Sustainable poverty alleviation—changing role for engineers

A significant proportion of volunteer engineers are involved with poverty alleviation in the developing world. Such work invariably involves a contribution from professional engineers, whether voluntary or otherwise. However, there is an increasing danger of using good engineering to support poor policy. The role of engineers is important, but they must work in collaboration with other professionals if long-lasting solutions are to be achieved. As illustrated by the case studies in this paper, sustained alleviation of poverty through implementation of infrastructure solutions requires careful attention to underlying social, economic and political influences.

The statistics on world poverty are frightening. Close to half of the world’s 6 billion people live on less than £1 per day and 1% has an income equal to that of the entire bottom 57%.\(^1\) Poverty, however, is not only about lack of wealth in monetary terms; it also implies the ‘denial of various choices and opportunities basic to human development. These include the ability to lead a long, creative and healthy life, to acquire knowledge, to have freedom, dignity, self-respect and respect for others, and to have access to the resources needed for a decent standard of living.’\(^2\)

Inadequate community infrastructure exists as one of the major barriers to human development (Fig. 1). Clearly, engineers have an essential role to play in poverty alleviation, whether voluntary or otherwise. Without ready access to clean water and sanitation, productivity is...
Poverty is not being ignored. However, the effectiveness of poverty alleviation strategies needs to be improved if world poverty alleviation is to be achieved.

Barriers to human development

The origins and causes of poverty are complex and not easily defined. Some examples include natural and man-made disasters, population growth, social exclusion, private sector greed and public corruption, inadequate planning and investment in growth. Many barriers to human development prevent people from breaking out of the poverty cycle. Some of these are

- lack of access to safe water and sanitation
- lack of facilities for adequate health care
- lack of access to educational opportunities
- shortage of adequate nutrition
- lack of adequately paid employment
- inadequate or expensive transport facilities
- limited or expensive power supplies.

In general, the barriers to development and poverty alleviation differ in urban and rural areas and many of these barriers are not mutually exclusive. In urban areas, the predominant barriers to poverty alleviation are likely to be

- lack of adequate income or no income, due to underemployment or unemployment
- inadequate housing, sanitation and water supply
- limited opportunities for education
- inadequate or expensive transport facilities.

Poor health and lack of access to education tend to minimise skills and therefore compound the problems of unemployment or underemployment and therefore reduce income-earning capacity.

In rural areas, the predominant barriers to poverty alleviation are likely to be

- lack of access to a range of facilities: healthcare, education
- inadequate shelter, sanitation and water supply
- lack of access to markets for agricultural products
- limited opportunity to earn income
- inadequate or expensive transport facilities
- lack of access to power and telecommunications facilities.

Poverty in rural areas tends to be more widespread and more intense than in urban areas because

- employment opportunities are more limited
- access to a range of key facilities is significantly reduced
- many households are headed by women, often due to abandonment of the family by the males, with commensurate reduction in income
- sanitation and water supply deficiencies are more intense, leading to ill-health.

The trend in developing countries worldwide, whereby male family members gravitate to urban areas in search of employment, often reduces the rural family’s ability to survive in a subsistence economy.

Poverty alleviation strategies

Understanding the potential role for engineers in poverty alleviation is informed by past and current project involvement. Historically, poverty alleviation strategies have focused on direct intervention to provide facilities that are lacking. Investments by the international lending agencies over the past two to three decades have concentrated on solutions to deficiencies in infrastructure that are usually expensive and often pay limited attention to ongoing operation and maintenance needs.

Local observers in a number of recipient countries and other stakeholders have commented on the following inadequacies in the implemented projects and programs

- lack of planning for ongoing operation and maintenance of the facilities
- limited attention to the development of a sense of ownership by the local community
- political interference and intervention
- allocation of funds to countries without a poverty alleviation strategy of their own
- corruption, leading to ineffectiveness of investment.

At the recent Rio+10 Sustainability Summit, both the United Nations and the World Bank called for alleviation strategies involving ‘no more hardware’, pointing out that major investments over the last 20 to 30 years in water infrastructure schemes had often failed to benefit the people at whom they were aimed. This is because the majority of facilities involving technology are generally abandoned within two years, as revenue streams are insufficient to pay for repairs and maintenance and because of the lack of local skills to carry out repairs. Corruption is also often a barrier to successful and sustainable investment.

In agreeing to a target to halve the number of people without sanitation globally by 2020, the summit noted that the emphasis should be on smaller-scale solutions suited to local capabilities, understanding and skills. The role of engineers in delivering infrastructure schemes needs to change significantly.

Over the last 20 to 30 years, experience with the implementation of large-scale infrastructure improvement projects has led to an improved understanding of the conditions that are necessary for sustainable reduction in poverty levels.

- The local community must be empowered by the decision-making process.
- The local community must be involved in ongoing operation and
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National and regional governments must also be involved in the project. Project selection must favour those projects that lead to economic growth. Strength of the market economy is a prerequisite to economic growth. Close involvement of the local community will improve the chances of project success—the project needs to be ‘owned’.

Poverty alleviation requires interventions that involve considerable social and cultural change. Poverty is complex and potential solutions require more than a technical or engineering basis. Provision of infrastructure alone will not alleviate poverty without access being provided to that infrastructure.

But what good is a road if there is no means of transport? What good is a latrine if it is not being used? What good is a water supply system if it is in disrepair? In developing strategies for the alleviation of poverty, we must take account of and address these wider issues.

**Sound engineering solutions**

Engineering solutions are integral to the mitigation of poverty. However, engineering is not the sole contributor to successful poverty alleviation programmes. Sustained alleviation of poverty also entails attention to social, economic and political influences.

- **Sustainable engineering**—will be achieved when the engineering solutions adopted take into account their utilisation of natural resources. Optimum solutions will have a positive or neutral impact on natural resource consumption. Unsound engineering solutions, by comparison, may leave the environment depleted and society poorer over time.

- **Life-cycle engineering**—takes into account the operational and maintenance cost of the engineering solutions proposed, such that the completed projects have effective and affordable operational and maintenance regimes.

- **Empowered engineering**—will take into account the capabilities of the local community, in particular its engineering and technical professions. Where possible, the solutions developed will involve local professional and technical staff and will establish an ongoing engineering and operational resource.

- **Appropriate engineering**—will consider various options that meet the engineering needs of the project and may adopt labour-based construction techniques. Labour-based construction has been shown to compare favourably with plant-based construction. In addition, it facilitates knowledge transfer, creates jobs, encourages private enterprise, creates ownership and may reduce cost.

Labour-based construction differs significantly from labour-intensive construction. Labour-intensive construction is basically the substitution of men for machines, for example the construction of a concrete-framed building for which the concrete is mixed by hand, without the use of a mixer. Labour-based construction, however, aims to change the technology employed in the construction process so as to make it appropriate for manual labour, for example eliminating the concrete frame and building the structure using load-bearing masonry (Fig. 2).

The two case studies that follow illustrate the application of engineering to poverty mitigation programs and identify the associated social, economic and political actions that have been put in place. Each case illustrates characteristics of sound and appropriate engineering, applied in close collaboration with other professionals, achieving inroads toward improved living conditions.

**South African AIDS roundabout**

The AIDS epidemic is tearing apart the social and economic fabric of many African nations. Around 70% of the world’s AIDS-infected adults and 80% of infected children live in sub-Saharan Africa. There are 11 million child AIDS orphans and grandparents are forced to assume the responsibility for childrearing.

Affected families lose income-earning capacity, both through the unavailability of the income earner and the time and cost incurred in nursing the infected. The problem compounds itself: poverty is a key factor leading to the behaviour that exposes people to risk of HIV infections and the resulting HIV compounds the poverty.

**Project details**

The scheme concept is simple: a child’s playground roundabout is bolted on top of an existing borehole (Fig. 3). The energy of the children at play is harnessed to pump drinking water into an overhead storage tank. These tanks are screened with bill-
boards promoting HIV/AIDS awareness to the children and communities. A communal tap is located at ground level.

The roundabouts and pumps cost £2800 each and are based on standard windmill equipment located below ground. The above-ground equipment includes a tank and galvanised sheet as advertising boards, available at any farm supply store. Project construction and replication is assisted by the use of standard and easily procurable materials. ‘Play power’ has advantages over conventional energy sources—it is clean, renewable and robust and the borehole recovers naturally during the night. There is no risk of pumping the hole dry or engine burnout if the pump is ‘accidentally’ left on overnight.

At least 50% of the advertising space on the billboards is used to promote health-related information, in particular with regards to HIV and AIDS. This is an effective advertising medium in the absence of conventional ‘first world’ media such as newspapers, magazines, television and the internet. Revenue from commercial advertisers in the remaining space will provide a regular flow of income for the manufacture of new roundabouts and to cover maintenance costs.

Women and young girls benefit from the saving of time and energy previously spent fetching water for daily water needs from deep wells at long distances and are placed at less risk. In addition, they benefit from the HIV/AIDS awareness campaign.

### Progress report

More than 300 roundabout pumps have been installed in South Africa, each serving communities of over 2500 people. Various improvements to the standard of living have been noted, including the ready availability of clean drinking water (Fig. 4) that has resulted in the reduction of water-borne diseases such as cholera and the development of thriving vegetable farms that provide fresh produce for schools and for sale at market.

### Communal sanitation, Myanmar

Access to clean water and adequate sanitation is essential to the development of a sustainable community. Access for the poor is a key factor in improving health and economic productivity and is therefore an essential component in any effort to alleviate poverty.

In 2001, 16% of the world was without water supply and 40% without access to adequate sanitation. Water-borne diseases are responsible for more than 80% of all sicknesses in the world, resulting in the death of more than 4 million children annually. Diarrhoeal diseases are the third most significant child killer (after respiratory infections and malaria), accounting for 15% of the under-five mortality rate, especially in rural areas. Substantial decreases in the frequency of contagious disease caused by inadequate sanitation and water supply would result in substantial savings in healthcare costs. These savings could be invested in national development, thus further increasing national productivity.

In 1997, Myanmar in Southeast Asia was crippled by diarrhoeal disease, killing 30 000 children. Sanitation coverage stood at only 39% of the population and personal and domestic hygiene was poor. Myanmar ranked 190 out of 191 in the 2000 World Health Report.

### Project details

Over the past decade, significant attempts have been made to improve sanitation in Myanmar. In the mid-1990s the Myanmar Government, in a bid to promote community participation, adopted a strategy in which families were provided with free latrine pans. However this proved too costly, failed to achieve community support and was phased out.

The Government then recognised it could no longer be the sole provider of sanitation services. It recognised its key role should be to facilitate and stimulate local communities to recognise and meet their own needs. This was to be carried out through organising and financing community mobilisation and household motivation and running an awareness campaign, known as ‘National Sanitation Week’. For the past five years, United Nations Childrens Fund (UNICEF) has supported this programme.

National Sanitation Week activities are...
carried out under the guidance of the National Health Committee and with the active involvement of the entire nation. The week has three key objectives:

- educating the general public in the values of sanitation
- assisting the people in the actual implementation of sanitary work
- reducing the spread of communicable disease.

**Community mobilisation**

As individual users are the ultimate ‘decision makers’ in the acceptance or rejection of new technology, community involvement is widely accepted as a key ingredient in the success of any aid project. Participation of local people in all stages of a project, from design, construction, operation and maintenance, is paramount in fostering a sense of ownership and to ensure that facilities are properly used and maintained.

Sanitation cannot be imposed; use had to be ‘created’ by demand. In the past, supply-driven approaches to the provision of sanitation have led to widespread disuse of latrines, leaving latrine slabs as a health hazard and a negative influence on any future sanitation attempts.

Demand for use of sanitation systems is not something that is easily generated, as rural populations do not often perceive the health benefits arising from sanitation. It is therefore fundamentally important that sanitation be effectively promoted as part of health education, to create demand.

**Promotional campaign**

The campaign treated sanitation as a product to be marketed to individual households, using all the skills of the advertising and marketing industry. All available and affordable media and communication channels were used to promote sanitation messages. A broad-based approach was adopted that emphasised not only potential health improvements but also benefits such as privacy and convenience, elevation of household status, respect and dignity (especially for women), environmental awareness and the potential economic benefits of generating resources out of waste.

Social mobilisation was intensified through community meetings organised at various levels, supported by visiting health teams, non-governmental organisations, school teachers and local leaders. A range of information and communication materials, such as posters and pamphlets, and models of affordable latrines were produced. National television and media played a significant communication role. UNICEF contributed about £36 000 a year to these promotional activities.

The communication and social mobilisation package has been improved each year, to give greater attention to the upgrading of unsanitary latrines and the integration of washing of hands into the sanitation cycle. Interested households form a village sanitation committee, which plays a fundamental role in coordinating activities.

**Implementation**

Construction activities started only after the awareness campaign had been launched and hygiene and sanitation education provided. Construction occurred only in motivated communities and with the cooperation of the end user. A ‘do-it-yourself’ construction programme was promoted. Families were responsible for the installation and financing of their own sanitation facilities (Fig. 5) as subsidies were only available for schools and for the communities that could not afford self-finance.

The private sector responded to meet the rising demand for parts. Local production of plastic latrine pans has increased by a factor of six in the last five years, from about 40 000 in 1995 to more than 250 000 annually today. To reduce costs, locally available materials were widely used and some village leaders organised the bulk purchase of bamboo.

**Progress report**

In 1997, prior to the launching of the national campaign, the sanitation coverage throughout rural areas stood at 39%. By 2001, sanitation coverage stood at 57%. Hand-washing with soap and water after latrine use has also increased, from 18% in 1996 to 43% in 2001. Too frequently, the success of sanitation programmes is measured by the total number of latrines constructed, with little attention to actual operation, maintenance or usage. Long-term success of these systems depends on the availability of supplies, parts, equipment and the availability of trained people needed to monitor, maintain and repair the systems, as well as continued community demand for their use.

As sanitation coverage in Myanmar grows, campaigning continues. Programmed follow-up to National Sanitation Week is being provided in selected townships through more intensive social mobilisation targeted at ‘hard-to-
reach’ households and communities and activity-based sanitation and hygiene education in selected schools. This approach recognises that schools create an excellent participatory and learning environment in which to promote sanitary habits and hygienic practices. General training of decision makers, planners and trainers in social mobilisation programs for hygiene also continues to be widely undertaken.

The 2002 National Sanitation Week accordingly gave special emphasis to activities to be carried out in 73 of a total of 324 townships, where 50% or more of the households still do not have access to a sanitary latrine.12

Myanmar’s success is a model to other countries and has been internationally recognised by other Southeast Asian countries. Government delegates from Indonesia, Pakistan, Bhutan, China, Vietnam and Laos have come to Myanmar to observe their activities and learn from their experiences. Nepal launched its own National Sanitation Action Week in March 2001.

Conclusions

The two case studies illustrate the application of relatively low-technology engineering in small-scale investments that enjoy high levels of community engagement. The success of these programmes is due in significant measure to this level of community commitment and to the extent of understanding the social, economic and political influences in that local community.

In both case studies and in many similar scenarios, the solutions developed have not been primarily engineering solutions, although engineering plays a key part in the outcome adopted. It is not known which profession took the lead in which scenario but it is clear that engineers with appropriate sensitivity could have lead in both of the case studies.

The case studies illustrate the application of sound engineering solutions to poverty alleviation.

■ Sustainable engineering has been achieved, as the solutions adopted will have a positive or neutral impact on natural resources.

■ Life-cycle engineering has taken into account the operational and maintenance cost of the engineering solutions. The completed projects have effective and affordable operational and maintenance regimes.

■ Empowered engineering has taken into account the capabilities of the local community, in particular its engineering and technical professions. The solutions developed involve local professional and technical staff and will establish an ongoing engineering and operational resource.

■ Appropriate engineering has considered various options that meet the engineering needs of the project and adopted labour-intensive construction where relevant, in order to create community involvement and knowledge of the project’s operations and to stimulate community income.

The challenge for the engineering profession is to revisit our ‘Brunel’ roots and to develop a suite of solutions to the issues raised in this paper. These should include solutions not only to the alleviation of poverty when it occurs but also to the development of sustainable urban infrastructure, which recognises rather than resists the inevitability of migration to urban centres and then makes provision for these rapidly growing populations.

As engineers, whether voluntary or otherwise, we can work effectively in collaboration with other development-focused professionals and community leaders to implement sustainable solutions to poverty. However, we need to ensure that these solutions are well integrated into a wider decision-making, planning and institutional development process to improve living conditions of the poor. As engineers, we need to be involved in developing sustainable concepts for the urban areas of the future, concepts in which

■ access to and opportunities for employment are enhanced

■ housing, sanitation and water supply are provided at affordable prices

■ access to and opportunities for education are enhanced

■ affordable transport facilities are available.

This is our Brunel challenge—it is worthy of our commitment.

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References


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