An Interactive Model of Creative Design Behavior with 3D Optical Technology

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Abstract. The research is based on the design computer technique and optical 3D scanning technology, which integrated with cloud data, human engineering and surface simulation and reconstruction technology. In addition, a web based design education prototype with 3D scanning and printing technique will be created by researcher as well, in order to verify the results of the research in the actual application environment. It will allows us to refine our system and propose more subjects under with similar technologies to help to develop creative skills of students who are often got stuck with 3D modeling which are not helpful for those who wish to study design without sketching and modeling skill.

Keywords: 3D imaging · 3D scanning and printing · Creative design · Interactive design

1 Introduction

Digital media are increasingly collaborated with culture, design, and education fields. An increasing number of number of institutions and other heritage museums are now undertaking 3D digitisation as normal part of their activities [1]. The 3D model always created by a computer-aided design software or a scan an existing object [2].

The technologies of 3D scanning and printing are generally considered as one of the important symbols of the third industrial revolution, and apply into different type of industries. 3D technologies are able to generate the products with complex structures, high accuracy, and particular features. Therefore, such strengths lead 3D technologies used into various areas, which include industrial manufacture, biomedical engineering, construction engineering, and culture creativity. Besides, many companies around the world have launched the 3D scanners and personal 3D printers. Thus, 3D scanning and printing technique will be collaborated with digital producing mode to promote industrial development. According to the development of 3D technology, the application of 3D scanning and printing in education has been concerned by many researchers. As recorded in Horizon Report: 2013 higher education edition., the new technology of scanning and printing in the next four to five years brings innovation of teaching, learning and research. And in the next three years, 3D technique will become a major direction in educational technology [3]. The application of 3D technology

A. Marcus (Ed.): DUXU 2016, Part I, LNCS 9746, pp. 43–52, 2016.
DOI: 10.1007/978-3-319-40409-7_5

education helps students to enhance their interactive ability, innovative thinking, and creative thinking in classroom which compared to the traditional teaching scheme. In this paper, researcher proposed an interactive design model to analyze how 3D optical technology to improve creative skill of students.

Over the past decade, advanced 3D optical scanning technology developed into a widely used tool and medium in various enterprises and educational fields. Although the 3D scan process is not a new research topic, the integration of 3D scanning and printing in education has been paid a great attention to by many researchers and experts. High speed and accuracy of 3D optical scanning technology makes the productivity efficiency, and capturing point-cloud data in 3D modeling and animation will be a huge potential of ascension [4]. 3D application software for modeling, rendering, and animation has become an essential part of the industrial design [5, 6]. However, the 3D modeling based on 3D optical measurements data has not widely used in the field of education. In the case of design studies, the integration of 3D scan data and technology provides the unlimited potential for complex modeling. The students in design major still rely on 3D modeling software to produce complex surface model [7]. As we know, most of students need to spend amount of time to build a three-dimensional models [8], such as gloves, shoes, and face. Even those of them master the modeling skill and software, there are still many limitations in the application of surface modeling. In this paper, the 3D optical scanner used to capture the basic 3D modeling data, students able to choose existing output models for their own design requirement and re-creation without basic modeling process. This interactive model integrates cognitive, creative, collaborative and pedagogical representations of user behavior and creative skill that enable better understanding of students and their intents through a theoretical framework.

2 Background of Design Education

Design is the arrangement of forms and colours of an artefact or natural form. The word "design" is from the Latin designare, meaning to mark out, trace out, contrive, or arrange [9]. In The Oxford Dictionary, the explanation for the word "design" is a plan or drawing produced to show the look and function or workings of a building, garment, or other object before it is made. It is the creation of a plan and convention for the construction of an object or system. There are countless philosophies for guiding design as the design values and accompanying aspects of modern design vary, both between different schools of thought and among practising designers. Design, so construed, is the core of all professional training. It is the principal mark that distinguishes the professions from the sciences. Thus, design education forms an important part of the whole design research and practice.

Design education is the teaching of the theory and application of the design of products, services, and environments. It encompasses various disciplines of design, such as graphic design, user interface design, web design, packaging design, industrial design, fashion design, information design, interior design, sustainable design, and universal design. However, design education is also concerned with the training of theoretical thinking or practical skills in a process that can be mapped out to other areas of applications, while theoretical thinking is often provided at the postgraduate level and practical skills can be given to students at the undergraduate level or high-school level.

Throughout the history of Western civilization, education was limited to the children of families with wealth or social power [10]. Educational matters have been the subjects of earnest discussions by philosophers and statesmen. As we know, Western culture dawned in Greece, where two great philosophers, Plato and Aristotle, wrote not only about education but also about the place of the arts within it [9]. The concept of art education as distinct from craft training was realized in Italy in the sixteenth century due to the recognition of art as a product of the intellect rather than skilful hands, and a “scienza studiosa” investigated the principles of design of natural phenomena [9]. On the contrary, for many decades design studio pedagogy continued to be taboo, undebatable and untouchable. Until the late 1970s, few scholars discussed design education [11].

With the development of the world and artistic forms, art and design education as it stands today has been greatly influenced by the Bauhaus school (Bauhaus meaning house of building). Most consider it to be the first formal design school. The origins of Bauhaus can obviously be traced back to Kindergarten, the school system for educating young children perfected by Friedrich Froebel. Friedrich Froebel was a German pedagogue who created the concept of the “kindergarten” and also coined the word now used in German and English.

In Norman Brosterrman’s book “Inventing kindergarten”, the series of “gifts” used by children at kindergarten are very much what young designers were taught to experiment and to “play” with as they were learning about formal principles and relationships. The gifts stimulated imagination and creativity while teaching the designers to think about formal principles in two dimensions and in three dimensions. In 1919, a German architect named Walter Gropius was appointed as head of the Bauhaus in Weimar. He came from the Werkbund movement, which sought to integrate art and economics and to add an element of engineering to art [12]. Students at this new school were trained by both an artist and a master craftsman. Gropius thought that modern artists familiar with science and economics need to unite the creative imagination with practical knowledge of craftsmanship, and thus to develop a new sense of functional design [12].

The first aim of the school was to rescue all of the arts from the isolation in which each then found itself to encourage individual artisans and craftsmen to work cooperatively and combine all of their skills [13]. The school also set out to elevate the status of crafts to the same level enjoyed by fine arts such as painting and sculpting. Another important aspect is to maintain contact with the leaders of industry and craft in an attempt eventually to gain independence from government support by selling designs to industry.

In 1937, the stars of the Bauhaus fled to the United States in the wake of the Nazis’ rise to power. At that time, the United States welcomed them with open arms. Gropius was made the head of the school of architecture at Harvard. One of the most versatile artists of the twentieth century, named Laszlo Moholy-Nagy, opened the new Bauhaus, which evolved into the Chicago Institute of Design (“Illinois Institute of Technology” today). Mies van der Rohe, who was a great architect of the time, became the head of the Bauhaus in 1930, and was installed as the Dean of Architecture at the Armour Institute in Chicago. Bauhaus is still a very important part of today’s design education scene. Its effect stretches beyond product design into the realms of architecture, theatre, and typography, in which the designs and style of Bauhaus also occupy a significant position.

3 The 3D Optical Technology

3D scanning integrated light, machine, electricity and computer technology in order to obtain the spatial coordinates of the object surface. It mainly used to scan the object space shape and structure. As an important technical support in manufacturing, the technology plays an indispensable role in its development, research and application has become a new subject. The significant of this technology is able to convert the solid information of object into digital signal which is provide a convenient and efficient method of digitization with computer. There are two kinds of digitizing techniques for capturing 3D data, mechanical which uses contact sensors, and the optical/laser which processes by non-contact sensors. 3D optical scanning technology can realize the non-contact measurement with white light in high speed and accuracy. Besides, the measurements results are able to connect with wide variety of software, which makes it becoming popular in CAD, CAM, and CIMS application. The different subject fields 3D scanning is application into are RE [14], 3D modelling and visualisation, point cloud data comparison, prototyping, analysis, digital archiving, inspection and quality control requirements [15]. With 3D optical scanning technology for plants, samples, and models to obtain the steric size data. The data can adjust and repair in CAD system before sent final results to manufacturing center or prototyping equipment to reduce the product manufacturing cycle in efficiency.

3.1 The 3D Optical Scanner in Research

The 3D scanner used in this paper is a desktop 3D optical colour scanner, this basic structure of three-dimensional sensor based on the phase mapping of the structure light illumination. It mainly composed of binocular stereo vision camera and structure light illumination device, and the core technology of the sensor is phase assisted active stereo (PAAS) (Fig. 1). The working principle is the structure light illumination device projected sinusoidal fringe sequences to the object to be measured with variable frequency and phase shifting. The ideal stripe is modulated by the height of the object surface, and the deformation fringe pattern is processes by the phase recovery technique to reduce the absolute phase distribution on the surface of object. To be the only feature, absolute phase can be used to establish homonymy point matching of the right and left camera, and then reconstruct the 3D geometry of the object surface by binocular stereo vision theory.

At the same time, to construct multisensory measurements networks which uses of high pixel SLR camera and binocular stereo vision system not only capture geometry stereo structure data, also collects the colour texture information by SLR camera. The system matches geometric data and colour texture with internal and external parameters after obtain high quality colour texture from single vision through SLR camera (Fig. 2).

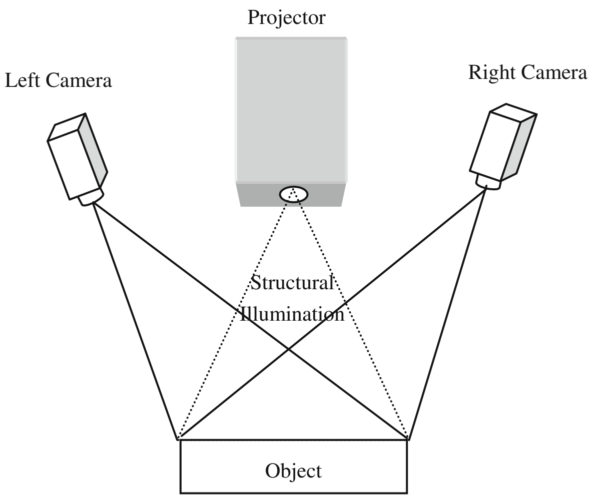

Fig. 1. Binocular stereo vision camera and structure light illumination device

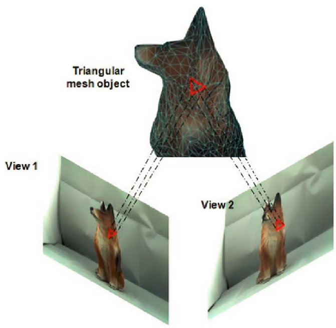

Fig. 2. Colour texture corresponded 3D geometric data

The obtained colour texture information need to establish one to one correspondence relationship with 3D geometric data. Then obtains the final 3D data model with real colour texture data through a variety of mechanisms of weighted coefficient algorithm and fusion processing of colour texture (Fig. 3). Researcher intend to apply 3D optical scanning technology on design education in order to improve the creative behaviour in design subject.

The 3D optical technology is able to measure and record the complex interface of the products (Fig. 4). There are lots of 3D basic models captured by 3D optical scanner, then designers and students could recreate the new shape on the basis of existing models.

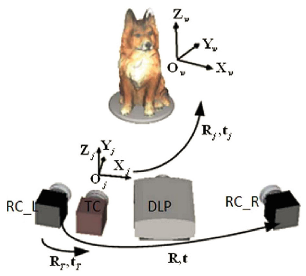

Fig. 3. Example texture geometric measurements

Fig. 4. Examples by Scanner

4 An Interactive Model in Design with 3D Optical Technology

Researcher creates an interactive model integrated four factors which are cognitive, creative, collaborative and pedagogical. This model proposed to improve user behavior and creative skill that enable better understanding of students and their intents through a theoretical framework (Fig. 5). Cognitive skills are the mental mechanisms that are used in the process of acquiring knowledge; these skills include reasoning, perception, and intuition. Reading and writing rely on a specific set of cognitive skills, such as attention, memory, symbolic thinking, and self-regulation. For example, when children learn to read and write, they continue to improve these skills, making them more purposeful and deliberate. Deliberate attention is required to differentiate between letters, even if they look alike, and to isolate specific portions of a word for encoding to decode it. Children must remember the previous words as they decode the subsequent words in a sentence. A teenager's cognitive skill set is made up of several mental skills, including auditory and visual processing, short- and long-term memory, comprehension, logic and reasoning, and attention skills. Most college prep courses focus on academic materials and study habits. Meta-cognition allows teens to think about how they feel and what they are thinking. It involves being able to think about how one is perceived by others. It can also be used to develop strategies, also known as mnemonic devices, for improving learning.

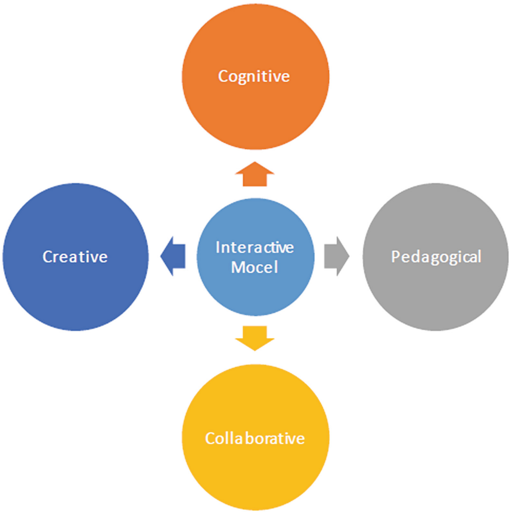

Fig. 5. The theoretical framework

Cognitive skills are also considered when designing an integrated interactive model. In this case, the cognitive model works in contrast to another element of artificial intelligence study, the cognitive architecture. The cognitive model attempts to recreate how the brain can carry out a particular task, such as design learning or making decisions. Cognitive design has been considered by many researcher in design fields. Cognition is the scientific term of "the process of thought" to knowing. Cognitive artefacts (CA) are acknowledged as important for individual cognition [16], but their function in design group work also has largely potential. In this paper, researcher inherent 3D optical technical hardware with design process in order to improve the creative ability. By advancing the science of design, and by creating a broad computer based methodology for automating the design of artifacts and of industrial processes, researchers can attain dramatic improvements in productivity [17]. The 3D optical technology introduced in this research to allow students and designers to perform how this technique impact the design cognition. A design project would be conducted in two groups, one group need to complete the product design in traditional process which include brainstorm, prototype, and modelling. Another group Finish the design project with existing 3D models captured by the 3D optical scanner. Researcher needs to observe the two groups, and record the whole design process to prove the achievement of this model.

Design in many settings is an inherently collective and creative undertaking, with phenomena of emergence at the heart of the activity [18]. Complex design problems require more knowledge than any single person possesses because the knowledge relevant to a problem is usually distributed among stakeholders [19]. Bringing different and often controversial points of view together to create a shared understanding among these stakeholders can lead to new insights, new ideas, and new artifacts [19]. Collaborative success can therefore be said to be achieved when we have accomplished something in a group which could not be accomplished by an individual. The representation available in the CA can be an effective means of passing this information between stakeholders. This theory supported designers are faced with distribute, ill-structures problems.

Shared Understanding is the important factor affect the collaborative design. In designing artifacts, designers rely on the expertise of others [20], by referring to text book, standards, legal constraints, and especially previous design efforts. Project complexity forces large and heterogeneous groups to work together on projects over long periods of time. Knowledge bases to support design should include not only knowledge about the design process but also knowledge about the artifacts of that process-parts used in designing artifacts, subassemblies previously created by other design efforts, and rationale from previous design decisions [21]. The interactive model is the basis for conducting research and experiments with the students.

In this research, a platform (Fig. 6) has been built based on this theoretical model. With this computational interactive platform, it is then possible to test and evaluate whether the original objectives of the research have been achieved or not, and to identify the direction for further research and improvements.

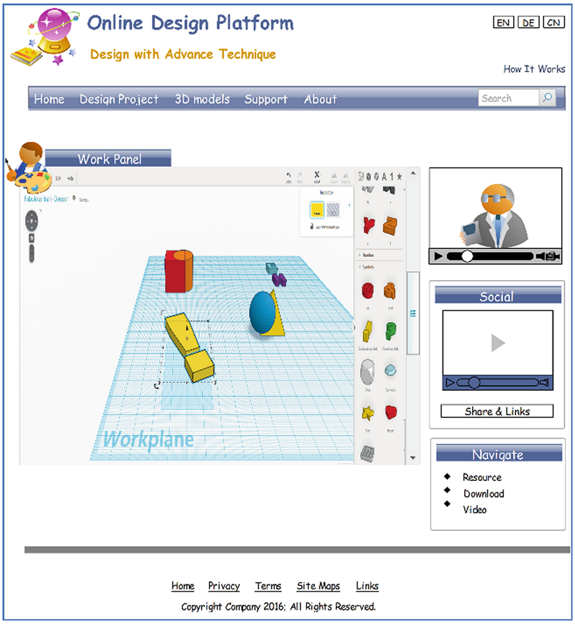

Fig. 6. The prototype of the online design platform

5 Conclusion

This paper aim to use 3D optical scanner to capture the basic 3D modeling data, students allowed to choose existing output models for requirement of design project and recreation without basic modeling process. The advanced 3D optical technology able to improve the speed for modeling especially for the students and designers without background of 3D software modeling. The integration interactive model includes four factors: cognitive, creative, collaborative and pedagogical representations of user behavior and creative skill that enable better understanding of students and their intents through a theoretical framework. The online platform as a medium for this interactive model to prove the proposition of researcher.

The research supports by Shenzhen University and Esun. Corporation Shenzhen.

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