NEW USES FOR CERAMICS IN WET AREAS

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ABSTRACT

These are the results of a research project promoted by ASCER for the purpose of determining the viability of using ceramic material for manufacturing kitchen and bathroom worktops and to give guidance to ceramic companies wanting to move into this field.

To achieve this, the study tackled three groups of tasks:

- In the first group, it looked at critical aspects of ceramic worktop design, such as the state of the technique, different existing types of wet areas, types of worktops and the formal possibilities of ceramic finishes.
- In the second group, it analysed the technical requirements involved in using ceramic material for worktops, such as functional performance and regulatory requirements.
- The third group comprised a market study and work on marketing strategies.

An analysis of the results of this work allows us to propose a suitable ceramic system, defined by the basic product, solutions for joins, finishes and installation methods.

Finally, we look at production strategies for ceramic companies according to their degree of involvement for introducing their products into the worktop field, paying particular attention to product suitability for the requirements detected in the industrial area. The criteria that define these strategies focus on the size of the basic ceramic pieces, in order to reduce the number of joints and the number of pieces necessary to make the joins.

1. INTRODUCTION

Ceramics have been widely used in traditional kitchens, because their properties and prices were better than those of other materials. However, falling prices of other options such as natural stone and the appearance of new, compact materials that can be used to create worktops with invisible joints has meant that ceramic materials are now rarely used for this purpose.

Because of the way ceramic materials are developing, larger sizes of different thicknesses are being obtained which, when coupled with new ceramic machining techniques, mean that ceramics may once again become a popular option that can compete with the materials used more commonly today.

What's more, the current economic climate is forcing the ceramic sector to diversify its markets and to introduce high added value products, highlighting all the factors that have made ceramic products an integral system that encompasses features relating to its high performance, post-shaping technologies and a whole series of installation requirements.

2. CRITICAL ASPECTS OF DESIGN

The project began with a thorough search for information on the **state of the arte** with regard to materials used for kitchen and bathroom worktops, which showed that those most commonly used in the worktop sector were wood, natural stone, cement, compact quartz, synthetic laminate, melamine, stainless steel, glass and ceramics.

A further study was made of the ergonomic considerations for worktop design, which provided the information needed to adapt materials to people's needs based on anthropometry as well as perceptive and safety aspects. The following table lists kitchen sizes with anthropometric measurements according to the task to be performed.

	Guide, 2001	Pheasant, 1987	Market, 1988	ISO, 1985	Conservative recommendation
Work surface: Height	Standing: 850-950	Standing: 900		Standing: 850-900	**Standing: 850-900**
	Seated: 750-800			Seated: 750-800	**Seated: 750-800**
	Fixtures: 850-1100				**Fixtures: 850-1100**
Depth	500			< 670	**500**
Width				Multiples of 300	**Multiples of 300**
Free space under the work surface: Height	700				**700**
Depth	600				**600**
Width	800				**800**
Shelves: height		1950-2250	1750-1850		**1750-1850**
Shelves: Height for wheelchair users	500-1400 (500-1200 for backs)				**500-1400 (500-1200 for backs)**
Depth - high shelves		600	630-640		**600**
Depth - low shelves		600	675-695		**600**

Table 1. Summary of kitchen measurements_ measurements in mm. IBV

Next, an analysis of the wet areas in the home was made, taking into account the way these areas have been transformed in recent years. Consolidated architectural styles were analysed and related to emerging trends obtained from the Habitat Trends Observatory (HTO).

Kitchen and bathroom types were then analysed, according to the minimum sizes of these spaces, the layout of the furniture, the number of elements they comprise, their situation in the home, their relationship with other rooms, etc. As a result of this we defined six kitchen types, which were the kitchen with furniture on just one side, kitchen with furniture on both sides, U-shaped kitchen; L-shaped kitchen, office kitchen and island kitchen. Five types of bathroom were identified according to the number of items they contained, which ranged from one to five items.

At the same time, the nine households units (obtained from the monograph "new ways of dwelling" published by the HTO) were analysed, thus establishing a relationship between the different types of wet areas and household, which highlighted the design of kitchen and bathroom design for end users.

Thirdly, the types of worktops were analysed. To do this, technical aspects were studied such as morphology, finishing, joins with washbasins/sinks and hobs,

anchoring, components parts and aesthetic aspects such as surface finishes, finishes of edges and joints, which influence worktop design.

The conclusions drawn from this analysis are: the importance of the joints between the pieces making up the worktop, their interrelationship and the surface finish, and the importance of correctly creating the joins and finishes using adhesives.

3. APPLICABLE TECHNICAL REQUIREMENTS

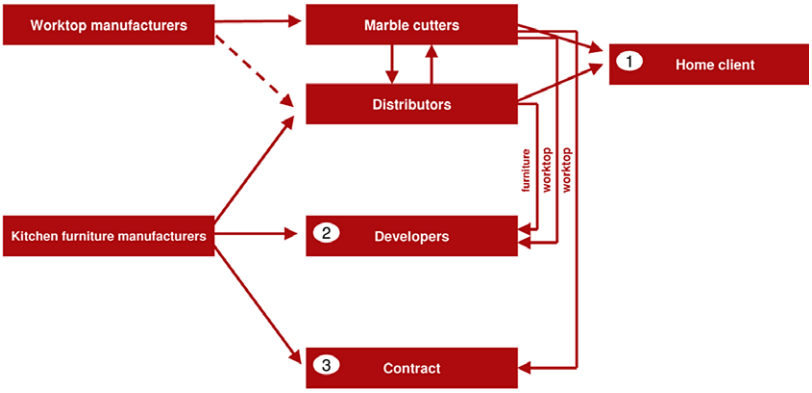
This group of tasks defined the technical requirements applicable to ceramic materials to be used for worktops. This was done by compiling the existing standard governing the different materials commonly used for our purpose.

These are ceramic tiles (UNE-EN ISO 10545); kitchen furniture (UNE 56842:2001); kitchen sinks (UNE-EN 13310:2003); stone agglomerate kitchen and bathroom worktops (UNE-EN 15388:2009); bathroom furniture (UNE 56867: 2002); and laminates (UNE-EN 438:2005)

Among the technical characteristics set out in the standards, those directly dealing with suitability for the use in question were selected. The technical characteristics evaluated were: Surface impermeability, mechanical strength, impact resistance, scratch resistance, linear thermal expansion, resistance to thermal shock, resistance to dry heat at 180ºC, chemical resistance, stain resistance, resistance to cigarette burns. The most appropriate test technique was chosen to measure each of these properties, and each proposed test method was described.

4. MARKET STUDY

This task involved **defining the channel** used to market worktops in the kitchen and bathroom furniture sectors.



Example flow chart from the kitchen sector_Source: ITC

Due to their importance in the worktop production process, the main agents to be taken into consideration are the marble cutters. Marble cutters are responsible for buying and installing the material and are the primary advisors when it comes to choice of materials. They sell the worktops directly to the distributor, developer, contact channel and even, in some cases, the final client.

The worktop manufacturers, despite selling to the marble cutter, are present on the distributor's premises where their products are promoted. They also maintain promotional relationships with bathroom furniture manufacturers at trade fairs.

The critical factors when choosing kitchen and bathroom worktops that will allow us to introduce ceramics into this market and compete with leading products must meet a series of requirements demanded by the marble cutter when working with the material.

Marble cutters' main problem involves stocks and scrap or rests that are hard to sell, factors that have repercussions on the final price of the product. To avoid this, the following points need to be taken into account:

- Materials should be the same colour and tone from batch to batch.
- Materials must adapt to the measurements of a standard kitchen (105x62 cm) to help the marble cutter avoid scrap. As well as making better use of the material, the measurements of items such as edge profiles or fronts need to be taken into consideration.
- The material must be compatible with the marble cutter's tools (e.g. for cutting).
- It should be resistant to storage and must not be deformed or discoloured through exposure to light.

Other aspects that concern marble cutters are the following:

- Leading materials such as compacted quartz are toxic when they are being cut.
- The material must be easy to install and simplify access to homes during the installation process.
- The showroom model used by numerous companies to train their clients, primarily marble cutters but also architects and interior designers, should be considered.

From an aesthetic point of view, the following aspects should to be taken into account:

- A material should be available in a wide variety of colours that offers numerous decorative options.

- Shine is better than matt, but this issue is linked more closely to hygiene and cleanability than to aesthetics.
- There should be no joints, but if this is not possible, they should be hidden to the greatest possible extent.
- Finishes vary according to fashion; therefore, the material should be able to adapt to these changes (e.g. going from rounded to straight edges).
- The product samples shown to the client should be the same as the product installed. This problem occurs with natural stone.
- The material should be about 2 cm thick and should be able to simulate greater thicknesses (for example, mitred edges or 2+2cm).

5. DESIGNING THE CERAMIC SYSTEM

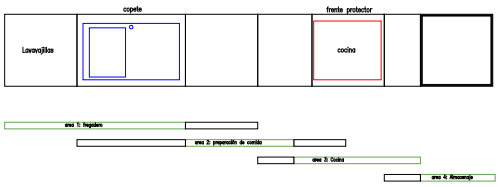
With the information obtained from the above tasks, it is now time to start **designing ceramic worktop systems** for kitchens and bathrooms.

Design means defining all the requirements to be fulfilled by the design of the ceramic worktop, including the product, optimum sizes and solutions for joins and finishes, validation of specifications and functional requirements of the worktop.

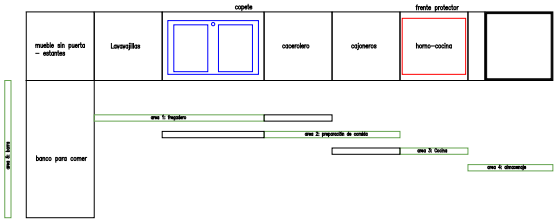
The following are proposed as basic products to be used in manufacturing and installing ceramic worktops for kitchens and bathrooms, due to their great resistance, versatility in large-sizes and because they are materials that suitably address all the requirements of a worktop:

- Through-body coloured porcelain tile.
- Porcelain tile with a satin finish.
- Porcelain tile with a polished finish and pore-sealing treatment.
- 3 mm laminate porcelain tile.

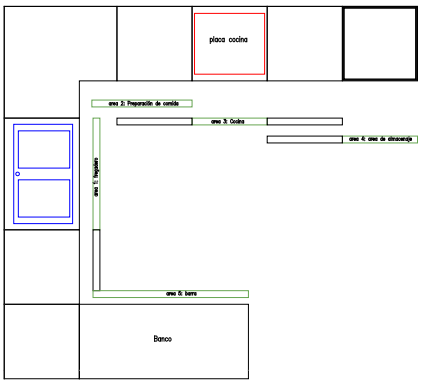
To ascertain the optimum sizes of the ceramic pieces to be used for worktops, four types of kitchen were defined on which the functions carried out, the standard furniture used and the types of kitchen discussed above were analysed.



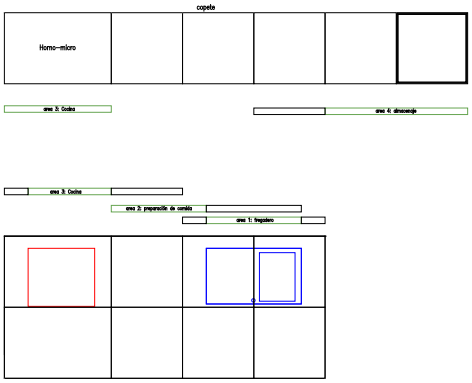
Type 1: Kitchen with furniture on one side only



Type 2: L-shaped kitchen



Type 3: U-shaped kitchen



Type 4: Island kitchen

What's more, to define these optimum formats, a set of criteria was established with which the design of these worktops should comply:

- Avoid joins as far as possible
- Joins should be positioned to coincide with the beginning or end of items.
- The worktop should be at least 63 cm wide.

Once the main design criteria and types of kitchen to be used had been defined, the following were analysed:

- The components parts used to make worktops with the most popular materials (e.g. synthetic materials).
- The components parts to be used to make the worktops should be ceramic materials existing in the market (Dimensions: 120x60 cm).
- The components parts of the worktops using the optimum ceramic material, taking the worktop developed in the breakdown of the most popular materials, studied above, as the reference to be achieved.

Type of kitchen	Breakdown with synthetic material	Breakdown with existing ceramic material	Breakdown with new ceramic formats		
			Size 1	Size 2	Size 3
			1200 x 630	1850 x 770	2100 x 1588
Kitchen with furniture on one side only	1	3	3	2	1
L-shaped kitchen	1	6	6	3	2
U-shaped kitchen	2	6	6	4	2
Island kitchen	0	4	4	2	1

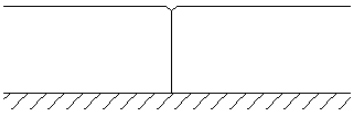
Table showing the number of joints per type of kitchen according to the sizes used

In addition, a study was made of the joins between the worktop and other items in the room, in order to find optimum solutions and finishes to resolve these joins with the ceramic material defined above.

Joins

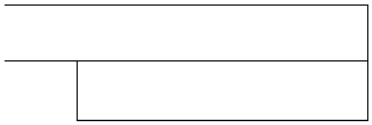
Level with the hob

Joints



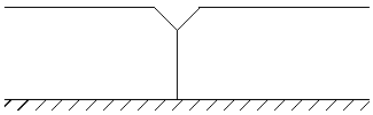
Butt joint (rectified tiles)

Edges

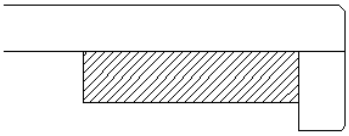


Straight thickened edge (1.2+1.2)

Fitted into the sink



Bevelled joint



Straight thickened edge at 90º

Once the basic product and optimum sizes and solutions for joins and finishes had been defined, a **performance validation** of the optimum ceramic material for worktop use was carried out. To do this, different unglazed porcelain tiles were chosen, taking into account the following aspects: surface finish, tile size and thickness, colour, and possible decorations.

Characteristics	Marble	Granite	Synthetic	Porcelain tile		
				Natural	Satin	Polished
Surface impermeability						
Breaking load						
Impact resistance						
Scratch resistance						
Thermal expansion						
Thermal shock						
Heat resistance						
Chemical resistance						
Stain resistance						
Resistance to cold food products						
Resistance to hot food products						
Resistance to cigarette burns						

Comparison of the properties of ceramic material with other worktop materials. The level of performance is shown in the following colour scale: Green: HIGH, yellow: MEDIUM, red: LOW.

As the table shows, ceramic material has better technical characteristics for workshop use than the materials habitually used for worktops, i.e. marble, granite, and synthetic products.

Users' **functional requirements** were also studied, comparing three types of materials with which ceramic material must compete, marble, granite, and synthetic products, showing that the synthetic material response best to the demands defined by the user. Ceramics need to respond as well or better to these demands so that emphasis should be given to users' functional requirements:

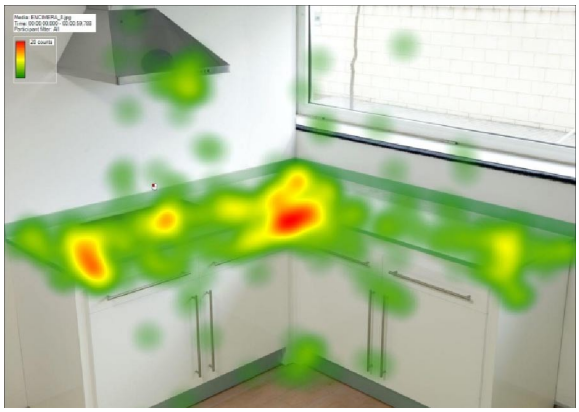
- Impact resistance: Inform the general public that ceramics are resistant to knocks and to cutting and piercing utensils.
- Moisture resistance: The ceramics must display high moisture resistance, especially at the joints.
- Hardwearing material: In the kitchen and bathroom where foodstuffs and acidic products are used, users want hardwearing materials that do not show marks or stains. The ceramics must exhibit this quality.
- Easy-to-clean material: It should shine when cleaned.

- Wide range of colours: It is important to show potential clients the variety of colours and possibilities offered by ceramics. The product should be well-presented using brochures coherent with the product.
- Good value for money: Good value for money means that private users and especially large clients (construction companies) would be open to using ceramic for worktops.

Lastly, usability and perception tests were conducted with 25 users. To do this, two prototypes of real kitchen worktops were installed in the IBV Living-Lab. One of these was created with ceramic material and the other with a synthetic material. Each user did daily living activities in the environments to be evaluated and the areas on which users focused, for how long, and the order of their visual exploration were monitored.

The results obtained show that users prefer a polished surface, which shines when cleaned, and which has the lowest possible number of joints.

Prototypes assembled at Living Lab (left, ceramic worktop, right, synthetic worktop).



Images obtained while carrying out tests and example of the heat maps obtained.

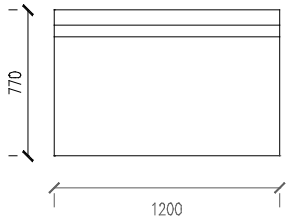
6. CONCLUSIONS

Based on the results of the analysis, three strategies were proposed depending on the degree to which the ceramic company is involved in the production of basic pieces and the size of the basic ceramic pieces used to manufacture the ceramic worktops, which range from a minimum size required to make the ceramic worktops to an ideal maxi-size for obtaining corner pieces.

Strategy 1.1: Production. Basic level of involvement.

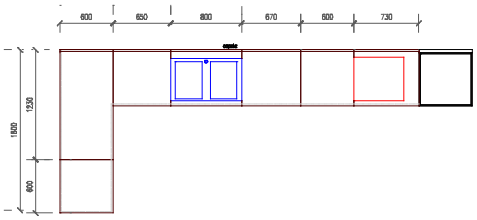
This strategy enables the ceramic company to introduce itself into the worktop line with a minimum modification to its production process and, therefore, with minimum costs, taking into account its dimensional limitations in comparison to the rest of the products on the worktop market.

The first proposal consists of developing a 1200x630 mm piece, which is 1.2 mm thick, and eliminating the rib. In this case, because the width is 630 mm, another ceramic piece of the same size is required to make the edge profile and the edge with the same material. Another possibility consists of making a much wider piece, allowing the profile and edge to be obtained from the same piece, thus avoiding colour differences between items.

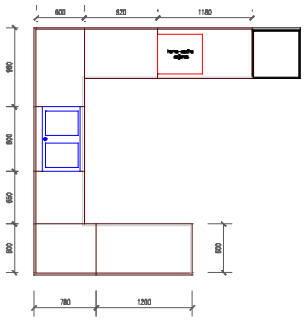
Characteristics			
1. Minimum dimensions	Length	1200 mm	
	Width	770 mm	
2. Thickness		12 mm	
3. Elimination of the rib			
Benefits			**Drawbacks**
Cost of minimum adaptation			Difficulty with market launch
Same production and stock system			The number of joints is not reduced

Distribution and number of joints according to strategy 1.1:

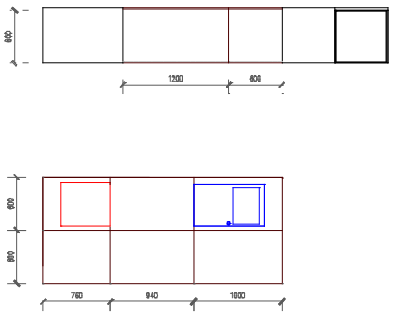
Kitchen with furniture on one side only



L-shaped kitchen



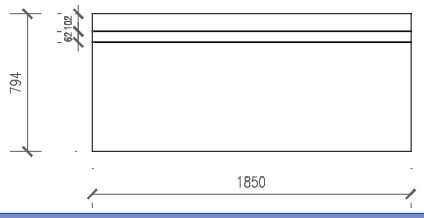
U-shaped kitchen



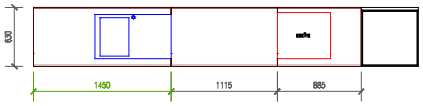
Island kitchen

Strategy 1.2: Production. Intermediate level of involvement

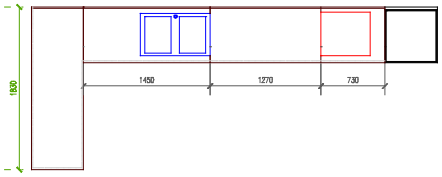
This strategy enables the ceramic company to introduce itself into the worktop line with a minimum modification to its production process and, therefore, at minimum cost.

Characteristics			
1. Minimum dimensions	Length:	1850 mm	
	Width	770 mm	
2. Thickness		12 mm	
3. Elimination of the rib			
Benefits			**Drawbacks**
Development of larger formats			Adaptation of the production process
The number of joints is reduced			

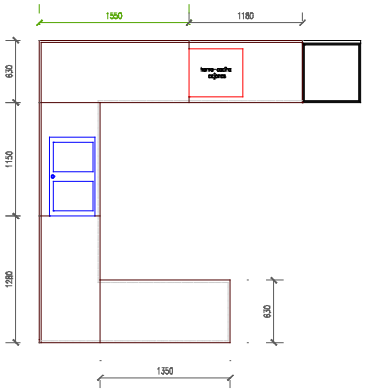
Distribution and number of joints according to strategy 1.2:



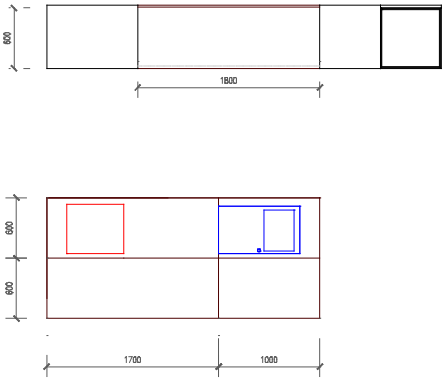
Kitchen with furniture on one side only



L-shaped kitchen



U-shaped kitchen

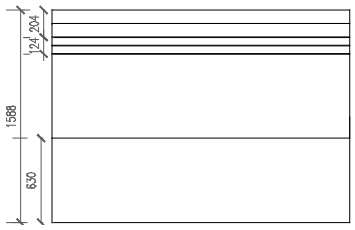


Island kitchen

Strategy 1.3: Production. High level of involvement.

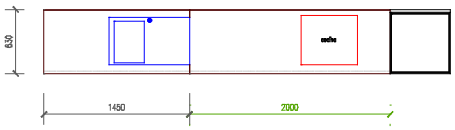
This strategy enables the ceramic company to introduce itself into the worktop line in a manner that will allow it to compete very well with popular materials such as synthetics.

Two worktops are incorporated into the dimensions, two edge profiles and two edges, with 630 mm for the worktop, 60 mm for the edge profile and 100 mm for the edge.

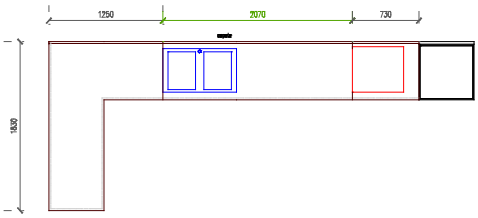
Characteristics			
1. Minimum dimensions	Length:	2100 mm	
	Width	1588 mm	
2. Thickness		12 mm	
3. Elimination of the rib			

Benefits	**Drawbacks**
Development of larger formats	Modification of the production process
Competes with popular materials existing in the market	Large formats must be handled delicately.
The number of joints is significantly reduced	
Possibility of making the corner from a single piece	

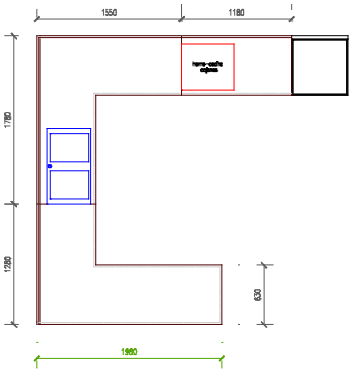
Distribution and number of joints according to strategy 1.3:



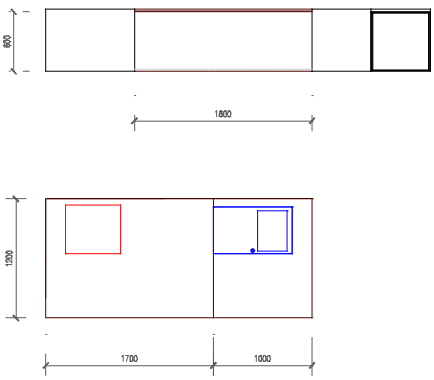
Kitchen with furniture on one side only



L-shaped kitchen



U-shaped kitchen



Island kitchen

Summary table: Based on an analysis of the joints in the 4 types of kitchens according to the different strategies proposed:

Type of kitchen	Strategy	Size used	No. of joints
Kitchen with furniture on one side only	1	1200x630	3
	2	1850x770	2
	3	2100x1588	1
L-shaped kitchen	1	1200x630	6
	2	1850x770	3
	3	2100x1588	2
U-shaped kitchen	1	1200x630	6
	2	1850x770	4
	3	2100x1588	2
Island kitchen	1	1200x630	8
	2	1850x770	4
	3	2100x1588	1

By way of a conclusion, we hope that the strategies proposed in this article will serve as guidance for ceramic companies wanting to move into the worktop world, in terms of the different specific cases according to the level of involvement.

ACKNOWLEDGEMENTS

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