FULL COLOUR GRAPHICAL PAINTING FINISH

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ABSTRACT

The full colour graphical painting finish is an original process that Mitsubishi Electric Corporation has developed. This allows full-colour graphic designs to be created on computer and transferred directly onto the surfaces of the lift landing doors and wall panels by using special inks.

Through the use of this development, a very high level of detail can be achieved with a wide range of colours available and the finish and design reproduction are of the highest quality.

1. INTRODUCTION

Lifts play an important role in a building as vertical transportation. Besides this basic role, however, customers increasingly require the lifts to be compatible with the aesthetics of building interiors; thereby providing continuity for the users. This leads to the demand that the lift should be closely integrated with the architecture of buildings such as offices, hotels, shopping centres and housing developments, and also demands high levels of coordination with the finishes. We, as manufacturers, should meet these increasingly varied demands.

In response to these requirements, we have developed the new technology of full colour painting which allows graphic artwork to be accurately reproduced in full colour and transferred onto steel panels. This new process, called "MEL ART" was launched in Japan last December. Figure 1 shows an actual sample of the landing doors finished using the "MEL ART" system. This paper gives an introduction to the new "MEL ART" system and provides details of the new technology involved in its production.

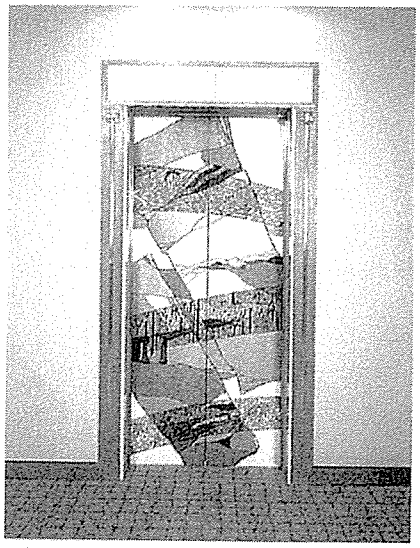

Fig.1 MEL ART 0f landing door
(TOBA SEASIDE HOTEL)

Fig. 1

2. DEVELOPMENT GOALS AND MAIN SPECIFICATIONS

Up to now, only silk screen printing method has been used for many colour patterns coatings.

In the manufacturing method of this silk screen printing, the number of net type plate has to be made in the same number as colour of the pattern and each colour ink is printed to the printing panel.

Figure 2 shows the print (image) source.This method however has the following disadvantages.

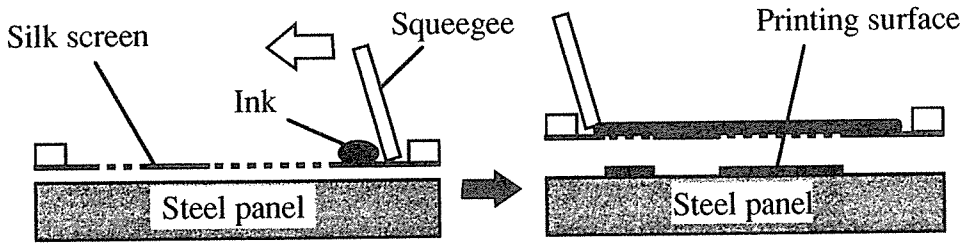

Fig. 2 Principle of Silk Screen Printing

(1) Since a printing plate is needed for each colour, the design colour is limited as well as high cost.
(2) Many man-hours are required when resolving colour and fabricating the printing plate.
(3) The printing surface is limited to flat surfaces since the print plate is flat.

Development of our new paint finishing included the following to solve the above problems.

(1) The new method faithfully reproduces the customer's design in full colour.
(2) The new paint method uses no print plate in order to reduce the cost and the manufacturing period.
(3) The products applicable to this new paint method would include the lift landing doors, car doors and walls of the lift compartment. the colour printing can consecutively be applied to both the front and side surfaces.

The specifications has been established as shown in Table 1, accompanying with this development.

ITEM	SPECIFICATIONS
Image source types	Pictures, hand-paintings, digital data from computer graphics
Paint method	Heat transfer method by electrostatic recording paper
Paint surface size	Width 750 × length 3000mm or less
Base paint	Urethane type
Ink	Sublimable dyes
Resolution	400 dpi
Available colours	260,000

Table 1

3. FEATURES OF THE "MEL ART" PRODUCT & MANUFACTURING PROCESS

The "MEL ART" manufacturing process is shown in Fig. 3.

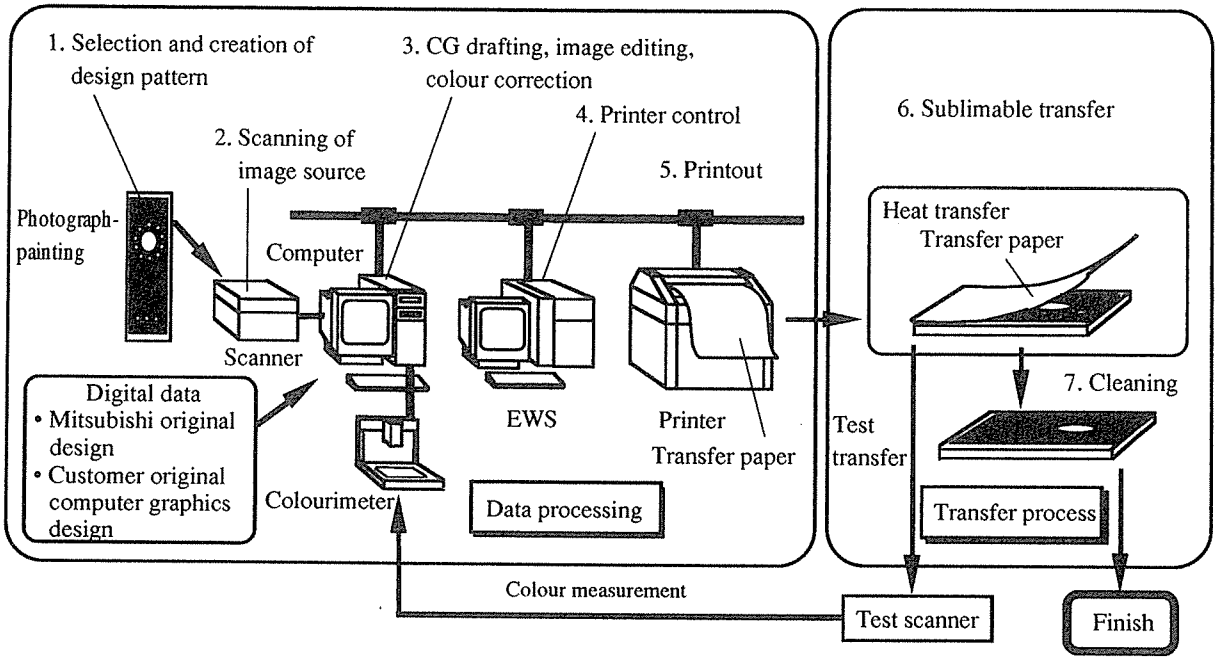

Fig. 3 Production Process

The manufacturing process is broadly categorized as follows.
(1) Data processing --- The source image is transformed into digital data and the ink is printed onto the transfer paper.
(2) Transfer process ---The transfer paper is placed on the painted steel panel and the ink then transferred.
Each manufacturing process is explained next.

3.1 Data Processing

In the data processing stage, the data is produced by utilizing scanner, computer, colourimeter, engineering work station (EWS) and static toner printer.
Process for fabricating the source image
(1) The actual items such as photograph and picture are scanned and processed on digital data making the contrast ,colour and tint etc. The original design created by computer with colour graphics uses that (CG) data as it is.
(2) The source image data is converted into image data in the digital halftoning process and this print image data is sent to the engineering work station (EWS).
(3) The printer control process, the image editing process and the image sizing process are performed at the EWS, and the printout on the transfer paper is made in the electrostatic full-colour printing process by using 4 colour inks containing sublimable dyes.

3.2 Transfer process

The principle of the transfer printing used in this system is shown in Fig. 4.
Process
(1) The transfer paper printed out is placed on the painted steel panel.
(2) The transfer paper is sealed in the furnace and heated.

(3) The transfer paper is removed, the surface cleaned and the high grade design panel then finished.

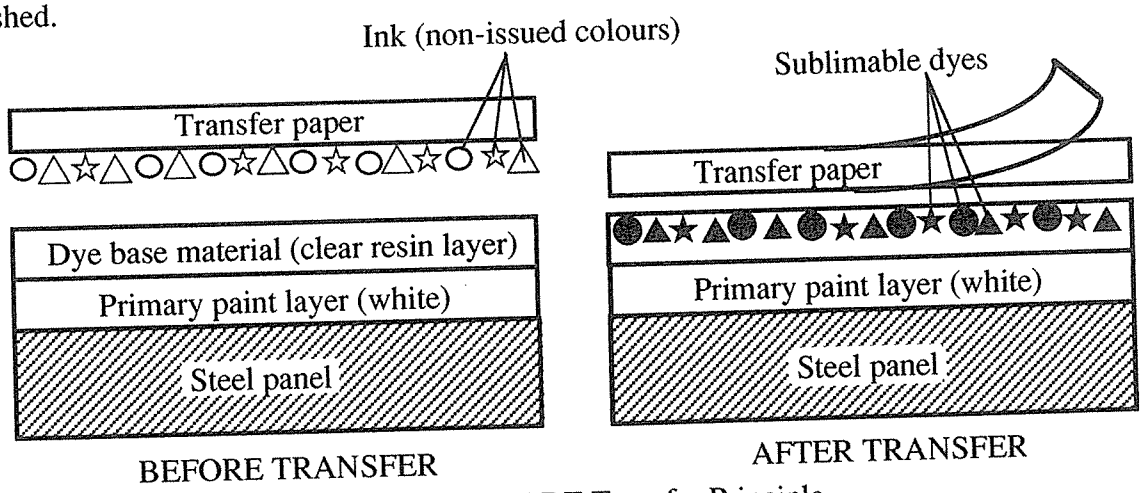

Fig. 4 MEL ART Transfer Principle

4. IMPORTANT POINTS IN "MEL ART"

We encountered the following problems to develop the new painting technology.
(1) Large-image data processing technology
(2) Improved light-resistant ink technology
(3) Stable transfer of the image and dual surface transfer technology
We introduce these three technologies in this chapter.

4.1 Large-image data processing technology

We first introduce the image processing technology for fine printing on the painted panel of the full-colour image designed on the computer.

Figure 5 shows the structure of the image processing system.

The image processing consists of colour matching process and the digital halftoning process. Here, we describe the digital halftoning process.

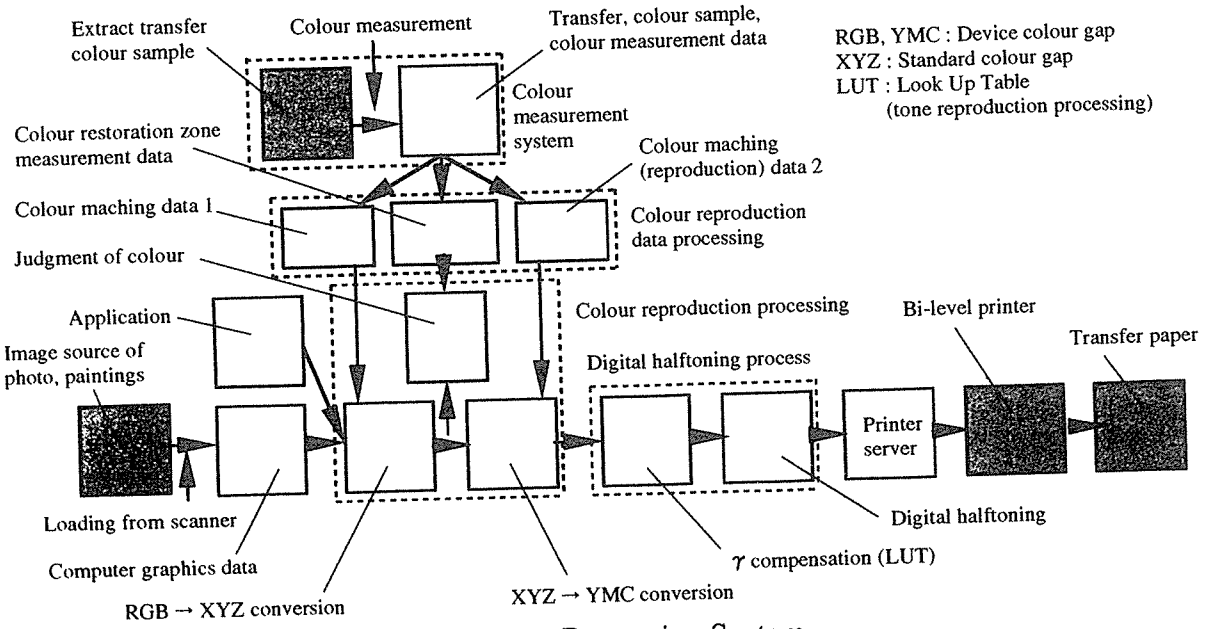

Fig. 5 Image Processing System

4.1.1 Digital halftoning technology

The printer used in this system is an electrostatic bi-level or digital printer. In the digital printer, the colour and the pattern depend by whether ink dots are printed on the paper or not. To show the halftone colour on the bi-level printer, a simulated digital halftone colour must be shown by changing the number of dots and the pattern the dots are printed in. This method for image processing is called digital halftoning and many digital processing methods have been proposed. Our new system utilizes a scanner to load the halftone image such as being taken out photograph or picture and also the graphic image from the picture or the photograph recreated by the computer. This method is referred to as the Error Diffusion Method.

However, the conventional error diffusion method has the following disadvantages.

(1) The line patterns easily occur when showing a uniform and single colour.

(2) The gradation from dark to light colours cannot be smoothly turned out.

The following problems occur in the new colour graphical painting finish method

(1) The ink dots tend to diffuse and to enlarge during sublimation of colours on the painted steel panel.

(2) These enlarged dots overlaps one another, making artifacts and pseudocontours occur.

In order to solve these problems, we have developed the new Error Diffusion Method which has the following functions.

(1) Function to correct the position and the quantity of dots under the condition that the dots get larger. This means that the colour can resemble that of the source image after transfer.

(2) Function to change the dot position according to the hue and halftone levels to prevent artifacts and pseudocontours.

The result of the tone reproduction (contrast) test performed by using this new Error Diffusion Method is shown in Fig. 6. The vertical axis is the luminance(L) and the horizontal axis is the brightness of the colour that was input. Nearly the linearity of tone reproduction (contrast) characteristics was obtained after making digital halftone processing and correcting by parameters from the new Error Diffusion Method.

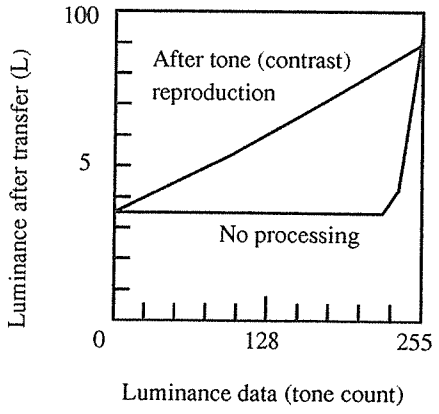

Fig. 6 Tone Reproduction Characteristics

4.2 Improved light-resistance technology

The process in which ink fades under light depends not only on the chemical composition of the ink but also on the external conditions such as the dye status of the ink, the characteristics of the base material , heat, and light, and also is determined by the internal conditions such as the chemical compounds coexisting in the material.

A drop to light-resistance is mainly caused by the oxidation reaction. This is because the auto-oxidation occurs due to the radical chain reaction related to the oxygen, which brings the

ink into discolouration.

This kind of colour fading mechanism and methods to suppress it are shown in Table 2.

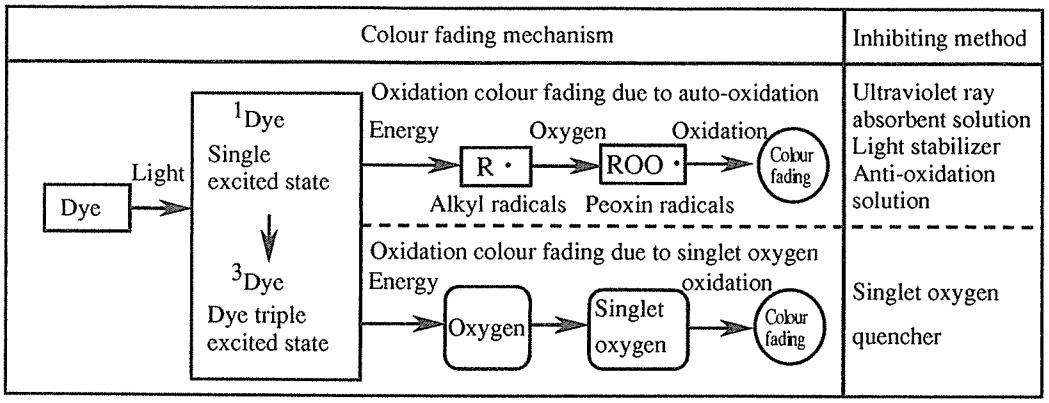

Table 2. Dye Colour Fading Mechanism & its Inhibitor Mechanism.

Based on these colour fading mechanisms we evaluated the use of sublimating dyes to act as colour fading inhibitors.

A urethane base resin which had good ink stability, transferability and good compatibility with the liquid toner was selected as the base resin for transfer of the sublimation dye.
A variety of light/colour fading inhibitors was then added to this resin to obtain a base dye material having good light resistant properties.

A light stabilizer and a light stabilizer which absorbs ultraviolet light were found to be effective in preventing ink oxidation. As a result, a base resin was obtained by mixing these inhibitors in optimal amounts. This base resin we have developed, is remarkably effective because smaller amounts of ultraviolet ray absorber solution were required.

This newly developed base resin was tried out to evaluate the light-resistant qualities of the ink. The results are shown in Fig. 7. A sunshine weather meter was used for measuring the light beam and a colour difference meter was used to measure the colour fading.

As a result, the light-resistance more than three times of conventional inks was obtained and could be applied for use with the product.

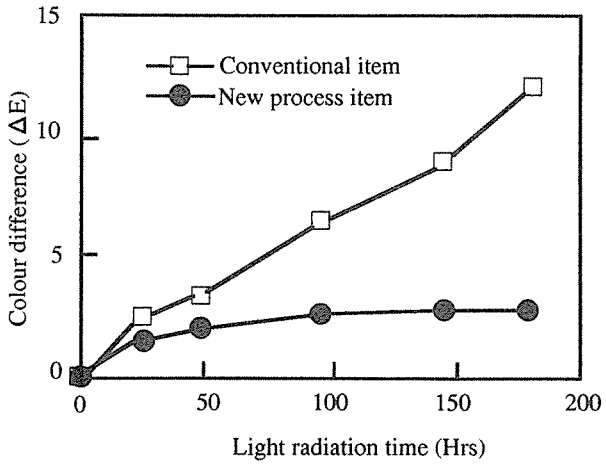

Fig. 7 Effect after adding Photofading Inhibitor

4.3 Transfer technology

As described in the previous paragraph, colours are applied by transferring the ink to the base resin of the pre-coated steel panel through this new paint process. Next we introduce the technology to transfer the transfer paper coloured in the sablimating ink on the steel panel.

4.3.1 Stable transfer of the large-image and dual surface transfer technology

In order to transfer the image to the lift a maximum of 2 square meters of steel panel (front and side) is needed and a stable transfer process must be performed. A custom-made transfer jig was therefore developed to meet these conditions. The principle of this transfer jig is shown in Fig. 8.

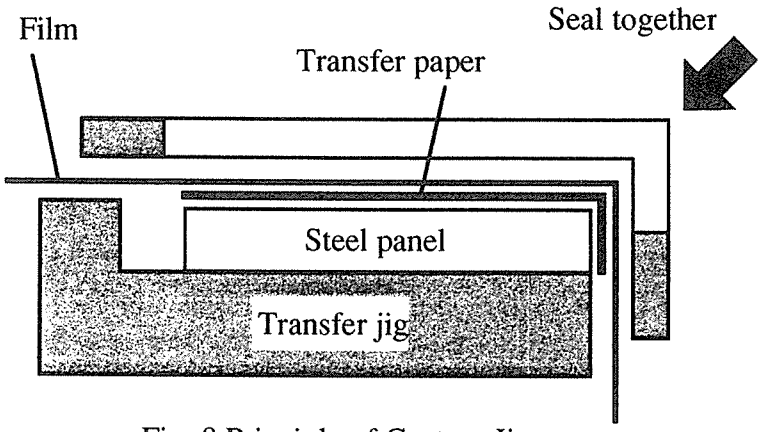

Fig. 8 Principle of Custom Jig

The steel panel and the transfer paper are set in the jig, then sealed and the pressure is applied. If the pressure at this time is too strong, the steel panel will be deformed. Conversely, if the pressure is too weak, the patterns on the front and side surfaces become unclear.The correct clamping pressure was, therefore, sought by experiment.

This transfer jig made a stable transfer,which resulted in producing continuous patterns on the front and side surfaces.

4.3.2 Transfer conditions

The following conditions are essential for the transfer.

Thickness of the clear resin layer as a base resin

Temperature settings for the heating furnace

Heating time

The bi-level printer uses four colour sublimating inks. The time required for them to start to sublimate varies slightly between them. The heating time was therefore set somewhat long to allow the colour to be applied equally.

The thickness of the clear resin layer on the steel panel must be thick enough to allow the ink to penetrate it. Further, if the clear resin layer is thin and the heating time is long, the sublimating ink becomes unclear. This is because the sublimating ink penetrates to the first coating.

Figure 9 shows the results of the interrelation between the thickness of the clear resin layer, the transfer temperature and the concentration of the colour pattern transferred. These results set a fixed thickness for the clear resin layer and the thickness of the ink coating. The correct use of these factors pemits a stable transfer to take place thereby avoiding unclear marking by the sublimating ink and variations in transfer temperature.

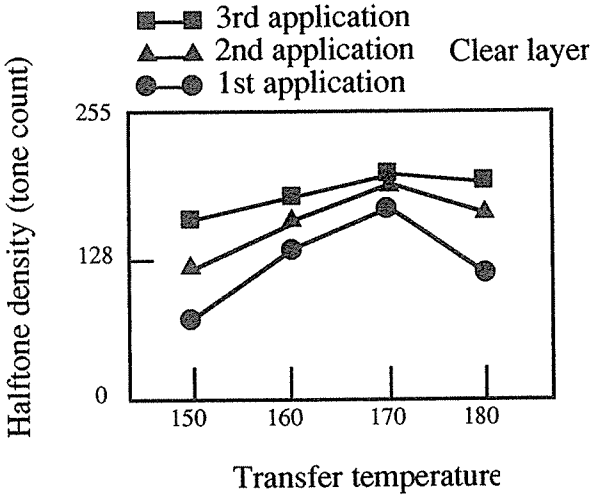

Fig. 9 Transfer Temperature & Colour Concentration

5. SPECIAL FEATURES OF "MEL ART"

This new finishing method has the following advantages. These are explained while comparing with conventional silk screen printing.

(1) Flexible source image.

The source images can all be converted to digital data by computer graphics. Thereby anything such as films, pictures and illustrations can be used as a source image.

(2) Easy and free arrangement.

The source image can be processed and edited by computer so that problems like corrections of image patterns, colour change and compound of images can be solved in a short time.

(3) New quality impression

"MEL ART" allows transparent colour inks to penetrate into the clear resin layer to create the image. This mean makes the colour pattern of great depth, thus providing a sense of high quality which was not previously possible with silk screen printing method. Further when using metallic gold or silver colours in the primary paint layer and mixing with colour inks, it allows the panels to make further high quality finishing.

(4) High quality image and finest accuracy

The printer has 260,000 colours and the resolution of 400 dpi.

6. FUTURE ISSUES

6.1 Acquiring on-line data from customers and branches

If digital data of the source image for "MEL ART" can be obtained at the factory, then a full-colour painting finished product can be produced immediately. It is presently impossible to achieve this using current silk screen printing method. Digital data is currently transferred by means of magnetic optical (MO) disks and hard disks but it would be ideal if this data could be obtained on-line from customers and branches. If this is realized,the information required for production could be obtained directiy and quickly from customers and branches.

6.2 Expansion to applicable range

This new process is currently used on lift landing doors, car doors (inner) and walls of the lift compartment. In the future, we intend to include to the car ceiling. In addition to the lift, the hall walls for the lift entrances, interior panels for general building use and high quality signboards are being considered. Samples for the applications are listed in Table 3.

APPLICATIONS	SAMPLE PRODUCT APPLICATIONS
Building materials	High quality door having steel panel (indoors) – Interior panels for walls Interior ceiling panels – Decorative fire-proof doors Decorative panel surfaces and pillars in lobbies etc.
Signboards	Large and small indoor high class signboards Colour signboards of all types – Large-scale guide panels
Photo-related items	Commemorative photograph panels – Commemorative plates Exhibition hall presentation panels of all types
Shop items	Decorative tables – Decorative pictures Product presentation panels
Gift items	Commemorative shields – Nameplates Commemorative plates Packages such as for decorative storage items Cosmetic products etc.

Table 3 MEL ART Sample Applications to other Products

7. CONCLUSION

We started to develop this new technology on the basis of the idea "Is it impossible to paint a full colour large scale image on steel plate?" because there is currently no other painting process that can accurately transfer larg-scale graphic artwork directly onto steel panel, and succeeded in creating "MEL ART" technology.
This method of combining the conventional manufancturing technology and the latest computer graphics technology has produced a new and existing product.

From now on, there will be a greater demand for a wider variety of designs.To meet the needs of our customers, we will continue to develop "MEL ART"and increase the variety of applications.

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