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THE EVOLUTION AND REVOLUTION OF SCREENING TECHNOLOGY: A REVIEW

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ABSTRACT

Screening technology makes acquainted with the numerous aspects of transforming continuous tone image into printable dots. This technology proved to be a boon for printers not only it decides the gravity of tiny small dots on the image carrier but also none of the printing principle permits to print continuous tone. Converting continuous tone image to halftone image is the primordial aspect while preparation of image carrier. Technology with time has witnessed many remarkable transformations in screening methodologies since 1850 when W. F. Talbot introduced the concept of halftone printing. This is a review paper which is intended to explicate the various dimensions of screening technology with its evolution in past and revolution in this modern era as printers are consistently looking for betterment of quality.

Keywords: *Screening, Amplitude Modulation, Frequency Modulation, XM Screening, Digital Screening, Rosette.*

I. INTRODUCTION

The efficiency of every printing technique is ensured by each and every printed tiny dot on to the substrate which is delivered by its image carrier. It is only the combination of all numerous tiny dots that creates illusion of continuous tone photograph while printing. Therefore halftone screening is inevitable fundamental of all printing principles as it is impossible to print continuous tone. This process of converting (creating) continuous tone image into halftone during prepress while ripping is known as screening.

II. SCREENING TECHNOLOGY: THE EVOLUTION

The journey started in 1850 when William Henry Fox Talbot developed the idea of halftone printing and acquired a patent of mesh screen in 1852. Talbot, Meisenbach, Frederic Ives and Max Levy were major contributors for the development of halftone printing process. In 1882, Meisenbach laid the foundation for screening by structured grid based on breaking up an image. Grids consisting evenly distributed lines/grid structure were in the form of glass screen. In 1877 an attempt was made to print to print newspaper with halftone plates. In 1885 F. Ives used cross-line screen and in 1893 M. Levy manufactured commercial cross line screen. Afterwards around 1940 contact screen came into existence and still popular for reproduction and half toning work. Digital half toning is in vogue from 1970 due to technological upgradation in most of the industrial segments. Two methods were available for halftone screening which include: -

- AM (Amplitude Modulation) Screening
- FM (Frequency Modulation) Screening

Initially AM or conventional screening was only the option for half toning of continuous tone image. But later on many changes were made as 'Change is the law of Nature'.

AM Screening

AM Screening acronym for Amplitude Modulated Screening, also known as periodic Screening. Individual dots are spaced at the same distance apart but have different diameter. The diameter of the dot depends on the dot shape.

Larger dots are rendered for darker tonal values while smaller dots are used for lighter values, hence the term used are Amplitude Modulated screen or AM screen. It facilitates even and smooths flat tones especially for mid-tone area. The halftone dots in a conventional AM halftone screen are arranged on a grid at some specific angle. When viewed from a distance these dots create the illusion of a continuous tone reproduction. The idea was started in 1850 by William Fox Talbot. He suggested photographic screens to produce photographic image in Gravure Printing Process. And by 1881, the first successful commercial halftone process was patented by Fredric. This technology is still widely used by today's printers. Two types of screens used for halftone image production:

- Glass Screen which is made of glass offering sharp dots during reproduction.
- Contact Screen which is made of film which generates vignette dots.

FM Screening

FM Screening acronym for Frequency Modulated Screening which is known as non-periodic Screening also. Individual dots have same size but are spaced different distances apart. It is also referred to as stochastic screen because a random pattern is followed to arrange very small dots of same size and impossible to predict. To provide dark tone, more dots while for light tone fewer dot are rendered hence called Frequency Modulated screening. The idea of FM (Stochastic) screening was put forwarded in 1965 by Karl Scheuter in Gremany. FM (Stochastic) screening is further evaluated in two generation:-

- 1st Generation Screen: Uneven tones with fixed dot size with variable spacing
- 2nd Generation Screen: Grainy structure with variable dot size with variable spacing.

Type of Screening	Dot Size	Spacing
AM or Periodic	Variable	Fixed
FM or Non-Periodic	Constant (Same)	Random

Summary: AM Screening and FM Screening

III. SCREENING TECHNOLOGY: THE REVOLUTION

Hybrid Modulated Screening (XM): As AM and FM screening have their pros and cons. In order to avail the duo benefit of AM and FM technology, XM i.e. Hybrid Screening is one of the best alternate for achieving high quality and productivity. Hence XM screening uses AM in the mid-tones and FM screens in highlight and shadow areas. It is based on segmentation method. But it uses a patented technology to smoothly transition from one screen to the other. The shadows and highlights may look stochastic. However this is not a true stochastic screening. Smaller dots for highlight and shadow areas are controlled in FM mode which are aligned in continuation of the AM screen angles established in the mid-tones resulting as an entirely new order of screening aptly named XM or cross-modulated screening. Development of Hybrid Screening takes place in three different approaches enlisted as below:

- **First approach** divides images in fine details and flat tones and FM and AM screen are used respectively. Consequently this creates a visible pattern between the different tones and an unpleasant artefact in the rendered image.
- **Second approach** offers AM for the mid-tones and FM screens to the highlights and shadow areas which creates a visible pattern at the intersection of AM and FM areas.
- **Third approach** distributes AM dots using the FM method. This delivers good detail at modest frequencies. But it does not overcome the inherent limitations of FM screening and its grainy appearance in mid-tones and flat tints as well.

Hybrid AM screening is primarily used in flexography printing. Hybrid screening is suitable when high resolution is needed with negative plates especially in photopolymer plate.

Digitally Modulated Screening: Digitally Modulated Screening is the true revolution in the field of printing technology. In order to overcome all the issues related to AM, FM and XM technology of screening, DM screening was developed by Andy Cave. For ensuring detail dots are created and placed exactly where it is needed. In this method of screening each and every pixel is modulated digitally. While screening factors taken into consideration

includes nature of light used, printing plate, press conditions and ink flow to ensure that dot gain is eliminated resulting in the complete removal of patterning artefacts and graininess.

IV. THE STUDY

Convention screening where screen dots are set at a same distance separated from each other offer to deliver even and smooth flat tones particularly in mid-tones. It served the industry enough for a long time however it has poor image fidelity and details particularly in highlights. Also color hues look grainy and noisy in appearance and screen angles causes moire pattern while printing as well. Ultimately AM screen have limited to reproduce fine details in picture. In order to overcome these shortcomings, various printers opted to work with FM i.e. stochastic screen which offered uniform sized dot at random order resulting in better picture quality and details. First generation FM screen experienced with grainy appearance especially in midtones and the dot gain was comparatively high as of AM screens. Consequently Print conditions are needed to be adjusted and printers were confronting trouble in transferring the microdots to plate. Hence many endeavours were made to enhance the FM innovation and printing analysts came up with the solution. Second generation FM was acquainted with defeated the constraint of First generation FM by having exact control on dot positioning. Focusing the end goal to enhance the print quality an endeavour was made to conquer these quality issues by utilizing a blend of AM and FM named Hybrid screening. Hybrid screening innovation offered significant advantages over AM and FM screens. Most prominent screening existing today is Digitally Modulated screening developed by Andy Cave to beat every one of the issues related with AM, FM and XM screening. Digitally Modulated Screens analyse and modulate every pixel that it produces for beautiful print quality. It is the need of hour to provide acceptable quality with least wastage. DM screening enhances print quality, smoothen flat tints and vignettes and improves work detail with remarkable quality to the printer. Hence DM screening has revolutionized the entire print segment and accelerated the prepress functioning to many folds in this modern era.

Research has been carried out in different segments of Printing like Digital, Flexography and Sheet fed printing. During research the number of factors were analysed which includes TVI, Density, Print contrast, Colour Gamut and Dot Gain. The study depicted that:-

Digital Printing Process: The Study was carried out in order to compare results of two screening methods (AM and FM) using dry toner EP commercial digital system- Kodak Nexpress2100. Finding of the study depicted that the visual quality and print reproducing made on the coated wood free paper was very satisfied and compatible to those specified as the highest printing quality. Also printed results were found trustworthy in terms of density, TVI and printed colours. During study it was found that FM screening enables high fidelity, consistent presswork that exhibit fine details. Also it is hardly suitable for high quality, full coloured illustrative printed products and requires precise developments in prepress technologies.

In another study made to compare Quality between AM and FM screening in dry toner electro photographic commercial printing field with digital Kodak NexPress2100 plus system. The comparison of results AM screen of 300 lpi and FM screen of 20 um was applied and concluded that continuous tones and TVI were too closed for all process colors (C,M ,Y) without large deviation. Middle tone values for Cyan and Yellow with AM screen are slightly higher when compared with FM screens, while for the very highlights in Magenta and particularly in Yellow, TVI for FM Screens were above those of AM screen. But for black half tones it is said that with AM screen were obtained a higher value in the whole tonal range except mid tones where a very small (1%) tonal value increase of FM is available. The result of TVI in the highlights up to 30% with AM was visible higher. And results of solid densities are higher for black and yellow in FM screens and for Cyan and Magenta in AM, densities are higher.
On the basis of the whole results it can concluded that FM methods is a better way for reproducing fine details, specific structure as human skin, face and different fabrics. On the other hand AM method is suitable for reproducing slowly varying images tones.

Flexography Printing Process: In Flexography process, a study carried out on hybrid screening. The study was done on 11 different screening combinations by measuring different attributes like Dot gain, TVI, Trapping and Print Contrast on PVC. The research recommended 10-75-15/10-70-20 as optimal hybrid screening combinations

and 10-85-5/15-70-15 as least appropriate for Flexography Process. It is also found that Hybrid screening adds solution to improve image details, smoother gradients and allows highlights to be reproduced more faithfully. Besides this XM screening can be used at available printing system with different printing conditions on different grades of paper. Ripping and screening is the final determining factors to achieve desired result quality.

Dr. Khaled Talaat Youssef investigated the effect of FM-AM hybrid and AM screenings on printing quality of flexography printing particularly in highlights areas and image. The study employs a test form that be generated in two screening techniques, the FM/AM hybrid screening technology (Kodak/ Maxtone) for highlights areas from 1-6% and the halftones areas from 7-99% were employed AM dots. After printing the measurements were evaluated. As result of the investigation, the following conclusions have been drawn:

- Using FM-AM hybrid screening technology adds solutions to improve image detail, smoother gradients and allows highlights to be reproduced more faithfully.
- The problem resulting from FM-AM hybrid screening is high dot gain compared with AM screening.
- It is very important for pre-press operators to try to make combinations between FM dots for highlight areas and shadow areas and AM dots for intermediate areas to define the best combination to get more effective results for printing quality.
- It must specify a minimum dot size that can be printed to avoid the problems during the production.
- XM screening technology accomplishes the task to obtain unhampered high-screen frequencies without detail loss and with no extra problems on press. XM screening enables its users to realize the true benefits and potential of a computer-to-plate workflow.
- The common factor in AM and FM screening is that when hold highlight dots and the deep shadow dots equally well and produce very sharp and detailed images. Not all hybrid screens reduce or eliminate moiré equally well. But with high screen frequency results a definite reduction of moiré in all the tested hybrid screens as well as XM screens.
- Another discovery is that dot gain doesn't need to be a bad thing. One can make good contrast and high densities print with a less ink.
- Especially the FM-type screens have a very stable appearance despite fluctuations during the press run in ink density levels.
- XM screening technology can be used at available printing systems with different printing conditions and different property of paper (newspaper, flexography, sheet fed and web offset). The last mile in prepress i.e. ripping and screening is a determining factor in print quality.

Sheet Fed Printing Process: The research is based on AM and FM screening comparison and claimed that FM screens allows better reproduction, more consistent colour, lower ink consumption and faster ink drying that leads to reduction in cost. And it is difficult to draw conclusion regarding dot gain as both technologies had significant level of higher dot gain. Besides this researchers claimed that FM gamut is larger than AM gamut and subsequently it increases the reproduction of secondary colour such as purple, green, aqua blue and red. FM screening provides uniform and lower ink film thickness on substrate leads to lower ink consumption and contrast.

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