Ceramics in Developing Countries

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Developing countries have gained a new understanding about the urgency of promoting small enterprise and appropriate technology in recent years. This is largely because "turnkey" projects built rapidly and on a large-scale, have nearly all failed. This grand-scale industrialization simply did not work. Within the last few years, however, microprojects providing necessary skills to small-scale entrepreneurs have flourished. Low-tech ceramic projects offer unparalleled opportunities in this growing approach to development.

Manufacturers' products, starting with basic refractories, can be produced through ceramic-related, high-temperature appropriate technology. Ceramics, therefore, stands at the forefront of the movement toward microenterprise. Developing countries that encourage small-scale ceramic enterprise will be among those best able to diversify their cottage industry, and, with time, their industrial base, moving constructively toward self-sufficiency.

With refractories being a first step, the subsequent steps would include small-scale mining, processing, and working of metals. These yield a second tier of manufacturers' products, beginning with simple tools. In many developing countries, even hand tools are priced beyond people's means. Producing them from scratch can make them affordable.

Equally true for industrial countries is that the extent of industries of all kinds is directly related to the extent of ceramic industry. It is true in both industrialized and developing countries that new industries in manufacturers' products enable diversification of the industrial base. New business and trade opportunities with other countries result and new prosperity enables national solvency.

The same is true on a microscale. Assuming that each person is an economy of one, local resources, such as tools, materials, and education, are the seeds of self-sufficiency. It is by having a knowledge of the use of *local* resources that economic independence is established. If, for example, affordable refractory brick is locally available, buy it. If not, learn to make it.

Another ceramic manufacturers' product in a different category from refractories and tools is building materials such as tile, building brick, and drainage pipe. Concrete building materials, however, have all but supplanted ceramic ones in many developing countries. A primary concern among funding agencies, has been the inconsistency of ceramic materials and processes from one location to the next. From a planning perspective, importation of clinkers for manufacture of cement is considered easier.

However, ceramic building materials offer some serious ad-

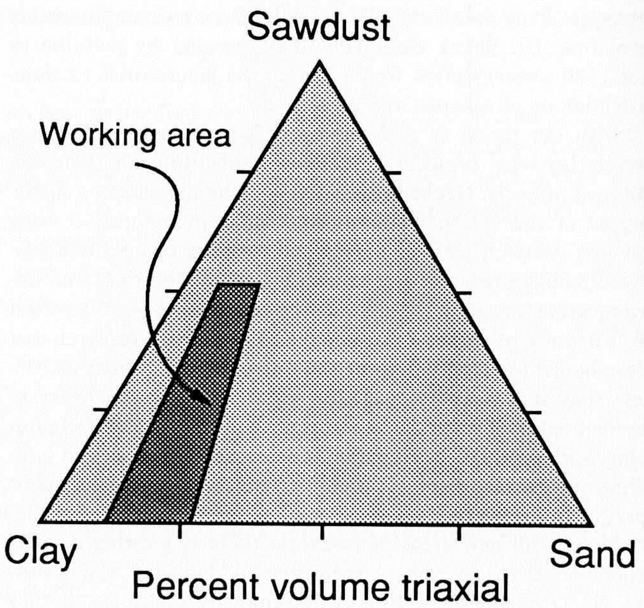

Fig. 1. This triaxial shows the working area for fabrication of refractories from locally available materials. Because of a lower level of formal education in developing countries, measurement by volume is recommended. The above percentages are based on the Alfred Refractory Project, in which the weight per volume for both clay and sand was approximately the same. Aspiring ceramic entrepreneurs are encouraged to make their own refractories based on this triaxial.

vantages over concrete ones. Some of these include accommodating small-scale fabrication, independence from importing raw materials, and avoiding staggering shipping expenses. Nevertheless, ceramic options have been downplayed. Lack of ceramic building materials has been a serious shortcoming in the overall development picture, in the same way that the lack of refractories and tools has been.

People in developing countries know they want a more independent role in this process. "Why can't we make manufacturers' products here in Africa?" This is a question that bothered me more and more the longer I lived in Liberia, West Africa, where I spent 11 years engaged in a glass art project. Why, on a continent so rich in human and natural resources, did the manufacturing sector of the economy include only those industries producing consumer products such as soap, matches, baskets, and furniture?

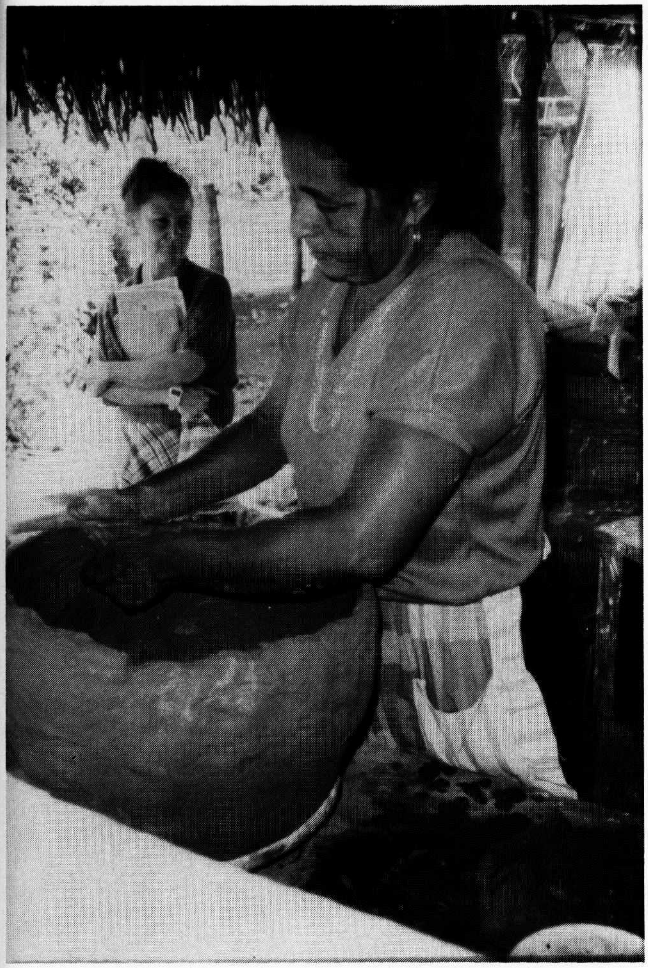

Fig. 2. In the Native American pottery community of Guaitil, Costa Rica, Maria Alvarez handbuilds a highly burnished earthenware pot as VITA/Alfred volunteer Barbara Castle looks on.

The glass art project I was working on offered inspiration. In a labor-intensive pursuit like stained glass, even while importing handmade European glass, we could price the locally cut and fabricated windows at 10% of the imported price. This meant our prices were competitive with those of ordinary casement windows and our enthusiastic clientele was countrywide. Why couldn't the same principles be applied to ceramics, another high-temperature industry? Why, in Liberia, did I have to travel over roads of kaolin to get to the store that could sell me imported refractories.

For me, finding the answer to this question began a quest that led to completing a degree in ceramic design at the New York State College of Ceramics at Alfred University in Alfred, NY. In addition, I participated in related session topics in the Design Division of several conventions of the American Ceramic Society. Today, I am still seeking answers.

While a superficial answer might hold that there is a less-educated work force which is unprepared to produce new products, a deeper understanding of the issues uncovers the fact that many of these countries have had their aid priorities set by organizations which stand to benefit by the kinds of aid packages offered. What is clear, however, is that developing countries are not being encouraged to stimulate low-tech industry. Often it is not clear whether issues such as the lack of skilled and educated workers are the causes of these problems or merely the effects of current policies.

As a result of this situation, poor countries import their finished goods and export their raw materials at record pace to pay for these imports. They have been as unrealistic as wealthier countries in plans for turnkey industries. That is to say, money and industry, promised from abroad, appeared to be the panacea for these strapped economies. Problems that have prevented this rapid industrialization and thwarted the success of these businesses, to mention but a few, have included lack of commitment to on-going training of local staff, lack of responsibility for maintenance by the donor, and corruption of local officials. After such turnkey plans fail, all that remains is an abandoned worksite and a mountain of debt.

Largely because big projects have enjoyed wide popularity among funding agencies, working along with officials in developing countries, conventional wisdom still persists in planning large-scale industries. Unfortunately a steel mill or a glass factory is less viable in places with no tradition of cottage industry in glass and metal because there were no interim steps, no fundamental knowledge of the process. An understanding of small-scale projects as a viable alternative and as a stepping stone to the larger industries is necessary. Many of the most successful enterprises are those which have been established through a commitment to education, and use of locally available resources, and human industry. These inputs allow the establishment of enterprise with minimal financing. Large industries are more successful when workers on the production line know the materials and processes they are using from earlier experience on a microscale.

It is because ceramics plays a profound role in the solution to this problem that a growing group of experts feel passionately about sharing their knowledge with people in developing countries. This article mentions but a few in this group.

The importance of appropriate technology led to a request in 1987 from a Peace Corps volunteer in Paraguay. "We need to decrease imports and use local resources," said volunteer Kyle Roberts. Roberts was speaking on behalf of Paraguayan potters who were importing 95% by weight of their glaze materials. As he put it, the problem was that the only locally available materials for flux in pottery glazes were boron based. Glazes would, therefore, be water soluble. A phenomenon that is common in tropical latitudes is the scarcity of the feldspars, of soda, potassium, and calcium, that are used for fluxes. Because of this, a series of tests needed to be performed in triaxial blending in order to formulate a suitable frit, composed of silica, clay, and boron materials. Time and facilities needed for such tests were beyond local resources, and local potters were not yet aware of the need for simple fritting technology.

Roberts made a request for fritting information through Volunteers in Technical Assistance (VITA), of Arlington, VA. VITA has had a reputation for assisting people in developing countries with appropriate technology for nearly 20 years. Composed of 5000 scientists and engineers, the organization consults and provides information in five areas of appropriate technology. These are housing and construction, water and sanitation, agriculture and food processing, renewable energy applications, and small business development. Ceramics cuts across all of these.

VITA's request, and samples of Paraguayan glaze materials sent by Roberts, went out to volunteers at Alfred University. At Alfred, Bill Walker, a senior engineering student, took on the Paraguayan request as a special project. Walker characterized the materials through X-ray diffraction and wet chemistry, then experimentally determined the right proportions of the three constituents. He also recommended the best ways of preparing the frit, and the appropriate equipment. In following his recommendations, the only imported constituents for a Paraguayan glaze body then became oxides, used as colorants, comprising less than 5% by weight of the glaze materials. Thus was developed an appropriate technology glaze, representing important savings, both in expense to the potters and in hard currency for Paraguay.

Belief in the importance of appropriate technology and small enterprise in ceramics led to the set-up of VITA/Alfred, in 1986, by people in the Alfred community in and around the New York State College of Ceramics. It led further to a refractory project inspired by Alfred University Provost Richard Ott. The goal of the project was to make appropriate refractory brick out of materials such as earthenware clay and "creek sand," two materials that are widely available. In developing countries, the lack of refractory brick for kilns has been a major hindrance to ceramic cottage industry. Conventional wisdom strongly encourages importing refractories.

The refractory project involved making refractories from combinations of clay and "creek sand" to avoid importation. In this simple clay body, the sand is of variable composition of quartz, feldspar, and extraneous materials, and provides the body with additional refractoriness. Such bricks do not have nearly the life of the imported variety, but are nevertheless adequate in firing useful ware. Given a third constituent, sawdust, the body then requires simple tests in triaxial blending to discover optimal proportions for insulating brick (Fig. 1). These vary by location and availability of materials. Measurement by volume, of the body constituents, is recommended because the lack of formal education in many developing countries makes this approach more widely applicable.

With this new approach in mind, 15 VITA/Alfred volunteers set about the task of digging the earthenware clay and following procedures that could subsequently be repeated in developing countries. Several tons of clay and sand were dug, measured by volume, and wedged together by foot. Bricks were slop cast in wooden forms and set out to dry. Using a design followed in the early years of American brickmaking, a "scove kiln" was built. Such kilns are constructed of the very bricks that are being fired, stacked throughout with the bricks only inches apart to allow circulation of heat. After firing this kiln, it was dismantled and rebuilt, this time with the outermost bricks on the inside. In this manner, all bricks can be well fired.

Here, then, is a simple method by which people in developing countries can start local projects in ceramics by using available resources and minimal financing. Frequently all that is needed, in addition to local fuel, are simple tools such as a shovel and a pail. Add to this a willingness for experimentation and small failures, and one has the essentials to launch into a broad range of industries. A key is setting aside a little space in each firing to test new clay bodies and glazes and to experiment with new processes. If one does not experience at least some failure, then one is not taking the necessary chances that lead to growth and development.

With these principles in mind, VITA/Alfred members gave a demonstration on ceramics to a group of Costa Rican municipal officials who were on a visit to Alfred. Subsequently, VITA/Alfred organizer Bill Castle and his wife Barbara were invited by the officials to Costa Rica on a fact-finding mission to evaluate the needs and potential of the Costa Rican ceramic industry. The Castles visited small, family enterprises in brickmaking, slipcasting, wheel throwing, and handbuilding. Bill Castle was struck by a widespread need for education in ceramics, as evidenced by a lack of knowledge among slipcasters in techniques of plaster-of-Paris, namely model and mold-making. The slipcasters had swarmed to meetings with the Castles.

The Castles visited a Native American pottery community that has a reputation for wonderfully designed earthenware vessels. These are handbuilt and colorfully decorated with engobes that are highly burnished (Fig. 2). The breakability of the ware, however, severely limits the number that reach the market to be sold, thus revenue to the community suffers. Design of beehive kilns used from one generation to the next prevents heat from effectively getting to the pots; wood fuel is piled around and on top of these.

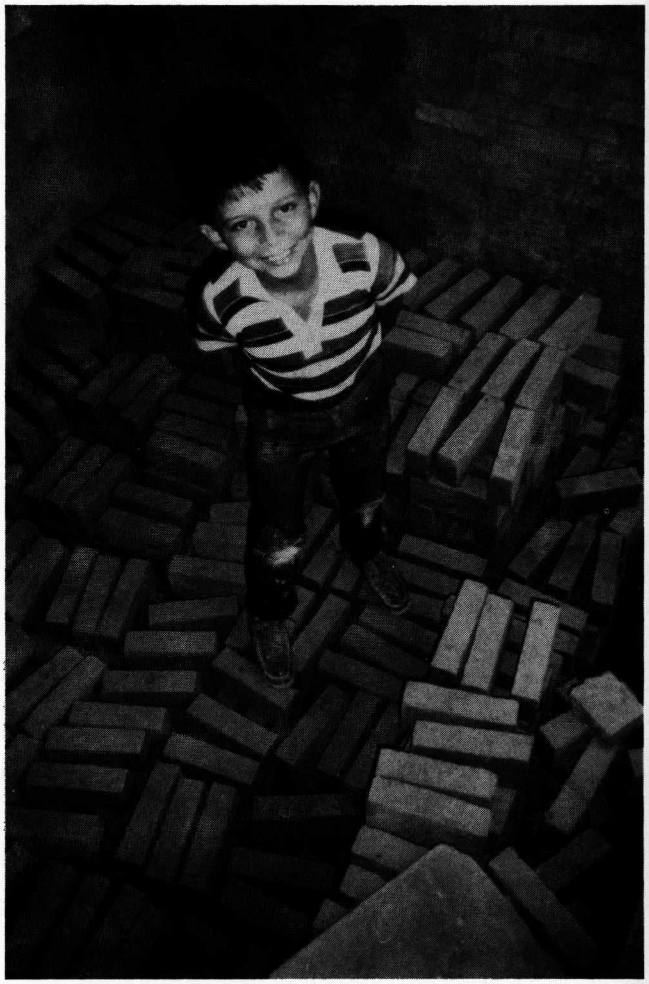

Fig. 3. For Manual Marvin, daily chores often include a hand at unloading the brick kiln for his father's four-generation family business. The bricks are widely used in their region of Costa Rica.

In this case, providing appropriate technical assistance may not have as much to do with redesigning the kiln as it does with recognizing custom and providing the appropriate solution. A more optimally designed kiln would require the community to completely rethink a host of methods, from firing to clay body formulation to a change in surface decoration. The correct solution may be as simple as the addition to the clay body of locally available calcium oxide, a high-temperature flux that would promote additional crystallization. Finding such culturally sensitive solutions has often meant rethinking initial answers.

Another of the Castles' visits was to a four-generation brickmaker, Victor Marvin, who was hungry for information. Marvin had, for years, individually slopcast his building brick—a product that is prized in his region. This has provided an inexpensive alternative to concrete building materials. The brickmaker saw a potential market for tile and refractories, but given day-to-day demands of his business, did not have time for the research needed to diversify. A lack of ceramic information and technical assistance had made this even more difficult. (Fig. 3)

Subsequently, Bill Castle went to North Africa on another project, where his recommendations on changing from beehive kilns differed diametrically from suggestions on the Costa Rican

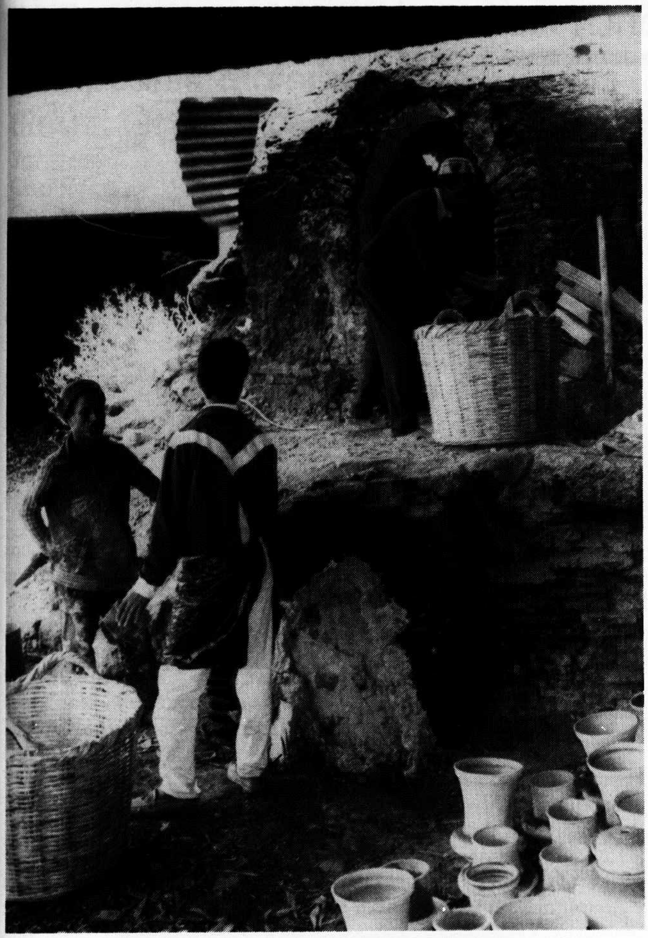

Fig. 4. A Morrocan beehive kiln is unloaded. In the foreground, clay used to cover its fire chamber can still be seen.

kilns. Because of the more intermediate technology employed by his new hosts in Morocco, Bill concluded that antiquated kilns of locally made refractories needed replacing with downdraft, propane-fired kilns.

In Morocco, his job was to assist a family ceramic business in expanding to an export market. More specifically this meant redesigning their kilns. Standards of quality control, in production of the company's lines of dinnerware and vases, had necessitated better temperature control of kilns. Existing beehive kilns had, to their credit, used fuels that were waste products of other industries: crushed olive pits, eucalyptus leaves, and pine boughs (Fig. 4). The updraft design of their kilns, however, had meant problems in controlling temperature and air pollution. Instead, a downdraft, propane-fired kiln would make a consistent product possible.

Scarcity of fuel in places like Morocco has led to similarly resourceful firing solutions in other arid places where firing with industrial waste products is largely practiced. During another trip to Costa Rica, several VITA/Alfred volunteers traveled to neighboring Nicaragua to compare notes with a ceramic organization there, Potters for Peace. For several years that group had been involved in upgrading facilities and education of the country's potters. The VITA/Alfred team had been asked to give ideas on design and fuel efficiency of a sawdust-fired kiln. When they arrived in Managua, the Potters for Peace director, Ron Rivera, gave a tour of a large brick and tile factory located at Ciudad Sandino.

There, another waste product, coffee hulls, are used exclusively in firing a massive, 150-foot-long by 25-foot-high kiln. Nicaragua is a typical case of a country that desperately needs to depend on its own resources and conserve hard currency. Absence of low-temperature fluxes for earthenware glazes, for example, has plagued this group as well. One brainstorming session offered as a possible solution the X-ray diffraction of banana peels as a source of potassium!

Often in developing countries, the appropriate solution is to be found in 50- to 75-year-old technology. Such old information is readily accessible at Alfred University's Scholes Ceramic Library. There, Technical Reference Librarian and VITA volunteer Paul Culley periodically handles requests from VITA headquarters, such as the one from Nicaragua. At Scholes Library, Paul either answers requests through research, or passes them on to experts in the field. The library holds the best collection anywhere of combined materials on art and engineering aspects of ceramics.

It is old information, after all, that is seriously needed in developing countries. What scientists and engineers can do to help is to work towards transfer of skills. A database on old technology does not exist and is seriously needed. Aspiring entrepreneurs in the villages, and workers in development agencies, need to be educated by designers and engineers as to just how essential ceramics is.

In addition, volunteers are needed to evaluate problems and offer solutions. Victor Marvin needs technical advice on diversifying from brickmaking into tiles. The Native American potters of Guaitil, Costa Rica need experiments performed on strengthening their clay body. Donor agencies which do have money, do not have the information about all the possibilities that ceramics offers. For developing countries, self-sustainability in the industry requires its heaviest investment in training and education. On the other hand, the capital-intensive approach has all too often resulted in failed industries and broken spirits.

It is exasperating that for a whole lifetime people in the developing world go without simple information, just because they don't know the possibilities and the questions to ask. Paraguayan potters would never have known about fritting if technical advisers had not been present. In this computer era, such information could be sent in mere seconds by the experts with the answers.

Such old technology, after all, is new technology for much of the world, and offers bright hope in development. Given that ceramic raw materials are widely available, education is the bridge between poverty and industrialization. Through small ceramic enterprise, less-developed countries can bootstrap themselves into the twenty-first century. As ceramic industries progress from low to intermediate technology, the ability to diversify will increase exponentially in these countries. This will create a wide array of new business and trade opportunities that stand to benefit everyone.

Acknowledgment

Photographs courtesy of Bill Castle.

Editor's note: For further information on ways to assist, contact: Paul Culley, VITA/Alfred, Scholes Ceramic Library, Alfred University, Alfred, NY 14802, (607) 871-2492. ■