A Procedural Approach to Creating Second Empire Houses

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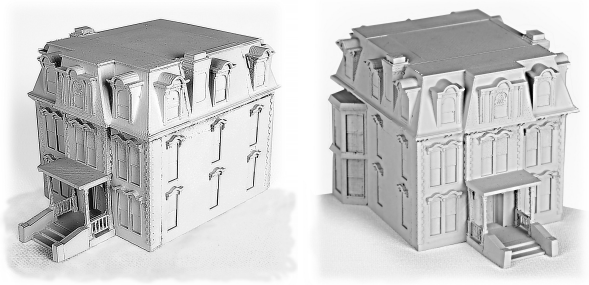
(a) *Two views of a CG model of a Second Empire house, which is designed using our system. Note the details such as balconies and cresting on the roof.*



(b) *Two photographs showing similar views of the 3D printed version of the model in 1a. The printed model is hand painted to gray. Note missing details.*

Figure 1: Our procedural 3D model and 3D print of a Second Empire house: The Hamilton-Turner Inn. Note that 3D printed version looks simpler because of the missing details such as balconies and cresting on the roof.

ABSTRACT

In this work, we present a procedural approach to capture a variety of appearances of American Second Empire houses. To develop this procedural approach, we have identified the set of rules and similarities of Second Empire houses. Our procedural approach, therefore, captures the style differences of Second Empire houses with a relatively few numbers of parameters. Using our interface, we are able to generate virtual houses in a wide variety of styles of American Second Empire architecture. We have also developed a method to break up these virtual models into slices in order to efficiently and economically 3D print them. Using this approach we have created miniatures of two landmark buildings: the Hamilton-Turner Inn in Savannah and the Enoch Pratt House in Baltimore. Note that the virtual models still provide more details because of the limited resolution of 3D printing processes.

CCS CONCEPTS

• **Computing methodologies → Procedural Modeling**;

KEYWORDS

Procedural Modeling, 3D Printing, Second Empire Architecture

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1 INTRODUCTION AND MOTIVATION

With the rapid progress of our world, the preservation of our cultural heritage has now been more important than ever. Many digitization techniques have recently been developed to capture historical artifacts or architectural structures from houses to bridges [Addison 2000; Pavlidis et al. 2007]. Still, most of these techniques require these artifacts to still be standing. For example, digitally reproducing a long-destroyed artifact or structure is impossible unless one were to create its 3D model by hand. Additionally, if multiple variations of one style of architecture are needed, creating each building in the same style but with significant structural and decorative differences would take an immense amount of time. Therefore, there is a need for formal approaches that allow us to develop methods for creating many models in a rapid and clear manner. 'Procedural modeling' provides such a formal approach for developing solutions to these problems [Ebert et al. 2003]. However, there is still a need for the development of an associated procedural method for every architectural style by identifying the common features that make that particular style unique. In this work, we present such a procedural modeling approach to create 3D models of Second Empire houses and 3D print them easily and inexpensively to provide a visual and physical aid. To demonstrate the power of this approach, we have developed a prototype system and using this system, we have created and printed two miniature replicas of Second Empire houses.

2 METHODOLOGY

Second Empire was a popular style of American houses constructed between 1860 and 1880 [McAlester and McAlester 1984]. Although similar to the Italianate and Gothic Revival styles, Second Empire was considered to be modern because it imitated the style of French building that was fashionable at the time. The style made use of the unique Mansard roof, named after the French architect Francois Mansart [Paradis 2008]. Second Empire architecture can be extremely ornate, and its variety means that many of the houses can look remarkably different. Through research and our own observations, we have identified the common features of these houses and have classified those features into two categories: (1) House and (2) Roof. Within these categories, we have outlined the typical features of these categories as well as their possible additions and elaborations.

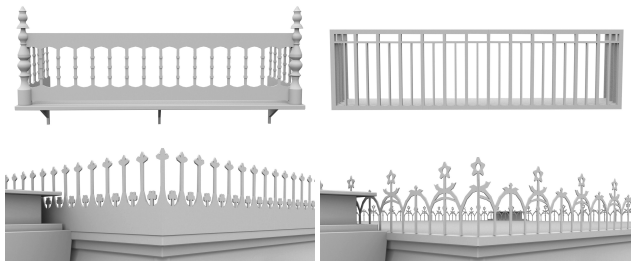

Figure 2: Example of detailed balcony and cresting types that cannot be 3D printed.

In the House category, we defined seven sections of defining features: house sub-types, body, doors, windows, porch, centered wing, and tower. In the Roof category, we defined seven sections of defining features: roof designs, dormers, cornices, brackets, cresting, chimneys, and centered gable. For every category and section, we have identified a variety of cases (See Figures 2). For instance, the main body of Second Empire houses is often square or rectangular in shape [McAlester and McAlester 1984]. These houses typically have one to three stories not counting the mansard roof, with two stories being the most common. Towers or centered wings can be added to this main body. This tree structure of categories and sections helped to identify all the parameters that are needed to define a unique Second Empire house. It also provided a simple hierarchically organized user interface approach to design these unique houses.

3 IMPLEMENTATION

We implemented our methodology as a digital asset through SideFX's Houdini, whose user-friendly graph editing node networks can be turned into a reusable custom node with its own user interface to allow for the controlling of parameters [Patow 2012]. The parameters of our Houdini digital asset (HDA) allow for complete customization of the house, although exceptions have been made for instances where combinations of parameters would not be realistic. Using our classification of features and subsequent procedural method, we are able to generate many styles and variations of Second Empire houses (See example in Fig 1). By controlling the parameters, we are able to interactively change the appearance of the 3D model to look like Second Empire houses that either previously existed or currently exist.

We also developed a decomposition approach for printing miniature models of these houses in a more cost-effective way. Our decomposition reduces the cost of printing an entire house at once, which would be costly. For a cost-effective solution, we use an approximate decomposition approach and decompose the houses into approximate rectangular prisms. Using our method for 3D printing, we were able to create 3D prints of both the 3D models of the Hamilton-Turner Inn (See Fig 1) and the Enoch Pratt house. The prints are still not inexpensive compared to the prices of commercial miniature landmarks. However, the printing cost dropped significantly, and we have obtained a better visual quality than printing the whole model of the house at once. However, because of the size of our prints and quality of the printer we used, details such as the balconies or cresting were not able to be printed (See Figures 2).

4 CONCLUSION AND FUTURE WORK

Our procedural method is capable of creating almost all well-defined forms of Second Empire building types. However, there are some free-form structures, such as asymmetrical building types, that need to be included to fully encompass the Second Empire styles. Our digital asset could be incorporated into other software such as Maya or gaming engines such as Unreal Engine or Unity.

This procedural approach can provide important details that create a true feeling of Second Empire buildings. Therefore, the virtual 3D models look closer to the original buildings. On the other hand, the 3D printed models look simpler because we were unable to obtain important details such as the balconies or cresting. Although the houses could be printed at a larger scale in order to include more details, this is not ideal as the printing cost would increase significantly. Another alternative would be to caricature the more delicate aspects of the buildings and make them larger and less in number, potentially making them printable [Grant G. III et al. 2004].

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