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Flip Flop and Spatial (3D) Graphics in Lenticular Technique

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Abstract: The research work presented in this paper refers to printing techniques used in spatial (3D) and flip flop graphics, and to multi-layer graphics carried out in lenticular micro-lens technique. Such research work makes way for new contemporary and future areas linked with the topic «New developments in printing materials» and to new manners of visual communication, modern graphic design and product protection. The possibility to carry out the work by means of dynamic micro-lens technology is a challenge to any graphics designer. Playing with words and messages they convey, joining of certain meanings, blending of photographs, three-dimensional graphics and portraits are examples of the numerous possibilities of visual communication and contemporary advertising, graphic product improvement and protection of documents.

Keywords: spatial 3D graphics flip flop graphics, lenticular technology, holography, contemporary design, new technologies, protection

1. Introduction

Contemporary documents: identification cards, passports, diplomas, certificates, packaging material for various products, especially medicaments all have security elements with individualized data designed and carried out in lenticular technique. Whereas this is considered in the first two cases as a high level of security, in the latter cases lenticulars enable top modern design.

Spatial and flip-flop graphics are most often present in holographic products. Those are high resolution smaller format graphics (in documents, securities and bills) that include micro-text, and numerous security contents. During the past conferences we reported on spatial and flip-flop graphics, especially on holography as a means for protection on packaging material (Iarigai 2004). Micro-lenses open a new designer sequence of 3D spatial design and flip flop graphics depending on the position and angle of viewing. We have studied a graphic work in lenticular technology that is observed from a greater distance. We have achieved extraordinary results where multi-layer graphics and multi-layer messages are in the depth of our perception and some tens of centimeters above and below the print's surface. With these designs the viewer himself plays a large role participating actively in producing the impression, depth, spatial characteristics and the speed of visual message altering depending on the position he has taken.

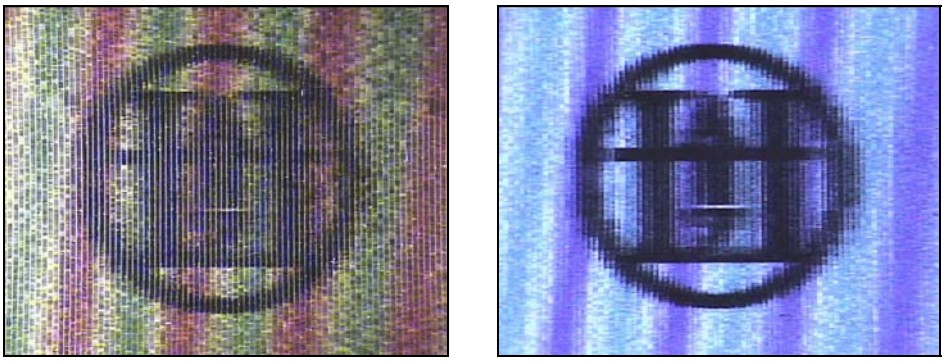
2. Research Methods

Spatial and alternating graphics computer models enable effective working out of the design for which it is necessary to first carry out testing and to set realization standards. The standards apply to parameters that determine the angle of viewing, the number of flip flop graphics, the number of deep

layers (3D graphics), the height and depth of the image (3D portrait), the ratio of alternating certain levels, blending, colors, contrasts.

Designing of lenticulars is followed up with keeping documentation on graphics, layers and colors. The lenticular technique, also called micro-lens technique may be carried out in digital printing. The print containing two or more incorporated images represents a high level of security. Only those who possess the original image parts can carry out and reproduce the original image. Experiments with lenticular images on security elements coming out from our laboratory have already been applied in practice and they proved to have extraordinary results. The method was applied on identification cards, certificates, diplomas, in advertising products, as direct mailing, advertisements in newspapers or on posters. The innovations are in the flip-flop design, alternating graphics or in two or more graphics, floating graphics, and imitation of object movement and in the three dimensional – 3D display. Experiments covered small and larger formats on different micro-lens liniatures: from 20 to 120 LPI. The printing background was paper, foil and glass. The most important printing technique is direct digital print on the micro-lens plastic material itself (on its smooth side) with application of contact film in spray form.

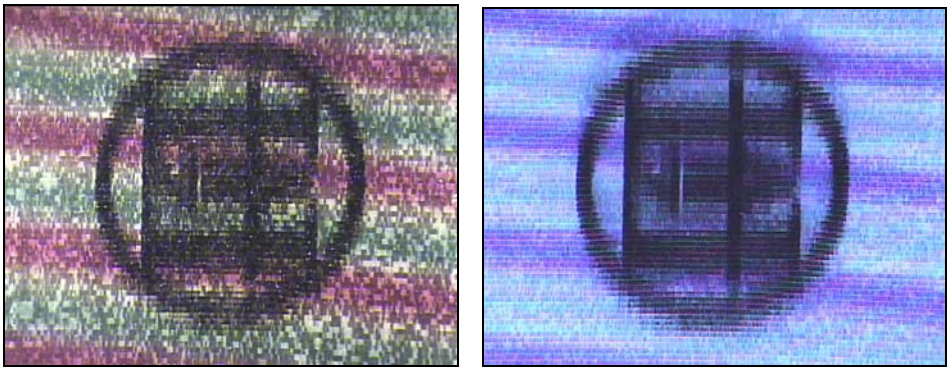
The example chosen for this paper's discussion is a 3D sign with a floating background (Picture 1). The method for extending lenticular analysis after printing is determined. Scanning is done with a reflected white light, with UV light of selected wave lengths UV254, 312, 365 nm and with IR light. High quality scanning in the UV area is carried out under an angel parallel in a line of micro lenses and perpendicularly to the micro-lenses.



Picture 1 lenticular HATZ1 original, and in HATZ1 under UV 365nm

Besides the quality of being three dimensioned, lenticular, the sign for Hrvatska akademija tehničkih znanosti (Croatian Academy of Technical Sciences) has a security color. A color has been designed that changes the response of red RIv500 in daylight into purple RIv365 under UV light with wave length 365 nm with the condenser for LUMI illumination in values 5 and 6, and also from green GIv500 into blue Biv365 under UV light with wave length 365 nm with condenser for LUMI illumination in values 5 and 6.

On basis of results up till now it may be concluded that it is useful to use black, blue and red linear background. They react differently under UV lighting and IR lengths. If UV invisible color is introduced, it is necessary to print it after the lenticular printing. The case with the uncontrolled background is simpler due to the fact that the graphic’s parallel quality is not apparent. UV paint with a visible tone must be positioned under the UV light. UV invisible paints for inkjet printing directly onto the lenticular plastic have not been offered yet.



Picture 2. lenticular HATZ 90^0, lenti HATZ 90^0 UV365

The scanned lenticular (Picture 2) image in day light and UV light under the angle of 90^0 in respect to the lens direction is shown in the picture. The optical scanner for UV area does not create the impression of a 3D image nor flip-flop, but it recognizes multi-layer graphics only.

Special research work was carried out in respect to the problem of typography for the described communication and carrying it out in lenticular technique. It was determined that in order to carry out the typography by using this technology it is necessary to respect certain rules. On basis of analyzing and carrying out different designs, parameters were determined for setting the standardization and for new directions of testing. Liniature and resolution, and the very micro-lens structure set certain limitations. On the other hand there is a goal to make the maximum out of spatial experience. It was determined that due to a certain set liniature amounting to 20 – 120 lpi it was not possible to reproduce letters smaller than 8 pt, i.e. that «small» typography would not be legible. But the most important thing is that through such reduction i.e. simplifying to the most essential, it is quite evident how a large quantity of text is left out, such, as for instance, product descriptions, and a great deal of space is left to the visual graphic and designer intervention. In a certain way the ordering party is forced to give its consent to simplicity, sharpness and clearness of visual messages. Large formats have not been studied due to difficulties in bringing into coordination the parallel quality of micro-lens miniature and the printed graphics liniature as this must be in full coordination.

The text example carried out in 3D technology (Picture 3): *graphics and typology with micro-lenses* was designed in sizes ranging from 10 to 20 typographic dots. The text was designed for three dimensional executions on micro-lenses where the sense of height ranged up to 8 mm above the print's surface. When carrying out the design it is possible to plan precisely and determine what the sense of height will be even in cases of up to several centimeters above the surface, depending on the liniature, dimensions and lenticular thickness. A low resolution of 50 lpi was deliberately given in this example for purposes to illustrate the display. This lenticular as a separate 3D graphic work in spot colors may be applied over various vector floating lenticular graphics, as in the example «iz» (Picture 4).

Grafika i tipografija sa mikrolećama
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Picture 3. graphics and typography with microlenses for 50 lpi microlens

The relations between the graphics, typography and background, i.e. the color and the background contrast are also important. In case black typography is alternating on a white basis and in case the words are long, there is possibility that with vertical movements (viewing from left to right) there will be black «remaining residue», i.e. the previous image in relation to the new image will not disappear in full. A color background is much better (red, black), especially if it is carried out in the spot color technique, and the alternating typography is in the negative – white. In this case the possible «traces» are covered with the very color of the background and an impression is gained of total covering capacity. A good combination is also the one with black letters on a color background. Testing has proved that the best results are achieved by spot color application.

We have tested various graphics that simultaneously function in the same space but are of different height and depth in direct contact, as for instance, the effect of the floating typography. The effect is greater if there is contact, i.e. the relationship, contrast between two different letter heights.

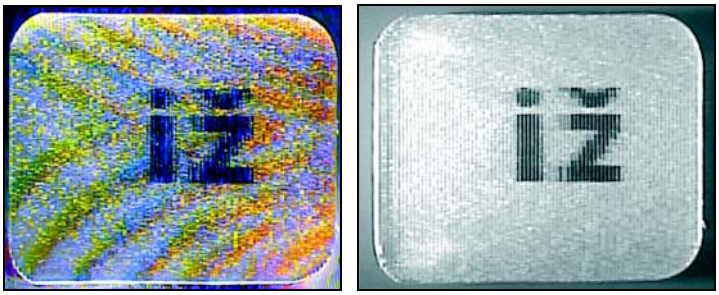
3. Results

Lenticular technology and micro-lenses set a limitation in resolution, and this applies especially to vector graphics thickness values and typography size, as well as vector graphics thickness values. Spatial and flip flop graphics carried out in the micro-lens technology are applied in documents such as ID cards, i.e. on cards that have a certain thickness required by such technology due to optical laws.

Resolution is firmly set and we have carried out the testing and analyzing on 20 to 120 lpi micro-lenses. The smaller liniatures (20 lpi) are more suitable for 3D designs; - their structure and the height of three-dimensional effect are stressed. Such designs on 20 lpi micro-lenses are good for larger formats, posters and material that are placed in large interiors or on jumbo posters. Such designs are not suitable for carrying out smaller formats due to the very micro-lens size being up to 5 mm. Flip flop alternating graphics are formed in the application of smaller format promoting material and thinner micro-lenses; promotion material. The 50 to 75 lpi to 120 lpi lens structure has proven excellent for application on wrapping material 5 to 15cm in size. The number of alternating images may be from 2 to 12 or even 24 horizontally or vertically in respect to the viewer. The effect of printing animation is achieved and this improves significantly the wrapping material graphics. However, in case of more than four images in an alternating sequence there is blending of contents. This paper describes successful cases with two to three image changes.

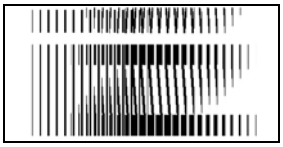
In order to prove the authenticity of the lenticular graphic element scanning has been done under different lighting conditions, under precisely determined angles of slanting EPI light with precisely determined wave lengths of 254nm from the UV are to 1000nm from the IR area. For proving the authenticity of the lenticular, first the make ready is done by designing security graphics. The following are taken into consideration at the beginning of planning: flip flop, floating graphics, three dimension

quality, lenticular thickness, resolution, direction of observation, color, transparency, printing technique with which the lenticular will be carried out. In case the project for making the graphic product did not anticipate the use of various and wide events with visible altering of the above listed parameters, it will not be possible to check nor prove anything later.



Picture 4. a) Slanted light EPI b) IR 780 nm

Picture 4. Three-dimensional design for IŽ sign in lenticular technique, three-dimensional design for personal initial sign in lenticular technique with altering digital printing colors.



Picture 4 c) IŽ 3D

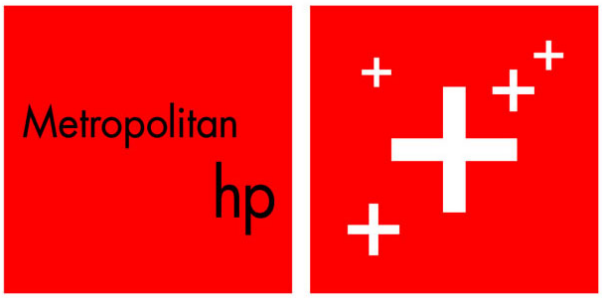
Reproductions of 3D lenticulars give only the print plane regardless of whether the picture was taken in EPI position with a small angle of the light beam or the light falls perpendicularly onto the lenticular. The small angle provides additional shading due to the light refraction on the micro-lenses. This is uncontrollable in the micro-structure, but the graphics are, nevertheless, recognizable. The example of a background with colors that do not respond in IR light has been enclosed on purpose. The graphics of the floating in-depth background consists of magenta, cyanogens and yellow color. 3D initials IZ are visible under IR light as the security element where only the security IR black color is seen in wave lengths of 780nm, 830nm and 850nm.

Picture 5. a) UV 254 nm b) UV 365 nm pseudo c) UV 365 nm

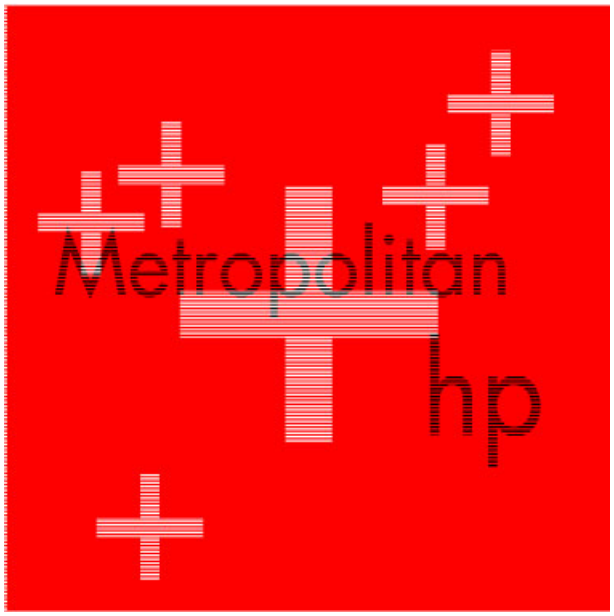
The picture IZ Lenticular picture scanned in the UV area with pseudo color interpretation

The pseudo color effect has been applied in the pictures and so the index color arrangement has been added to the UV area. It is a well-known method from early interpretations of “heat images”, where the programmed line of index colors is copied allowing visual demarcation in the rich color system.

In Picture 6 the «hp» flip flop lenticular is shown containing two alternating images. The typography appears or vanishes completely. The red background executed in spot red color is excellent for visual coverage of images alternating from one to the other.



Picture 6. a) Design for HP flip flop picture 1 and picture 2

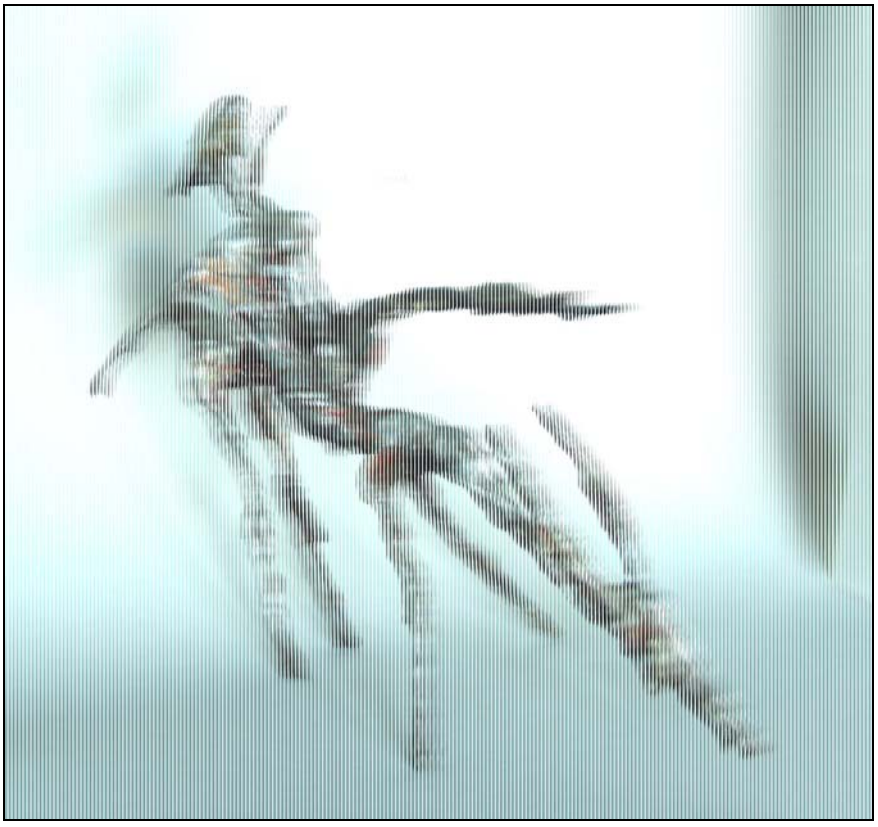


Picture 6. c) HP flip flop Lenticular, 75 lpi

Flip-flop lenticular pictures can be taken with digital cameras from longer distances so as to provide dividing of incorporated pictures. Such digital records do not have known values of all shooting parameters so the experiment can not be repeated in the quantitative sense. Such pictures are information on quality only. Lenticular technique is already incorporated into money bills as *micro-lens of dome form* with thin-layer materials and a liniature above 120lpi. This novelty provides the impression of a moving picture from all viewing angles. Due to the very high liniature it is almost impossible to produce outside a laboratory.

The next example is designing the lenticular sculpture (Picture 7.). The sculpture has been photographed with the designed technique of 3D photographing that consists of six cameras placed under a precisely set angle of shooting in respect to the object to be taken. The first and last pictures have been enclosed as examples. Six pictures are programmed and merged into a lenticular whole for 3D execution on a 50 lpi lenticular.

Picture 7. a) Original Skulpture 1/6 **b) Original Skulpture 6/6**



Picture 7. c) Lenticular Skulpure 3D 50 lpi microlens

Sophisticated methods of the 3D portrait are proposed as the ultimate security level, photographed with 6 cameras, programmed and printed in 3D lenticular micro-lens technology. The 3D lenticular portrait is combined with flip-flop elements and floating 3D graphics in a 120lpi resolution, with security Ultraviolet 254 nm, 312 nm and 365 nm and infrared colors. Colors are used for infrared checking that in day light give the impression of color and black, whereas under infrared 780 nm to 1000 nm are not visible, the portrait vanishes completely and the security graphics appear in its place. It is impossible to scan and fake such a portrait on identification cards and in passports because its initial record had been made in the technique of 3D photographing with six cameras, and is stored in the database.

4. Discussion

An extreme area in the printing business is the lenticular graphics design that can not be imitated or faked. This paper is on further development and extending of printing practice, graphic design and demanding printing practice. The scientific contribution in this paper is the fresh knowledge on graphics' transformation carried out in the lenticular flip flop technology and 3D manner and their quantitative measurements. Merging of lenticular technology with ultra-violet and infrared colors in relief digital printing is a proposal for future wide application in the area of document and securities protection. The quantitative method of designing, execution and checking of the lenticular print is an excellent application in security printing, where there is a database for each element that is further used for checking of color, designed graphics, materials and provides the possibility of repeating the whole procedure.

Attached to this paper is our proposal for classification of printed matter promotion using spatial images, as part of instructions for appearing in the new graphics market. The classification covers the design technology, the limitations of contemporary printing technique precision, limitations of digital printing trial prints. The future application of dynamic and deep computer graphics in lenticular technique is not only a means of protection (personal identity number, initials, and identification digits) but also promotion, advertising and top design as additional product values. Wrapping material is an excellent type of media, as are all kinds of credit cards, for which a new visual event may be applied for each new edition. Then there is packaging material, promotion material such as promotion cards, direct individualized parcels sent to address (mailing), magazine covers, and advertisements in magazines – where the design in micro-lenses may be applied in segments, business and promotion material, planners (covers), covers of yearly reports, calendars, and posters. The application may be also applied to all graphic products, and also to products from the product design area (advertisements in sale spots), all aimed at having a noticeable visual communication, great possibilities in design and promotion design as well as in product security. Lenticular graphics carried out in order to present the various possible applications are in the attachment to this paper.

5. Conclusion

The most frequent application of graphics designed in the lenticular technology is in the field of advertising, in 3D flip flop lenticular design consisting of two or more images. The most significant application is in the field of security documents where flip flop protection is applied in personal identification cards, and the sophisticated method of the 3D portrait is proposed as the highest level of protection in combination with flip flop elements and floating 3D graphics, UV and IR colors.

The set and proposed methods comprised lenticular technology in flip flop and three dimensional executions, from 20 till 120 lpi in digital printing with conventional spot and process paints, protective ultraviolet and infrared colors responding in precisely determined wave lengths. Related databases are created as a basis for software type analysis. This is the first time that such analysis is approached systematically, with quantitative measuring on facilities with precisely determined lighting angles and determined wave lengths ranging from 254 to 1000 nm. Printing of lenticular graphics with UV and IR paints by means of digital techniques has extended the design complexity protection of securities and prevention of counterfeiting. Research results have been transferred to the field of practical and security digital printing on micro-lenses. This is a completely new way of protecting graphic products.

The value of such research work is in the new quantitative procedures for proving the authenticity of a lenticular graphic product. A new system of design and marking with precisely coded micro-lens structure has been implemented, providing different behavior depending on the different viewing angles and in various lighting. This work has extended the knowledge and practice of designing security graphics and using digital printing with application on micro-lenses. This paper is a contribution to extending graphic design and printing practice and opening possibilities of further investigation in the field of lenticular graphics.

Visual communication through spatial and flip flop graphics in lenticular technique is an original method. The graphic design consists of two or several different messages, visual, typographic,

illustrations or photos that are alternating in a precisely determined sequence or blending in different combinations, having different depths and heights and coming out into the third dimension. By passing by the graphic design carried out in the spatial and alternating graphic technology or by moving a graphic product; flyer, mailing, advertisement add, packaging material, the viewer changes the angles of viewing and thereby takes part in creating the visual message. Such a graphic product or segment is interesting as an «eye catching» product, and is very soon singled out from other products. The value of a graphic product designed in this manner is that it remains preserved during time and in the majority of cases it is not destroyed or wasted as a single-use printed product.

Its additional value is in its property to protect a product. It is impossible to copy, reproduce, photograph or counterfeit lenticular technique spatial and flip flop graphics. The ordering party remains permanently protected and its product or campaign remains in one's memory as original. This kind of approach to graphic design through new lenticular technology is linked to other contemporary technologies in multimedia. The reason for lagging behind in this area up till now is only because the area for application has not been fully researched. This paper is a contribution to expanding knowledge through practical application of spatial and flip flop graphics in lenticular techniques and is aimed at having not only scientific research goals, but commercial ones as well.

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