Innovations In 3D Technology and How They Are Relevant to Packaging

Joris Nijs

Keywords: 3D, packaging, simulation, software, virtual

Abstract

Even though packaging is generally printed on flat substrates, the end product is never really flat. Many stakeholders in the packaging production chain can benefit from using tools that work in three dimensions. Those tools already exist. There is packaging specific software that makes use of 3D to help creating better designs, detect and fix errors and improve communication.

The computer graphics industry is evolving rapidly. We believe that some of the recent innovations are relevant to the packaging industry: web-based 3D, cloth simulation, augmented- and virtual reality. These technologies improve current 3D software tools or allow the creation of completely new tools. Easy communication using interactive 3D mockups is made possible with web-based 3D technology while advances in cloth simulation, augmented- and virtual- reality contribute to create more convincing and immersive experiences.

In conclusion, we expect that the continuous improvements in the field of computer graphics will lead to the use of more and more 3D enabled software in the packaging workflow.

Introduction

Packaging, labels and displays are printed on flat substrates, but the end product is never just flat: it is folded, bent, glued, curved, wrapped or shaped in another way into a three-dimensional product. For a long time, the software tools used in the graphic arts ignored the third dimension. The existing 3D software was not adapted to the needs of the printing industry, but over the years this has drastically improved: from several vendors, tools have emerged that speak the language of the print industry and that are better integrated in their workflow.

Esko

Many stakeholders in the packaging production chain (designers, pre-media companies, converters and packaging buyers) can benefit from using tools that work in three dimensions:

- Brand owners can get more creative designs that perform better on the shelves.
- Designers and packaging vendors can communicate better with their clients by showing a virtual version of the final product instead of two-dimensional artwork or technical drawings. In many cases computer-generated images can also replace costly photo shoots.
- In the production chain, 3D tools can help to detect and fix errors in artwork, for example by correcting distortions that happen with conical labels or shrink sleeves.

The 3D computer graphics industry has developed hardware and software that makes it possible to create interactive 3D experiences, realistic virtual environments or a combination of both. However, until a decade ago, these technologies did not find their way into the tools used in the graphic arts. Neither has the packaging community embraced the tools used in the animation and gaming industry, two strongholds of 3D computer graphics.

The reason why is quite obvious: the computer graphics pipeline is complex.

In this paper, we first give an overview of the possibilities of existing 3D software in packaging. Next, we highlight some recent innovations in the field of 3D technology that we believe are relevant to the packaging industry: web- based 3D, cloth simulation, augmented- and virtual reality.

Obstacles

Many obstacles exist when trying to create 3D packaging models.

The first step to generate a virtual packaging model is creating its geometry. In order to display anything on the screen a mathematical description of the object's geometry is required. The geometry is typically created in general- purpose modeling tools like AutoDesk's 3ds Max or Maxon's Cinema 4D. Because those tools are intended to be able to produce any kind of geometry they tend to be very complex, time-consuming and require experienced artists to be able to create convincing results. This is not an ideal situation for an industry where the number of SKUs is constantly growing.

In a second step the artwork should somehow be applied on the geometry. For us, humans, it looks like the position of artwork on a packaging model is a given. After all, we tend to think in terms of a printed substrate that most of the time is only shaped into its corresponding three-dimensional product after being printed on.

For computers, some kind of mapping between the two-dimensional artwork and the three-dimensional product must be calculated or provided. On top of that, not any mapping will do: the layout of the two-dimensional artwork is predefined; it must match the technical drawing.

After that the object needs to be rendered, this means: transformed into a two-dimensional image that can be viewed on a screen. To create a convincing looking image, the rendering system must be configured such that the model appears to have the correct substrate and that inks and other printing operations appear realistic. This poses some challenges. The terminology and technology of the print industry and the 3D graphics world do not always match.

Finally, there are some challenges with respect to sharing assets and working with 3D in a workflow. At least traditionally, working with 3D requires special purpose software, even when simply viewing an interactive model. Sharing a model requires choosing between one of the many file formats, all with different capabilities and there is always the possibility that the receiver might not be able to work with that specific format.

Current State

In the last decade the packaging industry has come up with solutions in the form of packaging specific tools and has started to embrace 3D technology.

To solve the modeling problem tools exist that ease creation of packaging specific shapes. There is specific software for all kinds of cardboard boxes and displays, for flexible packages, for shrink sleeves, to add labels, etc.

These applications also calculate the correct mapping between the two- dimensional artwork and the three-dimensional geometry.

There is software to support the packaging artwork designer in doing his work in 3D. These tools can preview the 2D artwork design on the 3D geometry instantaneously. Because the software knows how the package looks in 3D and where each part of the artwork will end up on the three-dimensional package, the software can also provide assistance to the designer, for example by automatically aligning artwork that continues across different design panels.

For rendering, tools exist that translate substrate appearance and print operations, ranging from printing spot colors to applying complex foils or embossing effects, into a format that render technology understands. This can be used to preview the complex interaction of different print processes for design or QA purposes.

An example of a packaging mockup created with a series of such tools can be seen in Figure 1: Example of virtual packaging mockup..

Figure 1: *Example of virtual packaging mockup.*

Innovations

Over the last few years a lot of technologies have appeared that improve the current workflow or create new possibilities.

Web-Based 3D

To generate non-trivial 3D computer images at interactive speeds, special purpose hardware, a Graphics Processing Unit (GPU), is required. 3D graphics software needs to be able to access this hardware. Until a few years ago the most common available technologies to communicate with this hardware were OpenGL and DirectX on desktop platforms and OpenGL ES on mobile platforms. To make use of these technologies, specific software had to be created and installed.

In 2011 the Khronos Group ratified the WebGL standard (Khronos Releases Final WebGL 1.0 Specification to Bring Accelerated 3D Graphics to the Web without Plug-ins, 2011), a technology to uniformly access graphics hardware from within web browsers. Since 2015 this technology is available by default in all major browsers on both desktop and mobile platforms.

By using WebGL it is possible to integrate 3D in packaging workflows that are typically web-based. A major example is an approval workflow: packaging buyers need/want to approve any packaging designs they ordered before they go into production. Typically they only use the flat representation of the product to do so. WebGL enables the creation of online tools that require no installation of extra software, thus enabling them to use 3D virtual mockups, directly built into web-based approval tools. This gives the packaging buyer the opportunity to experience the final product before the product is approved and produced.

Another web-based 3D application related to packaging can be found in the field of e-commerce. Online stores, like Amazon, could integrate a 3D mockup of the products they sell, or their packaging. This could give the packaging consumer a similar experience as in a physical retail store, where the consumer can take the product of the shelf and inspect it up close.

WebGL is a technology that enables us to have interactive 3D available during the complete packaging design and approval workflow and thus motivates the use of 3D early on in the packaging design process.

Cloth Simulation

The creation of realistic looking cloth is an important sub-problem when creating convincing computer-generated images. For static images a 3D artist could try to manually create the cloth's geometry. This, however, is difficult, time-consuming and simply not practically feasible for the more common case of moving images. The solution used in the film industry is to simulate (an approximation of) the physics of how cloth behaves. These simulations need a starting point: a typical approach in standard 3D modeling software is to arrange flat sheets of cloth around the model as if cut out of a sewing pattern (Cloth and Garment Maker Modifiers, 2016; Cloth Simulation, n.d.). Next, the artist marks which edges should be sewed together and finally starts a cloth simulation. By simulating physics, a convincing looking piece of garment will form around the model.

The geometry of one class of packaging can be constructed using a similar approach: flexible packaging. The pieces of a technical drawing of a bag can be laid out and sewed together, after which a physics-based simulation creates convincing looking flexible packaging geometry (Figure 2). This approach was proposed by (Van Bael, 2007).

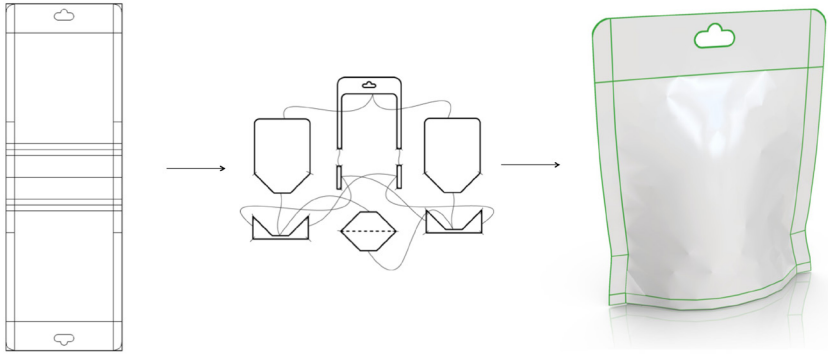

Figure 2: *Left: technical drawing of flexible bag; center: technical drawing decomposed as a cut out sewing pattern; right: computer generated flexible bag.*

More modern cloth simulation algorithms have been developed to create even more convincing looking clothes. These newer algorithms are especially good in producing finer details in wrinkly areas. These advances have found their way in software to create flexible packaging. Bags that have many wrinkly areas, e.g. where the flexible material is clamped together, can now also be simulated.

The advances in the computer animation industry to simulate cloth more convincingly, have led to the creation of tools that aid designers to create virtual mockups of more complex flexible packaging.

Augmented Reality

Augmented reality is the technology of combining real world images, either static or video, with computer-generated information. Applications range from games and apps on smartphones and tablets to applications on purpose-build hardware such as Google Glass or Microsoft's HoloLens. Example apps include retailers giving a preview of the product to their customers (Williams 2016),

One type of augmented reality applications positions the virtual information at specific locations within the real world image. For example putting a game on the back of a cereal box when looking at the box through the camera of your smartphone or labeling the location of the oil dipstick in your car engine. Applications can do this by recognizing well-known markers in the real image. Then they can use those markers as a basis to calculate the position, orientation and even scaling and perspective of virtual content.

This has applications in the packaging industry:

1. Virtual mockups of packaging can be placed on actual shelves next to real products to assess whether the design works.
2. Augmented reality technology can also be used when designing Point- Of-Purchase (POP) displays for retail stores. Because the technology can put virtual objects in the real world to scale, one can try whether a future POP display fits into the envisioned store design at the retail location.

Virtual Reality

In virtual reality everything you see is computer-generated, in contrast to augmented reality. Virtual reality technology wants to immerse the user into a completely virtual world. This is definitely not a new idea. However, the technical requirements to achieve such an immersive experience are tough: you need to be able to generate two (one for each eye) high-resolution images at 95 frames per second, the delay between input and output should be minimal, counter-measures against motion sickness must be in place, etc. Only recent advances in hardware, mostly driven by the entertainment industry, have made this technology possible and easily accessible. Concrete examples include the Oculus Rift and HTC Vive head mounted displays.

For packaging, virtual reality brings new future possibilities:

1. Virtual packaging mockups can be viewed and experienced within context. The packaging buyer can experience how the end result will look in different simulated retail environments under different simulated lighting conditions.
2. More elaborate consumer insight studies can be conducted. Brand owners are interested in the behavior of consumers when they shop: which packaging designs work, and which do not. One way to conduct such research is that marketers set up experiments where a consumer's eye movements are tracked while they walk around or look at shelves in a retail environment. Meanwhile, a video feed of what the consumer sees is recorded. By correlating the video feed with the eye tracking data, researchers can determine how much attention all the products get. With virtual reality these experiments can be carried out in a completely virtual environment. Data processing can be automated much more since the system knows the complete environment. It could also be easier to vary setups or make them more complex.

Conclusion

Three-dimensional computer graphics have evolved a lot since the initial experiments in the second half of last century. In the last decade, this has led to the creation of several 3D enabled software tools for creating and managing packaging. Innovations in different computer graphics branches have opened up new possibilities for packaging specific software in the last few years.

- Standardized web-based 3D technology makes it possible to use interactive 3D mockups during the complete packaging workflow.
- Advances in physical simulation are used to create more convincing virtual flexible packaging models.
- Augmented and virtual reality open up a world where computer- generated packaging mockups can be seen in either the real world or even in a completely virtual world.

Computer graphics are still evolving rapidly. On the hardware front, vendors release more powerful graphics cards at a steady pace; augmented and virtual reality goggles and sensors are only just getting mature. On the software front, new algorithms and techniques are constantly being developed to create more realistic looking images faster. These evolutions lead to more and more convincing and emerging virtual experiences. We believe this will continue to drive the creation of more and better 3D enabled tools that will help simplify and improve the packaging workflow.

Acknowledgements

The author likes to acknowledge following members of Esko staff for there valuable input: Kris Van Bael, Wim Fransen and all members of the Studio R&D Team.