

An Interactive System for Drawing Cars in Perspective

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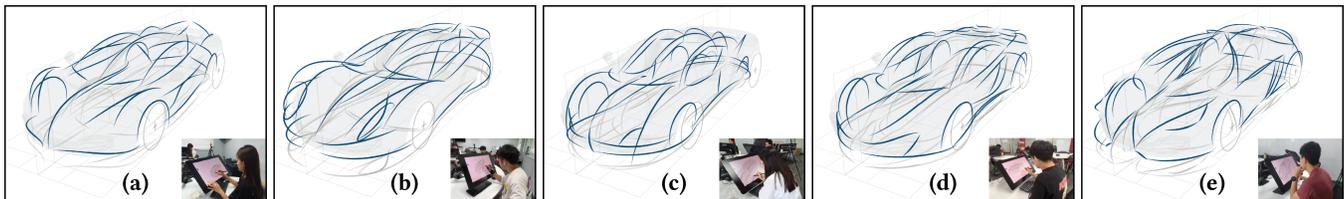


Figure 1: In the pilot test, five participants using our novel interactive system for drawing cars in perspective were able to design new cars after a brief instruction. The participants explained their concepts as (a) “angled and aerodynamic” (P1), (b) “a sleek GT supercar” (P2), (c) “round and friendly” (P3), (d) “an homage to McLaren GT” (P4), and (e) “aggressive” (P5).

ABSTRACT

We propose a novel interactive system for drawing cars in perspective. Our harmonious set of pen and touch interactions based on traditional tools and techniques can help car designers naturally transition from 2D sketching to 3D sketching and allow them to sketch cars in 3D intuitively and iteratively. The pilot test shows that our system is easy to learn and use.

CCS CONCEPTS

• Human-centered computing → Interaction techniques.

KEYWORDS

3D sketching, perspective drawing, car design

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1 INTRODUCTION

3D sketching can be a powerful tool for car design because it allows designers to express 3D curves in their minds in 3D space directly. This study proposes a novel 3D sketching system for drawing cars in perspective (Figure 1). We designed our system based on car designers’ traditional sketching tools and techniques so that they can naturally transition from 2D sketching to 3D sketching. In our system, car designers can intuitively and iteratively create 3D planar and spatial curves with a harmonious set of touch and pen

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interactions that incorporates the benefits of the approaches using extruded surfaces [1], planes [2, 5–8], orthographic projections [4], and cast shadows [3] to define 3D curves from 2D strokes.

2 SYSTEM

In our system, the user can take inspiration from an existing car (Figure 2), perform 2D loose sketching from a fixed viewpoint to express ideas quickly (Figure 3), and sketch 3D curves on top of the loose sketch with intuitive touch and pen interactions and iteratively refine them (Figure 4-7).

2.1 Taking Inspiration

Car designers often develop new ideas from an existing car’s established proportion by sketching on translucent paper with the car’s photo underneath or a grid depicting its ratio of overhang, wheelbase, width, and height [9]. We brought these tools to our 3D sketching system.

3D underlay. The user can import the 3D model of a car into our system to create a cloud-like 3D underlay (Figure 2a). The appearance of the 3D underlay is not too vague, allowing the user to observe the car’s overall silhouette and not too specific, encouraging the user’s focus and creativity.

3D grid. The system also provides a 3D grid consisting of a center, ground, and vertical plane perpendicular to one another. Each plane displays the profile or cross-section of the underlay, providing a reference for the user to ground their design (Figure 2c). Moreover, in the later stages, each plane serves as a canvas on which to draw 3D curves.

2.2 2D Loose Sketching

Car designers make quick and rough strokes with light markers to explore a car’s overall shape before sketching more elaborately with darker pens [9]. It is a simple yet effective technique that allows car designers to envision a car’s overall look and feel rapidly. In our system, the user can tap the “marker” button on the screen and make 2D loose sketches from fixed viewpoints (Figure 3).

2.3 3D Curve Sketching

Once a car’s concept emerges through 2D loose sketching, the user can substantiate the concept by sketching 3D curves on the 2D loose sketch. To do so, the user taps the “pen” button on the screen and sketches 3D planar and spatial curves using the following four methods that closely resemble the construction procedures of perspective drawing [9].

Method 1: Sketching a 3D spatial curve with an extruded surface. Car designers often first draw a car’s 2D profile and later construct 3D spatial curves that satisfy it because orthographic profiles are crucial in car design. In our system, the user can easily do this using the “extrusion guide,” a set of parallel lines representing a surface extruded from a 3D planar curve (Figure 4).

Method 2: Sketching a 3D planar curve with an orthographic plane. Car designers often draw profiles and cross-sections to express a car’s volume effectively. In our system, the user can sketch a 3D planar curve on the orthographic planes (Figure 5).

Method 3: Sketching a 3D spatial curve with two 3D planar curves. Car designers often draw important characteristic curves from two orthographic profile curves. In our system, the user can effortlessly achieve this by using two extrusion guides (Figure 6).

Method 4: Sketching a 3D spatial curve with its cast shadow. Car designers often draw unconstrained 2D strokes without using construction lines. To convert such a 2D stroke to a 3D spatial curve, its cast shadow can be utilized [3]. In our system, the user can do this using the “projection guide,” which represents an area where the cast shadow of the 3D spatial curve can reside (Figure 7).

In Method 1, 3, and 4, a sketched design curve, its mirrored pair, and its cast shadow are updated simultaneously when the user redraws a stroke or re-marks on the extrusion or projection guide so that the user can iterate on the 3D planar and spatial curves.

Furthermore, each curve is fitted to a B-Spline curve, making 3D sketches appear more polished and making it possible to import them to conventional 3D CAD modeling software used by car designers in the later stages of design.

3 PILOT TEST

We conducted a pilot test with five industrial design students to evaluate our system’s potential usefulness. After receiving brief instructions lasting five minutes, they were able to produce plausible concept sketches using the 3D underlay of McLaren GT (Figure 1).

4 CONCLUSION & FUTURE WORK

In this study, we propose a novel interactive system for drawing cars in perspective. In our system, the user can take inspiration from an existing car with its 3D underlay and 3D grid, explore new ideas with 2D loose sketching, and sketch 3D planar and spatial curves with extruded surfaces, orthographic planes, and cast shadows. In future work, we will evaluate the system’s usability and effectiveness with professional car designers in the field, as well as design students in an educational context.

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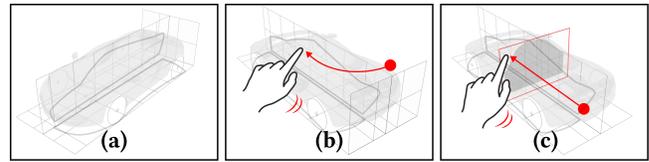


Figure 2: Taking inspiration. (a) With a cloud-like 3D underlay and interactive 3D grid, the user can inspect (b) the car and (c) its cross-sections.

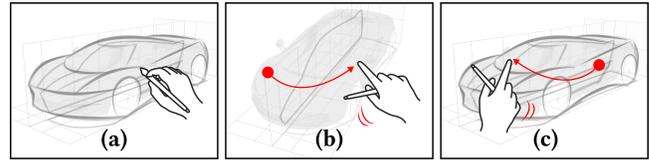


Figure 3: 2D loose sketching. (a) The user performs a loose sketch from a fixed viewpoint. (b) The loose sketch fades away when the user switches the viewpoint, but (c) reappears when the user revisits a similar viewpoint.

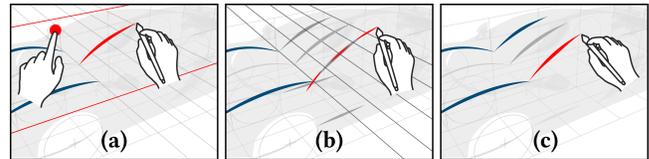


Figure 4: Method 1. The user (a) draws a 3D planar curve while holding an orthographic plane (the center plane in this case), (b) ticks on the extrusion guide to create a 3D spatial curve, and (c) overdraws it to confirm.

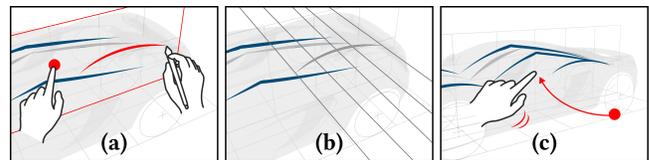


Figure 5: Method 2. The user (a) draws a 3D planar curve while holding an orthographic plane (the center plane in this case) and (b) without ticking on the extrusion guide, (c) switches the viewpoint to confirm the 3D planar curve.

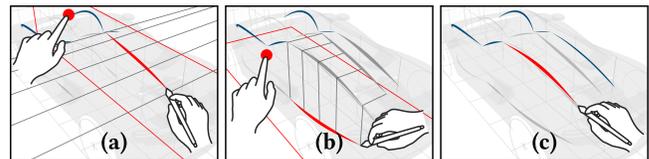


Figure 6: Method 3. The user (a) draws a 3D planar curve on an orthographic plane (the center plane in this case) and (b) draws on another orthographic plane (the ground plane in this case), which produces the intersection curve of the two extruded surfaces. (c) The user overdraws the 3D spatial curve to confirm.

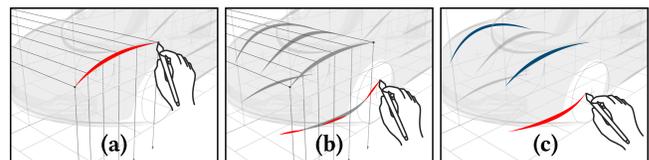


Figure 7: Method 4. The user (a) draws a 2D stroke, (b) ticks on the projection guide to create a cast shadow, and (c) overdraws the cast shadow to convert the 2D stroke to a 3D spatial curve.

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