

Circular Path Solid Models

Convert the surface model to a solid volume model

If you are using AutoCAD version 2007 or greater, a solid model version of this form can be developed by using the same computed points as the surface version required for each section.

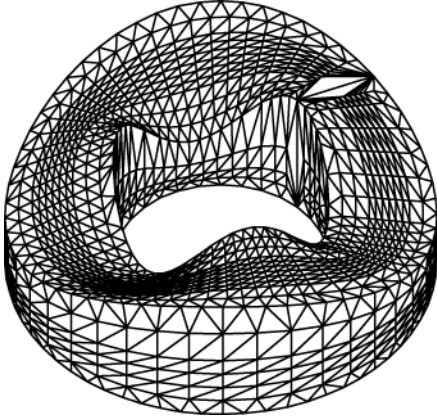


Figure 5.35a: PROG07, converting frames model to a solid volume, smooth fit closed

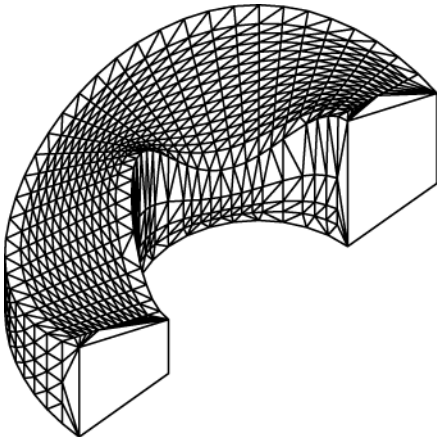


Figure 5.35b: PROG07, converting frames model to a solid volume, smooth fit open

Copy PROG06 to PROG07. Remove the code sections for adding the front and back closing points and remove the section counter.

Change the 3DMESH command from:

```
; segment count
(setq nseg 0)
; start mesh, check sweep angle
(if (= SweepAngle 360)
  (command ".3DMESH"
    (+ NumSegs 1) "5")
  (command ".3DMESH"
    (+ NumSegs 3) "5")
)
```

To starting a new selection list:

```
; selection list for sections
(setq slist (ssadd))
; number of sections
(setq nsects NumSegs)
(if (< SweepAngle 360)
  (setq nsects (+ NumSegs 1)))
```

The number of sections is computed differently if the form is closed or open.

Change the repeat value from:

```
(repeat (+ NumSegs 1)
```

To:

```
(repeat nsects
```

Change the adding of the 3DMESH points from:

```
; add to mesh
(command pnt1 pnt2 pnt3
  pnt4 pnt1)
```

To creating the section and adding it to the selection list:

```
; add to selection list
(command ".3DPOLY" pnt1 pnt2
  pnt3 pnt4 "c")
(command ".REGION" "last" "")
(setq slist
  (ssadd (entlast) slist))
```

At the completion of the loop, execute the LOFT command on the sections in the selection list, add:

```
; loft sections
; turn off history
(setqvar "SOLIDHIST" 0)
; set DELOBJ to delete the sections
(setqvar "DELOBJ" 1)
; set LOFTNORMALS =1 for smooth
; =0 for ruled
(setqvar "LOFTNORMALS" 1)
; set LOFTPARAM to default
(setqvar "LOFTPARAM" 7)
; set to close
(if (= SweepAngle 360)
  (setqvar "LOFTPARAM" 15))
(command ".LOFT" slist "" "")
(command ".ZOOM" "e")
; turn on history
(setqvar "SOLIDHIST" 1)
```

Check the description of the values of the system variable in the previous section.

The LOFTPARAM variable is set to its default value plus 8 if the loft is to be closed, the first and last sections are connected.

If other settings are required, check AutoCAD Help for a complete description of all the system variables that pertain to the LOFT command.

Sample script file for PROG07:

```
-----
(prog07)
; layer
c07_1
; outside X radius
10'
; outside Y radius
10'
; inside X radius
5'
; inside Y radius
5'
; outside height
5'
; outside height offset
2'
; inside height
5'
; inside height offset
2'
; segments
```

```

64                                     (* oXRad (cos (dtr ang))))
; sweep angle                         (setq yoff
360                                     (* oYRad (sin (dtr ang))))
;-----
[NOT FOR CLASS]                       ; outside edge
                                        (setq pnt1
                                        (list (+ (nth 0 cpnt) xoff)
                                              (+ (nth 1 cpnt) yoff)
                                              grdelev))
Completed function PROG07:             (setq pnt2
;-----                                (list (+ (nth 0 cpnt) xoff)
                                        (+ (nth 1 cpnt) yoff)
                                        top))
(defun prog07 ()                       ; compute top
  (graphscr)                           (setq top
  ; circular curve                      (+ iHeight
  (setvar "CMDECHO" 0)                  (* (cos (dtr (* ang 3)))
  ; center point                        iHeightOff)))
  (setq cpnt (list 0.0 0.0 0.0))        ; compute inside edge
  ; get curve parameters                (setq xoff
  (princ "\nProg07 - Circle")           (* iXRad (cos (dtr ang))))
  (setq CurveLayer                      (setq yoff
    (getstring                            (* iYRad (sin (dtr ang))))
    "\nEnter layer name: "))            (setq pnt3
  (setq oXRad                             (list (+ (nth 0 cpnt) xoff)
    (getdist cpnt                        (+ (nth 1 cpnt) yoff)
    "\nEnter outside X radius: "))      top))
  (setq oYRad                             (setq pnt4
    (getdist cpnt                        (list (+ (nth 0 cpnt) xoff)
    "\nEnter outside Y radius: "))      (+ (nth 1 cpnt) yoff)
  (setq iXRad                             grdelev))
    (getdist cpnt                        ; compute midpoint of bottom
    "\nEnter inside X radius: "))      (setq mpnt
  (setq iYRad                             (polar pnt4 (angle pnt4 pnt1)
    (getdist cpnt                        (/ (distance pnt4 pnt1) 2)))
    "\nEnter inside Y radius: "))      ; add to selection list
  (setq oHeight                           (command ".3DPOLY" pnt1 pnt2
    (getdist cpnt                        pnt3 pnt4 "c")
    "\nEnter outside height: "))        (command ".REGION" "last" "")
  (setq oHeightOff                       (setq slist
    (getdist cpnt                        (ssadd (entlast) slist))
    "\nEnter outside height offset: ")) (inc ang
  (setq iHeight                           (setq ang (+ ang anginc))
    (getdist cpnt                        )
    "\nEnter inside height: "))        ; loft sections
  (setq iHeightOff                       ; turn off history
    (getdist cpnt                        (setvar "SOLIDHIST" 0)
    "\nEnter inside height offset: ")) ; set DELOBJ to delete the sections
  (setq NumSegs                          (setvar "DELOBJ" 1)
    (getint                               ; set LOFTNORMALS =1 for smooth
    "\nEnter number of segments: "))    ; =0 for ruled
  (setq SweepAngle                       (setvar "LOFTNORMALS" 1)
    (getreal                              ; set LOFTPARAM to default
    "\nEnter total sweep angle:"))     (setvar "LOFTPARAM" 7)
  ; clear layer                          ; set to close
  (command ".LAYER"                       (if (= SweepAngle 360)
    "THAW" "*" "ON" "*" "")            (setvar "LOFTPARAM" 15))
  (command ".LAYER"                       (command ".LOFT" slist "" "")
    "MAKE" CurveLayer "")                (command ".ZOOM" "e")
  (command ".LAYER"                       ; turn on history
    "THAW" CurveLayer "ON" CurveLayer  (setvar "SOLIDHIST" 1)
    "SET" CurveLayer "")                 (setvar "CMDECHO" 1)
  (command ".ERASE" "ALL" "")             (princ)
  )
  ; calculate curve variables
  (setq anginc
    (/ SweepAngle NumSegs))
  ; start angle
  (setq ang 0.0)
  ; set ground elev
  (setq grdelev 0.0)
  ; selection list for sections
  (setq slist (ssadd))
  ; number of sections
  (setq nsects NumSegs)
  (if (< SweepAngle 360)
    (setq nsects (+ NumSegs 1)))
  (repeat nsects
    ; compute top
    (setq top
      (+ oHeight
        (* (sin (dtr (* ang 2)))
          oHeightOff)))
    ; compute outside edge
    (setq xoff

```

As with the lineal form example, the circular path model section can also be converted to a spline.

In this example the Cubic B-spline conversion is selected.

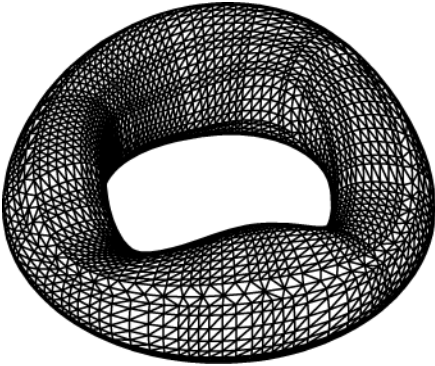


Figure 5.35c: PROG07a, converting frames model to a solid volume, smooth fit closed, spline section

The section remains as a 3DPOLY, so the curve fit option is not available for the curve conversion.

Add function PROG07a using a copy of PROG07. Add the PEDIT command to convert the section to a spline and add the midpoint to the section to set flatten the base surface

Change the section creation from:

```
; compute midpoint of bottom
(setq mpnt
 (polar pnt4 (angle pnt4 pnt1)
 (/ (distance pnt4 pnt1) 2)))
; add to selection list
(command ".3DPOLY" pnt1 pnt2
 pnt3 pnt4 "c")
(command ".REGION" "last" "")
(setq slist
 (ssadd (entlast) slist))
```

To:

```
; compute midpoint of bottom
(setq mpnt
 (polar pnt4 (angle pnt4 pnt1)
 (/ (distance pnt4 pnt1) 2)))
; add to selection list
(command ".3DPOLY" pnt1 pnt2
 pnt3 pnt4 mpnt "c")
(setq obj1 (ssadd (entlast)))
; convert polyline to a spline
(if (/= ftype "STRAIGHT") (progn
 (if (= ftype "SPLINE6") (progn
 (setvar "SPLINETYPE" 6)
 (command ".PEDIT" obj1 "s" "")))
 (if (= ftype "SPLINE5") (progn
 (setvar "SPLINETYPE" 5)
 (command ".PEDIT" obj1 "s" "")))
))
(command ".REGION" "last" "")
(setq slist
 (ssadd (entlast) slist))
```

Sample script file for PROG07a:

```
;-----
(prog07a)
; layer
c07a_1
; outside X radius
10'
; outside Y radius
10'
; inside X radius
5'
; inside Y radius
5'
; outside height
5'
; outside height offset
```

```
2'
; inside height
5'
; inside height offset
2'
; segments
64
; sweep angle
360
; straight, spline6, spline5
SPLINE6
;-----
```

Completed function PROG07a:

```
;-----
(defun prog07a ()
 (graphscr)
 ; circular curve
 (setvar "CMDECHO" 0)
 ; center point
 (setq cpnt (list 0.0 0.0 0.0))
 ; get curve parameters
 (princ "\nProg07a - Circle")
 (setq CurveLayer
 (getstring
 "\nEnter layer name: "))
 (setq oXRad
 (getdist cpnt
 "\nEnter outside X radius: "))
 (setq oYRad
 (getdist cpnt
 "\nEnter outside Y radius: "))
 (setq iXRad
 (getdist cpnt
 "\nEnter inside X radius: "))
 (setq iYRad
 (getdist cpnt
 "\nEnter inside Y radius: "))
 (setq oHeight
 (getdist cpnt
 "\nEnter outside height: "))
 (setq oHeightOff
 (getdist cpnt
 "\nEnter outside height offset: "))
 (setq iHeight
 (getdist cpnt
 "\nEnter inside height: "))
 (setq iHeightOff
 (getdist cpnt
 "\nEnter inside height offset: "))
 (setq NumSegs
 (getint
 "\nEnter number of segments: "))
 (setq SweepAngle
 (getreal
 "\nEnter total sweep angle:"))
 ; straight, spline6, spline5
 (setq ftype
 (strcase (getstring
 "\nEnter frame type:")))
 ; clear layer
 (command ".LAYER"
 "THAW" "*" "ON" "*" "")
 (command ".LAYER"
 "MAKE" CurveLayer "")
 (command ".LAYER" "SET" 0 "")
 (command ".LAYER"
 "OFF" "@*" "FREEZE" "@*" "")
 (command ".LAYER"
 "THAW" CurveLayer "ON" CurveLayer
 "SET" CurveLayer "")
 (command ".ERASE" "ALL" "")
 ; calculate curve variables
 (setq anginc
 (/ SweepAngle NumSegs))
 ; start angle
 (setq ang 0.0)
 ; set ground elev
 (setq grdelev 0.0)
 ; selection list for sections
 (setq slist (ssadd))
 ; number of sections
 (setq nsects NumSegs)
```

```
(if (< SweepAngle 360)
  (setq nsects (+ NumSegs 1)))
(repeat nsects
  ; compute top
  (setq top
    (+ oHeight
      (* (sin (dtr (* ang 2)))
        oHeightOff)))
  ; compute outside edge
  (setq xoff
    (* oXRad (cos (dtr ang))))
  (setq yoff
    (* oYRad (sin (dtr ang))))
  ; outside edge
  (setq pnt1
    (list (+ (nth 0 cpnt) xoff)
      (+ (nth 1 cpnt) yoff)
      grdelev))
  (setq pnt2
    (list (+ (nth 0 cpnt) xoff)
      (+ (nth 1 cpnt) yoff)
      top))
  ; compute top
  (setq top
    (+ iHeight
      (* (cos (dtr (* ang 3)))
        iHeightOff)))
  ; compute inside edge
  (setq xoff
    (* iXRad (cos (dtr ang))))
  (setq yoff
    (* iYRad (sin (dtr ang))))
  (setq pnt3
    (list (+ (nth 0 cpnt) xoff)
      (+ (nth 1 cpnt) yoff)
      top))
  (setq pnt4
    (list (+ (nth 0 cpnt) xoff)
      (+ (nth 1 cpnt) yoff)
      grdelev))
  ; compute midpoint of bottom
  (setq mpnt
    (polar pnt4 (angle pnt4 pnt1)
      (/ (distance pnt4 pnt1) 2)))
  ; add to selection list
  (command ".3DPOLY" pnt1 pnt2
    pnt3 pnt4 mpnt "c")
  (setq obj1 (ssadd (entlast)))
  ; convert polyline to a spline
  (if (/= ftype "STRAIGHT") (progn
    (if (= ftype "SPLINE6") (progn
      (setvar "SPLINETYPE" 6)
      (command ".PEDIT" obj1 "s" "")))
    (if (= ftype "SPLINE5") (progn
      (setvar "SPLINETYPE" 5)
      (command ".PEDIT" obj1 "s" "")))
  ))
  (command ".REGION" "last" "")
  (setq slist
    (ssadd (entlast) slist))
  ; inc ang
  (setq ang (+ ang anginc))
)
; loft sections
; turn off history
(setvar "SOLIDHIST" 0)
; set DELOBJ to delete the sections
(setvar "DELOBJ" 1)
; set LOFTNORMALS =1 for smooth
; =0 for ruled
(setvar "LOFTNORMALS" 1)
; set LOFTPARAM to default
(setvar "LOFTPARAM" 7)
; set to close
(if (= SweepAngle 360)
  (setvar "LOFTPARAM" 15))
(command ".LOFT" slist "" "")
(command ".ZOOM" "e")
; turn on history
(setvar "SOLIDHIST" 1)
(setvar "CMDECHO" 1)
(princ)
)
;-----
```

The sections can also be converted to members as in the lineal form examples.

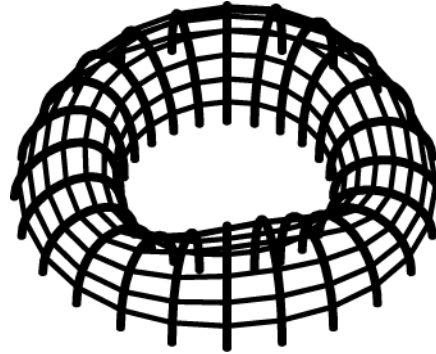


Figure 5.35d: PROG07b, converting frames model to a solid volume, smooth fit closed, spline section members

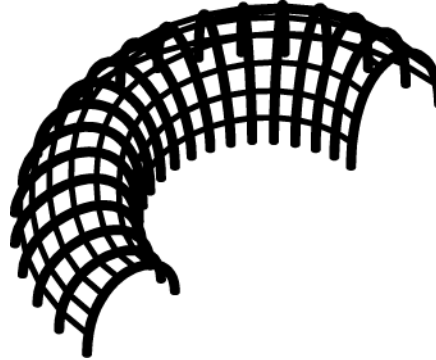


Figure 5.35e: PROG07b, converting frames model to a solid volume, smooth fit open, spline section members

Add function PROG07b using a copy of PROG07a and PROG27c from the last section.

Sample script file for PROG07b:

```
;-----
(prog07b)
; layer
c07b_1
; outside X radius
10'
; outside Y radius
10'
; inside X radius
5'
; inside Y radius
5'
; outside height
5'
; outside height offset
2'
; inside height
5'
; inside height offset
2'
; segments
24
; sweep angle
360
; frame section radius
2.0"
; member section radius
1.0"
; straight, spline6, spline5
SPLINE6
; number of members
```

```

8
;-----
Completed function PROG07b:
;-----
(defun prog07b ()
  (graphscr)
  ; circular curve
  (setvar "CMDECHO" 0)
  ; center point
  (setq cpnt (list 0.0 0.0 0.0))
  ; get curve parameters
  (princ "\nProg07b - Circle")
  (setq CurveLayer
    (getstring
      "\nEnter layer name: "))
  (setq oXRad
    (getdist cpnt
      "\nEnter outside X radius: "))
  (setq oYRad
    (getdist cpnt
      "\nEnter outside Y radius: "))
  (setq iXRad
    (getdist cpnt
      "\nEnter inside X radius: "))
  (setq iYRad
    (getdist cpnt
      "\nEnter inside Y radius: "))
  (setq oHeight
    (getdist cpnt
      "\nEnter outside height: "))
  (setq oHeightOff
    (getdist cpnt
      "\nEnter outside height offset: "))
  (setq iHeight
    (getdist cpnt
      "\nEnter inside height: "))
  (setq iHeightOff
    (getdist cpnt
      "\nEnter inside height offset: "))
  (setq NumSegs
    (getint
      "\nEnter number of segments: "))
  (setq SweepAngle
    (getreal
      "\nEnter total sweep angle:"))
  (setq sectrad1
    (getdist cpnt
      "\nEnter frame section radius:"))
  (setq sectrad2
    (getdist cpnt
      "\nEnter member section radius:"))
  ; straight, spline6, spline5
  (setq ftype
    (strcase (getstring
      "\nEnter frame type:")))
  (setq nmembers
    (getint
      "\nEnter number of members:"))
  ; clear layer
  (command ".LAYER"
    "THAW" "*" "ON" "*" "")
  (command ".LAYER"
    "MAKE" CurveLayer "")
  (command ".LAYER" "SET" 0 "")
  (command ".LAYER"
    "OFF" "@*" "FREEZE" "@*" "")
  (command ".LAYER"
    "THAW" CurveLayer "ON" CurveLayer
    "SET" CurveLayer "")
  (command ".ERASE" "ALL" "")
  ; calculate curve variables
  (setq anginc
    (/ SweepAngle NumSegs))
  ; start angle
  (setq ang 0.0)
  ; set ground elev
  (setq grdelev 0.0)
  ; points list for sections
  (setq slist (list ))
  ; number of sections
  (setq nsects NumSegs)
  (if (< SweepAngle 360)
    (setq nsects (+ NumSegs 1))
    (repeat nsects
      ; compute top
      (setq top
        (+ oHeight
          (* (sin (dtr (* ang 2)))
            oHeightOff)))
        ; compute outside edge
        (setq xoff
          (* oXRad (cos (dtr ang))))
        (setq yoff
          (* oYRad (sin (dtr ang))))
        ; outside edge
        (setq pnt1
          (list (+ (nth 0 cpnt) xoff)
            (+ (nth 1 cpnt) yoff)
            grdelev))
        (setq pnt2
          (list (+ (nth 0 cpnt) xoff)
            (+ (nth 1 cpnt) yoff)
            top))
        ; compute top
        (setq top
          (+ iHeight
            (* (cos (dtr (* ang 3)))
              iHeightOff)))
        ; compute inside edge
        (setq xoff
          (* iXRad (cos (dtr ang))))
        (setq yoff
          (* iYRad (sin (dtr ang))))
        (setq pnt3
          (list (+ (nth 0 cpnt) xoff)
            (+ (nth 1 cpnt) yoff)
            top))
        (setq pnt4
          (list (+ (nth 0 cpnt) xoff)
            (+ (nth 1 cpnt) yoff)
            grdelev))
        ; compute midpoint of bottom
        (setq mpnt
          (polar pnt4 (angle pnt4 pnt1)
            (/ (distance pnt4 pnt1) 2)))
        ; add to selection list
        (command ".3DPOLY" pnt1 pnt2
          pnt3 pnt4 "")
        (setq obj1 (ssadd (entlast)))
        ; convert polyline to a spline
        (if (/= ftype "STRAIGHT") (progn
          (if (= ftype "SPLINE6") (progn
            (setvar "SPLINETYPE" 6)
            (command ".PEDIT" obj1 "s" ""))
          (if (= ftype "SPLINE5") (progn
            (setvar "SPLINETYPE" 5)
            (command ".PEDIT" obj1 "s" ""))
          ))
        (setq obj1 (ssadd (entlast)))
        ; get pts from frame
        (command ".DIVIDE"
          obj1 (+ nmembers 1))
        ; get points
        (setq spts (ssget "_p"))
        ; make pt list
        (setq plist (list ))
        (setq cnt 0)
        ; get pt locations
        (repeat (sslength spts)
          ; entity name
          (setq objname (ssname spts cnt))
          ; entity record
          (setq objrec (entget objname))
          ; pt corrd
          (setq objpt
            (cdr (assoc 10 objrec)))
          ; add to plist
          (setq plist
            (append plist (list objpt)))
          ; delete pt
          (setq itemp (entdel objname))
          ; inc count
          (setq cnt (+ cnt 1))
        )
        ; add to point list
        (setq slist

```

```

    (append (list plist) slist))
; add cross sections
(command ".CIRCLE" pnt1 secrad1)
(setq obj2 (ssadd (entlast)))
(command ".ZOOM" "e")
; SWEEP frame section
; turn off history
(setvar "SOLIDHIST" 0)
; set DELOBJ to delete the sections
; and path
(setvar "DELOBJ" 2)
; sweep sections
(command ".SWEEP" obj2 "" obj1)
; turn on history
(setvar "SOLIDHIST" 1)
; inc ang
(setq ang (+ ang anginc))
)
(command ".ZOOM" "e")
; horizontal members
(setq ipt 0)
(repeat nmembers
  (setq iframe 0)
  ; start 3DPOLY
  (command ".3DPOLY")
  (repeat nsects
    ; add pt to 3DPOLY
    (setq npt
      (nth ipt (nth iframe slist)))
    (command npt)
    ; next frame
    (setq iframe (+ iframe 1))
  )
  ; set to close
  (if (= SweepAngle 360)
    (command "c")
    (command ""))
  (setq obj1 (ssadd (entlast)))
  ; add cross section
  (command ".CIRCLE" npt secrad2)
  (command ".ROTATE3D"
    "last" "" "y" npt "-90")
  (setq obj2 (ssadd (entlast)))
  (command ".ZOOM" "e")
  ; SWEEP members across frames
  ; turn off history
  (setvar "SOLIDHIST" 0)
  ; set DELOBJ to delete the sections
  ; and path
  (setvar "DELOBJ" 2)
  ; sweep sections
  (command ".SWEEP" obj2 "" obj1)
  ; turn on history
  (setvar "SOLIDHIST" 1)
  (command ".ZOOM" "e")
  ; next pt
  (setq ipt (+ ipt 1))
)
)
(princ)
)
;-----

```

Revise function PROG07b for another member section profile; elliptical, a polygon, or rectangular.

For rapid prototyping applications the entire model may have to be UNIONed.

For rendering purposes, the frame members can be placed on separate layers from the horizontal connecting members to be able to assign different materials.

These models can also be merged together, members and the surfaces between them.

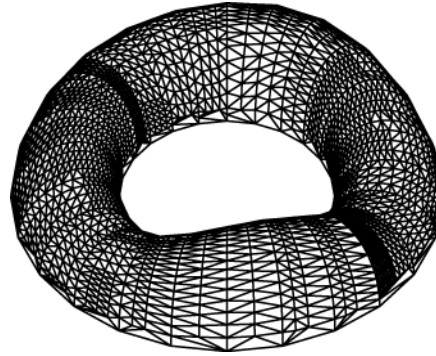


Figure 5.35f: PROG07c, converting frames model to a surface, ruled, closed, spline section

Add function PROG07c using a copy of PROG07a. Modify PROG07c to create a surface that is equal to the computations of the frames in function PROG07b. The section is not closed at the bottom edge.

First modify the points in the section, change:

```

; add to selection list
(command ".3DPOLY" pnt1 pnt2
  pnt3 pnt4 mpnt "c")

```

To:

```

; add to selection list
(command ".3DPOLY" pnt1 pnt2
  pnt3 pnt4 "")

```

Modify the LOFT parameter to create a ruled surface, change:

```

; set LOFTNORMALS =1 for smooth
; =0 for ruled
(setvar "LOFTNORMALS" 1)

```

To:

```

; set LOFTNORMALS =1 for smooth
; =0 for ruled
(setvar "LOFTNORMALS" 0)

```

Place each model from PROG07b and PROG07c on a separate layers using the same dimensions for each. Show both layers. The model from PROG07C is a lofted surface model, the one from PROB07b is a solid model.

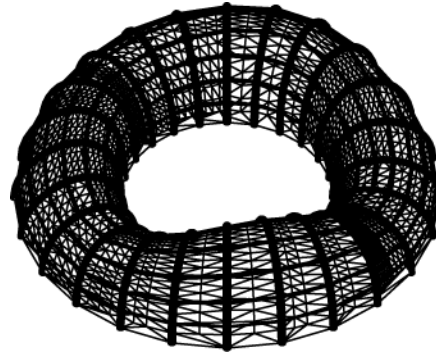


Figure 5.35g: PROG07b and PROG07c, converting frames model to a surface and members

This second example displays the inside condition of the combined models.

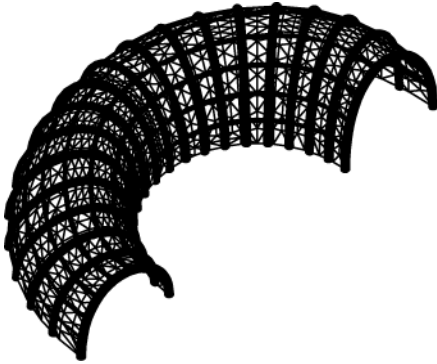


Figure 5.35h: PROG07b and PROG07c, converting frames model to a surface and members, open path

Sample script file for PROG07c:

```
;-----  
(prog07c)  
; layer  
c07c_1  
; outside X radius  
10'  
; outside Y radius  
10'  
; inside X radius  
5'  
; inside Y radius  
5'  
; outside height  
5'  
; outside height offset  
2'  
; inside height  
5'  
; inside height offset  
2'  
; segments  
24  
; sweep angle  
360  
; straight, spline6, spline5  
SPLINE6  
;-----
```