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*Digital Glazing*  
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of ceramic tiles



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Association of Italian Manufactures of  
Machinery and Equipment for Ceramics



ACIMAC

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# Colour management for Multicolor-type printing systems

Digital decoration is no longer a new concept, but a technology which is now consolidated and in continuous development in the ceramics sector. To provide support to the intrinsic characteristics of a digital printing system, (speed, flexibility, productivity, etc..), various colour management systems have been introduced, each with its own characteristics, specific functions, functioning principles and all other relative elements. However, they all have the same objective, that of managing the colour starting from the preprinting phase, with a view to minimising as much as possible any testing that may be required in order to obtain a specific shade, and optimising and making the most of the

potential of the inks used. With current colour management systems, as the colour cannot be managed in the preprinting phase, it is therefore practically impossible to preview the final colour in the printing phase and after firing. One development in the digital printing for ceramics sector is the ever-increasing tendency to use colour configurations with more than 3 or 4 colours.

The research work performed by ceramic colour producers has enabled new tints to be developed, in addition to those which have already been in use in the sector over the last few years. Blue, Cyan, different shades of Brown and Yellow, Beige, Pink, Green, Magenta, Black and White inks: the

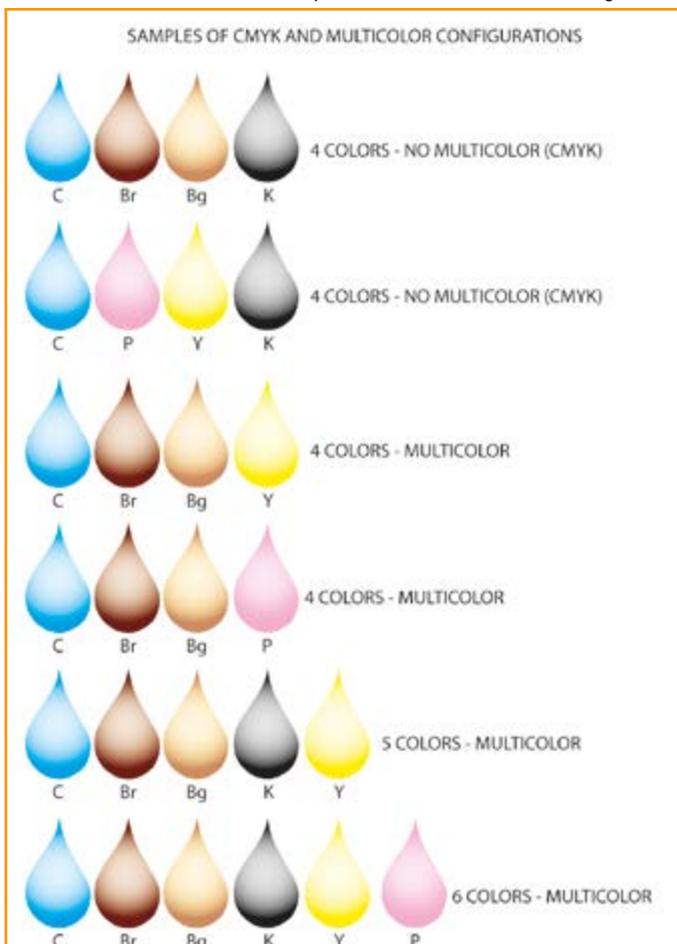
se are the colours present in almost all the catalogues of the various suppliers.

The purpose of extending traditional colour 3-4 colour configurations to the increasingly popular 5-6 colour configurations, is to try and obtain an increasingly wider range of gamuts and therefore extend the possibilities of colour reproduction.

This new trend, like many of the other innovations taking place, brings many benefits; however, at the same time, it introduces a difficult problem that graphic workers in the sector are struggling to overcome, and that is: how to use a Multicolor-type colour configuration and succeed in managing the colour correctly?

## PRIMARY COLOURS AND DEFINITION OF MULTICOLOR

FIG. 1 - Examples of CMYK and Multicolor configurations



First of all, before going into more technical detail, we must understand what is meant by Multicolor printing in general in the printing sector:

Even if, effectively, there are no true rules or standards, usually the term Multicolor is used to refer to printing systems which have additional primary colours to the usual four used, which are: Cyan (C), Magenta (M), Yellow (Y) and Black (K).

But that's not all; a printing system that uses more than three primary colours without using black ink (K) can also be referred to as Multicolor.

When we talk about primary colours, it is useful to remember that there are no pre-defined primary colours.

In theory, but also in practice, primary colours (both in additive and subtractive colour compositions) are those that the individual printer decides to use.

The digital printing sector for ceramics is a clear example of this: in many of the colour configurations used often, primary inks other than CMY are used. Cyan is often replaced with diffe-

rent blues, magenta with shades of brown, and yellow with very warm shades of beige or yellow.

Indeed, as is known, in the graphic arts sector, the three primary colours used are precisely CMY.

The reason behind this choice lies in the fact that, in order to obtain the highest number of colours with three primary colours in subtractive colour mixing (printing), it is ideal if these three colours are in fact CMY.

The use of black ink (K) is obligatory, as in practical terms, the combination CMY is not capable of providing a black colour, but only a dark brown.

This is why it is necessary to also implement K as a support to the triple primary colour combination CMY.

For this reason, a configuration of more than three colours which does not contain black can also be defined as Multicolor; this is true if we refer to current printing and colour management technologies, and work flows, etc..

Some practical examples of Multicolor configurations in the offset printing sector can be provided by printing systems with CMYK + O

(Orange) + G (Green), or we can refer to come inkjet printers, where in some cases we can also have CMYK+O+G+R(Red)+B(Blue), excluding the same primary colours in their "light" version (Light C, Light M, Grey etc..). in this case we can even have printing systems with 12 colours which are more or less different from one another.

Instead, practical examples linked to the ceramics sector can be:

- C Br (Brown) Bg (Beige), K, P(Pink),
- C Br Bg Y P,
- C Br Y P.

In the latter example, we have four colours but no black ink is used.

This factor, the absence of black in a colour configuration, is important as described below, as it is one of the problems linked to the improper management of colour in a Multicolor configuration.

Fig.1, shows some examples of CMYK and Multicolor configurations used in the ceramics sector:

**CURRENT COLOUR MANAGEMENT METHODS FOR MULTICOLOR-TYPE PRINTERS**

In inkjet digital printing in ceramics, with a 4-colour configuration including black, there are various colour management solutions, based on standard ICC, that can be used to create a colour profile.

These are solutions essentially derived from the paper printing sector, which can provide results that may be more or less satisfactory for printing on ceramics.

Up to this point, we could say that there are no huge problems in terms of colour management.

The ICC colour profiles that are generated with these systems are "ptr" type profiles (printer) and they work on various fields of device colour spaces: RGB (3 colours), CMYK (4 colours) or Multichannel (Ncolor), as per the example in Fig.2.

But as mentioned previously, although the advent of Multicolor printing systems has brought obvious advantages, it has also been accompanied by various issues effectively linked to colour management.

Let's take a look at these problems by examining some practical examples.

**EXAMPLE 1:** Let's suppose we have a colour configuration with C Br Bg P: Practically speaking, we still have 4 primary colours but no black. How could the colour be managed in a case like this one? As often occurs, with the traditional software at our disposal, we tend to create an ICC colour profile based on space CMYK (4 colours). However, this type of profile re-

quires the use of black ink, which does not exist in the example in question; so it is replaced with one of the four inks available, and therefore, in the printout of the testchart, the information relative to the black colour is reproduced using an alternative colour.

However, as can easily be seen, this method presents significant limits, and is also based on a methodology which is completely incorrect.

By operating in this way, the software itself is taxed during the calculation of the colour profile and often provides disappointing, or in any case incorrect results, in the conversion phase.

For example, once the graphic file has been converted, the intensity between the various channels often appears unbalanced.

This puts an excessive strain on the print heads of some of the colour bars during the decoration phase.

Another problem caused by this methodology is the fact that the colour which replaces the black is not used to its maximum potential, and therefore in the conversion phase, it is impossible to achieve certain results, which might be obtained if the colour in question was managed correctly.

This kind of situation defeats the entire purpose of using a Multicolor system, and of having access to a wider range of inks when reproducing a colour.

**EXAMPLE 2:** Let's take the example

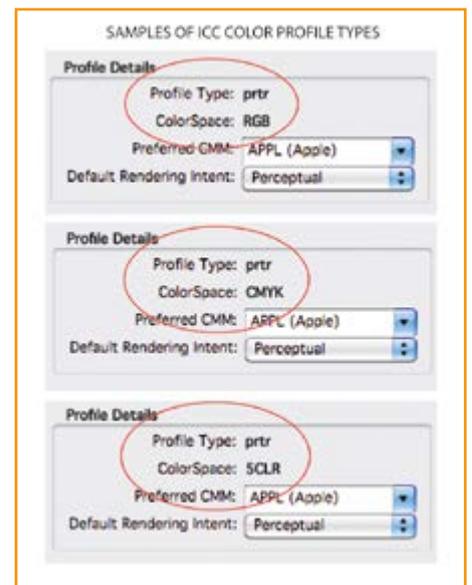
of a Multicolor colour configuration with: C Br Y K Bg P. Therefore, we have 6 colours including black (this example is also valid for 5-colour configurations). How could a configuration like this one be managed? If we have a traditional software, which enables, at most, the creation of CMYK (4 colours) colour profiles, there is no possibility of us correctly generating an ICC colour profile, as we effectively have 6 colours to manage. Here too, there are methodologies which prove absolutely incorrect and most of all, nonsensical.

The most common of these is to create an ICC colour profile for 4 of the 6 colours (e.g. C Br Y K) and, once the graphic file has been converted, manually add 2 spot channels into the channels palette of Adobe Photoshop®, assigning colour values which are similar or identical to the 2 colours that it has been impossible to print in the testchart (in this case Bg and P).

This system is completely useless for the purposes of colour management: indeed, the two spot channels will not be taken into consideration for the purposes of producing a soft-proofing (colour proof viewed on the monitor) or hard-proofing (colour proof printed on paper).

But this is only one of the problems that exist. From this point of view, it is important to remember a cou-

**FIG. 2 - Example of ICC colour profile types**



ple of fundamental concepts:

- when we decide to use ICC colour profiles, these must be created using the correct methods; otherwise they will prove absolutely useless.
- ICC colour profiles do not contain magical properties, so it is not feasible to think that one can count on them to resolve certain critical situations. The solution to these two concepts is to equip ourselves with suitable colour management solutions.

Another alternative for managing the Multicolor colour configuration of the example in question might be to create an ICC colour profile, commonly known as Multichannel (N Color). This is valid for cases in which the software solution sup-

ports this possibility.

In this case, the printed testchart includes all 6 machine colours and, in theory, once the graphic file has been converted using Adobe Photoshop®, it is possible to see all 6 colours, both singularly and in their combinations.

However, there is still one big problem: With Adobe Photoshop® it is possible to convert the graphic file from RGB/CMYK/Lab to Multichannel, but it does not support all the colour management functions relative to the soft-proofing. There is also the problem that it is impossible to correct the graphics using the traditional tools usually available in Adobe Photoshop®, for example the colour methods RGB or CMYK.

All this can easily be verified in Ado-

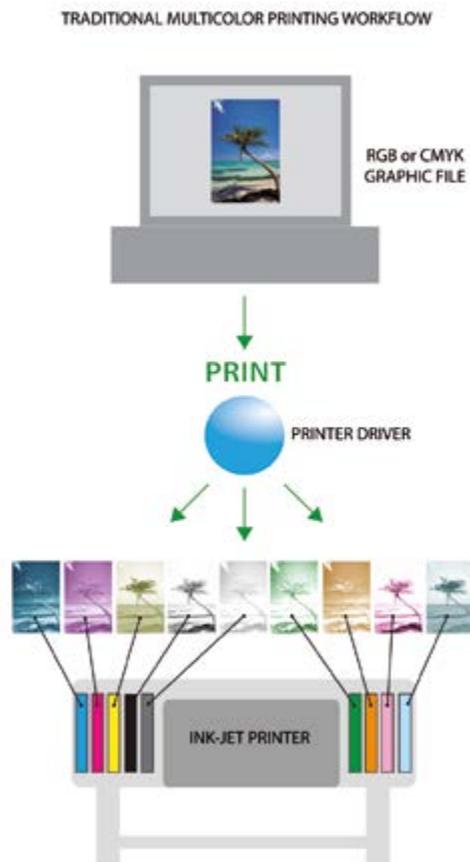
be Photoshop®: once the file has been converted, the function "Set up Proof" is not available, and neither are many of the colour correction tools, such as for example "colour balancing", "colour tone-Saturation", "Selective colour", etc...

We should also consider the intrinsic difficulty of the Multichannel colour method in terms of colour management. Indeed, it proves particularly difficult to make colour corrections on the graphic file, as there is no way of obtaining a reliable colour preview.

For this reason, even in Multichannel modality, managing the 6-colour configuration of the example in question proves tricky and unfeasible, at least for the large majority of graphic operators.

## HOW TO MANAGE COLOUR CORRECTLY

FIG. 3 - Traditional Multicolor printing workflow



From the examples provided, we can draw the following conclusion: when managing the colour for a Multicolor colour configuration, traditional software for creating colour profiles (CMYK and Multichannel) is extremely restrictive, and also entirely inadequate in cases where the graphic applications used fail to support certain colour management functions. As described in the introduction, any digital printing system (whether it is used on ceramics or other materials) which does not provide the possibility of managing colour correctly, loses all benefits of speed, versatility and productivity, and defeats the purpose of part of the investment made when purchasing the printing technology in question. But how can colour be managed correctly for Multicolor printers? The classic example could be that of a traditional inkjet printer which, as we know, can even have up to 12 colours.

We should first of all specify that no-one manages colour following the two examples described above (CMYK+N Spot Color and Multichannel).

The correct procedure, or better, the only correct procedure is that which involves printing a traditional testchart, RGB or CMYK, depending on the configuration of the printer.

Even if the testchart is RGB (3 colour channels) or CMYK (4 colour channels), it is in any case reproduced using all the inks present in the printer, both singularly and as a combination.

This is all possible thanks to the driver of the printer, which separates the 3 or 4 incoming colour channels, into the same number of channels as the number of inks used.

Once an RGB or CMYK ICC colour profile has been created, and the conversion has been completed, we can still continue to work on the graphic files, in RGB or CMYK mode, in all cases. Indeed, all the colours used by the printer are visualised in the converted graphic file, even if the file has 3 (RGB) or 4 (CMYK) colour channels. The same solution is valid when the next graphic files have to be printed (Fig.3).

Indeed, therefore by working in RGB or CMYK mode, Adobe Photoshop®

and other preprinting tools are capable of supporting all the soft-proofing and hard-proofing functions,

so enabling colour to be managed correctly, even if Multicolor printing systems are used.

At the present moment in time, this technology is the only correct way of managing colour.

**APPROACHING THE MANAGEMENT OF GRAPHICS IN DIGITAL PRINTING**

One of the main problems linked to the management of the graphic files destined for digital printing on ceramics is often the type of approach favoured by the graphic operators in the sector:

Indeed, the most common error is that of approaching digital printing on ceramics by using methodologies designed for other printing technologies: this most commonly occurs with the method used for printing on silicone rollers. Indeed, for this technology, the colour method used within Adobe Photoshop© for managing graphics is the Multichannel method: we could say that this printing technology is typically suitable for screen printing. On the contrary, digital printing is a technology which has little in common with screen printing (planar or rotating). It is a traditional printing technology for placing colours one on top of the other, and must therefore be discussed in full.

Furthermore, also the fact that colour management systems are used (which does not occur with

screen printing) means that the approach and know-how required for the management of the graphic files must necessarily differ.

Indeed, when working with colour management systems based on ICC standards, and with non-Multichannel colour models, the graphic applications offer a larger number of tools for correcting the colours of the graphics. This means that the graphic operators in the ceramics sector must have very different notions or know-how regarding the management of the graphics, compared to those required for other printing technologies: a prime example of this is the ability to correct the colours in the files in RGB mode.

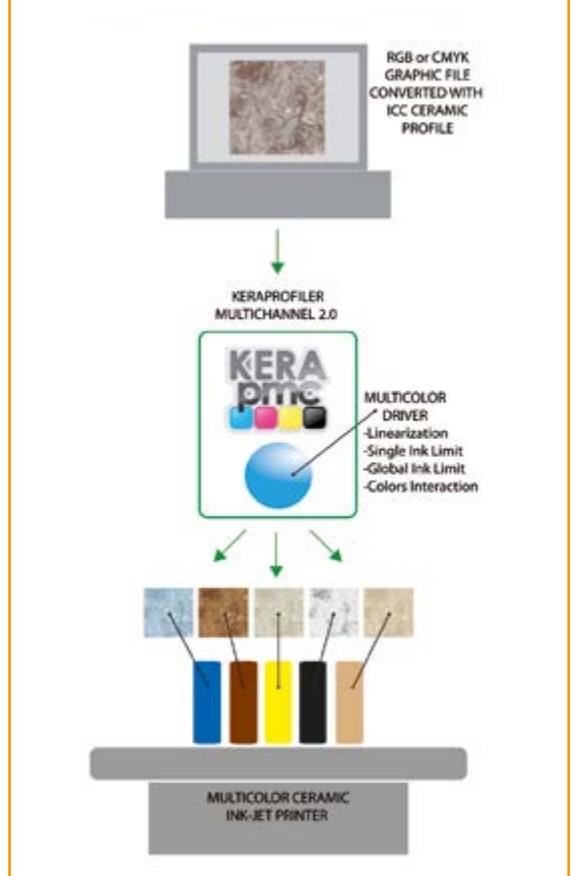
Here too, as in the case involving the management of an inadequate or incorrect colour, indeed, engaging an incorrect methodology to manage the graphic files defeats the purpose of, or significantly limits all of the benefits described above, which are intrinsic to a digital printing system. Lastly, it is crucial to remember

that when managing colour, the type of lighting used to view the colour plays an important role, as does the quality of the monitors engaged in the workflow and, last but not least, the quality of the spectral readings performed.

We will not go into detail regarding these points, as they have been discussed in full detail in the previous editions of the ACIMAC technical notebooks.

One fundamental rule remains valid for colour management: the better the quality of the devices and the data used, the more coherent the colours will be between the various devices.

**FIG. 4 - Keraprofiler Multichannel 2.0 separation workflow**



**KERAPROFILER MULTICHANNEL 2.0:  
THE COLORSTORE SOLUTION FOR MULTICOLOR MANAGEMENT**

As detailed above, in order to manage the colours effectively in Multicolor systems, adequate solutions are required.

One of these is the Keraprofiler Multichannel 2.0 colour management software solution, which is supplied by Chromatech and part of the Colorstore product line.

This software is composed of two modules: one for the creation of colour profiles and one for the

separation of the graphic files.

**Module for creating colour profiles**

The module for creating colour profiles is capable of creating these based on ICC, in RGB, CMY and CMYK modes. It was specifically designed for the ceramics sector: indeed, in addition to the particular calculations algorithms present, it also features several functions which are closely

linked to printing on ceramics, such as, for example, the use of coloured backgrounds, or white point optimisation (WPO).

This characteristic is of fundamental importance, as the use of profiling solutions - which are mainly created for paper - in ceramics, often creates huge limits in terms of the quality of the profiles and therefore in the quality of the converted files.

Keraprofiler Multichannel 2.0 can be

used in two modes for the creation of colour profiles: automatic or manual, the latter being destined for expert users.

Creating colour profiles automatically is extremely simple and meets the requirements of users without much experience.

Despite any lack of expertise, the quality of the colour profiles produced in any case proves extremely high.

The ICC colour profiles generated are fully compatible with all graphic applications which include colour management modules based on ICC standards.

Another available function is that of

creating colour profiles in "Batch" mode, that is: from one or more spectral readings it is possible to create infinite colour profiles, each one with different characteristics, in a single session.

This offers the operator the opportunity to do other things while the software is calculating the colour profiles.

The main reading tools are compatible with Keraprofiler Multichannel 2.0, specifically: X-Rite i1 and iO version 1 and 2, Barbieri LFP.

The software has its own testcharts for the creation of profiles.

Another exclusive function is known as the White Point Optimizer (WPO).

It is capable of providing a level of detail and a range of contrasts in the converted file which are not easily obtained when converting the graphic file in the traditional way with Adobe Photoshop®.

This function is effective on all types of graphics, but especially in the presence of coloured or particularly dark backgrounds.

management solution, as it indeed manages all the colours used in the machine.

In order to understand better how it works, it is a good idea to return to the example illustrated above, relative to printing files with traditional inkjet printers.

As mentioned, these printers have a part in the printing driver which separates a 3 colour channel (RGB) or 4 colour channel (CMYK) incoming file into a file with as many channels as the number of colours used in the printing.

Indeed, the Keraprofiler Multichannel 2.0 separation module, works based on exactly the same principle, with only one important difference: in a traditional printer, the printing driver provided by the manufacturer is closed (Fig. 4).

The graphics are printed using colours based on set parameters which cannot be modified.

Instead, the Keraprofiler Multichannel 2.0 separation module, can be fully defined by the user: this results in several important benefits.

Creating a separation model (or Multicolor driver) using Keraprofiler Multichannel 2.0 involves linearising or calibrating the printer by printing, firing and reading a specific target.

In this phase the maximum values of each single ink, the linearisation curves and a maximum inking limit are defined for the superimposition of all the inks.

This last aspect plays a fundamental

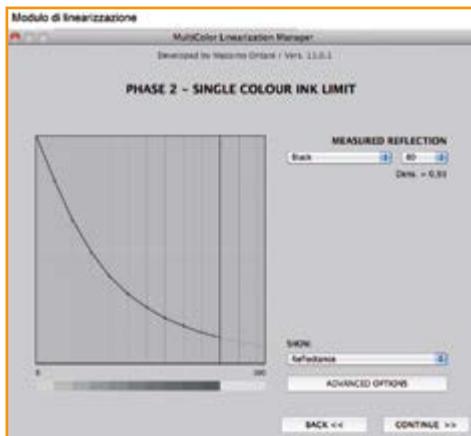
**FIG. 5 -** Multicolor workflow with Keraprofiler Multichannel 2.0



**FIG. 6 -** ICC profile making module



**FIG. 7 -** Linearization module



**Module for creating separation models (Multicolor driver)**

This module is the bonus factor of this colour

**FIG. 8 -** Module for single ink and gamut management



role in the field of ceramics, as it resolves potential problems (e.g.: ink/ink or ink/glaze rejection, or problems linked to an excessive or superfluous discharge of ink), which lead to undesired effects that become visible after firing (the colour becoming matt, efflorescence etc..).

Specifically, regarding an excessive discharge of ink, with the linearisation function of Keraprofiler Multichannel 2.0, it is possible to check and establish the correct quantity of ink in order to avoid the problems highlighted above.

Moreover, it is also possible to verify significant reductions in the consumption of ink.

The last step in the phase of creation of a Multicolor driver is another, just as important phase, which is one of the advantages of Keraprofiler Multichannel 2.0, that is, the possibility of establishing how and how much of each ink is to be used in the separation phase of a graphic file.

In the example with the printing driver of a traditional inkjet printer, there is no way to establish whether one ink should be used more than another, as the parameters are based on the default settings established by the manufacturer: instead, with Keraprofiler Multichannel 2.0, these parameters can be defined by the user.

It is however advisable to specify: in the separation of a graphic file, cases can occur whereby a colour channel appears excessively intense (dark).

This can cause problems to occur in the printing phase: the print heads are taxed and unpleasant stripes may appear.

Regarding colour channels, it is advisable to differentiate between quantity and intensity.

The quantity can be managed with Keraprofiler Multichannel 2.0 using the procedure described, while the intensity is directly linked to the physical characteristics of the ink itself.

To put it more simply, the lighter the ink, the darker its respective colour channel will be: the best example



**FIG. 9** - Comparison between an ICC colour profile created with general software developed for printing on paper (on the left) and an ICC colour profile created with Keraprofiler Multichannel 2.0



**FIG. 10** - Traditional conversion of the graphic file (on the left) and conversion of the graphic file with the White Point Optimizer or WPO function (on the right).

can be seen in some cases of yellow. As yellow is intrinsically lighter than the other colours used, the colour channel relative to the colour yellow will be the darkest.

With Keraprofiler Multichannel 2.0, adjustments can be made in any case, in order to obtain the best possible balance between the various colour channels.

In practical terms, during the creation of a Multicolor driver, the user has access to all the tools required to control the colours, either singularly or globally.

On completion of the phase in which the Multicolor driver is created, both the RGB or CMYK testcharts, and the graphic files converted using the respective ICC colour profiles, must

be separated in N channels in order to be printed: practically speaking, like the driver of a traditional printer. The result will be a graphic file with several channels (Multichannel) where each channel represents a specific colour bar.

This procedure can be used for all types of printer, regardless of the brand or model, and for this reason Keraprofiler Multichannel 2.0 can be used to linearise and create ICC colour profiles on any digital inkjet machine.

#### **Keraprofiler Multichannel 2.0 and the colour spaces used**

In the phase of creation of an ICC colour profile, Keraprofiler



Multichannel 2.0 offers the possibility of working with an RGB or CMYK colour model, depending on the type of colour configuration.

If the colour configuration of the printer requires the use of black ink as a single colour, the colour model used is CMYK. In this case, traditional CMYK testcharts will be used, the ICC colour profiles will be in CMYK mode, and the graphic files, once converted using the colour profile, will also be in CMYK.

If, instead, the colour configuration of the printer does not require the use of black ink as a single colour, the colour model used is RGB. In this case, the testcharts, ICC colour profiles and the colour model of the converted graphics will be in RGB, as if we were using a traditional inkjet printer: exactly the same principle, work flow and working mode will therefore be used.

**Keraprofiler Multichannel 2.0: main functions and advantages**

The main functions and advantages

that can be obtained with Keraprofiler Multichannel can be summarised as follows:

- software entirely developed for the ceramic sector and not derived from the sector of printing on paper;
- possibility of managing 3-4 colour and Multicolor printing systems, while guaranteeing correct, fully autonomous colour management;
- high quality RGB or CMYK colour profiles based on ICC standards;
- easy to use: Automatic or Manual functions for creating profiles;
- compatible with the main reading instruments: X-Rite and Barbieri;
- compatible with the main desktop publishing applications;
- WPO (White Point Optimizer) function for obtaining a greater level of detail and an accurate contrast;
- function for use with coloured or dark backgrounds (glazes);
- BATCH mode for creating multiple colour profiles;

- creation of ICC colour profiles for any type of printer;
- compatible with MAC and PC;
- creation of printer driver defined by the user for any type of printer;
- full colour control, using the functions of linearisation, individual and global ink limitation, ink combination management;
- full colour control to prevent or resolve phenomena of ink rejection or instances of excess inking;
- possibility of saving ink;
- function for separating the graphic files from RGB-CMYK to N colours.

In addition to its software solutions, Chromatech is pleased to offer a full series of services, from training personnel based on their different levels of experience, providing graphic support in the product start-up phase, to providing systems for producing colour proofs on paper and everything else that regards the management of colour for the ceramics sector.



**Massimo Franchini** boasts around 15 years of experience in colour management for printing on ceramics, starting from when the first ever digital printing systems with laser technology were introduced.

In 2004, he founded Chromatech, the company he uses to supply technical training services and software solutions for colour management, in the field of ceramics. In 2009, in collaboration with Shot, he introduced the first software solutions of the Colorstore line.

**NOTE**

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