

## PAPER BREAKTHROUGHS

*European answers to societal challenges*

Heidy van Beurden



# TABLE OF CONTENTS

INTRODUCTION	4
INTERVIEW	10
“Innovation happens in a context”	10
BRIDGING THE GAP BETWEEN THE PHYSICAL AND THE DIGITAL WORLD	13
Sound paper	16
WiFi-blocking wallpaper	20
Travel catalogue	25
Digital workplace	29
FLEXIBLE AND LIGHTWEIGHT	33
Cardboard buildings	36
Cardboard surfboard	40
Biofore car	45
ENERGY AND THERMAL SOLUTIONS	49
Solar cell paper	51
Paper insulation	55
Noise-absorbing paper	58
REUSING NATURAL MATERIALS	61
Tomato box / book	63
Cacao wrappers	67
SAFETY IN FOOD AND HEALTH	71
Antibacterial paper	73
Antimicrobial paper	76

# INTRODUCTION

## *The most unexpected vehicle for innovation*

This collection of innovative paper solutions arose out of fascination and surprise. One of the oldest known materials, often a symbol for the opposite of today's smart technologies, turns out to be on the threshold of remarkable technological breakthroughs. This is not expected of paper. And even more interesting, it's not the paper industry alone that ignites these innovations. Different areas of expertise, from the horticulture sector to architecture, are investigating the qualities of cellulose fibres for today's societal challenges, demonstrating that innovation can come from unexpected directions.

This book is an invitation to all creative minds and accelerators of knowledge to bring great ideas and demonstration projects a step closer to widespread practical use. How will these paper solutions spark your own creativity, and give your own ideas, research and business plans a twist?

*Heidy van Beurden, September 2015*

Who dares to live in a house made from cardboard or hit the waves with a surfboard made from the same material? Who would be comfortable driving a car with wooden components to the office every day? An office where lightweight paper devices connect you to the internet and where you can print a simple piece of solar paper which allows you to recharge your mobile phone anywhere, anytime. Some of these scenarios might seem unrealistic, but the technologies to make them happen are already available.

Global megatrends encourage us to investigate unusual scenarios. World population and consumption are growing, resulting in competition for natural resources. Long term, we're engaged in a global endeavour to minimize CO<sub>2</sub> emissions, and dependence on fossil fuels, and to manage scarce natural resources. So we intensively investigate renewable energies, the sensible reuse of materials and alternatives to plastics, foams and even steel. It also includes the creation of new products made from waste materials in production chains, focusing on the circular economy.

There are essential short-term challenges too. On a daily basis we need to protect our online data, in order to secure safe business, safe payments and privacy. This is a side effect of the ubiquity of today's network connectivity. At home, rising energy bills increase interest in energy-saving measures, as long as comfort levels remain intact.

And so on.

Data security, energy savings, reducing waste and replacing fossil fuels. All these societal challenges are at the top of the list of international research

programmes and think tanks. They don't seem to have much in common, except the overarching need to act responsibly and sustainably for a safer, healthier and greener globe. However, they do share one surprising thing: paper can be part of the solutions for overcoming the challenges. Paper or cardboard are not necessarily the drivers in these solutions, but innovation is. And paper turns out to be a good alternative to existing materials in the search for innovative breakthroughs. It is a most unexpected vehicle for innovation.

### **Beyond paper's traditional key function as an information carrier alone**

Paper, a material that we have used for centuries. A material that caused a technology revolution in medieval times and has helped society to communicate, to learn and to prosper ever since. The city of Xàtiva in Valencia, Spain, was the first European city to adopt and improve the paper manufacturing techniques from China and the Middle East in medieval times. The 12th century saw the beginning of a lively paper industry here. In 1154 geographer Al Idrisi said, "(in Xativa)... they produce paper of a quality found nowhere else in the world." The technological revolution of that period changed the world of communications and transfer of knowledge forever.

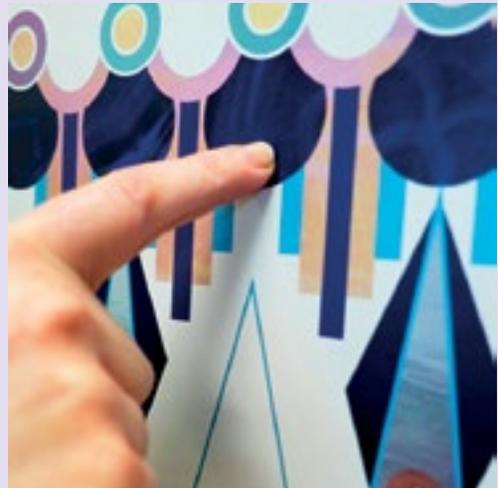
There is a common sentiment that paper has lost this valuable position in society. Yes, in western society printed newspapers still lose market share compared to their online equivalents and rapid newsgathering through social networks. But this sentiment is only partly right when looking beyond paper's traditional key function as an information carrier alone.

# SOUND PAPER

## *Education and engagement with people in a physical way*

Paper has been the leading vehicle to communicate for centuries. The digital age has changed this dramatically. However, paper is continuously adapting to new ways to communicate. First, we were able to print letters (books), followed by printed images. Today, we are also able to interact with the paper by adding sounds and building interfaces into paper documents. Will this allow paper to be web-connected in the near future, just as any other device?

- [www.novalia.co.uk](http://www.novalia.co.uk)



## WHAT IS HAPPENING?

### Incorporating digital advances into beautifully designed printed objects

Various companies and research institutes are investigating how to develop interactive paper, with the help of printed electronics. This is already actively used in packaging, for example in temperature indicators or the automatic identification of products and parcels. The principle of printed electronics is printing electronic circuits and components (like chips, displays and sensors) in ink patterns on conventional industrial printing machines. This allows paper to become interactive. Depending on which parts are printed, not all interactive paper can be defined as printed electronics.

One key motivation for creating interactive paper is education and engagement with people in a physical way. In our smart society we rely massively on screens for information sharing. This is a fact of life and it is hard to turn back the clock. However, some believe that interaction with people is, in specific cases, more effective through materials that we have been familiar with for ages. Like paper. One of them is technology company Novalia in the United Kingdom. They make information billboards, music posters and notebooks, and even a DJ slide deck. The aim of the company is to connect the digital world to printed objects. “The digital soul is wonderful: the ability to touch, the connectivity and the ability to collect data. We aim to tap this soul into print, hidden within the surfaces of beautifully designed objects”, says Kate Stone, engineer and owner of Novalia. “We love technology, but our vision of the future is that it will look more like the past”, she says. She expects screens to become invisible.

The Novalia team consists of engineers, designers and software specialists, reflecting the multidisciplinary approach required for innovation. They work together with the universities of Central Lancashire, Dundee and Surrey, having joined forces in Interactive Newsprint.

## WHY IS THIS RELEVANT?

### Social engagement in the information age

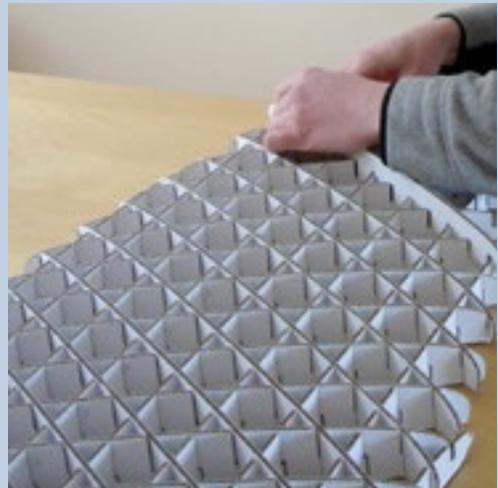
In her inspiring presentations, including one TED talk, Kate Stone is always straightforward: she loves making everyday things interactive, having fun along the way. At the same time, connecting the digital world to the physical world touches on many social aspects she believes are worth pursuing. Stone: “Adding sounds to paper means that you can make information accessible to people in a different way. People who can’t see, can hear information. By pressing a button in a regular newspaper you can hear the press conference of that specific news item. Schools can teach music with piano notebooks. It will change how people learn: through their fingertips.

# CARDBOARD SURFBOARD

## *Replacing foam with recyclable cardboard sliceforms*

“There is something in the air. Various ideas, some quite old, seem to be converging towards an increased use of cardboard based solutions away from just packaging”, says Arnaud Marmier from the University of Exeter in the United Kingdom. He has tentatively started to call himself a cardboard engineer in an endeavour to develop cardboard engineering as a bona fide academic field. While not his primary research interest, after working on various cardboard projects with engineering students he now recognises there is great potential for this topic, with obvious societal impact but also improved performances in some cases.

- [www.exeter.ac.uk](http://www.exeter.ac.uk)



## WHAT IS HAPPENING?

### Cardboard engineering with societal impact

Arnaud Marmier has built different prototypes for transport and mobility, such as a baby car seat insert and a cricket helmet. In collaboration with the international cardboard packaging company Smurfit Kappa, he designed and manufactured a surfboard, ready to hit the waves. His students are experimenting with remote controlled drones made principally of cardboard.

*“The principles of creation in 3D printing and cardboard sliceforms are identical”*

## WHY IS THIS RELEVANT?

### The creation of recyclable objects on large scale, alongside 3D printing

The possibilities to create complex shapes with cardboard are considerable, far beyond the more obvious applications such as furniture. Marmier: “You can think of many products currently made from foam. These include helmets and baby seats, but also bigger objects such as some wind turbine blades. Most blades are currently made of a PVC foam core covered with glass fibre and are typical examples of what is called a sandwich panel. In such a structure, most of the loads are taken by the outer layers, and the core can be light foam. Replacing foam with cardboard slices makes objects more disposable and recyclable. In addition, current tests on bicycle helmets liners made of cardboard slices show that shock absorption performances are better than those made of polystyrene foam. Cardboard research will provide alternative materials for mass production, very possibly at lower costs with lower tooling costs.”

According to Marmier, cardboard products are part of the trends in current micro production by 3D printing within the 'maker' movement. “3D printing allows professionals and enthusiasts to create complex shapes from digital files and to share them with a community. It is a fast growing industry. FabLabs are popping up in many cities and leading technology companies are providing free software to support this development. But while 3D printing is primarily interesting for creating relatively small things, cardboard sliceforms can be used for much bigger shapes. The principles of creation are identical; in fact the same digital model can be 3D printed in a plastic like ABS or sliced in cardboard.”