How Digital Printing Can Address the Smart Card Industry

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Abstract

Today the plastic card and more precisely the smart card (chip card) market is growing up very fast in all segment application (mobile phone, bank, identity, loyalty, …). This growth come also with the request from the customer and/or the application to have a dedicated product in a very large scale of production batches, from few cards to few million cards. At the end, final customers want to have a unique product but at a very low cost.

We are facing the problematic of large volume production but where each product can be different, personalized, customized. This problematic is today a difficult reality and the plastic card manufacturers and suppliers are searching solution in order to answer positively this demand.

Digital Printing could be a very interesting solution but request to change significantly the organization of production actually in place and introduce also several technological challenge.

In this paper, the traditional manufacturing flows of plastic card is described with more attention on the printing, personalization processes and their associated problematic. A simulation use of Digital Printing will be also proposed, and forecasted results compared to the actual flows.

Introduction

The smart card is one of the latest additions to the world of information technology. Similar in size to today's plastic payment card, the smart card has a microprocessor or memory chip embedded in it. The chip stores electronic data and programs that are protected by advanced security features. When coupled with a reader, the smart card has the processing power to serve many different applications. As an access-control device, smart cards make personal and business data available only to the appropriate users. Another application provides users with the ability to make a purchase or exchange value.

Smart cards provide data portability, security and convenience.

Technology

Memory Cards And Microprocessor Cards

Smart cards come in two varieties: memory cards and microprocessor cards. Memory cards simply store data and can be viewed as a small floppy disk with optional security. A microprocessor card, on the other hand, can add, delete and manipulate information in its memory on the card. Similar to a miniature computer, a microprocessor card has an input/output port operating system and hard disk with built-in security features.

Contact Smart Cards

Contact smart cards must be inserted into a smart card reader.

They have a small gold plate about ½" in diameter on the front, instead of the a magnetic strip on the back like a credit card. When the card is inserted into a smart card reader, it makes contact with electrical connectors that transfer data to and from the chip.

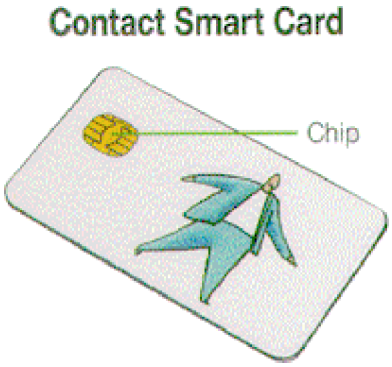

Figure 1. Contact Smart Card

Contactless Smart Cards

Contactless smart cards are passed near an antenna to carry out a transaction.

They look just like plastic credit cards, except that they have an electronic microchip and an antenna embedded inside. These components allow the card to communicate with an antenna / coupler unit without a physical contact. Contactless cards are the ideal solution when transactions must be processed very quickly, as in mass-transit or toll collection activities. Most contactless cards also derive the internal chip power source from this electromagnetic signal.

Two additional categories, derived from the contact and contactless cards are Combi cards and Hybrid cards. A Hybrid card has two chips, each with its respective contact and contactless interface. The two chips are not connected, but for many applications, this Hybrid serves

the needs of consumers and card issuers. Just emerging is the Combi card which in a single chip card with a contact and contactless interface. With Combi cards, it is now possible to access the same chip via a contact or contactless interface, with a very high level of security. The mass transportation and banking industries are expected to be the first to take advantage of this technology.

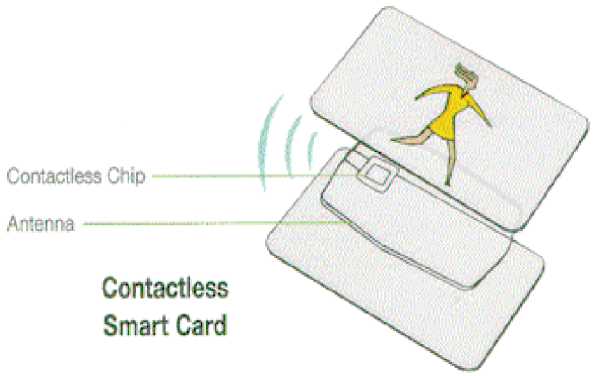

Figure 2. Contactless Smart Card

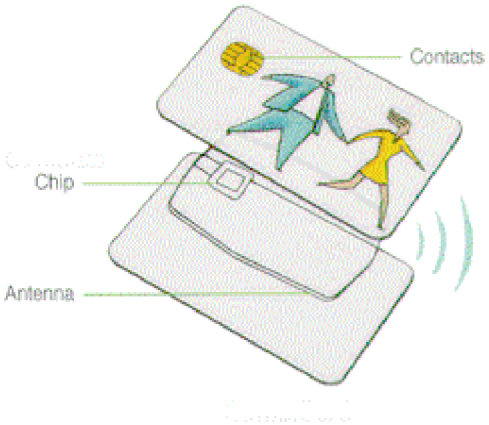

Figure 3. Combi Smart Card

Applications

The list of potential applications for smart card technology would be too long for this paper. Instead, listed below are some of the major applications seen around the world.

There are over 300,000,000 GSM mobile telephones with smart cards which contain the mobile phone security and subscription information. The handset is personalised to the individual by inserting the card which contains its phone number on the network, billing information, and frequently call numbers.

Almost every small dish TV satellite receiver uses a smart card as its removable security element and subscription information. There are over 4 million in the US alone between DirectTV, USSB and Echo Star. There are millions more in Europe and Asia.

The Financial industry has been quick to adopt smart card technology in various countries around the world. Every French Visa Debit card (over 25,000,000) has a chip in it. In Germany, about 40,000,000 banking cards have been issued. EuroPay, MasterCard, and Visa all have smart card programs for their bank members. In the Portugal and Singapore, the national banking networks have launched electronic purse projects. Proton has worked with its banking partners to issued over 25,000,000 electronic purse cards in several countries.

Various countries with national health care programs have deployed smart card systems. The largest is the German solution which deployed over 80,000,000 cards to every person in Germany and Austria.

There are over 100 countries world wide who have reduced or eliminated coins from the pay phone system by issuing smart cards. Germany, France, UK, Brazil, Mexico, and China have major programs.

Other applications for smart cards include computer/internet user authentication and non-repudiation, retailer loyalty programs, physical access, resort cards, mass transit, electronic toll, product tracking, national ID, drivers license, pass ports, and the list goes on.

All of these different application require to have each card different from the others, each card are unique and personalised with the data of his owner.

Manufacturing Processes

The manufacturing of all different type of smart card involve various flow which can be resume into two main processes :

- injection molding
- lamination

In fact, injection molding or lamination describe only the card body fabrication. This card body receive along the manufacturing flow different processes who will generate the complete smart card product. On the following figure 4 you can see the different manufacturing flow description (the chip or module manufacturing process is not described).

The molding process produce a unique plastic card body (ABS material) with the right physical dimension including the cavity for the chip or micromodule.

Several sheet of plastic (mainly PVC or PVC/PET combination) are used for the lamination process. Generally we have a total of four plastic sheet : two are white and printed with the recto and verso images of the cards (36 to 72 per sheet) and the two others sheet are transparent, which provide a protection of the printed information. All sheet are laminated together and each individual card are generated by cutting process for the body and milling process for the chip micromodule cavity.

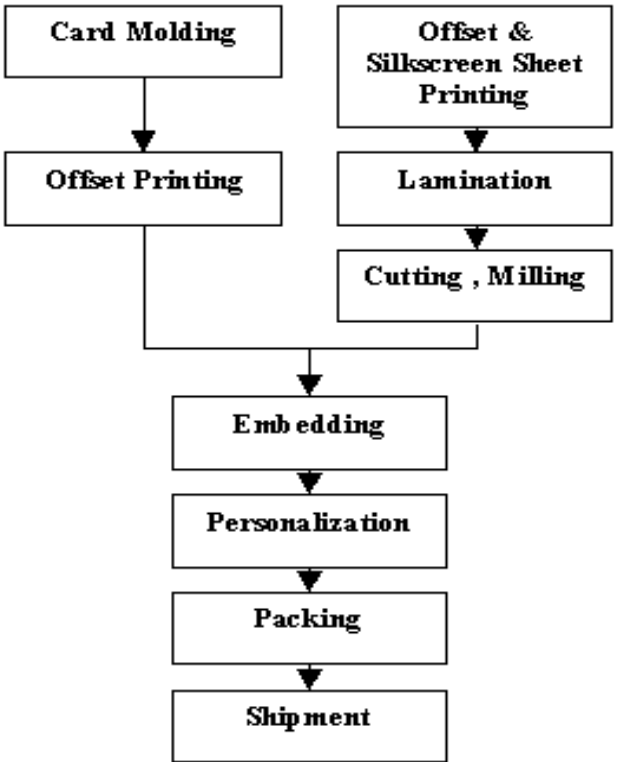

Figure 4. Manufacturing flow

The printing processes used are based, in a both case, on offset technology for printing the background of the card (image, logo, solid block color, ..). Very often the type of inks used are U.V. due to their good adherence on plastic material and also for their easy to use characteristic. The offset printing equipment are very similar to the conventional press already used in the paper industry, except for the card produced by injection molding. In this case the equipment used still based on the offset technology but the card handling is designed for a card by card format.

On a both flow, during the embedding operation, the chip or micromodule is inserted and glued in the cavity who was made by injection molding or milling.

The personalization is the process during which a smart card is modified to contain the information for one person. Electrical personalization modifies the information in the card's chip. Graphical personalization modifies the visual aspect of the card (holder's name, photograph). The equipment used for the graphical personalization are mainly based on a thermal transfer, dye sublimation, monochrome continuous ink jet, embossing and laser technologies. The personalization include also sometimes the mailing operation.

At the end, packing of the cards, individually or in a batches, using blister wrap or others format and materials.

Figure 5. Smart Card personalized

Manufacturing Performances

Today, the performance of the manufacturing line using the flow described before are good for a large batches of card (more than 40,000 cards/batch). The response time and the cost per card are compatible with this market, based on high volume of the same product.

However, for the batches less than 40,000 cards, the cost per card and the delivery time are not well adapted, and for a small number of card (2,000 cards) per batch, absolutely not adapted. Today, the total smart card market is now more and more oriented to the medium, small and very small batch of cards.

We are facing the problematic of large volume production but where each product can be different, personalized, customized, unique.

After analysis of the different manufacturing flow, the bottleneck are located at the printing and personalization processes.

Traditional offset printing requires film, plates, specialist and substantial press setup time. A typical job takes about four to eight hours in order to setup an equipment capable to print 20,000 cards/hour. This doesn't offer card issuers an opportunity to print multiple card designs in a single run. Typically, conventional press run starts with stabilization period, where tens or hundreds of impressions are wasted until machine stabilizes. With short run printing, stabilization runs mean important waste percentages. For example, 3,000 cards job, stabilization run of 1,000 copies means 33% waste. Traditional offset printing technology simply is not economical or practical for runs under 40,000 cards.

Graphical smart card personalization are based today on technologies which are limited in term of speed. The maximum throughput achievable is 3,000 cards/hour using continuous ink jet or laser but with limitation (small and a very simple marking information). Very often, the throughput of the equipment is related to the number of information printed during the graphical information. For example, a laser personalization require 0.7 second for two line of characters, 3 to 4 second for a barcode and 20 second for a black & white photo. If the personalization require a color photography, the technology used is the dye diffusion thermal transfer and in this case the printing time of an identity photo require 35 to 50 seconds.

The throughput is dramatically related to the complexity and type of information printed. One more think concerning graphic personalization is the fact that we are using different type of plastic and the printing technologies used are sometimes not compatible with all type of plastic. These constraints are not easy to manage into a production flow.

For a short run of card (< 40,000 cards) we can resume the situation by :

- setup time of the conventional offset press are too long and complex (either for card by card or sheet press).
- the cost per card is too high versus customer needs.
- the personalization equipment throughput are too dependent of the quantity of information printed and also limited by the type of plastic used.
- printing and personalization processes are two and different processes doing very close function but on different equipment.

Digital Printing for Smart Card

During the last 5 years, digital techniques have become extremely important in the graphic arts industry. All sections in the production flow for producing multicolor printed products are influenced by digitalisation. The focus is put on high quality multicolor printing, together with high productivity. All big players in this field are trying to propose to their customer digital press, mainly for the paper industry.

Lamination Process

On the basis of their digital press for paper E-PRINT 1000, INDIGO was the first company to propose a digital press for plastic sheet. This new, full color digital systems have revolutionised the economics of customised card printing in lower quantities, opening profitable new opportunities for card plants and card issuers alike. New digital card printing presses add speed and efficiency of desktop publishing to the high speed productivity of an offset press. Cost-per-card is significantly lower than offset printing for runs under 30,000 and the image quality is enough. The key to digital card printing is an electronic workflow. Digital plastic sheet of card presses eliminate the need for film, plates and press setup. Images are sent to a digital press directly from a server, hard drive or removable media. The system prints plastic sheet of card immediately after it receives image, proofs are done on press in real time, saving hours or days in the production schedule. The process is instant, electronic and can deliver up to 20,000 cards per hour. The manufacturing plant needs to be adapted in order to use the flexibility of the equipment and a dedicated area is generally allowed for that, inside the conventional offset manufacturing plant.

This type of press have some limitation like metallic ink or special spot color.

Molding Process

In this area, the situation is totally different. No solution are today available due to the technical difficulties to handle and print a rigid piece of plastic (0.8 mm) with a particular dimension and material.

Some alternative solution are proposed by DATACARD company (Artista machine), but are more oriented for small quantities of cards (1000 cards/hour maximum). The system first digitally merge photos, artwork, fixed data and individual smart card holder information. Next, they print images onto a transfer material, then bond the images to a plastic using heat and pressure. These on-demand custom printing systems fit more appropriately in the category of card personalization equipment, so they will be likely be installed and operated in service bureaus. The cost per card is too high today for a medium or mass production use and the compatibility between the transfer material and the different plastic card body modify the reliability of the smart card into the application.

What Smart Card Manufacturer are Looking For

It's clear that today printing and personalization are very closed and will merge in a near future. The next generation of equipment waited by the smart card industry will be able :

- to print all information necessary on the card, including the background and the personalization element in a same time.
- to print the both side of the card in automatic mode.
- to electronically personalize the chip or micromodule during the printing operation in order to assume the right link with the graphical information.
- to use a technology flexible in order to address the different type of plastic card body.
- to have a printing cost per smart card competitive comparing to the others technologies and quasi constant versus the batch size, including consumable, yield, set up time and equipment amortization.
- to use a Non Impact Printing technology able to print without physical contact with the smart card and more precisely with the chip or micromodule in order to have the possibility to print white card already embedded. This new approach will modify significantly the manufacturing process, specially for the molded card.
- to have a throughput around of 3,000 cards/hour including printing, personalization (electrical, graphical) and fully independent of the quantities of information printed.
- to be easy to use without specialist in front of the equipment.
- to be connected with a network to the graphic studio (pre-press), manufacturing supervisor and others e-connection.

All the technologies are now or very soon available in order to address this equipment specification. A revolution is coming and will change the manufacturing approach, organization and probably, the plastic and the smart card market.

Simulation

We have made a small simulation (based on GSM card) using the specification above and compared the data to the actual manufacturing flow. The results are very interesting. For example, for a batch of 3000 cards, the cost per car is divide by five and the delivery time reduced by three.

Of course, this simulation is not enough precise but demonstrate that we can easily predict a significant advantage using digital printing technologies for a small and medium size of card batches.

Conclusion

It's clear, digital printing will change radically the way to produce smart card but also the smart card market himself. The new possibilities offer by the digital technologies are opening new doors for marketer and are also making life easier for manufacturing people.

If today some solution are available, specially for plastic sheet printing, the market is waiting for a new generation of equipment based on a card by card concept and able to manage different processes, function like printing, graphical and electrical personalization.

A revolutionary time in the smart card manufacturing and business is coming.

References

1. H.Kipphan, Digital Multicolor Printing, State of the Art and future Challenges, Proc. SPIE 2413-02 Color Hard copy and Graphic arts. IV, pg. 7-31 (1995)
2. Dorron Levy and Joel Preminger, IndigoServe: a system for the remote Management of Print Engine Stability, IS&T's NIP13: International Conference on Digital Printing Technologies, pg. 363-369 (1997)
3. Bonnie Lervik, Personalization Trends ans Opportunities: What's New, What's Next in the World of Plastic Cards, www.icma.com web site, Article/News Resource Center.
4. H.Kipphan, Status and Trends in digital Multicolor Printing, Technologies, Materials, Processes, Architecture, Equipment and Market, IS&T's NIP13: International Conference on Digital Printing Technologies, pg. 11-19 (1997)

Biography

Paul Morgavi is working at Gemplus since 12 years and is today Manager of the Manufacturing Equipment Department, part of the Gemplus R&D division. Since 1988 he has worked on the development of Printing Technologies and associated systems. His background covers the technologies like offset, thermal transfer, dye sublimation, laser and ink jet, applied on plastic materials. During 1996, he has worked in the U.S. in collaboration with an American company in order to develop a color plastic card printer using dye sublimation technology. Email: paul.morgavi@gemplus.com