The Power of Print
Evolution of Print Media Production through Digitalization, Innovations, Electronic Media and Market Demand

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Abstract / Short Version

This paper gives an overview on the state of the art in print production systems and methods, applied printing technologies and their positioning within the graphic arts, communication and media/multimedia industry including the description of trends for further developments (figs. 1, 4, 10, 23, 24, 25, 26, 27, 28).

Digitalization allows the linking of the production/ workflow sections prepress, press and postpress and can lead to print production systems which include all these three conventional sections (figs. 8, 15, 23).

The high quality of print media and their economical production is based on powerful printing technologies and systems. Conventional printing technologies for high productivity which use plates (figs. 1, 2, 5) as well as masterless NIP (non-impact printing) technologies (figs. 1, 3, 15, 16, 25) are realized in commercial systems. The combination of several different printing processes (Figure 11) leads to hybrid printing systems which are optimized for special applications and versions for print media (e.g. offset and ink jet, Figure 13) for personalization/customization and print quality improvements etc. (figs. 2, 12, 14).

New technologies make distributed, print on demand production and fully variable printing page per page possible and economical (figs. 9, 10). The driving force for doing this was the digitalization in prepress, digitalization of workflow, equipment, processes and tools to describe the print product to be produced completely with one data file (Figure 22), as well as advanced printing and finishing systems, networking (Figure 8) and the communication techniques (Figure 35) which are available. Printing via the net, measurement and automation control techniques and systems, remote proofing, all the computer to ... – technologies (Figure 4, 32) for digital print production and the production of multimedia products (Figure 23), are established and secure high quality multicolor print media (figs. 17, 18, 19, 20, 21) within the world of E-commerce and global communication.

All in all, print media do not compete with electronic media, only some partial replacement effects for special print products and applications, e. g. dictionaries, can be observed; the synergy effects between both kind of media support each other and lead also to cross-publishing and multimedia products (Figure 37). The demand for print media is growing continuously, also as an effect of the high growth rate of electronic media (Figure 24). Premedia as a new section in the workflow – in front of prepress – creates and provides a digital master for producing printmedia and/or electronic media (Figure 23). A hybrid / multimedia product is, for example, a conventional book which includes a CD-ROM, especially with search functions and animations added to the file, describing the content of the book itself.

The power of print can be clearly recognized by the high quality which is available at relatively low costs, the great volume and demand of printed products and their high variety (figs. 25, 26, 33, 34). The power of print is also confirmed by the innovations in technologies, systems and applications, with realization and the strong demand for different systems for digital printing (Figure 28).

Synergies and innovations allow the creation of new components within a printing system and continuous improvements. Image processing, new materials, optoelectronic and micromechanical components are being developed in the labs worldwide and used in improved or new systems. Short comments/information about "X"-graphy (Figure 1) – new NIP-technologies like Elcography, TonerJet, Direct Imaging Printing, Zurography and "Ink mist jetting" are given.

There is a wide field of interest in interdisciplinary scientific, research, engineering, system and product design and for customer-friendly solutions and applications within the graphic arts and communication industry; these are challenges and chances to enter the market with new ideas and systems in time, successfully for all partners – users, suppliers and customers (Figure 39).

The presentation covers this wide field of subjects and gives an overview on the state-of-the-art status and the future trends (figs. 24, 25, 27, 33, 34, 38). A selection of examples are shown and explained for the different printing and production systems optimised for several applications. This especially for offset and flexographic printing including direct imaging techniques (figs. 2, 5, 6, 13) as

well as for the leading NIP-technologies electrophotography and ink jet (figs. 3, 14, 15, 16, 25).

Examples for innovative new technologies and product concepts which are "on the road" to be checked and used in practice are mentioned like E-book, E-ink, E-paper (figs. 29, 30, 31), erasable and rewritable substrate/surfaces with storage capability (fig. 6, 7), OLEDs, MEMSs (e. g. digital micro mirror devices) and PLZT-light valves for designing new imaging systems, etc. as well as improved and new print production techniques and systems.

The following list of figures (mostly based on Ref. 1) should be like a "red line/road map" through the evolution and world of print media production, provide summarized key messages and information and describes the content of the presentation:

1. Printing Technologies and Printing Systems

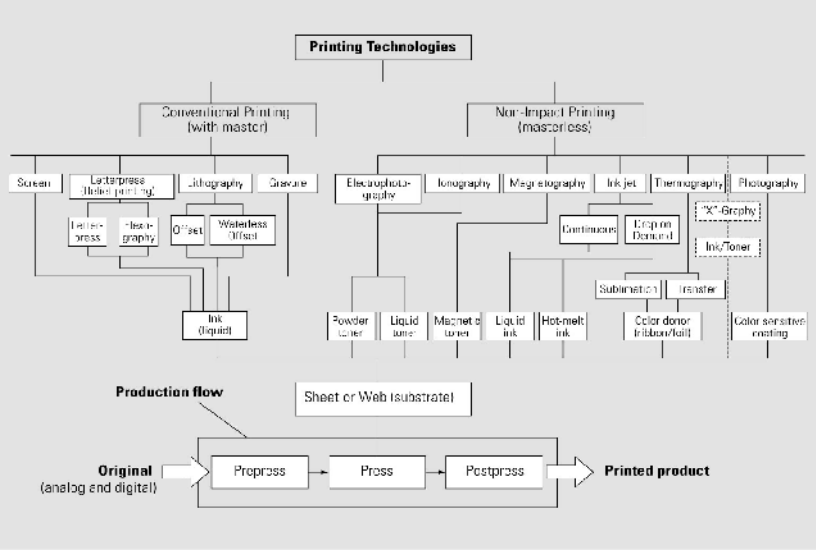


Figure 1. Printing technologies and production flow for print media

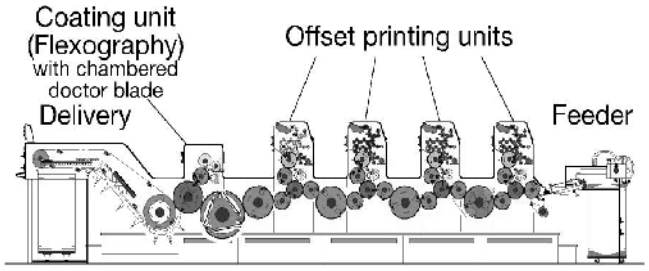


Figure 2. Multicolor sheet-fed offset with coating unit (flexography), (SM 74-4P+L: 5000 A2 pph/1000 A4 ppm, Heidelberg)

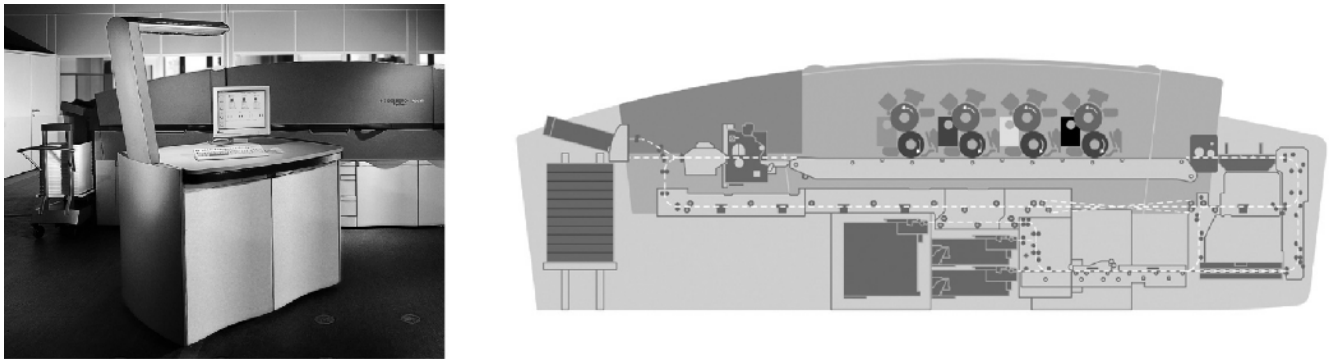


Figure 3. Digital production multicolor sheet-fed printing system with NIP-technology of electrophotography (NexPress 2100: 600dpi, 70 A4 ppm/2100 A3 pph, Heidelberg/Kodak)

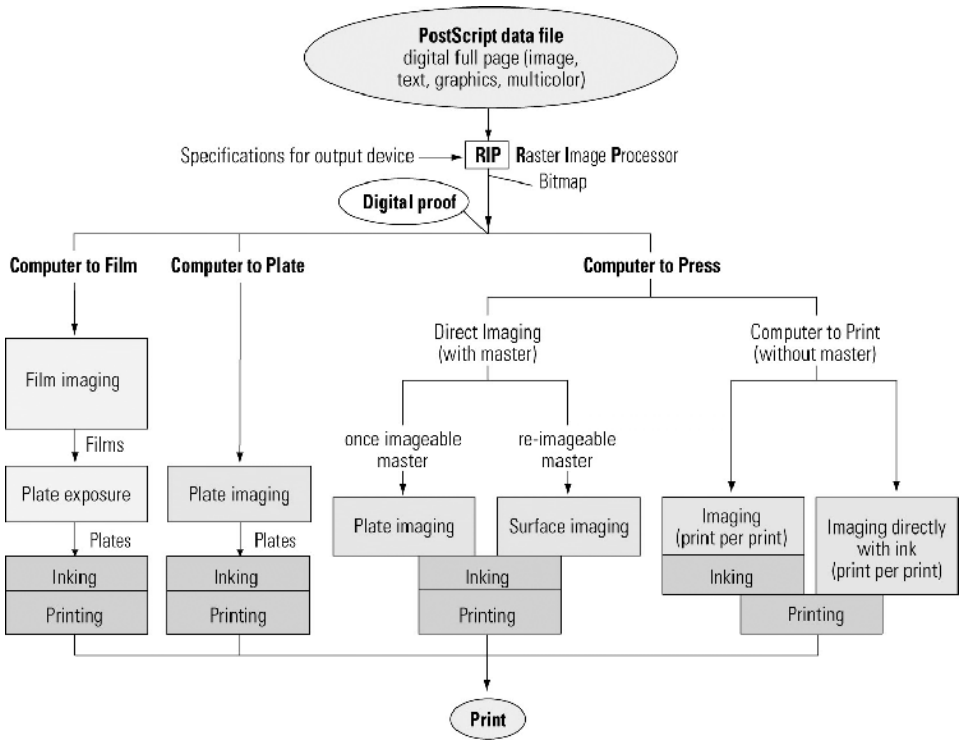


Figure 4. Computer to …-technologies

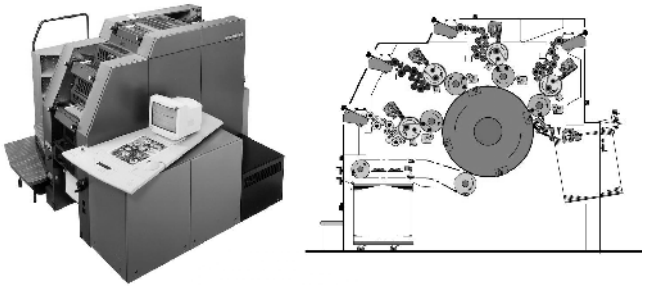


Figure 5. Computer to press/direct imaging system for multicolor waterless offset printing (Quickmaster DI 46-4: 1270/2540 dpi, 333 A4 ppm/10000 A3 pph, Heidelberg)

Figure 6. Computer to press / direct imaging system with erasable and re-imageable master (sleeve), (DICOweb Litho, lab prototype/1995, MAN Roland)

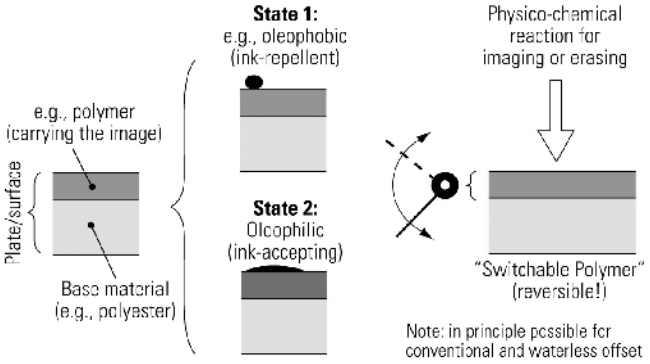


Figure 7. Concept for rewritable surfaces for re-imaging without material deposition or ablation ("Switchable Polymer")

2. Production of Print Media

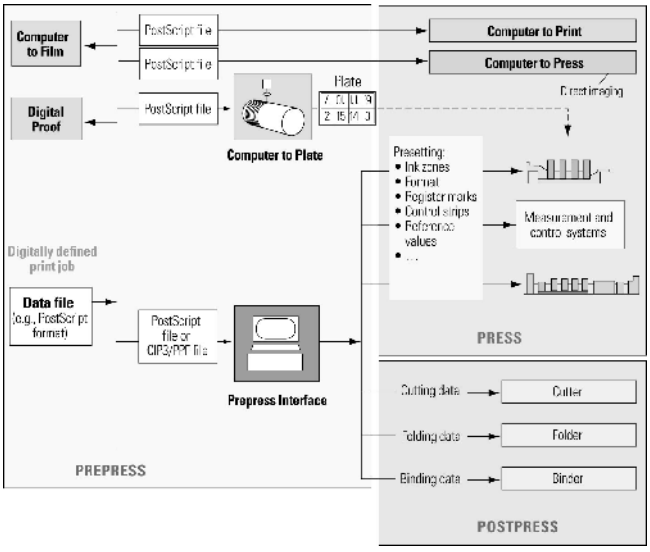


Figure 8. Networked print media production based on digital prepress and computer to …-technologies

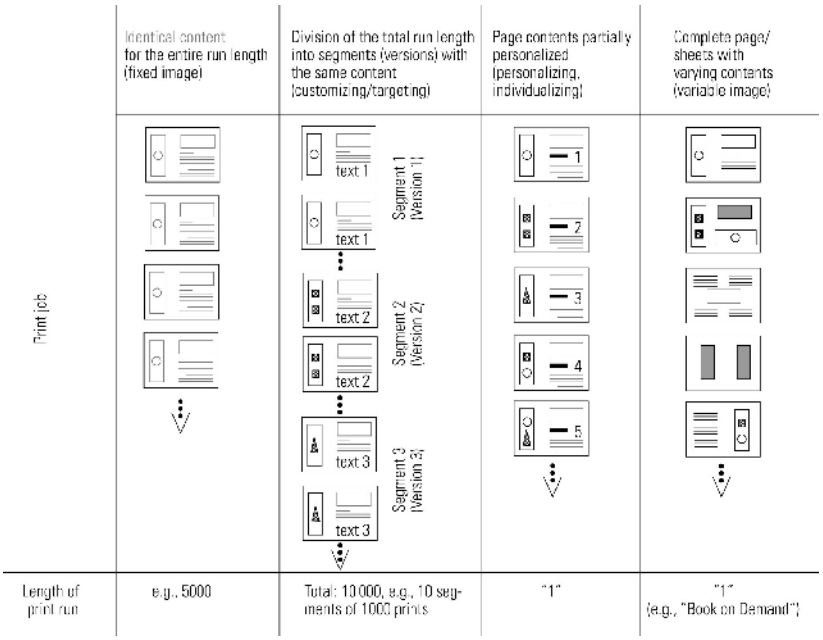


Figure 9. Examples of print jobs with identical, partially variable and fully variable content page by page

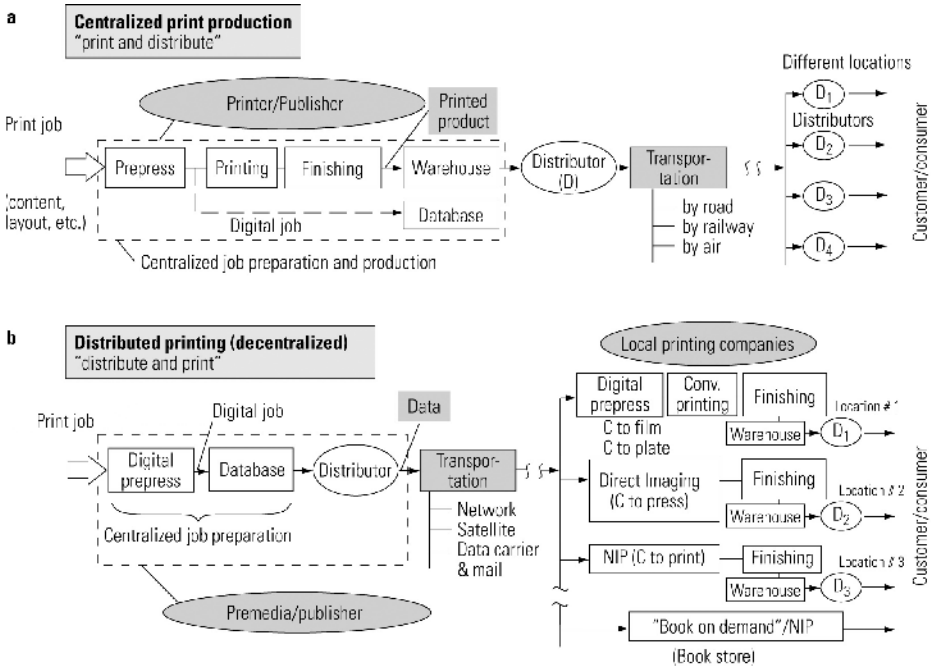


Figure 10. Production methods and strategies with distribution channels for print media. (a) Print and distribute; (b) Distribute and print

3. Hybrid Printing Systems

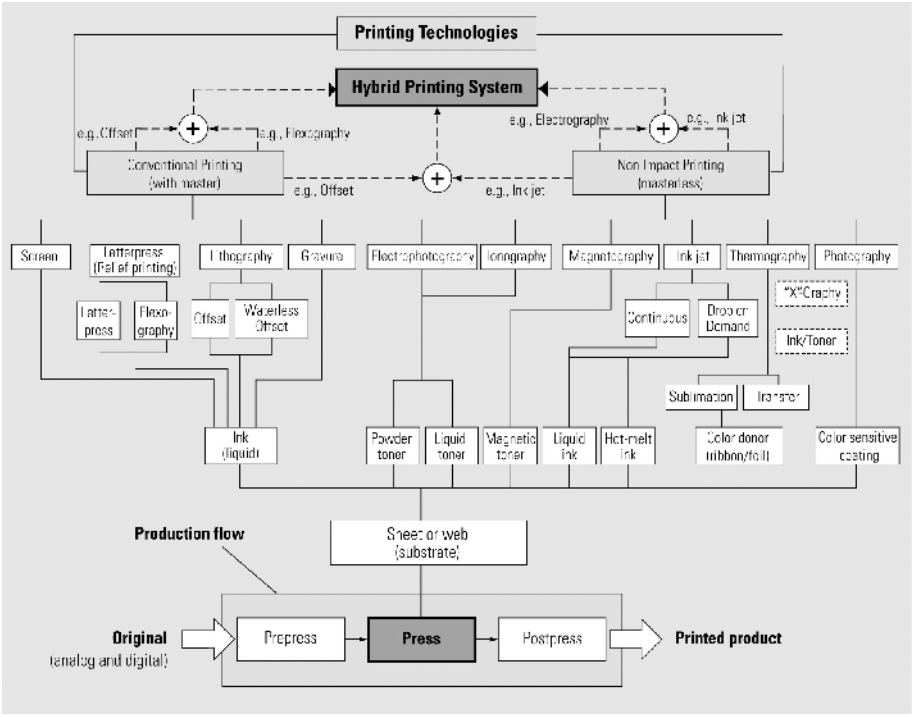


Figure 11. Hybrid printing systems: combination of various printing technologies

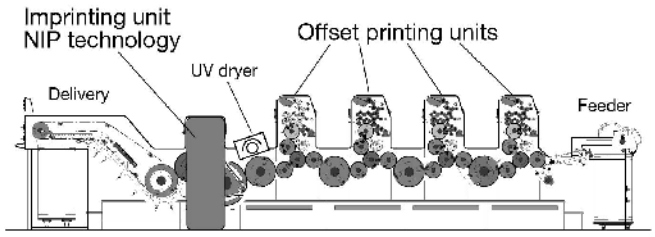


Figure 12. Hybrid printing system combining offset technology for multicolor printing with NIP- technology (for example ink jet or electro-photography) for imprinting additional, variable information

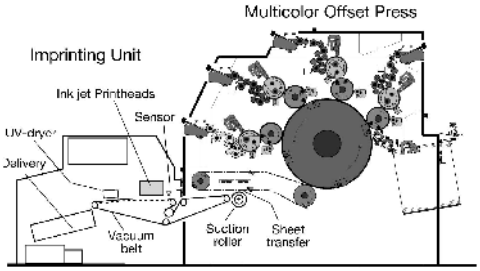


Figure 13. Hybrid printing system combining computer to press / direct imaging (waterless offset) with NIP- technology ink jet imprinting unit (pagewide head, piezo drop on demand system), (concept study / lab prototype, Heidelberg)

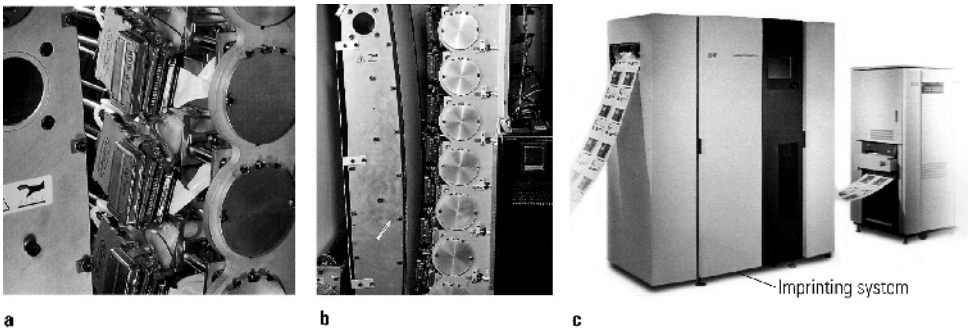
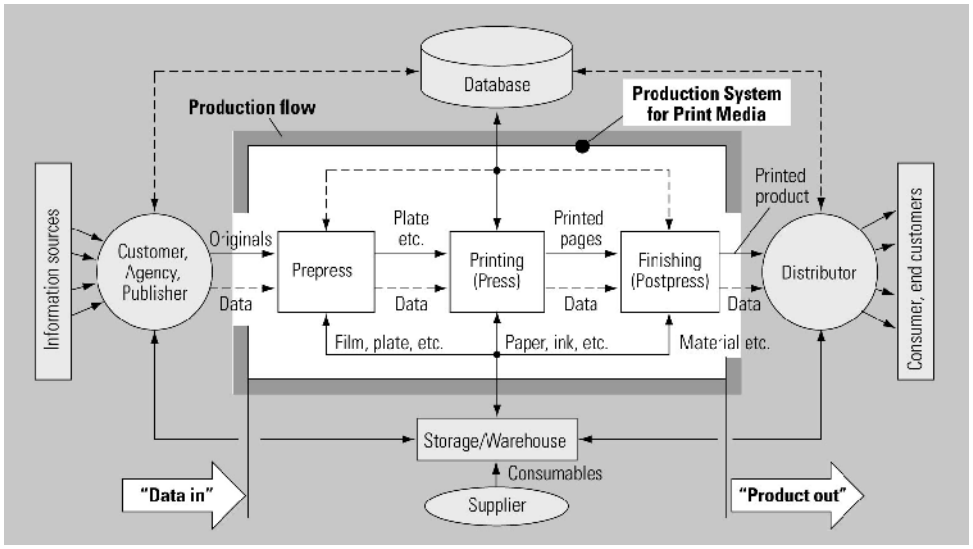
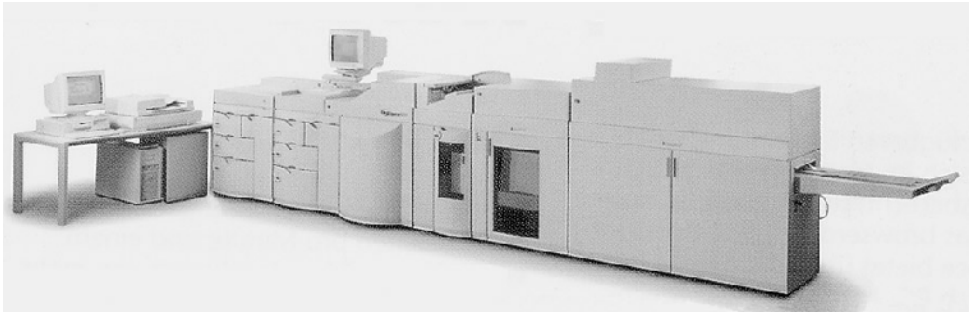


Figure 14. Hybrid printing system combining NIP-technology of electrophotography (monochrome printing) and ink jet (spot color imprints) a, b) Ink jet heads and web guidance Printing system: InfoPrint 4000 & InfoPrint Hi-Lite color (IBM / GroupSET)

4. Inline Digital Print Media Production



a



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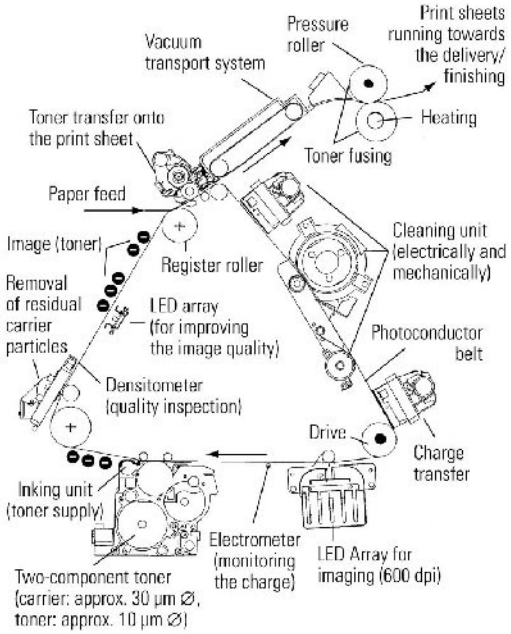

Figure 15. Integrated print media production system for "Data in, Product out". (a) Production workflow and system components; (b) Example: Digital production printing system Digimaster 9110: 600 dpi, 110 A4 ppm (Heidelberg)

Figure 16. Digital printing system for monochrome document production. (a) DocuTech 6180:600 dpi, 180 A4 ppm (Xerox); (b) System design: DocuTech 135 (Xerox)

5. Print Quality

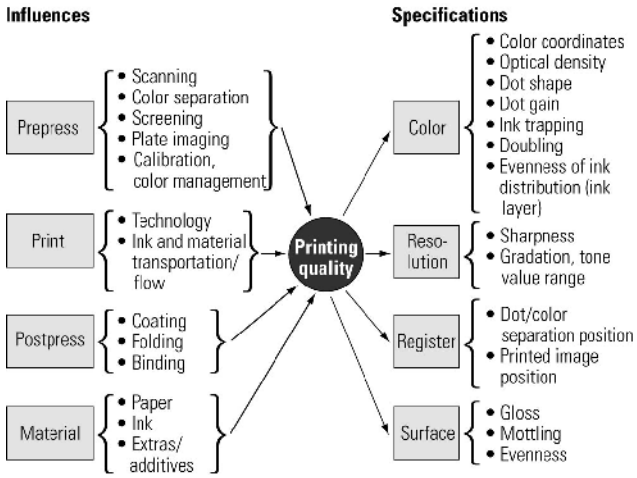

Figure 17. Print quality: factors of influence and specification determining the quality of the print

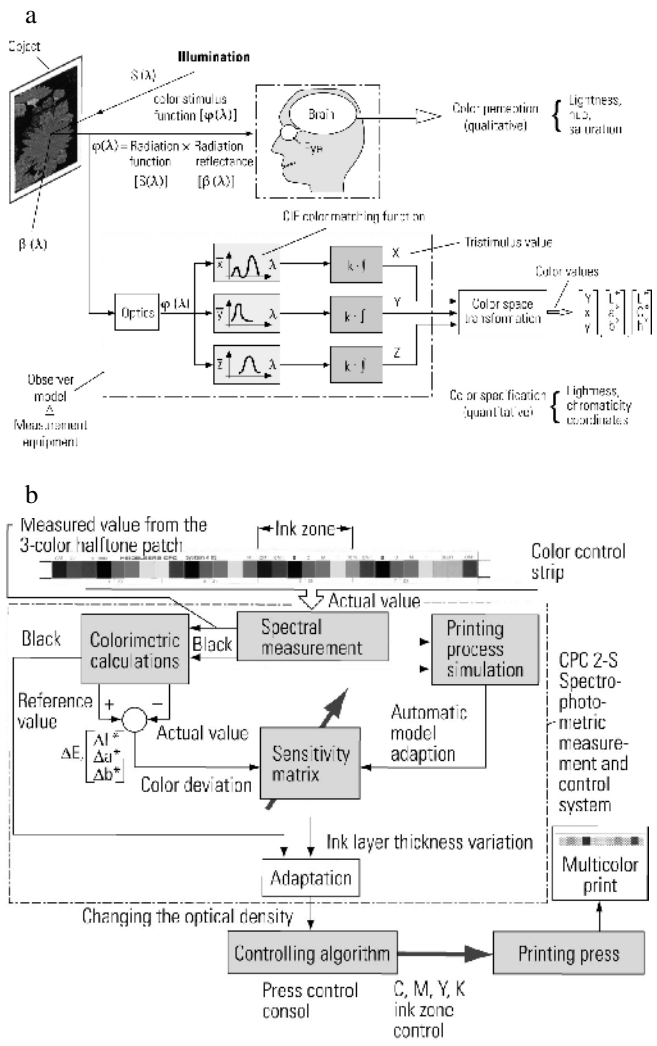

Figure 18. Color measurement and control Model for human color perception and basic design for measurement systems Block diagram for converting color variations for adjusting the ink supply with a printing system

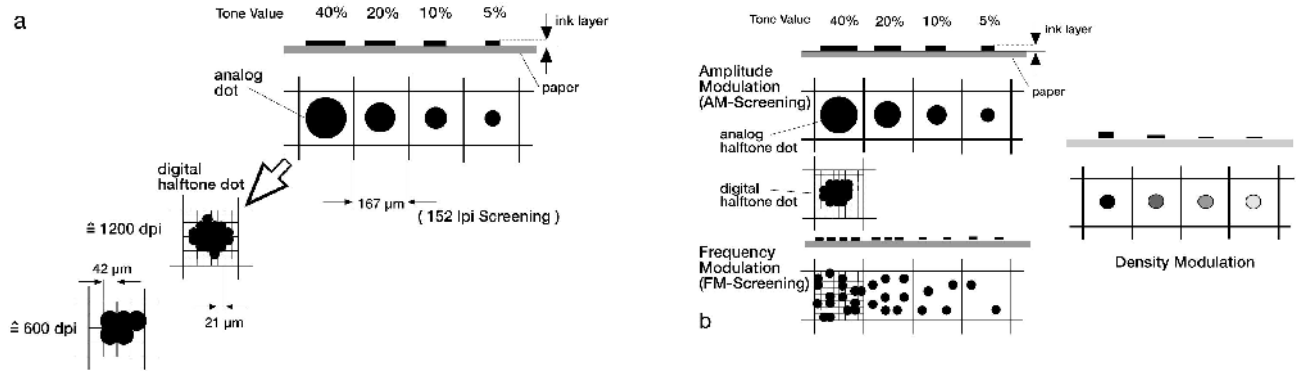

Figure 19. Screening technologies and digital halftone dot creation. (a) Digital dot creation; (b) Continuous tone reproduction with amplitude-modulated (AM) screening, frequency-modulated (FM) screening and density modulation

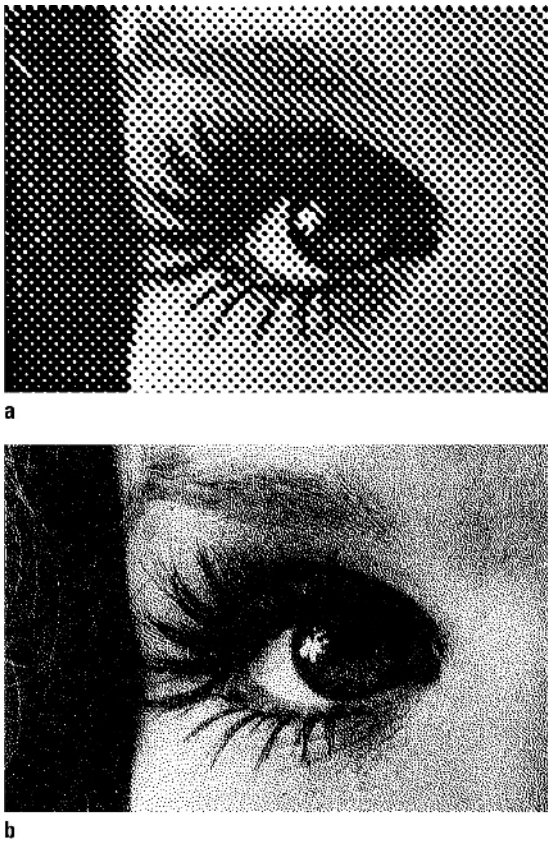

Figure 20. Comparison of AM and FM screening. (a) AM: amplitude-modulated; (b) FM: frequency-modulated (stochastic)

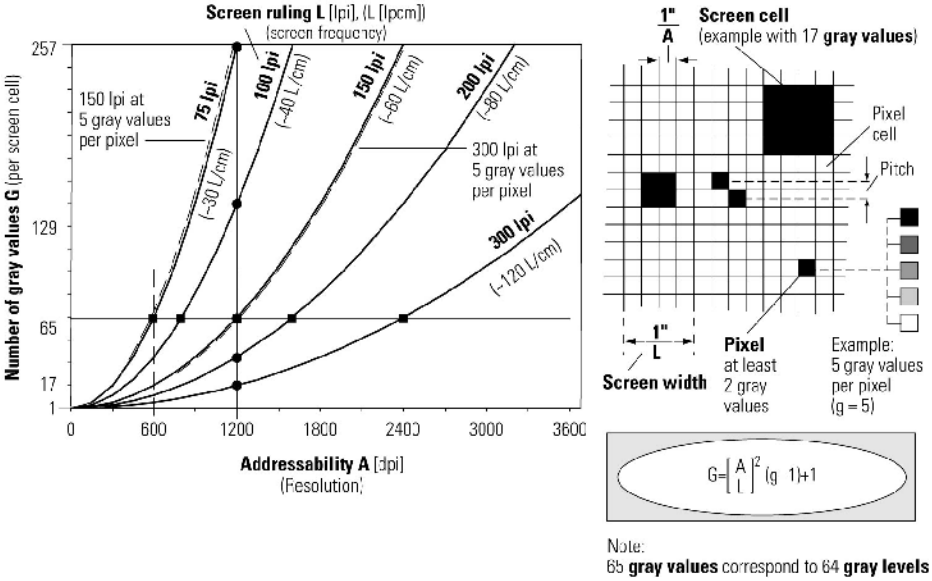

Figure 21. Correlation between screen ruling (screen frequency), addressability (resolution) and gray values (gray levels+1) for digital imaging and printing

6. Print Media and Electronic Media

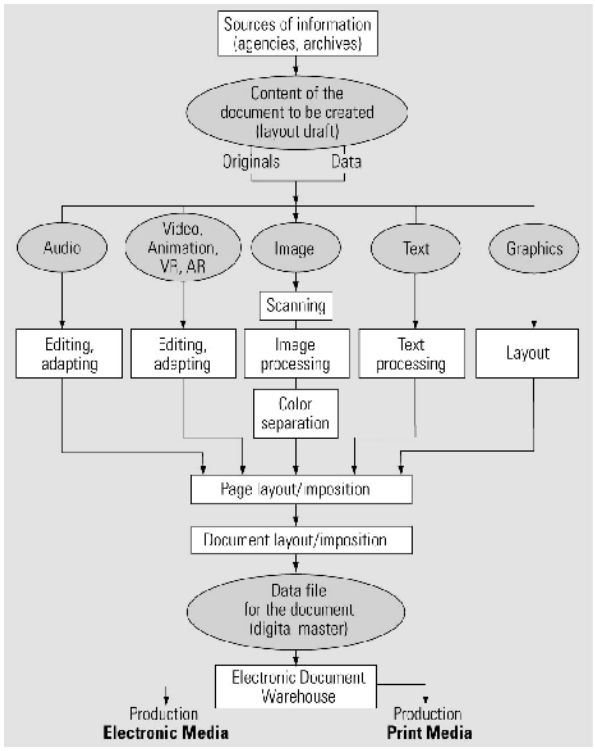

Figure 22. Digital document/master production for print media and electronic media

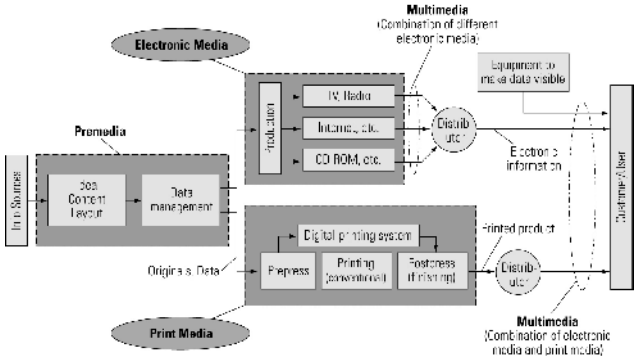

Figure 23. Production flow for print media, electronic media and multimedia

7. Positioning and Trends in Print Media Production

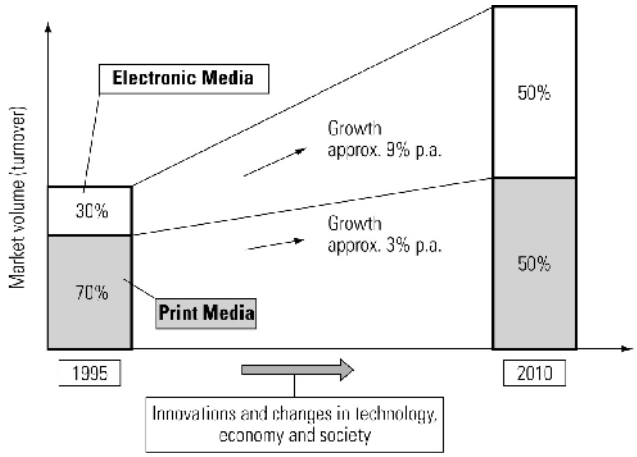

Figure 24. Trends of application/demand and market shares of print media and electronic media

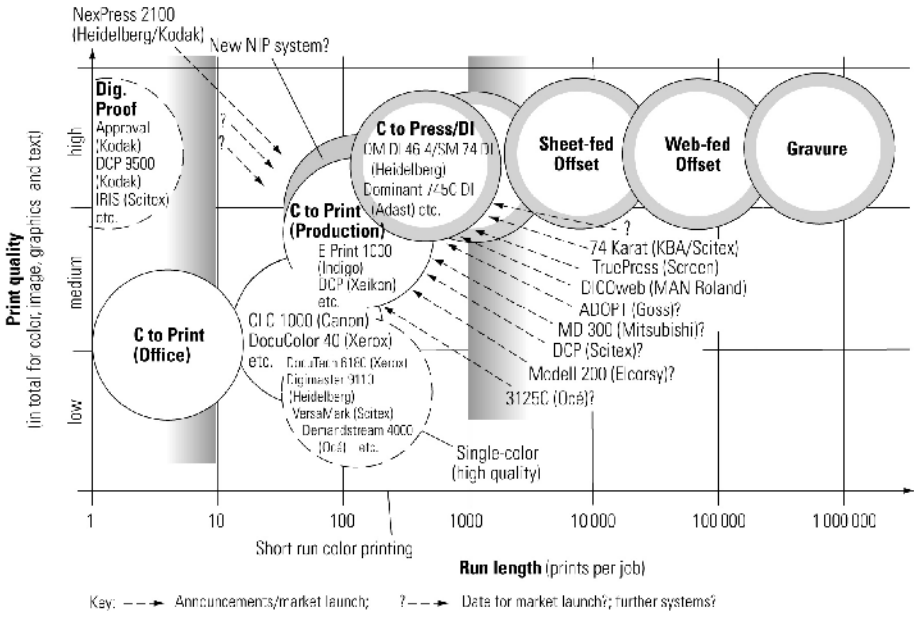

Figure 25. Positioning of printing processes, technologies and systems for multicolor printing

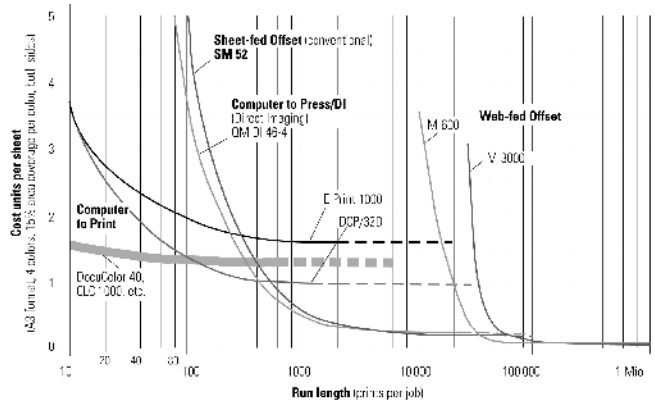

Figure 26. Comparison of the total cost of ownership (TCO) for multicolor printing using different technologies and selected printing systems (status: 1999)

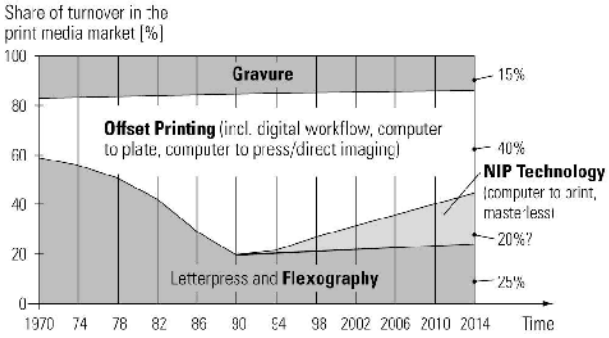

Figure 27. Portion of the use of several printing technologies for print media production (status and trend)

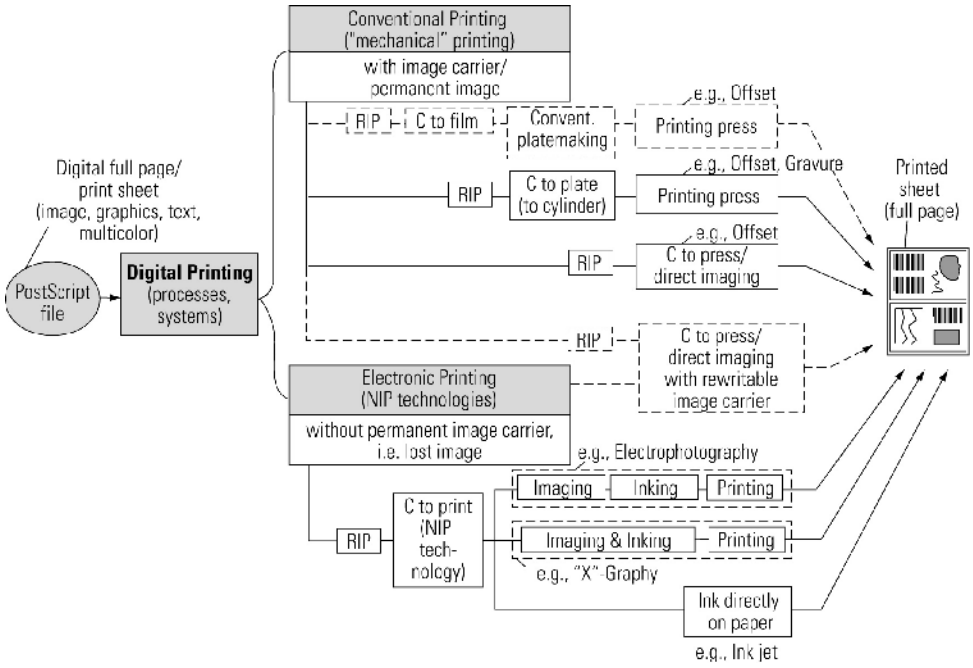

Figure 28. Digital printing: processes, components and systems

8. New Concepts/Developments for Electronic Media

Figure 29. Electronic book (E-book). (a) Rocket eBook/NuvoMedia; (b) Concept study with roll-out screen (Philips)

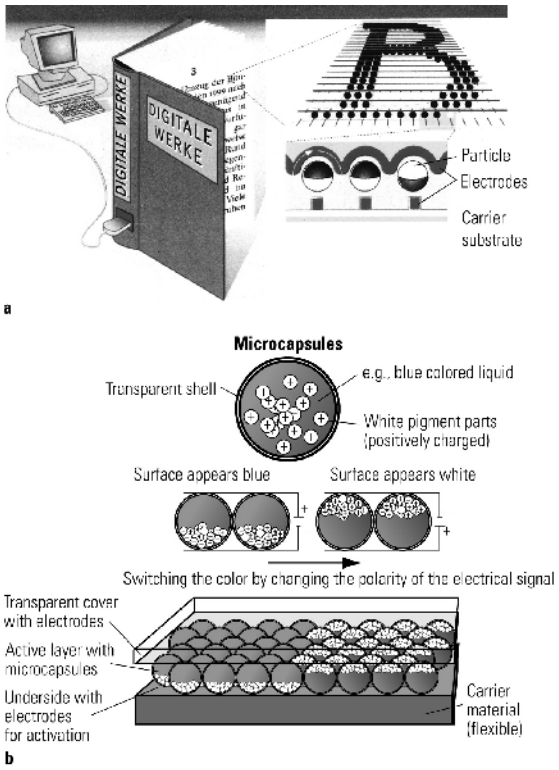

Figure 30. Concepts for setting up E-books using E-ink/E-paper. (a) E-ink: rotating particles/spheres (MIT; similar: Gyricon/Xerox); (b) E-ink: microcapsules with moveable pigments (E Ink Corp./MIT)

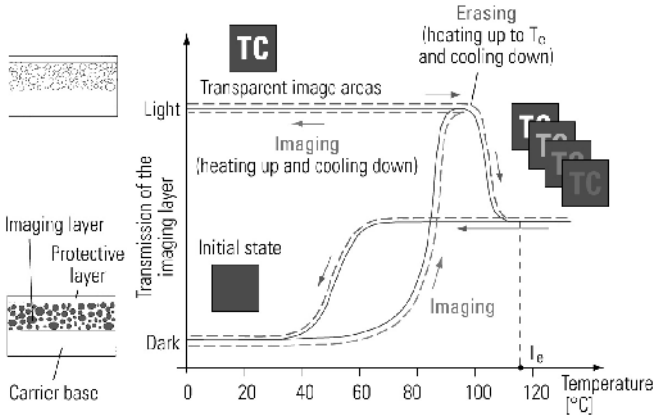

Figure 31. Rewritable paper (E-paper), (thermochromic technology, RICOH)

9. Summary:
The Power of Print and Print Media Production

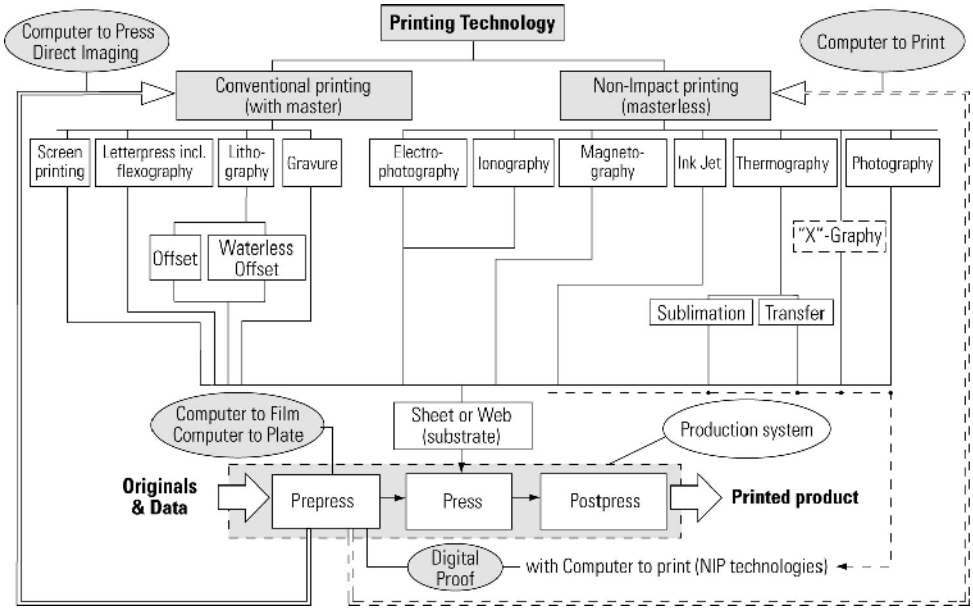

Figure 32. Printing processes, computer to …-technologies and workflow for the production of print media

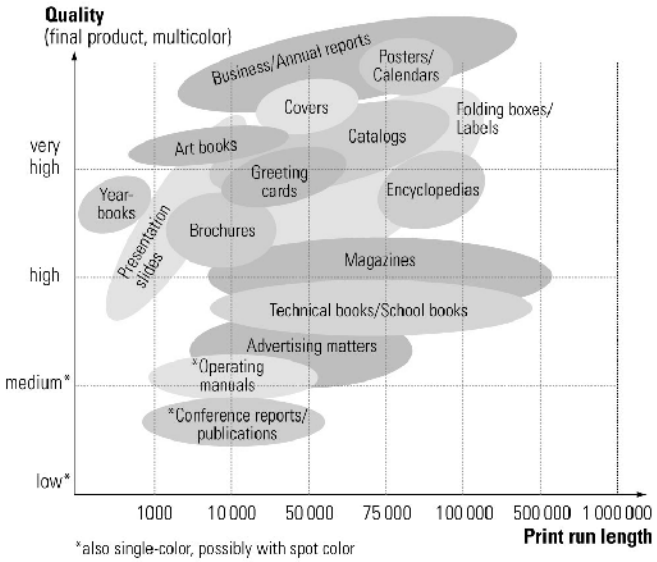

Figure 33. Selected product groups of print media (quality requirements and demand of run length)

Figure 34. The power and variety of print media

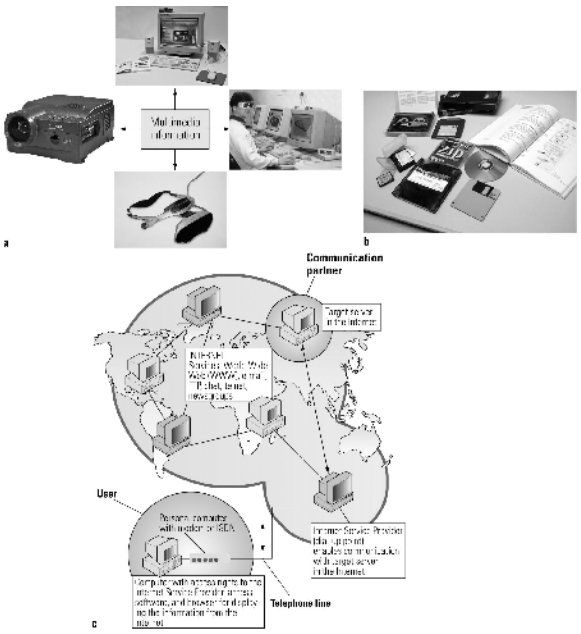

Figure 35. Electronic media: data carrier, networks, visualization equipment and multimedia

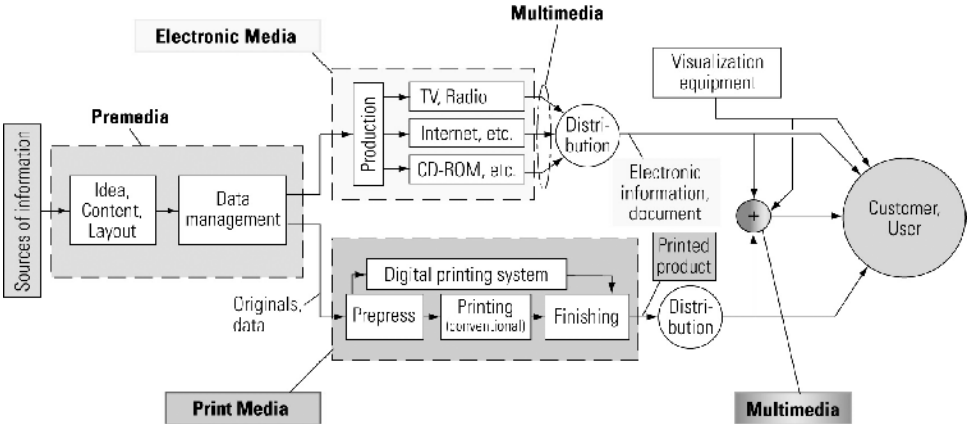

Figure 36. Production flow for print media, electronic media and multimedia

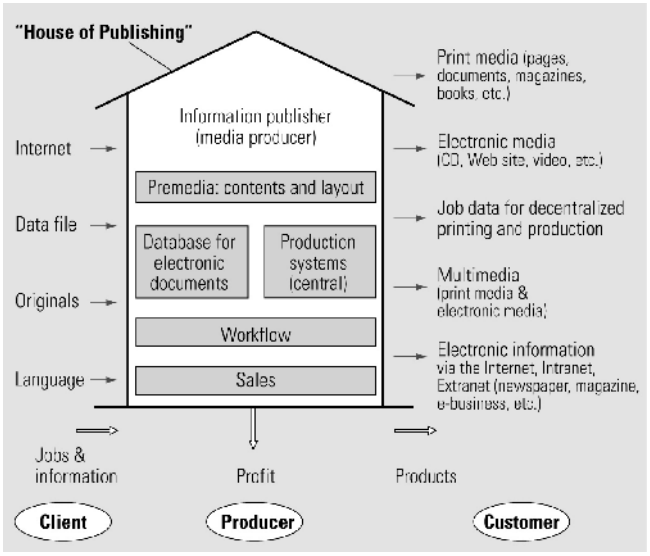

Figure 37. "House of Publishing": Production of print media, electronic media and multimedia documents when using digital technology for product preparation, production and distribution

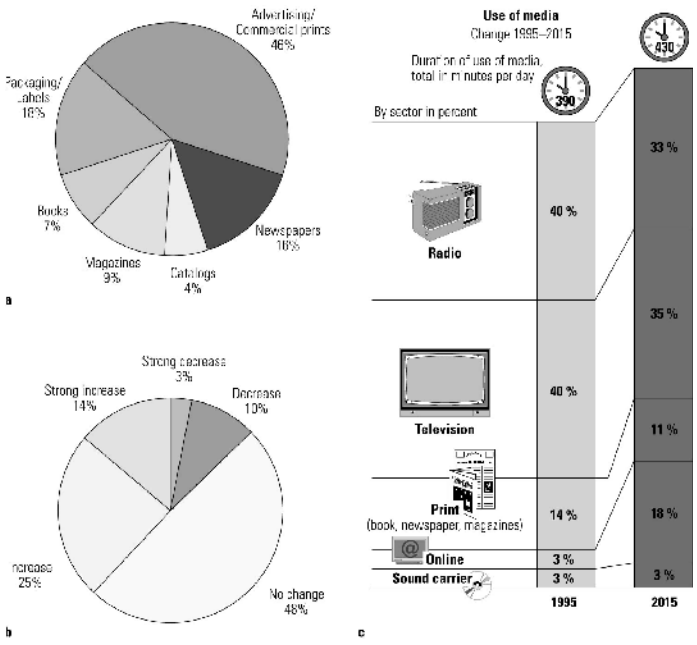

Figure 38. Demand and use of print media and electronic media (status: around 1999). (a) Market share of various print media; (b) Prediction for using print media; (c) Duration of use of media in leisure time

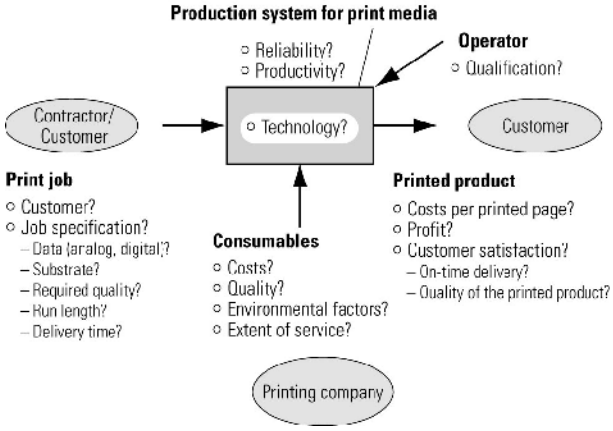

Figure 39. Criteria and questions concerning investment decisions for new production systems within a printing company

Conclusion

The power of print as well as the need of print media is confirmed by market numbers and growth worldwide, the search for and findings of trends and the result of several scenarios. There is a great continuously growing and secure future for print but only if producers - system designer and manufacturers, printers, publishers -, engineers, researchers and scientists are focussed on cooperation and solutions which meet the requirements of their customers - especially the end users of print media and electronic media.

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Biography

Helmut Kipphan was born in 1943 in Heidelberg. He did an apprenticeship as a toolmaker at Schnellpressenfabrik Heidelberg AG and employed in manufacturing and design (1957-1963).

He studied mechanical engineering at the University of Applied Sciences in Mannheim and at the University of Karlsruhe. In 1971 scientific assistant at the Institute for Measurement and Automation Control Engineering at the University of Karlsruhe. Doctoral thesis (1975) on Correlation Measurement Techniques and Identification Processes for Industrial Applications, post-doctoral thesis on Correlation of Filtered Poisson Point Processes and their Applications in Measurement Systems (1979) and professorship (1985) in Measurement Technology and Systems. Since 1979 teaching as a lecturer at the University of Karlsruhe, Faculty of Mechanical Engineering.

In 1978 he joined Heidelberg again as a research engineer. Projects in printing technology and processes, automation, measurement and control techniques in printing system engineering.

Professor Dr. Kipphan has held several management and executive positions in R&D and technology/product development in the fields of sheet-fed and web offset printing, technology transfer, patenting and education.

Since 1992 he has been responsible as senior vice president for technology and innovation research, dealing especially with advanced and future technologies for digital printing with conventional and NIP technologies.

He holds leading positions in international committees within the graphic arts industry and associations for industrial joint research. He is a member of TAGA and IS&T; served several IS&T and IS&T/SPIE conferences and TAGA as a member of the board of directors.

He is the inventor of over 30 patents, a speaker at various international technical conferences, author of numerous publications as well as main author and editor of the newly published "Handbook of Print Media – Technologies and Production Methods". In 2001 he received the TAGA Honors Award for his research activities, his contributions for technology and product development and his contributions and support to improve worldwide education and technologies within the graphic arts and communication industry.