

Designing stoves for mass production

Don O'Neal, HELPS International, 15301 Dallas Parkway, Suite 200, Addison TX 75001 US.
Email : dononeal@usa.net Tel: 972-784-8259

Introduction

It has been estimated that there is a current need for over 600 000 residential cooking stoves in Guatemala alone and that the need will double in the next 25 years. If Guatemala is indicative of other developing countries, the world's need for stoves is enormous and becoming more acute. How do we focus our money, time, and energy to derive the maximum benefit and ensure the people most in need are not left out? Mass-production, commercialization, sustainability, and subsidies are tools and goals but different people have different ideas on their use. The HELPS stove project in Guatemala (Figure 1) has uses the principles described in this article.

Background

Commercialization

In this paper, *commercialization* is a steady state in which the needs of the manufacturer, the distributor, and the consumers are all met simultaneously; there has to be sufficient difference between the manufacturing cost and the price the consumer is willing to pay. Both the manufacturer and the distributor must make a reasonable

profit, and the product must be sufficiently valued that the consumer would rather have the product's benefits than the money he/she must pay.

Commercialization, when achieved, is good for everyone. Unfortunately, in rural Guatemala, 90% of the population lives in poverty, and 75% live in extreme poverty. No matter how good the solution is, or how low the price, in rural Guatemala and much of the world, they cannot afford it.

Poverty reduction

If our goal is only to have a commercial operation supplying the somewhat affluent, that can be done today. If we are to solve the problems confronting the poor, then our programmes must include poverty reduction components that will 'lead' to commercialization with time. If we rush to commercialization without first reducing poverty, the poor will still be without solutions. Poverty reduction programmes are needed which address health, education, and economic development. Such programmes will increase the purchasing power of those now poor to a level that they can, in the future, pay for a commercial stove as well as paying for better housing, food, health

care, and education. But, poverty reduction takes time.

HELPS has been working in poverty reduction in Guatemala for more than twenty years and is focusing on the following:

- Curative and preventative health
- Education
- Economic development
- Community development
- Infrastructure construction
- Cooking stoves (Figure 2)

All of these items must be addressed simultaneously.

Partnerships

Partial subsidies, usually thought of as being negative, have a positive role when attempting to solve the problems of the poor. Partial subsidies should be used as a bridge between the poverty condition and a self-sustaining, healthy economic condition. Once the bridge is crossed, the need for them will no longer be needed, but without the bridge, there is no way across. In addition to the compelling humanitarian motivation, major funding groups understand that all of us who live in the more affluent countries derive a benefit when the developing countries are stable. If we derive a benefit, then we should be a partnerpartners in providing the bridge. It would be more constructive if we thought of this as partnerships rather than as subsidies.

Designing stoves for mass production

Mass production is a manufacturing technique. It does not imply a complex factory or even a building. This technique implies only that a group of identical products are manufactured. This can be a run of 100, or 1000, or more.

Mass production is independent of commercialization. A product can be mass-produced for use in a subsidized project or for a commercial project. In the case of the HELPS stove project,

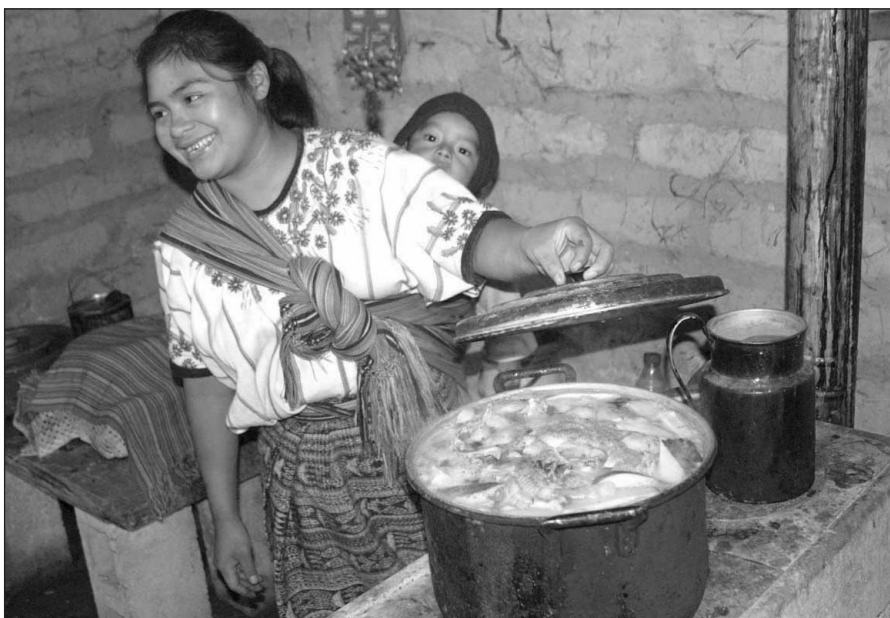


Figure 1 Woman cooking on a HELPS stove



Figure 2 Impact of stove installation on kitchen

stoves are sold to other NGOs for use in their community development projects. Some of these NGOs elect to part-subsidize their installations; others use micro-credit, while others sell at full price up front. All NGOs and end users receive in-depth training and follow-up inspection.

Stove design

Since one of the major poverty reduction functions of the cooking stove is to provide improved health and safety, the selection of the stove design must be tailored to provide those benefits. If the stove solution is tailored only to what people can now afford, the maximum health benefit will not be derived and one of the major poverty reduction factors will be missed.

There is not one stove that meets everyone's needs and it not practical for one supplier to supply all the various specialty stoves required. However, the vast majority of household stoves share common requirements. Any solution that can make a significant impact on a problem with the magnitude of the world's stove needs must be mass-produced. *The provision for mass production must be designed into the product and into its distribution, marketing, installation and maintenance.*

The benefits of mass-produced stoves are:

- Consistency – Each stove is manufactured identically – thus, if maintained, its performance should be consistent. This allows the manufacturer to know if it is working properly by making a quick test – the temperature rise of a standard amount of water which should match the results from a laboratory stove – otherwise something is wrong. Consistency is good from a community standpoint. No one feels

he/she paid more than necessary for the stove or that someone else received better treatment. A consistent product is the only way an organization can have a standard price.

- Maintainability – Through consistency comes maintainability of a broad base of stoves. Businesses dealing in large quantities must have a stockpile of standard replacement parts and trained local repairmen.
- Quality control – Quality of manufacture can be controlled in the factory. An artisan stove, built on site, requires that a person return to each house for quality inspection. If the artisans themselves check the stoves this is unsatisfactory, as they will be judging themselves. A good industrial requirement is that a separate person is responsible for quality control and he / she reports to a more senior person than the people making the stoves.
- Transportability – A mass produced stove can be designed so that it can be moved when the family moves or builds a new room on the house.
- Fast assembly and fire-up – Assembly and fire-up of a mass produced stove can usually occur within an hour. The stove is then ready to use. The alternative, building on site, impacts the family because the stove needs to cure for several days. By then, training may be forgotten and the builder is



Figure 3 HELPS Rio Brovo stove factory

not there for the initial fire-up. Alternatively, it requires the builder to go back to retrain and fire-up.

- Training – Training materials and courses can be specific to the stove installed. Pictures in the training material can be identical to the stove the family receive. Training local trainers is easier with a consistent product.
- Volume – Greater numbers of stoves can be produced in any given time. For example, Guatemala is expected to double its population within twenty years. To provide the required volume of stoves will require a mass-produced, consistent stove that is quickly and efficiently distributed.
- Cost reduction – A mass-produced product can be supplied at the lowest possible cost for a given design.
- Distribution – A stove designed for mass-production allows for efficient distribution through normal distribution channels (Figure 4).

Project phases

There are several specific phases relating to designing for mass production. Each phase has a specific objective.

These include:

Research

The objectives of research (within the scope of the design process) are to generate principles that could apply to many designs within the bounds of the project goals. An example of this is Dr Larry Winiarski's stove guiding principles (see *Boiling Point* 47, page 36).

Conceptual design

During the 'concept phase', the designer is aiming to solve a problem or group of problems. Obtaining advice from potential users is absolutely necessary at this stage (Figure 5). However, even at this early phase, one must think about how the product is to be mass-produced, marketed, and distributed. The output of this phase generally consists of a design on paper and specifications that are to be used to guide the project. It outlines the customer needs as well as mass marketing, training and distribution strategies.

Prototyping and laboratory testing

Once the project concept is well defined, prototypes are constructed and are typically tested in a laboratory environment. The goals of the labora-

tory testing are to determine if the design meets the objectives, and to establish performance specifications that can be used to ensure consistency in performance characteristics that have been designed into the product.

Field testing

This is the first real customer-based test of the design. Without exception, there will be things that the users will find that could be done better or new features that could be incorporated with minimum cost that would result in a better product. *However*, it is counter productive to omit the prior phases thinking that the users will find all the problems so why bother with the laboratory testing. If the user finds many problems, his/her confidence in the product can be destroyed and the project marginalized before it is started.

Design review

Following a solid field test, there will be a need for a design review and for changes to be made in order to incorporate what has been learned during the field test.

Pilot production

At this phase, a factory will be built and the tools necessary for limited production will be constructed. Since this requires considerable expense, it is extremely important that all the above steps have been taken and that the product and its marketing and distribution techniques have been established prior to starting the pilot production phase.

Hard production

This is the scaling up phase. The tools produced for the limited quantity of a pilot project must be re-thought for higher production quantities since different types of manufacturing technique may be more economical. For example, sheet metal parts that have been previously cut by hand might be produced more economically in a stamping press even when the cost of a stamping die is included. It cannot be over emphasized that all parts of the project must be scaled-up at the same time. It does not do any good to scale-up production if distribution or



Figure 4 Trained stove promoters with their certificates

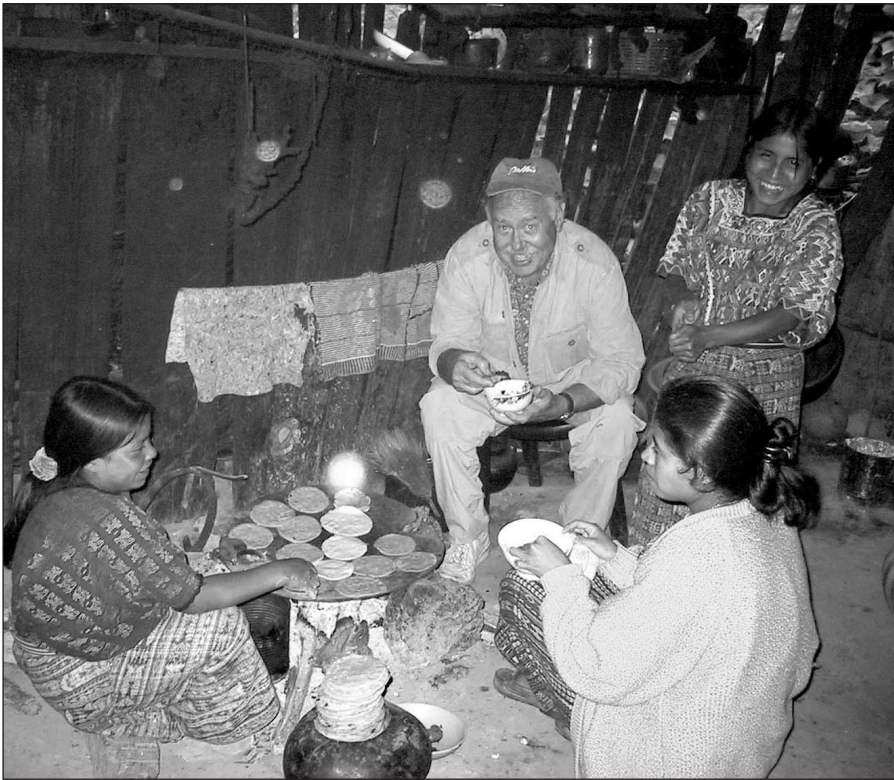


Figure 5 Discussing needs with potential stove users

marketing lags behind. Spare part depots and maintenance strategies must be in place to accommodate the increased production.

Engineering for mass production

Engineering roles and responsibilities

In the design of the overall project, it is important to understand the differing roles of the *production* engineer and the *design* engineer, although in a small project, one person may have both of the duties. It is the responsibility of the *design* engineer to design the ‘product’ while it is the responsibility of the *production* engineer to design the ‘process’ used in producing the product. Each must be aware of, and understand, the other’s needs.

Handover of project control usually occurs during the pilot production phase. Before handover, the design engineer has primary responsibility and consults with the production engineer about production issues. After handover, prime responsibility is with the production engineer, though even after handover, any changes that affect form, fit, or function should be signed off and documented by the design engineer.

After handing over primary responsibility for a product, the design engineer will typically be designing the next model. This new model must not be introduced before it is ready to be delivered or the customers will wait for the new model thus destroying the market for the current product.

Quality

In any organization engaged in mass production, someone must be responsible for maintaining quality. This individual is responsible for the quality of the product shipped as well as the quality of incoming purchased parts.

To prevent the pressures of delivery schedules from compromising quality, quality control should not be the responsibility of the production engineer or anyone in his/her organization and should report at a higher level in the organization than the manufacturing function.

Cost considerations

The ability to determine manufacturing costs and to estimate future costs is vital to the success of the project. If one were to set the selling price based on the cost of producing in limited quantity, it would be difficult to find

sufficient customers to justify the scaling up to production quantities. Therefore, it is necessary to make an educated estimate of costs for the quantities projected. Typically this is done using a ‘manufacturing learning curve’.

Experience gained from doing repetitive tasks increases efficiency in proportion to the number of repetitions. This technique has been in use since the mid 1930s and has been used extensively by NASA. For those with access to the web, a ‘Google’ search on “Manufacturing Learning Curve” will produce several articles on this technique.

Each product or manufacturing type will have its own learning curve. Experience during the pilot phase can be used to determine base (initial) cost and to estimate the percentage reduction for each doubling of production quantities. Typically, each time the production volume doubles, the cost will be 80–95% of the cost before the doubling. It should be pointed out that this holds only if the production process is continuous. Starting and stopping of production will interrupt the learning process.

Conclusions

The need for cooking stoves in Guatemala is large and is growing faster than stoves are being distributed. If we are to solve the problems associated with IAP, this trend must be reversed. The majority of these stove needs can be met by a few stove designs that can be mass-produced and mass production is our only hope to produce stoves in sufficient quantity, quality, and at the lowest possible cost for a given design.

Don O’Neal is a retired corporate executive with 30+ years in engineering management. His last post in industry was as Senior Vice President of Engineering for a public corporation. Previous assignments in industry have been as Vice President of Manufacturing and Vice President of Marketing. Don now serves as the project manager of the HELPS stove project and is on the boards of both HELPS International and ETHOS.

HELPS International is a non-profit corporation that has been working in poverty reduction in Guatemala for over 20 years.