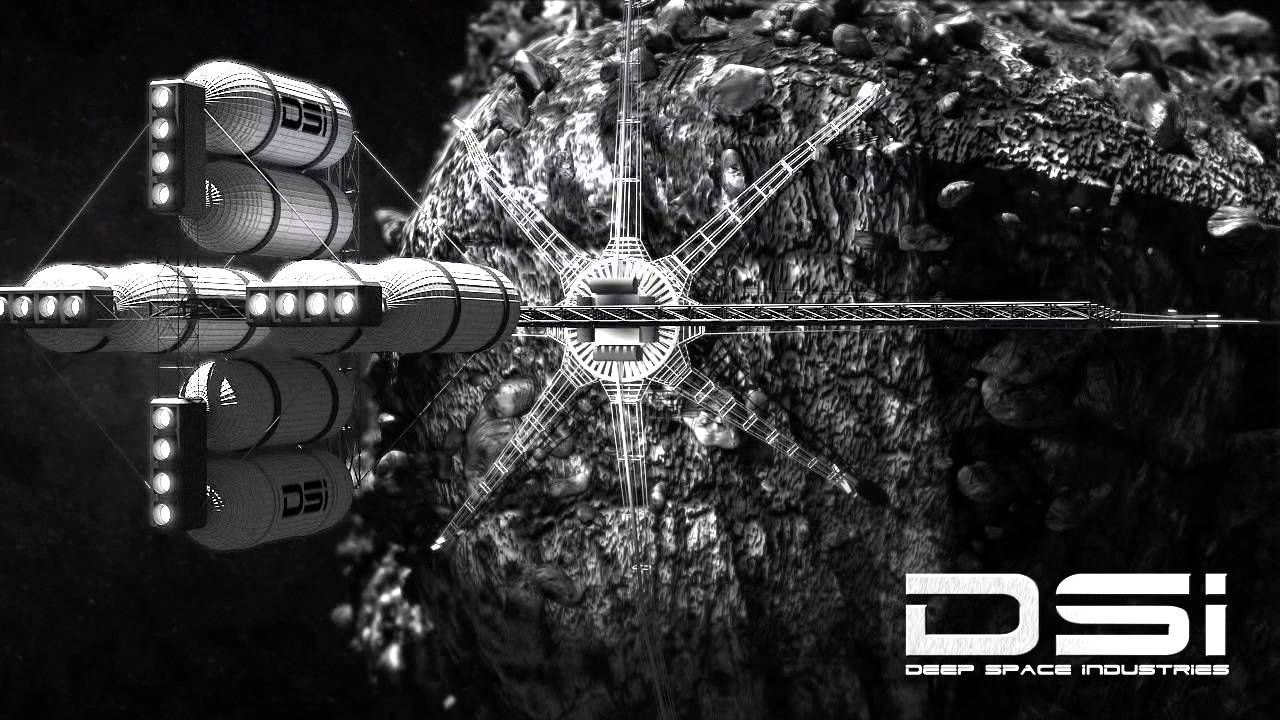
**Engineering an Asteroid Processor Project Design Files**

**Asteroid Mining**

Our human population is growing faster than ever. With almost 8 billion people on the planet, we need massive amounts of resources to meet everyone's needs. Resources on Earth are not infinite; eventually, we will run out. Mining of those resources is often costly, hazardous to human life, and devastating to the environment. We need a better solution.

Mining asteroids is one solution. Scientists have discovered that asteroids contain many of the resources that we need and could be mined without harming Earth. While asteroid mining may seem like an outlandish suggestion at first, some companies have already started to seriously explore the possibility of mining asteroids, including some in the Puget Sound region.

In this project, you will investigate the challenges, decisions, risks, and rewards faced by these companies.

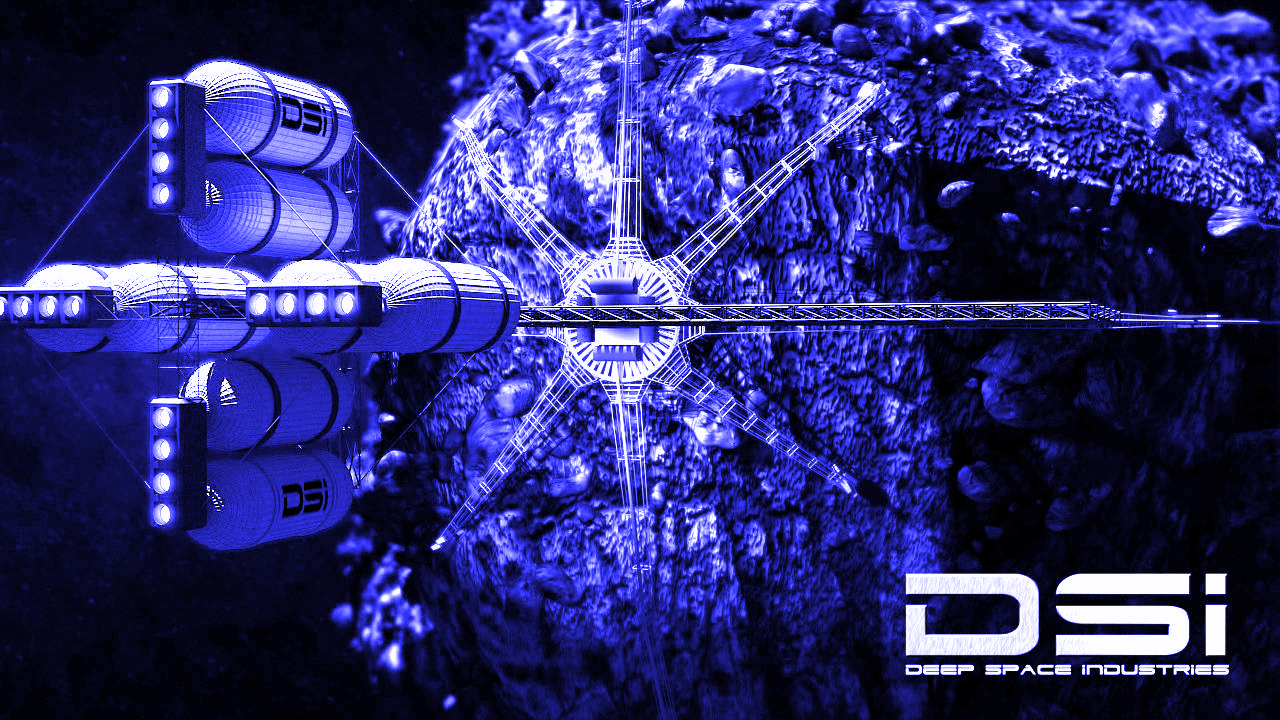
There are three phases of your team’s work:

1. Prospecting: You will need to choose a prospecting method to determine which asteroids you might mine and the resources you might expect to find there. You will be able to purchase a map, use spectroscopy, or send a probe.
2. Harvesting: You will need to choose the size of the harvester.
3. Processing: You will need to build a processor capable of separating the valuable ore from the less valuable substrate.

The choices you make at each of these phases has rewards and risks. Riskier plans may yield greater rewards… or might result in no ore at all. Plan carefully, and good luck!

**Tentative Timeline:**

|  |  |  |
| --- | --- | --- |
| **Day** | **Task** | **Deliverable(s)** |
| 1 | Project introduction, team operating agreement | Team operating agreement |
| 2 | Background & explore in functional groups:   * prospecting methods * asteroid types * processing methods | Progress report  Individual notes  Outline of cost, potential reward, and risks of each method |
| 3 | Develop plan for prospecting, harvesting, and processing in teams | Asteroid mining plan - prospecting and harvester sections |
| +1 | Risk and Reward | Gross return summary |
| 4 | Present prospecting plan | Remainder of Asteroid mining plan  Advertisement: visual, written, oral |
| 5 | Design processor | Processor initial design and budget |
| 6 | Build processor | Processor and budget |
| 7 | Build processor, test, refine | Progress report and budget |
| 8 | Process harvested material and redesign | Design analysis  Redesign and updated budget sheet \*time permitting |
| 9 | Reflection and analysis | Final analysis  Individual reflection |
| 10 | Elevator Pitch | Elevator Pitch speeches |

**Asteroid Mining**

**Team Operating Agreement**

|  |  |  |
| --- | --- | --- |
| **Name** | **Phone** | **Email** |
|  |  |  |
|  |  |  |
|  |  |  |

What individual strengths does each team member bring to the group?

How will we divide work equitably?

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Task** | **Task leader** |  | **Task** | **Task leader** |
| experiment with and identify pros and cons of different prospecting methods | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  | ensuring quality craftsmanship of processor | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| research different types of asteroids and summarize risks and rewards of mining each | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  | ensuring results are accurately calculated and reported | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| research and summarize potential rewards and risks of different prospecting methods | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  | ensuring overall quality of prospectus | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| ensuring overall quality of press release | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  |  |  |

If managed properly, conflict can be a great source of growth and learning.

* What are some potential sources of conflict among team members?

* How will we resolve conflict efficiently, respectfully, and productively?

The steps we’ll take before someone can be fired:

1. If team member’s behavior continues to fall below minimum acceptable levels, have team meeting with management (instructor or his designee).
2. If team member’s behavior continues to fall below minimum acceptable levels, fire him / her.

Team member 1 Signature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Team member 2 Signature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Team member 3 Signature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Management Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Paying (and getting paid) for asteroid mining**

Preliminary investors have offered you $100,000,000 to test the feasibility of asteroid mining. You and your team will need to use that money to pay for prospecting, harvesting, and processing ore from an asteroid. Balance your choices carefully.

There are two goals:

1. Spend as little money as you can and make as much as you can.
2. Convince future investors that your goals, strategies, results, and intended next steps are worth additional investment.

Of the two, the second goal is by far more important.

Review the price for prospecting, harvesting, and processing ore.

**Prospecting**

The cost and benefit for different prospecting methods in our model are shown in the table below:

|  |  |  |
| --- | --- | --- |
| **Prospecting** | **Cost** | **Benefit** |
| Map | $60,000,000 | 3 scoops |
| Spectroscopy | $30,000,000 | 2 scoops |
| Probe | $10,000,000/ scoop | 1 scoop during harvesting |

**Note:**

If you picked the same asteroid as another group, you have three options:

1. Mine the same asteroid.
   1. The team whose processor is done first gets to mine the asteroid first. They will keep the ore they processed, but return the byproduct (including unfiltered ore).
2. Change course.
   1. For $20M, you can select a different asteroid using the information that you have available to you.
3. Buy a faster rocket.
   1. For $20M, you can get to the asteroid faster.
   2. In our model, this purchase gives you an additional 10 minutes to finish designing and constructing your processor.

**Harvesting**

The cost and benefit for different harvesting methods in our model are shown in the table below:

|  |  |
| --- | --- |
| **Harvester size** | **Cost** |
| Small (1/4 cup) | $5,000,000 |
| Medium (1/2 cup) | $8,000,000 |
| Large (1 cup) | $10,000,000 |

If you want to add a camera to help guide your harvesting, you may add one to your harvester for $15M. In our model: a team member may provide verbal guidance to the team member harvesting ore.

**Processor Building Materials**

The table below shows materials available for building your processor and their current costs. Costs are subject to change.

|  |  |
| --- | --- |
| **Material** | **Cost** |
| Copy paper (per sheet) | $1,000,000 |
| Cardstock/Tag Board (per sheet) | $5,000,000 |
| Rubber Band | $1,000,000 |
| 20 cm Tape (Masking) | $1,000,000 |
| 6 cm Tape (Duct) | $5,000,000 |
| Dowel | $1,500,000 |
| Popsicle Stick | $1,000,000 |
| Plastic Spoon | $2,000,000 |
| Wax paper (12in x 8in) | $1,000,000 |
| Toothpick | $500,000 |
| Magnet | $10,000,000 |
| Pipe Cleaner (each single) | $500,000 |
| Twine (20 cm) | $500,000 |
| Straw | $500,000 |
| Paper bowl | $1,000,000 |
| Balloon | $1,000,000 |
| Tissue paper (per piece) | $500,000 |
| Cardboard tube | $1,000,000 |
| Unfolded paperclip | $250,000 |
| Hot glue (per minute) | $200,000 |
| Cardboard plank (~20 cm x 30 cm) | $2,000,000 |

If you want to test your prototype prior to launch, you may test it on a sample asteroid. The cost is $3,000,000 / 3 minutes.

If you want to buy extra time to harvest / process, you may do so for $5 M / min

**Value of Processed Ore**

The table below shows the value of processed ore, current 8 March 2016 2100 UTC (1300 PDT). Values are subject to change.

|  |  |  |  |
| --- | --- | --- | --- |
| **Material** | **price per kg in space** | **simulated by** | **price per unit in our model** |
| Iron | $4,000 | rubber bands | $20,000 |
| Nickel | $8,710 | macaroni | $20,420 |
| Cobalt | $20,420 | paper clips | $102,100 |
| Ice | $3,800,000 | ¼ packing peanut | $19,000,000 |
| Platinum | $29,900,000 | BBs | $149,500,000 |

**NOTE:**

For every mL of waste substrate in the processed ore, your team will be fined $500,000 as an impurity penalty.

**Summary of Research**

**Cost, Risk, & Reward**

The matrix below summarizes the cost, expected risk, and potential reward for the major choices faced by our group.

**Asteroid Type**

|  |  |  |  |
| --- | --- | --- | --- |
| **Choice** | **Expected distribution** (how many out of 20) | **Benefits** | **Risks** |
|  |  |  |  |
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**Prospecting**

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| --- | --- | --- | --- |
| **Choice** | **Cost** | **Benefits** | **Risks** |
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**Harvesting**

|  |  |  |  |
| --- | --- | --- | --- |
| **Choice** | **Cost** | **Benefits** | **Risks** |
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**Processing**

|  |  |  |  |
| --- | --- | --- | --- |
| **Choice** | **Cost** | **Benefits** | **Risks** |
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**Asteroid Mining Plan**

You have 3 decisions to make at this stage of the project; which material and asteroid to mine and what size harvester to use. You must justify each of your choices in the reasoning section provided. You have already chosen and implemented your prospecting choice and will fill in the blanks below based on that choice. Be sure to discuss each choice carefully, weighing the possible risks and rewards for each. In the Risks and Rewards section explain what the possible outcomes of your plan will be.

**Prospecting choice \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Cost \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Reasoning and Risks & Rewards:**

**Harvester size \_\_\_\_\_\_\_\_\_ Cost \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Reasoning and Risks & Rewards:**

**Material to be mined \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Price per volume \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Reasoning and Risks & Rewards:**

**Asteroid# choice \_\_\_\_\_\_**

**Reasoning and Risks & Rewards:**

**Budget Sheet**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Material** | **Price per unit** | **Quantity** | **Total Cost** | **Beginning Balance - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
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**Press Release instructions**

A press release is the quickest and easiest way to get free publicity. If well written, a press release can result in multiple published articles about your firm and its products. And that can mean new prospects contacting you asking you to sell to them.

Using the template provided, create a press release that announces your team's plan to mine an asteroid. Discuss each part and decide what information to include and how best to word that information. It must fit in the format provided.

**Headline:** The headline is your first chance to grab your reader’s attention and inspire them to keep reading. You should keep your headline short and to the point. (Place above top solid line)

**Why Mine Asteroids:** Explain briefly the reason for mining asteroids and the material you are going for.

**Prospecting Method:** What did your team choose and why? How did that lead to your choice of asteroid?

**Harvesting method:** What did your team choose and why?

**Potential Risk and Reward:**  What are some possible risks associated with your choices and how does that compare with the possible rewards. Be sure to talk about budget expenses and potential profit here.

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Why Mine Asteroids?** 

**Potential Risks and Rewards**

**Initial Processor Planning Chart**

|  |  |
| --- | --- |
| Innovations  (Features included in the initial design) | Justifications for the Innovations being Used |
|  |  |
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**Initial Processor Design**



**Rationale**

Briefly summarize your design and why it will be successful.

**Analysis of Your Initial Processor Design**

With technology, perfect solutions do not exist. All technological solutions involve trade-offs in which decisions to include more of one quality means less of another. All solutions involve consequences, some intended, others not.

1. What were some trade-offs that your team made in the process of designing your initial processor  
 prototype?

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1. As a group, discuss each statement below as it relates to your work together on this project. Come to consensus about how you would rate each statement and indicate your response by circling the number below each item that best represents your group’s view.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Statement | STRONGLY  DISAGREE | DISAGREE | UNSURE | AGREE | STRONGLY  AGREE |
| The group was clear about its goal. | **1** | **2** | **3** | **4** | **5** |
| Group members were committed to working together. | **1** | **2** | **3** | **4** | **5** |
| The division of labor within the group was based on members’ skills and interests. | **1** | **2** | **3** | **4** | **5** |
| Decisions were made by consensus. | **1** | **2** | **3** | **4** | **5** |
| Group members gave useful feedback to each other | **1** | **2** | **3** | **4** | **5** |
| The group moved forward as a unit and with spirit. | **1** | **2** | **3** | **4** | **5** |
| No one member dominated group discussions or tasks. | **1** | **2** | **3** | **4** | **5** |
| Group members listened to each other. | **1** | **2** | **3** | **4** | **5** |
| Group members clarified ideas for each other. | **1** | **2** | **3** | **4** | **5** |
| Alternative solutions and ways of thinking were generated. | **1** | **2** | **3** | **4** | **5** |

**Final Processor Design**



**How is your redesign different than your initial design?**

**Processor Redesign Analysis**

1. What were your successes and failures for the redesigned processor?
2. What led your team to select the innovations that you did during the re-design process? What considerations did you make as you choose each innovation for your re-design?
3. Did your redesign accomplish your goals? Why or why not?

**Asteroid Mining Final Analysis and Profit/Loss**

Team Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Team Members \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_,   
 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Asteroid Mining Cost**

Prospecting choice \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Harvester size \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Final Processor cost - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Total spent \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Asteroid Mining Earnings**

Material Mined \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Price per unit \_\_\_\_\_\_\_\_\_\_\_ X #mined \_\_\_\_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Waste material amount \_\_\_\_\_\_\_\_\_ ml X 500,000.00 = - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Total earned \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Total Profit/Loss**

Total earned(from above) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Total spent(from above) - \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Total - if positive = profit/if negative = loss \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Analysis - answer as a team**

What did your team learn about Asteroid Mining?

What did you struggle the most with?

What did you struggle the least with?

If you could do this project again or another project like it what would you do different?

What skills did you learn that can be applied in any situation?

**Asteroid Mining Elevator Speech Guidelines**

Elevator Pitch Guidelines The term “elevator pitch” captures the ability of an entrepreneur to have his or her business concept down so tightly and effectively that he or she could walk into a hypothetical elevator, meet a potential investor, and convey the essence of his or her business by the time the elevator reaches the 20th floor. ***You should be able to deliver your pitch in 90 seconds—1 1/2 minutes.***

1. The problem: Everything starts and ends with the customer. So open with the problem you are solving or the need you are fulfilling.
2. The solution: Briefly describe what you sell and how it solves the problem or meets the need.
3. The market: Briefly indicate to whom you are selling your product or service.
4. The competition: Mention the competition (and there is always some form of competition). Acknowledge how others solve the problem, and then explain why your solution is better.
5. The revenue model: How will you make money?
6. The team: Why should anyone bet on you? Build the credibility of our company by talking about your team’s background, experience and achievements.
7. The close: Close strongly by reiterating that you are solving a problem in a specific market with a   
    model that works and a team that can execute.

* Keep it simple:
* Say the unexpected:
* Be concrete:
* Demonstrate credibility:
* Show emotion:
* Tell a story: