



A WHEEL- MANUFACTURING TECHNOLOGY FOR RURAL WORKSHOPS

Africa's need for low-cost transportation is often inhibited by the lack of good quality, inexpensive wheels. But appropriate wheel-manufacturing technology is now available, as Ron Dennis explains, and it can help rural households by making it easier for them to move their goods.

The everyday movement of goods is a major burden to households in the rural areas of developing countries. Water and firewood have to be collected, crops brought in from the fields, with possibly follow-up trips to the local mill or market, and other farming inputs such as seed, manure and fertilizer have to be collected and transported to the fields.

The majority of these trips take place in and around the village where the road network generally comprises earth paths and tracks. The lack of an adequate road infrastructure and the low level of household income mean that few households have access to motorized transport. This is a situation which seems likely to persist in many areas for the foreseeable future.

Present means of transport, often by head or back carrying, are generally time-consuming, arduous and have a limited capacity for the movement of goods. It is not unusual for households to spend up to six to eight hours a day in transport activities. The time involved in and the difficulties of movement of goods are often seen as factors which restrict the output of small farmers.

Improving means of transport is therefore an important area of development for rural communities. Benefits include an increase in the efficiency and productivity of small-scale farming and a reduction in the transport burden for rural households, particularly for women, who are always the main load carriers.

Low-cost vehicles

Simple vehicles offer a significant improvement in the efficiency of moving goods as compared with carrying methods like head-loading and back-carrying. On the majority of terrains the most efficient method of moving loads is on wheeled vehicles such as wheelbarrows and handcarts, bicycles and bicycle trailers and animal-drawn carts.

Versions of these vehicles are found in many developing countries, but there is a great need and potential to help local workshops improve the quality of these vehicles and to make them more readily available to a wider section of the rural community by increasing their supply at lower costs.

Wheel manufacture

A major constraint on the production of affordable, non-motorized vehicles such as handcarts and animal-drawn carts in rural workshops is the lack of good quality, low-cost wheel and axle assemblies - this is particularly the case in African countries. Most rural workshops do not have

the equipment needed to produce good quality wheels and bearings, while setting up centralized production of conventional wheels involves a level of technology and capital investment which is not viable in many developing countries. Imported versions, even those which are taken from scrap vehicles, are generally in short supply and very costly. Because of these problems it is not unusual for the cost of the wheel/axle system to comprise 50 to 70 per cent of the total vehicle cost.

IT Transport is an associate of the Intermediate Technology Development Group, managing the transport programme on its behalf. IT Transport's experience, gained from transport studies in the rural areas of over 30 developing countries, has clearly indicated the need to develop localized manufacture of wheels and this has been one of the main aims of the transport programme.

The wheel development programme initially looked at methods of constructing alternative wheel designs, to assess which would be most suited to the skills, tools and materials generally available in small rural workshops. The two main conclusions drawn were: the skills and materials required to produce wooden wheels of consistent quality were available in some Asian countries but in few African countries. Also these wheels are rather limited in their range of application and in their compatibility with different types of tyres. Steel wheels made from commonly available steel sections such as flat and round bars, and tube and angle sections could be produced quite readily in most rural workshops, provided that the means of producing good quality rims was made available.

Also these wheels could be produced in a range of sizes to suit various types of tyres.

It was decided, therefore, to concentrate on the development of these forms of wheels and on the methods of producing them. Two basic designs have been developed:

- A split-rim wheel which can accept most car or truck tyres. This wheel is mainly for use on animal-drawn carts, but could also be used on tractor-drawn trailers.
- Rigid-spoked wheels which can accept bicycle or moped tyres, rubber tyres and steel tyres. These wheels can be used on a range of vehicles including wheelbarrows, handcarts, bicycle trailers, rickshaws, and animal-drawn carts.

The manufacture of these wheels is based on a simple, hand-operated rim-bending device which is able to bend a variety of steel sections into good quality wheel rims to suit a range of different tyre types. The device is simple to construct and can readily be made in workshops equipped with welding equipment. Operation of the device is quite straightforward and experience in a number of developing countries has shown that it can be successfully introduced and used in rural workshops to produce a range of good quality wheels. The versatility of the rim-bender is demonstrated by the details given in Table 1 which lists the maximum sizes of different steel sections which can be bent in the device.

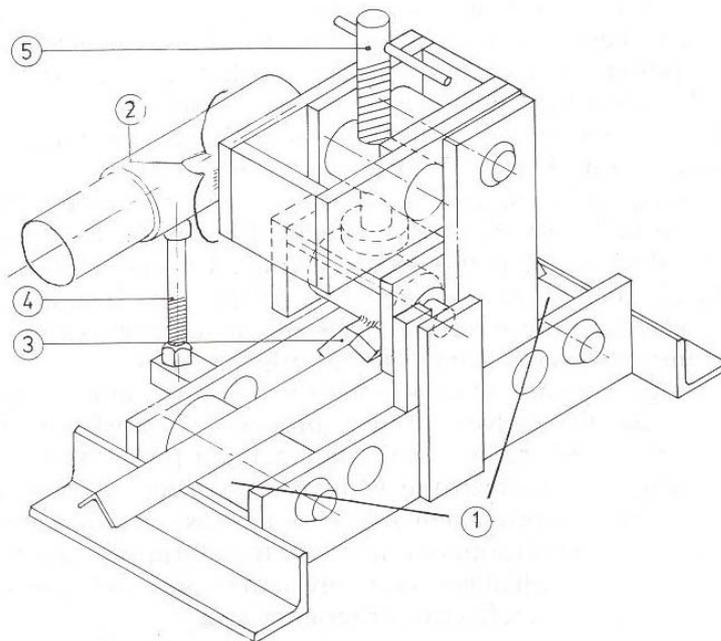


Figure 1: The wheel-rim bending device.

1. Two lower fixed rollers; 2. Lever arm; 3. Forming tool;
4. Preset stop; 5. Adjusting screw.

Table 1: Capacity of wheel-rim bending device

Type of section	Maximum size that can readily be formed	Minimum diameter that can be formed
1. Roller in outer position (290mm centres)		
flat angle round tube	100 x 12mm	450-500mm
	40 x 40 x 6mm	400-450mm
	25mm diameter	Approx. 400mm
	¾-inch water-pipe	Approx. 400mm
2. Rollers in inner position (150mm centres)		
flat angle round tube	100 x 6mm	Approx. 300mm
	25 x 25 x 5mm	Approx. 300mm
	16mm diameter	Approx. 300mm
	½ -inch water-pipe	Approx. 300mm

The wheel manufacturing equipment also includes assembly jigs which ensure that the wheels are set up accurately for welding and that a consistent quality of manufacture is maintained.

Wheel-rim bending device

The device is illustrated in Figure 1. It comprises a main frame in which are mounted two lower fixed rollers (1), and a lever arm (2) which supports a central upper roller or forming tool (3). The section to be formed rests on the two fixed rollers and is bent by the forming tool which is forced downwards by the lever arm. Prior to bending, the section is marked out into equal increments of 25-50mm, and during bending the section is fed over the lower rollers in these increments. At each increment the lever arm is depressed to a preset stop (4) to produce a short length of the desired curvature in the rim.

This method of incremental bending produces a formed circle in which the variation in radius is of the order of 2mm. The amount of bending, and hence the diameter of rim produced, is set by the adjusting screw (5). The section only needs to be passed through the device once to obtain the fully formed rim so that it is possible to produce a rim in minutes.

Three forming tools are needed to cater for the range of sections listed in Table 1. Additional tools can easily be made if other sections such as channel are to be formed. Two positions are provided for the lower rollers. For the Outer position, less force is needed to bend the rim and this position is used for forming heavier sections and larger diameter rims.

The Inner position is used to bend smaller diameter rims.

The bending device has two major advantages over conventional rolling machines. Firstly, the simplicity of its construction: no rotating shafts, bearings or drive mechanisms are needed. Secondly, the small degree of sliding movement at the rollers during bending means that unhardened rollers can be used without risk of significant wear.

Assembly jigs

The most important function of the assembly jig is to ensure that the rim is aligned concentrically with the wheel hub and axle. If this is not achieved the wheel will run eccentrically and/or wobble from side to side, reducing the efficiency of the vehicle and increasing the wear of both tyre and bearings.

The design of assembly jigs may be quite complicated in order to cope with changes in wheel diameter and the various materials which may be used in different workshops. For instance an assembly jig for split-rim wheels needs to be adjustable to cater for rim diameters to suit tyre sizes from 13-inch to 16-inch. Also a great deal of care needs to be taken to ensure that the jig is constructed as accurately as possible, otherwise the quality of wheels made on the jig will suffer. However, the use of a well-made assembly jig greatly simplifies the construction of wheels and ensures a consistent quality of manufacture.

An assembly jig used for the construction of bicycle-type wheels is shown in Figure 2. In this case the brackets supporting the adjustable stops may be bolted to the frame at different positions to cater for wheel sizes from 20-inch to 28-inch.

Wheel designs

Figure 3 shows a basic range of wheels which can be manufactured using the bending device. The following features are noteworthy:

- The novel concept of fitting a standard bicycle tyre and tube into a rim made from 25x25x3mm angle section. This produces a low-cost wheel which is significantly more robust and durable than a standard bicycle wheel. Heavier duty wheels may be made by fitting moped tyres into rims made from larger size angle.
- In the split-rim wheel the two parts of the wheel are fitted either side of the tyre and then bolted together to hold the tyre in position. It is therefore very simple to assemble and disassemble the tyre by hand. A similar type of wheel can be produced to accept motor-cycle tyres.
- A variety of rims can be produced to suit different types of tyres, all from materials which are commonly available in developing countries, such as angle, flat, and round bar.

Since the wheels will generally operate over earth roads and tracks they will be subjected to quite severe impact loads from rocks, potholes, ruts, etc. and careful attention to design is necessary to ensure the wheels are adequately robust and durable. A wheel testing rig has therefore been developed by IT Transport so that wheel designs can be thoroughly tested and proven before they are introduced into service. In the rig the wheel is run on a rotating drum which is fitted with bumps to simulate the type of repeated vertical and side impacts that would be applied to the wheels in typical service applications. Of major interest in this area is the testing of the welded joints in the wheel, which have often been a source of fatigue failure in fabricated wheels.

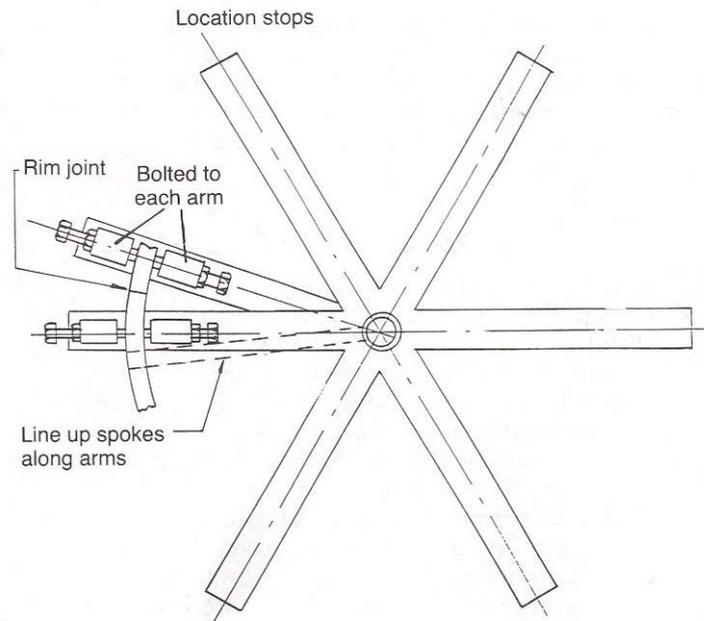
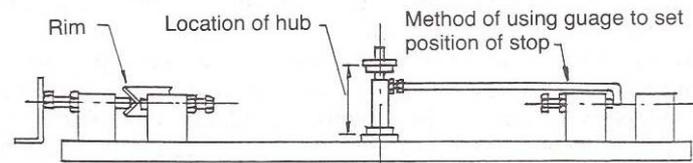


Figure 2: The assembly jig used for the construction of bicycle-type wheels.

Introduction of the technology

The wheel manufacturing technology is currently being used in workshops in a number of countries, including Ghana, India, Kenya, Tanzania and Zimbabwe. This experience is demonstrating that workshops readily adopt the technology and are able to use it to produce good quality wheels which cost less than alternative versions.

Although most of the equipment in use at present has been supplied by IT Transport, the primary aim is to develop a wheel manufacturing package which will enable workshops to construct and set-up their own production facilities. A project currently being carried out in Zimbabwe provides a good example of this approach. Courses are being run in the better equipped workshops at which technicians from other rural workshops are being trained to construct and operate the wheel-manufacturing equipment. At the end of a course the trainees take the equipment they have made back to their own workshops, thus achieving an efficient introduction of the technology into a broad spectrum of rural workshops. The first course, which was carried out recently, proved very successful and has resulted in the introduction of the technology into seven additional workshops. It is anticipated that the Zimbabwe project will form the model for similar courses in other countries.

In order to help in the promotion of the technology a technical manual is being prepared which will present full details of the construction and operation of the equipment, and will be used in training courses. The promotion and dissemination are being backed up by an extensive programme of R & D aimed at developing a comprehensive package on wheel and bearing manufacture which can be readily adapted to meet the wide range of needs and situations found in the rural areas of developing countries.

The wheel manufacturing technology has already been proved successful and viable - it is appropriate in that it is affordable, sustainable and enhances the technical capabilities and productivity of rural manufacturing enterprises. It clearly has the potential to play a major role in increasing the availability of simple vehicles to rural households.

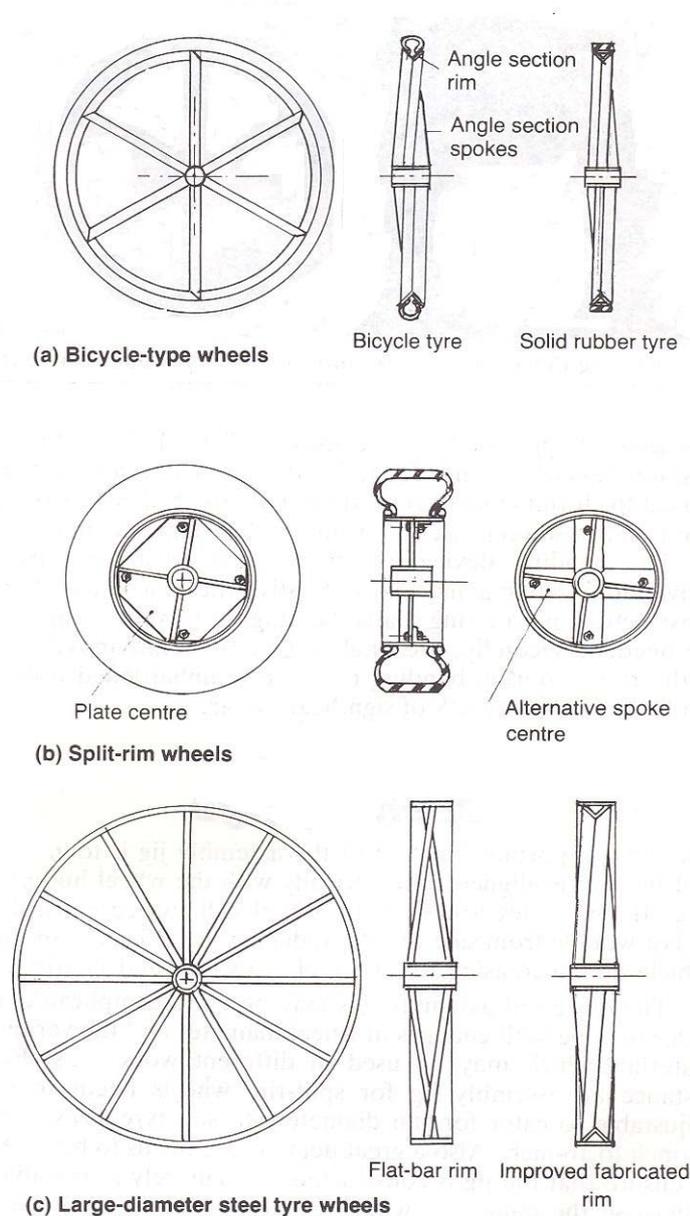


Figure 3: A selection of wheels that can be produced using the bending device.

Reference and further reading

- [Wheel Jig](#) Practical Action, Sudan, 2008.
- [Making Wheels: A Technical Manual on Wheel Manufacture](#) R. A. Dennis Practical Action Publishing, 1994.

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