INTEGRATED INFORMATION SYSTEM FOR CERAMIC DESIGN

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ABSTRACT

The present paper describes the design methodology and tool developed by the authors for the editing module of the Design Pattern Information System (DPIS) for the ceramic industry. This system is made up of three functionally different modules, which however communicate with each other. One is the analysis module. From a bit map image of a ceramic design the analysis module allows obtaining its compositional structure, expressed through its fundamental parallelogram and plane symmetry group, as well as the objects in vectorial form and the object groupings that make up the design. Another module is the database module, which contains bit map images of tilings to be analysed and the products of this analysis: objects, groups and structures. And, finally, there is an editing module, which is described in more detail in this study, and which enables the designer to generate new designs from the products of the analysis. For this purpose, in addition to the usual tools for editing objects and groups, this module also has other specific tools for editing on a structural level.

The structure of a design can be represented either by means of the fundamental parallelogram and the plane symmetry group, or by minimum regions and the isometries that are applied to their sides. The methodology set out here is conceived from the edition of both representations. In synthesis, the modifications of the fundamental parallelogram allow varying the distribution density of the objects and groups, whereas the modifications of the isometries for a minimum region allow obtaining different compositions.

Finally, this methodology is also intended for the creation of completely new designs, enabling the designer to choose the fundamental parallelogram and plane symmetry group, or to choose the geometry of the minimum region and edit its sides, in both cases adding the desired patterns, of which the necessary replicas will automatically be generated.

Keywords: *Ceramic Design, Redesign, Tilings.*

1. INTRODUCTION

In the ceramic tile industry, graphic design has become of great importance owing to its powerful contribution to the added value of the finished product. At the moment, most companies have their own design departments with computer applications, capable of creating and editing decorative patterns in both raster and vectorial form, equipped with different peripherals for design data input and output in an evaluation stage. In addition, these departments usually have different sources of graphic information to help the designer in his creative tasks. Such sources are found in the form of previous productions, catalogues, magazines, and in the best of cases, access to specialised databases.

In relation to these last aspects, the volume of pre-existing information in design tasks is equally characterised by the general situation arising from the overwhelming dissemination of information. This is further compounded by the scatter in formats in which the information on graphic design appears, as well as the almost generalised absence of any rigorous and objective classifications in this field, this being a key aspect for rapid and exhaustive access to information. All this adversely affects the consulting activity of the designer, which in the worst of cases leads to abandoning the use of the references provided by the sources, and in the best of cases, to less favourable attitudes towards these sources than would be otherwise desirable

In our opinion, this situation stems from the lack of integration of sources in the design environment and the shortage in structural design tools capable of exploiting these sources, leading to the conclusion that the activity of the designer is not integrated in a single Overall Assisted Design and Manufacturing Environment, as occurs in other production sectors.

The future tendencies of graphic design platforms, to our mind, are going to be marked by the presence of similar assistants to those of other computer applications. We believe that this will enable qualitatively enhancing the work of specialists in graphic design, upgrading their functions towards a profile increasingly similar to that of a manager-planner of creativity. From our point of view, this possibility will be conditioned by the existence of operational and efficient documentary databases, as well as tools for their exploitation for design tasks. Evidently, the effect and influences of these potential tools on present design habits and methodologies are going to be notable.

In this context, the authors of this paper propose a Design Pattern Information System (DPIS) which uses Plane Symmetry Group Theory to structure the information from documentary design databases and helps to develop the graphic design methodology set out in the following sections. In its conception[1], the simultaneity of access to this information base, and the fact that some of its modules could be of interest for the rest of departments in the company, have been taken into account. This mode of concurrent work has been solved by means of Client/Server architecture, and envisages connection to the Internet in the future. Within this system, the information flow is as follows:

1. The digitised images of ceramics and textiles are deposited, jointly with textual information on these features, in the acquisition database.
2. The analysis software[2,3,4] analyses and catalogues the digitised designs. The result of the analysis is the obtainment of patterns (objects and object groupings)

that contain the digital image with its isometries and in vectorial form. In addition, the structure of the design is determined, expressed in the fundamental parallelogram (existing translations) and the plane symmetry group (existing rotations and symmetry axes). The result of the analysis (Figure 1) and descriptors associated with the patterns are stored in the design database.

3. The edition tool enables the designer to retrieve the information from the design database to generate new designs from existing ones. This tool raises the issue of using new editing methodologies to take advantage of the information available in the design database. Although in the development stage, the proposed methodology and some partial results are presented in following sections.

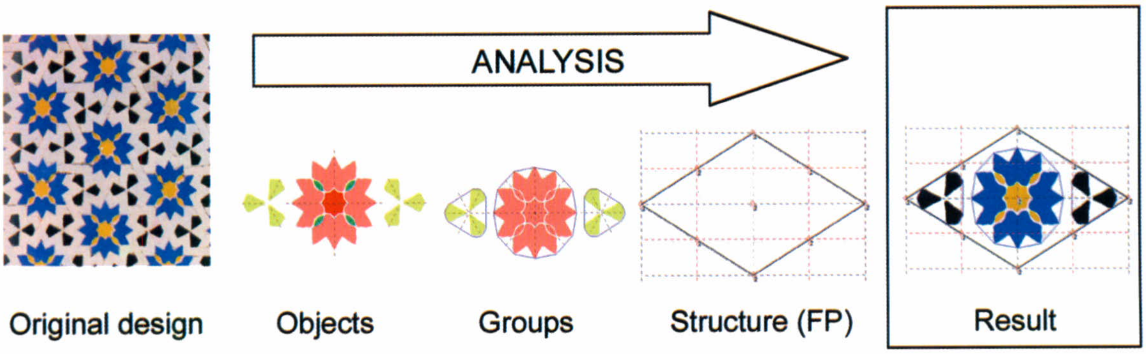


Figure 1. Results of the Analysis Tool: objects, groups and structure

2. STATE OF THE ART

Certain graphic applications are currently available on the market, which allow editing graphic designs by means of symmetries. Of these, we highlight the two shown in Figure 2: Terrazo[5], available integrated with Corel Photopaint[6] or as a plugin with Adobe Photoshop[7], and SymmetryWorks[8], available as a plugin for Adobe Illustrator[9]. Table 1 compares some of their characteristics. The differences between these lie fundamentally in their raster (Terrazo) or vectorial (SymmetryWorks) nature. Both select a given minimum region for each plane symmetry group, to which they directly apply the necessary isometries.

Summing up, we may conclude that neither of the two allows edition from previously analysed designs and that the edition possibilities are limited to recreating the 17 plane symmetry groups without going further into the use of the parameters involved in these.

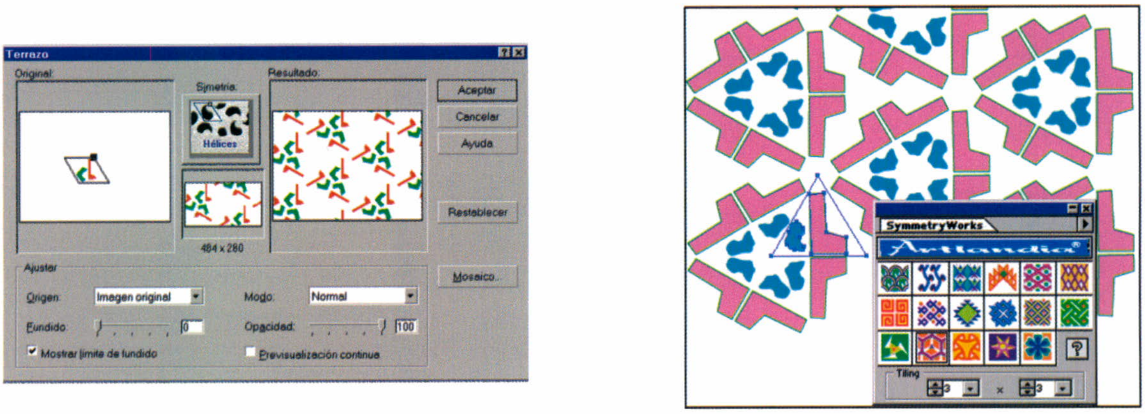


Figure 2. Examples of Terrazzo (left) and SymmetryWorks (right).

	Terrazo	Symmetry Works
Initial selection of minimum region geometry	No. Only one for each plane symmetry group	No. Only one for each plane symmetry group
Initial election of minimum region size and position	Yes (but cannot be rotated)	No
Parameterisation of the minimum region	No	No
Edition of the minimum region	No	Yes (very difficult to control the result)
Transparency and fusion	Yes	No
Edition of objects	No	Yes

Table 1. Comparison of Terrazo and SymmetryWorks characteristics.

3. PROPOSED METHODOLOGY FOR DESIGN AND REDESIGN

Taking into account the structure of the information obtained in the analysis (Figure 1), the authors propose a design methodology with continuous enrichment of its creative sources, shown in Figure 3. The application of this methodology requires the enabling tools. In this task, we can state that the edition of objects is sufficiently developed in the existing commercial applications of graphic design. In fact, their use together with the DPIS databases indicated above constitute some of the tools envisaged for the exploitation of results by this methodology. However, the edition of groups and compositional structures has required designing a specific tool, which is described in section 4.

The proposed edition methodology is based on the fact that some regions of the plane are able to create different patterns depending on the isometries used. If each of these regions of the plane is considered as a tile or minimum region (MR) of a fundamental parallelogram (FP), which in our case is one of the results obtained from the analysis, the first problem to be solved is obtaining this from the FP and from its plane symmetry group.

3.1. FUNDAMENTALS

The method starts with 93 types of marked tiles from an isohedral tiling [10]. Each of these 93 tiles generates an isohedral tiling with a given plane symmetry group. These tiles are defined by combining the following features:

a) the figure or contour that delimits the tile;

b) the isometries that are applied to the tile to generate the regular partition.

In addition, we have taken into account the fact that the geometry of the tile implicitly contains a series of geometric restrictions[11], to avoid voids or overlapping when applying the isometries that generate the tiling.

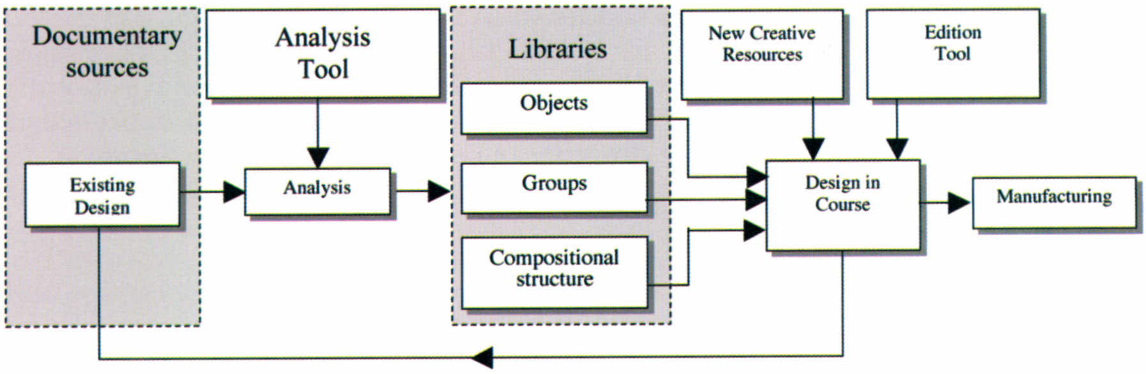


Figure 3. Stages in the proposed methodology for design and redesign

One of the first tasks involved relating the tiles of[10] with geometric restrictions to[11], which allowed establishing the geometry of the tile as well as the isometries applied to the tile to generate the tiling. For this, the 93 types of marked tiles were ordered based on the number of sides or corners (3, 4, 5 or 6).

In turn, each of these four types has been ordered as a function of the geometric restrictions imposed on the tile to generate a certain plane symmetry group. The arrangement takes place from the tile with fewer geometric restrictions, or which is less regular. The more regular the tile, the more geometric restrictions it bears. As parameters are fixed (angles and/or distances) to the less regular tile, tiles are obtained with greater geometric restrictions or which are more regular. The arrangement for the case of a triangular tile is shown in Figure 4 and for the quadrangular tile in Figure 5; in both, next to the tile, the isohedral tilings it can generate are indicated.

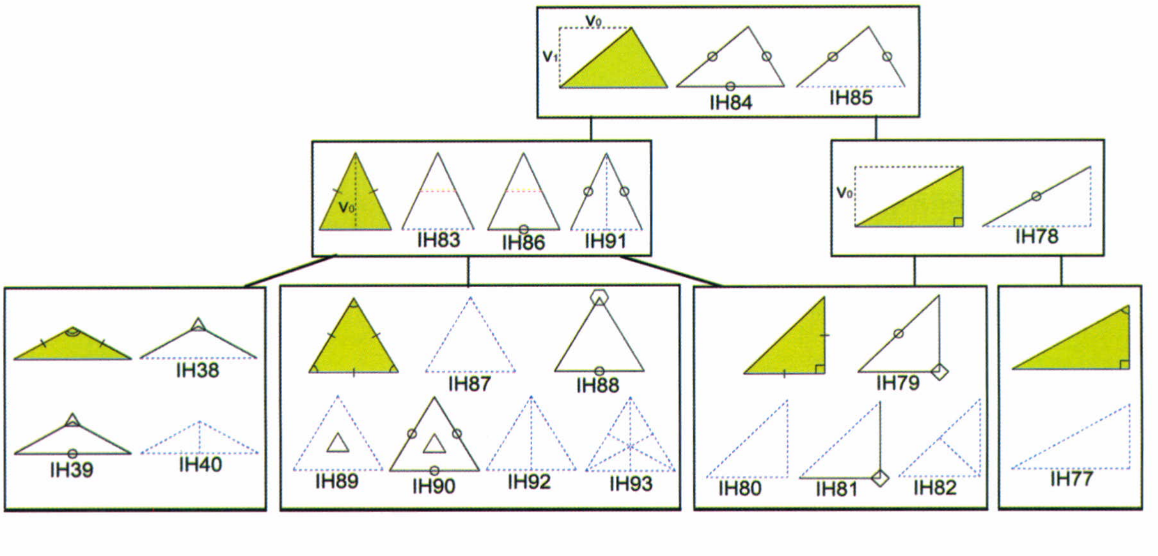


Figure 4. Diagrams of triangular tiles.

It is to be noted that each tile, in addition to the associated tilings, can generate the ones associated to the tiles that are less regular than this tile. This arrangement establishes the starting point for the edition of the different compositional possibilities of any tile or MR, both when this is obtained from the analysis of a pre-existing design, and when established by the designer in developing a new creation.

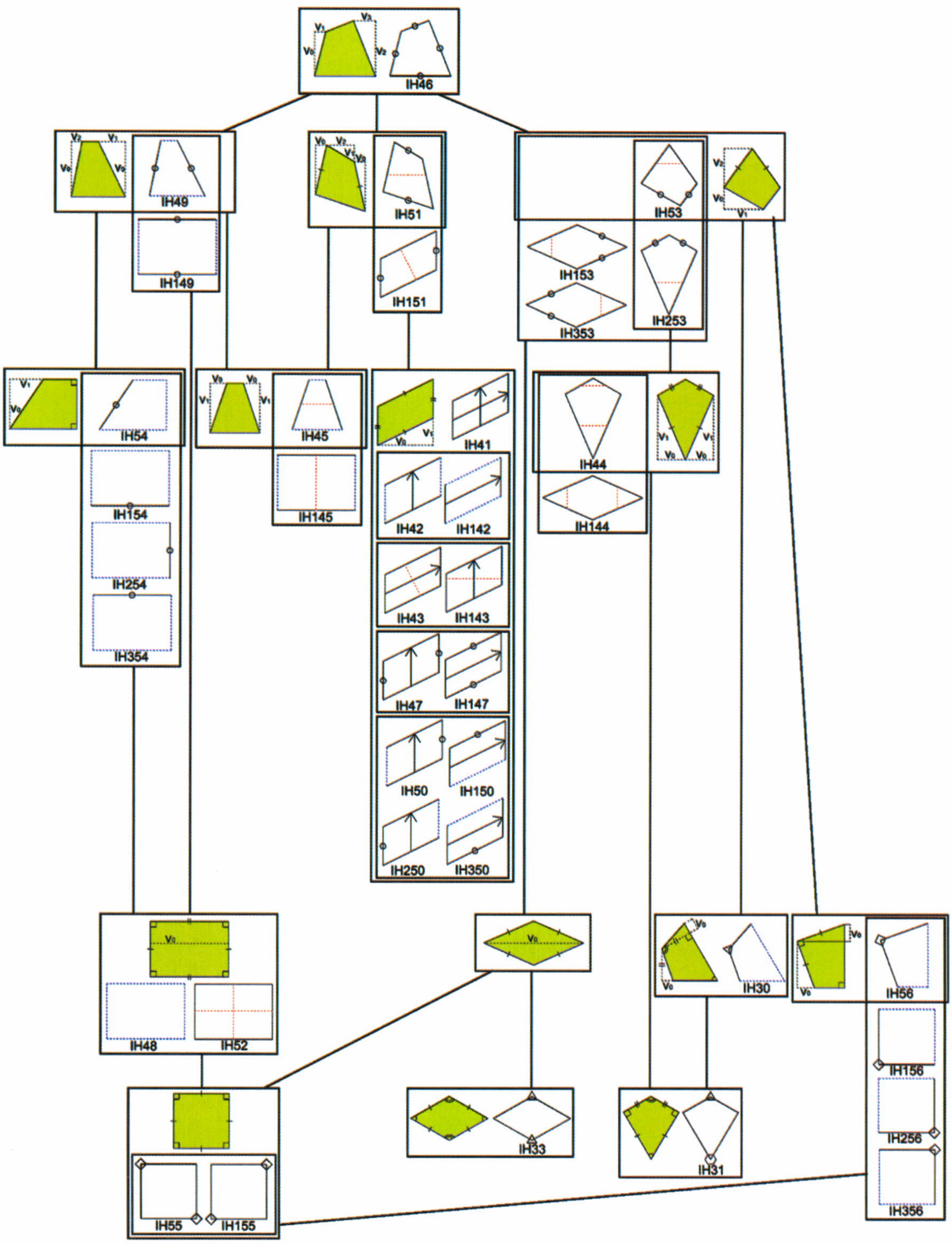


Figure 5. Diagrams of quadrangular tiles.

3.2. OVERALL SCHEME

The general approach to the structural edition consists of a series of steps organised according to Figure 6. Basically this edition is developed from the parameters derived from the definition of a MR and its associate isometries. The beginning of the edition process varies, depending on whether it commences with data obtained from redesign analysis or if a new design is to be created. In the former case, the MR is conditioned and in the latter case, the designer establishes this.

In editing new designs, the process sequence shown on the left of Figure 6 is followed, whereas in redesign, editing is approached by means of any combination (without concern for the order) of the steps contemplated on the right of Figure 6. To avoid voids and overlapping, the system automatically provides restrictions on the edition of sides, object grouping and the edition of isometries.

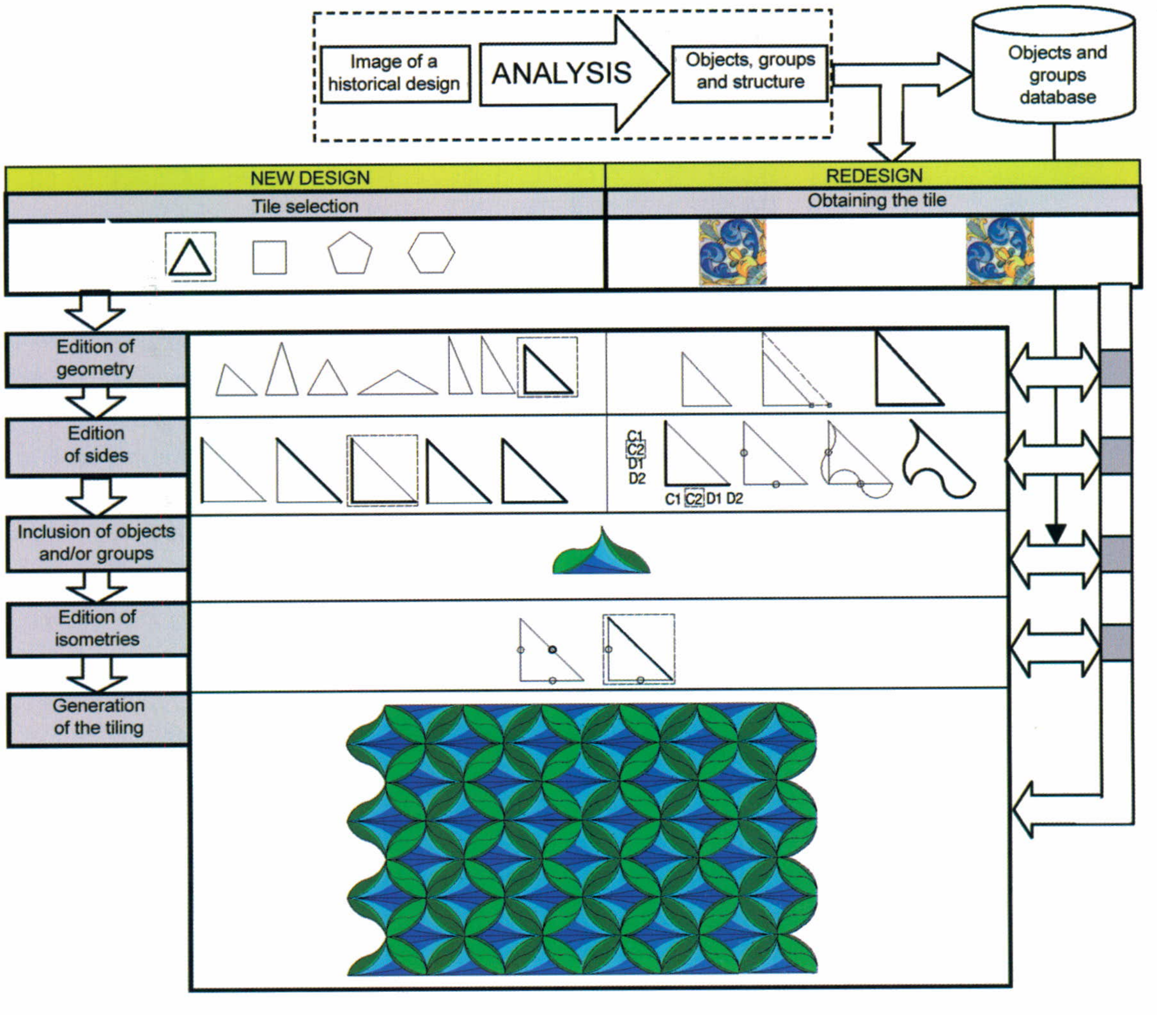


Figure 6. Scheme of the methodology.

4. EDITING TOOL

For the application of the proposed methodology we have developed a computer tool as a plugin for Adobe Illustrator.

Structural editing can be performed at two levels: group level and design level. In both cases, templates are envisaged, formed by the necessary isometries for the generation of compositional structures (Figure 7). The group template allows creating object groupings with a certain point symmetry group. In the case of the design template, two work modes are provided: these involve starting with fundamental parallelograms (FP) or minimum regions (MR). In addition, the capacity is available for switching from one to the other, by which their advantages are combined, i.e., simplicity (FP) and the generation of variants (MR). In both cases, the position, size and orientation of the structure can be modified, as well as the free parameters that the FP or MR geometry respectively has.

With the FP (design template) the structure is defined by means of the FP itself, the isometries that characterise the plane symmetry group (PSG), and the situation of the MR. In the example in Figure 7, the FP appears in black, the symmetry axes with sliding in red, the symmetry axes without sliding in green, and the minimum region in yellow. With the MR (tiling template) the structure is defined by means of the MR and the isometries that are to be applied to it in order to generate the tiling.

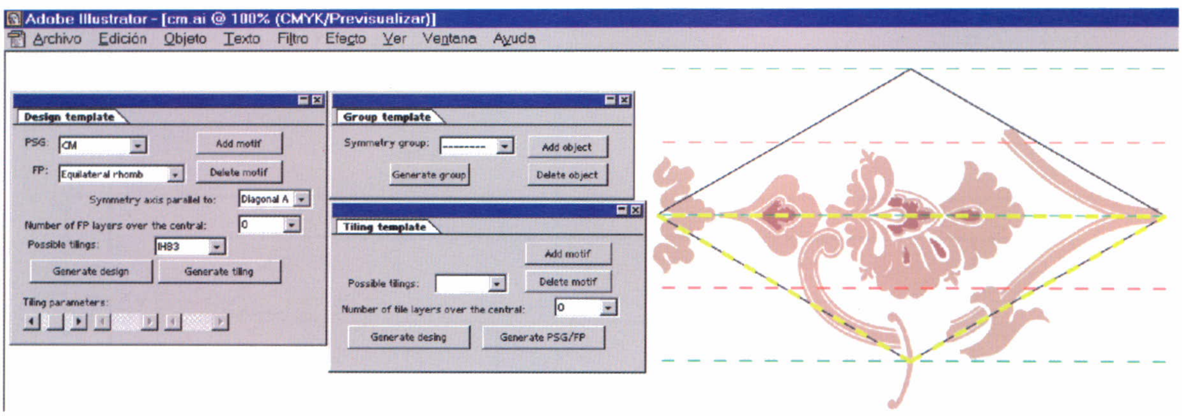


Figure 7. Screen of the experimental plugin with an example.

Table 2 sets out the editing variables and parameters of the editing tool developed in relation to Terrazzo and SymmetryWorks.

Design tool characteristics			TERRAZO	SYMMETRY WORKS	OUR PLUGIN
Group template	psg (point symmetry group): [C2, C12], D1, D12		NO	NO	
	Direction of one symmetry axis				
FP/PSG template	FP (fundamental parallelogram)	Geometry: square (C), rectangle (RE), rhombus (RO), equilateral rhombus (ROE), parallelogram (P)	NO	NO	YES
		Position			
		Size			
		Orientation			
		Parameters: C, ROE (0); RE, RO (1); P (2)			
	PSG (plane symmetry group)	PSG: P1, PM, CM, and PMG	YES	YES	YES
		Direction of 1 axis for: PG, PM, CM and PMG	NO	NO	YES
	Design size		YES	YES	YES
MR/IH template	MR (minimum region or tile)	Geometry: 3, 4, 5 or 6 sides	NO	NO	YES
		Position	YES	YES (But very unintuitive)	YES
		Size	YES		
		Orientation	NO		
		Parameters: 0,1,2,3,3,5, or 6	YES (But not all)	NO	YES
	IH (tiling)	Resulting IH and associated PSG	NO	NO	YES
		Different options for the same IH			
	Tiling size		NO	NO	YES
Obtainment of the MR/IH template from the FP/PSG template			NO	NO	YES
Obtainment of the FP/PSG template from the MR/IH template			NO	NO	YES

Table 2. Comparison of editing tool characteristics.

5. RESULTS.

This section sets out some of the results obtained by the methodology and editing tool described. Certain results are in fact examples of different redesign actions, as previously analysed designs were used to start with, i.e., of objects, groups and structures of existing designs. Some of these illustrate two aspects of the proposed methodology: the obtainment of the tile or MR and the edition of the isometries.

5.1. EXAMPLE 1.

In this example (Figure 8) the MR is established and some of the redesigns are shown that can be obtained from this. The geometry of the MR is a rhombus with inner angles of 120° and 60°. With this MR (IH33), and according to the diagram of Figure 5 (quadrilateral), the isometries that can be applied are the ones corresponding to tiling IH33 (bottom area of the diagram) and, in addition, the ones corresponding to all the quadrilaterals that are less regular than this, depicted in the graphic by connectors between the different MRs in a rising sense.

Figure 8 displays some of the redesigns that are generated together with the original image, the result of the analysis and the three MRs that are obtained.

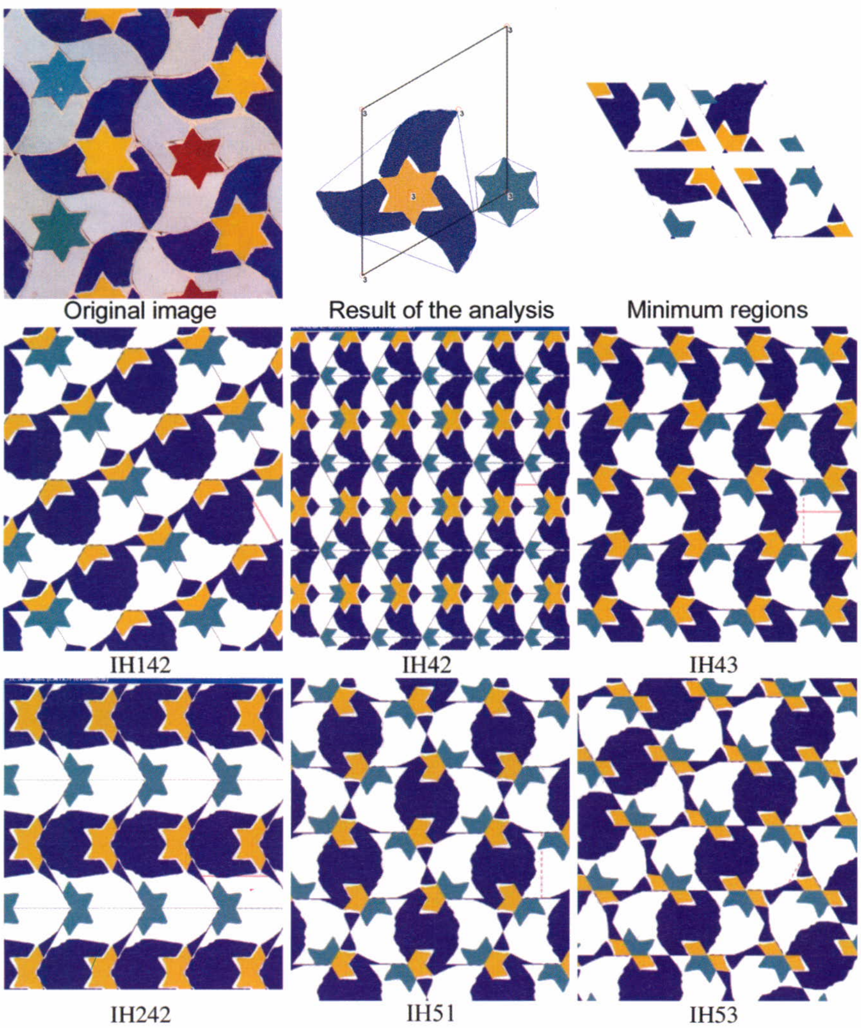
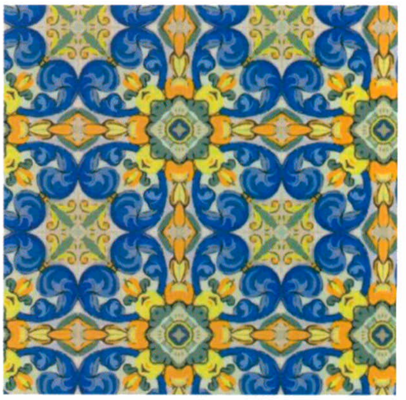


Figure 8. Redesigns obtained from the results of the analysis of a mosaic image

5.2. EXAMPLE 2.


IH78 (CMM)


IH79 (P4)


IH80 (P4M)

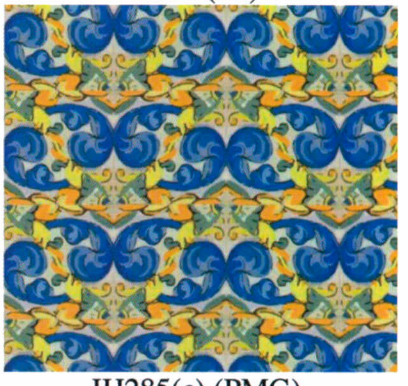

IH81 (P4G)


IH83 (CM)


IH84 (P2)


IH85(a) (PMG)


IH185(b) (PMG)


IH285(c) (PMG)


IH86 (PGG)


Tile of the original design (D1)

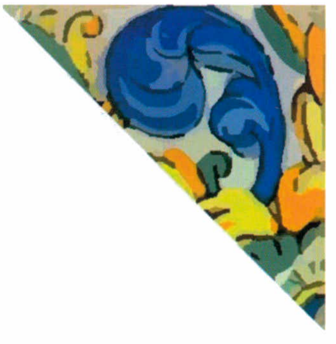

Vectored C1 tile

Figure 9. Generation of variants from a traditional tile

This example (Figure 9) depicts the tilings obtained from a traditional tile.

The MR geometry corresponds to that of a right angle isosceles triangle. The diagram in Figure 4 (triangles) shows the isometries that can be applied to this MR are those corresponding to tilings IH79, IH80 and IH81, in addition to the isometries corresponding to the generic right angle triangle (IH78), to the generic isosceles triangle (IH83, IH86) and to the scalene triangle (IH84 and IH85). In the case of IH85, three designs are obtained, depending on which sides the isometries are applied to, all of them PMG.

The bottom row of Figure 8 shows the tile from the original design with point symmetry group D1 in the centre, and on the right the vectored tile with symmetry group C1 which is used to generate all the variants. With the square D1 tile, only types IH71, IH70 IH68 and IH69 are generated. This result is important, since with the C1 tiles all the possibilities are realised, and the tiles with larger symmetries do not generate new cases, but only part of the ones obtained with the asymmetric tiles.

5.3. EXAMPLE 3.

In this case, various compositions appear with a pattern (group of objects) extracted from the Design Database. For this purpose, the pattern is located in a certain MR and the different designs are generated according to the chosen type of MR. In the example shown (Figure 10 and 11) the pattern is a pomegranate taken from a historical tile and the MR is a rectangle, a trapezium or a right angle triangle.

The different isometries that can be applied to these MRs are depicted in the diagrams (Figure 4 and 5). Figure 10 displays some of the different tilings that can be generated with the chosen pattern and the rectangular MR, and Figure 11 shows these with the trapezoidal and triangular MR.

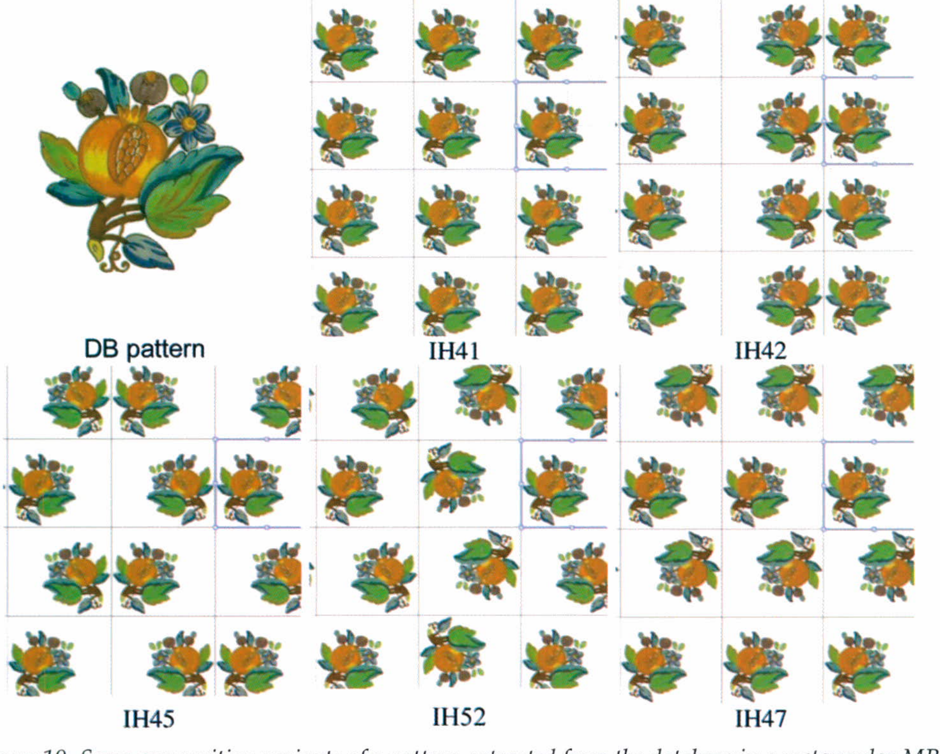


Figure 10. Some composition variants of a pattern extracted from the database in a rectangular MR.

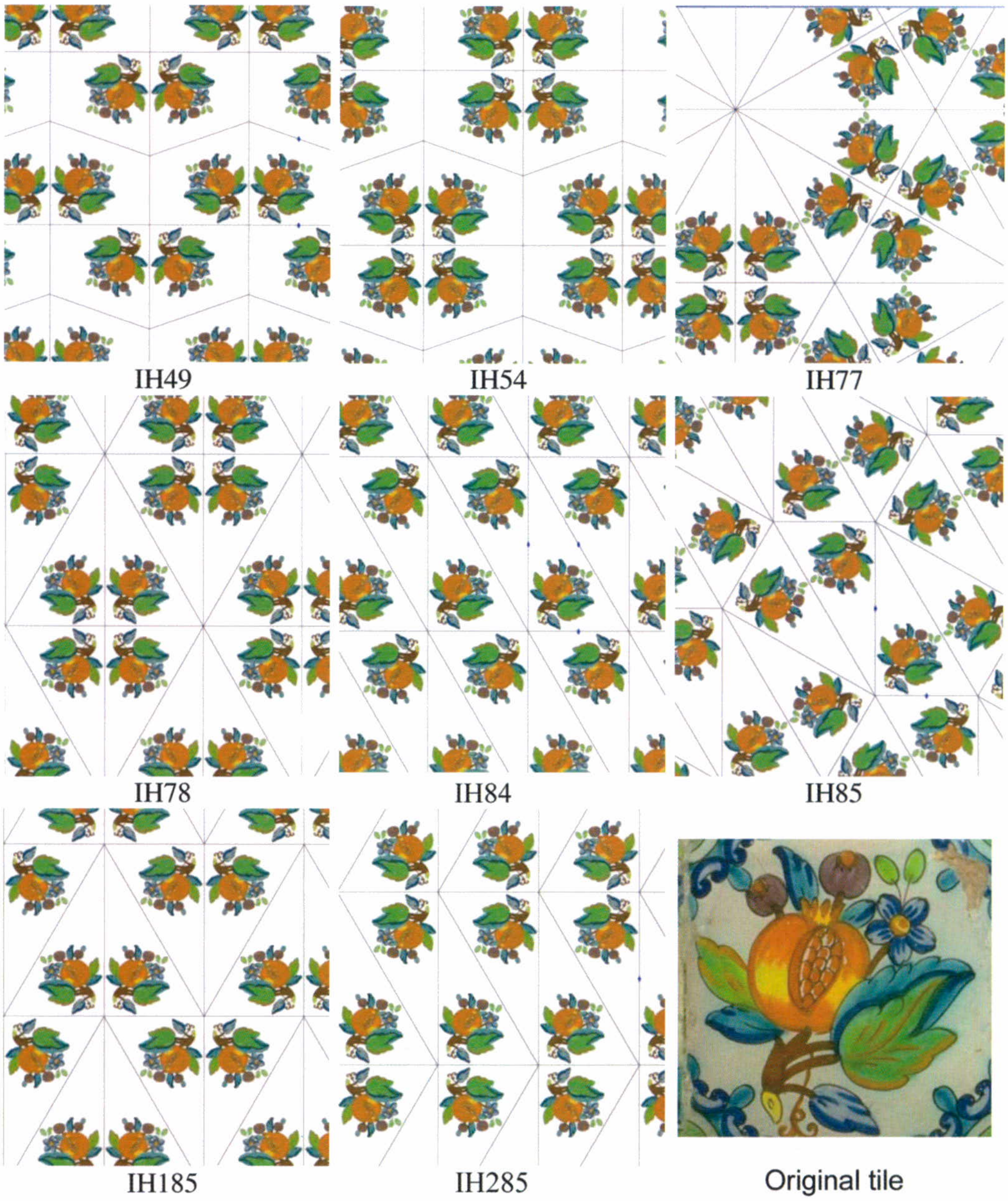


Figure 11. Some composition variants of a pattern extracted from the database in a trapezoidal and triangular MR.

5.4. EXAMPLE 4.

This example illustrates the editing of new designs and shows the different compositions that are obtained when working with a set of tiles.

A grouping of four tiles was used, involving two square and two rectangular ones, which together formed a square MR (Figure 12). From this square minimum region (the grouping), in accordance with the diagram in Figure 5, it can be observed that the applicable isometries are the ones corresponding to tiling IH55 (bottom area of the diagram) and, in addition, the ones corresponding to all the less regular quadrilaterals than this one, depicted in the graphic by the connectors between the different MRs. Figures 12 and 13 show the composition variants that can be obtained with the grouping of the 4 tiles.

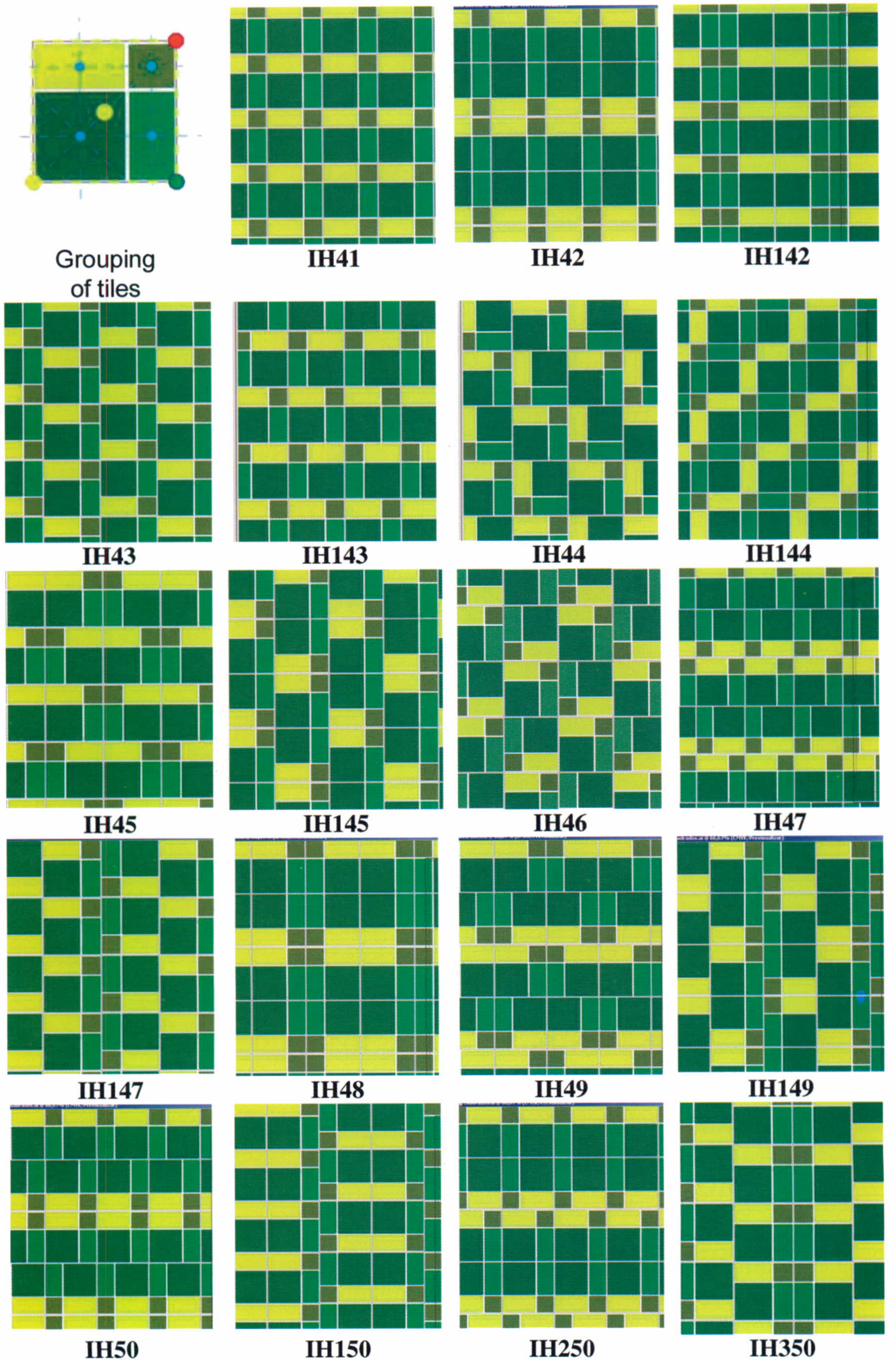


Figure 12. Generation of variants from a set of tiles (A)

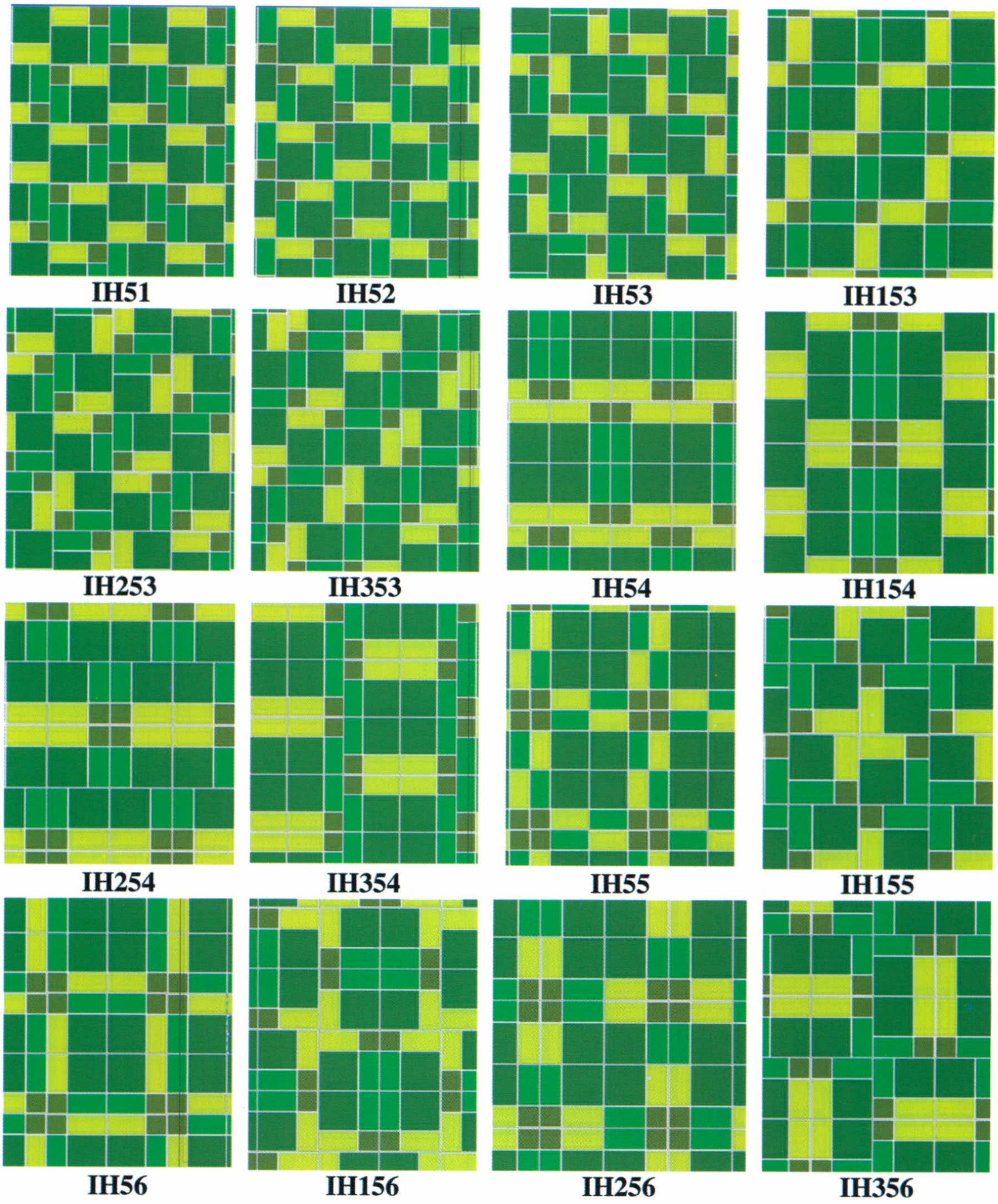


Figure 13. Generation of variants from a set of tiles (B)

6. CONCLUSIONS

A methodology for tiling design and redesign has been presented, based on editing the tiling minimum region (MR), which includes: selection of its geometry, modification of its sides, definition of its inner composition and application of different isometries.

This methodology is applied in an editing module set in an Integrated Ceramic Design and Redesign System. One of its objectives focuses on the recovery and exploitation of the historical heritage of our ceramic tiles. In this context it is to be noted that the proposed methodology is capable of reusing the analysis results of already existing designs, thus enriching the creative options of the designer.

For the application of the methodology, a specific computer tool is currently being developed, implemented as a plugin for the design software [Adobe Illustrator], whose first partial results have been set out in this paper.

7. ACKNOWLEDGEMENTS

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