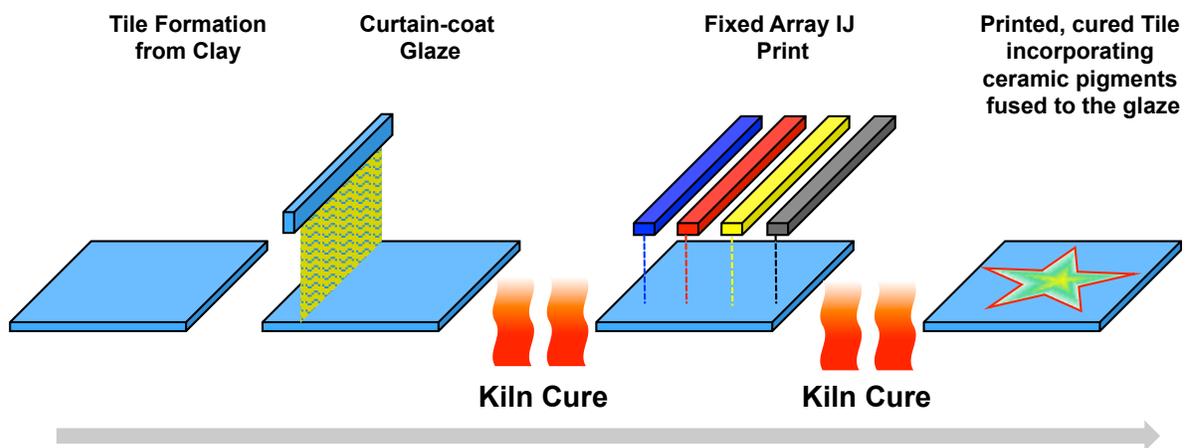


Ink Jet Ceramic Tile Printing Analysis - 2013

The ceramic tiles market is a market for home and commercial decorative tiles of varying sizes, which are made of clay, baked hard and then glazed prior to printing. Printing takes place with a ceramic pigment containing ink that is then further baked in a kiln, which causes the ceramic pigments to become molten and integrate to the glaze substrate in a glass-like permanent 'frit.' Printing needs normally to be fully integrated to kiln-driven pre-print manufacture, and to the kiln-driven print-fixing stage.

Schematic of Ceramic Tile Manufacture & Printing



Analog Market & Specifications:

The market for ceramic tiles represents around 10-11 billion square meters (M²) per year globally. The total market is growing at around 7% per year a rate driven beyond the growth rate of the underlying construction market by the ability with digital printing to create new demand among new and old consumers for products whose appeal goes beyond traditional ceramic tiles and markets of the past (see digital drivers below). Ceramic tiles is one of four major sectors of the ceramics industry, the other three being: sanitary ware (toilets, basins), tableware (dishes and cups) and refractory materials (non-metallics able to withstand very high temperatures). Of all the sectors tiles is the biggest and most valuable. A small percentage of tiles are porcelain, which is a material that is rendered impervious to external agents during manufacturing without the need to glaze, though they can be glazed for decorative purposes. These tend to be lower value tile products.

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This is I.T. Strategies' best estimate of the current regional distribution of ceramic tile manufacturing:

China	50%
Europe	15%
South America (Brazil)	10%
Rest of Asia	25%

The ceramic tiles market collapsed with the effects of the great recession on construction markets from 2008, though growth has picked up during the last two years back to its original organic growth rate. But in the meantime European manufacturing, which is almost entirely focused on Spain and Italy, went down by approximately half with Italy and Spain going down to about 350 million M² and 380 million M² respectively. Meanwhile China has now become the epicenter of digital ceramic tile printing in terms of numbers and capacity, though not in terms of output quality.

Analog ceramic tile printing today is mostly undertaken using specially adapted flexo-type silicon rollers. A set of five rollers might cost 5,000 EUR. Almost no new analog equipment is now sold in this market, and the industry is well on its way to full substitution by digital print systems. Some say that the penetration rate as a measure of productive capacity is now over 40%. A typical analog production line can generate between 5,000 and 10,000 M² per day if it does not stop. The speed is determined by the level of print coverage and the quality of the print coverage. This tends also to relate to tile value. The industry is motivated to higher value in core markets so that average daily productive capacity is likely to tend to the lower end of the scale. Ink coverage is between 4 and 8 GSM, with an average around 6GSM. There are said to be about 10,000 kiln lines for manufacturing ceramic tiles worldwide including China. Ceramic tile printing lines are on average about 1.8M wide, though narrower (for test and sample printing) and wider (for multiple lines in different formats and sizes) lines are also used.

In general in the analog tiles market as it has developed until recently almost every tile manufacturer uses similar equipment and uses similar materials addressing a similar client base. In other words, until digital printing arrived, the market offered few avenues for differentiation of product or value. There is a sense that the dominant and driving grouping in the productive industry is of glaze chemistry manufacturers who are also sometimes the ink (analog and digital) manufacturers. That is not to suggest that the print equipment manufacturers are not also highly innovative with ink jet. It is to be noted that glaze chemistry in volumetric terms is a market up to ten times as big as the ink market. On the other hand, glaze is relatively unspecialized and is sold at EUR 5-7/KG where digital ink jet inks are sold around the EUR 20 level.

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This is a representative list of the main ceramic glaze and ink manufacturers:

- Torrecid: www.torrecid.com (Spain)
- China Glaze: www.china-glaze.com.tw (China)
- Colorobbia: www.colorobbia.it (Italy)
- Esmalglass-Itaca: www.esmalglass-itaca.com (Spain)
- Ferro: www.ferro.com (USA)
- Smalticream: www.smalticream.it (Italy)

These are some smaller participants/claimants:

- Inco
- Zschimmer & Schwartz
- Endeka
- Vidres
- Metco
- Megcolor
- Color Esmalt
- Colores
- Fritta
- Chimigraf
- Bonet

Digital Market Size:

This is I.T. Strategies' current summary of market size and dynamic to 2017. Some observers state that the analog ceramic tiles production market whose underlying extent is assumed at about 10,000 kiln lines globally corresponding to one print system per line, is already over 40% penetrated by digital systems, and our numbers reflect this. Our projection assumes an 86% penetration by 2017. No one is buying analog print systems any more and the use of digital printing has become a basic term of competitive viability. In Europe penetration has nearly reached its maximum extent with penetration rates of close to 90%.

Our projection puts vendor revenues for systems and ink at \$713M for 2012 rising to \$1.3B by 2017. We assume a 9% decline in hardware prices per year and an 8% decline in ink prices. In 2012 hardware is more valuable than ink by about 20%. By 2017 ink has come to have five times the value of hardware. That is on the hardware side a function of market saturation as much as of price decline for hardware. At this time China is experiencing a boom in sales of systems. That will inevitably start to cool even by next year.

The action in digital has now shifted to Brazil, China and the rest of Asia. In China domestic digital print system manufacturers are selling at a rate of close to 100 per month mid-2013. This rate of sale will moderate, but China has 50% of world ceramic tiles manufacturers, and has a lot of ground to make up in digital. In China most digital systems are likely to be of

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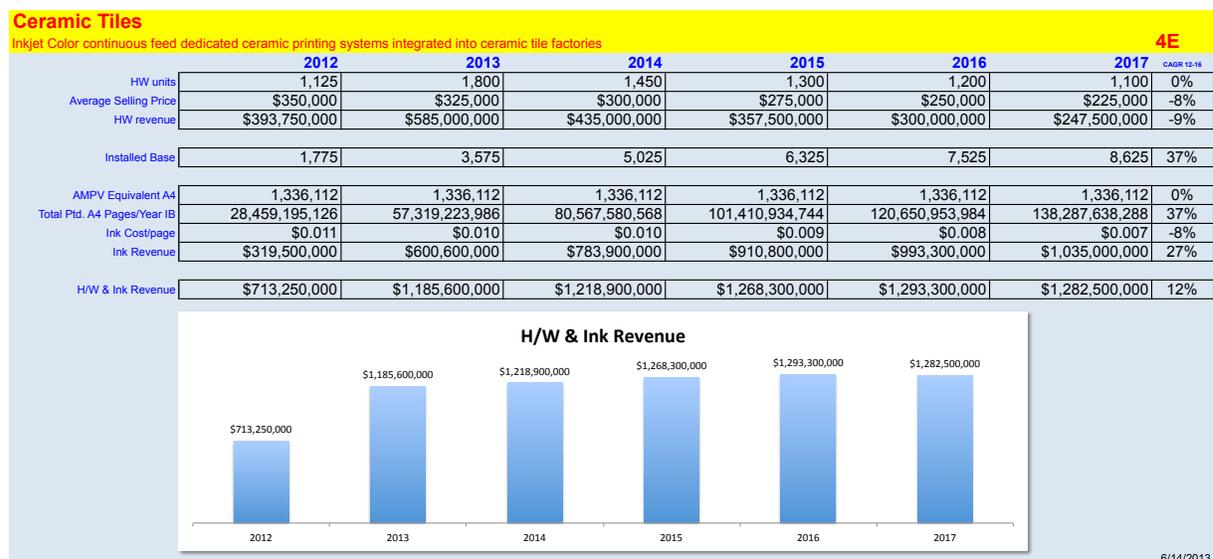
Chinese manufacture, but the high end of that large market will still require a certain proportion of what are perceived today to be higher quality systems made in Europe. Some European system manufacturers are even said to be examining manufacture in China.

Globally ink jet inks from the European chemistry manufacturers are currently dominant and seem likely to remain so given the specialized nature of the ceramic pigments of which these companies are the lone suppliers, and which are very specialized products. Additionally the same chemistry companies dominate the glaze chemistry supply to much of the world in terms of channel control going to secure the ink market, though in China most glaze chemistry is in fact locally supplied. Chinese glaze manufacturers do not have an extensive capability today to develop and supply ink jet inks, which are highly specialized chemistries that took ten years to develop in Europe.

The ink jet ink market for ceramic tile manufacture has a total size at full market penetration at current pricing of over \$1B revenue to suppliers, with an underlying market organic growth rate of around 7% driven by market extension, not just construction industry health. The prices of inks are between \$20-30/KG. For ink jet ink that is relatively low and it is also in decline as a function of fierce competition between suppliers mostly from Europe.

The dynamic of this market is very fast. Growth in China has dramatically accelerated unit growth in 2012 and will result in market saturation probably within less than five years (compared to earlier I.T. Strategies Forecasts). One of the likely consequences of this dynamic may be also a rapid consolidation resulting in a very few successfully dominant companies in hardware and separately in chemistry. The outcome is as yet far from settled.

Figure 1 Ink Jet Ceramic Tile Market Projection



Digital Systems & Vendors

This is a list of the principal vendors of digital ink jet ceramic tiles, nearly all of whom with the notable exception of Durst (in origin a Wide Format Graphics system vendor) started out as suppliers of equipment into the analog printing market:

System Vendor	Principal Head Supplier
• Cretaprint (EFI) (Spain/USA)	XAAR, TTEC
• Durst (Italy)	Dimatix
• Flora Runtianzhi (CN)	Dimatix
• Hope (CN)	XAAR
• Jettable (IL)	Dimatix
• Kerajet (Spain)	SII, XAAR, Dimatix
• Meijia (CN)	Dimatix
• New King (CN)	Dimatix
• Projecta (Italy)	XAAR
• SACMI (Intesa) (Italy)	XAAR
• System (Italy)	Dimatix
• Teckwin (CN)	XAAR, Dimatix
• TecnoFerrari (Italy)	XAAR
• TSC (Italy)	XAAR

Most ink jet printing of ceramic tiles is undertaken on single-pass fixed-array printers made by these manufacturers. Manufacturers offer at the high-end modular systems that can be varied in width, ink jet head count and color count. There are also systems available, which are less flexible for a lower price and even systems designed for very low volume or sampling which are serial printing systems. The average price of a production ceramic tiles ink jet printer today is around \$350,000. That used to be over \$600,000 a very few years ago, and the competitive pressure on the price is still enormous. The cost of ink jet printheads represents much more than half of the cost of the print system, and that becomes a higher proportion as the price of the systems falls. This also means that Chinese systems, in many non-ceramic markets steeply discounted in price against western systems, are relatively close in price to western systems in ceramics with a differential usually of considerably less than 20%.

All systems use specialized ink jet inks utilizing adapted ceramic pigments. Nearly all of these inks are manufactured by the European companies listed above whose technical mastery of the chemistry is not rivaled by outsiders.

Digital Drivers & Value Propositions

Digital printing of ceramics tiles has seen the fastest adoption rate and increase in the rate of analog-to-digital penetration of any digital market anywhere. The market effectively began around 2006 and will have achieved nearly full penetration by perhaps 2015/16. That is because the value propositions and drivers are overwhelmingly in favor of digital. These value propositions maybe summarized as follows:

- **Process Cost Reduction**

The analog roller printing process is cumbersome and expensive relative to digital. The roller system requires 4+ large heavy rollers available from very few suppliers, a set of which cost around EUR 5,000. When these are changed it can take up to 20% of productive time out of a 3-shift work pattern. Pre-digital the average change cycle might be once per day in a 9,000 M² productive day or once every two days in a 5,000 M² productive day allowing for an average run length of about 6,000 M². The analog cost to cycle at this run length was therefore something like EUR 30,000 per week in roller costs for new rollers in weeks where new designs are adopted (there is a premium on using new designs wherever possible) and lost capacity of up to one day per week. Digital largely removes both cost factors. This argument alone is decisive for digital.

Additional costs arise under an analog scheme which fall away under digital, such as manual ink calibration, staff and equipment to replace the extremely heavy rollers, staff and cost involved in acquiring and storing the large and heavy rollers, as well as other inefficiencies in manual set-up of workflow and the physical print process which become integrated into a single mostly-automated process under a digital scheme.

- **Product Capability Extension**

Beyond production efficiencies ceramic tiles is a market driven at its leading edge and in increasing quantity terms by fashion and design within a value-added 'lifestyle' oriented high-end commercial and high-end consumer market environment. Digital is of course ideally adapted to allow design variances to drive fragmentation of product offerings resulting in shorter and shorter runs corresponding more and more closely to actual fragmenting market demand. For digital there is no cost involved in design variance on-demand without halting production. The closer production can in this way correspond to real demand patterns, the higher the value that can be asked for the printed products, and the less the waste there is in over-production or late arrival to market.

The core underlying value of the ceramic tiles market lies in its ability to generate organic growth beyond the native growth rate of the construction industry by driving design and adoption. For example, it is now possible with digital print not just to match design to real fast-changing demand, but also to use it to allow ceramic substrates to emulate other substrates, partly through ink jet's unique capability to print

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over an engineered 3-dimensional surface. In this way you can mix the benefit of ceramics, which can be hygiene, durability, lightness, strength, with the attractiveness in appearance of other substrates such as wood, fabric, and metal. Beyond that substrates can be offered at realistic pricing levels that were previously out of cost-reach of all but a small minority of consumers. An example might be near-perfect reproduction of antique aged tile designs and formats (including textures and stressed aging), from the past. Advanced ceramics technology itself combined with digital print technology allow the emulation of almost any substrate allied with the benefit of ceramics' unique durability, hygiene and long life. This can be done at price levels close to those of the original emulated substrates. A ceramic substrate might easily be saleable at EUR 8M against a non-ceramic substrate at EUR 5-6M. This is a significant new competitive threat to previously independent industries.

As a result of this extended capability of the ceramic product partially-enabled by digital print the base of ceramics users is undergoing extension from the traditional areas of bath and kitchen to many more environments such as airports, sports clubs, hospitals, other public institutions, both in the private and public sector. This has special potential significance for China in the context of that country's rapidly modernizing infrastructure and rising middle class.

Barriers to Digital

There are few barriers to the progress of digital in the ceramic tiles market. There are the limitations described above in access to market and the ability of vendors to monetize digital technology driven by the speed of the market's development and the close control of the channel of pre-digital existing ceramic markets suppliers. These limitations make market participants arguably attractive to outside buyers in providing turnkey entry to a market with healthy organic growth driven by digital technology. EFI's purchase of Cretaprint of Spain is perhaps a good example. This is especially significant in the context of a market also subject as explained above to rapid consolidation.

Market Channels & Sites

As stated above, there are around 10,000 kiln lines worldwide, with an approximate one-to-one relationship to print lines on average. The access to these kilns for digital systems is mostly in the hands of the traditional ceramics machinery and chemistry suppliers already listed. These channels are not subject to significant challenge given the deep brand loyalty they inspire, the technology lock they have in chemistry and systems, even in ink jet inks now, and the speed with which the market transformation to digital is maturing. This may make some of them ideal acquisition/consolidation targets.

The Bottom Line for the Ink Jet Opportunity

There is no truly strategic opportunity for new market participants in print systems at this development stage of the market; the opportunity to challenge existing chemistry suppliers is seriously circumscribed except perhaps for a very powerful player. Even then the economic and competitive conditions do not allow excessive leeway in leveraging differentiation. The opportunity seems to be more geared to acquisition.

Ceramic tile printing is a key growth market for ink jet technology. In a period of less than 10 years it will have become a nearly \$1.2B market the end of 2013. However, price pressures are causing devaluation of both hardware and ink prices.