In [1]:
```
%reload_ext autoreload
%autoreload 2
from openscad3 import *
set_printoptions(suppress=True)
# from IPython.display import display, HTML
# display(HTML("<style>.container { width:100% !important; }</style>"))
```

Table of Contents (alphabetic ordered)

- **3d-knots** : various interesting 3d knots
- **align_sol(sol,ang=10)** : same as align_sec but for solid with multiple slices
- **align_sol_1(sol)**: same a align_sec_1 but for a solid with multiple slices
- **ang(x,y)**: calculates the angle with base(x) and perpendicular(y) distances. if x<0 and y>0 the angle will be 90<x<180)
- **ang_2lineccw(p0,p1,p2)** : ccw angle of the line p0p2 from base line p0p1
- **ang_2linecw(p0,p1,p2)** : cw angle of the line p0p2 from base line p0p1
- **arc(radius=0,start_angle=0,end_angle=0,cp=[0,0],s=20)**: function for calculating 2d arc. 'cp': center point of the arc. 's': number of segments in the arc
- **arc_2p(p1,p2,r,cw=1,s=20)**: calculates arc with 2 given points.cw or ccw will change the arc, also this generates the shortest distance arc
- **arc_2p_3d(n1,p0,p1,r,cw=1,s=20)** : draws an arc with 2 points and normal in 3d space
- **arc_2p_3d_cp(n1,p0,p1,r,cw=1)** : finds center point of the arc with 2 points and a normal
- **arc_2p_cp(p1,p2,r,cw=-1)** : calculates the center point of an arc based on 2 given points, cw or ccw dirctions are important to calculate the correct center point
- **arc_3d(v=[0,0,1],r=1,theta1=0,theta2=360,cw=-1,s=50)** : calculates the arc in 3d space w.r.t. plane defined by normal vector 'v1', radius 'r1', start and end angles, cw or ccw and number of segments 's'
- **arc_3p(p1,p2,p3,s=30)**: function to draw arc with 3 known points 'p1','p2','p3'. 's' is the number of segments of the arc
- **arc_3p_3d(points,s=20)** : draws an arc through the 3 points list. 's' is the number of segments of the circle
- **arc_long_2p(p1,p2,r,cw=1,s=20)**: long arc with 2 points 'p1,p2' with radius 'r' and with orientation clockwise (1) or counterclock wise(-1)
- **arc_long_2p_3d(n1,p0,p1,r,cw=1,s=20)** : draws a long arc with 2 points and normal
- **artifact** :
- **axis_rot(axis,solid,angle)**: rotate a solid around an axis
- **axis_rot_1(sol,ax1,loc1,theta)**: rotate a solid on any pivot point 'loc1' with axis of rotation 'ax1' by an angle 'theta'
- **axis_rot_o(axis,solid,angle)**: rotate a solid around an axis considering the solid is centered at origin
- **back-camera-clamp** :
- **ball-bearing** :
- **bb(prism)**: function to find the bounding box dimensions of a prism
- **bezier (p , s = 10)**: function to draw bezier curve with 'p' control points and 's' number of points on the resultant bezier curve)
- **bottle-with-cut-design** :
- **bspline_open(pl,deg,s=100)** : draws a bspline curve for the given control points 'pl' , 'deg' is the degree of curve that is quadratic, cubic or higher order 's' defines the number of points in a bspline curve
- **bspline_close(pl,deg,s=100)** : draws a bspline curve for the given control points 'pl' , 'deg' is the degree of curve that is quadratic, cubic or higher order 's' defines the number of points in a bspline curve
- **business-card-holder** :
- **c_hull(pnt)**: function to calculate convex hull for a list of points 'pnt'
- **c2ro(sol,s)** : change the orientation of points of a cylinder from circular to rectangular orientation. 'sol': is a cylindrical type 3d shape. 's': number of segments required between each straight line segments
- **c2t3(p)** : function to convert 2d to 3d, it just adds the z-coordinate to the points list
- **c3t2(a)**: function to convert 3d to 2d, it just removes the z-coordinate from the points list
- **cam-profle** :
- **Car Seat** :
- **chimney-panel-support** :
- **cir_2p(p1,p2,r,cw=1,s=20)** : circle with 2 points 'p1,p2' with radius 'r' and with orientation clockwise (1) or counterclock wise(-1)
- **cir_3p(p1,p2,p3,s=30)**: function to draw circle with 3 known points 'p1','p2','p3'. 's' is the number of segments of the circle
- **cir_3p_3d(points,s=20)**: draws a circle through the 3 points list. 's' is the number of segments of the circle
- **cir_p_t(cir,p)**: circle to point tangent line (point should be outside the circle)
- **circle(r,cp=[0,0],s=50)** : function for creating points in circle with radius "r", center point "cp" and number of segments "s"
- **coil-example** :
- **concave_hull(p_l,k=3)**:calculate the concave hull of a random list of points. larger number for 'k' will give smoother shape
- **convert_3lines2fillet(pnt1,pnt2,pnt3,f=1.9,s=10)** : Develops a fillet with 3 list of points (pnt1,pnt2,pnt3) in 3d space, f: is a factor which can be reduced to 1.5 in case of self intersection observed, s: number of segments in the fillet, increase the segments in case finer model is required
- **convert_3lines2fillet_closed(pnt1,pnt2,pnt3,f=1.9,s=10)** : Develops a fillet with 3 list of points (pnt1,pnt2,pnt3) in 3d space, f: is a factor which can be reduced to 1.5 in case of self intersection observed, s: number of segments in the fillet, increase the segments in case finer model is required
- **convert_secv(sec)** : function removes all the radiuses from the section 'sec' where points are ccw
- **convert_secv1(sec)** : function removes all the radiuses from the section 'sec'
- **convert_secv2(sec,d)** : function removes all the radiuses from the section 'sec' where points are cw. 'd' should be > the maximum radius at cw corner to give the right results
- **convex(sec)** : function to check whether a section is convex or not
- **convex_hull(pnts)**: calculates convex hull for a list of points 'pnts'
- **corner_radius(sec,s)** : function to create section with corner radiuses)
- **cosinewave(l,n,a,p)** : creates a cosinewave with length 'l', number of cycles 'n' amplitude 'a' and number of points 'p'
- **cp_3p(p1,p2,p3)** : function to calculate center point of a circle created from 3 known points 'p1','p2','p3'
- **cp_arc(arc1)** : function returns the center point of a given circle or arc
- **cp_cir_3d(cir)** : center point of circle with atleast 3 known list of 'points' in 3d space
- **cpo(prism)** : function to change the orientation of the points of the prism
- **cs1(sec,d)**: creates a cleaning section for removing excess points for offseting a section 'sec' with offset distance 'd'
- **cube(s,center=False)** : function to draw cube with size 's'

- **cut_plane(nv=[0,0,1],size=[5,5],thickness=10,trns1=0,trns2=0,trns3=0)** : function for defining a solid (cutting plane) oriented as per the defined normal vector, nv: normal vector for defining plane orientation of the section, thickness: thickness or height of the cutting plane, trns1: translate the solid in the direction of normal vector 'nv', trns2: translate the solid in the direction 'right' to the normal vector 'nv', trns3: translate the solid in the direction 'up' to the normal vector 'nv', '-ve' values given to the trns1,trns2,trns3 will translate the solid in the reverse direction
- **cw(sec)** : function to identify if an enclosed section is clockwise(cw) or counterclockwise(ccw). this returns 1 if section is clockwise and -1 if it is counterclockwise
- **cwv(sec)** : function to identify whether each point in a section is clockwise or counter clockwise.
- **cylinder(r1=1,r2=1,h=1,cp=[0,0],s=50,r=0,d=0,d1=0,d2=0,center=False)** : function for creating cylinder, cone
- **cylinder-with-rectangular-pocket** :
- **cylinder-with-star-pocket** :
- **cytz(path)**: converts 'y' points to 'z' points in a 2d list of points
- **drill-bit** :
- **e_wave(l,a,w,t)** : create a graph of exponential function a*e^-(wt) where, w: omega, t: time steps, a: amplitude, l: length of time
- **end_cap(sol,r=1,s=10)** : function to draw radius at the ends of 'path_extrude_open' models. sol: path extruded solid, r: radius at the ends, s: segments of the radius
- **equidistant_path(path,s=10)** : divides a path in to equally spaced points
- **equidistant_pathc(path,s=10)** : divides a closed path in to equally spaced points
- **equivalent_rot_axis(r1=[])** : function returns an equivalent axis for rotation and angle of rotation for a sequence of rotations given by list 'r1'
- **example-of-rounding** :
- **exclude_points(list1,list_to_exclude)** : function to remove points from a list
- **prism(sec,path)** : creates a solid or prism with a 2d section and a 2d path. This is a much faster version of function prism, but may not work with few shapes correctly)
- **faces(l,m)** : calculate the faces for the vertices with shape l x m with first and the last end closed
- **faces_1(l,m)** : calculate the faces for the vertices with shape l x m with first and the last end open
- **fillet_2cir(r1,r2,c1,c2,r,s=50)** : fillet between 2 circles with radius 'r1' and 'r2' and center points 'c1' and 'c2' and 'r' is the radius of the fillet
- **fillet_3p_3d(p0,p1,p2,r,s)** : fillet with 3 known points 'p0,p1,p2' in 3d space
- **fillet_3p_3d_cp(p0,p1,p2,r)** : center point 'cp' of the fillet with 3 known points 'p0,p1,p2' in 3d space. 'r' is the radius of fillet
- **fillet_line_circle(l1,c1,r2,cw=-1,option=0,s=50)** : function to draw a fillet between a line and a circle, option can be '0' or '1' to flip the fillet from one side to another, 's' is the number of segments in the arc
- **filleto_2cir(r1,r2,c1,c2,r,s=50)** : fillet between 2 circles with radius 'r1' and 'r2' and center points 'c1' and 'c2' and 'r' is the radius of the fillet. This is an open fillet where first or the second fillet can be called based on requirement
- **flip(sec)** : flips the sequence of a list or list of points
- **gcd(a,b)** : calculates greatest common divisor for 2 numbers
- **glass-model** :
- **handling-trolley** :
- **helix(radius=10,pitch=10, number_of_coils=1, step_angle=1)** : creates helix
- **honeycomb(r,n1,n2)** : function to draw a honeycomb structure with radius 'r', n1: number of hexagons in 1 layer, n2: number of layers
- **i_line_fillet(sol1,sol2,ip,r1,r2,s=20,o=0)** : calculates a fillet at the intersection of 2 solids when the intersection points 'ip' are separately defined. r1 and r2 would be same in most of the cases, but the signs can be different depending on which side the fillet is required. r1 is the distance by which intersection line offsets on sol2 and similarly r2 is on sol1
- **i_line_planes(p1,p2)**: intersection line between 2 planes 'p1' and 'p2'
- **i_p_n(sol,i_p)** : calculates normal at the intersection points, sol: solid on which the normal is required, i_p: list of intersection points between 2 solids
- **i_p_p(sol,i_p,r)** : function to project the intersection point on the cutting lines based on the distance 'r'
- **i_p_t(path)** : function to calculate tangent vectors to a given path
- **intersections(segments)** : calculates the intersections of adjacent line segments only
- **ip(prism,prism1,side=-1)**: function to calculate intersection point between two 3d prisms. "prism" is the 3d object which is intersected with "prism1". side: when a ray intersects a solid it can intersect at 2 locations, if the ray is travelling from outside, in that case if '0' is given meaning only the first intersection point is considered, and in case '-1' is given meaning the last intersection point will be considered.)
- **ip_fillet(sol1,sol2,r1,r2,s=20,o=0)** : calculates a fillet at the intersection of 2 solids. r1 and r2 would be same in most of the cases, but the signs can be different depending on which side the fillet is required. r1 is the distance by which intersection line offsets on sol2 and similarly r2 is on sol1
- **ip_sol2line(sol,line)** : function to calculate intersection point between a 3d solid and a line. "sol" is the 3d object which is intersected with a "line". in case there are more than 1 intersections of the line with the solid/ prism ip(sol,line)[0] will give the first intersection point and ip(sol,line)[-1] will give the last intersection point
- **ip_sol2sol(sol,sol1,n=0)** : function to find the intersection point between 2 solids. this function is to be used where the cutting lines of sol1 are intersecting sol at more than 1 times.sol: solid which is intersected. sol1: this intersects the solid 'sol'. n: if the first intersection points of all the cutting lines are to be considered, value of n should be '0'. if the last intersection points of all the cutting lines are to be considered, value of 'n' should be set to '-1'
- **ip_triangle(sol1,p0)** : finds the trianle where the intersection point "p0" lies in a solid "sol1"
- **iterative-approach-towards-creating-fillets** :
- **l_cir_ip(line,cir)** : line circle intersection point
- **l_len(l)** : calculates length of a line 'l'
- **l_lenv(l)** : calculates sum of lengths of all the segments in a line 'l' considering the section is closed
- **l_lenv_o(l)** : calculates sum of lengths of all the segments in a line 'l' considering the section is open
- **l_sec_ip(line,sec)** : line and section intersection point
- **l_sec_ip_3d(sec,line)** : finds the intersection points between a section in 3d space and a line in 3d space
- **l2l_intersection(l1,l2)** : function to find the intersection point between 2 lines in 3d space
- **lamp** :
- **lcm** : calculates least common multiple for 2 numbers
- **lexicographic_sort_xy(p)** : function sorts the points list 'p' first with x and then with y smallest to largest
- **lexicographic_sort_yx(p)** : function sorts the points list 'p' first with y and then with x smallest to largest
- **linear_extrude(sec,h=1,a=0,steps=1)** : function to linear extrude a section where, se/users/sanjeevprabhakar section to extrude, h: height of the extrusion, a: angle of twist while extruding, steps: number of steps in each angular extrusion
- **list_r(sec)** : function list the corner radiuses of a given section (only where the radius is specified)
- **ls(line,n)**: plots 'n' points in a straight line)
- **m10** :
- **m35** :
- **m39** :
- **max_r(sec)** : finds the maximum radius of a given closed section)
- **mobile-phone-stand** :

- **multiple_sec_extrude(path_points=[],radiuses_list=[],sections_list=[],option=0,s=10)**: path_points: are the points at which sections needs to be placed,radiuses: radius required at each path_point. this can be '0' in case no radius required in the path, sections_list= list of sections required at each path_points. same section can be provided for various path_points as well, option: can be '0' in case the number of points in each section do not match or '1' in case number of points for each section are same, s: in case value of radiuses is provided 's' is the number of segments in that path curve
- **normals_along_path** :
- **nv(p)** : finds the normal vector for a given points in a 3d plane
- **o_3d(i_p,sol,r,o=0)** : function to offset the intersection points 'i_p' on a solid 'sol' by distance 'r'. option 'o' can have values '0' or '1' and changes the direction of offset
- **o_p_p(sol,i_p,d)**: calculates projected points on the surface of a solid , sol: solid on which the points to be projected, i_p: list of points in 3d space near the solid, d: approximate distance of the points from the surface, specifying too big distance , may create multiple projection of the same point on the solid
- **o_solid(nv=[0,0,1],sec=[],thickness=10,trns1=0,trns2=0,trns3=0, theta=[0,0,0])** : function for defining a solid with any defined section. solid gets oriented as per the defined normal vector, nv: normal vector for defining plane orientation of the section, se/users/sanjeevprabhakar cross section of the solid, thickness: thickness or height of the solid, trns1: translate the solid in the direction of normal vector 'nv', trns2: translate the solid in the direction 'right' to the normal vector 'nv', trns3: translate the solid in the direction 'up' to the normal vector 'nv', '-ve' values given to the trns1,trns2,trns3 will translate the solid in the reverse direction , theta: rotate the section around axis fox example if nv is [1,0,0] or x-axis, the sequence of rotation will be x, y ,z axis
- **offset(sec,r)** : calculates offset for a section 'sec' by amount 'r'
- **offset_3d(sec,d)** : offsets an enclosed section in 3d space, in case the section is in 1 plane, se/users/sanjeevprabhakar section in 3d space, d: offset distance -ve sign means inner offset and +ve sign is outer offset
- **offset_points(sec,r)** : function to calculate offset of a list of 2d points. in defining sections, providing corner radius is a must
- **offset_points_ccw(sec,r)**: function to offset only those points which are counter clockwise
- **offset_points_cw(sec,r)** : function to offset only those points which are clockwise
- **offset_seg_cw(sec,r)** : function offsets the segment only when the point is clockwise
- **offset_segv(sec,d)** : function makes the segments of the original section and offset each segment by a distance 'd'
- **orthos_along_path(path,scale=1)** :
- **oset(sec,r)** : function to draw offset of a section 'sec' with distance 'r'
- **p_cir_t(p,cir)** : point to circle tangent line (point should be outside the circle)
- **p2p_intersecion_line(pa,pb)** : function to calculate intersection line between 2 planes in 3d space
- **path_extrude_closed(sec,path,twist=0)** : function to extrude a closed section to a closed path. closed path means the path provided has it's first and the last point same example a circle
- **path_extrude_open(sec,path,twist=0)**: function to extrude a closed section to an open path. twist can be set either to '0' or '1' depending on the shape produced
- **path_offset(path,d)** : function to offset a 'path' by 'd' distance
- **pies1(sec,pnts)** : function to find points 'pnts' which are inside an enclosed section 'sec'
- **plane(nv,size=[100,100])** : plane defined by normal 'nv' and 'size'
- **plos (surf,line,vector,unidirection)** : function to project line on a surface, vector is the vector in which direction the projection is required, unidirection is set to '1' by default meaning the projection will happen only in the direction of vector, if this parameter is set to '0' then the projection will happen in both direction, that of vector and opposite to vector
- **pntsnfaces(bead2)** : function returns points and faces of a prism
- **points_inside_offset_surround(sec,sec2,r)** : function returns points in a list 'sec2' which are inside the offset surround of a section 'sec' with offset radius of 'r'
- **ppesec(p0,sec)**: point's projection on an enclosed 3d section
- **ppplane(p0,v1,loc)** : function to find projected points of a given list of points 'p0' on a plane defined by normal'v1' and location 'loc'
- **prism(sec,path)** : function to make a prism with combination of 2d section and 2d path
- **prism2cpo(s1)** : function to change the orientation of the surface
- **psos(s2,s3,v1)** : function to project a surface on to another
- **pts(p)** : calculates the cumulative sum of 2d list of points 'p'
- **pts1(p)**: 'p' is a list of points. function calculates the cumulative sum of x,y values in the list while z value remains the same. this is mainly used in function corner_radius(pl,s).
- **q(vector=[1,0,0],point=[0,5,0],theta=0)** : function to rotate a point around a vector(axis) with angle theta)
- **rot(a,sol)** : function to rotate a group of points around a series of axis with defined angles
- **rot2d(theta,sec)** : function to rotate a 2d point or 2d points list by an angle theta around z-axis
- **r_sec(r1,r2,cp1,cp2)** : creates a rounded section around a line defined by points 'cp1' and 'cp2'. radius around 'cp1' is 'r1' and radius around 'cp2' is 'r2'
- **reorient_sec(sec)** :re-orient section to create a better surface through 'prism' function
- **rounding-various-rounded-cubes** :
- **rsz2d(sec,rsz)** : function to resize a 2d section to dimensions 'rsz'. resized section will be placed on bottom center of the original section
- **rsz2dc(sec,rsz)** : function to resize a 2d section to dimensions 'rsz'. resized section will be placed in center of the original section
- **rsz3d(prism,rsz)** : function to resize a 'prism' to dimensions 'rsz'. bottom left corner of both the prisms would be same
- **rsz3dc(prism,rsz)** : function to resize a 'prism' to dimensions 'rsz'. resized prism will be placed in the center of the original prism or center point of both the prisms will be same
- **s_int(s)** : calulates the self intersection points of a list of line segments 's'. it also picks the points in case the 2 lines are just connected at 1 point and are not crossing
- **s_int1(s)**: calcultes the self intersecting segments such that there is a complete intersection and not only end points touching
- **samsung-tab-s6-holder** :
- **scl2d(sec,sl)**: scale a 2d section to a scaling factor 'sl')
- **scl2d_c(sec,sl)** : scale a 2d section such that the center of original and scaled section is same)
- **scl3d(p,s)** : scale any 3d prism to a scaling factor 's')
- **sec2vector(v1=[1,0,0],sec=[])** : function to align a section 'sec' with a vector 'v1'
- **sinewave(l,n,a,p)** : creates a sinewave with length 'l', number of cycles 'n' amplitude 'a' and number of points 'p'
- **sinwave-box** :
- **sl_int(sec,line)** : function to find intersection between an enclosed section in 3d space and a line
- **slice_sol(sol,n=10)**: function to slice a solid with 'n' intermediate steps
- **sol2path(sol,path)**: function to extrude a solid along a path
- **sol2vector(v1=[],sol=[],loc=[0,0,0])**: orients a solid as per a given vector
- **sort_points(sec,list1)** : function picks the nearest point of a section from a reference section and matches the length of points for the 2 compared sections
- **sphere(r=0,cp=[0,0,0],s=50)** : function to draw sphere with radius 'r' , center point 'cp' and number of segments 's'
- **sunflower** :
- **surf_base(surf,h=0)** : creates a solid from any surface, 'h' is the height of the base of the surface
- **surf_extrude(sec,path)** : extrudes an open section 'sec' to a 3d 'path' to create surface

- **surf_extrudef(surf,t=-.05)** : surface with a polyline 2d sketch and a 3d path. thickness of the surface can be set with parameter "t". positive and negative value creates thickness towards +z and -z directions respectively
- **surface_offset(sec,d)** : function to offset the surface 'sec' by a distance 'd'
- **surface_for_fillet(sol1=[],sol2=[],factor1=50,factor2=10,factor3=1,factor4=100,dia=40)**: sol1: Solid on which the surface needs to be created. sol2: Intersecting solid. factor1: number of segments in the circle. factor2: number of layers or slices of surface. factor3: decides the size of the surface lower value means bigger size. value can be set between 1 to any number. factor4: any high number should be ok like maybe 100 or greater, basically greater than the bounding box dimension of the "sol1". dia: diameter around the solid 2 where surfavce needs to be created
- **surface_offset(surf,d)** : offsets the surface by an amount 'd'
- **surface_thicken(surf,d)** : Thickens the surface by an amount 'd'
- **SurfaceFrom3LinesInDifferentPlanes(l1,l2,l3,s1=15,s2=15)** : create surface with 3 lines in different planes
- **swp_prism_h(prism_big,prism_small)** : creats a hollow prism with 2 similar prisms (1 big and 1 smaller)
- **t_cir_tarc(r1,r2,cp1,cp2,r,side=0,s=50)** : function draws a arc which is tangent to 2 circles defined by radiuses 'r1' and 'r2' and center points 'cp1' and 'cp2'. 's' is the number of segments of the tangent arc. 'r' is the radius of the tangent arc (it should be >= (r1+r2+center distance of 2 circles)/2). 'side' there are 2 sides of the circles where the arc could be created defined by '0' and '1'
- **tangents_along_path(path,scale=1)** :
- **tcct(r1,r2,cp1,cp2,cw=-1)** : two circle cross tangent
- **tctp(r1,r2,cp1,cp2)** : 2 circle tangent points (one side) r1 and r2 are the radius of 2 circles and cp1 and cp2 are the center points)
- **tctpf(r1,r2,cp1,cp2)** : 2 circle tangent point full (both the sides))
- **translate(p,sec)** : translates a prism or section by [x,y,z] distance
- **translate_2d(p,sec)** : function to translate a group of points "sec" by "p" distance defined in [x,y]
- **v_sec_extrude(sec,path,o)** : extrude a section 'sec' through a path 'path' . section will vary from start to end such that at the end the section will be offset by 'o' distance
- **wrap_around** : complex function see the example to understand

path_extrude_open

In [ ]:
```
# example of path_extrude
t0=time.time()

sec2=corner_radius(pts1([[-25,0],[10,5,5],[10,-3,10],[10,5,5],[10,-8,7],[10,1]]),10)
path2=cytz(corner_radius(pts1([[-35,5,0],[10,8,20],[20,-5,10],[20,8,20],[10,-9,20],[10,1,0]]),10))

surf2=path_extrude_open(sec2,path2)

fileopen(f'''

{swp_surf(surf2)}

''')
t1=time.time()
total=t1-t0
total
```

surface_thicken

In [ ]:
```
# example of surf_extrudef
t0=time.time()

sec2=corner_radius(pts1([[-25,0],[10,5,5],[10,-3,10],[10,5,5],[10,-8,7],[10,1]]),10)
path2=cytz(corner_radius(pts1([[-35,5,0],[10,8,20],[20,-5,10],[20,8,20],[10,-9,20],[10,1,0]]),10))
surf2=path_extrude_open(sec2,path2)
surf3=surface_thicken(surf2,-1)
fileopen(f'''

{swp(surf3)}
//color("blue")for(p={surf3})p_line3dc(p,.1,rec=1);

''')
t1=time.time()
total=t1-t0
total
```

two_cir_tarc

In [ ]:
```
# example of function fillet_2cir
t0=time.time()
c1=circle(5)
c2=circle(3,[7,0])
f1=two_cir_tarc(c2,c1,r=1)
f2=two_cir_tarc(c1,c2,r=1)
# fillet=fillet_2cir(r1=5,r2=3,c1=[0,0],c2=[7,0],r=1)
fileopen(f'''

%p_line({c1},.2);
    %p_line({c2},.2);
   for(p={[f1,f2]}) p_lineo(p,.2);

''')

t1=time.time()
t1-t0
```

trim_sec_ip

In [ ]:
```
# example of function filleto_2cir and arc_long_2p
t0=time.time()
c1=circle(10)
c2=circle(10,[20,0])
f1=two_cir_tarc(c2,c1,10)
f2=two_cir_tarc(c1,c2,10)
cir1=trim_sec_ip(c1,f1[-1],f2[0])
cir2=trim_sec_ip(c2,f2[-1],f1[0])
fileopen(f'''

    //%p_line({c1},.2);
    //%p_line({c2},.2);
    color("blue")p_lineo({f1},.2);
    color("yellow")p_lineo({f2},.2);
    color("magenta")p_lineo({cir1},.2);
    color("cyan")p_lineo({cir2},.2);


''')
t1=time.time()
t1-t0
```

corner_radius(sec,s)

In [ ]:
```
# example of function corner_radius(pl,s)
t0=time.time()
sec=corner_radius(sec=[[0,0,.5],[10,0,2],[7,15,1]],s=5)

fileopen(f'''

color("blue")p_line({sec},.1);


''')
t1=time.time()
t1-t0
```

translate

In [ ]:
```
# example of function translate(p,sec)
t0=time.time()
sec=corner_radius([[0,0,.5],[10,0,2],[7,15,1]],5)
sec1=translate(p=[10,5,3],sec=sec)

fileopen(f'''

color("blue")p_line({sec},.1);
color("magenta")p_line3dc({sec1},.1);


''')
t1=time.time()
t1-t0
```

scl2d(sec,sl)

In [ ]:
```
# example of function scl2d(sec,sl)
t0=time.time()
sec=corner_radius([[0,0,.5],[10,0,2],[7,15,1]],5)
sec1=scl2d(sec,.7)
fileopen(f'''

color("blue")p_line({sec},.1);
color("magenta")p_line({sec1},.1);


''')
t1=time.time()
t1-t0
```

scl2d_c(sec,sl)

In [ ]:
```
# example of function scl2d_c(sec,sl)
t0=time.time()
sec=corner_radius([[0,0,.5],[10,0,2],[7,15,1]],5)
sec1=scl2d_c(sec,.7)
```

```
fileopen(f'''

color("blue")p_line({sec},.1);
color("magenta")p_line({sec1},.1);


''')
t1=time.time()
t1-t0
```

scl3d(p,s)

In [ ]:
```
# example of function scl3d(p,s)
t0=time.time()
sec=circle(10);
path=corner_radius(pts1([[2,0],[-2,0,2],[0,10,3],[-3,0]]),5)
sol=prism(sec,path)
sol1=scl3d(sol,.5)

fileopen(f'''

%{swp(sol)}
{swp(sol1)}


''')

t1=time.time()
t1-t0
```

ip(prism,prism1)

In [ ]:
```
# example of function ip(prism,prism1)
t0=time.time()

sec=circle(10)
path=corner_radius(pts1([[2,0],[-2,0,2],[0,10,3],[-9.9,0]]),5)
p_0=prism(sec,path)
p_1=cylinder(r=3,h=15,s=30)
ip_1=ip(p_0,p_1)


fileopen(f'''

%{swp(p_0)}
%{swp(p_1)}
color("magenta")points({ip_1},.2);
//color("blue")for(p={cpo(p_0)})p_line3d(p,.05);
//color("blue")for(p={cpo(p_1)})p_line3d(p,.05);
''')
t1=time.time()
t1-t0
```

In [ ]:
```
t0=time.time()

sec2=corner_radius(pts1([[-25,0],[10,5,5],[10,-3,10],[10,5,5],[10,-8,7],[10,1]]),10)
path2=cytz(corner_radius(pts1([[-35,5,0],[10,8,20],[20,-5,10],[20,8,20],[10,-9,20],[10,1,0]]),10))
surf2=surf_extrude(sec2,path2)
sol1=linear_extrude(circle(10),30)
# sol1=slice_sol(sol1,10)
i_p1=ip_surf(surf2,sol1)

fileopen(f'''


color("blue")p_line3dc({i_p1},.2);
%{swp_surf(surf2)}
''')
t1=time.time()
total=t1-t0
total
```

two_circle_tangent

In [ ]:
```
# example of function tctp(r1,r2,cp1,cp2)
t0=time.time()
c1=circle(10)
c2=circle(5,[15,6])
sec=two_circle_tangent(c1,c2)

fileopen(f'''

p_line({c1},.5);
p_line({c2},.5);


color("blue")p_line({sec},.5);
color("magenta")points({[sec[1]]},2);

''')

t1=time.time()
t1-t0
```

In [ ]:
```
t0=time.time()

c1=circle(10)
c2=circle(5,[15,6])
l1=two_circle_tangent(c1,c2)
l2=two_circle_tangent(c2,c1)
sec=l1+l2

fileopen(f'''
```

```
p_line({c1},.5);
p_line({c2},.5);
color("blue")p_line({sec},.5);


''')
t1=time.time()
t1-t0
```

multiple_sec_extrude

In [ ]:
```
# example of function multiple_sec_extrude(path_points=[],radiuses_list=[],sections_list=[],option=0,s=10)
t0=time.time()

sec1=circle(10)
sec2=square(5,True)
sec3=corner_radius(pts1([[-3.5,-2.5,2.49],[7,0,2.49],[0,5,2.49],[-7,0,2.49]]))
sections=[sec1,sec2,sec3,sec1,sec3]
path=array([[0,0,0],[20,2,5],[-7,25,3],[5,10,30],[-30,15,3]]).cumsum(0)
r=[0,5,7,12,0]
sol=multiple_sec_extrude(path,r,sections,0,20)
sol=cpo([ bezier(p,200)  for p in cpo(sol)])
fileopen(f'''

//color("blue")for(p={multiple_sec_extrude(path,r,sections,0,20)})p_line3dc(p,.1);
{swp(sol)}
    ''')
t1=time.time()
t1-t0
```

path_extrude_open(sec,path)

In [ ]:
```
# example of function path_extrude_open(sec,path)
t0=time.time()
sec=corner_radius(pts1([[0,0,.2],[3,0,.2],[0,2,1],[-3,0,1]]),10)
path=helix(10,2.5,4,5.01)
sol=path_extrude_open(sec,path)
fileopen(f'''

{swp(sol)}
color("blue")p_line3d({path},.1);
    ''')
t1=time.time()
t1-t0
```

path_extrude_closed(sec,path)

In [ ]:
```
# example of function path_extrude_closed(sec,path)
t0=time.time()
sec=corner_radius(pts1([[0,0,.2],[3,0,.2],[0,2,1.49],[-3,0,1.49]]),10)
path=c2t3(circle(10))
sol=path_extrude_closed(sec,path)
fileopen(f'''

{swp_c(sol)}
color("blue")p_line3d({path},.1);
    ''')

t1=time.time()
t1-t0
```

cylinder

In [ ]:
```
# example of function cylinder(r1=1, r2=1, h=1, s=50, r=0, d=0, d1=0, d2=0, center=False) and function swp
t0=time.time()
sol=cylinder(r1=10,r2=5,h=20)
fileopen(f'''

{swp(sol)}
    ''')
t1=time.time()
t1-t0
```

bezier(p,s=10)

In [ ]:
```
# example of function bezier(p,s=10)
t0=time.time()
control_points=array([[0,0,0],[10,5,5],[-10,10,20],[-10,5,15],[10,0,10]]).cumsum(0).tolist()
curve=bezier(control_points,50)

fileopen(f'''

color("blue")p_line3d({curve},.1);
// control points
color("magenta")points({control_points},.5);
color("cyan")p_line3d({control_points},.05);
    ''')
t1=time.time()
t1-t0
```

arc_3d

In [ ]:
```
# example of function arc_3d(v=[0,0,1],r=1,theta1=0,theta2=360,cw=-1,s=50)
t0=time.time()
vector=[[0,0,0],[1,0,1]]
arc1=arc_3d(v=[1,0,1],r=3,theta1=0,theta2=270,cw=-1,s=50)

fileopen(f'''

//arc
color("blue")p_line3d({arc1},.1);
// vector
color("cyan")p_line3d({vector},.1);

    ''')
t1=time.time()
t1-t0
```

plane

In [ ]:
```
# example of function plane(nv,radius)
t0=time.time()
vector=[[0,0,0],[-3,0,2]]
plane1=plane(nv=[-3,0,2],size=[10,10])

fileopen(f'''


//plane
%{swp(plane1)}

// vector
color("magenta")p_line3d({vector},.1);

    ''')
t1=time.time()
t1-t0
```

convex_hull

In [ ]:
```
#  example of function c_hull(pnt)
t0=time.time()
a=random.random(1000)*(20-5)+5
b=random.random(1000)*(30-10)+10
points=array([a,b]).transpose(1,0).tolist()
sec=convex_hull(points)
fileopen(f'''


points({points},.2);
color("blue")p_line({sec},.05);

    ''')
t1=time.time()
t1-t0
```

convex

In [ ]:
```
# example of function convex(sec)
t0=time.time()
sec1=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
sec2=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)


fileopen(f'''


// not a convex section
color("blue")p_line({sec1},.2);

//convex section
color("magenta")translate([20,0,0])p_line({sec2},.2);

    ''')
t1=time.time()
convex(sec1),convex(sec2),t1-t0
```

cir_p_t

In [ ]:
```
# example of function cir_p_t(cir,pnt)
cir=c3t2(translate([20,10,0],circle(10)))
point=[1,30]
tangent_point=cir_p_t(cir,point)
fileopen(f'''

// "cyan" is the tangent point from circle to some external point ("magenta color")
%p_line({cir},.1);
color("magenta")points({[point]},.5);
color("cyan")points({[tangent_point]},.5);
//color("blue")
%p_line({[point,tangent_point]},.05);
    ''')
```

concave_hull

In [ ]:
```
# example of function concave_hull(pnts,x=1,loops=10)
t0=time.time()
a=random.random(1000)*(20-5)+5
b=random.random(1000)*(30-10)+10
points=remove_extra_points(array([a,b]).transpose(1,0))
conc_hull=concave_hull(points,3)
fileopen(f'''


points({points},.2);
color("blue")p_line3d({conc_hull},.1,1);

    ''')
t1=time.time()
t1-t0
```

In [ ]:
```
# example of pies1(sec,pnts) and concave_hull
t0=time.time()

a=random.random(10000)*(10-0)+0
b=random.random(10000)*(20-0)+0
c=array([a,b]).transpose(1,0).tolist()


sec=corner_radius(pts1([[1.5,8,.9],[2,0,.9],[0,-3,1.4],[3,0,1.4],[0,4,1.9],[-5,0,2.5],[0,6,2.5],
               [7,0,2.5],[0,-4,.9],[-2,0,.9],[0,3,1.4],[-3,0,1.4],[0,-4,1.9],
              [5,0,2.5],[0,-6,2.5],[-7,0,2.5]]),20)

pnts=pies1(sec,c)

s1=concave_hull(pnts,50)

fileopen(f'''


points({pnts},.1);
color("magenta")p_line({s1},.05);



''')
t1=time.time()
t1-t0
```

path_offset

In [ ]:
```
# example of function path_offset_n(path,d)

path=corner_radius(pts1([[-5,0],[5,0,2],[-1,10,2],[-5,0]]))
path1=path_offset_n(path,-1)
fileopen(f'''

// orginal path
color("blue")p_line3d({path},.1,1);
//offset path
color("magenta")p_line3d({path1},.1,1);


    ''')
```

In [ ]:
```
# example of function path_offset(path,d)
r=-1
path=corner_radius(pts1([[-5,0],[5,0,2],[-1,10,2],[5,0]]),20)
# path=circle(10)
# path=corner_radius(pts1([[0,0],[10,0,.1],[-10,5,.1],[-10,-5]]),20)

path1=path_offset(path,r)
```

```
fileopen(f'''

// orginal path
color("blue")p_lineo({path},.1);
//offset path
color("magenta")p_lineo({path1},.1);

    ''')
```

pntsnfaces

In [ ]:
```
# example of function pntsnfaces(bead2)

path=corner_radius(pts1([[-5,0],[5,0,2],[-1,10,2],[-5,0]]))
path1=path_offset(path,-1)
final_path=path+flip(path1)
sec=circle(10)
sol=prism(sec,final_path)

pnts, fcs=pntsnfaces(sol)[0],pntsnfaces(sol)[1]

fileopen(f'''


polyhedron({pnts},{fcs},convexity=10);
    ''')
```

offset_points

In [ ]:
```
# example of function offset_points(sec,r)
t0=time.time()
sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
sec1=offset_points(sec,2)

fileopen(f'''



//original points
points({sec},.2);

// offset points
color("blue") points({sec1},.2);


    ''')
t1=time.time()
t1-t0
```

In [ ]:
```
set_printoptions(suppress=True)
```

s_int

In [ ]:
```
# example of function s_int(s)
t0=time.time()
sec=corner_radius(pts1([[0,0,.1],[7,5,2],[-7,10,2]]),3)
sec1=offset_segv(sec,-1)
self_intersections=s_int1(sec1)

fileopen(f'''


// line segments
color("blue") for (p={sec1}) p_line(p,.3);

// intersection points
color("magenta")points({self_intersections},.8);

    ''')
t1=time.time()
t1-t0
```

In [ ]:
```
# example of function s_int(s)
t0=time.time()
sec=corner_radius(pts1([[0,0,2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),5)
sec=seg(sec)
s=s_int(sec)

fileopen(f'''


// line segments
color("blue") for (p={sec}) p_line(p,.4);

// intersection points
color("magenta")points({s},.8);

    ''')
t1=time.time()
t1-t0
```

s_int1

In [ ]:
```
#  example of function s_int1(s)
t0=time.time()
sec=offset_segv([[0,0],[10,0],[15,7]],-1)
self_intersections=s_int1(sec)

fileopen(f'''


// line segments
color("blue") for (p={sec}) p_line(p,.3);

// intersection points
color("magenta")points({self_intersections},.8);

    ''')
t1=time.time()
t1-t0
```

offset_seg_cw

In [ ]:
```
#  example of function offset_seg_cw(sec,r)
t0=time.time()
sec=sec=corner_radius(pts1([[0,0,2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),5)
sec1=offset_seg_cw(sec,-2)

fileopen(f'''


// original section
color("blue") points({sec},.2);

// offset segments
color("magenta")points({sec1},.2);

    ''')
t1=time.time()
t1-t0
```

offset_segv

In [ ]:
```
#  example of function offset_segv(sec,r)
t0=time.time()
sec=sec=corner_radius(pts1([[0,0,2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),5)
sec1=offset_segv(sec,-1)

fileopen(f'''


// original section
color("blue") points({sec},.2);

// offset segments
color("magenta")for(p={sec1})points(p,.2);

    ''')
t1=time.time()
t1-t0
```

In [ ]:
```
#  example of another method to offset segment where points are clockwise and example function cwv(sec)
t0=time.time()
sec=corner_radius(pts1([[0,0,2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),5)
sec0=seg(sec)
decision=cwv(sec)
sec1=[path_offset(sec0[i],-2) for i in range(len(sec0)) if decision[i]==1]

fileopen(f'''


// original section
color("blue") points({sec},.2);

// offset segments
color("magenta")for(p={sec1})points(p,.2);

    ''')
t1=time.time()
t1-t0
```

sort_points

In [ ]:
```
#  example of function sort_points(sec,sec1)
t0=time.time()
sec=circle(10)
sec1=corner_radius(pts1([[-2.5,-2.5,1],[5,0,1],[0,5,1],[-5,0,1]]))
sec2=sort_points(sec,sec1)
sec3=cpo([sec2,sec])
fileopen(f'''
```

```
p_line({sec},.2);
p_line({sec2},.2);
color("blue") for(p={sec3})p_line(p,.1);

    ''')
t1=time.time()
t1-t0
```

surface_offset

In [ ]:
```
# example of function surface_offset(surf,o)

sec=circle(10);
path=corner_radius(pts1([[2,0],[-2,0,2],[0,10,3],[-3,0]]),5)
sol=prism(sec,path)
sol1=surface_offset(sol,-1)
sol1=surface_offset(sol,1)
fileopen(f'''

%{swp_c(sol)}
{swp_c(sol1)}


''')
```

pts1

In [ ]:
```
# example of function pts1(p)

sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),5)

fileopen(f'''

color("blue")p_line({sec},.3);


''')
```

arc_2p

In [ ]:
```
# example of function arc_2p(p1,p2,r,cw=1,s=20)

p1=[2,0]
p2=[0,2]
arc1=arc_2p(p1,p2,2,1,20)

arc2=arc_2p(p1,p2,2,-1,20)


fileopen(f'''


// arc clockwise
//color("blue")
%p_lineo({arc1},.1);

// arc counter clockwise
//color("magenta")
%p_lineo({arc2},.1);

color("cyan")points({[p1,p2]},.5);

''')
```

arc_long_2p

In [ ]:
```
# example of function arc_long_2p(p1,p2,r,cw=1,s=20)

p1=[2,0]
p2=[0,2]
arc1=arc_long_2p(p1,p2,2,1,20)

arc2=arc_long_2p(p1,p2,2,-1,20)


fileopen(f'''


// arc clockwise
//color("blue")
%p_lineo({arc1},.1);

// arc counter clockwise
//color("magenta")
%p_lineo({arc2},.1);

color("cyan")points({[p1,p2]},.5);

''')
```

arc_2p_cp

In [ ]:
```
# example of function arc_2p_cp(p1,p2,r,cw=-1)

p1=[2,0]
p2=[0,2]
arc1=arc_2p(p1,p2,2,1,5)
cp1=arc_2p_cp(p1,p2,2,1)

arc2=arc_2p(p1,p2,2,-1,5)
cp2=arc_2p_cp(p1,p2,2,-1)


fileopen(f'''


// arc clockwise with center point of the arc
color("blue")
{{p_lineo({arc1},.05);
points({[cp1]},.2);}}
```

```
// arc counter clockwise with center point of the arc
//color("magenta")
//{{p_lineo({arc2},.05);
//points({[cp2]},.2);}}

''')
```

offset

In [ ]:
```
# example of function offset(sec,r)

t0=time.time()

# sec=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)

# sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),10)
# sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),10)
sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),15)
# sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),10)
# sec=circle(10)
# sec=pts([[0,0],[10,0],[0,5],[-10,0]])

# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,5.3],[-5.3,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),20)
os=linspace(-2.5,50,50)
sec1=[offset(sec,i) for i in os] #
fileopen(f'''


color("magenta")for(p={sec1})p_line(p,.1);
color("blue")p_line({sec},.1);

''')
t1=time.time()
t1-t0
```

In [ ]:
```
t0=time.time()
r=-2
# sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,5],[-7,5,5]]),10)
sec=circle(10,s=200)
sec1=offset(sec,r)

fileopen(f'''

p_line({sec},.2);

color("magenta")p_line({sec1},.2);
''')

t1=time.time()
t1-t0
```

In [ ]:
```
sec=corner_radius(pts1([[0,0,.1],[10,0,.1],[0,3,.1],[-3,0,.1],[0,3,.1],[-3,0,.1],[0,3,.1],[-4,0,.1]]),20)



# sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),40)
# sec=sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,5],[-7,5,5]]),20)
# sec=corner_radius(pts1([[-15,0,2.49],[0,15,3],[30,0,3],[0,-15,2.49],[5,0,2.49],[0,20,7],[-40,0,7],[0,-20,2.49]]),20)
# sec=circle(10)
d=-2

fileopen(f'''

p_line({sec},.2);
color("blue")p_line({offset(sec,d)},.2);
%offset({d})polygon({sec});
''')
```

prism

In [ ]:
```
# example of function prism(sec,path) and function swp_prism_h(prism_big, prism_small)
t0=time.time()
# sec=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
# sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),10)
# sec=pts([[0,0],[10,0],[0,5],[-10,0]])
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),20)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,5.2],[-5.2,0]]),20)
path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),10)

sol=prism(sec,path)

fileopen(f'''


{swp(sol)}

''')

t1=time.time()
t1-t0
```

p_cir_t

In [ ]:
```
# example of function p_cir_t(pnt,cir)
cir=c3t2(translate([20,10,0],circle(10)))
point=[3,5]
tangent_point=p_cir_t(point,cir)
# tangent_point=point_to_circle_tangent(point,cir)
fileopen(f'''
```

```
%p_line({cir},.3);
color("magenta")points({[point]},.8);
color("cyan")points({[tangent_point]},.8);
%p_line({[point,tangent_point]},.3);
    ''')
```

v_sec_extrude

In [ ]:
```
# example of function v_sec_extrude(sec,path,o)

sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),10)
path=helix(20,15,1,5)

sol=v_sec_extrude(sec,path,-2)

fileopen(f'''


{swp(sol)}
    ''')
```

two_cir_tarc

In [ ]:
```
# example of function t_cir_tarc(r1,r2,cp1,cp2,r,side=0,s=50)

r=17
c1=circle(10)
c2=circle(5,[-15,10])
arc1=two_cir_tarc(c1,c2,r,0,20)
fileopen(f'''


%p_line({c1},.05);
%p_line({c2},.05);
arc1={arc1};
color("blue") p_lineo(arc1,.1);
color("magenta")points({[arc1[0],arc1[-1]]},.2);

    ''')
```

In [ ]:
```
# example of function two_circles_tangent_arc

t0=time.time()
c1=circle(20)
c2=circle(10,rot2d(30,[52.5,0]))
a1=two_cir_tarc(c2,c1,45)
a2=two_cir_tarc(c1,c2,20)
sec1=concave_hull(c1+c2+a1+a2,5)
c3=circle(10)
c4=circle(5,rot2d(30,[52.5,0]))
```

```
s1=linear_extrude(sec1,10)
s2,s3=[translate([0,0,0],linear_extrude(p,10)) for p in [c3,c4]]
e1=end_cap(s1,2)
e2=end_cap_1(s2,2)
e3=end_cap_1(s3,2)
fileopen(f'''


difference(){{
{swp(s1)}
for(p={[s2,s3]})swp(p);
for(p={e1})swp_c(p);
for(p={e2})swp(p);
for(p={e3})swp(p);
}}
''')
t1=time.time()
t1-t0
```

tcct

In [ ]:
```
# example of function tcct(r1,r2,cp1,cp2,cw=-1)
c1=circle(10)
c2=circle(5,[15,-8])

line= tcct(10,5,[0,0],[15,-8],cw=-1)

fileopen(f'''


%p_line({c1},.05);
%p_line({c2},.05);
color("blue") p_lineo({line},.05);



    ''')
```

arc_3p

In [ ]:
```
# example of function arc_3p(p1,p2,p3,s=30)

p1,p2,p3=[3,0],[0,0],[0,3]
arc1=arc_3p(p1,p2,p3)
fileopen(f'''



color("blue") p_lineo({arc1},.05);
points({[p1,p2,p3]},.2);
    ''')
```

cir_3p

In [ ]:
```
# example of function cir_3p(p1,p2,p3,s=30)

p1,p2,p3=[3,0],[0,0],[0,3]
cir=cir_3p(p1,p2,p3,30)
fileopen(f'''



color("blue") p_line({cir},.05);
points({[p1,p2,p3]},.2);
    ''')
```

cp_3p

In [ ]:
```
# example of function cp_3p(p1,p2,p3)

p1,p2,p3=[3,0],[0,0],[0,3]
cir=cir_3p(p1,p2,p3,30)
center= cp_3p(p1,p2,p3)
fileopen(f'''



color("blue") p_line({cir},.05);
points({[p1,p2,p3]},.2);
color("magenta")points({[center]},.2);
    ''')
```

pies1

In [ ]:
```
# example of function pies1(sec,pnts)
# function points inside enclosed section
t0=time.time()
a=random.random(10000)*(20-(-5))+(-5)
b=random.random(10000)*(25-(-2))+(-2)
points=array([a,b]).transpose(1,0).tolist()
# sec=corner_radius(pts1([[2,1,.1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
sec=corner_radius(pts1([[8,0],[11,10,10],[0,10,5],[-10,0,5],[-1,-6,0.3],[-1,6,5],[-10,0,5],[0,-10,10]]))

fileopen(f'''



color("blue") p_line({sec},.05);
points({points},.2);
color("magenta")points({pies1(sec,points)},.2);
    ''')
t1=time.time()
t1-t0
```

In [ ]:
```
# example of pies1(sec,pnts)
t0=time.time()

a=random.random(10000)*(10-0)+0
b=random.random(10000)*(20-0)+0
c=array([a,b]).transpose(1,0).tolist()


sec=corner_radius(pts1([[1.5,8,.9],[2,0,.9],[0,-3,1.4],[3,0,1.4],[0,4,1.9],[-5,0,2.5],[0,6,2.5],
               [7,0,2.5],[0,-4,.9],[-2,0,.9],[0,3,1.4],[-3,0,1.4],[0,-4,1.9],
              [5,0,2.5],[0,-6,2.5],[-7,0,2.5]]),20)

pnts=pies1(sec,c)
pnts1=pies1(offset(sec,-.45),pnts)

fileopen(f'''

    points({c},.1);
    color("magenta")points({pnts},.1);
    color("cyan")points({pnts1},.1);
    color("blue")p_line({sec},.05);
    color("green")p_line({offset(sec,-.45)},.05);

    ''')

t1=time.time()
t1-t0
```

swp_prism_h

surface_thicken_1

In [ ]:
```
# example of function swp_prism_h(prism_big,prism_small)

sec1=circle(10)
path=corner_radius(pts1([[2,0],[-2,0,2],[0,10,3],[-3,0]]),5)
sol=prism(sec1,path)
sol1=surface_offset(sol,1)
sol2=swp_prism_h(sol,sol1)

fileopen(f'''

{swp_c(sol2)}

''')
```

In [ ]:
```
# alternatively use function surface_thicken_1
sec1=circle(10)
path=corner_radius(pts1([[2,0],[-2,0,2],[0,10,3],[-3,0]]),5)
sol=prism(sec1,path)
sol2=surface_thicken_1(sol,1)
fileopen(f'''


{swp_c(sol2)}

''')
```

In [ ]:
```
# example of function prism(sec,path) and function swp_prism_h(prism_big, prism_small)
t0=time.time()
# sec=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
# sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,5],[-7,5,5]]),20)
sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),20)
# sec=pts([[0,0],[10,0],[0,5],[-10,0]])
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),20)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,5.2],[-5.2,0]]),20)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),20)

# sec=equidistant_pathc(sec,300)
sec1=offset(sec,.5)

sol=linear_extrude(sec,50)
sol1=linear_extrude(sec1,50)
sol2=swp_prism_h(sol1,sol)
```

```
fileopen(f'''


{swp_c(sol2)}

''')

t1=time.time()
t1-t0
```

In [ ]:
```
sec=corner_radius(pts1([[0,0,1],[25,0,1],[0,15,1],[-25,0,1]]),10)
sec1=offset(sec,2)
sol=linear_extrude(sec,10)
sol1=linear_extrude(sec1,10)
sol2=swp_prism_h(sol1,sol)

fileopen(f'''


{swp_c(sol2)}

''')
```

In [ ]:
```
sec=corner_radius(pts1([[0,0,1],[15,0,1],[0,10,1],[-15,0,1]]),10)
sec1=offset(sec,2)
sol=linear_extrude(sec,10)
sol1=linear_extrude(sec1,10)
sol2=swp_prism_h(sol1,sol)

fileopen(f'''


{swp_c(sol2)}

''')
```

surf_base

In [ ]:
```
# example of function surf_base(surf,h)
t0=time.time()

sec2=corner_radius(pts1([[-25,0],[10,5,5],[10,-3,10],[10,5,5],[10,-8,7],[10,1]]),10)
path2=cytz(corner_radius(pts1([[-35,5,0],[10,8,20],[20,-5,10],[20,8,20],[10,-9,20],[10,1,0]]),10))
surf2=surf_extrude(sec2,path2)
sol=surf_base(surf2,0)
fileopen(f'''

difference(){{
{swp(sol)}
//{swp(cut_plane([0,0,1],[15,10],20,10))}
}}
''')
t1=time.time()
total=t1-t0
total
```

helix

In [ ]:
```
# example of function helix(radius=10,pitch=10, number_of_coils=1, step_angle=1)

path=helix(10,5,10,5)
sec=circle(1)
sol=path_extrude_open(sec,path)
fileopen(f'''

//p_line3d({path},1,$fn=20);
{swp(sol)}
    ''')
```

offset_points_cw

In [ ]:
```
# example of function offset_points_cw(sec,r)

sec=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
# sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
# sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),20)

# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,5.3],[-5.3,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),20)


offsetPoints=offset_points_cw(sec,-2)

fileopen(f'''

color("blue")p_line({sec},.05);
color("magenta")points({offsetPoints},.2);

''')
```

offset_points_ccw

In [ ]:
```
# example of function offset_points_ccw(sec,r)

sec=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
# sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,3],[-5,7,5],[-7,5,5]]),20)
# sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),20)

# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,5.3],[-5.3,0]]),40)
```

```
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),20)


offsetPoints=offset_points_ccw(sec,2)

fileopen(f'''

color("blue")p_line({sec},.1);
color("magenta")points({offsetPoints},.2);

''')
```

cpo

In [ ]:
```
# example of function cpo(prism)

sec=corner_radius(pts1([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),10)
# sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,3],[-5,7,5],[-7,5,5]]),20)
# sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),20)

path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,4.2],[-4.2,0]]),10)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,5.3],[-5.3,0]]),40)
# path=corner_radius(pts1([[2,0],[-2,0,2],[0,7,2],[-2,0]]),20)

sp1=translate([0,50,0],sphere(10,s=20))
sp2=translate([30,0,0],cpo(sp1))


sol=prism(sec,path)
sol1=translate([20,0,0],cpo(sol))

fileopen(f'''


color("blue")for(p={sol})p_line3dc(p,.1,1);
color("magenta")for(p={sol1})p_line3d(p,.1,1);

color("blue")for(p={sp1})p_line3dc(p,.1,1);
color("magenta")for(p={sp2})p_line3d(p,.1,1);

''')
```

fillet_3p_3d

In [ ]:
```
# example of function fillet_3p_3d(p0,p1,p2,r,s)

p1,p2,p3=[[3,0,0],[0,0,0],[0,3,3]]
fillet=fillet_3p_3d(p1,p2,p3,3,10)

fileopen(f'''


color("blue")p_line3dc({fillet},.05);
color("cyan")points({[p1,p2,p3]},.2);

''')
```

fillet_3p_3d_cp

In [ ]:
```
# example of function fillet_3p_3d_cp(p0,p1,p2,r)

p1,p2,p3=[[3,0,0],[0,0,0],[0,3,3]]
fillet=fillet_3p_3d(p1,p2,p3,3,10)[1:]
centerPoint=fillet_3p_3d_cp(p1,p2,p3,3)
cp1=cp_cir_3d(fillet)

fileopen(f'''


color("blue")p_line3d({fillet},.05);
%color("magenta",.2)points({[centerPoint]},.2);
color("cyan")points({[cp1]},.15);


''')
```

arc_3p_3d

In [ ]:
```
# example of function arc_3p_3d(points,s)

p1,p2,p3=[[3,0,0],[0,1,0],[5,3,2]]
arc1=arc_3p_3d([p1,p2,p3],30)



fileopen(f'''


color("magenta")p_line3d({arc1},.05);
color("blue")points({[p1,p2,p3]},.2);


''')
```

cir_3p_3d

cp_cir_3d

In [ ]:
```
# example of function cir_3p_3d(points,s)

p1,p2,p3=[[3,0,0],[0,0,0],[0,3,2]]
cir=cir_3p_3d([p1,p2,p3],50)

cp1=cp_cir_3d(cir)

fileopen(f'''


color("magenta")p_line3dc({cir},.05);
color("blue")points({[p1,p2,p3]},.2);
color("cyan")points({[cp1]},.2);

''')
```

linear_extrude

In [ ]:
```
# example of function linear_extrude(sec,h=1,a=0,steps=1)

sec=corner_radius(pts1([[-5,-2.5,1],[10,0,1],[0,5,1],[-10,0,1]]),20)
sol=linear_extrude(sec,50,360,200)

fileopen(f'''


//color("magenta") for(p={sol})p_line3dc(p,.05);
{swp(sol)}

''')
```

rsz3d

In [ ]:
```
# example of function rsz3d(prism,rsz)

sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),5)
sol=translate([-5,0,0],linear_extrude(sec,10))
sol1=rsz3d(sol,[5,6,7])

fileopen(f'''


%{swp(sol)}
{swp(sol1)}

''')
```

rsz3dc

In [ ]:
```
# example of function rsz3dc(prism,rsz)

sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),5)
sol=translate([-5,0,0],linear_extrude(sec,10))
sol1=rsz3dc(sol,[5,2.5,5])

fileopen(f'''


%{swp(sol)}
{swp(sol1)}

''')
```

bb

In [ ]:
```
# example of function bb(prism)

sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),5)
sol=translate([-5,0,0],linear_extrude(sec,10))
dim=bb(sol)
sol1=rsz3dc(sol,array(dim)-[2,2,2])

fileopen(f'''


%{swp(sol)}
{swp(sol1)}

''')
```

cube

In [ ]:
```
# example of function cube(s,center=False)

sol=cube([5,4,7],False)

fileopen(f'''


{swp(sol)}

''')
```

sphere

In [ ]:
```
# example of function sphere(r=0,c=[0,0,0],s=50)


sol=sphere(10,[15,15,10],30)


fileopen(f'''

difference(){{
{swp(sol)}
//cube(10);
}}
''')
```

rsz2d

In [ ]:
```
# example of function rsz2d(sec,rsz)

sec=corner_radius([[0,0,.5],[10,0,2],[7,15,1]],5)
sec1=rsz2d(sec,[4,3])
fileopen(f'''

color("blue")p_line({sec},.1);
color("magenta")p_line({sec1},.1);


''')
```

rsz2dc

In [ ]:
```
# example of function rsz2dc(sec,rsz)

sec=corner_radius([[0,0,.5],[10,0,2],[7,15,1]],5)
sec1=rsz2dc(sec,[4,3])
fileopen(f'''

color("blue")p_line({sec},.1);
color("magenta")p_line({sec1},.1);


''')
```

cs1

In [ ]:
```
# example of function cs1(sec,d) cs1 meaning cleaning section. This function is used in offset function for clearing extra points

sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),10)
# sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,3],[-5,7,5],[-7,5,5]]),20)
# sec=corner_radius(pts1([[-15,0,2.49],[0,15,3],[30,0,3],[0,-15,2.49],[5,0,2.49],[0,20,7],[-40,0,7],[0,-20,2.49]]),20)

fileopen(f'''

color("blue")p_line({sec},.1);
color("magenta")for(p={cs1(sec,-2)})p_line(p,.08);
```

```
''')
```

c2ro

In [ ]:
```
# example of function c2ro(sol,s), 'c2ro' stands for circular to rectangular orientation

cyl=linear_extrude(circle(5,s=31),10)

cyl1=translate([15,0,0],c2ro(cyl,1))

cyl2=translate([30,0,0],cpo(c2ro(cyl,5)))

fileopen(f'''



color("blue")for(p={cyl})p_line3dc(p,.05);
color("blue")for(p={cyl1})p_line3dc(p,.05);
color("blue")for(p={cyl2})p_line3d(p,.05);
swp({cyl});
for(p={cyl1})polyhedron(p,[[0,1,2,3]]);

    ''')
# for i in range(14):
#     with open('trial.scad','a')as f:
#         f.write(f'''
#     {swp(cyl1[i:i+1])}

#     {swp(cyl)}

#     ''')
```

In [ ]:
```
# example of function c2ro(sol,s)

sp=sphere(5,s=21)

sp1=translate([15,0,0],c2ro(sp,3))

sp2=translate([30,0,0],cpo(c2ro(sp,3)))

fileopen(f'''



color("blue")for(p={sp})p_line3dc(p,.1);
color("blue")for(p={sp1})p_line3dc(p,.1);
color("blue")for(p={sp2})p_line3d(p,.1);


    ''')
```

In [ ]:
```
sec=circle(5,s=50)
path=corner_radius(pts1([[-1,3],[1,0,1],[0,10,1],[-1,0]]),10)

s2=linear_extrude(circle(10,s=100),16)
```

```
s3=translate([10,0,0],prism(sec,path))

p1=corner_radius_with_turtle([[1,0],[-1,0,1],[0,1]],20)

s4=[ linear_extrude(circle(10+x,s=100),16) for (x,y) in p1]
s5=[translate([10,0,0],prism(sec,path_offset(path,y))) for (x,y) in p1]
e1=end_cap(s2,1.5)

fileopen(f'''

difference(){{
{swp(s2)}
for(p={e1})swp_c(p);
}}
{swp(s3)}

for(i=[0:19])
hull(){{
intersection(){{
swp({s4}[i]);
swp({s5}[i]);
}}

intersection(){{
swp({s4}[i+1]);
swp({s5}[i+1]);
}}
}}

    ''')
```

In [ ]:
```
sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
sec=translate([0,0,10],rot('y30x30',sec))
sec1=offset_3d(sec,-4)
surf1=[sec,sec1]
sol=linear_extrude(circle(2,[5,9],s=50),20)
i_p1=ip(surf1,sol)
fileopen(f'''

{swp_sec(sec)}
color("blue")for(p={[sec,sec1]})p_line3dc(p,.05);
color("magenta")points({i_p1},.3);
%{swp_c(sol)}

    ''')
```

axis_rot

In [ ]:
```
# example of function axis_rot(axis,solid,angle)
vector=[2,0,2]
# sec=translate([-5,5,0],circle(5))
sec=path_extrude_closed(circle(.05),c2t3(circle(5)))
sec1=[path_extrude_closed(circle(.05),axis_rot(vector,circle(5),i)) for i in arange(0,360,5)]

fileopen(f'''



for(p={sec1})swp(p);
//original section
color("blue"){swp(sec)}
// axis of rotation
color("magenta")p_line3d({[[0,0,0],vector]},.1);

    ''')
```

path_extrude_closed

In [ ]:
```
sec=circle(1,s=20)
path=c2t3(circle(10,s=20))
sol1=path_extrude_closed(sec,path)

fileopen(f'''

$fn=20;
for(p={sol1})p_line3dc(p,.05);
for(p={cpo(sol1)})p_line3dc(p,.05);

    ''')
```

cam-profile

In [ ]:
```
# example of cam profile

l_1=corner_radius(pts1([[0,50],[90,0,100],[180,-20,100],[360,0]]),30)
l_1=rot('x90',equidistant_path(l_1,360))
p1=c2t3(arc(30,0,362,s=360))
l_2=extrude_wave2path(l_1,p1)
l_3=[[-5,0],[5,0]]
surf_1=path_extrude_open(l_3,l_2)
surf_2=c2t3(c3t2(surf_1))
sol_1=[surf_2[i]+flip(surf_1[i]) for i in range(len(surf_1))]
c1=circle(3)
sol_2=path_extrude_open(c1,l_2[10:190])

fileopen(f'''


difference(){{
{swp(sol_1)}
{swp(sol_2)}
    }}
    ''')
```

drill-bit

In [ ]:
```
# drill bit

sec=circle(7.5,s=100)

path=pts([[-7.49*cos(360/200*pi/180),0],[7.5,5],[0,70]])
sol=prism(sec,path)
hx1=helix(7.5,20,2,5)
hx2=rot('z180',hx1)
```

```
fileopen(f'''

//    render(){{

difference(){{
   color("orange"){swp(sol)}
   color("cyan")p_line3d({hx1},4.5,$fn=70);
   color("cyan")p_line3d({hx2},4.5,$fn=70);

   }}
//   }}
    ''')
```

bottle-with-cut-design

psos

reorient_sec

prism2cpo

In [ ]:
```
# example use of function psos (project a surface on to another without loosing the original points)
it=time.time()
# designing bottle with cut design
sec=circle(10,s=100)
path=corner_radius(pts1([[-3,0],[3,0,3],[3,5,7],[-5,20,100],
                        [8,30,20],[-11,10,5],[0,10,0]]),30)
path=equidistant_path(path,100)
sol=prism(sec,path)

sec1=corner_radius(pts1([[-7.5,10,3],[15,0,3],[0,20,30],
                        [-3,20,30],[0,10,4.4],[-9,0,4.4],
                        [0,-10,30],[-3,-20,30]]),10)

sec1=equidistant_pathc(sec1,100)
sec1=reorient_sec(sec1)
path1=corner_radius(pts1([[1,0],[-1,0,1],[-1,2,2],[-2,0]]),10)
path1=equidistant_path(path1,10)
surf1=prism2cpo(prism(sec1,path1))
s1=[equidistant_path(p,100) for p in surf1]
p1=rot('y90',path)
s1=[wrap_around(p,p1)  for p in s1]
s1=translate([0,10,0],rot('z-90',s1))
p2=rot('y90',circle(10,s=200))
s1=[wrap_around(p,p2) for p in s1]
s1=rot('y-90z30',s1)
sol=psos(s1,sol,[0,-1,0])
s1=rot('z120',s1)
v1=rot('z120',[0,-1,0])
sol=psos(s1,sol,v1)
s1=rot('z120',s1)
v1=rot('z240',[0,-1,0])
sol=psos(s1,sol,v1)
sol1=[offset_3d(p,-.5) for p in sol]
bottle=sol+flip(sol1)[:-16]
bottle=smoothening_by_subdivison_surf(bottle,2,[1,0])
fileopen(f'''
{swp(bottle)}

    ''')

ft=time.time()
ft-it
```

example-of-rounding

In [ ]:
```
# m37 rounded
i_t=time.time()
sec=[[i,3*sin(i*18*pi/180)] for i in arange(-20,20,.5)]

path=[[i,0,20+3*sin(i*12*pi/180)] for i in arange(-30,30,.5)]

surf=surf_extrude(sec,path)
surf1=surf_base(surf,-1)
sec1=corner_radius(pts1([[0,0,2],[20,0,2],[0,20,2]]),40)
sec1=equidistant_pathc(sec1,200)
l1=plos(surf,c23(sec1),[0,0,1])
l2=plos(surf,c23(offset(sec1,-1)),[0,0,1])
l3=translate([0,0,-1],l1)
f1=cpo(convert_3lines2fillet(l3,l2,l1,s=20))[:-1]
l4=offset(sec1,-1)
sol=linear_extrude(l4,25)
sol1=c23([l4,sec1])+f1+[c23(l4)]
fileopen(f'''

intersection(){{
{swp(surf1)}
{swp(sol)}
}}
{swp_c(sol1)}

    ''')
f_t=time.time()
f_t-i_t
```

m39

In [ ]:

```
# m39
i_t=time.time()
c1=circle(10,[-35,0])
c2=circle(10,[35,0])
c3=circle(10,[0,44.06])
l1=rot2d(16.5,[[0,0],[10,0]])
l2=rot2d(-16.5+180,[[0,0],[10,0]])
l1=cir_line_tangent(c1,l1)
l2=cir_line_tangent(c2,l2,1)
f1=fillet_intersection_lines(l1,l2,30)
l3=cir_line_tangent(c2,[[0,0],[0,10]])
p0=[45,35]
p1=p_cir_t(p0,c3)
l4=[p0,p1]
f2=fillet_intersection_lines(l3,l4,10)
p3=[-45,35]
p2=cir_p_t(c3,p3)
l5=[p2,p3]
l6=cir_line_tangent(c1,[[0,0],[0,10]],1)
f3=fillet_intersection_lines(l5,l6,10)
l1o=path_offset(l1,-2.5)
l2o=path_offset(l2,2.5)
l3o=path_offset(l3,-2.5)
l4o=path_offset(l4,-2.5)
l5o=path_offset(l5,-2.5)
l6o=path_offset(l6,2.5)
f4=fillet_line_circle(l1o,c1,2.5)
f5=fillet_intersection_lines(l1o,l2o,32.5)
f6=fillet_line_circle(l2o,c2,2.5,2)
f7=fillet_line_circle(l3o,c2,2.5)
f8=fillet_intersection_lines(l3o,flip(l4o),7.5)
f9=fillet_line_circle(l4o,c3,2.5,3)
f10=fillet_line_circle(l5o,c3,2.5)
f11=fillet_intersection_lines(l5o,l6o,7.5)
f12=fillet_line_circle(l6o,c1,2.5,2)

sec_outer=trim_sec_ip(c1,l6[0],l1[0])+f1+trim_sec_ip(c2,l2[0],l3[0])+f2 \
+trim_sec_ip(c3,l4[-1],l5[0])+f3

sec_inner=flip(f12)+flip(trim_sec_ip(c1,f12[0],f4[0],1))+f4+f5+flip(f6)+ \
flip(trim_sec_ip(c2,f6[0],f7[0],1))+f7+f8+flip(f9)+flip(trim_sec_ip(c3,f9[0],f10[0],1)) \
+f10+f11
sec_inner=remove_duplicates(sec_inner)

sol1=linear_extrude(sec_outer,15)
path1=cr2dt([[-1.25,2.5],[1.25,0,1.25],[0,12.5,1.25],[1.25,0],[0,.1]],10)
sol2=prism(sec_inner,path1)
e1=end_cap(sol1,1.25)
sol3=linear_extrude(offset(c1,-2.5),15)
sol4=linear_extrude(offset(c2,-2.5),15)
sol5=linear_extrude(offset(c3,-2.5),15)
e2=end_cap_1(sol3,.5,s=2)
e3=end_cap_1(sol4,.5,s=2)
e4=end_cap_1(sol5,.5,s=2)

fileopen(f'''
//color("blue")for(p={[c1,c2,c3,l1,l2,l3,l4,l5,l6,f1,f2,f3]}) p_line3d(p,.3);
//color("magenta") for(p={[l1o,l2o,l3o,l4o,l5o,l6o,f4,f5,f6,f7,f8,f9,f10,f11,f12]}) p_line3d(p,.3);
//color("cyan")p_line3d({sec_outer},.5);
//color("cyan") p_line3d({sec_inner},.5);

difference(){{
{swp(sol1)}
{swp(sol2)}
for(p={e1})swp_c(p);
{swp(sol3)}
{swp(sol4)}
```

```
{swp(sol5)}
for(p={e2})swp(p);
for(p={e3})swp(p);
for(p={e4})swp(p);

}}
''')
f_t=time.time()
f_t-i_t
```

cylinder-with-rectangular-pocket

In [ ]:
```
# cylinder with rectangular pocket
c1=circle(20,s=100)
sol1=linear_extrude(c1,80)
sol2=linear_extrude(offset(c1,-2),80)
sec=homogenise(cr2dt([[-15/2,-25/2,2],[15,0,2],[0,25,2],[-15,0,2]],10),.5,1)
sol3=o_solid([1,0,0],sec,30,0,0,40)
e1=end_cap(sol1,1)
e2=end_cap_1(sol2,1)
l1,l2=ip(sol1,sol3),ip(sol2,sol3)
l3,l4,l5=mid_line(l1,l2),o_3d(l1,sol1,-1),o_3d(l2,sol2,-1)
sol4=flip(lines_fillets_solid(l5,l2,l3,l1,l4,o=-1))
sol4=sol4+[sol4[0]]
fileopen(f'''
//color("blue") for(p={[l1,l2,l3,l4,l5]}) p_line3d(p,.2);
difference(){{
{swp(sol1)}
{swp(sol2)}
{swp(sol3)}
for(p={e1})swp_c(p);
for(p={e2})swp(p);
{swp_c(sol4)}
}}
''')
```

cylinder-with-star-pocket

In [ ]:
```
# cylinder with star pocket

t=2 # thickness
n=100 # number of segments of circle
s=5 # number of sides of the star
d=20 # outer diameter of the star
# h=50 # height of the star prism
c1=circle(d,s=(s+1))
c2=c3t2(rot(f"z{360/(s+1)/2}",circle(d/4,s=(s+1))))
sec=l_(concatenate(cpo([c1,c2])))
r_l1=[1]*5
r_l2=[3]*5
r_l=l_(concatenate(cpo([r_l1,r_l2])))
sec=corner_n_radius_list(sec,r_l,10)
sec=homogenise(sec,.25,1)
c1=circle(20)
```

```
sol1=linear_extrude(c1,80)
sol2=linear_extrude(offset(c1,-t),80)
sol3=o_solid([1,0,0],sec,40,0,0,40)
e1=end_cap(sol1,t/2)
e2=end_cap_1(sol2,t/2)
l1,l2=ip(sol1,sol3),ip(sol2,sol3)
l3,l4,l5=mid_line(l1,l2),o_3d(l1,sol1,-t/2),o_3d(l2,sol2,-t/2)
sol4=lines_fillets_solid(l4,l1,l3,l2,l5,o=t/2)
sol4=sol4+[sol4[0]]
fileopen(f'''
//color("blue") for(p={[l1,l2,l3,l4,l5]}) p_line3d(p,.2);

difference(){{
{swp(sol1)}
{swp(sol2)}
{swp(sol3)}
for(p={e1}) swp_c(p);
for(p={e2}) swp(p);
{swp_c(sol4)}
}}
''')
```

lamp

In [ ]:
```
# lamp

n=20 #number of strands in the lamp
t=5 # thickness of each strand
path=[[42,0],[62,50],[25,100],[25,180]]

path1=cytz(bezier(path,100))

path2=[axis_rot([0,0,1],path1[i],i/(len(path1)-1)*(180+1.8)) for i in range(len(path1)-1)]

sol=[]
for i in range(len(path2)):
    theta=ang(path2[i][0],path2[i][1])
    sol.append(translate(path2[i],rot(f'z{theta}', \
            offset(square(t,center=True),i/len(path2)*-1.5))))
sol=rot('z0',sol)

c1=circle(45)
c2=circle(30)


fileopen(f'''

for(i=[0:360/{n}:359])
rotate([0,0,i])
{{
{swp(sol)}
//p_line3d({path2},.5);
mirror([0,1,0])
{swp(sol)}
//p_line3d({path2},.5);

}}
linear_extrude(2)
difference()
{{
polygon({c1});
polygon({c2});
```

```
}}
''')
```

samsung-tab-s6-holder

In [ ]:
```
# samsung tab s6 holder to hang in car back seat

sec=corner_radius(pts1([[0,0,.1],[124,0,3],[27*cos(45*pi/180),27*sin(45*pi/180),1],
             [15*cos(135*pi/180),15*sin(135*pi/180),1],
             [5*cos((180+45)*pi/180),5*sin((180+45)*pi/180),1],
             [10*cos(-45*pi/180),10*sin(-45*pi/180),1],
             [17*cos((180+45)*pi/180),17*sin((180+45)*pi/180),1],
             [10*cos(135*pi/180),10*sin(135*pi/180),1],
             [8*cos(225*pi/180),8*sin(225*pi/180),1],[20*cos(135*pi/180),20*sin(135*pi/180),1],
             [8*cos(45*pi/180),8*sin(45*pi/180),1],
             [105*cos(135*pi/180),105*sin(135*pi/180),1],
             [8*cos(225*pi/180),8*sin(225*pi/180),1],
             [20*cos(135*pi/180),20*sin(135*pi/180),1],
             [8*cos(45*pi/180),8*sin(45*pi/180),1],[10*cos(135*pi/180),10*sin(135*pi/180),1],
             [17*cos(45*pi/180),17*sin(45*pi/180),1],[10*cos(-45*pi/180),10*sin(-45*pi/180),1],
             [5*cos(45*pi/180),5*sin(45*pi/180),1],[15*cos(135*pi/180),15*sin(135*pi/180),1],
             [21*cos(225*pi/180),21*sin(225*pi/180),1],[0,30,2],[-4,0,1]]),10)


sec1=corner_radius(pts1([[0,0,2],[17,0,2],[0,85,2],[-17,17,2]]),5)
path1=[[0,0],[0,6]]
sol=translate([123.5,7.7,30],rot("x90z45",prism(sec1,path1)))

sol1=translate([5,129,130],rot("x90z45",prism(sec1,path1)))

sec2=corner_radius(pts1([[0,0,4],[10,0,4],[0,40,4],[-10,0,4]]),5)
path2=[[0,0],[0,8]]
sol2=translate([-0.25,140,40],rot("x90z90",prism(sec2,path2)))

sol3=translate([-0.25,140,170],rot("x90z90",prism(sec2,path2)))

sec4=corner_radius(pts1([[0,0,0],[15,0,5],[0,90,5],[-15,0,0]]),5)
path4=[[0,0],[0,3]]
sol4=translate([90,35,0],rot("z45",prism(sec4,path4)))

sec5=corner_radius(pts1([[0,0],[120,0,0],[32*cos(135*pi/180),32*sin(135*pi/180),1],
              [8*cos(45*pi/180),8*sin(45*pi/180),1],
              [105*cos(135*pi/180),105*sin(135*pi/180),1],[8*cos(225*pi/180),8*sin(225*pi/180),1],
              [33*cos(135*pi/180),33*sin(135*pi/180),0]]),5)

sec6=corner_radius(pts1([[0,0,5],[90,0,5],[0,110,5],[-90,90,5]]),5)
path6=[[0,0],[0,7]]

sol6=translate([15,6,25],rot("x90",prism(sec6,path6)));
sol7=translate([-1,15,25],rot("x90z90",prism(sec6,path6)));
sol8=translate([94,30,25],rot("x90z135",prism(sec6,path6)));

fileopen(f'''

rotate([90,0,0])
{{
difference(){{
difference(){{
linear_extrude(250)
polygon({sec});

translate([0,0,-.05])
linear_extrude(250.1)
```

```
polygon({offset(sec,-4.5,2)});
}}

//color("blue")
{swp(sol)}
//color("blue")
{swp(sol1)}
//color("blue")
{swp(sol2)}
//color("blue")
{swp(sol3)}
//color("blue")
{swp(sol6)}
//color("blue")
{swp(sol7)}
//color("blue")
{swp(sol8)}
}}

//color("magenta")
{swp(sol4)}
}}
''')
```

business-card-holder

In [ ]:

```
# business card holder

sec=corner_radius(pts1([[0,0,1],[95,0,1],[0,10,1],[-95,0,1]]),10)

sol2=linear_extrude(offset(sec,1),1);

sec1=corner_radius(pts1([[10,0,5],[50,0,5],[10,30],[-70,0]]),10);

sol3=translate([12.5,2,21],rot("x90",linear_extrude(sec1,5)));

# difference(){
# union(){
# sol4=swp_prism_h(prism1,prism)
# swp(prism2);}
# swp(prism3);}


fileopen(f'''

render(){{
difference(){{
linear_extrude(50)
difference(){{
polygon({offset(sec,1)});
polygon({sec});
}}

{swp(sol3)}
}}
{swp(sol2)}
}}
''')
```

m10

In [ ]:
```
t0=time.time()
c1=circle(17.5)
c2=circle(7.5,[14.5,0])
c3=circle(7.5,[-14.5,0])
sec1=c_hull(c1+c2+c3)
c4=circle(3,[14.5,0])
c5=circle(3,[-14.5,0])
c6=circle(10)
c7=circle(6.5)
path=corner_radius3d_with_turtle([[0,0,-0.01],[0,0,29,17.5],[-44,0,0]],30)
c8=circle(19.5)
c9,c10,c11,c12=[rot2d(i,circle(2.5,[15,0])) for i in [0,90,180,270]]
s1=linear_extrude(sec1,5.5)
s2,s3=[translate([0,0,0],linear_extrude(p,5.5)) for p in [c4,c5]]
s4=align_sol_1(path_extrude_open(c6,path))
s5=linear_extrude(c8,4)
s6,s7,s8,s9=[translate([0,0,0], linear_extrude(p,4)) for p in [c9,c10,c11,c12]]
s5,s6,s7,s8,s9=[translate(a_(path[-1])+[4.01,0,0], sol2vector([-1,0,0],flip(p))) for p in [s5,s6,s7,s8,s9]]
s10=align_sol_1(path_extrude_open(circle(6.5),path))
s11=swp_prism_h(s4,s10)
l1=i_p_p(s4,s4[0],5.5)
l2=offset_3d(l1,1.25)
l3=i_p_p(s4,s4[0],5.5+1.25)
f1=convert_3lines2fillet_closed(l2,l3,l1)

l4=i_p_p(s4,s4[-1],-4)
l5=offset_3d(l4,1.25)
l6=i_p_p(s4,s4[-1],-4-1.25)
f2=convert_3lines2fillet_closed(l6,l5,l4)
e1=end_cap(s1,1.25)
e2=end_cap(s5,1.25)
e3=end_cap_1(s2,.5)
e4=end_cap_1(s3,.5)
e5,e6,e7,e8=[ end_cap_1(p,.5)  for p in [s6,s7,s8,s9]]
e9=end_cap_1(s10,1.25)
ey=l_(concatenate([e3,e4,e5,e6,e7,e8,e9]))
fileopen(f'''

//color("blue")for(p={[l4,l5,l6]})p_line3dc(p,.2);
difference(){{
for(p={[s1,s5]})swp(p);
for(p={[s2,s3]})swp(p);
{swp(s4)}
for(p={[s6,s7,s8,s9]})swp(p);
for(p={e1})swp_c(p);
for(p={e2})swp_c(p);
for(p={ey})swp(p);

}}
difference(){{
{swp_c(s11)}
for(p={e9})swp(p);
}}
{swp_c(f1)}
{swp_c(f2)}
''')
t1=time.time()
t1-t0
```

m35

In [ ]:
```
# m35
t0=time.time()

p0=[15,0]
p1=[15,45]
cir1=circle(7.5,[0,75-7.5])
p2=p_cir_t(p1,cir1)
p4=[-15,45]
p3=cir_p_t(cir1,p4)
arc1=arc_2p(p2,p3,7.5,-1,45)
p5=[-15,0]
p0,p1,arc1,p4,p5=[[15,0,0]],[[15,45,20]],c2t3(arc1),[[-15,45,20]],[[-15,0,0]]
sec=corner_radius(p0+p1+arc1+p4+p5,10)
sec=translate([0,.1,0],sec)

path=corner_radius(pts1([[0,0],[45,0,7],[45*cos(d2r(30)),45*sin(d2r(30))]]),50)
path=rot('x90z90',path)

surf0=wrap_around(sec,path)
surf1=sec2surface_1(surf0)
surf2=surface_offset(surf1,4)
sol=solid_from_2surfaces(surf1,surf2)
sol=translate([0,0,9],rot('z-90',sol))

sec2=translate([0,0,-2],linear_extrude(circle(3.75,[0,75-7.5]),6.1))
surf3=[ wrap_around(p,path) for p in sec2]

sol1=flip(translate([0,0,9],rot('z-90',surf3)))

path1=cytz(pts([[0,9],[25.5+19.5,0],[(30-7.5)*cos(45*pi/180),(30-7.5)*sin(45*pi/180)]]))
# sec1=c2t3(m_points_o(pts([[-15,0],[30,0],[0,5],[-30,0]]),1))

sec3=[[-30,-15]]+arc_2p([0,-15],[0,15],15,-1,20)+[[-30,15]]
p6=l_cir_ip([[-30,-15+10.5],[0,-15+10.5]],circle(7.5))
p7=l_cir_ip([[-30,15-10.5],[0,15-10.5]],circle(7.5))
sec4=[[-30,-15+10.5]]+arc_long_2p(p6[0],p7[0],7.5,-1,30)+[[-30,15-10.5]]

sec5=circle(6)
path2=corner_radius(pts1([[0,-15.1],[0,4.6],[-3,0],[0,21],[3,0],[0,4.6]]),5)
sol2=translate([-30+12,0,11.25],rot('x-90',prism(sec5,path2)))


sec6=[[25.5+9,-15.1]]+arc_2p([25.5+9,0],[25.5,0],4.5,-1)+[[25.5,-15.1]]
txt1=dim_linear(translate([0,0,9],[sec6[-1],sec6[0]]),3)
txt2=dim_linear(point_vector(translate([0,0,9],sec6[-1]),[0,0,4]),-2)
txt3=dim_radial(translate([0,0,22.5],sec4[10:-1]))
txt4=dim_linear(translate([0,0,22.5],[sec4[-1],sec4[0]]),2)
txt5=dim_radial(sol1[0][10:])
txt6=dim_radial(sol2[0])
txt7=dim_radial(sol2[2])
txt8=dim_radial(translate([0,0,22.5],sec3[12:-1]),outside=1)
txt9=dim_linear(translate([0,0,22.5],[sec3[-1],sec3[0]]),10)
l1=translate([0,-20,9],rot('z-90',path))[:2]
l2=translate([0,-20,9],rot('z-90',path))[-2:]

txt10=dim_angular(l1,l2)
txt11=dim_radial(translate([0,0,13],sec6[1:-1]))
txt12=dim_linear(translate([0,0,13],mid_line(flip(sec6[:2]),sec6[-2:])))
txt13=dim_linear(point_vector(c23(sec3[0]),[0,0,22.5]),6)
txt14=dim_radial(translate([0,0,9],rot('z-90',surf0[20:30])),outside=1)
txt15=dim_radial(translate([0,0,9],rot('z-90',surf0[1:10])),outside=1)
l1=translate([0,0,22.5],[sec4[-1],sec4[0]])
p0=center_arc3d(translate([0,0,22.5],sec4[1:-1]))
p1=vcost1(l1,p0)
txt16=dim_linear([p0,p1],0)
p0=center_arc3d(sol2[0])
l1=c23(sec3[:2])
p1=vcost1(l1,p0)
txt17=dim_linear(translate([0,-2,0],[p1,p0]),0)

l1=point_vector(c23(sec3[-1]),[0,0,22.5])
p0=center_arc3d(sol2[-1])
p1=vcost1(l1,p0)
txt18=dim_linear([p0,p1],2)

l1=cpo(sol2)[0][-2:]
txt19=dim_linear(l1,-5)
fileopen(f'''

//color("cyan")for(p={[l1]})p_line3d(p,.3);
```

```
//color("cyan")points({[p0,p1]},.5);
{txt1}{txt2}{txt3}{txt4}{txt5}{txt6}{txt7}{txt8}{txt9}{txt10}{txt11}{txt12}
{txt13}{txt14}{txt15}{txt16}{txt17}{txt18}{txt19}
%
difference(){{
{swp(sol)}
linear_extrude(22.5)polygon({sec4});
{swp(flip(sol1))}
linear_extrude(22.5)polygon({sec6});
}}
%
difference(){{
linear_extrude(22.5)
difference(){{
polygon({sec3});
polygon({sec4});
}}
{swp(sol2)}
}}


''')
t1=time.time()
t1-t0
```

l_cir_ip

In [ ]:
```
# example of function l_cir_ip(line, cir)
p0=[-30,-15+10.5]
p1=[0,-15+10.5+10]
line=[p0,p1]
cir=circle(7.5)
p2=l_cir_ip(line,cir)

fileopen(f'''


%p_line({cir},.1);
%p_line({[p0,p1]},.1);
color("magenta")points({[p0,p1]},.5);
color("cyan")points({[p2[0]]},.5);
color("blue")points({[p2[1]]},.5);

''')
```

fillet_line_circle

In [ ]:
```
# example of fillet_line_circle(l1, c1, r,o=1, s=10)

line=[[0,0],[0,60]]
cir1=circle(10,[-10,30])
cir2=circle(5,[-10,30])
fillet1=flip(fillet_line_circle(line,cir1,4.5,3,10))
fillet2=fillet_line_circle(line,cir1,4.5,1,10)
a,b=[fillet1[-1],fillet2[0]]
a1=lineFromPointToPointOnLine(flip(cir1),a,b,1)
sec1=remove_extra_points([[-45,0],[0,0]]+fillet1+a1+fillet2+[[0,60],[-45,60]])
sec2=remove_extra_points([[45,60],[0,60]]+flip(fillet2)+flip(a1)+flip(fillet1)+[[0,0],[45,0]])
sol1=linear_extrude(sec1,10)
sol2=translate([0,0,.001],linear_extrude(sec2,10))
sol3=translate([0,0,-1],linear_extrude(cir2,12))


fileopen(f'''

{swp(sol1)}

color("cyan")
difference(){{
{swp(sol2)}
{swp(sol3)}
}}

''')
```

In [ ]:
```
# example of fillet_line_circle(l1, c1, r, o=1, s=10)
h=15
line=[[-10,h],[30,h]]
cir1=circle(10,[10,10])
```

```
r2=5
s=20
fillet1=fillet_line_circle(line,cir1,r2,1)
fillet2=fillet_line_circle(line,cir1,r2,2)
fillet3=fillet_line_circle(line,cir1,r2,3)
fillet4=fillet_line_circle(line,cir1,r2,4)
fillet5=fillet_line_circle_internal(line,cir1,1,1)
fillet6=fillet_line_circle_internal(line,cir1,r2,2)
fillet7=fillet_line_circle_internal(line,cir1,1,3)
fillet8=fillet_line_circle_internal(line,cir1,r2,4)


fileopen(f'''


color("blue",.1)p_line({line},.3);
color("violet",.2)p_line({cir1},.3);
color("cyan")p_lineo({fillet1},.3);
color("blue")p_lineo({fillet2},.3);
color("magenta")p_lineo({fillet3},.3);
color("green")p_lineo({fillet4},.3);
color("blue")p_lineo({fillet5},.3);
color("magenta")p_lineo({fillet6},.3);
color("cyan")p_lineo({fillet7},.3);
color("green")p_lineo({fillet8},.3);

''')
l_(a_([radius_arc2d(fillet1),
radius_arc2d(fillet2),
radius_arc2d(fillet3),
radius_arc2d(fillet4),
radius_arc2d(fillet5),
radius_arc2d(fillet6),
radius_arc2d(fillet7),
radius_arc2d(fillet8)]).round(3))
```

equidistant_pathc

In [ ]:
```
a=circle(5,s=200)

fileopen(f'''

points({a},.2);
color("blue")points({equidistant_pathc(a,20)},.2);


''')
```

artifact

oset

In [ ]:
```
# it takes around 200 sec for calculations


t0=time.time()

stages =200

stage_height = 1.25

rad = 50

f1 = 25

f2 = 25

phase1 = 0

phase2 = 180

height_depth=5

depth1 = 20

depth2 = 20

thickness = 1

bottom_thickness = 3

myslices = 5

angle_step=.5

var=1

def pauw(x,p):
    return sign(x)*abs(x)**p

def f(i,stages):
    return sin(d2r(i/stages * 120))**2 * 7 + 1

def a(i,stages,var,height_depth):
    return (sin(d2r((i/stages*360*f(i,stages))%360)) * 0.5 + 0.5) * (var * height_depth)


# generate outer points

# points_base = [for (i = [0:1:stages])
#                let(f = sin(i/stages * 120)^2 * 7 + 1, var = 1 , a=((sin((i/stages*360*f)%360) * 0.5 + 0.5) * (var * height_depth)))
#                [for(j = [0:angle_step:360-angle_step])
#                 [sin(j) * (rad+a+(pauw(sin(j *f1+phase1),0.5)*0.5+0.5)*depth1*i/stages+(pauw(sin(j *f2+phase2),0.5)*0.5+0.5)*depth2*(1-i/stages)),
#                  cos(j) *(rad+a+(pauw(sin(j *f1+phase1),0.5)*0.5+0.5)*depth1*i/stages+(pauw(sin(j *f2+phase2),0.5)*0.5+0.5)*depth2*(1-i/stages)),
#                  i*stage_height]]]

points_base=[[
```

```
    [
        sin(d2r(j)) * (rad+a(i,stages,var,height_depth)+(pauw(sin(d2r(j *f1+phase1)),0.5)*0.5+0.5)*depth1*i/stages+(pauw(sin(d2r(j *f2+phase2)),0.5)*0.5+
        cos(d2r(j)) * (rad+a(i,stages,var,height_depth)+(pauw(sin(d2r(j *f1+phase1)),0.5)*0.5+0.5)*depth1*i/stages+(pauw(sin(d2r(j *f2+phase2)),0.5)*0.5+
        i*stage_height
    ]
    for j in arange(0,360,angle_step)] for i in range(stages+1)]


p1,p2=[],[]
for i in range(stages):
    points_base1= flip(c3t2(points_base[i]))#flip(c3t2(points_base[i])) if cw(c3t2(points_base[i]))==1 else c3t2(points_base[i])
    points_base2=oset(points_base1,-thickness)
    p1.append(translate([0,0,i*stage_height],points_base1))
    p2.append(translate([0,0,i*stage_height],points_base2))


p2=flip(p2)
l1,l2=p2[-5],p2[-3]
l3=translate([0,0,2.5],offset(c3t2(p1[2]),-7))
f1=cpo(convert_3lines2fillet(l1,l3,l2))[:-1]
sol=p1+p2[:-6]+f1
fileopen(f'''

{swp(sol)}

''')

t1=time.time()
t1-t0
```

wrap_around

In [ ]:

```
# example of function wrap_around(sec,path)
t0=time.time()

sec=corner_radius(pts1([[-10,0,2],[20,0,2],[0,15,5],[-10,10,1],[-10,-10,5]]),30)
sec_h_l=h_lines_sec(sec,500,.01)
path=cr3dt([[0,0,0,0],[0,15,0,1],[0,-4,5,1],[0,10,0,0]],50)

sec1=[wrap_around(p,path) for p in sec_h_l]
sec2=surface_offset(sec1,-.5)
sol1=flip(solid_from_2surfaces(sec1,sec2))

sol2=o_solid([0,1,0],circle(1),40,0,0,3.5)
fileopen(f'''

difference(){{
{swp(sol1)}
//{swp(sol2)}
}}
''')
t1=time.time()
t1-t0
```

In [ ]:
```
# example of function wrap_around(sec,path) work flow

sec=equidistant_pathc(corner_radius(pts1([[-10,0.1,1],[20,0,1],[0,15,1],[-10,10,2],[-10,-10,1]]),20),200)

path1=corner_radius(pts1([[0,0],[15,0,1],[-16,15]]),50)
path2=circle(5,s=200)
path3=corner_radius(pts1([[0,0],[5,0,1],[0,5,1],[3,0,1],[0,-5,1],[10,0]]),10)
path1=rot('x90z90',path1)
path2=rot('x90z90',path2)
path3=rot('x90z90',path3)

sec1=wrap_around(sec,path1)
sec2=wrap_around(sec,path2)
sec3=wrap_around(sec,path3)

path4=corner_radius(pts1([[6,2],[-6,0,1],[0,-2.001,1],[25,0]]),10)
path4=rot('x90z90',path4)

sec4=translate([0,9,0],rot('z-45',sec1))
sec4=wrap_around(sec4,path4)

sec5=translate([0,9,0],rot('z90',translate([0,-9,0],sec4)))
sec5=wrap_around(sec5,path4)

sec6=rot('z-45',translate([0,-9,0],sec5))


fileopen(f'''


translate([30,40,0]){{
p_line3d({path2},.1);
color("magenta")p_line3dc({sec2},.1);}}

translate([30,60,0]){{
p_line3d({path3},.1);
color("magenta")p_line3dc({sec3},.1);}}

color("blue")p_line3dc({sec},.1);
translate([0,30,0]){{
color("blue")p_line3d({path1},.1);
color("magenta")p_line3dc({sec1},.1);}}


translate([0,50,0]){{
color("blue")p_line3d({path4},.1);
color("magenta")p_line3dc({sec4},.1);}}

translate([0,80,0]){{
color("blue")p_line3d({path4},.1);
color("magenta")p_line3dc({sec5},.1);}}

translate([0,110,0]){{
//p_line3d({path4},.1);
color("magenta")p_line3dc({sec6},.1);}}

''')
```

In [ ]:
```
# wrap_around example 4
t0=time.time()

sec=corner_radius(pts1([[-10,0,2],[20,0,2],[0,15,5],[-10,10,1],[-10,-10,5]]),30)
sec1=h_lines_sec(sec,500,.01)
sec1=[equidistant_path(p,50) for p in sec1]

path1=corner_radius(pts1([[0,0],[15,0,1],[-16,15]]),50)
path1=rot('x90z90',path1)


sec1=[wrap_around(p,path1) for p in sec1]

path4=corner_radius(pts1([[7,5],[-7,-5,1],[45,0]]),10)
path4=rot('x90z90',path4)

sec2=translate([0,9,0],rot('z-45',sec1))
sec2=[wrap_around(p,path4) for p in sec2]

sec3=translate([0,9,0],rot('z90',translate([0,-9,0],sec2)))
sec3=[wrap_around(p,path4) for p in sec3]

sec3=rot('z-45',translate([0,-9,0],sec3))
sec4=surface_offset(sec3,-.5)
sol=solid_from_2surfaces(sec3,sec4)

fileopen(f'''

{swp(sol)}

''')
t1=time.time()
t1-t0
```

ball-bearing

In [ ]:
```
#  ball bearing

sec=corner_radius(pts1([[31,.5,0],[.5,-.5,0],[9.5,0,1],[0,15,1],[-9.5,0,0],[-.5,-.5,0]]),10)
sec1=corner_radius(pts1([[16,.5,0],[.5,-.5],[9,0,0],[0.5,.5,0],[0,14,0],[-.5,.5,0],[-9,0,0],[-.5,-.5,0]]),10)
sec2=circle(7,[28.5,7.5])
```

```
fileopen(f'''


rotate_extrude($fn=200)
difference(){{
union(){{
polygon({sec});
polygon({sec1});
}}
polygon({sec2});
}}

for(i=[0:360/12:359])
rotate([0,0,i])
translate([28.5,0,7.5])
sphere(6.8,$fn=100);

''')
```

mobile-phone-stand

In [ ]:

```
t0=time.time()
sec=pts([[0,0],[120,0],[0,4.1],rot2d(120,[7,0]),rot2d(210,[4.1,0]),
        rot2d(300,[4.7,0]),[-21.8,0],rot2d(120,[50,0]),
        rot2d(210,[4.1,0]),rot2d(300,[47.7,0]),[-88.7,0]])
r_l=[2,3,4,2,2,1,6,2,2,3,1.9]
sec1=corner_n_radius_list(sec,r_l,10)

p1=arc_2p([0,0],[150,0],350,s=20)
p2=rot('x60z90',p1)
p3=rot('z90',p1)
s1=sec1[33:55]
t=array(s1[0])
s1=translate(cytz([t])[0],path_extrude_open(translate_2d(-t,s1),p2))
s2=sec1[77:99]
t=array(s2[0])
s2=translate(cytz([t])[0],path_extrude_open(translate_2d(-t,s2),p2))

s3=sec1[110:]+sec1[:11]
s3=path_extrude_open(s3,p3)
s4=rot('x90',sec1[11:33])
s4=slice_sol(surface_line_vector(s4,[0,150,0]),20)

s5=rot('x90',sec1[55:77])
s5=slice_sol(surface_line_vector(s5,[0,150,0]),20)

s6=rot('x90',sec1[99:110])
s6=slice_sol(surface_line_vector(s6,[0,150,0]),20)

# now join all the surfaces together
# orientation of the surfaces needs to be changed
surf1=cpo(flip(cpo(s3))+cpo(s4)+flip(cpo(s1))+cpo(s5)+flip(cpo(s2))+cpo(s6))
l1=ppplane(surf1[0],[0,1,0],[0,0,0])
l2=offset_3d(l1,-1.8,1)
l3=i_p_p(surf1,surf1[0],2)
f1=cpo(convert_3lines2fillet(l2,l3,l1))[:-1]
f2=flip(mirror_surface(f1,[0,1,0],[0,75,0]))
# now create the solid with final shape
sol1=flip(f1+surf1[1:-1]+f2)
# radiuses can be now increased as desired
# That's it
fileopen(f'''

{swp(sol1)}

    ''')

t1=time.time()
t1-t0
```

In [ ]:
```
#  car mobile stand
sec=corner_radius(pts1([[-160/2-4,-15/2-4,23/2-.1],[160+2*4,0,23/2-.1],[0,15+2*4,23/2-.1],[-160-2*4,0,23/2-.1]]),10)
sol=o_solid([0,1,sqrt(3)],sec,60)
sol1=surface_offset(sol,4)
sol2=swp_prism_h(sol,sol1)
surf1=translate([0,0,10],plane([0,0,1],200))
ip1=ip_sol2sol(surf1,sol,0)
surf2=ip1[:22]+translate([0,100,0],ip1[22:44])
surf3=translate([0,0,-4],surf2)
sol3=[surf3]+[surf2]
sol4=o_solid([0,0,1],square(200,center=True),20,-10)

sec1=corner_radius(pts1([[-130/2,0],[130,0],[5,60],[-130-2*5,0]]),10)
sol5=o_solid([0,-sqrt(3),1],sec1,10,5,0,10)

sol6=[ip1[22:]]+[translate([0,2,0],ip1[22:])]+[translate([0,1,sqrt(3)],ip1[22:])]
fillet1=convert_3lines2fillet(translate([0,5,0],ip1[22:]),translate([0,2.4,4.34],ip1[22:]),ip1[22:])
fileopen(f'''
difference(){{
{swp_c(sol2)}
{swp(sol4)}
{swp(sol5)}
}}
//%{swp(surf1)}
//color("magenta")points({ip1[:22]},.5);
{swp(sol3)}
{swp(fillet1)}
''')
```

back-camera-clamp

In [ ]:
```
# back camera clamp

sec=corner_radius(pts1([[-37/2,0.1,3],[37,0,3],[0,15,2],[-5,24,13.5],[-27,0,13.5],[-5,-24,2]]),20)
l1=h_lines_sec(sec,120)

path=corner_radius(pts1([[0,0],[15,0,3.5],[15,41.21]]),10)
path=rot('x90z90',path)

l2=[wrap_around(p,path) for p in l1]
l3=surface_offset(l2,2)

sol=solid_from_2surfaces(l2,l3)
sol1=translate([0,0,-3],linear_extrude(circle(9,[0,28],s=100),10))
sol1=[wrap_around(p,path) for p in sol1]

slit=rot('x70',translate([-.5,15,-17],linear_extrude(square([1,20]),10)))
cyl1=cylinder(d=4,h=5)
# creating fillet
l1=surface2sec(l2)[0]
l2=surface2sec(l3)[0]
l3=mid_line(l1,l2)
l4,l5=surface_offset([l1,l2])
s1=[interpolation_bspline_open(p,20,2) for p in cpo([l4,l3,l5])]
s2=surface_offset(s1,2)
sol2=solid_from_2surfaces(s1,s2)
sol2=sol2+[sol2[0]]
fileopen(f'''

//color("blue")for(p={[l1,l2,l3,l4,l5]})p_line3dc(p,.2,1);

difference(){{
{swp(sol)}
{swp(sol1)}
{swp(slit)}
{swp_c(sol2)}
for(i=[-27/2,27/2])
translate([i,5,-2])
{swp(cyl1)}
}}

''')
```

align_sol

In [ ]:
```
# example of function align_sol(sol,angl)

sqr1=circle(5,s=5)
pent1=circle(5,s=6)

sqr1=c2t3(sort_points(pent1,sqr1))
pent1=translate([0,0,10],pent1)
sol=[sqr1]+[pent1]
sol=align_sol(sol,1)
sol1=slice_sol(sol,100)

fileopen(f'''


{swp(sol1)}
color("blue")p_line3dc({sol[0]},.05);
color("blue")p_line3dc({sol[1]},.05);

''')
```

In [ ]:
```
# example of function align_sol(sol,angl)


sqr1=c2t3(equidistant_pathc(circle(5,s=5),200)[:200])
pent1=equidistant_pathc(circle(5,s=6),200)[:200]
pent1=translate([0,0,10],pent1)
sol=[sqr1]+[pent1]
sol=align_sol_1(sol)
sol1=slice_sol(sol,10)


fileopen(f'''


{swp(sol1)}
color("blue")p_line3dc({sol[0]},.05);
color("blue")p_line3dc({sol[1]},.05);
''')
```

In [ ]:
```
sqr1=circle(5,s=5)
pent1=circle(5,s=6)

sqr1,pent1=c2t3(equate_points(sqr1,pent1))
pent1=translate([0,0,10],rot('y-30',pent1))
sol=[sqr1]+[pent1]
sol=align_sol(sol,.1)
sol1=slice_sol(sol,100)

fileopen(f'''


{swp(sol1)}
color("blue")p_line3dc({sol[0]},.05);
color("blue")p_line3dc({sol[1]},.05);
color("magenta")p_line3dc({pent1},.05);


''')
```

In [ ]:
```
# example of function align_sol(sol, ang=10)
t0=time.time()

path=cr3dt([[0,0,0,3],[15,0,0,4],[5,3,15,3],[0,10,0,3],[-5,3,-15,4],[-15,0,0,3]],10)
sec=pts([[-1.5,-1.25],[3,0],[-1.5,2.5]])
sol=path_extrude_closed(sec,path,twist=1)
sol=align_sol(sol,1)

# sol=slice_sol_1(sol,200)
fileopen(f'''

//color("blue")for(p={sol})p_line3dc(p,.1,1);
{swp_c(sol)}


''')
t1=time.time()
t1-t0
```

In [ ]:
```
# approach to align absolutely different shapes

sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),30)
sec1=scl2d_c(corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),10),.5)

sec2=c2t3(equidistant_pathc(sec,100))
sec3=translate([0,0,20],equidistant_pathc(sec1,100))
sol=[sec2,sec3]
sol=slice_sol(align_sol(sol),50)

t0=time.time()
fileopen(f'''

color("blue")p_line3dc({sol[0]},.2,1);
color("magenta")p_line3dc({sol[-1]},.2,1);
%difference(){{
{swp(sol)}

//cube(10);
}}
```

```
''')
t1=time.time()
t1-t0
```

align_sol_1

In [ ]:
```
# example of function align_sol_1(sol)

t0=time.time()

sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
cp1=array(sec).mean(0)


pent1=circle(7,s=6)
pent2=c3t2(rot(f'z{360/5/2}',circle(3.5,s=6)))
sec1=concatenate(cpo([pent1]+[pent2])).tolist()

sec=translate(-cp1,(equidistant_pathc(sec,200)))
sec1=translate([0,0,20],equidistant_pathc(sec1,200))
sol=slice_sol(align_sol_1([sec,sec1]),20)

fileopen(f'''


sec={sec};
sec1={sol[1]};
%{swp(sol)}
color("blue")points({sol[-1]},.1);
color("blue")points({sol[0]},.1);
//for(i=[0:len(sec)-1])translate(sec[i])linear_extrude(.1)text(str(i),.2);
//for(i=[0:len(sec1)-1])translate(sec1[i])linear_extrude(.1)text(str(i),.2);


''')

t1=time.time()
t1-t0
```

In [ ]:
```
# very fine merging of 2 very different shapes
t0=time.time()
sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
sec1=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),20)
sec1=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),30)

s1=translate([0,0,20],equidistant_pathc(sec,1000))
s2=c2t3(equidistant_pathc(sec1,1000))

s3=slice_sol(align_sol_1([s2]+[s1]),100)
```

```
fileopen(f'''


swp({s3});


''')
t1=time.time()
t1-t0
```

end_cap

In [ ]:
```
# example of function path_extrude_open and end_cap

i_t=time.time()
sec=corner_radius(pts1([[-1.5,-1.5,.5],[3,0,.5],[0,3,1.49],[-3,0,1.49]]),20)
path=rot('x-90',cr3dt([[0,0,0,0],[3,5,10,5],[17,-2,5,6],[1,-10,10,0]],20))
sol=rot('x90',path_extrude_open(sec,path))
sol=align_sol_1(sol)
# sol=slice_sol(sol,10)


e_cap=end_cap(sol,1,30)
f3=e_cap[0]
f4=e_cap[1]

fileopen(f'''


difference(){{
{swp(sol)}
{swp_c(f3)}
{swp_c(f4)}

}}

''')
f_t=time.time()
f_t-i_t
```

sec2vector

In [ ]:
```
# example of function sec2vector(v1,sec)
i_t=time.time()
sec=corner_radius(pts1([[-1.5,-1.5,.5],[3,0,.5],[0,3,.5],[-3,0,.5]]),10)
v1=[1,2,-1]
vector1=[[0,0,0],v1]
sec1=sec2vector(v1,sec)


fileopen(f'''

// original section
p_line3dc({sec},.05);

//aligned section in cyan color
color("cyan")p_line3dc({sec1},.05);

//vector with whom the section is expected to be aligned with in blue color
color("blue")p_line3d({vector1},.05);


''')
f_t=time.time()
f_t-i_t
```

cut_plane

In [ ]:
```
# example of function cut_plane(nv,radius,thickness,trns)

t0=time.time()

sec2=corner_radius(pts1([[-25,0],[10,5,5],[10,-3,10],[10,5,5],[10,-8,7],[10,1]]),10)
path2=cytz(corner_radius(pts1([[-35,5,0],[10,8,20],[20,-5,10],[20,8,20],[10,-9,20],[10,1,0]]),10))
surf2=path_extrude_open(sec2,path2)
surf3=flip(surface_thicken(surf2,-1))

fileopen(f'''


difference(){{
{swp(surf3)}
{swp(cut_plane([0,0,1],[100,100],10,14))}
}}

''')
t1=time.time()
total=t1-t0
total
```

In [ ]:
```
sec=[[0,0],[5,0],[0,5]]
path=[[0,0,0],[10,0,0],[5,10,5]]
sol=path_extrude_open(sec,path)
sol=align_sol_1(sol)
sol2=slice_sol(sol,10)
fileopen(f'''


difference(){{
{swp(sol2)}

//{swp(cut_plane([1,1,1],30,7,-3))}
}}
''')
```

slice_sol

In [ ]:
```
sec=turtle2d([[0,0],[5,0],[0,5],[-5,0]])
path=rot('x-90',[[3,0,0],[0,0,10],[10,0,15],[10,0,25]])
sol=rot('x90',path_extrude_open(sec,path))
# sol=align_sol(sol)
# sol2=slice_sol(sol,10)
txt1=dim_linear(sol[0][:2],2,1)
txt2=dim_linear(sol[0][1:3],2,1)

txt3=dim_linear(sol[1][:2],2,1)
txt4=dim_linear(sol[1][1:3],2,1)

txt5=dim_linear(sol[-1][:2],2,1)
txt6=dim_linear(sol[-1][1:3],2,1)

fileopen(f'''

//color("blue")p_line3dc({sol[0]},.1,1);
//color("blue")p_line3d({cytz(path)},.1,1);
//color("cyan")points({cytz(path)},.5);
{txt1}{txt2}{txt3}{txt4}{txt5}{txt6}
{swp(sol)}
//color("magenta")for(p={sol})p_line3dc(p,.1,1);
```

```
''')
```

In [ ]:
```
sec=corner_radius_with_turtle([[-2,-2,.55],[4,0,.55],[0,4,.55],[-4,0,.55]],10)
path=rot('x0',corner_radius3d_with_turtle([[3,0,0],[-7,5,10,4],[15,-5,7,4],[-3,15,2]],20))
sol=path_extrude_open(sec,path)
sol=align_sol(sol,1)
sol2=slice_sol(sol,5)
sol3=align_sol(path_extrude_open(offset(sec,-.5),path),1)
sol4=swp_prism_h(sol2,sol3)
e1=end_cap(sol2,.25)
e2=end_cap_1(sol3,.25)
fileopen(f'''

color("magenta")p_line3d({path},.1,rec=1);
difference(){{
{swp_c(sol4)}
for(p={e1})swp_c(p);
for(p={e2})swp(p);

}}
''')
```

o_solid

In [ ]:
```
# example of function o_solid(nv,sec,thickness,trns1,trns2,trns3)


# sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),30)
# sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,5],[-7,5,5]]),10)
sec=corner_radius(pts1([[-15,0,2.4],[0,15,3],[30,0,3],[0,-15,2.4],[5,0,2.4],[0,20,7],[-40,0,7],[0,-20,2.4]]),10)
# sec=corner_radius(pts1([[0,0,1],[10,0,1],[0,5,1],[-10,0,1]]),10)
# sec=circle(10)

sol=o_solid([1,0,0],sec,20,-10,0,0,theta=[0,0,0])
e1=end_cap(sol,2.5)
a1=sol[0][1:11]
txt1=dim_radial(a1,1,text_size=.5,outside=1)
fileopen(f'''

difference(){{
{swp(sol)}
for(p={e1})swp_c(p);
}}
color("blue")p_line({sec},.05);
```

```
{txt1}

''')
```

In [ ]:
```
t0=time.time()
sec=corner_radius(pts1([[-5,-5,1],[10,0,1],[0,10,1],[-10,0,1]]),5)
sec1=corner_radius(pts1([[-5,-5,1],[10,0,1],[0,10,1],[-10,0,1]]),5)

path=corner_radius(pts1([[-4,0],[4,0,1],[0,10,1],[-4,0]]),5)
# path=equidistant_path(path,100)
sol1=prism(sec,path)

sol2=o_solid([1,0,.1],circle(2,s=50),15,-7,0,10,[-90,0,0])


fileopen(f'''

{swp(sol1)}
{swp(sol2)}


    ''')
t1=time.time()
t1-t0
```

In [ ]:
```
#  example of defining normal vectors to a given vector 'v1'

v1=[1,1,sqrt(2)]
u1=v1/norm(v1)
ua=array([0,0,-1]) if u1[2]==0 else array([0,-1,0]) if (u1==[0,0,1]).all() else array([-1,0,0]) if (u1==[0,0,-1]).all() else array([u1[0],u1[1],0])
v2=cross(u1,ua)
u2=v2/norm(v2)
u3=array(axis_rot(u2,u1,-90))

u1,u2,u3=array([u1,u2,u3]).tolist()
fileopen(f'''



color("blue")p_line3d({[[0,0,0],u1]},.05);
color("magenta")p_line3d({[[0,0,0],u2]},.05);
color("cyan")p_line3d({[[0,0,0],u3]},.05);


''')
```

In [ ]:
```
fileopen(f'''


 cylinder (d=30,h=30); // hub.
  linear_extrude (height=30, twist=100, $fn=100)
     for (a=[0:120:359]) rotate (a) translate ([15,-1]) square ([45,2]);
```

```
''')
```

ppplane

In [ ]:
```
# points projected on a plane
t0=time.time()

p0=random.random([10,3])*(20-(-20))+(-20)
loc=[0,10,1]
v1=[2,3,4]

sec=pts([[-50/2,-50/2],[50,0],[0,50],[-50,0]])
plane1=translate(loc,o_solid(v1,sec,.001))


ip1=ppplane(p0,v1,loc)
lines1=array([p0,ip1]).transpose(1,0,2).tolist()

fileopen(f'''


//p_line({sec},.05);

color("cyan")p_line3dc({plane1[0]},.1);
 color("blue")points({p0.tolist()},.5);

 color("magenta")points({ip1},.5);

 for(p={lines1})p_line3d(p,.1);

''')
t1=time.time()
t1-t0
```

ppesec

In [ ]:
```
# points projected on an enclosed section in 3d space
t0=time.time()

p0=random.random([10,3])*(20-(-20))+(-20)
loc=[0,10,1]
v1=[2,3,4]

sec=pts([[-50/2,-50/2],[50,0],[0,50],[-50,0]])
plane1=translate(loc,o_solid(v1,sec,.001))


ip1=ppesec(p0,plane1[0])[0]
```

```
lines1=array(ppesec(p0,plane1[0])).transpose(1,0,2).tolist()

fileopen(f'''


//p_line({sec},.05);

color("cyan")p_line3dc({plane1[0]},.1);
 color("blue")points({p0.tolist()},.5);

 color("magenta")points({ip1},.5);
 for(p={lines1})p_line3d(p,.1);

''')
t1=time.time()
t1-t0
```

In [ ]:

```
# another example of points projected on an enclosed section in 3d space
t0=time.time()

p0=random.random([10,3])*(20-(-20))+(-20)
v1=[2,3,4]
sec=circle(10)
loc=[0,10,0]
plane1=translate(loc,o_solid(v1,sec,.001))


ip1=ppesec(p0,plane1[0])[0]
lines1=cpo(ppesec(p0,plane1[0]))
fileopen(f'''


//p_line({sec},.05);

color("cyan")p_line3dc({plane1[0]},.1);
 color("blue")points({p0.tolist()},.5);

 color("magenta")points({ip1},.5);
for(p={lines1})p_line3d(p,.1);

''')
t1=time.time()
t1-t0
```

honeycomb

In [ ]:
```
# honeycomb structure

sec4=honeycomb(1,6,15)
sec=corner_radius(pts1([[3,2,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),30)
pnts1=[p for p in sec4 if len(pies1(sec,p))==6]

fileopen(f'''


for(p={sec4})p_line(p,.1);

color("blue")p_line({sec},.1);

color("cyan")for(p={pnts1})p_line(p,.1);


''')
```

In [ ]:
```
# honeycomb structure with intersection option
t0=time.time()

sec4=honeycomb(1,6,15)
sec=corner_radius(pts1([[3,2,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),30)
# pnts1=[p for p in sec4 if len(pies1(sec,p))==6]

fileopen(f'''

color("cyan")linear_extrude(1)for(p={sec4})p_line(p,.1);

color("blue")
linear_extrude(1){{
for(p={sec4})
intersection(){{
p_line(p,.1);
polygon({sec});
}}
p_line({sec},.1);
}}


''')
t1=time.time()
t1-t0
```

chimney-panel-support

In [ ]:
```
# chimney panel support

sec=corner_radius(pts1([[0,5],[0,-5,3.5],[10,0,4],[2,1,1],[34,0,4],[1,3.5]]),10)
sec1=path_offset(sec,-3)
path=bezier([[-27.5,0,3]]+ arc_3p_3d([[-27,0,3],[0,0,0],[27,0,3]],100)+[[27.5,0,3]],100)
sol=path_extrude_open(sec,path)
sol1=path_extrude_open(sec1,path[1:-1])
sec2=corner_radius(pts1([[0,0],[25,0,.5],[0,4,.5],[-1,3,.5],[-1.5,0,.5],[-2,-3,1],[-20.5,0]]),10)
sol2=translate([0,-17,1],path_extrude_open(sec2,path[47:-47]))
sec3=corner_radius(pts1([[-6,-5,5],[12,0,5],[0,10.0001,5],[-12,0,5]]),10)
sol3=o_solid([0,0,1],sec3,5,0,0,-37)
sec4=corner_radius(pts1([[0,0],[5,0,10],[7,7,10],[14,0]]),20)
sec5=path_offset(sec4,-3)
sec6=sec4+flip(sec5)
sol4=translate([0,-25,1],path_extrude_open(sec6,path[16:30]))
sol5=translate([0,-25,1],path_extrude_open(sec6,path[-30:-16]))
sol6=translate([12,-25,2],rot('x90z-90',linear_extrude(sec6[20:-20],39)))

fileopen(f'''

module chimeny_support(){{
difference(){{
{swp(sol)}
{swp(sol1)}
{swp(sol3)}
}}

{swp(sol2)}

{swp(sol4)}
{swp(sol5)}

}}


difference(){{
translate([0,0,28])
rotate([0,-90,0])
chimeny_support();
//{swp(cut_plane([0,0,1],60,50,12,0,22))}
}}
//support for 3d printing the part
//translate([-15,-55,0])
//cube([25,60,2]);
//translate([0,0,27])
//rotate([0,-90,0]){{
////{swp(sol3)}
//{swp(sol6)}
//}}
''')
```

offset_3d

In [ ]:
```
# example of offset_3d(sec,d)
sec=corner_radius(pts1([[3,2,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),30)
sec1=o_solid([2,3,5],sec,1,10)[0]
sec2=offset_3d(sec1,-2)

fileopen(f'''


color("blue")p_line3dc({sec1},.1);

color("magenta")p_line3dc({sec2},.1);

''')
```

convert_3lines2fillet

In [ ]:
```
# example of convert_3lines2fillet(pnt1,pnt2,pnt3,f=1.9,s=10)
t0=time.time()

sec=[[0,0],[5,0],[2.5,5]]
sol=o_solid([0,0,1],sec,1,10)
line1=sol[0]
line2=sol[1]
line3=offset_3d(line1,1)
fillet1=convert_3lines2fillet(line3,line2,line1)
fillet1=fillet1+[fillet1[0]]
# fillet1=flip(cpo(fillet1)[1:])
fileopen(f'''


color("blue")p_line3dc({line1},.05);
color("cyan")p_line3dc({line2},.05);
color("magenta")p_line3dc({line3},.05);
{swp_c(fillet1)}

''')
t1=time.time()
t1-t0
```

sunflower

In [ ]:
```
# example of offset_3d when the section is not in 1 plane
# example of path_extrude2msec(sec_list, path)
t0=time.time()

t=1.1 # thickness
s=10 # number of sides of the star
d=20 # outer diameter of the star
h=50 # height of the star prism
cir1=circle(d,s=(s+1))
cir2=c3t2(rot(f"z{360/(s+1)/2}",circle(d/4,s=(s+1))))
sec1=array(c2t3([cir1,cir2]))
sec1=sec1.transpose(1,0,2).reshape(-1,3)
sec1=sec1
sec1=[(sec1[i]+[0,0,1]).tolist() if i%2==0 else (sec1[i]+[0,0,t]).tolist() for i in range(len(sec1)) ]
sec1=m_points(corner_radius(sec1,20),1.1)
sol1=linear_extrude(sec1,h)

line1=corner_radius(pts1([[-20,0],[20,15,30],[20,-15]]),40)
line2=cytz(line1)
surf1=surf_extrude(line1,line2)

ip1=ip_surf(surf1,sol1)
ip2=offset_3d(ip1,-2.01)

surf4=[ip2,ip1,translate([0,0,-t],ip1),translate([0,0,-t],ip2),ip2]
avg2=array(surf4).mean(0).mean(0)

sec3=circle(5)
path3=m_points_o(corner_radius(pts1([[-4,0],[0,15,2],[3.5,4,2],[0,1]]),5),.5)

sol3=prism(sec3,path3)

path4=rot('z90x90',cytz([[i,3*sin(d2r(i*20))] for i in linspace(0,20,44)]))
sol4=sol2path(sol3,path4)
v1=-array(nv(sol4[-1]))
avg1=array(sol4[-1]).mean(0)
surf4=translate(-avg2+[0,0,-.5],surf4)
surf4=sol2vector(v1,surf4,avg1)

arc1=arc_2p([0.01,0],[4.65,0],3,-1)
arc2=[rot(f'z{i}',arc1) for i in arange(0,360,360/50)]
arc2p=translate([0,0,5],arc2)
arc2=array([arc2,arc2p]).transpose(1,0,2,3)

arc3=arc_2p([0.01,0],[4.65,0],3,1)
arc4=[rot(f'z{i}',arc3) for i in arange(0,360,360/50)]
arc4p=translate([0,0,5],arc4)
arc4=array([arc4,arc4p]).transpose(1,0,2,3)

arc5=circle(4.5)
path5=arc_2p([0,0],[-4.5,2],10,-1)
sol5=prism(arc5,path5)

ip1=[ip_sol2sol(sol5,p,-1) for p in arc2]
ip2=[ip_sol2sol(sol5,p,-1) for p in arc4]

ip1=sol2vector(v1,ip1,avg1)
ip2=sol2vector(v1,ip2,avg1)
sol5=sol2vector(v1,sol5,avg1)

fileopen(f'''


{swp_c(flip(surf4))}
{swp(sol4)}
//color("blue")p_line3dc({sol4[-1]},.2);
//color("magenta")p_line3d({path4},.2);

difference(){{
{swp(flip(sol5))}
for(p={ip1})p_line3d(p,.05,rec=1);
for(p={ip2})p_line3d(p,.05,rec=1);
}}

''')
t1=time.time()
t1-t0
```

sol2vector

In [ ]:
```
# checking orientation of solid w.r.t. vector
t0=time.time()

sol=linear_extrude(circle(5),6)
v1=[2,3,4]
loc=[5,10,7.5]
sol1=sol2vector(v1,sol,loc)

fileopen(f'''

%{swp(sol1)}
color("blue")points({[loc]},.5);
color("magenta")p_line3dc({sol[0]},.1);
color("magenta")p_line3dc({sol1[0]},.1);
color("blue")p_line3d({[[0,0,0],v1]},.1);

''')

t1=time.time()
t1-t0
```

In [ ]:
```
# checking orientation of solid w.r.t. vector
t0=time.time()

sec=circle(5)
v1=(array([1,1,-1])*10).tolist()
sol=o_solid(v1,sec,5,0,0,0)

fileopen(f'''

%{swp(sol)}
color("blue")p_line3d({[[0,0,0],v1]},.1);


''')

t1=time.time()
t1-t0
```

In [ ]:
```
# difficult fillet
t0=time.time()

sec1=circle(10,s=6)
pent1=circle(7,s=6)
pent2=c3t2(rot(f'z{360/5/2}',circle(3.5,s=6)))
sec2=concatenate(cpo([pent1]+[pent2])).tolist()

sec3=offset(sec2,-1.5)
sec4=offset(sec3,1)
path1=helix(20,30,1,5)
path2=[[0,0,10],[-30,20,13]]
sol=path_extrude_open(sec2,path1)
sol1=path_extrude_open(m_points1(sec3,50),path2)
sol2=path_extrude_open(m_points1(offset(sec3,.3),50),path2)
v1=array(path2[1])-array(path2[0])
u1=v1/norm(v1)
ip1=[ip_sol2line(sol,p)[-1] for p in cpo(sol1)]
ip2=translate(u1,ip1)
ip3=[ip_sol2line(sol,p)[-1] for p in cpo(sol2)]
```

```
fillet1=convert_3lines2fillet(ip3,ip2,ip1)
fillet1=fillet1+[fillet1[0]]
fileopen(f'''


color("orange"){swp(sol)}
%{swp(sol1)}

//color("blue")p_line3dc({ip1},.05);
//color("blue")p_line3dc({ip2},.05);
//color("blue")p_line3dc({ip3},.05);
color("cyan"){swp(fillet1)}

''')
t1=time.time()
t1-t0
```

ip_sol2sol

In [ ]:
```
# example of function ip_sol2line(sol,line)
t0=time.time()

sec=circle(10)
path=corner_radius(pts1([[-10+.1,0],[12,0],[-2,0,2],[0,10,3],[-10,0]]),5)
sol=prism(sec,path)

sol1=o_solid([1,0,1],circle(3),20,-5)

ip1=ip_sol2sol(sol,sol1,-1)
ip2=ip_sol2sol(sol,sol1,0)



fileopen(f'''


%{swp(sol)}

%{swp(sol1)}

color("magenta")points({ip1},.3);
color("blue")points({ip2},.3);


''')
t1=time.time()
t1-t0
```

ip_sol2line

In [ ]:
```
# example of function ip_sol2line(sol,line)
t0=time.time()

sec=circle(10)
path=corner_radius(pts1([[-10+.1,0],[12,0],[-2,0,2],[0,10,3],[-10,0]]),5)
sol=prism(sec,path)

line=ls([[0,0,-1],[20,20,10]],10)

ip1=ip_sol2line(sol,line)[-1]
ip2=ip_sol2line(sol,line)[0]





fileopen(f'''


%{swp(sol)}

color("blue")p_line3dc({line},.05);

color("magenta")points({[ip1]},.3);
color("cyan")points({[ip2]},.3);


''')
t1=time.time()
t1-t0

ip1
```

In [ ]:
```
t0=time.time()

s1=corner_radius_with_turtle([[0,0],[5,0],[0,5],[-5,0]],10)
s2=linear_extrude(s1,5)
s3=translate([1,2.5,-2.5],cylinder(r=1.75,h=10));
p1=corner_radius_with_turtle([[.5,0],[-.5,0,.5],[0,.5]],20)
s4=[translate([0,0,-x],linear_extrude( offset(s1,x),5+2*x)) for (x,y) in p1]
s5=[offset_sol(s3,y) for (x,y) in p1]
fileopen(f'''


{swp(s2)}
{swp(s3)}

for(i=[0:19])
hull(){{
intersection(){{
swp({s4}[i]);
swp({s5}[i]);
}}

intersection(){{
swp({s4}[i+1]);
swp({s5}[i+1]);
}}
}}
    ''')

t1=time.time()
t1-t0
```

In [ ]:
```
t0=time.time()
sec1=circle(10,s=6)
pent1=circle(7,s=6)
pent2=c3t2(rot(f'z{360/5/2}',circle(3.5,s=6)))
sec2=concatenate(cpo([pent1]+[pent2])).tolist()
sec2=corner_radius(array(c2t3(sec2))+[0,0,.5],15)
sec3=concatenate(cpo([pent1]+[pent2])).tolist()
sec3=offset(sec3,-1)
sec3=corner_radius(array(c2t3(sec3))+[0,0,.2],10)
path1=helix(20,30,1,5)
path2=[[0,0,10],[-30,20,13]]
sol=path_extrude_open(sec2,path1)
sol1=path_extrude_open(equidistant_pathc(sec3,300),path2)

sol2=sol[22:33]
sol3=slice_sol(sol1,20)
sol4=path_extrude_open(equidistant_pathc(offset(sec3,1),300),path2)
sol4=slice_sol(sol4,20)

i_p1=ip_sol2sol(sol2,sol3[12:17],0)
i_p2=i_p_p(sol3,i_p1,1)
i_p3=ip_sol2sol(sol2,sol4[12:17],0)

i_p1,i_p2,i_p3=align_sol_1([i_p1,i_p2,i_p3])

fillet1=convert_3lines2fillet_closed(i_p3,i_p2,i_p1)
# fillet1=fillet_sol2sol(sol2,sol3[12:16],1,s=20)

fileopen(f'''

//color("blue")for(p={sol3[12:16]})points(p,.1);


%{swp(sol)}
%{swp(sol3)}
//color("blue")for(p={sol4[12:16]})p_line3dc(p,.1,rec=1);
color("blue")p_line3dc({i_p1},.05,rec=1);
color("blue")p_line3dc({i_p2},.05,rec=1);
color("blue")p_line3dc({i_p3},.05,rec=1);

{swp_c(fillet1)}

''')
t1=time.time()
t1-t0
```

equidistant_path

In [ ]:
```
t0=time.time()
path=helix(15,20/10,10,5)
# path1=[[0,0,p[2]] for p in path]
path1=helix(0,20/10,10,5)
sec=circle(10)
path2=arc(10,-90,90,[-10+.1,10],50)
sp1=prism(sec,path2)
sol1=[path1,path]
i_p1=ip_sol2sol(sp1,sol1,0)
i_p1=equidistant_path(i_p1,500)
d=l_len([i_p1[0],i_p1[1]])
sp2=translate([0,0,10],sphere(10-d/2))
sp3=sphere(d/2)

fileopen(f'''

    %{swp(sp2)}
    color("blue")p_line3d({i_p1},.05);
    for(p={i_p1})translate(p){swp(sp3)}

    ''')
t1=time.time()
t1-t0
```

iterative-approach-towards-creating-fillets

In [ ]:
```
# iterative approach towards creating fillets

t0=time.time()
sec1=circle(10,s=6)
pent1=circle(7,s=6)
pent2=c3t2(rot(f'z{360/5/2}',circle(3.5,s=6)))
sec2=concatenate(cpo([pent1]+[pent2])).tolist()
sec2=corner_radius(array(c2t3(sec2))+[0,0,.3],5)
sec3=concatenate(cpo([pent1]+[pent2])).tolist()
sec3=offset(sec3,-1)
sec3=corner_radius(array(c2t3(sec3))+[0,0,.3],5)
path1=helix(20,30,1,5)
path2=[[0,0,10],[-30,20,13]]
sol=path_extrude_open(sec2,path1)
sol1=path_extrude_open(sec3,path2)
sol2=sol[20:40]
# a=array([[1-cos(d2r(i)),1-sin(d2r(i))] for i in linspace(0,90,90)])*1
# b=[offset_sol(sol2,i) for i in a[:,0].round(2)]
# c=[offset_sol(sol1,i) for i in a[:,1].round(2)]
a=cr2dt([[1,0],[-1,0,1],[0,1]],90)
b=[ path_extrude_open(offset(sec3,x),path2) for (x,y) in a]
c=[ path_extrude_open(offset(sec2,y),path1[25:35],1) for (x,y) in a]
fileopen(f'''

for(i=[0:89])
intersection(){{
swp({b}[i]);
swp({c}[i]);
}}
color("cyan"){swp(sol)}
color("blue"){swp(sol1)}

''')
t1=time.time()
t1-t0
```

In [ ]:

```
# iterative approach for creating fillets, example-2

t0=time.time()
sec=circle(10)
path=corner_radius(pts1([[2,0],[-2,0,2],[-1,15,3],[-8,0]]),10)
s2=rot('z90',prism(sec,path))

sec1=corner_radius(pts1([[0,0,1],[5,0,1],[0,7,2],[-5,0,2]]),10)
path1=corner_radius(pts1([[-2,0],[2,0,2],[0,5,.3],[-.5,0]]),10)
s3=translate([6,0,12],rot('x90z90',prism(sec1,path1)))

p1=corner_radius_with_turtle([[1,0],[-1,0,1],[0,1]],20)

s4=[rot('z90',prism(sec,path_offset(path,x))) for (x,y) in p1]
s5=[translate([6,0,12],rot('x90z90',prism(sec1,path_offset(path1,y)))) for (x,y) in p1]

fileopen(f'''


{swp(s2)}
{swp(s3)}

for(i=[0:19])
hull(){{
intersection(){{
swp({s4}[i]);
swp({s5}[i]);
}}

intersection(){{
swp({s4}[i+1]);
swp({s5}[i+1]);
}}
}}

    ''')

t1=time.time()
t1-t0
```

In [ ]:
```
s2=linear_extrude(circle(10,s=200),30)
s3=translate([10,0,5],linear_extrude(circle(5,s=100),20))
p1=corner_radius_with_turtle([[1,0],[-1,0,1],[0,1]],20)

s4=[ translate([10,0,5-x],linear_extrude(offset(circle(5,s=100),x),20+2*x)) for (x,y) in p1]
s5=[linear_extrude( offset(circle(10,s=200),y),30) for(x,y) in p1]

fileopen(f'''


{swp(s2)}
{swp(s3)}

for(i=[0:19])
hull(){{
intersection(){{
swp({s4}[i]);
swp({s5}[i]);
}}

intersection(){{
swp({s4}[i+1]);
swp({s5}[i+1]);
}}
}}
    ''')
```

In [ ]:
```
t0=time.time()
```

```
s2=o_solid([0,1,0],circle(5),70,-35)
s3=o_solid([1,0,0],circle(5),70,-35)

p1=corner_radius_with_turtle([[1.5,0],[-1.5,0,1.5],[0,1.5]],20)

s4=[o_solid([0,1,0],circle(5+x),70,-35) for (x,y) in p1]
s5=[o_solid([1,0,0],circle(5+y),70,-35) for (x,y) in p1]

fileopen(f'''


%{swp(s2)}
%{swp(s3)}

for(i=[0:19])
hull(){{
intersection(){{
swp({s4}[i]);
swp({s5}[i]);
}}

intersection(){{
swp({s4}[i+1]);
swp({s5}[i+1]);
}}
}}

    ''')

t1=time.time()
t1-t0
```

In [ ]:
```
cyl1=linear_extrude(circle(5),20)
fileopen(f'''

{swp(cyl1)}
''')
```

lexicographic_sort_xy

In [ ]:
```
#  example of function lexicographic_sort_xy(p)
t0=time.time()
a=random.random(50)*(20-5)+5
b=random.random(50)*(30-10)+10
p=array([a.round(1),b.round(1)]).transpose(1,0)


fileopen(f'''

p2={lexicographic_sort_xy(p)};
color("blue")for(i=[0:len(p2)-1])translate(p2[i])text(str(i),.3);
```

```
p_lineo(p2,.05);
color("magenta")points(p2,.2);

    ''')
t1=time.time()
t1-t0
```

lexicographic_sort_yx

In [ ]:
```
#  example of function lexicographic_sort_yx(p)
t0=time.time()
a=random.random(50)*(20-5)+5
b=random.random(50)*(30-10)+10
p=array([a.round(1),b.round(1)]).transpose(1,0)


fileopen(f'''

p2={lexicographic_sort_yx(p)};
color("blue")for(i=[0:len(p2)-1])translate(p2[i])text(str(i),.3);
p_lineo(p2,.05);
color("magenta")points(p2,.2);

    ''')
t1=time.time()
t1-t0
```

convex_hull

In [ ]:
```
t0=time.time()
a=random.random(1000)*(20-5)+5
b=random.random(1000)*(30-10)+10
px=array([a.round(1),b.round(1)]).transpose(1,0).tolist()
p=px
sec=[]
while(p!=[]):
    p1=convex_hull(p)
    sec.append(p1)
    p=exclude_points(p,p1)
    if p==[]:
        break


fileopen(f'''

points({px},.2);

color("blue")for (p={sec})p_line(p,.05);

    ''')
t1=time.time()
t1-t0
```

In [ ]:
```
s_y=20+5/sin(d2r(45))
h_z=10/20*s_y
s_y1=(s_y**2-h_z**2)**0.5
sec=corner_radius(pts1([[20,s_y,5],[-20,20,5],[-20,-20,5],[20,-20,5]]),20)
sec1=offset(sec,5)

path=cr3dt([[0,0,h_z,0],[0,s_y1,-h_z,5],[0,s_y1,h_z,0]],20)

sec2=wrap_around(sec,path)
sec3=wrap_around(sec1,path)

surf1=[sec2,sec3]
surf2=surface_offset(surf1,-1)
sol=surf1+flip(surf2)+[surf1[0]]
d=s_y1/s_y*20
path2=cr3dt([[20,s_y1+.25,0,3.5],[-20,d,10,5],[-20,-d,-10,3.5],[20,-d,10,5]],20)

fileopen(f'''


//color("blue")for(p={cpo(sol)})p_line3dc(p,.05);
//color("magenta")p_line3dc({path2},.05);
{swp_c(sol)}

    ''')
```

path_extrude_open

In [ ]:
```
# example of path_extrude_open(sec,path,twist=0) which adds a twist to the section
sec=pts([[0,0],[5,0],[0,1],[-5,0]])
path=cr3dt([[20,0,10,5],[-20,20,-10,5],[-20,-20,10,5],[20,-20,-10,5]],20)

sol=path_extrude_open(sec,path)
sol=slice_sol(sol,10)
fileopen(f'''


color("blue")p_line3d({path},.1);

{swp(sol)}


    ''')
```

tangents_along_path

normals_along_path

orthos_along_path

In [ ]:
```
# path=rot('x90.001',circle(10))
# path=cr3dt([[0,0,0,3],[15,0,0,4],[5,3,15,3],[0,10,0,3],[-5,3,-15,4],[-15,0,0,3]],10)
path=cr3dt([[20,0,10,5],[-20,20,-10,5],[-20,-20,10,5],[20,-20,-10,5]],20)
# path=helix(10,5,3,5.001)

# sec=pts([[-1.5,-1.25],[3,0],[-1.5,2.5]])
# sec=pts([[0,0],[5,0],[0,1],[-5,0]])
sec=[[0,0],[1,0],[0,1]]
sol=path_extrude_open(sec,path)
# sol=slice_sol(sol,10)
# sol=align_sol(sol,1)

t_v1=tangents_along_path(path,1)
n_v1=normals_along_path(path,1)
o_v1=orthos_along_path(path,1)


fileopen(f'''


p_line3d({path},.05);
color("blue")for(p={t_v1})p_line3d(p,.05);
color("magenta")for(p={n_v1})p_line3d(p,.05);
color("cyan")for(p={o_v1})p_line3d(p,.05);

//{swp(sol)}




''')
```

cp_cir_3d

In [ ]:
```
# sec2=[[0,0,0],[2,0,0],[0,0,2]]
sec2=[[0,1,0],[2,3,0],[0,3,2]]

cir1=cir_3p_3d(sec2,100)
cp=cp_cir_3d(sec2)
fileopen(f'''

color("blue")points({sec2},.2);
p_line3dc({cir1},.05);

color("magenta")points({[cp]},.2);

''')
```

l_sec_ip

In [ ]:
```
#  example of line to section intersection point function
line=[[1,4],[7,10]]
sec=[[0,0],[5,1],[3,7]]


i_p1=line_section_ip(line,sec)
fileopen(f'''


p_line3dc({sec},.05);
color("cyan")p_line3dc({line},.05);
color("blue")points({i_p1},.2);


''')
```

surface_for_fillet

In [ ]:
```
# example of function surface_for_fillet(sol1=[],sol2=[],factor1=50,factor2=10,factor3=1,factor4=100,dia=40)
t0=time.time()

sec=circle(10)
path=corner_radius(pts1([[-8,0],[10,0],[-2,0,2],[-1,15,3],[-8.9,0]]),10)
path=equidistant_path(path,100)
sol1=rot('z90',prism(sec,path))

sec1=corner_radius(pts1([[0,0,1],[5,0,1],[0,7,2.3],[-5,0,2.3]]),10)
path1=corner_radius(pts1([[-2.4,0],[2.4,0,2],[0,5,.3],[-.5,0]]),10)
path1=equidistant_path(path1,30)
sol2=translate([6,0,12],rot('x90z90',prism(sec1,path1)))

sol3=surface_for_fillet(sol1,sol2,100,20,4,23,8)
ip2=ip_sol2sol(sol2,sol3)


fillet1=il_fillet(ip2,sol2,sol3,-1,1)
fillet1=fillet1+[fillet1[0]]
fileopen(f'''

%{swp(sol1)}
%{swp(sol2)}
color("cyan")for(p={sol2})p_line3dc(p,.01,rec=1);
color("cyan")for(p={cpo(sol2)})p_line3d(p,.01,rec=1);

color("blue")for(p={sol3})p_line3dc(p,.01,rec=1);
color("blue")for(p={cpo(sol3)})p_line3d(p,.01,rec=1);
color("magenta")p_line3dc({ip2},.02,rec=1);




{swp_c(fillet1)}
color("green")for(p={fillet1})p_line3dc(p,.02,rec=1);
color("green")for(p={cpo(fillet1)})p_line3dc(p,.02,rec=1);

''')

t1=time.time()
t1-t0
```

In [ ]:
```
t0=time.time()
sec1=circle(55,s=70)
path1=corner_radius(pts1([[-50,30],[56,0],[0,8,5],[-4,3,5],[0,18,10],[8,5,10],[0,12],[-50,0]]),10)
sol1=rot('z0',prism(sec1,path1))

sec2=circle(7.5)
path2=corner_radius(pts1([[-5,0],[5,0,5],[0,35,3],[-4,0]]),10)
sol2=translate([58,0,35],prism(sec2,path2))

surf1=surface_for_fillet(sol1,sol2,70,20,5,200,50)

fillet1=fillet_sol2sol(sol2,surf1,4)
fileopen(f'''
```

```
%{swp(sol1)}
%{swp(sol2)}

color("blue")for(p={cpo(surf1)})p_line3d(p,.05);
{swp_c(fillet1)}

''')
t1=time.time()
total=t1-t0
total
```

i_line_fillet

In [ ]:
```
i_t=time.time()
sec1=circle(55)
path1=corner_radius(pts1([[-50,0],[50,0,.2],[0,30,3],[6,1,3],[0,6,3],[-4,2,3],[0,22,6],[8,2,6],[0,10,.2],[-50,0]]),10)
# path1=equidistant_path(path1,200)
sec2=circle(7.5)
path2=corner_radius(pts1([[-5,0],[5,0,5],[0,35,2],[-5,0]]),10)
path2=equidistant_path(path2,50)
sol1=prism(sec1,path1)
sol2=translate([57.5,0,37],prism(sec2,path2))
sol2=axis_rot_o([0,0,1],sol2,180)
p1=ip_sol2sol(sol1,cpo(sol2))
p2=ip_sol2sol(sol1,cpo(sol2),-1)

p3=flip(p1)+p2


fillet1=i_line_fillet_closed(p3,sol1,sol2,-3,3)

fileopen(f'''


%{swp(sol1)}
%{swp(sol2)}

//color("blue")for(p={cpo(sol2)})p_line3d(p,.1,rec=1);
color("magenta")points({p1},.3);
color("magenta")points({p2},.3);
color("cyan")p_line3dc({p3},.1,rec=1);
{swp_c(fillet1)}


''')


f_t=time.time()
f_t-i_t
# len(p1),len(p2),len(p3)
```

In [ ]:
```
i_t=time.time()
sec=corner_radius(pts1([[-5,-5,1],[10,0,1],[0,10,1],[-10,0,1]]),10)
path=corner_radius(pts1([[-4,0],[4,0,1],[0,10,1],[-4,0]]),10)

sol1=prism(sec,path)
sol2=o_solid([1,0,.1],circle(2,s=100),15,-7,0,10,[-90,0,0])
# sol2=slice_sol(sol2,2)
l1=corner_radius_with_turtle([[1,0],[-1,0,1],[0,1]],20)
a=[prism(sec,path_offset(path,x)) for (x,y) in l1]
b=[offset_sol(sol2,y) for (x,y) in l1]

fileopen(f'''


{swp(sol1)}
{swp(sol2)}
for(i=[0:len({a})-2])
hull(){{
intersection(){{
swp({a}[i]);
swp({b}[i]);
}}
intersection(){{
swp({a}[i+1]);
swp({b}[i+1]);
}}
}}
    ''')
f_t=time.time()
f_t-i_t
```

In [ ]:
```
import sys
set_printoptions(threshold=sys.maxsize)
```

align_sol_1

In [ ]:
```
# merging 2 different shapes
t0=time.time()


sec=corner_radius(pts1([[1.5,8,.9],[2,0,.9],[0,-3,1.4],[3,0,1.4],[0,4,1.9],[-5,0,2.5],[0,6,2.5],
                [7,0,2.5],[0,-4,.9],[-2,0,.9],[0,3,1.4],[-3,0,1.4],[0,-4,1.9],
               [5,0,2.5],[0,-6,2.5],[-7,0,2.5]]),20)

cp1=-array(c2t3(sec)).mean(0)+[0,0,10]
sec=translate(cp1,sec)
sec1=c2t3(pts([[-5,-10],[10,0],[0,20],[-10,0]]))

sec=equidistant_pathc(sec,300)
sec1=equidistant_pathc(sec1,300)


sol=align_sol_1([sec1,sec])

sol=slice_sol(sol,30)

sol1=array(sol).reshape(-1,3)


fileopen(f'''

difference(){{
    {swp(sol)}
     translate([0,0,-.01])cube(5);
     }}

color("blue")p_line3dc({sol[-1]},.05);
    ''')

t1=time.time()
t1-t0
```

coil-example

In [ ]:
```
coil=array([i/360*array([cos(d2r(i)),sin(d2r(i)),-1]) for i in linspace(0,3600,720)]).tolist()
cyl1=translate([0,0,-10],cylinder(r1=10,r2=0.1,h=10))
fileopen(f'''
translate([0,0,10]){{
color("blue")p_line3d({coil},.05);
%{swp(cyl1)}
}}
    ''')
```

In [ ]:
```
x,y=sympy.symbols('x y')

f1=sympy.lambdify(x,10*sympy.cos(x),'numpy')
f2=sympy.lambdify(x,10*sympy.sin(x),'numpy')

a=linspace(0,2*pi,100)
cir1=array([f1(a),f2(a)]).transpose(1,0).tolist()

fileopen(f'''
    include<dependencies.scad>
color("blue")p_line({cir1},.05);



    ''')
```

In [ ]:
```
v1x,v1y,v2x,v2y,p0x,p0y,p1x,p1y,t1,t2=sympy.symbols('v1x,v1y,v2x,v2y,p0x,p0y,p1x,p1y,t1,t2')

p0,v1=array([[2,3],[4,5]])
p1,v2=array([[10,7],[-3,7]])

# p0+v1*t1=p1+v2*t2
# v1*t1-v2*t2=p1-p0
# v1x*t1-v2x*t2=(p1-p0)x
# v1.y*t1-v2.y*t2=(p1-p0).y

sympy.linsolve([v1x*t1-v2x*t2-(p1x-p0x),v1y*t1-v2y*t2-(p1y-p0y)],t1,t2)
```

In [ ]:
```
# p0+v1*t1=p2+v2*t2+v3*t3
# v1*t1-v2*t2-v3*t3=p2-p0

v1x,v1y,v1z,v2x,v2y,v2z,v3x,v3y,v3z,p0x,p0y,p0z,p2x,p2y,p2z,t1,t2,t3= \
sympy.symbols('v1x,v1y,v1z,v2x,v2y,v2z,v3x,v3y,v3z,p0x,p0y,p0z,p2x,p2y,p2z,t1,t2,t3')

f=sympy.linsolve([v1x*t1-v2x*t2-v3x*t3-(p2x-p0x),v1y*t1-v2y*t2-v3y*t3-(p2y-p0y),v1z*t1-v2z*t2-v3z*t3-(p2z-p0z)],t1,t2,t3)
```

axis_rot_o

In [ ]:
```
t0=time.time()
sec=corner_radius(pts1([[-5,-5,1],[10,0,1],[0,10,1],[-10,0,1]]),10)
path=corner_radius(pts1([[-4,0],[4,0,1],[0,10,1],[-4,0]]),10)
sol1=axis_rot_o([0,1,0],prism(sec,path),90)


fileopen(f'''

%{swp_c(sol1)}
color("blue")for(p={sol1})p_line3dc(p,.1);
    ''')
t1=time.time()
t1-t0
```

In [ ]:
```
a=random.random(1000)*(10-1)+1
b=random.random(1000)*(10-3)+3
```

handling-trolley

In [ ]:
```
# frame
sec1=circle(12.5)
path1=c2t3(corner_radius(pts1([[0,0,5],[900,0,5],[0,600,5],[-900,0,5]]),10))

sol1=path_extrude_closed(sec1,path1)

path2=cr3dt([[600,0,0,5],[0,600,0,5],[0,0,500,5],[0,-600,0,5]],10)
sol2=align_sol_1(path_extrude_closed(sec1,path2))

sol3=translate([-100,0,0],sol2)

# hinge supports
fillet1=flip(fillet_line_circle([[0,75],[200,75]],circle(40,[100,120]),20,1))
fillet2=fillet_line_circle([[0,75],[200,75]],circle(40,[100,120]),20,3)
arc1=arc_long_2p(fillet1[-1],fillet2[0],40,-1)
sec2=[[0,0],[200,0],[200,75]]+fillet1+arc1+fillet2+[[0,75]]
sol4=translate([450,250,465],rot('x90',linear_extrude(sec2,20)))
sol5=translate([450,350,465],rot('x90',linear_extrude(sec2,20)))

# long arm
x1=o_solid([-1,0,0],circle(30),1800,-900,290,590,[0,0,0])
x2=o_solid([-1,0,0],circle(25),1800,-900,290,590,[0,0,0])
sol6=swp_prism_h(x1,x2)
# sol6=axis_rot_1(sol6,[0,1,0],[550,290,590],10)


# frame
sol7=o_solid([0,1,0],circle(12.5),600,0,100)
sol8=o_solid([0,1,0],circle(12.5),600,0,200)

# cylinder body
x3=o_solid([0,0,1],circle(40),300,135,150,-290)
x4=o_solid([0,0,1],circle(35),300,135,150,-290)
sol9=swp_prism_h(x3,x4)
# sol9=axis_rot_1(sol9,[0,1,0],[150,290,100],1)

# cylinder bottom cover
x5=o_solid([0,0,1],circle(40),20,135,150,-290)
# x5=axis_rot_1(x5,[0,1,0],[150,290,100],1)

# hinge of cylinder
sec1=corner_radius(pts1([[-20,-35,20],[40,0,20],[0,70],[-40,0]]))
sol10=o_solid([0,1,0],sec1,20,-10+290,150,125-20)
# sol10=axis_rot_1(sol10,[0,1,0],[150,290,100],2)

# piston
x6=o_solid([0,0,1],circle(35),20,175,150,-290)
# x6=axis_rot_1(x6,[0,1,0],[150,290,100],1)

# piston rod
x7=o_solid([0,0,1],circle(15),350,175,150,-290)
```

```
# x7=axis_rot_1(x7,[0,1,0],[150,290,100],1)

# cylinder top cover
x8=o_solid([0,0,1],circle(40),20,425,150,-290)
# x8=axis_rot_1(x8,[0,1,0],[150,290,100],1)


# c-clamp for hinge support
sec1=corner_radius(pts1([[-20,0,20],[40,0,20],[0,260,20],[-40,0,20]]),10)
sec1=equidistant_pathc(sec1,300)
sec2=offset(sec1,-19)

path1=corner_radius(pts1([[0,100],[0,-100,10],[70,0,10],[0,120]]),10)
path1=equidistant_path(path1,300)
path1=translate([0,0,0],rot('x90z90',path1))
fold1=wrap_around(sec1,path1)

fold2=wrap_around(sec2,path1)
surf1=[fold1]+[fold2]
surf2=surface_offset(surf1,-5)
sol11=[surf1[1]]+[surf1[0]]+[surf2[0]]+[surf2[1]]
sol11=translate([150,255,520],sol11)
# sol11=axis_rot_1(sol11,[0,1,0],[550,290,590],10)
# sol11=axis_rot_1(sol11,[0,1,0],[170,290,670],-9)

# c-clamp for counterweight
x9=[surf1[1]]+[surf1[0]]+[surf2[0]]+[surf2[1]]
x9=translate([850,255,520],x9)

# catcher
arc1=c2t3(arc(200,-90,90,s=100))

sol12=path_extrude_open(circle(10),arc1)
sol12=translate([-1090,290,590],sol12)
# sol12=axis_rot_1(sol12,[0,1,0],[550,290,590],10)

# hinge pin c-clamp
sol13=o_solid([0,1,0],circle(5),100,240,150,590)
# sol13=axis_rot_1(sol13,[0,1,0],[550,290,590],10)

# hinge pin cylinder mounting
sol14=o_solid([0,1,0],circle(5),100,240,150,90)

# hinge pin long arm
sol15=o_solid([0,1,0],circle(5),140,220,550,590)

# hinge pin counterweight
x10=o_solid([0,1,0],circle(5),100,240,850,590)


# rod for counterweight
x11=o_solid([0,0,1],circle(15),300,225,850,-290)

# counterweight
s1=corner_radius(pts1([[100,20],[-120,0,19],[0,-40,19],[120,0]]),10)+arc_long_2p([100,-20],[100,20],100,1,50)

x12=o_solid([0,0,1],s1,100,235,850,-290,[90,0,0])

# support for counterweight
x13=o_solid([0,0,1],circle(100),10,225,850,-290)

# trolley wheel
s1=circle(15)
p1=rot('x90',circle(50))
wh=path_extrude_closed(s1,p1)
wh=align_sol_1(wh)
s2=circle(4)
p2=[[-50,0,0],[50,0,0]]
spk=[axis_rot([0,1,0],path_extrude_open(s2,p2),i) for i in linspace(0,360,6)[:-1]]



fileopen(f'''


// frame
swp_c({sol1});
swp_c({sol2});
swp_c({sol3});
swp({sol7});
swp({sol8});

// hinge supports
swp({sol4});
swp({sol5});

for(i=[20,80])
translate([-400,i,-500])
swp({sol4});
swp_c({sol6});

//cylinder body
sol9={sol9};
%swp_c(sol9);
//cylinder bottom cover
x5={x5};
swp(x5);

//hinge for cylinder
swp({sol10});

//piston
x6={x6};
swp(x6);


color("cyan")
union(){{
```

```
//piston rod
x7={x7};
swp(x7);

//cylinder top cover
x8={x8};
swp(x8);
}}

// c-clamp for pivot point hinge support
sol11={sol11};
swp(sol11);

// catcher
sol12={sol12};
swp(sol12);

//hinge pin
sol13={sol13};
color("cyan")swp(sol13);

//hinge pin cylinder
sol14={sol14};
color("cyan")swp(sol14);


//hinge pin long arm
sol15={sol15};
color("cyan")swp(sol15);

//c-clamp for counterweight
x9={x9};
swp(x9);

// hinge pin counterweight
x10={x10};
color("cyan")swp(x10);

// rod for counterweight
x11={x11};
color("cyan")swp(x11);

//counterweight
x12={x12};
swp(x12);

//counterweight
x13={x13};
color("cyan")swp(x13);

//trolley wheels
for(j=[0,900])
for(i=[-30,630])
translate([j,i,0]){{
swp_c({wh});
for(p={spk})swp(p);
}}

''')
```

r_sec

In [ ]:
```
# example of function r_sec(r1,r2,cp1,cp2)

t0=time.time()


line=[[1,2],[5,-6]]
r1,r2=5,1
```

```
sec1=r_sec(r1,r2,line[0],line[1])

fileopen(f'''

color("blue")p_line3dc({sec1},.1);
color("magenta")p_line3d({line},.1);
color("cyan")points({line},.2);

''')
t1=time.time()
t1-t0
```

3d-knots

In [ ]:

```
# 3d knots various types
t0=time.time()
# trefoil knot

path=[[10*(sin(t)+2*sin(2*t)),
      10*(cos(t)-2*cos(2*t)),
      -10*sin(3*t)] for t in d2r(arange(0,360))]

# circular sin theta knot

# path=[[60*(cos(t)),
#       60*(sin(t)),
#       20*sin(4*t)*cos(4*t)] for t in d2r(arange(0,360))]

# random knot

# path=[[20*(-0.22*cos(t) - 1.28*sin(t) - 0.44*cos(3*t) - 0.78*sin(3*t)),
# 20*(-0.1*cos(2*t) - 0.27*sin(2*t) + 0.38*cos(4*t) + 0.46*sin(4*t)),
# 20*(0.7*cos(3*t) - 0.4*sin(3*t))] for t in d2r(arange(0,360))]

# torus knots

# path=[[10*cos(3*t)*(3+cos(4*t)),
# 10*sin(3*t)*(3+cos(4*t)),
# 10*sin(4*t)] for t in d2r(arange(0,360))]

# cinquefoil torus knots
# a,p,q=3,11,12
# d=10

# explanation
# radius of the torus = a*d
# section radius of the torus = d
# p in number of cycles of the wrapping coil over torus
# q in the number of turns of the wrapping coil over torus

# path=[[d*cos(p*t)*(a+cos(q*t)),
# d*sin(p*t)*(a+cos(q*t)),
# -d*sin(q*t)] for t in d2r(arange(0,360,.25))]



# Lissajous knots

# path=[[10*cos(3*t+5),
# 10*cos(3*t+10),
# 10*cos(3*t+2)]for t in d2r(arange(0,360))]
r=4
sec=circle(r)
```

```
sol=align_sol_1(path_extrude_closed(sec,path))

# sec1=circle(d-r)
# path1=c2t3(circle(a*d))
# sol1=path_extrude_closed(sec1,path1)

# sol2=o_solid([0,0,-1],circle(38),2,10)
# sol3=o_solid([0,0,-1],circle(20),2,10)
# sol2=swp_prism_h(sol2,sol3)

sol1=o_solid([0,0,1],pts([[-50,-50],[100,0],[0,100],[-100,0]]),2,-15)
fileopen(f'''

//difference(){{
{swp_c(sol)}
{swp(sol1)}
//{swp(cut_plane([0,-1,0],[100,100],100))}
//}}

''')
t1=time.time()
t1-t0
```

0
20
20
40

-40
-20
20
40
60

-40
-20
0
20
40

In [ ]:
```
# sinwave
# length=200
# starting_point=-100
# number_of_waves=10
# amplitude=5
# a=[[r2d(i)/360*length+starting_point,amplitude*sin(number_of_waves*i)] for i in d2r(arange(0,360))]
a=translate_2d([-100,0],sinewave(200,10,5,100))
fileopen(f'''

color("blue")p_line3d({a},1);


''')
```

glass-model

In [ ]:
```
# glass model
r=15
a1=1/20 #taper of the glass
h1=20
h2=20
s1=10
cir1=circle(r,s=s1+1)
path1=corner_radius(pts1([[-1,0],[1,0,1],[a1*h1,h1]]),10)
sol1=prism(cir1,path1)
sol1=align_sol_1([equidistant_pathc(p,200) for p in sol1])
sol1=slice_sol(sol1,30)

cir2=circle((r+a1*h1)/cos(d2r(360/(s1+1)/4)),s=201)
path2=corner_radius(pts1([[0,h1+.25],[a1*h2,h2,.49],[-1,0,.49],[-a1*h2,-h2,.5],[-.5,-.5,.5],[-a1*(h1-3),-(h1-3),1],[-2,0]]),10)
sol2=prism(cir2,path2)
sol3=sol1+sol2
p0=sol1[-1]
p1=sol2[0]
p2=sol1[-2]
fill=convert_3lines2fillet(p2,p1,p0,s=30)
fill=fill+[fill[0]]
sec=square(100,center=True)
cut1=o_solid([0,-1,0],sec,100,theta=[0,0,10])
fileopen(f'''

difference(){{
union(){{
{swp(sol3)}
{swp_c(fill)}
}}

{swp(cut1)}

}}
''')
```

rot

In [ ]:
```
line=[[0,0,0],[10,0,0]]
line1=rot('z30x90',line)

pnt=[20,0]
pnt1=rot('z45',pnt)
fileopen(f'''


p_line3d({line},1);
color("blue")p_line3d({line1},1);
color("magenta")points({[pnt]},1);
color("magenta")points({[pnt1]},1);

''')
```

ang(x,y)

In [ ]:
```
# example of function ang(x,y)
pnt=[20,0]
pnt1=rot('z125',pnt)
ang(pnt1[0],pnt1[1])
```

l_len

In [ ]:
```
l_len([[0,0,0],[10,0,0]])
```

l_lenv

In [ ]:
```
l_lenv([[0,0,0],[10,0,0],[10,5,0],[0,5,0]])
```

l_lenv_o

In [ ]:
```
l_lenv_o([[0,0,0],[10,0,0],[10,5,0],[0,5,0]])
```

arc

In [ ]:
```
arc1=arc(radius=5,start_angle=0,end_angle=120,cp=[0,0],s=30)
fileopen(f'''
```

```
color("blue")p_lineo({arc1},.1);
''')
```

pts

In [ ]:
```
# calculates the cumulative sum of points
pts([[0,0],[4,0],[2,3],[5,-8]])
```

axis_rot_1

In [ ]:
```
sol=o_solid([1,0,0],circle(5),100)
sol1=axis_rot_1(sol,[0,1,0],[80,0,0],15)
fileopen(f'''


%{swp(sol)}
{swp(sol1)}
''')
```

arc_2p_3d

arc_2p_3p_cp

In [ ]:
```
'''
    draws an arc through 2 points
    n1: normal vector to define plane on which the arc will be drawn
    r: radius of the arc
    cw: '1' stands for clockwise and '-1'stands for counter-clockwise
    's' is the number of segments of the circle
```

```
    '''

p0=[5,0,0]
p1=[2,4,2]
p2=[0,0,0]
n1=nv([p0,p1,p2])
n2=(array(n1)*3).tolist()
arc1=arc_2p_3d(n1,p0,p1,3,-1)
cp=arc_2p_3d_cp(n1,p0,p1,3,-1)
n_line=[cp,(array(cp)+array(n2)).tolist()]

fileopen(f'''

color("blue")p_line3d({arc1},.1);
color("magenta")p_line3dc({n_line},.1);
color("cyan")points({[p0,p1]},.5);

''')
n1
```

c2t3

In [ ]:
```
# function to convert 2d to 3d, it just adds the z-coordinate to the points list
#     example:
list=c2t3([[1,2],[3,4],[6,7]])
list
```

c3t2

In [ ]:
```
# function to convert 3d to 2d, it just removes the z-coordinate from the points list
#     example:
list=c3t2([[1,2,3],[3,4,5],[6,7,8]])
list
```

nv

In [ ]:
```
# given 3 points ['p1','p2',p3] function calculates unit normal vector
#     example:
p1,p2,p3=[1,0,0],[0,10,0],[-5,0,0]
nv([p1,p2,p3]) #=> [0.0, 0.0, -1.0]
```

cytz

In [ ]:
```
#     function to convert the y co-ordinates to z co-ordinates e.g.[x,y]=>[x,0,y]. 2d to 3d coordinate system
list=cytz([[1,2],[3,4],[6,7]])
list
```

d2r

In [ ]:
```
# function to convert from degrees to radians
d2r(90)
```

r2d

In [ ]:
```
# function to convert from radians to degrees
r2d(1.57079)
```

flip

In [ ]:
```
# function to flip the sequence of a list or a list of points
#     example:
list=[1,2,3,4,5]
flipped_list1=flip(list) #=> [5, 4, 3, 2, 1]

list=[[1,2,3],[4,5,6],[7,8,9]]
flipped_list2=flip(list) #=> [[7, 8, 9], [4, 5, 6], [1, 2, 3]]
flipped_list1, flipped_list2
```

gcd

In [ ]:
```
# calculates the greatest common divisor of 2 numbers 'a','b'
gcd(12,15)
```

lcm

In [ ]:
```
# calculates the least common multiple of 2 numbers 'a','b'
lcm(12,15)
```

list_r

In [ ]:
```
#     function list the corner radiuses of a given section (only where the radius is specified)
#     example:
sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1.25],[-8,0,2],[-5,20,1.4]]),5)
r1=list_r(sec)
fileopen(f'''

sec={sec};
r1={r1.tolist()};
color("blue")p_line({sec},.05);
color("magenta")points({sec},.2);
color("black")for(i=[0:len(sec)-1])translate({offset(sec,.5)}[i])text(str(r1[i]),.25);

''')
r1
```

ls(line,n)

In [ ]:
```
# function to draw number of points 'n' in a line 'line'
#     example:
line=[[0,0],[10,0]]
line1=ls(line,5) #=> [[0.0, 0.0], [2.0, 0.0], [4.0, 0.0], [6.0, 0.0], [8.0, 0.0], [10.0, 0.0]]
line1
```

max_r(sec)

In [ ]:
```
# function calculates the maximum radius in a given closed section
#     example:
sec=cr2dt([[0,0,.2],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]],20)
max_r(sec) #=> 3.0
```

arc_long_2p_3d

In [ ]:
```
# draws a long arc through 2 points
#     n1: normal vector to define plane on which the arc will be drawn
#     r: radius of the arc
#     cw: '1' stands for clockwise and '-1'stands for counter-clockwise
#     's' is the number of segments of the circle

p0=[5,0,0]
p1=[2,4,2]
p2=[0,0,0]
n1=nv([p0,p1,p2])
n2=(array(n1)*3).tolist()
arc1=arc_long_2p_3d(n1,p0,p1,10,-1)

cp=arc_2p_3d_cp(n1,p0,p1,10,1)
n_line=[cp,(array(cp)+array(n2)).tolist()]

fileopen(f'''

color("blue")p_line3d({arc1},.1);
color("magenta")p_line3dc({n_line},.2);
color("cyan")points({[p0,p1]},.5);

''')
```

In [ ]:
```
t0=time.time()

sec=cr2dt([[0,0],[5,0],[0,5],[-5,0]],10)
path=corner_radius(pts1([[-2.5,0],[2.5,0,0.25],[0,5.01,0.25],[-2.5,0]]),10)
sol=prism(sec,path)

v1=[2,0,7]
sec1=axis_rot([0,0,1],circle(1.5,s=100),90)
sol1=o_solid(v1,sec1,10,-1.5,-2.5,0)
path1=cr2dt([[.5,0],[-.5,0,.5],[0,.5]],20)
a=[prism(sec,path_offset(path,x)) for (x,y) in path1]
b=[o_solid(v1,offset_3d(sec1,y),10,-1.5,-2.5,0) for (x,y) in path1]
fileopen(f'''

for(i=[0:18])
hull(){{
intersection(){{
swp({a}[i]);
swp({b}[i]);
}}
intersection(){{
swp({a}[i+1]);
swp({b}[i+1]);
}}
}}
{swp(sol)}
{swp(sol1)}
''')
t1=time.time()
t1-t0
```

ang_2lineccw

In [ ]:
```
p0=[0,0]
p1=[5,2]
p2=[7,8]
```

```
fileopen(f'''


// case 1: counter-clockwise angle between line p1p0 and p1p2 is 229.76 degrees
color("blue")points({[p0,p1,p2]},.2);
color("cyan")p_line3d({[p0,p1,p2]},.1);
color("magenta")translate([0,-.5]){{
translate({p0})text("p0",.5);
translate({p1})text("p1",.5);
translate({p2})text("p2",.5);
}}

// case 2: counter-clockwise angle between line p0p1 and p0p2 is 27.01 degrees

translate([10,0,0]){{
color("blue")points({[p0,p1,p2]},.2);
color("cyan")p_line3d({[p1,p0,p2]},.1);

color("magenta")translate([0,-.5]){{
translate({p0})text("p0",.5);
translate({p1})text("p1",.5);
translate({p2})text("p2",.5);
}}
}}

''')
ang_2lineccw(p1,p0,p2),ang_2lineccw(p0,p1,p2)
```

ang_2linecw

In [ ]:

```
p0=[0,0]
p1=[5,2]
p2=[7,8]
fileopen(f'''


// case 1: clockwise angle between line p1p0 and p1p2 is 130.23 degrees
color("blue")points({[p0,p1,p2]},.2);
color("cyan")p_line3d({[p0,p1,p2]},.1);
color("magenta")translate([0,-.5]){{
translate({p0})text("p0",.5);
translate({p1})text("p1",.5);
translate({p2})text("p2",.5);
}}

// case 2: clockwise angle between line p0p1 and p0p2 is 332.98 degrees

translate([10,0,0]){{
color("blue")points({[p0,p1,p2]},.2);
color("cyan")p_line3d({[p1,p0,p2]},.1);

color("magenta")translate([0,-.5]){{
translate({p0})text("p0",.5);
translate({p1})text("p1",.5);
translate({p2})text("p2",.5);
}}
}}

''')
l_(ang_2linecw(p1,p0,p2)),l_(ang_2linecw(p0,p1,p2))
```

cir_2p

cp_arc

In [ ]:

```
p1=[5,2]
p2=[7,8]
r=10
c1=cir_2p(p1,p2,r,cw=-1,s=50)
cp1=cp_arc(c1)
fileopen(f'''


color("cyan")points({[p1,p2]},.5);
color("blue")p_line3dc({c1},.1);
color("magenta")points({[cp1]},.5);


''')
```

circle

In [ ]:
```
c1=circle(r=10,cp=[0,0],s=50)
fileopen(f'''


color("blue")p_line3dc({c1},.1);


''')
```

CW

In [ ]:
```
sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
cw(sec)
```

cwv

In [ ]:
```
sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)
array(cwv(sec))
```

exclude_points

In [ ]:
```
p0=[[ 0,  1,  2],[ 3,  4,  5],[ 6,  7,  8],[ 9, 10, 11],[12, 13, 14],[15, 16, 17],
[18, 19, 20], [21, 22, 23],[24, 25, 26], [27, 28, 29]]

p1=[[0,1,2],[9,10,11]]

p2=exclude_points(p0,p1)
p2
```

intersections

In [ ]:
```
sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),10)
# sec=sec=corner_radius(pts1([[0,0,.1],[7,5,2],[5,7,2],[-5,7,2],[-7,5,3]]),20)
# sec=corner_radius(pts1([[-15,0,2.49],[0,15,3],[30,0,3],[0,-15,2.49],[5,0,2.49],[0,20,7],[-40,0,7],[0,-20,2.49]]),20)
# sec=circle(10)
# sec=pts([[0,0],[10,0],[0,10],[-10,0]])

offset_line_segments=offset_segv(sec,-3.5)
intersection_points=intersections(offset_line_segments)

fileopen(f'''

color("blue")p_line({sec},.1);
color("cyan")for(p={offset_line_segments})p_line(p,.1);
color("magenta")points({intersection_points},.2);

''')
```

In [ ]:
```
c1=c2t3(circle(10))
c2=translate([0,0,10],circle(5,s=70))

c3=path2path1_closed(c2,c1)
sol=cpo(align_sol_1([c3,c2]))

fileopen(f'''


color("blue")points({c2},.2);
color("cyan")points({c3},.2);
color("green")points({c1},.2);
color("magenta")points({circle(10,s=70)},.3);

color("magenta")for(p={sol})p_line3d(p,.05,rec=1);

''')
```

sol2path

In [ ]:
```
#  example to extrude a solid along a path

# profile of the fan blade
t0=time.time()

p0=corner_radius(pts1([[0,0,.5],[20,-2,300],[20,-5,5],[5,5,4],[-5,5,5],[-20,0,300],[-20,-2,.5]]),20)

# blade profile smoothened with bezier
# sec=bezier(p0,300)
sec=equidistant_pathc(p0,300)

sol=linear_extrude(sec,45)
sol1=translate([45,0,0],rot('y-90',sol))
sol1=c2ro(sol1)
# zval=[p[0][2] for p in sol1]
# sol1=c3t2(sol1)


# generating helical path to extrude the profile
arc1=c2t3(arc(30,-10,0,s=2))
path=arc1+helix(30,120,.25,5)[3:]
path=bezier(path,100)


# code to extrude the solid along the given path
sol2=sol2path(sol1,path)
sol2=slice_sol_1(sol2,200)

# file path needs to be modified
fileopen(f'''

difference(){{
union(){{
for(i=[0:360/3:359])
rotate([0,0,i])
mirror([0,1,0]){swp(sol2)}
}}

//{swp(cut_plane([0,0,1],[1000,1000],100,20))}
}}

color("blue")p_line3d({path},.3,1);
''')
t1=time.time()
t1-t0
```

In [ ]:
```
# profile of the fan blade
t0=time.time()

p0=corner_radius(pts1([[0,0,.5],[20,-2,300],[20,-5,5],[5,5,4],[-5,5,5],[-20,0,300],[-20,-2,.5]]),20)

# blade profile smoothened with bezier
sec=bezier(p0,200)
# sec=equidistant_pathc(p0,300)

sol=linear_extrude(sec,45)
sol1=translate([45,0,0],rot('y-90',sol))
sol2=c2ro(sol1,1)
arc1=c2t3(arc(30,-10,0,s=3)[:-1])
path=arc1+helix(30,120,.25,5)
path=equidistant_path(path,len(cpo(sol1))-1)
sol3=c2ro(sol2path(sol2,path))
sol3=slice_sol([ bezier(p,200) for p in sol3],20)
sol3=bspline_surface(c2ro(sol3),3,3,150,100,[1,0])
fileopen(f'''
for(i=[0,120,240])
rotate([0,0,i])
mirror([0,1,0])
{swp(sol3)}

//color("magenta") p_line3d({path},.2);
''')
t1=time.time()
t1-t0
```

In [ ]:
```
t0=time.time()

sec=circle(5)
path1=corner_radius(pts1([[-3,0],[3,0,3],[0,15,2],[-2,5,3],[2,5,2],[0,20,3],[-3,0]]),10)
path1=equidistant_path(path1,200)
sol=prism(sec,path1)
path=bspline_open(cr3dt([[10,0,0,0],[10,15,10,8],[0,0,15,6],[20,0,0,0]],20),2,50)
sol2=sol2path(sol,path)
```

```
fileopen(f'''


%{swp(sol)}
%{swp(sol2)}
color("cyan")p_line3d({path},.5);
''')

t1=time.time()
t1-t0
```

In [ ]:
```
sec=circle(5)
path=bezier(pts([[5,0],[15,10],[-26,10],[0,10],[5,6],[5,15],[4,4]]),50)
path1=rot('x90',corner_radius(pts1([[0,0],[0,45,15],[30,0]]),10))
sol=prism(sec,path)
sol1=sol2path(sol,path1)

fileopen(f'''


color("blue")p_line3d({path1},1);
{swp(sol1)}
    ''')
```

rounding-various-rounded-cubes

In [ ]:
```
t0=time.time()
p0=corner_radius(pts1([[0,0,1],[10,0,1],[0,10,1],[10,0,1],[0,10,1],[-20,0,1]]),10)
p1=corner_radius(pts1([[-3,0],[3,0,1],[0,10,1],[-3,0]]),10)
sol=prism(p0,p1)

p2=corner_radius(pts1([[0,10,1],[10,0,1],[0,10,1],[-10,0,1]]),10)
p2=offset(p2,-.001)
p3=corner_radius(pts1([[0,8],[0,12,1],[-3,0]]),10)
sol1=prism(p2,p3)
f1=ip_fillet(sol,sol1,-.7,.7)
fileopen(f'''

    {swp(sol)}
{swp(sol1)}
{swp(f1)}
    ''')
t1=time.time()
t1-t0
```

ip_triangle

In [ ]:
```
t0=time.time()

sec=pts([[0,0],[5,0],[0,5],[-5,0]])
# sec=equidistant_pathc(sec,50)
sec=m_points1(sec,7)
path=corner_radius(pts1([[-2.49,0],[2.49,0,0.25],[0,5,0.25],[-2.49,0]]),10)
sol1=prism(sec,path)
v1=[2,0,8]
sec1=axis_rot([0,0,1],circle(1.5,s=100),90)
sol2=o_solid(v1,sec1,10,-1.5,-2.5,0)
p1=ip_sol2sol(sol1,sol2)
p2=ip_sol2sol(sol1,sol2,-1)

p3=flip(p1)+p2


tri_1=ip_triangle(p3,sol1)
fileopen(f'''


%{swp(sol1)}

//%{swp(sol2)}

color("magenta")points({p3},.05);
color("blue")for(p={tri_1})p_line3dc(p,.04,rec=1);
''')
t1=time.time()
t1-t0
```

p0 + v0*t0* = *pa* + *v1*t1 + v2*t2

v0*t0*-*v1*t1-v2*t2 = pa-p0

[v0, -v1, -v2] *[t0 , t1 , t2] = [pa-p0]

In [ ]:
```
sec=pts([[0,0],[5,0],[0,5],[-5,0]])
path=corner_radius(pts1([[-2.4,0],[2.4,0,0.25],[0,5,0.25],[-2.4,0]]),10)
sol1=prism(sec,path)
fileopen(f'''


color("blue")for(p={cpo(sol1)})p_line3dc(p,.01,rec=1);
color("cyan")for(p={cpo(sol1)})polyhedron(p,[{arange(len(cpo(sol1)[0])).tolist()}]);


''')
```

bspline

In [ ]:
```
p0=pts2([[0,0,0],[10,-2,2],[0,10,3],[5,-3,-6],[-5,5,1],[0,7,-2],[0,0,5]])

p1=m_points1_o(p0,10)
c1=bezier(p0,100)
```

```
s1=bspline_open(p0,2,100)

fileopen(f'''


color("blue")points({p0},.5);
//color("magenta")points({p1},.4);
color("cyan")p_line3d({c1},.05,rec=1);

color("green")p_line3d({s1},.05,rec=1);



''')


(len(p0)-2)*20,len(s1),l_lenv_o(p0)/10
```

In [ ]:

```
# bspline_closed function
px=pts2([[0,0,0],[5,2,3],[5,8,5],[-15,-3,1],[-3,5,-5],[3,5,6],[-13,-10,10]])

# b=bspline_open(px,2,100)
c=bezier(px,100)
d=bspline_closed(px,2,100)
fileopen(f'''

color("blue")points({px},.5);
color("cyan")p_line3d({px},.1);
color("blue")p_line3d({d},.1);

''')
```

In [ ]:
```
px=pts2([[0,0,0],[5,2,3],[5,8,5],[-15,-3,-2],[0,10,0],[7,0,6],[-3,5,-4]])
px=helix(10,5,1,5)
b=bspline_open(px,4,100)
c=bezier(px,100)

fileopen(f'''

color("blue")points({px},.5);
color("magenta")p_line3d({b},.1,rec=1);
//color("cyan")p_line3d({c},.1,rec=1);


''')

len(b)
```

faces

In [ ]:
```
sec=pts([[0,0],[5,0],[0,5],[-5,0]])
# sec=equidistant_pathc(sec,50)
path=corner_radius(pts1([[-1,0],[1,0,0.25],[0,5,0.25],[-1,0]]),10)
sol1=prism(sec,path)
l,m,_=array(sol1).shape
v=array(sol1).reshape(-1,3).tolist()
f1=faces(l,m)

fileopen(f'''


polyhedron({v},{f1});

''')
```

faces_1

In [ ]:
```
sec=pts([[0,0],[5,0],[0,5],[-5,0]])
# sec=equidistant_pathc(sec,50)
path=corner_radius(pts1([[-1,0],[1,0,0.25],[0,5,0.25],[-1,0]]),10)
sol1=prism(sec,path)
l,m,_=array(sol1).shape
v=array(sol1).reshape(-1,3).tolist()
f1=faces_1(l,m)

fileopen(f'''


polyhedron({v},{f1});

''')
```

In [ ]:
```
p0=[10,0,0]
p1=[5,2,3]
p2=[10,1,-10]

l1,p2=array([p0,p1]),array(p2)

v1=l1[1]-l1[0]
u1=v1/norm(v1)
v2=p2-l1[0]

v2sint=norm(cross(v1,v2))/norm(v1)
v2cost=(v1@v2)/norm(v1)
t1=v2cost/norm(v1)
p3=l_(a_(p0)*(1-t1)+a_(p1)*t1)
p2=l_(p2)
txt1=dim_angular([p0,p1],[p2,p3])
fileopen(f'''


color("blue")points({[p0,p1,p2,p3]},.3);
color("cyan")p_line3d({[p0,p1]},.1);
color("magenta")p_line3d({[p2,p3]},.1);
{txt1}


''')
v1=a_(p1)-a_(p0)
v2=a_(p3)-a_(p2)
u1=v1/norm(v1)
u2=v2/norm(v2)
t1,r2d(arccos(u1@u2)) # angle between the 2 lines
```

i_p_p

i_p_n

i_p_t

o_3d

ip_fillet

In [ ]:
```
i_t=time.time()
sol=o_solid([1,0,0],circle(5),30,-15)
```

```
sol1=o_solid([0,1,0],circle(4.8),30,-15)
sol1=slice_sol(sol1,2)
fillet1=ip_fillet(sol,flip(sol1),1,1,o=-1,style=2)
fillet1=fillet1+[fillet1[0]]
fillet2=ip_fillet(flip(sol),sol1,1,1,o=-1,style=2)
fillet2=fillet2+[fillet2[0]]
fileopen(f'''


%{swp(sol)}
%{swp(sol1)}

{swp_c(fillet1)}
{swp_c(fillet2)}



''')
f_t=time.time()
f_t-i_t
# len(i_p),len(i_p1),len(i_p2)
```

In [ ]:
```
i_t=time.time()
sec=corner_radius(pts1([[-5,-10,1],[10,0,1],[0,15,1],[-10,0,1]]),10)
path=corner_radius(pts1([[-5,0],[5,0,1],[0,20,1],[-5,0]]),10)
sol=prism(sec,path)
sec1=circle(2,s=100)
path1=bezier(pts2([[0,-4,2],[0,5,10],[10,1,20]]),20)
sol1=path_extrude_open(sec1,path1)
fillet1=ip_fillet(sol,sol1,-1,1,style=2)
fillet1=fillet1+[fillet1[0]]
# p1=ip_sol2sol(sol,sol1,-1)

# p2=i_p_p(sol1,p1,1)
# p3=o_3d(p1,sol,-1)

# fillet1=convert_3lines2fillet_closed(p3,p2,p1)

fileopen(f'''


%{swp(sol)}
%{swp(sol1)}
{swp_c(fillet1)}

    ''')
f_t=time.time()
f_t-i_t
```

In [ ]:
```
i_t=time.time()
p1=[[0,-31],[21-5,0,.2],[2,10,4],[35,0,10],
    [5,22,5],[-5,22,10],[-35,0,4],[-2,10,.2],[-21+5,0]]

path1=corner_radius(pts1(p1),10)
sec1=circle(5,s=72)
sol1=prism(sec1,path1)



sec5=corner_radius(pts1([[-20,-7.5,2.45],[5,0,2.45],[0,10,3],[15,2,70],[15,-2,3],[0,-10,2.45],
             [5,0,2.45],[1,7.5,5],[-1,7.5,7],[-20,3,90],[-20,-3,7],[-1,-7.5,5]]),10)


sec5=equidistant_pathc(sec5,201)
sec6=scl2d_c(sec5,.6)
sol2=[c2t3(sec5)]+[translate([0,0,120],sec6)]
sol2=translate([0,41,0],rot('x90z190',sol2))

# p1=ip_surf(sol1,sol2)
# p2=i_p_p(sol2,p1,6)
# p3=o_3d(p1,sol1,6)
# fillet1=convert_3lines2fillet_closed(p1,p2,p3)
fillet1=ip_fillet(sol1,sol2,-6,6,style=2)
fillet1=fillet1+[fillet1[0]]
fileopen(f'''


%{swp(sol1)}
%{swp(sol2)}
{swp_c(fillet1)}

''')

f_t=time.time()
f_t-i_t
# len(p1),len(p2),len(p3)
```

In [ ]:
```
i_t=time.time()

p1=[[0,-31],[21-5,0,.2],[2,10,4],[35,0,10],
    [5,22,5],[-5,22,10],[-35,0,4],[-2,10,.2],[-21+5,0]]

path1=corner_radius(pts1(p1),10)
sec1=circle(5,s=72)
sol1=prism(sec1,path1)



sec5=corner_radius(pts1([[-20,-7.5,2.49],[5,0,2.49],[0,10,3],[15,2,70],[15,-2,3],[0,-10,2.49],
             [5,0,2.49],[1,7.5,5],[-1,7.5,7],[-20,3,90],[-20,-3,7],[-1,-7.5,5]]),10)


sec5=equidistant_pathc(sec5,200)
```

```
sec6=scl2d_c(sec5,.6)
sol2=[c2t3(sec5)]+[translate([0,0,120],sec6)]
sol2=translate([0,41,0],rot('x90z190',sol2))
p1=ip(sol1,sol2)

p2=ip(sol1,offset_sol(sol2,8))
# p2=sort_points(p1,p2)
# p2=sort_points(p1,p2)
p3=i_p_p(sol2,p1,8)
# p3=sort_points(p1,p3)

fillet1=convert_3lines2fillet_closed(p2,p3,p1,style=2)

fileopen(f'''


%{swp(sol1)}
%{swp(sol2)}
//%{swp(offset_sol(sol2,6))}
{swp_c(fillet1)}
color("blue")p_line3dc({p2},.2,rec=1);
color("green")p_line3dc({p3},.2,rec=1);

color("magenta")p_line3dc({p1},.2,rec=1);


''')
len(p1),len(p2),len(p3)
f_t=time.time()
f_t-i_t
```

In [ ]:

```
# m10
t0=time.time()

sec1=arc(20,0,359,s=150)
path1=[[0,0],[-5,25]]

surf1=prism(sec1,path1)

sec2=corner_radius(pts1([[-25,0],[10,5,5],[10,-3,10],[10,5,5],[10,-8,7],[10,1]]),10)
path2=cytz(corner_radius(pts1([[-35,5,0],[10,8,20],[20,-5,10],[20,8,20],[10,-9,20],[10,1,0]]),10))
surf2=path_extrude_open(sec2,path2)

# p1=ip_surf(surf2,surf1)
# p2=o_3d_surf(p1,surf2,2)
# p3=i_p_p(surf1,p1,2)
# # # p=fillet_surf2sol(surf2,surf1,2,10,0)
# fillet1=convert_3lines2fillet_closed(p1,p3,p2)

fillet1=ip_fillet_surf(surf2,surf1,2,2)
fillet1=fillet1+[fillet1[0]]
fileopen(f'''

%{swp(surf1)}
%{swp_surf(surf2)}
{swp_c(fillet1)}



''')
t1=time.time()
total=t1-t0
total
```

In [ ]:

```
t1=time.time()

p1=[[0,-15,.5],[6,0,.3],[0,-16,.1],[1,-1,.1],[4,0,.2],[2,10,4],[35,0,10],
    [5,22,5],[-5,22,10],[-35,0,4],[-2,10,.2],[-4,0,.1],[-1,-1,.1],[0,-16,.3],
    [-6,0,.5]]
sec1=corner_radius(pts1(p1),10)
path1=c2t3(circle(10,s=72))
sol1=path_extrude_closed(sec1,path1)

sec3=circle(7,s=50)
path2=corner_radius(pts1([[2,0],[-2,31]]),10)

sol3=translate([51.2,0,12],prism(sec3,path2))
# px=ip_surf(sol1,sol3)
# py=i_p_p(sol3,px,3)
# pz=o_3d_surf(px,sol1,3)
# fillet1=convert_3lines2fillet_closed(px,py,pz)
fillet1=ip_fillet(sol1,sol3,-3,3,style=2)
fillet1=fillet1+[fillet1[0]]
f3=end_cap(sol3,2)[1]
fileopen(f'''


{swp_c(sol1)}
difference(){{
{swp(sol3)}
{swp_c(f3)}
}}
{swp_c(fillet1)}

//color("blue")for(p={[cpo(fillet1)[0],cpo(fillet1)[-2]]})p_line3dc(p,.2);
    ''')

t2=time.time()
t2-t1
# len(p1),len(p2),len(p3)
```

In [ ]:
```
line=[[0,0],[10,0]]
pnts=[[5,1.5]]
d=2

perp_points_d(line,pnts,d),perp_distance_within_line(line,pnts)
```

In [ ]:
```
t0=time.time()
sec=corner_radius(pts1([[0,0],[40,0],[0,40],[-40,0]]),10)


sol1=linear_extrude(sec,10)

sol2=translate([0,20,12],rot('y90',cylinder(r1=7.5,r2=0,h=40,s=100)))
a=cr2dt([[4,0],[-4,0,4],[0,4]],50)
b=[ translate([0,0,-x],linear_extrude(sec,10+2*x)) for (x,y) in a]
c=[ translate([0,20,12],rot('y90',cylinder(r1=7.5+y,r2=0,h=40,s=100)))
     for (x,y) in a]
fileopen(f'''
a={a};
b={b};
c={c};
for(i=[0:len(a)-2])
hull(){{
intersection(){{
swp(b[i]);
swp(c[i]);
}}
intersection(){{
swp(b[i+1]);
swp(c[i+1]);
}}
}}

{swp(sol1)}
{swp(sol2)}

''')


t1=time.time()
t1-t0
```

partial_surface

shield

In [ ]:
```
i_t=time.time()
sec1=circle(55)
path1=corner_radius(pts1([[-50,0],[50,0,.2],[0,30,3],[6,1,3],[0,6,3],[-4,2,3],[0,22,6],[8,2,6],[0,10,.2],[-50,0]]),10)
# path1=equidistant_path(path1,200)
sec2=circle(7.5)
path2=corner_radius(pts1([[-5,0],[5,0,5],[0,35,2],[-5,0]]),10)
path2=equidistant_path(path2,50)
sol1=prism(sec1,path1)
sol2=translate([57.5,0,37],prism(sec2,path2))
sol2=axis_rot_o([0,0,1],sol2,180)

s1=shield(sol1,sol2,50,10,4,135)
v,f1=partial_surface(sol1,prism_center(sol2),50)


fileopen(f'''


%{swp(sol1)}
%{swp(sol2)}

color("blue")for(p={s1})for(p1=p)p_line3dc(p1,.2,rec=1);
polyhedron({v},{f1});

''')


f_t=time.time()
f_t-i_t
# len(p1),len(p2),len(p3)
```

In [ ]:
```
# example of function surface_for_fillet(sol1=[],sol2=[],factor1=50,factor2=10,factor3=1,factor4=100,dia=40)
t0=time.time()

sec=circle(10)
path=corner_radius(pts1([[-8,0],[10,0],[-2,0,2],[-1,15,3],[-8.9,0]]),10)
path=equidistant_path(path,100)
sol1=rot('z90',prism(sec,path))

sec1=corner_radius(pts1([[0,0,1],[5,0,1],[0,7,2.3],[-5,0,2.3]]),10)
path1=corner_radius(pts1([[-2.4,0],[2.4,0,2],[0,5,.3],[-.5,0]]),10)
path1=equidistant_path(path1,30)
sol2=translate([6,0,12],rot('x90z90',prism(sec1,path1)))

i_p1=shield(sol1,sol2,100,20,4,23)
v,f1=partial_surface(sol1,prism_center(sol2),10)

fileopen(f'''

%{swp(sol1)}
%{swp(sol2)}
color("blue") for(p={i_p1})for(p1=p)p_line3dc(p1,.05,rec=1);
polyhedron({v},{f1});

''')

t1=time.time()
t1-t0

# len(ip2),len(ip3),len(ip4)
```

In [ ]:
```
t0=time.time()
c1=circle(22.6,s=100)
c2=circle(6,rot2d(90,[26.27,0]))
c2,c3,c4=[rot2d(i,c2)  for i in [0,120,240]]
a1=two_cir_tarc(c1,c2,7.5,s=20)
a2=two_cir_tarc(c2,c1,7.5,s=20)
a3=two_cir_tarc(c1,c3,7.5,s=20)
a4=two_cir_tarc(c3,c1,7.5,s=20)
a5=two_cir_tarc(c1,c4,7.5,s=20)
a6=two_cir_tarc(c4,c1,7.5,s=20)
sec=concave_hull(c1+c2+c3+c4+a1+a2+a3+a4+a5+a6,3)
s1=linear_extrude(sec,3)
c5=circle(33.75/2)
path=corner_radius_with_turtle([[1.88,3],[-1.88,0,1.88],[0,5.63],[-1.125,0],[0,3.75],
                                [1.125,0],[0,7.5],[-1.125,0],[0,3.75],[1.125,0],[0,5.63]],20)

s2=prism(c5,path)
h=a_(s2).reshape(-1,3)[:,2].max()
s3=linear_extrude(circle(14.06),h)
s4=linear_extrude(circle(2.81,rot2d(90,[26.27,0])),3)
s4,s5,s6=[rot(f'z{i}',s4) for i in [0,120,240]]
e1=end_cap(s1,1)
e2=l_(concatenate([end_cap_1(p,1)  for p in [s4,s5,s6]]))
e3=end_cap_1(s3,1)
e4=end_cap(s2,1)[-1]

fileopen(f'''
```

```
difference(){{
for(p={[s1,s2]})swp(p);
{swp(s3)}
for(p={[s4,s5,s6]})swp(p);
for(p={e1})swp_c(p);
for(p={e2})swp(p);
for(p={e3})swp(p);
{swp_c(e4)}
}}


''')
t1=time.time()
t1-t0
```

In [ ]:

```
i_t=time.time()

sec1=r_sec(60,60,[-55/2,0],[55/2,0],s=50)[:-1]
path1=corner_radius(pts1([[0,0],[0,8],[-14.5,0,2],[0,24,20],[-25,0]]),10)

sol1=prism(sec1,path1)
sol1=sol1+[sort_points(sol1[-1],[[0,0,24+8]])]
e6=end_cap(sol1[:2],2)
sec2=offset(sec1,-22.5)
path2=corner_radius(pts1([[0,-0.01],[0,24.01,12],[-12-25.5,0]]),10)
sol2=prism(sec2,path2)
sol2=sol2+[sort_points(sol2[-1],[[0,0,24]])]
e1=end_cap_1(sol2[:2],5)[0]
sec3=circle(8)
path3=corner_radius(pts1([[0,16],[0,27,2],[7,0,2],[0,5]]),10)
sol3=prism(sec3,path3)
e4=end_cap(sol3,2)
fillet1=ip_fillet_closed(sol1,sol3,-2,2,style=2)
fillet2=ip_fillet_closed(sol2,sol3,-2,-2,style=2)

sol4=translate([34.75,0,28],linear_extrude(circle(9),8))
e5=end_cap(sol4,2)[1]
fillet3=ip_fillet_closed(sol1,sol4,-2,2,style=2)

sol5=translate([0,0,16],linear_extrude(circle(4),32))

e2=end_cap_1(sol5,2)
sol6=translate([34.75,0,24],linear_extrude(circle(5),12))
e3=end_cap_1(sol6,2)
sol7=translate([0,52.5,0],linear_extrude(circle(4),8))
sol8=[translate([-55/2,0,0],rot(f'z{i}',sol7)) for i in [0,60,120,180]]
sol9=[translate([55/2,0,0],rot(f'z{i}',sol7)) for i in [0,-60,-120,-180]]
sol10=end_cap_1(sol7,1)
sol11=l_(concatenate([translate([-55/2,0,0],rot(f'z{i}',sol10)) for i in [0,60,120,180]]))
sol12=l_(concatenate([translate([55/2,0,0],rot(f'z{i}',sol10)) for i in [0,-60,-120,-180]]))
fileopen(f'''
//color("blue")p_line({sec1},.05);
//color("blue")p_lineo({path1},.2);

difference(){{
union(){{
difference(){{
{swp(sol1)}
{swp(sol2)}
for(p={sol8})swp(p);
for(p={sol9})swp(p);
{swp(e1)}
for(p={sol11})swp(p);
for(p={sol12})swp(p);
}}
{swp(sol3)}
{swp(sol4)}
}}
{swp(sol5)}
for(p={e2})swp(p);
{swp(sol6)}
for(p={e3})swp(p);
for(p={e4})swp_c(p);
{swp(e5)}
for(p={e6})swp_c(p);
}}

{swp_c(fillet1)}
{swp_c(fillet2)}
{swp_c(fillet3)}
```

```
//color("blue")for(p={sol1[:2]})p_line3dc(p,.5,rec=1);
''')

f_t=time.time()
f_t-i_t
```

In [ ]:
```
i_t=time.time()

a1=c2t3(arc_2p([0,0],[5,28],58,-1))
a2=flip(c2t3(arc_2p([-1,2],[3,28],56,-1)))

a3=[[-5,0,0],[0,0,3]]+a1[2:-1]+[[5,28,.9],[3,28,.9]]+a2[1:-1]+[[-1,2,2],[-5,2,0]]
path1=corner_radius(a3,10)
sec1=circle(43/2,s=50)
sol1=prism(sec1,path1)

c1=circle(7.75,[10,18])
p0=[0,8]
p1=p_cir_t(p0,c1)
p2=c1[19]
a4=arc_long_2p(p1,p2,7.75,-1,s=50)
path2=cytz([p0]+a4)
sec2=circle(2,s=30)
sol2=translate([18.7,0,-3],align_sol_1(path_extrude_open(sec2,path2)))

a5=[[-5,0,0],[0,0,5]]+a1[1:-1]+[[5,28,1],[3,28,0]]
path3=corner_radius(a5,10)
sol3=prism(sec1,path3)
fillet1=flip(ip_fillet_closed(sol1,sol2[:-10],-2,2,style=2))
fillet2=ip_fillet_closed(sol3,flip(sol2[30:]),2,2,style=2)

sol4=cut_plane([0,-1,0],[100,100],100)
fileopen(f'''

{swp(sol1)}
difference(){{
{swp(sol2)}
{swp(sol3)}
}}
{swp_c(fillet1)}
{swp_c(fillet2)}



''')

f_t=time.time()
f_t-i_t
```

In [ ]:
```
sec=corner_radius(pts1([[-2.5,-2.5,0],[5,0,2.5],[0,2.5,0.5],[5,0,0]]),10)

fileopen(f'''
color("blue")p_lineo({sec},.05);

''')
```

In [ ]:
```
s=100
x=2
a=linspace(0,4,s)
b=sin(d2r(720/x*a))

theta=720/x*a
c=cos(d2r(theta))
d=sin(d2r(theta))
e=array([[cos(d2r(i)),sin(d2r(i))] for i in linspace(0,360,s)])
e=einsum('ij,i->ij',e,abs(b)).tolist()
sw=array([a,b]).transpose(1,0).tolist()
```

```
fileopen(f'''
e={e};
sw={sw};
color("blue")p_lineo(loop(sw,0,100*$t),.05);
color("magenta")p_lineo(loop(e,0,100*$t),.05);



''')
```

In [ ]:
```
s=200
x=2
a=linspace(0,4,s)
b=sin(d2r(270/x*a))

theta=270/x*a
c=cos(d2r(theta))
d=sin(d2r(theta))
e=array([[cos(d2r(i)),sin(d2r(i))] for i in linspace(0,360,s)])
e=einsum('ij,i->ij',e,abs(b)).tolist()
sw=array([a,b]).transpose(1,0).tolist()

fileopen(f'''
e={e};
sw={sw};
color("blue")p_lineo(loop(sw,0,200*$t),.05);
color("magenta")p_lineo(loop(e,0,200*$t),.05);



''')
```

In [ ]:
```
# 3d knots various types
t0=time.time()
# trefoil knot

# path=[[10*(sin(t)+2*sin(2*t)),
#       10*(cos(t)-2*cos(2*t)),
#       -10*sin(3*t)] for t in d2r(arange(0,360))]

# circular sin theta knot

# path=[[60*(cos(t)),
#       60*(sin(t)),
#       20*sin(4*t)*cos(4*t)] for t in d2r(arange(0,360))]

# random knot

# path=[[20*(-0.22*cos(t) - 1.28*sin(t) - 0.44*cos(3*t) - 0.78*sin(3*t)),
# 20*(-0.1*cos(2*t) - 0.27*sin(2*t) + 0.38*cos(4*t) + 0.46*sin(4*t)),
# 20*(0.7*cos(3*t) - 0.4*sin(3*t))] for t in d2r(arange(0,360))]

# torus knots

# path=[[10*cos(3*t)*(3+cos(4*t)),
# 10*sin(3*t)*(3+cos(4*t)),
# 10*sin(4*t)] for t in d2r(arange(0,360))]

# cinquefoil torus knots
# a,p,q=3,3,16
# d=10

# explanation
# radius of the torus = a*d
# section radius of the torus = d
# p in number of cycles of the wrapping coil over torus
# q in the number of turns of the wrapping coil over torus

# path=[[d*cos(p*t)*(a+cos(q*t)),
# d*sin(p*t)*(a+cos(q*t)),
# -d*sin(q*t)] for t in d2r(arange(0,360,1))]



# Lissajous knots

path=[[10*cos(3*t+5),
10*cos(3*t+10),
10*cos(3*t+2)]for t in d2r(arange(0,360))]
r=2
sec=circle(r)
```

```
sol=align_sol_1(path_extrude_closed(sec,path))

# sec1=circle(d-r)
# path1=c2t3(circle(a*d))
# sol1=path_extrude_closed(sec1,path1)

fileopen(f'''
//color("blue")p_line3d({path},4);
sol={sol};
//color("magenta")swp_c(loop(sol,0,360*$t));
//color([.2,.5,.7,.3])
{swp_c(sol)}

//%{swp_c(sol1)}

''')
t1=time.time()
t1-t0
```

In [ ]:

```
sec=circle(25)
path=corner_radius(pts1([[0,0,0],[0,15,1],[-6,50,1],[0,18,0]]),10)
sol=prism(sec,path)
sol1=prism(circle(24),path)
sol0=swp_prism_h(sol,sol1)
sec2=circle(15)
path2=cr3dt([[0,0,15,0],[-60,0,40,20],[0,0,30,0]],10)
sol2=path_extrude_open(sec2,path2,twist=1)
sol3=path_extrude_open(offset(sec2,-1),path2,twist=1)
sol02=swp_prism_h(sol2,sol3)
fillet1=ip_fillet_closed(sol,sol2,-5,5,style=2)

sec3=corner_radius(pts1([[0,0],[-2,1,.2],[2,1]]),10)
path3=helix(14,2.5,6,5)
sol4=path_extrude_open(sec3,path3)

sol4=sol2vector([0,0,1,],sol4,[-60,0,70])
fileopen(f'''
difference(){{
{swp_c(sol0)}
{swp(sol3)}
}}
difference(){{
{swp_c(sol02)}
{swp(sol)}
}}
{swp_c(fillet1)}
intersection(){{
color("blue"){swp(sol4)}
{swp(sol3)}
}}

''')
```

sinwave-box

In [ ]:
```
i_t=time.time()
# sinwave glass
height=125
dia=100
width=pi*dia
factor=round(width/height,0)
sec=[[[i,j,1*sin(d2r(i*360/height*3))*sin(d2r(j*360/width*3*factor))] for j in linspace(0,width,150)] for i in linspace(0,height,100)]
# path=translate([0,100/pi/2,100/pi/2],rot('y90',arc(100/pi/2,0,400,s=200)))
path=rot('y90',arc(dia/2,0,400,s=200))

surf1=[wrap_around(p,path)[:-1] for p in sec]

surf2=offset_sol(surf1,-2)

sol1=rot('y-90',swp_prism_h(surf2,surf1))
sol2=rot('y-90',surf1[:2])

p0=sol1[2][:-1]
p1=sol1[15][:-1]
p2=offset_3d(p0,-15)
fillet1=convert_3lines2fillet_closed(p2,p1,p0,s=30)

sol3=flip(sol1)[:-15]+flip(cpo(fillet1)[1:-1])

sol4=cut_plane([-1,0,0],[300,300],300,0,0,0)
fileopen(f'''
    difference(){{
   {swp(sol3)}
   //{swp(sol4)}

   }}
    ''')
f_t=time.time()
f_t-i_t
```

In [ ]:
```
i_t=time.time()
# sinwave-box
w1=rot('x90',sinewave(100,2.5,1.5,100))
w2=rot('x90z90',sinewave(60,1.5,1.5,60))
s1=translate([50,-30,0],rot('y-90',surface_from_2_waves(w1,w2,1.5)))
s2=[cpo(rot(f'z{i}',s1)) for i in [0,90,180,270]]
l1=s2[0][-1]
l2=s2[1][0]
l3=translate([0,20,0],l1)
f1=cpo(convert_3lines2fillet(l1,l2,l3,s=30))[:-1]
f2=[rot(f'z{i}',f1[1:-1]) for i in [0,90,180,270]]
s3=cpo(s2[0]+f2[0]+s2[1]+f2[1]+s2[2]+f2[2]+s2[3]+f2[3])
s4=offset_sol(s3,-2)
sol=s3+flip(s4)[:-2]
l1=flip(s4)[-6]
l2=flip(s4)[-3]
l3=offset_3d(l2,-3)
f3=convert_3lines2fillet_closed(l3,l1,l2,s=20)
fileopen(f'''
    union(){{
{swp(sol)}
{swp_c(f3)}
}}

    ''')
f_t=time.time()
f_t-i_t
```

rot2d

translate_2d

In [ ]:
```
c1=circle(22.5)
c2=translate_2d([26.25,0],circle(6))
c3=[rot2d(i,c2)  for i in [0,120,240]]

a1=two_cir_tarc(c1,c2,7.5)
p0,p1=a1[0],a1[-1]

a2=two_cir_tarc(c2,c1,7.5)
p2,p3=a2[0],a2[-1]
p4=rot2d(120,p0)

sec=arc_2p(p0,p1,7.5,cw=1)+arc_2p(p1,p2,6,cw=-1)+ \
arc_2p(p2,p3,7.5,cw=1)+arc_2p(p3,p4,22.5,cw=-1)

sec=[rot2d(i,sec)  for i in [0,120,240]]

sec=remove_extra_points(concatenate(sec).round(5))

sol=linear_extrude(sec,5)


fileopen(f'''
//color("blue",.2)p_line3dc({c1},.3);
//color("magenta",.2)for(p={c3})p_line3dc(p,.3);

//color("cyan")p_line3dc({sec},.5);
//color("blue")points({[p4]},1);
{swp(sol)}

    ''')
```

In [ ]:
```
peri=400
height=100
sec=corner_radius(pts1([[0,0],[9,0],[0,1],[1,0]]),10)
sec=concatenate([translate_2d([i,0],sec) for i in arange(0,peri,10)]).tolist()

sec=translate([0,1,0],rot('x90z90',sec))
path=rot('y90',arc(401.07/(2*pi),0,360,s=100))
sec=rot('y-90',wrap_around(sec,path))
sec1=translate([0,0,5],sec)
sec2=offset_3d(sec1,-.5,2)
sec3=rot('z5',translate([0,0,5.5],sec))
sec4=offset_3d(sec3,-.5,2)
sec5=translate([0,0,5],sec3)
sec6=translate([0,0,5],sec4)
sec7=translate([0,0,11],offset_3d(sec,-.5,2))
sec8=translate([0,0,11],sec)


sol=[sec,sec1,sec2,sec4,sec3,sec5,sec6,sec7,sec8]
sol1=concatenate([ translate([0,0,i],sol) for i in range(0,110,11)]).tolist()
a=[0,5,5,5.5,5.5,10.5,10.5,11,11]
b=[10,10,9,9,10,10,9,9,10]
sol2=[translate([0,0,a[i]],offset(c3t2(sol[i]),-b[i],2)) for i in range(len(a))]
sol2=concatenate([ translate([0,0,i],sol2) for i in range(0,110,11)]).tolist()
sol3=swp_prism_h(sol1[:-2],sol2[:-2])
fileopen(f'''

{swp_c(sol3)}


    ''')
```

In [ ]:
```
sec=corner_radius(pts1([[0,0],[70,0],[0,28],[-17.5,0,7],[0,24.5,17.5]
                        ,[-35.01,0,17.5],[0,-24.5,7],[-17.5,0]]),20)

cp_1=cp_arc(sec[26:30])
c1=circle(10,cp_1)
c2=circle(2.5,[7.5,14])
c3=circle(2.5,[62.5,14])
sol1=linear_extrude(sec,16)
sol2=[translate([0,0,-.5],linear_extrude(p,17))  for p in [c1,c2,c3]]
sol3=translate([-.5,-.5,12.5],cube([18,40,20]))
sol4=translate([70-17.5,-.5,12.5],cube([18,40,20]))
c4=circle(7.5,[-7.5,32.5])
p0=[0,0]
```

```
p1=p_cir_t(p0,c4)
p3=[-52.5+29,16]
p2=cir_p_t(c4,p3)
p4=[-52.5+17.5,16]
p5=[-52.5+17.5,0]
c5=circle(2.5,[-7.5,32.5])
sec1=[p0]+arc_2p(p1,p2,7.5,-1,30)+[p3,p4,p5]

sol5=linear_extrude(sec1,7.5)
sol6=translate([0,0,-.5],linear_extrude(c5,9))
fileopen(f'''
//color("blue")p_line3d({sec},.2,1);
//color("magenta")p_line3d({c1},.2,1);
//color("magenta")p_line3d({c2},.2,1);
//color("magenta")p_line3d({c3},.2,1);
//color("blue")points({[p0,p1,p2,p3,p4,p5]},.5);
//color("magenta")p_line3dc({sec1},.2,1);
for(i=[17.5,17.5+35-7.5])
translate([i+7.5,0,0])
rotate([90,0,-90])
difference(){{
{swp(sol5)}
{swp(sol6)}
}}

difference(){{
{swp(sol1)}
for(p={sol2})swp(p);
{swp(sol3)}
{swp(sol4)}
}}

    ''')
```

sinewave

cosinewave

e_wave

In [ ]:
```
wav1=sinewave(50,6,1,200)
wav2=cosinewave(50,6,1,200)
wav3=e_wave(50,6,.1,200)

fileopen(f'''
color("blue") p_line3d({wav1},.2);
color("magenta") p_line3d({wav2},.2);
color("cyan") p_line3d({wav3},.2);



    ''')
```

In [ ]:
```
wav1=sinewave(50,6,1,200)
wav2=sinewave(50,9,1,200)
```

```
a=[[wav1[i][0] , wav1[i][1]*wav2[i][1]  ]  for i in range(len(wav1))]
# b=[[wav1[i][0] , wav1[i][1]*wav2[i][1]  ]  for i in range(len(wav1))]

b=rot('x90',a)
c=rot('x90z90',a)

surf_1=surface_from_2_waves(b,c,1)
surf_2=surface_offset(surf_1,-.1)

path=circle(50/2/pi+.01,s=100)
path=path+path[:3]
path=rot('y90',path)
sol=[ wrap_around(p,path) for p in surf_1]
sol=rot('y-90',sol)
h=[[0,0,p[0][2]] for p in sol]
s=c3t2(sol)
s1=[offset(p,-.5)  for p in s]
sol1=[translate(h[i],s1[i])  for i in range(len(s1))]
sol2=swp_prism_h(sol,sol1)
sol2=scl3d(sol2,2)
fileopen(f'''
{swp_c(sol2)}

    ''')
```

SurfaceFrom3LinesInDifferentPlanes

In [ ]:
```
i_t=time.time()
w1=arc_3p_3d([[0,0,0],[5,20,0],[0,40,0]])
w2=arc_3p_3d([[0,0,0],[-4,0,20],[0,0,40]])
w3=arc_3p_3d([[0,0,40],[2,15,40],[0,30,45]])

surf_1=SurfaceFrom3LinesInDifferentPlanes(w1,w3,w2)
surf_2=surface_offset(surf_1,-1)
sol=solid_from_2surfaces(surf_1,surf_2)

fileopen(f'''

color("blue")for(p={sol})p_line3dc(p,.1,1);

{swp(sol)}

    ''')

f_t=time.time()
f_t-i_t
```

In [ ]:
```
# complex part with fillet
i_t=time.time()

c1=circle(20)
c2=circle(5,[25,0])
f_1=two_cir_tarc(c1,c2,10,0)
f_2=two_cir_tarc(c1,c2,10,1)
p0,p1,p2,p3,p4,p5=f_1[0],f_1[-1],[70,-5],[70,5],f_2[0],f_2[-1]

sec=[p3]+arc_2p(p4,p5,10,1)+arc_long_2p(p5,p0,20,-1,s=50)+ \
arc_2p(p0,p1,10,1)+[p2]

sec=remove_extra_points(array(sec).round(5))
sec=equidistant_path(sec,1000)
sol=translate([0,0,-25],linear_extrude(sec,50))
sol1=translate([40,0,0],rot('x90z180',sol))
```

```
ipa=ip_sol2sol(sol1,sol)
ipb=ip_sol2sol(sol1,sol,-1)

ipc=remove_extra_points(array(ipa+flip(ipb)).round(5))
fillet1=i_line_fillet(ipc,sol,sol1,-2,2,10)
fillet2=solid_from_fillet_closed(fillet1,-4)

sol2=o_solid([0,0,1],circle(15),10,-5)
e1=end_cap_1(sol2,2)
sol3=o_solid([0,1,0],circle(15),10,-5,40)
e2=end_cap_1(sol3,2)
fileopen(f'''

    difference(){{
    intersection(){{
    {swp(sol)}
    {swp(sol1)}
    }}
{swp_c(fillet2)}
{swp(sol2)}
{swp(sol3)}
for(p={e1})swp(p);
for(p={e2})swp(p);

}}
    ''')

f_t=time.time()
f_t-i_t
```

In [ ]:

```
# mobile stand revised version
i_t=time.time()
sec=cr2dt([[0,0,1.9],[150,0,1.9],[0,4,1.9],[-150,0,1.9]],10)
path=cr2dt([[-1.9,0],[1.9,0,1.9],[0,120,1.9],[-1.9,0]],10)

sol=prism(sec,path)
sol=rot('z90',sol)
sol=[equidistant_pathc(p,400) for p in sol]
path1=arc_2p([0,0],[150,0],500,1,150)
path1=translate([0,0,120],rot('x90z90',path1))

sol1=translate([0,0,-120+1.9],sol[-10:])
sol1=[wrap_around(p,path1) for p in sol1]

path2=arc_2p([0,0],[150,0],500,-1,150)
path2=translate([0,0,0],rot('x90z90',path2))
sol2=sol[:10]
sol2=[wrap_around(p,path2) for p in sol2]

sol3=[sol2[-1]]+[sol1[0]]
sol3=slice_sol(sol3,100)
sol4=sol2+sol3+sol1
sol4=translate([0,10,0],rot('y90z90',sol4))

path3=cr2dt([[0,0],[127,0,6],[-50*cos(d2r(60)),50*sin(d2r(60))]],10)
path3=rot('x90z90',path3)

sol5=[wrap_around(p,path3) for p in sol4]

sec=cr2dt([[6,0,1.9],[150-12,0,1.9],[0,4,1.9],[-150+12,0,1.9]],10)
path=cr2dt([[0,0],[0,1.9,1.9],[-1.9,0]],10)

sol=prism(sec,path)
sol=rot('z90',sol)
path=arc_2p([0,0],[150,0],300,1,150)
path=translate([0,0,50],rot('x90z90',path))

sol1=[wrap_around(equidistant_pathc(p,400),path) for p in sol]
sol2=translate([0,0,-50],equidistant_pathc(wrap_around(sol[0],path),400))
sol2=[sol2]+sol1
sol2=translate([0,100,1],rot('z90x30',sol2))

sol6=[sol5[10]]+[sol5[90]]
sol7=[sol2[0]]+[sol2[1]]
fillet1=flip(ip_fillet_closed(sol6,sol7,-4,3.8,style=2))

fileopen(f'''
    {swp(sol5)}
    {swp(sol2)}
    {swp_c(fillet1)}

    ''')

f_t=time.time()
f_t-i_t
```

points_inside_offset_surround

In [ ]:

```
i_t=time.time()
sec=corner_radius(pts1([[0,0,1],[7,5,2],[5,7,3],[-5,7,2],[-7,5,3]]),10)
```

```
a=(random.random(5000)*(30-0)+(-10))
b=(random.random(5000)*(30-0)+(-5))
c=array([a,b]).transpose(1,0).tolist()
r=3
sec2=cs1(sec,r-.01)
p_0=points_inside_offset_surround(sec,c,r-.01)
fileopen(f'''
    color("blue")p_line3dc({sec},.1,1);
    color("cyan")points({c},.2);
    color("green",.1)for(p={sec2})p_line3dc(p,.1,1);
    color("magenta")points({p_0},.2);

    ''')
f_t=time.time()
f_t-i_t
```

In [ ]:

```
od=150
id=75
n=16
t=3
sl_ang=50
sl_h=(od/2-id/2)*tan(d2r(sl_ang))
a=c2t3(circle(od/2,s=n+1))
b=rot(f'z{360/len(a)/2}',c2t3(circle(od/2,s=n+1)))
h=l_len(a[:2])/2

sol_1=[translate([0,0,i*h],a) if i%2==0
       else translate([0,0,i*h],b)
       for i in range(5)]
a=flip(c2t3(circle(od/2,s=n+1)))
b=flip(rot(f'z{-360/len(a)/2}',c2t3(circle(od/2,s=n+1))))
h=l_len(a[:2])/2
sol_2=[translate([0,0,i*h],a) if i%2==0
       else translate([0,0,i*h],b)
       for i in range(5)]

a=c2t3(circle(id/2,s=n+1))
b=rot(f'z{360/len(a)/2}',c2t3(circle(id/2,s=n+1)))
# h=l_len(a[:2])/2

sol_3=[translate([0,0,i*h],a) if i%2==0
       else translate([0,0,i*h],b)
       for i in range(5)]

a=flip(c2t3(circle(id/2,s=n+1)))
b=flip(rot(f'z{-360/len(a)/2}',c2t3(circle(id/2,s=n+1))))
# h=l_len(a[:2])/2
sol_4=[translate([0,0,i*h],a) if i%2==0
       else translate([0,0,i*h],b)
       for i in range(5)]

a=[seg(p)[:-1] for p in cpo(sol_1)]
b=[seg(p)[:-1] for p in translate([0,0,sl_h],cpo(sol_3))]

sol_5=array([a,b]).transpose(1,2,0,3,4).tolist()

a=[seg(p)[:-1] for p in cpo(sol_2)]
b=[seg(p)[:-1] for p in translate([0,0,sl_h],cpo(sol_4))]

sol_6=array([a,b]).transpose(1,2,0,3,4).tolist()

fileopen(f'''

    for(p={sol_5})for(p1=p)
        let(
        a=slice_sol(p1,10)
        )
        for(i=[1:len(a)-1])
    hull(){{
    p_line3d(a[i-1],{t/2},1);
    p_line3d(a[i],{t/2},1);
    }}

        for(p={sol_6})for(p1=p)

        let(
        a=slice_sol(p1,10)
        )
        for(i=[1:len(a)-1])
    hull(){{
    p_line3d(a[i-1],{t/2},1);
    p_line3d(a[i],{t/2},1);
    }}

    ''')
```

In [ ]:
```
sec=corner_radius(pts1([[-15,0],[0,-3,3],[30,0,3],[0,6.1,3],[-30,0,3]]),10)
cir1=circle(8,s=51)
cir1=c2t3(cir1)
cir2=translate([0,0,5],circle(10,s=51))
cir3=translate([0,0,10],circle(9,s=51))

sec=rot('z0',translate([0,0,50],equidistant_pathc(sec,50)))
sec=align_sec_1(cir1,sec)[1]
# sol_1=cpo([equidistant_path(p,50) for p in cpo([cir1,cir2,cir3,sec])])
sol_1=slice_sol_1([cir1,cir2,cir3,sec],50)
path1=corner_radius(pts1([[0,0,0],[1,25,10],rot2d(5,[40,0])]),20)
path1=rot('x90',equidistant_path(path1,50))
sol_1=sol2path(sol_1,path1)

sol_2=translate([0,0,-1],cylinder(r1=6,r2=12,h=50))
path2=corner_radius(pts1([[-15,10],[17,0,10],[3,18.5,8],rot('z5',[36,0])]),10)
path2=rot('x90',path2)
surf_1=surface_line_vector(path2,[0,20,0],1)
surf_2=translate([-10,0,10],surf_1)
sol_3=solid_from_2surfaces(surf_2,surf_1)

l_1=[path1[-1],(array(path1[-1])+array(rot('y-5',[150,0,0]))).tolist()]
p0=mid_point(l_1)

sol_1_1=axis_rot_1(sol_1,[0,1,0],p0,180)
sol_2_1=axis_rot_1(sol_2,[0,1,0],p0,180)
sol_3_1=axis_rot_1(sol_3,[0,1,0],p0,180)

sol_4=align_sol_1([sol_1[-1],flip(sol_1_1[-1])])
fileopen(f'''
 //color("blue")p_line3d({path1},.2,1);
 //color("blue")p_line3d({path2},.2,1);


    union(){{
   difference(){{
    {swp(sol_1)}
   {swp(sol_2)}
 {swp(sol_3)}
  }}
 difference(){{
    {swp(sol_1_1)}
    {swp(sol_2_1)}
    {swp(sol_3_1)}
    }}

    {swp(sol_4)}
    }}

    ''')
```

In [ ]:
```
it=time.time()
sec1=corner_radius(pts1([[-27.5,-2],[0,2,2],[6,0,.9],[0,-2,.9],
                         [14.5,0,.9],[0,2,.9],[6,0,.9],[0,-2],[2,0],[0,2,.9],
                         [6,0,.9],[0,-2,.9],[14.5,0,.9],[0,2,.9],[6,0,2],[0,-2]]),10)

path1=cr3dt([[0,0,20,0],[0,30,0,2],[0,0,30,0]],20)

s1=path_extrude_open(sec1,path1,twist=1)

sec2=corner_radius(pts1([[-27.5,6],[0,-6,2.4],[6,0,2.4],[0,6,2.4],[14.5,0,2.4],[0,-6,2.4],
                         [6,0,2.4],[0,6],[2,0],[0,-6,2.4],[6,0,2.4],[0,6,2.4],[14.5,0,2.4],
                         [0,-6,2.4],[6,0,2.4],[0,6]]))
path2=cr3dt([[0,0,0,0],[0,50,0,20],[0,0,50,0]],20)
```

```
s2=path_extrude_open(sec2,path2,twist=1)

sol1=[ equidistant_pathc(s1[i]+flip(s2[i]),300)+[s1[i][0]] for i in range(len(s1))]

sec3=corner_radius(pts1([[-27.5,-2],[0,2,2],[6,0,.9],[0,-2,.9],[19,0,.9],[0,2,.9],
                        [5,0,.9],[0,-2,.9],[19,0,.9],[0,2,.9],[6,0,2],[0,-2]]))

path3=cr3dt([[0,0,0,0],[0,0,30,2],[-30+2,0,0,0]],20)
s3=translate([0,30,50],rot('z90',path_extrude_open(sec3,path3,1)))

sec4=corner_radius(pts1([[-27.5,13],[0,-13,2.4],[6,0,2.4],[0,13,2.4],[19,0,2.4],
                        [0,-13,2.4],[5,0,2.4],[0,13,2.4],[19,0,2.4],[0,-13,2.4],[6,0,2.4],[0,13]]))

path4=cr3dt([[0,0,0,0],[0,0,50,20],[-50+2,0,0,0]],20)
s4=translate([0,50,50],rot('z90',path_extrude_open(sec4,path4,1)))

sol2=[ equidistant_pathc(s3[i]+flip(s4[i]),300)+[s3[i][0]] for i in range(len(s3))]

sec5=circle(27.5,s=100)
path5=corner_radius(pts1([[-15,-2],[15,0,2],[0,24,2],[-15,0]]),20)
sol3=prism(sec5,path5)
sol4=translate([0,50,50],rot('x90',sol3))
sec5=circle(15)
l1=[[-21.5,3],[21.5,3]]
a1=flip(fillet_line_circle(l1,sec5,3,1))
a2=fillet_line_circle(l1,sec5,3,3)
sec5=corner_radius(pts1([[-21.5,3,3],[0,5],[-6,0],[0,-8,5],[10,-15,3],
                        [35,0,3],[10,15,5],[0,8],[-6,0],[0,-5,3]]),10)
sec6=sec5+a1+arc_2p(a1[-1],a2[0],15,-1,50)[1:-1]+a2

path5=corner_radius(pts1([[-5,0],[5,0,2],[0,20,2.4],[-5,0]]),20)
sol5=translate([0,0,80],prism(sec6,path5))
sol5=[p+[p[0]] for p in sol5]
sol6=o_solid([0,0,1],circle(45/2,s=100),30,-5)
sol7=o_solid([0,1,0],circle(45/2,s=100),30,25,0,50)
sol8=o_solid([0,0,1],circle(5),30,75)
sol9=o_solid([1,0,0],pts([[-25,-25],[50,0],[0,50],[-50,0]]),2,-1,-40,10)

f1=ip_fillet(sol3,sol1,2,2,type=0)
f2=flip(ip_fillet(sol4,flip(sol1),-2,2))
f3=ip_fillet(sol4,sol2,2,2)
l1=translate([0,0,-.01],equidistant_path(s4[-1][50:-50],100))
l1=psos(sol5,[l1],[0,1,0])[0]
l2=translate([0,2,0],l1)
l3=o_3d(l1,sol5,2)
f4=convert_3lines2fillet(l3,l2,l1)

l1=translate([0,0,.01],equidistant_path(s3[-1][50:-50],100))
l1=psos(sol5,[l1],[0,1,0])[0]
l2=translate([0,2,0],l1)
l3=o_3d(l1,sol5,-2)
f5=convert_3lines2fillet(l3,l2,l1)
fileopen(f'''

difference(){{
union(){{
{swp(sol5)}
{swp(flip(sol1))}
{swp(flip(sol2))}
{swp(sol3)}
{swp(sol4)}
{swp(f1)}
{swp(f2)}
{swp(f3)}
{swp(f4)}
{swp(flip(f5))}
}}
{swp(sol6)}
{swp(sol7)}
{swp(sol8)}
{swp(sol9)}
}}

    ''')

ft=time.time()
ft-it
```

In [ ]:

```
i_t=time.time()
a=rot('y90',helix(3,35,5,360*5/300))
a_1=rot('z120y90',helix(3,35,5,360*5/300))
a_2=rot('z240y90',helix(3,35,5,360*5/300))

a2=bezier([[30,-5],[40,30],[60,50],[60,60],[40,107]],300)
b=equidistant_path(axis_rot_1(c2t3(a2),[1,0,0],[0,0,0],90),299)
```

```
ba=[i for i in linspace(0,90,300)]
b=[rot(f'z{ba[i]}',b[i]) for i in range(len(b))]
c=extrude_wave2path(a,b)
c1=extrude_wave2path(a_1,b)
c2=extrude_wave2path(a_2,b)
d=align_sol_1(path_extrude_open(circle(4.5),c))
d1=align_sol_1(path_extrude_open(circle(4.5),c1))
d2=align_sol_1(path_extrude_open(circle(4.5),c2))
g=cylinder(r=200,h=100)
h=prism(circle(2),a2)
fileopen(f'''
    intersection(){{
    union(){{
for(i=[0:17.25:360])
rotate([0,0,i])
{{
{swp(d)}
{swp(d1)}
{swp(d2)}
}}
{swp(h)}
}}
{swp(g)}
}}

    ''')

f_t=time.time()
f_t-i_t
```

In [ ]:

```
i_t=time.time()

sec=pts([[-155/2,-101/2],[155,0],[0,101],[-155,0]])
rl=[15,15,15,15]
sec=corner_n_radius_list(sec,rl,11)
l1=norm(cp_arc(sec[:10]))
a=cp_arc(sec[:10])
theta=r2d(arctan(a[1]/a[0]))
l2=[rot2d(i,[[0,0],[l1,0]])  for i in [theta,180-theta,180+theta,-theta]]
l3=[surround(m_points1_o(p,2),15) for p in l2]
c1=circle(55/2,s=100)
la,lb,lc=seg(l3[0])[22],seg(l3[-1])[0],seg(l3[-2])[-1]
a1=fillet_intersection_lines(flip(la),lb,15)
a2=c32(mirror_line(c23(a1),[1,0,0],[0,0,0]))
a3=flip(fillet_line_circle(lc,c1,15,4))
a4=c32(mirror_line(c23(a3),[1,0,0],[0,0,0]))
a5=c32(mirror_line(c23(a3),[0,1,0],[0,0,0]))
a6=c32(mirror_line(c23(a4),[0,1,0],[0,0,0]))
s1=a1
sec1=flip(a1)+l3[0][23:]+a6+arc_2p(a6[-1],a5[-1],55/2,-1)+flip(a5)+ \
                      l3[1][22:]+a2+l3[2][23:]+a3+arc_2p(a3[-1],a4[-1],55/2,-1) \
                      +flip(a4)+l3[-1][22:]
sec1=equidistant_pathc(sec1,299)
path1=corner_radius(pts1([[-3,0],[2.9,0,3],[0,18,3],[-3,0]]),10)
sol1=prism(sec1,path1)
path2=corner_radius(pts1([[-3,0],[3,0,3],[0,12,3],[-3,0]]),10)
sol2=prism(sec,path2)+[translate([0,0,12],circle(.2,s=len(sec)+1))]
sol3=linear_extrude(circle(55/2,s=100),45)
e2=end_cap(sol3,2)[1]
sol3_1=translate([0,0,0],linear_extrude(circle(42/2,s=100),45))
e1=end_cap_1(sol3_1,2)
csnk=translate([0,0,10],linear_extrude(circle(22/2,a),11))
csnk1=mirror_surface(csnk,[0,1,0],[0,0,0])
csnk2=mirror_surface(csnk,[1,0,0],[0,0,0])
csnk3=mirror_surface(csnk1,[1,0,0],[0,0,0])

td=translate([0,0,-1],linear_extrude(circle(14/2,a),20))
td1=mirror_surface(td,[0,1,0],[0,0,0])
td2=mirror_surface(td,[1,0,0],[0,0,0])
td3=mirror_surface(td1,[1,0,0],[0,0,0])

slot=o_solid([0,1,0],pts([[-30,0],[60,0],[0,20],[-60,0]]),8,-4,0,32)


l1=ip_sol2sol(prism2cpo(sol1),translate([0,0,4],offset_sol(sol3,-.1)))
l2=o_3d_rev(l1,prism2cpo(sol1),3)
l3=translate([0,0,3],l1)
f2=convert_3lines2fillet_closed(l3,l2,l1,style=2)

l1=ip_sol2sol(sol2,sol1,-1)
l2=o_3d_rev(l1,sol2,-3,dist=6)
l2=psos_v(prism2cpo(sol2),[l2],[0,0,-10],dist=3)[0]
l3=o_3d_rev(l1,sol1,3)
f1=convert_3lines2fillet_closed(l3,l2,l1,style=2)

path3=corner_radius(pts1([[5,12],[-5,0,3],[0,33]]),10)
s2=prism(circle(55/2,s=300),path3)
path4=corner_radius(pts1([[0,9],[0,3,3],[-5,0]]),10)
s3=prism(sec1,path4)
s2=align_sol_1(s3+s2)
```

```
v1=rot('y45z-90',[100,0,0])
sec2=corner_radius(pts1([[-4,0],[0,45,3],[8,0,3],[0,-45]]),10)
sec2=equidistant_path(sec2,200)
sec2=translate([0,-55/2+.5,0],rot('x90',sec2))
s3=flip(surface_line_vector(sec2,v1))

path3=corner_radius(pts1([[5,12],[-5,0,3],[0,35]]),10)
s4=prism(circle(55/2,s=49),path3)
path4=corner_radius(pts1([[0,9],[0,3,3],[-5,0]]),10)
s5=prism(sec,path4)
s4=align_sol_1(s5+s4)
l1=psos_n(s4,sec2surface(sec2,1)[19:-1],-1)
l2=[p[0] for p in l1]+flip([p[-1] for p in l1])
l2=equidistant_path(l2,200)
l1=psos(s4,[l2],[0,0,-1])[0]
l1=psos_v(s4,[l1],[0,0,0])[0]
l2=o_3d_rev(l1,s3,-2,type=1)
l3=o_3d_rev(l1,s4,2)
f3=convert_3lines2fillet(l2,l3,l1,style=2)
sol4=translate([0,0,4],linear_extrude(sec,45-4))
fileopen(f'''

   difference(){{
 union(){{
    {swp(sol1)}
    {swp(sol2)}
    {swp(sol3)}

{swp_c(f1)}
{swp_c(f2)}

    intersection(){{
    {swp(flip(f3))}
    {swp(sol4)}
    }}

    intersection(){{
    {swp(s3)}
    {swp(sol4)}
    }}
mirror([0,1,0])
{{    intersection(){{
    {swp(flip(f3))}
    {swp(sol4)}
    }}

    intersection(){{
    {swp(s3)}
    {swp(sol4)}
    }}
    }}

}}

for(p={[csnk,flip(csnk1),flip(csnk2),csnk3]})swp(p);
for(p={[td,flip(td1),flip(td2),td3]})swp(p);
{swp(slot)}
{swp(sol3_1)}
for(p={e1})swp(p);
{swp(e2)}
    }}



    ''')

f_t=time.time()
f_t-i_t
```

In [ ]:

```
l1=pts([[0,0],[20,0],[0,20],[-10,10],[-10,-10]])
l1=bspline_closed(m_points1(l1,3),3,50)
l2=h_lines_sec(l1,100)
l2=[equidistant_path(p,100) for p in l2]
l2=translate([0.1,1,1],l2)
l2=rot('z90',l2)
path=pts([[0,0],[1,0],[5,5],[5,-5],[3,0],[5,5],[5,-5],[7,0]])
path=rot('x90z90' ,bspline_open(path,3,100))
path=translate([1,0,0],path)
path=equidistant_path(path,100)
l3=[wrap_y(p,path) for p in l2]

fileopen(f'''
{swp_surf(l3[3:])}
//{swp_surf(l2)}
color("magenta")points({path},.3);
    ''')
```

In [ ]:
```
a=pts([[-50,-25],[100,0],[0,50],[-100,0]])
b=pts([[-10,0],[10,0],[0,60],[-1,-1],[0,-58],[-10,0]])
c=prism(a,b)
a=pts([[-15,-15],[30,0],[0,30],[-30,0]])
b=pts([[0,80],[-2,30],[-1,0],[2,-32]])
d=prism(a,b)
sol=c[:3]+d+c[3:]
# sol=smoothening_by_subdivison_surf(sol,4,[1,0])
sol=bspline_surface(sol,3,3,100,200,[1,0])
fileopen(f'''
difference(){{
    {swp(sol)}
    //{swp(cut_plane([0,-1,0],[1000,1000],500))}
    }}
    ''')
```

In [ ]:
```
sec=corner_radius(pts1([[0,0,1],[8,3,3],[5,7,1],[-8,0,2],[-5,20,1]]),20)

sec1=h_lines_sec(sec,60)
sec2=v_lines_sec(sec,40)

fileopen(f'''
   color("cyan")for(p={sec1})p_line3d(p,.1,1);
    color("magenta")for(p={sec2})p_line3d(p,.1,1);
    color("blue")p_line3dc({sec},.1,1);

    ''')
```

plos (project line on surface)

In [ ]:
```
l1=[[0,0,0],[10,5,0]]
pl1=plane(nv=[0,0,1],size=[25,25],intercept=[0,0,20])
l2=plos(surf=pl1,line=l1,vect=[0,0,1],unidirection=0)

fileopen(f'''
    color("blue")p_line3d({l1},.2);
    %{swp_surf(pl1)}
    color("magenta")p_line3d({l2},.2);

    ''')
```

In [ ]:
```
p0=pts2([[0,0,0],[10,-2,2],[-5,10,3],[5,-3,-6],[-5,5,1],[0,7,-2],[0,0,5]])
l1=line2length(p0[0:2],l_len(p0[0:2])*1.5)
l2=p0[1:3]
p1=polp(p0,.25)
n1=nv([l1[1],p0[1],p0[2]])
pl1=plane(n1,[50,50],p0[1])
c1=plos(pl1,translate(p0[1],rot('z-5',circle(2))),n1,0)
a1=lineFromStartTillPoint(c1,p1,.5)
txt0,txt1,txt2,txt3,txt4=[ dim_angular(seg(p0)[i],seg(p0)[i+1]) for i in range(len(p0)-2)]

fileopen(f'''

color("blue")points({p0},.5);
color("green")p_line3d({p0},.1);
{txt0}{txt1}{txt2}{txt3}{txt4}

''')
```

In [ ]:
```
t0=time.time()
c1=circle(55/2)
c2=circle(3,[21,0])
s1=linear_extrude(c1,5)
s1=flip(sol2vector([1,0,0],s1,[50,0,0]))
s2=rot('z90',s1)
s3=rot('z135', translate([0,-20,0],s2))
s27=[flip(linear_extrude(rot2d(i,c2),5)) for i in linspace(0,360,7)[:-1] ]
s27=translate([50,0,0],sol2vector([1,0,0],s27))
s28=rot('z90',s27)
s29=rot('z135',translate([0,-20,0],s28))

path=corner_radius_with_turtle([[0,0],[0,50,2],[2,0]],10)
s4=rot('y90',prism(circle(30/2),path))
s5=rot('z90',s4)
path=corner_radius_with_turtle([[0,0],[0,30,2],[2,0]],10)
s6=axis_rot([-1,1,0],prism(circle(30/2),path),-90)
s7=o_solid([1,0,0],circle(12),55)
s8=rot('z90',s7)
s9=o_solid([-1,-1,0.0001],circle(12),35.01)
e1=end_cap_1(s27[0],1)
e1=l_(concatenate([axis_rot([1,0,0],e1,i) for i in linspace(0,360,7)[:-1]]))
e2=rot('z90',e1)
e3=rot('z135',translate([0,-20,0],e2))
e4=end_cap_1(s7,2)[1]
e5=rot('z90',e4)
e6=end_cap_1(s9,2)[1]
e7=end_cap(s1,2)
e8=end_cap(s2,2)
e9=end_cap(rot('z.001',s3),2)
l1=ip(s4[:2],s5[:2])
l10=translate([5,0,0],l1)
l11=translate([0,5,0],l1)
l2=ip(s6[:2],s4[:2])
l3=ip(s5[:2],s6[:2])
l30=translate([0,5,0],l3)
l31=translate([-5,-5,0],l3)
```

```
f1=convert_3lines2fillet(l10,l11,l1)
f2=convert_3lines2fillet(l30,l31,l3)
f3=rot('z135',f2)


fileopen(f'''

difference(){{
for(p={[s1,s2,s3,s4,s5,s6]})swp(p);
for(p={[s7,s8,s9]})swp(p);
for(p={s27})swp(p);
for(p={s28})swp(p);
for(p={s29})swp(p);
for(p={e1})swp(p);
for(p={e2})swp(p);
for(p={e3})swp(p);
for(p={[e4,e5,e6]})swp(p);
for(p={e7})swp(p);
for(p={e8})swp(p);
for(p={e9})swp(p);

}}

{swp(f1)}
{swp(f2)}
{swp(f3)}

''')
t1=time.time()
t1-t0
```

In [ ]:

```
i_t=time.time()
c1=circle(7.5,[-55-7.5,0],s=200)
c2=circle(7.5,[55+7.5,0],s=200)
c3=circle(10,s=200)
c4=circle(10,[-55-7.5,0],s=200)
c5=circle(10,[55+7.5,0],s=200)
c6=circle(15,s=200)
l1=[[-100,.001],[100,.001]]
l2=flip(path_offset(l1,-1.25))
p=line_multi_sections_ip(l1,[c1,c2,c3,c4,c5,c6])
q=line_multi_sections_ip(l2,[c1,c2,c3,c4,c5,c6])

sec1=arc_2p(p[1],p[2],7.5,1,s=20)+arc_2p(p[5],p[6],10,1,s=20)+ \
arc_2p(p[9],p[10],7.5,1,s=20)+arc_2p(p[11],q[3],10,-1,s=20)+ \
arc_2p(q[4],q[7],15,-1,s=20)+arc_2p(q[8],p[0],10,-1,s=20)

sec2=rot('x90',sec1)
sol1=surface_line_vector(sec2,[0,20,0],1)
l1=two_circle_tangent(c5,c6)
l2=trim_sec_ip(sec1,l1[0],l1[1])
sec3=remove_duplicates(l1+flip(l2))
sec31=offset(sec3,-2,2)
l1,l2=sec3[1:],sec31[1:]
l3=translate([0,0,2],l1)
l1,l2=c23([l1,l2])
sol2=flip(surface_line_vector(rot('x90',l1),[0,2,0],1))
sol3=translate([0,-2,0],rot('x90',convert_3lines2fillet(l3,l2,l1)))
l4=translate([0,-2,0],rot('x90',[l1[0],l1[-1]]))
l5=translate([0,0,-1],l4)
l6=translate([0,1,0],l4)
f1=cpo(convert_3lines2fillet(l5,l6,l4))[:-1]
f2=surface_offset(f1,-2)
sol4=solid_from_2surfaces(f2,f1)

l7=turtle2d([[-75,-5],[22.5,0],[37.5,-10],[30,0],[37.5,10],[22.5,0]])
```

```
l8=mirror_line(l7,[0,1,0],[0,0,0])
l9=l7+flip(l8)
sol5=surface_line_vector(c23(l9),[0,0,20],1)
sol6=[m_points1(p,50) for p in sol1]
l10=ip_sol2sol(sol5,sol6)
l11=ip_sol2sol(sol5,sol6,-1)
sol6=[l10,l11]
l12=o_3d(l10,sol5,.5)
l13=translate([0,.5,0],l10)
f1=cpo(convert_3lines2fillet(l12,l13,l10))[:-1]
f2=surface_offset(f1,.5)
f3=solid_from_2surfaces(f1,f2)
f4=flip(mirror_surface(f3,[0,1,0],[0,0,0]))
f5=flip(mirror_surface(f3,[1,0,0],[0,0,0]))
f6=flip(mirror_surface(f4,[1,0,0],[0,0,0]))
fileopen(f'''

difference(){{
{swp(flip(sol6))}
{swp(f3)}
{swp(f4)}
{swp(f5)}
{swp(f6)}
}}

{swp(sol3)}
mirror([0,1,0])
{swp(sol3)}
difference(){{
{swp(sol2)}
{swp(sol4)}
mirror([0,1,0])
{swp(sol4)}
}}

mirror([1,0,0]){{
{swp(sol3)}
mirror([0,1,0])
{swp(sol3)}
difference(){{
{swp(sol2)}
{swp(sol4)}
mirror([0,1,0])
{swp(sol4)}
}}
}}

''')
f_t=time.time()
f_t-i_t
```

In [ ]:

```
i_t=time.time()

c1=circle(20,s=100)
c2=offset(c1,-3)
l1=point_vector([-25,3.5],[25,0])
l2=point_vector([0,0], rot2d(110,[25,0]))
p0,p1= s_int1_first([l2]+seg(c1)+seg(c2))
p2,p3= s_int1_first([l1]+seg(c1)+seg(c2))
f1=fillet_line_circle_internal(l1,c2,r=6,s=30)

l3=homogenise(rot('x90' , f1+[p3]),pitch=0.5)
sol1=sphere(20,s=100)
sol2=sphere(17, s=100)
l3=plos(sol2, l3, [0,1,0])
c3=circle(3.5,[-2,0])
l4=point_vector([12.6,-20],[0,40])
f2=fillet_line_circle(l4,c3,r=15)
l5=point_vector([0,0],[-8,0])
p4=s_int1([l5]+seg(c3))[0]
p5=f2[0]
p6=s_int1(seg(f2)[:-1]+ seg(c2)[:-1])[0]

l7=lineFromStartTillPoint(c1,p0)+flip(trim_sec_ip(c2,f1[0],p1)) + f1 + \
trim_sec_ip(c1,p2,[-20,0])
l7=rot('x90', homogenise(l7,0.5,closed_loop=1 ))
sol3=surface_line_vector(l7,[0,-25,0],both_sides=1)

s1=flip(trim_sec_ip(c3,p5,p4))+lineFromStartTillPoint(f2,p6)
s1=homogenise(s1,0.5)
s1=plos(sol2,c23(s1),[0,0,1])
s1=plos_v_1(sol3,s1,[0,0,4],[0,1,0])
p7=s_int1_3d(seg(s1)[:-1]+seg(l3)[:-1])[0]
s2=lineFromStartTillPoint(s1,p7)+lineFromPointTillEnd( l3, p7)[2:]

l8=homogenise(rot('x90' , f1+[p2]),pitch=0.5)
l8=plos(sol1,l8,[0,1,0])
p8=s_int1(seg(f2)[:-1]+ seg(c1))[0]

s3=flip(trim_sec_ip(c3,p5,p4))+lineFromStartTillPoint(f2,p8)
```

```
s3=homogenise(s3,0.5)
s3=plos(sol1,c23(s3),[0,0,1])
p9=s_int1_3d(seg(s3)[:-1] + seg(l8)[:-1])[0]
s4=lineFromStartTillPoint(s3,p9) + lineFromPointTillEnd(l8,p9)
s2=s2+flip(mirror_line(s2,[0,1,0],[0,0,0]))[1:-1]
s4=s4+flip(mirror_line(s4,[0,1,0],[0,0,0]))[1:-1]

sol4=translate([0,0,p9[2]],linear_extrude(c32(s4), 25))

s1=s2
s2=path2path1(s1,s4)
s2=plos_v(sol1,s2,[0,0,4])
s3=mid_line(s1,s2)
s4=offset_3d_sec(s1,-1.5)
s5=o_3d(s2,sol1,-1.5)

sol5=lines_fillets_solid(s4,s1,s3,s2,s5,20,-1.5)
sol5=flip(sol5+[sol5[0]])
fileopen(f'''
//color("blue") for(p= {[c1, c2, c3, l4]}) p_line3d(p , 0.3);
//color("cyan") points({[p0, p1, p2, p3, p4, p5, p6, p7, p8, p9]}, 0.5);
//color("magenta") for(p={[s1, s2, s3, s4, s5]}) p_line3d(p, 0.31);
resize([40,30,15])
difference(){{
intersection(){{
{swp(sol1)}
{swp(sol3)}

}}
{swp(sol4)}
{swp_c(sol5)}
}}
''')
f_t=time.time()
f_t-i_t
```

Car_Seat

In [2]:

```
i_t=time.time()

h=[100,180,120,200]
r=[800,750,840]
r1=[420,75,350,100]
l1=cr2dt([[0,780],[0,-300],rot2d(-60,[554,0]),[420,0],rot2d(30,[100,0]),rot2d(120,[75,0])],10)
a1=arc_2p(l1[-1],l1[2],400,-1)
a2=arc_2p(l1[2],l1[1],350,-1)
a3=two_cir_tarc(a1,a2,75)
a4=fillet_line_circle(path_offset(l1[:2],-10),a2,100,3)
l2=lineFromStartTillPoint(a1,a3[0])+a3[1:-1]+trim_sec_ip(a2,a3[0],a4[0],0,5)+a4[1:]+[path_offset(l1[:2],-10)[0]]
p0,p1,p2,p3=translate([0,0,100],l1[0]), translate([0,0,180],l1[1]), \
translate([0,0,120],l1[2]), translate([0,0,200],l1[3])
a1,a2,a3=arc_2p_3d([1,0,0],p0,p1,800), arc_2p_3d(rot('z30',[1,0,0]),p1,p2,750), \
arc_2p_3d([0,1,0],p2,p3,840)
x1,x2=extend_arc3d(a3,15),extend_arc3d(flip(a1),10)
x3=flip(a2)
s1=SurfaceFrom3LinesInDifferentPlanes(x1,x2,x3)
a4=fillet_line_circle_internal_3d(point_vector(p0,[0,0,-1]),flip(a1),150,3)
x1=lineFromPointTillEnd(a1,a4[0],5)
x2=mirror_line(x1,[0,0,1],[0,0,0])
x3=a4+flip(mirror_line(a4,[0,0,1],[0,0,0]))[1:]
x4=arc_3p_3d([x1[-1],[0,420,0],x2[-1]])
s2=cpo(surface_from_4_lines(x1,x2,x3,x4,5,30))
x1=a2
x2=c23(bspline_open([[0,420],[125,125],[125,80],[230,0]],3,20))
x3=mirror_line(x1,[0,0,1],[0,0,0])
s3=convert_3lines2surface(x1,x2,x3,s=30)
x1=a3
x2=mirror_line(x1,[0,0,1],[0,0,0])
x3=s3[-1]
x4=[x1[-1],x2[-1]]
s4=surface_from_4_lines(x1,x2,x3,x4)
x5=turtle2d([[0,0],[30,0],[50,-50],[50,0],[50,50],[30,0]])
x5=flip(mirror_line(x5,[1,0,0],[0,0,0]))+x5[1:]
x5=translate(translate_2d(rot2d(120,[55,0]),l1[4]),rot('y90z30',bspline_open(x5,3,50)))[1:-1]
x6=plos(s4,x5,line_as_vector(c23(l1[3:5])),0)
x6=flip(extend_line3d(flip(x6),a3))
x1=lineFromStartTillPoint(a3,x6[0])
x2=mirror_line(x1,[0,0,1],[0,0,0])
x6=x6+[x2[-1]]
s4=cpo(surface_from_4_lines(x1,x2,x3,x6,10,30))
x1=plos(s1,homogenise([x6[0],x5[0]],.5),[0,0,1])
```

```
x2=mirror_line(x1,[0,0,1],[0,0,0])
x5=fit_pline2line(x5,[x1[-1],x2[-1]])
s5=cpo(surface_from_4_lines(x1,x2,x6,x5,5,30))
surf1=cpo(s2+s3+s4+s5)
l3=plos(s1,homogenise(c23(l2),10),[0,0,1])
p4=s2[0][0]
p5=vcost2(l3,p4)
l3=flip(lineFromStartTillPoint(l3,p5,5))
l3=path2path1(surf1[0],l3)
surf2=slice_sol([l3,surf1[0]],5)
surf3=flip(mirror_surface(surf2,[0,0,1],[0,0,0]))
surf4=surf2+surf1[1:-1]+surf3
surf5=bezier_surface(surf4,100,50)
surf6=surface_offset(surf5,-30)
sol1=solid_from_2surfaces(surf5,surf6)
l1=mid_line(surf5[0],surf6[0])[5:]
l2=mid_line(surf5[-1],surf6[-1])[5:]
l3=mid_line(cpo(surf5)[0],cpo(surf6)[0])
l4=mid_line(cpo(surf5)[-1],cpo(surf6)[-1])
f1=l1+l4+flip(l2)+translate([1,0,0],flip(path_offset3d(l3,-10,[1,0,0]))[6:-6])

l1,l2,l3,l4=s5[0],s5[-1],cpo(s5)[0],cpo(s5)[-1]
l5=remove_duplicates(l1+l4+flip(l2)+flip(l3))
pl1=plane(rot('z120',[1,0,0]),[500,500],c23(l1[14]))
l5=plos(pl1,l5,rot('z120',[1,0,0]),0)
l5=translate(rot('z30',[30,0,0]),offset_3d(l5,-40))
l5=bspline_closed(homogenise(l5,40,1),3,100)
l51=offset_3d(l5,-10)
l6=plos(surf6,l5,rot('z120',[1,0,0]),0)
l7=translate(rot('z120',[15,0,0]),l6)
l8=translate(rot('z120',[15,0,0]),plos(surf6,l51,rot('z120',[1,0,0]),0))
f2=cpo(convert_3lines2fillet(l6,l8,l7))[:-1]

l1,l2,l3,l4=s4[0],s4[-1],cpo(s4)[0],cpo(s4)[-1]
l5=remove_duplicates(l1+l4+bezier(flip(l2),20)+flip(l3))
l5=offset_3d(l5,-50)
l5=homogenise(l5,40,1)[:-1]
l5=bspline_closed(l5,3,100)
l6=offset_3d(l5,-10)
l5=plos(surf6,l5,[0,1,0])
l6=translate([0,15,0],plos(surf6,l6,[0,1,0]))
l7=translate([0,15,0],l5)
f3=cpo(convert_3lines2fillet(l5,l6,l7))[:-1]

l1,l2,l3,l4=s3[0],s3[-1],cpo(s3)[0],cpo(s3)[-1]
l5=homogenise(l1+l4+flip(l2)+flip(l3),50,1)
pl1=plane(rot('z30',[1,0,0]),[1000,1000],a_(l5).mean(0))
l5=plos(pl1,l5,rot('z30',[1,0,0]),0)
l5=remove_duplicates(bezier_closed(offset_3d(l5,-70),100))
l6=[offset_3d(l5,-i) for i in linspace(0,125,10)]
l6=psos(surf6,l6,rot('z30',[1,0,0]),unidirection=0)
f4=bspline_surface(flip(l6)+translate(rot('z30',[15,0,0]),l6),3,3,100,100,[1,0])

l1,l2,l3,l4=s2[0],s2[-1],cpo(s2)[0],cpo(s2)[-1]
l5=l1+l4+flip(l2)+flip(l3)
l5=bspline_closed(homogenise(l5,50,1),3,50)
l5=remove_duplicates(offset_3d(l5,-50))
l6=[offset_3d(l5,-i) for i in [0,10]]
l6=psos(surf6,l6,[1,0,0],unidirection=0)
l6=[l6[0]]+translate([15,0,0],l6)
f5=cpo(convert_3lines2fillet(l6[0],l6[-1],l6[1]))[:-1]

l1,l2=surf5[0][15:-5],surf5[10][15:-5]
l3=flip(l1)+l2
n1,incpt=best_fit_plane(l3)
pl1=plane(n1,[1000,1000],a_(l3).mean(0))
l3=plos(pl1,l3,n1,unidirection=0)
l3=bspline_closed(homogenise(offset_3d(l3,-40),40,1),3,100)
l4=[offset_3d(l3,-i) for i in linspace(0,30,5)]
l4=translate([20,20,0],l4)
l4=psos(surf6,l4,n1,unidirection=0)
l4=flip(l4)+translate(vector2length(n1,15),l4)
f6=bspline_surface(l4,3,3,100,100,[1,0])
f7=mirror_surface(f6,[0,0,1],[0,0,0])

fileopen(f'''
rotate([90,0,0]){{
for(p={[f1]})p_line3dc(p,30);
{swp(sol1)}
{swp(f2)}
{swp(f3)}
{swp(f4)}
{swp(f5)}
{swp(f6)}
{swp(f7)}
}}
    ''')
f_t=time.time()
f_t-i_t
```

Out[2]: 12.33798599243164

In [3]:
```
s1=o_solid([1,0,0],circle(10),80,-40)
s2=o_solid([0,1,0],circle(10),80,-40)
path1=cr2dt([[5,0],[-5,0,5],[0,5]],20)
s1x=[ offset_sol(s1,x) for (x,y) in path1]
s2x=[ offset_sol(s2,y) for (x,y) in path1]

s3=o_solid([1,0,0],circle(8),80,-40)
s4=o_solid([0,1,0],circle(8),80,-40)
path2=cr2dt([[3,0],[-3,0,3],[0,3]],20)
s3x=[ offset_sol(s3,x) for (x,y) in path2]
s4x=[ offset_sol(s4,y) for (x,y) in path2]

e1=end_cap(s1,1)
e2=end_cap(s2,1)
e3=end_cap_1(s3,1)
e4=end_cap_1(s4,1)
fileopen(f'''
s1x={s1x};
s2x={s2x};
s3x={s3x};
s4x={s4x};
difference(){{
union(){{
for(i=[0:len(s1x)-2])
hull(){{
intersection(){{
swp(s1x[i]);
swp(s2x[i]);
}}
intersection(){{
swp(s1x[i+1]);
swp(s2x[i+1]);
}}
}}
}}

union(){{
for(i=[0:len(s3x)-2])
hull(){{
intersection(){{
swp(s3x[i]);
swp(s4x[i]);
}}
intersection(){{
swp(s3x[i+1]);
swp(s4x[i+1]);
}}
}}
}}
for(p={[s3,s4]})swp(p);
}}

difference(){{
for(p={[s1,s2]})swp(p);
for(p={[s3,s4]})swp(p);
for(p={e1}) swp_c(p);
for(p={e2}) swp_c(p);
for(p={e3}) swp(p);
for(p={e4}) swp(p);

union(){{
for(i=[0:len(s3x)-2])
hull(){{
intersection(){{
swp(s3x[i]);
swp(s4x[i]);
}}
intersection(){{
swp(s3x[i+1]);
swp(s4x[i+1]);
}}
}}
}}

''')
```

```
/Users/sanjeevprabhakar/python_openscad/openscad3.py:5350: RuntimeWarning: invalid value encountered in divide
  u4=(v4/norm(v4,axis=1).reshape(-1,1)).round(4)
```