DESIGN

OF A

LAMINAR

OCTET TRUSS

by

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INTRODUCTION

Buckminster Fuller designed and patented the Octet Truss. The more familiar version is formed from a vast number of identical strut components, and its first practical use was in the structure of the Ford Rotunda dome. Still in its strutted form the octet truss has found many applications in the space satellite and Voyager programs.

Bucky left us two designs for laminar octets ["laminar" is used here in the sense "formed from sheet material"]. Fig 1 shows a method of assembly from numbers of identical 60° equilateral triangles. Fig 2 is a method for folding ribbon material into single-unit-width strips of truss. In both these methods relatively large numbers of identical components must be brought together and joined by various means to produce a final product.

My design for a LOT [laminar octet truss] attends to the idea of production as a continuous flow, from raw sheet material to finished panels, beams etc, of various forms. The design is applicable to virtually all of the common laminar raw stock; e.g. paper, cardboard, plastics, sheetmetals and composites. It also covers a wide dimensional range.

Readers unfamiliar with the theoretical and practical advantages of the octet truss are referred to Buckminster Fuller's "Synergetics" [Macmillan, 1975] section 420 on pp 135 to 148, and to his relevant patents. I am not here claiming invention of the octet truss - merely a method, a group of design ideas for its economical production in laminar form.

No attempt will be made here to detail the design and operation of the production tools and machinery needed to produce LOT commercially. Sufficient to say that current technology is quite capable of their design and construction, where they do not already exist.

I shall confine myself to demonstrating the practicality of the design by providing patterns and instructions sufficient for you to easily construct an illustrative model. There is *nothing* as convincing as making a scale model for yourself.

I shall conclude with some notes and comments on various attributes and possibilities that may not be immediately apparent.

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THE MODEL

What you will need:

1] Cardboard. At least A3 size [420x297mm], equal to two pages of this book laid side-by-side. I suggest that you should make the model in A2 size [594x420mm], equal to two A3 pages side-by-side. You want the type of cardboard used by picture framers to back prints, something between 1/32 and 1/16th inch thick.

2] A Stanley or Xacto knife for cutting the card.

3] Cellotape and/or a small office stapler.

4] Sheet plexiglass or transparent acetate of comparable stiffness to the chosen card.

5] An adhesive that will bond item 4 to item 1.

6] Access to a xerox type copier with enlarging facility.

MODELLING THE SINGLE MODULE.

First we will make a model of the single module [fig 3] both for practice and for greater understanding.

a] Make a xerox copy, actual size, of fig 3.

b] Paste this copy on to a piece of card.

c] SCORE all the dotted lines with a dead ballpoint pen. Be firm.

d] CUT all the solid lines with your Xacto knife.

e] FOLD all the scored lines, always folding 'away' from you. Properly scored and folded the card will stay at 90° to its original plane.

f] Slide the A triangles over the B triangles until they are congruent, exactly superimposed.

g] Stabilize, either by stapling through the superimposed faces or by cellotaping the exposed doubled edges.

You should now have a tetrahedron with three truncated edges, a truncated vertex marked "P" and an open base.

Note well the obvious facts: This three dimensional module has a base area much less than that of the plane material from which it has grown. The two 'flat' dimensions have shrunk [in fact by one third] in creating the third. It has also gained a little structural integrity;
not much, but we haven't finished yet.

We next develop the single module pattern into an all-over tesselation. You see this completed as fig 4.

MODELLING THE LOT.

h] Using the xerox enlarger blow up fig 4 to A3 size. This is, on most copiers, the maximum enlargement [1.44x].

i] Paste pattern onto card.

j] SCORE ALL dotted fold lines before cutting anything.

k] CUT ALL solid lines before folding anything.

l] FOLD the first THREE rows of large (A & B) triangles down. NOTE that it is not possible, due to the planar shrinkage effect, to completely fold and stabilize one row of modules unless the next two rows have been folded open. Note also that while the P vertex triangles rise towards you, the N triangles sink away.

m] Continue folding and stabilizing progressively.

n] The model can now be completed by applying adhesive to the truncated vertex triangles [Ps & Ns], and affixing the upper and lower sheets of plexiglass or acetate.

If these instructions have been followed in a workmanlike manner you now possess a model which not only demonstrates the practicality of the design concept, but also shows that surprising resistance to deformation that is the prime characteristic of any octet truss.

We have also discovered that this cutting and folding of multiples of the original [fig 3] module has produced not only the expected P type tetrahedra, but also a complementary set of N [negative] tetras and that each group of P & N tets surrounds an octahedron.

NOTES AND COMMENTS:

A] The orientation of the cutting pattern, relative to the edges of the sheet material, has significance, and for different purposes it may be differently oriented [usually by rotation in increments of 30°]. For instance we see in fig 5 three heavy lines which extend the edges of an N vertex. These lines [from *any* N vertex] indicate Troughs in the core which may be used as fold lines before the application of the upper and lower sheets. Such a fold may be of any angle from 0° to 90° positive or from 0° to 180° negative. As the folds may be of any chosen degree and frequency it is therefore possible to change the planar angle of the truss to produce abrupt angles or graduated plane curves, cylindrical or helical forms. Making the point, to produce a fold horizontal to the run of the material in fig 5 would require a rotation of the pattern by 30° or 90°.

B] The repetition pattern shown here is simple and uniform, i.e. the dimensions are identically repeated in each module. By varying some or all of the dimensions within or between modules, or both, the core may be caused to follow, or to produce simple or complex compound curvatures. This is within the scope of current computer programming and machine control.

C] Very simple modification of the cutting pattern can produce, for instance, struts of "U" or triangular section in place of the double walled structure of the P tets. See fig 6.

D] The demonstration here of only single layer construction must not be construed as a limit. The octet truss may, by definition, be extended in multiple layerings in any of the twelve possible directions.

E] Much that is 'common knowledge' concerning the octet truss has been left out of this paper which is written, by request, originally for an audience well acquainted with the subject.

F] The construction of continuous laminar octet truss is not limited to variations of the "cut and fold" methods described here for purposes of demonstration. The many materials that have a flowing phase, such as most industrial metals, many plastics, ceramics and composites, may all be persuaded into the form of LOT using one or another, or a combination, of such standard manufacturing processes as extrusion, vacuum and press forming and so on.

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I am available for consultation, advice and assistance at this address:

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SUPPLEMENTARY NOTES ON MAKING LARGER AND STRONGER MODELS:

Take the pattern to a Reprographic office or Plan Printer; they have the ability to enlarge it to any size up to AO [1189 x 841 mm].

With larger sized models, instead of pasting the pattern and cutting through, try temporaily taping down the pattern and with a heavy needle or bradawl mark all the line junctions by pricking through the pattern. Score using a metal straight-edge and a tracing wheel, after removing the pattern sheet.

With heavy gauge cardboard and with sheet metal or plexiglas your cutting lines will have to be widened to equal, or slightly exceed,the thickness of your material.

As sheetmetals and plexiglass will predictably hold to their folded shapes you will be able to use the [fig 6] modification to produce strut-form models.

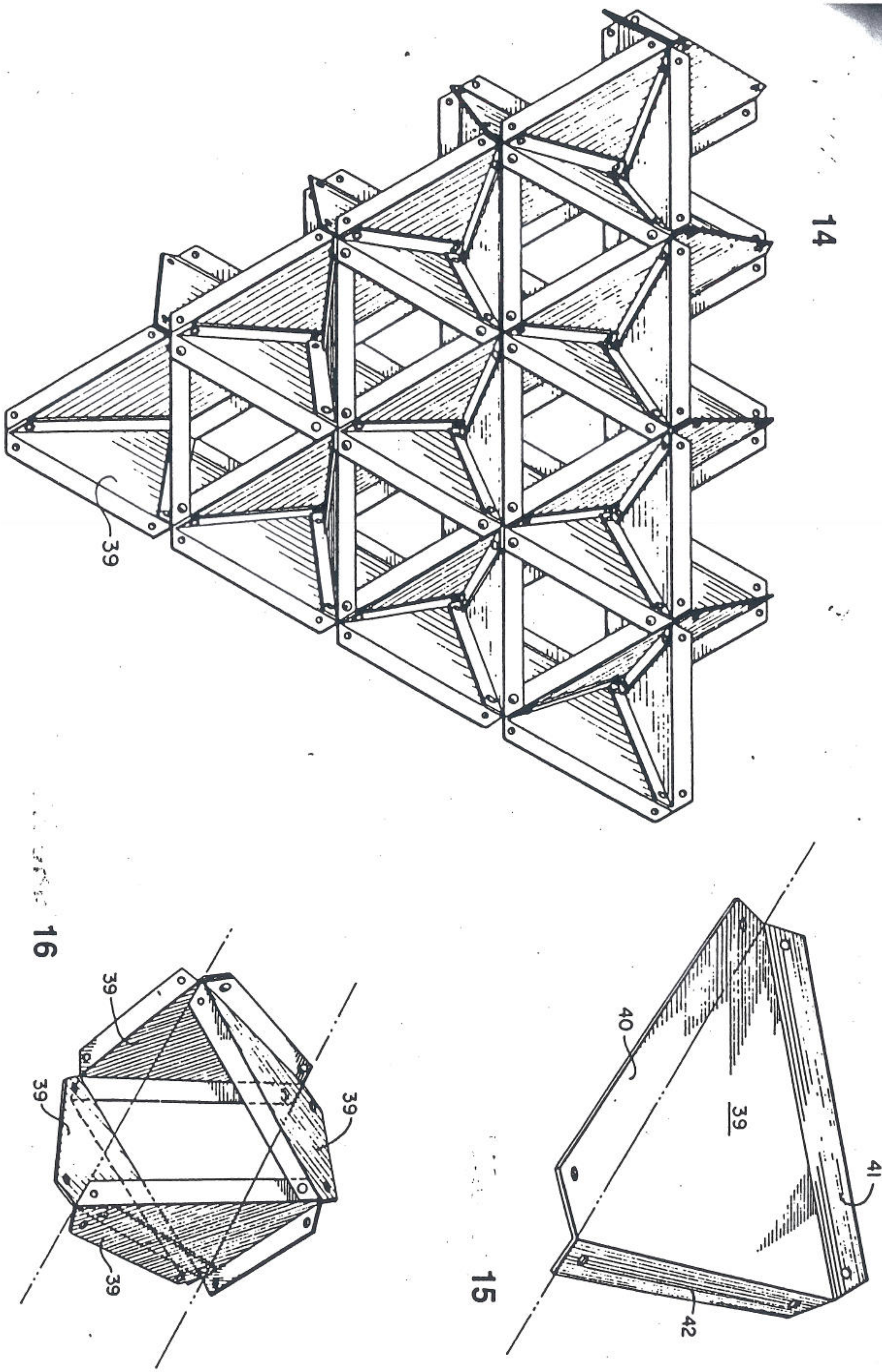


Fig 1.

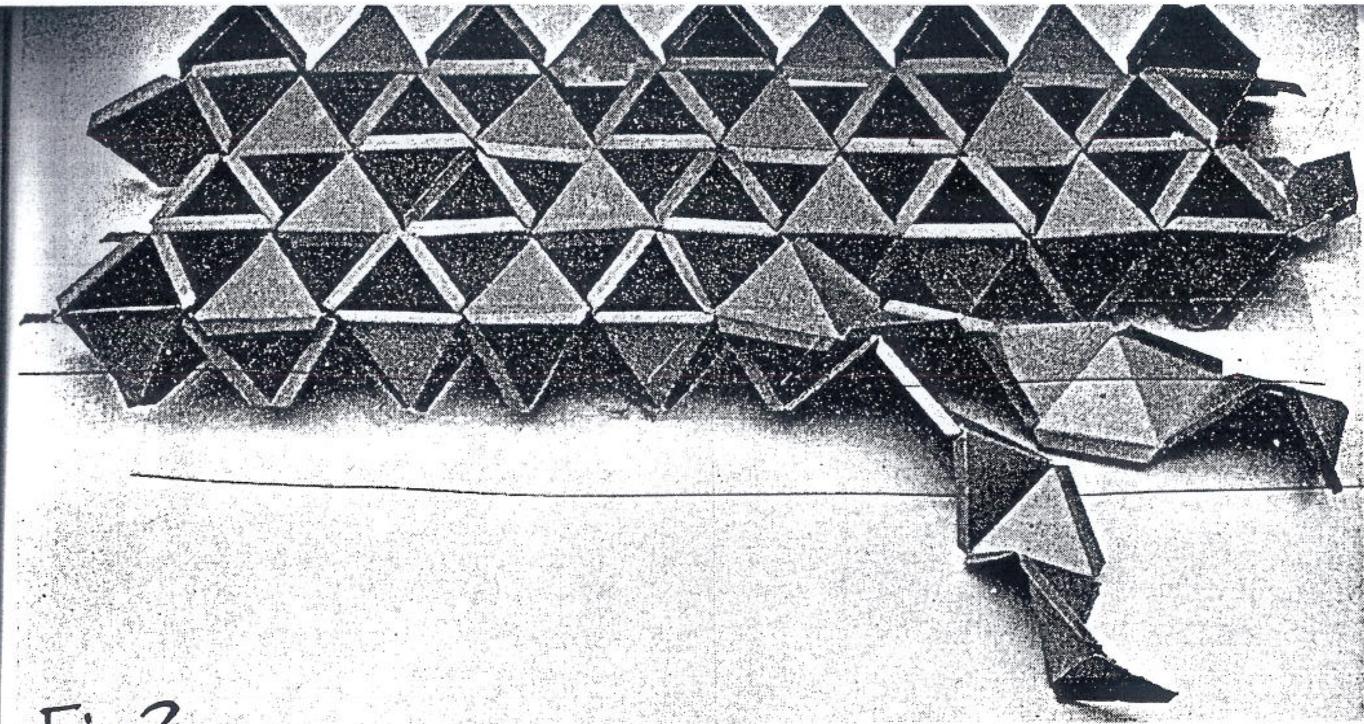


Fig 2.

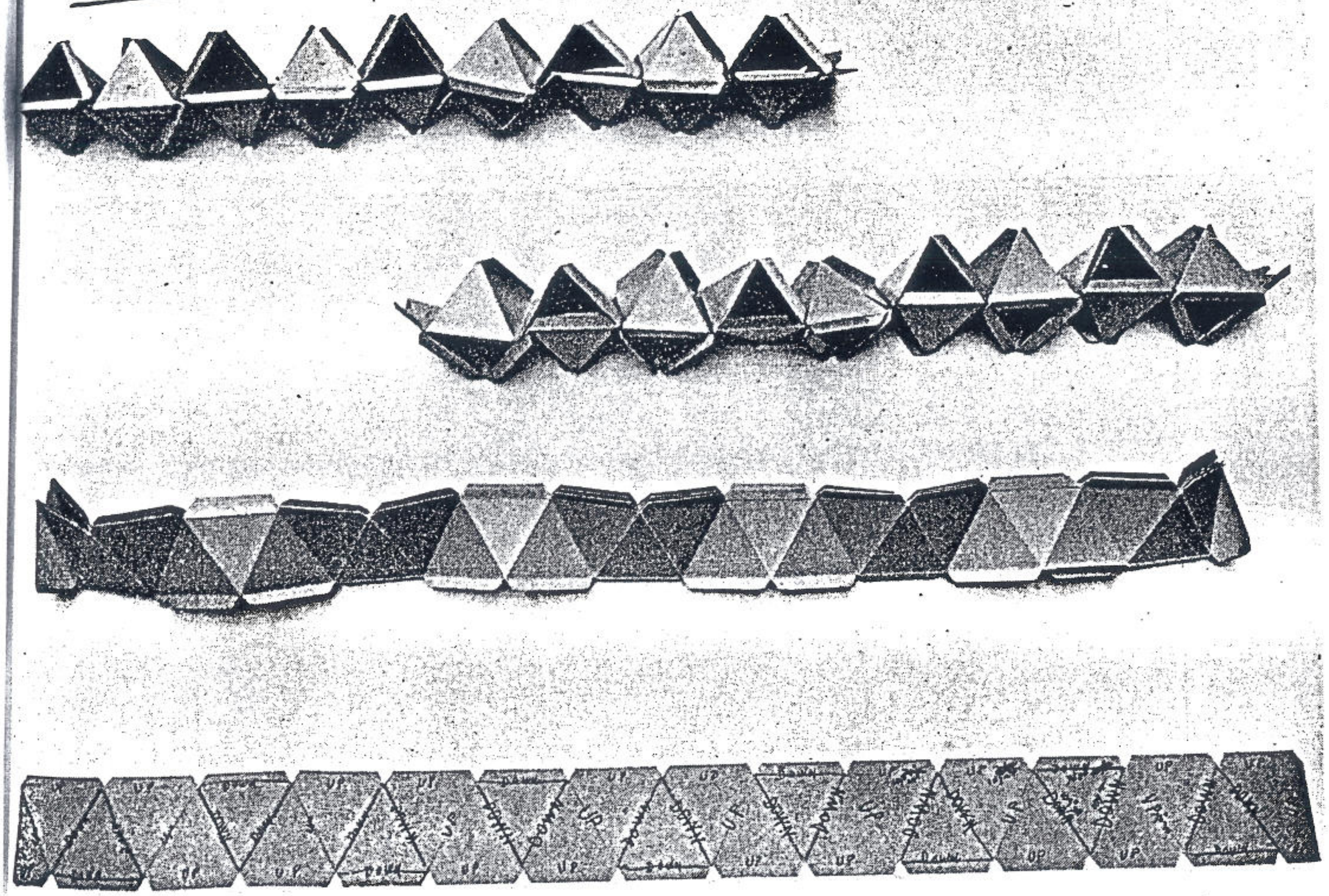


Fig. 930.11: This continuous triangulation pattern strip is a 60°, angular, ''come and go'' alternation of very-high-frequency energy events of unit wavelength. This strip folded back on itself becomes a series of octahedra. The octahedra strips then combine to form a space-filling array of octahedra and tetrahedra, with all lines or vectors being of identical length and all the triangles equilateral and all the vertexes being omnidirectionally evenly spaced from one another. This is the pattern of ''closest packing'' of spheres.

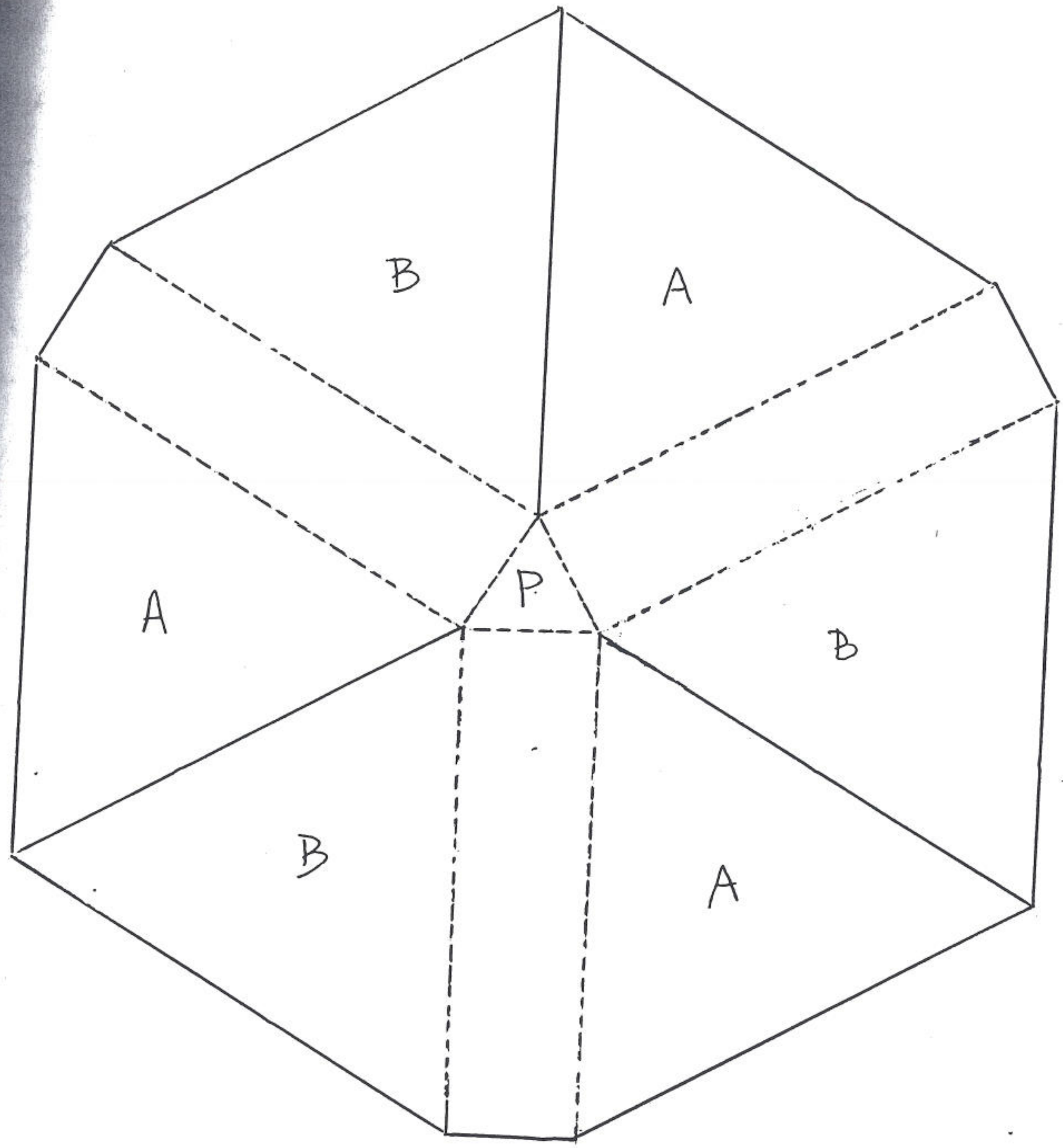


Fig 3. Make Xerox copies on card for models.
Cut all solid lines
Fold dotted lines. (Score before folding)

Fig 4.

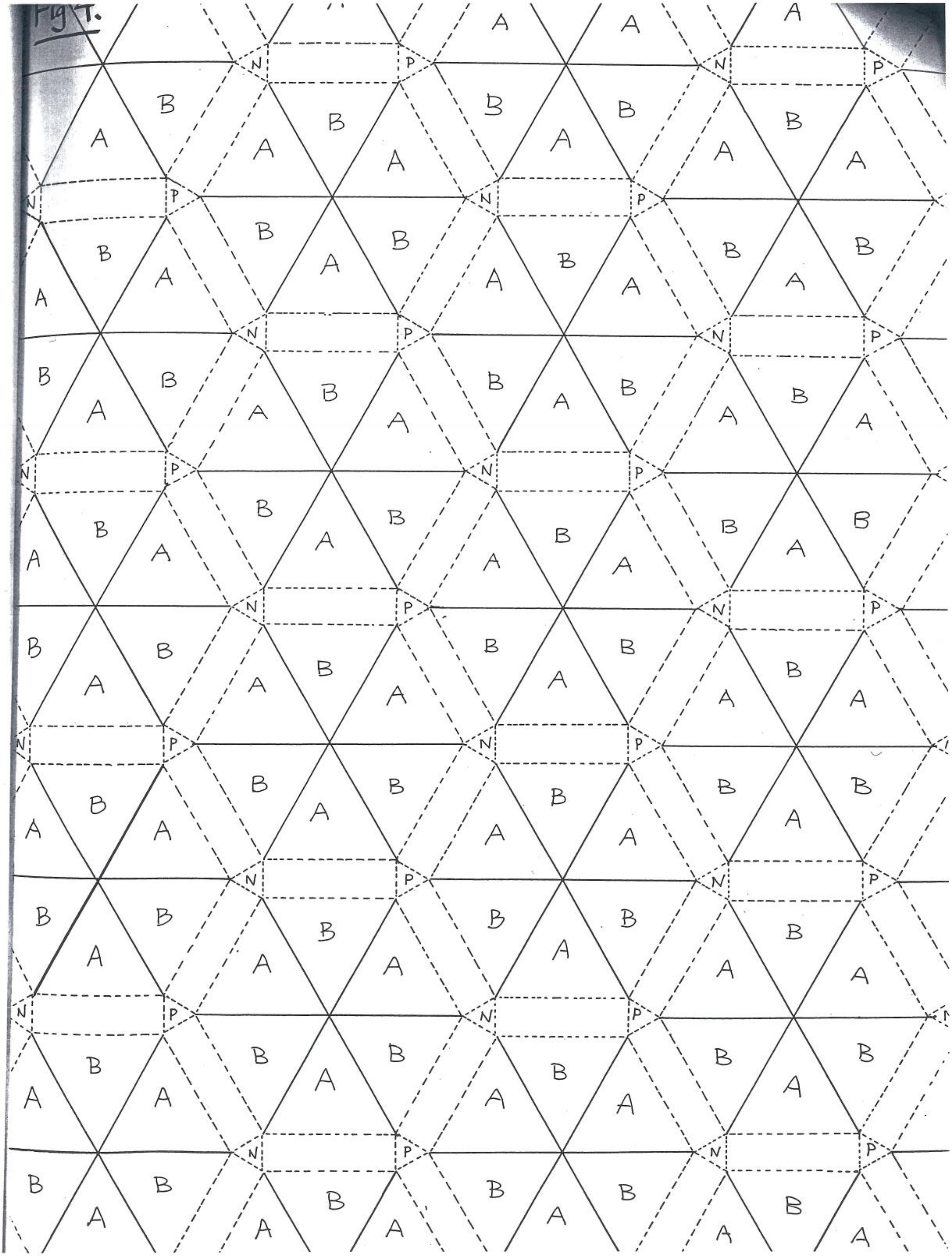
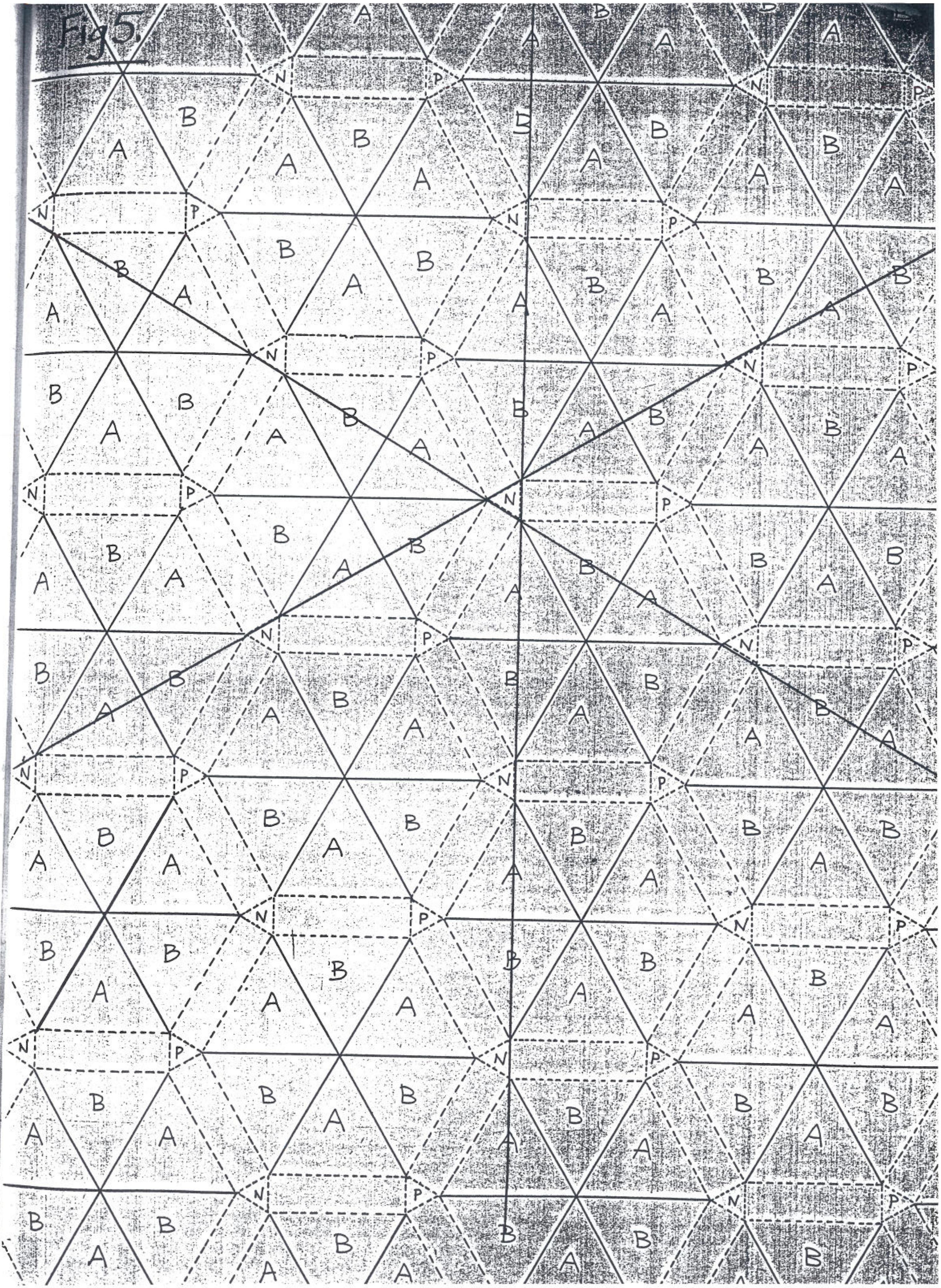


Fig 5.



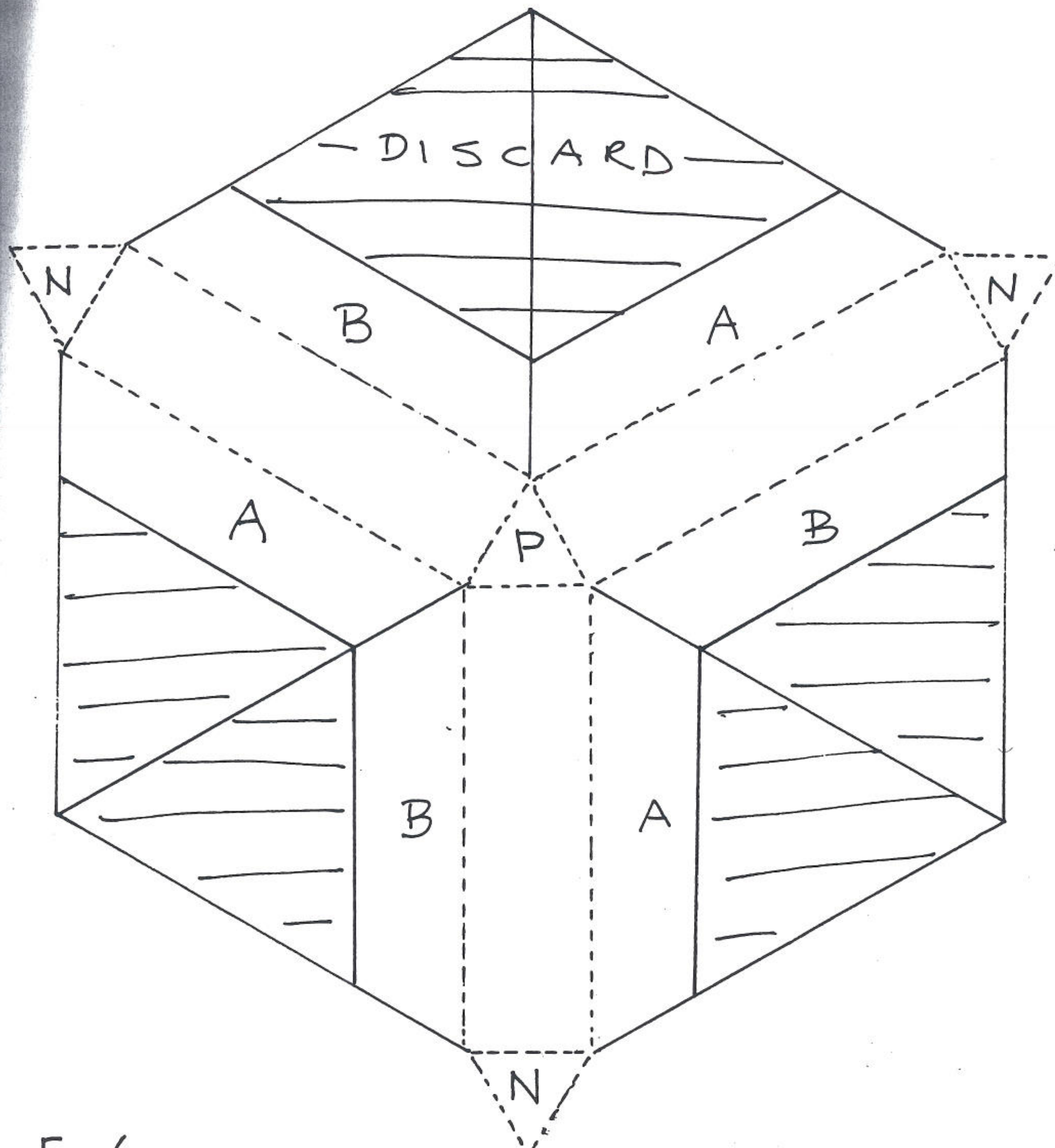


Fig 6.

Discard waste. Fold down A + B flaps 90° to make "U" section struts, or fold 120° and tape to make tiangular section struts.