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The Sten-Screen: Making and Using a Low-Cost Printing Process

by Ian McLaren

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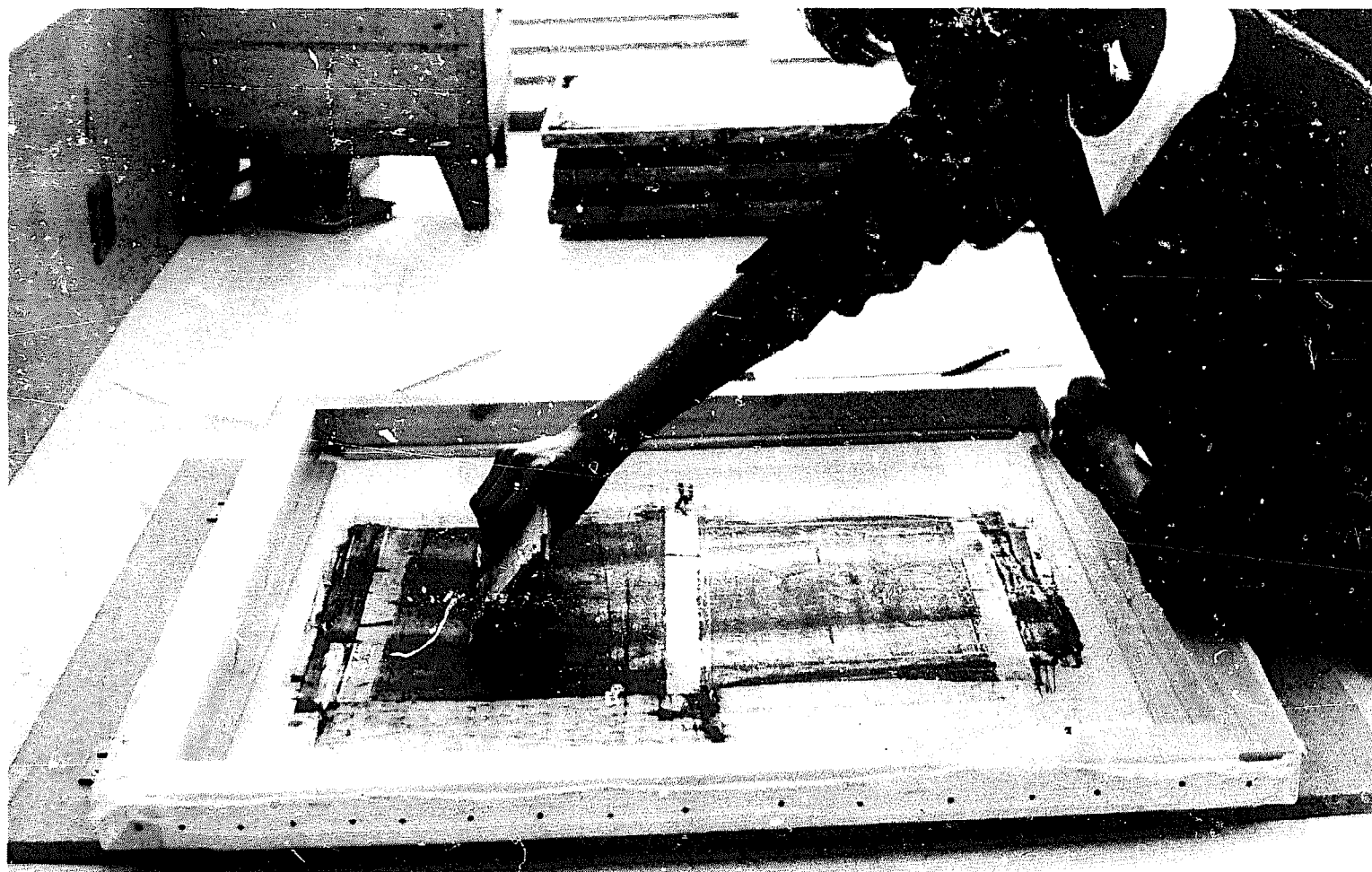9 King Street
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ENGLAND

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The Sten-screen
Making and using a low-cost printing process
Ian McLaren

THE STEN-SCREEN PRINTER

**A manual on how to produce and use
a low cost printing device**

Ian McLaren

ILLUSTRATION 1

Printing with the Sten-Screen process at the Co-operative
College Moshi. Notice that the work is conducted in the
open air, without the need for electricity.

1 - General description

The Sten-Screen Process is a hybrid duplicating and printing technique. Basically it combines stencil duplicator stencils with the screen process. This enables one to create legible and compact printed matter, using equipment which one can make oneself out of readily available items. The process does not require electricity.

These instructions give guidance on how to build and use the equipment. The screen uses a simple rectangular frame with textile stretched across it. This is used as a support for stencil duplicator stencils. The text and images which are required to be reproduced may be either typed, handwritten or drawn upon these.(One may also reproduce photographs, details are given in Section 4.7)

If one wishes to print two or more pages simultaneously one simply fixes the corresponding number of stencils to the underside of the screen.

Because it is a form of screen process printing one may print onto a large sheet. If the intention is to produce posters the sheet will be left unfolded. Alternatively one may fold the sheet to produce newspaper or booklet formats.

The process may also be developed to print onto materials other than paper; eg cloth, plastics, etc.

Our drawing shows the basic elements of the process.

squeegee

INK

Frame
(Screen)

stencils

Fabric

Baseboard
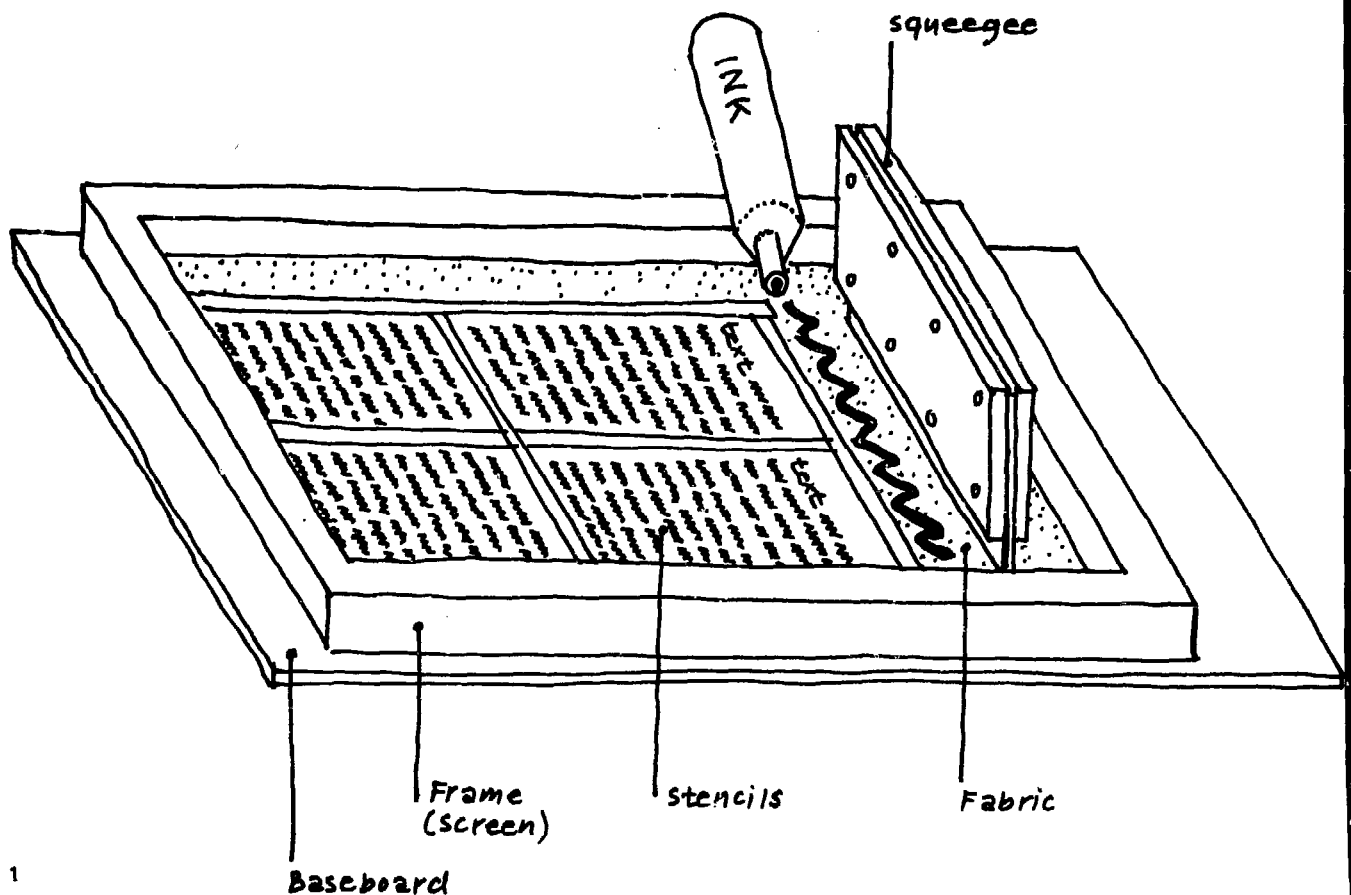
PREFACE

The Sten-Screen printing process was
developed to produce a simple low
cost printing technique which
fulfills the following criteria:

- it can produce legible and compact
  text

- it does not require electricity to
  run

- it can be made from locally
  available materials

- it can print on a variety of
  materials apart from paper

- it can be easily operated without
  the aid of sophisticated equipment

Essentially, the Sten-screen process
is a combination of a screen process
'press' with stencil duplicating
stencils for the production of the
original text and imagery.

Following a UNESCO funded study on
low cost printing techniques in
which the Sten-screen was first
mentioned, Intermediate Technology
Industrial Services provided funding
for the development and field
testing of the process. The field
testing was conducted in three
African countries, Kenya, Tanzania
and Zimbabwe, during the summer of
1982. Kenya and Tanzania made their
own equipment from the original
draft of this manual, and a ready
made up unit was sent to Zimbabwe
for demonstration at the Rural
Technology Development Fair.
Inevitably, there were variations in
the results of the device from the
various locations, but the reactions
in all cases were very positive and
encouraging. As a result, it was
decided to publish this modified
version of the original manual.

The screen should be built from
seasoned timber, preferably hardwood
(1). A smooth baseboard is essent-
ial; this is best made from block-
board, marine ply, or hardwood.

The equipment can be used to print
either a single page individually by
using a single stencil:or if a large
number of copies are required, one
can reduce the labour of printing by
making duplicate stencils. If one
does this one can print two or more
copies simultaneously by mounting
the duplicate stencils onto the
screen. The process is probably
best suited to this type of work.

Alternatively one may print a docu-
ment with a number of pages using a
single pass of the press by mounting
the appropriate number of stencils
onto the screen. Sections 3.3 and
4.4 give further guidance on this.

1) Hardwood is recommended because
one uses liquid generously when
washing the equipment after use.
This may cause softwood to warp;
which will make it difficult to
print effectively. If you have only
softwood available and wish to pro-
long the life of the screen then it
might be worthwhile giving it either
a protective coating of sealer, or
impregnating the timber. However,
we do not know whether there is
likely to be any reaction between
the protective medium and whatever
ink you may use.

In industrial applications the
screen is made from rectangular sec-
tion stainless steel tube. An A1
sized screen of this type costs £23
in the UK, plus fabric. If you can
get something suitable made up bear
in mind that you will require a
sophisticated method of fixing the
fabric to the screen if the correct
tension is to be maintained. We can
provide details of this.

To make the press you will require

Screen

To print an A2 sheet (594 : 420mm,
33 1/3 : 23 3/8").

- Timber

    approximately 45 : 45mm ex 2 : 2")
    two lengths, each of approximately
    2m (6' 7") and 1.4m (4' 9").

- Dowel (and glue) or screws to join
  the timber

- Fabric
  (organdie, rayon, nylon or silk)
  to act as a support for the
  stencil

- Hinges
  to join the screen to the
  baseboard.
  75mm (3"), rising butts are best
  for this purpose, see section 2.4

- Battens
  for extra tightening of the screen
  (see Section 2.3) and for spacing
  apart the screen and baseboard
  (see Section 2.4). You will need
  a total of 6 pieces, all approxi-
  mately 5mm (3/16") thick.
  4 lengths approximately 850mm
  (2' 9 1/2")
  2 lengths approximately 600mm
  (1' 11 1/2")

Baseboard

To act as a smooth surface on which to
print.

- Plywood or blockboard
  1 : 0.8m (3' 4" : 2' 8")

Squeegee

To press the ink through the stencil

- Offcuts of timber, an old ruler,
  or some other similar smooth
  straight material.

Tools

You will also require the following

- Carpenters saw
- Wood drill, to suit the dowels
- 4 carpentry C clamps

- Scissors
- Hammer and 12mm (/2") ta s, or
  staple gun
- Screwdriver
- Bradawl

To prepare the stencil
you will require:

- Something with which to create the
  master on the stencil.
  A typewriter for lengthy text,
  and/or a pointed tool such as a
  dried-up biro (or needle), if you
  wish to write by hand or make
  drawings.   (Section 3.1)

- Water
  to help stretch the stencils
  smoothly onto the screen: (Sec-
  tion 3.2) and also to clean up
  with after-wards. (Section 4)

- A clothes line and clothes pegs
  (or string and paperclips) to hang
  the printed copies upon when dry-
  ing. Alternatively you can use a
  drying rack, if you can get hold
  of one. (Section 3.3)

- Rags, and maybe a sponge.
  (Sections 3.2 and 4.7)

- Gumstrip
  (paper tape with a water soluble
  adhesive on one side - the wider
  the tape the better for some uses)
  for fixing the stencil (s) to the
  screen. (Section 3.2)

When printing you will require:

- Something to print upon of the
  appropriate size. If you use
  paper, the more absorbent it is
  the better. A glazed surface is
  likely to take longer to dry and
  this can be troublesome if you
  have a lot of wet copies flapping
  around. If you wish to make more
  robust copies you may also print
  by Sten-screen onto cloth, plastic
  and other materials.

- An overrall or working clothes

- A minimum space of 2.4 : 1.2m (8 :
  4')

- A work surface the size of a
  standard door

- Ink
  stencil duplicator ink is adequate

- As little wind as possible!

- You will also need a calm method-
  ical working atmosphere. It will
  probably be helpful to have some-
  one to assist you; children seem
  to enjoy taking part in this acti-
  vity.

After printing you will require

- Plenty of rags

- Water
  It is important to clean the
  screen thoroughly as soon as you
  finish printing. (Section 4.7)
  If you have a short length of hose
  available (say 2m - 6') which you
  can fix to a tap, this will make
  cleaning much quicker and more
  effective.

2 - Making the screen

You may decide to use a professional carpenter, or someone with better wood working skills than you have yourself. The jointing method suggested here is suitable for someone with only modest carpentry ability. A professional carpenter may prefer to use something more elegant. The precise way in which one makes the frame is not significant: but it is __important__ that the screen is flat, ie that it does not 'rock' when in contact with the baseboard.

2.1   Cut the timber to size

These instructions enable one to build a screen which will print an A2 sheet (594 : 420mm, 23 3/8 : 16 1/2"). The screen is larger than the printed sheet to give one extra room when printing. The amount of this extra space is a matter of personal preference, you may after trying these suggestions decide that you need to allow a little more.

Assuming you accept the dimensions we suggest here (and use 45 : 45mm / ex 2 : 2" wood) you will require four lengths of timber, two each of approximately 2m and 1.2m (6'7" and 3'11"). Ideally the timber should be cedar or rahmin, seasoned softwood is OK but bear in mind our comments in Section 1.

Our drawing shows the required __internal__ dimensions; depending upon the size of timber you use this will affect the overall external dimensions.

## 2.2   Joining the Timber

Drill the joints

Clamp the timber in place and drill (preferable two) holes per joint. One may use either screws or dowels as fixings. If you choose to employ screws proceed to Section 2.3 - but bear in mind that it is best to use countersunk screws. __Cut the dowels__ to the right length.

Glue the Joints

Insert the dowels; and when the glue has dried, smooth off any surplus dowel or hardened glue (this may snag the material which you will be using for the screen).
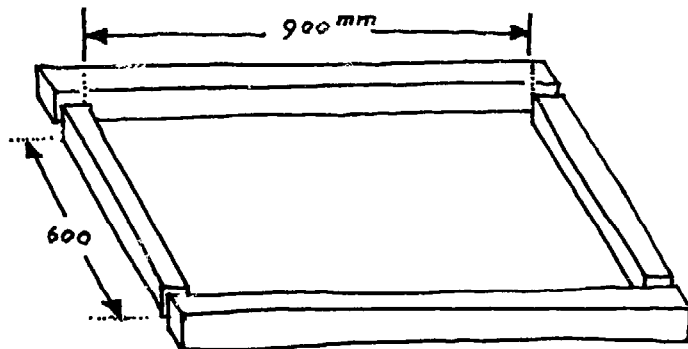
NB   This drawing specifies __internal__ dimensions in millimetres.
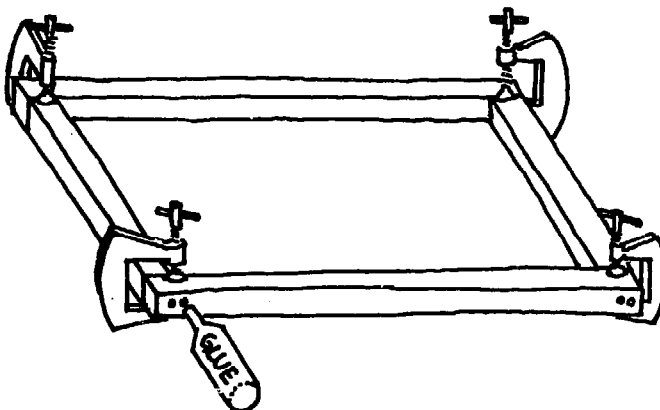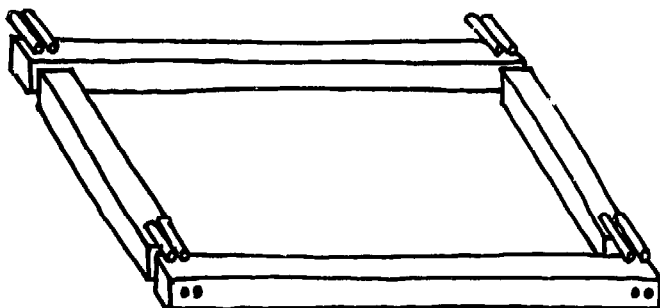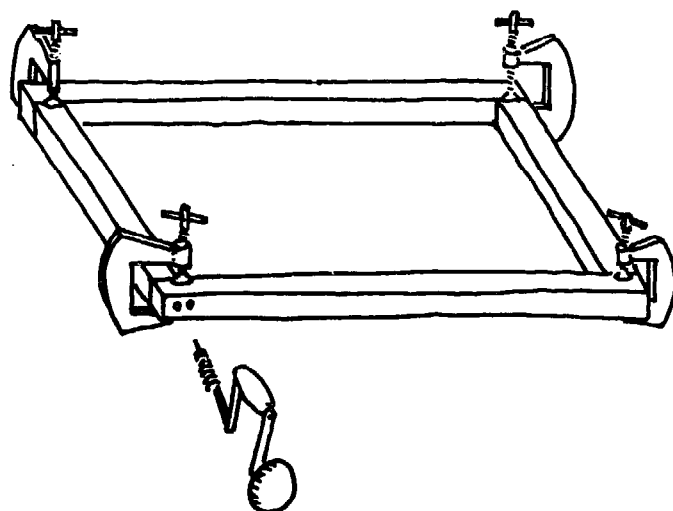
It is _important_ that the timber is
smooth where it will come in contact
with the fabric; otherwise the fabric
may tear as it is stretched tight.
Use a flat file or sandpaper to smooth
all of the undersides and round off
all edges and corners.

2.3 Stretching the Fabric

This is probably _the most difficult
part_ of the business of making the
screen. It can probably only be done
by an adult. You need strong fingers
if working on your own – or one person
to pull the fabric and a second to
secure it.

Lay the fabric out and place the
screen on top of it. Cut out of the
fabric to allow extra so that you will
be able to wrap the fabric over the
frame.

Fix the fabric to the frame with
either staples or tacks.

It is important that the fabric is
nice and taut. (As a guide, it should
be sufficiently taut that a small
light object such as a coin will
bounce if dropped onto it from approx-
imately 300mm (12").

The best way to obtain the correct
degree of tension is to start along
one of the long sides. Spread the
fabric evenly along the sides of the
frame and tack it at approximately
70mm (23/4") intervals. It is a good
idea at this stage _not_ to drive the
tacks home fully, as you may wish to
remove them as the fabric becomes
tighter. Once you have done this
repeat the process on the opposite
(long) side. Having made a pre-
liminary fixing in this way, pull the
fabric as tight as you can over the
edge of the frame and double the num-
ber of tacks (or staples). You may
find that as the fabric tightens you
will need to change the position of
the first row of tacks. If you find
that the fabric is insufficiently taut
after fixing, you can increase the
tension by pushing thin bits of card-
board or wooden battens approximately
5mm (3/16"), between the frame and the
fabric. Similarly, if you use a nat-
ural fabric for the screen, and this
tends to "give" with use; you can use
this technique to increase the ten-
sion.

5
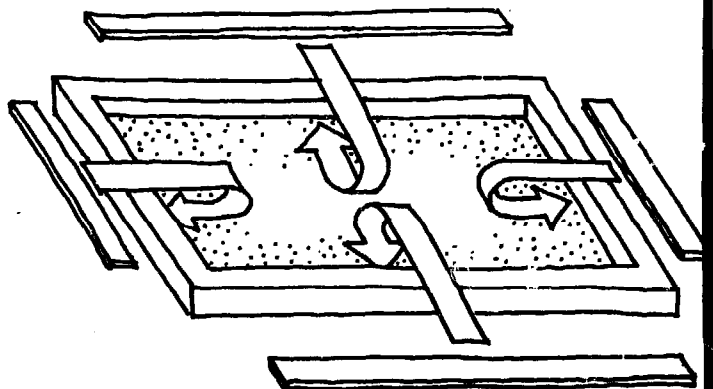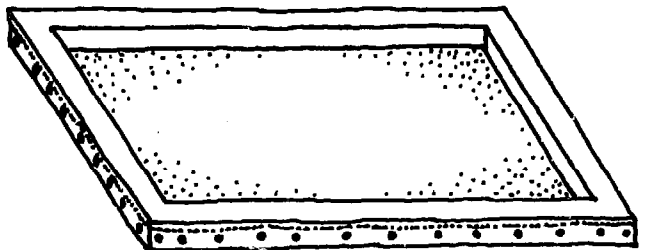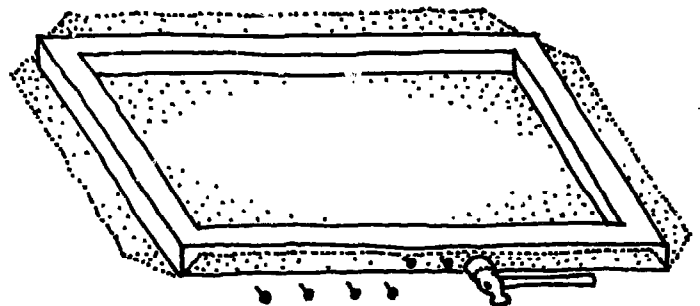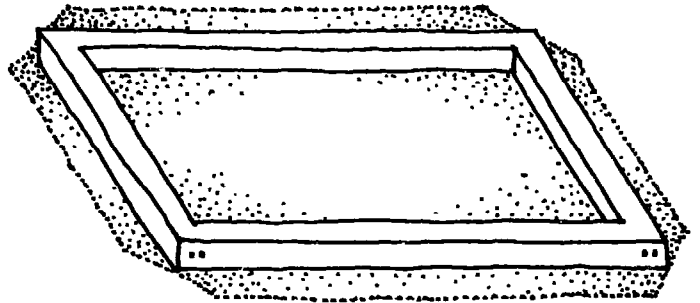
You are likely to find that after
using the screen several times it
becomes torn or clogs in places with
dried ink or other wastes. When this
happens you will have to take off the
fabric and stretch new material onto
the frame.

## 2.4 Hingeing the Screen and Baseboard

We mentioned in Section 1 that you
need to print onto a smooth flat sur-
face if you are to obtain legible
results. Also, when printing you will
need to position the screen accurately
onto the paper.

To do this you need a baseboard cut
from a sheet of smooth flat wood (such
as chipboard or plywood). This should
be a little larger than the screen,
which should be joined to the base-
board with a pair of hinges. It is
best to use rising butt hinges, so
that you can remove the screen easily
from the baseboard when you have fin-
ished printing. If you have nothing
to hand, a hinge can be improvised by
simply nailing a bit of textile or
leather to both the screen and base-
board. Before you fix the hinges see
Section 4.1.

2.5 Supporting the Screen

While printing you will be continu-
ously loading and unloading sheets of
paper between the screen and base-
board. It is useful (though not
essential) to be able to prop the
screen up temporarily for this pur-
pose. A simple light piece of wood is
sufficient to act as a prop and
screen. (An added 'touch' - to pre-
vent the prop getting in the way when
printing one can fit a hook and eye to
keep things tidy).

Industrial screen printing tables use
a counterbalance so that the screen
rises automatically after each impres-
sion. Equipment of this type costs
£1,450 in the UK for an A1 sized
sheet. You may be able to improvise a
counterbalance.
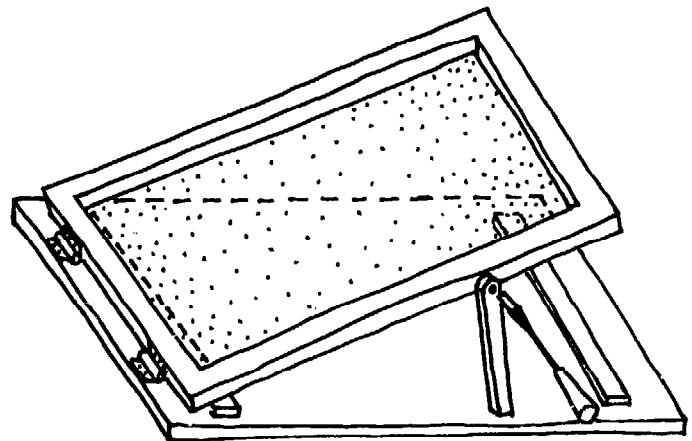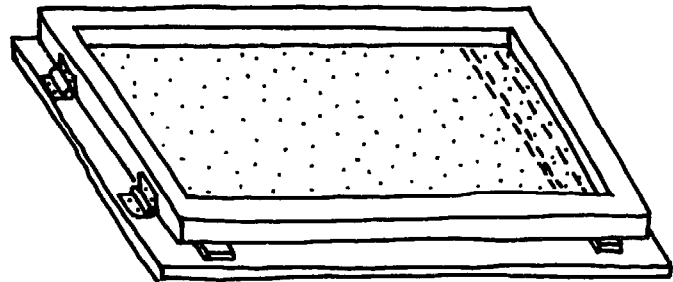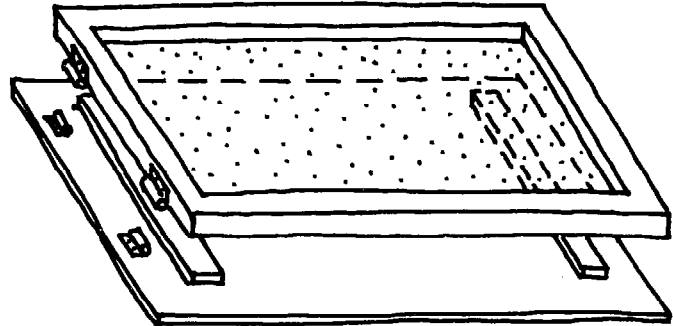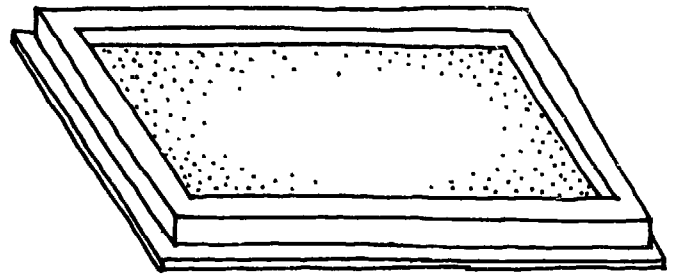
2.6   Making the "Squeegee"

In Section 1 we mentioned that the ink
is forced through the stencil by pass-
ing a film of ink across the screen
(once the stencil has been fixed to
it).

To obtain a consistent and manageable
film of ink one requires a smooth
straight blade of some sort. Con-
ventional screen processs printers use
a rubber blade approximately 7mm
(1/4") thick mounted in a wooden
handle. This tool has the wonderful
name "squeegee". We find that one
does not require a professional
squeegee to obtain adequate results;
and have improvised one by sandwiching
an old plastic ruler or piece of per-
spex between two bits of wood. This
suggests that any smooth straight edge
which has a little "give" in it will
probably be OK.

Once you have your;
- screen
- baseboard and
- squeegee

you have a "printing press"!
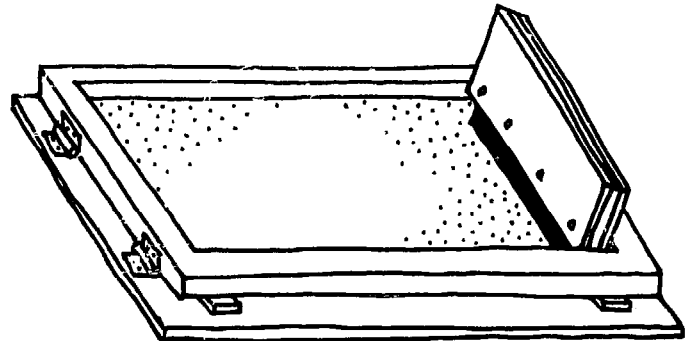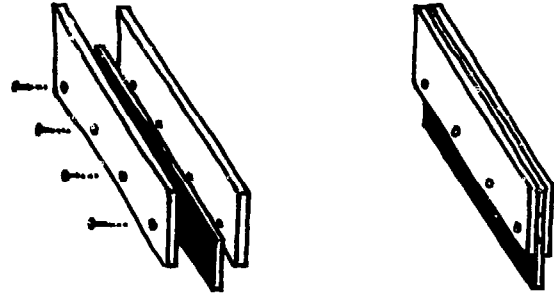
3 - Using the screen

3.1   Prepare the Stencil(s)

Once you have a screen and the other
ancillaries you are in a position to
start print production.

Assuming you have a clear idea of <u>what</u>
you wish to print; for example to whom
your message is addressed; the form it
should take (the written style, mix of
words and illustrations, etc); the
number of copies required; and have
the necessary supplies of paper and
ink – then you are in a position to
start preparing the stencil(s).

Although one can draw and write onto
the stencils (using a dried out biro
or similar tool) the best way to com-
press text so that it is compact but
still legible, is to use a typewriter.
If you have a choice of <u>sizes</u> of
alphabet, until you have some
experience of the Sten-screen Process
it is probably best to use a type-
writer with a larger size. Ten
characters to the inch (often known as
"pica") is preferable. Bear in mind
that the ink is likely to spread when
printed, so if you have a choice of
<u>style of alphabet</u> it is best to choose
one where the shapes are "open". By
this we mean a design where the inter-
ior forms of the letters (such as
o,e,a,m, etc.) are as large as
possible.

Prepare the stencils in the same way
as you would if you were using a sten-
cil duplicator. You will find supple-
mentary advice in Section 4 on how to
combine individual stencils so that
you may make full use of the potential
of the Sten-screen Process to minimise
the labour of printing.

If you require text which is larger
than a typewriter can produce you can
either handwrite this, or if one is
available, use a (drawing) stencil.
These are used for a variety of diffe-
rent purposes including:
technical drawing, agriculture
(forestry); and despatch (where they
are used for labelling packing cases);
as well as signwriting.
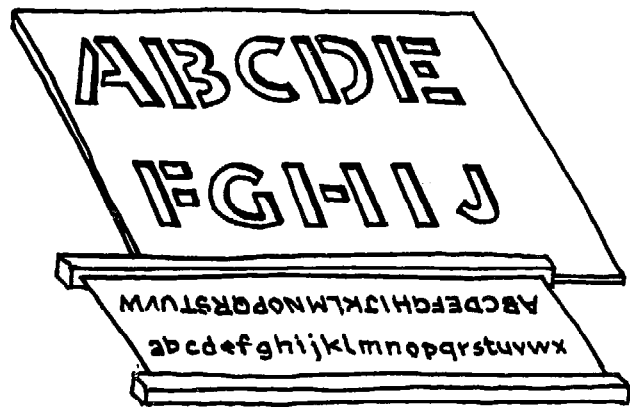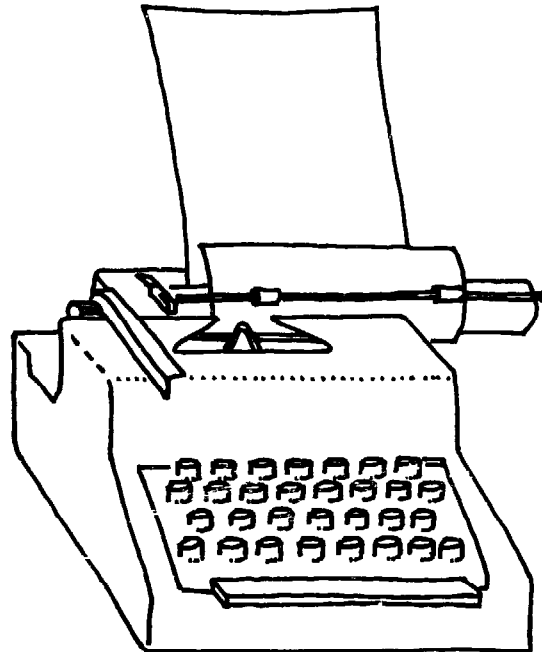
3.2 Stretch the Prepared Stencil onto the Screen

Once you have prepared the necessary stencils, these have to be mounted onto the screen. It is important that they are bonded evenly, without any wrinkles in the image making area. (If not, the final copies will dupli- cate faithfully these irregularities). The best way to ensure an even contact between the stencil and the screen is to wet the screen fairly generously; and to spread the stencil onto the screen with a damp cloth or sponge. It is particularly important to do this in hot climates, otherwise you may find that the glue will dr before a good bond is obtained.

Note: It is essential that you mount the stencil on the underside of the screen. The easiest way to do this is to simply turn the screen upside down and fix one of the short sides of the stencil to the screen with dampened gumstrip. (1) The stencils should be mounted facedown.

It is helpful to draw guidelines on the screen for mounting the stencils. You can do this simply by drawing onto the fabric with a 'soft' pencil (2B). If you first draw guidelines onto the baseboard you can trace these through by laying the screen on the baseboard. Incidentally the guidlines on the baseboard will be useful later when printing (for positioning the paper). It is also a good idea to number each page in the position required, on both the baseboard and the screen. Then, when you turn the screen over to mount the stencils you will have a useful guide for the correct location (and orientation) of each stencil.

Once you have one side taped into position, and have smooothed the sten- cil down evenly, it is a simple matter to stick the other sides down using more gumstrip.

Having fixed the first stencil, follow the same procedure for the rest of them.

When all of the stencils are in posi- tion it is necessary to mask off the rest of the screen completely, to prevent surplus ink from making every- thing messy. Masking is easily done
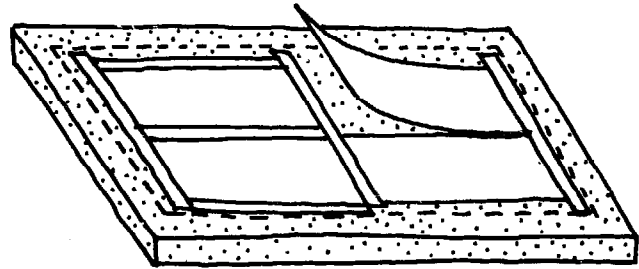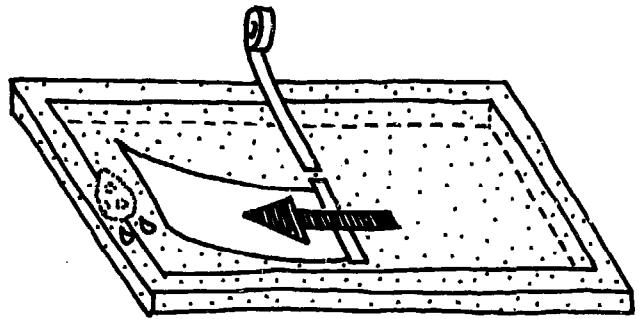

using either lots of gumstrip; or if you have a large area to cover, pieces of unused stencil stuck down with gumstrip. When you have completely masked the screen check that there are no holes where the ink can sneak through, by holding the screen up to the light. Cover any remaining holes with patches of gumstrip.

When the screen is neatly protected stand it up to dry in a warm, well ventilated location (best out of strong sunlight).

Once it is dry you are ready to print!

1) If gumstrip is not available you can use strips of practically any strong non-absorbent paper and glue these with a water soluble glue. Use water soluble glue, otherwise you will have difficulty cleaning the screen after use. As we mentioned in Section 1, once the screen becomes permanently blocked you will have to restretch it. You will find further advice in Section 4.7.
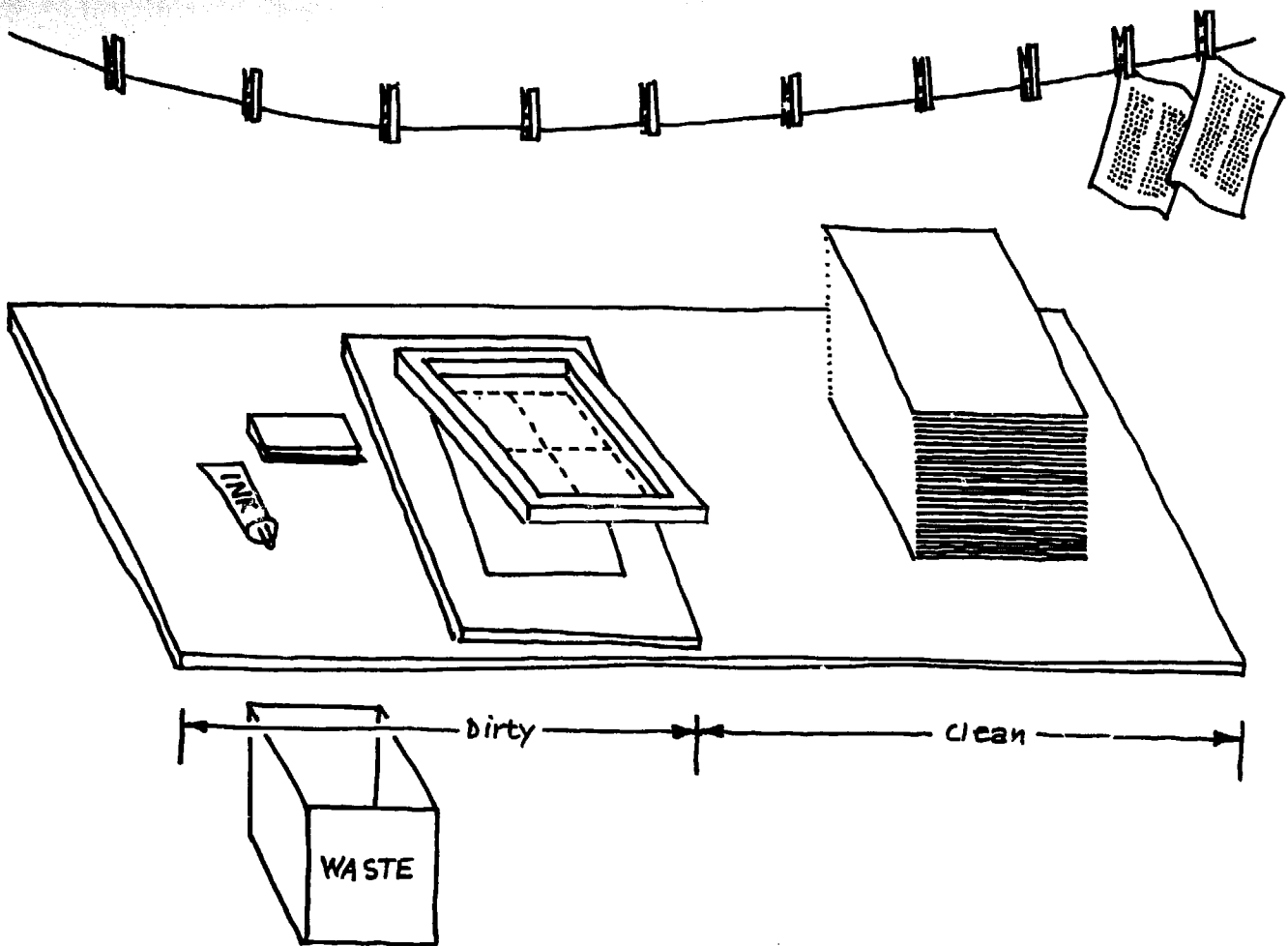
3.3 Printing

Before you start printing it is well
worthwhile sorting out the workspace
into "clean" and "dirty" areas. You
will probably find that no matter how
carefully you work, you will tend to
get ink onto your fingers. Once this
happens it is easy for the printed
matter to become messy – as well as
everything else you touch!

It is helpful to have a second person
to assist you, if only to hang the
printed sheet up to dry. We find that
children from twelve years old are
capable of assisting, and even seem to
enjoy the business of printing itself.
The act of taking an impression does
not require great strength or skill;
older children are in our experience
capable of this.

Once you have prepared your workspace;
and instilled in your assistant(s) the
need for a calm and methodical working
atmosphere; stand the squeegee against
the inside of the screen.

Place paper under the screen and posi-
tion it, as described in Section 3.4.
Squeeze a ribbon of ink onto the

screen, between the squeegee and the
stencil image.

Scrape the ink across the stencil
wherever an image is required. Try to
keep the film of ink even. You will
probably use more ink than you re-
quire. Trial and error will demon-
strate that you in fact require sur-
prisingly little ink for it to pene-
trate the fabric. Having made the
impression, collect the ink together
with the squeegee before you lift the
screen – try to keep the stencil free
of ink when lifting the screen.

Having lifted the screen, remove the
printed copy; hang it up to dry; and
load another sheet of paper.
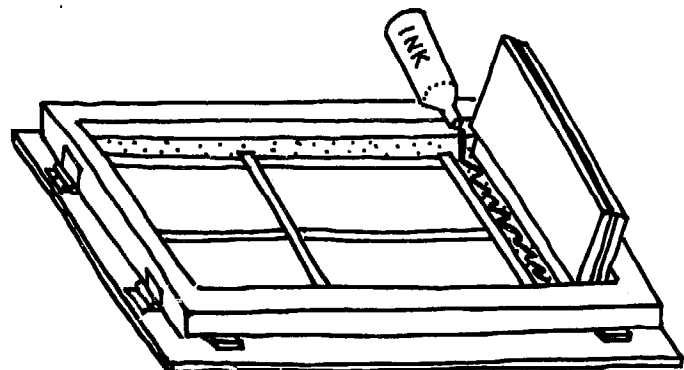
3.4 Positioning the Paper

If you have drawn the guidelines onto
the baseboard as suggested in Section
3.2 you can avoid fiddling around each
time you make a copy lining up the
paper with the stencil. If you want
an additional aid for positioning the
paper then you can use four (or more)
"lay marks" made by simply sticking
short lengths of gumstrip onto the
baseboard. These are usually suffi-
cient to prevent the paper from moving
as you close the screen.

We mentioned in Section 1 that this
Sten Screen Process is also capable of
printing onto fabric and other mater-
ials such as plastic, glass, etcetera.
If you intend to try this you will
probably have to use different inks;
and in the case of fabric may have to
bake or steam the printed cloth to
prevent the design from fading when
washed. It is hoped that these tech-
niques will be a subject for further
development work; in which case we
would expect to publish an additional
publication describing suitable inks,
printing and fixing techniques.
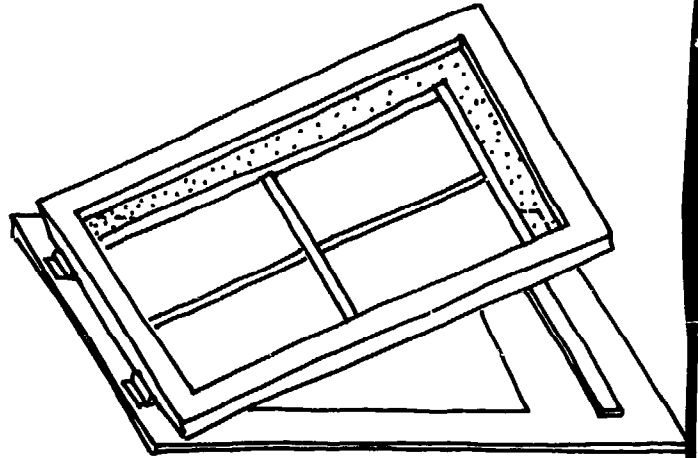
4 - Maintenance, Enhancements, Tips

4.1 Fixing the Hinges

The quality of the printed result is usually better if the fabric 'jumps' away from the paper as the squeegee passes. This is known as the 'snap distance'. It is easy to achieve this if the screen is kept about 5mm (3/16") above the paper. If you put something of this depth under the screen when fixing the hinges this will automatically give you the snap distance for one side of the screen. Once the hinges are fixed in position place another spacer at the opposite end of the screen and you will have an even snap distance over the full length of the screen.

4.2 Alternative Sized Screens

These instructions are for the production of a screen suitable to print an A2 sized sheet of paper. You can of course make the screen to suit any size of paper. We assume that you will probably also require ultimately other sized screens to suite A1 and A3 production.

4.3 Formats obtainable from an A2 Sheet

We have mentioned that you can print items with a large format, such as posters or wallcharts, by mounting several stencils onto the screen. By doing this you can obtain a printed image over the entire sheet. When you do this you must bear in mind that the stencils are fixed to the screen with gumstrip - which will not allow the ink to penetrate. If your design requires stencils to be joined you will have to take account of this. (That is, you will have narrow bands in the image which will not be capable of printing). You can often camouflage this by adopting a "modular" design, such as this publication. Also, where you have large text running over two stencils, you can usually arrange for the gumstrip to be stuck in the space between the words.

4.4 Printing Pages Simultaneously

You may find that the principal advantage of the Sten-screen Process is that you can print two or more pages simultaneously. For example with an A2 screen you can print 4 pages of A4 with a single pass of the press. With this sized equipment you can print numerous different types of publication. You have the choice for example of printing any of the following:

- an 8 page booklet
By printing 4 pages on each side of the sheet.

- two copies of a 4 page booklet
By printing all of the pages simultaneously. Then once you have printed all the sheets on one side, turn the entire supply over, rotate it through $360°$ and continue printing on the reverse of the sheet.

To do this you will have to mount the stencils on the screen in the order which is shown in the drawing.
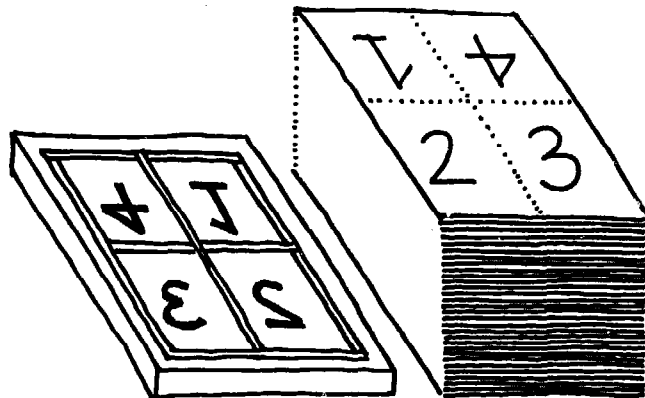

- two copies of A3 size
  printed one side
By making duplicate stencils and mounting both sets onto the same screen.
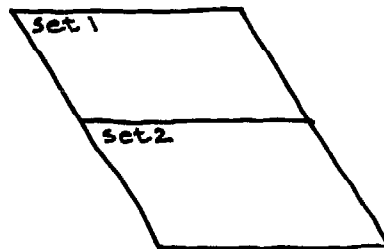
- two copies of an A4 size,
  printed both sides
By making duplicate stencils again, and printing both sets simultaneously. In this case you should mount the

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stencils as indicated in the drawing.
Having printed all the sheet simply
turn them over and print on the back -
on this occasion you do <u>not</u> need to
rotate the pile.
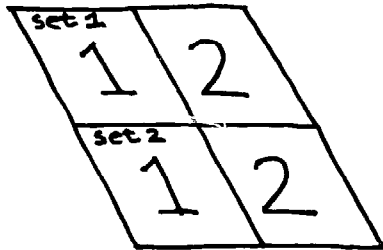
- <u>four copies of an A4 size</u>,
  printed on <u>one</u> side only.
By making four duplicate sets of sten-
cils and printing in the same way as
the previous example.
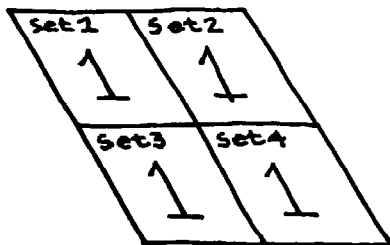
4.5 Amounts of Ink

When spreading the ink over the screen
for the first time you will require
much more ink that you will subse-
quently. Once you have a good film of
ink over the area you require, then
only <u>very little</u> is needed to print.
For example a single ribbon of ink
from the tube will usually be suffi-
cient for 4 or 5 copies. When print-
ing it is best of <u>pull</u> the ink towards
you; and to maintain a firm and even
pressure. When printing the squeegee
should be held at approximately 45°.

4.6 Photographs

Preliminary trials suggest that if an
electronic stencil cutter is available
this can be used to produce stencils
in the conventional way, but to print
them by Sten-screen. If you decide to
experiment with this you must ensure
that when the stencil has been cut
that the perforations are sufficiently

'open' for the ink to pass through
with ease. To test the stencil simply
hold it up to the light. If light
shows through clearly, then you should
have no difficulty printing with them.
If the image is not clear enough, then
remake the stencil with a more con-
trasty setting on the machine.

Once you have an adequate stencil then
mount it in exactly the same way as
described in Section 3.2.

4.7 Cleaning the Screen

We said in Section 1 that the process
depends upon the ink passing through
the fabric of the screen. It is
obvious therefore that if you wish to
re-use the screen you should keep it
as clean as possible. This is not
difficult if you clean up as you
finish printing. Stencil duplicator
inks are soluble with white spirit,
you do not require specialist cleaning
fluids.

Start the cleaning by wiping up most
of the surplus ink onto scrap paper.
When most of the ink is off, you can
wash off the stencil and gumstrip with
water. Use a hose for this, because
if the supply is sufficient you can
squirt a high pressure jet at the
fabric without damaging it; and this
is a good way of clearing waste matter
from the fabric. Use the turps to
dissolve any patches of ink which
remain, and for cleaning the screen
fabric generally.

Cleaning up is a messy business - you
will need plenty of rags, a large
waste bin, and a generous supply of
water.

If you are scrupulous in the way in
which you clean up, it is possible to
lift off the stencil - and if it is
clean enough, you may be able to store
it and use it for a second edition at
some future time. You can also leave
the stencils on the screen and print
further copies later, so long as you
mop up most of the ink with paper.

No matter how clean you keep the
screen, nor how careful you are with
it, ultimately it will need replacing.
When this time comes follow the proce-
dures outlined in Section 2.3