards {125: 40, 120: 160, 108: 104, 99: 20, 60: 40,
49: 40, 43: 96, 34: 48, 30: 20, 12: 104}
The number of boards utilized: 404
The number of boards with perfect cuts: 337
Wood Size: 120 x337
Wood Size: 168 x0
The number of boards with wasteful cuts: 67
Wood Size: 168 x67
----- Total Boards Needed -----
Wood Size: 120 x337
Wood Size: 168 x67
----- Cutting Patterns -----
Cutting patters to get inventory: {size, quantity}
--- Perfect cuts (no waste) ---
Wood Size: 120
{120: 1} x160
{108: 1, 12: 1} x104
{60: 2} x15
{60: 1, 30: 2} x10
{43: 2, 34: 1} x48
Wood Size: 168
--- Imperfect cuts (some waste) ---
{125: 1} x40
{99: 1, 49: 1} x20
{49: 3} x6
{49: 2} x1
--- End of cutting patterns ---
Unusable waste produced: {}
Amount wasted: 0
Usable waste produced: {43: 40, 20: 20, 21: 6, 70: 1}
Amount reusable through further cutting: 2316
```

3.4 10 Houses (Wood Sizes 120, 168)

```
Preprocessed Wood Size [128, 168]
Quantity of Houses 10
Quantity of needed boards {125: 100, 120: 400, 108: 260, 99: 50, 60: 100,
49: 100, 43: 240, 34: 120, 30: 50, 12: 260}
The number of boards utilized: 954
The number of boards with perfect cuts: 319
Wood Size: 128 x144
Wood Size: 168 x175
The number of boards with wasteful cuts: 635
Wood Size: 168 x635
----- Total Boards Needed -----
Wood Size: 128 x144
Wood Size: 168 x810
----- Cutting Patterns -----
Cutting patters to get inventory: {size, quantity}
--- Perfect cuts (no waste) ---
Wood Size: 128
{60: 1, 34: 2} x60
{49: 2, 30: 1} x33
{49: 1, 43: 1, 12: 3} x34
{43: 2, 30: 1, 12: 1} x17
Wood Size: 168
{125: 1, 43: 1} x100
{120: 1, 12: 4} x35
{108: 1, 60: 1} x40
--- Imperfect cuts (some waste) ---
{120: 1, 43: 1} x72
{120: 1, 12: 1} x1
{120: 1} x292
{108: 1} x220
{99: 1} x50
--- End of cutting patterns ---
Unusable waste produced: {5: 72}
Amount wasted: 360
Usable waste produced: {36: 1, 48: 292, 60: 220, 69: 50}
Amount reusable through further cutting: 30702
```