



APPROPRIATE PAPER-BASED TECHNOLOGY

There are many ways of making things out of waste paper and card, but they are not usually referred to as 'technology'. Appropriate Paper-based Technology (APT for short), however, is a system of knowledge and techniques that has been developed in Zimbabwe over the past 18 years.

APT does not include every technique that uses paper and card to make things. 'Appropriate' in this case means that the objects created must be suitable for and able to be used by the intended owner, and capable of meeting some need which for reasons of cost or unavailability cannot otherwise be met.

Appropriateness is the essence of APT. It was born in 1977 as 'Art that costs nothing' among students needing both a cheap art form and furniture and equipment. They discovered that with waste paper and card and a paste made from leftovers of their daily meal of 'sadza' (boiled maize flour), they could make a variety of much needed products that were remarkably strong. By 1980 they were making desks and using them in schools, and within years people were making special furniture and teaching tools, low-cost solar cookers, handicrafts and furniture to sell, and an endless list of apparatus and special furniture needed by people with disabilities.

Four strict rules became and still are the parameters for the development of the technology.

1. Every APT article must be strong. Furniture must stand up to use, and some abuse. Weak furniture would be dangerous, especially to people with disabilities. APT structures are based on simple but sound engineering: APT boards made by laminating card cannot crack; properly made APT joints that are wrapped over with several layers of strong pasted paper cannot work loose. Paper, though thin, is not weak, and when layered or laminated it dries hard and resembles the wood from which it was made.
2. Every article must be useful. Strength of course is a prerequisite for usefulness, but the rule means more than that. The technology is manual and individual. Things are designed for individuals or distinct categories of users. APT technicians make or modify shapes and dimensions to suit the user; where possible they check the product with the user during its construction, and make it adjustable to allow for growth or to suit another user.
3. Every article must be attractive. This is not an optional extra. It contributes to the value of the article and ensures that it will be cared for. APT decoration has to be done with no-cost materials. Decorative material comes from magazines, calendars, coloured wrapping paper, or earth paints. APT earth paint is made simply by grinding and sifting selected soils and mixing the fine powder with water and a little paste. It is usually applied by hand, smoothed with a piece of foam rubber, and textured with different home-made plastic 'combs' or 'grainers'. Larger articles are invariably painted with earth colours to save decorative paper. APT artists may branch out into APT for art's sake, but APT's approach, like that of the finest traditional arts and crafts, is to make useful things that are beautiful.
4. Every article must be made from materials that cost nothing. (Flour for paste and varnish, if used, is the only exception to this rule.) Limiting the user to flour paste as an adhesive has far-reaching effects. Applying paste moistens and weakens paper and softens card. It also causes the material to expand in a certain direction and as it dries to contract with a very strong pull. Things do not dry evenly: the top surface dries and contracts first, tending to curl upwards. All this gives rise to some very difficult situations that the APTer has to learn to control.

Using paste also means that work has to be done in stages, so it can dry in between. The construction of an APT item is a protracted process, but pasting brings advantages that far outweigh any problems. It makes everything flexible and easy to manipulate. Surfaces can be worked smooth with the hand. Pieces of card can be cut and manipulated or moulded into a desired shape. Thin pasted card can be rolled tight to make a hard strong tube. While still soft, tubes can be flattened to make bars or bent into any shape. Moist paper tubes are even more flexible.

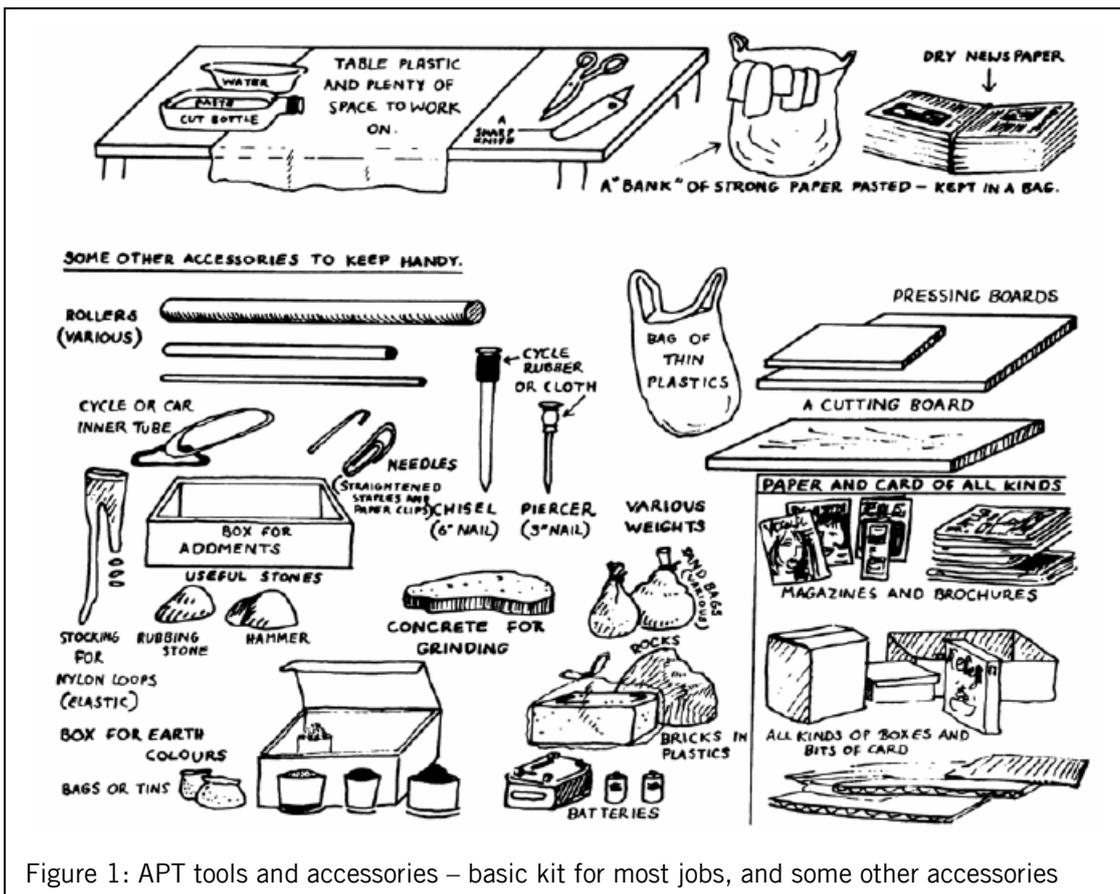
They can be pressed like putty along the angle between two boards to strengthen the join, or they can be flattened, to make belts for pulling and holding things together. Pasted paper can be moulded into any shape, and the pasted material will always dry hard and strong. Thus the overall effect of using paste as the adhesive is to give the APTer the freedom to manipulate the material just as he wishes. It facilitates almost every operation of the technology.

Few technologies can be more friendly to the environment. APT consumes waste and it recycles paper and card to make articles that would often have been made of wood. It makes solar devices that cook without fuel and pollution. It saves human resources by making equipment that helps in the rehabilitation of people with disabilities, and by providing them and many unemployed people with the opportunity to earn a living, and APT waste is biodegradable!

Essential technology

The freedom enjoyed by the experienced APTer has to be earned. It can be disastrous for the novice to innovate. APT is technically very disciplined, and its skills and techniques have to be learned. These can be considered under two heads:

The Basic knowledge and techniques applicable in most constructional processes, and the Standard approaches, designs and special techniques for using paper in its different forms to make different categories of articles.



technical brief

Basic knowledge and techniques

The main material used is waste paper and card. All forms of paper and card share some common characteristics. First and foremost among these is 'grain'. It is recognizable in paper and card as the direction along which a piece of paper or card will tear, crease, or roll most easily. (In corrugated card the direction of the corrugation is treated as grain.) Grain affects virtually every operation. Don't fight the grain — use it!

Another important characteristic is the stretch/shrink factor. All paper and card swells and stretches when it becomes moist, and as it dries it contracts. To prevent damaging shrinkage, paste paper and card and leave it until the moisture has been fully absorbed, then finish your layering as quickly as possible. When laminating card, on the other hand, cover it very thinly with paste, and again work quickly.

Recognizing different kinds of paper and discovering and using their special characteristics is an ongoing process. Flour paste is the other indispensable material. It is used in every APT construction process.

Essential techniques include:

- Knowing how to make and use different kinds of flour paste
- Making and using mash
- Tearing, cutting, scoring, creasing, and folding paper and card
- Layering strips or pieces of paper and card singly or two or three layers thick
- Rolling card or paper to make tubes of different strengths and sizes
- Laminating sheets of card (or even paper) to make different kinds of boards
- Joining components and strengthening the joints
- Strengthening and tidying an article
- Decorating
- Pressing and or drying, both between stages and finally

Standard approaches

These can be broadly classified according to the four main forms of paper they use: mash, paper strips and pieces, thin card, or thick (i.e. corrugated) card. Generally speaking these main forms of paper are used to make different categories of articles.

Mash is paper ground to a pulp and mixed with paste. It is moulded, and mainly used in products for the nursery and pre-school.

Layered paper and card is used mainly for making various utensils for home and school, including small light furniture and some articles for people with disabilities.

Thin card and tubes of thin card are used to construct a full range of light-weight legged furniture referred to as the 'Classic style', and other things such as cots, lampstands, and hinged and tubular apparatus for people with disabilities, such as walking frames and crutches.

Thick card is used for making boards for what has become the main range of APT products: 'Utility style' furniture. This includes a normal range of furniture as well as some large items such as workbenches and wardrobes, and a great variety of equipment for people with disabilities.

The Utility style uses three approaches:

- Slotting boards together and strengthening the joins.
- Making a structure of two sideboards, joined by a system of tubes that fit into a pattern of holes in the sideboards so that, where desired, they can support other boards. This approach is used to make chairs, armchairs, tables, and shelves, as well as special chairs and apparatus for people with disabilities such as lying, standing, walking, and rocking equipment (horses, round rockers, and so on).
- Making box structures, with or without supporting tubes. These range from cassette boxes to coffins, and include more equipment for people with disabilities, a range of solar box cookers, water heaters, fruit dryers, and heat-conserving boxes. (The glass for the cookers is junk glass, including cracked windscreens from the car breakers.)

Wheeled items

Thin card, thick paper, and sometimes carton card is used to make wheel assemblies consisting of a bearing in which an axle with fitted wheels can rotate or a single wheel between two bearings, and also to make steering systems for some items for people with disabilities. Bearings are usually attached under a chassis. Wheeled items include toy cars and carts for pre-school, and much sturdier items for people with disabilities including push chairs with insertable wheel systems, floor rafts, push-along tricycles, self-propelling trolleys, and low-level wheelchairs. All these are for clinical or home use rather than for rough use outside, but they are quite durable and easy to repair.

Making a child's chair

This chair is a Utility model, using Approach II: two vertical boards joined by a pattern of rails which support a seatboard. It is not a difficult model, but making it involves a number of operations. It is the prototype of all Approach II Utility models. Some preliminary knowledge is necessary, and as the chair will be made in stages this knowledge will be provided before the actual working instructions, stage by stage.

Preparatory stage

Making the templates and the components
 First: Get a clear idea of the job. Study the illustration on page 20. Decide the exact size and shape of the chair you want to make, and cut card templates for the three boards. On the sideboard templates mark where the holes for the tubes (rails) will be, allowing for the top of the seatboard to project slightly above the sideboards.

You need to know:

- What grain/corrugation direction is. (See earlier)
- How to make paste from plain flour. Follow these instructions exactly: Mix a heaped tablespoonful of plain flour in a little cold water, stirring until it is the consistency of cream and there are no lumps. Pour in 500ml of boiling water, stirring vigorously and continuing to stir for some time.
- How to prepare your work surface. Spread a square of plastic on your table and place either on it or nearby the following: a container of paste; a container of water; a sharp knife; a plastic bag of pre-pasted strong paper (such as from a potato bag); some newspaper; cutting and pressing boards; a rough stone; and weights.
- How to laminate corrugated card to make boards. Decide from the thickness of the card that you have how many layers will be needed to make a board about 150mm thick. Use a template to cut each piece of card to the right sizes with grain direction alternating with each piece. Place one card on your table plastic. Paste it generously all over. Place the next card on it, with grain alternated. Paste that one. Continue until the board is over 150mm thick, with the template as the top layer. Wrap in a sheet of newspaper. Press it first by treading all over it, then leave it pressed under a weighted board to dry.
- How to roll tubes of thin card for the chair. Prepare rectangles of card which are about 40mm longer (along the grain) than the width of the seatboard. Find a suitable roller (such as a broomstick). Lay the card on the table plastic, with its grain parallel to the table edge. Smear paste thinly over the card and onto the roller. Place the roller along the front edge of the card. Roll the card tightly onto it, and continue rolling it to stick the end edge down. Seal it down with pasted paper and pull it off the roller without delay.

Get to work:

Laminate the boards, roll the tubes, and let them all dry.

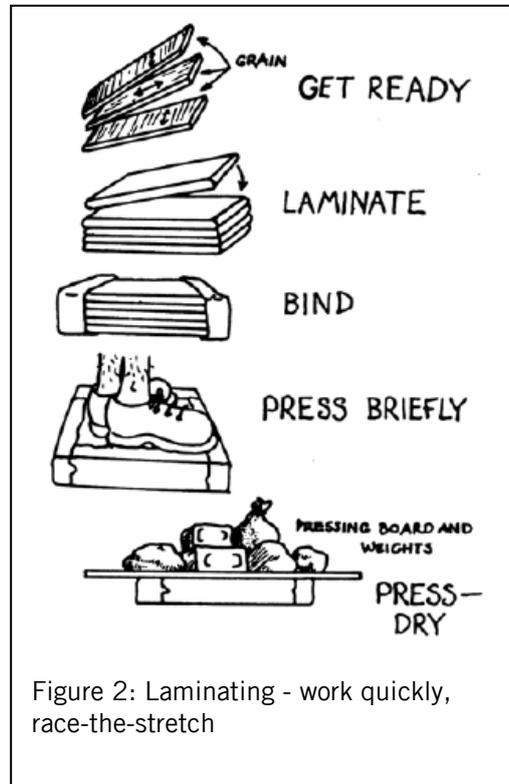


Figure 2: Laminating - work quickly, race-the-stretch

Stage 1: Building the chair

Add to your working kit:

A hole-cutting tool (such as a flattened five-inch nail and stone hammer); a piercing tool (a smaller sharpened nail in a holder); a piece of rusty piping (to use as a rasp); and some string.

You need to know:

- How to layer paper or thin card. Pieces of paper are pasted (and thus stretched) and applied with hand pressure to an article. They must lie quite flat and may have to be lifted, torn, and relaid. They may be applied one, two, or three layers thick, and may be referred to as 'strapping', 'binding', 'strengthening', or 'tidying', according to the job they do.
- How to cut holes for tubes. Holes can be rough but must hold the tube tightly without crushing it. Their sides should be perpendicular. Use a chisel-like tool to cut them. Enlarge or tidy them with the piece of piping. Match each hole to its tube and number them both.

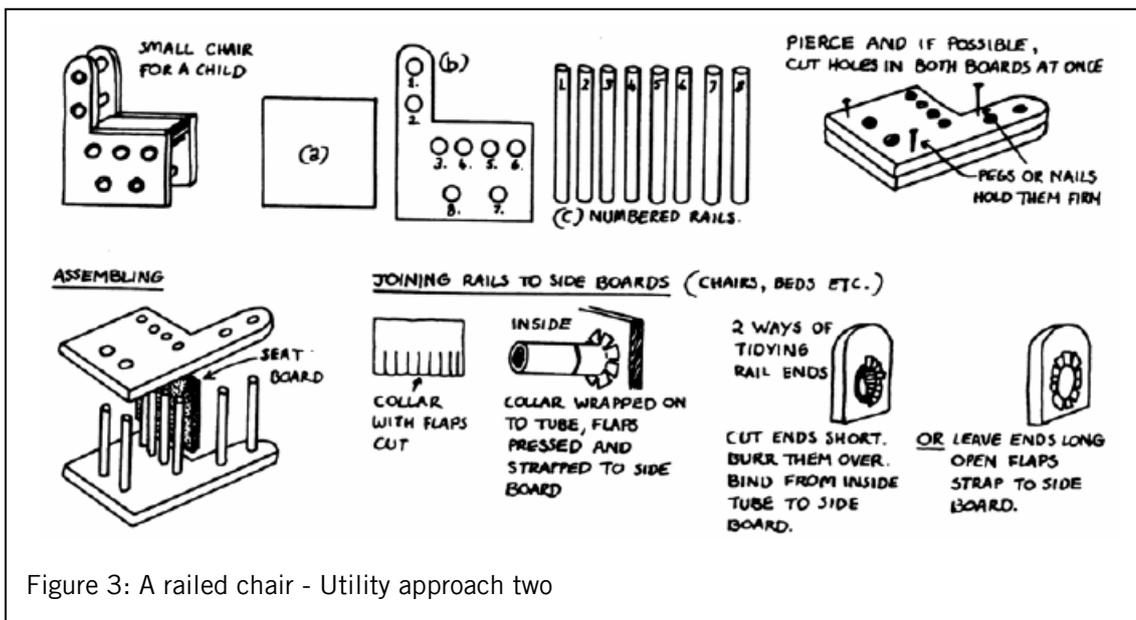


Figure 3: A railed chair - Utility approach two

Get to work:

- Tidy all board edges and make the two sideboards identical by rubbing on a concrete surface, with or without paste. Bind the edges.
- Cut the holes. Test-fit and number the tubes.
- Do a mock assembly (i.e. without paste).
- Lay one sideboard on the table and fit the tubes into their holes. Hold the other sideboard in position over the tubes and guide, press, and screw each tube into its hole. Place the seatboard in position then press the sideboard hard down against the seatboard.
- Stand the chair upright and manipulate the rails so that their ends project evenly about 5mm through one sideboard. (Trim the other ends later on.) Square up everything, checking particularly that the distance between the sideboards is everywhere the same and that the chair stands upright, then disassemble the chair.
- Paste all joining pieces, rail ends, and holes, and reassemble the chair. Pierce holes through the seatboard and tie it firmly down to at least one rail. Trim the remaining rail-ends to project 3 to 5mm. Burr all rail ends over with a suitably shaped stone, cutting into them if necessary. They should lie flat like rivets. Stand the chair up, and after squaring up leave it to dry with a weighted board across the seat.

Stage 2: Strengthening and tidying

First: Add some magazine paper to your working space.

Get to work: The object is first to strengthen all the joints and make the chair rigid, then to layer it all over with a very smooth coat of plain paper. Some essential operations are described. You will find other things to do as you work.

- Make collars, with flaps cut and bent outwards at one end, to secure all unsupported rails to the sideboards (see illustration). Press and strap their end-flaps to the sideboards.
- Paste and roll some tubes of magazine paper and press them, like putty, along the angles where the rails support the seatboard. Half-collars may also be used for the seat rails.
- Find one or two pieces of thin card and laminate (layer) them over the seatboard, so that their edges wrap over and a little way down the sideboards, and if possible down and onto the front rail. Rail ends may be left open or closed.
- Layer tidily over the whole chair, and add extra strong layering over the bottom of each sideboard. Check again for straightness, then leave to dry.

Stage 3: Decorating

This is left to the individual. Earth painting is recommended. Once the chair is dry the seat, in particular, should be rubbed smooth.

Stage 4: Finishing

After checking that the surface is perfectly smooth, apply a polyurethane or other varnish to harden and seal the surface. Use a hard varnish first to protect it, then a softer one to give a smooth surface. Apply the varnish with your hand, using plastic bags as gloves.

Note: APT articles should not be stood on damp surfaces, or left outside in the rain.

Further information

[*Appropriate Paper-based Technology \(APT\): A manual*](#), Bevill Packer. Practical Action Publishing 1995. ISBN 9781853392689

[*Small-scale Paper Making*](#) Practical Action Technical Brief

This technical brief was originally written for the *Appropriate Technology* magazine Volume 22/Number 3 December 1995 ATBrief No 15, by Bevill Packer.

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