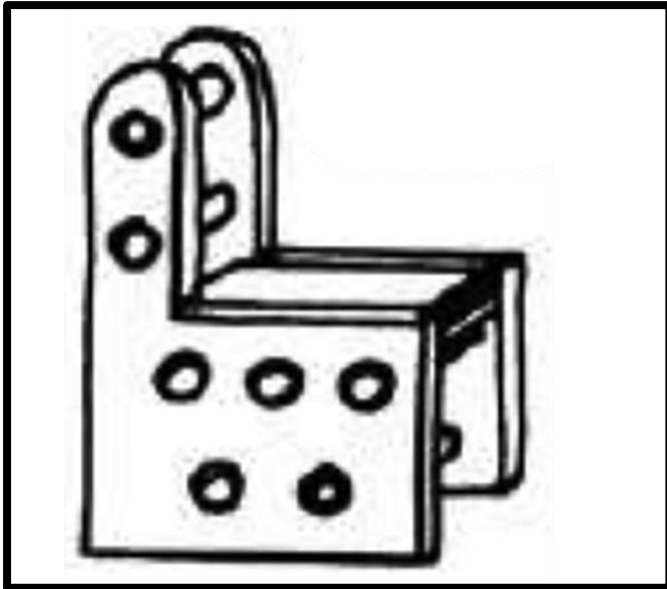




a shell book

Appropriate Paper-Based Technology

Making use of waste paper and card



level: intermediate / advanced

Appropriate Paper-Based Technology

Making use of waste paper and card

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Appropriate Paper-Based Technology

Making use of waste paper and card

Introduction

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 50 years.

APT does not include every technique that uses paper and/or 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 form of art, 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 teaching aids for use in schools, and soon after that they were making low-cost solar cookers and an endless list of special apparatus and ad hoc furniture items for people with disabilities.

Four rules became, and still are, fundamental to the development of the technology.

1. **Every APT article must be strong.** Furniture must stand up to use, and even to some abuse. Weak furniture would be dangerous, especially for 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 make products 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 can come from magazines, calendars, coloured wrapping paper, or earth paints. APT earth paint is simple to make, 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 at this stage of use.** (Of course the original paper, magazines etc. did incur a cost of production, but that happened at an earlier stage, before the materials reached the APT technician.) Flour for paste and varnish, if used, is the only exception to this rule. Limiting the user to flour-based 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 technician 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 joint, 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 worker the freedom to manipulate the material just as he or she wishes. It facilitates almost every operation of the technology.

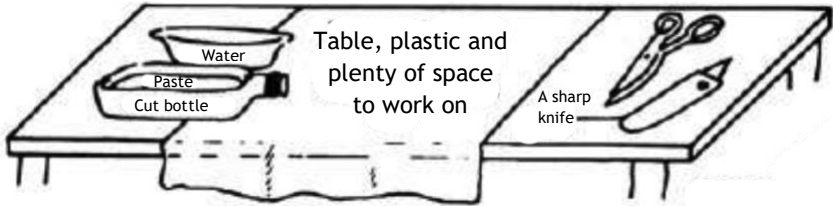
Few if any technologies can be more environmentally friendly than APT. APT consumes waste by recycling paper and card to make articles that would otherwise need to be made of wood. It makes solar devices that cook without expensive fuel or pollution. It enhances human resources by making equipment that aids the rehabilitation of people with disabilities, giving them, and many unemployed individuals, the opportunity to earn a living. Plus, APT waste is biodegradable!

Essential technology

The freedom enjoyed by an experienced worker in APT has to be earned. APT is technically very disciplined, and its skills and techniques have to be learned. These can be considered under two headings:

The **Basic knowledge and techniques** which apply to most constructional processes; and the **Standard approaches**: designs and special techniques for using paper in its different forms to make different types of articles.

Get organised with the basics



A 'bank' of strong paper, pasted and kept in a bag



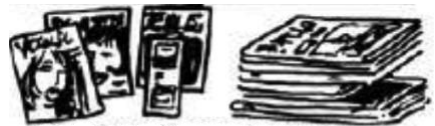
Dry newspaper

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'. Grain is the direction along which a piece of paper or card will tear, crease, or roll most easily.

(In corrugated cardboard the direction of the corrugation is treated as grain.) Grain affects virtually every operation. Don't fight the grain — use it!



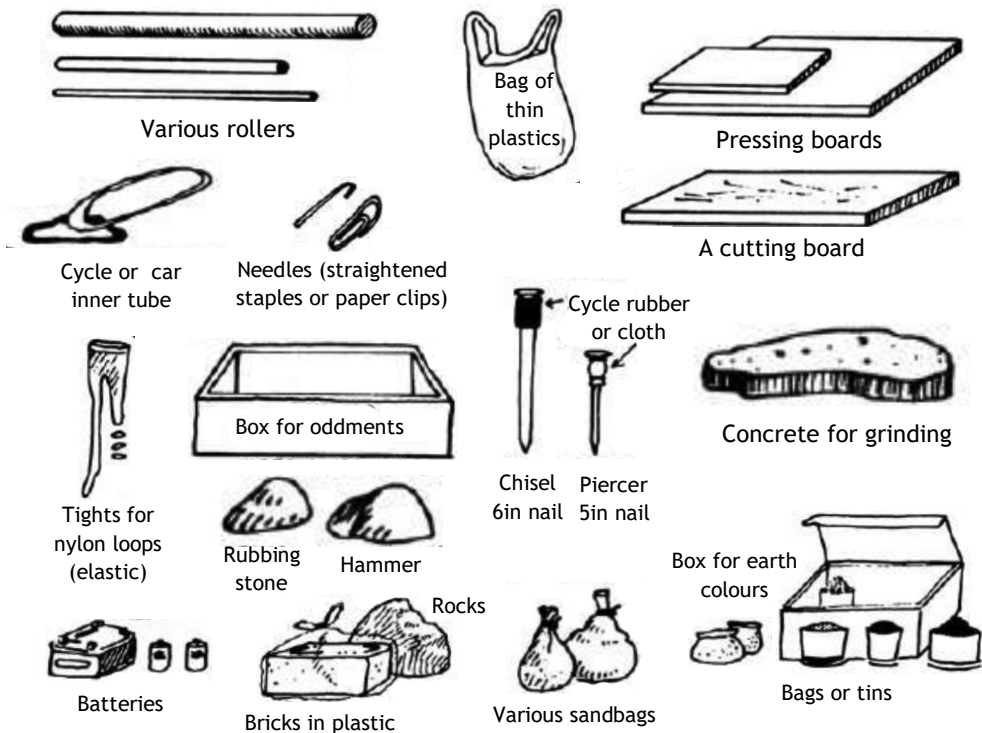
Magazines and brochures



All kinds of boxes and bits of card



Keep these accessories close by



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 unwanted 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 to make boards, on the other hand, cover it very thinly with paste, and again work quickly.

Recognising different kinds of paper and discovering and using their special characteristics is an important part of the process. The other indispensable material. Is flour paste, used in every APT construction process.

Essential techniques include:

- Knowing how to make and use different kinds of flour paste
- Making and using ‘mash’ - also known as papier-mâché
- 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 at the end of the construction process.

Standard approaches

These can be broadly classified according to the four main forms of paper they use: mash, paper strips and pieces, thin card, and corrugated card (cardboard).

Generally speaking, these main forms of paper are used to make different categories of articles.

1. Mash (aka papier-mâché) is paper ground to a pulp, mixed with paste and then moulded into shape: mainly used in products for nursery or pre-school.
2. Layered paper and card is used mainly for making various utensils for home or school, including small pieces of light-weight furniture and also articles for people with disabilities.
3. Thin card, and tubes of thin card, can be used to construct a full range of light-weight furniture with legs, referred to as the 'Classic style'; also other items such as cots and lampstands; and hinged and tubular apparatus for people with disabilities, such as walking frames and crutches.
4. Corrugated 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 larger items such as workbenches or wardrobes, and a great variety of equipment for people with disabilities.

The Utility style uses three approaches

1. Slotting boards together and strengthening the joints.
2. Making a structure of two side-boards, joined by a system of tubes that fit into a pattern of holes in the side-boards so that, where desired, they can support other boards. This approach is used to make standard chairs, tables and shelves, as well as special chairs for people with disabilities, plus a wide range of equipment to make it easier for them to lie down, stand, walk or rock (e.g. horses).
3. 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 cardboard, 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. These are usually attached to a chassis. They can also be used to make steering systems for items for people with disabilities.

Wheeled items include toy cars and carts for pre-schoolers, and much sturdier items for adults with disabilities, including pushchairs with insertable wheel systems, floor rafts, push-along tricycles, low-level wheelchairs, and self-propelling trolleys. All of these items are for clinical or home (indoor) use rather than for rough use outside.

Making a child's chair

This chair is a Utility model, using Approach 2: two vertical boards joined by a series of rails which support a seat board. It is not difficult to make, but it does involve a number of different operations. This chair is the prototype of all Approach 2 Utility models, so what you learn as you make it will stand you in good stead for future APT constructions.



There are some things ***you need to know*** before you tackle each stage of construction: be sure to read them first!

Preparatory stage

Making the templates and the components.

Start by getting a clear idea of the job. Study the illustration on page 16. Think carefully before deciding on the exact size and shape of the chair you want to make, then cut card templates for the three boards: two sides and one seat.

On the side-board templates mark where the holes for the tubes (rails) will be, allowing for the top of the seat board to project slightly above the side-boards.

You need to know:

The direction of the grain/corrugation — see page 8.

How to make paste from plain flour. 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 (16 fl.oz) of boiling water, stirring vigorously and continuing to stir for several minutes to make sure it is smooth throughout.

How to prepare your work area. Spread a square of plastic on your table and place either on the table or nearby the following: a container of paste and one of water; a sharp knife; a plastic bag containing pre-pasted strong paper (e.g. potato bags); newspaper; cutting and pressing boards; a rough stone; weights.

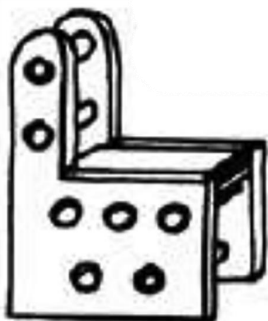
How to laminate corrugated card to make boards.

Calculate from the thickness of the card that you have how many layers you will need to make a board about 150mm (6 in.) thick. Use a template to cut each piece of card to the right size, making sure that the grain direction alternates with each piece. Place one card on your plastic-covered table. Paste it generously all over. Place the next card on it, with grain reversed. Paste that one. Continue until the board is over 150mm thick, with your template as the top layer. Cover the whole stack with newspaper. Compress it first by treading all over it, then place one of your pressing boards on top, add weights, and leave to dry.

How to roll tubes of thin card for the chair. Prepare rectangles of card which are about 40mm (1½ in.) longer, along the grain, than the width of the seat board. Find a suitable roller (such as a broomstick). Lay the card on the table, 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 some pasted paper and pull it off the roller without delay.

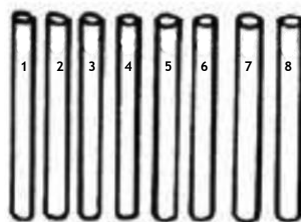
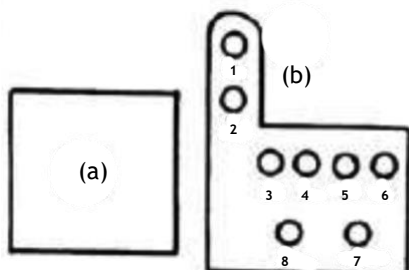
Get to work:

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



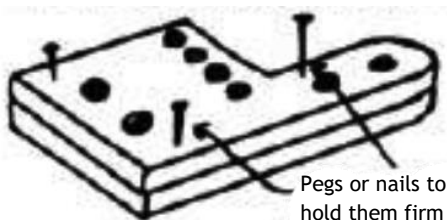
The child's chair

Study these diagrams carefully and in detail before you start.

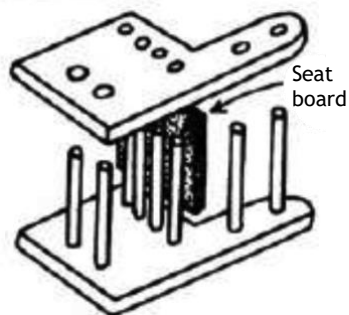


(c) Numbered tubes

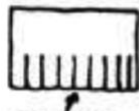
Pierce and, if possible, cut holes in both boards at once



ASSEMBLING



JOINING RAILS TO SIDE-BOARDS (chairs, beds, etc.)



Collar with flaps cut



Collar wrapped onto tube, flaps pressed and strapped to side-board



Cut ends short; smooth them off; bind from inside tube to side-board

Two ways of tidying rail ends

OR



Leave ends long, open flaps, and strap to side

Stage 1: Building the chair

Start by adding these items 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);
- 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 re-laid. 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-type tool to cut them. Enlarge or tidy them with the piece of piping. Match each hole to its tube and number them both.

Get to work:

- Tidy all board edges and make the two side-boards 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 side-board on the table and fit the tubes into their holes. Hold the other side-board in position over the tubes and guide, press, and screw each tube into its hole. Place the seat board in position, then press the side-board hard down against the seat board.
- Stand the chair upright and manipulate the tubes so their ends project evenly about 5mm ($\frac{1}{4}$ in.) through one side-board. Leave the other ends for trimming later. Square up everything, checking particularly that the distance between the side-boards is everywhere the same and that the chair will stand upright. Then disassemble the chair.
- Paste all joining pieces, tube ends, and holes, and reassemble the chair. Pierce holes through the seat board and use string to tie it firmly down to at least one tube. Trim the remaining tube ends to project 3 to 5mm (not more than $\frac{1}{4}$ in.). Smooth off all the tube ends with a suitably shaped stone, cutting into them if necessary, so that they lie flat like rivets.

Stand the chair up, and after squaring up, leave the chair to dry with a weighted board across the seat.

Stage 2: Strengthening and tidying

First add some magazine paper to your working kit.

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 tubes to the side-boards (see illustration on page 16). Press and strap their end-flaps to the side-boards.
- Paste and roll some tubes of magazine paper and press them, like putty, along the angles where the structural tubes support the seat board. Half-collars may also be used for the seat supports.
- Find one or two pieces of thin card and laminate (layer) them over the seat board, so that their edges wrap over and a little way down the side-boards, and if possible down and onto the front tube. Tube ends may be left open or closed.

- Layer tidily over the whole chair, and add extra strong layering over the bottom of each side-board. Check again for straightness, then leave to dry.

Stage 3: Decorating

This is up to you! Earth painting is recommended. Once the chair is dry the seat, in particular, should be rubbed smooth.

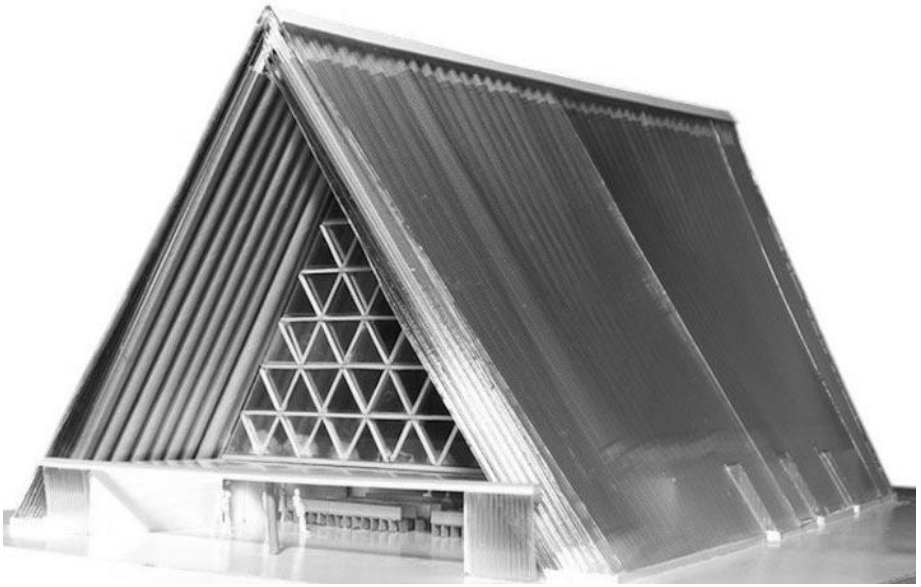
Stage 4: Finishing

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 hands, using plastic bags as gloves.

Note: Avoid standing APT articles on damp surfaces, and above all **never leave them out in the rain!**

The Cardboard Cathedral

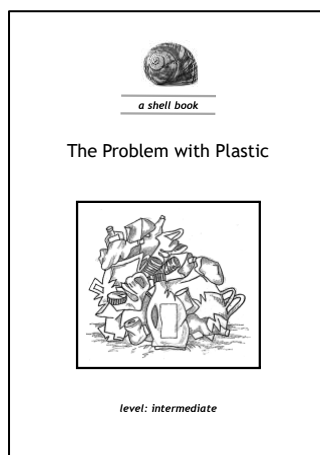
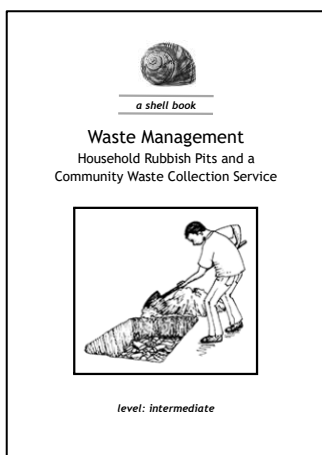
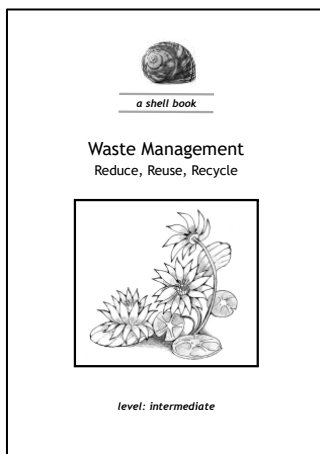
Zimbabwe is not the only country to have developed APT. Japan, too, has a long history of making useful everyday objects from paper. So it was no surprise to find a Japanese architect, Shigeru Ban, being invited to design a temporary replacement made of cardboard after the historic stone cathedral in Christchurch, N.Z. was destroyed by an earthquake in February 2011.



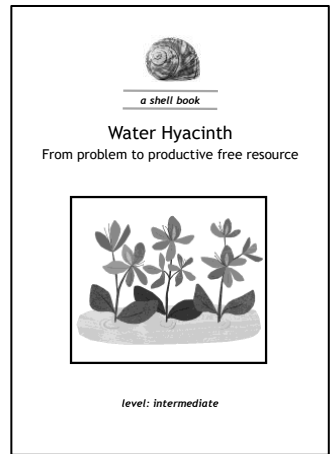
A-frame in style, rising 24m (79 ft), the new cathedral incorporates 86 cardboard tubes, each weighing 500 kg (1,100 lb), standing on walls made of 6m (20 ft) long shipping containers. The old cathedral was famous for its rose window, but the new A-frame design called for something different: a large triangular window made up of many smaller triangles of stained glass. The new building has been designed to last 50 years, so it was not in fact possible to build it entirely of cardboard. However, the symbolic key handed to the bishop at the formal opening of the building, just 2 years after the earthquake, was indeed made of cardboard!

Other Shell Books which may be of interest

People are increasingly looking at creative ways to use waste products and we have published several books on both the problem and the possibilities of reducing, reusing and recycling waste.



A Shell Book which looks at how we can make use of a completely different free resource is the one on Water Hyacinth. Because this plant has adapted so well to habitats far from its original source, it is choking lakes and rivers in a great many locations.



However, just like the paper and card used to make furniture in APT, water hyacinth too can be used to construct a wide range of surprisingly sturdy handcrafted items for everyday use, as illustrated by these examples from the book.

You can download these titles and many others free of charge at <https://www.ma.shellbooks.org/>

Summary

This book introduces Appropriate Paper-Based Technology, designed to make things out of waste paper and card that cost next to nothing to make and yet will be useful to the intended owner – this even includes a child's chair!

