

# GLOBAL ERGONOMICS

## Wheelchair Postural Support Solutions for Low-Income Countries

BY RAY MINES

**A**bout 10% of the global population – that is, about 650 million people – have disabilities. It is estimated that 80% of the world's disabled people live in low-income countries; the majority of them are poor and do not have access to basic services, including rehabilitation facilities. About 10% of a disabled population need wheelchairs, which translates to about 65 million people worldwide (World Health Organization, 2008b). In 2003, it was estimated that 20 million of those requiring a wheelchair for mobility did not have one (U.S. Agency for International Development, 2003). Importantly, disability is both a cause and a consequence of poverty (Department for International Development, 2000).

Motivation is an international development organization working in low-income countries to enhance the quality of life of people with mobility disabilities. The organization's programs aim to improve opportunities by having a positive impact on disabled people's physical, social, and economic situations to enable their full participation in society.

Motivation partners with a range of organizations – from grassroots disability groups to national governments and international organizations – to ensure that local people have the skills to meet the needs of disabled people in their communities and to effect positive, lasting change.



*User trials of new sports wheelchairs in Romania.*

Initiating appropriate wheelchair provision is a major focus of Motivation's efforts. Work with partner organizations is carried out in more than 35 countries, over half of which are in the 50 Least Developed Countries. These local partners are in various stages of service delivery: some just establishing the first wheelchair service in their country, others having run services for many years.

Since 1991, Motivation's designers, engineers, and therapists have designed almost 30 products for adults and children, including wheelchairs, supportive seating units, and tricycles, often in collaboration with local partners. The design process is multidisciplinary and partici-

patory; users are involved in many stages, from setting the design brief to testing prototypes. User trials and focus groups aim to test real-world performance and capture user feedback.

### Challenges for Wheelchair Users in Low-Income Countries

Different users have differing needs depending on a range of factors, including



*Supportive seat – Sri Lanka.*

**AT A GLANCE:** An estimated 80% of the world's disabled people live in low-income countries. The majority of them are poor and do not have access to basic services, including rehabilitation facilities. Motivation is an international organization working in low-income countries to improve opportunities for disabled people by positively influencing their physical, social, and economic situations to enable their full participation in society. Providing good-quality, low-cost, ergonomic wheelchairs in low-income countries is extremely challenging. These complex issues are best addressed by establishing comprehensive services with trained staff and a range of innovative product solutions.

**KEYWORDS:** postural support, development, product design, mobility, disability

their type of disability, the environment they live in, and their lifestyle. Although infectious diseases such as polio and malaria are largely under control in high-income countries, in some low-income countries, these diseases cause almost half of the disabilities (United Nations Statistics Division, 1990). Road traffic accidents, war injuries, and poor birthing conditions are also major causes of mobility disabilities (WHO, 2008a). Postconflict areas such as Angola, Afghanistan, Sri Lanka, and Cambodia often have very high numbers of landmine survivors with amputations of lower limbs. However, the less widely publicized consequences of war are the high numbers of other disabilities caused by preventable diseases such as polio, which is attributed to the interruption of vaccination programs, and cerebral palsy, caused by a lack of primary and maternity health care facilities.

Just as a child with cerebral palsy will have individual needs and might require a great deal of support just to sit up, a person with spinal cord injury will need to sit on a pressure-relieving cushion to stop hard surfaces from creating pressure ulcers. These different and complex requirements mean that ergonomic seated posture means different things to different people.

Environmental conditions common in low-income countries – such as potholed roads, high curbs, and muddy tracks – demand advanced wheelchair skills of every wheelchair user just to get outside and access the spaces around the home. Climates are often extreme; humidity and coastal salt corrodes steel parts, and high temperatures and sunlight degrade plastics, rubber, foam, and fabric.

Although basic ergonomics principles have permeated most modern seating in the mainstream of Western society, they have yet to reach all corners of the wheelchair industry. Most wheelchairs available in low-income countries are still based on the basic cross-folding format, an outdated 1930s design that, because of its ease of manufacture, transport, and storage, has hung on perniciously, causing postural deformities and pressure ulcers. In richer countries, these wheelchairs are now acceptable only for short-term use, usually within hospitals, and would not be con-

sidered for people who need postural support.

However, these outdated wheelchairs are still being distributed widely in low-income countries under the philosophy that “something is better than nothing.” Unfortunately, these products were not designed for everyday, outdoor use and do not survive long in the reality of low-income countries. The low production cost and convenience of folding for transportation would be positive factors if donor organizations provided supportive, pressure-relieving cushions, adjustable backrests, and increased local service capacity, but often this does not happen.

### Application of HF/E Principles to Wheelchair Design

Motivation’s seating methodology is based on the idea of achieving a neutral, or as close to neutral posture as possible – much the same as in mainstream ergonomics practice. Ergonomic seating for people with disabilities is more complex because the user’s own individual variations in muscle tone, joint range of motion, skin integrity, involuntary movements, balance, and other factors all have an effect on his/her ability to achieve and sustain a neutral posture. Motivation’s approach for sitting with neutral posture is achieving a neutral pelvis. For some users, this may be easy; for others, impossible.

Figure 1 is an illustration of neutral pelvic posture from the side. Note the horizontal alignment of the reference points on the front and rear of the pelvis, the natural lumbar curve, and the horizontal upper legs.

In Figures 2 through 5, it’s possible to see the alignment of these reference points

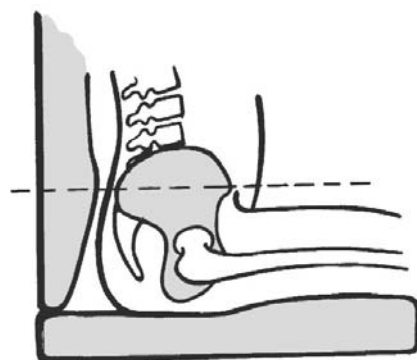


Figure 1. Neutral pelvic posture – side view.

on the pelvis in four common pelvic postures. Figure 3 shows a lateral pelvic tilt, which is likely to be accompanied by a

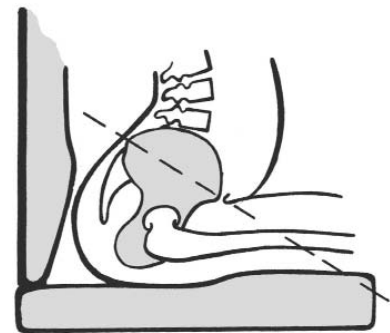


Figure 2. Anterior pelvic tilt.

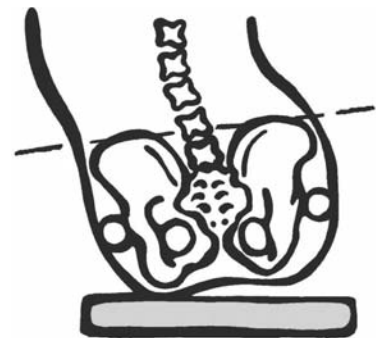


Figure 3. Lateral pelvic tilt.

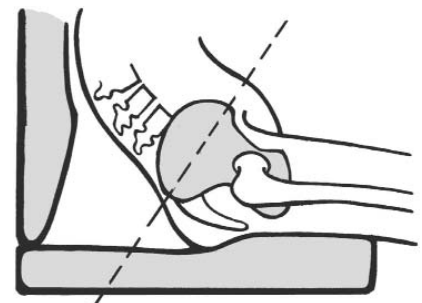


Figure 4. Posterior pelvic tilt.

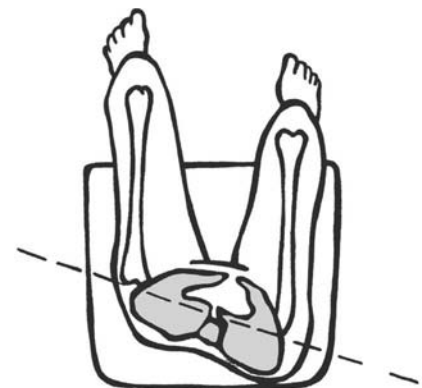


Figure 5. Pelvic rotation.

laterally curved spine (*scoliosis*) as the user tries to function in an upright position. This common postural deformity could be caused by long-term sitting in a wheelchair that is too wide for the user, particularly if he or she has poor trunk balance.

Figure 4 shows the extremely common condition of posterior pelvic tilt. This is commonly seen when users have been inappropriately prescribed a wheelchair with an unsupportive backrest and seat; it is usually accompanied by a forward-curving spine (*kyphosis*).

Sometimes combinations of three of these common issues create a complex three-dimensional posture that makes it challenging to create products to support the user. If one starts from the foundation of a neutral pelvis, it is then possible to work outward to the extremities of the feet and the head. Often, less support is required at these extremities if the pelvis has been well supported.

It is at this point that Motivation's seating methodology splits into two streams: *correction* and *accommodation*. If the flexibility exists in the user's joints and muscles to bring the pelvis to neutral, then the product must provide support to maintain that correction. Figure 6 shows someone sitting with a lateral pelvic tilt and scoliosis. If the deformity is flexible, support can be provided by the forces shown in Figure 7.

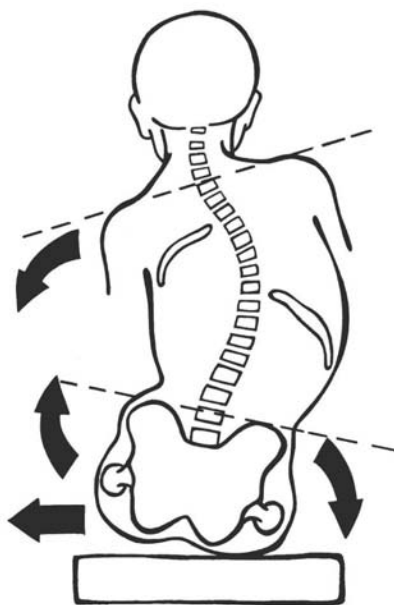


Figure 6. Lateral pelvic tilt and scoliosis.

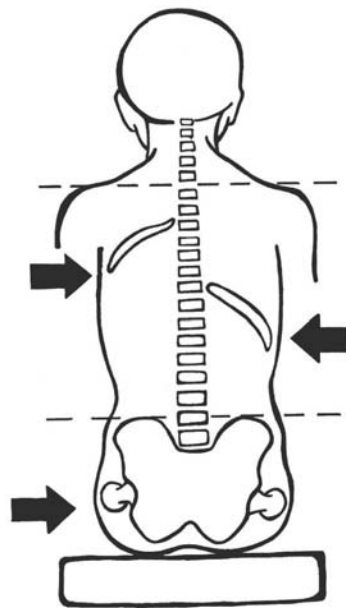


Figure 7. Forces to support body.

Figure 8 shows the postural support that the seating product must provide for the user to maintain the neutral posture.

If the user's joints and muscles are not flexible enough to allow a neutral posture, then the product must accommodate the most neutral posture that is possible to achieve. Figure 9 (next page) shows what support a seating product might have to provide to accommodate a fixed (i.e., not flexible) lateral pelvic tilt and scoliosis.

### Designing Low-Cost Wheelchair Seating Solutions

Example factors in the design of supportive seating for people with disabilities in low-income countries are flexibility, strength, cost, durability, appropriateness, efficient contact surfaces, and a good understanding of wheelchair ergonomics in order to promote self-mobility and independence.

Designing and producing relatively low technology postural support devices that are cheap to produce but still provide adequate support is a major challenge. For example, in Bangladesh and Sri Lanka, materials such as plastic clip buckles, nylon webbing, and EVA closed-cell foam are available because of the shoe, garment, and rucksack industries. In other countries, alternatives for these useful materials must be found. It is a constant process of sourcing and problem solving to produce

durable postural support devices that are lightweight and allow enough air to flow around the user's body. (More surface area increases body temperature, particularly in hot or humid climates, which can increase discomfort and exacerbate other health issues, including pressure ulcers.)

For the nondisabled population, the parameters for anthropometric sampling are well established; however, researchers are still debating the variables and deciding standard terms and definitions for the disabled population. With little data available for disabled people (let alone disabled people in low-income countries), Motivation's designers must interpret data from the mainstream while collecting as much new data as possible. Anthropometry is an extremely important but very challenging factor.

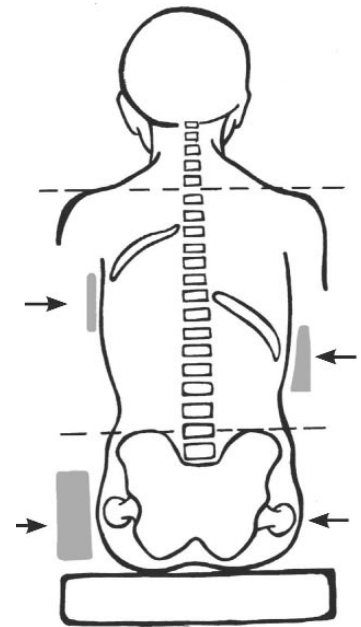


Figure 8. Postural support for correction.

Generalizations are difficult and can be misleading, particularly across types of disability. However, one common factor for all wheelchair users is that they have different needs, which have to be assessed and met individually. This requires products that are flexible and can be adjusted, modified, built to order, or customized in order to provide an ergonomic solution for everyone. For many wheelchair users with spinal cord injury, for example, a contoured pressure-relieving cushion and

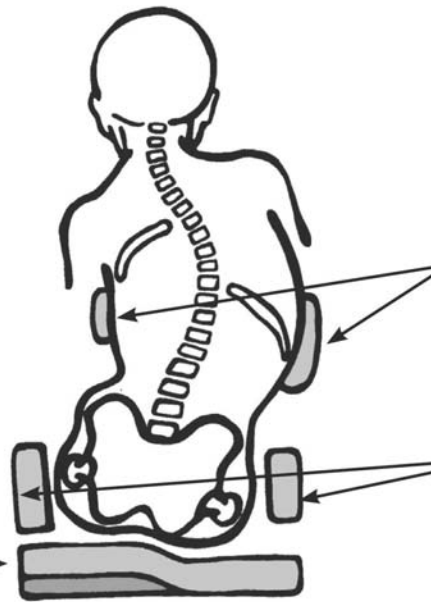
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The lateral scoliosis is flexible only to a point – the posture should not be forced beyond that.

At this point the posture can be accommodated to reduce further deformity.

Accommodation of a fixed scoliosis can help to improve sitting tolerance and provide stability from which to function. It may be possible to improve the posture gradually over time.

A seat built up under the high side of the lateral pelvic tilt improves stability.



Asymmetrical lateral trunk supports are adjusted to help with trunk balance.

Lateral hip pads may also allow asymmetrical posture.

Figure 9. Postural support for accommodation.

an adjustable backrest can provide sufficient support for many people to achieve a neutral pelvic posture. However, for children with cerebral palsy, much more complex support may need to be provided.

Providing good-quality, low-cost ergonomic wheelchairs in low-income countries is challenging. The issues are complex and cannot be solved by products alone. They are best addressed by establishing comprehensive services, with trained staff and a range of product solutions. Motivation has used a multi-

disciplinary approach to develop a comprehensive seating methodology based on experience, skilled practitioners, and innovative design. Local partners may never deliver lightweight, high-performance products made from sophisticated materials, but they strive to satisfy user needs by providing individualized service and good-quality products made from appropriate (often local) materials.

For more information about Motivation's work, please visit <http://www.motivation.org.uk>.

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Mobile supportive seating wheelchair – Bangladesh.



Example of a broken donated wheelchair.



Ray Mines is a senior product designer and project manager with the British development organization Motivation. He has a BSc (Hons) in industrial design from Brunel University in the UK. He has been working in developing countries with Motivation since 1996, designing wheelchairs and seating systems, establishing local workshops, leading new product development and sourcing in China, presenting at international conferences, and representing Motivation at a senior level in key relationships. He may be reached at [mines@motivation.org.uk](mailto:mines@motivation.org.uk) 