

PROPOSAL OF MODEL OF APPLYING OPTIMAL PROCEDURE OF REPRODUCTION OF SEA CHARTS AND NAVIGATIONAL PUBLICATIONS

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Abstract: *Printing systems of hydrographic organisations are systems of preparation/prepress and reproduction of sea charts and navigational publications. Different procedures (conventional and digital) indicate the necessity to optimise reproduction procedure (Jeličić T., Kasum, J., 2006).*

Conventional printing system refers to conventional cartographic processing of the original and copying procedures for producing the reproduction original as the base for offset press.

Digital printing systems use computer technology in cartographic and graphic prepress. Instead of conventional, in modern procedure reproduction originals are obtained by the use of computer to... technology (film, plate...).

Another possibility of digital system is reproduction of sea charts by ink jet printing (print on demand - POD).

The subject of this paper is the possibility of use of various reproduction technologies and the possibility of selecting the most effective, i.e. optimal technology. The authors propose the model of applying the optimal reproduction of sea charts and navigational publications.

Key words: *printing systems of hydrographic organisations, optimisation, model.*

1. INTRODUCTION - PRESENT SITUATION

The present situation in the Croatian Hydrographic Institute (CHI), which is official hydrographic organisation (Basic Documents of the International Hydrographic Organization, 1996) in the Republic of Croatia (Law of Hydrographic activities, 1998), is a transitional period between conventional and digital production method. In such periods it is most important if one is familiar with technical varieties and how to implement them in the most adequate way. Hence, an analysis of the present situation is necessary, and it will be the basis of the development model for the future (Jeličić T., 2008).

1.1. Cartographic preparation

Cartographic department (Cart. dept.) of the CHI has digitally processed the majority of sea charts and they are produced by applying one of the modern procedures, either offset press or ink jet printing. The most recent example are Small charts, prepared digitally as a New edition, in a new format, while reproduction originals have been created by imagesetter (*computer to film-CTF*) instead by means of reproduction camera.

However, small number of charts are still processed using conventional cartographic reproduction method. (Lovrić, P., 1983, Jeličić, T., 2003)

1.2. Graphic prepress

In the prepress of sea charts and navigational publication, performed in the Reproduction department (Repro. dept.) of CHI, there have been few changes. In fact, some of the charts are produced in conventional method and photo-mechanical devices, reproduction camera and contact copying frame are still used. Except out-dated technology, there is also the problem of purchasing photo- and other repro-materials that are used in graphic prepress.

However, several years ago the Cart. dept. started digitalisation of Small charts, one of the most required products, and the Repro. dept. purchased an imagesetter, a device which is used in preparation of reproduction original directly on the film. For profitability reason, the format of the imagesetter has been A2, format of Small charts (45x60 cm). Devices for larger formats, B1 or A0 are much more expensive and profitable only in case of massive use in commercial printing houses.

Nautical publications are graphically processed and prepared on Macintosh computers, and then sent for printing and binding to other printing houses. For digital graphic prepress the Repro. dept. uses recent computer software for image processing (Photoshop), for drawing (FreeHand, Illustrator) and for page layout (QuarkX Press, In-Design). Since those programmes are standard in graphic prepress, the communication with other printing houses is easier, using PostScript or PDF format (Adobe Acrobat).

1.3. Reproduction (press / printing)

Most of the charts in CHI are nowadays produced at a technologically out-dated offset machine. Either way a chart is prepared, using conventional or digital procedure, the end result, i.e. the quality, depends on the offset machine. The offset machine is Roland V Ultra, which can print on the substrates of minimum 50x70 cm to maximum 88x126 cm. When the machine was new its maximum speed was 7,000 prints/h, but being in use for 35 years it can now make 3-4,000 prints/h.

The machine has the system of water dampening, which causes difficulties with the register when printing large multicolour sheets. From technological aspect, when the

machines are of large format even small dimensional instability of the printing substrate may cause significant problems with register (Bolanča, S., 1997).

Besides troubles and delays in work, there is also a problem of finding qualified experts and service for maintenance. Also, spare parts ordered in the last years have delivery term of a month or longer and they are expensive almost as a parts for a new machine.

However, thanks to the experience of the offset machine tender, besides occasional hold-ups and delays, there have been no emergency situations so far.

1.3.1. Sheet formats

The formats of sea charts are B1 and A0. In the last decade the ratio of consumption between those two formats was 90-95% of B1 and 5-10% of A0, with the average annual consumption of 5 tons of B1 and 0.5 tons of A0 formats.

Figure 1 shows paper consumption according to the sales in the last decade, the ration between A0 and B1 format and the total consumption of cartographic paper (Radić, E., 2007).

The consumption changed after the format of Small charts was changed from B3 to A2 in 2008, to about 3 tons of each format a year. In order to save offset plates and shorten press time it would be more acceptable to print Small charts from A0 format (4 in a sheet), however, in order to achieve a precise register, the B1 machine could print in A1 format (2 charts in the printing form).

1.3.2. Printing runs

Figure 2 shows production price for various runs in offset press and ink jet printing system.

It is known that unit price of offset press decreases if the number of copies increase, while with ink jet printing the

price is the same for each copy regardless of the number of copies.

The crossing point of two curves denotes the number of copies more profitable at offset press or ink jet printing.

It can be seen that the border is at the edition of about 400 copies. However, since the data in the diagram not including time needed for press preparation which is longer than the print preparation, we can conclude that the borderline for plotter printing is under 500 copies. Larger run is more suitable and profitable in offset press. Besides the printing run, it is important to study the frequency of changes in the areas shown in charts and include that factor when considering the best production technology. Larger number and higher frequency of changes, drive us to use of ink jet printing system.

1.4. Graphic finishing / postpress

The average age of the equipment in the bookbinding of the Repro. dept. is over 20 years. The format of the paper cutter is suited to sea charts and to cutting larger sheets. Another cutter is used for sheet preparation for printing (cutting to a press format). However, except those two adequate cutters, other out-dated machinery and equipment in the bookbinding is surely not adequate. This primarily refers to folding machine of B2 format. It is designed for folding to B5 format if the sheet contains 16 pages, and for folding to A4 format if the sheet contains 8 pages. Moreover, because it is old and worn-out, the device cannot be considered adequate for a more demanding task. The next important stage is stitching of folded sheets, which can be done by means of thread or wire. At present there are two stitching devices that use metal wire. It has to be noted that books and navigational publications are bound by means of thread, while wire is used for less demanding publications (brochures etc.) and for publications of shorter period of use.

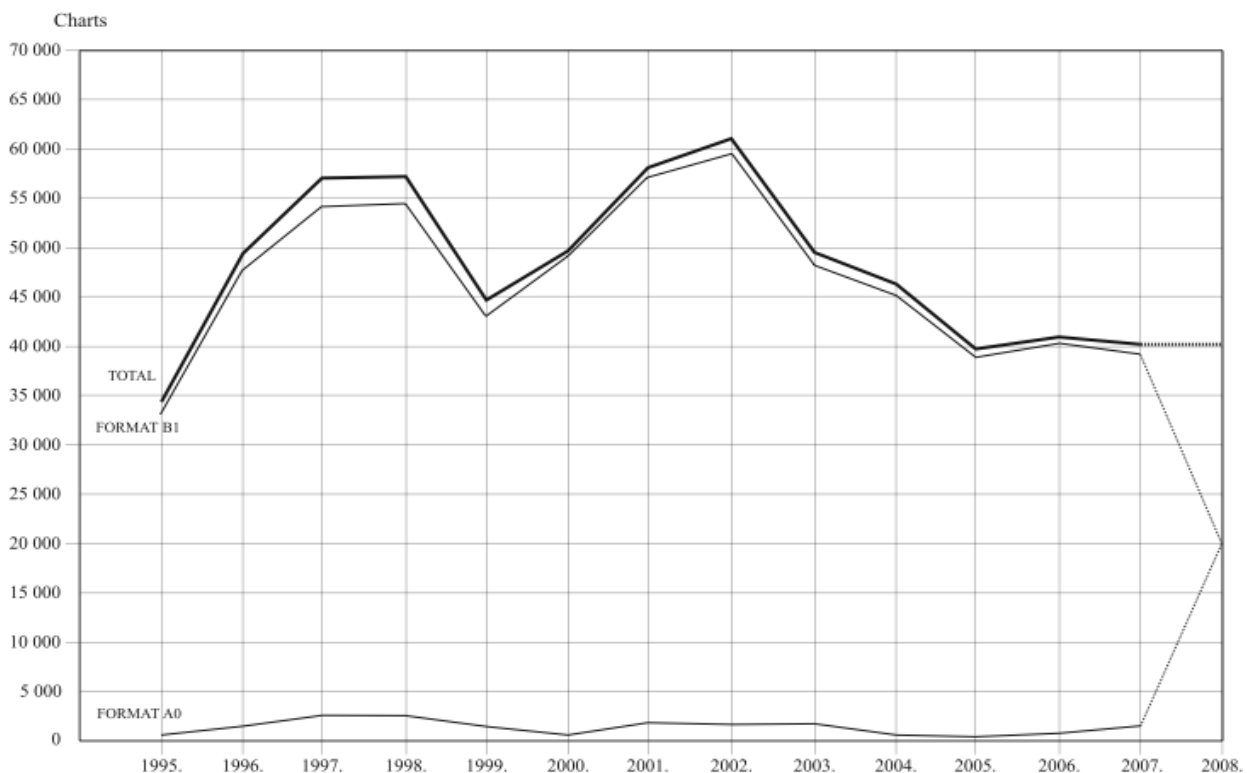


Figure 1. Consumption of cartographic paper in CHI, according to formats and total consumption

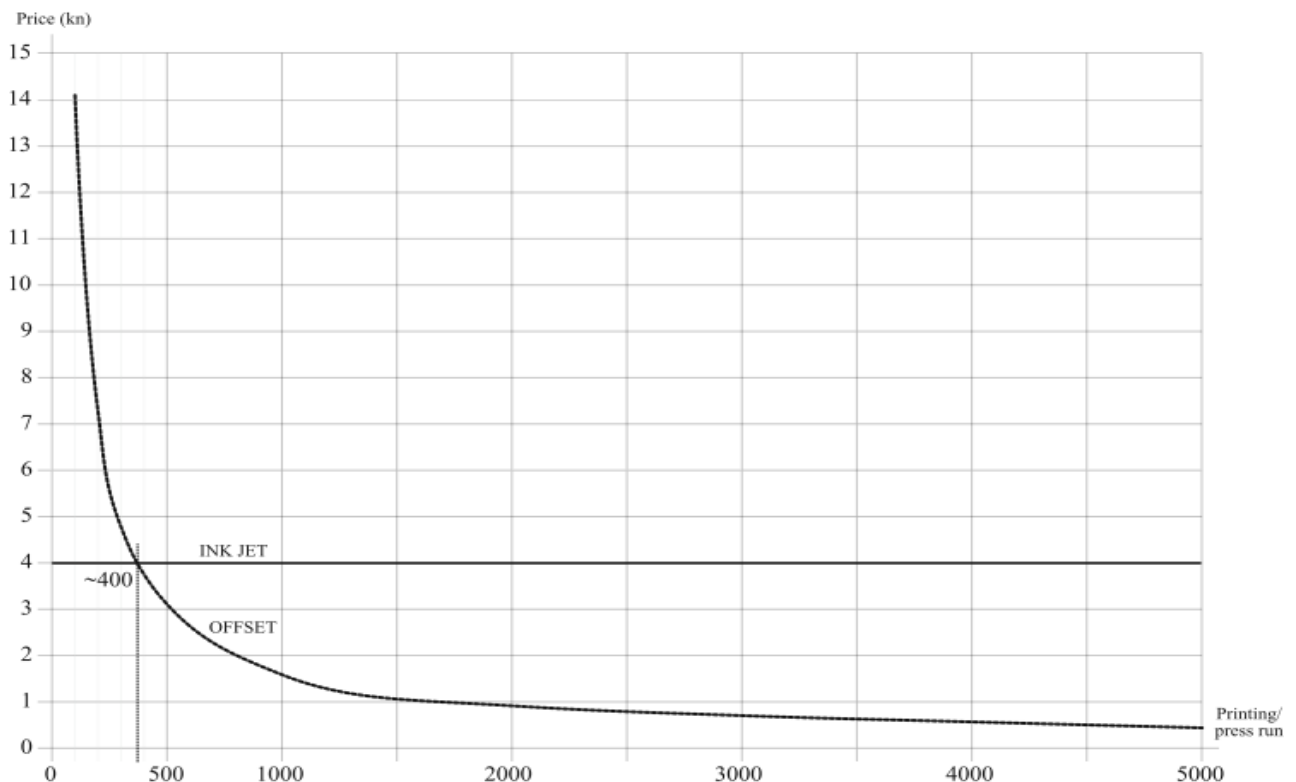


Figure 2. Production price for various runs in offset press and ink jet printing system

The final phase, after the cover has been finished, is binding the cover with the sheets. In better bookbinderies there are production lines for brochures (soft) and hardcover, while smaller binderies bind books manually using glue, or partly automated binding single copies. Bookbinding is adequate for the present production, but if a new offset machine should be purchased, then other equipment and devices in the bookbinding should be modernised too.

2. PROPOSAL OF DEVELOPMENT MODEL

In view of development possibilities of the Repro. dept., there are two main directions (Jeličić, T., 2008).

The first is the orientation to quality graphic prepress and outsourcing services for printing and binding of publications. Charts could be still printed on the present offset machine as long as it is in working order after which sea charts (the same as publications) would be printed in other printing houses.

The other, development option, is to implement a new technology, which refers to investing into new systems of prepress and printing, that is, introducing computer to plate (CTP), instead of the conventional method of production of offset plates, purchasing new offset machine and implementing digital printing technology.

2.1. Cartographic preparation and graphic prepress

Cartographic preparation of most sea charts has for some time now been done in digital form. Besides appropriate working stations and monitors, the Cart. dept. also has software support for digital cartographic preparation.

Repro. dept. has to provide adequate graphic prepress. There are two main methods for producing reproduction originals. One is reproduction of films by imagesetter (CTF). However, besides the fact that such technology is almost outdated, another problem is the following phase

which is a conventional method. Namely, in order to produce offset plates, the obtained reproduction films are used as the original in the contact copying frame.

Another method for press preparation is direct to the offset plate, computer to plate - CTP. It differs from CTF in the manner that when CTF is used only reproduction camera is eliminated, while when CTP is used both reproduction camera and contact copying frame are eliminated. It has to be noted that reproduction camera and copying frame are photo mechanical devices and are not sufficiently precise; hence, in terms of accuracy and speed, they are weak points. Also, instead of two operators, in digital procedure only one operator is needed.

2.2. Reproduction of sea charts

Reproduction of sea charts and navigational publications can be performed in two ways, offset press and ink jet printing.

2.2.1. Offset press

When dealing with offset press as the main method of reproduction of charts, first it has to be decided what to do with the present machine.

One of the solution ideas has been to purchase another machine for B1 format, which, however, raises the problem of locating it in the current premises.

A new machine means a new technology and its compatibility with new technologies in cartographic and graphic preparation. On the other hand, purchasing a second-hand machine does not necessarily imply installing new technology if the machine was built before the year 2000.

Another important reason is keeping the present foundations and installations and possibly adapting them for a new machine.

It is not difficult to conclude that there is a series of reasons to substitute and write-off the old device. The main reason is switch over to the new work technology. That will be followed by writing-off the old photo mechanical devices, which will consequently free two large working areas which could then be used for installing digital printing devices (printers, plotters etc.).

The format of the machine should be A0 so that the complete sea chart programme could be printed in CHI, since the New edition of Small charts in A2 format significantly affect the relationship of consumption between paper formats. This is clearly seen from the diagram of consumption of cartographic paper. However, the price of A0 format machine is much higher than of B1 format machine.

When the purchase of a new machine is considered, it is important to know how the market is organised today. Besides several reputable producers (MAN Roland, Heidelberg) there are numerous new producers in graphic industry. They are mostly Far East countries like China, Korea and India, which is the result of their fast-growing markets and the use (sometimes illegal) of Western technologies. However, taking into consideration the long experience in production, and equally important, in servicing and maintenance, the priority should be given to European producers.

It is interesting to note how producers approach to each buyer. The machine is assembled and delivered only after the order was made in accordance to defined needs of the buyer.

For instance, if a buyer wanted to print sea charts, a producer would offer offset machine with 6 printing units. In such device, a sea chart would be printed in one pass, containing five colours at the front, and the sixth colour at the back of the chart. If a product should be UV coated, a unit for UV coating would be added. Hybrid machines are particularly interesting, as they are a combination of various technologies. In such cases one of the units could be an ink jet printing unit.

If printing runs and profitability of the investment are taken as criteria, the Repro. dept. should then opt for a minimal configuration. Since modern machines contain as a minimum 2 to 8 or even more printing units, a suitable would be two-colour machine with possibility of turning the paper sheet would be suitable. The printing process would consist of three passes of the paper: printing two black colours first, at the front and the back of the chart, then violet and sepia and finally blue and yellow colour. The charts which have double side five colours print would be printed in five passes containing two same colours in each.

Also, from technological aspect it is recommended to find a right combination of colours and replace 5-colour press with 4-colour cmyk press/printing. The reason is to match the colours in sea charts to those in navigational publications which contain colour photographs and are printed in cmyk. Ink jet printers use cmyk combination of colours as well.

2.2.2. Print on demand (POD)

Besides offset press, digital technology of ink jet printing is also important. Ink jet printing has been significantly

developed in recent years. Several kinds of printers were developed and a user is able to choose the most suitable type for their needs. Colour printers of large printing formats are produced in various technologies: ink jet, electrostatic, solid ink, piezo-electrical (Kipphan, H., 2001) and of various prices. Ink jet printers are mostly used because of their low price, simple use and options of printing on various substrates, in special colours and at acceptable quality of print. They offer a large range of resolutions and a good control of colours. Their main disadvantage is that they are relatively slow, but the problem may be eliminated if several devices are engaged.

The use of ink jet systems in the production of sea charts has already been implemented in the USA and Canada (Holroyd, P. N., 2000, Enabnit, D. B. et al., 2002, Queeney, T., 2004).

The quality of ink jet printed sea charts should be equal to the quality of standard sea charts produced in offset technique on the cartographic paper. It is therefore necessary to study their properties in terms of durability, special requirements and various outer impacts. Besides technical characteristics of finished charts, other graphic materials and POD technology are studied and developed.

It is expected that POD procedure will not completely replace the conventional production procedure of sea charts, but it will probably cover production of small editions, A0 formats and of areas subject to constant changes (Jeličić T., 2005).

2.3. Reproduction and graphic finishing / postpress of navigational publications

The situation is similar with navigational publications as well. Less demanding publications, that is, of smaller volume, smaller printing runs and of shorter period of validity can be produced by combining digital print. Publications of larger edition and of longer validity and period of use are printed in offset and finished in conventional bookbinding.

Acquisition of a new offset machine would surely increase the quality of print of navigational publications.

Two-colour machine could be used for printing all four-colours editions of CHI in two passes, which would save outsource printing expenses and prevent disclosing digital data from the CHI.

In the last several years, the Repro. dept. developed another bookbinding, the so-called, office bookbinding. It contains equipment suited to simple works which do not require specialised equipment. These are table-cutters, punching devices, spiral binding, gluing etc.

The development of such equipment was instigated by increasing number of digital printing devices, and by the need to produce small printing runs and fast binding. Such materials are usually various studies, brochures and other simple graphic products.

In case a new offset machine is purchased some investments will be needed in the bookbinding as well, and outsourcing service of binding of sheets printed in the Repro. dept. would be a temporary solution.

It has to be noted, though, that a more serious modernisation of bookbinding would require substantial funding and require another employee.

3. CONCLUSION - MODEL OF APPLYING OPTIMAL PROCEDURE OF REPRODUCTION

As a conclusion, it is necessary to point out the following parameters for making a decision about the course of development. A high price of a new offset machine will require careful consideration on profitability of the investment, but there are other reasons as well. Firstly, it is the independent printing system of CHI, which means that all tasks could be performed within the CHI and unauthorised activities and use of data could be prevented. There is also a need to install new technology in order to obtain high quality prints based on digital cartographic prepress.

Further, after new technology is introduced a number of specialists would not be needed (reproduction photography, conventional film-composition) and could be replaced by universal computer operators. For instance, the same computer operator could work at the CTP device and at the ink jet printing system. Hence, there are a number of reasons for introducing new technology and acquisition of a new machine.

However, when the diagram showing the annual sale of charts is studied, the situation seems more complicated. If the largest annual editions of 60,000 charts are divided by approx. 300 working days, the result would be 200 charts a day, which means 25 charts an hour. Plotters on average can produce 10 charts a working day, which leads to the conclusion that permanent use of several plotters could complete all orders.

For the CHI, a printing system is the main means for performing its activities, and requires a serious approach. The final solution is probably the right combination of offset press and ink jet printing.

According to the results of this study, the following can be concluded:

1. In terms printing runs, it is proposed use ink jet printing system for printing runs below 500 copies, and to use offset press for larger printing runs,
2. In terms of formats, it is proposed to use ink jet printing system for A0 formats regardless of the number of copies, and to use offset machine for B1 formats, and
3. It is proposed to use cmyk colour system for either offset press or ink jet printing.

Finally, it is therefore proposed to purchase a two-colour offset machine of B1 format instead of the current A0 format, which will result in significant savings. The balance could be used to purchase a ink jet printing systems.

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