Digital Design and Modelling – Ian Campbell, Loughborough University

Digital design and modelling refers to aspects of two-dimensional (2D) and three-dimensional (3D) design work that can be undertaken within a computerised environment. This has become increasingly common over the past few decades with the improving speed of desktop computers and advances in user interfaces. Traditionally, 2D and 3D design and modelling are done using manual techniques such as sketching, hand rendering, engineering drawings and hand-made physical models. These techniques can be employed in a range of disciplines including industrial design, fashion design, furniture design and architecture. They are still used widely used today, often to complement the use of digital techniques, and a competent designer will be comfortable in both the manual and digital realms.

The most commonly used digital techniques tend to replicate that which is conventionally done through manual methods. For example, 2D computer aided design (CAD) tools are sometimes called “electronic drafting” since they can be used to replace engineering drawing on paper. Likewise, CAD rendering produces high quality, photorealistic colour images that are also the aim of hand rendering on paper (see Figure 1). 3D printing can be used to produce physical models that would previously have been made through skilled handicraft and, more recently, graphic tablet interfaces (such as those from Wacom) have been used to capture sketching movements directly into a digital format. Therefore, the entire manual toolkit of the designer has now been digitalized, although this has not led to wholesale rejection of conventional techniques. There are some digital tools that have become dominant in most design disciplines (e.g. 3D CAD modelling) but others that are less popular. Normally, initial design work is still in the form of manual sketches but these can be used to help create 2D computer renderings (using software such as Photoshop) and 3D CAD models (using software such as Rhino).

Take in Figure 1 – CAD renderings

There are a number of advantages to using digital tools. First of all, anything done on computer can be readily stored and retrieved for future use. At the same time, most digital design and modelling software packages will have an “undo” function, not only for correcting errors, but to get back to an earlier design. Hence, use of a computer means that it is much easier to explore different versions and to make changes to the design. Hopefully, this increased ability to iterate designs should lead to more optimized solutions. This is true whether 2D or 3D digital techniques are being used. However, with 3D modelling tools, there are additional benefits. 3D models are a complete representation of the shape of an object and therefore lend themselves to “downstream applications” in development and manufacturing. Having 3D data in a digital environment enables simulated evaluation and testing of products, often referred to as virtual prototyping. At a later stage, prototype or production tooling, and even the

product itself, can be produced using computer numerical control (CNC) machining or additive manufacturing (an extension of 3D printing into final part production) (see Figure 2). The ability to convert 3D “virtual” data into 3D reality can save substantial time in the product development process. Sometimes, it is necessary to do the reverse, i.e. convert physical objects into digital data, and this is often referred to as “reverse engineering”. This can be accomplished using 3D scanning techniques and associated data manipulation software such as Geomagics.

Take in Figure 2 – additive manufacturing models

Perhaps the most exciting aspect of digital design and modelling is when the computer is used to do something which goes beyond that which is possible using manual techniques. One example of this is so-called “haptic modelling”. This technique enables designers to interact with a 3D computer model through a force-feedback interface, which actually allows them to feel the shape of the object they are creating. One implementation of haptic modelling (the Freeform system from SensAble Technologies) represents the shape of the object as a lump of “virtual clay” that can be manipulated using virtual tools and is often referred to as “virtual sculpting”. Unlike sculpting with physical clay, virtual sculpting enables the designer to experiment with novel techniques such as magnetic attraction, pushing the shape outwards from inside the model and squirting new clay out from a “toothpaste tube” in a gravity-free environment. As a result, extremely imaginative shapes can be generated that would be impossible (or certainly very difficult) to create in a physical medium.

What does the future hold for digital design and modelling? Increasing computer power and ever-more sophisticated interfaces promise to make all the different digital techniques easier and quicker to use. In theory, this will make them even more attractive to use in comparison to manual techniques and a totally digital world of design could prevail. However, there are many designers who would resist this and a hybrid approach is sure to continue for the foreseeable future. Other developments we can expect to see are greater flexibility in moving shapes between the real and virtual worlds, and greater integration between 2D and 3D representations, currently a weakness within the digital realm. Coupled with the geometric freedom offered by additive manufacturing, the complexity of shapes that can be produced through digital modelling will lead to a new generation of product aesthetics were the only limitation will be the imagination of the designer.