ParaShape Parametric Approach to Personal Design Shadan Sadeghianborojeni

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Expert User

Who is the User?

Novice User



Initial Survey





Expert Users

• Use WYSIWYG CAD to visualize design ideas (AutoCAD) Think more functionalities and learnability makes a tool usable Spend minimum 30 minutes on a design visualization

Novice Users

 Use pen and paper and to visualize design ideas

- Like composing parts to make complex objects
- Spend minimum 30 minutes on a design visualization







Related Work















lakerBot Thingiverse	DASHBOAR
Customizer by MakerBo	t
Home My Things Queue	
Tool Holder (Open	SCAD P
Parameters	
Global Thickness	
1.2	
Shelf Length	
120	
Shelf Width	
20	
Backingheight	
30	
Back Hole Size	
4	
Number Of Holes	



Ponoko

MakerBot Thingiverse





Related Work (Problems)

CAD

- High learning curve
- Complex UI



blender

• Small range of object models covered

Sake Set Creator



3D Creators/Customizers

3D model libraries

 Static models, 3D modeling skill required for customizing

MakerBotThingi







Requirements

High flexibility of the existing 3D models for customization

High readability of 3D model code Cabability of code tellse Easy and fast search and browsing for the models

Capability of making complex 3D models without having 3D modeling skill Time efficiency of the system







by bincage	
Length length of the bracelet in mm 15	
Nozzle diameter of your 3d printer nozzle in mm	
0.4	11-
Sections number of sections on bracelets 22	
Text text to put on bracelet	= 12
3Dprinter.net	
Holes view text as holes?	
yes 💌	
Text Thickness text thickness as amount of nozzle 4	

View Source

Makerbot Customizer

- Met 5 out of 10 of our system requirements
- Low system usability scale (52%)
- Users feedback not satisfactory

Hypotheses of ParaShape



HI:Component-based Modeling

Every object is made of its composing components



H2: Primitive Instancing of Components



```
\\Parameter
Shade-heghit=50;[10:70]
\\component
difference() {
  cylinder(h=50,r1=40,r2=20,center=false);
  cylinder(h=50,r1=35,r2=15,center=false);
```

```
\\Parameter
Shade-heghit=50;[10:70]
top-radius=20;[10:30]
bottom-radius=40;[20:30]
\\component
difference(){
cylinder(Shade-heghit,top-radius,bottom-radius,center=false);
cylinder(h=50,r1=35,r2=15,center=false);
```

```
\\Parameter
Shade-heghit=50;[10:70]
top-radius=20;[10:30]
bottom-radius=40;[20:30]
pleat=30;[10,20,30,40]
\\component
difference(){
cylinder(Shade-heghit,top-radius,bottom-radius,center=false,$fs=pleat);
cylinder(h=50,r1=35,r2=15,center=false);
```

1.5

H3: Units of Measurement

- *Metric Units:* a cylinder with a cross s 44 millimeters
- Market Units: AAA battery

76% rated the market units of measurement as a more acceptable system: is more familiar, prevents measurement errors



Metric Units: a cylinder with a cross section radius of 10 millimeters and height of

H4: Component Code Templates

shaft_is_flatted = true; flat_size_adjustment = -0.0; // you won't need to mess with this. less than 5 makes it disappear. you can, however, // set the adjustment to be a negative decimal if you need a flat but not as big as the default. // go positive if you need a bigger flat flat_size = 5 + flat_size_adjustment; // some potentiometers need to have their knobs affixed with a set screw

// some potentiometers need set_screw = true; set_screw_radius = 1.5; set_screw_depth = 9; set_screw_height = 4; quality_of_set_screw = 20;

// Decorations

// smoothing variables // thanks to http://www.iheartrobotics.com/ for the articles on smoothing edges!

smoothing = true; smoothing = true; circle_height = 10; circle_radius = knob_radius; ct = -0.1; // circle translate? not sure. smoothing_radius = 5; smooth = 100; // Number of facets of rounding cylinder

 $\prime\prime$ this is a corner edge of a cube sticking out of the cylinder at the bottom $\prime\prime$ you can use it instead of the arrow shaped cutout in the top if you like. Or both. pointy_external_indicator = true; pointy_external_indicator_height = 3;

pointy_external_indicator_poignt = 3; pointy_external_indicator_pokey_outey_ness = -0.0; // pokey_outey_value = pointy_external_indicator_pokey_outey_ness - 1 - pad; pokey_outey = [pokey_outey_value, pokey_outey_value,0]; // there's an arrow shaped hole you can have. There aren't a lot of controls for this

arrow_indicator = false: arrow_indicator_scale = 0.8; arrow_indicator_translate = [-1,0,0];

// indentations // for spherical indentations, set the quantity, quality, size, and adjust the placement indentations_sphere = false; sphere_number_of_indentations = 3; sphere_quality_of_indentations = 40; size_of_sphere_indentations = 9; translation_of_sphere_indentations = [9,0,22]; // for cylinder indentations, set quantity, quality, radius, height, and placement // Yor Cythmer Indentations, set quantity, quality indentations_Cylinder = true; cylinder_number_of_indentations = 6; cylinder_quality_of_indentations = 100; radius_of_cylinder_indentations = 17; translation_of_cylinder_indentations = [-3,0,-8];

// these are some setup variables... you probably won't need to mess with them.
negative_knob_radius = knob_radius*-1;

this is the main module. It calls the submodules. make_the_knob();

module make_the_knob() difference() { difference()

Viewport: translate = [0.49 -0.07 6.51], rotate = [35.90 0.00 243.10], distance = 197.14

Set_screw_deptn = 9; set_screw_height = 4; quality_of_set_screw = 20;

// Decorations

// smoothing variables // thanks to http://www.iheartrobotics.com/ for the articles on smoothing edges!

smoothing = true; circle_height = 10; circle_rodius = knob_rodius; ct = -0.1; // circle translate? not sure. smoothing_rodius = 7; smooth = 100; // Number of facets of rounding cylinder // this is a corner edge of a cube sticking out of the cylinder at the bottom

// you can use it instead of the arrow shaped cutout in the top if you like. Or both.

pointy_external_indicator = true; pointy_external_indicator_height = 3; pointy_external_indicator_pokey_outey_ness = -0.0; // pokey_outey_value = pointy_external_indicator_pokey_outey_ness - 1 - pad; pokey_outey = [pokey_outey_value, pokey_outey_value,0];

// there's an arrow shaped hole you can have. There aren't a lot of controls for this

arrow_indicator = false; arrow_indicator_scale = 0.8; arrow_indicator_translate = [-1,0,0];

/ indentations

// for spherical indentations, set the quantity, quality, size, and adjust the placement // for spherical indentations, set the quantity, indentations_sphere = true; sphere_number_of_indentations = 40; sphere_quality_of_indentations = 40; size_of_sphere_indentations = 3; translation_of_sphere_indentations = [10,0,15];

// for cylinder indentations, set quantity, quality, radius, height, and placement indentations_cylinder = true; cylinder_number_of_indentations = 10; cylinder_quality_of_indentations = 40; cylinder_quality_or_indentations = 40; radius_of_cylinder_indentations = 2; height_of_cylinder_indentations = 15; translation_of_cylinder_indentations = [-1,0,0];

/ these are some setup variables... you probably won't need to mess with them
egative_knob_radius = knob_radius*-1;

// this is the main module. It calls the submodules make_the_knob()

module make_the_knob() difference()

{ difference() difference

i difference()

union()

difference(

port: translate = [0.23 1.03 6.16], rotate = [52.00 0.00 249.20], distance = 143.72

Parsing design (AST generation)... Compiling design (CSC Tree generation)... Compilation finished. Compiling design (CSC Products generation)... Compiling design (CSC Products normalization)... CSG generation finished. Total rendering time: 0 hours, 0 minutes, 0 seconds OpenSCAD - potknob_parametric.scad

Parsing design (AST generation)... Compiling design (CSC Tree generation)... Compiling design (CSC Products generation)... Compiling design (CSC Products generation)... Compiling design (CSC Products normalization)... CSG generation finished. Total rendering time: 0 hours, 0 minutes, 0 seconds



OpenSCAD - potknob_parametric.scad

- Increases 3D model code readability
- Supports 3D model code reuse
- Prevents errors

Paper Prototype

		Para Shape My Thing
ParaShape ParaShape > Crea	My Things Create	Lamp A Shede Base Socket height I mon 3 De top radius I De bottom radius I De pleat width I
	General View	
	Proffessional View	
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		(tub 2.) Socket type = 1 W Variables with = 2+P.+

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25] ; // [10, 12, 14]			
/10			
	Errors		
			•
× .		1	
	Save to My things	Export	

< shade >

- Qualitative user study
- Separate questionnaires for both user groups
- Comments and suggestions used as requirements for final mockup

Mockup

A Web Page	
ParaShape My Things Create	Q search log in
Lamp A	
Description Lamp A is a round uno style egg pleated lamp	
Tags add tag lamp mylamp eggpleatedroundlamp round lamp household unolamp furniture decertion spherelamp	
Comments	Customize Lamp A
I have a new favorite derivativeAwesome work	Go to code
Leave your comment here	Download AMF
	"



A Web Page	
My Things Create	Q search log in
Shade Base Socket height 50 height 50 top radius 20 20 1 bottom radius 40 40 1 pleat width 1 1	Or to CodeDownload AMF
	"

A Web Page	
ParaShape My Things Create	Q search
Lamp A	
Shade Base Socket	
height 50 Gefault	
top radius 40 default	
bottom radius 40 default	Save to My Thing
pleat width	Export AMF Go to Code
color	
texture select	
material select 💌 💭 default	
coordinate 0 0 0 G default	
Change Component	



Mockup

A Web Page			A Web Poge
My Things Create	Q search log in	And the search log in My Things Create	ParaShape My Things Create
\\\lampA \\Parameters height = 50;[20:80] topradius = 20;[10:60] bottomradius = 40;[20:70] sockettype= 10; [10,12,14] \\Variables width= 2*pi*r/2; pleat=10; \\components <lampshade> difference(){ cylinder(height, bottomradius, topRadius, center = false,\$fs= pleat); cylinder(he 50, r1 = 35, r2 = 15, center = false); }; <\lampShade> difference(){ translate([0,0,-20])color("deepPink") sphere(r=30); translate([- 25,-25,-95]) cube(50); }; <\lampBase></lampshade>	Errors Preveiw Save to Export	\\lampA \\lampA \\Parameters height = 50,[20.80] Parameter topradius = 20,[10.60] bottomradius = Add Parameter bottomradius = Add Parameter sockettype= 10 Parameter Name: Control type: sockettype= 10; Min: Vicomponents <lampshode> difference(){ Max: </lampshode>	\\lampA Add Comp height = 50,[20:80] height = 50,[20:80] Add Param \\shade1 \\Parameters \\Parameters Add height = 50,[20:70] tor oo 30.1 \\Shade1 \\Parameters \\Parameters Image: tor oo 30.1 \\Shade1 \\Parameters \\Parameters Image: tor oo 30.1 bottomRadius= 40[20:60] \\variables pleat= 40 \\cade \\cade Save olor("blue")cylinder(h eight, topradius, bottomradius, center = false,\$fs= pleat); cylinder(h = 50, r1 = 35, r2 = 15, center = false); }; Save \\cade Add
	customizer My Things AMF File	Customizer My Things AMF File	



Evaluation of Mockup

Hypotheses Verification H1: Component-based modeling H2: Primitive instancing of components H3: Units of measurement H4: Component code templates



•PSSUQ Results

Overall	85%
SysQual	86%
InfoQual	87%
IntQual	88%

- Implement a working system of ParaShape
- Evaluate the system with 3D printers
- Using other interaction techniques (digital pen, virtual clay, etc.)
- Prevent 3D printing mistakes (printability of the model, ergonomics, cost)

Future Work

- ideas into physical objects.
- of having 3D modeling background.

Conclusion

• The goal of personal design is to make everyone able to turn their

• ParaShape proved that by using the knowledge of experts, we can make almost everyone able to make complex 3D models needless

