21. Paradise Valley (SL Version)

A. Define the term operations management.	2

The process of designing, planning, organizing, and controlling the process of creating goods and services. Or simply, transforming inputs into outputs to achieve business objectives.

B. Explain the difference in job vs batch production for PV.	4

Job production involves the production of a single unique product from start to finish to meet the needs of a customer, and this is what PV does for each of its jackets. Batch production is when a firm makes a group of identical products together at the same time. For PV, they do this with *components* of jackets, but each jacket itself is assembled as a unique job to customers' specifications even if certain aspects of it were made in batches.

C. Explain two factors that may have been important to setting up Wales as PV's manufacturing location.	4

Answers may include, but are not limited to the following:

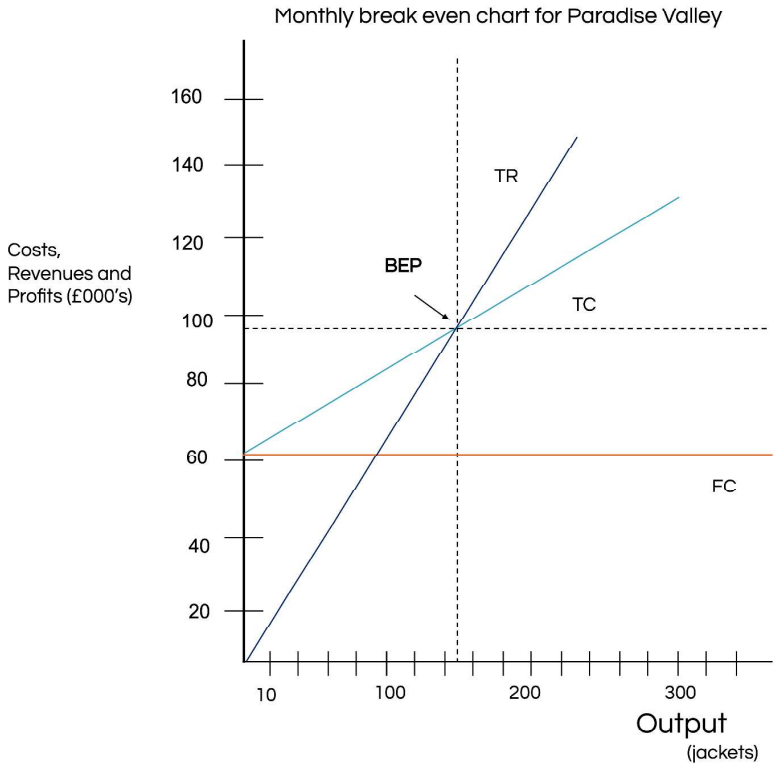
- Location preferences of original founders. They were probably set up in Wales in 1963 because that's where the founders lived. Without a compelling reason to move, that's where they would naturally stay.
- Let's take a moment to ponder the beauty of the Welsh countryside. I'm sure it's lovely.
- Since that Welsh countryside is indeed lovely, it could be a fairly popular tourist destination, and so they may sell some jackets on-site to tourists.
- There may be a supplier network in Wales or around the UK that makes it sensible for them to operate nearby in Wales.
- The cost of production in whatever particular part of Wales in which they're located may be lower than in other suitable parts of the UK because of land costs and so on. Welsh labor costs may also be lower than in other parts of the UK.
- Though Wales isn't *known* for leather goods, the industry has been there for a long time, and if 30% of their workforce is foreign, that means that 70% of them are local to the UK. So Wales may have a big workforce availability advantage.
- Before Brexit, being located in Wales would've given them an advantage in terms of being able to sell to the EU market and get supplies and labor in and out fairly easily.
- Who knows? Maybe the local government gives them tax incentives for staying there. Probably not though.

D. Explain the differences between outsourcing and offshoring for PV.	4

Outsourcing is when a firm uses another organization to fulfill some aspect of its business operations that would otherwise be done internally. For example, PV is considering outsourcing its production to a firm in Portugal rather than being directly controlled/run by PV itself. Offshoring is when a firm produces in a country other than its country of origin but still runs that production itself. If PV were to open a facility in Spain, this would be offshoring.

E. Construct a monthly break-even chart for PV if they only sold jackets to UK customers.	4

BEQ = (53000+2500+1500+4500)/(575-200) = 164 jackets
At the BEQ, revenue/cost would be $94300 (revenue = 164*575)
See next page for diagram



F. If PV sold 200 jackets to UK customers and 50 to international customers in a month, calculate their profit or loss that month.	4

(200*575)+(50*600)-53000-2500-1500-4500-(200*8)-(50*18) = £81000

G. Analyze how PV purchasing improved computer systems for inventory management could impact its margin of safety.	4

Answers may include, but are not limited to the following:

- The up front cost of the computer systems would increase their fixed costs in the time period in which they were purchased, and so it would reduce the margin of safety as the total cost would rise in relation to the total revenue.
- However, these are systems for improving their inventory management, so the idea here is probably that this is going to make the firm more efficient in the long run and be able to turn over more revenue, and so in the long run these systems should improve their margin of safety by increasing revenue by more than the increase in costs. As long as the purchase is a one-off cost, then the hit to their margin of safety should realistically be a temporary thing.

H. Explain two limitations of PV conducting break-even analysis.	4

Answers may include, but are not limited to the following:

- As with any business that sells multiple products, they're taking an average here of costs and revenues, and depending on the mix of products they actually sell in a given period, the break-even point may be quite a bit different than what the diagram says. This is why I asked the break-even diagram question using only UK sales for the sake of simplicity.
- The analysis doesn't take into account semi-variable costs, and much of what this firm incurs probably would be semi-variable. Utilities, for instance, is almost certainly a semi-variable cost because if they sell more jackets then they will need to run equipment for more hours and use more electricity.
- Costs have changed a lot just within the last two years with inflation, the solidification of Brexit status, and so on. Even without these two issues, input costs would be changing frequently enough to make this diagram need constant updating to be accurate.

I. Recommend one of the options that PV is considering pursuing to improve profits.	10

Arguments in favor of Option 1 include, but are not limited to the following:

- Using the average cost and revenue figures given, international sales are sliiiiightly more profitable per unit than UK ones, so opening a Spain location would improve profit margins. The difference is so slight (£5) though that this shouldn't be seen as much of an advantage.
- Much more importantly, it would reduce their cost of production by possibly allowing them to make jackets at a lower wage cost, to reduce the cost of import/export fees and such within the EU, and probably cut the materials and energy costs, assuming that it is able to source materials from within the EU. We don't know what their supply chain looks like, so if they're not having to use a lot of inputs from the UK then costs should lower.
- Since 30% of their workforce is foreign and Brexit has made it harder for them to bring in foreign workers, then the facility in Spain would allow them to hire more workers from EU countries. We aren't told if many of their current foreign workers are from the EU, but given that the case study says post-Brexit it's been harder to bring in foreign workers, we can assume that many of them are European. We're told that if they made more sales, they'd have a hard time increasing their workforce, and thus this option may make that easier.
- Unlike option 2, they'd be keeping the tanning in house, which could potentially help them retain their quality controls and help them to position themselves as a luxury brand.
- Shipping costs within the EU would probably go down, further improving profit margins there.
- Option 2 might increase their production cost or time. Even if it costs slightly less to buy from the tanning supplier, they may now incur a greater shipping cost and a longer production time because that process now needs to be coordinated with an offshore supplier. If they were mass producing and kept a just in case stock this may not be much of an issue, but given that it's custom made orders, this may really slow things down.

Arguments in favor of Option 2 include, but are not limited to the following:

- It frees up £150000 in cash to use elsewhere. We don't know if that is a ton of money for this organization, but it seems pretty substantial, and there are any number of ways that they could reinvest that money into equipment and processes that would make them more efficient.

- As the case study says, it would increase their productive capacity, which is a big deal considering that some customers wait up to 3 months and we know that if they increased sales, they'd have a hard time actually doing what was necessary to fulfill those orders in a timely fashion. Not only does this allow them to re-allocate labor elsewhere (which is not a guarantee by the way - they may just lay off the tanning workers if that is their specialized skill set), but it would free up *space* within the facilities to house more inventory and equipment.
- The cost of production would slightly decrease, which is important with inflation running so high.
- Most leather goods makers don't do the tanning themselves, so while we can argue that with option 2, PV would give up control over a process in a way that could harm quality, it is equally likely that quality may actually *increase* because the tanning would be done by a business that specializes in it.
- Option 1 is a lot more expensive and time consuming to set up, and then communication and coordination in the firm becomes more challenging because it's running a facility in another country. Organizing operations under option 2 is probably much easier. We don't know if PV's owners have any knowledge of producing in Spain, and we don't know if any workers would be willing and able to transfer there. In reality, *someone* from the Welsh facility would probably have to transfer over to Spain. And…you know…they speak Spanish there.

21. Paradise Valley (HL Version)

A. Define the term operations management.	2

The process of designing, planning, organizing, and controlling the process of creating goods and services. Or simply, transforming inputs into outputs to achieve business objectives.

B. Define the term labor productivity.	2

Output per worker, or output per working hour.

C. State two examples of data analytics that PV may use.	2

Examples may include, but are not limited to the following:

- Descriptive analysis of their past performance, which could be on tons of different aspects. It could be looking at data relating to any form of productivity, sales numbers or other data on customers, shipping and logistics efficiency. I'm not going to bother listing them all, because there are so many.
- Predictive analytics over future needs for production, which products will be in style, and so on.
- Diagnostic data analytics to figure out where problems may lay in certain areas such as production, shipping and returns, the marketing mix, customer service, and so on. If customers are sometimes waiting up to 3 months, for instance, diagnostic data analytics could help them to determine what the problem is.
- Prescriptive data analytics could help them to make decisions about their product portfolio, how to plan their production needs, and so on.

D. Explain the difference in job vs batch production for PV.	4

Job production involves the production of a single unique product from start to finish to meet the needs of a customer, and this is what PV does for each of its jackets. Batch production is when a firm makes a group of identical products together at the same time. For PV, they do this with *components* of jackets, but each jacket itself is assembled as a unique job to customers' specifications even if certain aspects of it were made in batches.

E. Explain two lean production techniques that may be appropriate for PV to use.	4

Examples may include, but are not limited to the following:

- Kaizen: With skilled workers, you'd want them to be helping to identify ways to cut waste and increase/improve production or quality.
- Just-in-time production: Considering that these jackets are custom made, you wouldn't want too much stock sitting around because it may be quite a long time before it's actually used. Using JIT would help to minimize money that's tied up in unproductive inventory.

- If teachers still mention kanban or andon which was in the old syllabus, the use of these signals and computer systems to organize production could help identify where products are in their stages of production and to reduce wasted time and material in the process.
- Anything that reduces waste could be mentioned here, including attempting to use processes that reduce water usage, upgrading facilities in a way that reduces energy use and loss such as better insulation, smart thermostats or lights, and so on.
- Cellular production could potentially work as well if it allowed workers to produce more in a given amount of time in the long run.

F. Explain two problems in PV's production planning that can be seen through the stock control chart.	4

- Their lead time on orders is way different from the first order to the second, so they may be having problems getting predictable delivery windows from suppliers, or maybe they had to make a rush order the second time and pay more for it since they were running through more hides in that time period.
- They went over their maximum stock level, which means that either this is a max *desired* stock level and they can actually stock more, or that they had to find some other storage facility, possibly through renting warehouse or other space, which would've increased their costs and made production planning more challenging.
- The usage rate of hides is very different from weeks 1-4 to 4-6.
- They went well below their minimum stock level in weeks 3-4, meaning either that the lead time was too long or that they did not order soon enough, or both.
- You could argue that their minimum stock level is a bit too low. They may not need this many hides in stock at all times.
- There's not a huge difference between their reorder level and the minimum stock level, so they may need to increase the reorder level to guarantee that they have the right amount of stock at all times.

G. Explain two factors that may have been important to setting up Wales as PV's manufacturing location.	4

Answers may include, but are not limited to the following:

- Location preferences of original founders. They were probably set up in Wales in 1963 because that's where the founders lived. Without a compelling reason to move, that's where they would naturally stay.
- Let's take a moment to ponder the beauty of the Welsh countryside. I'm sure it's lovely.
- Since that Welsh countryside is indeed lovely, it could be a fairly popular tourist destination, and so they may sell some jackets on-site to tourists.
- There may be a supplier network in Wales or around the UK that makes it sensible for them to operate nearby in Wales.
- The cost of production in whatever particular part of Wales in which they're located may be lower than in other suitable parts of the UK because of land costs and so on. Welsh labor costs may also be lower than in other parts of the UK.
- Though Wales isn't *known* for leather goods, the industry has been there for a long time, and if 30% of their workforce is foreign, that means that 70% of them are local to the UK. So Wales may have a big workforce availability advantage.

- Before Brexit, being located in Wales would've given them an advantage in terms of being able to sell to the EU market and get supplies and labor in and out fairly easily.
- Who knows? Maybe the local government gives them tax incentives for staying there. Probably not though.

H. Explain the differences between outsourcing and offshoring for PV.	4

Outsourcing is when a firm uses another organization to fulfill some aspect of its business operations that would otherwise be done internally. For example, PV is considering outsourcing its production to a firm in Portugal rather than being directly controlled/run by PV itself. Offshoring is when a firm produces in a country other than its country of origin but still runs that production itself. If PV were to open a facility in Spain, this would be offshoring.

I. Analyze how PV purchasing improved computer systems for inventory management could impact its margin of safety.	4

Answers may include, but are not limited to the following:

- The up front cost of the computer systems would increase their fixed costs in the time period in which they were purchased, and so it would reduce the margin of safety as the total cost would rise in relation to the total revenue.
- However, these are systems for improving their inventory management, so the idea here is probably that this is going to make the firm more efficient in the long run and be able to turn over more revenue, and so in the long run these systems should improve their margin of safety by increasing revenue by more than the increase in costs. As long as the purchase is a one-off cost, then the hit to their margin of safety should realistically be a temporary thing.

J. Explain two limitations if PV were to conduct a break-even analysis.	4

Answers may include, but are not limited to the following:

- As with any business that sells multiple products, they're taking an average here of costs and revenues, and depending on the mix of products they actually sell in a given period, the break-even point may be quite a bit different than what the diagram says. This is why I asked the break-even diagram question using only UK sales for the sake of simplicity.
- The analysis doesn't take into account semi-variable costs, and much of what this firm incurs probably would be semi-variable. Utilities, for instance, is almost certainly a semi-variable cost because if they sell more jackets then they will need to run equipment for more hours and use more electricity.
- Costs have changed a lot just within the last two years with inflation, the solidification of Brexit status, and so on. Even without these two issues, input costs would be changing frequently enough to make this diagram need constant updating to be accurate.

K. Explain two challenges that PV may experience if it were to upgrade its critical infrastructure.	4

Answers may include, but are not limited to the following:

- Cost: upgrading a tech hardware is usually pretty expensive, and with them having made losses in many of the last financial quarters, owners may not want to do something that adds costs unless they feel like it's going to increase revenues by more than the cost.
- Added training costs: anytime you upgrade computers or software systems, there may be added time that you need to account for in terms of getting people used to the new systems.
- Resistance to change: Similar to the above point, managers or lower level employees may be so used to using certain computer systems and programs that they are reluctant to learn the new ones.
- Integrating the new critical infrastructure with existing systems may be quite challenging, and in some cases it may not even be possible.
- There may be added maintenance costs of doing so, even if new critical infrastructure and the use of ISO9001 practices makes the firm more efficient.

L. Evaluate the two options that PV is considering pursuing to improve profits.	10

Points in favor of option 1 may include, but are not limited to the following:

- Owners assume that this will improve quality to the point where they'll be more in a position to increase prices. Note that the word *assume* is doing some heavy lifting here; there is no guarantee at all that customers will notice a quality difference and see that as a justification of higher prices.
- It could allow them to operate more efficiently and thus cut down on the wait time for orders. That would both please customers and help them be able to handle more sales, especially considering that the case study says that if they had an increase in sales, they'd have a hard time fulfilling those orders.
- Less material and time might be wasted because quality controls would improve.
- It could reduce their costs long term because of all of the operational efficiencies that they'd be gaining.
- It could improve trust and relationships with suppliers if they see the ISO 9001 certificate and/or it leads to them being better at communication, production and supply chain management, and so on.
- Unlike option 2, it keeps production fully in-house, which gives them greater control over the production process and thus could allow them to better justify their desired luxury status and image on quality.
- Production planning could be a lot easier in option 1 than in option 2, because adding an overseas supply element could really slow down production, especially as Brexit has made shipping to and from the EU more complicated than it was previously.

Points in favor of option 2 may include, but are not limited to the following:

- It frees up £150000 in cash to use elsewhere. We don't know if that is a ton of money for this organization, but it seems pretty substantial, and there are any number of ways that they could reinvest that money into equipment and processes that would make them more efficient.
- As the case study says, it would increase their productive capacity, which is a big deal considering that some customers wait up to 3 months and we know that if they increased sales, they'd have a hard time actually doing what was necessary to fulfill those orders in a timely fashion. Not only does this allow them to re-allocate labor elsewhere (which is not a guarantee by the way - they may just lay off the tanning workers if that is their specialized

skill set), but it would free up *space* within the facilities to house more inventory and equipment.

- Option 2 allows them to focus more on what their likely core competencies are, such as cutting, stitching, design, and so on.
- The cost of production would slightly decrease (assuming PV is correct about this - it says they *believe* it would be a lower cost to buy), which is important with inflation running so high.
- Most leather goods makers don't do the tanning themselves, so while we can argue that with option 2, PV would give up control over a process in a way that could harm quality, it is equally likely that quality may actually *increase* because the tanning would be done by a business that specializes in it.
- Option 1 would cost money and a lot of time to implement. Many firms that attempt to implement ISO 9001 are frustrated by how long the process becomes, and whether it's worth it is questionable.
- Option 1 says owners *assume* it would allow them to justify higher prices, but that is a very big assumption. In reality, we could imagine that customers wouldn't know anything about ISO 9001 even if PV promoted its certification, and choosing to raise prices is perhaps a decision that should be considered independently from option 1.

22. BlueFire Geothermal *SL Version*

A. Define the term break-even.	2

The level of sales at which point total revenue equals total cost.

B. Explain two roles of operations management at BG.	4

Answers may include, but are not limited to the following:

- Researching and developing new heat pump products, components, processes for manufacturing, etc.
- Designing and running the production systems, whether that be job production, mass, or mass customization.
- Managing the supply chain to get inputs into their facilities in order to produce heat pumps.
- Managing delivery logistics to customers.
- Getting information about the manufacturing process in order to improve production of heat pumps.
- Helping to make location decisions.

C. Explain an advantage and a disadvantage of BG using job production at its Icelandic facility.	4

Advantages may include, but are not limited to the following:

- The facility's primary role is research and development, so doing lower volume job production could probably enable them to make changes to design as they find performance and design improvements much more easily than they would with mass production lines.
- Doing 100 units per year doesn't really sound like enough volume to invest in the capital you'd need for mass production, or perhaps even batch production.
- It would allow them for a lot more customization than any other production type, which could be helpful because we see that homes have a wide variety of needs for different sizes etc.
- There's the standard answers of employees being motivated when doing job production and the method possibly resulting in higher quality production because of that motivation.
- It could lower their cost of holding stock because this could enable them to only start producing a unit when a customer has ordered it.

Disadvantages may include, but are not limited to the following:

- It really limits their production volume, and as a result we're told that they don't expect to break even on the Icelandic facility.
- Very often job production in manufacturing settings results in *lower* quality because there's less standardization and thus more opportunities for things to go wrong or to be slightly different in a way that's bad for quality.
- Their labor costs would definitely be higher in this situation because less of it is automated (and also, Iceland would have pretty high wages compared to many other countries, which further adds to the labor cost).
- It's probably more time consuming to produce a specific unit

- They don't benefit from economies of scale, whether through bulk purchasing, technical economies, or other categories of economies of scale.

D. Explain how the existence of a trade agreement between the US, Mexico, and Canada may be an advantage to BG locating a factory in Mexico.	4

Answers may include, but are not limited to the following:
(Yes, I know that this is not an economics class and that students aren't expected to know the ins and outs of trade deals. Still, they should have a basic awareness of how they can be important for businesses, and I would first expect students to establish the basic idea of what a trade agreement does.)

- It can allow them to access 3 big markets for sales with much lower tariffs and administrative barriers like paperwork than would otherwise be the case.
- The Mexican factory in particular could allow them to take advantage of lower Mexican labor costs and/or other reasons why production costs may be lower, while still being able to access the other two markets more easily than if they were exporting to the US/Canada from another country with which there wasn't a trade agreement.
- Because of the reduced paperwork and administrative barriers, it could make the import/export process quicker than it would otherwise be.
- It would also give them easier/cheaper access to inputs that may come from the US or Canadian side for use in a Mexican facility.
- It may open them up to more investment potential because of the proximity of the US in particular, but also Canada.

E. Explain two potential disadvantages to BG offshoring its production of heat pumps to Mexico.	4

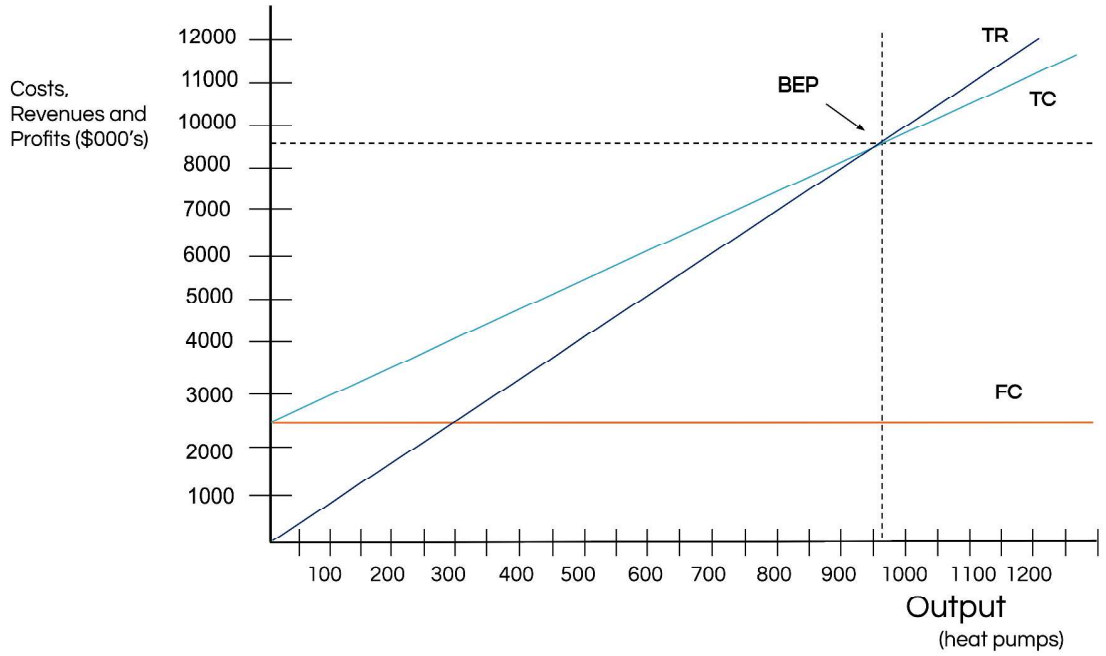
Answers may include, but are not limited to the following:

- There's a language difference, along with plenty of other cultural differences that may make things difficult for the Icelandic firm.
- Just a general lack of knowledge of doing business in Mexico would be difficult.
- Because this says offshoring and not outsourcing, they'd have to run the facility themselves and take control of its business functions. Thus, things like hiring would be more difficult,and there are tons of other operational challenges that would be easier if this were outsourced rather than offshored.
- Mexico is obviously quite far from Iceland, so the distance could create a lot of communication problems, require the leaders to make many trips between the two countries, and so on.
- The above point could lead to quality control problems that could have been much more easily and quickly fixed if the manufacturing plant were in Iceland.
- A lot of employees may need to relocate to Mexico, which they may be unwilling to do.

F. Construct a break-even chart using the data listed in the table for year 1.	4

2400000/(10000-7500) = 960 units to break-even
Total revenue at BEQ = 960*10000 = $9600000

Monthly break even chart for BlueFire Geothermal



G. Calculate the difference in the quantity from year 1 to year 3.	2

BEQ year 3 = 2500000/(9800-6000) = 657.89473684
960-657.89 = 302.11 units fewer in year 3 than in year 1.

H. If BG investors want to target a profit of $1 million in year 2, calculate the price that they would need to charge to customers if they sold every unit in their sales target.	1

TP = 2450000/800 + 6900 = $9962.5

I. In order to earn a profit of $2 million in year 3, calculate the target profit output.	1

Target profit output = (FC+target profit)/unit contribution
= (2500000+2000000)/(9800-6000) = 1184.21 units

J. Explain how increased spending on research and development could affect BG's break-even point.	2

- It would raise their fixed costs through researchers' salaries and other spending on materials that wouldn't vary depending on the number of units produced, and so would act as fixed costs. All else held constant, that would then increase the break-even quantity and revenue needed.

- However, you could also argue that if the R&D spending results in them being able to cut costs or increase prices, then the break-even point would decrease through improved unit contributions of selling each heat pump.

K. Evaluate the decision for BG to use mass production or mass customization.	10

Reasons in favor of mass production may include, but are not limited to the following:

- It should be cheaper to run mass production because more would be standardized and thus they'd be able to make larger bulk orders of certain supplies.
- *They're projected to lose money in the first two years of production*, and if mass production can get the unit costs down and production volumes up, they'll break even and start turning a profit sooner.
- It would make supply chain management easier because, again, they would have fewer different components to manage.
- The quality of the products may improve because with more standardization, they'd have much more opportunities to repeat processes and such in a way that would reduce the risk of defects or other problems.
- They could probably produce a larger volume, which would bring down their average fixed cost and allow them to be more price competitive. Considering that in the first year the price will be $1500 above the industry average, any cost savings could really help, especially since they'll be selling the fact that the systems will be cheaper to install.
- Carrying on these points, there's an investor who thinks that they should be able to produce 300 more units than managers' projections, at $500 less per unit than they are their current projections. Both of those numbers would imply that mass production of just 2 models would allow for more production and cost savings through volume, so If he's right about this, then it would greatly increase their profits.
- Delivery times to customers would probably be a lot quicker since they wouldn't be made to order. The longer a customer has to wait, the more likely they are to buy from a competitor.

Reasons in favor of mass customization may include, but are not limited to the following:

- There's a wide variety of needs for different houses, so if they offer customization then they could make far more sales. Having just 2 units may severely limit the number of customers for whom a BG unit is workable or preferable.
- It could allow them to capture both the higher priced and lower priced segments of their market.
- There are a lot of different ways to optimize production lines today for mass customization, so this method may allow them to still get the benefits of mass production while also meeting customers' needs.
- There's less need for the firm to hold large amounts of inventory, which can improve their working capital.
- The customization process might actually help them with further research into customers' needs and thus help them to identify future products or more ways of improving what they are currently planning to produce.

22. BlueFire Geothermal *HL Version*

A. Define the term break-even.	2

The level of sales at which point total revenue equals total cost.

B. Explain two roles of operations management at BG.	4

Answers may include, but are not limited to the following:

- Researching and developing new heat pump products, components, processes for manufacturing, etc.
- Designing and running the production systems, whether that be job production, mass, or mass customization.
- Managing the supply chain to get inputs into their facilities in order to produce heat pumps.
- Managing delivery logistics to customers.
- Getting information about the manufacturing process in order to improve production of heat pumps.
- Helping to make location decisions.

C. Explain an advantage and a disadvantage of BG using job production at its Icelandic facility.	4

Advantages may include, but are not limited to the following:

- The facility's primary role is research and development, so doing lower volume job production could probably enable them to make changes to design as they find performance and design improvements much more easily than they would with mass production lines.
- Doing 100 units per year doesn't really sound like enough volume to invest in the capital you'd need for mass production, or perhaps even batch production.
- It would allow them for a lot more customization than any other production type, which could be helpful because we see that homes have a wide variety of needs for different sizes etc.
- There's the standard answers of employees being motivated when doing job production and the method possibly resulting in higher quality production because of that motivation.
- It could lower their cost of holding stock because this could enable them to only start producing a unit when a customer has ordered it.

Disadvantages may include, but are not limited to the following:

- It really limits their production volume, and as a result we're told that they don't expect to break even on the Icelandic facility.
- Very often job production in manufacturing settings results in *lower* quality because there's less standardization and thus more opportunities for things to go wrong or to be slightly different in a way that's bad for quality.
- Their labor costs would definitely be higher in this situation because less of it is automated (and also, Iceland would have pretty high wages compared to many other countries, which further adds to the labor cost).

- It's probably more time consuming to produce a specific unit
- They don't benefit from economies of scale, whether through bulk purchasing, technical economies, or other categories of economies of scale.

D. Explain two roles of benchmarking for BG.	4

- It can help BG to determine and follow best practices for production.
- It can help BG set standards or targets for itself for what they want their products to achieve relative to industry standards, in this case being installation costs and time.
- They can use benchmarks as selling points in their marketing to emphasize the efficiency vs competing products.
- It can help them to identify areas of improvement in quality, production techniques, materials used, cost of production, and so on.
- It can serve the role of motivating and challenging employees to think outside the box or to work harder.

E. Explain how quality control and quality assurance would differ at BG.	4

Quality control would involve checking BG's products after they were produced, and it does not involve the entire organization. This means one person or a team inspecting a finished BG heat pump on the assembly floor. Quality assurance would involve everyone in the organization inspecting elements of the products throughout the entire production process and also includes their suppliers and customer service representatives. This would mean a lot more communication up and down the levels of the organization and across departments rather than just checking finished heat pumps.

F. Explain how the existence of a trade agreement between the US, Mexico, and Canada may be an advantage to BG locating a factory in Mexico.	4

Answers may include, but are not limited to the following:
(Yes, I know that this is not an economics class and that students aren't expected to know the ins and outs of trade deals. Still, they should have a basic awareness of how they can be important for businesses, and I would first expect students to establish the basic idea of what a trade agreement does.)

- It can allow them to access 3 big markets for sales with much lower tariffs and administrative barriers like paperwork than would otherwise be the case.
- The Mexican factory in particular could allow them to take advantage of lower Mexican labor costs and/or other reasons why production costs may be lower, while still being able to access the other two markets more easily than if they were exporting to the US/Canada from another country with which there wasn't a trade agreement.
- Because of the reduced paperwork and administrative barriers, it could make the import/export process quicker than it would otherwise be.
- It would also give them easier/cheaper access to inputs that may come from the US or Canadian side for use in a Mexican facility.
- It may open them up to more investment potential because of the proximity of the US in particular, but also Canada.

G. Explain two potential disadvantages to BG offshoring its production of heat pumps to Mexico.	4

Answers may include, but are not limited to the following:

- There's a language difference, along with plenty of other cultural differences that may make things difficult for the Icelandic firm.
- Just a general lack of knowledge of doing business in Mexico would be difficult.
- Because this says offshoring and not outsourcing, they'd have to run the facility themselves and take control of its business functions. Thus, things like hiring would be more difficult,and there are tons of other operational challenges that would be easier if this were outsourced rather than offshored.
- Mexico is obviously quite far from Iceland, so the distance could create a lot of communication problems, require the leaders to make many trips between the two countries, and so on.
- The above point could lead to quality control problems that could have been much more easily and quickly fixed if the manufacturing plant were in Iceland.
- A lot of employees may need to relocate to Mexico, which they may be unwilling to do.

H. Explain two reasons why an investor may see low capacity utilization as a problem for BG.	4

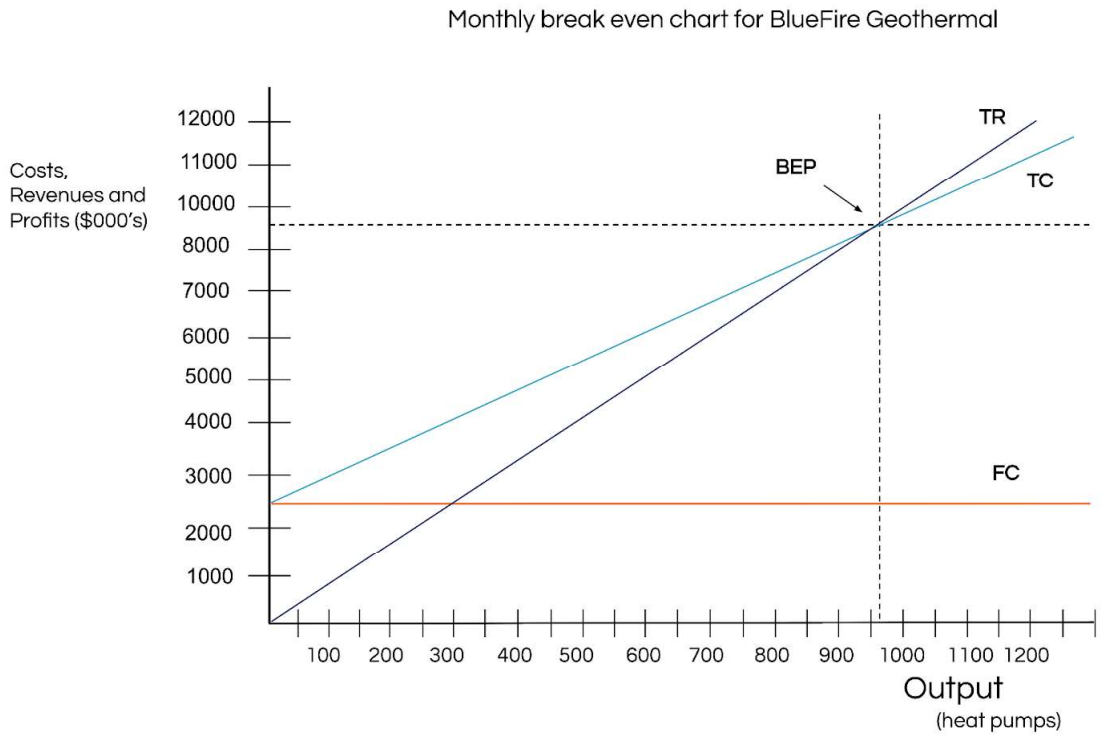
If BG has relatively low capacity utilization, then this means that they're not using a very high percentage of their potential production capacity in their factories. So therefore:

- They'd have spent money on constructing a manufacturing space that is capable of producing more than they actually are, so then they may have wasted money in renting or purchasing a space that was larger than they needed, and have more equipment and/or employees on hand than they actually need.
- They may also incur greater ongoing costs of having a larger space than needed, like spending more on electricity through lighting or heating/cooling than they really need to.
- It also means that BG isn't getting the most use of their productive capital, their fixed assets, and so the average fixed cost and thus average total cost per unit produced is too high. If they increased capacity utilization, then they could lower the average cost per unit and thus expand profit margins and/or lower their price to customers to be more competitive. *Note that they're projected to lose money in the first two years. Higher capacity utilization could bring profitability sooner.*
- It could hold them back from meeting demand, either through existing customers or tapping into the potential demand that they could be meeting if they made more heat pumps.
- They wouldn't experience the full potential of economies of scale through bulk purchasing from suppliers and negotiating lower prices on their inputs.

I. Construct a break-even chart using the data listed in the table for year 1.	4

2400000/(10000-7500) = 960 units to break even

Total revenue at BEQ = 960*10000 = $9600000



J. Calculate the difference in the break-even quantity from year 1 to year 3.	2

BEQ year 3 = 2500000/(9800-6000) = 657.89473684

960-657.89 = 302.11 units fewer in year 3 than in year 1.

K. If BG investors want to target a profit of $1 million in year 2, calculate the price that they would need to charge to customers.	1

Target price = FC/Q + direct cost of production

TP = 2450000/800 + 6900 = $9962.5

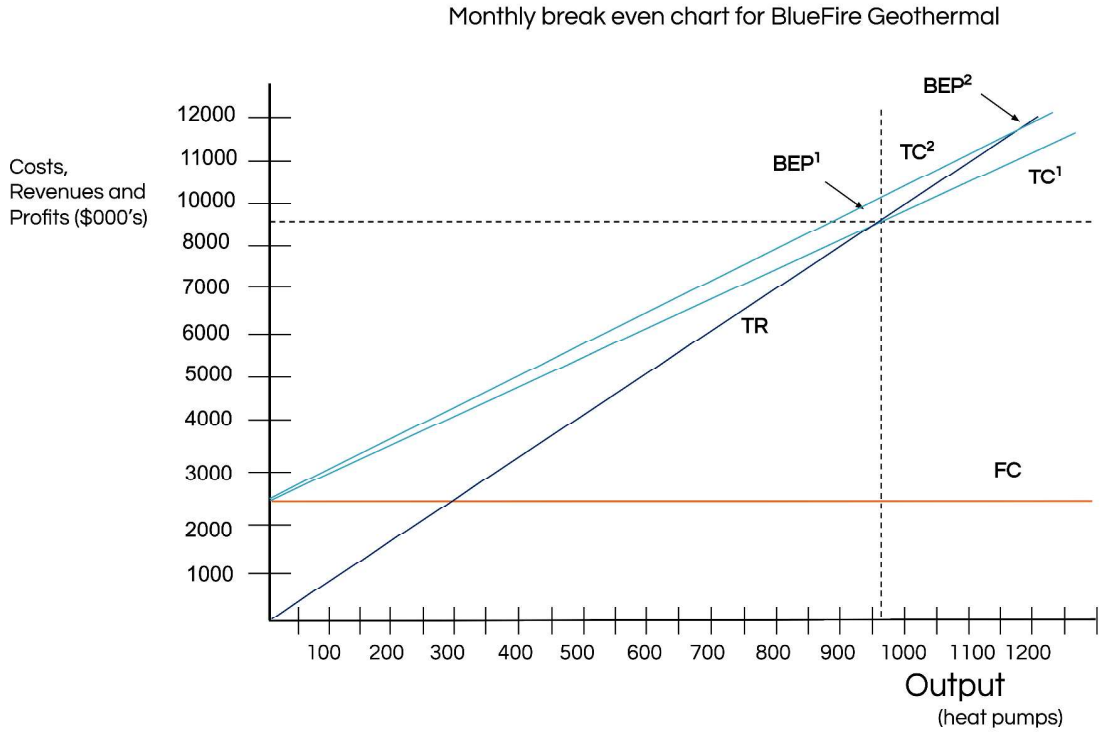
L. In order to earn a profit of $2 million in year 3, calculate the target profit output.	1

Target profit output = (FC+target profit)/unit contribution

= (2500000+2000000)/(9800-6000) = 1184.21 units

M. Explain one way in which a higher than expected defect rate on a component of BG's heat pumps would alter its year 1 break-even chart, and demonstrate this on your break-even diagram.	2

This would increase their variable costs, because they'd be spending more money on materials and perhaps on labor for each product on average to get a fully functioning one off the production line and delivered to a customer. That would mean that the total cost curve would have a steeper upward slope and thus would intersect with the revenue curve at a higher point and push the break-even quantity higher. The actual numbers are unknowable, so the new break-even point here is not a mathematical representation of what would happen.



N. Explain two reasons investors would want to see improvements in BG's capital productivity.	4

Answers may include, but are not limited to:

- Investors want to see their money being used productively, and the more production BG gets out of every dollar invested, the more profitable the firm will be.
- More productively used financial capital also means that BG could expand operations more and be able to hit or exceed their production and sales targets.
- Increased capital efficiency can lower their average costs, again leading to more profits.
- It would increase their liquidity, giving the firm a greater safety buffer and giving them more flexibility in the decisions they make.
- It would reduce their need to raise additional financing later, whether from investors or through any other form of financing

O. Explain the differences between incremental and disruptive innovation for BG.	4

Incremental disruption is when a firm makes small improvements to products and services, which in this case is what BG is doing by improving on the design of geothermal heat pumps in a way that reduces the installation cost by 20% and the speed by 10%. Neither of those is disruptive to the industry.

Disruptive innovations much more substantially change the market by introducing products and services that are totally new. If BG invented some new kind of heat pump product that is totally different from existing products and replaces the need for what is on the market right now, or if they introduced a different kind of energy-efficient heating and cooling system entirely, then that would be disruptive innovation.

P. Explain two ways in which data analytics could be important to BG's research and development efforts.	4

Answers may include, but are not limited to the following. There are so many different possible answers for this question:

- Optimizing performance: By analyzing data on the production process, BG can identify inefficiencies and better ways of doing things. They could do the same for the performance of their heat pumps, allowing them to improve designs.
- Quality control: Whether through data collected in the production process or through their machines' performance in the real world, BG could analyze data to figure out how to improve their product quality.
- Product design: Similar to the above point, better data analytics whether on the R&D side, production side, or customer side, BG could analyze data to have a better handle on how to design their products for customers' needs and in ways that improve their performance in the field.
- Analysis of the market and competitors: By looking at market data and the behavior of competitors and customers, they can identify or predict trends, identify new technologies and/or opportunities, and so on.
- Supply chain management: By analyzing data on inventory levels, lead times, and supplier performance, the company can identify opportunities to streamline operations, reduce costs, and improve overall efficiency.
- Predictive maintenance on their equipment so that they can have a better idea of when and how to replace or service their equipment.

Q. Explain two challenges to BG using cradle to cradle design for their systems.	4

Answers may include, but are not limited to the following:

- It's probably going to make the design and production of their heat pumps more expensive. This is not a guarantee, because C2C can reduce costs via materials or recovery of materials to make new systems, but more likely than not it would be more expensive to make a system with C2C design. Along with that, it could make the cost of these systems prohibitively expensive for customers.
- It could present a huge design challenge and may well be impossible. Geothermal heat pumps are large and complex systems, and designing all of that to be truly cradle to cradle may border on the impossible.
- If the lifespan is 20-25 years, then there's a huge lag time between production and recovering the resources from the heat pumps to be recycled or used back in the

production of new BG systems. Over that time horizon it's highly possible that the original consumer is different from the consumer using the system by the end of its lifespan, and the new consumer may have no knowledge or interest in BG or its potential process for recycling/recovering elements of the heat pump.
- Ultimately a heat pump's advantage is in being much more energy efficient than typical heating/cooling systems. If you design it for cradle to cradle, there may be performance tradeoffs that erode that advantage and thus ruin the case for installing a geothermal heat pump instead of a cheaper system in the first place.

R. Evaluate the potential decision for BG to prioritize total quality management or efficient mass production.	10

Arguments in favor of TQM may include, but are not limited to the following:
- If customers are going to pay $1500 more for a BG system, they would expect quality along with the installation cost savings. These systems are large investments for the consumer, so TQM could solidify their status as a high quality producer of a system that saves people money.
- TQM could bring higher customer satisfaction, which in turn could be a big marketing advantage as installers tell people about these systems and try to convince consumers to use them, or the consumers themselves tell others about BG products.
- Increased efficiency: Mass production may seem more efficient at first, it could be that focusing on quality can actually increase efficiency in the long run. By catching and addressing issues early on, Bluefire Geothermal can avoid costly mistakes down the line.
- Reduced waste: By emphasizing quality, Bluefire Geothermal can reduce waste in its production processes. This can save money on materials and reduce the company's environmental impact.
- Improved employee morale: By prioritizing quality over speed, Bluefire Geothermal can create a culture where employees feel empowered to do their best work. This can lead to improved employee morale, which can in turn lead to higher productivity and lower turnover.

Arguments in favor of efficient mass production may include, but are not limited to the following:
- *They're projected to lose money in the first two years of production*, and if mass production can get the unit costs down and production volumes up, they'll break even and start turning a profit sooner.
- It would make supply chain management easier because, again, they would have fewer different components to manage.
- The quality of the products may improve anyway because with more volume, they'd have much more opportunities to repeat processes and such in a way that would reduce the risk of defects or other problems.
- Considering that in the first year the price will be $1500 above the industry average, any cost savings could really help, especially since they'll be selling the fact that the systems will be cheaper to install. They could pass cost savings from mass production on to customers, allowing them to sell more systems.
- Carrying on these points, there's an investor who thinks that they should be able to produce 300 more units than managers' projections, at $500 less per unit than they are their current projections. If he's right about these assumptions based on mass production, then this is a big advantage over focusing on TQM.

- Delivery times to customers could be quicker because BG is focused on efficiently producing a large quantity. The longer a customer has to wait, the more likely they are to buy from a competitor.
- TQM requires buy-in from employees across the company, and it can be hard to get everyone on board with what needs to be done for TQM. It also doesn't just involve people at the new Mexican facility, but would include people in Iceland too. Managing all those people and keeping them working together in a TQM system can be hard.
- Investors matter. We don't know how much equity investors have in the company, but you cannot totally ignore their wishes, because that could lead them to sell their shares and thus lower the firm's share value, or make it harder for BG to raise additional capital later.