Communication and brand protection of consumer packages

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1. Abstract

New functional characteristics can be created to the customer packages in order to create value-added in the package itself by utilising the latest digital printing techniques. This means, for example, that personalised and up-to-date consumer information, announcements and advertisments can be as an integrated part of a package. Also totally new kinds of logistic and anti-counterfeit systems, based on the potentiality of digital printing methods, coding and detection systems, and information networks, can be developed for the optimisation of the delivery chain. Brand protection, safety and features ensuring authenticity are important features of packages. The packages of the future will thus be much more multifunctional, informative and demand-oriented than they are today. This is why companies in the packaging industry are interested in research and product development that is paving the way to the introduction of new business models.

VTT Information Technology has launched a project aimed at the development of a comprehensive system for new kinds of package production chains. The system pays attention to the special needs of consumer packages with regard to product information, identification, anti-counterfeit and appearance. Our project is being carried out under a larger VTT-driven theme, the main purpose of which is to develop and integrate active, communicative packaging with an effective logistics system for sensitive and demanding products. Intelligent coding, RFID and data networks are the technologies applied. In this paper we present different aspects of our packaging research regarding the communication needs of consumer packages and especially the utilization and potential of digital printing.

2. Introduction

Four VTT-wide themes were launched at the beginning of 2002, one of which is Intelligent Products and Systems. The Intelligent Products and Systems theme aims to make synergetic use of new technologies to develop intelligent products and systems which can be applied in future societal and business concepts. Intelligent products capable of observing, processing information, reacting and communicating will be able to adjust to different circumstances and communicate with their environment. A “smart” system

adapts to expected situations in a predictable manner. An “intelligent” system is able adapt to unexpected situations as well (reasoning and learning).

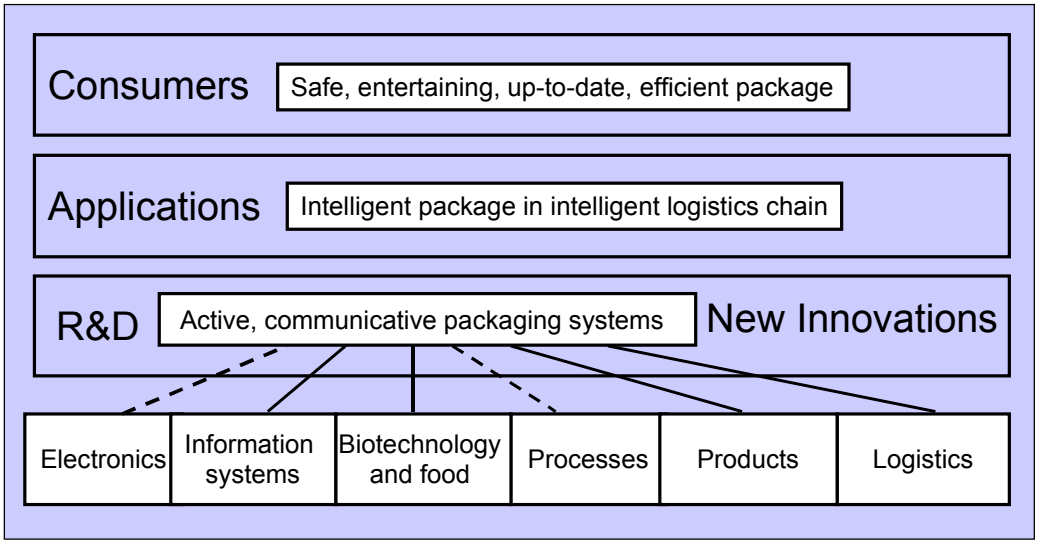

Figure 1. Active, communicative packaging - from research to finished products.

One of the projects in the above mentioned Intelligent theme is Active, Communicative Packaging. Figure 1 shows the principle by which the multidisciplinary knowledge of VTT is combined to achieve innovations that will lead to applications that ultimately serve consumers.

3. Active, communicative packaging

The purpose is to develop packages that will give the product the required protection without additives. They will deliver information about the product (its condition and history in every phase of the logistical chain) and control the progress of packages, thus decreasing losses and mistakes. Packages will communicate topical information about the characteristics, usage and state of the product to consumers and consignees in entertaining ways. The idea is to increase the efficiency of the logistical chain while decreasing the use of packaging materials and packaging waste.

We have several other projects going on at VTT which support our development. Figure 2. shows the other projects related to the theme project, “Active, communicative packaging systems”, and gives an idea of future development trends.

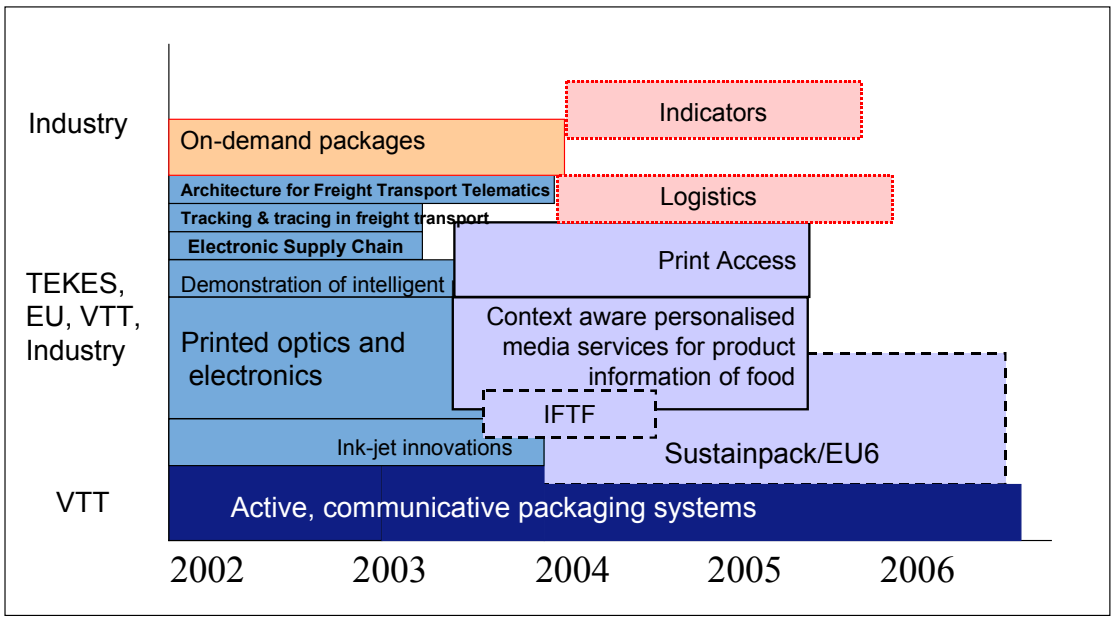

Figure 2. Projects related to Active, communicative packaging systems organised according to the financial structure.

4. Target - intelligent packaging in an intelligent logistical system

The main goal is to develop a comprehensive, effective logistical system for sensitive, demanding products. The system is based on active, communicative packaging and mobile communications.

New functional characteristics can be created for customer packages in order to create value-added in the package itself (advertising, consumer information and education; edutainment, infotainment, etc.). Value-added can also be created for the packed product (prevention of damage, freshness) or to produce savings for consumers (less waste, no overpacking) and/or suppliers (brand protection, traceability, theft protection, optimisation of the supply chain).

The project focuses on three sub-areas (see Figure 3) which interact with each other. These areas are:

1. Communication via consumer packages
2. Monitoring systems
3. Logistical chain

Although this paper focuses mainly on communication via consumer packages, it also deals with developments regarding the logistical chain.

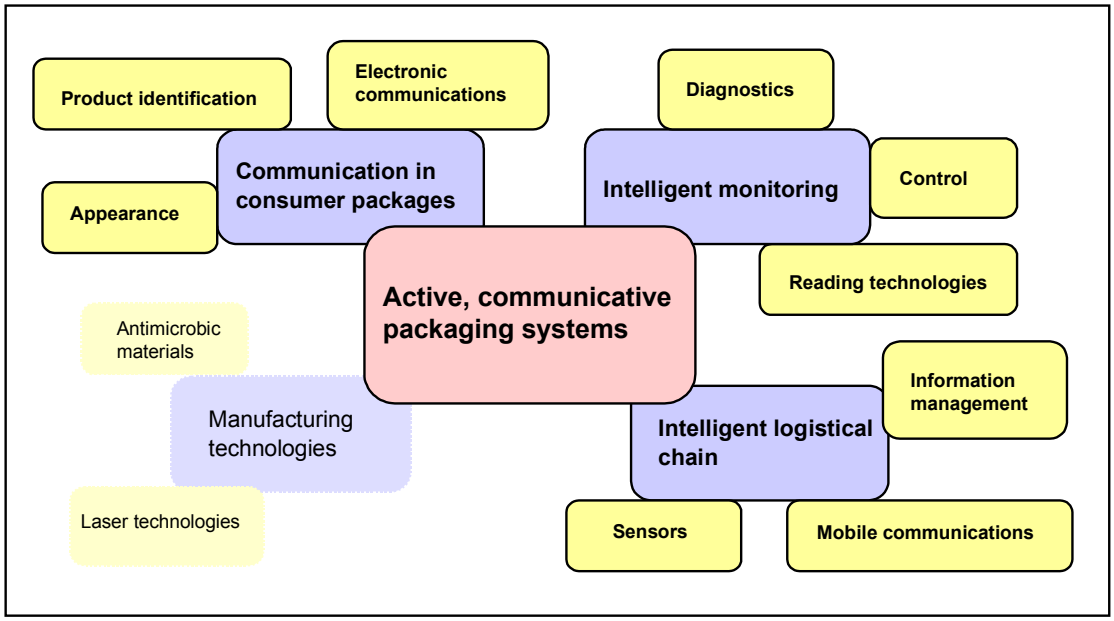

Figure 3. Technology map of Active, Communicative Packaging Systems.

5. Improving information, traceability and brand protection of packages

The general trends in packaging production, such as shorter delivery times, larger selections and smaller product quantities, give an impetus to develop package production and packaging logistics. It is also important to develop packages so that they have better product information, a more visible trademark and a more selling appearance. More precise product specifications, better product traceability are today required by consumers and the authorities. There is the tempting possibility to use consumer packages as a medium for advertisements.

Nowadays, an increasingly important task of packaging is to provide greater brand protection, because forgers usually try to falsify the package rather than the product itself. Forgery is estimated to affect over 300 billion dollars of goods annually, which is about 10% of total world trade. The European Union has estimated that as many as 100,000 workplaces have been lost through forgery. Moreover, some forgeries (e.g. pharmaceuticals or spare parts for airplanes) can threaten the health and safety of consumers. Up to 50-60% of medicines can be bogus in some parts of Africa.

One way to increase the information on packaging is to use coding systems to compress data into a denser form. These methods can be optical, such as visual bar codes, or electronic, such as RFID tags. Usually these methods can also be used for brand protection and/or theft prevention. The most commonly used linear bar code system is the Universal Product Code (UPC) which is one of the most successful standards ever developed. Originally this code was meant to benefit the retail trade, but over the years its use has also become common among raw material producers, manufacturers, wholesalers, distribution companies and consumers. This code makes it possible to control many activities of product supply chains and to track and identify products all over the world. The downside of the UPC bar code is that it carries only a limited amount of information, usually only twelve characters. For this reason, the normal bar code cannot include real information, but it is a link to a data base where the information is stored.

A two dimensional bar code can act as an independent data base. In this case, information can be read wherever a suitable scanning device for the code can be found. The other benefits of two dimensional bar codes are small physical size, scalability, big capacity of data storage and high data density, good correctness of information and high durability. Two dimensional bar codes can be attached to packages by using stickers or printing them straight onto the packages by means of an ink jet printer.

Two dimensional bar codes are usually used in the manufacturing sector, because more information, even over one thousand aphanumerical characters, can be included in the code. Every 2-D code includes an independent data base with total freedom of transportation. This is a great benefit compared to a landline network, because the information can be downloaded wherever the product is. Moreover, special encryption technologies can be used, if the information is confidential. Thus an encrypted 2-D code can be used to confirm the genuineness of the product. Multi-level confirmation technologies can also be added to the 2-D bar codes to ensure that the code will be read right.

Optical bar codes can also be invisible, which makes them hard to find and impossible to copy with a color copier. One way to do this is to print the word “original”, for example, on a black box by using UV ink. After this the text can only be read in UV light. Thermochromical inks have also been used for pharmaceuticals and designer clothes. The best thing about thermo inks is that they do not require special reading devices, because they can change their color by touch, through body temperature.

Another developing coding system is Radio Frequence Identification (RFID). This technology allows information loaded onto a tag to be transferred wirelessly and without optical contact between a tagged product and an electronic reader. RFID tags use radio antennas which transmit information over a short range. Active tags include batteries so that they can actively send data over longer distances. Passive tags need power from the reader to be activated and to transmit data. Compared to optical bar codes, RFID tags can carry much more information. The biggest benefit of electronic tags is that they make continuous identification, tracking and communication of products possible, when they are connected to a reader network. RFID tags can also be used for theft prevention since they allow the continuous tracking of products. This was the motivation for Gillette to order 500 million RFID tags from Alien Technologies. Three of Gillette’s products had been among the five most stolen items in department stores.

The downside of RFID tags is that their price is much higher than the price of printed codes. Inexpensive electronic components can be manufactured by using conductive or luminous polymers and ink jet printing (Figure 4). For example, it has been forecasted that the price of ink jet printed RFID tags could be as cheap as half a cent in the future. Thus, electronics could be directly integrated with consumer packages. Working in co-operation with several companies and research institutes, VTT has launched a project called PRINTO (Printable Optics and Electronics) aimed at investigating the potential to fabricate passive and active electrical, optical and opto-electronic elements by means of roll-to-roll processes. The ability to successfully attach flexible and cost-effective electronics and displays to packaging and publication products would notably increase the number of applications and boost market potential.

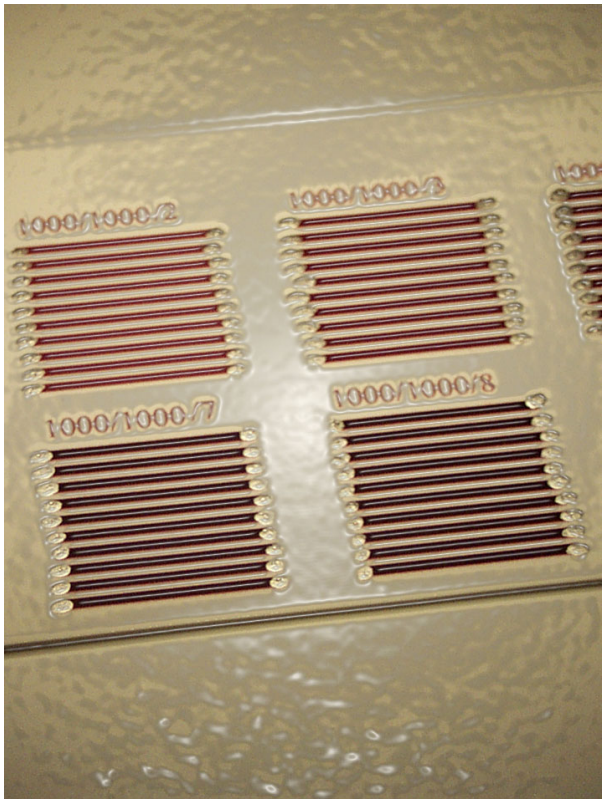

Figure 4. Ink jet printed conductors. Inexpensive electronic components can be manufactured by using conductive or luminous polymers and ink jet printing.

6. Flexible package production

The key technology for flexible package production is digital printing. Because digital printing is masterless, i.e. there is no plate or cylinder that needs to be prepared in advance, it can produce small quantities of printed products cheaper and faster than any other printing method. Digital printing plays an important role in developing new operational and business models, because it provides a strong tool for the value addition of packages. Moreover, when digital printing methods are used, different work phases can be integrated and the transportation and storage of semi-finished products can be avoided, as can be seen in Figures 5 and 6 where conventional and integrated package production chains have been shown. Printing can also be decentralized and done in the locations where it is logistically most economical, as shown in Figure 7. The best tool to boost package communication is on-demand package production, in which the production of packaging or the whole product does not start until the order has been received, as shown in Figure 8. This brings extreme flexibility to the package production chain.

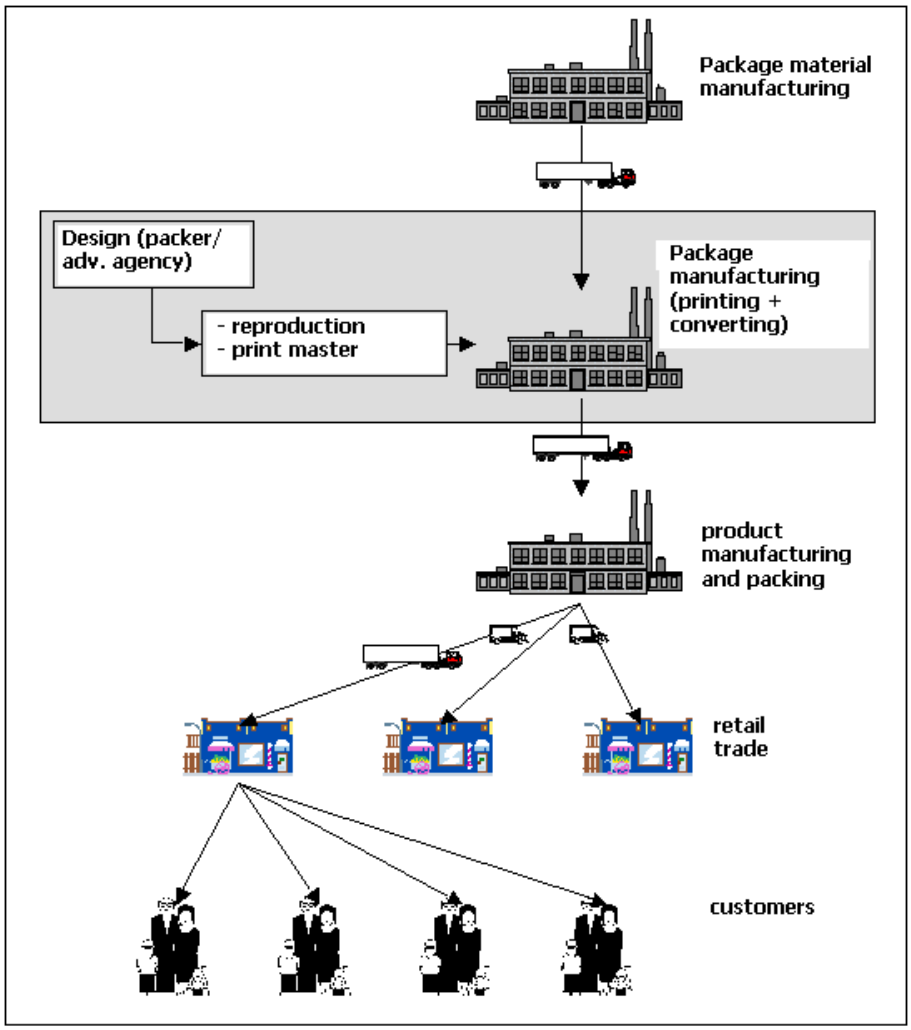

Figure 5. Conventional packaging process and delivery chain.

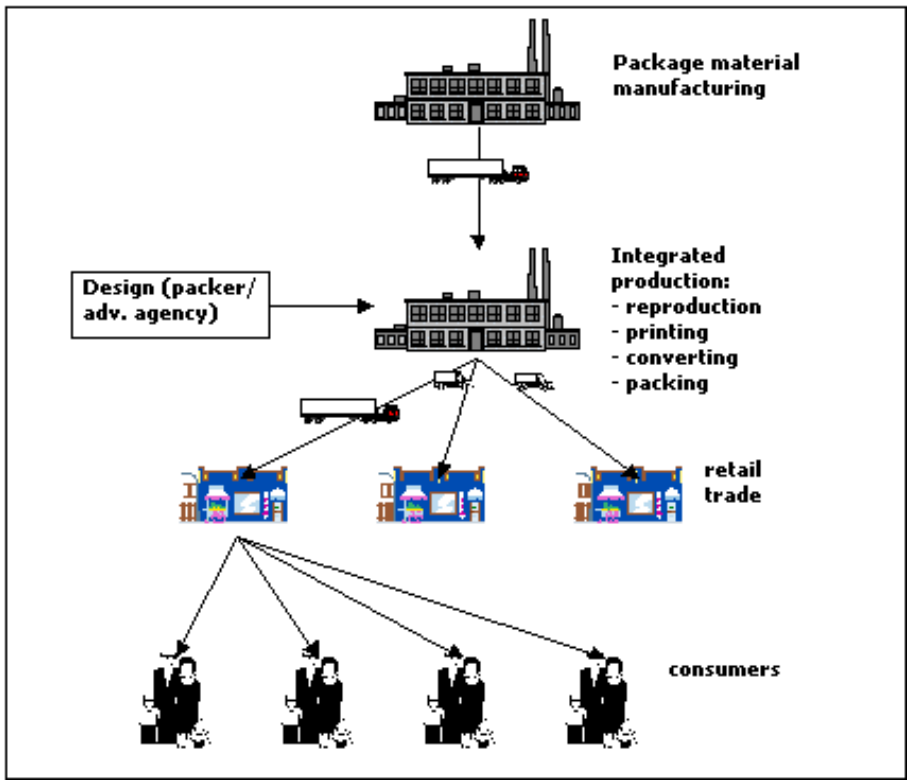

Figure 6. Integrated package production and delivery chain.

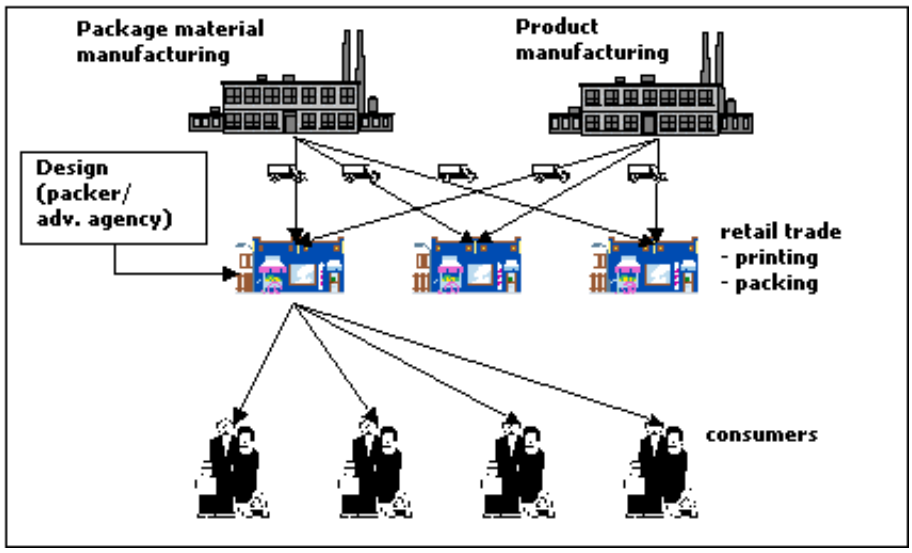

Figure 7. On demand printing in retail trade.

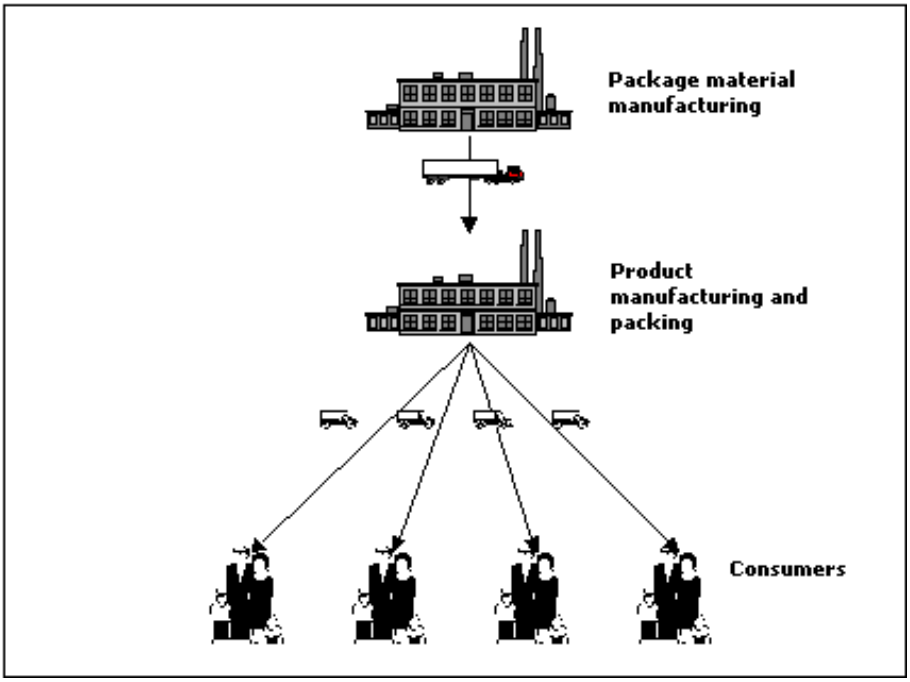

Figure 8. Integration of the whole packaging process.

To sum up, the benefits of on-demand package production are that it:

- allows the production of customised and tailored packages
- means shorter delivery times, which helps to improve customer service
- decreases the waste of materials, which saves costs and nature
- decreases storage costs
- shortens production chains and accelerates production, which saves costs
- allows the production of packaging or even products to be started after order
- allows totally new kinds of products and business opportunities to be implemented

So, the main benefit of digital printing is that it opens up possibilities for new ways of marketing and creates logistical savings. VTT Information Technology has started several multidisciplinary projects to screen the possibilities and technical solutions of new digital package production chains.

7. Utilising digital printing in package production

There are two main utilisation areas, dictated by the present level of digital printing technology, in which variable information printing on packages can be implemented. In the first case, the whole package is printed digitally, so that every printed package can be 100 % different. Four-colour digital printing is usually done by electrophotographic means, but nowadays high-speed ink jet printers can also be used. During recent years, ink-jet printing technology in particular has developed rapidly and new applications have been created to produce documents, publications, personalised advertisements, security documents, textiles, cartons and packages. The method is suitable for a wide variety of materials, frequently updated information and for multicolour high-quality products.

Another way to utilise digital printing in packaging production is to use ink jets to add variable information onto pre-printed packages, which are often printed by conventional printing methods. Typically only black or one spot colour is added. The flexibility of ink jet technology makes it possible to place ink jet heads at the right location in the printing or packaging process. For example, the heads can be placed in the conventional printing press after traditional printing or they can be integrated in a packaging line before or after packaging. In any case, each interface and procedure must be carefully pre-organised so that the actual work flow will go smoothly.

In digital package production, it is important to understand that digital printing does not eliminate the need for graphic reproduction. In fact, variable data printing (VDP) adds complexity to an already complex process. The digital job must also be adjusted according to the target printer, so we still need to take care of reproduction of details, colour management, the right content of text, etc. In the digital workflow, these tasks are easier and quicker to accomplish, because many of them can be automated or semi-automated.

One bottleneck in the digital package process is converting. Many converting stages are needed for packages after printing, such as scoring, die-cutting, varnishing, folding, gluing and filling. These stages should be integrated as an inseparable part of the digital work flow to avoid expensive manual work and to gain the greatest benefits from digital package production. Because the digital manufacture of packages is a new concept, there are only a limited number of suitable alternatives for most packaging applications. For this reason, converting machines must often be developed or at least tailored as part of a digital manufacturing line development project. VTT has actively participated in projects to develop digital package production systems.

Another bottleneck in digital package printing is materials. Different demands are placed on materials in electrophotography and ink jet printing. Generally speaking, electrophotography is more material-independent - as long as high quality paper and board grades are used. Ink jet printing sets stricter demands on the printing material, because the image is created directly onto the surface of paper, usually using solvent-based inks. The print quality will decrease dramatically, if ink flows on the surface of coated paper, as can be seen in Figure 9, or spreads in the capillary network of uncoated paper.

Figure 9. Test picture printed on two coated paper grades printed by the same printer. The print quality in ink jet printing is extremely surface-dependent.

These phenomena are especially crucial in high-speed ink jet printing where there is no time for evaporation of solvent. A better knowledge of the basic mechanisms of the dynamic interaction between ink and paper is needed to produce more reliable and appropriate quality specifications for printing surfaces. A unique approach to this problem is the laboratory-scale testing environment developed by VTT Information Technology for the high-speed imaging of ink jet drops. Differences in spreading dynamics between paper grades can be noticed immediately after drop impact, as can be seen in Figure 10. The absence of any other method to detect these high-speed phenomena, this research environment has proven to be a precise tool for the development of ink jet printing materials, inks and printers. To sum up, digital printing packaging applications require great care to find the right balance between the printing method, the material properties and the final print quality.

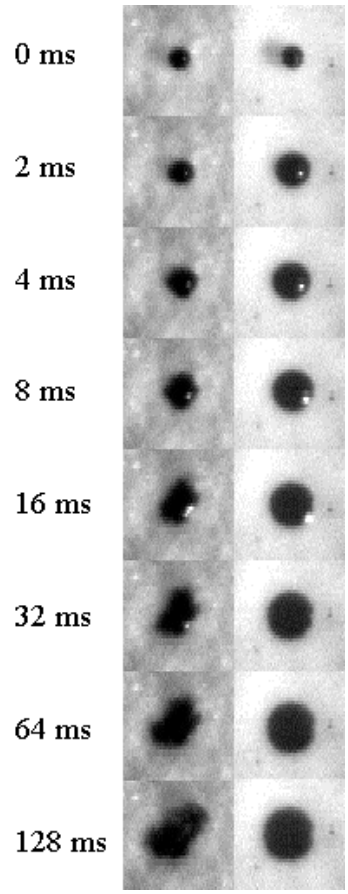

Figure 10. The behaviour of 3 pl ink drops on two different papers during the first 120 ms after impact.

8. Conclusions

On one hand, general packaging production trends, such as shorter delivery times, larger selections and smaller product quantities, are setting higher and higher demands on package production and packaging logistics. On the other hand, developing communication and printing technologies are providing new tools for solving problems, boosting production and giving value addition to packages. An increasingly important task for packaging is to improve brand protection, because forgers usually try to falsify the package rather than the product itself. Methods such as visible or invisible printed bar codes and electronic RFID tags can be effectively used for brand protection and theft prevention.

VTT Information Technology has long-time expertise in these areas and several new activities have also been started. One of our projects, called Active Communicative Packaging, is being carried out under a larger VTT-driven theme and its main purpose is to develop and integrate active, communicative packaging with an effective logistics system for sensitive, demanding products. The aim is to develop a comprehensive system for new kinds of package production chain which pays attention to the special needs of consumer packages as regards product information, identification and appearance. VTT has also launched a project called PRINTO (Printable Optics and Electronics) aimed at investigating the potential

to fabricate passive and active electrical, optical and opto-electronic elements for packages and printed products. The achievements of these projects will be reported in the near future.

References

Ahvenainen, Raija; Juhola, Helene, *VTT Strategic Technology Theme Intelligent Products and Systems: Active, communicating package. Nordic FoodPack. Helsinki, 4 - 6 Sept. 2002, 4 p.*

Heilmann, Jali; Juhola Helene; Linna Hannu, *New challenges of package-based communication. TAGA 2003 Conference, Montreal 2003. 11 p.*

Heilmann, Jali, *Measuring dynamic interactions between paper and microscale ink drops IS&T's NIP 17: International Conference on Digital Printing Technologies. 2001. 4 p.*

Heilmann, Jali; Lindqvist Ulf, *Effect of drop size on the print quality in continuous Ink Jet Printing. The Journal of Imaging Science and Technology. Vol. 44 (2000) No: 6, 491 – 494.*

Heilmann, Jali; Lindqvist, Ulf, *Significance of paper properties on print quality in continuous ink jet printing. The Journal of Imaging Science and Technology. Vol. 44 (2000) No: 6, 495 – 499.*

Linna, Hannu; Vallenius, Risto. *Printing of variable information on packages. Digital Printing for Packaging. London, 12 - 13 July 2000. Pira International. Leatherhead, Surrey (2000).*