Round Table

— DISCUSSION —

THE CERAMIC TILE SECTOR IN XXI CENTURY

Take part :

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THE CONTEXT

Other workshops have already considered the probable global tile production trends, necessarily focusing on internal domestic factors such as consumption demands and the consequences of government economic policies, albeit within the larger context of international investments, regional differences, and supply/demand market forces. Such discussions presume that ceramic tiles will remain a competitive material. How competitive will ceramic tiles be with respect to other floor finishes and wall cladding materials? What further technological changes are likely to enable tiles to be manufactured more competitively? What new or significantly enhanced characteristics can be engineered into tiles? What technological advances might enable tiles to be fixed more competitively and in a manner that improves the life cycle performance of buildings? What external threats does the tile industry face, and how can these be most effectively addressed? What changes might be introduced to maximise customer satisfaction and to fulfil unrecognised consumer needs?

Different professions and industry sectors will have divergent opinions. However, common evaluation criteria might include:

- Conservation of resources and minimisation of environmental pollution (from a manufacturing perspective)
- Perceptions of visual quality, hygiene, air quality, thermal performance, acoustics, safety, maintenance requirements and other desirable properties (from a consumer perspective)
- Relevance of product literature, ease of product specification and incorporation of appropriate tiling system details as a part of the project planning process (from an architect's perspective)
- Ease and reliability of installation practices, and consideration of relevant Occupational Health and Safety issues (from a builder's perspective)
- Life cycle performance and associated cost considerations, and flexibility of building use (from a property manager or building owner's perspective)

It is more important that this Round Table should outline the possible technological developments, trends and issues that will have to be tackled in the more distant future.

In looking at likely future changes, you may find it easier to distinguish the 'drivers for change' by using two separate axes or scales. Tile production and tile application issues would be at the opposite ends of a technological axis. Improved manufacturing machinery and innovative control equipment will impact on tile production, as will the introduction of new technologies. On the other end of this scale, we have to consider what will make it easier to fix tiles and to reduce their life cycle costs in the face of other possible changes: improved (and new types of) fixing materials, more demanding standard compliance requirements, the introduction of engineered performance design codes, the availability of skilled tilers, and the consequences of any new building industry requirements or technologies (such as the introduction of new materials, shorter construction cycles, changed construction sequences, improved life cycle performance, greener buildings etc).

Environmental considerations and marketing initiatives would be at the ends of the other scale, reflecting a response to consumer demands (whether generated by fashion or government regulation). These demands will affect the tiles that are produced, the materials they are made from, and how they are installed.

Although it is intended that debate on "The future of the Ceramic Tile Sector in XXI Century" should not concentrate on the likely global tile production, consumption, imports and exports in the near future, you are at liberty to report relevant trends that support your opinions.

A logical aspect would be to use this Round Table as a means of determining the direction of the following one. An initial consideration of the issues that might not be covered in adequate detail within this Round Table suggests that an environmental theme would work very well in 2004. This could look at materials balances (the effectiveness with which materials are used in minimising energy and waste); the associated new production technologies; government environmental regulations and their impact on the industry; the development of new products to cope with changed demands for the built environment, etc. This would make a positive note on which to conclude the Round Table.

Richard P. Goldberg [U.S.A.]

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CURRICULUM VITAE

Richard P. Goldberg, AIA, CSI is a Vice-President of the Architectural & Engineering Services Division of FORCON International, an international design and construction consulting company. Mr. Goldberg is responsible for managing and providing technical consultations to architects, contractors, building owners, product manufacturers, insurers and attorneys. He specializes in ceramic tile, stone, masonry and concrete applications, with a sub-specialty in building envelope systems. Mr. Goldberg is involved in all phases of a building project, from design development to forensic investigations.

Prior to joining Forcon International, Mr. Goldberg served as the Director of the Technical Services at LATICRETE International, a tile and stone installation product company, for 7 years. Mr. Goldberg has over 24 years of architectural and construction industry experience. An Architect by training, Mr. Goldberg was in general private practice of architecture as a licensed architect for 12 years prior to specialization in the tile, stone, masonry and concrete industries. Mr. Goldberg received his Bachelor of Architecture and Bachelor of Science in Building Sciences degrees from Rensselaer Polytechnic Institute in Troy, NY, and has continued professional education at Harvard University Graduate School of Design in Cambridge, MA. Mr. Goldberg holds National Council of Architectural Registration Boards NCARB certification, and is a registered Architect in the U.S. in multiple states. He is a professional member of the American Institute of Architects (AIA) and the Construction Specifications Institute (CSI), and serves as a Vice-President for the Hartford, CT/USA chapter of CSI for 2000 -2002.

Mr. Goldberg is the author of numerous technical articles and books published worldwide. His most recent book is titled Direct Adhered Ceramic Tile, Stone & Thin Brick Facades. This book is considered the authoritative text on this emerging building facade envelope technology. Trade association appointments include the Tile Council of America (TCA) technical handbook committee, the Technical Committee of the National Tile Contractors Association (NTCA), and the editorial advisory board of Tile Design and Installation magazine. Mr. Goldberg is a frequent speaker at global technical symposiums and trade shows such as COVERINGS / International Tile & Stone Exposition, USA, International Masonry Institute IMI, USA and QUALICER, Spain.

THE FUTURE OF THE CERAMIC TILE SECTOR IN THE XXI CENTURY - ARCHITECTURE

There has been a trend towards shorter construction cycles, limit-state design, etc., where it is expected that external and internal wall and floor cladding systems will be installed sooner in buildings that may be subjected to greater movements. What impact is this likely to have on tiling systems ? What can the tiling industry do to minimize any negative effects ?

Shorter, more aggressive construction cycles are one of the most significant causes of problems in the construction industry today, second only to the availability of properly trained and skilled labor. The problem is exacerbated in the tile industry, as the proper adhesion of ceramic tile wall and floor cladding relies on the stability of underlying construction assemblies more so than other, more tolerable and flexible construction materials.

All building materials are subject to different degrees of expansion, contraction, and structural movements during and immediately after construction. Many of these movements dissipate with time and exposure to the elements, with the different building systems reaching their ideal equilibrium states within known periods of time. In many building projects, economic and scheduling pressures require the installation of tiling systems long before the known stabilization period has expired.

The result has been a significant increase in the number of problems attributable to differential movements between tile and the underlying construction assemblies. The initial tile industry response has been development of a plethora of new products aimed at reducing the effect of differential movement. New generations of adhesives and membranes provide significantly increased flexibility and adhesion at the tile and fixing surface (substrate) interface to allow the underlying materials to continue movement to equilibrium without inducing stress on the tile adhesion.

Historically, small tile modules had the advantage of a significant number of joints which effectively absorbed and dissipated differential movements that occurred in new buildings with compressed construction schedules. Today's large tile modules exacerbate the differential movement conditions in new construction, therefore increasing the importance of flexible adhesive interfaces and movement joints in tiling systems. Similarly, both the tile manufacturing and architectural / engineering sectors must focus on the development of more reliable fail-safe configurations that provide mechanical "locking" effect between the adhesives and tile bonding surface (substrate).

It is my opinion that the tile industry must be more proactive in promoting engineering models for tile system installations in order to minimize the negative effects of failures caused by aggressive construction schedules.

Are there any other materials that you see as having technical characteristics that are likely to surpass those of ceramic tiles ?

There have been significant advances in resin-stone composite tile technology in recent years, especially advances in the technical characteristics that allow many new color, texture, surface and other aesthetic options. The flexural strength of resin tile is significantly greater than ceramic tile, which is a desirable quality given the concern over building movement, especially floor deflection. Many of the other physical attributes of these materials are comparable to ceramic tile, although adhesion and dimensional stability of resin tile remains a significant problem under certain circumstances.

If you could obtain tiles with ideal characteristics, what would these characteristics be ?

Certainly one desirable tile characteristic would be in direct response to the problem of aggressive construction schedules and decreased availability of skilled construction labor: pressed tiles with a mechanical locking surface configuration, similar to those available on some extruded tiles. This characteristic would provide for more reliable adhesion performance and wider acceptance on more critical applications such as facade cladding.

Also, a ideal tile would have less rigidity, while maintaining its durability and strength; in other words, higher flexural strength, similar to that of the resin-stone composite tile discussed above. Perhaps new material or additive technology could make this property a reality.

If ceramic tiles were to be given some new property, or made to serve a new function, what would be most beneficial ?

It is my opinion that the future of ceramic tiles would be best served by developing new functions rather than specific properties, as the need to develop new physical characteristics would be driven by the study of new functions and applications. I have long been a proponent of ceramic tile as an external building facade cladding material, but not within the current milieu of ceramic tile products. In other words, exterior facade applications require new tile products which have been developed with that particular function in mind, rather than the current approach of adapting existing tile products to new and completely different functions.

I also believe that there is a future for ceramic tile products as freestanding structural units for use in applications such as mechanically anchored facade cladding and raised interior and exterior pedestal floor systems.

Which ceramic tile characteristics give you the most concern ?

The extremely low water absorption rate of many tile products today, while providing many highly desirable physical characteristics, creates a problem for a material which has traditionally relied on a moderate degree of water absorption to allow direct adhesion with inexpensive cement based adhesives. Similarly, the quality and inconsistency of the bonding surface among different products tends to exacerbate the adhesion problems presented by low absorption. As the water absorption rates of tile decrease, other characteristics must be developed to compensate for the affect of low absorption on adhesion.

Are there any tile characteristics that are too variable and are in need of better control ?

From an architect's perspective, there are two tile characteristics which require better control. The accelerated moisture expansion characteristics of tile provided in tile product literature can often result in problems in critical design applications. Industry manufacturing standards require only 24 hour accelerated testing, yet tile often exhibits significantly higher moisture expansion from long term water or vapor exposure. It is my opinion that the tile industry needs to tackle the general problem of better understanding and communicating the long term performance of their products.

Architects are also concerned and confused with dimensional tolerances. The tile industry should provide architects with a more basic understanding and clear explanation in literature of the effect and consideration of those tolerances on critical designs applications.

What are the major problems that architects have in using tiles ? How can such problems be overcome?

The most significant problems that architects confront in using tiles is specification of proper installation, and insuring suitability of the tile for the intended use. In most of

the prominent large-scale tile installations that I'm involved with, there always seems to be a lack of involvement and concern by tile manufacturers providing information and supporting test data on proper installation and long term suitability. They leave this for the architect and tile installation product manufacturers to figure out, only to find that they do not have the time or the funding to investigate and test the long term behavior of the tile products. My involvement with two recent projects underscore this problem.

In one case, a glazed ceramic tile was marketed as suitable for protected exterior use, only to find that after one year in service, the glaze failed and spalled off the tile. Forensic investigation revealed a significant difference between the rigidity of the glaze and tile body, making the glaze susceptible to failure from repeated cycles of differential thermal and moisture movement. In retrospect, the tile manufacturer could not provide any substantive test data to support their representation that the tile was suitable for the marketed use.

In another case, tile which exhibited acceptable moisture expansion characteristics from accelerated tests conducted by the manufacturer, actually had significantly higher expansion due to prolonged contact with setting bed moisture, resulting in the tile warping and loss of adhesion.

Tile manufacturers must take more responsibility for insuring long term performance of tile products through increased involvement in developing both installation recommendations and procedures, as well as determination of suitability for intended uses.

What changes could be made to standards to simplify the tile selections and tiling specification processes for architects ?

Architects are responsible for specifying hundreds of materials and construction assemblies for each building. While architects are technically oriented, they often do not have the time for an in-depth understanding of technical standards. The tile specification process can be simplified by developing standards which are based on intended applications or performance, rather than a prescription of technical characteristics.

For example, when assessing the suitability of a tile for an intended use, an architect needs to know if a tile will function in a swimming pool or on an exterior facade rather than having to make the assessment based on water absorption or thermal /moisture movement characteristics.

Many tiling system failures occur at the interface between concrete substrates and renders. What building system developments might lead to more sustainable tiling systems?

The performance of tile systems are only as good as the underlying construction. In the U.S., this problem is minimized somewhat by standards and construction procedures which allow placement of vertical reinforced concrete or concrete masonry units within acceptable plumb and flatness tolerances that allow elimination of renders, thus eliminating this potential weak link by allowing tile adhesion directly to concrete with latex cement adhesives.

Understanding this is not a practical approach in many countries, there are several solutions to minimizing adhesion failures at the render-concrete interface. It is quite obvious that careful attention to the surface preparation for, and installation of the render can minimize this problem. This is easier said than done.

Specifically, there are several procedures that have proven successful in increasing the reliability of render adhesion. In Japan, the mortar-concrete rivetback system (MCR) was developed as an inexpensive method of lining concrete formwork with polyethylene plastic bubble sheet plastic. When forms are removed, the plastic leaves an imprint in the concrete which provides a mechanical locking effect for the subsequent application of a render. Similar proprietary commercial systems, also known as controlled permeability formwork, have also been developed.

In addition to products and procedures that are available to improve render adhesion, renders should be engineered and tested prior to construction and monitored during construction as an integral part of an engineered tile system model.

What future initiatives might stop architects from recycling obsolete tiling system specifications ?

Certainly the only initiative which would completely eliminate recycling of obsolete specifications is regulation of architects through license renewal to submit proof of a current specification system. This initiative is somewhat impractical, as many architects prepare their own specifications (as opposed to a automated proprietary system), so there would be no quick and concise method for regulatory agencies to determine currency and accuracy of an architect's (tile) specification.

A more realistic approach would be a tile industry initiative to send registered architects (preferably via the internet) an annually updated master specification for ceramic tile that would be compatible and enable integration into the architect's specification system, whether manual or automated.

What opportunities might the ceramic tile industry benefit from, given the trends towards sustainable construction and environmental protection ?

The most important opportunity for the ceramic tile industry is that tile is a natural and durable material which is compatible with sustainable construction initiatives. Sustainable architecture focuses on local use of materials, energy efficiency in both manufacture and construction, and permanence of construction materials to reduce waste and energy use over the life cycle of a building. The raw materials used in tile, for the most part, are natural, not in danger of depletion, and are not energy-intensive to extract and prepare for tile manufacture.

In cold climates, tile can contribute to energy efficient building, as tile assemblies allow easy integration of radiant heating systems, which are much more efficient than other types of heating systems. In warm climates, thermal lag allows radiation of body heat to cool tile surfaces. Tile systems also contribute to energy efficiency through effective absorption, conduction and dissipation of solar radiation.

The tile industry can also benefit from the need to maintain indoor air quality, as tiles are naturally hygienic and do not allow accumulation or absorption of airborne contaminants or mold growth. Similarly, tiles for the most part are installed with natural cement based adhesives which do not contribute vapors which can affect indoor air quality after occupancy.

Energy use during production of tiles, and use of re-cycled content (raw materials) are the two most important issues the tile industry must address to further benefit from the trend towards sustainable architecture. The production of ceramic tile is arguably energy intensive, and therefore, indirectly contributes to depletion of other natural resources, so the industry must continue its commendable efforts to date in developing more efficient production equipment and procedures. I would defer to the manufacturing and university research sectors to comment on re-cycling initiatives.

To what extent are architects swayed by sustainable construction and environmental protection ?

In the US, there is tremendous pressure on architects in the US to practice and produce sustainable architecture, most recently driven by owner initiatives, and now increasingly driven by consensus standards and government regulation. The primary goals of sustainable architecture are to reduce energy use, waste, and protect the health of building occupants. The construction industry in the US is currently responsible for 35% of the energy usage and 28% of waste entering landfills in the US.

In the US, the Leadership in Energy and Environmental Design (LEED) initiative has developed the LEED Green Building Rating System, the first voluntary benchmark for measuring the environmental performance of buildings. LEED certification is quickly becoming the voluntary standard by which owners can claim the value inherent in sustainable architecture, and in the near future, this system is likely to be adopted and regulated by local, state and federal government building agencies.

Is there a need for the development of a new capability so that tiling systems can be designed using engineering principles, where the design is based on characteristics and expected movements of the specific building ?

There certainly is a need to develop a methodology for quantitative assessment of tiling systems using engineering principles. Only recently has computer analysis of dynamic, non-linear structural systems become cost effective and widely available. Finite element analysis (FEA) is a fairly common but complex mathematical modeling system for simulating a complex assembly's behavior and quantifying stresses and deflections. One closely related use of FEA is for determining the behavior of mechanically anchored natural stone curtain wall cladding systems for the purpose of designing anchorage systems. The variable or non-linear movement of forces, together with the heterogeneous physical characteristics of a natural stone, requires this type of analysis to assure safety. Finite element analysis has also been proven effective in analyzing and quantifying the stresses in a tile system, however, there are no commonly accepted engineering methods currently available that would facilitate development of standards.

As ceramic tile is now used in critical applications, such as external facade cladding, that directly affect the health and safety of building occupants, there is an urgent need to develop engineering methodology and design criteria for tile systems. Constructing critical building systems without engineering substantiation of the performance and safety required under actual service conditions is negligent at best, and a disservice to the advancement of the tile industry. The lack of engineering standards and monitoring of compliance during construction are primary causes of problems in external tile cladding in the U.S. and many other countries. Past QUALICER papers have addressed and proven the viability of applying engineering principles and methodologies to the design of tile systems, and future QUALICER congresses should establish further study and promotion of engineering modeling as a priority in order to assure the future of ceramic tile as a safe and aesthetic material without boundaries.

Doug Adamson [U.S.A.]

Ceramic Tile Consultant (CTC)

Astound! Leadership Group

CURRICULUM VITAE

Mr. Adamson began in the tile business in 1980. His experience of over 20 years includes retailing, wholesaling and contracting ceramic tile and natural stone.

In 1990 Doug completed the Ceramic Tile Consultant tile course and Doug was certified as a Ceramic Tile Consultant (CTC). Later that same year, Doug founded Tile West Distributing, Inc, an exclusively wholesale tile and stone distributor. Over the next several years, Tile West grew into a prestigious tile importer/distributor with locations in Phoenix, Scottsdale and Tucson Arizona, USA until Doug sold the business in 1999.

Doug was CTDA (Ceramic Tile Distributors Association) Education Committee Chairman from 1996-1999 and presently serves on the CTDA Education Committee. Also in 1996, Doug produced and hosted a live national broadcast entitled "Ceramic Tile Live". This live three-hour closed-circuit broadcast featured five tile industry experts who discussed tile manufacturing, characteristics and selling ceramic tile was delivered across the United States to several host sites.

In 1997 Doug co-authored a national tile sales training program (Training in a Box) for the CTDA.

In 1998, Doug authored a book entitled "Principle-Focused Selling". This book addresses sales presentations and processes of retail and wholesale operations.

In 1999, Doug presented "Selling Tile by Design" on behalf of the Italian Tile Manufacturers (Assopiastrelle) at the Tilex '99 show in Sydney, Australia. He also presented "Turning Design Centers into Profit Centers" at the PCBC (Pacific Coast Builders Conference) show in San Francisco, CA. That same year he developed guidelines for tile shade variation that is currently used by distributors and manufacturers around the world. Doug was honored to serve as "Editorial Board" member for Tile and Decorative Surfaces from 1999-2000.

In 2000 Doug made a presentation to Brazilian tile manufacturers entitled "How to Sell Tile in the USA" in Sao Paolo, Brazil. In 2000, Doug began writing for "National Floor Trends" magazine and was also a columnist for "Tile and Decorative Surfaces" magazine.

Doug formed Astound! Leadership Group in 2001. Astound! is dedicated to producing tile and stone education and training materials. Doug's many speaking engagements include national retail organizations as well as a domestic tile manufacturer. Doug was a keynote speaker at Floor Covering International (FCI) National Convention, a featured presenter at the Carpet One National Convention and a speaker at the CTDA annual management convention. Doug also hosted and produced a three-hour session entitled "Ceramic Tile University" presented to a standing-room only audience at Coverings 2001.

Presently Doug writes a monthly column entitled "Tile Insights" for Floor Covering Weekly. Doug is writing and developing new and innovative sales training programs including an international ceramic tile sales certification course covering ceramic tile manufacturing, stone and tile features and benefits, installation and how to use design in the selling process.

THE CHANGING CONSUMER AND NEW OPPORTUNITIES IN THE NEW ECONOMY

Change. Over the past 20 years we have seen a lot of changes in the ceramic tile industry.

- Floor tile has changed from primarily a double-fired product to the rise of porcelain floor tiles.
- Imported tile change to well over 74% of total product consumed. (However, with the availability of so much high quality tile we may question if we are reaching a point of over-supply.)
- As more tile is produced internationally, we experience a decrease in the average price of tile every year.
- Over the past decade we have seen changes in the way ceramic tile reaches the consumer; from the traditional distribution method of manufacturer>distributor> contractor>consumer to just about every form of distribution imaginable. We have seen the rise of the floor covering distributor. We have seen the floor covering retailer gain prominence on the national scene.

The economic changes that we now see were long-developing trends that were already well underway before 9/11. From the longest peacetime economic expansion in history, to a full fledge recession and plummeting consumer confidence. The events of 9/11 have called into question what we value and why. The principle change, however, is the changing consumer:

- She has become more sophisticated
- She has developed an "affluent" mindset and will spend more for perceived value
- She wants her home to reflect her personal style, and fits with her lifestyle
- She wants to buy from someone she trusts and feels they understand her challenges, needs and wishes and meets them in a problem-free way.

Are you willing to change and take advantage of the opportunities in this new economy, or are you content doing things the way we have always done them? For those who want to understand these changes and want to explore the opportunities, we will discuss each of these points further.

HOW DID WE GET HERE?

It's apparent that the US economy is in a recession and, in retrospect, was in a recession before the events of 9/11. "We're fairly far along in the adjustment," said John Ryding, senior economist at Bear Stearns, who figures the recession really started a year ago when industrial production began sinking.

However, significant reduction in interest rates encouraged people to buy homes and the effects of the recession were not really felt in the new home market until very recently. The new home market is important to the tile business for two reasons:

- The importance of the new home market in our national economy
- The amount of ceramic tile sold to the new homebuyer.

Primarily due to this economic "one-two punch", the Tile Council of America estimates total consumption of ceramic tile to be down slightly in 2001 compared to previous years.

NEW HOME CONSTRUCTION

The National Association of Home Builders (NAHB) reports that- "Housing is a powerful force in the economy. Single family and multi family housing construction plus remodeling account for about 4% of the USA's total economic activity, or almost $328 billion USD annually."

56 percent of builders in a NAHB poll said that new home sales had declined since 9/11. The primary reasons that they cited were lower consumer confidence, a weaker economy and job market, and the declining stock market."

Nevertheless, the NAHB remains confident that the housing market will stabilize in the first part of 2002 following a modest decline in the third and fourth quarters of 2001 and that housing is strategically positioned to play a major role in the nation's economic recovery.

ORIGINAL ASSUMPTIONS THAT ARE NO LONGER VALID

Traditionally the tile business has depended heavily upon a strong US economy and strong housing market. In any recession there are winners and losers. Our objective is to work together to win the hearts and minds of the consumer, so we increase market share and as the economy regains ground, emerge a stronger industry overall.

GROWTH OF THE TILE MARKET

Floor Covering Weekly reports "Ceramic's double-digit volume growth for 1999 continued. Sales reached nearly 2.4 billion square feet, besting 1999's 2.1-billion figure — a healthy gain of 12 percent. Dollar-wise, estimates reached about $2 billion, a 6.4-percent increase from the prior year's $1.9 billion. Tile commanded 7.2 percent of overall floor covering volume sold and 9.6 percent in value.

STRONG HOUSING MARKET

The commercial market represents 43.6% of the volume of tile consumed and residential is 56.6%. Of that residential segment, remodeling makes up 56.6%, new home construction, 43.4%. And in a survey among new homebuyers, 55% stated that ceramic tile tub walls were "very desirable."

KITCHEN AND BATH REMODELING

As one retailer stated "when the new home market is hot, we're hot, because a robust new home market is good for the economy." In a NAHB survey in October 2000, remodelers throughout the country report that the two most popular remodeling jobs are kitchen remodeling & bathroom remodeling. Without question, ceramic tile is desirable in both the new home market and the remodeling markets.

DIVERSE DISTRIBUTION CHANNELS

One of the most striking changes over the years has been in the distribution channels. There are so many possible options, that there are not reports on some specific channel. In their "State of the Industry" report, Floor Covering Weekly (FCW) reports on a study conducted by Navigant Consulting.

INDEPENDENT RETAILERS

According to an April 2000 study independent retailers' share of market grew to 18.2 percent or about 418.6 million square feet of tile. The retail dealer has challenges on how to invest in proper, consistent displays, without having their sales floor look like an eclectic array of confusion to the consumer.

HOME CENTERS

Home centers represent about 8.1 percent of the market and 186.3 million square feet of tile. The "big box" home centers have taken note of the inability of many retailers to provide ample floor space for displays. At Home Depot's "Home Expo", tiles are displayed in vignettes and larger grouted panels. Sears has entered the arena with their "Great Indoors" concept, which boasts large, beautiful tile departments and tile vignettes placed throughout many departments.

FLOOR COVERING DISTRIBUTORS

Floor covering distributors represent 2.5 percent of the market or 57.5 million square feet of tile.

TRADITIONAL TILE DISTRIBUTION

A business-conditions survey of members conducted by the CTDA revealed that 63 % of respondents said sales were higher in November than in the previous month. Fifty-three % said sales in November 2000 outpaced those in November 1999. Eighty-four % reported the same or higher average gross profit than in October 2000; 53 percent said it was higher than November 1999.

For now, the tile distributor is still the king of the showrooms. But as alternative sources arise, distributors need to consider how they will continue to add perceived value to the consumer.

PROFILING CUSTOMER NEEDS

CONSUMER NEEDS

People don't buy "things" they buy solutions to their problems. The basic purposes of our enterprises haven't changed. We still need to find out what problems people have today and solve them.

The typically new homebuyer is getting older. In 1995 43.3% of buyers were over 35, with 19.6% 56 and older. In 2010 that number is projected to be 52.7% with 27.8% in the 56

and older category. Demographically speaking, the target market for residential end users included 35-to-44-year-old consumers with a household income of more than $150,000.

The typical baby boomer in the US has been said to have an "affluent" mindset. This is nowhere more apparent than the "stuff" that we accumulate. Self-storage facilities in this country have tripled from the mid-eighties to today. The average home has grown from 1,000 sq. ft. 2 bdrm, one story, and one bath in the 1950's to 2,265 sq.ft. 3 or more bedrooms, 2 _ bathrooms, 2 stories, with 2 or more car garages today.

Consumers are also looking for genuine, real, authentic and personalized. The trend toward personalization is a huge selling opportunity. Ceramic tile is a semi-manufactured product, with the final manufacturing completed on the jobsite. Consequently, ceramic tile is made to take advantage of the trend towards personalization.

It's time for manufacturers and distributors to work together take a more proactive position to meet the needs of today's consumer. The consumer needs visually appealing marketing and merchandising materials, as well as products in the sizes, trims and textures. Manufacturers need to partner with distributors to create excitement for their products and created marketing and merchandising materials that cause their products to stand out from their competitors. As an industry we need to continue to work together and look beyond the needs of the distributor, beyond the needs of the distributor's customer (the retailer and contractor) to the needs of the end user, the consumer. These are a few of the needs that must be met in order to appeal to the consumer:

- Visually attractive displays
- "Consultive" sales approach
- Warrantees on tile and labor
- Ability to visualize the installed product

INDEPENDENT RETAILER NEEDS

Most retail stores have limited display space. Many tile manufacturers have developed several product displays, however, as they aren't compatible, the result is a hodgepodge of displays. The retailer needs a uniform tile display system which includes vignettes, concept panels, floor installations and display boards

- Sales training and product knowledge training
- Marketing and merchandising materials
- Display challenges
- Product samples

- Understand how to utilize tile's design capabilities
- Manufacturer specific product knowledge

DISTRIBUTOR NEEDS

- Quality products
- Timely availability
- Domestic back-up inventory
- Favorable price points
- Visual marketing and merchandising aids
- Tiles in multiple sizes, decos and trim packages

DISTRIBUTOR OPPORTUNITIES

There is a growing need for national and regional distribution. Dealers are spreading out throughout the country, but are not usually interested in stocking truckloads of tile. The distributors function is basic: buy large quantities of tile and sell it in individual orders, while giving great service. As we look to the future, there are specific actions that the tile distributor can take. . The following is from "Facing the Forces of Change", a study of distributors of all types by the National Association of Wholesalers (NAW) and their recommendations.

USE THE INTERNET AS A MARKETING TOOL.

Customers will use the Internet to search for new suppliers. Make sure that you are using the Internet to reach prospective customers. Research which sites customers use. If your competitors are listed on a particular search engine, so should you. Your customers will go to the Internet as well as the phone book. Make sure your ads are in both places. Develop an online version of your product catalogue.

REORIENT THE SALES FORCE FORM ORDER TAKERS TO RELATIONSHIP MANAGERS.

The salesperson is more likely to become an extension of the customer's business than an arm's length vendor selling simple products on a price and availability basis. As your service offering increases, your sales force will need to educate your customers on the best array of value-added services for them.

EXPAND VALUE-ADDED SERVICES.

As customers demand and receive more value-added services from distributors, they begin to expect these services as part of the general distribution offering. You need to understand your customers' changing service requirement. Consider surveying your

customers regularly. Maintain an actively engaged sales force that knows not only which products and services customers want.

CHARGE ACCORDING TO YOUR CUSTOMERS' PREFERENCES

Learn how much it costs you to sell and fulfill products and provide service to your customers. Understand your profitability in each activity so that you can create a service package that will have value to your customers.

TRAIN YOUR SALES FORCE TO LEVERAGE ONLINE PRODUCT AND TECHNICAL INFORMATION

The role of the sales force must go beyond just order takers. The sales force must be comfortable selling through new technology as well as ready and able to teach customers how to gain information and place an order. Sales representatives will need to teach and encourage customers to access a manufacturer's website for product information and marketing promotions.

MAINTAIN OR BUILD A WIDE SELECTION OF COMPLEMENTARY COMMODITY PRODUCTS.

Distributors operating in a coordinated channels scenario will need to maintain their role as provider of economic product assortment to customers. It is critical that a wholesaler-distributor carry complementary commodity products so that customers can get all of their ancillary products from one source. Narrowing down product lines to a few manufacturers or even just one will reduce the distributor's ability to fill certain customer orders.

INVEST IN TRAINING AND RECRUITING TOP-QUALITY SALESPEOPLE WHO MAINTAIN RELATIONSHIPS

A salesperson's relationship with the customer will be critical to maintaining margins and a place in the channel. Successful distributors will expand their local sales force. FCW reports, "... according to Rick Church, executive director of the CTDA 'Carpet dealers know how to sell carpet and vinyl, but they don't know how to sell tile. What we're finding is they need better training.' Church believes this crucial issue could perhaps surpass concern over the lack of qualified installers, a major dilemma in some regions. To that end, CTDA is ramping up a program to train and certify salespeople to sell tile effectively. Independent retailers, by their very nature, have considerable turnover, especially when compared to wholesale distributors. Many of the new hires do not have floorcovering experience, and many do not have any sales experience. This makes the job of delivering education even more challenging. Training cannot be just dispensing product knowledge, as many of the attendees will not know what to do with that knowledge. Tile training must part of an overall program that includes sales training, customer service training, technical tile training, some design training and installation training.

THE IMPORTANCE OF CHANGE

Our economy is changing. As of November 1, 2001 consumer confidence is at a seven year low. We obviously have to face challenges that our generation has not had to face before.

Tile is also changing. Every year, manufacturers have new product offerings. There seems to be a rush towards technology that produces tile that look more and more like natural stone, but with more attractive characteristics. We don't seem to have a challenge changing our products. However, there seems to be a tremendous opportunity in this new economy. These opportunities are all directed all looking to the consumer, and working with distributors to provide the value-added resources to wholesale distribution and retail distributor alike.

Our opportunities seem to revolve around these common needs:

1. Products that provide multiple design options and work well in both form and function and have been designed specifically for American tastes and preferences
2. Displays that are visually attractive, and work together in a store setting with other manufacturers displays.
3. Marketing, merchandising and visual aids such as self-running cd-rom catalogues, tie in with manufacturers web sites, brochures showing lifestyle usage, catalogues that are useful in a showroom setting and tile designing tips.
4. Product knowledge on what makes each product unique and adds value to the sales equation
5. Sales education on how to communicate the value of ceramic tile

So, will you take the challenge? Are we willing to change and take advantage of the opportunities in this new economy, or will we be content doing things the way we have always done them? I say let's work together, manufacturer, distributor and retailer to make tile even more attractive to the consumer. We've come a long way, and by working together, we can accomplish much, much more than ever before.

SOURCES

Floor Covering Weekly, National Association of Home Builders, National Association of Wholesalers, CBS online, The *Agenda* por Michael Hammer

Richard Bowman [AUSTRALIA] - CHAIRMAN

Principal research scientist at
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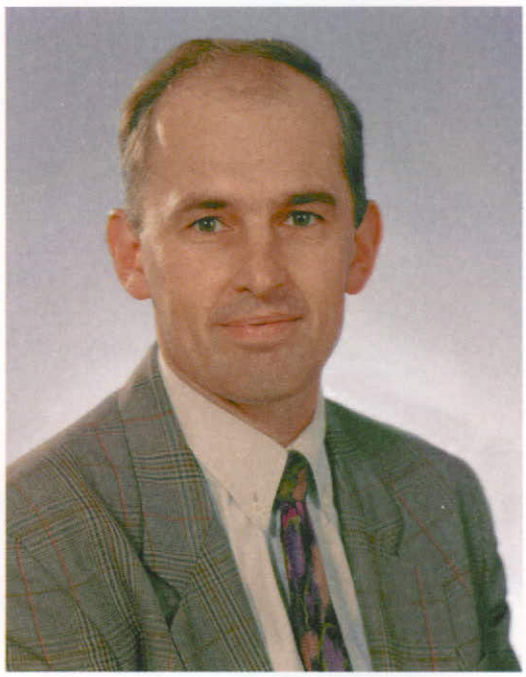

CURRICULUM VITAE

Richard Bowman qualified as a ceramic engineer (1975) and works as a principal research scientist at CSIRO Building Construction and Engineering in Melbourne, where he manages the Sustainable Slip Resistance and Tiling Systems project. His research has focused on the moisture expansion of ceramic tiles and differential movement in tiling systems, but is now more concerned with pedestrian slip resistance. His interests include engineering tile surfaces to improve product performance, particularly from an integrated perspective; the development of process control equipment to assure the slip resistance of tiles; and the evolution of test methods that will better characterise the sustainability of product performance.

CSIRO is the premier Australian Government R&D organisation. It undertakes a wide range of Australia and international collaborative studies with industry and research organisations. CSIRO BCE is the Australian member of CERLABS, provides tile and adhesive testing services, and consults on a wide range of tiling system failures. Analysis of such data is used to identify areas where the industry should take corrective action, and to discern opportunities for product development or system improvement.

Richard chairs the Standards Australia committees on ceramic tiles, fixing of ceramic tiles, ceramic tile adhesives, and slip resistance of pedestrian surfaces. He has led the Standards Australia delegation to ISO/TC 189, Ceramic Tiles, since 1985.

Richard is the principal author of over 80 papers, many of which have a futuristic focus or take a practical holistic approach to educating architects about improved specification practices and optimising the functional performance of tiling systems. He is also interested in injury prevention and is a member of the National Occupational Health & Safety Commission's Research Advisory Panel.

Richard is a past President of the International Ceramic Federation (1995-7) and the Australasian Ceramic Society (1990-4). While he has delivered invited papers at several international conferences, he feels particularly honoured to have been invited to deliver a paper at the inaugural Qualicer Congress in 1990, and then again in 1994.

THE FUTURE OF THE CERAMIC TILE SECTOR IN THE XXI CENTURY - STANDARDS

What will be the major drivers for the ceramic tile and tiling standards this century?

The ceramic tile industry has developed and introduced a vast range of innovations in the last thirty years. Each year the Alfa de Oro prize recognises innovative techniques and products, such as Torrecid's Lamipress technique and Vitrocid product. Technological developments associated with System's Lamina process for production of Sinterflex laminates changed established perspectives. New types of tiles and fixing systems will inevitably change product and fixing standards, the focus of this presentation.

While it is exciting to contemplate what might be achieved in the next thirty years, the tragic events of 11 September 2001 have shown how quickly perspectives can change. An immediate consequence was the postponement of the first full meeting of ISO Technical Committee 189, Ceramic Tiles, since July 1992. Although this ISO meeting will immediately follow QUALICER 2002, its postponement has caused this paper to be more speculative than originally intended.

The major external driver is likely to be the global pursuit of sustainable development, reflecting environmental concerns, based on the need to conserve material and energy resources. Improved sustainable development will require new performance-based standards that cover all ceramic tiles, not just first quality products. Furthermore, there will be a changed emphasis in assessing product performance, in that tiles and tiling systems will need to exceed minimum performance levels throughout their

service life. Sustained performance requirements will also apply to other system components and will impact on adhesives and grout standards, as well as codes of practice for fixing tiles. The global presence of some adhesive manufacturers will also act as driver to potentially unify tile fixing codes.

An element of the sustainable performance driver that is too often overlooked is the absolute necessity to learn from the industry's most insidious problem: tiling system failures. The tile may or may not make a significant contribution to the failure, but whatever the contributing factors are, failures have both an immediate cost and a long-term effect. Since there may be several contributing factors, it is generally the case that nobody wants to accept responsibility and the cost of rectification. Disputes aggravate all parties, but the industry is harmed by aggrieved building owners and architects with damaged reputations. In several instances where the tile has made a significant contribution to a failure, it has still been capable of passing the relevant compliance requirements. This does not inspire confidence in the standards.

Architects, who have had a ceramic tiling failure, will often specify stone or terrazzo for the majority of their projects for the following few years, until they experience failures with these materials. They seem destined to repeat their past mistakes because they are unaware of the underlying causes and potential solutions. The tile sector needs to break this cycle by developing improved codes of practice for fixing tiles, as well as education packages for design and specification professionals, including user-friendly software.

Other major drivers will include superior quality improvement and risk management policies. Increasing consumer expectations will continue to drive established initiatives, such as the need to provide dignified and equitable access. Since ageing of the population will lead to a greater proportion of disabled persons, the 'whole-of-life' or 'universal design' housing concept will influence the design provisions of some national building codes. Bureaucrats are seeking to minimise health care costs, while enabling people to enjoy the security of living at home in comfortable surroundings for as long as possible.

How will the pursuit of sustainable development influence the standards?

The forthcoming ISO/TC 189 meeting will have to consider how the goals of sustainable development might be best achieved. The European Construction Products Directive (CPD) 89/106/EEC mandates that any construction product, which is covered by the CPD, "shall have such properties that the building or structure is able to fulfill specific essential requirements". The following essential requirements shall be satisfied during "an economically reasonable working life":

1. Mechanical resistance and stability;
2. Safety in case of fire;
3. Hygiene, health and environment;
4. Safety in use;
5. Protection against noise; and
6. Energy economy and heat retention.

Since most ceramic tile test methods relate to aspects of durability, safety or hygiene, the CPD essential requirements will influence the European approach to the development and adoption of new standards. Ceramic tiling is covered by European Mandates M/119 Floorings, M/121 Internal and external wall and ceiling finishes, and M/127 construction adhesives, where the mandates refer to all forms of cladding not just ceramics [1]. Hence, about 12 technical committees are independently submitting work programmes. Compliance is required from all construction materials used. **This means that tile standards must also include products that are not of first quality**. ISO/TC 189 must consider how to extend the standards framework to include second quality tiles.

The CPD interpretative documents are a series of Guidance Papers. Each addresses a specific topic such as durability (Paper F) or the use of classes of product performance (Paper E). Given the comprehensive nature of their instructions, it would seem sensible for ISO/TC 189 to delegate the initial development of an appropriate framework for the long-term revision of the product standards to a European subcommittee. In so doing, they would need to anticipate the requirements of developing countries.

CPD Guidance Paper E[2] distinguishes between "regulatory" and "technical" classes of product performance. Threshold levels must not be used to exclude products that are either already legally placed on the European market, or that could be considered fit for some intended uses but not all. Threshold levels must not be used as an arbitrary means of discrimination between products or producers. Competing products shall not be excluded from the scopes of technical specifications, unless there are important and justified reasons for doing so. Where a technical specification covers more than one intended use, different threshold levels may be necessary for each category of use.

ISO/TC 189 may need to differentiate between functional performance and aesthetic issues. The gradual accumulation of scratches on floor tiles might be unsightly, but, depending on where they have been used, it may not impair the performance of the facility. The service life of tiles and tiling systems need to be predicted, although their performance will depend on several factors that might have to be assumed. Condemning a product because it may craze or stain would be counterproductive. When mechanical stresses induce crazing, tiling systems are not immediately condemned, although recognition of such defects may bring about plans for renovation. Third quality tiles might be used in temporary buildings or in facilities that have a short design service life.

The CPD essential requirements reflect changes being made in various national provisions. While the tile sector has still to determine the best means of fulfilling the CPD objectives, the New Zealand Building Code has, since 1992, contained quantitative requirements for the service life of various parts of buildings and for construction products. Most building elements must continue to satisfy the performance of the Code for the specified intended life of the building, if any, or for 15 years. **The CPD also requires products to perform adequately at the end of their service life**. This poses a

[1] WALTERS, W., 'Product Standards: Their strengths and weaknesses', Qualicer 2000, p. G11 – 225.

[2] URL: http://europa.eu.int/comm/enterprise/construction/internal/guidpap/e.htm.

great challenge as many worn products may fail some tests, such as stain, chemical and slip resistance.

Can the current standards provide sufficient information to satisfy any Construction Products Directive design requirements?

The ceramic tile standards use simple measures, both quantitative and qualitative, to characterise new tiles. It is difficult to relate some measures to in-service performance, and thus to predict durability, since products may be subjected to an extremely wide range of conditions. Furthermore, the performance of a tile might be more related to other system components than its intrinsic characteristics. For instance, the impact resistance of a floor tile is influenced by the resilience of the adhesive and the substrate, and the quality of the fixer's workmanship.

There have been very few studies of how products perform in-service, where the degradation factors are measured and any degradation in the product is quantitatively determined. Given vast product ranges, and the short period over which some tiles are manufactured, such studies are unlikely to be widely undertaken unless they are externally funded by industry associations or government grants.

Designers need to have information on durability to meet the building owners' requirements and to develop a rational policy for the durability of the tiling system. Such information should logically be obtained from:

- Experience in the use of traditional materials and fixing systems;
- Certificates assessing the performance of products;
- Research publications, although very few recent publications may be available; and
- Predictions of the service life of products provided by their manufacturers.

To what extent will designers be able to rely on the current practices of reporting compliance with standards?

Manufacturers naturally give top priority to satisfying the needs of their domestic market. INEF Report 54 [3] states "Standards are less important in the tile industry than in many other industries. Product certification does not play much of a role so far, be it technical, environmental, or social standards. Many products are certified according to technical standards, but this does not create a competitive advantage and is not even expected by customers. ISO 9000 plays hardly any role at all. Many firms are certified according to ISO 14000 or EMAS, and they expect that this will be expected by customers in the future; right now, it is no issue". The compliance requirements for many classes of tile are so low that they do not allow manufacturers to establish a competitive position.

[3] MEYER-STAMER, J., MAGGI, C. AND SEIBEL, S., 'Improving upon Nature. Creating Competitive Advantage in Ceramic Tile Clusters in Italy, Spain and Brazil'. INEF Report 54/2001.
URL: http://www.uni-duisburg.de/Institute/INEF/publist/report54.pdf.

Where tiles have been imported, relevant test certificates are rarely available from local suppliers. Several manufacturers state that products comply with the various quantitative test methods rather than providing a specific figure. Some manufacturers will state that their products pass a more demanding compliance requirement than that demanded by the standards. Other manufacturers will report a value, but do not make it clear whether this is a typical value or a minimum value. Product claims are sometimes based on the most recently obtained test results, although some such results can be years old. Furthermore, the product literature provides no indication of variability, and some degree of variability must be expected in any manufactured product. The least slip resistant tile in a batch might cause an accident, but it is unlikely to be included in the test sample. The differences in reporting practices make it hard for an expert to make a meaningful comparison between products. Any presumption that architects and specifiers are only expected to ensure that products comply with some standards, rather than using such data for design purposes, is contrary to the principles of sustainable development.

The situation is also uncertain with respect to tests that are based on qualitative visual assessments, such as the abrasion resistance of glazed tiles. Some claims are exceedingly conservative, whilst others might best be described as optimistic. This may partly reflect cultural differences, both with respect to consumer expectations and the propensity to litigate. Experts can have great difficulty in using technical data sheets to make a meaningful comparison between products. Unless some tests are again conducted, any inappropriate subjectivity will remain unrecognised.

Where the service life of a tile or a tiling assembly has to be predicted, this could be based on a principle of demonstrated effectiveness where identical assemblies have been successfully used in the same environments. If the environment is moderately different, modeling of deterioration processes may be required. Where proven components or assemblies are to be used in significantly different environments, or where innovative tiling systems are to be used, some modeling and testing is likely to be required.

The new ISO 13006 ceramic tile standards are largely based on the old CEN standards. Will they provide a suitable basis for the tiles that will be produced later this century?

Standards, by their nature, tend to be reactive rather than proactive. They also tend to be evolutionary rather than revolutionary, and the process of evolution can take a long time, such that the standards may even be out of date by the time that they are published. When ISO/TC 189, *Ceramic Tiles*, last met in July 1992, the possibility of large thin porcelain sheets was not considered. The development of Sinterflex laminates may require a reconsideration of some of the compliance criteria.

The ISO 13006:1998 system of tile classification, according to water absorption and method of shaping, might be retained. However, further modifications are likely if a significant proportion of tiles are formed by means other than the traditional extrusion and dust pressing techniques. The existing class C, 'tiles made by other processes', potentially covers processes such as plaster casting, pressing of high temperature

material, tape casting, electrophoresis, etc. Class C has no compliance criteria. It may be necessary to develop further classes with appropriate compliance criteria if new production processes result in tiles that have substantially different characteristics.

The recent fabrication of polished tiles has led to higher consumer expectations of planarity. These expectations are sometimes not fulfilled, yet problematic tiles can comfortably pass the surface flatness requirements. The standards need to be revised so that polished tiles have more stringent requirements. The existing surface flatness requirements for large tiles are also far too generous.

The polishing of glazed tiles requires that the definition of a polished surface be changed from 'surface of an unglazed tile which has been given a glossy finish by mechanical polishing as the last stage of manufacture'. The practice of applying a surface protective layer to unglazed tiles, a thin 'vitrified covering which is impermeable', yet is not (officially) a glaze, suggests that the definitions of glaze, glazed and unglazed should be re-examined. Test houses may often be uncertain as to which tests should be conducted, particularly since they should be acting in their client's best interests, which generally amounts to providing the consumer with reliable information. If they consider that a polished unglazed tile is likely to show wear at an early stage, then the abrasion resistance test for glazed tiles is the appropriate test method. It would also be an appropriate test method for determining whether a surface protected unglazed tile is likely to stain before reaching its intended design life.

ISO 13006 requires that tiles and/or their packaging shall bear a mark to indicate first quality. Even though Europe has the CE mark, there is no ISO designated mark for this purpose, or an agreed international convention. Second quality tiles will need to comply with some basic criteria in order to be considered fit for use as construction products. Companies have overcome size variation problems by using up to ten different calibres for tiles of the same nominal size. Since the mixing of different calibres results in poor aesthetics, TC 189 should consider modifying the measuring and marking requirements, so that any potential problems in using dissimilar sizes become more readily apparent.

Do the ceramic tile standards require significant revision, and are further test methods needed?

In adopting the ISO 10545 test methods, Standards Australia introduced some variations. These mainly clarify or improve the procedural details without affecting the test results, and typically reflect prudent laboratory practice. In some instances, the variations extend the test methods to other tile types, but also indicate that some types of tiles may not be tested. Informative annexes have been added to provide interpretative data. Perhaps most significantly, the variations permit reporting of additional observations. The revised ASTM ceramic tile standards also depart from the ISO test methods. ISO/TC 189 needs to consider all such national 'deviations', and to determine what changes are appropriate in order to reconsolidate the test methods. The Committee must also consider the need for new standards to cover salt attack (of unglazed terracotta

tiles) and reverse staining (or watermarking) of glazed tiles. It may, in time, have to determine whether to devise new test methods to assess special characteristics such as photoluminescence or self-cleaning capabilities.

Given the need to determine how products are likely to perform at the end of their service life, **the ISO 10545-7 test procedure might be used to prepare 'worn' tiles for further testing**. The Australian variation to ISO 10545-7 notes that the abrasion test for glazed tiles may also be used with unglazed fully vitrified tiles, particularly those that have been surface treated (to improve characteristics such as stain resistance) or polished. It permits use of white corundum grit that is of nominal F80 size provided that the apparatus is appropriately calibrated (thereby removing a need to confirm that the alumina complies with particle sizing requirements). It permits a practical alternate abrasive load checking method. It specifies a grey shade for the interior of the viewing box, and provides a definition of a darkened room. It provides rational requirements for the observation phase. However, most significantly, it introduces additional reporting requirements: "It is expected that where an independent laboratory conducts this test, that they will report whether there has been a significant gloss change, and, if it occurs, the abrasion stage at which the stain resistance of the tiles changes". While the gloss change may still be subjectively assessed, a proposal will be formulated for instrumental assessment.

Accelerated qualitative wear tests, such as ISO 10545-7, can make light coloured tiles seem to be better than dark coloured tiles. However, soiling of the tiles in-service will accentuate any degradation of a light coloured product whilst tending to mask it in a dark coloured product. While extended surface abrasion test cycles will remove the surface layer of products, the process is one of polishing rather than of grinding or scratching. The latter processes are more commonly encountered in-service externally, or where coarse hard particles are introduced into an internal environment. This is not to say that the simulation is fundamentally flawed, since it is impossible to simulate all possible degradation mechanisms and weathering stresses in the laboratory. It is well known that the polishing process can open up subsurface micropores, so that the tiles become less stain resistant.

Another Australian variation is the inclusion of a comprehensive diagram to facilitate the chemical resistance classification of glazed tiles. Australia has identified a major problem with the chemical resistance classification of unglazed tiles, but it has not taken unilateral action since this could cause confusion internationally. However, prompt rectification is expected: the GATT Technical Barriers to Trade Code permits variations to standards to eliminate deceptive practices.

The unglazed chemical resistance classification is based on three options: no visible effect; visible effects on cut sides; or, visible effects on cut sides, non-cut sides and on the proper surface. In order to fail, the body of the tile (an internal cut edge) must display a visible effect. Where 'protective coatings' are applied to 'unglazed' tiles, chemical attack of the ultra-thin glaze film may change the appearance of the surface of the tile, but the appearance of the cut edge will not change because it was never treated. There should thus be a class "visible effects on the proper surface" since this is the surface that is most likely to be exposed to chemicals.

The chemical resistance standard is further complicated by the statement "If the hue becomes slightly different, this is not considered to be chemical attack", since this determines whether a colour change is a visible effect. How pronounced does the colour change have to be, and how does one know what is a slight difference and what is not? There is now a test method for determining small colour differences, but the use of ISO 10545-16: 1999 is restricted to plain coloured glazed tiles. That standard also notes that it should only be used when small colour differences are important in a specification. Should a polished unglazed tile receive a lower chemical test classification if it loses its gloss? Gloss can be easily measured instrumentally.

There are other inconsistencies that need to be addressed because, as the size of tiles continues to increase, increasing demands that are being made on the size of testing equipment. The test method for water absorption permits tiles with sides longer than 200 mm to be cut into smaller pieces provided that all the pieces are included in the measurement. The modulus of rupture test permits tiles with edges longer than 300 mm to be cut. The crazing test permits exceptionally large tiles to be cut. The frost and thermal shock tests require that whole tiles be tested, where no permission is given to cut the tiles.

An informative appendix to AS 4459-12 (for determining moisture expansion) encourages a most significant variation for analysing failures: 'If the sample being measured is an old tile that is related to a differential movement failure, it is recommended that an initial two measurements be made on each prepared specimen prior to the reheating procedure. The shrinkage that commonly occurs when aged tiles are reheated is highly indicative of the moisture expansion that has occurred since production of the tile. In trying to assess the degree to which moisture expansion has contributed to any differential movement failure, it should be noted that a large amount of the expansion may have occurred prior to the installation of the tiles'. Such guidance is intended to assist inexperienced consultants to interpret test data, so that they do not provide advice that leads to unsuitable claims or unsoundly based litigation.

Do the standards have a positive or negative effect in facing threats from competitive products, such as stone and terrazzo tiles?

Standards that have demanding compliance criteria tend to defend products against competitors that might be assessed against the same criteria. Architects favour the harmonisation of test methods that allow direct comparison of performance. Stone tiles are poorly covered by standards, but this is changing with the development of EN standards. While standards are predominantly reactive, industries need proactive standards committees in order to best compete with other materials. Where industries can determine that first and second quality products comply with the essential CPD requirements, they will have an advantage over industries that cannot.

Recent technological developments have improved the quality of terrazzo tiles. This quality is typically assessed using standards produced for testing stone and other materials. Have the test methods been selected so that compliance is undemanding? Will the cement-based and polymer-bonded terrazzo tile manufacturers unite to form terrazzo product standards? How will they demonstrate that their first and second quality

products will continue to comply with the CPD essential requirements over their designated service life?

When testing abrasion resistance, terrazzo manufacturers have chosen to use the EN 102 deep abrasion test, the old ASTM C241 test for stone or ASTM C501, the Taber test for ceramic tiles. Unlike the EN 154 and ISO 10545-7 classifications for the abrasion resistance of glazed tiles, few architects readily understand the significance of the Capon and Taber test results. Many terrazzo products perform poorly when subjected to ISO 10545-7. Terrazzo manufacturers may also prefer not to use this test because it requires products of each colour to be assessed.

Why have there been so many difficulties in developing an ISO standard for slip resistance?

The World Trade Organization now administers the General Agreement on Trade and Tariffs (GATT) Technical Barriers to Trade Code. The Code permits variations from the ISO technical requirements on a number of grounds, including human health and safety. The CPD Guidance Papers recognise that Member States are responsible for ensuring that building works on their territory are designed and executed in a way that does not endanger the safety of persons, while respecting other essential requirements. Guidance Paper E also recognises that national design provisions vary throughout Europe because of, *inter alia*, differences in the philosophy of regulation, the definition of criteria and the required levels of protection. In the short term, harmonisation of such provisions is not foreseen. Differences in geographical or climatic conditions or in ways of life can also lead to justified differences in national provisions, which cannot be harmonised.

Standards are intended to protect the consumer. If the protection is inadequate, either the consumers or the Government or some other body will take action. Given that the CPD requires that products should be slip resistant at the end of their service life, the problems surrounding the measurement of slip resistance provide an excellent case study of some of the aspects of international standards development and adoption.

ISO/TC 189 Working Group 1, *Ceramic tile test methods*, failed to resolve difficulties with the draft of ISO 10545-17, the test method for coefficient of friction. These difficulties fundamentally arose because of different national provisions and approaches. The coefficient of friction test method was dropped from the ISO list of tests in November 1999, but is being pursued within Europe as prEN 13552, with the same text as before. However, there does not appear to have been any significant progress.

In Germany, the floors in workplaces must comply with the specific requirements that have been established for various work environments, before companies can obtain workers' insurance coverage. These requirements, which are based on the DIN 51130 oil-wet ramp test, have been found to provide adequate worker protection.

In Italy, DPR No. 236 (14 June 1989) stipulates the use of the Tortus for ensuring that the floors in the shared or public areas of private residential and non-residential buildings

are not slippery. Although the British developed the Tortus, the UK Health and Safety Executive (HSE) has refused to accept its use, particularly in the wet. Australia proposed the inclusion of the Pendulum as a compromise, recognising that this was the preferred test method in the UK and Australia (for the more critical wet testing). Legal disputes in the UK had traditionally seen the manufacturers defending their products with high Tortus figures and injured plaintiffs basing their cases on low Pendulum readings – a classic manufacturer versus consumer scenario, where the UK Slip Resistance Group[4] has ultimately adopted the Pendulum. While it might be seen as a case of Government (HSE) influence having determined the outcome in favour of the consumer, it should be seen as an instance of a more reliable test method being adopted, where it provides both parties with a common test method that allows them to exactly determine their position.

In addition to the proposed use of the ramp test, the Tortus and the Pendulum, the draft ISO standard also contained a modified version of the ASTM C1028 test method (where the 22 kg weight was replaced by a 4.5 kg weight for occupational health and safety reasons). These test methods are based on the use of a manually operated horizontal pull tester, which ASTM Committee F13, *Safety and Traction for Footwear*, considers unsuitable. ASTM Subcommittee C21.06, *Ceramic Tile*, has been persuaded that the wet test method is not reliable and is revising the test method to apply to dry conditions only. Any decision as to which of the ASTM slip resistance standards should be adopted for wet testing ceramic tiles has been deferred.

Protracted feuding between advocates of different test devices led the ASTM Board of Directors (BoD) to form a special Task Group on Slip Resistance to develop an action plan to help resolve issues. The most recent proposal was to determine a relative ranking of products using standardised surrogate surface reference materials that represent the range (low to high) of pedestrian slip resistance situations[5]. Following a detailed procedure, a valid test device would be required to rank these material sets in the proper order, and in doing so would develop a calibration curve. Once generated for any apparatus, this curve might be used, with the reference set of surfaces, to verify the instrument or measure the relative slip resistance of other surfaces.

Recent CSIRO work[6] suggests that this may not be technically feasible. A study of ten ceramic tiles using twelve variants of six test methods revealed that some commonly used test methods (ASTM C1028 and F1679) gave poor correlation when compared to human subjects walking on the ramp (DIN 51097 and 51130). The Pendulum with TRRL rubber was the best-performed portable apparatus. Somewhat ironically, ASTM E303 covers the use of the Pendulum with TRRL rubber, but this equipment is so little used by American slip resistance experts that nobody could operate it at the 1991 Bucknell workshop[7]. Interestingly, the Pendulum with TRRL rubber has recently been adopted for

[4] UK Slip Resistance Group, 'The Measurement of Floor Slip Resistance. Guidelines Recommended by the UK Slip Resistance Group', Issue 2 June 2000, circulated by Rapra Technology Limited, Shawbury, Shrewsbury, Shropshire, UK.
[5] DI PILLA, S., FLEISHER, D. AND MARPET, M.I., "A New Approach to the Development of Pedestrian Slip-Resistance Standards", Proceedings American Academy of Forensic Sciences Annual Meeting, Seattle, WA, February 19-24, 2001, p.90.
[6] BOWMAN, R., STRAUTINS, C.J., WESTGATE, P., AND QUICK, G.W., 'Seeking the Benefits of Real and Sustainable Slip Resistance Results', *ASTM STP 1424*, in press.
[7] MARPET, M., Comparison of Walkway-Safety Tribometers, *Journal of Testing and Evaluation*, **24** (4), 1996, p. 245.

the EN 1341 and 1342 external paving stone standards. The UK Slip Resistance Group[4] recommends the use of the TRRL rubber in the pendulum where the general roughness of the floor surface is greater than normally found in internal flooring situations.

As Rowland[8] stated "Much time and effort has been expended on comparisons between machines and arguments for and against dynamic and static friction measurement, without success. Yet regardless of this well documented confusion there is a desire by those who do not have in depth knowledge of the problem, to have one instrument which will give one reading which will cover all situations for all floors, all shoes/heels, all seasons, all contaminants, all ages, all infirmities, in fact for everybody, anywhere, anytime. It is perhaps now time to forget the much sought after and now obviously mythical 'universal test machine' that will, with one result tell us all we need to know, and concentrate on a composite solution which in itself might be quite complex". The need to devise foolproof systems, that are likely to be closely examined in court, is incompatible with the desire to devise simple provisions and guidance that will be readily understood.

Given the wide range of surfaces that may be encountered, all the slip resistance test methods have limitations, although the significance of the impact of these limitations can vary greatly. Such limitations must be identified so that they can be widely recognised. On surfaces where the results may be unreliable, devices can either be excluded from making measurements, or supplementary measurements may become compulsory.

The Ceramic Tile Institute of America Slip Resistance Committee[9] considers ASTM C1028 to be an inadequate test method. It has also identified that some authorities have recognised its inappropriateness. Exemplifying a market pull reaction, to determine what will best fulfill consumer requirements, the CTIOA is considering the use of the variable-angle ramp test methods (and the associated German safety standards), as well as the Pendulum and Tortus as portable test devices.

What will drive further developments of the slip resistance standards, and will there be any spin-off developments?

The major import markets tend to be quite litigious and to have increasingly high expectations for dignified and equitable access for the disabled. Furthermore, the CPD effectively requires that products will have to have adequate slip resistance at the end of their service life. The need to predict the slip resistance of worn products will be a major driver. The need for accurate assessments of available traction will be another important influence. An associated research goal will be the development of process control equipment that assesses whether tiles have acceptable levels of slip resistance as they exit the kiln. This might be achieved by a suitable packaging of optoelectronic measuring systems and intelligent software, but is ultimately dependent on the ability to distinguish between the available traction provided by closely related surface textures. This ability will lead to the improved design of slip resistant surfaces that are relatively easy to clean.

[8] ROWLAND, F.J., 'Recent HSE Research into the Interface Between Workplace Flooring and Footwear'. 5th NOKOBETEF Conf. on Protective Clothing, 5-8 May 1997, Denmark.

[9] SOTTER, G., Sotter Engineering Corporation, personal communication, December 2001.

In 1997, Jess McIlvain stated[10] "Based on more than 14 years of testing ceramic tile and marble floors where people have slipped and fell and filed litigation, I have found that the static coefficient of friction usually exceeds 0.6, and some exceeded 0.8 when the floors and walkway surfaces were tested according to ASTM C1028. None tested less than 0.5. People who fell in these litigations included both able and disabled persons. In each case, floors were contaminated with water, ice, snow, grease, dust, dirt or some sort of spillage. In some cases, shoes worn by the plaintiff provided no more slip resistance than bald, worn-out tyres on an old automobile".

This quotation reinforces the need to adopt not only suitable test methods, but also appropriate compliance criteria. The 1990 Americans With Disabilities Act (ADA) ruled that the minimum static coefficient of friction for accessible floor surfaces would be 0.6, and 0.8 for ramps. Significantly, the ADA failed to nominate a specific test method. Interestingly, recent ASTM standards (F1677, F1678 and F1679) do not measure static coefficient of friction, and Committee F13 is in the process of introducing variable angle ramp tests. Historically, the ADA requirements were based on the work of Buczek *et al* [11], who measured the traction demand of nine disabled and five able-bodied volunteers as they walked across a force plate. There is a significant difference between determining traction demand (the slip resistance that individuals 'require'), and using test devices to indicate the 'available' slip resistance, where the indications may vary greatly. Compliance criteria must be related to the test device that is being used. Any change to the ADA stipulating a specific device would have a major effect.

The available traction is as much a function of the footwear as it is of the floor surface. Alvin Hyde[12] wrote 'One needn't be a Nobel laureate to realise that the friction coefficient of a floor is of little consequence when it is trod upon by a slippery-surfaced shoe sole or when there has been oil or water spilled upon the floor. In short, the measurement of and specification for only one of the two surfaces that contact each other appears to be an exercise in near-futility. If you must specify friction coefficients for floors, you should also specify them for shoe soles; and if you do not or cannot do so, please don't take your one-surface requirements too seriously, because no matter how hard you may wish for them to determine whether or not a pedestrian will slip, by themselves they simply cannot do so'. In preparing forensic evidence for litigation, there appears to be an increasing trend towards considering the contribution of the footwear, as well as the predisposition of individuals to fall. Further multidisciplinary research could significantly benefit tile manufacturers. The ASTM BoD Task Force envisages a standard for footwear that is again based on a relative ranking of products.

CEN/TC 134 is proposing that resilient floor coverings, which are not intended for use in areas that will become wet, will only have to have dry slip resistance measurements. Resilient safety products will have to have wet slip resistance measurements.

[10] 0MCILVAIN, J., 'Confusion Continues to Reign Over Slip Resistance', *Tile & Decorative Surfaces*, February 1997, p.38.

[11] BUCZEK, F.L., CAVANAGH, P.R., KULAKOWSKI, B.T., AND PRADHAN, P., 'Slip Resistance Needs of the Mobility Disabled During Level and Grade Walking', *ASTM STP 1103*, 1990, p.39.

[12] HYDE, A.S., Accidental Falls: Their Causes and Their Injuries, HAI, Key Biscayne, FL, 1996.

CSIRO has been using the ISO 10545-7 surface abrasion test to prepare worn areas on tiles to assess how their slip resistance may change with wear over time. The slip resistance has been assessed using a laboratory based SATRA[13] STM 603 device since it can make measurements on the small (80 mm diameter) abraded surface

Are there any other problems with slip resistance or their Standards?

There are several other factors that influence the measurement of slip resistance that potentially complicate the real world application of the Standards, but this is too complex an area to consider here. Any standard that is adopted should recognise that all the test methods have inherent limitations and provide some cautionary advice.

The balance and independence of Standards Committee members deserves consideration. ASTM Committee F[13] has a turbulent history and faces further interesting times. The Committee has over 250 members. ASTM has overturned meeting outcomes due to disproportionate attendances by biased interests. The members have recently elected a new Chairman and First Vice Chairman, both of whom are Certified XL Tribometrists [14]. Their candidature was supported by William English, manufacturer of the XL Variable Incidence Tribometer [15], which is covered by ASTM F1679. English's Newsletters take a very adversarial position: "I appreciate all of the complimentary remarks from users concerning my part in the slipmeter war, but without you faithful loyalist voting in the standards committees, I could do nothing". While we are all entitled to our opinions, standards should be based on scientific findings rather than commercially influenced rhetoric and biased committees. If the world is to accept ASTM standards, the Board of Directors must ensure their integrity.

Another major problem is with the variability of the slip resistance of the tiles produced. The slip resistance of new tiles has been found to vary, sometimes dramatically, within batches of tiles, between batches of the same tile, between batches of different sizes of the same tile, and between different coloured tiles within the same product range. Yet when it comes to tile selection, the architect is generally only given a minimum compliance figure or a single classification. This indication applies (supposedly) to all the sizes and colours within a product range. The reporting of a classification, by itself, does not indicate whether a product is at the top or bottom of the range, and this may make the architect's task even harder. Furthermore, product literature provides no indication as to how the slip resistance is likely to vary with wear.

The draft ISO standards for ceramic tile adhesives and grouts are nearing publication. Are they likely to stand the test of time?

The draft ISO 13007 standards provide unambiguous classifications of the different types of adhesives (cementitious, dispersion and reaction resin). New types of adhesives (possibly coatings applied to membranes, or products that may require application of some chemical or thermal treatment in order to initiate adhesive characteristics) may require the preparation of new standards. While the draft standards make no provision for testing proprietary organic additives, the manufacturers of such products should be able to test them to the same standard. However, they should clearly state the composition of the mortar mix to which the product was added. This should even detail the type of

[13] URL: http://www.satra.co.uk.
[14] URL: http://www.englishxl.com/cert.html.
[15] URL: http://www.englishxl.com/xl.html.

cement that was used, as the types and qualities of cements vary globally. It has proven impossible to achieve the bond strengths that have been published in locally distributed product literature, using the cements that are utilised for tiling in some countries.

The use of concrete substrates for determining adhesive tensile bond strength is of some concern, as the concrete properties will inevitably vary. The potential strength and open time are a function of the water absorption rate of the concrete, given that the environmental conditions are closely controlled. Sensible manufacturers will test on a wider range of concretes to ensure that their products will still perform adequately. This will also enable limitations to be identified and appropriate warnings to be issued.

Some national regulatory authorities require, as a building quality control measure, that pull-off tests be conducted 28 days after tiles have been installed. Subsequent tests may reveal a progressive loss in strength if differential movement is occurring within the tiling system. There may be a need to develop a test for the long-term drying shrinkage of adhesives, particularly for thick-bed products.

Tiling system failures are caused by a combination of both shear and tensile stresses. Since the Standard does not require the determination of both types of stresses, the test results are not well suited for engineering design purposes. However, it should be noted that the design of tiling systems is still based on empirical experience rather than engineered solutions. The sustainability of a tiling system is a function of its design, the materials used, the quality of the workmanship and the stresses that it is ultimately subjected to. While a significant body of research must be conducted before one can envisage the engineered design of tiling systems, some adhesive manufacturers have been very reticent about providing test results. Past experience suggests that a specifier is only expected to ensure that products comply with the standards rather than using such data for design purposes. Although the absence of test data makes it difficult to compare products, the more explicit definition of specific adhesive characteristics should assist specifiers to select products that are most appropriate to the intended application.

Do you foresee an international code of practice for fixing ceramic tiles?

There appear to have been some problems in developing a European code of practice for the fixing of ceramic tiles. National codes of practice have evolved reflecting traditional building practices, whilst accommodating regional differences. AS 3958.1:1991, *Guide to the installation of ceramic tiles*, was based on the ANSI and BS 5385 standards, but reflected some local building practices and materials. Given the increasing usage of ceramic tile adhesives and the global presence of some manufacturers, there is no reason why a common code could not be developed, where countries might be permitted to retain existing practices as national variations. The code should be frequently reviewed where the intention is to continuously improve it, whilst also progressively reducing the number of variations.

The use of very large tiles is placing increasing demands on how other trades prepare backgrounds. There have also been concerns about external fixing of wall tiles on tall buildings, and this is partially covered by different national provisions.

Spain[16] has provided the most logical approach to developing guidance for architects and specifiers. The "Ceramic Tile Guide"[17] involves a functional tile classification, which gives two numerical identifiers and up to three alphabetical identifiers based on the dimensional characteristics, mechanical characteristics, and additional characteristics (chemical, frost and slip resistance). Tiles are selected for specific building domains (rooms and areas associated with different classes of buildings), where each domain establishes minimum requirements for either floor or wall tiling (based on the desired grout joint size: less than 3 mm, or 3 mm and greater). It also provides guidance on finding the appropriate tile installation technique, considering the intrinsic characteristics of the backgrounds, substrates, movement joints, bedding technique and materials, type of tile, and selection of grout and back-up materials. Related software is being developed where inputting the domain details will provide the best tile installation solution, without the fixer or merchant having to remember tile characteristics, as these are implicitly expressed in the tile code.

The Spanish system imposes more stringent dimensional tolerances than ISO 13006, particularly on large format tiles. It also goes beyond ISO 13006 in recognising the need for testing stain resistance and gloss loss after determining abrasion resistance of glazed tiles. It also requires some additional characteristics that are common to all uses, such as crazing and stain resistance, and a maximum moisture expansion of 0.06%.

Is the composition of the ISO/TC 189 committee likely to harm developing countries?

In past meetings, Italy, Spain, UK, Germany, France and the Netherlands consistently represented Europe. The rest of the world was principally represented by the USA, Brazil, Australia and Canada, with Italy having the Chinese proxy vote. It is hoped that China, Japan, and several other countries will participate in future meetings. At the outset, the Europeans and Americans appeared mutually suspicious, but meetings became far more harmonious. Where conflict arose, Australia suggested compromise solutions, seeking to adopt the best aspects of both the European and American standards. Given that Australia has imported 85% of its tile consumption for the last 20 years, and recognising that consumers already expect first quality tiles to exceed the current requirements, Australia has advocated more demanding test methods and compliance criteria. In the recent adhesives meetings, countries unanimously sought to eliminate poorly performing cementitious products that are unsuitable for fixing porcelain tiles.

Many developing countries have purchased modern tile manufacturing plants that are capable of producing tiles that comply with ISO 13006. The local market is absorbing any second quality tiles. In the case of adhesives, many traditional fixing practices, such as using neat cement, are inappropriate for porcelain tiles. However, it is conceivable that the forthcoming adhesives standards will need to be modified to include lower class products that have traditionally proved suitable for fixing higher porosity tiles. This may also be driven by the need to comply with measures such as the CPD.

[16] PORCAR, J.L., "Tile Installation Project. A Spanish initiative for quality tiling', Qualicer 98, p. G1 – 119.

[17] URL : http://www.ascer.es/es/gbc.pdf (disponible únicamente en español).

The stipulation that frost resistance testing of adhesives as a mandatory rather than an optional requirement penalises manufacturers of products intended for use solely in hot climates, particularly in countries where there is no frost testing capability. However, the GATT Technical Barriers to Trade Code permits variations to international standards based on fundamental climatic or other geographical factors.

Just as European has sufficient representation at meetings to influence the content of standards, there are enough developing countries to dominate the final postal voting on any standard. However, it is the responsibility of all countries to ensure that the standards are to the greatest common good.

In conclusion, as with any other business activity, standards developers need to formulate strategic development plans that reflect quality improvement and risk management policies that will benefit the industry. ISO/TC 189 needs to plan how to modify the ISO 10545 ceramic tile standards. In the short term, it must address any recognised weaknesses, particularly where these have resulted in national variations. Change is continuous, and ISO/TC 189 must become more reactive so that the standards can be modified in a timely manner to reflect recent developments, such as the evolution of new products. There is an immediate need to provide architects and specifiers with better guidance. In the longer term, ISO/TC 189 must also tackle how to revise the test methods and compliance requirements in order that the results might provide better service life predictions, in line with the need for sustainable development.

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Gianpietro Mondini [ITALY]

Chairman of the Board of Cooperativa Ceramica d'Imola

CURRICULUM VITAE

After taking the Technical Course at the State College for Ceramic Art at Faenza in 1970, Gianpietro Mondini entered the firm Cooperativa Ceramica d'Imola, where he started working in the technical laboratory. He became a member of this organisation and for 9 years held a position of responsibility in production.

In 1987 he was chosen as a member of the Board of Directors, and became Chairman of the Board in 1990. Under his Chairmanship, Ceramica d'Imola reached new heights, both with regard to turnover, going from 130 thousand million liras in 1990 to 369 thousand million liras in 2000, and to the number of jobs: in the same period the number of workers went from 648 to 1197. The total number of persons currently working for the Cooperativa Ceramica d'Imola Group, established in 1991 on taking over and relaunching three other ceramic companies, is 2000, while the current turnover is over 600 thousand million liras.

In the context of Imola, the Group has been the driving force behind various initiatives of an economic, non-profit nature, which have led to the creation of several hundred jobs.

Gianpietro Mondini is also Chairman of the Assopiastrelle Centre for Studies.

In the first place, I should like to remember with gratitude and emotion, here in this country, José Soriano Ramos, a great ceramist, a great man and a great friend.

One could respond in a summary way to the question posed in this meeting, precisely by observing the work done by a man, a businessman who loved life and work, driven by a passion for beauty, good and what is authentic.

When a man has this humanity, he also possesses the necessary entrepreneurial creativity to reach unexpected goals and open up new avenues, not just with regard to his own activity, but for all his sector.

Passing now more concretely to the issue at hand in this meeting, I would like to highlight a few points.

1. The migration of the manufacturing sector, including the ceramic sector, from north to south in the world has been gradually accelerating. In the north of the globe, districts that compete in the markets involved continue to hold their own by offering products with ever greater aesthetic and technological quality, for an international public with medium-to-high purchasing power. To be able to act as qualified suppliers to this public, it is necessary to meet the following requirements:

a) Be able to offer different technologies, from porcelain tile in its different evolving forms, to single-fired tile and wall tiles.

b) A wide range of types.

c) Become day by day, more and more, the client's stockist and be able to deliver according to sale (at present 75% of the deliveries consist of merchandise that does not fill a pallet).

d) Establish a before and after-sales service also for the contractors.

e) A training system linked to the traditions of the country involved, capable of finding support and follow-up in branch companies.

2. In the big cities, non-traditional construction technologies, such as the mechanical mounting on site of prefabricated elements, already account for over 75% of building. I do not know the exact dimension of this market, which I would call "Architecture", and which in terms of internal, external walls and flooring can be estimated at thousands of millions of m_. It should be noted that in this huge market, traditional ceramic products are still infrequently used. In fact, this building system, which includes curtain walls and raised floors hardly absorbs 5 million m_ of tiles. If we also wished to add to this tacit potentiality steps, handrails, windowsills and tilings, we would have the illusion of a limitless market. An enormous step has already been taken with full body porcelain tile, in private as well as in public building construction (shopping centres, hotels, airports, schools, hospitals, banks, etc.), with an estimated consumption of about 250 million m_/annum. One can do much more, but it is not easy to evolve from expert ceramists to the tile selection department of systems suppliers.

In fact, when we speak of raised flooring or facade systems, we find ourselves faced with issues that not only relate to production and sales, but which pose problems concerning design and tile installation, which cannot normally be solved by the usual commercial structures.

The companies that wish to pursue such objectives need to be equipped internally with technical structures capable of managing projects, presenting the planners with images of the expected results of the work after the installation of the floor or wall tiling, by means of photo simulations.

The same companies will then need to seek collaboration with companies from the technical raised floor and facade tiling sector, able to provide the specific technical support for the design and installation of floorings or facades, whose finish consists of ceramic tile or large-size, full body porcelain tile.

In particular, facades require a design that presupposes knowledge of the static resistances, as well as of the location of the building where the tiles are to be installed, in order to be able to calculate whether this building will be able to withstand the added weight contributed by the tiling, of about 40 kg/m2, and whether the structure to be installed is appropriate and able to resist the possibly arising stresses caused by the wind; in fact it is necessary to keep in mind that in different areas of the planet, wind speeds can exceed 250 km/h, generating very important stresses in the tiling, which can ultimately cause its collapse if the cladding has not been designed with all due precaution.

EXAMPLE FOR CURTAIN WALLS

A) Study of the project with the planner and the building manager, definition of colour and size.

B) Preparing the executive project with static calculations.

C) Machining the product for monocalibre.

D) Lodgings for tile fastening to the substructure.

E) Adhesion of a fall-proof safety net.

F) Metal supporting substructure.

G) Eventual thermal insulation.

H) On-site assistance.

Up to this point I have described what we are doing, in an already consolidated way, though at the same time open to ongoing developments and new frontiers.

Now I should like to briefly sketch the horizons toward which research is heading.

1) With regard to external or internal walls, always in terms of non-traditional building construction, we have already experimentally produced very large size tiles only about 3 mm thick, made by pressing (System) and tape casting (a branch

project conducted by Cooperative Ceramic d'Imola), which still requires more studies on tile installation systems, such as laser centring systems, applied by a pressure stud-type technique, enabling wall disassembly, inspection or relocation.

2) Finally, regarding floorings, at the moment systems are being studied of tiles with added thickness (high acoustic absorption and thermal insulation) which are self-blocking, for dry fixing on the deck with a self-levelling system, providing for easy tile installation and allowing removal of the flooring with equal ease.

The foregoing underscores the importance, for continuously evolving research and industry, of having the support and backing of an equally valid training and education system.

1. If we ask ourselves what the expectations of the working world are in relation to the school, we need above all to define the scenario in which companies have to operate, which is the so-called market globalisation, where companies not only have to compete with individual companies, but also with districts and the system "Country". We could compare the current context with a kind of Olympic Games, or perhaps rather with a permanent world championship, since the key issue is not participating, but winning. As the sports world teaches us, the winner is the one who is backed by a strong organisation, with a team spirit, clear shared objectives, devotion to the flag, and personal responsibility together with a winner's mentality.

2. Many companies ask themselves whether they should take their production abroad or valorise to the utmost the quality of European manpower, perhaps the best in the world. It is evident that we cannot compete in the commodities market, however we can continue to lead where, besides technology – which can be bought by anyone - the need exists of a factor, let us call it cultural, which is the fruit of a tradition, of a culture that cannot be bought, but only absorbed by "osmosis". The fashion industry provides a significant example of the quality of the work "made in Italy", manufacturing the normal low cost, though good quality product in the south of the world, but making the high quality product in Italy.

3. Historically, the manufacturing sector has moved from North to South. At the moment, this process, which has taken place very slowly in the previous two centuries, has taken on great speed, with possibly very negative effects for Europe, and evidently with different situations from one country to another. Indeed, the global labour market not only tends to move production to where manpower costs are cheapest, but also indirectly gives rise to lower wages in the industrialised countries. The result is the "exportation of wealth" and the "importation of poverty", since the workers enter into a wage competition with workers from developing countries, making them poorer twice over, since they also have to face the higher cost of life in the opulent cities.

4. If what has just been set out actually is the current context, a good training system is vital. Our education system appears to focus on adopting models, which in the United States, their home country, are already the target of severe criticism. Paradoxically, in a country where there has always been strong criticism of the United States, their educational model is being followed, a model which according to foremost scholars ends up by depriving students of a true cultural base and critical capacity, the only thing that enables us to address problems

starting out from a comprehensive vision, and hence to be really creative and constructive. That model can be defined as a kind of a cultural-educational "Fordism."

The adoption of training or educational models that fail to take into account the specific characteristics of our countries and their culture, including that of the work culture, can be very dangerous and full of negative consequences. We need a training system that allows us to go on being a winning industry in the manufacturing sector, by virtue of a widespread entrepreneurial spirit and high degree of specialisation, capable of offering high-tech products to that market segment of more than a thousand million people with high purchasing power.

5. I am personally convinced that he who leaves school with a solid cultural base can fit more readily into a specific context, developing the acquired knowledge toward more and more specialised forms. On the other hand, the continuous technological changes demand a mental attitude open to ongoing training, and thus is indispensable in a country whose "work culture", understood as taste and capacity for work, creativity and widespread entrepreneurial spirit, is its trump card.

6. Of course, schools cannot provide training in all the skills that a company needs. The cultural base that it provides or should provide logically needs to be supplemented by in-company training. According to the experience of Cooperative Ceramic d'Imola, internal training plays a fundamental role and it absorbs important human and economic resources (internal training also carried out in collaboration with Universities, Research Centres and specialised companies). In the last four years we have dedicated some 56,000 hours to training, of which 31,000 were devoted to teaching people about to enter the company the necessary skills. Besides these hours of training, formally set out in ISO 9001 management, it is necessary to include about the same number of hours spent together with staff in the department or in the office. For this four-year period, the estimated expenses borne by the company are assessed at one million five hundred and fifty thousand euros.

   Other even more significant and concrete examples of such collaboration are the Sassuolo and Castellón districts, where higher education institutions, specialised University degree courses, and Research Centres highlight the pivotal role of these structures in a positive osmosis college-work-industrial growth.

CONCLUSIONS

I hope to have made a real contribution concerning what is being done and what can be done in the future, so that in the north of the world the ceramic manufacturing sector will continue to hold its own and develop, seeking innovation with fantasy and creativity, thus continuing to create work and business.

Franco Stefani [ITALY]

Chairman of SYSTEM S.p.A.

CURRICULUM VITAE

After a first brief working experience as a technician at Ceramica Marazzi, Franco Stefani has followed his intuitions, putting into practice his talent and creativeness, in time proposing highly innovative solutions, which have largely become benchmarks worldwide for automation in the ceramic industry.

With a purely technical background and a great passion for automated systems, he established his own company towards the end of the sixties and started building the first automatic screen-printing machines.

In 1970, he established SYSTEM S.p.A., currently an industrial holding with five branches abroad (Spain, France, Bohemia, Singapore and Brazil)

He has organised his firm, System S.p.A., in competitive way according to a slim, flexible model, based on quality of service and integration with allied activities, in which he has decentralised various industrial processing stages. Internal activity is in fact focussed on planning and design, sale, assemblage and after-sale activity.

His approach has always been that of simplifying technical concepts, even the most difficult, and addressing them from completely different logical standpoints, compared with already existing ones. His "marketing" is: niche products with important innovation and technology contents. The most significant example of this approach has surely been Rotocolor, an automatic decorating machine that has contributed added value to ceramic tiles and a strong identification of the product.

Franco Stefani is Chairman of System S.p.A.

President of ACIMAC - Association of Italian Ceramic Machinery and Equipment Builders.

Chief Executive of the Union of Industrialists of Modena.

CERAMIC WALL AND FLOOR TILES IN THE NEW CENTURY

The recently ended century has left us knowledge of a standard industrial process for ceramic products, which is about to become mature.

Certain areas exist however, in which industrial processes can and need to be optimised. The environmental impact or labour costs of emerging countries are surely two levers that can feed such optimisations. My vision takes me, as a next step, to the integration of the forming process with the aesthetic and surface decoration process.

This area will bring important developments in the new century; we shall in fact need to become accustomed to a new culture of product aesthetic design.

The glazing processes for creating effects, aesthetic valences and possible multiple elaboration, have till now used analogical systems and equipment fitted in the production lines. A way of working that reduces the efficiency of production facilities.

In the near future, decoration processes will be simulated thanks to the support of dedicated computer tools, and the product will hence be created digitally. We can surely state that processes and products will no longer be the result of variables and trials, but will have sure success.

This computerising of the production process is being perfected and will shortly enable making products no longer bound to expensive simulations near production sites, but to previously defined certainties.

In the production process, one of the stages most closely involved in this change is the pre/post press stage. Accepting this change will undoubtedly provide great benefits for the whole process; however if the stability and efficiency reached, based on man's individual professionalism, is instead the preferred choice, we will surely run into great difficulties. Knowledge, computerisation and automation are the only guarantees of stable yield over the time.

The future of ceramic applications does not mean exclusively focusing on tradition, but in contrast to giving the imagination room and inventing new horizons of use. My vision in this respect brings me to express an observation regarding the use of large surfaces, regarding ventilated external walls, regarding the great external walls of imposing urban works with large surfaces to be clad.

There is no doubt that the knowledge developed in these decades has focused the use of ceramics in the home; few, instead have been the exterior uses, unless for decorative purposes, but surely not because of functional criteria of ventilation or thermal protection.

It is necessary to make an effort and think about this new type of application and the concepts that it introduces. The comparison that I suggest is the present use of large glass surfaces.

At the beginning of the century in fact, glass was only used in small areas. This was because of its high cost, the impossibility to produce it in large sizes and the difficulty of its installation. No sooner had the evolution of production and application processes removed these constraints, did the use of great glass surfaces become fundamental in all the most modern urban structures.

The experience with glazed surfaces is used today by all architecture and engineering firms in their projects.

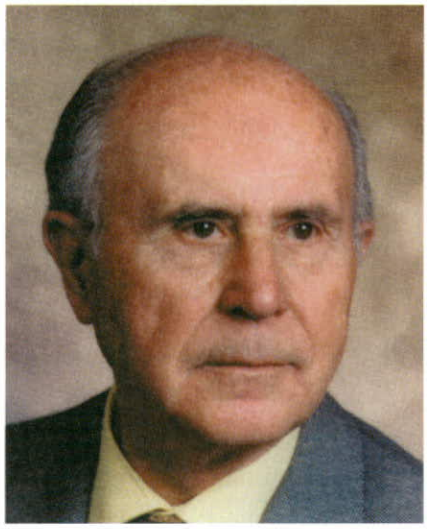
Our current striving should be to follow this example for ceramics, integrating this application with traditional ceramic uses. If on the one hand, we can consider to have fine-tuned the manufacturing processes of large-size ceramic materials with suitable thickness, on the other one we need to urge these same architecture and engineering firms to use appropriate elements for holding these large ceramic surfaces.

Undoubtedly, our sector would be repaid immediately in view of the great consumption horizons in an area in which ceramics currently does not feature.

However, this all needs to be programmed and subsequently taken up by architecture and engineering firms in an important common effort of those responsible for works, with a view to standardising the result for the market.

Federico Michavila [SPAIN]

President of ANFFECC (Spanish National Association
of Frit, Glaze and Ceramic Colour Producers) since 1998
Founder de Torrecid



CURRICULUM VITAE

ACADEMIC BACKGROUND

- *Air Force Staff course – (1961-1963)*
- *Degree in Management from Maxwell University of the North American Air Force– (1963)*
- *Joint Staff course – (1967-1968)*
- *Executive Master in Business Administration from the Polytechnic University of Valencia – (1996)*

POSTINGS

- *Teacher at the Air Force Staff School (1966-1968).*
- *Teacher at the School of Joint Staffs (1968-1972).*
- *Head of Material of Wing no. 12 - Torrejón (1972-1975).*
- *Head of the Air Force of Wing no. 12 – Torrejón (1975-1977).*
- *Director of the Air Force General Academy – San Javier (1977-1980).*
- *Head of the Logistic Division of the Air Force Staff (1980-1982).*
- *Director General of Personnel at the Ministry of Defence (1982-1986).*
- *Chief of Staff of the Air Force (1986-1990).*
- *Qualified in various fighter planes:*

  Messerschmit 109, T-6 Harvard, F-86 F- (Sabre), F-4 C

  PHANTOM, Junkers-52, DC-3 (Dakota), etc., with a total of 7000 flight hours
- *Founder of Torrecid in 1963*
- *President of ANFFECC (Spanish National Association of Frit, Glaze and Ceramic Colour Producers) since 1998*

WHAT WILL THE COMPETITIVE POSITION OF CERAMIC TILE BE WITH REGARD TO OTHER FLOOR AND WALL COVERINGS IN THE XXI CENTURY?

LEADERSHIP OF THE CERAMIC COMPANIES

The leadership achieved by the Spanish ceramic companies is based fundamentally on effort, firmness, perseverance, risk, personality of the leaders, and on the excellent personnel available, including technicians and operators; all of which should be a source of pride and satisfaction to the Ceramic Sector.

In the last 10 years the ceramic companies have undergone extraordinary development as regards innovation, product improvement in quality and design, as a result of the collaboration with glaze and machinery companies; which has enabled achieving spectacular growth.

This favourable situation could give rise to some "complacency" in the companies because of their management, but enterprise should not rest on its laurels. The paradox of success states that the greater a company's triumph, the harder it is for the company to perceive the need to change and react quickly in the face of the new threats. "NOTHING IS MORE DANGEROUS THAN SUCCESS, BECAUSE THE SUCCESS OF THE PAST IS THE SEED OF FUTURE FAILURE".

And this paradox could come true in the XXI century, if ceramic tile manufacturers are unable to understand that their future success does not essentially lie in their own hands, but, rather more and more in a better understanding between themselves and the companies that supply frits, glazes and colours, machinery and third-fire products.

To ensure survival in the face of competitors from other sectors, the Ceramic Sector and its tile companies need to grow and lead the market. For this, they must base themselves on technological advances and knowledge of the market. And this is so because technology and the market have always been the keys to achieving sustained economic growth in the companies, and in turn in the Sector, and will be even more so in the future.

Technical progress is considered to provide the most important competitive business edge, on effectively incorporating the new technology into products and processes.

However, technology is not the only force that drives growth. Broadening and improving the market is the other force that helps business grow.

The market is therefore the other great driver of business growth. Broadening and

improving the market complements and extends the positive effects that technical progress has on products and processes.

According to Philip Kutler: "Good companies satisfy needs, excellent companies create markets". If tile companies are to become excellent, they will create markets and will therefore lead them, preventing other competing sectors from developing and becoming dangerous threats.

THE CERAMIC SECTOR: A UNIFIED SYSTEM

Ceramic tile must compete with companies that produce carpeting, parquet, marble, glass, natural stone, plastic, etc., which demands unceasingly striving to gain market share. This challenge requires tile companies to have the capacity to transform technological ideas into products, processes or services that are successful, and success will come in terms of the number and quality of the technological innovations that can be generated.

To achieve technological innovations and successfully face the future, the Ceramic Sector needs to understand that it is a unified system and realise that it is made up of 4 industrial pillars: ceramic tiles, glazes and colours, machinery and third-fire products. Only teamwork between the companies that form these 4 pillars can ensure a successful future for the Ceramic Sector and provide it with the necessary capability to have an edge in respect of other competing sectors in the same market.

To lead the floor and wall coverings market against other sectors, the Ceramic Sector has to think about its development in a context of continuous change, in which anticipation, innovation and flexibility constitute key corporate values. Companies need to pre-empt the market, client needs and competitors. They must be able to ideate, design and try new opportunities. They need to be more expeditious in launching new products and services, as well in continuously trying out new ideas.

This should all be a fundamental part of the business culture. And the best way to compete is by directing and fostering the Sector's four pillars in co-operation and mutual support, based on the knowledge that each pillar is an expert in its basic business activity. Only the combined efforts of the 4 pillars can yield the anticipation, innovation and flexibility that the market demands, besides surely doing so at a lower cost.

Co-operation and mutual support enables and counsels rationalisation and optimisation of basic business activities to achieve a united striving. In this sense:

- Tile companies should continue enhancing product quality and improving their marketing capabilities and image, to try and achieve market leadership.

- Frit, glaze, colour and raw materials companies must continue investing important financial, technical and human resources in product and process innovation, and provide ever better, customised technical assistance to tile factories in order to provide them with the best competitive advantages.

- Machinery and equipment companies must continue investing in means to build tools and produce equipment that facilitate the development of new processes and products.

- Third-fire companies must provide trims and accessories that help create new environments and designs for the tile factories.

To sum up, tile manufacturers must lead the market, glaze and colour producers the technological advances, machinery builders the tools for their application and the third-fire companies the trims to complement design and ceramic environments.

The better integrated the teamwork between the ceramic tile, glaze and colour, machinery and third-fire companies, the better will the products and processes be. In particular, constant innovation will be achieved, which will allow addressing the market with an edge over other competing sectors.

BUSINESS COLLABORATION FOR INNOVATION

Ceramic tile companies are traditionalistic, perhaps because of their great antiquity, and also perhaps owing to their cautiousness in innovating. They want novelties but they find it difficult to accept the risks that all innovation involves. In general, they prefer to implement innovation when the technical difficulties have been clearly overcome and market acceptance is favourable. They are reluctant to accept uncertainty, and by so doing are giving up leadership.

This attachment to guaranteed success, without risk or uncertainty, is usually an obstacle for the future development of companies and hence of the sector, especially, if such a conservative attitude is not shared by other competing sectors, such as natural stone, plastic, paper, wood, paint, glass, etc.

The fitness of the frit, glaze, colour and machinery companies has made them the drivers of innovation. They therefore need to dedicate important financial, human and material resources not only to improving current products and processes, but also to doing research into the creation of new products, processes and equipment that enhance technical conditions and qualities of use, application and aesthetics.

This research focus of the frit, glaze, colour and machinery companies could be greatly heightened, if it was supported and fostered more by the tile manufacturers, by continuous, close collaboration in order to have information on the market with regard to possibilities, needs, expectations, etc., with a view to having the products that the market needs, is waiting for, or would like to have. Once the products have been developed, tile manufacturers should make the necessary efforts to put them onto the markets.

The introduction onto the market of the innovations presented at trade fairs by frit, glaze, colour and machinery producers would also encourage the development of the companies and of the Ceramic Sector, which though entailing risks, also provides

opportunities for leadership in innovation, on a company as well as sectoral level, and would reinforce the superiority of ceramic materials over other competing sectors in the field of floor and wall coverings.

"The future is not a gift, it is a conquest". A future that must be conquered together by the 4 pillars of ceramics, by teamwork and the necessary creativity for envisioning other ways of applying ceramics, and hence of creating suitable products as regards their structure, forms, and technical and aesthetic qualities.

Together they need to open up new ceramic horizons with the latest technologies, jointly devoting important resources and efforts to achieve this. Only an innovative attitude, willing to accept the risks involved in applying technological advances, will be able to guarantee the ceramic sector a XXI century full of hope and success, and enable widening the market by raising the awareness of building professionals and users of the advantages of using ceramics compared to other materials, and hence of achieving sustained growth of the companies making up the sector.

WHAT THREATS DOES THE CERAMIC INDUSTRY FACE AND HOW COULD THEY BE ADDRESSED MOST EFFECTIVELY?

The ceramic industry, as every industry, faces threats from 2 environments: the external and the internal environment.

In the external environment, it has to compete with the following industries: marble, natural stone, carpeting, plastic, wood, paint, varnishes, glass, etc. In the internal environment, it must compete with itself, attempting to avoid falling into a rut, becoming conformist, and lacking a vision of the future.

EXTERNAL THREAT

The external threat basically depends on technological advances in competing industries, which could provide these competitors with better development and uses than the ceramic industry. Technological advances are the result of corporate innovation capacity and structure. If the competing companies are better organised, working in a team with their suppliers and clients, have a greater ability to generate resources and know they must invest generously in R+D+I (Research+Development+Innovation), besides investing in image and marketing, the competing industrial competitors will surely have good growth potential. The Sector that has companies with this profile will end up being an excellent Sector, creating markets and acting as a threat to the Ceramic Sector.

To my understanding, it is necessary to be watchful of the size, management capacity and teamwork of competing companies from other sectors. It is necessary to monitor how much they dedicate to R+D+I, and how much to enhancing their image and market. It is necessary to constantly watch the competition, know it and neutralise it, to thus keep it from arresting the growth and development of the ceramic market.

INTERNAL THREAT

To eliminate the internal threat of falling into a rut, conformism and lack of vision of the future, the companies in the Ceramic Sector should:

- Be aware that a potential threat can always arise at any time, in any country, from another more competitive Sector.
- Realise that the vision, values, strategies, tactics, organisational structures etc., which have been useful till now, will possibly not be valid in the future in view of the globalisation that provides economic, scientific, technological and social benefits which should be taken advantage of in business.
- Avoid inbreeding and isolationism, which arrest business development. Globalisation, market breadth and the need for complete solutions to satisfy a requirement or existing need make it absurd and quite unthinkable to compete in an individual way. The new company can only survive if it is an open company, if it is able to adapt permanently to change, if it overcomes and destroys surrounding barriers to establish flowing, efficient relationships with its clients and suppliers, and even with its competitors.
- Risk and dedicate the necessary resources to searching for new products, improving current ones, and doing all this together with suppliers and clients, working in a team, with a common vision of the future.
- Carry out projects jointly with suppliers to innovate products and processes.
- Reduce production costs by good organisation and business administration and not confuse the price of raw material purchases with production cost. A lower price does not mean a lower product cost.
- See that technical progress is the most important source for competitive business and sectoral growth on effectively incorporating the new technology into products and processes.
- Understand that suppliers need to generate resources to progress technically and thus provide companies with technological innovation, collaboration and technical assistance, with a view to increasing their competitiveness.
- Strive to achieve a good image and excellent marketing, aspects which help improve business results to a greater extent than any other type of action.
- Monitor the evolution in technology and market share of other competing sectors.
- Foster companies that create new markets besides meeting current needs.
- Use the competitive advantage of locating production centres near international markets.
- Cultivate a business mind open to whatever measures are needed to promote the creation of companies of an appropriate size to address the demands and realities of the market, attained by organic growth or alliances, acquisitions, mergers, etc.

THE TRUE THREAT

In the ceramic companies there is logical concern regarding the competition among companies in the Sector, because it affects growth of market share and profits; on the other hand however, it also impels them to be ever more competitive, stronger and sounder, in order to be able to survive not only in the Ceramic Sector but also against other Sectors which fight mercilessly to occupy the largest possible slice of the floor and wall coverings market.

The really dangerous adversaries of the ceramic companies are not the companies of their own Sector, but the companies from other Sectors, which fight to substitute the technical and decorative qualities of ceramics by other products that limit and reduce the market for ceramic tiles.

The strategy of Ceramic Sector companies for neutralising companies from other competing Sectors consists of close co-operation among tile, glaze, machinery companies etc. to achieve technological advances that will allow developing innovative products and processes, which far exceed the technical and aesthetic benefits of products from competing Sectors and thus increase available market share.

Company size is steadily becoming more and more important in defending the company against tough competition with firms from other sectors and inside its own sector. Experience has shown that: "Big companies usually bury their errors, but small companies are buried by them". And who can be sure of not making some mistake? It is necessary to meditate deeply, and on the basis of this reflection prepare the future, ever uncertain, looking outward from a company that is open, co-operative, flexible, solid, efficient, capable and especially, innovative..

Salvador Martí [SPAIN]

Chief Executive of the firm AZULINDUS & MARTI, S.A.
Co-President of QUALICER

CURRICULUM VITAE

ACADEMIC BACKGROUND

- *Teacher of commercial subjects*

POSITIONS

- *1ST Vice-President of the Castellón Official Chamber of Commerce, Industry and Navigation for 8 years*
- *President of the Council of Chambers of Commerce of the Valencia Region for 5 years*
- *President of the Spanish Ceramic Tile Manufacturers' Association (ASCER) for 11 years*
- *President of the Tile Medical Care Fund for 8 years*
- *Since 21 March 1991, President of the Castellón Official Chamber of Commerce, Industry and Navigation*
- *2nd Vice-President of the Council of Chambers of Commerce of the Valencia Region*
- *Chief Executive of the firm AZULINDUS & MARTI, S.A. (Ceramic tile manufacturing)*
- *President of the Board of Directors of the firms ATOMIZADORAS, S.A. and VERNIS, S.A.*
- *Co-President of QUALICER*

THE FUTURE OF THE CERAMIC TILE SECTOR IN XXI CENTURY

DRIVING FORCES OF THE FURTHER EVOLUTION OF CERAMIC TILES

The evolution of the industry and of ceramic tiles themselves will be directed towards enhancing user satisfaction and reducing the environmental impact of ceramic tiles throughout their whole life cycle.

With regard to user satisfaction, tiles currently have very high functional and decorative characteristics, though there is still room for improvement. Tile functional and decorative durability is satisfactory; the durability of certain characteristics is even indefinite. This is not new. Ceramic products found in cities that vanished centuries ago still entirely conserve their original characteristics, while beside these wares, rust has made objects of iron or copper quite unrecognisable.

Besides durability, advances will be made, or rather are already in progress, directed towards concurrently providing tiles with the most demanding functional quality and decorative diversity. Tiles for outside uses can be abrasion or frost resistant, while at the same being highly visually attractive. Non-slip tiles need not look rough or be difficult to clean; in fact they no longer are.

Nevertheless, it cannot be ignored that there are and will certainly continue to be markets or consumers with greater or lesser purchasing power. The industry needs to be able to satisfy both.

With regard to the reduction of the environmental impact, the industry will continue striving to use cleaner processes that consume fewer mineral resources, water and energy, and produce less waste. In this sense, the great progress made in recent years will be set forth.

The implementation of fast firing was a watershed in the progress of the ceramic tile manufacturing industry. This great step forward set off a phase that has lasted over 20 years, during which many smaller steps forward have been taken. At present the industry is exploring various avenues, achieving satisfactory results along some of these, though the goal has not yet been attained.

Wet milling has enabled us to reach a very high level of product quality, and reduce arising waste. However this involves high energy consumption, which has been partly compensated by incorporating co-generation facilities. The attempts to improve milling by the dry method, to the point of enabling production of powder compositions of a quality comparable with that produced by the wet method, could yield very positive results.

New ground has also been broken in the glazing operation, for instance by single pressing, applying the glaze powder in the press while forming the product; or substituting the aqueous suspension by sheets prepared by frit producers according to the design specified by the tile manufacturer.

There are also horizontal techniques, such as computer science or robotics, whose degree of incorporation into the industrial tile manufacturing process can be increased. And advanced communications are being increasingly used to improve management; up till now, a tile manufacturing plant has required close in-works attention, but a plant can conceivably be managed from a distance, even from another continent.

These or other achievements could set the stage for a new industrial phase, though there might not be such a great change as with the switch from slow twice fire to fast single fire.

DEMAND FOR SPECIAL TYPES OF PRODUCTS, FOR SPECIFIC MARKET NICHES

Companies have striven to engineer tiles with new functions: luminescent, tactile, antibacterial, anti-scale, or other functions. They satisfy small, specific market niches, though the market does not pay back the search for new types of products or the effort involved in developing them. However, there will always be companies interested in profiling themselves as leaders in innovation, or wishing to satisfy a small group of clients, and thus in seeking to find the philosopher's stone, however difficult to find. In 1492 it was possible to discover a New World. In the XXIst century, it is only possible to discover or rediscover some little island, unless we start thinking about other planets. And to be sure, to reach these planets, ceramic tiles have been used on the bows of spaceships. Still, the market for such specialty products does not appear to be likely to grow sufficiently to require mass production.

CLAIMS IN THE U.S.

The industry cannot advance so much or so swiftly as certain law firms that specialise in claims for damages. There appears to a direct relation between the number of accidents and the expectation of high compensation awards. However, even without the threat of such lawsuits, the ceramic industry is working to diminish the risk of accidents for users. EEC Directive 89/106 is designed to harmonise Community regulations intended to ensure building products satisfy certain minimum requirements, which include safety in service. Ceramic tile performance is excellent, for instance, in the case of fire. However tile slip resistance needs to be assured to prevent any risk of falls and years have been spent attempting to reach a consensus on the test methods that can be used for measuring slip resistance. This is not an easy objective, despite the extensive European experience, to which American and Australian experiences have been added. We can tell the consumer that the degree of safety is such, that a fall cannot be attributed to the ceramic flooring, if the tiles have been properly chosen and installed.

DEVELOPMENT OF NEW PRODUCTS

The development of new products is and will continue to be the result of the co-operation of all the parties involved, not just of the ceramic industry, machinery builders and glaze producers, but also of education and research centres. This collaboration has yielded extremely valuable results, an example of which is the evolution of the Spanish tile industry, particularly in the last decade.

GOVERNMENT POLICIES

Domestic or international government policies undoubtedly affect the development of the industry. Labour legislation, including regulations on occupational health, environmental issues and product liability, is much stricter in some EU States than in others, in which the absence of legislation or failure to comply with regulations gives rise to social or environmental dumping.

The European ceramic industry has a sense of social responsibility and structure which do not encourage relocation. Though some countries may not have stringent governmental policies, which facilitate the establishment of factories, decisions are based on more immediate reasons such as profit expectations, local demand or economic development programmes. The ceramic industry does not use an inaccessible or highly complex technology, at least not for the basic products. The powerful Italian machinery or Spanish glaze industries provide full technical assistance. QUALICER itself serves to disseminate new techniques. We must accept this new competition, in the face of which we shall intensify our efforts, while simultaneously asking the EU not to provide tariff facilities for such social and environmental dumping.

WORLD OVERCAPACITY

The European industry is reacting to increasing world tile production capacity by improving quality and value for money, both with regard to products and services, devoting a great deal of attention to research, development and the application of results. Industrial policy needs to be directed towards products in which sale price is not a decisive factor, i.e., towards products with greater added value.

PRODUCT STANDARDS

Product standards are by nature voluntary, except the "harmonised" part, which contains the characteristics whose compliance will shortly become compulsory in the European Union to assure the essential requirements of Directive 89/106. Some of these characteristics are intrinsic to ceramic tiles, and compliance requires no control, for example such as behaviour in the case of fire. Enforcement and control of Directive 89/106 materialise in tile slip resistance and in tile installation techniques and materials to prevent tiles from debonding and causing accidents.

However, the fact that there is no legal obligation to meet technical standards does not mean there is no quality control. A growing number of Spanish companies has a quality assurance system in accordance with the ISO 9000 standards. And the market is often more demanding than the standards.

THE SALE PRICE

The technological upgrading of the 80s and 90s has in real terms led to a lower market price. Besides this, ceramic tile prices are subject to great macro-economically

driven swings, which are more marked in certain markets or in certain types of product, or even greater in some factories than others. The swing can be very sharp, and one can never know if it has peaked or hit bottom. Current prices are in general certainly unsatisfactory for the Spanish industry, but we hope to see a recovery soon.

TILE INSTALLATION MATERIALS AND TECHNIQUES

The adhesives industry has booked significant advances and continues endeavouring to improve the quality of its products and hence tile installation. In turn, the ceramic industry is studying possible changes on the backs of tiles, which could facilitate tile fixing or make it cheaper, but there would appear to be little room for important advances. Tile installation techniques do not seem to evolve at the same rate as the ceramic industry, or that of the adhesives branch, possibly because the structure of this activity is less propitious for research, even though considerable attention is paid to training.

The three pivotal points of the triangle (ceramic tiles, adhesives and fixing) are receptive to the demands of technical advances in building and to environmental requirements. At times we find that these demands are unaware of or do not take into account the intrinsic characteristics of ceramic tiling, and that environmental requirements relate to situations that have long been overcome, or demonstrate unfamiliarity with the constraints of the ceramic process. It is difficult for us to make clear to the players of the building sector or the social partners, the spectacular advances achieved in ceramic coverings. Perhaps because, since tiles have been used for centuries, the various parties have remained unaware of the quality, variety, functionality and versatility of modern ceramic tiles.

SHORTAGE OF TILE FIXERS

The shortage of tile fixers leads to training new professionals for the trade, not to prefabrication. The use of pre-tiled facings does not go beyond being a peculiarity of some market with low rates of consumption. Italy, Portugal and Spain have the highest per capita consumption of ceramic tiles, despite the shortage of tile fixers, which is on the other hand comparable to that of other countries. The highly demanding tile fixer training found in certain countries, presumably assuring great quality in finishes, has not led to a rise in the use of ceramic tiles and may even have fostered DIY or non-professional tile fixing, in detriment to quality.

CERAMIC TILE COMPANY PURCHASES

The models of ceramic tile industry growth are not the same in all the tile producing countries. Notable growth has taken place in the industry in Spain, without an important degree of concentration or take-overs. Perhaps this is a Spanish characteristic, which makes us well equipped to wage guerrilla warfare or war with small units, but possibly less so for waging war with large armies. In Italy, take-overs appear to have contributed to the positive development of the branch. However, there are exceptions in both

countries: an important Spanish company has purchased a worldwide ceramic holding, while more than one Italian company has opted for growth without take-overs. Each company chooses its path according to its own circumstances. We ought not to forget that although we talk about a world market, the most important market for the manufacturers is their home market, and this demands their greatest attention.

CUSTOMER VALUE

New names do not always correspond to new concepts. In such a competitive industry as the ceramic tile business, with open markets, attention to customer value has been a constant for decades.

The same applies to attention to innovation and improvement of the offer for the building industry. This is all addressed while trying to avoid the influence of passing fashions.

The new information technologies have not yet demonstrated their potential in practice for the industry, nor for contributing customer value. Nevertheless, ASCER, with the support of the European industry, has submitted a proposal to the CEN to establish a workshop to facilitate e-commerce in ceramic tiles and adhesives.

Distribution is with few exceptions an improvable link in the chain. Few companies have tackled their own distribution, though this has been done very successfully in certain cases. However, as a whole, the industry can only influence distribution to a limited extent, though it is closely watching any eventual change.

HIRING PROFESSIONALS

The evolution of the industry makes hiring experts in the field of quality and the environment, and particularly of ceramic engineers, highly likely. Increasing technologisation is also calling for specialists with middle or higher education qualifications in computer science, electronics, pneumatics, electromechanics and other fields. Outside the production process, there is a shortage of trained salespersons, while merchandising is becoming more and more demanding and directed towards technical sales. Operators can also be expected to have better training and be multi-skilled to facilitate functional mobility, in accordance with changes in the process and technological advances, and this can even be advisable from an occupational health standpoint.

OTHER COVERINGS

Tiles have existed side by side with stone, wood, textile coverings and even paper or paint for centuries. We have all found our place and have alternately found favour with consumers depending on regions, customs, culture, economy or other circumstances. Other competitive materials have appeared and will continue to appear, but to date none have been sighted with the potential to occupy and hold a market share comparable to that of traditional coverings, amongst which ceramic tile holds a foremost position.

Anselmo Ortega [BRAZIL]

Professor in the Department of Materials Engineering (DEMa)
of The Federal University of São Carlos (UFSCar) since 1979

CURRICULUM VITAE

ACADEMIC BACKGROUND:

- *Materials Engineer at the Department of Materials Engineering (DEMa) of the Federal University of São Carlos (UFSCar)*
- *MSc in Science and Materials Engineering from the University of PPG-CEM/ UFSCar, (1979-82)*
- *Doctor in Ceramic Engineering from the University of Leeds (England), (1982-86)*
- *Postdoctorate at the Max–Planck Institute PML-Stuttgart (Germany), (1991-92)*

PROFESSIONAL EXPERIENCE

- *Industrial placement at Klabin (1979)*
- *Lecturer in the Department of Materials Engineering (DEMa) of the Federal University of São Carlos (UFSCar) since 1979*
- *Director of the Brazilian Ceramic Association since 1995*
- *Member of the Board of Centro Cerâmico do Brasil (CCB) since1996.*

- *Founder and Editor in Chief of the journal "Cerâmica Industrial" since 1996*
- *Founder and Co-ordinator of the Ceramic Tile Laboratory (LaRC) since 1992*
- *Currently Technical Adviser to ABRACOLOR, the Brazilian Association of Colour Producers.*
- *Co-ordinator of a great many Co-operative Projects with Brazilian ceramic companies associated with the tile sector.*
- *Author of numerous publications in national and international papers, as well as presentations at Congresses and book chapters.*
- *He has directed various postgraduate studies.*
- *On the Editing Committees of various Brazilian and international journals.*
- *Ad-hoc consultant of various research-supporting institutions.*

CERAMIC FLOOR AND WALL TILES IN THE NEW CENTURY

INITIAL CONSIDERATIONS

On considering the topic of this round table, the professional experiences of the other participants and my own background in the sector, I decided to first focus on an analysis of a more global character and subsequently conclude with a particular, personal vision of the Brazilian ceramic floor and wall tile industry.

Generally speaking, the historical data regarding tile production and markets have been based on a mixture of the constant information that has appeared in the references listed at the end, and personal contacts. Specific references to sources are therefore often not made.

The fact that the Chinese production and market are frequently not considered is simply a consequence of the difficulty of obtaining reliable data.

For the sake of simplicity, the term tile will be used as a synonym of floor and wall tiles.

THE COMMERCIAL PRODUCT

In general we can say that the most positive features of tile, as far as its competitive advantages in relation to other types of coverings are concerned, consist of the combination of cleanability, durability and decorative potential. On the other hand, its main negative aspects are related to tile installation, generally considered difficult, expensive, slow and "dirty" in comparison with other types of coverings.

Considering the growth of this sector until today, the advantages have been more important than the disadvantages and practically none of the competitors have seriously threatened the position of ceramic tile as market leader. Everything indicates that this situation will be set forth in the new century, because on one hand, the group of typical

tile characteristic will certainly continue satisfying consumer needs, and on the other, no alternative is known, which, keeping in mind the cost/benefit factor, offers the competitive advantages mentioned before.

CURRENT GLOBAL SCENARIO

PRODUCERS

A quick analysis of the current scenario shows that ceramic tile production, innovation and marketing in the last few years have been practically dominated by Italy and Spain.

With regard to production, these two countries were responsible for 36.3% of world production (without considering China) in 2000. With regard to innovation, on one hand, Italy is mainly responsible for the development of new equipment and products, while on the other, Spain leads in glazes. As far as marketing is concerned, besides dominating their domestic markets, which together add up to 10.7% of the world market, the joint exports of Spain and Italy represented 66.3% of total tile exports in 2000. One of the main reasons for the high level of development and innovation that has taken place in Sassuolo and Castellón is the high concentration of top level competition in these regions.

Other outstanding producers are Brazil, Indonesia, Turkey and Mexico. As regards these producers, generally one can say that they have limited themselves to reproducing and adapting products and processes developed in Italy and Spain, and mainly dominate domestic or nearby markets. The diffusion of technologies and innovations is a consequence of the fact that the suppliers of inputs (equipment, glazes, vehicles, etc.) are practically the same ones in the world over, and that Italy and Spain participate actively in the developments and innovations.

CONSUMERS

The consumer market can basically be divided into six large economic blocks, Europe, North America, Central and South America, Asia, Africa and Oceania. Of these blocks, it can be said that Europe, Central and South America, and Asia have productions that are able to satisfy a considerable part of their domestic markets and to hinder import growth. Therefore, North America, Africa and Oceania would in principle be potential importers, while the other blocks, if the installed production capacities were bigger than the domestic markets, would be potential exporters.

In 2000, Italy and Spain dominated 66.3% of exports, with 86.2% of Italian and 68.4% of Spanish exports going to Europe and the United States. In the North American market, Spain and Italy have adopted a behaviour characterised by a mixture of association and competition. Such behaviour is a very interesting example that should certainly be followed by other producers and applied to other markets. The effectiveness of the method is clearly evidenced by the significant growth of the North American market in the last few years.

The average values of the Italian and Spanish products exported to different regions are presented in Figure 1.

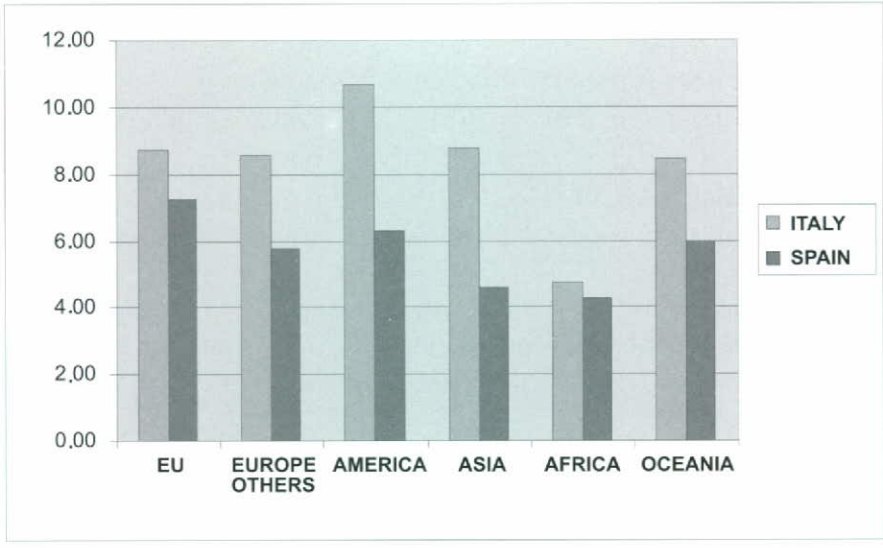


Figure 1: Average values of Italian and Spanish exports to different economic blocks. (Calculated from the data in ref. 1.)

It is interesting to observe how the values reflect local purchasing power, distances and eventual tariff barriers. Another interesting aspect concerns the different marketing strategies of the two countries. While Italian products exploit a "tradition" in the sector in order to add value, the Spanish focus more on the cost/benefit aspect.

RESEARCH AND DEVELOPMENT

A considerable part of the research and development activities, specifically dedicated to ceramic tiles, is in general carried out at the moment at the plants and/or laboratories of the equipment and input suppliers themselves. The results of this work have certainly contributed considerably to the evolution of the sector. One of the big advantages of these types of developments is the ease of practical application of the results. On the other hand, the constraints imposed by the need for an immediate, simple and economic application often make developments impracticable, which could lead to more significant advances. In general these priorities have created a certain preconception regarding work conducted at research institutions not directly bound to production activity, and they have hindered to a certain extent the incorporation of the latest developments from other fields of knowledge to the needs of the industries.

As a consequence of the foregoing situation, the number of research institutes specialising in this specific subject, not directly linked to producers is relatively small compared with the economic expression of the sector. On an international level, the most prominent are the Ceramic Centre of Bologna (CCB) and the Institute of Ceramic Technology (ITC). One of the great advantages of these institutes is the combination of two features, on the one hand they do not participate in production activity, but on the other, they are near enough to guarantee correct evaluation of the parameters, necessities and possibilities of application. This combination, added to sound training of its researchers and access to extensive sophisticated equipment and literature, provides these centres with a unique capacity to contribute to the development of the sector.

GLOBAL FUTURE SCENARIO

The development of the producing centres depends largely on the behaviour of the consumer centres. Therefore these two aspects will be addressed simultaneously.

With respect to the participation of Italy and Spain in the world market, one can say that the current situation will foreseeably not suffer major changes in the next few years, mainly because the distance between the command of the technologies and marketing strategies of these countries compared with the other producers is considerable. However this does not mean there will be no changes.

Regarding the possible emergence of a new leadership, it is always necessary to consider the possibility that China may turn its attention to foreign markets and alter the current situation. This possibility is strongly corroborated by the equipment suppliers and colour producers, and to a certain extent by technical personnel in general. However, the road to be travelled for significant quantities of Chinese products to be able to reach the same levels of quality as Italian and Spanish products, which is a fundamental demand of the major current import markets, is relatively long and if this happens, it will therefore not be in the near future.

Yet, in relation to other producing countries, Brazil is among those that have the greatest possibilities of playing an ever more important part on the world tile stage. Some of the major aspects to be highlighted with regard to the Brazilian ceramic tile industry are as follows: 1) the domestic market is today, after China, the biggest in the world; 2) installed capacity is larger than current domestic market demand and should continue to be so in the near future; 3) there has been significant improvement in quality and efficiency of most production processes in the last few years; 4) practically all the international equipment and input suppliers are present and interested in production growth; 5) a more aggressive international trade policy has been adopted in recent years, which is already showing results in the significant growth of the Brazilian share of the North American market; 6) modernity and constant investments in upgrading in the great majority of the plants; 7) geographic location. On the other hand, domestic market volume (393.3 million m^2 in 2000) and frequent variations in the domestic economy (mainly variations in the exchange rate of the national currency, the real) often discourage a greater dedication to exports.

With regard to the effects of globalisation, bearing in mind the difficulties involved in penetrating markets with relatively minor purchasing power, mainly in regions that already have strong local or nearby industries, as mentioned previously, the possibilities for production levels in Italy and Spain to grow significantly will largely depend on the growth of European and North American markets. At the moment, as was to be expected, exports mainly target centres with high purchasing power. Considering that in these markets the sale price is not so decisive as in the centres of relatively minor purchasing power, the general tendency should continue being that of adding greater value to the product, seeking to further improve its technical and aesthetic qualities. These efforts, however, on their own will probably not lead to a significant increase in these markets and bigger efforts will be necessary in the marketing sphere to change "consumption" habits and eliminate barriers, such as those related to tile installation mentioned above. With

these actions, the consumer market in the centres of high purchasing power will be able to continue growing for some more years and the tendency, regarding products and production processes, will mainly be focussed on adding value to the product. For this, they will continue developing new products and processes using the privileged conditions that they possess. On the other hand, the process of technology transfer and innovations will continue in the same patterns as today and will increase the possibilities of other producing centres, raising their participation in international markets.

Generally speaking, product development must respect market characteristics. In this sense, while a large part of production is concentrated in two centres, Sassuolo and Castellón, and the fact that export products will be subject to increasing transport costs and customs duties, possible markets will foreseeably be limited to certain centres with levels of purchasing power exceeding a given minimum value, and will be saturated in a certain number of years. In this sense, it is of vital importance to consider other options that can provide continuity in the sector's growth. Once the markets with high purchasing power have been saturated, those remain with a relatively minor purchasing power, which have no strong local or nearby industries. In these centres, the values that define product competitiveness are quite different from the ones that hold in the centres of high purchasing power, and characteristics such as price and regional peculiarities, for instance such as *design* (colour, textures, sizes, etc.) will play an even more critical part. Thus, dominance of those markets will depend on establishing local production centres, which adapt research and technologies to local market values and aesthetics. Thus, besides achieving lower transport costs and customs duties, the possibilities of product success increase. In relation to these considerations, the data in the following table sets out the expectations of population growth in Europe, South America and the United States for 2025.

EUROPE			SOUTH AMERICA			USA		
2000	2025	GROWTH	2000	2025	GROWTH	2000	2025	GROWTH
728.8	702.3	-3.7%	345.8	460.9	33.3%	309.6	363.6	17.4%

PRODUCT-RELATED DEVELOPMENTS

To assure the current position of market leader in the future, it is necessary, besides enhancing even further all the positive features and functions, to eliminate or at least minimise the negative aspects that have in some way hindered sector growth. From this standpoint it has been attempted to identify some aspects that will play a part in the new century.

Regarding **cleanability and durability**, it has become necessary to develop polished products that are stain resistant and provide high resistance to risk. In this sense, glass-ceramics has provided a promising approach.

A general tendency of mature markets is the development of relatively small market segments ("niches"), where added value is produced as a result of satisfying specific needs. This category includes tiles with bactericidal, phosphorescent, special electrical and/or thermal properties, etc. This practice certainly contributes to adding value to the product, and should therefore grow in the new century.

DEVELOPMENTS RELATING TO THE PRODUCTION PROCESS

The innovations relating to **decorating techniques** will certainly play a key role in the development of ceramic tiles in the new century. In the last few years, numerous possibilities have appeared that promise a true revolution in this process stage. It is very difficult to evaluate the potential of each innovation, because they are all very recent and still require fine-tuning before true potential can be determined. Besides this, for most of the innovations to be used effectively in production, the collaboration will be needed of various suppliers, unfortunately not that easily acquired. With regard to the new decorating techniques, there will probably be a considerable increase in decorative resources, with various techniques, new and already consolidated, functioning together in the same work environment. It is important to remember that once the technical quality has been assured, marketing and decorative elements define product competitiveness.

Another important feature to be considered concerns the **environment**. The growing awareness on the one hand, and more and more demanding legislation (with ever-tougher penalties) on the other, will certainly require revising several aspects of the current process and make implementing preventive measures and installing control equipment more and more common. In the new century, some of the aspects that will receive special attention are those envisaged by the Kyoto protocol, and the gas emissions from the firing of organic products, which are widely used in decoration.

USE-RELATED DEVELOPMENTS

As mentioned previously, one of the negative aspects with the greatest market-restricting impact is tile installation. Besides the issues already considered, it is very common to have dissatisfied consumers present claims with regard to tile installation quality and cost. Some competing products already include installation in the price and accept responsibility for the quality of the installation. That procedure is already starting to be adopted for ceramic tiles in some local areas, but much still needs to be done in this sense. Undoubtedly, in the new century, great efforts will be directed towards increasing the number of properly trained professionals, to match consumption levels and product quality. This is without a doubt a fundamental aspect that needs to be addressed in order to guarantee further market expansion.

ROLE OF THE RESEARCH AND DEVELOPMENT INSTITUTIONS IN THE FUTURE

The growing need to add value to products, mentioned above, can be achieved in two ways: 1) through design and 2) by improving technical properties. It can be said, mainly with regard to the latter point, that tiles are becoming more and more advanced ceramics, manufactured on a large scale. This transformation has been essentially based on applying chemistry and materials science principles to tiles. Significant developments will need profound understanding of materials characteristics and of the principles that affect their behaviour. Without appropriate command of these aspects, development will become random and, in turn, this command will be hard to achieve when attention has to be divided between production and research. In this sense, I believe that in the future the

contributions of research and development institutions will become increasingly important. The activity of the research and development institutions is also always linked to training and to upgrading the knowledge of specialised technical personnel working in the plants. These contributions (books, courses, papers, workshops, etc.) will also become more highly valued, for the reasons set out before.

THE BRAZILIAN CERAMIC TILE INDUSTRY

HISTORICAL AND CURRENT SITUATION

We should now like to present a brief, personal overview of the evolution and current situation of the ceramic tile sector in Brazil.

The current situation can be summed up by the following data:

1. With a domestic market of 393 million m^2/year (8.6% of the world market), it was, after China, the world's largest consumer market in the 2000. Imports play a very minor role in the domestic market and Brazil's share in the international market has increased considerably in the last few years.

2. In 2000, Brazilian ceramic tile production was the fourth largest in the world (453 million m^2/year) and Brazil was the fourth largest tile exporter (48 million m^2/year).

The Brazilian ceramic tile industry can be divided into two big groups, in terms of the production process, namely by the wet and by the dry method. In 1985 practically the whole production was by the wet method. The Italian dry method technology was adapted to the peculiarities of the region and began to grow quickly in terms of product quantity and quality. To provide an idea of that growth, in the period 08/95 to 04/2000, during which Brazil was ranked as the world's third largest producer (without considering China), total installed capacity grew by 29.1%, with wet and dry method industry growth of 1.7 and 31.9%, respectively. This quick growth is related to investment of the profits made by sales success in the domestic market. Sales success, in turn, is a direct reflection of the perfect match between market and product, as mentioned previously.

Some of the main competitive advantages of the products made by the dry method are: a) lower production cost compared to the wet method; b) the largest manufacturing district lies very close to the raw materials sources and biggest consumer market in South America (the region next to the city of São Paulo with more than 20 million inhabitants).

The significant improvements in product quality have also contributed to this expansion. Another aspect that has played a fundamental part in the advances was the close collaboration between the input suppliers (equipment, glazes, etc.), practically all linked to Italian and/or Spanish companies, and company technicians. The big business groups, realising the excellent business opportunities, spared no effort or investment in making this growth feasible.

At the moment a considerable part of the companies that work by the dry method are concentrated in a small region close to the geographic centre of the State of São Paulo. The production capacity of these companies, by all indications, has already exceeded local market dimensions and a steadily larger part of production is transported by trucks to other parts of the country. In these cases, freight represents a considerable part of the sale price and several companies have started to decentralise the production process. This strategy causes at least 2 of the big competitive advantages to be lost: proximity to the raw materials sources for which the process was adapted and the vicinity of the support services. Time will tell whether these companies have the capacity to overcome the difficulties. Regarding the industries that continue manufacturing in the Santa Gertrudes region, competition amongst the companies is steadily becoming more and more frantic, and factors such as quality and sale price are becoming more and more critical to success.

The growth of the dry method industries largely took place in detriment to the markets previously held by wet method products. All this forced those companies to make changes. In the environment of the domestic market, the wet method companies put in place tough policies aimed at reducing costs and market prices. In the external environment, the companies manufacturing by the wet method sought association and they attacked foreign markets more aggressively. The first fruits of those actions can already be seen in the data relative to 2000. With respect to the domestic market, the part of the market dominated by products manufactured by the wet method seems to have stabilised, and in foreign markets Brazilian products broke all records by reaching an increase in market share of 11.5%. compared with 1999. It is important to highlight that the biggest increase in exports was for the American market and that practically all the exported products destined for markets outside Latin America were produced by the wet method.

THE FUTURE OF THE BRAZILIAN CERAMIC TILE INDUSTRY

As far as production is concerned, Brazil has an installed capacity that enables considerable growth if market opportunities permit.

With regard to the domestic market, despite today being the world's largest, after China, current per capita consumption is relatively small (2.4 m^2 per inhabitant), and the housing shortage is estimated at 6 million dwellings. In this scenario, domestic market growth seems to depend fundamentally on two aspects: 1) the purchasing power of the potential consumers and 2) better knowledge of the market. With regard to the first point, in view of the advances reached with the stabilisation of the economy in the last few years, it can be said that perspectives are good. With regard to the knowledge of the domestic market, firstly it is necessary to point out that Brazil has an area of 8,547,403 km^2 (for reference purposes, the area of the whole of Europe is 10,349,915 km^2) and the population, in 2000, was 165 million inhabitants, which hinders the work considerably. On the other hand, it can be said general speaking that this knowledge was not necessary until now, and therefore was not one of the priorities of the companies and associations. Hence joint work will be required with regard to the domestic market, in which there is certainly a lot of room for the sector to grow.

As far as foreign markets are concerned, mainly due to the excellent work done by the National Association of Ceramic Tile Manufacturers (ANFACER), Brazilian exports grew 11.5% in 2000 compared with 1999. An interesting aspect worth noting is that 46.5%

of the exports went to the United States and 19.5% to MERCOSUR. When only the ANFACER member companies are considered, which in their great majority manufacture by the wet method, export growth in the period from 1999 to 2000 was 22%. For comparative purposes, Italian and Spanish exports in the same period grew 4.6 and 15.6%, respectively. A considerable part of this success was due to the work of the Ceramic Centre of Brazil (CCB), which through product certification (50% of production was certified in 2000), contributed greatly to the improvement of Brazilian tile quality. The Brazilian share in the international market can therefore be expected to continue to grow in the future.

These two factors together can be expected to provide notable growth in Brazilian tile production in the future.

Some of the conditions that could accelerate such growth are: 1) greater associative character (such as that of Italy and Spain with regard to the North American market, mentioned before), 2) better knowledge of the characteristics of the domestic market, 3) decentralisation of production according to market characteristics, 4) larger investments for improving the quality of human resources, 5) better control of raw materials quality, 6) greater interaction with research and development centres, and 7) change in mentality from the principle "economising provides the greatest profit " to "making the right investments provides the greatest profit."

RESEARCH AND DEVELOPMENT IN BRAZIL

Practically all the foregoing with regard to the research and development institutions, present and future, is also applicable to Brazil. Some of the principal institutions are: 1) the Laboratory of Ceramic Tiles (LaRC) of the Department of Materials Engineering of the Federal University of São Carlos, 2) the Interdisciplinary Laboratory of Materials (LabMat) of the Department of Mechanical Engineering of the Federal University of Santa Catarina, 3) the Centre of Ceramic Technology of SENAI of Santa Catarina and 4) the SENAI School - Mário Amato - National Centre of Ceramic Technology.

FINAL CONSIDERATIONS

Finally, I would like to thank my many colleagues for their collaboration, who through their experiences, comments, suggestions and discussions have contributed greatly to preparing this analysis. I alone am responsible for any shortcomings.

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