15-294 Rapid Prototyping Technologies:

DXF Files

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The DXF File Format

- Drawing Interchange Format
  – *or* –
  Drawing Exchange Format
- Proprietary file format, not an ANSI standard.
- Developed by AutoDesk in 1982 to allow their AutoCAD product to inter-operate with other programs.
- Partial specification now publicly available on AutoDesk's web site.

Types of DXF File

- ASCII (human readable) or binary.
- DXF version number:
  - 2013, 2010, 2007-2009, 2004-2006
  - R14, R13, R12
- Later versions add new features such as complex curves and 3D shapes.
- When exporting to DXF for use with a laser cutter, use the latest version if offered a choice.

Sections of a DXF File

- HEADER – parameters such as units, min/max values
- CLASSES – application-specific data
- TABLES – line types, colors, layers, etc.
- BLOCKS – macros for repeating entities
- **ENTITIES** – where the lines and arcs are defined
- OBJECTS – data for non-graphical objects
- THUMBNAILIMAGE
- END OF FILE

Tagged Data Format

- Every element in a DXF file takes two lines:
  - Integer “group code” indicating the type of item
  - Value of the item (can be a number, string, etc.)
- Some common group codes:

  0: Entity type (string)

  2: Name of the entity (string)

  9: DXF variable name in header section (string)

  10, 20, 30: Primary X/Y/Z value (float)

  11, 21, 31: Secondary X/Y/Z value (float)

  40: radius

DXF File: One Line and One Arc

```
  0
SECTION
  2
ENTITIES
  0
LINE
  10
5.125
  20
7.625
  11
107.25
  21
 50.875
```

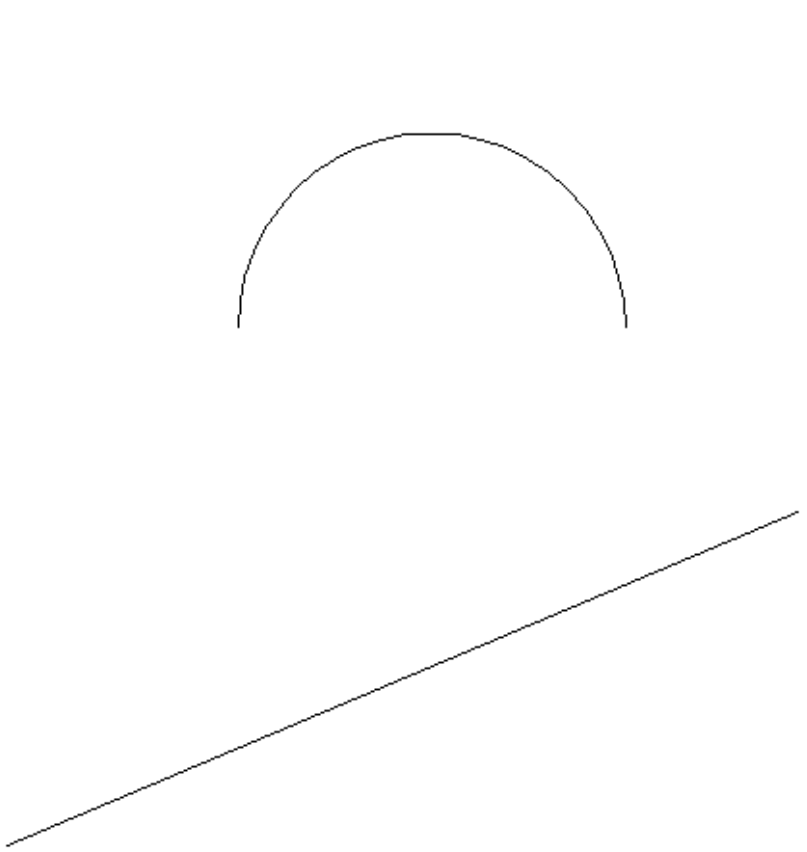
Line from (5.125,7.625) to (107.25,50.875)

```
  0
ARC
  10
60.0
  20
75.0
  40
25.0
  50
0.0
  51
180.0
  0
ENDSEC
  0
EOF
```

Arc at (60.0,75.0), radius 25.0, from 0 to 180 deg.

Do not put any blank lines in the file.

Sample DXF Result



Python DXF Libraries

- Multiple DXF libraries exist for Python.
- **dxfwrite** is used in assignment #2:
  - Sets up reasonable header values and tables.
  - You can modify them if desired.
  - Provides primitives to make entities.
- **dxfgrabber** reads a DXF file and returns a Python structure with all the info.

Using dxfwrite

```
from dxfwrite import DXFEngine as dxf

drawing = dxf.drawing('mypiece.dxf')


drawing.add(
  dxf.line((5.125, 7.625),
           (107.25, 50.875),
           color=1))


drawing.save()
```

Graphics in Python

- Use Tkinter for simple on-screen graphics
- Create a Canvas widget, then add lines etc.
- Coordinates are in pixels; must be integers.
- Use mainloop() to have Tk render the canvas.

Drawing A Line With Tk

```
from Tkinter import *

master = Tk()

w = Canvas(master, width=800, height=800)
w.pack()


w.create_line(51, 77, 1070, 508,
                  fill='red')


mainloop()
```

Future Project: Vector Optimizer

- Drawing programs output vectors in seemingly random order.
- Laser cutting can go *much* faster if the vectors are ordered so as to minimize head motion with the laser off (not cutting = not useful).
- Many laser cutter drivers now include a vector optimizer, sometimes with user controls.
- Rabbit Laser's optimizer (Tools → Unite Lines) can be improved.