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VOLUME 3

## WORKSHOP DESIGN OF GRAPHIC MEDIA

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## **PREFACE: DESIGN OF GRAPHIC MEDIA**

Planning of production a graphic product is based on software tools including the specifics of contemporary digital basics for image and text definition and transformation. The central point is producing the printed form and thereby complex systems are carried out starting from screening designing to press plans and postpress. We have previously put forth the assertion that knowing how to make a printed form is the same as passing the necessary testing for successful designing of the complete printing process. Prepress, Press and Postpress are integrated and managed by a unique system called Job Definition Format. Conventional press has put great significance to the printed form production phase. In digital printing the printed form is a virtual record taking into consideration all graphic product production steps the same way as with CTP in conventional printing. More complex printing products include hybrid technology. In the line of procedures and processes, different technologies are confronted. General knowledge on the printing business can be extended by overcoming the integration of different printing techniques. The motivation for learning is somewhere at the edge, in the area of extreme interventions. Contemporary designers stretch out reaching impossible solutions. But, that is what actually motivates all the participants in making a graphic product to approach a new area with ease. That is what extends their knowledge in the printing and designing area. New proposals and new design solutions have been created. Such borderline printing areas are the subject of this section at «Design 08».

We have made efforts to bring together scientists who are not only experienced in theory but also possess practical knowledge and skills in carrying out complex graphic products. This section coming under the title «Design of graphic media» puts stress on planning the printing of securities, documents and applying such graphics in the security area.

We have articles approaching new screening elements. Elements are also shown that mutate depending on grayscale. Their application is in the security printing area because individualization elements are included on the level of choice and screen cell deformation. A more extensive application is expected in jumbo poster design in order to acquire liveliness and a certain innovation in presenting contents. Some works have offered algorithms in the PostScript graphic language with the goal to open the tool for the automatic, «computer» expressing in the design area. Stochastic systems have been proposed for initializing and carrying out computer graphics with graphic product security procedures.

A new research area has been introduced through implementation of colors, design and infrared area programming. Up till now this subject was unknown to the public because it was applied only in producing securities. While IR color has appeared in this graphic example in one tone only, in other papers for this Congress the subject of IR color is extended to a whole specter of coloring. Solutions for applying pixel graphics with the use of templates are considered, setting thereby new separation standards. A double separation transition of RGB into CMYK has been proposed with controlled gradation of the black component.

The image in the visible part of the light remains the same, but in the infrared area it reflects according to the plan and design of the designer who has the task to create top security. New algorithms have

been proposed as well as relations of continuous transition of GCR towards the UCA method in the same documents. The vector graphics are carried out with an algorithm into which the procedures for infrared effect appearing have been incorporated. The stochastic use of multi-color digital print has also been shown giving a fully planned infrared effect. This is why prints have been attached to this paper having a series of examples with infrared printing use. Copying of such additional prints will not have any effect because in such device there is no infrared color control.

A conventional graphic product is the beginning of a web publication with the same subject, the same title. The requirements are different. There is demand for dynamics, search, selection, connections. Design is extended to producing and designing a dynamic image, stochastic graphics, and video. The designer covers new areas known from previous times. Integration of a series of methods is the basis for creating e-books. The designer becomes part of a team, the system for making an electronics-based school: planning of remote learning, examination, testing, training, «quizzing». Visualization and design quality become even key elements for content presentation. The graphics profession is making adaptations in order to continue developing the product at hand in its primary form into a multiplied virtual product.

In these pages the authors are presenting their positions, innovations and skills: the area that has appeared as a completely new one but very important for future development of teaching. The initial experience is linked with producing e-material for learning subject-matter from the printing industry area. Experience is presented through reports following the testing of pupils and students that have joined in for the experimental work on graphic production software simulators. These tools are presented through separate papers and they are the result of a ten-year elaboration of production digital standards. The same goes for digital job orders in printing production. Tested manual planning procedures are simulated. Solutions are given through new graphic languages with SVG domination. The elegance of working with a production printing process is shown. The article's authors are graphic experts, electronics experts, informatics experts and programming virtuosos.

Vilko Žiljak

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## **EDUCATION OF GRAPHIC DESIGNERS FOR CROSS MEDIA PUBLISHING NEEDS**

I. Čaljkušić, M. Barišić and I. Pogarčić

*Keywords: new media, cross media publishing*

### **1. Introduction**

Fast development of computers has by the end of the 20<sup>th</sup> century led to an expansion of new media, as well as to their ingression into the domain of everyday life. Like every other new social and technological occurrence that has radically changed everyday life, it has become necessary for the scientists to approach it systematically, in order to define its contents, describe its domain of operation and its influence on technology and society.

Today, we observe the expansion of press media and, especially, new media. New media occupy their place in the information system, and have seized from the press media the primacy and significance they had concerning the information distribution. For example, three of the US leading daily newspapers, New York Times, Washington Post and USA Today, are printed daily in 5,5 million copies, while 25 million visitors visit their WEB pages per day. We are witnessing a historical development of media and the dilemmas concerning the continued existence of certain media which were at one point, during the introduction of new media, repressed, yet not driven out from the information domain.

Precisely this is today happening in the press and new media clash.

Alongside the fight for dominance in the information world, aided by science and the development of information systems, the XML code language was developed, which allows media networking, while enabling media to keep all the advantages they hold over others, as well as to highlight them in an adequate way. A new field has developed in this information distribution clash, in view of accomplishing faster, more accurate and simpler presentation – “cross media publishing”.

The described situation has not only caused the development of new code languages, new domains of information science, it has also defined additional demands in the visual design of information of cross media publishing.

The design world, whose dominant field of representation was, up to the development of new code languages, in graphic design, has caused the call for introducing new contents in designer education.

### **2. Comparison of Design Principles in Old and New Media**

Perceiving graphic technology as a technological field which has by tradition had the right to define rules designers were to uphold during press media design, in order to make printing possible, we may not at first view see the need to compare it with design principles designers should follow while designing in the new media domain. It is assuredly only an initial reaction, for if we dig deeper under the surface of designing and under the domain of the intertwining of press and new media in the today’s information and communication system, we shall observe that even now, and most assuredly in the future, there exists an undeniable need for a proper and quality education of graphic designers, not only in understanding the press media, but also in getting acquainted with the possibilities and the rules of new media.

What contents should absolutely be introduced into the education of graphic designers in order to successfully respond to the new media demands?

To begin with, if we analyse the design elements of graphic media with new media elements we can recognise a design foundation which applies in both cases and consists of: the format, layout, composition, colour, typography, photos, illustrations, manner of information communication, realisation technology, presentation technology... Each of the stated elements, precisely because of its manner of information communication and presentation technology, calls for a specific approach to design, as well as for a redefinition of design principles during the information transformation from one media to another. In order to present the specificities of transformation more accurately we can compare the significance of the format, layout, typography and photography in old and new media.

The format in press media, as well as many other elements, can trace its history back many centuries – to the format and form studies in Ancient Greece, and to the 20<sup>th</sup> century work of La Corbusier, Mondrian and other modern art authors. La Corbusier studied the complicated and modular system of space division in correlation with the ideal proportions of the human body. The system thus obtained was a reflection of the Golden Ratio into which he had succeeded in implanting new ideas in accordance with the modern visual presentation demands. Analysing the print layouts we notice that the structure of each of them depends primarily on the type of the prints, on the format in which the prints will appear in their final form and content. Thus, for example, the single column structure in the simpler sheet prints, which are compositionally the simplest, while the most frequent combination in book layouts are the two and four-column structures, and the most frequent combination in newspaper editions are the three and six-column structures. A very common case in print layout is the combination of several kinds of columns. The reasons for this relatively various layout combinations derive precisely from the fact that such variety allows for untrammelled variations of graphic elements' composition on the pages of print media.

If we observe the electronic media layouts we'll find that they are more fixed. In most cases, they consist of the three column layout, which is even called "the holy trinity" in the web language. The first column is usually navigational, as well as narrower, while the middle column is the main column, and designated for the main content arrangement, and the third column is most frequently reserved for advertising space, links, banners... What are the reasons for this approach to layout design in electronic media? First of all, information is presented to the information receiver via the electronic display. Displays have their formats, resolutions, frequencies and all this is defined by the manufacturer and is unchangeable. On the other hand, studies have shown that people prefer reading information from the paper to reading it from the display, as well as that, contrary to the print media, where the number of pages doesn't influence the reader's willingness for reading, in the electronic media the maximum quantity of "screens" the reader is willing to scroll is – three. It is apparent from the above mentioned that it's necessary to situate all the important and constant information on, for example, a web site, on the first screen, and to hierarchically organise them in such a way as to enable the best usability. The consequence is the reduced number of possible variations of the design elements composition, which is one of the reasons why web sites look less attractive than, for example, a magazine whose information they are relaying.

The development of typographies in print media can be traced from the first Gutenberg prints to the majestic work of Renaissance typographers which perceived typography as a powerful means of expression in artwork. Notwithstanding the long history of the development of typography, it has to this day remained probably the most conservative part of graphic design, especially considering the book and newspaper typography. In fact, the typography's primary goal, regardless of the esthetical and formal level, is to retain the maximal level of text legibility, thus fonts and rules enabling exactly that have been developed. On the other part, a need for a revision of these principles has occurred in the electronic media, or more precisely with their occurrence, as neither formats, nor the composition or the resolution on which the typography is presented are not the same as when it comes to press media. The largest problem for the functioning of fonts in electronic media, fonts formerly used in press media, is the 72 dpi resolution of the monitor's screen. Consequently, a need to create new fonts has occurred, fonts more suitable to be presented on the monitor's screen, which don't possess at printing or stamping the beauty of fonts used in book typography, yet still maintain the primary

condition of legibility. Moreover, due to the 72 dpi monitor screen resolution, treatment of photographs or illustrations in the electronic media is significantly different than in print media. The speed of the network data transfer presents an additional problem in presentation and treatment of photographs in electronic media layouts. In print media the photographs are an element equal in value to others in the layout design, and are often considered in newspaper production as of greater significance than the text it accompanies. In print media there are no technological limitations as to the reproduction of photographs, that is, for their presentation in the media. In electronic media, as a result of the abovementioned problems of resolution and data transfer, the photo has a more decorative role, that is, it doesn't take over the information's role, as is the case in print media, but is attributed an unjust role of a design element which doesn't possess any important informational value.

In order to conclude the comparison we have considered the publishing process of press and electronic media – the electronic media definitively hold the advantage in that sector. The production time is significantly shorter, they are more flexible in view of changes in information, and the production is significantly cheaper.

### 3. Conclusion

Taking into account all the elements in press and electronic media production we can conclude the following: concerning the design aspect, the press media allow for more creativity and more possibilities in presentation and information coding, while the electronic media are on the other part not as successful when it comes to design, yet their advantages lie in the possibility of larger modularity, in the interactivity of design elements, variability, possibility of transcoding and lower cost of production.

Adapting the education of graphic designers by directing them to more fully acquiring the specificities of new media, as well as the methods, languages, design principles for transforming information from old to new media, and reversely, should, we believe, turn out to be a successful answer to the emerging expansion of cross media publishing.

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## POSSIBILITY OF E-LEARNING IN GRAPHICS EDUCATION

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### *Summary:*

Needless to say, the teaching methods, the learning methods and communication have been changed forever with introduction of the World Wide Web and the Internet.

However, one should not forget that technology and tools are important, but the most important performance criterion of e-learning is the available content. Moreover, the desired effect of e-learning will not be achieved if the content has not been adjusted to individual learning or if it supports only typical lecturing presentations. The most important role of the content is that the one who is learning by using the program can learn how to keep the range and the interaction, in order to maintain the adequate high level of feedback between the student and the teacher.

The results cannot be reached by pure consumption of the content. This implies that the situation already present in the class or traditional classroom, i.e. the contact and the connection of the students with the teacher, should also be taken into consideration.

E-learning does not replace a classroom, but adds to it.

The article assesses the implementation of e-learning in the secondary education graphic courses and as well presents and analyses the implementation of e-learning by means of online education and knowledge testing.

*Keywords: e-learning, graphic technology, online knowledge testing*

### **1. Introduction**

The accelerated development and expansion of science, changes in graphic technology and communication media have always had impact on the educational process. In late 20th century, computers entered our living and working areas, very large and powerful in the beginning, serving hundreds and thousands of users. They were followed by personal computers, available to every man, in every office, in every home, in every place where a man is or works.

One medium has united the advantages of all singular media (text, drawing, animation, photography, film recordings). They have not only been united, but they also have acquired a new quality. A new, powerful medium, the Hyper-medium, has been created. This has changed options of education tremendously. Today, there undoubtedly exist a need of a more powerful integration of education (learning) and work, of including new contents into educational processes and new methods of learning.

The necessary options in education should be based on research and should define job vacancies, especially the new ones (complied with the development of information and communication technologies), on defining knowledge and skills necessary in acquiring qualification for certain profession, on defining a curriculum (integration, modular programming), on providing conditions for a high quality realization of the curriculum including education and innovation within the teaching profession.

By means of implementation of e-learning into the education of graphic designers and via multiple repetition and computer simulation, new knowledge and skills are acquired.

## **2. E-learning**

The development of the state-of-the-art technology in the area of Graphics has resulted in the need of implementing new contents in the teaching process, in new methods of learning as well as in the system of lifelong learning.

The appearance of the Internet and the interactive multimedia has given a new sense to education. A need for new learning methods has arisen. The contemporary learning methods are a turning point that brings changes to the teaching process which is, in turn, to provide for new knowledge and skills in the realm of printing where acquiring new knowledge via a worldwide database is an ultimate necessity. E-learning and computer-assisted learning that are in turn supported by all the conveniences of the Internet, databases and applications that make the system easy to use have made that way of acquiring knowledge more and more popular and -above all- necessary. The “learning from the socket” has been creating networks within which knowledge circulates from educational institutions and very printing offices to institutes that do research into printing and laboratories that develop new printing technologies.

E-learning, learning supported by the computer, using all the benefits of the Internet, the databases and applications that make the system user friendly, has made learning more and more popular and, first and foremost, crucial. Development of the state-of-the-art technology has resulted in the need of lifelong learning.

Fundamental principles relating to the learning process in general, also apply to the e-learning system or online education. And it is their understanding and implementation that enable the development of a successful online education system. In order to be more interactive and adaptable to the person using it, the system should, in as much as possible, make use of the existing technology and infrastructure.

### **2.1. General Requirements of Online Education of Graphic Designers**

Following the stated data general, the requirements for online education system may be set as follows:

- to increase the level of interactivity, so that the students can directly participate all the time
- to use various material presentation techniques (text, image, exercises, films, animations, questionnaires)
- to achieve harmony between virtual interaction and direct communication with the student
- to ensure methodical and simple learning
- to ensure clear and simple navigation through individual topics and units
- to continuously seek feedback from the students through questions and tests
- to use audio and video animation elements as much as possible to encourage learning
- to use more graphic and less text, because students like the text on the screen about 30% less than on the paper
- to let students choose the sequence of topics independently, but as a part of a meaningful and organized unit
- to ensure access to a separate unit, through the table of contents, index, etc.
- to ensure the rhythm of teaching that matches the abilities of the students
- to focus teaching on solving exercises or problems and not on memorizing facts

### **2.3. How to attain quality in e-learning**

What has to be faced is a demanding task of designing and implementing education for all students and graphic workers within the entire area of graphic profession to make them ready for the future global community.

Possibilities of the Internet, being the global communication medium of the present times, ensure access to education independent of physical, political, cultural or religious obstacles. In that way, a high quality education becomes available 24 hours a day to every user of the Internet, who can select a module or a unit (s)he wants to take, a course (s)he wants to choose, whether (s)he wants to evaluate his/her own knowledge, etc.

With help of the Internet communication services, the student is provided with professional advice, support and possibilities of cooperation. The cooperation is enabled through the following services: e-mail, forum and chat.

By using the e-mail, a student can directly communicate with the teacher but also with his/her group of peers. Web forums provide for asking questions and finding answers. Chat is a good alternative to life discussion and exchange of ideas.

To be able to use all the possibilities of the Internet, one should have the necessary education and apply new learning methods.

Successful search results presume that every student has a computer and access to the Internet at home or at school. Language is an important factor in connecting to the world database and searching through the knowledge base, using key words in the field of graphic and education at the same time.

### **3. Research Methodology**

#### **3.1. Objective**

The paper analyzes a part of research results on upgrading the teaching process by using the Internet and the e-learning system, and evaluation of the acquired knowledge online.

The intention of that part of the research is to point out the importance and the role of school in motivating students to that way of work and to indicate the level of knowledge acquired in that way of work.

Online evaluation of acquired knowledge enables objective evaluation of progress for every student individually at the time that suits him/her best, and conducting exams. In this part of the research the goal is to compare results acquired in online evaluation with those of traditional evaluation.

Another part of the research presents the usage of e-learning through the project entitled “Hybrid printing technologies configuration designing methods” that features a high level of conformity with needs of secondary school students attending graphic designing courses. A designed software that is balanced in sense of system provides for an electronic learning in the realm of graphic production, which brings acquisition of new knowledge and new skills within the graphic technology.

A student is to enter the logic of the graphic production workflow by means of cost-free virtual simulation models of the production process. Various techniques are thus acquired by multiple repetition and computer simulations.

#### **3.2. Research Sample**

The research sample includes 85 first grade, 104 second grade and 78 third grade students of the Secondary Graphic School in Zagreb, of different courses. The courses include the Graphic Preparation Technician, Graphic Designer, Graphic Technician in Printing Industry and Graphic Editing Technician. Students in the course of Graphic Preparation and Graphic Design have been using the computer as the teaching aid in their practical work. Students in the course of Graphic Editing and Printing have not been using the computer as the teaching aid in their practical work.

Students in all courses use the computer in Computer Science taught in the first and the second year of their education. Classes are divided into two groups. One group works following the advanced teaching process, by applying new forms of education and e-learning system and the other uses traditional method. The precondition for a successful use and implementation of e-learning system in teaching graphic workers is certain knowledge in the area of Internet search. Students should be acquainted with existing technologies of access and search on the Internet, with how to find Internet contents important for their education, and possibilities of software solutions and tools.

#### **3.3. Measuring Instruments**

Evaluation was conducted in two groups (in students' classes): groups/classes working according to the advanced teaching process and applying the e-learning system (the e-group), and groups/classes

working in the traditional way (the t-group). Surveys and tests were conducted at the beginning of the school year to balance the two groups. The research included three tests. In the end, the achieved results of the e-group and the t-group were compared to those of the initial testing.

E-learning has been experimentally introduced into the first and the fourth year courses on graphic production via a system-balanced and designed software and it has yielded positive results. A significant improvement has been observed and it has been proved by numerous testings that pupils have entered into the logic of the graphic production workflows.

#### 4. Findings and Analysis

The conducted research provided test results which have shown that the e-group, comprising groups working in accordance to the advanced process and application of the e-learning system, has achieved better general results compared to groups working in the traditional way. It was also noticed that proficiency of the e-group has been directed towards higher results. In the survey questionnaire the students expressed satisfaction with application of new teaching methods, e-learning system and particularly with online evaluation.

By using the e-learning system it is possible to acquire new expertise and skills. The advantage of the e-learning system is its independence related to time and space, its practicality, interactivity and unification of different data transfer and information display media, active attitude towards learning, abundance of the material available. E-learning system makes education encouraging and interactive, acknowledges the student as an active figure in problem solving situations, and enables the student to conduct meaningful evaluation and testing.

By using e-learning methods learning achieves high educational effects. This research shows all important advantages of such learning methods and suggests more intensive application in teaching process.

##### 4.1. Upgrading the teaching process in graphic technology

A part of the research dealt with testing knowledge related to Graphic Technology, a subject taught to first and second year students in accordance with the improved curriculum and e-learning implementation. After the completion of courses attended by the monitored groups (e-group and t-group), the final measurements were performed: an online testing and a traditional testing (i.e. paper-and-pencil testing).

The obtained results are shown in Tables 1 and 2.

**Table 1: Knowledge test results – first year students**

	test 1		test 2		test 3	
	e- group	t- group	e- group	t- group	e- group	t- group
1b	3,3	2,8	4,1	3,6	2,86	2,38
1c	2,1	2,4	3,06	2,6	2,1	2,04
1d	2,5	2,3	3,26	2,84	2,86	2,68
Arithmetic Mean	2,63	2,50	3,47	3,01	2,60	2,36
Arithmetic Mean Difference	0,13		0,36		0,24	
Difference of Arithmetic Means	0,24					

**Table 2: Knowledge test results – second year students**

	test 1		test 2		test 3	
	e-group	t-group	e-group	t- group	e- group	t- group
2a	2,83	2,62	4,3	3,94	3,2	2,8
2b	2,75	2,5	3,76	3,52	3,6	3,1
2c	3,6	2,94	4,46	4,04	3,1	3
2d	2,4	2,3	3,63	3,24	2,4	2,18
Arithmetic Mean	2,89	2,59	4,03	3,68	3,7	2,95
Arithmetic Mean Difference	0,3		0,35		0,75	
Difference of Arithmetic Means			0,46			

The comparative testing results survey shows that the e-group scored a 0.24 and 0.46 point better result in first and fourth year students, respectively. The t-group yielded a lower result, which corresponds to the level usually attained at testings of the kind in the traditional teaching process.

Results achieved in the group working in compliance with the advanced process and application of the e-learning system show a trend towards higher efficiency of teaching, and are the basic precondition for efficiency of the applied methods and work forms within the Graphic Technology course.

The research yielded the knowledge testing results showing that the e-group, the groups that were taught in accordance with the improved teaching process and of the e-learning system have attained a better overall result if compared to the groups that were taught in the traditional way.

It has been noticed as well that the knowledge acquired by the e-group shows a tendency toward a higher level. The respective survey form has shown that the students were highly satisfied with the application of the new teaching methods, the e-learning system and especially by the online knowledge testing. Students. Learning by means of the e-learning system implementation attains a high level of educational efficiency. This research is an important indicator of the advances that the form of learning features and that are to be implemented more intense in the teaching process.

#### 4.2. Software mechanisms of learning graphic technology

The e-learning applications described in the project “Hybrid printing technologies configuration designing methods” feature a high level of conformity with the needs of secondary school students attending graphic designing courses and provide for an electronic way of learning the graphic production. The production processes in printing industry impose a need of research to be done in order for production “bottlenecks” to be eliminated. A designed software that is balanced in sense of system provides for an electronic learning in the realm of graphic production. The development of the e-learning of graphic technology is based on Microsoft YUCOM base and HML technology. The HML principle provides for a continuous adding of new entries thus making possible for the graphic production norms and standards to be updated.

The system functions in a form of a network and it is thus appropriate for learning in a laboratory with a larger number of computers. Through a virtual presentation of the graphic production flows, a student is given an opportunity of acquiring new knowledge and conclusions in a cost-free manner, which is not possible in the real printing office. The numeric data on norms are obtained from printing offices in order for the graphic production workflows to be simulated to as high level of fidelity as possible.

A student can repeat a certain production cycle for many, many, many times on the virtual production process workflow models without generating material expenses that would have been generated in the real printing office. Experimenting and learning on the actual printing jobs are too expensive and the time is too precious. There is no simulation in a real printing office. Multiple repetitions, process

management based on different parameters and independent repetition of a model without expenses and waste is the best way of learning and understanding printing processes. The simulation as well provides for occasional knowledge assessment and skills testing.

Within a part of the research, knowledge testing was performed by means of the graphic technology learning software mechanisms and in accordance with the improved teaching process and the e-learning system implementation. Upon completion of the course, the final measurements related to the monitored groups were performed;

The e-group worked with a system-balanced and designed software for electronic learning of graphic production that provides for a student to enter into the workflow logic. The computer simulation is a virtual presentation of the graphic production flows ranging from pre-press, printing and product finalization to production planning; It makes possible for a student to repeat a certain production cycle for a number of times in a cost-free manner and the t-group that was taught in a traditional way, i.e. the content was directly lectured to them. The obtained results are shown in Table 3.

**Table 3: Knowledge testing results – software mechanisms of learning graphic technology vs. traditional learning**

	e-group	t- group
test 1	2,48	2,52
test 2	3,83	3,15
test 3	4,76	3,36
Arithmetic Mean	3,69	3,01
Difference of Arithmetic Means	0,68	

## 5. Conclusion

The traditional methods of teaching and training of graphic designers and optimization of the graphic production have become too expensive and ineffective. The new methods, e-learning in graphic designers' education, training and new optimizations can be implemented successfully only by means of simulators. The school system has a task of implementing simulations in the education of graphic designers. Even after the completion of the compulsory education course, simulation remains the most efficient method of the lifelong education of graphic designers, i.e. the method of additional training. The purpose of the afore mentioned is a virtual printing office whereas – via a model – a simulator of pre-press, printing, product finalization, production planning or work order etc contribute to understanding of the graphic processes. The management of the processes can be performed by means of a computer in order for the actual production damage to be avoided. The advantage of simulation is the fact that one works with a model thus eliminating errors and the damage that errors would cause.

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## PRINCIPLES OF TOTAL QUALITY IN WEB DESIGN

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*Abstract:* With the development of the Internet as a means of mass communication, users have a survey of all possible existing offers to meet their needs, and due to the possibility of being free to make a choice, they are becoming more demanding in all respects. Companies of all sizes and sectors have understood the importance of presenting themselves through the web, but there is accent on the fact that the web presentation design must reflect their specific quality and differentiation, and must follow with the basic mission in respect to pleasing and surpassing users' expectations. Web presentation is usually the first step of the user with the company, and therefore it is of crucial importance that the graphic elements of the picture, layout and other visual elements should attract and win over the user and make him become a pleased client. In this respect the user may be of very specific profile, such as the student in the eLearning area. Principles of total quality in presentation designing provide competitive advantage and users' trust as well as motivation in use.

*Keywords:* Web design, Total Quality, E-Business

### 1. Introduction

The Web has become a strategic media for promoting, sale, providing services to a great number of companies of all sizes and domains. The Web also offers unique possibilities in investigating markets, measuring and analyzing promotion content efficiency. Previous investigation [Chang, Arnett, 2000] measured which variables made an influence in producing of a successful website and they resulted in making a thesis in respect to what is valuable: information quality, attractive and amusing subject-matter, the possibility of learning through carrying out web activity, the whole system's functioning quality, usability and service quality are some of the criteria directly linked with the success of a website. Therefore, success is the consequence following the good quality of each single web site element, and they were rated so because care had been taken about the good quality of each individual segment. Quality comprises time dimension too, and it is therefore necessary to continuously test web site segments, improve them, installing and applying new knowledge, applying new technological achievements always taking care that this results in an accepting and satisfied user. Business operations, marketing or presentation of any subject-matter in the web territory thus requires including the principles of total quality into process planning, realization and maintenance.

### 2. Quality

Quality is a complex concept comprising several elements and criteria. These elements or criteria are derived from the quality essence of different types of products, services, activities, depending on their use, usefulness, importance to the user. Quality is a cluster with many small components of which all are equally important because they are all part of a 100% quality, and if only one single component is missing, or is not totally «healthy» or not visible attractive, then there is no total quality. [Holjevac, 2002].

To Philip B. Crosby good quality is adaptability, i.e. meeting of requirements. He asserts that ‘we must define quality as meeting of requirements if we want to manage it [Crosby, 1996].

All of these concepts as to quality defining may be brought down to one point: to produce a product with such characteristics that will fulfill the demands of buyers/users, and tie them to a certain company with long-term confidence, and in the final stage this should have a positive impact as to a better position in the market, and consequently to better business results.

„Quality managing is a process that recognizes and manages activities that are necessary in order to achieve quality goal of an organization.“

„Quality is a cluster of those products features, that serves the best the needs, demands and customer expectation.“ [Juran, Gryna, 1999]

### 3. Total quality principles

In every organization there are processes such as production, sales, distribution, marketing, market research and research as to whether customers are satisfied. Following the path of total quality it is understood to be concentrated on the quality of each process in the organization, bearing in mind the knowledge that the overall «health» of all of them is indispensable for successful functioning of the whole organization [Joiner, Scholtes, 1988]. All of the processes are under constant control with the goal to have early diagnosis of problems, or to optimize the existing situation by applying new ideas or technologies. The essence of TQM is to incorporate the consciousness in respect to quality into all organization processes at all levels and to lead the organization along the path of continuous improvements in all respects. Another key characteristic in going along the path of total quality is consumer orientation: real understanding and knowing the needs and expectations of consumers, their reasons for buying something, as well as the basic factors that influence the buyer in being satisfied. A high level of sensibility towards the customer is required, for measuring and following up of different factors that make an impact in order for the customer to have a positive feeling and the customer’s readiness to remain faithful to his supplier-organization.

TQM as a body of systematic approaches and methods for managing an enterprise was organized as a reaction to altered business conditions in the last century’s Nineties. Changes have taken place in 2 areas:

1. Customers want a higher level of quality and lower prices. The consequence of transportation development, product distribution as well as mass communication means was a situation where the customer could buy and get a product he wanted any time and any place.
2. The stress on more efficient organization managing – due to increased and very specific demands and expectations from the customers, an enterprise had to become more efficient in the following sense:
  - More precise and duly recognizing of customer requirements and expectations (quality as required by the customers)
  - Fast reacting to identified customer demands
  - Better solutions and linking of one's own internal processes

By defining quality as «user's/customer's satisfaction», W.E. Deming stressed the need to introduce a new approach in market research work. It is very essential to foresee the needs, and not only learn about customer demands, and this is explained by Deming's philosophical approach to the meaning of quality «everything begins and ends with the buyer who is the most important factor in the production line». All activities are aimed at one goal, and that is to incorporate into the product/service those qualities that are considered as values by the customer [Deming 1982][Deming, 1993].

### 4. Strategy and Design: using design to articulate and define strategic directions

“It is not enough to do your best; you must know what to do, and then do your best.” W.E. Deming [1]

Organizations that recognize the strategic value of design know that the power and force of design lies in communication. Interactive product design requires efficient communication with end users.

Each product (through its interface design) should point out to its function (utility), manner of use (usability) and its special qualities, i.e. characteristics that will make the user choose it among many other products (desirability).

The same communication capacities that enable designers to create visual and interaction plus impact efficient design play an important role in developing business strategy. Designers interpret and carry out, articulate business strategy through an attractive combination of words, graphics, and movements so that everyone can understand. The distinctness, attractiveness and singularity of offered product design are key points in winning over of clients.

The previous perception of design as a type of decoration has turned into comprehending design as the initiator of innovation and business strategy reflections. The key questions are:

- How should design be used as a means of differentiation for a company in the market?
- How can communication be encouraged through visual design?
- How should design be used as a means for simplification and better understanding of complex concepts?

## **5. Two factors and approaches in managing quality**

There is an approach to quality and understanding of quality that is aimed at searching for and eliminating negative, i.e. those product characteristics that bother the buyer or make him be dissatisfied, as for instance faults deformations and certain drawbacks. The goal of such an approach is to eliminate the dissatisfaction of buyers, i.e. make a tendency towards having 0 faults, 0 repairs, and 0 complaints. Quality indicators are the number of faults, the number of repairs and the number of claims. Kaoru Ishikawa names this approach to quality as Backward-looking Quality and Noriaki Kano calls it Must-be Quality [Kafol, 1999].

Another approach aims at searching for and producing positive, i.e. those qualities that the buyer likes or make him satisfied. The producer is thus directed to qualities that will make his product be specific, be different in respect to other similar products and thus win over customers. Ishikawa calls this approach Forward-looking Quality and Kano calls it Attractive Quality [Kafol, 1999]. It is underlined by Kano that Must-be Quality is the quality expected by the buyer to be something obligatory, basic, minimal and necessary, whereas Attractive Quality is something more, it is the attractiveness that the product has and due to which the buyer makes his choice and buys this specific product and not any other.

## **6. Analogy – Two factor categories in web site design**

Further to previously described two approaches to quality in general, using the analogy and Herzberg's «hygiene-motivator» theory [Herzberg, 1987], we can say that there are two factor categories in web design: «hygiene» and «motivator». The hygiene factor category applies to the basic functionality and serviceability, the absence of which is the cause for user dissatisfaction. The motivation factors are those that give additional value adding to the user's sense of pleasure [Zhang, Von Dran, 2000]. The stress, of course, is on identifying factors that increase pleasure, increase interest for the web site and stimulate repeated returning to the same product and those that decrease discontent, avoiding frustration and obscurities. When acting upon such principles it is possible to stress important goals and achieve a high performance level. Satisfied users will stay longer on the site, they will keep returning, recommend it to others, and those are essential goals for any organization that manages e-business operations.

There are several useful aspects of Herzberger's theory applicable to web site research. It is this dual structure, making difference between satisfaction and dissatisfaction as two dimensions instead of two values that is logical and valuable. If someone is not unsatisfied, it does not mean that he is satisfied and vice versa – not being satisfied does not mean that someone is unsatisfied. Using the analogy of Herzberger's theory efforts are made to stress that the user will consider web design to be good only in cases when the basic hygiene factors have been met and when alongside to this there are factors that provoke special satisfaction and pleasure.

Spool [Spool a.o., 1999] define the criteria «users like most» and «users dislike least». The first criteria (like) answers to satisfaction of the user whereas the second (dislike) dissatisfaction. So the thing that users dislike is non-existence of basic, functional or hygiene factors. The criteria «users dislike least» were closely related with successful orientation on the site. However, Spool's research showed that those sites liked by users were often not the ones where they were well oriented. This implicates that designing sites where users were well oriented and those they liked could be divided into two completely separate ways of designing that are in no way in conflict, and that it is a real work of art when the manager and designer succeed in obtaining a balance between these two goals in order to reach and surpass users' needs and expectations.

According to Allport [Allport, 1961] motivation includes the dimension of time. Whatever motivates must motivate in the present time, i.e. those things that users find especially motivating and like the most change in time. Therefore, the process of web site designing, more than any other process (first of all due to fast IT development), must be improved constantly, as well as innovated, and checked as to efficiency. Organizations that manage according to overall quality principles have all processes carried out according to Deming's PDCA (Plan do check act) cycle that is successfully applicable with the web design process as well.

Examples of web design hygiene factor absence (10 mistakes in designing web applications by Nielsen):[2]

- Non-Standard GUI Controls
- Inconsistency
- No Perceived Affordance
- No Feedback
- Bad Error Messages
- Asking for the Same Info Twice
- No Default Values
- Leaving Desorientated Users into the Application
- Not Indicating How Customer's Info Will Be Used
- System-Centric Features

As to motivator factors, they are most often variable and depend on the product's specific quality and the company's activities. Various taxonomies, guideline, standards and recommendations are an essential source of information on some basic factors, but also about motivator factors. WQM (Web Quality Model) is stressed here with all its characteristics, for instance Heller-Martin taxonomy, and requirements for web site usability.

## **7. Web usability analysis and E-matrices**

Web analysis is research on web site visitors' behavior in the context of web marketing and analyzes parts having had positive impact, which aspects should be changed and improved, which goals have been reached and which aspects offer greatest perspective. Areas of the greatest potential are identified, and successfulness of marketing campaigns and ROI is measured. Usability of web pages determines to what extent it allows the user to fulfill his goals: find the necessary information without excessive effort, provide the user with the desired image of the site owner and motivate him to visit the pages again.

### **7.1. Web Usability**

The concept of usability places the user in the center of observation. Therefore, the development paradigm has changed in the ICT area: the emphasis has shifted from the technologically oriented development process methods to user oriented methods. The process of designing that places the user at the center of the development process is mentioned in ISO 13407 norms. The designer bears the end user's needs in mind in all the steps he takes.

## 7.2. Web usability analysis

Web usability analysis points to potential problems and locations on the web that prevent a web site being useful and simple for use, and propose expert and argument-based altering in order to achieve better efficiency and user satisfaction and it also gives insight into a clear and detailed graphic display of all positive and negative elements. The Web usability analysis process is a detailed and extensive usability frame for all web site categories (corporative pages, web shops, web sites...) Analysis usually comprises navigation and simplicity in searching for information, and it results in written reports pointing out to the problems and web locations that disable the web site in the context of usability and simplicity of use. For every detected problem clear and argument-based recommendations have been given in order to find solutions for improvement. Each problem has been evaluated and commented: positive comment (+), negative comment (-) or a combination of the positive and negative comments (+-).

## 7.3. E - metrics

E-metrics for the web are considered to be of key importance for on line business's profitability rise. There are too many measurable areas in e-business, so that the focus of measuring should be concentrated on what is essential, such as: entrance to the site and exit from the site identification, time spent on the site, the percentage of quitting after observing the first page, measuring of actions that are interpreted as the client's demonstrated interest, monitoring of the existing clients' stay on the site, measuring of lost users, the altering of users into clients, etc.

By analyzing results critical and successful areas are identified, as well as the possibility for improvement, such as: Low level of interest for buying a product may point to the problems in navigation or the product being unattractive to potential buyers. If there are many visits but the volume of business is low – it is time for a huge turn in promotion strategy.

In this sense many companies have comprehended the strategic value of a great quantity of information unconsciously «left» by the navigators on the sites, and how to take steps for improving business after detailed analysis of such data. The great quantity of information left by the user on sites enables precise profiling of navigators, individualization of his preferences and habits, analysis from the user's geographical and social-economic position, all being determining factors for the conversion of users into clients.

The formula for website success is: [3]:

**B = V × C × L** where:

**B** = amount of business done by the site

**V** = unique visitors come to the site

**C** = conversion rate (the percentage of visitors who become customers)

**L** = loyalty rate (the degree to which customers return to conduct repeat business)

## 8. Conclusion

Companies that operate on-line today are faced with new demands and challenges as it is a place of high competition level, with whimsical clients who do not become loyal to the company, service or product so easily, and are always ready to immigrate to some competitive site that is only one click away. In such an economical context and reality, the competitor's advantage sets forth the necessity for «special» offers to the potential client. A special, personalized offer must result in the success-satisfaction of the client. It is therefore necessary to know how users behave when they are on the web and how to improve search. The manner of presenting the products and services is important. The combination of web presentation elements should result in positive user experience. Finally, the identification «Critical to quality» elements that are held most highly by the users (and make them spend money), must be the goal achieved in order to increase user satisfaction.

Design goals and the web designer's role have undergone changes: design is not only meant to enhance the visual side and to be only an additional option because markets evolves quickly and are constantly growing, even the ones that have just been created. In such conditions, a greater number of producers

offer similar products, all having acceptable quality, and differentiation is the imperative of remaining in the market and design is definitely a powerful means of differentiation and winning over of clients. As client needs and technology are constantly undergoing changes, so is design in the function of meeting client needs in constant evolution. However, the complexity of some processes and concepts are overcome by having good quality design and eliminates information cluttering, making it possible for the client's moving through the web to be elegant.

In order to create recognizability and successful presentation on the web, it is necessary to include and combine knowledge on web design, graphic design, marketing, managing total quality, communication and social psychology. The goal is to have the web site look professional and to represent the company authentically, to enable easy moving through the pages, to provide good quality and relevant information, to contain relevant images and contents, to be functional, to have fast input and to be easily found by search engines and to do well with its on-line presentation. Design has the goal to satisfy users' needs and thereby to meet the company goals, so that traffic on a web site turns into results, sales, successful marketing. In order to achieve the above mentioned it is necessary to have constant communication between a manager who knows what he wants and a designer who knows how to carry it out.

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## **A DESIGN-BASED RESEARCH FRAMEWORK FOR ASSESSING E-LEARNING IN SUSTAINABLE DEVELOPMENT**

J. Pibernik and J. Dolić

*Keywords: E-Learning, Ecology, Graphic Design, Research Framework*

### **1. Introduction**

This paper reports on a study conducted on an instructional design-based research framework for assessing e-learning system in sustainable development education at The Faculty of Graphic Arts, University of Zagreb. The primary purpose of this study was to propose a developmental model for internet resource-based web course. Resource-based learning can be effectively adopted in internet learning environments where resources exist in the form of various data and information in the web. The paper argues that a successful development process for Web-based learning systems can be built by understanding how technology could be used in the process.

“The Ecology and Graphic Design” is a project with the main aim of developing a blended learning course about how to integrate ecological contents in the graphic design, both at the level of a graphic design message and graphic design product. At the end of the course, students would be able to integrate autonomously ecological considerations into a given project, to understand the consequences of different choices and to evaluate alternatives, in order to optimize the graphic product. The aim of the course is not only to analyze the ecological implications of certain choices, but also to give to the next generation of designers the skills to include these components in their professional activity. Thanks to e-learning, students would experience directly the case studies and, would test the impact of different design choices on energy, air, and water fluxes, as well as on the human environment, through exercises and simulations.

### **2. The Main Issues of “The Ecology and Graphic Design” Course**

The principle focus of the Course is on the role which graphic design products play in cultural formation, representation and practice of the ecological thinking. From marketing to advertising, from corporate communication to public awareness campaign, the messages on sustainability have a key role to make the idea of sustainable development approachable and understandable.

The ecological commercials are a part of an inter-disciplinary area of ‘green marketing’ (economy), socio- ecological scientific research, social responsibility (ethics) and politics and media theory. Within each of these mentioned areas, interest groups participate, to a certain extent, in the creation of commercials. Some designers and institutions started to promote so called 3R Design (Reduce, Reuse, Recycle) - the use of easily recyclable materials as well as the use of recycled materials to reduce the amount of discharged waste and to contribute to the recycling-oriented society (US EPA). For some companies (Natura, The Body Shop, American Apparel), communicating sustainable development and its main fields (the environment, social justice, human rights, etc.) became a core part of their identity. In that way, the sustainable development is utopian given the amount of products/services sold – and not their social or environmental qualities remain the chief criterion for evaluating them in terms of social relevance.

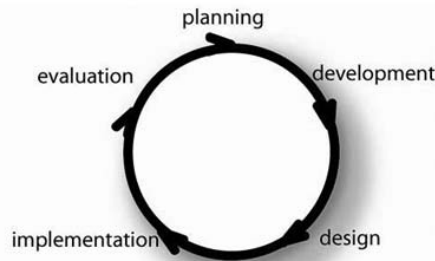
Neither the scientific paradigms for solving the ecological problems, nor their media framework overlap on the global level. Therefore, even though the general public expects that the creators of ecological propaganda use scientific ecological research as the main source of their information and only partially to rely on data provided by the ecological activists and government officials (since the data provided by corporate protagonists are considered to be biased), in practice the ecological propaganda primarily relies on the interests of corporate capital owners. The supposed ‘interdisciplinary’ level of information in the media comes down to reducing, ignoring and concealing the data offered by the ‘green’ sciences (biochemistry, social ecology, political ecology, bioethics, etc.) (UNEP, 2006).

### 3. Design-Based Research Model

Among many approaches to technology-enhanced learning environments, design-based research is one of the most appropriate methodologies for designing and evaluating Web-based learning through successive cycles of refinements and improvements (Barab & Squire, 2004; The Design-Based Research Collective 2003; Motschnig-Pitrik, 2004; Terashima, 2004). Design-based research embodies specific theoretical claims about teaching and learning, and help to understand the relationships among learning theory, designed artifact, and educational practice. Design and research are not isolated as in traditional instructional design and research. There are interdependent and reciprocal. “Research is not a phase to be conducted after design, but conducted concurrently: Design is research, and research is design” (Wang, Hannafin, 2003).

Design-based research is conducted in three major steps. First, design must be based on a theoretical educational framework or learning model. The model supports the designers’ work, forming the foundation for evaluation and research. Second, the framework is tested and evaluated through empirical educational research. Finally, the design is validated iteratively through successive cycles of implementation (Wang, Hannafin, 2003). Design-based research is suitable for technology-enhanced learning, primarily the Internet and Web. Web-based learning needs to evolve rapidly in order to ensure the relevance, correctness, and completeness of the information on the Web. Thus, a continuous evolution is of crucial importance for the quality of Web-based learning.

Unlike traditional software systems that evolve over a series of planned, chronological, and specific releases, Web-based learning systems call for continuing update, change, and continuous refinements, because they need to be constantly evaluated against what is in fact delivered to the students (Hadjerrout, 2004a). Clearly, Web-based learning systems are living systems. They must be developed in successive cycles with five major phases for each cycle: planning, development, design, implementation, and evaluation (Fig.1.). In futher text we will briefly explain three key steps aimed to provide the basis for e-learning environment design.



**Figure 1. Development Cycle**

### 3.1. Step 1.: Planning Phase: Learning Model

Basically, the Web can be designed according to the main commonly accepted learning paradigms: objectivism and constructivism (Khalifa, & Lam, 2002; Lin & Hsieh, 2001). The goal of objectivist instruction is to efficiently transmit knowledge from the instructor to the learners. Instructors are central to learning activities, directing the learning process and controlling students’ access to information. Students are passive recipients of knowledge, rather than constructing their own knowledge. Hence, there are few opportunities for learners to express their own ideas. The objectivist model is therefore criticized for stimulating surface learning and knowledge reproduction (Steffe & Gale, 1995). Objectivist techniques found in the classroom can be duplicated through the use of Web. Nevertheless, it may be useful to use Web-based learning technologies as a means for knowledge transmission from the teacher to the students. However, if approaches to using Web-based learning are to move closer to the learners, teachers’ conceptions need to shift from objectivist learning to constructivist learning. The constructivist paradigm of learning clearly diverges from the objectivist model which presumes that knowledge can be put directly into the learner’s head. Constructivism regards learning less as the product of passive transmission than a process of active construction (Piaget, 1969; Vygotsky, 1978). Learning is considered as an active process in which learners construct new knowledge based upon their prior knowledge. Constructivism is learner-centered, assuming that learners learn better if they construct knowledge for themselves, rather than being told by an instructor. Hence, given the shortfalls of objectivist and teacher-directed instruction, constructivism may be helpful to create a learner-centered environment that promotes active knowledge construction. The design of constructivist learning environments goes far beyond computer-based material, but well-designed Web technologies may facilitate constructivist learning if they provide learners the information they need (Lin & Hsieh, 2001) Fig.2.

Learning as information processing	Learning as experiential growth	Learning as social dialogical process
Effective communication/recall of information	Individual development of appropriate cognitive maps	Embed learning in authentic tasks leading to communities of practice
Transmission Approach	Nurturing/Developmental Approach	Collaborative Approach
<b>Conceptualization Phase</b>	<b>Construction Phase</b>	<b>Dialogue Phase</b>
Web as source of subject information.	Web for task-based learning.	Web for dialogue and collaboration.

Figure 2: Mayes and Fowler’s learning cycle adapted to the Web

### 3.2. Step 2.: Conceptualization Phase: Approach of Resource-Based Learning

Since there is no widespread consensus or agreement within the design community on the particular goals to be pursued by ecologically-sensitive design, constructivist learning environment is especially suitable for this kind of research. Some argue that Green Design and pollution prevention should be pursued solely to reduce costs (Michael, 2007). Others focus on particular strategies, such as implementation of industry-wide ISO standards, and develop goals specifically for these strategies. To be environmentally conscious designer means to pay attention to the content of paper pulp and entire growth and use cycle - recommendations given by Forest Stewardship Council (Sidles, 2007). Another approach is to direct attention to a particular environmental problem, such as waste and global warming, or a particular media, such as air and water pollution, where non-renewable or toxic materials are exchanged for materials that can be easily recycled, reused, and do not pose a threat to people or the environment.. “Energy reduction” strategies recommend to lessen the amount of energy (often produced by creating pollution or merely putting a strain on available resources) required to produce, distribute, operate, service, or dispose of products This is manifested in packaging industry through the „Sustainability in Packaging“ (InertechPira Conference, 2007) program and use of tools as Life Cycle Analysis.

The complexities of problems stated above are the main reason for a resource-based approach to course design. Resource-based approaches offer the potential for establishing situational relevance in a flexible development and delivery environment. They support efforts to adapt information to meet particular instructional needs. Resource-based learning is flexible in terms of adaptability to different learning styles and subject areas. Students become active learners as they use a wide range of materials to investigate subject material prepared and prescribed. Teachers become motivators and facilitators in the learning process. Students seek information and become creative problem-solvers. Resource-based learning also allows for information-gathering as a continuous process rather than unconnected tasks by encouraging the construction of knowledge at every subsequent phase (Moore, 1995). Moreover, resource-based learning promotes the development of thinking skills such as problem solving, reasoning, and critical evaluation through information handling and independent research (Resnick, 1987).

Resource-based approaches to course design utilize a variety of resources, including print, manuals, magazines, video, audio, computer-based instruction, and human resources to accomplish goals and specific learning outcomes. Resources are organized sets of data or case studies combined by an expert or specialist to convey a message, thus providing information related to a specific topic or task.

**3.3. Step 3.:Development Phase: Filming With Network Cameras**

In order to foster the student’s interest in science experiments and observational learning, the authors propose an instruction method of science experiments and observational learning using a video clip generation system with network cameras. By filming with network cameras, the teachers attempt to show the students all the transitions of the subjects in the experiments. The video clip generation system with network cameras can film the transition for a long duration. The system can produce and provide compressed and shortened video clips. Students can study by observing the video clips of experiments that included their subjects by accessing the website (Fig. 3). In addition, the system can produce video clips in parallel from each of one or more cameras so that each student can film and observe their subject(s); however, many cameras are needed for this purpose. Network cameras are designed and developed mainly for the purpose of observing the external environment; hence, they are compact and robust and can work under relatively harsh environments, such as refrigerators, constant-temperature bathes, and rooftops. The system consists of a server that produces the video clips and allows designers to edit the relevant video clip and post on the Internet. Network cameras can be located no matter where they can send images of the subjects via the Internet or LAN at regular periods.



**Figure 3. Conditions where students can set network cameras**

**4. Conclusion**

The primary purpose of this study was to propose a developmental model for internet resource-based course for ecology teaching for graphic designers. The Ecology and Graphic Design course covers the basic concept and knowledge about integration of ecology into the graphic design. Trough the iterative and continuous cycle of design, evaluation, and redesign in varied contexts, the underlying design-based research approach of this work has the potential to improving the overall construction of Web-based learning at The Faculty of Graphic Arts. The article describes the pedagogical and technological choices made by the project team in order to enable students to analyze the ecological implications on graphic products. The resource-based model consists of several steps and includes strategies to

enhance the learning process of self-directed learning in internet environment. The paper proposes the teaching of science experiments using video clips recorded by network cameras.

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## **THE ROLE OF GRAPHIC ELEMENTS IN VISUALIZING DIGITAL TEACHING AID CONTENTS**

M. Gligora Marković, I. Pogarčić and S. Šuman

*Abstract:* The paper contains the analysis of problems linked with graphic element design as part of teaching aids and material for students in digital form, whether it is used in classical teaching or in the field of eLearning. After evaluation digital form teaching aids have been brought to the same level in the RH higher education system as is that of printed material, so it is even more in the interest of teaching personnel to make efforts to have digital forms of good quality not only in respect to contents, but also as to the visual side. The visual content design as a possibility to conquer language barriers in teaching aids is becoming more important. Good quality and security of teaching subject-matter in digital form is of exceptional importance as to the contents, as well as in the formal sense. Students are the ones who often remove security protection produced against unwanted copying and alter the original product's contents, and regretfully, this has the result of introducing information that is not correct. What is more important: the correct choice of digital format or the visual design uniqueness?

*Keywords:* *graphic elements, digital educational material, visualization of digital teaching aid contents.*

### **1. Introduction**

With the development of informatics communication technologies and the growing availability of computers to the users, digital forms have proved to be a great media for spreading different contents and therefore teaching ones as well. Evaluation of digital form teaching aids has been brought to the same level in the RH higher education system as is the level of printed material. It has not been made very precise as to what digital aids are in question, i.e. the digital educational material has not been categorized within the prescribed legal decision. Digital teaching aids may have different contents and formats. According to the adopted standardization, digital teaching aids may be classified as follows: simulation, animation, textbooks, exercises, lessons/presentation, case studies, series (as for instance animation that is linked thematically) or reference material (Gomez, 2008). The growing presence of eLearning most often understood as computer backup of studies certainly comprises teaching courses that are fully in digital form.

### **2. Digital educational material**

Which format should we choose and which specific contents of certain courses should be visually brought to students' attention is a challenge for teachers/authors of digital teaching aids. Today we find a many possible formats for digital material storage depending on the software solution we have chosen or that has been offered to us. There is a certain number of more popular and more widely spread products, and they certainly depend on the tools used in creating them. For instance, most teachers use MS Word or MS Power Point in creating teaching material, the formats of which are not

suitable for distribution, especially not by Internet. If they decide to use the possibility of taking over material from the Internet, the choice is most often PDF format, with the explanation that it is used by the majority. Some of the formats from the Open source environment are used by a greater minority.

The advantages of digital material may be the following:

- ⇒ less space is necessary (approximately 500 average e-books can be stored on one CD)
- ⇒ quick copying
- ⇒ low distribution price
- ⇒ acceptable from the economic and ecological point of view because they decrease paper consumption
- ⇒ there is no wear after some time in use
- ⇒ contents may be searched very quickly not depending on the manner of presenting
- ⇒ simplicity in altering

Digital material deficiencies:

- ⇒ many users prefer paper instead of computer screen because of poor layout (screen size)
- ⇒ it may incompatible with new hardware and software
- ⇒ require attention in manipulating and storing documents
- ⇒ a program may prevent printout possibility
- ⇒ security
- ⇒ standardization

In case decision is made to create online courses, the choice is most often some LMS (learning management system) from the Open source environment, such as Moodle or Claroline systems that are in leading positions in our country according to teacher choice. Commercial tools are not as available to all due to their price, and there is good support for tools such as Moodle from CARNet as the Croatian academic research community's center. Initiative has been started to educate teachers for online mentors and authors of online courses that have been working to date with WebCT commercial tools supported by Carnet itself. When comparing the currently available and digital database formats that would be satisfactory for teacher needs in respect to content digitalization, data goals and security, one of the key problems is designing and content visualizing.

It is expected from tools for producing online courses to provide satisfactory graphic design, simplicity in use, intuitively, and localization and installation in the Croatian language inside our country's boundaries.

### 3. Teaching contents visualization

Learning is an activity of the individual resulting in acquiring certain knowledge, skills and habits. There are several degrees in learning subject-matter:

- ⇒ recognizing as a possibility to identify facts and events with which the individual has had previous contact with;
- ⇒ remembering and reproduction are linked with independent recalling and repeating subject-matter learned previously (for instance some historical facts);
- ⇒ solving problems from a smaller area where some knowledge had been acquired (for instance: mathematical calculations, chemical analysis, computer program calculations and similar);
- ⇒ orientation and adapting to new conditions is linked with problem defining in new situations, elaboration of the manner in which to solve them, creative approach and innovating in previously acquired knowledge application, creating new knowledge as well as adapting of the environment to one's own needs and goals, respecting social, ethical, ecological and other values. [1]

The ultimate goal of all teachers is to have all the degrees of knowledge acquired by students in a learning process be as high as possible. One of the good ways for sure, especially today when there

are great possibilities and availability of informatics and communication technologies and amount of knowledge growing daily, is to have the appropriate subject-matter design. Besides problems of technical nature, most of the problems connected with designing subject-matter, especially when it is about the one presented on the Internet, i.e. the spreading eLearning where it is the interface graphic design which is the first point of contact for the students undergoing the learning process of the subject-matter. [2]

There are numerous elements to be taken into account when designing graphic interfaces and developing software support in eLearning. The visual subject-matter must be in the form of texts, drawings, graphic displays, models, scale models and similar. However, the subject-matter is generally in the form texts, but it may be made more diverse by adding some other multimedia elements.

There is also danger that visualization should become goal by itself instead of becoming a well chosen segment that fits into the learning process and provides the best possible communication process. A glance at the computer screen must replace in a sense one's own impressions acquired in a classroom, and the student should be given the feeling of confidence in respect to simple learning of the subject-matter and without difficulty. The navigation support must be such to enable simple access to the desired subject-matter. The visual subject-matter must be in the form of texts, drawings, pictures, graphic display, models, scale models and similar. Of course, it depends to a great extent from which scientific or expert context a certain subject-matter comes from and is being designed, and the necessary tools are chosen depending on this.

For instance:

- ⇒ Mathematica provides numerical and symbolic calculations, visualization and simulation;
- ⇒ Open DX provides generation and visualization of scientific, technical, medical and business data;
- ⇒ 3D Studio Max enables animation and creating effects for various games;
- ⇒ Animation Master enables making films, virtual reality and representation jobs;
- ⇒ ProEngineer enables sketching, modeling and presentation in all technical areas;
- ⇒ Maya enables animation and virtual reality;
- ⇒ VEGA enables visual and audio simulation, virtual reality;
- ⇒ Chief Architect is a powerful tool for visualization in construction, etc.

#### **4. Graphic elements and communication**

An important part of the overall design composition is the graphic elements themselves. Under the idea of graphic elements we usually consider vector forms such as the square, rectangles, ellipse, circles, polygons various lines used in visualization completion for certain kinds of subject-matter. When we are talking about teachers who prepare learning material in digital form, we can not be expecting an expert for all areas necessary in preparing such material, so that most comprehend pictures as well under the term of graphic elements, i.e. the overall graphic design. The graphic elements need to be linked with functionality, and all with the goal to have knowledge be acquired by the students in the best possible way. Communication is a process of sending and receiving information, whether it is verbal or not. We are witnessing new forms of communication daily for which the development of informatics and communication technologies was very favorable. [1]

The communication that we realize through the Internet is generally asinchrone, verbal and its non-verbal part like eye contact, face impression; various movements are the ones we try to support with visual design, i.e. with graphic elements integral part. The visual design covers all kinds of design linked with graphics, typography, photography, cinematography, animated films. [Dorfles,2005]

The word as a form of recorded speech loses part of its significance if it is printed, visually displayed in respect to the situation when it is spoken by a human. Today's efforts are that by using simple signs like J, L , the so-called emoticons, various graphic elements all the way to well designed images, animations, are the ones we improve messages in computer supported communication. An instinctive need arises to add a unique character to graphics, and to achieve more with it than mere sending of messages. [Mueller-Brockman, 2001]

Criteria set for virtual (first of all graphic) design is criteria set as to its elementary components, and those are graphic components. Graphic design is a kind of language with a very unstable grammar and dictionary that are constantly expanded; the imprecise nature of its rules means that it can only be constantly studied and never be completely learned [Hollis, 2002].

Graphic design today is an integral part of any country's culture and economy, and the all-around present eRevolution provides new possibilities for graphic design development. The first thing that a visitor notices is the digital teaching material level of presentation, i.e. its graphic design. Designing a good-quality interface is not simple. Visitors demand applications that are reliable, look good and are simple to use. [Tidwell,2005]

The first criteria set for graphic design visible on the presentation level are sign identification, how to say that something is and where it has come from. A well defined profile of potential students, their interests and intellectual possibilities determine whether they will identify correctly certain signs (text or image). A graphic designer's line of work is significantly extended with the use of new informatics communication technologies and the next criteria that is set for graphic design has a special position. It is information design.

Information design comprises the manner and form of displaying (information) subject-matter and planning how the visitor should reach it. It makes a difference whether the subject-matter will be shown with the help of text, image (or in the form of some other multimedia data, so we go away from graphic design towards multimedia design and a graphic designer becomes a multimedia designer). The textual display limits us to one language area, whereas image display or some other graphic element is understandable to a larger number of visitors. However there is greater risk of having single-meaning interpretation by the visitors.

Navigation design is closely connected with information design and sign identification. If the navigation system is well designed in the visual and logistics sense, and if it supports the planned situations on an interactive level of the prepared teaching aids, then the functionality criteria on behalf of the visitors is satisfactory.

Meeting all criteria first of all comprises applied graphic element design.

## 5. Conclusion

During the process of planning and the very process of creating teaching subject-matter in digital form, it is necessary to approach it according to plan, taking into account all aspects that determine it whether it is by its expert contents or methodic quality adapted to a new digital environment. Accent on the content aspect is not by chance. The manner of its display and the correct perception represents the essence of its teaching process, i.e. the final knowledge adoption. Display quality is important not only to contents but in the formal sense as well. Graphic design does not solve only the question of visual design, but information design as well. Presentation level of the graphic design is the first thing a visitor sees. If he identifies the used graphic elements correctly, the presumption is that he will perceive the contents well too. The subject-matter is presented with the largest part in textual form, and this may be a challenge for teachers-authors because it is possible to overcome the barrier of one language area with the graphic design.

Except for knowledge and skills from a certain expert area, there is also the request for knowledge from the area of graphics, design, security, and informatics and communication technologies in general.

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## THE TRANSFORMATION OF DIGITAL TYPOGRAPHY FROM VECTOR TO PIXEL FORM FOR ON SCREEN DISPLAY

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*Abstract:* After the transformation of types, from the vector into the pixel form, when displaying on the screen, the smoothing of the borders of type occurs. The basic element of the screen image is pixel. The purpose of the methods of measurement and counting of pixels that form one type is to examine the transformation from vector to pixel form for on screen display. Due to the characteristics of the display, there are some deviations from the original inscription. It has been proved that this deviations of that kind depends on typography characteristics, thus the right choice of the font will result in the smallest deviations during the transformation.

### 1. Introduction

When displaying digital typography on the screen and after the transformation of types to the pixel form, by using the algorithms for smoothing of objects defined by vectors, what happens is the smoothing of borders of the type. While displaying black letters on the white background, due to the low resolution of the screen and because of smoothing, the grey borders appear, which affects the readability.

The purpose of this article is to try to quantify the deviations from the ideal vector inscription, as well as to suggest a few fonts whose characteristics will satisfy the given criteria, with the aim of the best possible readability on the screen. Types have been chosen according to the characteristic geometrical elements. The uppercase types A and S together with lowercase types m, o, and t have been chosen.

The research objectives are: explain the way of transforming the types from vector to pixel form for on screen display; to measure, analyze and systemize the deviations which occur during the transformation from vector to pixel form, at characteristic groups of fonts; analyze and prove which typography characteristics cause the decreased readability on the screen; to examine whether decreased readability also depends on distribution of the border pixels value; to recommend using the types with certain characteristics the lowest deviation when displayed on screen, and the highest readability.

### 2. The research

When displaying the digital typography on the screen and transforming vector data to pixel form the smoothing of borders of the types occur. Without the algorithm for smoothing, the letters would be ragged and would seem coarse. There would be decreased quantity of information for the reader, and decreased readability of letter in that respect. In this article, the research is divided into the following stages:

1. Defining the research domain
2. Production vector type files
3. Transformation to a pixel form for on screen display
4. Measuring the density of grayness of the pixel
5. The counting of the pixels of the same density of the grayness
6. Systematization and drawing of tables
7. Visualization and drawing of graphs
8. Synthesis of the results

Results of the research shown in the tables have been put together in the end of the article. In five tables the results for each type (A, m, o, S and t), of all fonts, are shown. The sixth table shows the average values of counted pixels for all fonts. These eight fonts have been chosen for research because of different geometric characteristics, but also because it has been wanted to examine the role that different font thickness had on the results. For that purpose one black font has been chosen (Rounded Black), two bold fonts (Times Bold and Helvetica Bold), and five normal fonts. In addition, two handwriting fonts had been chosen (New Berolina i Edwardian Script), two serif fonts (Times Bold i Officina Serif), two sans serif (Helvetica Bold and Frutiger Roman) and two fonts marked as other fonts (Rounded Black i Scrubadoo).

It has been worked with the font size of 50 pt, because after the transformation into a pixel form for on screen display there is still enough pixels (206-580 on average, per font) necessary for the analyses. If the font has been smaller (12 pt, for example) one letter displayed on the screen could have only a few pixels that do not provide enough information for making a conclusion.

The second reason for the research of the letters that size is that they are suitable for headlines or titles displayed on the screen, and they preserve their ‘classical beauty’ and readability.

There are fonts, so called pixel fonts, designed exclusively for the screen. They have no rounds, it is not necessary to smooth the borders of their types, because they are designed (as the name says) to ‘cover’ pixels accurately during the transformation from vector to pixel form. Those fonts are not aimed to be printed; their characteristics are fully adjusted to be displayed on the screen. If one of those fonts would be included in the research, it would have the best results, undoubtedly. However, these research wanted to examine the characteristics of the classic typography, which could be used (in PDF format, for instance) for a quality display on the screen, and than be printed afterwards.

The entire research has been made on the pixel level. All measured and counted pixels have been sorted into the three groups:

- The first pixel group                     $\Sigma_{1G} = 0 - 7\% k$
- The second pixel group                 $\Sigma_{2G} = 13 - 73\% k$
- The third pixel group                    $\Sigma_{3G} = 81 - 100\% k$

The first group is neglected.

The total pixel number for one letter is:

$$N_{UK} = \Sigma_{2G} + \Sigma_{3G}$$

The percent of the second pixel group to total number of pixels ratio:

$$N_{2G} = \Sigma_{2G} / N_{UK} (\%)$$

The purpose of these pixels is to smooth the borders, but because of certain characteristics of the typography (serifs or thin lines), they might dominate in the percent towards the third group of the pixels. Than instead of the distinct letter, the grayness prevailed, and that kind of the display had been troublesome. That is why the assessment of the second level (N2G) was introduced. If the percent of the second pixel group exceeds 51% after the transformation, that kind of display will be assessed negatively from the readability aspect. The grades for each type and all fonts are defined as follows:

- $N_{2G} = 0 - 15\% \Rightarrow$  grade 5
- $N_{2G} = 16 - 25\% \Rightarrow$  grade 4
- $N_{2G} = 26 - 35\% \Rightarrow$  grade 3
- $N_{2G} = 36 - 50\% \Rightarrow$  grade 2
- $N_{2G} = 51 - 100\% \Rightarrow$  grade 1

The following objectives of the research have been achieved: the way of transformation of types from vector to pixel form for on the screen display has been explained. In addition, the deviations of the data during transformation from the vector into the pixel form, for the characteristic groups of fonts have been measured, analyzed and systemized.

What research has also shown is that there it cannot be confirmed that there is ‘good’ or ‘bad’ distribution of counted pixels. The visualization of the research by means of forty graphs has shown that the distribution of the border pixels in relation to the amount of grayness cannot qualify as regular in any shape.

### 3. Conclusion

The best results of transformation in the pixel form, due to the characteristics of the on screen display, the best results were for the type t. The letters with curves (o i S) had the worst results, while letters A and m are in the middle.

If the on screen display is standard, the pixels are quadratic, aligned at angle of 0°. That is why the horizontal and vertical lines of the letters are done in the most precise manner. For each diagonal line, and let alone round, the significant smoothing of borders is necessary during the rendering on the screen.

It has been proved that the quality of transformed data depends on the following characteristics of the typography: font thickness, the form of the serif (if there are any), the thickness of the basic and connection lines, and the roundness of the curves. If the characteristics of the font are such that the ratio of the second pixel group ( $\Sigma 2G$ ) to all pixels that form a letter (NUK) does not exceed 35%, than this is the optimal number of pixels that smoothes borders.

For the on screen display of the headlines of 50 pt, suitable also for the additional printing, the thicker fonts (bold or black), one without serifs or any additional ornamental rounds, and with the minimal difference between the connection lines are recommended. Since the bold or black fonts without serifs has 'classic beauty' on paper, and on the screen they have desirable characteristics, as the research shows, it's been suggested to use: Helvetica Bold, Frutiger Bold, Rounded Black, Futura Bold, Franklin Gothic Heavy, Eurostile Bold ili ColNova Bold. The research has proved that the right choice of the font with certain characteristics will diminish the deviation during the transformation of vector data for on screen display, consequently, the readability will be the best possible.

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## ACHIEVING THE SAME COLOR VISUAL OUTPUT ON THE PRINT BY APPLYING CMY AND CMYK COMBINATION OF INKS

D. Agić, L. Mandić, I. Žiljak and M. Strgar-Kurečić

*Keywords: Achromatic methods, CMY and CMY+K color spaces, visual perception*

### 1. Introduction

There are various situations that a captured image must have some predefined values and color range. This probably could not be defined or corrected by appropriate profile or the color management system (CMS) engine. The characteristics of the output device will only ensure, that such a color could be reproduced, if it is in the proposed output gamut. Captured image is commonly in the RGB color space. Various programs for image manipulating are also designed for that, or in proposed conditions Lab color space. That is an acceptable way of changing some colored image parameters or implementing some desired colors, in controlled conditions. Of course it is possible to get predictable CMY or CMYK values, and so to modulate them to get the same image appearance. In common discussion approximate transformations converting RGB to CMY are shown above: (1)

$$\begin{aligned} \text{Cyan} &= 1 - (\text{Red}/255) \\ \text{Magenta} &= 1 - (\text{Green}/255) \\ \text{Yellow} &= 1 - (\text{Blue}/255) \end{aligned}$$

or converting CMYK to CMY (2)

$$\begin{aligned} \text{Cyan} &= \text{Min}(1, \text{Cyan} * (1 - \text{Black}) + \text{Black}) \\ \text{Magenta} &= \text{Min}(1, \text{Magenta} * (1 - \text{Black}) + \text{Black}) \\ \text{Yellow} &= \text{Min}(1, \text{Yellow} * (1 - \text{Black}) + \text{Black}) \end{aligned}$$

or converting CMY to RGB (3)

$$\begin{aligned} \text{Red} &= 255 * (1 - \text{Cyan}) \\ \text{Green} &= 255 * (1 - \text{Magenta}) \\ \text{Blue} &= 255 * (1 - \text{Yellow}) \end{aligned}$$

are not exact, as they do not take in consideration some specific parameters of program used (1), and attributes of printed image such as additivity failure, light trap, ink trapping, dot gain etc.

The black ink separation and the black printer are applied to graphic reproduction long ago (2). The black print, often called key print (K) has various functions: from rising the density of the print, expanding contrast, performing the gray scale as well as gray balance more natural and constant, etc.(3). But very important role have achromatic methods. Recent graphic arts reproduction methods very often use achromatic models, also proposed by ISO standards(4). The basic idea is to find the joined achromatic part of CMY in the desired, mostly tertiary color, or the whole image, and change it partially or in the full amount, with black. These methods have various technical benefits, but differ

somewhat from theoretical thesis. That is the reason that calculated values for some specially designed colors on the screen containing CMY and CMYK showing the same colorimetric output, do not achieve the same in printed form.

## 2. Experimental

For some observed color patches containing CMY combination various CMY+K combinations were recalculated. In all combinations the appropriate RGB and colorimetric composition values were almost preserved. In some combinations the theoretical, or near by, undercolor removal was achieved, but in some cases the exchange overflow the theoretical black amount (line II patches). That interesting case is shown in table I where the basic combination (pattern in line II) was 80C 60M 60Y, and possible achromatic commutation would be coverage  $\bar{a}=60$ , but the value of  $\bar{a}=70$  was achieved. Practically in all sampled patches the recombination values were successful, with no significant irregularity in chromatic values or lightness.

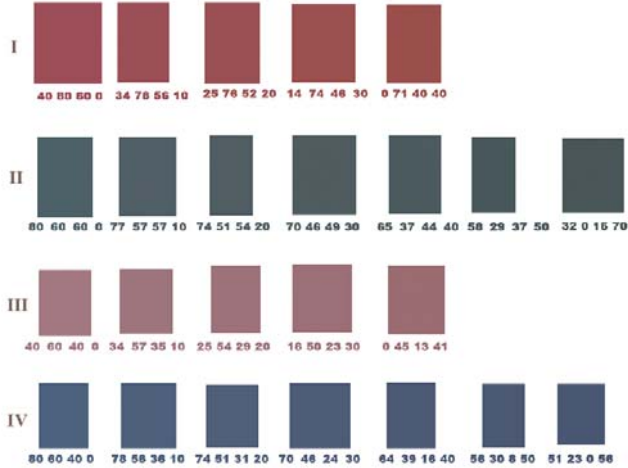


Figure 1: selected color patches I-IV, with associated C M Y and K values

In all lines, the first to left is the basic color with no K value (start) combination, and the right is the maximum exchange value. The shape of the change curve (figure 2) indicates a non-linear slope, different for each reproduction C M Y curve. The full lines represent the recalculated coverage values of C M Y that achieved desired result, and dashed lines represent linear coverage “as it should be” from common achromatic reduction principles.

Realised color patches, as tiff cmyk file on Xeikon D 32 digital printing system, show no notable or distinctive deviations. The very important data, the reflectance, denoted as colorimetric lightness, show very equalized values, slightly decreasing to achromatic maximum (Figure 4). Difference from programmed to realized values differ no more than 3 “L\* ” units. Chromacity values (a\* and b\*) slightly differ from programmed too. They also decrease according the higher achromatic end, table 1:

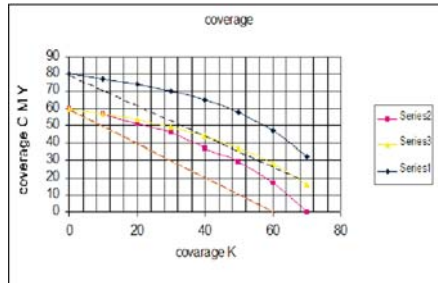


Figure 2: achieved coverages of the patch (II) C80 M 60 Y

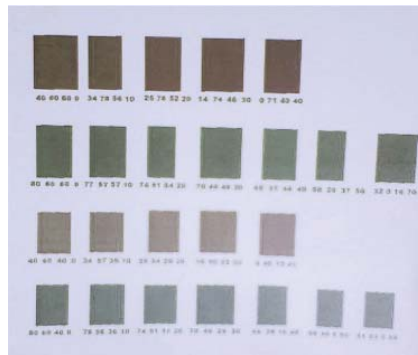


Figure 3: realised patches (photograph)

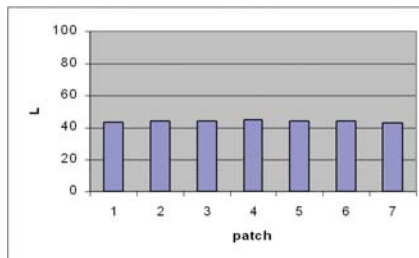


Figure 4: lightness of realized patches (II)

It can be assumed that the decrease of chromatic values dues to the relative large black amount, and lowering the coverage of process colors, as well as specific characteristics of the output device.

**Table 1: chromatic values of patches (II)**

a*	b*
-18,19	-4,91
-18,75	-5,46
-17,34	-5,68
-17,41	-6,07
-13,36	-5,63
-9,55	-3,86
8,39	-4,63

### 3. Conclusion

Recent reproduction achromatic modes, meaning gray component or other tertiary colors reduction, are accepted and applied to reproduction for various reasons. However, higher or maximum possible amounts of substitution with black printer can due to lightness and/or chromacity changes. This assumed that the model of transformation can not be employed to the whole image yet, but however, in a variety of situations, special or custom colors or colored patches, as well as parts of an image can be treated in a different e.g. achromatic way. The high amount of achromatic substitution in a programmed way, even more than theoretical, can produce a satisfactory result with no significant loss in perception of colors, in such way produced. Of course some input, and specially parameters of output device have to be defined, specified and individualized more accurate than the “default cmyk” color profile used in this work. Furthermore, such considerations and treatment of black printer and various inks can take forward to some special characteristics of reproduction systems usage.

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## THE QUALITY OF DIGITAL PRINT

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*Keywords: digital print, resolution, modulation transfer function*

### 1. Introduction

In a competitive global market, organizations face numerous challenges attracting and retaining customers. Marketing communications documents require a balance between the benefits of both offset and digital print technologies. The print quality compares to offset as digital photos compare to analog shots. Each technology has distinctive characteristics that affect output, but the quality achieves professional standards in nearly every application. Deciding between digital and offset printing is more about turnaround time and costs — and other factors, like printing variable information.

Offset will always have a cost advantage on longer runs. But as digital technology improves, its cost advantage extends to increasingly longer “short” runs. And many are willing to pay a slight premium for the improved workflow efficiency, faster turnarounds, elimination of warehousing and personalization of every piece in a production run that digital printing provides. In many cases, these benefits compensate for the higher cost of digital printing by delivering big costs savings and better results.

Today’s digital presses sets new standards for printing a wide range of coated and uncoated substrates from the very light to the very heavy. Paper manufacturers have continually developed new substrates for digital printing. In recent years, many print needs have been met with coated one- and two-sided papers, parchments, off-white graphics stocks for text and covers, and specialty products for ID cards, labels, transparencies, photos and other applications.

Offset printing is well-suited for a wide range of static print applications. It remains the most cost-effective method for producing long-run, static documents.

Digital printing is ideal for short-run or variable data applications. Digital printers accept electronic files and produce images using special toners and inks without the need for printing plates, reducing setup time dramatically. Color correction and color-to-color registration are handled electronically, minimizing the amount of waste. However, digital printers require significantly more maintenance than offset printers, and the special toners and inks are more expensive than offset inks. In addition, digital printers require special paper stocks that are smoother and manufactured specifically for digital printing [Kotera, 1995].

Hardware vendors continue to improve the output from digital print engines. Both monochrome and color engines produce high-resolution images. Software algorithms tune the output differently for different objects on the pages and modify the digital image for smoothly rounded edges on text characters, fine lines in drawings, and solid colors in images. The visual effect simulates the very high resolution produced by offset printers. Today’s digital color presses have steadily improved color depth and quality over the years and now rival offset printing.

## 2. Digital offset color technology

The three core technologies of the Digital Offset Color process are: ElectroInk –liquid ink, Thermal offset transfer technology and On-the-fly color switching.

ElectroInk contains electrically charged ink particles, in a liquid [Caruthers, 2003]. ElectroInk enables very small particle size, down to 1-2 microns. This small particle size enables higher resolution, higher gloss, sharp image edges, and very thin image layers. In other words, ElectroInk enables printing that matches conventional offset printing quality.

Thermal Offset uses a blanket heated to approximately 100°c. This causes the specially shaped pigment-carrying particles within the ElectroInk to melt and blend into a smooth liquid plastic. The blanket heat is not high enough, nor is the dwell time long enough, to heat the paper or other substrates as they contact the blanket. When it contacts the cooler substrate, the ElectroInk immediately solidifies, strongly adheres and transfers to the substrate. The print is effectively dry as soon as it leaves the press, eliminating any risk of ink ‘set-off’ marking other copies. Print finishing can be performed immediately.

### 2.1. Digital half-toning

In the traditional analog half-toning, the original analog image is converted by a screen to a half-tone image. In digital half-toning, the original image is often digital with 8-bit or more gray levels and it is thresholded into a binary, half-tone, digital image. The basic principle is to place binary dots spatially in a way that creates the illusion of continuous-tone images. The black-to-white area ratios are controlled by varying the size of the dot. The entire image area is divided into regularly spaced half-tone cells of equal area. If those cells are turned on as a cluster, it is called the clustered-dot pattern. Modern digital half-toning methods often break up the single black dot into many smaller dots and distribute them evenly in a half-tone cell, called dispersed-dot. Both the clustered-dot and dispersed-dot ordered dithers are point operations, each pixel is compared with a value in the threshold array, independently of what the neighboring pixel values are. The error diffusion method is use neighborhood operations [Mizuta, 2004]. The basic idea behind the error diffusion algorithms is that, when quantizing a gray-level pixel into a binary black or white dot, an error in brightness at that image point is created. This error can be compensated by turning the neighboring pixel in the direction that will cancel the current error when all the reflectances in the neighborhood are integrated by our visual system. Therefore, there are three key components in designing an error diffusion algorithm: an error measure, a neighborhood to diffuse the error to, and a method for distributing the errors. Fig. 1. shows a conceptual block diagram of the error diffusion algorithm.

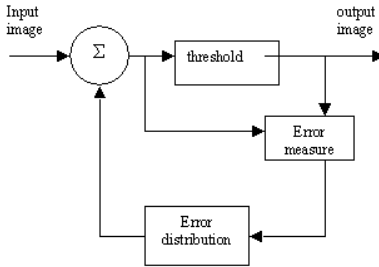


Figure 1. A conceptual block diagram off the error diffusion algorithm

On a computer screen, smaller pixels produce sharper pictures. It’s the same with the toner used to form the images printed on a laser printer or copier: smaller particles mean sharper images – plus

less toner usage. But as toner particles become smaller, the cost of making them by conventional technology rises exponentially.

### 2.2. Modulation Transfer Function

The MTF (Modulation Transfer Function) analysis is used to quantify the resolution of a printing system. By measuring the contrast in patterns of lines printed at various line frequencies (in lines per mm), Image Analysis apparatus can reveal the response of the printing system to spatial details in an image. Good MTF performance is crucial to producing good pictorial and graphical images. The image Analysis apparatus approximates the MTF by making CTF (Contrast Transfer Function) measurements of a high- density line sequence and plots the results against respective line frequencies. Modulation measurements are made using the standard formula (1):

$$(1) \quad M = \frac{R_{paper} - R_{line}}{R_{paper} + R_{line}}$$

Where M is modulation, R<sub>paper</sub> is the average reflectance in the areas between the lines, and R<sub>line</sub> is the average reflectance of the lines. When R<sub>line</sub> is very small (i.e. dark lines), the modulation always evaluates to nearly 1.

### 3. Experiment

For our analysis we created special printing form which included standard CMYK RGB wedge in steps of 10 % screen value, ISO standard illustration and 378 fields for production of ICC profile.

Experimental prints were made on previously calibrated electrophotographic machine HP Indigo TurboStream after which the power variation of the laser head was performed with other electrophotography parameters retaining constant. Prints were printed on gloss fine art paper (135 g/m<sup>2</sup>), mat paper and transparency.

HP indigo printing machines generate 812 dpi prints. It prints 144 lpi line halftone, and uses 6x6 pixel superpixel for creation of a halftone element. Better resolution can be obtained with use of the HDI option, but it is enabled only with a Error diffusion halftone [Woods, 2004]. With HDI option halftone resolution can be augmented to 200 or 250 dpi. Superpixel for these resolution are shown in Fig. 2.

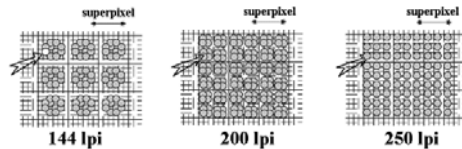
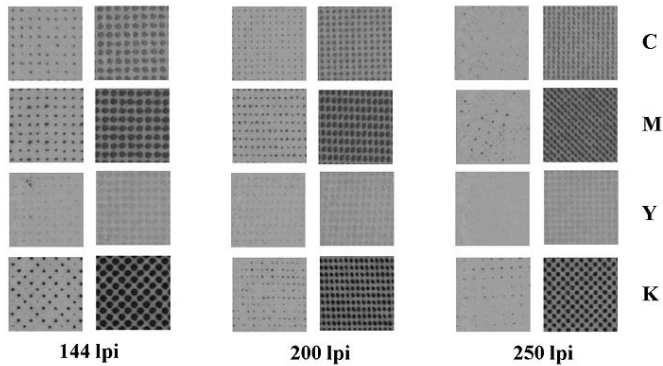


Figure 2. Superpixel display for differnt screen resolution

Shape and dimensions of the screen dot and MTF was tested with Image Analysis (Personal IAS) apparatus.

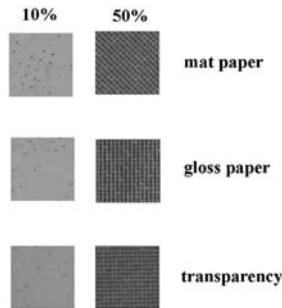
#### 4. Results

The results show aberration in tone values and element shape for 250 lpi resolution, specially for magenta test wedge, 10% and 50% tone values. The shape of raster element is not round, it become almost line. The results for mat paper are shown in Figure 3.



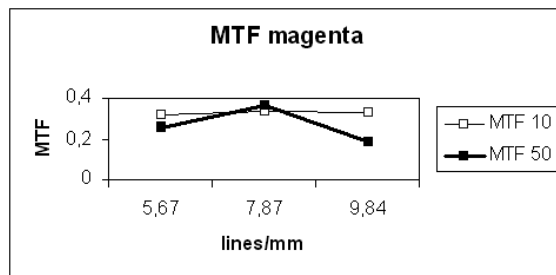
**Figure 3. Image analyse of CMYK wedge (10% and 50% tone values) for different screening**

In Figure 4 are shown image analyse for magenta wedge on three different media: mat paper, gloss paper and transparency. The largest aberration was for gloss paper, and good results were for transparency.



**Figure 4. 1 Image analyse of magenta wedge (10% and 50% tone values) for different media**

MTF for magenta tone values 10% and 50% are given in Figure 5. It can be noticed low value for 50% coverage.



**Figure 5. MTF for different tone values for magenta wedge**

## 5. Conclusion

The test form was printing on three different media (mat paper, gloss paper and transparency) with three different resolution (144 lpi, 200 lpi and 250 lpi). The results show that the best color reproduction was achieved with resolution 200 lpi. Higher resolution produces best contrast but causes the change in shape of raster element. The shape of raster element retain unchanged on transparency.

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## DIGITAL WORKFLOW SYSTEM IN GRAPHIC PRODUCTION

K. Pap, T. Pavlović, Z. Sabati, M. Barišić and A. Koren

*Summary: To shorten the job execution time and the need to carry out more complex work require implementation of integration and automation into complex graphic reproduction systems, on all levels, beginning from the publisher to the printing works and from graphic make ready to printing processes and graphic finishing. Setting of proper standards is a preliminary condition for any efforts to make production automatic. The dictionary that describes standards in printing production is large. It is necessary to perform the transition from analog to digital job orders, and in this transition there is a dramatic rise in demands requiring new skills, organization and making links on all levels.*

*Keywords: workflow, graphic production, optimization*

### 1. Introduction

For some time now efforts have been made to make the processes in the publishing and graphics industry answer to set standards. There is no scientific global analysis of graphic reproduction processes. There must be re-designing of the existing habits and workflows in the graphic reproduction process. Precise description of all operations in all phases must be brought to a higher level, beginning from the publisher, printing works, external collaborators in one or more work phases, and from the graphic product ordering party too. The corresponding data must be gathered from any production phase in order to pre-modify the workflow into real time. Productivity and quality improvement may be reached through workflow modification, but in what way? How do new technologies and markets influence these processes? How should new technologies be implemented into today's environment and how should they be used to improve the existing operations and workflows? Every producer offers his limited workflow model. This applies to the equipment producers and producers of graphic make ready programs, printing machine producers, finishing machine producers and producers of programs for production integration. But when there is necessary transition to the next link in the production chain, the enterprise is left to do its own linking and analysis. The decisions that must be made are difficult, dear and there is fear of making the wrong investments. Informatic description requires realistic and actual values as a result of measuring and testing individual equipment. The question is how to initiate this process. Should this be left to the graphic machine producers whose only interest is to sell their machines?

### 2. Research Procedures

A pilot system named WebPoskok has been developed by the department for computers and graphics with the Faculty of Graphics. The system has the goal to implement databases in the graphic industry with the following links: calculation and preliminary calculation, e-job order, production plan, communication between operators and machines. The WebPoskok system is used as a central testing place for scientific research of all graphic reproduction processes. The complete system uses XML

technology way for data description. The WebPoskok system is used for researching all effective and hypothetic workflows. Simulation and analysis is done with WebPoskok. Part of the data is already in the WebPoskok database, most of all from the graphic finishing area as the most complex part of graphic reproduction (Figure 1).



Figure 1 Graphic finishing area in database (Postpress)

Integration of knowledge on standard provisions and standards in the graphics industry coming from different sources into a unified description in the form of an XML document. The process of standard determining may be divided into four categories: defining standard provisions in the publishing business, defining standard provisions for the production equipment (including manual work), defining standard provisions for processes and their resources, as well as defining mutual relations. The set standard provisions must be changeable as time passes, not often but depending on the need to do so. Each production process tends to be improved through the standard provisions variables. It has been determined that determining graphic postpress requires the deepest and most complex informatic machine description, because each machine has its specific characteristics, depending on its function. Description of individual finishing machines requires setting of functional dependence of parameters that are typical for the machine in question. Postpress may be done with the help of hundreds of different finishing machines. The system for setting standards is based on measured time periods that are determined under the influence of various materials, printing runs and belonging make ready prices, as well as machine/time prices. The results are loaded into the WebPoskok base part for setting publishing process standards, standards for graphic make ready, printing and graphic finishing.

## 2. Prepress and graphic product classification

Classification is carried out in the area of scene and template digitalization, scanning (Figure 2), color separation, text and image integration, film making, direct and non-direct offset plate making, printout bitmap for digital printing, individualization of the digital record and interface function for elaboration of image elements and rasters, and in many other areas. The equation and function system linking the variables between different graphic reproduction phases is studied. One of the aim is direct loading from database of mathematical algorithms and mutual relations which depending on the keys for graphic product standardization and classification.

## NORMATIVI PRIPREME

Kategorija:  
**SKANIRANJE**

Naziv posla:  
**SKANIRANJE**

Naziv normativa:  
KOLIČINA NA SAT

Spremi

**Kategorije cijena**

Kat. sata:

Kat. pripreme:

Povratak

JEDINIČNA CIJENA:

SKANIRANJE				
KOLIČINA NA SAT				
VELIČINA	SLOŽENOST			
	jednotonski	višetonski	jednobojni	višetonski višebojni
minimal (do A5)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
srednji (A5 do A4)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
veliki (preko A4)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
posebni zahtjevi	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Figure 2 Prepress interface of normative standards for scanning facility

### 3. Research of workflows in graphic production and creating digital workflow databases

Studying the continuous automatic production process, operation elaboration and operation observation is very important. The first step is description of the digital job order (Figure 3) with XML elements and attributes. It is very important to research of individual solutions being created in respect to graphic system automation with XML interpreters in application and equipment, the automatic workflow with linking and branching of XML data files from the graphic production process junction points and research of automatic machine setting preceding the anticipated job as well as multiple start-stop mechanisms of the digital job order. Measurements are effected on three levels: phase, sub-chains (a group of several phases), chains and the complete workflow. Values necessary for start-up calculations and production control are stored in the database. They are concrete machine production standard provisions, including numbers. An individual XML description of the machine is created from each table with determined and described specific characteristics, like determining the XML dictionary, connecting publishers, printers, paper distributors, plants for finishing and packaging, cooperating firms and delivery firms.

**NARUČITEL:** Vjesnik  
**NAZIV PROIZVODA:** KNJIŽICA MERCATOR  
**NAKLADA:** 50000  
**FORMAT:** 210x300  
**OPSEG:** 32  
**PAPIR:** kb - lnc 90g  
 omot - kd 115g  
 od naručitelja  
**Priprema:** klemano,obrezano,pakirano  
**DOKADA:** klemano,obrezano,pakirano  
**OPIS:** Povezani svezaci, 2x kopčano šicom, obrezano, brojeno po 100, vezano trakom

IZSAK		Sati	Ostvareno sati
Iznak omot		11.13	
I STD 1 Č astr 4/4: omot		7.45	0.00
<b>MATERIJALI</b>		<b>Količina</b>	
papir: KD B1 115g magnostar		Arak	15141.00000
boja: Boja		KG	29.44000
ploča: STD1		KOM	4.00000
Iznak natp		3.33	
I LBH A 4 32 32str 4/4 86cm: m32 arak		3.33	0.00
<b>MATERIJALI</b>		<b>Količina</b>	
papir: WFC 86/90 UPM FINESSE		KG	5614.55420
boja: Boja		KG	124.77000
ploča: lithoman		KOM	8.00000
<b>DOKADA</b>		<b>Sati</b>	<b>Ostvareno sati</b>
a) rezanje omota - REZANJE - 7, araka 101 do 140 g.		3.14	0.00
b) savijanje omota - STROJNO SAVIJANJE ARAKA - AB - 3, 1 pregib, 101 - 140 g/m2, paralelno		6.28	0.00
c) klemanje,obrezivanje - LINIJA ZA UVEZ ŽICOM ARAK - PANZER - 2 arka, sabiranje klemanje, 32 str		7.45	0.00
d) pakiranje - PAKIRANJE GOTOVIH PROIZVODA - do AB - 4, vezanje trakom		13.31	0.00

Figure 3 Digital job order

#### 4. Graphic reproduction process optimization research with the help of digital workflow database

The digital workflow database that has been created enable a many simulation experiments, correlation research, machine performance utilization level, sub-chain, chain and the overall workflow productivity. The existing operations and workflows can be improved on basis of such research work in all graphic reproduction processes. Production bottlenecks can be detected. Productivity and cost measuring can be used as tools for determining areas where investment returns will be the greatest. The quest for the best work path, i.e. work flow will actually make use of results following digital workflows, the effective as well as hypothetic ones, in order to make the best investment moves.

IZSAK	Juzijena	Sati	Ukupno	Ostvareno sati	Ostvareno ukupno	Razlika sati	Razlika ukupno	
Iznak omot	1.53	242.98279		2.00	248.00000	-6.02	-5.01721	
I STD 1 Č 2str 4/4: Ploča B1	1.53	242.98279		2.00	248.00000	-6.02	-5.01721	
Trošak stroja:			151.30967					
Priprema		80.00000	1.20	108.66667				
Izjava		88.00000	0.30	40.00000				
Iznak:		80.00000	0.30	1.44400				
<b>MATERIJALI</b>		<b>Juzijena</b>	<b>Količina</b>	<b>Trošak</b>				
Trošak materijala:				91.56707				
papir: KD B1 115g magnostar kit		Arak	0.09923	261.00000	25.89903	265.00000	26.29995	
boja: Boja		KG	6.76000	0.15000	0.98004	0.10000	0.67600	
ploča: STD1		KOM	18.20000	4.00000	64.80000	4.00000	6.80000	
<b>DOKADA</b>		<b>Juzijena</b>	<b>Sati</b>	<b>Ukupno</b>	<b>Ostvareno sati</b>	<b>Ostvareno ukupno</b>	<b>Razlika sati</b>	<b>Razlika ukupno</b>
a) obrezivanje araka - REZANJE - 4, araka 141 do 200 g.		10.00000	0.58	7.09405	1.45	12.50000	-6.35	-5.40595
b) savijanje - PAKIRANJE GOTOVIH PROIZVODA - do AB - 4, natron		3.00000	0.33	3.57674	0.45	7.50000	-6.33	-1.92326
c) klemanje - PAKIRANJE GOTOVIH PROIZVODA - do AB - 4, natron		3.00000	0.17	1.51731	1.00	5.00000	-6.43	-3.48269
<b>MATERIJALI</b>		<b>Juzijena</b>	<b>Količina</b>	<b>Trošak</b>				
Trošak materijala:				0.07300				
Natron		kg	0.10000	0.75000	0.07500	0.00000	0.77500	

Sati 2.43 Ukupno 250.88279 Ostvareno sati 3.45 Ostvareno ukupno 376.54445  
 Razlika sati: 1.42 Razlika ukupno: -10.66000

Figure 4 Result of Graphic reproduction process optimization research (green cells)

## 5. Conclusion

Research of new technologies and manners of their implementation are very important to improve the existing operations and workflows. New technologies are introduced on basis of simulation experimenting, testing and measurements in practice. It is expected that many phases will be automated and improved with XML derivatives that will be introduced by then. Possibilities and tasks of the SVG, VML and XSL-FO graphic web languages are growing. The basic facts of interactive web vector graphics and animation on the web interface can be of big help, like also the dynamic creating of HTML and WML records, as well as the automation of making PDF documents from the database. It is expected that many phases will be automated and improved by the XML derivatives. The overall printing production workflow is described in the XML language. Recognizing of processes and conversion into the adequate standards as well as their mutual linking is made easier with the XML description in collaboration with database. Once the resources, operations and process junctions are described in the XML language, it is possible to elaborate electronic calculations, job orders and production plans in a printing plant. The goal is to create digital graphic reproduction standards and creating communication dictionaries in publishing processes, prepress, printing and postpress, developing the methods of transition from analog into digital workflows in the graphic reproduction process and defining the organization and linking on all levels of the production chain. The goal is to improve operations, workflows and habits.

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## POLYMER CLAY IN DESIGN AND MAKING UNICATE BOOKS

V. Kropar Vančina, A. Katar and J. Žiljak Vujić

*Summary: Polymer clay - a synthetic composite polymer material is one of the most widely used creative materias available today. Natural clays are derived from hydrated aluminium silicates, while polymer clay is synthetic material consited of polyvyniyl-chloride (PVC) dispersed in a plasticizer with colorants and inorganic fillers. When baked PVC particles fuse into a hard durable material, by irrevversible chemical reaction. Polymer clay is an excellent material for making: jewelry (earrings, necklaces, bracelets, brooches), office accessories (sparkling pens, luminous letter opners, business card holders), extraordinary home decor (glasses, vases, frames, mirrors can be decorated and even individualised with polymer clay) etc. Polymer clay is used by terapeuts as a didactic material to improve fine motoricks of childreen and adault persons too. At the end it is important to point out that polymer clay can be used in literary life and/or graphic desig when reading, writing and miscellaneous attractive accessories are created. In this work polymer clay was used for making hard covers for two unique designed books - according book and spiral binded book*

*Keywords: according book, hard cover, polymer clay, polymer covers, spiral binded book*

### 1. Introduction

#### *Polyvinyl Chloride*

Polyvinyl chloride (PVC) is a thermoplastic, water-insoluble polymer, derived from the polymerisation of momomer vinyl chloride. Consumers can identify Polyvinyl Chloride by looking for the number 3, PVC or the letter V inside or underneath the universal recycling symbol. PVC can be, easilly, modified by various processes and/or additives, so more then one hundred polymer materials based upon PVC are available today.

#### *CLAY*

Clays are aminosilicates which occur as a plastic paste in earth's crust. Primary or residual clays are found at the place of their formation. These clays are, in general, composed of kaolin (china clay) or montmorillonite and similar minerals, with relatively coarse particles and are not very plastic. Secondary or sedimentary clays, which have been transported by water, and redeposited are fine-grained and plastic.

#### *POLYMER CLAY*

Polymer Clay is synthetic composite polymer material consisted of PVC particles dispersed in a plasticizer with colorants and inorganic fillers. The first Polymer Clay was produced by Kaethe Kruse in 1930 (Germany). She named otained material FIMOIK, and used it for toys (dolls) manufacture. In 1950 Polymer Clay is frequently used in schools as creative didactic material. After ten years Eberhard Faber improved FIMOIK, renamed it to FIMO and he is still the most important producer of FIMO today. Another polymer clays are available too, and the best known are: SCULPEY, POLYFORM, CERNIT, PROMAT, MODELLO, FORMELLO and FRIENDLY CLAY. All polymer clays have the

the same major components, but numerous additives are used to obtain various plasticity, texture and color. Polymer Clay FIMO is produced in 72 shades, and special pigments are used too such as metal, pearl and luminiscent. New FIMO product since 2002 is FIMO LIQUID transparent gel. All sorts of polymer clay can be dried and baked at 130 oC and after 30 minutes fused hard durable material is obtained. According to varrious standards and socaities (EN 71, ACMI, AMES test, ASTM D4236) FIMO is not dangerous and no emmission of polutants is not recorded if baked at 130 oC. Thermal degradation of FIMO occurs at 150 oC, and products of degradation are HCl, CO2 and CO.

## 2. Experimental

In this work various tools were used, such as: rolling, shaping, forming, cutting and measuring tools. Materials used for books were: polymer clay FIMO of various shades (Eberhar Faber), coconut and aquarel paper, golden leaves and metallic powder gold (Eberhar Faber) and some plants from garden. Hardcover of spiral binded book is designed by random choice of polymer clay shades and quantities. Polymer clay is applied in several layers. Releified structure is nice and pleasant (Figs. 3-5).

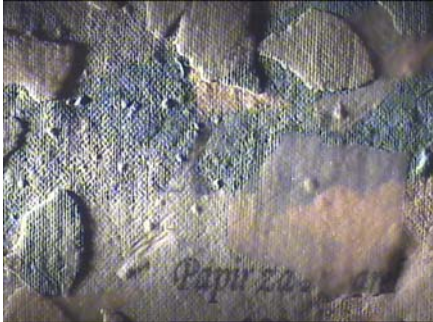


Figure 1 Hardcover of spiral binded book



Figure 2 Hardcover of spiral binded book

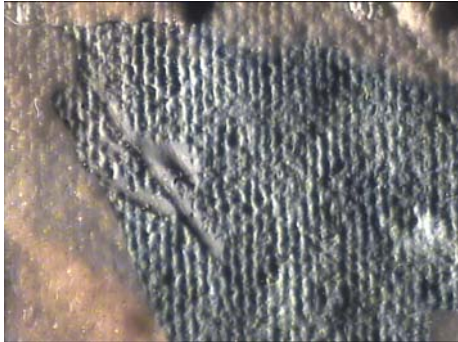


Figure 3 Hardcover of spiral binded book

Aquarel paper used for spiral binded book has grammage of 300 g/m2. It's structure is shownen in figure 6.



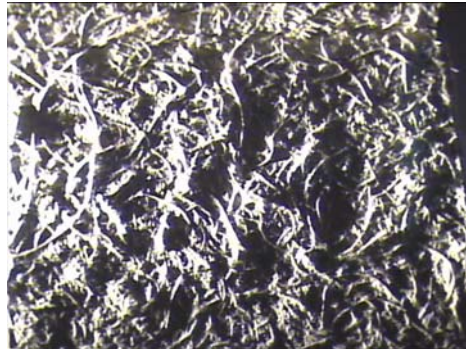
**Figure 4 Aquarel paper from spiral binded book**

Hardcover of according book has emmbossed plants covered with golden leaves and gold metallic powder. Tactility is well pronounced (Fig. 7).



**Figure 5 Hardcover of according book**

Coconut paper used for according book is attractive because of it's structure where individual cellulose fibres can be seen by naked eye and tauched by fingers (Fig. 8).



**Figure 6 Coconut paper from according book**

### 3. Discussion and conclusions

The use of polymer clay in design and making hardcovers for unique, attractive and even individualised books, is very successful and conclusions can be quoted as follows. Polymer clay is an extraordinary material for making hardcovers because it has good mechanical properties even when the thickness is 0.5 mm. By prolonged baking from 30 to 60 min. at 130 °C mechanical properties are better. Hardcover made of polymer clay protect book blocks well. Covers are decorative and there is no need for coating with paper or linen cloth. Polymer clay hardcovers can be punched before baking at the place of binding, or shaped according to book blocks properties. Polymer clay hardcovers are resistant to repeated baking without change of mechanical properties so additional application of polymer clay after first baking is possible. Finished/baked hardcovers can be polished to high level and engraved too. When hardcover is made of material which is not durable enough for example linen cloth FIMO LIQUID is used to obtain necessary properties. FIMO LIQUID coating provides additional resistance to atmospheric conditions, flexibility and prolongs „life time“ of book. Polymer clay is excellent material for hardcovers because numerous shades are available (72 shades), and material can be punched and/or embossed before baking. Even with the simplest techniques of binding interesting and attractive results can be achieved. Thin baked polymer clay foils are flexible after baking and can be used instead of paper in book blocks. Shape, dimensions and structure of books are variable. In USA students can attend courses where they learn traditional binding techniques combined with polymer clay techniques. Polymer clay is material which improves inventive development of books because it is a subject of constant scientific investigations even in nano scale. From designers state of view polymer clay is warm when touched and everybody wants to touch it again and again. Polymer clay hardcovers have well pronounced tactility.

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## INFLUENCE OF DIFFERENT CONSTRUCTIVE SOLUTIONS ON STRENGTH OF TRANSPORT PACKAGING

D.Babić, B. Lajić and D. Jurečić

*Abstract: The strength of the box «holandez» for fruit and vegetables, which was glued and folded in dependence on different double face and five-layered corrugated boards in two basic constructions, was tested. The construction A is the glued box and the construction B is the folded box. During the testing the resistance to pressure (BTC), the resistance of the corrugated board to dynamic penetration (PT) and the loading of the horizontal and vertical surface of the corrugated board (ECT) were measured. The obtained results were compared on the basis of the material grammage and the quality of the paper layers used in the production of the corrugated board.*

*Keywords: corrugated board, transport box, construction, strength*

### 1. Introduction

Packaging is mainly the result of the determined compromises concerning the price, quality and functionality. Special problem of today is the transport, storage and the distribution of fruit and vegetables. Because the fruit and vegetables continue after the harvest, with the respiratory processes which comprise the oxygen usage, the carbon monoxide, water and energy release, it is necessary to keep them in a cold atmosphere where the physiological functions are slowed down or stopped. In dependence on the fruit and vegetable type there are different processes of transport and storage as well as eventual exposition in the selling area. The easiest preserved kind of fruit and vegetables are those which contain a small percentage of humidity, such as root vegetables, almonds and hazelnuts and similar ones. During the harvest and transport of fruits and vegetables it is necessary to pay special attention to the protection of fruits from the mechanical damages which can cause the quality deterioration and the increased biological degradation. If the transport time to the storage is longer, it is necessary to ensure the vehicle to have firmly controlled climatic conditions (CA – controlled atmosphere) for preserving the fruit and vegetables. It can generally be said that the packaging for fruit and vegetables must be produced from light material but it must be strong enough to be piled on the necessary height in the vehicle or in the refrigeration plant with the aim to use the space best possible. It must be made from the material which have no toxic substances or odors and which are not sensitive to humidity. It must be solved constructional so that the fruit have enough airiness and that they can be exposed in the selling area. Before the usage it has to occupy the less possible storage space and the folding has to be possibly performed by machines. Packaging which corresponds best to all these demands is the transport box made from the corrugated board for the transport of fruit and vegetables – with the commercial name “holandez”. The “holandez” boxes for fruit and vegetables made from the corrugated board can be produced in different models and from different material qualities depending on: fruit and vegetable kind, the length and conditions of transport, demands of the shops which sell fruit and vegetables, class of fruit and vegetables, height of piling on the selling place, possibility of packing by machines in field or in the sorting place.

## 2. Experimental part

There is the whole series of demands which must be fulfilled in order to use the box “holandez” for defined fruit and vegetable packaging. In order to spare the space the storage of fruits in refrigeration plant demands the piling of boxes with the packed fruits one above another very high. During the long distance transport by ship, train or van where there are conditions of the controlled atmosphere with low temperature and with the increased relative air humidity, the dynamic loading is present because of the lower boxes in piles. The greatest loading of boxes is during the transport. Because of that the boxes must be constructed so that they can bear all the loadings and changes of the atmosphere. There are two basic box constructions whose box blanks are glued (in testing it was the construction A) and the boxes whose box blanks are formed by pushing in without gluing (in testing it was the construction B). For the box of B construction, the machine which glues the boxes is necessary to have and it is usually placed in field or orchard where the boxes are made by gluing before filling.

### 2.1. Resistance of the corrugated board on dynamic penetration – Puncture Test

Classification is carried out in the area of scene and template digitalization, scanning (Figure 2), color separation, text and image integration, film making, direct and non-direct offset plate making, printout bitmap for digital printing, individualization of the digital record and interface function for elaboration of image elements and rasters, and in many other areas. The equation and function system linking the variables between different graphic reproduction phases is studied. One of the aim is direct loading from database of mathematical algorithms and mutual relations which depending on the keys for graphic product standardization and classification.

This is the test in which the corrugated board is tested on direct mechanical blows. In this way the resistance of the corrugated board on tearing as well as its toughness is tested. The test shows how strong direct mechanical blows on corrugated board can be before it breaks. It is important if the products are packed into packagings which are sensitive to outer blows. The device on which the testing is performed is called Punctometer (figure 4) and the direct mechanical blows are reproduced on it. It consists of two plates one above another and the sample of the corrugated board to be tested is placed between them. The plates with the corrugated board are tightened up with the handle which is placed on the upper part of the device. In this way the corrugated board is clamped in order not to be moved. The device has a pendulum which is sharp at the end and has the form of the triangle pyramid. It serves for simulation of the direct mechanical blow which could happen during the transportation and the storage of the corrugated board packaging (figure 5). In the middle of the device there is the measuring scale for reading the obtained results. The scale has measuring units [kpcm] which are then calculated into Jule [J] which gives the obtained energy spent on penetrating the material which is tested. The samples of the corrugated board are cut to the dimension of 17,5 x 17,5 cm for testing; 20 pieces. 10 for testing the front side of the corrugated board and 10 for testing the back side of the corrugated board. At the end the 10 results are added and divided with the number of measurements (10) and we obtain the middle value of the testing results. The first sample of the corrugated board, on which the front side is tested, is put between the two plates with the face (front side) downwards, because this side is tested. The handle tightens the plates with the corrugated board. When the sample is in the correct position the handle with the pendulum is released and it swings freely and penetrates the corrugated board (figure 6). The measuring results show the badly glued paper layers in the corrugated board, badly formed or crushed waves which cannot be easily detected by any other apparatus.

## 2.2 Testing of the resistance of horizontal and vertical surface of the corrugated board to compression - Flat Crash Test i Edge Crush test

In this test the grade of squeezing and rigidity of waves in corrugated board is tested under compression. The test is performed to increase the paper quality used in the production of the waves or for the control itself. It is performed on the device Crush Tester (Lorentzen&Wettre Code 248) which was designed for testing the deformities of the corrugated board and its components. Thanks to its stability the device can stand to parallelism of the compression plates eliminating the folding and grooving risk. It is the digital device driven by electro engine. It consists of two plates, one of which is driven by electro engine and the second which resists to compression is placed on the flexible plate near to the digital control panel. The flexible plate is made so that the determined compression drives the mechanism on the control panel on which the dip of the plate is visible. When the sample of the corrugated board on which the waves have to be crushed is exposed to compression, in the moment of this compression, the plate stops and denotes the maximal pressure which the waves can resist before crushing. The result is read on the control panel and it is expressed in kPa. The results are plotted on a small printer which is a constituent of the equipment. The greater the compression is the quality of the paper for the production of the corrugated board is, because it can resist to greater loading. Compression necessary to deform the wave of the corrugated board is the strength factor of the wave. Samples with the dimensions 10 x 10 cm are necessary for testing. Totally 20 pieces, 10 for testing the front side of the board and 10 for testing the back side of the board. The sample of the corrugated board is placed between the two plates. If the front side of the board is tested it must be turned upwards and if the back side of the corrugated board is tested it must be turned upwards. When the sample is placed correctly, the button on the control panel is pressed which activates the upper plate and it starts to lower on the board sample (figure 32). It lowers as long as it starts to compress the waves of the corrugated board. When it happens the plate stops and automatically rises denoting the maximal pressure which the waves can resist before squeezing. The resistance of the corrugated board is tested in the direction of its waves stretching, i.e. the edge of the corrugated board on the edge of the waves. The testing process is the same as in the horizontal testing of boards. The upper plate of the device is activated and presses the edge of the board. In the moment of wave's deformations, there is the maximal pressure on the control panel which the waves can stand to, till the moment of bending. The result is expressed in kN/m. The greater the pressure is the edge of the corrugated board has greater resistance, because it can resist to greater loading.

## 3. Results and discussion

- Greater surface masses of the corrugated board give better BCT, PT and ECT results, independent on the box type. The material with five layers of 925 g/m<sup>2</sup> gives for 21,80% better results of BCT test than the five-layered material with the surface mass of 670 g/m<sup>2</sup>. The result is better than the result of the three-layered material which has the surface mass of 410 g/m<sup>2</sup> for 35,50%. The five-layered material of 925 g/m<sup>2</sup> has for 31,18% better PT results than the five – layered material with 685 g/m<sup>2</sup> surface mass, as well as for 61,64% greater PT results than the material with the surface mass of 430 g/m<sup>2</sup> and for 64,45% greater results than the three-layered material with the surface mass of 410 g/m<sup>2</sup>. Five-layered material with the surface mass of 925 g/m<sup>2</sup> has for 28,76% better ECT results than the five-layered material with the surface mass of 685 g/m<sup>2</sup>. It has better ECT result for 60,73% than the material with the surface mass of 430 g/m<sup>2</sup> and for 62,55% than the materials with the surface mass of 410 g/m<sup>2</sup>.

- By decreasing the surface mass of the corrugated board the greater areas are obtained if the quantity of the corrugated board is the same and that means the number of boxes is greater. For example for 1000 boxes A produced from the five-layered (925 g/m<sup>2</sup>) it is necessary to have 98,59 kg more corrugated board than when they are made from five-layered board (685 g/m<sup>2</sup>). If this number is

divided with the grammage of the material we obtain 144 m<sup>2</sup> of the corrugated board which can be used for the production of 350 pieces of boxes more.

- The box of type A has 12,5 % smaller surface of the box blank of the B type box which means 12,5% smaller material consumption.

- The box of A type has shown better BCT test result for 11,2% than the result from the type B in material quality of the five-layered (925 g/m<sup>2</sup>) board, 7,23 % in the quality of the five-layered material (685 g/m<sup>2</sup>), 6,75% in the quality of the three-layered material (430 g/m<sup>2</sup>) and for 20,65% in the quality of the three layered material (410 g/m<sup>2</sup>).

- The smallest difference of the measured values of the box resistance to compression of the A and B type boxes is the greatest for the five-layered material (925 g/m<sup>2</sup>) 392 N and the smallest one for the three-layered material (410 g/m<sup>2</sup>) 102 N, or the total difference is for the type A 2260 N i.e. 64,58% and for the type B it is 2204 N or 68,34%.

- The medium value of the corrugated board resistance to dynamic puncture is (925 g/m<sup>2</sup>) 10,22 J for five-layered corrugated board and for five layered one of (685 g/m<sup>2</sup>) is 7,32 J. The difference is 2,9 J, or 28,38 % which is too much from the point of experience that we could talk about the similarity of these two materials.

- The medium value of the corrugated board resistance to dynamic puncture for 430 g/m<sup>2</sup> is 3,92J and for 410 g/m<sup>2</sup> it is 3,73 J which is the relation between these two materials of 4,85% which is not a big difference.

- The structure of the corrugated board 685 g/m<sup>2</sup> with the built in testliner papers is essentially different in relation to the corrugated board 925 g/m<sup>2</sup> with built in kraftliner papers which are in any point better than the testliner papers.

- Medium surface mass of the five- layered corrugated board is 925 g/m<sup>2</sup>, and of the five-layered corrugated board is 685 gr/m<sup>2</sup>. The difference is 25,55 % .

- The box of A type has smaller surface of the box blank for 12,5% than the box blank of the B type box. The consumption of materials is decreased for the same percentage.

- Differences in the surface masses for five-layered materials between 925 g/m<sup>2</sup> and 685 g/m<sup>2</sup> is 25,55%. Differences in the surface masses for five-layered material 925 g/m<sup>2</sup> and for three-layered material 430 g/m<sup>2</sup> is 52,22%. Difference in the surface masses for five-layered 925 g/m<sup>2</sup> and three-layered material 410 g/m<sup>2</sup> is 54,44%.

#### **4. Conclusion**

Based on the mentioned results, it can be concluded that the strength of the transport boxes for fruit and vegetables as well as of all other transport boxes does not depend only on material quality but also on the construction of boxes. In order to give the recommendations to the producers which material they should use in the production and which constructive solution they have to apply to satisfy the strong demands of customers and market, the following things in the production of the corrugated board must be defined:

- a) composition of layers and their quality
- b) construction of boxes and the choice of material for that construction

The following values could be defined in advance:

- strength of boxes to compression
- resistance to free fall
- resistance to dynamic penetration of the surface
- resistance of boxes to humidity
- resistance of boxes to fire
- resistance of boxes to wear

These values could help to everybody (producer, distributor, and tradesman) in the process of distribution of products for which the packagings of corrugated board are used.

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## FIGURES

*Figure 1 Box «holandez» - construction A*

*Figure 2 Constructive solution of the box «holandez» A type, size: 385 x 285 x 130*

*Figure 3 Constructive solution of the box «holandez» B type, size: 385 x 290 x 90 mm*

*Figure 4. Punctometer*

*Figure 5. Triangle pyramid*

*Figure 6. Dynamic puncture*

*Figure 8. Resistance of the corrugated board to dynamic penetration*

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## **RASTER ELEMENTS IN SECURITIES TYPOGRAPHY**

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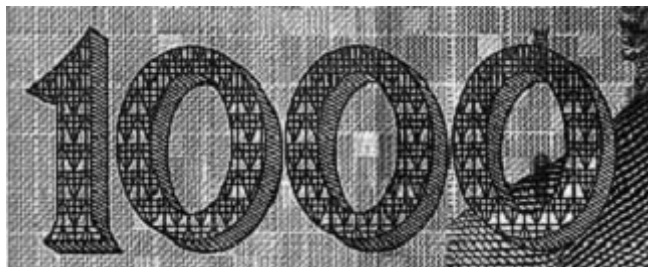
*Keywords: typography, raster elements, protection against counterfeiting*

### **1. Introduction**

By using Postscript (\*1) and the mathematical program Mathematica, various new raster forms (\*2) have been created in the past few years. A line drawing as shown in Figure 1 is the conventional typography rastering in respect to securities. Programming with new rasters allows individualization in such a way that each document has its solution. Such raster forms represent extensive additional protection of the printed matter against counterfeiting. When images are reproduced various types of raster combinations are used. The positioning of raster elements may be generated by a sequence of pseudo-random numbers and in this manner counterfeiting is impossible. This paper shows the results of using various raster forms in typography. Typographic solutions have been created that use individualized raster in a new way, and they me used as a form of protection against counterfeiting.

### **2. Typography In Securities**

Up till now the examples have maintained their uniqueness and individuality in designing of individual typographic designs on securities based on line drawings carried out by hand. Carrying out such designs is very demanding and complex, and also very time consuming. By using raster elements with fully defined and controlled individual forms the time consumption is less by far, and the results are high quality and non-repeatable designs.



**Figure 1. Example of using rasters in typography on 1000 Croatian Kuna banknote**

### 3. New Raster Elements In Typography

The use of various raster element forms in reproduction has been made possible with the development of digital typography. The application of new raster elements (\*3) is possible in many graphic design areas, from advertising to producing important documents that must be in compliance with the standards for securities safety against counterfeiting. Each raster element used in this work has been programmed in advance and may be applied to an image or text, by itself or in combination with other raster types.

In examples shown it has been tested how altering grayness (or color) of the text alters liniatures and the rastering angle. It is possible to combine such raster solutions with different font types. In order to stress individualization and wide possibilities in design, the choice of fonts in the examples has gone in the direction to use handwriting fonts with prominent individual characteristics. In order to use the desired font in the PostScript program, it must be generated as a PostScript font (\*1).

#### 3.1. Experimental examples of using raster elements in typography

The first example shows how a raster element is defined and applied to a text where grayness has been set to 60% of the area dot gain. We have used raster elements under code ‘r2’ (\*3), with liniature of 15 lpi and rastering angle of 0°. With the command ‘setgray’ the relation between the black and white raster element areas has been set in the raster cell. After recalling the handwriting font and determining its size and position, with the command ‘setscreen’ we generate a raster the size of which and direction are set by variables ‘liniature’ and ‘angle’, whereas the form is set with the mathematical formula defined with the name of the said raster and we apply it to a row of letter signs with the command ‘show’. The font used in this case is Helvetica. The result of this program is shown in Figure 2.



Figure 2. Raster element “r2”

In the second example another ‘r24’ raster type is defined

```
/r24 {dup 3 2 roll 3 mul exch sub abs add 2 div 1 exch sub 0.2 mul} def
```

That raster element was applied to a text whose grey level varies from 80% dot area in the first letter and decreases by 10% in each following letter so that the text becomes lighter. At the same time the raster element angle differs in each letter from the previous one by 20°.

```
{pop pop /grey grey 0.1 add def /angle angle 20 add def  
setgray  
angle liniature{r24} bind setscreen} (design)  
kshow
```

The command ‘kshow’ is necessary for displaying this typographical solution allowing the printout of various raster values for each sign in one string. ‘Bookman’ font was chosen for this example.



**Figure 3. Raster element “r24” with different angles**

The following example shows raster element liniature variation through one string text. We used the raster form under code ‘r14’ (\*3) on the ‘Chancery’ font text.

```
/r14 {dup 2 index 3 exp sub abs sqrt 3 1 roll 3 exp add abs sqrt exch sub
abs 1 exch sub} def
```

The initial liniature is set at 15 lpi and is less by two lines after each letter sign. In the final execution this results in the raster element increase. Liniature altering is defined by variable ‘liniature’, and the program design is the same in the previous example when the variable ‘angle’ was altered.



**Figure 4. Raster element “r14” with different liniatures on each letter**

All the effects from the previous examples have been applied in the fourth example and we have also added to the text gradual transition of colors from green to yellow. With the raster elements there is simultaneous liniature gain and angle expansion. The initial liniature is set at 5 lpi, and it is a 2 lpi gain for each letter, whereas the angle grows from the initial 0° to 15°.

In the cyan channel the text color changes by 80% for the first sign and in every following one it decreases by 10%. The magenta channel is set at 50% dot area, and the yellow one at 90%. After defining color, the raster element is set with an altering liniature and angle, and the raster form defined under code ‘r16’ (\*3). The raster solution was applied on an individual handwriting font.

```
/r16 {dup 2 index 3 exp abs sub abs sqrt 3 1 roll 3 exp abs add abs sqrt
exch sub abs 1 exch sub} bind def
angle liniature {r16} bind setscreen font
{pop pop /color color 0.1 sub def
/liniature liniature 2 add def
/angle angle 15 add def
liniature angle {r16} bind setscreen} (gf1234) kshow
```



**Figure 5. Raster element “r16” with differing liniature and angle**

The last example shows text and digit execution with various fonts and raster forms. The text is carried out with one of the handwriting fonts from our base, and the raster element ‘r24’ is used. Liniature and angle are defined by 13 lpi and 0° values. Each digit has a separate raster form and all are in the ‘Helvetica’ font. Digit ‘1’ is written with raster element ‘r14’, liniature 15 lpi and angle of 30°. Digit ‘2’ is with a ‘r16’ raster, and liniature and angle are 10 lpi and 45°. Digit ‘3’ uses raster ‘r2’ and liniature 5 lpi and angle 70°. Digit ‘4’ is carried out with a raster of ‘r14’, liniature of 8 lpi and a 120° angle.

All of this data has been listed on purpose in order to point out to the wide range of possibilities for carrying out various solutions. It is stressed that the possibility of repeating and carrying out such solutions is almost impossible. A solution can be repeated only by the person knowing the digital data values. Generating data as parameters of a congruent pseudo-random sequence introduces this subject into individualized solutions with a high security level.



**Figure 6. Different raster elements on each letter, with variation in liniature and angle**

The examples carried out in this work could find their use in various areas of design and graphics, such as lottery tickets, event tickets, and all printed matter with numeration that needs to be protected. The use of various raster elements, change of their liniature and angle, as well as using individual fonts could make counterfeiting such graphic designs more difficult. Additional protection would be to set a separate raster form for each letter sign as well, in the manner suggested in the following example.

#### **4. Conclusion**

Up till now the question of raster elements in the graphic design area was avoided as their generating belonged to the printing sphere and the technical abilities of machines. By developing digital printing techniques, possibilities have been opened for designing the very raster elements and their individualization. There are no estimates of dot gains for these rasters, so they should be used with caution and high liniatures should be avoided. Such raster elements may become the integral parts of designer ideas and creative designs, and at the same time they protect the work’s authorship or a document from attempts to be forged. We have shown possible application of various raster forms in examples of typographical design. Algorithms have been given that may be used for extensive investigation and application of some new future raster elements. Easy definition and the possibility of changing all parameters determining one raster element introduces a new step in graphic designing and represents a new area of indefinite possibilities for designers, and this should not be neglected.

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## SECURITY PAPER THICKNESS AS AN ELEMENT OF PROTECTION AGAINST COUNTERFEITING

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*Keywords: roughness, paper thickness, transparency*

### 1. Introduction

Money, cheques and other securities are most often the targets of counterfeiting. That is the reason why they contain the most modern graphic protection against counterfeiting. Protection elements are not only various techniques of printing with various toners, water stamps and holograms, but also the very paper from which securities are produced. When banknotes are produced, various protection elements are designed in order to prevent counterfeiting. The more numerous and newly designed protection elements there are on a banknote, the less chance there is for producing a competitive counterfeit. When there is a greater number of various types of protection, counterfeiting becomes more expensive, and therefore it lessens counterfeiting attempts. The most frequent and the most noticeable types of protection are: the water stamp, various types of printed matter visible or invisible to the bare eyes, holograms. One of the ways how to protect securities is uneven paper thickness on the overall securities area. This paper shows the results of investigating paper roughness and uneven thickness that have been produced on purpose in order to protect securities against counterfeiting. Estimates are given and recommendations for planning paper choice for this specific graphics production area.

Today it is considered that intaglio printing, although some hundred years in use is still the safest way of printing for securities. It is a combination of intaglio and «pregen» impressed printing carried out with steel printing forms. Most often it is printing where only one side has a coat of toner and on the other side of the print there is a relief niche.

Some of the professional digital printing units (Xeikon) may imitate recommended protection appearance that was possible to carry out only with controlled printing techniques (intaglio). This is why digital printing occurs in an area where there are graphic products that need to be protected. A print is characteristic because it is not possible to program a large quantity of toner to be applied, it is of relief form and not harmed by rubbing. It may be checked by touch and so it is used for hand-checking securities, as well as in places enabling people with poor sight to recognize graphic parts that have been actually designed for them.

With digital dry toner printing where there is possibility of controlled toner coating and programming of such a graphic product, as well as making a toner stack, it is possible to achieve print relief properties. A graphic product is designed, programmed and relief quality is achieved in a controlled manner. Most often it is linear graphics used for the design, or small plane elements (smaller than the forefinger area), for instance signs for the poor sighted.

The toner is baked and so it is scratch and peel resistant. The print may be recognized by touching it, in the same way as intaglio. There is tactile determining of lines, forms and the relief feeling. This is an excellent type of design, printing and protection because it is easy for the user to recognize the original, and it is not necessary to have additional measuring instruments. A text is ideal for the tactile effect because letter signs consist of thin parts and blank spaces with constant interchanging. A text

in bold form having an exceptionally thick coating provides the possibility to carry out typography recognized on touch. The same is recommended also for rough raster elements with low liniaiture that are easily recognizable and have a tactile quality. It is possible to have a precise register relief quality on both sides.

Besides the various printing elements in the process of producing securities, paper itself plays a big role in respect to protection. When production is planned it is also necessary to plan the composition of the paper on which the future piece of security will be produced on and to plan paper thickness in respect to the printing that is a step in the further production process. The paper composition comprises qualities such as paper fiber and additional loadings and glues, as well as additional components that determine the paper color. As a measure of protection, thin threads are incorporated into the paper during production that becomes visible under UV light. The thread length, width and color are planned, whereas their layout on the surface is random. During production a metal protection thread is also incorporated. This is especially frequent in banknotes. There is also a text on the metal thread and it is well noticeable in daylight.

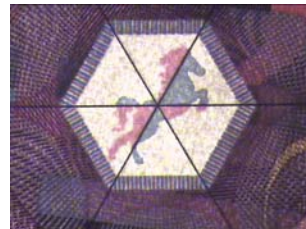
When producing securities the paper under the water stamp remains thinner while still in production, and it is also more transparent so that the water stamp is more noticeable. The paper remains the thinnest in places planned for the «see-through». This is the print on both sides where the printed image becomes whole and clear only when the security is observed against a source of light. Paper roughness on banknotes becomes more prominent by using various printing techniques, especially screen printing and intaglio that require a thicker coat of toner. Securities designed for the blind must have marks that are recognizable to the touch. This is obtained by increasing the paper roughness.

## 2. Experimental part

In the experimental part several different types of securities were researched in order to compare the measured paper surface thickness and roughness values. Thickness was measured on several different spots on the securities and the obtained values are given in micrometers.



Sample No.1 Detail on 200 Croatian Kuna

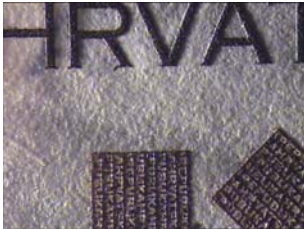


Sample No.2 Detail on 10 Hong Kong dollars

Sample No.1 shows a detail on a 200 Croatian Kuna banknote. The capital letter H is shown and it is made up of tiny triangles. The letter becomes clear only when it is seen through the banknote against a source of light. Half of the tiny triangle is printed on the banknote front and half on the back side. It is done by echo/duplex printing carried out in one passage on both sides. It is also one of the protections against counterfeiting because the register is good only in the case of simultaneous duplex printing and the triangles complement each other in full by creating the image. When there is a case of counterfeiting, the printer is unable to print on both sides simultaneously, and the image that appears when the banknote is held against the light is not the correct one. The register is shifted and the tiny triangles do not complement each other and there is either overlapping between them or there are gaps. The see-through method is one of the easiest and fastest methods for checking to see whether a banknote is authentic. The measured paper thickness at this spot on the sample is 8 micrometers. It is also the thinnest banknote part because paper thickness is 9.5 micrometers. For comparison reasons we are mentioning also the measured thickness of the metal thread incorporated into the paper. At that spot the paper thickness is 12 micrometers. The detail was taken with a scanner that has the possibility

to scan and illuminate with a diagonal light. This means that the light does not fall vertically on the sample but at a certain angle. This kind of scanning allows paper roughness to be shown. This detail does not have any relief so the roughness is very slight. It is not possible to feel the relief by touching the surface with fingers.

Sample No. 2 shows the see-through with a banknote of 10 Hong Kong Dollars. On each side three image parts are printed. By looking through the banknote against the light, image parts printed on the front and back banknote sides join and the complete image of a horse appears. The paper thickness is 9.5 micrometers. It is the thinnest banknote part. There is neither relief nor roughness.



**Sample No.3 Paper roughness on 200 Croatian Kuna**



**Sample No.4 Relief coating and paper roughness on 10 Hong Kong dollars**

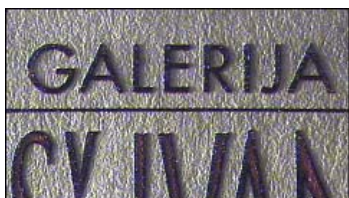
Paper roughness is very prominent in sample No. 3 – also a 200 Croatian Kuna banknote. The relief has been scanned under a diagonal light so that it is very noticeable. The greater is the shadow next to the printed text – the greater is the roughness. The paper thickness measured in this spot amounts to 10 micrometers. Part of the text where two colors are mixed in iris printing and where the letters turn from brown to green there is very prominent roughness. The banknote part is also shown that represents the mark for blind persons and it must be made in such a way as to be very easily and well noticeable if touched. Inside the mark for the blind a micro text is printed that adds to relief enhancement. Sample No. 4 shows a 10 Hong Kong dollar banknote detail of digit 10 printed with a thick coat of toner and in this part the banknote is very rough. The measured paper thickness amounts to 10 micrometers, whereas the paper thickness without print is 8 micrometers. These very prominent securities parts that can be felt when touched are also additional protection against counterfeiting. It is a banknote part that can be easily checked without additional instruments - by touching only.



**Sample No.5 Water stamp on 10 Hong Kong dollars**

Sample No. 5 shows a water stamp for securities. The water stamp is planned and made during the paper production process. On the spot where the water stamp is positioned the paper mass becomes thinner under the matrix pressure and the water stamp shape is formed. In our example it is an orchid. The paper thickness is 9 microns and at the flower petal edges it is 11 microns. Although there is a difference in the paper thickness, the water stamp is not very noticeable when touched because it

does not have sharp edges as is the case with relief printing where the transition from the printed and unprinted part is very clearly evident.



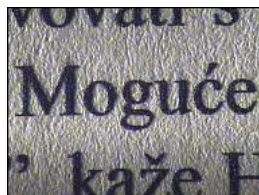
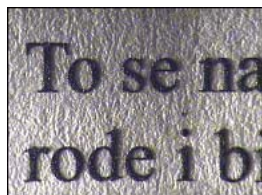
**Sample No. 6 The relief toner coating in digital printing**

The relief digital print, sign 'Galerija'

The tactile quality of digital printing provides a greater impression of relief quality in small letters 'GALERIJA'. The sign's design is made with an outline and with an incorporated reddish color so it has an exceptional relief quality.

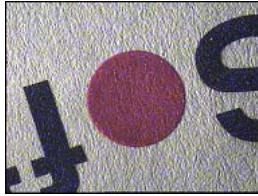
Diagonal scanning allows toner relief recognition, its coating and the basis roughness. On basis of the shadow due to diagonal programmed scanning, the toner stack height may be measured, and this allows checking the securities authenticity with the help of instruments.

The print may be repeated under the same printing conditions, and this is useful for proving a document's authenticity. Planning a high toner coating must be noted with a note in the project stating that the toner is not transparent. This is why that technique is used in multi-color printing (CMYK rastering), but with a high level of caution. Most of all it is used in outline graphics as a basis for other information. The high level of toner coating in color reproduction gives the feeling of 'richness' that can not be obtained by inkjet printing or offset. Such printing excludes GCR procedures for those colors that need to be accentuated on purpose.



**Sample No. 7 The relief print of «smooth text» by using digital printing**

The text on the colorless basis is of relief quality enhancing contrast, and thereby readability too. Such procedures are desirable in designing security graphics micro texts. Controlled roughness and tactile quality can not be imitated by photo static copy machines or conventional printing techniques, so nowadays it is this relief technology that is accentuated in designing documents with specialized digital printing. The letters in the picture have the size of 10 points; they have been taken from a catalogue representing works of art. The highest quality art illustration catalogues promote going away from GCR and getting closer to UCA separation. The advantage of such toner coating has been determined on basis of surveys. The question was posed whether the difference can be noticed in comparison with other prints. Positive answers were obtained along with the obtained information that "there is a difference". It is the very big layer type toner coating that directly resembles artistic oil on canvas structure, the rough paper with the drawing.



### Sample No. 8 Digital bossed printing in black and red

The red color has been carried out with magenta (100%) and yellow (100%) so a double relief was achieved. Planning tactile quality with two colors provides greater relief quality and is carried out with digital printing. Experiments with altered color combinations in the sequence of letters in the word CM, Y, KY, CY, K provide not only color tone altering but relief altering as well.

### 3. Conclusion

Digital printing with dry toners is increasing in the securities production area. In the beginning of such application it was connected with individualization based on linking the database and printing process. The most important characteristic for quick checking is some hundred years old and it is tactile sensing; paper structure, transparency, toner coating. Digital printing with dry toners provides tactile quality in duplex printing and it may therefore be applied as top protection and a new way of protection. When securities are checked for authenticity, paper thickness, roughness and transparency are elements that are used for quick checking. Those are elements that do not require any instruments as is the case with UV and IR colors, but may be observed or felt by touch. The planned different paper thickness along the overall securities area during production is an element that can not be produced by counterfeiting in any way.

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## UNDERSTANDING RANDOM NUMBERS THROUGH POSTSCRIPT

T. Koren, N. Stanić and M. Rudolf

### 1. Introduction

During study courses of programming in Postscript, we have been faced with the situation that students of the design department have difficulty in accepting the subject-matter. According to their opinion, the choice of design as the main course of studies eliminates programming and mathematical operations as subjects. It was necessary to find a way to make them be interested in programming and to make the course subjects interesting and fun. On basis of the previously acquired knowledge on Postscript we have found a «common language» based on a row of models, i.e. we have succeeded in linking their designer capabilities and creativity with programming.

### 2. Problem with design and mathematics

After their second year of studies, design students did not have any mathematics. The fourth year of studies, however, does have some subjects like ours – Mathematical graphics – where it is necessary to have basics in mathematics. A lecture on the subject of random numbers is difficult for those who do not wish to include mathematics and programming in their lives, but only designing, creating and creativity. There was no understanding of the subject-matter after lecturing on the stochastic generator for generating random number sequences. Therefore, we have joined this mathematical, but also very creative form of programming with Postscript and have started from the beginning during laboratory exercises.

Using random numbers for graphic elements in order to create an indefinite number of unique graphics had drawn their attention. Fractal graphics are also based on the random number generator by repeating the forms with altered color, transformations, change of size and position. And it was these elements that we used when producing the examples for carrying on study courses. We began by altering one parameter so that students could understand the random number generator. Each example begins by defining one random number. Then we have the definition of the largest number from which the random number with value between 0 and 1 is later obtained. We have used a sequence of variables that acquire different values through the random number generator's repeat loop.

### 3. Examples

In model number 1 we render the circle through the repeat loop, for which the values of the radius, final angle and line thickness are variable. We have determined the color through the RGB system in such a way that the values for red and green are random numbers, whereas the value of blue is constant. The whole process keep repeating 500 times.

### Model 1.

```
10657 srand
/m { 2 31 exp 1 sub } def
/rn { rand m div } def

/y {rn 300 mul 100 add} def
/r {rn 90 mul 40 add} def
/k {rn 360 mul 30 add} def
/d {rn 10 mul} def

500 {200 200 r 0 k arc
k rn 0.1 setrgbcolor
d setlinewidth stroke} repeat
showpage
```



In model number 2 we render 200 lines in such a way that the y coordinate of the start point changes. Both of the values for the final point coordinates are also random numbers. In this example we have defined the color through the HSB system and all the three values are random numbers. Line thickness is also a random number, and inside the loop we have also added shifting along the y axis.

### Model 2.

```
12131 srand
/m { 2 31 exp 1 sub } def
/rn { rand m div } def
/y {rn 300 mul 100 add} def
/r {rn 90 mul 40 add} def
/k {rn 360 mul 30 add} def
/d {rn 10 mul} def
2 2 scale
500 {100 250 moveto
10 y 50 r 100 d curveto
0.5 rn rn setrgbcolor
d setlinewidth
stroke
} repeat
showpage
```



In model number 3 we render curved lines 500 times. The start point of any curve is the same, whereas the other three y coordinate points are random numbers. The color is once again defined through the RGB system, the red color has a constant value, whereas the green and blue values, and the line thickness values are random numbers.

### Model 3.

```
11111111 srand
/m { 2 31 exp 1 sub } def
/rn { rand m div } def

/y {rn 300 mul 100 add} def
/r {rn 90 mul 10 add} def
/k {rn 360 mul 30 add} def
/d {rn 10 mul 9 sub} def
300 350 translate
0.4 0.4 scale
90 rotate
500{
300 y moveto 10 y lineto
r 50 lineto 100 d lineto
closepath
d d rn setrgbcolor
r setlinewidth
stroke
d rotate} repeat
showpage
```

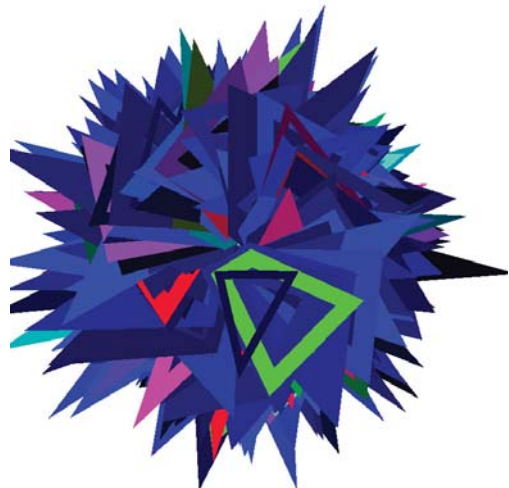


In model number 4 we render a rectangle 500 times. The start point coordinate x value is a random number. Furthermore, y value of the second and fourth points are random numbers as well as the second point x value. Color is defined through the RGB system, and all the three color values are random numbers. The line thickness value and the rotation degree values are also random numbers.

### Model 4.

```
5265791 srand
/m { 2 31 exp 1 sub } def
/rn { rand m div } def
/y {rn 300 mul 100 add} def
/r {rn 90 mul 10 add} def
/k {rn 360 mul} def
/d {rn 10 mul} def

200 {200 k moveto
k d lineto
rn d rn sethsbcolor
d setlinewidth
stroke
0 2 translate} repeat
showpage
```



## 4. Conclusion

The new way of educating and spreading knowledge to students has evoked a great deal of interest and excellent understanding of the random number chapter. Besides learning the subject-matter, it is evident that the design students' creativity has been kindled as well, and following the laboratory exercises they independently made a number of unique graphic works using the knowledge acquired by this type of education. In order to understand the subject-matter, the previous knowledge on Postscript and data stacking on stacks, i.e. memory was useful. But the main thing we have shown by the laboratory exercises and the new approach is actually found in the conclusion to this paper. Any subject-matter that first seems dull and uninteresting to students may be turned into something very interesting and inspiring. Through creativity and independent creative work the initial goal is achieved, to mutual content of both teachers and students who have thus learned much more than they would have through mere theory alone, without real models.

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## PARAMETAR MODIFIED SCREEN ELEMENT “MUTANT R70” IN SECURITY GRAPHIC

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*Abstract:* Individualized graphic products with screen elements have inspired us to carry on with further experiments with stochastic functions in the very definition for creating screen elements. The paper gives images and definitions of individual new screening elements under stochastic function impact. Unreleased screen forms were tested for application in security individualized printing. New forms have been created that alter their basic image as their coverage definition increases. Due to this transformation of form we have named them mutants. Mutating forms have two subdivisions. One is from the conventional set and the other from exponential advancing that appears either in initial dot gain or in extreme coverage values. These forms have a high dot gain in printing, so they are not to be recommended for high screen ruling. Therefore we recommend them for the area visible to the human eye. Such screen systems are applied in jumbo posters and in graphic work with exceptionally strong messages. Due to the fact that these designs are subject to pseudo-random generating where the initiator is known (congruent method seed), they are ideal for individualizing neutral surfaces in documents. The security is based on parameter secrecy of parameters in the congruent generator algorithm and in parameters with which the screen form is distorted.

### 1. Screen form R70 and its definition

The complex stochastically modified screen mutant being the subject of this paper is given in the following mathematic and postscript relations:

$$M70 = 1 - \text{Abs}[Kory * x * y + \text{Abs}[x]]$$

```
/r70 {kory mul 1 index mul exch abs add abs 1 sub} bind def
```

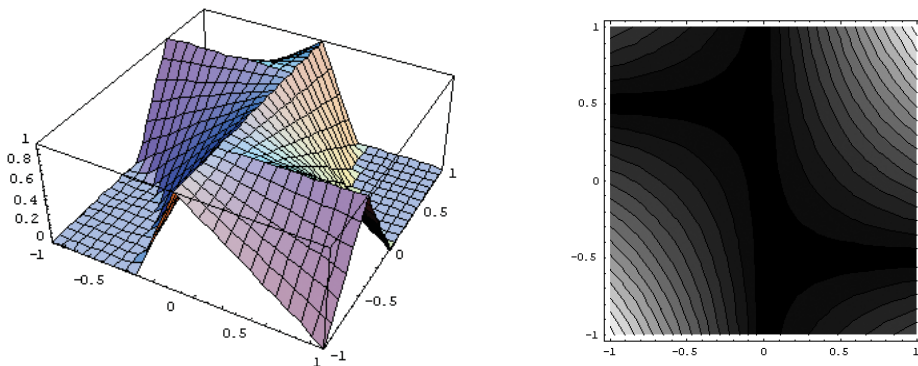


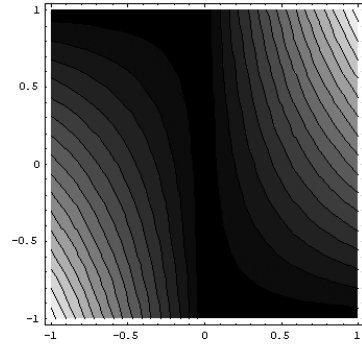
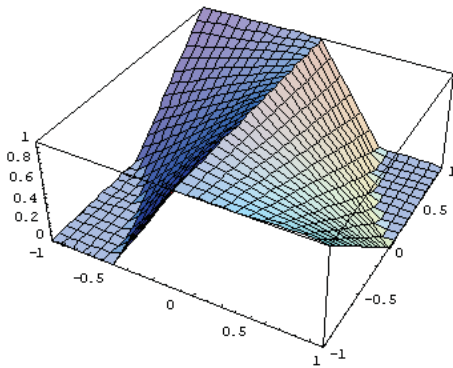
Figure 1. The 2D and 3D form of screen mutant R70 relation

The deformation of this same screen is given with the following relations:

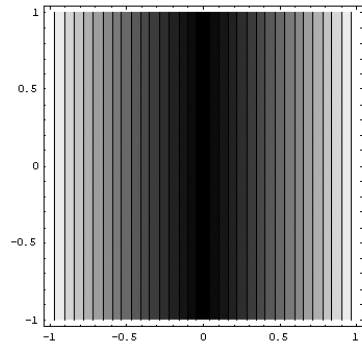
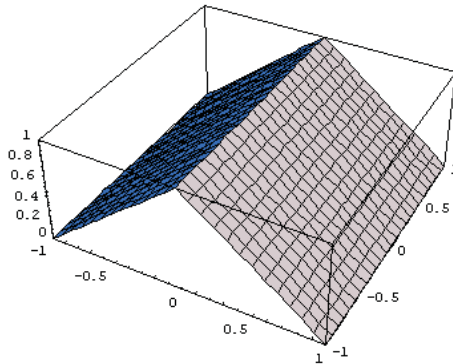
(deformation in range from 0 to 1)

```
/LY {3 15 rn mul add } def %rand number from 3 to 18, yellow channel  
/LC {15 15 rn mul add } def %rand number from 3 to 18, cyan channel  
/LM {15 15 rn mul add } def %rand number from 3 to 18, magenta channel  
/K {0 90 rn mul add } def %rand number from 0 to 90, screen angle  
/LK {45 0 rn mul add } def % black channel screen ruling at 45
```

The 'dxe' parameter introduced here is recalled through the continuous function with values from 1 to 10 in the execution program. The software solution has been made with functions that include the transformation model that can be generated either continuously or stochastically. The screen has been tested in detail as to all changes, the definition area, so as not to stop image processing in some borderline case. Development description and form altering is described in Figure 2.



Value of dxk =0.5

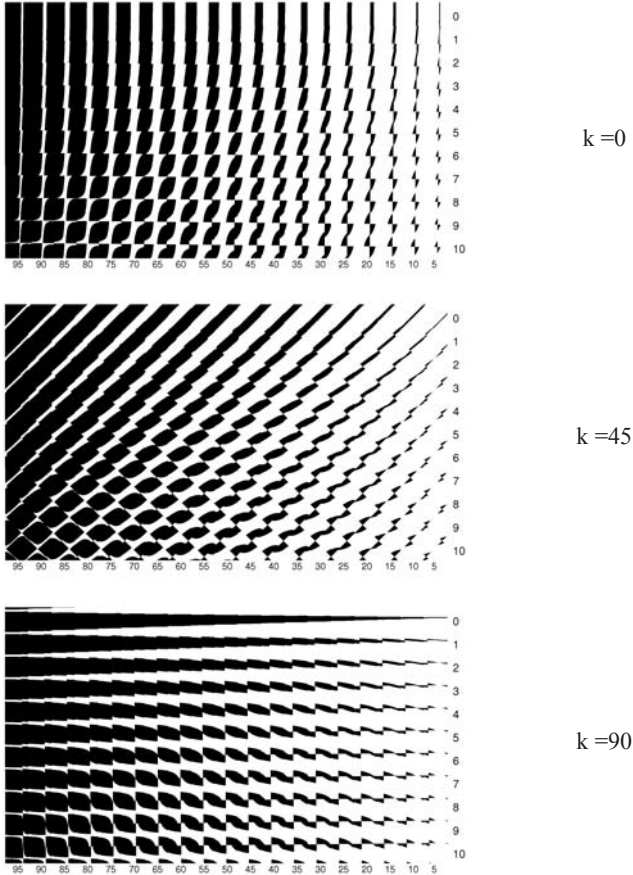


Value of dxk=0

Figure 2. 2D and 3D definition area for screen mutant M70

Low screen ruling are analyzed by print scanning. Some print scanning has been done with 900 tpi so as to study the dot gain in the environment of individual RE. The stochastic part of the discussion refers to application of an amplitude coverage model of each pixel separately. This applies to color printing as well where it is the usual procedure to set various angles of screen proceeding. As in this case, a randomly chosen angle is joined with each pixel, there is no limiting in the number of colors: it is possible to mix process and spot inks. Algorithms enable connecting of the color image with the angle and ruling screening alterations. We extend our research work with new RE R70. Testing on the Xeikon digital printing is carried out with the intention to link the data mass and the congruent generator parameters. The goal is to achieve full individualization of reproduction with the intention of applying in security printing. There is sense in measuring the screen element shell up to the moment when bitmapping is completed. There is spreading of each element's environment after printing, so the real border could not be determined any longer. Care should be taken only in respect to achieving the same coverage level: Before printing and after printing.

**2. Digital print with mutant screen form**



**Figure 3. Mutant screen R70 in continuous and interrupted display**

There are two independent designs of the picture ‘Dubrovnik’ in color interpretation with totally different screen ruling. The same is with the random digit choice at the beginning of the screening procedure. Our intention is to show individualization in application on a known example. Screening in the cyan color is with a 40 lpi ruling whereas there is only a 5 lpi ruling in example Figure 4.



Figure 4. Experimental results with new screening element R70 on picture of “Dubrovnik”

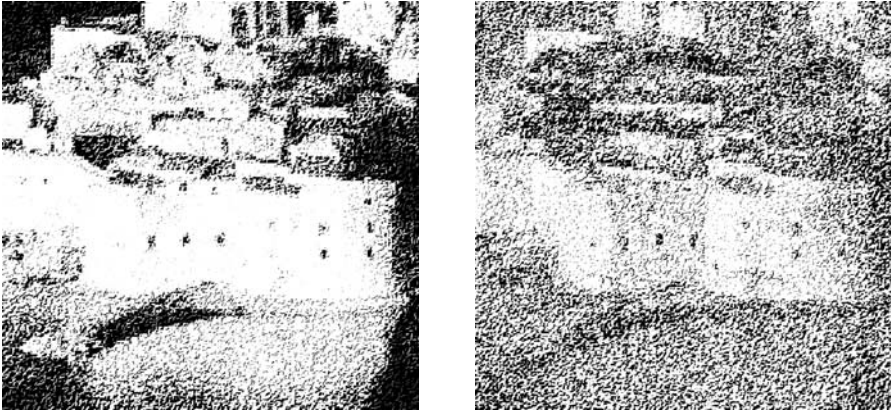
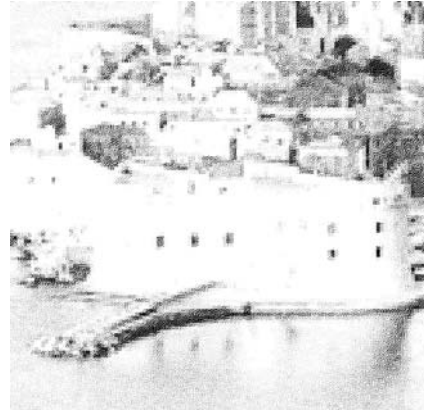
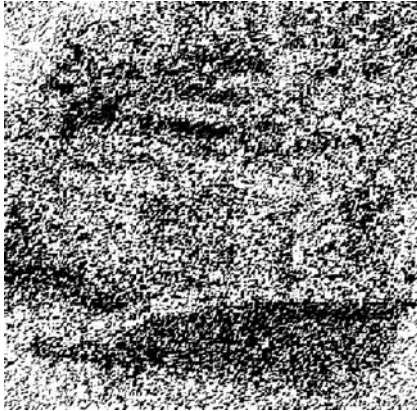


Figure 5a. Cyan and Magenta channel separations of “Dubrovnik” picture with screening element R70



**Figure 5b. Yellow and Black channel separations of “Dubrovnik” picture with screening element R70**

### **3. Conclusion**

Boundary application of the new screen element covers extreme deformation values in horizontal direction. Turning takes place through the execution program where the angle of screening proceeding is the parameter in setting the screen form when making a picture reproduction. The work shows how a conventional ‘modulation amplitude’ can be used in stochastic screening. Stochastics were used in color printing in order to decrease the moire effect. Measurements of good color interpretation with the new screen met the criteria for graphic reproduction. By introducing new screen forms we are proposing new protection standards in highly secure and primarily individualized security documents that are produced by all types of printing. They are especially suitable in digital printing where a database can be used from which initiators of pseudo-random sequences are taken from. The source of information was also used as a congruent algorithm multiplier parameter. Two independent solutions are shown from the same picture source. The rough screen line enables visual fixing of boundaries between the two solutions.

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## PSEUDO COLOR IN INFRARED DESIGN

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*Keywords: Infrared colors, Pseudocolor, Design securities, Digital print, Individualization*

### 1. Introduction:

This paper is an introduction into revealing new infrared design and security procedures. The article describes designing methods and procedures in a wider range of wavelengths up to the infrared ones. Designers usually pay more attention to the graphics they see in daylight. Knowledge in respect to the IR is a new printing area. Programmed designing is thus opened, aimed designing and graphic product coded protection.

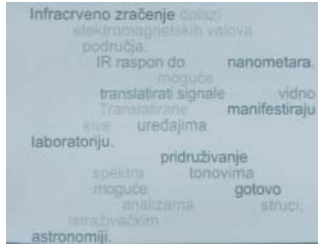
Experiments have been carried out with the goal to improve contemporary procedures of designing security graphics with standard colors for visibility in the IR area. The method for analyzing multi-layer quality of parameters describe the response in specific light wavelengths from 400 to 1000 nm. We are making efforts to extend the infrared effect idea in the printing business with application in graphic product protection. We can reveal it by scanning it under wave lengths that are in a much broader scale than those that we see in broad daylight. We approach security graphics by using specific characteristics that come out of the possibility of programming for digital printing: a print's individuality, color mixing programming, multi-layer application of toners, controlled ink separation for printing, simultaneous printing on both sheet sides;t. This may be applied for design effects and in proving the authenticity of a print, paper and color.

All examples have been carried out in our laboratory and the whole article has been printed with designed IR effects. We are letting the reader find them and to advise us about what he has discovered. In this manner we are trying to trigger off the interest for IR application. We will offer new examples from our security graphics base to successfull researchers.

### 2. Infrared and Pseudo color

Infrared radiation comes directly above electromagnetic waves of the area visible to our eye. The range of up to 1000 nanometers is used in graphic application. It is possible to detect this radiation with instruments and translate the signals into our range of visibility. On our laboratory equipment the translated images are manifested as gray. Pseudo color is applied to this; joining of the colored visible specter to gray tones. It is possible to see such application in almost all industrial analysis, in all fields, in all research laboratories. These possibilities are used mostly in security programs: printing of securities, documents, automatic readers, information hiding, and design of packaging material with IR effect. There is application in text detecting as well. Various inks have different presence of matter that responds under IR light.

Infracrveno zračenje dolazi iznad elektromagnetskih valova našeg vidnog područja. U grafičkoj primjeni koristi se IR raspon do 1000 nanometara. Instrumentalno je moguće detektirati to zračenje i translirati signale u naše vidno područje. Translatirane slike manifestiraju se kao sive na uređajima u našem laboratoriju. Na tu pojavu se primjenjuje pseudokoloriranje, pridruživanje obojenog vidljivog spektra sivim tonovima. Te primjene moguće je susresti u gotovo svim industrijskim analizama u svakoj struci, u svim istraživačkim laboratorijima i astronomiji.



**Original**

**Infrared 1000 nm**

**Pseudo color**

Such characteristics are applied in proving authenticity of the originals: graphics, signature, print type. Various light sources are combined in the graphics when analyzing reproductions. Besides IR there are slanting lights, UV sources and transparent lighting. In simultaneous scanning such combinations make it possible to carry out complex research on graphic product structure.

### 3. InfraRed Control

Process colors behave differently in the IR area. Offset inks, inkjet inks, digital printing toners have their own visibility characteristics in the transient area of the visible and soft IR area (visible towards IR 560 nm to 700 nm) and in the wavelength area above 700 nm to 1000 nm. We use the experimentally determined visibility characteristics of some process colors for programmed color mixing with the goal that some image parts would be seen and some image parts not to be seen under IR radiation. CMYK separation depends on our wish: what do we wish to see in the IR area and what is it that we do not wish to see in the IR area. There is a different transformation algorithm from RGB to CMYK applied to each pixel or vector graphics linear element.

The idea of the IR effect may be «dosed» from minimum to maximum values depending on the previously said system of minimum components and toner visibility characteristics in soft IR borderline areas.

A software tool using two images has been developed. The first is the one visible in the human eye wavelength visibility and the second image is the one that is seen only in the IR area. The double separation method called InfraRed Control extends the application of security individualization with digital printing. Each graphic element may be controlled as a target that is seen only under an IR scanner. It is also possible to program the appearance of graphic elements for the set IR light wavelength. The visible area (380 - 700 nm) uses the whole coloring specter so that the original image may be multi-color in full. The sample or mask that determines the visibility area in the IR area may be generated as an algorithm carried out with stochastic functions.



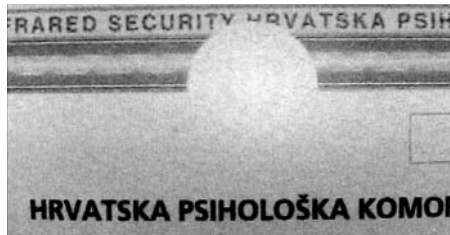
The IR area individualization is carried out with a generated mask when printing is being carried on, depending on the task for the relation between the visible area / IR area

**Example: Croatian psychological association license**

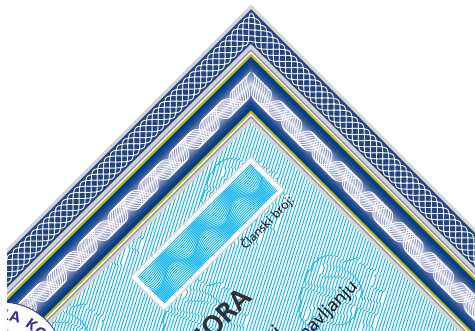
**01 Daylight**



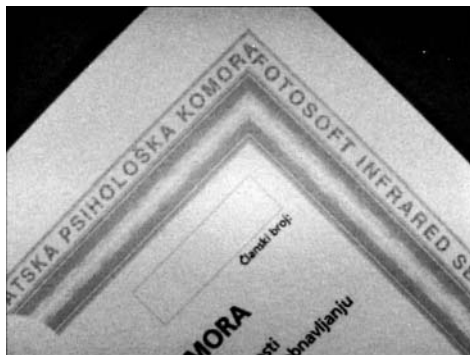
**01 IR**



**02 Daylight**



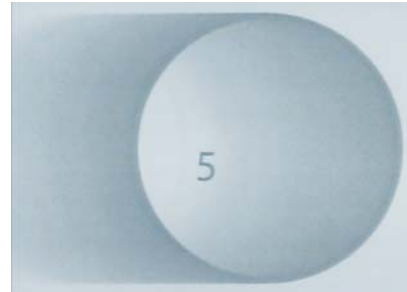
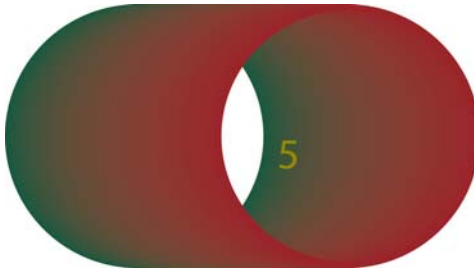
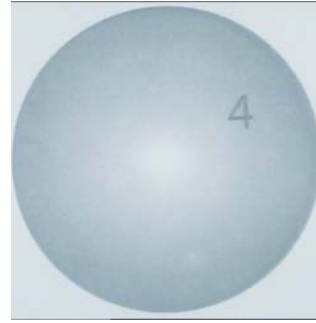
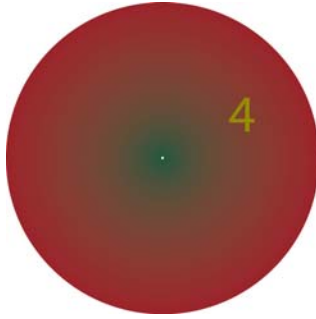
**02 IR**



**4. Infrared continuous tone**

The richness of IR control is demonstrated with continuous transition from red to blue. Several patterns have been carried out defined as 1, 2, 4, and 5. All the prints are the same in daylight on samples 1 and 2. The IR component is different. In sample no. 1 the IR effect becomes more prominent starting from the position of red towards blue. In sample no. 2 the IR effect diminishes from the beginning of red towards blue. These altered designs do not affect the graphics when observed in daylight. It is thereby shown that it is possible for the IR effect to appear independently in respect to the designed colors we observe with the naked eye. The power of protection is in the knowledge that there is no fixed recipe of forming colors with the intention of using IR security characteristics.

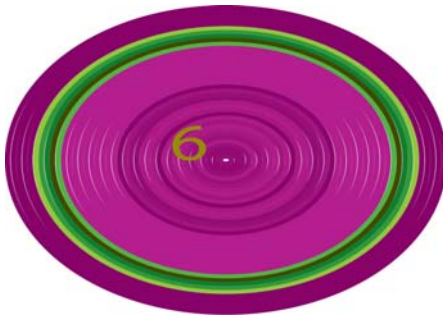




**Daylight**

**IR 1000 nm**

### 5. Infrared elliptical circles



**Daylight**

**Infrared**

Alternating of concentric ellipse coloring is planned with different IR response intensity. Picture IR shows several different levels of intensity. The IR effect is different for each ring and does not depend on the color highlight intensity. Multiple applications of different color tones in the same print will prevent counterfeiting to a significant extent. Those who would enter into such business would need to have instruments of exceptional quality for IR graphics and overall knowledge as to the internal color structure in the original print.

## 5. Conclusion

Infrared design we use for top-quality security graphics, as for instance in documents and securities, but also in commercial graphic design for brand security, packaging, infrared color barcodes, in order to have exclusive design. It is shown that by programming the graphic element structure a better quality protection can be achieved by using conventional inks with infrared design if one knows more about their structures and programming. There is preliminary analysis of each ink and its behavior in the invisible spectrum part. Secure information is recognized with the help of instruments in the set wavelength range from 400 to 10000 nm. The procedures for finding counterfeits have been set thereby, the document's life estimate and the original's physical state. After copying or scanning Infrared material the Infrared information disappears. Hidden information is revealed, lost and destroyed by some of the conventional methods.

Researching infrared design is a motivation for expanding knowledge linked with the printing business. Printing becomes more interesting if there is hidden information in printed matter that opens new areas of research and visual communication. Application is planned in designing future graphic products into which secret information is incorporated and it is being carried out by experts with special knowledge on print, color and paper structure. The area is becoming the privilege of designers experts committed to the research of the profundity and special qualities of graphics technology.

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