Aspects regarding the organization of printing production in the context of Industry 4.0

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Abstract. The development of information technologies has a strong impact on manufacturing systems, and the presence of the computer allows the efficient combination of various technologies needed for manufacturing into an integrated computer-controlled manufacturing system, which has also found utility in the printing field. The paper presents the results of the analysis of prepress, press (print) and postpress processes specific to printing companies in terms of integrated computer systems that make it possible to interconnect at the enterprise level. At the same time, were defined the stages, technological operations, procedures focused on the production structure through modern information and communication technologies. These represent goals of industrialization 4.0. Thus, functional and informational models, especially for prepress, were developed. The research methods involved in the study were observational, descriptive and correlational study. The results of the study indicate their usefulness to achieve high performance when raw printing materials are transformed into finished products.

1 Introduction

Manufacturing is a technical function of the enterprise, whose main role is to transform input resources into final material products or finished components, through a series of processes, with the active participation of the labour force.

The role of the "manufacturing" function is to bring together resources, materials, labour, tools, devices, technologies and equipment in a structured, organized way to produce the product [1].

The continuous development of information technologies has also had a strong impact on manufacturing systems, and the widespread use of computers and the internet has allowed the efficient combination of various technologies into an integrated manufacturing system. Thus, the strategic, tactical and operational level of the enterprise operates in a network, which makes production more organized and efficient.

Integrated computerized manufacturing has found use in various ways and in different manufacturing environments stemming from “targeted market strategies, available labour

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force, market size" [2]. In the printing industry this concept found its utility once the prepress field was marked by computer science, and the press field by the production of computer-driven printing machines (for example the ROLAND 700 sheet paper printing machines and the ROTOMAN). In order to successfully meet the challenges of the present and the future, but especially in the context of Industry 4.0 which has as principles: transparency of information, interconnection (devices, machines, people - in a network, communicating), technical assistance (through the information collected, visualized and easy to understand), the organization of manufacturing integrating the computer and the Internet is more current than ever in the printing field. All the more so as it includes not only manufacturing functions, but also design, administrative, economic, etc. functions. In this regard, there are note that in the printing field are involved a multitude of automatic manufacturing and production control systems - from accepting orders to receiving finished products, including prepress, press, postpress processes, with planning, statistics and archiving. All these contribute to the constant adaptation to the tendencies specific to the editorial-printing field, such as: the decrease of the circulations, the increase of the requirements towards quality and flexibility, the increase of the number of orders, etc.

The paper aims to present a structuring by classification and comparative analysis of various automated manufacturing systems with involvement in the prepress processes necessary for the organization of printing manufacturing and their efficiency.

2 Prepress processes based on PDF/X

The creative process (concept) involves the full involvement of the computer as a factor of integration of man and machine in order to design the product. The realization of the specific stages of the process of design and constructive-aesthetic creation of printing products is possible by involving specialized software and highly qualified staff who know and understand the succession of technological operations, continuous quality control and reflecting the results obtained in a domain specific manner. This multitude of technological operations requires the use of various computerized, specialized programs. Adobe InDesign is integrated with Adobe software, such as Photoshop, Illustrator or Acrobat. Enfocus PitStop Pro offers the possibility to create an Enfocus Certified PDF workflow, the essence of which consists in task information (in XML format), performing predefined prefight checks and controlling their execution [3, 5].

In conventional prepress process the files were developed only for print. With the appearance of PDF/X-6, different readers, writers and processors of PDF/X files will be able to process and interpret files according to the supplier's workflow (figure 1).

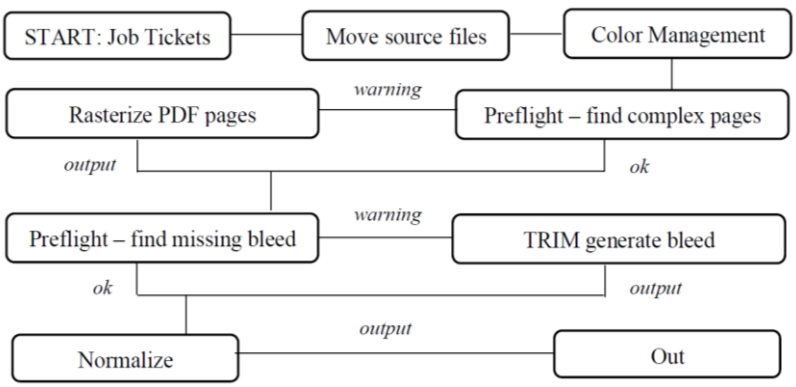

Fig. 1. Prepress workflow with the involvement of PDF files.

Since there is a multitude of data that are used to create the PDF files (vector, raster, text information etc.), there are a number of different software platform involved and also different workflows requirements, the need for a format to exchange the data without losing the integrity of the compound file was compulsory. With ISO 15930 the digital data exchange needs were covered with the use of complete exchange. Since this is a platform independent exchange, the files are not restricted just to CMYK, spot colour and can be upgrade to n-colorant print characterization spaces (figure 2).

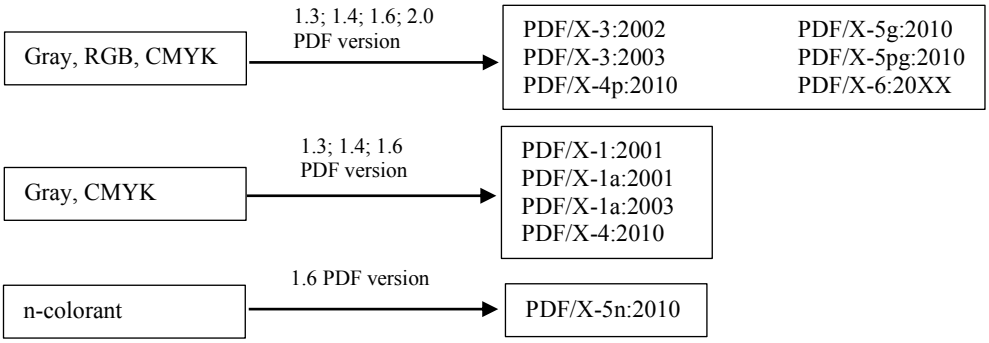

Fig. 2. PDF/X conformance levels.

During a traditional print output, the PDF/X file is used into a production workflow that includes a RIP (Raster image processor) that renders the PDF/X file. The rendered PDF file is used to generate rasterised data used for imposition, proofing and printing plate imaging.

With the use of the new PDF/X-6 file the data is used to produce multiple types of output: print, web or email. Since PDF/X-6 files are tagged with metadata (XML), they contain object and content description [9, 10].

One of the main advantages of using PDF/X-6 files is the ability to include page level outputs for each of the different component parts of a printed product. So, the printing workers are no longer bound to the document output and the need to create multiple documents for covers and interiors of printed products.

For example, for a special leaflet must made cover pages and interior pages. Since the cover will be printed using 5 colours (CMYK and a spot colour) on a high-grade glossy paper and the interior will be printed on a high speed headset offset machine on a SC paper, with the use of PDF/X-6 the designer will create only one single file with appropriate page level outputs [6, 8, 10].

During the validation part of the prepress process, the files will be checked using metadata embedded. After validation the files are processed using the RIP workflow and automatically distributed using the correct workflow based on the embedded page level output intents. The high level of ruled based automation used by the RIP software workflows reduces the time needed to complete the production.

The imposed production files are checked for correct imposition. Imposition refers to the process of automatically gathering the pages based on the materials stored on the servers, according to templates, arranging the pages so that once the printed signature sheets are folded and trimmed, the pages will appear in the correct order (figure 3).

Since PDF/X-6 is optimizing the features of previous PDF/X versions, the optimised files resulted are less likely to create issues during the production processes.

It is also important that CxF/X data can be easily embedded in a PDF/X file, allowing for colour and print data to be exchanged. This is very important because there is a correlated use of colour data and their relationship to the actual state of the press process parameters [4].

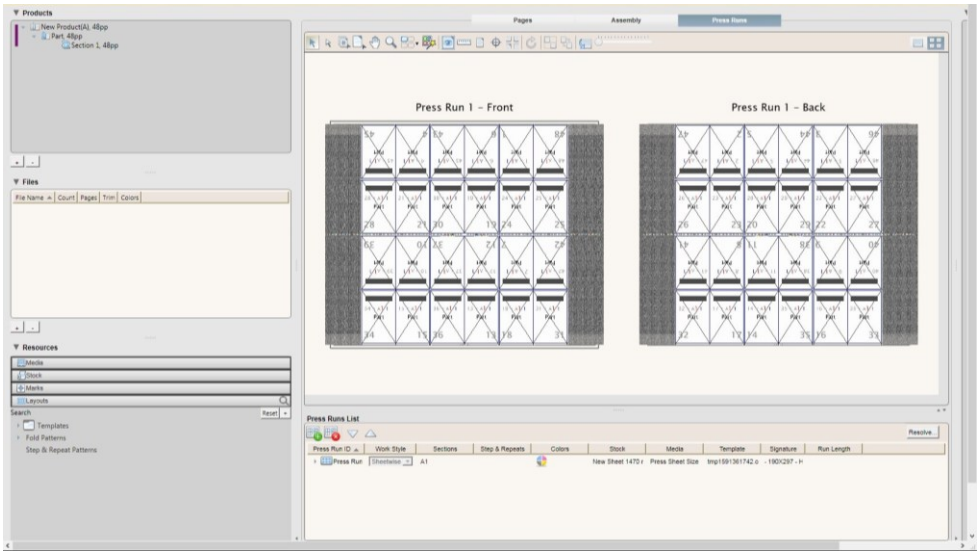

Fig. 3. Front and back signatures for a 48 pages imposition in Kodak Preps software.

3 JDF to XJDF differences during production

Another use of XML data can be found in the Exchange Definition format (XJDF) designates that the job ticket exists in management application only as a representation. Management applications are very diverse and they involve both information system and prepress, production control systems. JDF reports the interface in the middle of management applications and applications that implement the work instructions.

In printing processes, the purpose of an integrated computerized manufacturing is achieved due to the development of the concept JDF who report the information about a job or a technological process. An early version of XJDF is CIP3 (International Cooperation for Prepress, Press and Postpress). This interface contains information on both the ink application process and the administrative date, such as work name, work number, sheet number, sheet side (front / back) and even the customer's name. It can also be extended to production settings such as sheet size, ink name and even the location of the colour bar for side colour measuring equipment, job preview (figure 4) [7, 10, 11].

JDF is make use of to present data and automatically activate job tasks, and various degrees of job automation. Also, it can create new printing jobs, and automate the imposition and position of the files in the imposition (figure 5).

Using Kodak Prinergy workflow and Hiflex MIS, JDF creates job tickets that specify the imposition requirements in its data, so it can autogenerate press run list via template signature matching.

When there is open the MIS JDF file, the software will examine the data and will attempt to resolve the requirements. The automation process can be controlled with the help of the preferences options. It can be used “Signature Creation”, where it will be choose the automation method used to create the Press Runs List, or it can be used “Match only” option which will always try to build the Press Runs List by go whit the requirements to existing template signatures, and not at all automatically create press-run layouts (table 1). This going by the name of auto signature matching (ASM). Also, the imposition job can be created by using trigger parts: Check sheet size, Check work style, Match finishing properties to fold pattern templates, Check head and foot trim etc.

```
%!PS-Adobe-3.0
%%CIP3-File Version 2.1
% m_negativePrint:0
% m_mirrorPrint:0
% m_mediaClipRect:( 0, 0 )-( 4166.92919921875, 3617.008056640625 )
% m_plateRect:( 0, 0 )-( 4166.92919921875, 3617.008056640625 )
% m_appendNumSepsToFileName:0
% m_useOldPecomSpec:0
% m_deleteFilesAfterFTP:0
% m_sendFileUsingFTP:0
% m_imageHeightInPoints:3617.01
% m_imageWidthInPoints:4166.94
% m_rotateWithPreviewMatrix:0
% m_mirrorWithPreviewMatrix:1
% m_rotateCtpToPress:0
% m_replaceUnderscoresFromJobName:0
% m_useImpoNameForAdmJobName:1
% m_useSigNumInSheetNum:0
% m_bOutputJDF:0
% m_useImpoNameInFilename:1
% m_outputLowPageNumber:0
% m_truncateJobName:0
% m_writeMode:2
% m_outputType:1
CIP3BeginSheet
/CIP3AdmJobName (M3_93368_FoodNF_48p.1 SIG001) def
/CIP3AdmJobCode (93368) def
/CIP3AdmMake (Creo) def
/CIP3AdmModel (Prinergy) def
/CIP3AdmCreationTime (Thu Mar 11 12:05:38 2021) def
/CIP3AdmSheetName (Sheet 1) def
/CIP3AdmPlateType () def
/CIP3AdmPSExtent [4166.94 3617.01] def
/CIP3AdmPlateTrf [1 0 0 1 0 0 ] def
/CIP3AdmPlateExtent [4166.93 3617.01] def
/CIP3AdmPressTrf [1 0 0 1 0 0 ] def
/CIP3AdmPressExtent [4166.93 3617.01] def
/CIP3AdmPaperTrf [1 0 0 1 0 -34.441 ] def
/CIP3AdmPaperExtent [4166.93 3514.96] def
/CIP3TransferFilmCurveData  [0.000 0.000 1.000 1.000 ] def
/CIP3TransferPlateCurveData [0.000 0.000 1.000 1.000 ] def
CIP3BeginFront
/CIP3AdmSeparationNames [ (Black) ] def
CIP3BeginPreviewImage
CIP3BeginSeparation
/CIP3PreviewImageComponents 1 def
/CIP3PreviewImageWidth 723 def
/CIP3PreviewImageHeight 628 def
/CIP3PreviewImageMatrix [723 0 0 -628 0 628]  def
/CIP3PreviewImageResolution [12.5 12.5] def
```

Fig. 4. CIP3 definition file created during final exposure of the plates in prepress.

Also, during the automated imposition selected process, it can be added Smart Marks by using Mark Rule Editor to build the criteria for each rule and to pick the marks that are added by that rule.

The JDF data output can be printed, which include works which does not aim on MIS JDF data. By saving a JDF-based job as a regular JOB file, and you can also be printed to any of the supported output types. JDF output files contain all the information necessary to re-open and automatically reconstruct the job.

Other features of JDF output include:

- if fold patterns are used, fold information is included in JDF output for use by JDF-enabled bindery equipment;
- colour mapping and web-extension are supported and can be structured in the Print dialog packet;
- in the Print dialog packet, it can be exported CIP3 cutting data by placing it inside the JDF output file or by printing the work twice: to JDF and to PPF; it will depend on the postpress system capabilities;
- any Run Length values specified in a job's Press Runs List are included in the JDF output.

a) process group for 4 pages catalogue

b) process group for two part brochure

c) full job

Fig. 5. Different types of JDF used for job creation.

With the switch to new XJDF format there is possible to automate and control more parts of the production processes. XJDF by the fact that he became estranged from non-standard XML structure and that it does not operate directly with specific JDF instruments, this format is a much simpler version of JDF.

So XJDF made it possible to remove duplicate descriptions of print work and to detach any uncertainty compared to the way the product is described. With XJDF there is absolutely only one way to create a job ticket. And everything has its place; the way it is ordered things does now matter.

Another major difference is that JDF couldn't support product ganging because it was too complicated – it was aimed at one job for one product. But XJDF can handle many products in one job.

Table 1. JDF requirements for autogenerated data.

The content of JDF data	Destination	The action	The steps taken
Reference to valid template from the Templates folder	ASM, ASC, ASM/C	Ignores the profile settings, and generates the assembly and press runs based on the referenced template	Check the generated press runs in the **Press Runs** view, and make any necessary adjustments before printing.
Sufficient stripping data	ASM	Based on the **Matching Criteria**, tries to match the mandatory JDF	Check the necessary information in the

no template reference		values to the values in an existing template (within the profiles **Match Tolerance** limit) and if successful, generates the assembly and press runs based on the template	**Press Runs** view and in the **Properties** pane, for adaptation before printing process. If automatically was unsuccessful, it is possible manually.
	ASM/C	Based on the **Matching Criteria**, tries to match the mandatory JDF values to the values in an existing template (within the profiles **Match Tolerance** limit) and if unsuccessful, generates the assembly and press runs based on the JDF values	
	ASC	Applies the JDF values to the intent properties, and generates the assembly and press runs	
Insufficient stripping data	ASM, ASC, ASM/C	Highlights the missing properties and generates a minimal assembly or no assembly	The specific properties and requirements of the product to be printed must be reviewed.

XJDF does not require a workflow to be structured individually, it is as efficient as a work system that has only one controller and device.

It should be mentioned that XJDF is characterized by input and output terms. The materials used and the working parameters they control are part of the inputs, like parameters for imaging the cover of a brochure might include requirements for trapping, raster image processing, and imposing the image. At the same time the output it can be a raster image.

Usually a printing product involves several technological steps to make it. Referring to XJDF, it is worth mentioning that it will completely define any of the steps involved. if the receiving device needs specifications of the connections between the stages of the technological process, then these can be viewed in XJDF. Otherwise, these interdependencies should remain opaque and be processed in a proprietary manner by the job controller.

4 Conclusions

During these challenging times, the need for automation is higher than ever. With the production margins running low in terms of time, money, personnel and resources, implementing the use of PDF/X and JDF can create a series of benefits for the companies involved in the printing industry. So, time and money can be saved.

Data entry is reduced to an absolute minimum, as data from the costumer is transferred directly to the prepress workflow. The information about printing products, customer data and work-orders are stored and data is automatically transferred to the related fields. It can be reduce the errors, because manual transfer of information is not used and so is possible to prevent data entry errors

The time for the printers to setup the printing machines is smaller by the use of CIP 3 files, because the ink zone openings are predefined. The ink consumptions can be monitored during production, not just by the end of a print run.

It can be standardising the processes and it can be monitor them much more easily.

The integration of the automated steps can be used to trace the product from the order making to the delivery of the final product to the customer.

The quality of the printed product can be monitored as a whole during the production steps, and the errors can be quickly solved.

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