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The Implementation of Colour Management in Graphic Communication Companies in the UK

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Executive Summary

Colour management in the graphic communication industry offers improved job turnaround and colour accuracy. Further development would be possible with continuing adoption of standards throughout the production chain, improved implementation of the ICC profile format in software and better customer education in colour management and the tools with which to implement it.

Objective

The objectives of the project were:

1. To determine the strengths and weaknesses of current colour management implementations in graphic communication companies.
2. Identify developmental needs for graphic communications businesses and for vendors of colour management systems.

Approach

The study involved contacting and visiting companies who have adopted colour management systems. Through a questionnaire, the workflow and implementation of colour management was examined for strengths and weaknesses. The term 'graphic communication' covers several market sectors: graphic arts, digital still photography, digital motion picture, forensic imaging and medical imaging. The majority of companies contacted were from the graphic arts and therefore the analysis has been geared to this sector.

Key Findings

1. The key benefits of a colour managed work flow are improved workflow management, quicker job turnaround and increased ability to complete a job correctly.
2. The files and information supplied by a customer are the most frequent source of problems in a colour managed workflow.
3. Automation of the workflow, including the handling of ICC profiles, was a main area for future improvement.
4. ICC profiles are generally seen as capable in ensuring colour consistency, but current software implementation of the conversion of colour data to specific press parameters can be limited.

5. Softcopy proofing is not yet considered to be as reliable as hardcopy proofing for colour critical work but its adoption is growing.

Major Implications of the Findings

1. Business performance can be improved through the use of a colour managed workflow.
2. Issues with customer origination exist whether through lack of knowledge or the inadequacy of the tools available to the customer to produce to the required standard.
3. Shorter lead times for jobs in increasingly competitive graphic arts markets, means automation of tasks vital for business.
4. Software functionality needs to be increased to use all the options available in the ICC profile specification.
5. The need for increased job turnaround requires quicker proofing decisions. Soft proofing offers significant time saving advantages.

Research Objective

Background

Colour management has seen increasing application within the Graphic Communication Industry. With development of systems capable of using the version 4 ICC profile format, businesses should have the tools to produce colour accurate work for any job in their workflow. In addition, the development of digital workflow systems should mean businesses are in a position to improve quality and job throughput in an increasingly competitive market. But has this happened? Therefore this study is an attempt to assess progress within the industry.

Objective

The research aimed to identify current levels of implementation of colour management and the improvements required by companies in their production workflows. In particular:

- The fundamental customer expectations from a colour managed workflow.
- The barriers to adoption and to successful implementation.
- Any weaknesses in the present colour management architecture.
- Specific developmental needs.

Approach

Two methods were used. Firstly a small number of companies which use a colour management system or providing colour management solutions were visited to gain an overview of processes involved and problems encountered. Secondly a questionnaire was sent out to graphic communication companies.

The questionnaire consisted of two sections: The first section asked for the respondent to rate the frequency and type of problem at a particular workflow stage or function (See table 1).

Stage or Function
Customer-supplied digital images/documents
Producing colour images and documents to customer requirements
Manipulating/correcting digital images and documents
Preflighting before output
Matching customer-supplied originals in hard copy proofs
Matching customer-supplied originals in soft copy proofs
Matching proofs to final prints
Final output/printing of job

Table 1 – Section 1 Workflow Stages or Functions

In addition any problems with the use of profiles in the workflow were rated. The second section enabled respondents to give longer answers about the system they had in place, improvements seen with implementing a colour managed workflow and areas of improvement to their workflow or systems in general. The questions presented in both sections can be found in the Appendix.

The aim was to gather information from a broad range of companies involved with graphic communication. In addition to other sources, The British Printing Industry Federation and PrintWeek databases were used to obtain company information (BPIF (2005), PrintWeek (2005)). 410 businesses were contacted, of which 33 replies were received (8%). Section one had been answered by all respondents while 29 respondents completed section two. The returned questionnaires were predominantly from the prepress and print sectors. A breakdown of respondents by business is given in Figure 1.

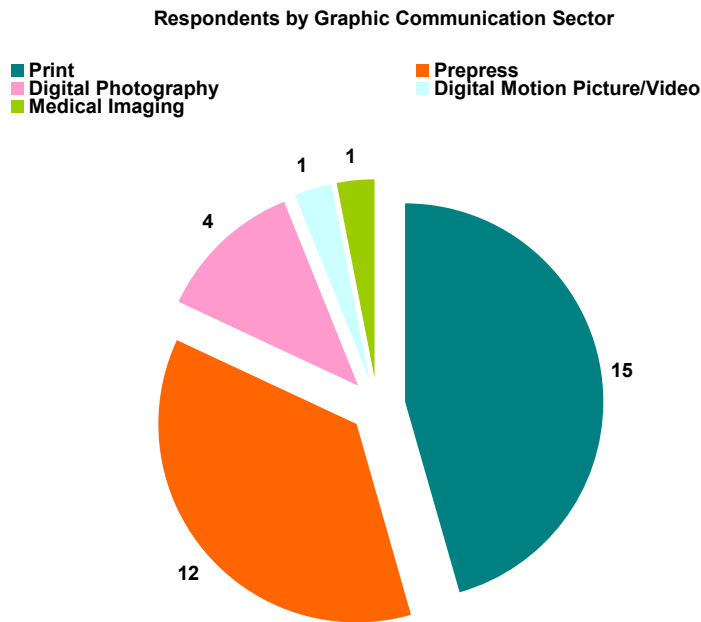


Figure 1 – Respondents by Graphic Communication Sector

The section one responses were examined for the stages which had the highest frequency of problems and for what type of problem experienced.

The section two responses were analysed for content. Content analysis codes were selected and each response was rated for each code in terms of being positive, negative or indifferent to the theme of the code (See table 2). Quantification of the responses was then possible. The responses were not limited to fitting a single code; therefore each response may have been found to be valid for other codes. The actual respondents were not quantified to each code for this reason but the occurrence of a response type was deemed sufficient to imply a trend.

Content Analysis Code	Themes
Customer	Customer contribution, supply of information, supply of files
Profiles	ICC Profile usage, architecture, colour space conversion, editing
Job speed	Job turnaround, speed through workflow
Files	Ease of File handling, file formats, file data, correction and processing
Accuracy	Colour matching, proof/output/print/image satisfaction, meeting job specification
Management	Workflow structure, automation, system structure

Table 2 – Content Analysis Codes for Section 2 Responses

1st Key Finding: The Benefits of a Colour Managed Workflow

The key benefits of a colour managed work flow are improved workflow management, quicker job turnaround and increased ability to complete a job correctly.

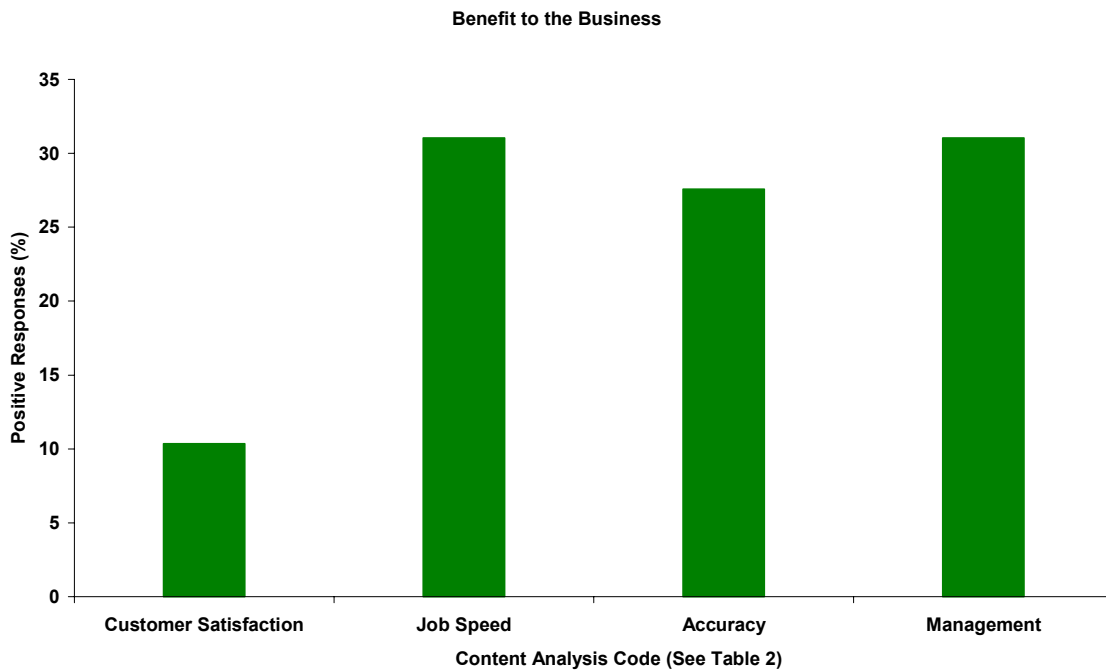


Figure 2 - Benefits to non-colour areas of the business (Section 2 Question B)

31% of responses cited quicker job turnaround and better workflow management as key benefits of having a colour managed workflow to other areas of their business. 28% of responses cited an increase in the ability to meet job requirements (as indicated by the accuracy content analysis code) (figure 2). Improvements to customer satisfaction were low with only 10% of responses indicating any benefit gained.

2nd Key Finding: Customer Contribution to Production

The files and information supplied by a customer are the most frequent source of problems in a colour managed workflow.

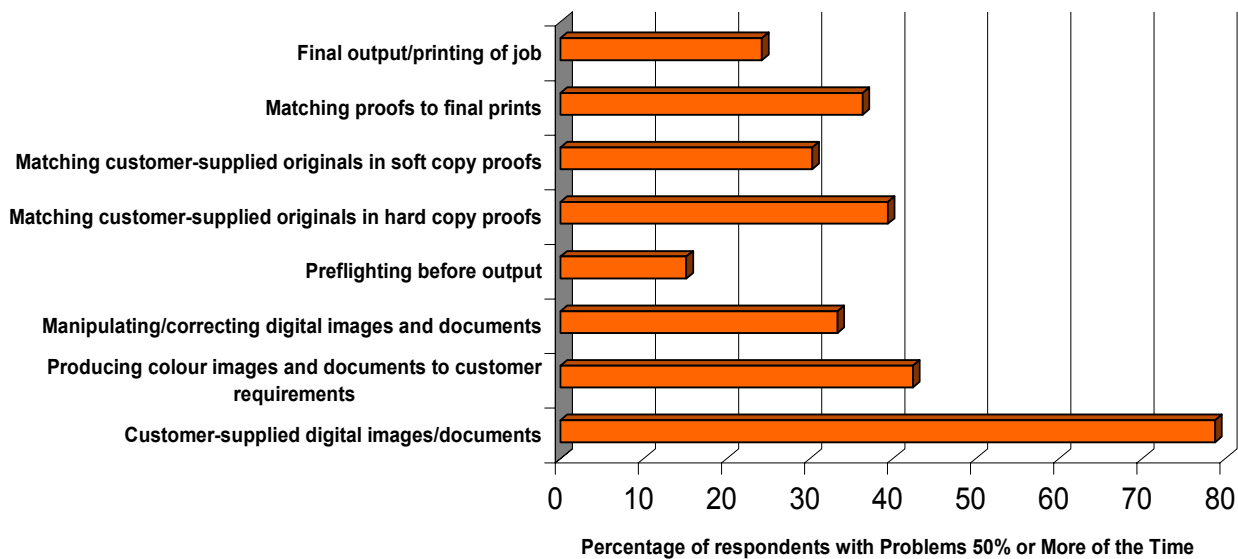


Figure 3 – Stages where Respondents Experienced Problems 50% or more of the time.

Respondents indicated that files received from the customer were frequently not fit to enter the workflow (figure 3). In addition, 31% of respondents pointed to customers as a source of common problems and 27% of respondents reported problems with image or data files (figure 4).

The problems found were not all specifically colour related, though colour was the largest specified area (figure 5). Wrong or mixed file formats, no or inappropriate profiles attached and corrupted or missing files were also among the comments made. This would account for the similar proportion of problems specifically labelled as technical (18%).

In the associated stages, producing colour images and documents to customer requirements and manipulating/correcting digital images and documents, a similar spread of problem type occurs.

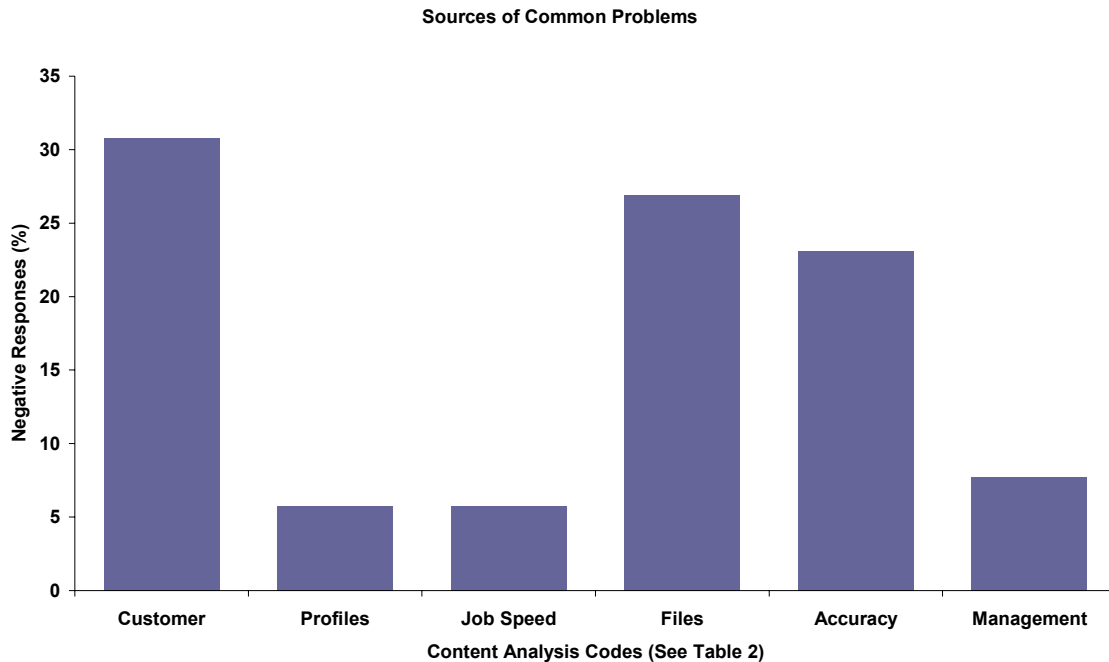


Figure 4 – Sources of Common Problems (Section 2 Question C)

Since these are the initial stages, any improvement here would improve the latter stages of the workflow. The problem is not simply customer incompetence or lack of fundamental colour management knowledge. It is possible that the customer is knowledgeable but is not as yet capable of using their file preparation system properly. With the increasing complexity of file preparation systems, the choice of file output options can lead to inadvertent errors. Following on from this point, are the system providers offering too much choice or are they providing the right technology in the first place? A good approach would be to restrict the options available, for example by using PDF/X. PDF/X has restricted PDF creation options to ensure reliable file throughput in a workflow. In particular a variant called PDF/X-3 has been specified to allow the transfer of ICC profiles (or device independent RGB data) through a production chain (Bailey 2005). Therefore, whilst the customer still needs to know what to send out, there should be less ambiguity about how to set up a file suitable for entry into a colour managed workflow.

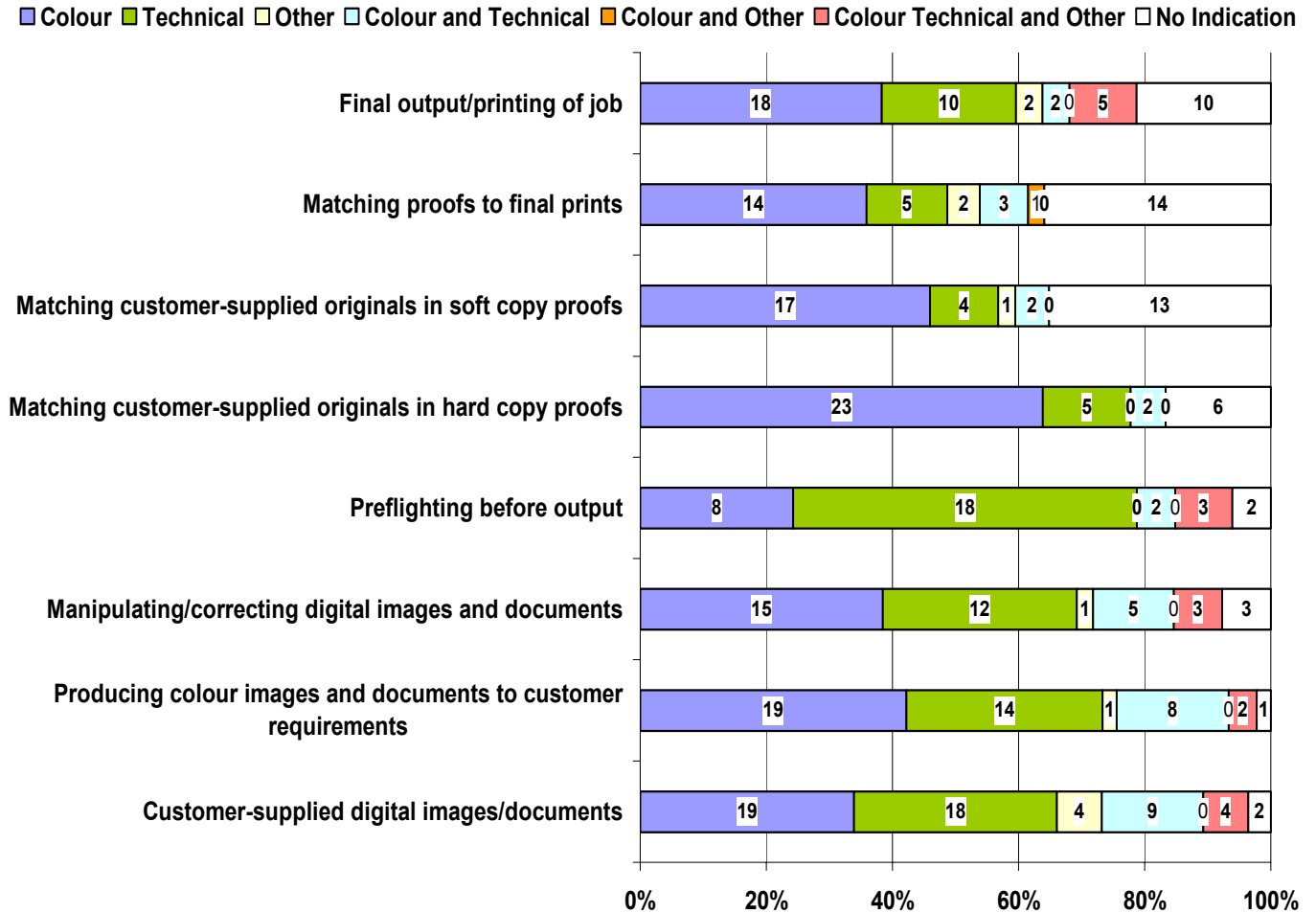


Figure 5 – Type of Problem at Each Stage (Section 1)

Note that the issues described by respondent and interviewees are similar to those found by GATF in 1998 and by Seybold in 2003 (Shaffer 2004), which indicates a continuing underlying problem.

3rd Key Finding: Future Improvement

Automation of the workflow, including the handling of ICC profiles, was the main area cited for future improvement.

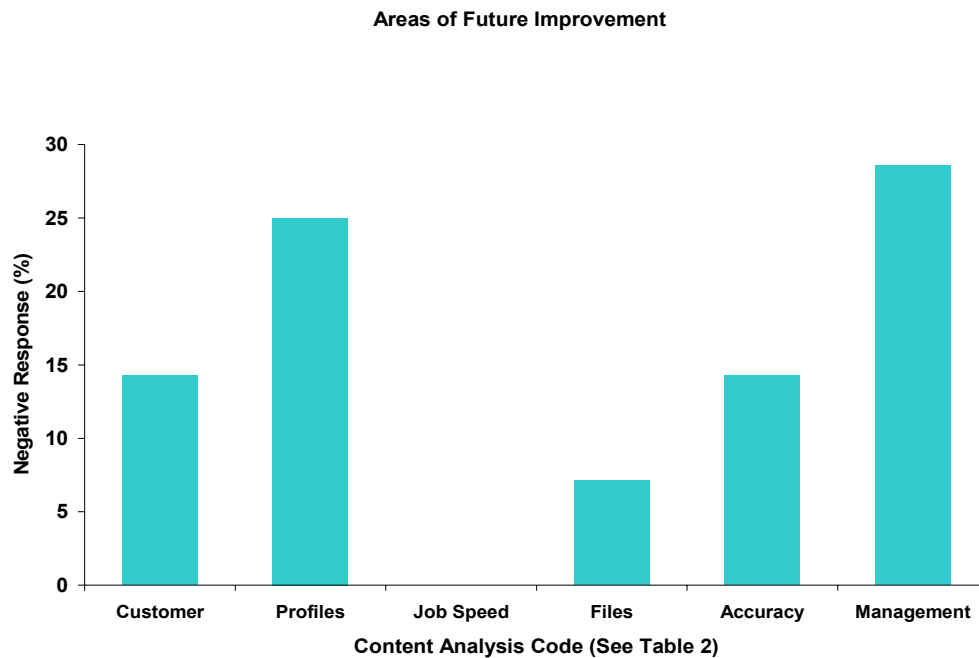


Figure 6 - Areas of Future Improvement to Colour Managed Workflows

29% of responses indicated the wish for improvement to their workflow management (in particular automation) and 25% of responses indicated a desire to have improved utilisation of ICC profiles, whether by improvements within their own workflow or to the profile implementation at the software level.

Colour accuracy was mentioned in 14% of responses as an area for improvement. By combining accuracy with the wish to improve ICC profiles (combined total 39%), this is an indication that improvements to colour reproduction quality was still an issue (see the 5th Key Finding).

By combining the responses relating to customers and files (21% combined) we have further evidence of dissatisfaction with the customer's part in the process. Respondents made specific mention of customer training regarding colour management and the wish for a graphic file standard that customers had to use that would enable an automated colour managed workflow. The request for customer training was discussed in the 2nd key finding.

The request for a graphic file standard is slightly strange. This does suggest poor business knowledge regarding what standards and specifications are available. There are several standards or specifications that could be adopted. For example SWOP, GRACoL, The ECI guidelines (ECI 2005), Pass4press (Psarianos 2005). It also raises the question about whether the customer has been encouraged to adopt relevant standards or specifications. Nevertheless, the needs are real. In a PDF based workflow the bottlenecks are correcting customer PDF files or creating the PDF files from the supplied originals and the transparency flattening process (where needed). Visually significant changes to colour data can occur and as customer acceptance and expectations need to be met, job throughput can slow down (Alterio 2005).

This finding implies that future improvement in the automation of a colour managed workflow would be limited to three areas:

- The adoption of standards or specifications that can produce consistent results in an automated workflow from customer through to final output.
- The ability of a customer to supply files which are of the correct specification and the subsequent conversion to PDF files (or other standardized file format).
- The ability of workflow software to provide acceptable conversion from PDF files (or other file format) to files suitable for the output device as per the specification that has been adopted for the workflow.

4th Key Finding: Colour Management Satisfaction

ICC profiles are generally seen as capable in ensuring colour consistency, but current software implementation of the conversion of colour data to specific press parameters can be limited

82% of respondents stated they used ICC profiles in their workflow. Of this group, 67% had no or only occasional problems with their implementation (figure7):

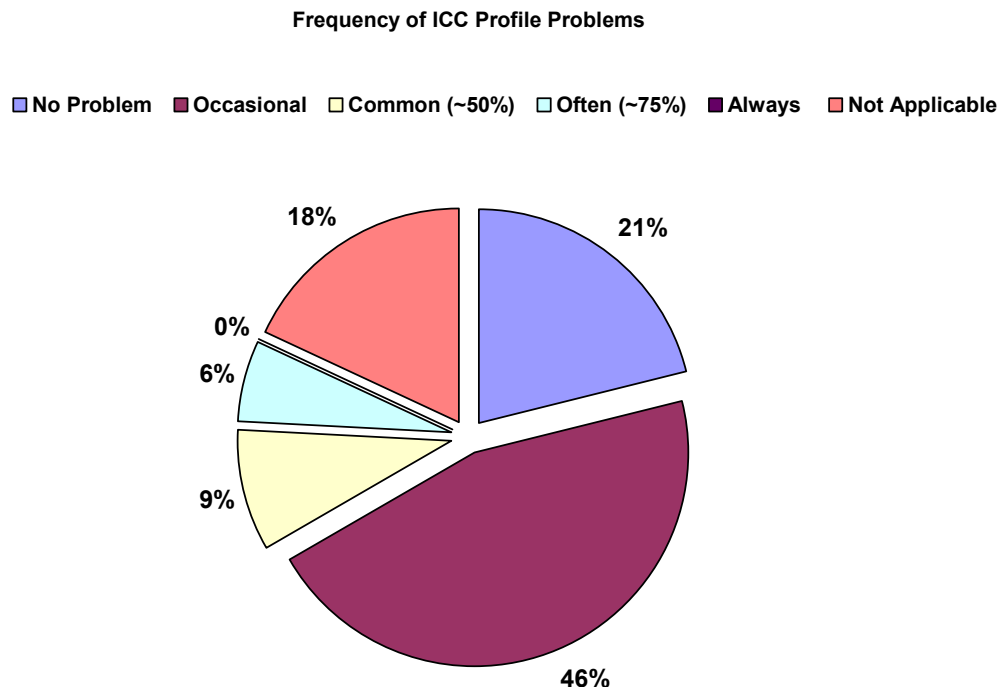


Figure 7 – Frequency of ICC Profile Problems

This implies that profiles generally perform adequately in the workflow of those surveyed. This was also apparent when asked about any current colour management problems (figure 8). 28% of responses cited limitations with using ICC profiles but 38% of responses indicated that no real problems were found. Nevertheless, as an area of future improvement, 25% of respondents wished to improve their ability to use ICC profiles (figure 6).

A common trend among respondents was the need for better data conversion to physical press parameters. To improve the conversion, five respondents stated they were using non-ICC profile implementations, which were able to take the profile data and convert to a specified minimum or maximum dot gain for a particular press. The opinion given of these systems was that they satisfactorily gave the required output.

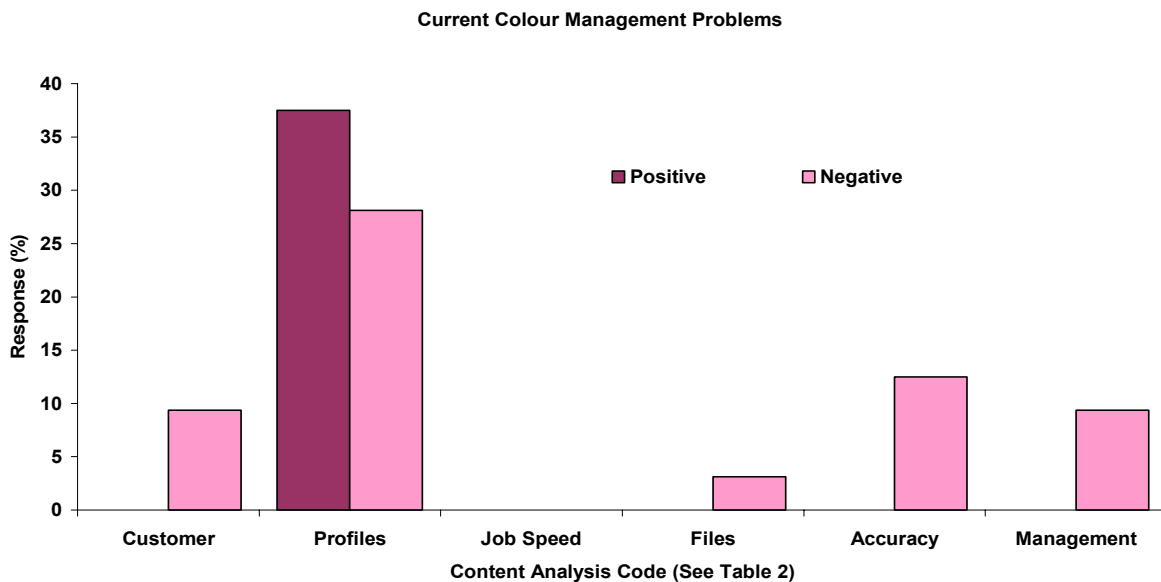


Figure 8 - Current Colour Management Problems (Section 2 Question D)

Amongst the comments, four respondents had just upgraded their profiling software or were aiming to generate profiles in house where they hadn't previously done so. It is possible that they would give more positive responses after the effects of these improvements begin to appear. The upgrade would be to take advantage of the version 4 profile features. Further details are described on the ICC website (ICC 2004). Unfortunately, if the business wishes to use PDF/X as the basis of their workflow they are currently restricted to using Version 2 profiles since version 4 profiles are not officially supported. Attempts are being made to correct this situation in the next PDF/X revision. The expected benefits of using version 4 profiles in a PDF/X workflow are described in an ICC white paper (ICC2005).

In recent meetings, the ICC has addressed the need for more information about the printing process to be stored inside the profile. Since many workflows are RGB based (to enable cross platform visualization and repurposing), discussions centred on methods to carry the original colorant information through the workflow without degradation. A set of proposed Printing Condition tags will, if adopted, provide extensive metadata about the output process and will allow exchange of information with JDF-enabled applications.

In many situations it is desirable to preserve the information in CMYK and n-colour separations. This information is lost when transforming between devices via the 3-component PCS. The DeviceLink profile type in Version 4 of the ICC specification provides an alternative method of transforming between devices. Unlike other profile types, a DeviceLink profile has device data as both source and destination. It is likely that one of these ideas would satisfy the respondents' requirements if available in colour management software.

5th Key Finding: Proofing Satisfaction

Softcopy proofing is currently not thought reliable enough compared to hardcopy proofing for colour critical work but its use is increasing.

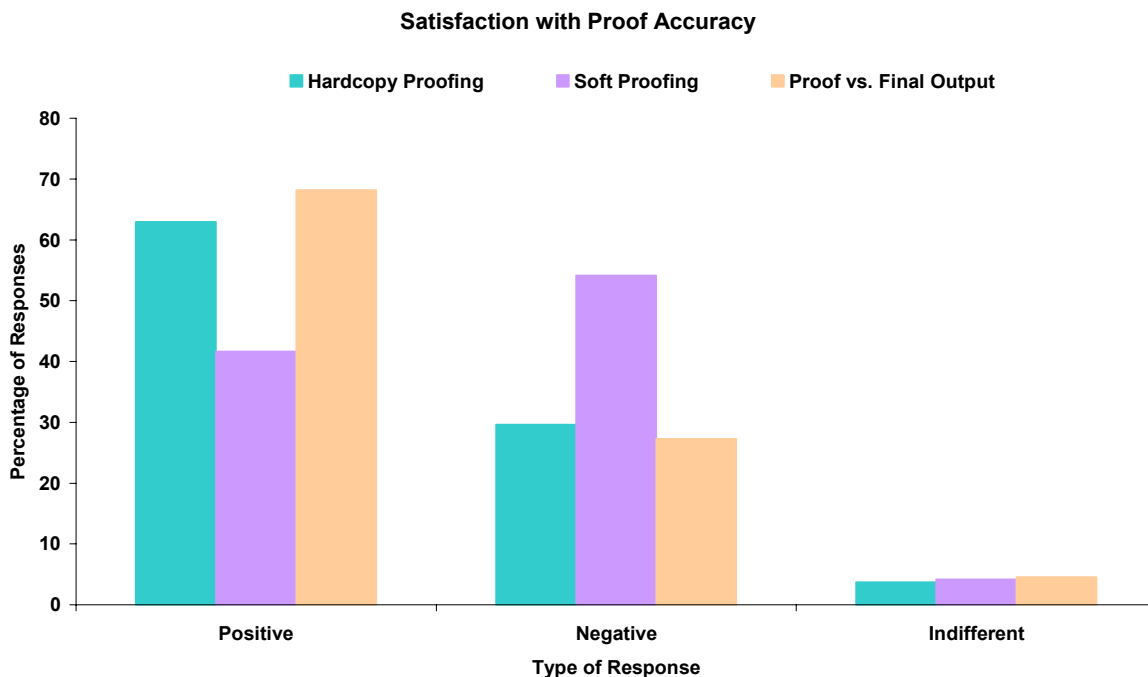


Figure 9 – Proof Accuracy Satisfaction

During the proofing stage, it was not surprising that colour representation issues were the main problem cited, with over 54% of respondents having specifically colour related problems 50% or more of the time (see figure 5). Nonetheless, over 60% of respondents were satisfied with the hardcopy proofs they were able to make, whether for comparison against the customer original or the final (printed) output.

Over 52% of respondents were not happy with the quality of soft proofs due to the measures needed to achieve accurate colour. Calibration, viewing conditions, correct profiling to the output device were all cited as conditions which needed constant monitoring. But 43% of respondents were satisfied with soft proofing which suggests that these differences can be overcome or at least a working compromise reached. For example one respondent was not satisfied with soft proofing except for newsprint work.

Therefore this implies that the hard copy proofs are thought to be more reliable for certain types of work, but the trend for using soft proofs for colour accurate work has increased since 2000 (Hinderliter 2000, Bassinger and Marin 2003).

It is likely with the respondent's desire to increase the automation of the workflow (See figure 6); soft proofing implementation will continue to grow. An improvement in the accuracy of soft proofing systems has been found with the year on year performance of systems tested in the 2004 and 2005 IPA Color Proofing RoundUPs (Zarwan 2004, Zarwan 2005).

Note that whilst matching the proof to the final output attracted 68% satisfied respondents, 27% of respondents were not. These respondents were prepress companies who indicated dissatisfaction with gamut conversion between the proofing system and the press, which suggests the rendering intents may be chosen incorrectly as there should be no gamut change after conversion to the print colour space. In addition loss of control once the job is returned to the customer or sent to the printer was cited as a factor.

Discussion & Conclusion

The fundamental customer expectations from a colour managed workflow.

Customers require that the job produced meets their expectations quickly. Businesses are meeting this expectation with improvements in accuracy and job turnaround with a colour managed workflow in place.

The barriers to adoption and to successful implementation.

Successful implementation requires conformance to industry standards and specifications. Businesses need to persuade customers to follow a preferred specification. They also need to ensure that the software they use actually meet their requirements, with vendors offering products with the appropriate level of functionality.

Any weaknesses in the present colour management architecture.

Currently there are no actual weaknesses in the current ICC profile based colour management architecture. The basic principles are robust and can give reliable results, the success of which has been the widespread use and support of the version 2 profile format. Where problems occur it is down to how the systems are used in the production chain and the functionality of the software available.

Specific developmental needs.

The use of Devicelink profiles has been offered as a solution for preserving CMYK and n-colour information. Unfortunately very few software applications can produce or use this profiles. For example, Adobe Creative Suite does not support Devicelink or abstract profiles. PDF/X based workflows are currently compatible with the version 2 profile only. This specification needs updating to handle version 4 profiles.

Weaknesses and Areas for Further Research

More detailed results could be obtained through more specific targeting of types of graphic communication companies. Different sectors do have specific customer requirements and therefore different workflow pressures can exist. Investigation in narrower market sectors would show the differences and confirm the broad trends seen.

Further investigation into specific use of standards and specifications (e.g. pass4press, JDF) and the differences in their performance in implementation would be beneficial for future industry investment.

Conclusion

The development and further implementation of colour management within graphic communication companies will depend on the following factors: Improved workflow management and automation, robust document handling and increased adoption of graphic arts standards.

Graphic communication companies currently face significant pressures on time and quality. The tools required to meet their needs are being developed. Nevertheless it must not be forgotten that the customer needs education in these new production techniques and be persuaded to adopt standards. This is an opportunity for businesses to improve the working relationship with customers.

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Appendix

Colour Management Questionnaire

Section 1 questions

The questions below are about the implementation of colour management in your business. For each question, please circle the appropriate letter/category (if responding by hard copy) or delete the other categories (if responding electronically) as it applies to your experience of colour management. Areas where responses are requested are indicated by italics. If time is available, please continue to Section 2 overleaf. Please return completed questionnaires to pj.green@lcc.arts.ac.uk

A. Business: *Graphic Arts* *Photography* *Digital Motion Picture* *Medical Imaging* *Other*

B. Below is a list of devices/systems. Please indicate by circling the correct letter or deleting the incorrect letter, whether you use them and if so, whether you calibrate and/or profile the device/system for colour:

	1. Do you use?	2. Is the device calibrated and profiled for colour work?
Digitisers (e.g. Scanners, digital cameras)	<i>Y/N</i>	<i>Y/N</i>
Image/colour manipulation software	<i>Y/N</i>	<i>N/A</i>
Proofing/workflow systems	<i>Y/N</i>	<i>Y/N</i>
Output/printing/reproduction devices	<i>Y/N</i>	<i>Y/N</i>

C. Below is a list of operations in a production workflow: Using the scale below, please rate the operations in terms of degree of colour management problem, by placing the appropriate number next to each operation. In addition, please indicate whether the major cause of the problem is due to colour, other technical issues or other causes, by circling or deleting the appropriate letter.

No problem	Occasional	Common	Often	Always	not applicable
1	2	3	4	5	6

1. Degree of Problem 2. *Colour? Technical? Other?*

Enter number below

Customer-supplied digital images/documents	.....	C / T / O
Producing colour images and documents to customer requirements	.....	C / T / O
Manipulating/correcting digital images and documents	.....	C / T / O
Preflighting before output	.....	C / T / O
Matching customer-supplied originals in hard copy proofs	.....	C / T / O
Matching customer-supplied originals in soft copy proofs	.....	C / T / O
Matching proofs to final prints	.....	C / T / O
Final output/printing of job	.....	C / T / O

Section 1 questions continued:

D. 1. Do you use ICC Profiles at any stage of your workflow? *Y / N*

Using the scale below, please answer the questions that appear afterwards:

No problem	Occasional	Common	Often	Always
1	2	3	4	5

2. If Y to D1: Are profiles problematic in your colour management? *Please enter number here:*

3. If N to D1: Do you implement colour management throughout your workflow? *Y / N*

4. If Y to D3: using the above scale please rate the level of problems you encounter with it. *Please enter number here:*

.....

Section 2 questions

A. What technical improvements to your production workflow and/or colour quality have there been?

B. By having a colour managed workflow, have there been any benefits to other areas of your business?

C. What are the most common recurring problems in colour reproduction, from customer files through to final output?

D. Do you have any current colour management problem(s)? If so, are they related to colour management software or to limitations in the ICC profile format or architecture?

E. Are you satisfied with the accuracy you obtain from a) hard copy proofing; b) soft proofing; c) the match between the proof and the final print?

F. Are there any improvements to your present colour management workflow that you wish to implement, or changes you think are needed in the way that colour management applications or the ICC architecture works?

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Colour imaging is an active area of research and postgraduate study at LCC. Information about opportunities in this area can be found at <http://www.digitalcolour.org>

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