Teamwork in Aerospace

Based on the NASA Activity and PowerPoint
https://www.grc.nasa.gov/WWW/K-12/airplane/TeamAct/teamwork.html

OBJECTIVE – Students will be able to learn about the importance of teams in the aerospace industry and demonstrate the importance of teamwork.

NATIONAL STANDARDS –

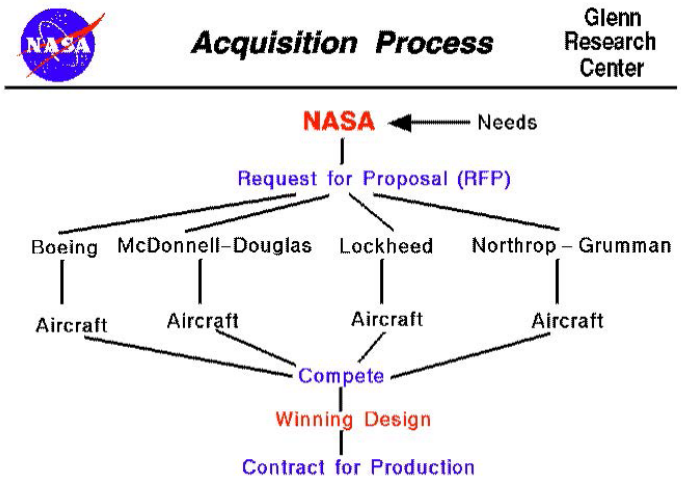
Next Generation Science Standards (www.nextgenscience.org):
Disciplinary Core Idea Progressions
Crosscutting Concepts
• Systems and system models
Science and Engineering Practices
1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
6. Constructing explanations (for science) and designing solutions (for engineering)
8. Obtaining, evaluating and communicating information

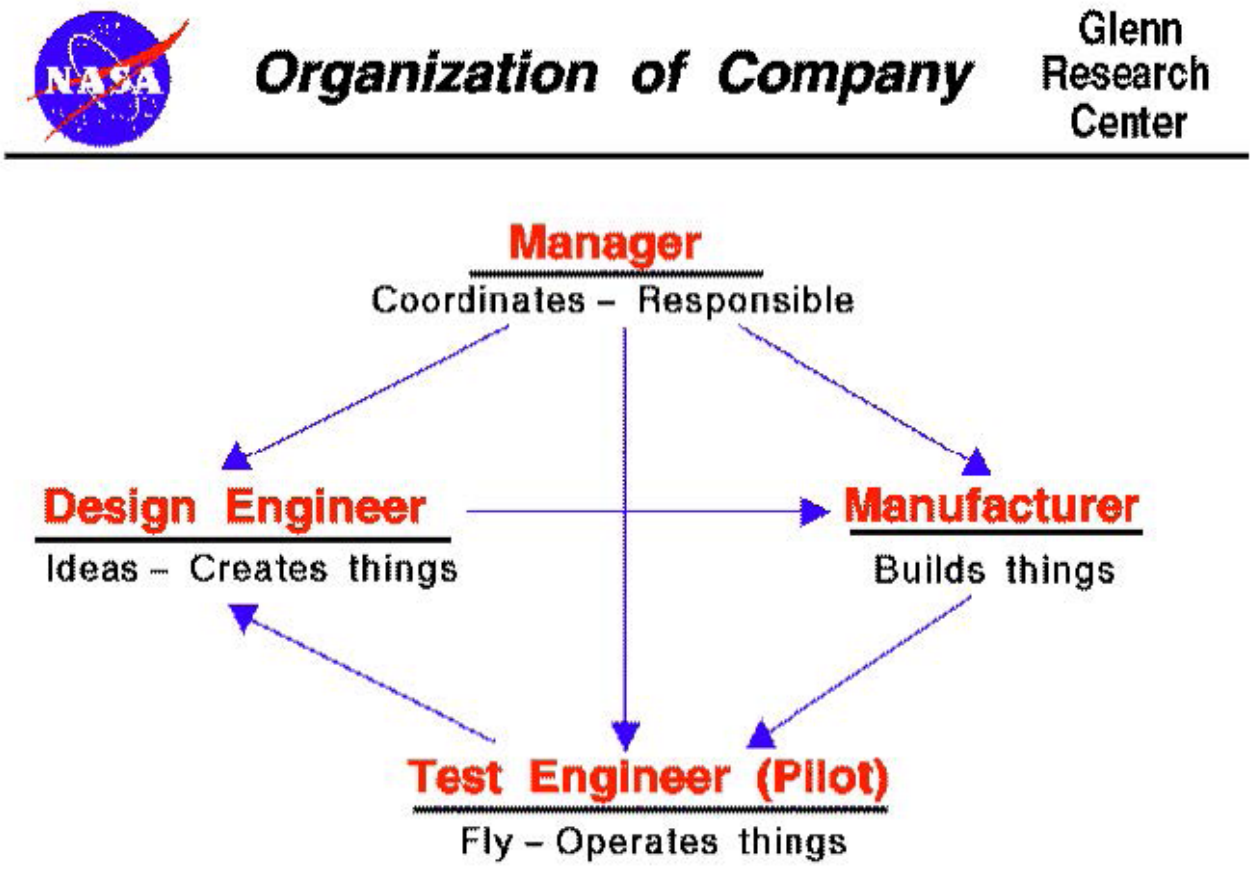
BACKGROUND – (Information from https://www.grc.nasa.gov/WWW/K-12/airplane/TeamAct/background.html)

There are three major parts to the aerospace industry; the research groups like NASA who figure out how aerodynamics and propulsion works, the suppliers like Boeing who make aircraft, and the users like the Air Force who fly the aircraft. People interested in careers in aerospace can join any part of this structure based on their own talents and interest. (Interestingly, the Wright brothers did all three parts themselves between 1900 and 1905!)

The user has some need for an aircraft and a mission that the aircraft is to perform. The needs are determined by the user and the user defines his needs in a Request for Proposal (RFP). The RFP is a document that spells out what the aircraft must do. The user publishes this document and the various suppliers must make a determination if they can design an aircraft which meets the needs of the user. In the best of all worlds, the supplier already has an aircraft that is close and can modify an existing aircraft. If not, the supplier proposes a new design to the user based on results from the research groups. The user normally receives more than one response to the RFP and must determine which design can best meet the mission. The user often conducts a competition between rival suppliers to determine the best aircraft and to lower the cost of the aircraft. The winning design is awarded a contract for production and the supplier produces some agreed upon number of aircraft for the user. This defined process by which the users obtain aircraft from the suppliers is called the acquisition process. Aerospace companies are normally very large. They may have subsidiary units, or even smaller companies, spread around the country to perform a variety of functions.

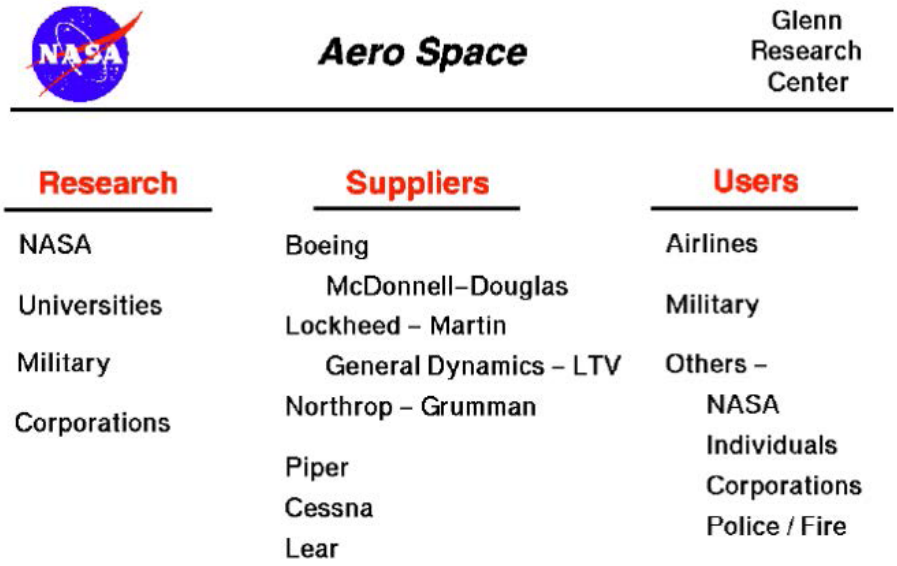
The major functions of any aerospace company are to design, manufacture, and test aircraft. Different groups of people perform these functions and there must be some coordination between the groups. This is one of the roles of management within the company. The managers are also responsible for the operation of the company and make the decisions about the response to RFP's from the users. Normally, the manager is the contact point between the user and the company. Inside the company, the manager has contact with the design, manufacture, and test groups. The designers also receive input from the test group so that they can modify and improve their ideas. The designers provide input to the manufacturing section who then convert the ideas of the designers into physical aircraft. The manufacturers make the airplanes. The test group takes the aircraft from the manufacturers and determines if they meet the needs of the users. They often provide input back to the designers. Most aerospace companies have company test pilots who fly their aircraft before it is turned over to the user.





MATERIALS – per "company" (group)
a. Ten sheets of white 8.5" x 11" copy paper
b. One sheet of 8.5" x 11" colored paper. Each group needs a different color so they can tell which one belongs to their company when the testing is over.
c. Tape
d. Scissors
e. Paper clips
f. Stopwatch
g. Markers
h. Company log and job nameplates

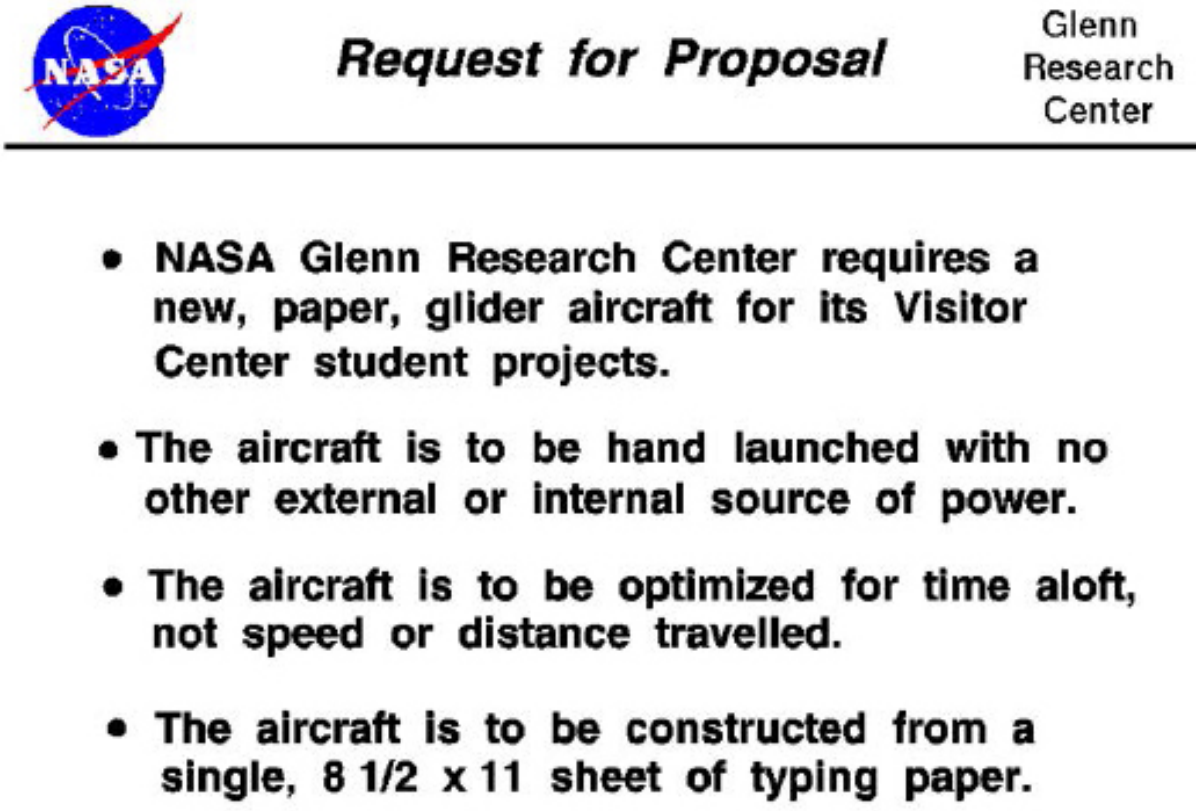
MANAGEMENT TIPS –
Prearrange students into teams of 4 students to form a "company" for best results. Also, arrange the classroom so that each "company" has its own table on which to place the required materials. Do not pass out the colored sheet of paper for the final design until the manager of the company requests the final paper from the teacher. Remind companies of time left for them to finish by giving warning times (10 minutes…5 minutes… 2 minutes...1 minute…STOP!) After time is called, each company must send their pilot to the competition area for a presentation to NASA (the "user"). Predetermine a large competition area before the lesson begins. Start the timer when the aircraft leaves the hand of the pilot and stop it when it hits the ground. Fly just one plane at a time. The average ((Flight 1 + Flight 2) /2) of the two flights will be the score.



PROCEDURE – Remember, the emphasis of this activity is not on the aerodynamics of the gliders or who wins the contest, but on the process that produced the plane. Students will have experience with communicating and working as a team and some of the problems that go along with management – worker relationships.

1. Before you begin the lesson, and once you have the attention of the class, throw a paper airplane.
2. Launch a discussion regarding predictions on the lesson related to the paper airplane.
3. Review how aerospace companies work, using the background information provided above as well as the first few slides from the NASA PowerPoint presentation related to this lesson. (https://www.grc.nasa.gov/WWW/K-12/airplane/TeamAct/teamwork.html)

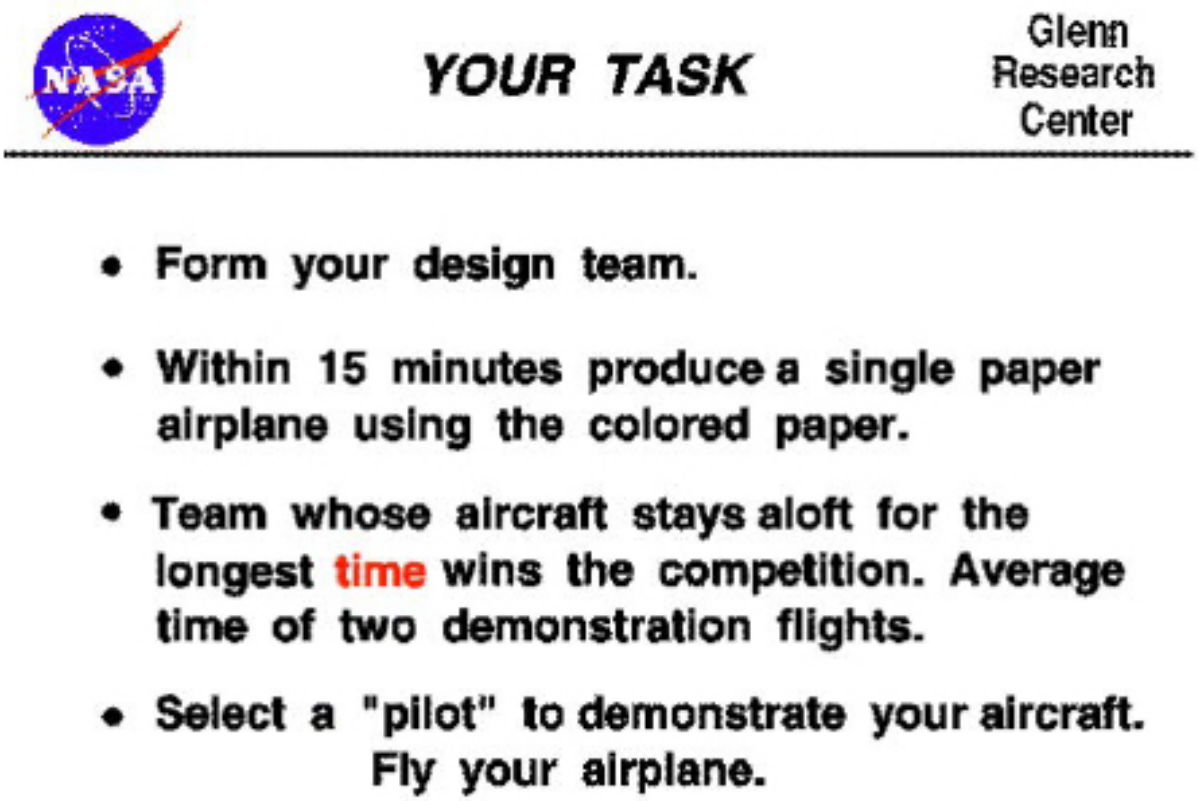
4. Explain to the students that they are going to be asked to do something that they already know how to do: build and fly an airplane, but with a twist. The students will be working together as an aerospace "company".
5. Show the video, "How NASA Used Teamwork to Reach Saturn: Science of Teams" to demonstrate the importance of teamwork in aerospace. (https://youtu.be/e-hPjkBooM4)
6. Ask students to get into their "company groups" that were predetermined, if they are not already sitting at their "company" table. Tell the students to come up with a creative name for their "company". Within the groups, have the team members assign one of the following positions (task cards included at the end of the Procedures) to each person in the "company":
    - Manager: Responsible for the operation of the company and makes the decisions about the response to RFP's from the users. The manager is the contact person between the user and the company. The manager also has contact with the Design Engineer, Manufacturer, and Test Engineer.
    - Design Engineer: Provides inputs to the manufacturer of how the airplane should be built. Receives inputs from the Test Engineer of problems that occurred in testing so the changes can be made to the airplane.
    - Manufacturer: Makes the airplane and changes the airplane with input from the Design Engineer.
    - Test Engineer (Pilot): Flies the airplane and communicates any problems to the Design Engineer.
7. Mention that NASA has just issued an RFP for a paper airplane to be used in student outreach activities at the NASA Visitor's Center locations all over the United States. Project or display the RFP below and go over the specific criteria and constraints with the students.
8. Inform the students that you (the teacher) represent NASA (the "user") as the judge of each of the air planes created by the different companies to find the winner of the contract. The awarding of the contract will be determined by a fly-off.
9. Tell students that each company will be building a single prototype aircraft using the colored paper. Pass out a different color of paper to each company.



10. Let the students know that they will have 15 minutes to produce the aircraft on the official colored paper. The white paper is to be used for testing different aircraft ideas. When the "company" has decided on the final prototype, it should be constructed out of the colored paper. This is the aircraft that will be used for the competition. The "company" may not compete with a white aircraft. If there is no aircraft made from colored paper, the "company" does not have a qualifying prototype.

11. The "company" whose aircraft stays aloft for the longest time wins the competition. Two demonstration flights will be conducted, and the average will be used to determine the winner. Teams may test their aircraft at any time before the final competition, however the contract will be awarded solely on the performance during the fly-off.

12. Make sure the students know that once the 15 minutes are up, the companies need to meet at the competition area (predetermined by the teacher) with all team members present. The Design Engineer (pilot) will be the one demonstrating the aircraft. "Companies" will go one at a time. Below are the rules for the fly-off. This slide is also included with the website listed at #3.



13. Before you start the timer, review the roles in the "company." Tell the students that the only person who may communicate with the user (NASA) is the manager of the "company."

14. Allow students time to build and test their prototype.

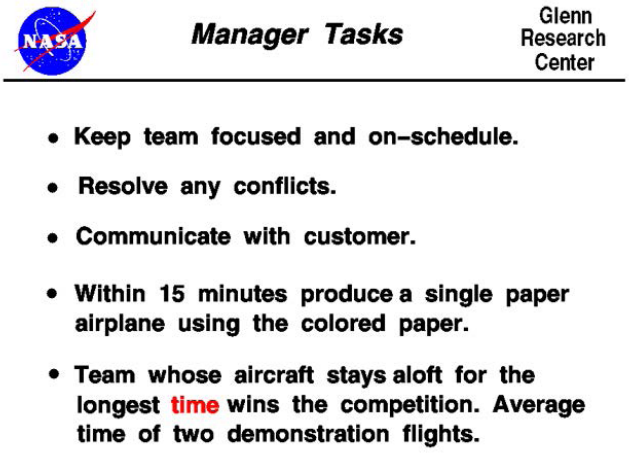
15. Conduct the fly-off following the "Management Tips" listed above.

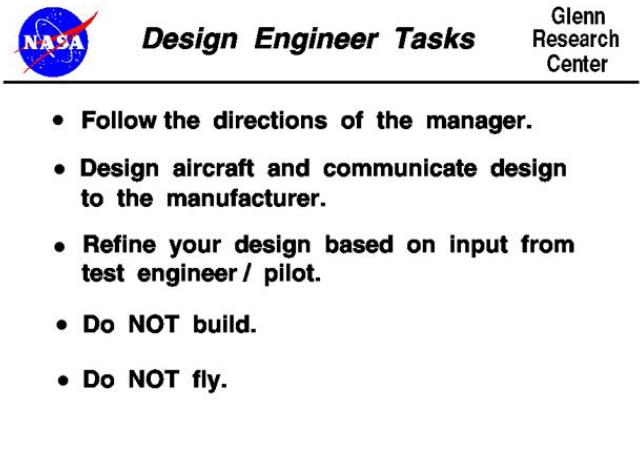
16. After the competition, have the "companies" answer the debriefing questions as a group and have the manager present the group answers to the class. The debriefing questions are included in the Power Point mentioned in #3 as well as at the end of the activity.

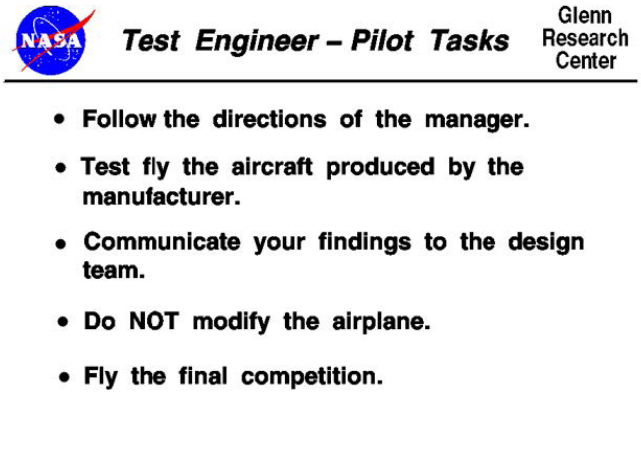
17. Evaluate students based on how well they worked as a "company" and the insights they gained from the activity as evidenced by the answers to the debriefing questions.

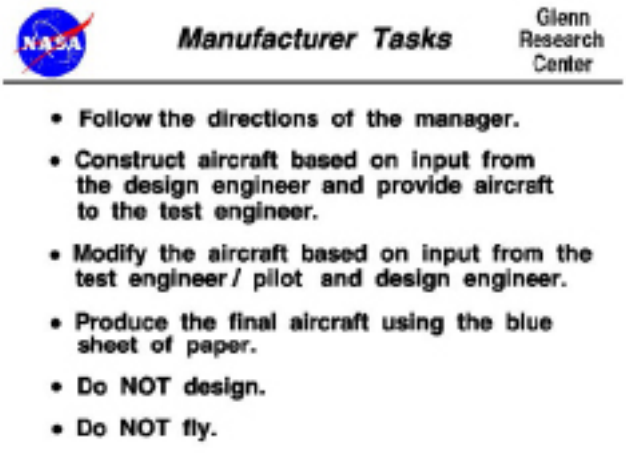
18. At the conclusion of the activity, show the raw footage of NASA celebrating the Mars Rover Landing by the Associated Press. This video shows the true euphoria that is felt when teamwork is successful. (https://youtu.be/dkVBXW4JeUI)

Task Cards for "Company" Jobs









EXTENSIONS:

- Anomalies (something that deviates from what is standard, normal, or expected) can be introduced with such changes as:
  - One member of a company is hired by another company and the person doing that job has to interview to work in another company.
  - There is a shortage of supplies to complete the project.
  - The "user" changes the requirements before the completion of the aircraft.
- Team building Resources:
  - Team building activities: http://nmctso.com/wp-content/uploads/2015/10/DECA-teambuildinggames.pdf (from Ohio DECA Leadership Retreat)
- For more information on aerospace:
  - Careers in Aerospace, Teamwork Activity, Space, Aeronautics http://www.grc.nasa.gov/WWW/K-12/airplane/topics.htm

Name: _____ Date: _____

COMPANY DEBRIEFING QUESTIONS

Name of Company: _____
Manager: _____
Design Engineer: _____
Manufacturer: _____
Test Engineer (Pilot): _____

After the fly-off competition, have your company come together and answer the questions below:

1. How did your team arrive at a design? Did you consider more than one design?

2. Did everyone participate in the aircraft activity and contribute the skills they were assigned? Explain.

3. Did your company feel constrained or pressured by the time limit? By the paper limit?

4. Did you worry about other teams using your ideas? Explain.

5. Did you share information with your team members? Explain.

6. How well did you work with your company manager?

7. Working as a team, how would you improve your company's production in the future?