



# COST PROPOSALS

Guggenheim Museum

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BUAN 5260: Math Modeling



To: Guggenheim Museum, Board of Directors  
From: Gabe Boucaud, Kimberly Le  
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Subject: Cost analysis of five different proposals

Prior to analyzing the proposals, we have considered the following constraints in all of the proposals (unless told otherwise):

Museum	<ul style="list-style-type: none"><li>• The display price includes the cost of paying the artist for loaning the piece to the museum, transporting the piece, constructing the display for the piece, insuring the piece while it is on display, and transporting the piece back to its origin</li><li>• Maximum of 4 sculptures</li><li>• Maximum of 20 paintings, collages, and drawings</li></ul>
Valentino	<ul style="list-style-type: none"><li>• One collage</li><li>• At least one wire mesh sculpture displayed if a computer-generated drawing is displayed</li><li>• At least one computer-generated drawing displayed if a wire mesh sculpture is displayed</li><li>• At least one photo-realistic painting</li><li>• At least one cubist painting</li><li>• At least one expressionist painting</li><li>• At least one watercolor painting</li><li>• At least one oil painting</li><li>• Number of paintings to be no greater than three times the number of other art forms</li><li>• All his own paintings included in the exhibit</li><li>• All of Helen's</li><li>• As many pieces from David as from Enrique and to display at least one piece from each of them</li><li>• Display as many pieces from David Lyman as from Enrique</li><li>• One display piece from Rick, if any at all</li></ul>
Celeste	<ul style="list-style-type: none"><li>• At least one piece from a female artist for every three pieces included from a male artist.</li><li>• Include either one or both of the pieces "Aging Earth" and "Wasted Resources."</li><li>• Include at least one piece by Stuart</li><li>• Include at least one of the following pieces: "Beyond," "Who Has Control," "Where are we now?" and "Pioneers."</li><li>• If "Narcissism" is displayed, "Reflection" should also be displayed</li></ul>

## Proposal 1

The Guggenheim allocates a \$4 million budget to fund the exhibit. Given the available pieces and the specific requirements from Valentino and Celeste, formulate and solve a BIP model to maximize the number of pieces displayed in the exhibit without exceeding the budget. How many pieces are displayed? Which pieces are displayed?

Given the specific requirements by Valentino and Celeste and the Guggenheim fund (\$4 million), we suggest displaying 15 pieces which would equate to \$3.95 million. Below is the list of art pieces:

Artist	Piece	Description of Piece	Medium/Style
Nicholas	Emergence	A wire mesh sculpture of a man	Wire Mesh
Rita	Beyond	A series of computer-generated drawings	Computer-generated
Norm	Wasted Resources	A collage of various packaging materials	Collage
Helen	Serenity	A painting with an all blue watercolor background and a black watercolor center	Watercolor
Helen	Calm Before the Storm	An all blue watercolor painting	Painting
Robert	Void	An all black oil painting	Oil
Enrique	Harley	A photo-realistic painting of a Harley-Davidson motorcycle	Photo-Realist
Angie	Reflection	A mirror (considered a sculpture)	Sculpture
David	Ziggy III	An expressionist self-portrait (painting)	expressionist
Stuart	Wisdom	A pen-and-ink drawing of an Apache chieftain	Drawing
Candy	Study of a Fruit Bowl	A cubist painting of a bowl of fruit	Cubist
Valentino	All That Glitters	A watercolor painting of the Golden Gate Bridge	Watercolor
Valentino	The Rock	A watercolor painting of Alcatraz	Watercolor
Valentino	Winding Road	A watercolor painting of Lombard Street	Watercolor
Valentino	1071 Fifth Ave	A watercolor painting of The Guggenheim	Watercolor

## Proposal 2

To ensure that the exhibit draws the attention of the public, Celeste decides that it must include at least 20 pieces. Formulate and solve a BIP model to minimize the cost of the exhibit while displaying at least 20 pieces and meeting the requirements set by Valentino and Celeste. How much does the exhibit cost? Which pieces should be displayed?

Adjusting for a new strategy by lifting the 20-art piece restriction to display at least 20 art pieces while minimizing the cost of the exhibit, we suggest displaying 20 art pieces which totals to \$5.6 million. Below are the pieces that should be displayed:

Artist	Piece	Description of Piece	Medium/Style
Nicholas	Burden	A wire mesh sculpture of a mule	Wire Mesh
Nicholas	Emergence	A wire mesh sculpture of a man	Wire Mesh
Rita	Beyond	A series of computer-generated drawings	Computer-generated
Rita	Who Has Control?	A computer-generated drawing intermeshed with lines of computer code	Computer-generated
Rita	Domestication	A pen-and-ink drawing of a house	Drawing
Norm	Wasted Resources	A collage of various packaging materials	Collage
Helen	Serenity	A painting with an all blue watercolor background and a black watercolor center	Watercolor
Helen	Calm Before the Storm	An all blue watercolor painting	Watercolor
Robert	Void	An all black oil painting	Oil
Robert	Sun	An all yellow oil painting	Oil
Enrique	Harley	A photo-realistic painting of a Harley-Davidson motorcycle	Photo-Realist
Angie	Reflection	A mirror (considered a sculpture)	Sculpture
David	Ziggy III	An expressionist self-portrait (painting)	expressionist
Stuart	Wisdom	A pen-and-ink drawing of an Apache chieftain	Drawing
Stuart	Superior Powers	A pen-and-ink drawing of a traditional Native American rain dance	Drawing
Candy	Study of a Fruit Bowl	A cubist painting of a bowl of fruit	Cubist
Valentino	All That Glitters	A watercolor painting of the Golden Gate Bridge	Watercolor
Valentino	The Rock	A watercolor painting of Alcatraz	Watercolor
Valentino	Winding Road	A watercolor painting of Lombard Street	Watercolor
Valentino	1071 Fifth Ave	A watercolor painting of The Guggenheim	Watercolor

### **Proposal 3**

Apparently, Valentino and Celeste were using an old pricing sheet when they made their exhibit decisions. They still want to maintain the same criteria but realize the cost of each piece of art could increase or decrease by as much as 20% of the cost on the old price sheet. That is, the random price change of each piece can range between -20% and +20% independently with equal probability. How does that possibility impact the cost of Celeste's plan in part 2?

Adjusting for the random increase/decrease of (-20% to 20%) price, the mean cost of the exhibit is \$5,485,087 with a range of \$4,997,720 to \$5,942,650. Comparing the possibility impact (mean cost of exhibit) to Celeste's proposal 2, we see that proposal 3 will reduce the total cost by \$114,913. However, there is a possibility that proposal 2 may be better if the exhibit price of proposal 3 reaches its maximum cost.

**Proposal 4:** Take slightly longer to make the prints (which would increase their average time to make a print to 1.2 hours), so that the inspector can keep up with his output better. This also would reduce the cost of the power for running each press from \$7.00 to \$6.50 per hour. (By contrast, decreasing the time would increase this cost to \$7.50 per hour while decreasing the average time to make a print to 0.8 hour.)

**A:** To provide a basis of comparison for Seymore, begin by evaluating the status quo. Determine the expected amount of in-process steady state inventory at the presses and at the inspection station. Then calculate the expected total cost per hour when considering all of the following: the cost of the in-process inventory, the cost of running the presses, and the cost of the inspector.

The expected amount of in process inventory is 7 units at the presses and 7 units in inspection. The expected total cost per hour of the printing and inspection systems \$115. Given the current number of units that arrive each hour and number of printers, the entire printing process costs \$49. Given the arrival time and inspection speed the total cost of inspecting prints is \$66

**B:** What would be the effect of proposal 4? Why? Make specific comparisons to the results from part 4 above. Explain this outcome to Seymore, who does NOT understand technical terms from queueing theory.

If print time is increased to reduce power costs, it will take about a half hour longer to print 7 poster sheets, but the overall cost per hour of printing is reduced by \$7.23. The benefits of spending less on power outweigh the general inventory costs. This proposal will reduce the hourly cost of both systems to \$108.25, which is a reduction of \$6.75 per hour.

**Proposal 5:** Substitute a more experienced inspector for this task. She is somewhat faster at 7 minutes per poster, so she should keep up better. However, this inspector is in a job classification that calls for a total compensation (including benefits) of \$19 per hour, whereas the current inspector is in a lower job classification where the compensation is \$17 per hour.

**A:** Determine the effect of proposal 5. Make specific comparisons to the results from part 4 above. Explain this outcome to Seymore, who still does NOT understand technical terms.

Hiring a more experienced inspector will reduce the amount of time it takes to inspect 7 prints by 21.6 minutes. The more experienced inspector has an hourly cost that is \$9 greater than the current inspecting process.

**B:** Make your recommendations for reducing the average level of in-process inventory at the inspection station and at the group of machines. Be specific in your recommendations and support them with quantitative analysis like that done in part 4. Make specific comparisons to the results from parts 5 and 6 and cite the improvements that your recommendations would yield.

To reduce the average level of in-process inventory in printing and inspection process:

- Decrease printing speed to 1.2 prints per hour to save \$7.23 per hour on printing
- Keep the current inspector because hiring a new inspector will cost \$9 more per hour. This \$9 per hour is not worthwhile because the new inspector finishes in 38.4 minutes which leaves 21.6 minutes, we will pay them for in an hour where they are not inspecting. Our current inspector completes 8 prints per hour, so he will only be paid for 7.5 minutes of not inspecting each hour.

