

Anatomy Primitives

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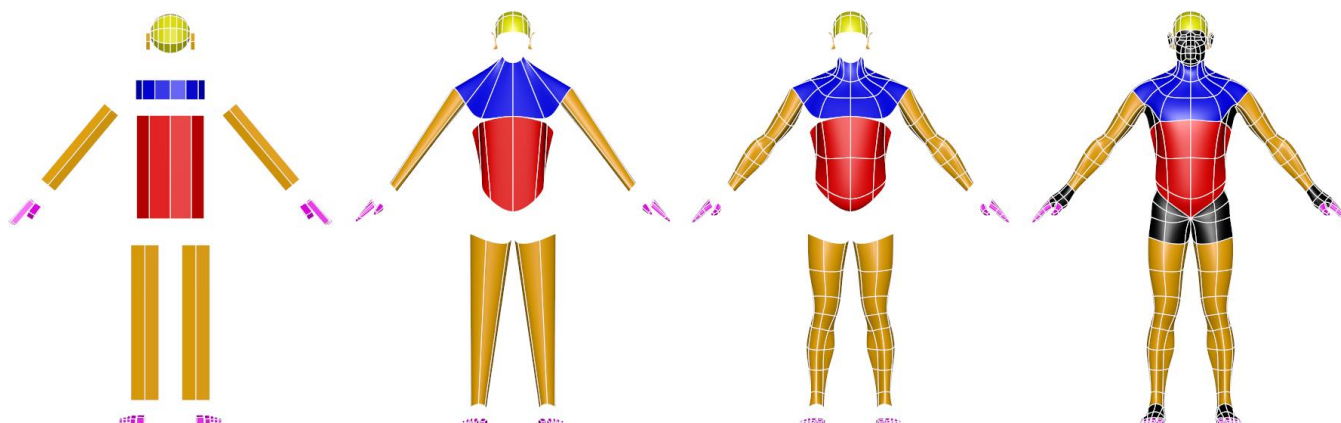


Figure 1: Human model created with standard primitives.

ABSTRACT

The present paper is a proposal for an installation that investigates the notion of the anatomical canon and its conceptual and practical role in the artistic modeling of human anatomy. This installation will guide the visitor through the interactive synthesis of a digital canon from standard 3D primitives. Through a model that can be interactively constructed or deconstructed step-by-step, using simple controls, the visitor is invited to study, and draw, the main features of human surface anatomy as interpreted through the natural tools of digital modeling.

CCS CONCEPTS

• Applied computing~Arts and humanities • Computing methodologies~Computer graphics

KEYWORDS

Anatomical canon, Human anatomy, Digital, 3D Model

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1 Introduction

Although anatomy remains unchanged, the artistic tools of each era impose particular constraints on the artistic modeling of the human body. These constraints are not only practical, but conceptual. There is a mental concept of the human body for one who yields a chisel, and a mental concept of the human body for one who yields a brush. There must therefore be a mental concept of the human body peculiar to one who yields a mouse.

The media of digital 3D modeling, along with new possibilities, raises its own multiplicity of complexities for anatomical modeling [8]. In particular, the body is not static anymore, but animated to simulate human motion and behaviour [7][9]. Past artists devoted themselves to modeling the expression of famous actors of their day, but only now do we expect a model's facial expressions to dynamically impersonate the gamut of an actor's well-recognized peculiarities [6][3]. This requires photographically scanned textures to be applied [10] over a very rigorous mesh topology that deforms properly when digital double actors speak or move. All of this requires new forms of sculpture, new concepts of what a human anatomical model is, and new concepts of how to achieve it. In this, the time-tested notion of the canon has a place.

It has been argued in [1] that it is a misconception to regard the anatomical canon as a mere transitory ideal of physical beauty. It is also, and perhaps most importantly, a repository of modeling knowledge, a blueprint aiming at simplicity of design with regards to the balance between anatomical verisimilitude, the universal constraints of geometry and the particular constraints of the tools of the trade. The artist must walk the thin path between conceptual

elegance and artistic practice, between theory and craft. The canon of Polykleitos would be incomplete without the embodied Doryphoros, and the one of Vitruvius was but a restless spirit until Leonardo found it a satisfactory embodiment – and it takes but the most cursory survey of the other attempts at Vitruvian ideal to see how poorly the constraint of words binds the embodied canon.

But just as the final form of the canon depends on the balance between geometry and tools, so do intermediate steps of the canon's construction.

The public views art mostly as finished object. For the artist, art is mostly process; and so the canon must also lead to a process of construction that is economical and mnemonic – a process that makes sense at each step, and, in a way, that is complete at each step. For any artist that has indulged in live drawing knows that although a single body in a single pose could be drawn for years without reaching completion, there is such a thing as the 10 minute body, the 1 minute body, or even the 30 second body, and neither of them is an incomplete drawing. Only a failed 30 second drawing of the body is an incomplete drawing of the body. A proper 30 second drawing is a finished thing. There is not a 30 second drawing of a body as much as there is a concept of a 30 second body, and hence a drawing of a 30 second body. So it is that at every point of the modeling of the canon, one should have a finished thing. And hence there is understanding to be attained through drawing these partial shapes.

Azevedo presented in [1] a proposal of an anatomical canon that answers the requirements alluded to above: a simple construct, adequate for early stage modeling, whose topology is simple, uniform, with a topology that handles animation elegantly. The present installation is based on the construction process that obtains this canon, starting from the standard primitives of 3D modeling.

The use of simple three-dimensional primitives is a good strategy to simplify the complex task of modeling the human body with correct proportions and surface anatomy features.

This is not an obvious approach. Usually, 3D primitives are used for hard surface modeling, and artist prefer to sculpt organic objects using sculpting 3D software, like ZBrush. Our approach can also be used with this kind of sculpting software, but does not require it.

Our proposal simplifies the very beginning of modeling the human body. Going forward to the modeling of realistic anatomy requires an intensive acquisition of artistic skills in this field [4]. But a simple foundation leads to geometric scaffolding that is simple and solid, on which anatomical knowledge can take hold.

There is ample precedent for this kind of approach in constructive anatomy manuals, such as Bridgman's [2], and Robert Hale [5] has eloquently argued for this approach in drawing. Simple volumes make volume, light and shade easy to understand in the gross, and then to refine progressively. Our approach has therefore a basis both in sculpture and in drawing, for which these primitives serve as dual building blocks. This dual mode is explored in the installation we propose, where visitors are encouraged to draw their own interpretation of our model.

2 Installation

The installation explores the construction of the canon proposed by Azevedo [1] using 3D standard primitives. The construction process uses only two standard primitives available in any 3D modeling software:

- 1 - The cylinder, created in four different versions: with 4, 6, 10, and 14 subdivisions on the axis.
- 2 - The sphere, with 8 subdivisions along the axis and 10 in height (Figure 2).

Each primitive presents a different color to help the visitor to identify it in the modeling process (e.g., the 6 subdivisions axis cylinder is used in the upper and lower limbs and ears).

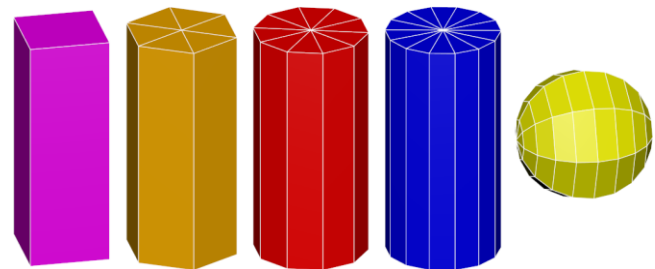


Figure 2: Primitives used to build the model.

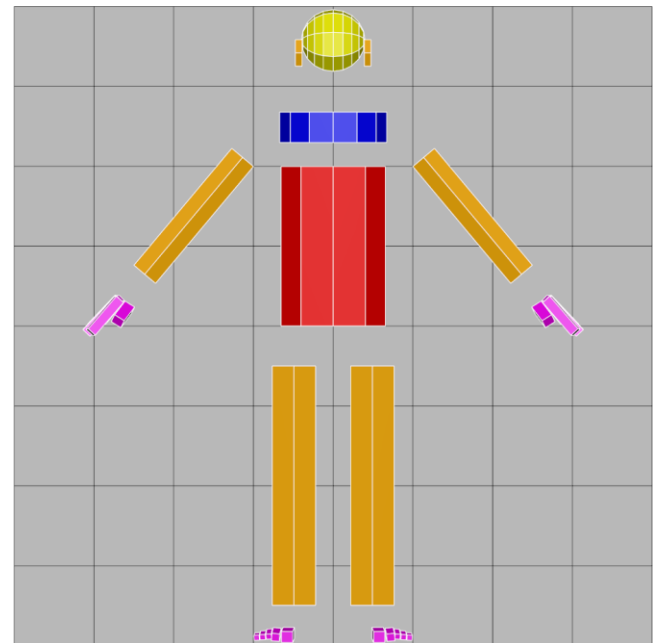


Figure 3: Placing 3D primitives over the matrix.

The cylinders are rotated so as to have an edge at the center, facing forward in the anterior view. All cylinders and spheres are scaled and placed over the reference eight head matrix proposed by Azevedo [1] (Figure 3). Placing the primitives for the feet and hands is the most complex part of the process; it is necessary to use

several views while the 4 subdivisions axis cylinder is duplicated, rotated and scaled according to each finger and toe.

Unnecessary cylinder faces are deleted to keep only the side geometry, allowing future geometry connections from the cylinder tops. Many faces from the sphere are also deleted; the face of the model will be created using more advanced 3D modeling techniques. All the vertices are repositioned over the matrix to reshape the primitives according to the reference canon anatomy (Figure 4).

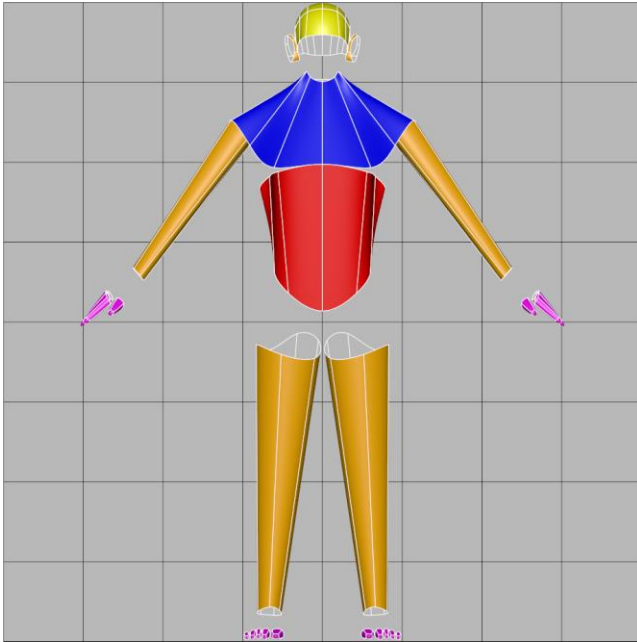


Figure 4: Reshaping primitive's geometry.

The next step consists on creating additional geometry in each primitive (Figure 5). This extra geometry is created according to the reference canon and it will allow to increase the anatomic surface features presented by Azevedo [1] in his canon proposal.

The installation presents the multiple steps carried to create the final geometry (Figure 6, in black). This final geometry is created using more advanced modeling techniques and tools. However, these techniques are developed in a simple way to facilitate visitor understanding.

3 The Artefact

The installation invites the visitor to draw, and through the drawing process to explore human anatomy through the particular filter of the canon. Concurrently, the inexperienced visitor is invited to enter the language of 3D modeling process, by visually interpreting complex shaped through the filter of simple primitives. The artefact is a collaboration with the visitors, who are invited to pin their drawings in a board that will fill up with artwork as visitors arrive, creating an evolving art gallery. It is an interesting experiment to

see how visitors will interpret the model. Is line or mass drawing appropriate? It is not obvious. Will the exhibition of early visitors interpretations influence the choice of visual language later visitors adopt?

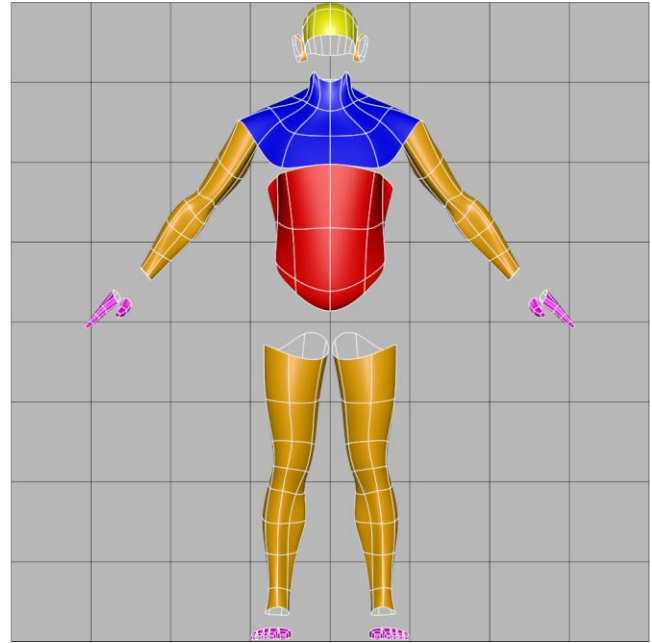


Figure 5: Adding extra geometry.

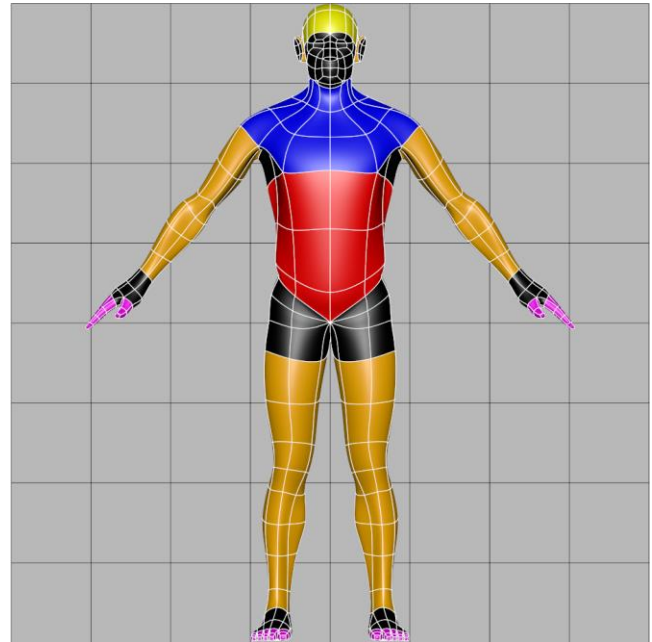


Figure 6: Conclusion geometry built without primitives.

For the uninitiated this installation may work like the preschool drawing experience, when toddlers are invited to make constructions with simple polygon objects: a step-by-step guide of growing complexity avoids the fear of the empty page.

For the initiated, the experience may resemble the sequences of quick poses in life drawing class, of 30 seconds or one minute, involving the fragmentary, yet complete interpretation of intermediate versions of bodies that are themselves both fragmentary and complete.

4 Technical requirements

The installation room is 4mx4m, or similar. The presentation is made on a large projection screen, with dimensions over 2mx2m, placed on the wall. On the opposite wall, a comfortable low chair or lounge chair, and a small table with pencils and paper for drawing. There is a large board on the side wall, for pinning drawings. The installation control device is also over the table and a laptop on the table's shelf bellow, hidden and not accessible to the visitor. Another small table placed next to the projection screen is used to place the vertical projector.

The room environment should ideally be dark, to help the visitor observe the interactive model geometry, and, to keep an intimacy ambience during the drawing process. The only light sources should be a floor lamp next to the chair, lighting the visitor's drawing, and a few spots lighting the board gallery.



Figure 7: Installation preview.

5 Interaction

The visitor interacts with the installation using the controls placed over the table, next to the chair. Pencil and paper, for drawing, may be obtained from the table next to the controls.

The model is presented animated by a slow rotation around its vertical axis, allowing the observation of its geometry details in all angles. The controls allow the interaction with the model: one button moves the construction process forward; another button moves it backward; a third button enables or disables the model rotation allowing the observation of its geometry in different angles. The model construction process will always be accompanied by brief text explanations for each step.

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REFERENCES

- [1] Hugo Azevedo and António Araújo. 2020. Towards a Canon for Digital Human Anatomy 3D Modeling. In *ARTEFACTo2020*, Edições Centro de Investigação em Artes e Comunicação, Faro, Portugal, 121–126.
- [2] George B. Bridgman. 1973. *Constructive Anatomy*. Courier Corporation.
- [3] Simon Clutterbuck, James Jacobs, and Richard Dorling. Tissue | Weta Digital. Retrieved March 8, 2020 from <https://www.wetafx.co.nz/research-and-tech/technology/tissue/>
- [4] Scott Eaton. 2006. 3D World. *Tutorials: Body Work*, 42–47.
- [5] Beverly Hale, Robert. 1964. *Drawing Lessons from the Great Masters*. Watson-Guptill, New York.
- [6] James Jacobs, Jernej Barbic, Essex Edwards, Crawford Doran, and Andy Straten. 2016. How to build a human: Practical physics-based character animation. In *Proceedings - DigiPro 2016: ACM SIGGRAPH Digital Production Symposium, Association for Computing Machinery, Inc.*, 7–9. DOI:<https://doi.org/10.1145/2947688.2947698>
- [7] Sung Hee Lee, Eftychios Sifakis, and Demetri Terzopoulos. 2009. Comprehensive biomechanical modeling and simulation of the upper body. *ACM Transactions on Graphics* 28, 4, (2009). DOI:<https://doi.org/10.1145/1559755.1559756>
- [8] Ferdi Scheepers, Richard E Parent, Wayne E Carlson, and Stephen F May. 1997. Anatomy-based modeling of the human musculature. In *Proceedings of the 24th Annual Conference on Computer Graphics and Interactive Techniques, SIGGRAPH 1997*, 163–172. DOI:<https://doi.org/10.1145/258734.258827>
- [9] Hyewon Seo and Nadia Magnenat-Thalmann. 2003. An automatic modeling of human bodies from sizing parameters. In *Proceedings of the Symposium on Interactive 3D Graphics*, 19–26. DOI:<https://doi.org/10.1145/641485.641487>
- [10] Ten24 – 3D scanning. Retrieved July 22, 2020 from <https://ten24.info/>