

Variable Data Printing

*Manfred Wiedemer
Océ Printing Systems GmbH
Poing, Germany*

Variable Data Printing

Processing and printing variable data is determined by the entire production process, not just the printing process itself.

The early beginnings of variable data printing go back to the 60ies when the industry started using output devices in host systems, punched tape-controlled telewriters and word processors in offices.

Digitisation

One of the decisive prerequisites for variable printing is the digitisation of information. Only discrete values that can be exactly differentiated will be processed, while analogue systems, as a contrast, permit an unlimited grading of value parameters.

Be it audio, video, TV or printing – digital technologies today have clearly conquered the media world and superseded analogue systems, and this despite the fact that on first sight contents seem to be defined less precisely.

The advantages though, are obvious: digitised data can be processed electronically, stored on and retrieved from data carriers much easier. Furthermore, digital information may be compressed and decompressed; the data can be reproduced to the dot and are completely interchangeable.

These benefits triggered the development of the so-called c-to techniques within the conventional printing industry.

From "computer to film" as one of the very basic stages of digitisation up to a print product generated in a completely digitised process, today's industry offers various complete and intermediate solutions.

However, not all printing methods can be integrated into a seamless digital workflow, and these "digital" printing processes, as of today, don't always cover all customer requirements.

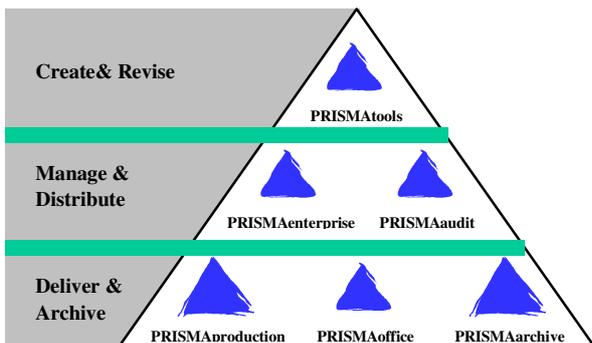


Figure 1. Electronic workflow architecture

Our objective is to define a seamless process from generating the original data input up to the final document, which does not require any change back to analogue media when being processed. In addition, archiving, re-prints and post-processing should also be tackled within the same medium.

Production Process

Variable data printing permits the user to arbitrarily change contents within the production cycle. This also applies, with certain limitations, to formats. This capability is a clear must for personalised print outputs such as invoices or insurance policies. Compared to conventional print production it also offers quite some rationalisation potential for small run lengths.

Traditional production methods are strongly tailored to distributing the individual production tasks, which in many cases does indeed lead to cost reductions. However, these methods are usually also rather time-consuming such that the finished output loses track with actuality and is not up to date anymore.

Best use of variable printing is made if, in order to generate the final document, no or only few additional non-digital process steps are required.

Solutions of this type need not and cannot be offered from one supplier. Neither do they have to be connected online all the time or integrated into a machine.

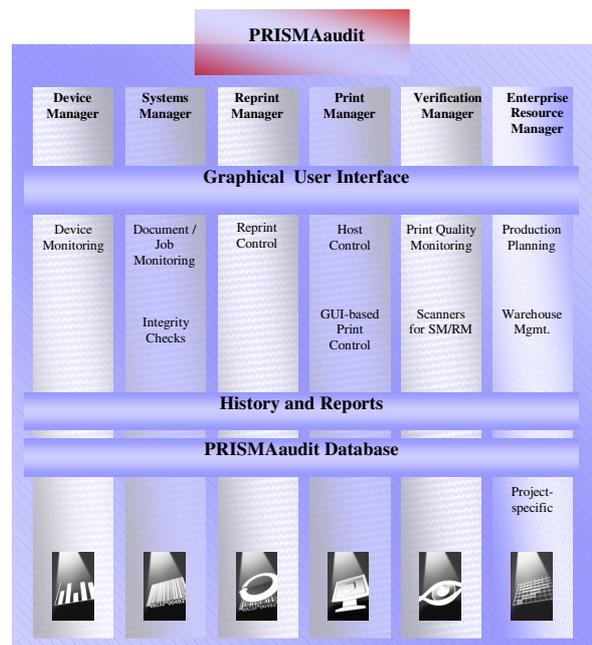


Figure 2. Management Systems

An indispensable prerequisite is the mechanical and electronic coupling between printers, pre-and post-processing units and uniform graphical user/operator interfaces.

Therefore we integrate and support initiatives such as UP³I, which helps to standardise the operation and connection of devices of different manufacturers.

www.up3i.com

By working with management systems such as PRISMA audit or Infoprint Workflow Manager we can augment the productivity and improve the workflow security.

Our aim here is to offer seamless printing solutions in an optimised process – starting from the paper input up to the ready-to-mail document.

Processing Print Jobs

Due to the ever-increasing availability of new communications devices and today's easy access to information data that grow on a daily basis, our clients have changed their consumer behaviour. This is especially true for print media.

Faced with an overwhelming flood of information, our clients increasingly focus their interest on issues such as data selection, authenticity, time to market and personalisation.

As a consequence of this change, but also owing to economical and ecological reasons, the requirements to a production process regarding flexibility, fast processing and targeted production volumes are on the rise.

From a technological point of view, digital printers meet and cover above challenges.

But there is also an entrepreneurial side to it: new areas of business are developing with new methodologies and sales and logistics channels that need to be adapted to these new tasks.

Requests for proposal, the processing of print jobs up to mailing and tracking the delivery of these documents to the customers are handled via the network or similar integrated structures.

Our objective here: The complete printing systems have to be designed such that they can be operated very flexibly. Short set-up times and easy handling features support the fast change of print jobs to be processed.

Workflow

Based on all the various origins of digitised variable data printing methods, various data formats as well as page and job description languages have developed in the course of time.

The various tasks along with technical improvements tied to individual device features have therefore inevitably entailed a lot of manufacturer standards that are not compatible to each other.

Up to now, no workflow specialist has succeeded in creating a one-for-all industrial standard.

Therefore an interchangeable data format is required that meets information technology demands regarding fast processing, a format which can be stored easily and which is easy to compress and decompress.

Format and structure of a document which usually contains information regarding typography, have to be strictly separated from the data format.

The job definition format (JDF), also referred to as "job ticket", describes the entire workflow within one processing cycle.

AFP/ IPDS (=Intelligent Printer Data Stream) is a data format tailored to the needs of IT technology. Here, we find exemplary processing standards which guarantee a secure production cycle including job tracking and error recovery, as is state-of-the art in the IT industry.

With "Imagestream" is a system solution in the market that stores print data in the same format that is later sent to the printer to process the job.

PCL is one of the widest-spread page description languages used in the office area, which permits the user to generate a page with utmost flexibility but which, owing to the environment where it is used, does not take into consideration larger jobs or their error recovery.

Postscript in turn offers the most versatile page generation tools that are independent of device-imposed parameters or resolutions of e.g. a film exposure device or a printer. This inevitably leads to low RIP performances which do not suffice to offer real-time processing with variable high-performance printers.

PDF is a format standard that can be efficiently processed but is very slow to recognise errors within the data string.

With XML we have a data format at our disposal that is much more powerful than the web standard HTML. Its proven advantages are the XML standards.

Workgroups such as the CIP 4 organisation strive for setting manufacturer-independent standards.

Until such a generally valid standard has been determined, requests for integrated workflow are replaced by manufacturer-specific solutions that are - at least in some cases – convertible.

The fact that data and formats are reproducible - particularly in full process colour printing – is the reason that uniform standards are indispensable.

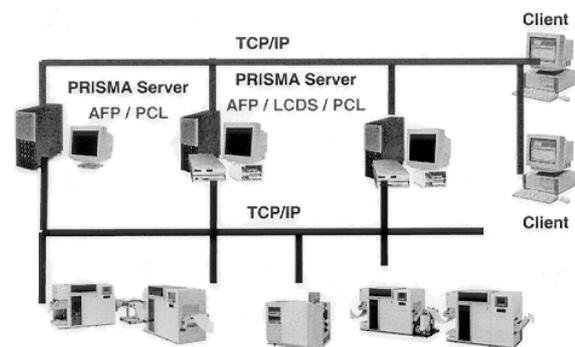


Figure 3. Multi-lingual Controller and Server

Our Objective: Create multi-lingual controllers and servers that can be interlinked via global networks such that no more obstacles thwart data exchange and workflow.

Consumer Behaviour

As the use of electronic communications media steadily grows, it is very difficult to foresee how the consumer will make use of print media in future.

Coverage of information required daily in Germany in 2000

Radio	209 min	On-time
TV	190 min	On-time
Internet	91 min	Utilisation online
Books	40 min	Readers above 14 years
School	16 min	Theoretical duration of talks teacher - pupil
Videotext	93 sec	Reading time
University, College Technological University	38 sec	Direct contact professor - student

Source: Gesellschaft für Konsumforschung, ARD/ZDF, Deutsches Studentenwerk, Media-Analyse, Stiftung Lesen, Kultusministerkonferenz

In contrast to all prognoses the consumption of paper has been on the rise continually. In the telecommunications business many more invoices are being issued nowadays printed on digital printers, owing to the strong growth of the mobile phone market. Even in the internet area several dozens of new magazines have been put on the market only in Germany (in the end user segment journals such as Internet Professional, Internet World, com!online and Tomorrow). And is there anyone who doesn't receive mail every week from AOL or CISCO, or other internet companies offering their customer information magazines?

In order to strengthen and further develop the competitiveness of print media, appropriate measures have to be taken.

The true challenge lies in the contents to be printed. Print media used for advertising have one unparalleled advantage: they can reach the receiver without there being any directly triggered activity (push market). Within the world-wide web, however, the consumer can only be directed to products if he either specifically searches for them or hits them more or less by chance while surfing the net (pull market).

There is one problem, though, that all readers have: the excessive - and often superfluous range - of information. This applies not only to advertising but also to specific topics.

Even today one is more or less forced to buy several reference books if one wants to read about one particular partial area of a topic in order to learn about the various approaches to the problem.

Imagine how very attractive it would be for a student to have at his disposal several data bases related to one special field, and if he were able to get various publications of different publishing houses including his professor's most current manuscript all in one paperback! And how nice would it be if you had the operator manual of your new TV-set not in five languages, but just yours. Also, life would be so much easier if you wouldn't stumble over the minute description of the diesel engine in your new car's user manual which your model is not even equipped with!

Unfortunately, the pre-conditions for customised print products are not yet established in full. In Germany, known to be on the leading edge regarding copyright laws, the representatives of authors' interests and those of information technologies have not yet managed to find agreement on reimbursement regulations. Without the consent of representative organisations for authors' rights such as "VG Wort or GEMA" (German organisations), there are still severe obstacles blocking an unlimited exchange of information.

Furthermore, generally accepted rules for electronic business have yet to be established. The "Napster" case shows how difficult it can be to develop a feasible business model that protects authors, artists and copyrights.

Objective: Define a standard that protects and safeguards copyrights and the handling of electronic business. With this standard set, the customer can be offered a product whose features and contents are exactly tailored to his needs.

Challenges for the Printing Industry

Given the changes described above, new features specifically related to variable data printing can be defined:

- A task-oriented printing production made of various small process steps turns into an integrated workflow system. The printing company has to handle also the asset management, i.e. text, image and page processing, as well as the print process itself and, very often, the entire finishing.
- The optimisation parameters are not the size of the run lengths anymore but the required quantities with an easy-to-handle option to trigger a re-print on demand. [Today, almost half of the conventionally generated printed matter is disposed of - and sometimes after years of expensive storage.]
- Individual and personalised print output calls for new logistics concepts in the print shop. Flexibility and speed required for order processing can only be established by means of multiple media and new business models.
- Software programs for accounting, archiving, re-printing and processing print jobs are key for these new business models.

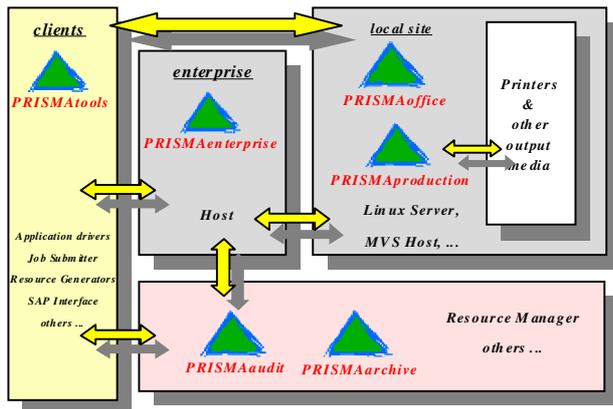


Figure 4. Software-Tools

Objective: Make print media more attractive and safeguard their competitiveness against purely electronic media.

Requirements to Printing Methods

Non-impact or electronic printing systems generate printed matter without any pre-set printing forme. The toner is applied to the paper in liquid or solid form either via carriers or directly. Contents can be modified arbitrarily and the format is limited only by the physical paper width lateral to the direction of the paper web. Along the web direction, there are in fact no format limitations whatsoever.

Electrophotography, magnetography, ionography and the inkjet technology are among the most popular technologies applied in variable data printing.

Quality parameters for these technologies are usually print quality as well as the cost and print performance compared to that of offset-printing.

Where-ever run length 1 is a must, we inevitably can compare only the various non-impact technologies. For reasons of cost but also of print quality, especially in colour printing, it is sometimes wise to give preference to hybrid solutions, even though they might be limited in terms of versatility.

The easiest way to print digitally is to print on pre-printed form paper.

Direct imaging methods such as a ctp-solution - offer another approach. Ctp permits the user to directly connect a conventional print press to a computer. This method, however, does not reflect a "true" variable data print process.

Objective: Find ways to operate flexible digital print solutions at the same cost and quality level as offered by conventional print processes and, in addition, utilise their specific benefits.

[Today, this can already be realised with many applications. If we compare digital printing with conventional printing, evaluating parameters such as set-up times, spoilage, handling cost etc., we find that the "Total Cost of Ownership" (TCO) enters the favourable area even with higher volumes. The benefits of digital

printing in the case of run lengths smaller than 1000 are obvious and beyond any doubt.]

Implications of Printing Methods

After being enthusiastic about quite a few high-flyers among dot.com and telcom companies, the printing industry has now returned to a more realistic evaluation of the future in this area. The idea gaining most acceptance is that communication media complement rather than replace each other.

Nevertheless, the printing industry has to face some substantial changes in their business.

During DRUPA 2000 it became obvious that digital printing has hit the road to success particularly with traditional manufacturers, and that, furthermore, the pre-press stage is on the verge of being eliminated as an independent process step.

For obvious reasons the software industry continues to support the exchange of information via internet, PDAs, WAP-capable mobile phones and "electronic paper" as a substitute for normal paper. Easy-to-handle LCD displays with very low power consumption features are to render to the customer a look-and-feel as if he was handling true paper. Contents can be downloaded via the net, mobile phones or chips.

Market Shares of Printing Methods in %

	2000	2005	2010
Offset printing	50	48	44
Flexo printing	19	20	22
Gravure printing	18	16	12
Digital printing	5	8	14
Desktop printing	3	5	6
Others (Letterpress or , screen printing)	5	3	2

Source: PIRA-study "The future printer"; Kodak, Deutscher Drucker

Objective: Thanks to its flexibility, variable data printing will take away market shares from offset and gravure printing.

[It is difficult to judge where the main work load will be found in future: in the print shop or directly at the end user's home. Any decision for a decentral or a central print solution will strongly depend on what manufacturers will offer regarding quality and economy of their solutions.]

Digital Printers

Frankly speaking, there is no such thing as the ideal printing method for all applications and performance areas.

Two technologies have established themselves within variable data printing:

- The electrophotography, a flexible flat-bed printing technology designed for single-sheet and roll-feed printing and very well suited for short set-up times and automated production

processes without start-up spoilage. The possible print volume ranges from a few A4 pages per minute up to over 1000 pages per minute in monochrome printing and more than 100 pages per minute in multi-colour printing.

- Inkjet technologies such as drop-on-demand or continuous jet are the two most integrated and compact technologies and thus perfectly suitable for the desktop area. The drop-on-demand methods are restricted in speed to very low volumes of just a few pages/min. A long expected approach to mount several print heads in parallel in order to achieve a performance of more than 100 ppm has not gained general acceptance, owing to reliability problems. The inkjet technologies (continuous jet) offer print speeds ranging above those of electrophotography. Engineers try to generate methods to create smaller drops and thus set up 600dpi resolution arrays. This is a pre-requisite for achieving a print quality and print media versatility that is comparable to that available with electrophotography.

The high controller processing performance required for variable full process colour printing results in limitations to print speed. Thus the processing speed of the printing method and the controller performance required have to be tuned in with each other.

Objective: Improve the electrophotography's versatility focussing on flexible family, platform or modular concepts in engine design.

[The ideal solution would be a printer that is easy to integrate in a print line, is capable to print monochrome and multi-colour, and which can be operated under very favourable cost conditions and with various print speeds that adapt to the respective controller performance.]

Print Colours, Print Quality

The print colour is a key component in every print method. As a consumable it has to be non-toxic, bleach-resistant, water-resistant, abrasion-resistant, versatile, long-lasting, easy to process and, last but not least, cost-favourable.

In the field of dry and liquid toners for electrophotography the development is far from being finished. Solutions must be found to get:

- dry toners comprising resins with a low melting-point (print speed) and quick-charge properties
- more stable charging behaviour at even finer toner particles and more intrinsic developer material (print quality)
- more efficient production methods such as chemically produced toners (profitability)

- colour toners that surpass offset colours in brilliance and bleach resistance qualities (colour space)
- colour toners that can be blended with each other (customised special colours, also referred to as custom tones)
- reduced emissions, especially in case of liquid toners that don't damage the environment

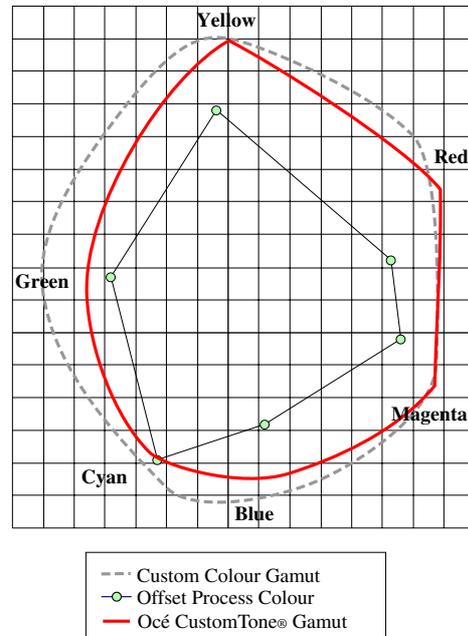


Figure 5. Colour space custom tone

These "chemical" further developments are supported by improvements in the construction of the engine itself, such as:

- fusing methods consuming less energy
- gentle development methods that prolong the shelf-life of the developer mixture
- control processes that help to eliminate the oscillations within the print process.

In addition, all other process steps within electrophotography are being optimised in order to improve the reproduction to tone values and colour spaces, specifically aiming at

- photoconductors with controlled process parameters.
- LED print heads with variable dot diameters and/or higher resolutions.

Today, 600 dpi is the established standard for high-performance printing systems. Higher resolutions such as 1200 dpi are still a challenge – particularly for the fast electrophotographic machines. But, in principle, 1200 dpi can be realised.

The other digital print technologies such as ink jet, magnetography, and ionography reach their limits in this resolution area, owing to manufacturing-related restrictions.

One of the challenges is the high data throughput which at this level of resolution reaches the gigahertz area. To screen and transfer this amount of data can be very cost- and labour - intensive and may not be justified in view of the print quality improvements to be expected.

In the case of pure text printing, we can, at any rate, "recognise" a 480 dpi resolution only if the developing units, the toner transfer and the fusing unit transmit and fuse the "electronic photography" (the latent image on the photoconductor drum) to the paper without any losses in quality.

From an economical point of view it is more feasible process texts with a resolution of 600 dpi, and, when reproducing images, to generate these with pixel diameters that can be varied in steps.

Smoothing algorithms permit the processing of other screens also with stationary character generators.

- Controllers capable to apply smoothing techniques and suitable colour management systems.

Objective: Achieve a print quality comparable to that of offset printing while eliminating spoilage and any sort of

manual quality control and monitoring within the production process.

Summary

Masses of commercials leading to a complete over-stimulation, an excessive availability of information, a "cost-optimised" surplus production of fiction books, new media systems competing each other whose main task in some cases is to produce and distribute junk data – this is the world of media that we have to face today.

Of course today's customers highly welcome the fact that knowledge has become an economic good available to everybody and on a global scale. We all should support this process – and not only for economic reasons.

By way of variable data printing, the print media can approach their customers individually and provide them with information that directly relates to their interests.

Customer Relationship Management (CRM) is the key word for the communication and relationship to a customer. The prevailing trend with regard to providing the customer with personalized data is to offer very small run lengths down to run length 1.

Variable data printing significantly contributes to a clearly outlined and well organised basic procurement of information.

Nevertheless, the main challenge remains to be met by manufacturers of products and system solutions: generate their customised print documents in such a way that they are even more competitive than comparable anonymous mass products.

Infoprint Workflow Manager, AFP/ IPDS, PCL, Postscript, PDF, LCDS, PRISMA, PRISMAaudit are trademarks from IBM, Hewlett Packard, Adobe, Xerox and océ