

THE MALAWI HANDCART PROJECT: 2008

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The Malawi Handcart Project addresses problems associated with the lack of wheeled transport in Africa.

I first became aware of the problems posed by African's lack of wheeled transport as a Peace Corps volunteer in Malawi in 1967-68. The absence of wheeled transport necessitates the expenditure of excessive amounts of physical labor, typically as headloading, for any appreciable load carrying. It also severely curtails the amount of weight and volume that can be transported at any one time. This dearth of wheeled transport has had an enormous negative impact on African's quality of life, on their economic (especially their agricultural) productivity, and on their health. As African women traditionally perform most transport work, the lack of wheeled transport exacerbates prevailing gender inequality, not only adding to women's burden, but by taking up girl's time with carrying water and firewood, preventing them from attending school.

The lack of wheeled transport increases African's morbidity and mortality. In most subsistence farmsteads, food production is exclusively reliant on manual labor, and production is diminished by the need to expend time and caloric energy on transport, as opposed to agricultural tasks. This in turn contributes to the endemic malnutrition of Malawian children. The lack of wheeled transport means that most African households, rural and urban, obtain their domestic water (for drinking, cooking, and washing) from more or less distant sources, water carried on the heads of women and children in amounts of no more than five gallons at a time. This requires large energy and time expenditures, and frequently results in an inadequate supply of water for domestic hygiene, resulting in an excess of skin, eye and gastro-intestinal disease, especially in infants and children. Lack of wheeled transport is responsible for many deaths in medical, especially obstetric emergencies, where no ambulance service is available, and where the patient is too sick to sit on the back of a bicycle.

Malawi has one of the highest levels of HIV/AIDS in the world, resulting in a severe labor shortage, as those infected tend to be in the economically productive age group. Many AIDS victims are too sick to effectively tend their gardens, and their families are burdened with their care. This domestic labor shortage diminishes food production on subsistence farms, and the associated malnutrition exacerbates the impact of the AIDS virus as well as the opportunistic infections (TB, pneumonia) associated with it.

The availability of wheeled transport is fundamental to civilization as we know it, and to any meaningful form of economic development. And so, a complementary challenge has been to address the failure of the 'development community' to act to transfer an existing, appropriate, mature, and affordable technology, namely the lightweight handcart, to fill this African transport void. This challenge has been compounded by that posed by unresponsive government and NGO bureaucracies, who seem indifferent to addressing (as opposed to merely recognizing) the problem of providing on-farm transport to subsistence farmers, and specifically of utilizing human-powered lightweight handcarts. (See *New York Times* article of 09/14/02 on my website.)

The bicycle is by far the most common form of wheeled transport in Africa. Unfortunately bicycles have essentially no applications on (as opposed to off) the farmstead. Bicycles and their spares are major consumer goods in Africa. Many businesses sell and service bicycles, which are imported almost exclusively from India and China. Yet although a bewildering variety of lightweight handcarts (wheeled luggage, baby carriages, shopping carts, garden carts, golf carts, letter carrier carts, hand trucks) are commonplace in developed countries, where they are sold at a profit, benefiting both seller and buyer alike, neither the commercial nor the consumer sector in Malawi (as elsewhere in Africa) are aware of their existence, let alone of their economic potential. My challenge therefore includes educating the commercial sector of the market potential of lightweight handcarts, and the African consumer of the advantages handcarts can confer to their quality of life, as well as of their time- and labor-saving capabilities, which translate into enhanced economic productivity, enhanced domestic food supply and hence increased income derived from the sale of agricultural surplus.

The Malawi Handcart is trying to improve the quality of life and the economic productivity of Africans by providing them with affordable and appropriate wheeled transport.

In developed countries, no one carries heavy loads over any appreciable distance. We never see citizens of the first world carrying their belongings or goods on their heads, whereas such 'picturesque' scenes are the norm in Africa.

Most Malawians, with per capita incomes of ~\$180 per year, are simply too poor to afford any locally available form of wheeled vehicle. Thus virtually all domestic transport (of water, firewood, and grain to grinding mill), and agricultural transport (of farm inputs such as fertilizer, compost and manure, harvested crops and crop residues for fodder), is performed by arduous and inefficient headloading, mostly by women and children. I have identified an appropriate and affordable wheeled transport technology that can assist these poor African farmers, namely the lightweight handcart.

The transport technology the Malawi Handcart Project is introducing to Africa is the lightweight handcart.

The lightweight handcart is the transport technology I have been introducing to Malawi. These handcarts are based on two rugged but relatively lightweight, purpose-built (typically spoked) handcart wheels, both wheels sharing a common steel (typically $\frac{3}{4}$ " thick) axle. Their rims and spokes are considerably stronger than bicycle wheels of the same diameter (as the steel is thicker), and the wheels have a rated load capacity of ~300 pounds apiece. They are fitted with pneumatic tires wide enough (>2") to ensure adequate flotation on soft ground, and with replaceable ball bearings. Handcart wheel hubs are much wider than hubs on comparable diameter bicycle wheels, enabling them to withstand large axial loads, which bicycle wheels are not subject to. The typical wheels are 26" in diameter, enabling them to readily roll over uneven terrain. A shallow wood plank box body is centered over the axle, enabling the load to be balanced, so that the handcart operator does no lifting. Wooden handles are bolted to one end of the box body. In essence, this is a simplified version of the typical 'garden cart' widely used in the U.S.A. The current design of handcart we are testing is not assumed to be the optimal design. It is simply a matter of convenience for initial assessments. In the future, Malawian carpenters and cart builders will adapt their handcart designs to suit their customer's varied transport applications.

As I was unable to source handcart wheel-axle sets in Malawi during the early phase of my Malawi Handcart Project, I carried one set (26" wheels) to Malawi in 1992 and built it into a handcart, which elicited considerable interest among the subsistence farmers my assistant Chika Mughogho and I demonstrated it to. Their enthusiasm encouraged me to approach the Malawi government, and in 1998 the Minister of Agriculture invited me to demonstrate handcarts at Chitedze Agriculture Research Station. I carried two sets of wheels from the U.S.A., and I built two handcarts, which were tested by the agricultural engineering staff, and a favorable report (See my website for the full report.) was presented to the Minister. It stated that: "The results of these investigations need to be disseminated to the lay and professional communities, via the agricultural extension service, the press, and professional journals. It should be kept in mind that this technology is applicable across sub-Saharan Africa, and it is to everyone's advantage to disseminate this technology as rapidly as possible." Unfortunately, nothing was done to implement the report's recommendations, in large part because there were no lightweight handcart wheels available in Malawi.

Being unable to find a supplier of handcart wheel-axle sets in Africa was the incentive for me to develop an interim handcart design in 2000. The 'AfriCart' (as we later named it), was based on the use of readily available bicycle rear wheels (28" diameter x 1 $\frac{1}{2}$ " wide). The two wheels were aligned on a common axis by a sturdy bolted wooden chassis supporting a wooden box body. (See my website for AfriCart photos and construction plans.) Between 2000 and 2007 I sponsored the construction of some 200 AfriCarts (built at a cost of \$40 to \$60 each), which were mostly donated to a variety of government agencies, NGOs, and individuals, in the hope that they would demonstrate the utility of lightweight handcarts. Early on, in 2001, with a small grant from the World Bank's Gender and Rural Transport Initiative, the Malawi Rural Travel and Transport Programme purchased 16 AfriCarts for assessment, and their generally favorable report was issued in March 2003 (See my website for a copy of the report.) Meanwhile, in January 2003 I discovered that handcarts using the same 28" bicycle wheels (but with welded steel frames) were in widespread use in Tanzania, carrying loads (on smooth pavement) of up to 300 liters/kilograms of water, far in excess of my AfriCarts, whose wheels buckled under ~100 kilograms, especially when used on rough ground. The secret was in the thicker spokes used by the Tanzanians. My associate in northern Malawi, Hastings Mkandawire, was able to source the thicker 12 gauge spokes, and we retrofitted them to most of the existing, and to all future AfriCarts. However, the wheels proved to be the AfriCart's Achilles heel, and it was apparent that unless more care than was practical under village conditions was applied to their use, the bicycle wheels were simply too fragile for farmstead use.

In 2006 Ellaton Mkwate, my friend and associate in southern Malawi, located a Chinese importer (Sinolink Investment Ltd.) who could supply heavy-duty handcart wheels and axles (rated load capacity of ~1000 kilograms per wheel), and I placed an order for a dozen sets. We built these into handcarts and they worked well, but were too expensive for subsistence farmers. In February 2007, after many abortive enquiries, I finally obtained (courtesy of Gardner's Supply Company in Vermont) the name of their Taiwanese supplier of handcart wheels (Pacific Greenbird Enterprise Co. Ltd.). I ordered 48 wheel-axle sets (36 of 26" diameter and 12 sets of 20" diameter, all with a rated capacity 300 pounds per wheel). The wheels, axles and spares arrived in Malawi in August 2007 (c/o the United Nations Development Program's Millennium Villages Project, and so exempt from customs duties) and all were finally distributed and built up into handcarts by January 2008.

Lightweight handcarts introduced by the Malawi Handcart Project are being put to many uses.

The handcarts are being used to carry water from source to homestead, for collecting domestic firewood, for carrying maize to and from the grinding mill, for transporting harvested crops from garden to home as well as to market, for moving manure from corral to garden, for collecting municipal solid waste, and as ambulances, propelled both by hand as well as used as a bicycle trailer.

In mid-2006 Ellaton Mkwate had supervised the construction of some two-dozen AfriCarts in Mwandama Village in southern Malawi, the first of the United Nations Development Program's Millennium Research Villages in Malawi. He later had the same Mwandama carpenters build five of the heavy-duty handcarts with the heavy-duty Chinese handcart wheels. By early 2008 Ellaton had organized the construction and distribution of 48 handcarts using the imported Taiwanese wheels. Twenty went to Mwandama Millennium Research Village, 12 went to Gumulira Millennium Research Village, and 12 went to Plan-Malawi's Mnkumbwe Model Village. The carts were distributed under an agreement between the Malawi Handcart Project, which supplied the carts, the Malawi Rural Travel and Transport Programme (of the Ministry of Local Government) which is coordinating the assessment and preparing the report, the United Nations Development Program's Millennium Villages Project, and Plan Malawi (of Plan International), who each selected the families the handcarts were given to in their respective villages, and who are each collecting data on the uses the handcarts are put to, as well as any problems associated with their use.

The handcarts were distributed to individual families selected by the Millennium Villages Project and Plan-Malawi, save that the ambulance versions of the handcarts are communally owned and under the control of the Village Headmen. The handcarts were loaned to the families for an initial three-month trial, and, in the event that they are not abused, the family gets to keep the cart, in return for cooperating in the ongoing data collection and assessment process.

The primary "use" of the handcarts is to enable the participating agencies to collect data on their utility in assisting the farm families with their transport activities.

The Malawi Handcart Project was conceived by, and is funded by, Arnold P. Wendroff, PhD.

I am responsible for the introduction of the concept that lightweight affordable handcarts have a major role to play in Malawi's (and Africa's) economic development. I introduced lightweight handcarts to Malawi in 1992 and more formally in 1998. In 2000, when the wheel-axle sets proved unobtainable, I developed and disseminated the AfriCart handcart design (employing bicycle wheels in a wooden chassis) to allow for continuing assessment of lightweight handcarts even in the absence of purpose-built handcart wheel-axle sets.

I sourced and imported two varieties of lightweight handcart wheel axle sets, from China (2006) and Taiwan (2007) respectively. I am responsible for having sourced improved wheels (with detachable spokes and precision ball bearings) from Pacific Greenbird's factory in China. These wheels can be shipped knocked-down for assembly in Malawi, thus greatly reducing their bulk, and halving their shipping costs, in addition to yielding a more durable and more readily repaired wheel.

I was responsible for initiating the past and current handcart assessment programs, having approached the Ministry of Agriculture in 1998, the Malawi Rural Travel and Transport Programme in 2000, the Millennium Villages Project in 2006, and Plan Malawi in 2007.

I funded the construction of most of the handcarts that have been and are currently being assessed, save for the aforementioned 16 tested by the Malawi Rural Travel and Transport Programme in 2003.

I established an Internet Web site, www.malawihandcartproject.org to promote lightweight handcart technology by means of photos of a variety of handcarts and their uses, papers on handcart applications, and plans, photos, and instructions on handcart construction.

I authored several papers advocating for the utilization of handcarts in Africa, and have participated in international conferences on rural transport held in Uganda and Tanzania, as well as sponsoring an assessment of handcarts by the Intermediate Technology Development Group in Kenya.

I funded our participation in the first and second National Agricultural Fairs in Malawi, sponsored by the Malawi Chambers of Commerce and Industry. In 2003 the AfriCart handcart won third place in the "Farm Mechanization Category," and in 2004 the AfriCart was granted the Gold Award (first place) in the "Farm Mechanization Category."

The Malawi Handcart Project is benefiting current handcart users, as well setting the stage for widespread and large-scale lightweight handcart use in Malawi and elsewhere in Africa.

Currently some 200 of the handcarts that I have donated are operating in Malawi, and their users are directly benefiting from their use. However as mentioned earlier, the ultimate objective is not to provide transport for a few handcart users, but rather to convince the governmental and non-governmental development agencies of the enormous potential that lightweight handcarts have for the population as a whole, and the commercial sector that they can benefit from importing and distributing handcart wheel-axle sets and spares. In the long term, everyone in Malawi (and elsewhere in sub-Saharan Africa) will benefit from the widespread availability of this appropriate and affordable wheeled transport technology.

Several systems are in place to deliver lightweight handcart technology to current and potential users.

The current formal assessments (conducted by the Millennium Villages Project, Plan Malawi, and Malawi Rural Travel and Transport Programme) are designed to convince these and allied agencies of the utility of handcarts, and of the need to incorporate them into existing and future development programs. The larger objective is to demonstrate to the public (subsistence and smallholder farmers as well as poor urban dwellers) that purchasing a handcart will be a valuable investment, not only as a labor-saver, but also as a money-maker.

In order for these objectives to be achieved, handcart wheel-axle sets and their spares must have widespread commercial availability at a reasonable cost. As mentioned earlier, I have been working to accomplish this by sourcing these components from Taiwanese and Chinese suppliers, and setting specifications for the best quality components that can be shipped for the lowest cost. I have been working with the only current importer of these Chinese components in Malawi, and, in light of Malawi's recent establishment of diplomatic relations with China, I have been negotiating with the Malawi Embassy in Washington, DC, and the Malawi Mission to the United Nations in New York, so that they assist me in sourcing these Chinese wheels, and urge the Chinese to foster their availability in Malawi, and possibly to establish a handcart wheel assembly plant in Malawi to reduce their shipping costs.

This effort at lightweight handcart technology transfer has enormous potential to assist Africans.

This attempt at introducing handcart technology to sub-Saharan Africa is worthy of recognition, because of its enormous potential for enhancing the quality of life of its users, primarily women and children, who currently have no alternative to laborious headloading for their basic transport needs. In addition, making this technology widely available will enormously enhance economic productivity, and, just as the bicycle did in the past, handcarts will literally revolutionize life in Malawi.

The lightweight handcart is transport mature technology, but one essentially unknown in Africa.

Lightweight handcarts are not a "new technology," but rather a "new use" (for Africa that is) of a mature technology that has simply been ignored and/or overlooked by the development community. (I have attempted to explain this failure of the development community in some of the papers to be found on my website.) Lightweight handcarts, with strong purpose-built handcart wheels (as opposed to strong but heavy automotive wheels, or weak but lightweight bicycle wheels) are essentially unknown to Africa in general and to Malawi in particular. The use of these handcart components allows a lightweight but strong handcart to be constructed at a cost affordable to at least as many people as the bicycle, currently the most common wheeled vehicle in Africa, and essential to the operation of most African economies.

The lightweight handcart is different from, and superior to, other existing handcart designs found in Africa.

Although the lightweight handcart (as defined above) is a mature technology in the U.S.A., Europe and China, it is essentially unknown in sub-Saharan Africa. Handcarts in use in Africa fall into four major categories, all being inferior to the lightweight handcart that I am attempting to introduce.

The wheelbarrow, with only one wheel, is possibly the most widespread and common form of handcart, but it is so ergonomically inefficient, that even its relatively low cost and widespread commercial availability have failed to result in its significant use on farmsteads. The wheelbarrow requires the operator to lift half the combined weight of the vehicle and its load, as well as laterally balancing that combined load and propelling it. The small diameter solid wheel, with

primitive bearings, is difficult to push over rough ground. The volumetric capacity is unsuited for bulky loads encountered on the farmstead.

The most common handcart design that I am familiar with is in essence an ox-cart, substituting humans for draught animals. These 'hand' carts employ recycled automotive axles and wheels just as most ox- and donkey-carts do, and they are therefore heavy and cumbersome, although they have a high load capacity (both weight and volume). Exclusively used by men, they generally require two men to propel them. As with the ox-cart and donkey-cart, their load capacity is far in excess of the needs of the average subsistence farm family. In any event, their high cost precludes any possibility of large-scale uptake.

A third type of handcart in widespread but limited use, is one cobbled together from a variety of industrial-type casters and wheels, typically of relatively small diameter (at most 12"). They tend to be confined to trading centers, as due to their small-diameter, narrow, low flotation wheels, which sink into soft ground, they can only be used on hard-packed earth or paved roads. They are generally very heavy, requiring two men to propel them

The handcart design is based on two bicycle or motorcycle wheels, aligned on a common axis (but each on its own short axle), by a welded steel framework. Compared to the previously described types of handcart, these are relatively lightweight, and when fitted with motorcycle wheels, are very rugged and have a high load capacity. However, these spoked-wheel handcarts have major disadvantages, as those using readily available and affordable bicycle wheels are too fragile for use in off-road applications, and those using motorcycle wheels are far too expensive, even with used wheels, which in any case are too scarce to enable large numbers of these carts to be built. Both of these spoked-wheel handcarts use welded steel (angle or tubing) frames, and so are much heavier than a handcart based on two wheels sharing a common axle, as well as being relatively expensive to construct and to repair. My AfriCart handcart design is in essence a variation of this type, save that bolted wood has been substituted for welded steel. This enables the AfriCart to be built and maintained by rural carpenters, using common hand tools and locally sawn lumber. The cost of a wooden AfriCart is generally far less than a comparable steel handcart, although it too is far heavier than the lightweight handcart due to its heavy wooden chassis, and its fragile bicycle wheels preclude its being a viable candidate for off-road use by farm families.

The fifth handcart variety, the lightweight handcart, is what I am attempting to introduce to Malawi. It differs from the others in it purpose built strong but lightweight wheels, which are mounted on a common axle. The strong steel (3/4" diameter) axle also forms the structural backbone of the cart, supporting the wood plank or bamboo flooring laid on top of it, enabling a strong, lightweight and affordable handcart to be built.

The lightweight handcart technology introduced by the Malawi Handcart Project is far superior to any existing handcart technology currently available in Africa.

Unlike other handcart types, the lightweight handcart possesses combines the following desirable characteristics, while lacking the undesirable ones:

- Lightweight handcarts are affordable in comparison to any other wheeled vehicle with similar capacity.
- Lightweight handcarts have the volumetric and weight capacity suited to the vast majority of typical subsistence and smallholder farm family loads.
- Lightweight handcarts are ergonomically efficient: low net weight, load balanced over axle requires no lifting and no lateral balancing by operator, large-diameter wheels which readily roll over irregular terrain, wide tires provide good flotation on soft soil, low-friction readily replaceable ball bearings and low-hysteresis pneumatic tires to minimize operator's propulsive effort.
- Lightweight handcarts are easily constructed, as the strong steel axle forms the structural backbone for the wood or bamboo load-carrying box body or platform. Only ordinary carpentry tools are needed, and no expensive and scarce (especially in rural areas) steel or steel-working equipment (welding apparatus, welding gases and/or electricity) are needed to build these handcarts.
- Lightweight handcarts are easily repaired and maintained by local artisans using locally available tools and materials, assuming that, as is the case with bicycles, the requisite spare parts are available. Carpenters can repair the body, and bicycle mechanics the wheels. No steel-working equipment is needed.

The Malawi Handcart Project is making a positive contribution to transportation technology transfer.

Having initiated this project in 1989, and having traveled to Malawi an additional eight times since then, I have personally observed the positive impact that my handcarts have made to the individuals using them. More importantly, the handcarts have made an impression on several government and non-governmental agencies in Malawi, agencies which have the ability to assess and to disseminate lightweight handcart technology.

In 1998 Malawi's Minister of Agriculture invited me to the Farm Engineering Unit of Chitedze Agricultural Research Station, to demonstrate the load-carrying abilities of conventional handcarts, whose wheel-axle sets I carried with me from the U.S.A. This very positive [Report of Dr. Arnold Wendroff's Visit and the Hand Carts](#) stated that "It was also amazing to see children pushing loads which was 2.5 times their body weight very easily. They pushed loads of 50kgs but they also the 12 year old could push 100kgs very easily." (See website for report.)

Since purpose built handcart wheels were unavailable in Malawi, I developed the AfriCart design in 2000, using two bicycle wheels aligned on a common axis (rather than sharing a common axle) by a rigid bolted wooden framework. I brought my design to the attention of the Malawi Rural Travel and Transport Programme, and with funding from the World Bank they purchased and field-tested 16 AfriCarts in four different Districts within Malawi. Their March 2003 report stated that "The ... project is that it managed to bring awareness to the people in the areas to be innovative in rural travel and transport to facilitate their mobility for example by adapting a wooden frame Malawi Handcart for carrying goods. ... The introduction of the Malawi Handcart has also relieved the burden of head and shoulder loading and it has been taken as an alternative to the bicycle for heavy carriage for both business and domestic use." (See website for report.)

The fact that the Millennium Villages Project, Plan Malawi, and the Malawi Rural Travel and Transport Programme are currently working to assess the lightweight handcart is another testimony to contribution of the Malawi Handcart Project.

A major objective of the Malawi Handcart Project is to generate data demonstrating the utility of lightweight handcarts.

The Malawi Handcart Project currently employs two Malawians on a part-time basis, Executive Associate, Ellaton Mkwate in Blantyre, and Field Assistant, Elasto Chanza, in Zomba. We are in frequent contact telephone and email. They keep me informed of the status of the handcarts at the three test sites. In addition I periodically telephone and email staff of the Millennium Villages Project, Plan Malawi, and the Malawi Rural Travel and Transport Programme. These stakeholders, with additional input from the Malawi Transportation Technology Transfer Centre, the Agricultural Engineering Department of Bunda College of Agriculture, and the Farm Machinery Unit of Chitedze Agricultural Research Station, jointly developed a formal assessment protocol for the field trials currently underway. They are collecting data on handcart use in the three test villages. In addition, Elasto Chanza is collecting similar data at Mwandama Millennium Research Village, and periodically emails me his findings. The official data collection forms are sent to the Malawi Rural Travel and Transport Programme for analysis and report preparation.

Any negative consequences of handcart uptake are more than balanced by the benefits they confer.

There are few serious potential negative consequences, and certainly none that would outweigh the potential benefits that widespread availability of handcarts would confer. The most frequently raised negative impact of widespread handcart use is that the lumber used in building the handcarts results in deforestation. It is true that if you build with wood, you must cut down trees. However, handcarts are a valuable adjunct to reforestation projects, where they enhance labor productivity in tree nurseries, as well as in transporting seedlings and digging tools to planting sites.

A potentially serious unintended negative consequence of handcart technology transfer, is a recently identified "link between a technological development intervention and an increase in both birthrate and childhood malnutrition." An African case study found that "women's nutritional status was not improved by the energy-saving technology, [piped water], because [caloric] energy was diverted into higher birthrates." (Gibson & Mace, "An Energy-Saving Development Initiative Increases Birth Rate and Childhood Malnutrition in Rural Ethiopia." *PLOS-Medicine* March 2003) Availability of handcarts to women currently headloading domestic water over considerable distances might have similar negative nutritional outcomes, unless access to contraception were included in the overall technology transfer program. Availability of handcarts should enhance agricultural productivity, and hence enhance nutritional availability, which was not the case in the Ethiopian study.

There are potential problems associated with the introduction of wheeled vehicles for use by women. In Malawi as elsewhere in Africa, bicycles, ox-carts, and wheelbarrows are largely owned and traditionally operated by men. However women and children perform the bulk of local transport by headloading. My intention is for handcarts to ease women's transport burden, although men may try to assume control of these carts and limit women's access to them. We have made efforts to prevent this from occurring when carts are distributed for assessment, and the results have been encouraging.

In June 2005, the United Nations Children's Fund Representative for Malawi wrote to me, after I had suggested to her that handcarts would be of great assistance to children, suggesting that: "Promoting the use of handcarts to "alleviate" the work of children may send the wrong message to the public or simply confuse the issue. The Convention on the Rights of the Child (Article 32), to which Malawi subscribes clearly states that *all children under the age of 18 must be protected from work that is harmful to their health, work that keeps them from going to school or from rest and recreation, or work that takes advantage of them.*" I believe that UNICEF's reservations are unfounded, and that the benefits to children of being able to perform their necessary domestic chores by carrying their loads (water, firewood, manure) on wheels, as opposed to headloading, far outweighs any alleged "wrong message." (See this letter and my response on my website.)

The Lightweight Handcart has the potential for widespread uptake elsewhere in the developing world.

Handcarts can be used in any part of Africa where topography and soil type (the former not too hilly and the latter not too soft) permit. Handcarts are a mature technology, that in innumerable variations, from wheeled luggage to shopping carts, have proven their value worldwide. The very fact that there are so many varieties of handcart scattered around the African continent demonstrates the dissemination possibilities for an affordable and lightweight handcart.

The market potential for affordable, lightweight, ergonomically efficient handcarts is at least as great as that for bicycles, once the public becomes aware of the advantages handcarts can confer. The principal obstacle to the rapid and widespread and large-scale uptake of lightweight handcarts is the current commercial unavailability of the wheel-axle sets essential for their construction. The development community can readily and rapidly eliminate this obstacle by incorporating handcarts into the transport component of their sponsored programs; by ordering the handcarts, or rather the wheel-axle sets, from local distributors, so establishing a demand and giving the local commercial sector an incentive to import and stock these components; and by employing Malawian artisans to assemble the wheels and build the handcarts, creating much needed employment, as well as ensuring that the necessary skills and tools are available for maintaining and repairing the handcarts.

It is hoped that lightweight handcart technology will be spread to other countries in Africa by the three major players currently assessing them in Malawi: the United Nations Development Program's Millennium Development Program, Plan International's Plan Malawi, and the World Bank-sponsored Malawi Rural Travel and Transport Programme. Each of these agencies has operations in other African countries, and assuming that the handcarts prove valuable in Malawi, it seems reasonable to assume that these agencies will act to apply handcart technology to their operations elsewhere in Africa. In collaboration with other stakeholders, I intend to write papers on the results of the current and future handcart assessments for publication in the relevant development journals.

In March 2008, while traveling in South America, I met a Peace Corps volunteer (Zachary Coventry) teaching at a rural technical school in Mindo, Ecuador, and also running the school chicken and fish farms. He needed a vehicle for delivering dressed chickens to local clientele, as well as for moving materials around the school farms. I suggested that a handcart would be ideal for this application, but as no wheel-axle sets appeared to be available in Ecuador, with the blessings of the Peace Corps office in Quito, I have sent him two set of 26" wheels and an axle for trials there, and with an eye to disseminating handcart technology to the larger community..

Future Plans of the Malawi Handcart Project.

We hope to work with some large NGO, (such as Plan-Malawi), and order a large number of wheel-axle sets and spares from China or India, via an importer in Malawi who would agree to stock them and their spares in several major cities. We would arrange with a local woodworking factory to explore the economics of manufacturing handcart kits of precut and predrilled lumber bundled with the requisite hardware, wheel-axle set, and illustrated assembly instructions, so that consumers could purchase them for assembly by their local carpenter. Few Malawians possess a hammer, screwdriver or wrench, let alone a drill, and so have little experience applicable to the assembly of a dynamically-

loaded structure such as a handcart. Their local carpenter can assemble such a prefabricated kit in an hour or two, for a nominal fee.

The economies of scale (volume purchase of seasoned lumber and fasteners, as well as the enormous saving of labor by the use of machinery to saw, plane, and drill the planks, should make it cheaper to build a better cart from a prefabricated kit than to have one built locally from hand-cut and hand-planed inadequately seasoned lumber. By ordering wood to be custom sawn at the mill, $\frac{3}{4}$ " planks can be economically obtained, as opposed to the normal 1" planks which are excessively heavy as well as being more expensive. The objective I would pursue would be to make the finished handcart and its components and spares commercially available for the minimum possible cost to the consumer.

We will continue to explore the use of different types and sizes of handcart wheels (especially small-diameter pressed-steel hand truck wheels which retail here in the U.S.A. for ~\$5.00 each), as well as different handcart designs (platform as opposed to box body, and long handles for pulling, as opposed to short handles for pushing).

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