

全图解!

自制弹力滑翔机

Rubber-band Powered Paper Glider

20架机型做法详解,
享受畅快的弹射滑翔乐趣!

不用引擎动力,
只需一条橡皮筋,
就可轻松翱翔天际!



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内附

彩绘滑翔机
实物大小纸型

航空工业出版社

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纸滑翔机达人

白仕斌 Spencer ©著

内 容 提 要

雪糕棒、竹签、A4纸、橡皮筋,用这些简单易得的材料,可制作出20种不同颜色、不同外型、不同性能的酷炫弹力滑翔纸飞机。感受纸飞机制作的成就、体验飞翔快乐、了解飞行奥秘,让你变身纸飞机达人!和小伙伴们一起来比赛吧,看看谁的弹力滑翔机飞得更高,更稳,更久……

本书适合小学三年级以上学生及广大纸飞机、航模爱好者使用,可以作为亲子手工读物,也可以作为广大中小学开展课外活动参考用书。

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前言

Foreword

本书内含 20 种不同机型，采用材料都是我们常见的纸（200g）、竹签、雪糕棒、蓝丁胶，所以制作成本相当低廉。作者设计出“刀锋式”D 形机翼，发挥纸张的可塑特性，大幅度简化了制作方法，有效达到伯努利流体力学（Bernoulli Fluid dynamics）的功能，这是本系列的最大特性，除了突破单片纸张的 C 形机翼，还比轻木及发泡材料的制作更加简单迅速与耐用，并且可以无限制地研发制作各类型与功能的滑翔机。

This book contains 20 different models of the gliders make using low budget materials like : A4 paper (200g), bamboo sticks, icecream sticks, blu-tack. The author designed a knife-like “D-Wings” greatly simplified the procedures of glider making and also effectively used the Bernoulli's Principle. This series not only breakthrough the single paper “C-shaped wings”, it is also easier to use and more lasting compared to light wood and bubbled material. And also, unlimited models of gliders can be made with the same materials.

读者可以从本书中复印各机型的展开图，按照书中图示和照片，并参阅文字指示说明制作。从最基本的机型 R1 开始逐一完成，过程可以学到基本制作技巧，还可以享有多种机型的弹射滑翔乐趣，而且在不断的练习制作下，技术就会更加纯熟、作品也会更加精湛。在享受弹射滑翔乐趣时，也可以从自制弹射飞机的各项调整中学到基本的飞行原理，不断提高滑翔机飞得更高、更远、更久的调控能力。

Readers is allowed to photocopy any design of the gliders, follow the steps in the pictures provided and make the gliders with reference of the instructions. Start off with the easiest Model R1. In the progress of making, many techniques of making can be learnt, and also, while enjoying shooting the gliders, different flying knowledge can be learnt too. With more practices, the product will be closer and closer to perfect.

本书中弹射滑翔机系列属于快速机，所以飞行速度快，飞行路径既高又远，因此适合户外宽敞的场地，尤其是在逆风爬升、顺风滑翔的情况下，不管风速大小都能出现丰富的飞行姿态，有别于其他慢速轻盈盘旋的滑翔机，尤其是在会产生上升气流的地形，更能提高滑翔机盘旋留空的效果。

This series of rubber-band powered gliders are speed gliders, thus their flying speed will be high and will be able to fly high and far. It is hence suitable for outdoors, especially when it is against the direction of wind, no matter the speed of the wind, it will still result in a nice flying style compared to the other models which are slow gliders.

纸张的优点是容易取得与制作，但是它的缺点是怕潮湿，所以弹射滑翔机时，必须在干燥的环境下进行。通常在正常的情况下弹射，一架滑翔机可以弹射百次以上，如果遇到撞击变形，只要用手捏回原状即可。若是不幸挂置在高处，绝对严禁试图冒险爬高取回，因为材料成本低廉，再制作就可以，而且还会越做技术越纯熟，就算是摔坏也不会心疼。

One plus point about paper is, that it is easier to purchase and made into gliders, however it cannot touches water. Thus when shooting the gliders, take note of the environment. The ground must be dry to prevent gliders being destroyed by the touches of water. If the gliders are shot correctly, it can have 100⁺ shots. In case the glider lost it shape, slight adjustments using hands will do. If the glider ever got stuck at a high location, do not climb to get it back, as the material used are very low budget, it would be safer and easier to make another one. At the same time, more practices will bring about more perfect glider.

要让滑翔机高飞，就必须有高效率的飞行条件，因为本系列滑翔机的制造工艺过程，还是会有小的误差存在，所以有可能会差强人意的飞行姿态，因此本书内容附有调整与修正的说明指示，可供玩家参考并做微调与修正，让滑翔机达到最高飞行效果。

To make the glider fly high, there must be high quality of flying. As any gliders may have their error in it which are not seen still, thus there might be chances for those error to happen and brought about disappointment in people. This book has the correct way to adjust the gliders, please follow those instructions to obtain a better result.

学习制作者可以依本书内容的指导步骤，从基本工法开始了解，然后逐一完成 20 种机型的制作。基本工法中分为认识线条功能、折叠法、安全使用刀具、黏合方法、各部件组合角度、机身制作、伯努利原理简介、飞行调整与修正、弹射法等。

Start learning from the “Basic Craftwork” to understand more about the techniques. Then, complete the 20 models one by one. Learn the basic techniques like : folding, safety with penknife, sticking method, angle of different parts, making of the body, Bernoulli's Principle Introduction, adjust methods, and the correct way to shoot.

每一机型均有展开图（彩色图与线条图）、成品照片、制作图示照片与说明等三部分。展开图是各机型的核心图稿，是提供制作前复印的母图，为了准确复印，请务必先将展开图剪下后，保持平整再进行复印，这样才不会出现线条弯曲的误差。

Every model of the glider has it's own “opened-design” drawing color graph and line graph, completed picture, procedure of making with pictures. “Opened-design” drawing is the drawing of the different types of models. Please cut down the drawings and make sure it is flat before photocopying to ensure zero error is made.

目录

Contents

1. 材料与工具 Self-prepared materials and tools

材质变化 Materials different 1

2. 基本工法 Basic Craftwork

认识线条功能 Differentiate the lines 2

折叠法 Folding 3

书页折叠法 Paper folding method

浅切折叠法 Slightly cutting method

安全使用刀具 Safety with penknife 5

裁切纸张 Cutting the paper

竹签、雪糕棒与削切方法 Method to cut bamboo stick and icecream stick

黏合方法 Sticking method 7

各部件组合角度 Angle of joining the parts 8

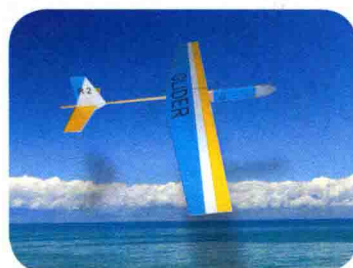
机身制作 Making of the body 9

伯努利流体力学简易原理 Bernoulli hydrodynamics 10

前后平衡 Balancing front and back 11

弹射方法与技巧 Shooting method and techniques 12

飞行调整与修正 Adjust methods 14



3.滑翔机组装步骤 Making model with illustration 16

<p>R1 先锋 Forward</p>  <p>P.16</p>	<p>R2 海鸥 Seagull</p>  <p>P.21</p>	<p>R3 旋风 Whirlwind</p>  <p>P.25</p>	<p>R4 飞鹰 Eagle</p>  <p>P.29</p>	<p>R5 猎豹 Cheetah</p>  <p>P.34</p>
<p>R6 红隼 Kestrel</p>  <p>P.38</p>	<p>R7 台风 Typhoon</p>  <p>P.42</p>	<p>R8 飞鱼 Exocet</p>  <p>P.46</p>	<p>R9 灰熊 Grizzlies</p>  <p>P.50</p>	<p>R10 勇士 Warriors</p>  <p>P.54</p>
<p>R11 鹦鹉 Parrot</p>  <p>P.58</p>	<p>R12 领航者 Leader</p>  <p>P.62</p>	<p>R13 闪电 Lightning</p>  <p>P.66</p>	<p>R14 飞马 Pegasus</p>  <p>P.70</p>	<p>R15 羚羊 Antelope</p>  <p>P.74</p>
<p>R16 火焰 Flame</p>  <p>P.78</p>	<p>R17 黄金翼 Gold Wing</p>  <p>P.82</p>	<p>R18 飞虎 Flying Tigers</p>  <p>P.86</p>	<p>R19 青箭 Green Arrow</p>  <p>P.91</p>	<p>R20 蓝天 Sky</p>  <p>P.95</p>

4.作品欣赏 Portfolios 100

5.活动写真 Activity Photo 103

1. 材料与工具

Self-prepared materials and tools



材料 / Materials

A4 书面纸或卡纸 (200g)、竹签、雪糕棒、蓝丁胶、白胶 (树脂)。
A4 Card Paper (200g per piece), bamboo stick, icecream stick, blu-tack, white glue.

工具 / Tools

美工刀、钢尺、剪刀、书本 (8K 或 A4) 厚度 1cm 以上、小平口夹。
Penknife, metal ruler, scissors, book (8K or A4) at least 1 cm in width, clip.

► 材质变化 Materials different

用 200g 的彩色卡纸或书面纸 (或相同厚度的纸张) 做材料, 在完成制作后可贴上彩色胶带做点缀, 也可以复印在白色卡纸上, 然后涂上自己喜欢的图腾, 美化心爱的滑翔机。

After finishing making the glider made using colored card paper, colored tapes can be stick on to create a nicer outer view of the glider. If it is made using plain white card paper, color it if you want to before starting to cut and assemble it.



在白色卡纸上创作自己想要的图腾。



在彩色卡纸上粘贴彩色胶带来装饰。

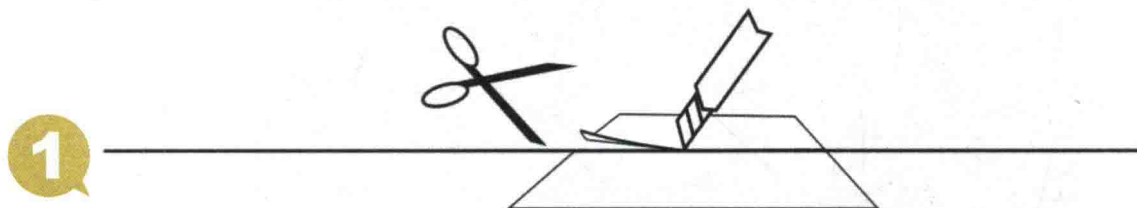
2. 基本工法

Basic Craftwork

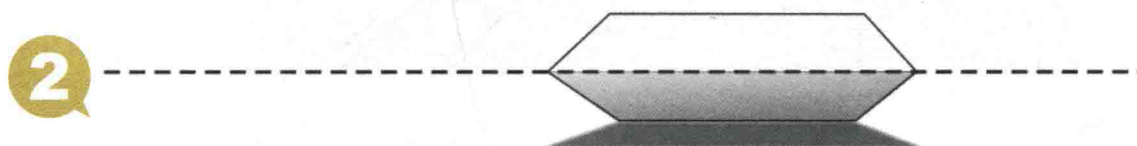
认识线条功能 Differentiate the lines

展开图中的线条共有 5 种，分实线、外折虚线、内折虚线、平面弯曲虚线、中心粗虚线。

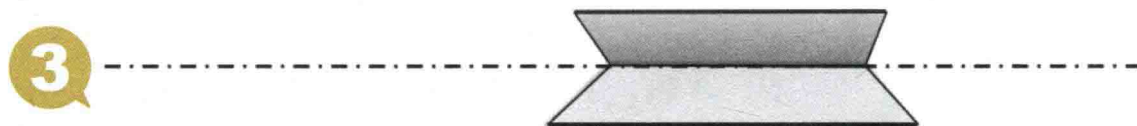
There are 5 different types of lines : solid lines, outwards folding dotted lines, inwards folding dotted lines, bending on flat surface dotted line, middle thick dotted line.



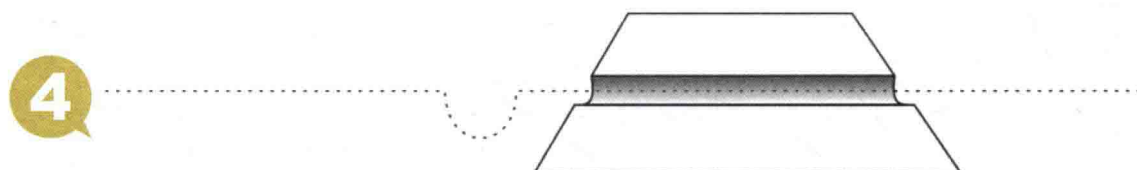
实线 Solid lines: 是裁切线，主要是作为裁切各部件的依据，可以用剪刀或是美工刀，沿着实线裁切即可。Cut against the line using penknife or scissors.



外折虚线 Outwards folding dotted lines: 以段虚线作代表，折叠时虚线必须在纸张的外侧。Fold the paper along the line with the line outside.



内折虚线 Inwards folding dotted lines: 以点段虚线作代表，折叠时虚线必须在纸张的内面。Fold the paper along the line with the line inside.



平面弯曲虚线 Bending on flat surface dotted line: 以点虚线作代表，表示纸张平面必须做出弯曲或沟状。Bend the paper into a U shape only along the line.

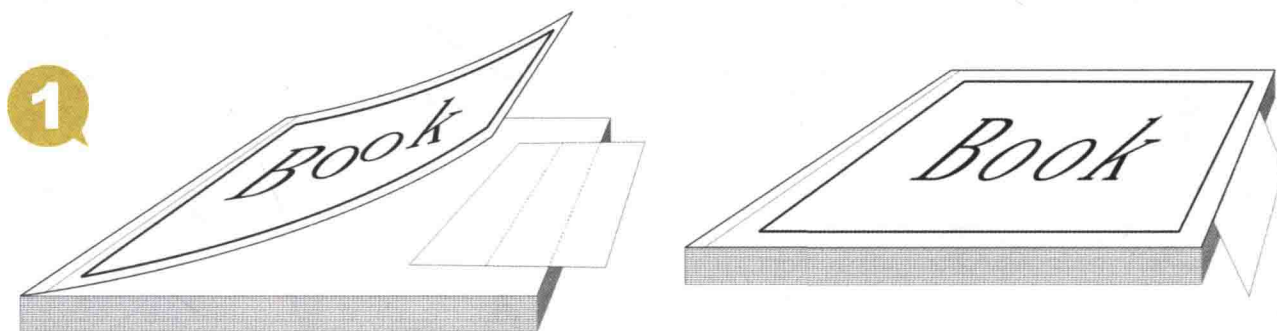


中心粗虚线 Middle thick dotted line: 以较粗的点段虚线作代表，主要是作为对准，以及标定前后平衡的中心（重心）位置。It is to ensure balance of the glider made. It is the centre of gravity of the glider.

折叠法 Folding method

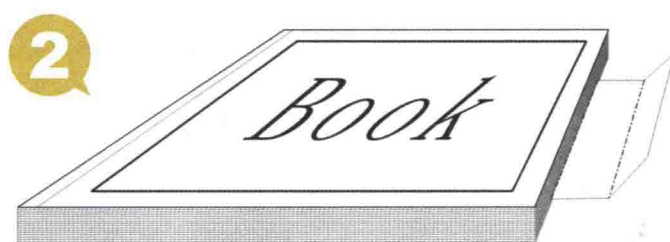
书页折叠法

Paper folding method



外折虚线折法 Outwards folding method: 将纸张放在书本的上页，把虚线与笔直的边缘对齐后，盖好并压紧书皮，利用书本的垂直切角把纸张往下折出角度。

Place the card paper onto the top page in the book, adjust the card paper so the line is align with the side of the book. Cover the book and press the cover tightly, bend the card paper downwards into the correct angle.



内折虚线折法 Inwards folding method: 将纸张放在书本最下页处，把虚线与笔直的边缘对齐后，盖好并压紧书页，利用书本垂直切角把纸张往上折出角度。

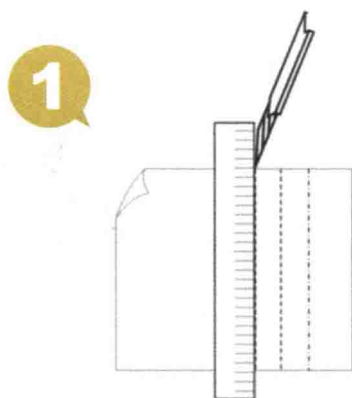
Place the card paper onto the back page in the book, adjust the card paper so the line is align with the side of the book. Cover the book and press the cover tightly, bend the card paper upwards into the correct angle.

浅切折叠法

Slightly cutting method

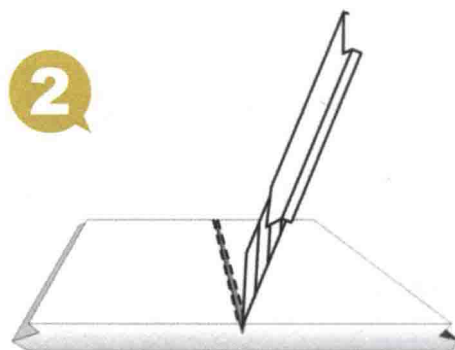
浅切的目的是让纸张比较准确及容易折叠。

Slightly cutting is to allow the paper to be folded easily and to ensure the accuracy of folding.



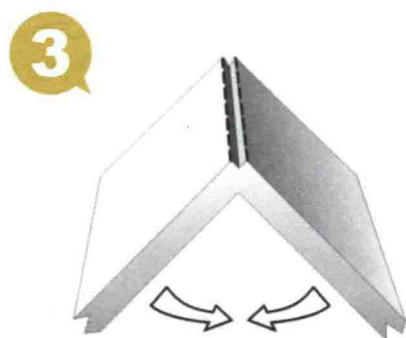
为了安全起见，所以使用刀具浅切时，务必以钢尺作压制，绝对禁用胶类尺。

Safely first, while slight cutting with knife, use a metal ruler and not plastic ruler.



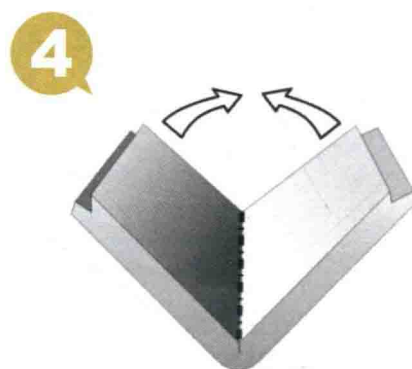
折叠前以钢尺对准线条，用刀尖轻轻沿着虚线划过，让纸张表面出现细细的浅沟线条。

Adjust metal ruler to be against the line, use the tip of the knife to lightly draw on the line. This time, the paper will appear a thin cut on the line.



段虚线是外折线，虚线必须朝外顺着浅沟线折叠，成为虚线在外侧的折叠状态。

Hyphenated dotted lines represents folding with the line outside.



点段虚线是内折线，虚线必须朝内顺着浅沟线折叠，成为虚线在内侧的折叠状态。

Dot-Hyphenated dotted lines represents folding with the line inside.

安全使用刀具 Safety with penknife

剪刀与美工刀是最基本的剪切工具，用在纸张裁切、竹签对劈削薄、雪糕棒切断，所以使用时必须特别小心。手部比较不灵活者，可用剪刀剪下展开图的各部件，以及采用书页折叠法比较安全。手部灵活者可以用刀具做裁切与浅切折叠，此法会比较完美与快速。刀具在没有使用的情况下，不可放在桌子边缘处，避免意外碰触后坠落伤到脚。美工刀在停顿或暂停使用时，务必养成顺手将刀片收回到刀把内的习惯，这样可以避免意外的伤害。

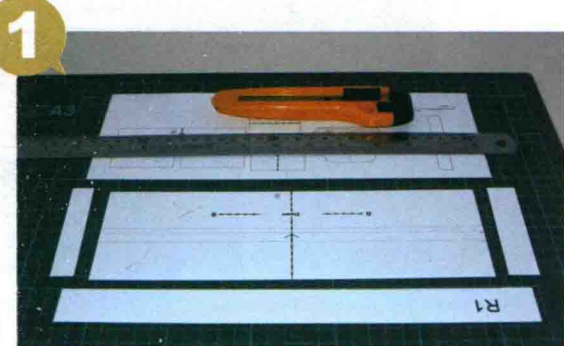
Scissors and penknife are the basic tools to cut all the materials needed. Those who can't work well with penknife please use a scissors to cut and use a book to fold the paper. Those who are able to work well with penknife, can work faster and ensure perfection while cutting. Do not place tools at the edge of the table when not in use to prevent it from dropping and causing injuries. Scroll back the blades when penknife is not in used to prevent accidents.

裁切纸张

Cutting the paper

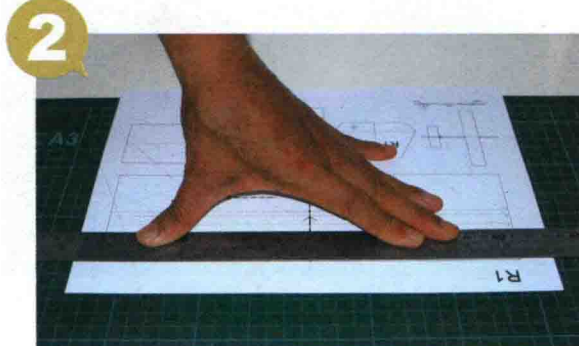
小心注意使用刀具，力道要轻、稳、准，以免失控造成伤害，使用剪切或移动刀具时，另一只手绝对禁止把持或放在刀具下游处。用美工刀依线裁切时可采用多刀次，第一刀先以轻力浅切划破表面，第二刀再将纸切开，如果两刀无法切开可以再增加刀次，一直到切割开为止。

Be careful with tools, do not use too much strength, be stable and accurate to prevent injuries. While moving the penknife take note of the other hand. While using penknife, cut a few more times to ensure that the paper is entirely cut is better than using a lot of strength to ensure that it is cut on the first try.



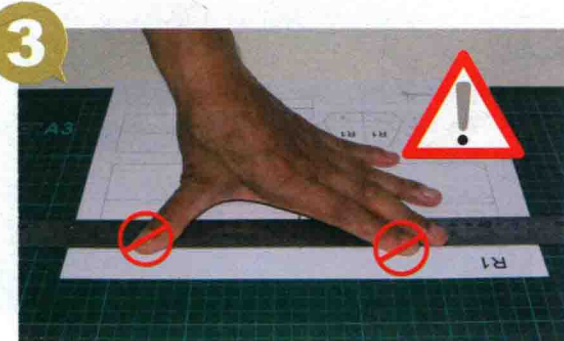
用美工刀在纸张上做直线裁切与浅切时，务必以钢尺做比照，绝对禁止使用胶类尺与木尺，以免刀锋滑出割伤自己的手指。

While cutting the paper with a penknife, align the metal ruler against the line. Do not use plastic or wooden ruler to prevent injuries.



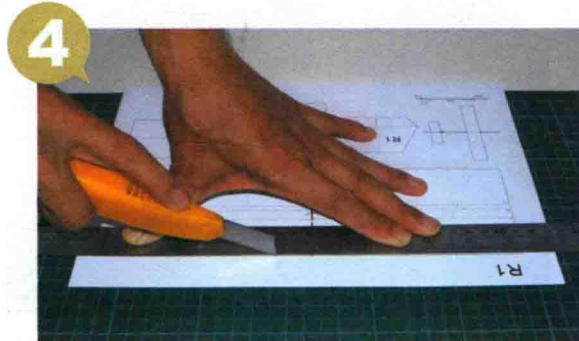
按压钢尺时，必须将手指力道平均按压在尺的中间位置，一律采用顺手的纵切姿势。

While pressing the metal ruler on the paper, ensure that the strength is at the middle.



当手指按在钢尺时，不能突出超越钢尺切线边缘，以免在裁切线条时伤到手指。

When pressing on the ruler, do not place finger other the edge of the ruler to prevent injuries during cutting.



以美工刀裁切时，刀锋以 30° 至 45° 斜角，刀尖侧面贴在钢尺边缘，由上往下切划。

Keep the penknife in the angle of $30-45$ digress while cutting. Cut from the top to the bottom of the paper.

竹签、雪糕棒与削切方法

Method to cut bamboo stick and icecream stick

竹签 Bamboo stick:

做机身以及机翼的骨架，选用笔直及直径 0.3cm 至 0.35cm 的竹签最理想。在做机翼的骨架时，要将较粗的竹签对劈或削薄，除了要选择坚韧性之外，还要避免过粗以及太重的竹签。选择适用的竹签时，要注意不要使用有竹节的竹签，因为竹节坚硬较难对劈、削平。

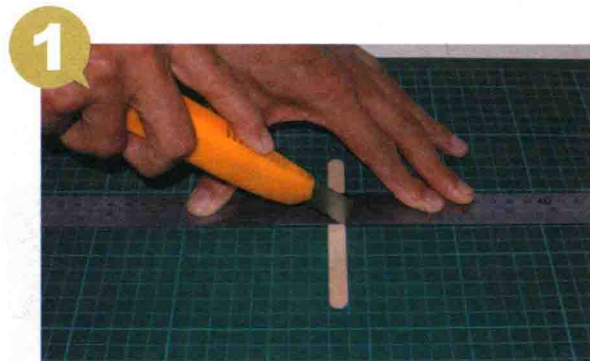
It is the body of the glider as well as the support of the wings. The bamboo stick must be straight and width from 0.3cm-0.35cm. While making the support for the wings, split the bamboo stick into half. Do not use bamboo sticks that are too heavy and too fragile.

雪糕棒 Icecream stick:

通常用于机头部位，所以会有切断的需求，为了与竹签保持密合，所以一定要选择平整的雪糕棒。

It is used as the head of the glider, to ensure that the icecream stick sticks well with the bamboo stick, use icecream sticks that are consistently flat.

削切方法 Shaving Method:



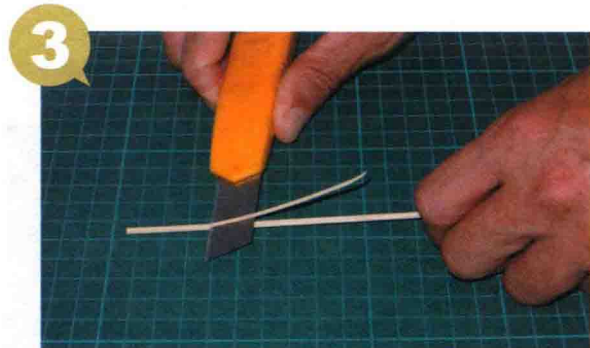
切断方法可以用美工刀在竹签、雪糕棒指定位置做连续切割凹陷，然后折断再修平切面。

Continuously cut a dent on the bamboo stick and icecream stick and then bend it to break and then shave the break line to flat.



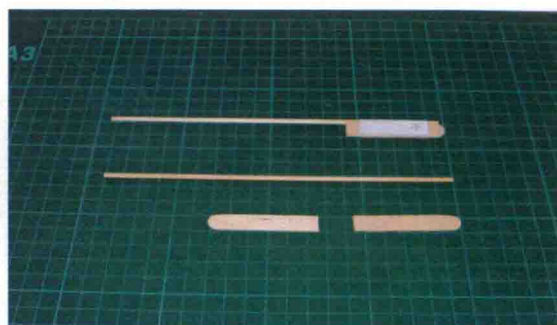
要劈开竹签时，先用单手将竹签直立着，另一手持美工刀，刀锋架在竹签上端圆面二分之一的中间位置，再拿工具轻敲刀背劈开竹签。

When splitting the bamboo, make the bamboo stick stand with one hand, and the other hand push the blade of the penknife into the bamboo stick, and knock the penknife using another tool to split the bamboo evenly.



削薄方式用抽刨法，美工刀锋朝前平躺桌面，用单手握压紧刀把，另一手将竹签放在刀面下方形成十字，然后刀面以小角度下压贴紧竹签，再用手抽拉竹签就能产生刨削效果。

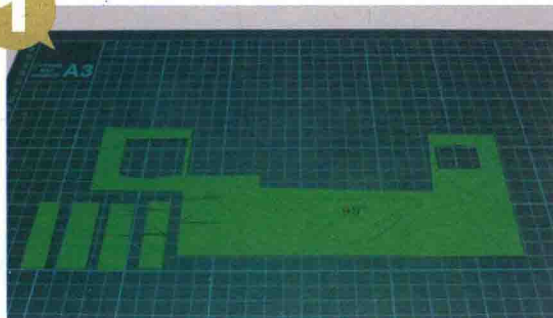
Shave the bamboo stick by holding the bamboo stick on one hand pressing against the table, another hand use a penknife to press against the bamboo stick. Pull the bamboo stick, and repeat this few steps for a few times and the bamboo stick is nicely shaved.



黏合方法 Sticking method

采用白胶（树脂）作粘合剂 Using white glue to stick the parts:

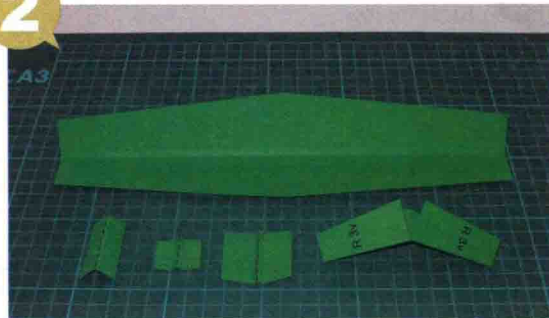
1



将剩余的展开图边料切成约 2cm x 3cm 片状，可以作为涂抹白胶的工具。

Cut the waste papers into around 2cm x 3cm rectangle to be the tool for glue applying.

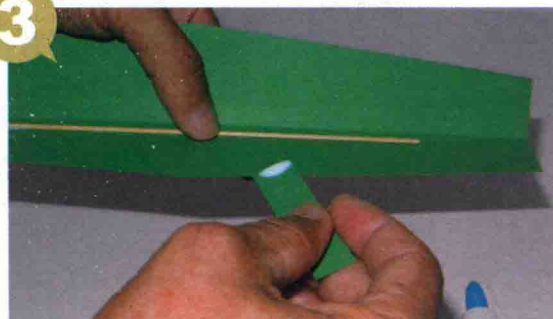
2



通常机翼、水平尾翼与垂直尾翼用边缘粘合，因为材料都是纸，所以沿着单侧纸张边缘涂上线条状均匀的白胶，然后快速将纸张密合，再用手左右滑动轻压紧密为止。

Wings, spoiler and rudder can be joined using glue on the edges. As the material used is paper, applying a thin layer of glue at the edge will be sufficient. Quickly apply pressure on the edges to complete the joint.

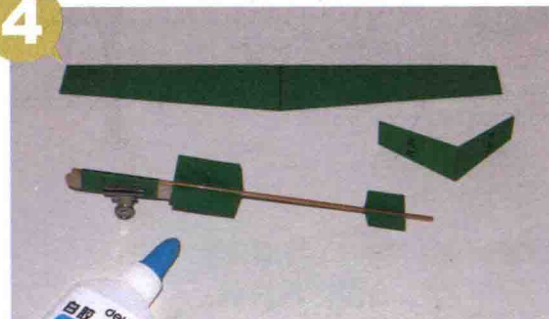
3



白胶量只要薄薄的一层即可，因为使用过量的白胶，在干固之后纸张会出现波浪状。

A thin layer of white glue is need. Over using of white glue may cause the paper to become wavy.

4



部件粘合通常出现在雪糕棒与竹签的机头粘合、机翼与机身的粘合、水平尾翼与垂直尾翼和机身的粘合，这些部分可用多一点的白胶涂面，可维持较长的干固时间，方便在粘合过程中做调整归位。

When it comes to joining the parts, it is most likely to be joining the wings and spoilers to the body itself. This means that it is to stick paper onto bamboo stick. Thus, more white glue is needed to ensure stabilization when dry. It also give more chances to adjust while the glue is still wet.

各部件组合角度 Angle of joining the parts

本滑翔机系列的部件分机身、机翼、水平尾翼、垂直尾翼四部分，组合时务必注意各部件角度关系，请参阅以下图示：

There are 4 parts in this series of gliders. Take note of the angles while joining the parts. More information is in the pictures below.

图示说明 graphic illustration:

1-1 水平尾翼与垂直尾翼保持垂直。

Spoiler and vertical wings align vertically

1-2 1-3 机翼与水平尾翼保持水平及平行。

Main wings and horizontal wings aligning horizontally

1-4 机翼与机身中线保持垂直。

Main wings and glider body aligning --

2-1 V形尾翼左右同高张开约95°，与尾翼中间线保持垂直。

V shaped spoilers opened 95 degrees, aligning with the middle of spoiler

2-2 V形尾翼面与机身线维持平行。

V shaped spoilers surface align with the line on the body of the glider. ---

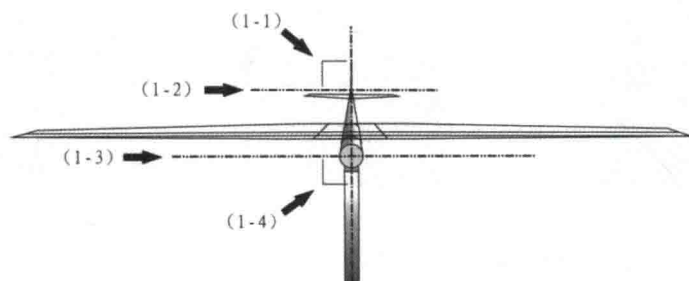
3-1 水平尾翼与机身水平中线保持垂直。

Horizontal wings align with the horizontal line on the body.

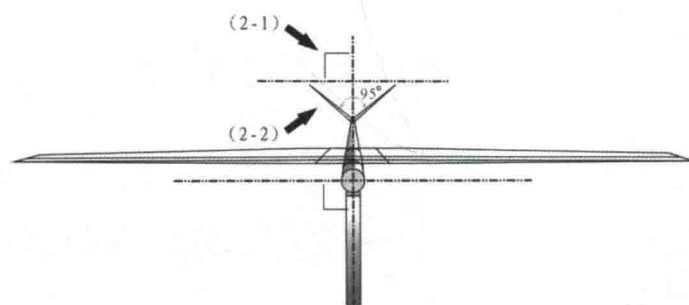
3-2 机翼与机身水平中线保持垂直。

Main wings align with horizontal line on the body.

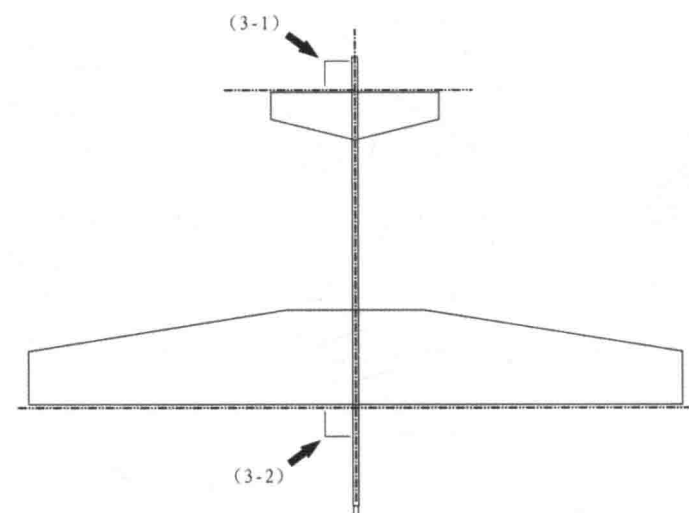
1



2



3

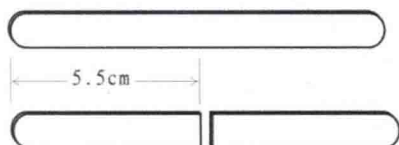


机身制作 Making of the body

本书中的各种机型，均采用同一种机身规格，所以只要依下面图示制作即可，如果无法取得与本书内容相同的雪糕棒与竹签，也可以用其他类似材料来裁切。

All the models in this book share the same glider body, thus follow the diagram below.

1



将约 11cm x 1cm 的雪糕棒从中间对切，取一截 5.5cm 做机头用。

Cut the 11cm x 1cm icecream stick into half, use one of it which is 5.5cm for the glider head.

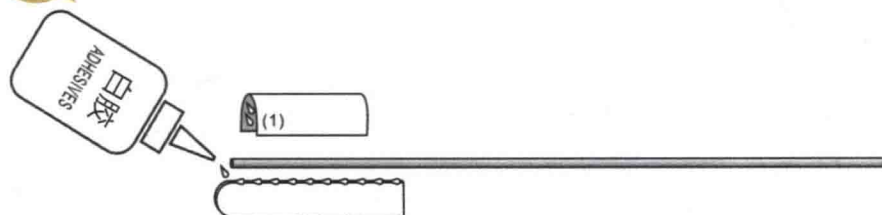
2



把直径 3mm 至 3.5mm 的竹签切成 19cm 的长度。

Cut the bamboo stick with a width of 3mm-3.5mm into 19cm in length.

3



在部件 (1) 内侧与雪糕棒上沿处涂白胶。

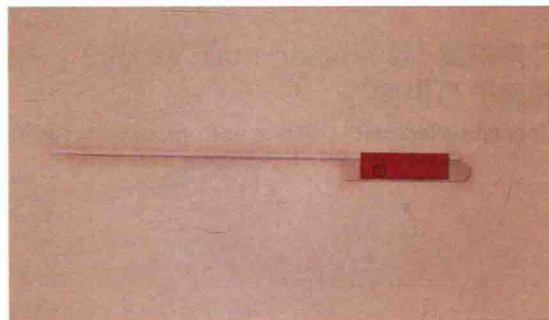
Apply some white glue onto one side of part (1) and the bamboo stick.

4



取部件 (1) 将竹签与雪糕棒做紧密结合。

Stick part (1) with the bamboo stick tightly.

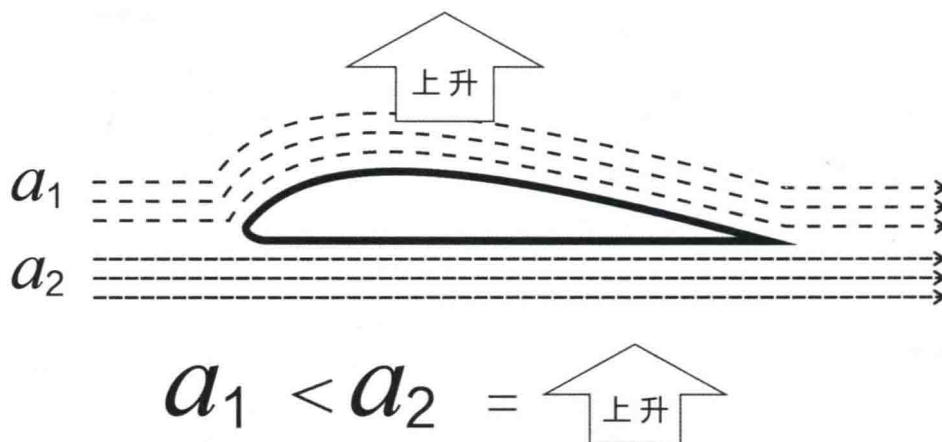


伯努利流体力学简易原理 Bernoulli hydrodynamics

空气流速越快，密度越低，压力就越小。

The faster the air flow, the more concentrated it gets, the lesser pressure it contains.

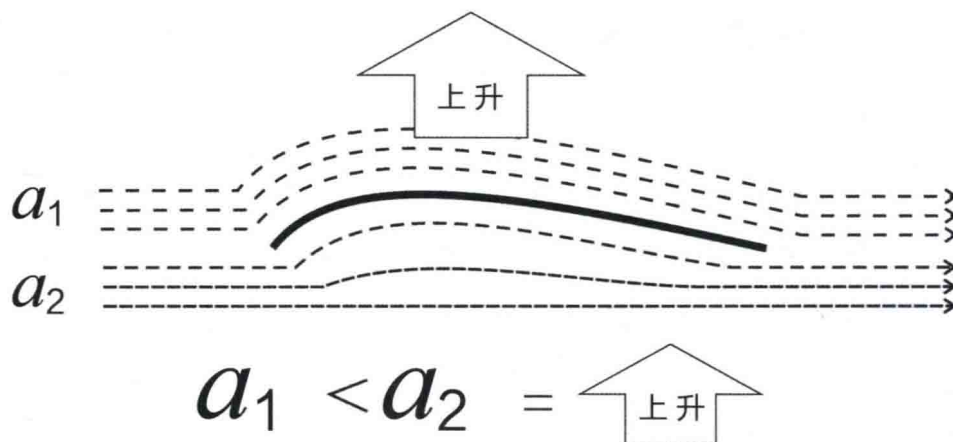
1



D 形机翼 (D shaped main wings) : 封闭式抛物线翼背, 作为各种大小型的飞机使用。

Enclosed surface with flat bottom, suitable for both large and small planes.

2



C 形机翼 (C shaped main wings) : 开放式抛物线机翼形状, 通常是轻小型飞机使用, 降落伞也是属于 C 形翼。

Opened surface with concave bottom, suitable for small planes, share the same properties as parachute.