Evolution of drawing and sketching with the use of zbrush and the live boolean tool

Evolución del dibujo y abocetado con el uso de zbrush y la herramienta buleana en vivo

ALFONSO BERROYA ELOSUA
PhD in Fine Arts, University of the Basque Country, Teaching and Research Academic Staff, Lejona, Spain; alfonso.berroya@gmail.com

MAITANE ECHEVARRÍA AGUIRRE
MFA in Animation, Savannah College of Art and Design, Savannah, Georgia, USA; mai.echevarria@hotmail.com

DAVID ARTEAGOITIA GARCÍA
PhD in Fine Arts, University of the Basque Country, Head of the Drawing Department, Lejona, Spain; david.arteagoitia@ehu.eus

In the video game and animated film industries, design techniques are used to facilitate the preview of complex architectures, buildings, and backgrounds. 3D programs can be utilized early in the visualization pipeline using a technique called "Kitbashing". The software analyzed here, ZBrush, was originally designed to focus on organic sculpture and character design; today it is used for both organic and inorganic modeling development. This software is classified as a specialized digital sculpture program, which, unlike 3D modeling programs, allows a closer approach to traditional drawing and sculpture. This article will focus on demonstrating an elaborated example of how the use of Kitbashing and the Boolean tool can be useful for a project, as it allows one to work with complex inorganic forms in an intuitive and simple way. The objective of these techniques and tools is to create and search for shapes intuitively, allowing the creator to reach advanced design phases quickly. Through this process, complex models and shapes can be created. In this sense, these systems can be of great help in industries and sectors like architecture and building, as they allow the user to achieve realistic and impactful results for the presentation of a project to possible customers.

Concept; Architecture; Building; Drawing; Kitbashing; Live Boolean

En las industrias de videojuegos y películas de animación, las técnicas de diseño se utilizan para facilitar la vista previa de arquitecturas complejas, edificios y fondos. Los programas 3D se pueden utilizar antes en el proceso de visualización utilizando una técnica llamada "Kitbashing". El software analizado aquí, ZBrush, fue diseñado originalmente para centrarse en la escultura orgánica y el diseño de personajes; hoy en día se utiliza tanto para el desarrollo de modelos orgánicos como inorgánicos. Este software está clasificado como programa especializado en escultura digital, lo que, a diferencia de los programas de modelado 3D, permite un acercamiento más cercano al dibujo y la escultura tradicionales. Este artículo se centrará en mostrar un ejemplo elaborado de cómo el uso de Kitbashing y la herramienta buleana puede ser útil para un proyecto, ya que permite trabajar con formas inorgánicas complejas de una manera intuitiva y sencilla. El objetivo de estas técnicas y herramientas es crear y buscar formas de forma intuitiva, permitiendo al creador alcanzar rápidamente fases avanzadas de diseño. A través de este proceso, se pueden crear modelos y formas complejas. En este sentido, estos sistemas pueden ser de gran ayuda en industrias y sectores como la arquitectura y la edificación, ya que permiten al usuario obtener resultados realistas e impactantes para la presentación de un proyecto a posibles clientes.

Concepto; Arquitectura; Edificación; Dibujo; Kitbashing; Buleana en vivo

1. PREVISUALIZATION TECHNIQUES

The architectural design of environments has always depended on line drawing and graphics to develop and communicate complex ideas. These visuals serve as a language and establish conventions that make these ideas globally comprehensible. Francis D. K. Ching, well known author of architectural drawing, emphasizes the relevance of graphics and communication through line drawing, which is understood both as an element of abstraction and representation of shapes:

"The basic premise of this approach is that graphic design is an inseparable part of the design process, an important instrument that gives the designer the means not only to present a design proposal but also to communicate with himself and with the studio's collaborators" [1].

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In addition, he mentions that this technique not only represents the shape and its silhouette, but also its volume:

"Although all drawings are representations and the main difference between a pure line drawing and a drawing using tones is only a difference in the degree of abstraction, a drawing with tonal value usually gives more information about the object drawn. Living in a world of light, we find that the change in tone value is the basis of our perception of the shape" [1].

These conventions and graphic languages persist over time, and are still used today in architecture and building, as well as in recent technological industries such as animated cinema and video games. Scott Robertson, author of the didactic book on perspective drawing "How to Draw" (one of the current reference manuals in sectors such as product design, vehicle design, cinema and video games), refers to hand drawing and sketching as an indispensable technique, and extolls its importance in expressing ideas:

"Drawing is almost a magical power. It enables you to communicate in a different way that spoken or written language. Perspective drawing convey how things work and how they look. You can inspire others with something as simple as a pen and a napkin" [2].

Derived from this traditional sketching technique, "thumbnail sketching" is a fundamental process to represent architectural spaces. Thumbnail sketches are used to communicate a general sense of the space, emphasizing atmospheric perspective, grey values, and overall spatial composition. These drawings provide several options among which a final image can be obtained.

"It just feels natural to sketch environments using a bit of value. This is because one of the best ways to perceive depth is through atmospheric perspective. In this photograph of the San Francisco Bay, Alcatraz, and the hills of Marin County, you can see this progression of value contrast, with the most contrast (the brightest and darkest values) in the foreground. All of these values lessen as the amount of atmosphere increases with distance. This principle can be applied to sketches in a loose and simple way to give environments extra depth. Look at the value contrast in these thumbnail sketches, and note how it makes them feel more realistic" [2].

Fig. 1: Image of the San Francisco Bay [2].

These techniques are also used to design environments in video game production, as seen in the examples in figures 2 and 3. These works include line sketches, thumbnail sketches with stain, and subsequent color work. It should also be noted that these works are created entirely in a 2D digital environment using a graphic "Cintiq" screen and software such as Photoshop and Clip Studio Paint.

In figure 3, an evolution of the same idea is developed, starting from a sketched line design and followed by color development:

However, as the work of drawing and designing elements becomes more complicated, the help of 3D environments becomes indispensable to save production time. Scott Robertson himself anticipated in 2013 the importance of using 3D software to complement hand drawing and design in order to simplify the most complex aspects:

"Some of most significant advancements in perspective drawing are 3 D modeling programs that can aid in the basic layout of perspective drawing grids and larger volumes. Why not then have the computer do it all? In order to use these computer programs efficiently and effectively, it's important to learn how to construct hand-drawn grids and volumes first. This combination of 2D and 3D tools can be very powerful to create awesome drawings" [2].
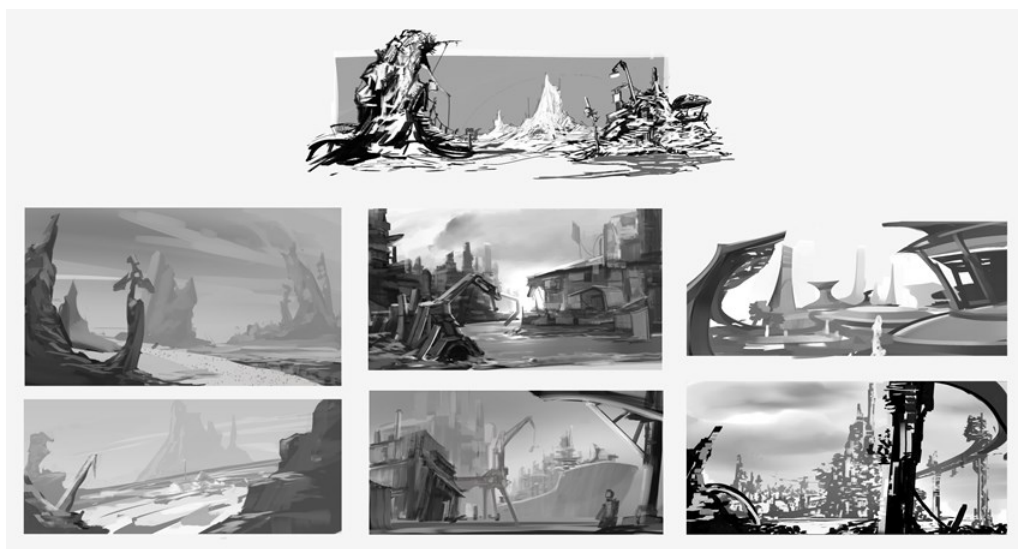

Fig. 2: Thumbnail sketchings through line and gray values made in Photoshop.

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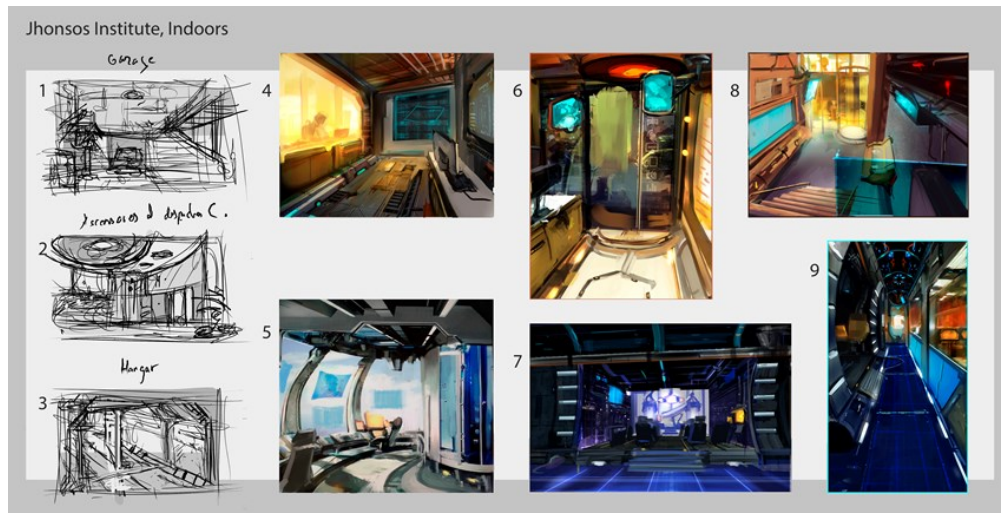
Fig. 3: Thumbnails of interiors starting from line drawing through prototyping in color, realized in Clip Studio Paint.

Nonetheless, Robertson mentions that it is essential not to spend too much time within these programs, because it is a time-consuming process to design and prototype shapes in 3D environments:

"It's easy to get sucked into modeling more than is needed, and to get carried away adding details or more complex forms that would be faster and easier just to draw. Hours can be spent messing around on the computer when all that was really needed was one good 3/4 view to get started" [2].

This problem, in fact, is mentioned in the research carried out by J. Alcaide-Marzal, J. A. Diego-Mas, S. Asensio-Cuesta, and B. Piqueras-Fiszman, in their work "An exploratory study on the use of digital sculpting in conceptual product design" [3]. They performed tests involving students who had basic, medium, and advanced skills in 2D illustration, drawing, and 3D. The students were split into groups based on the workflow in which they specialized to create concepts. The research concluded that:

"Paper and pencil are still more powerful than digital media to produce conceptual solutions, in terms of number of concepts. This evidence rejects our first hypothesis, as participants were more productive when using 2D sketches" (…) "Computer tools for conceptual design are already available, but it is difficult to use them properly. A new approach to computer aided design is needed in order to take advantage of them. The dialogue between designer and digital sculpting is actually there, but it needs some adjustments. A more comprehensive analysis of 3D sketching actions and their connection with 2D sketching would be needed in order to determine the right approach to these new tools" [3].

However, this research was conducted using the ZBrush 4 software version, which did not include the Live Boolean tool which will be subsequently discussed. The Live Boolean tool, introduced in version 4.8, allows for the design of complex shapes without requiring of the time and effort of previous versions and workflows.

The subject of the following study is the Live Bolean tool from ZBrush 4.8 and its application as a technique for designing architectural spaces and scenography. It is an advance on the classic techniques of pre-visualization, with both the speed of sketching and drawing but also providing the advantages of 3D. Realistic rendering becomes available with materials, reflections, and lighting shown.

Although there are already Booleans and modeling tools for designing 3D elements in programs such as SketchUp, 3DSMax, BIM, AutoCAD, etc., this Live Boolean tool is the most effective 3D alternative to thumbnail sketches. It allows one to create complex shapes without worrying about the mesh or topology and allows for the deformation, cutting, and modification of models using multiple meshes to obtain a real-time preview of what the result will be.

In the video game and animated film industries, design techniques are used to facilitate the preview of complex architecture, buildings, and backgrounds. These can include both organic and inorganic shapes. Within the workflows of these industries, 2D and 3D digital tools and software are used in various states of the process, as mentioned in the communication carried out in the international congress on building APEGA 2019 [4].

After analyzing the results, it was found that the use of previsualization techniques for the representation of concepts has proven its effectiveness (especially as a time saver), as it allows the user to achieve realistic and impactful results for the presentation of a project in a more efficient way. In this sense, these systems can be of great help in industries and sectors like architecture and building.

1.1. Introduction

3D programs have been utilized in many different realms of architecture. The most common use has been to previsualize models after they have already been designed. This is used to

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give customers an idea of what the final product could look like. Another use can be found in academics; scholarly examples include reconstructions of ancient architecture using 3D programs, as is demonstrated in Denker's work [5].

However, 3D programs can be utilized earlier in the visualization pipeline than they traditionally are using a technique called "Kitbashing". Using this technique, one collects, organizes, labels, and selectively stores all the objects previously created in 3D and then reassembles them to create a completely new object or scene [7-13]. Any element that has been modeled before can be reused in future projects. When designing for production, both speed and efficiency are fundamental factors. The Kitbashing methodology enables 3D software to contribute to the design process rather than simply visualizing previously designed concepts [15-23].

1.2. ZBRUSH

The example shown in the next section demonstrates one of the most effective workflows that can be used when designing inorganic elements. To do this, the 3D sculpting and modeling software ZBrush is used.

ZBrush is a software created by the company Pixologic in 1997. In order to understand the potential of the tool, it is necessary to understand the professional context in which it was created. At the end of the 1990's, 3D modeling and design software geared toward artistic industries rose in prominence due to the success of "Toy Story" (1995), the first animation film made entirely with 3D software. In this situation, 3D programs proved to be an effective tool for creating movies. They also enabled the generation of virtual environments created entirely in 3D for consoles like PlayStation.

However, developers lacked a tool to develop organic shapes and geometries with processes that were closer to traditional art. It is in this arena that Pixologic's tool has been fundamental. In fact, its focus on character development and specialization became notorious after its use in two The Lord of the Rings films: "The Two Towers" (2002) and "The Return of the King" (2003).

This software is classified as a program specializing in digital sculpture, which, unlike most 3D modeling programs, gives the user an experience closer to traditional drawing and sculpture. In fact, it has become an indispensable tool for three dimensional "sketching" when creating conceptual images.

"However, there are several key differences between 2D sketching and 3D sculpting that prevent trivial extensions of prior methods for our applications. 2D sketching operates on a simple 2D static planar canvas, the user strokes do not interact with one another, and remain there once placed.

3D sculpting dynamically deforms the base object shape, the later strokes can overlap and alter earlier ones including both visible/explicit mesh shapes and invisible/implicit stroke relationships, and similar input strokes can end up with dissimilar output structures due to intervening edits" [6].

1.3. EXAMPLES AND RESULTS

The software analyzed here, ZBrush, was originally designed to focus on organic sculpture and character design; today it is used for both organic and inorganic modeling development. Originally ZBrush did not feature fundamental spatial control tools commonly found in traditional modeling programs, such as 3D Max, Maya, or Blender. These programs include a position, scale and rotation manager as well as a hub showing the position of the object with respect to the "X", "Y", and "Z" axes, whereas ZBrush did not. This lack of visual orientation was a shortcoming that complicated the process of designing inorganic elements with precise control [14].

However, with the release of version 4r7 and subsequent iterations, the program has incorporated more and more tools that make it competitive with traditional modeling programs. These tools include "ZModeler", "Nanomesh", and the more recent "Live Boolean" tool, which will be analyzed here. This article will focus on the Live Boolean tool, as it allows one to work with complex inorganic forms in an intuitive and simple way.
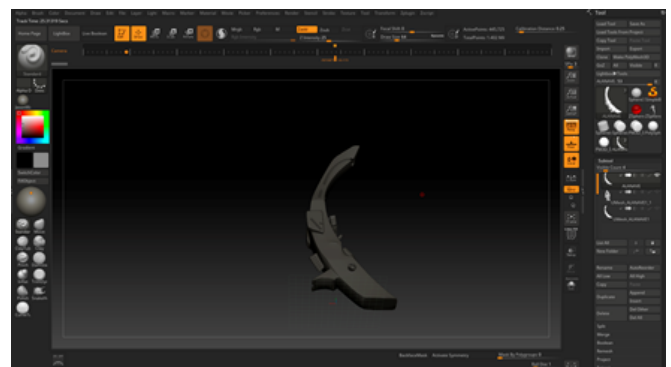

Fig. 4: Simple shape modified with Kitbashing elements.

This process begins with Kitbashing: the gathering and cataloging of previously created inorganic elements and objects to be combined afterwards. These will serve as the building blocks for creating modifications and suggesting new shapes.

The process of modeling inorganic objects through Live Booleans begins with a scene composed of a primitive or simple geometry. From here, as shown in Figure 4, the user will explore shapes as simple modifiers, cutting the original piece with the "Trim Curve" tool and playing with the symmetries.

To see a precise example of how the Trim tool set works, look at Figures 5(a) and 5(b). In Figure 5(a), this tool is used to draw a curve along the geometry. The program calculates everything marked along the curve and subtracts it from the original object. In this case, the Trim process results in the form shown in Figure 5(b). The Trim tool includes circles, rectangles

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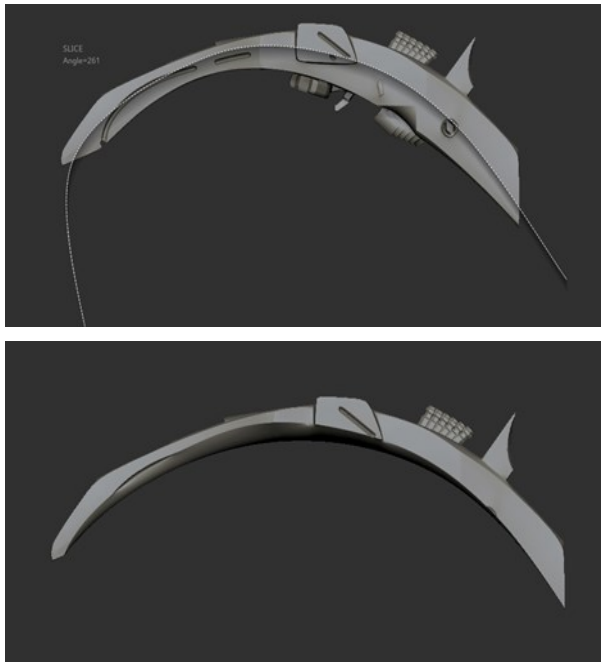and other forms of selection beyond a curve line, so the possibilities of creation are wide.

Fig. 5(a) and 5(b): Example of the use of the Trim tool.

From this point on, the user can always assemble shapes that have already been created and place them with small deformations of scale, position and size to suggest new volumes. For example, Figure6(a) shows a duplicate of the original shape that has been made in "symmetry" mode. Adding this piece to a bigger copy of the initial piece resulted in Figure 6(b). The result adds volume to the original shape and saves considerable design time. Again, this process is meant to be a quick and experimental way of working, and these tools help enormously in the process.
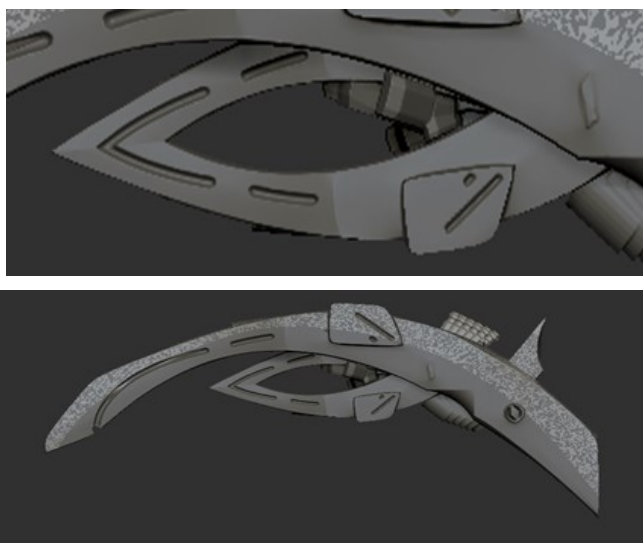

Fig. 6(a) and 6(b): Addition of symmetric duplicate to create interest.

In order for Kitbashing to be effective, one must compile a 3D elements library. This library consists of tools and 3D objects which were previously loaded into the program. It is important to maintain clear naming conventions and organization to facilitate an easier use. Figure 7 exhibits a 3D elements library in ZBrush which consists of numerous previously-modeled objects. These objects can be added to the primary volume, and, through the use of Kitbashing, used to modify and enlarge the final form.
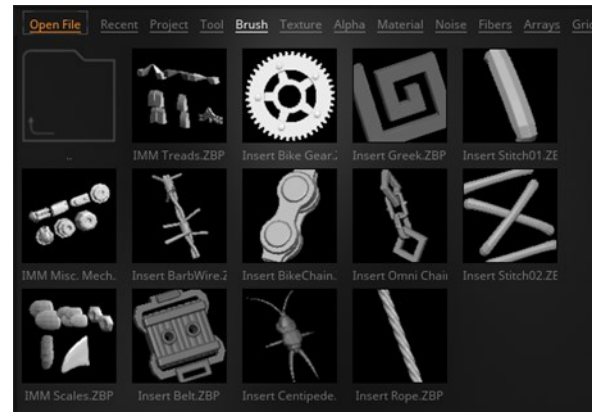

Fig. 7: Example of 3D elements library.

In this example, shown in Figure 8, the objects from the Figure 7 3D elements library were combined and manipulated to produce a new volume. The objects that were previously created with the "Trim" tools and deformers (Figure 6(b)) became the wings for this new model. This Kitbashing turned the wing and various mechanical elements from the library into a ship prototype.
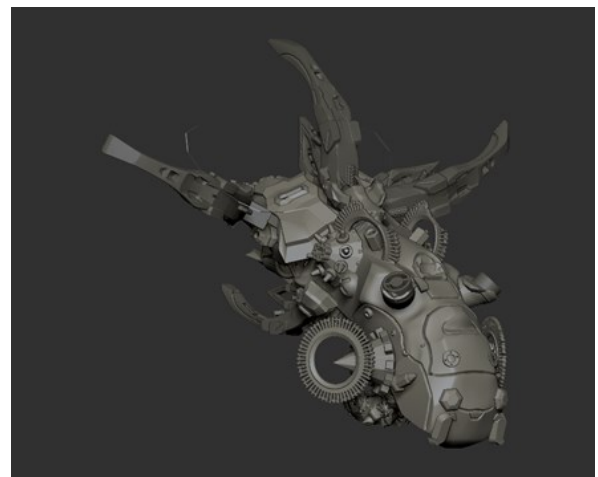

Fig. 8: Ship prototype created through Kitbashing, deformers and Trim tools.

Now is the time to use the Live Boolean tool.

This tool is very similar to those used in other modeling programs, such as 3DS Max, Maya, or Blender. Figure 9 shows two steps of the process to illustrate how the tool works. When two 3D objects are intersected (Figure 9(a)), the Boolean process can be used to subtract volumes from each other. It is possible to work with either the resulting piece or the pieces which were subtracted.

Most programs require significant time to perform the necessary calculations to display the results of the Boolean

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process. Thanks to the Live Boolean tool incorporated in ZBrush, several processes can be performed simultaneously while obtaining a real-time preview.
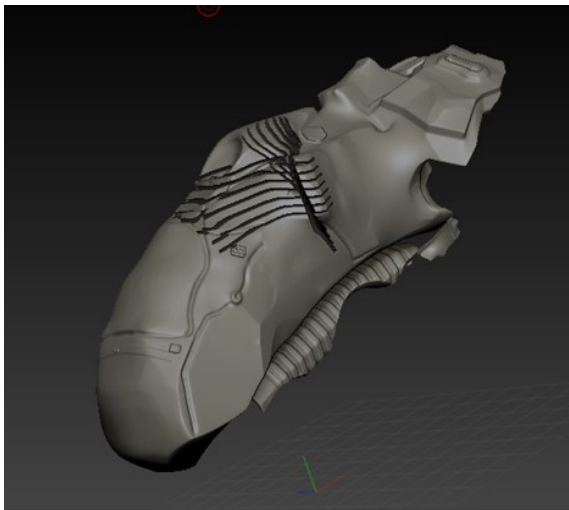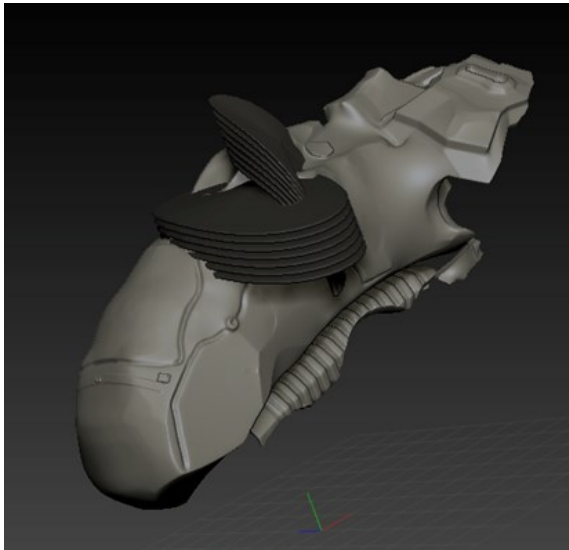

Fig. 9(a) and 9(b): Previsualization of Probooleans.

At this point, all the previously-mentioned techniques are combined. The Live Boolean tool is a powerful resource for Kitbashing elements to combine and subtract from existing volumes. The user can manipulate and deform the original shape to his or her liking without having to take into account the mesh or base topology of the objects involved.

Keep in mind that the objective of this technique is to create and search for shapes intuitively, which allows one to reach advanced design phases quickly. This technique has a drawback in that it requires a powerful computer to run the program and allow it to perform complex calculations simultaneously and in real time. Additionally, the resulting geometry of the 3D mesh will not be of final production quality; the topology can be chaotic and therefore difficult, if not impossible, to incorporate into film or video without retopologizing it first. This process, however, is more typical of 3D artists and professionals at more advanced stages of the

production pipeline. For this reason, this process deviates from the focus of this article and will not be discussed in depth.
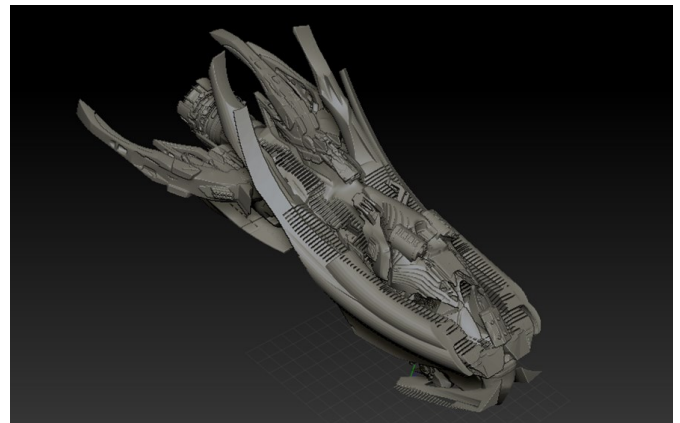

Fig. 10: Finished conceptual figure.

Kitbashing brings various elements together quickly to results in highly complex models and shapes, like that shown in Figure 10, which was created in less than two hours of working time. These powerful processes can be leveraged to conceptualize and previsualize 3D spaces and buildings, making them useful earlier in the building design pipeline than they are currently utilized.

Finally, to demonstrate the usefulness of this methodology, Figure 10 exhibits how elements of the previously pictured ship can be used to create an entirely different object. To do this, parts of the ship, such as the wings, have been extracted and cuts have been applied with the Trim tool. The objects have been modified with the deformation tools to adapt them to the new concept, as seen in Figure 11(a).

Fig. 11(a) and 11(b): Tower composed of parts from the previously pictured ship, and resulting 3D object.

After creating different modifications of these pieces, subtracting parts through Live Boolean, and cutting the pieces with Trim tools, a new volume was generated that could be suitable for a science fiction project. In the end, a complex shape, pictured in Figure 11(b), was generated in less than an hour.

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As stated before, after obtaining the objects through the modeling and sculpting processes, the rendering can begin. Through this rendering process, a 3D object that has been created can be placed in a virtual space. For this setting to achieve a realistic look, lights of different types will be added, which will illuminate both the object and the scene. One can see the differences between Figures 12 and 13, in which two distinct render engines have been used.

In Figure 12, the rendering engine that has been used is the one incorporated in ZBrush by default. It gives a realistic and appealing texture, to which you can adjust both the parameters of lights and quality of the shadows as well as the end result. In addition, it allows to create the final render within the same program. The main disadvantage compared to other more specialized rendering engines is that it does not offer the same control over the lights and their position in the world. The parameters with which one can experiment are smaller than a professional render engine such as "Arnold", "Keyshot" or "Vray".

Fig. 12: Image rendered through the embeded ZBrush rendering engine.

In Figure 13, the result has been obtained through the specific "Arnold" engine, which is integrated into the 3DS Max modeling software program. In order to do this, it has been necessary to export the ship previously modeled in ZBrush to the 3DS Max program as an object of type "OBJ", a process that allows one to continue working with the object modeled in 3DS Max. By incorporating natural daylight lighting within the environment, and adding some lights to the object itself, the result is a more realistic-looking scene.

Fig. 13: Image rendered through the "Arnold" engine in the 3DS Max program.

Finally, this model can be applied to an example created for a previous congress [4]. This new object can be used and imported into a complex 3D or rendering software, so that, by means of simple parameters, it can be incorporated into a realistic atmosphere. Through this technique, basic shapes that had been previously created have been used to define complex volumes in a matter of minutes.

This allows for the efficient design and exploration of new forms that can be offered to customers as a preview, like that shown in Figure 14.
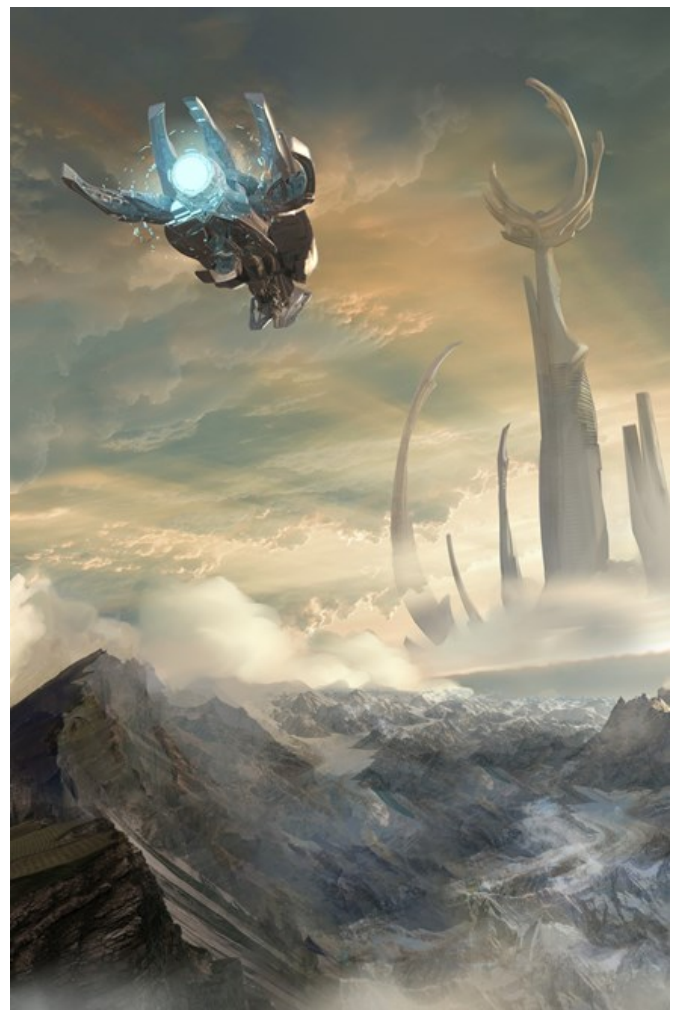

Fig. 14: Image rendered through the "Arnold" engine in 3DS Max, and retouched through "Matte Painting" in Adobe Photoshop.

2. CONCLUSIONS

As mentioned in the introduction, the most advanced software allows to create designs of complex shapes in a simple way. This allows to save costs to create preview images in the early stages of scenario and environment design.

For this, one can resort to ZBrush, a software designed for the film and video game industry, but that can actually be used in architectural work processes and building engineering. Through an organizational process known as "Kitbashing", the

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user can create libraries of materials that can then be reused in ZBrush.

Finally, the effectiveness and simplicity of the Live Boolean tool allows to generate complex shapes in an intuitive way. The user can go through a 2D rendering and postproduction process to create realistic and impacting images as conceptual design, prototype images, or environments that can afterwards be exported to virtual reality software.

This is why this process can be very useful for both students who want to experiment and create forms, and also for professionals who need to streamline production processes in the early stages of projects.

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WHAT DO YOU THINK?