

NASA CONNECT 1999-2000 Lesson Guides

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Questions or Comments?
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Introductory Packet



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 Mirror, Mirror on the Universe

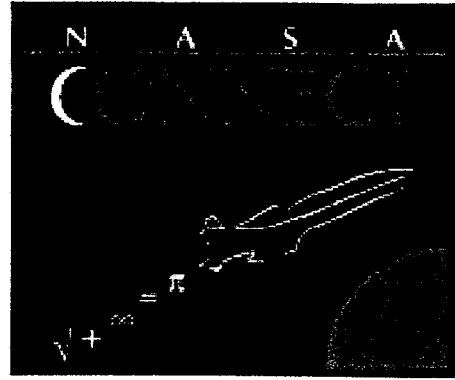


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National Aeronautics and
Space Administration
Langley Research Center
Hampton, VA 23681-0001



Program 5 in the 1999-2000 Series

Proportionality: The X-Plane Generation

Story Line: Students will learn why scaling and proportion are important factors in spacecraft design.

Math Concepts: Computation, Ratios, Estimates, Measurement

Science Concepts: Systematic Investigation, Force, Motion, Energy, Heat, Sound

NASA Research: X-Planes

DFRC, LaRC, MSFC, STENNIS



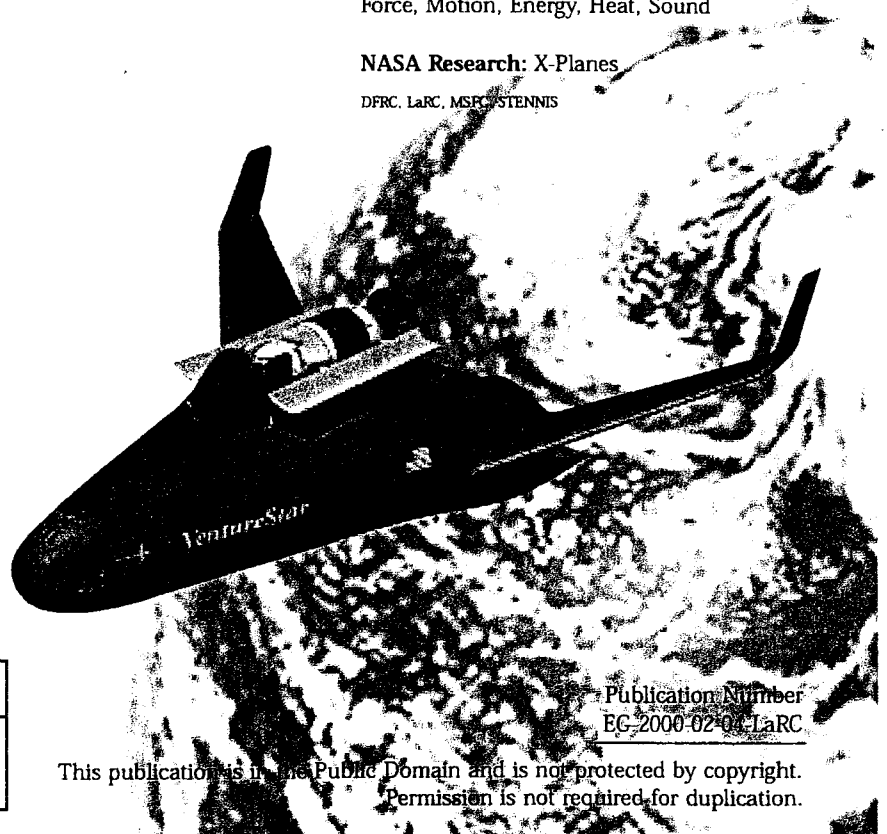
calculate ratios and proportions



use the internet and visit Norbert's Lab



make your own model of NASA's X-33



Educator's Guide	
Teachers & Students	Grades 4-8

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PROGRAM SUMMARY

OBJECTIVE

In *Proportionality: The X-Plane Generation*, students are introduced to the scale model as an engineering tool by using NASA's experimental aircraft, the X-33, as an example. Students may be familiar with scale models from toys, building kits, or from playing with dolls and dollhouses. This episode of NASA CONNECT focuses on the math concepts of computation, estimation, ratios, and measurement and illustrates a systematic scientific investigation. Students will meet NASA researchers and other professionals who will (a) describe the relationship between force, energy, and motion; (b) discuss how NASA's experimental X-plane is being tested to make space travel more reliable; (c) show students how proportionality and ratios are used to make scale models of spacecraft like the X-33; and (d) describe how scale models are more manageable than full-scale models when it comes to testing and retesting their designs.

CLASSROOM ACTIVITY

In this activity, students use the provided pattern to construct a paper scale model (1:140 scale) of the NASA X-33 experimental vehicle. Students will measure the linear dimensions of the model and, comparing those dimensions to the actual dimensions of the X-33, compute a scale factor. Demonstrating their understanding of the concept of proportionality, students may test whether the model is a true scale model. Finally, students use the scale model to estimate the volume of a "payload" that could fit inside the Lockheed-Martin Venture Star™. Optionally, advanced students may compare the surface area and volume of the scale model to the corresponding values for the full-scale X-33, discovering how area and volume scale factors relate to linear scale factors.

The suggested time schedule for the activity is based on a 45-minute teaching block:

- Day 1 Introductory information and construction of the X-33 model (1 hr.)
- Day 2 Find scale factor and use scale factor to determine the payload dimensions of the full-size and model X-33

For more information on *Proportionality: The X-Plane Generation*, visit the NASA CONNECT web site: edu.larc.nasa.gov/connect/xplane.html

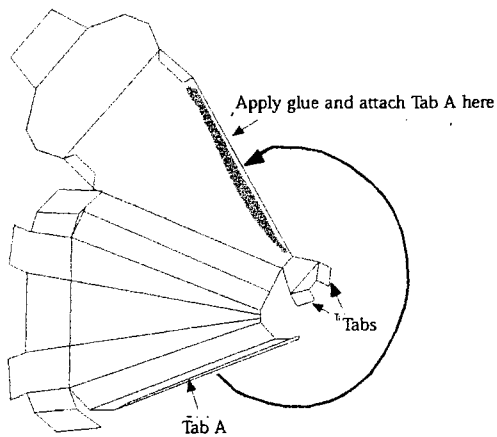


FOLDING AND ASSEMBLY INSTRUCTIONS

1. Carefully cut out the X-33 body. Use sharp scissors. Be sure to cut out the triangle near Tab C. Don't cut out the fins, flaps, and engine until you need them.
2. Crease along all the dashed lines. To make sharp folds, place a ruler along the line and hold it down tightly. Then slide your finger under the paper and lift it up against the ruler.
3. Cut the four slots, two for the canted fins and two for the vertical fins. Be careful to cut only on the cut lines and not on the fold lines.
4. (*Diagram 1*) Glue the back side of Tab A to the edge where it says "Glue A here." Be sure to fold the model so that all the writing is on the inside. Line up the alignment dots.

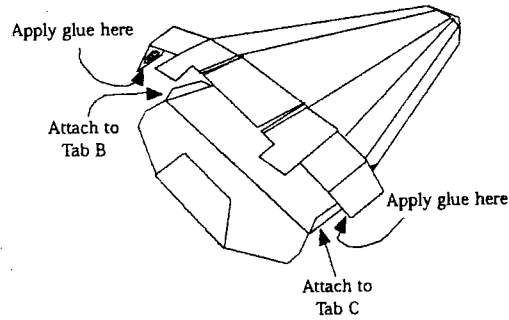
Fold up the nose and tuck the flaps into the front of the X-33. Push the nose in until it stays.

Diagram 1



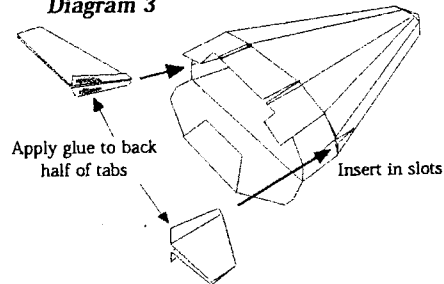
5. (Diagram 2) Glue Tab B to the flap that reads "Glue on B." Do the same with Tab C.

Diagram 2



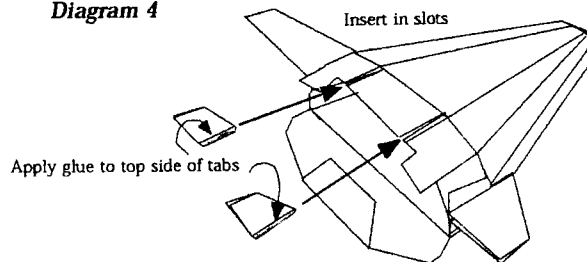
6. (Diagram 3) Cut out the canted fins. Fold each fin in half along the middle line. Be sure the markings are on the inside. Fold back the tabs of each fin. Apply glue and insert the fins in the slots that you cut on the side of the X-33.

Diagram 3



7. (Diagram 4) Cut out the vertical fins. Fold them in half on the middle line. Be sure the markings are on the inside. Fold back the tabs. Apply glue to the top side of the tabs and insert them in the slots on the top of the X-33.

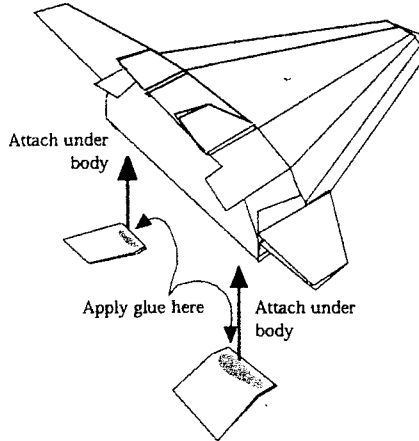
Diagram 4



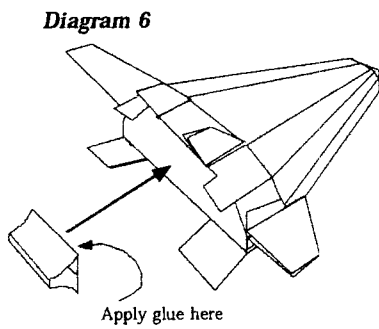
8. (Diagram 5) Close the back of the model but don't glue it. You may need to open it later.

Cut out the body flaps. Fold the body flaps in half and glue them closed. Attach the flaps under the back of the X-33.

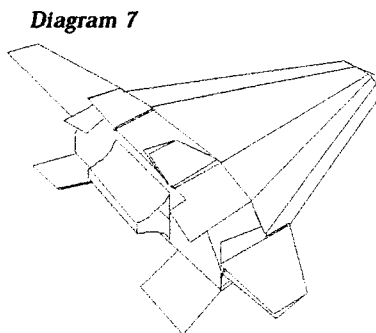
9. (Diagram 6) Cut out the engine. Line up "Edge A" at the



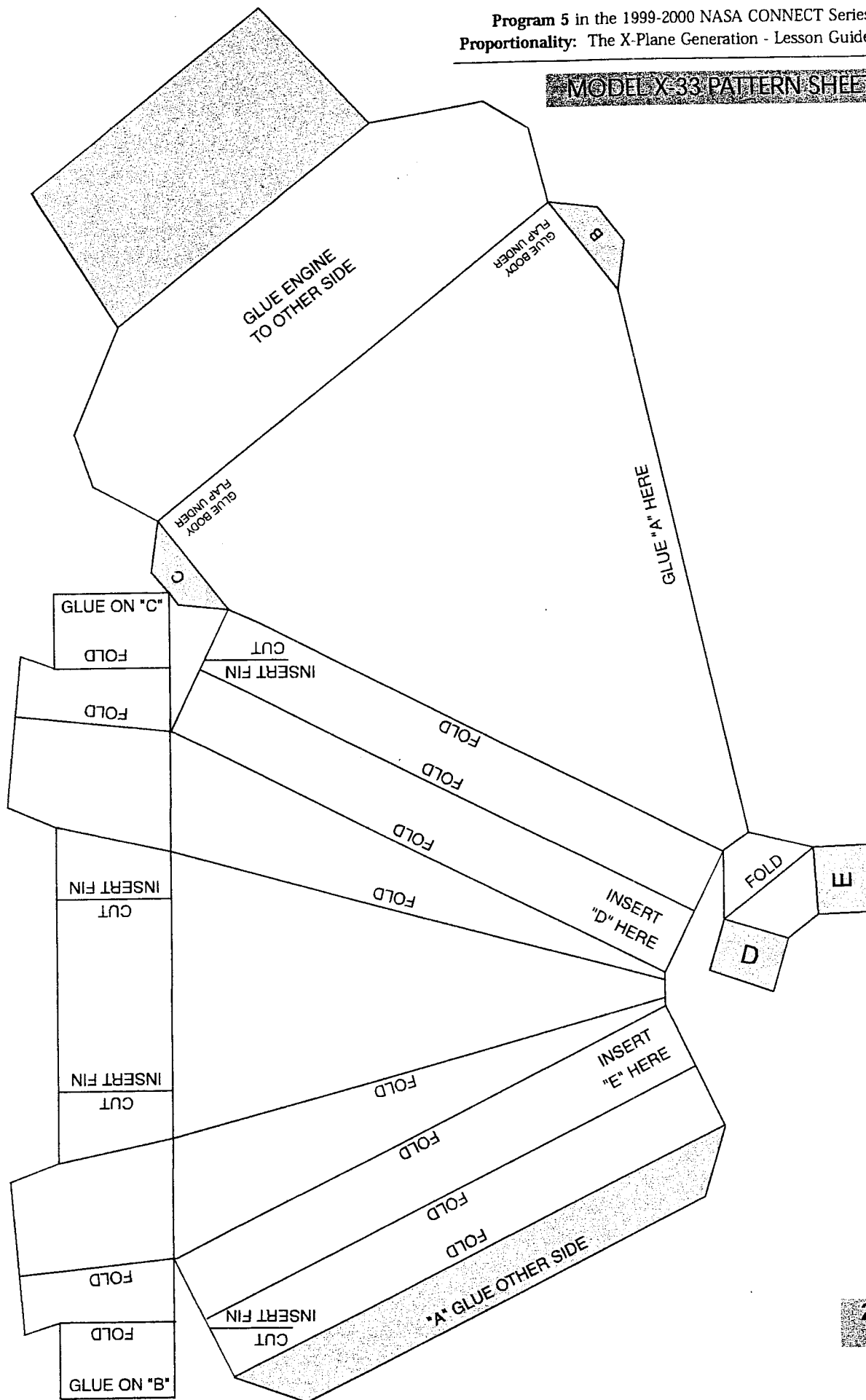
line that says "Line up edge A here" and glue it in place. Squeeze the engine so that the top and bottom are curved. Glue the engine to the back of the X-33.



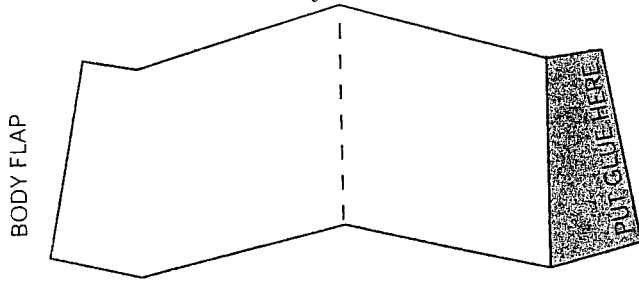
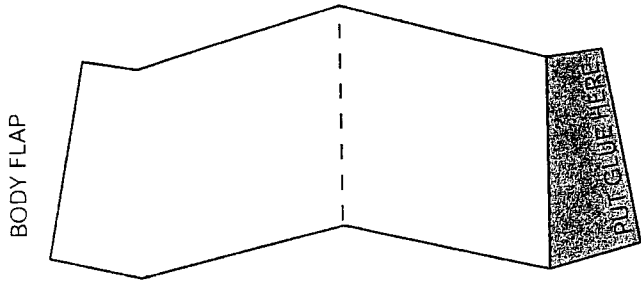
10. (Diagram 7) The finished X-33 model.



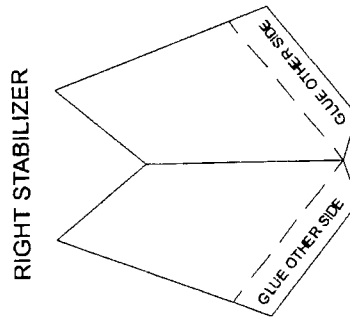
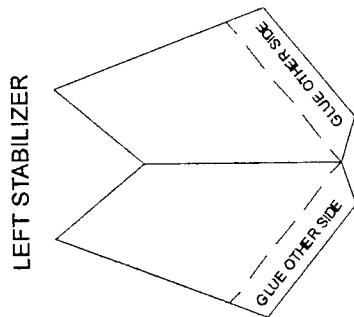
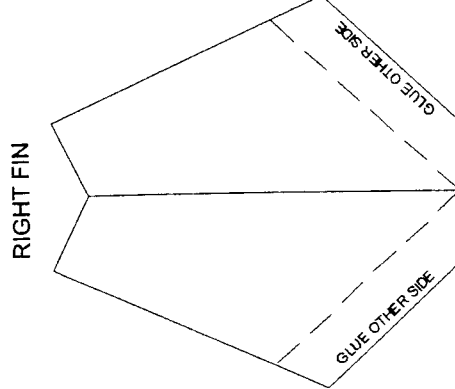
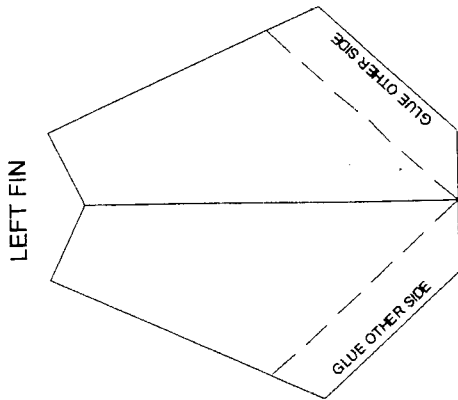
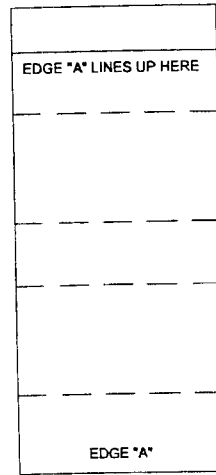
MODEL X-33 PATTERN SHEET



MODEL X-33 FINS, FLAPS, AND ENGINE



ENGINE





Frontier
AIRLINES

#5 FOLD IN ON DOTTED LINE

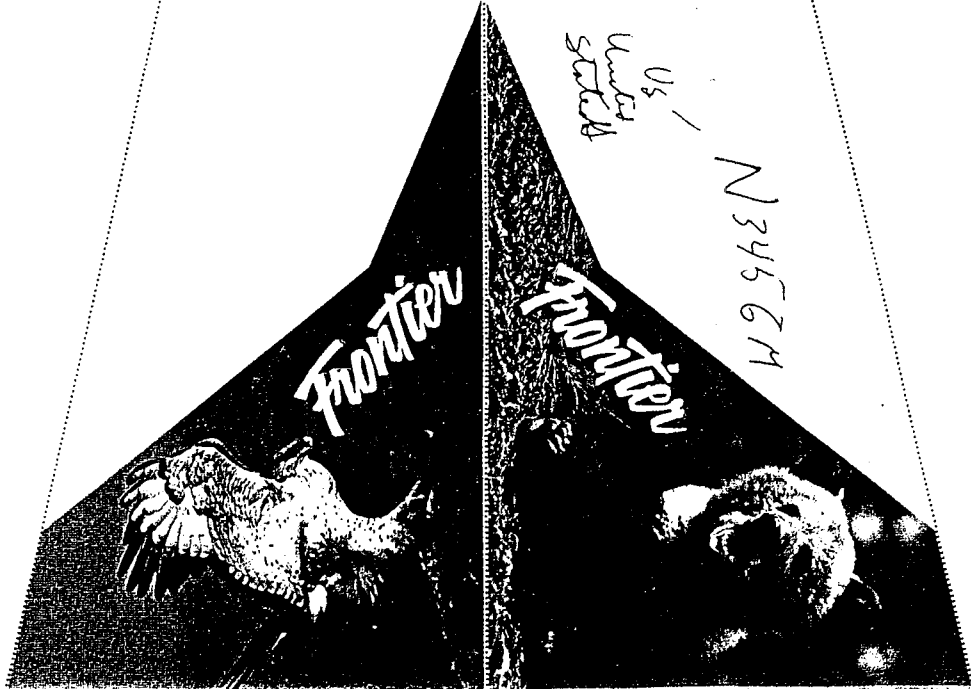
MOVABLE Z

#5 FOLD IN ON DOTTED LINE

Frontier
AIRLINES

US
UNITED
STATES

N3456M





#3 FOLD IN HIDING DOTTED LINE

#3 FOLD IN HIDING DOTTED LINE

#2 FOLD UP TO EDGE, HIDING DOTTED LINE AND REOPEN

#4 FOLD IN HIDING DOTTED LINE

#4 FOLD IN HIDING DOTTED LINE