USC ASTE-523 -- Spring, 2023
The Design of Low-Cost, Responsive Space Missions
A Near-Term, Income-Generating, Lunar Settlement

Homework Set #2 -- Due 2/2/23

Please note:

Homework Questions should be turned in to the TA, Kevin Sampson, via the DEN website as described in the message from Kevin.

This homework set concentrates on the issues of money and how costs vary with time and how things are built. We've allowed two weeks for this homework to allow more time to work on the Final Report outline in Homework #3.

Here's the real homework for the week:

1. Explain in your own words the difference between inflation and the time value of money.

2. Assume that the USC Astronautics Department (ASTE) gets a $1,000,000, 5-year loan at 12% interest to buy new computers and equipment for professors to work at home during the COVID crisis. (It is likely that the professor's equipment is better than the DEN equipment, but we'll ignore that.) Construct an amortization table of the payback of the loan, assuming 5 equal annual payments. What is the annual payment amount and the total cost of the equipment (principal plus interest)? What would be the payment cost and the total cost of the equipment if they could get the same loan at 6% interest. Assuming the new equipment would save ASTE $250,000/year, but was worthless and discarded after the 5 years, would it have been a worthwhile investment for ASTE to buy the equipment at 12% interest? Would it have been worthwhile at 6% interest?

3. Assume that we buy the first lunar settlement enclosure for $300 million. A. Assuming a Learning Curve of 90% for the entire enclosure, what would be the cost of the second enclosure? Explain why in words. B. What would be the average cost of the first four enclosures?

4. Assume that Sam's Catering and Memory (SCAM) builds low-cost computer memory for use in space for a Theoretical First Unit (TFU) cost of $50,000 and offers a quantity discount based on an 87% learning curve. What is the total cost, average cost per unit, and Nth unit cost for 1, 2, 10, 20, and 100 memory units? By what percentage have we been able to reduce the average cost/memory unit by buying 100 of them? If we keep the production line going and buy 20 more units as spares (i.e., after buying 100), what will be the average cost per unit for the 20 spare units?

5. It turns out that computer memory is a bit more complex than Sam had anticipated. If he is only able to achieve a 90% learning curve in the above problem, what is the average cost per unit of the 100 units? What is the average cost per unit of the following 20 spare units? For both the first 100 and the 20 spares, what would have been the percentage cost reduction (in average cost per unit) resulting from an 90% learning curve rather than an 87% learning curve?

6. Program X was done in 2011 at a cost of $800 million. Program Y was done in 2021 at a cost of $900 million. Program Z is projected to be done in 2031 at a cost of $1 billion. All costs are in then-year dollars. What was the cost of each program in FY23$M? Which was the least expensive and by what percentage was it less than the cost of the most expensive program? (Use the inflation table in the course notes.)

7. A change in parties in either the House or Senate, will likely drive up the cost of current and near-term government space programs. Explain why this is likely to be the case.

8. Name 6 different business/activity areas that would want to be among the first on the Moon and why

9. Compare the space hotel in low to medium Earth orbit with a lunar hotel on the surface of the Moon in terms of tourism. What are the principal advantages of the lunar resort. Are there any advantages of the LEO hotel for tourism? If so, what are they?

10. In your view, what is the reason or reasons that lunar settlements have not become popular destinations in the 50 years since Apollo?