



Resolution Independent Rendering

James C. King

**PDF Architect
A Principal Scientist
Adobe Systems Incorporated**



Resolution Independent Rendering

- **High resolution displays require**
 - Resolution independent interface
 - Resolution independent rendering
- **A core competence of Adobe Systems**
 - Founded in 1982 to create PostScript
 - Professional quality 2-D rendering
 - Carried forward in PDF/Acrobat



Image, Graphics and Text

Sampled Images



Typographic Text

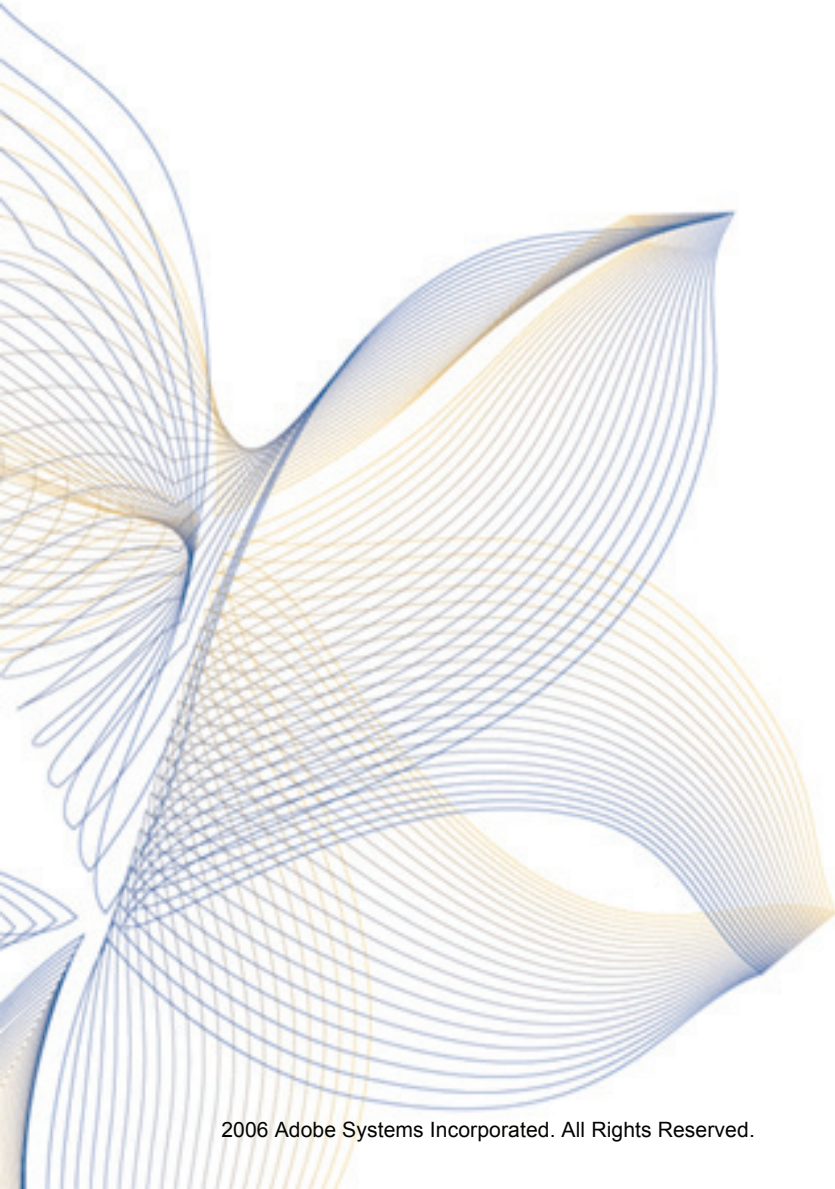
Typographic Text

Vector Graphics



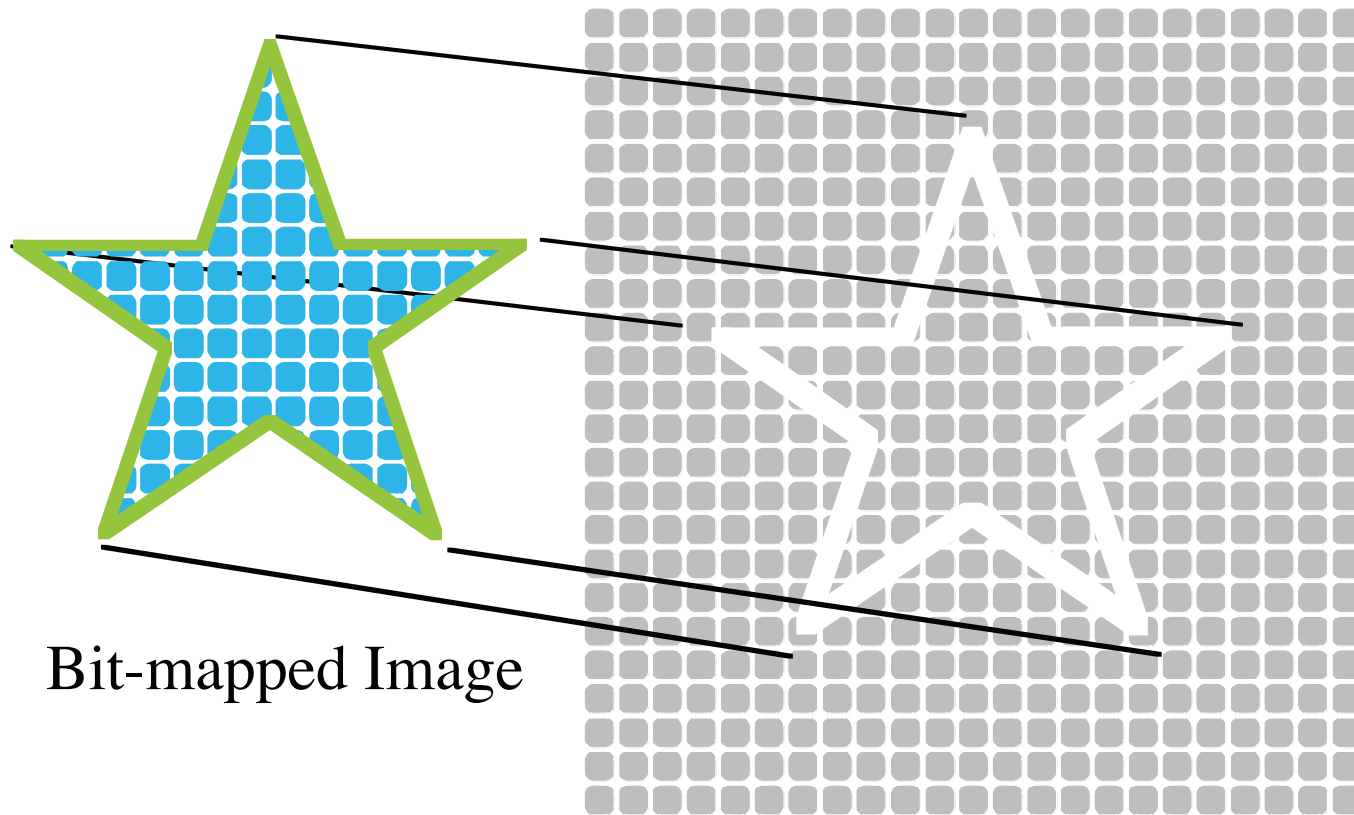
Images

Bitmaps versus Sampled images



Bitmaps

- **Frame Buffer**
 - Display surface mapped to an array of color values
- **Bit-mapped image (bit blt—block transfer)**

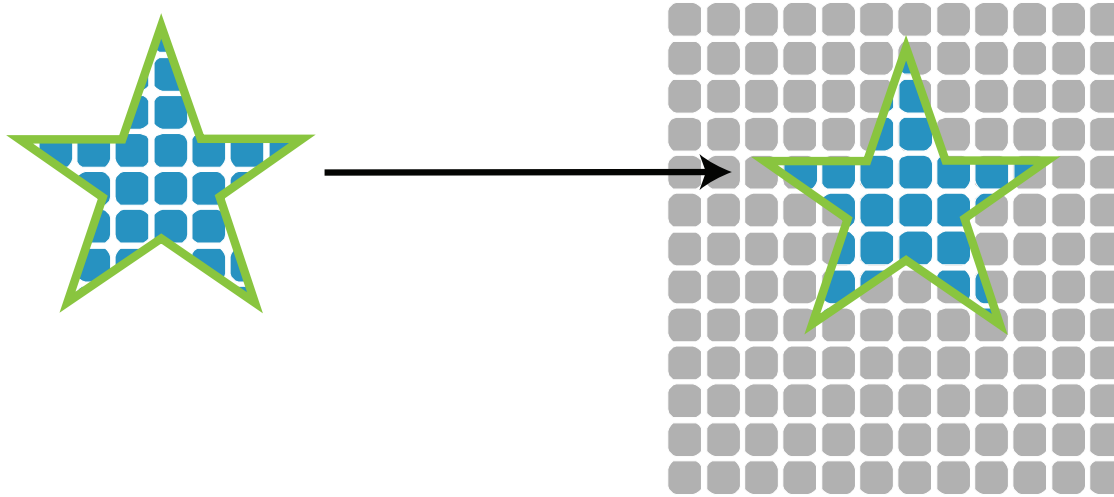


Bit-mapped Image

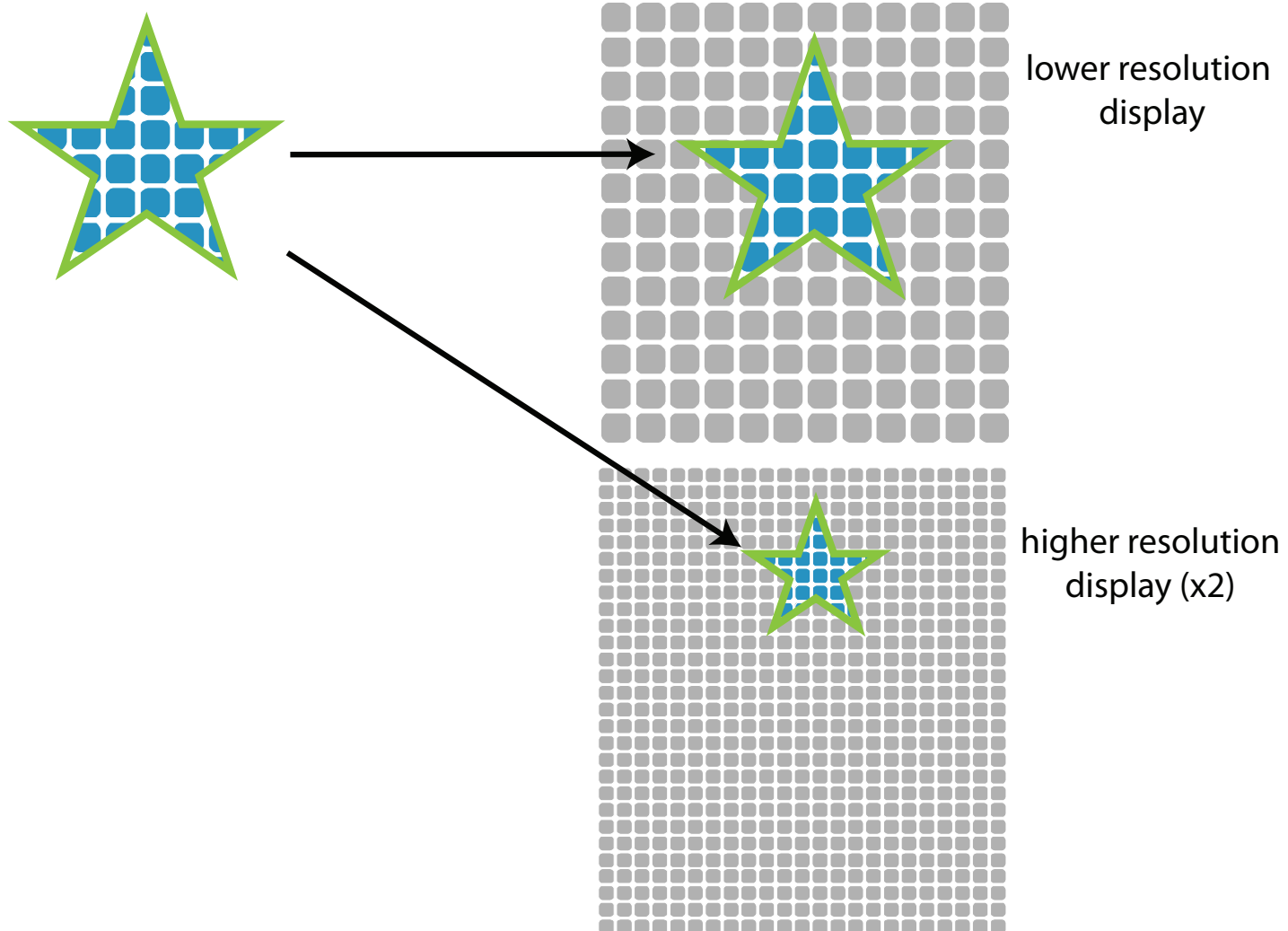
Frame Buffer



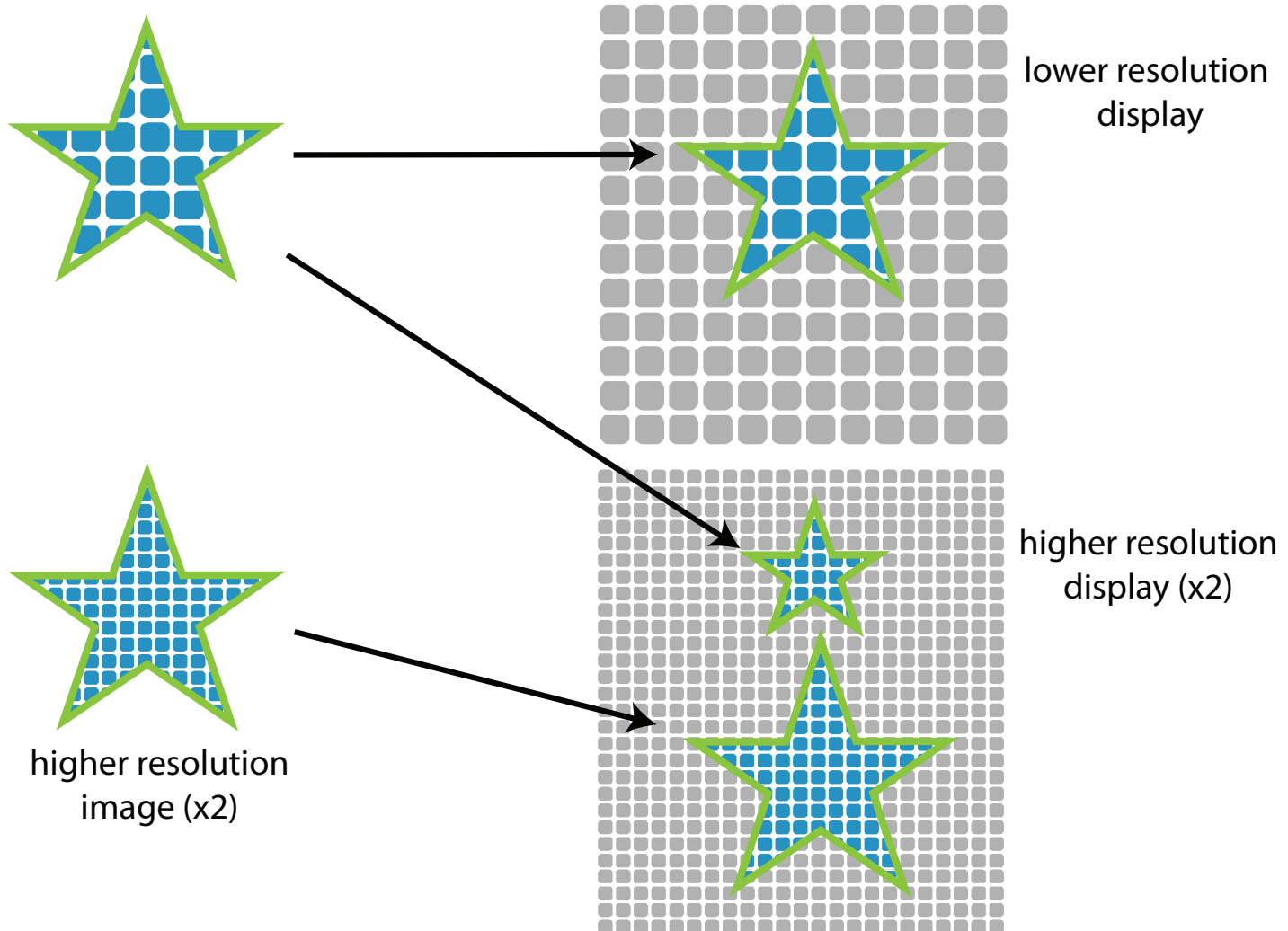
Resolution and Size



Resolution and Size

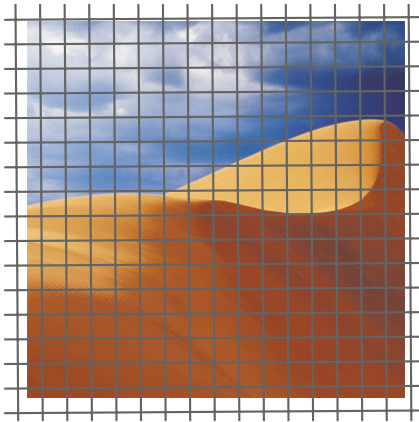


Resolution and Size



Sampled Images

- **Start with a picture**

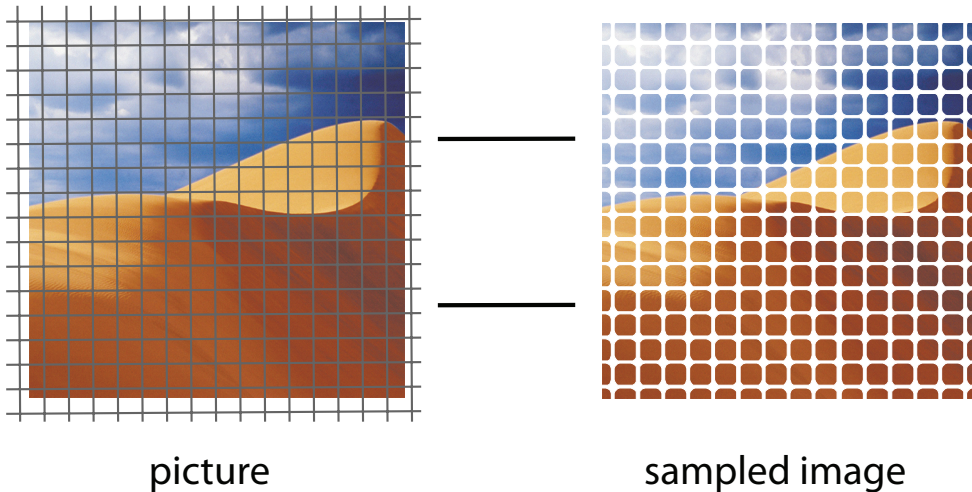


picture



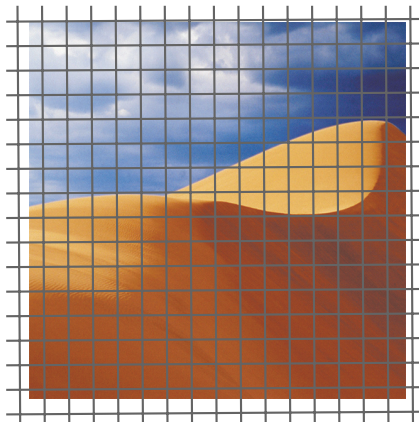
Sampled Images

- Take image “samples” at picture resolution

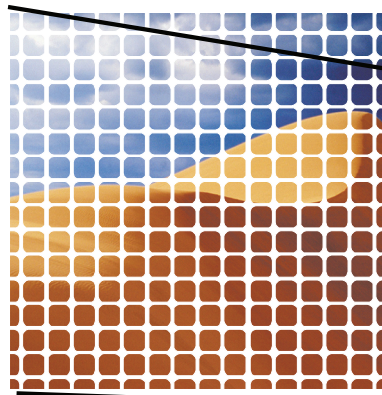


Sampled Images

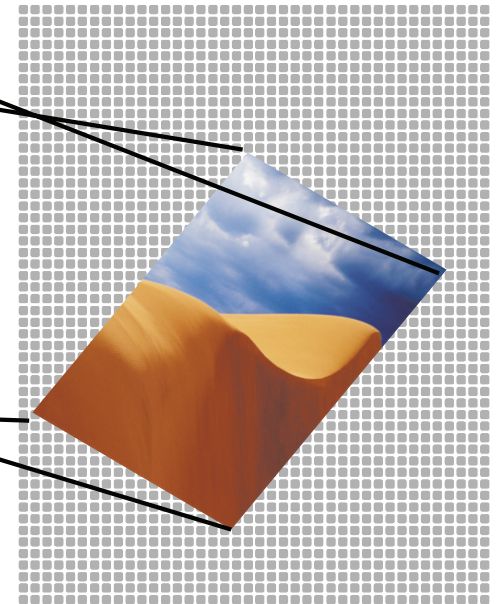
- Image & bitmap resolutions are independent



picture



sampled image

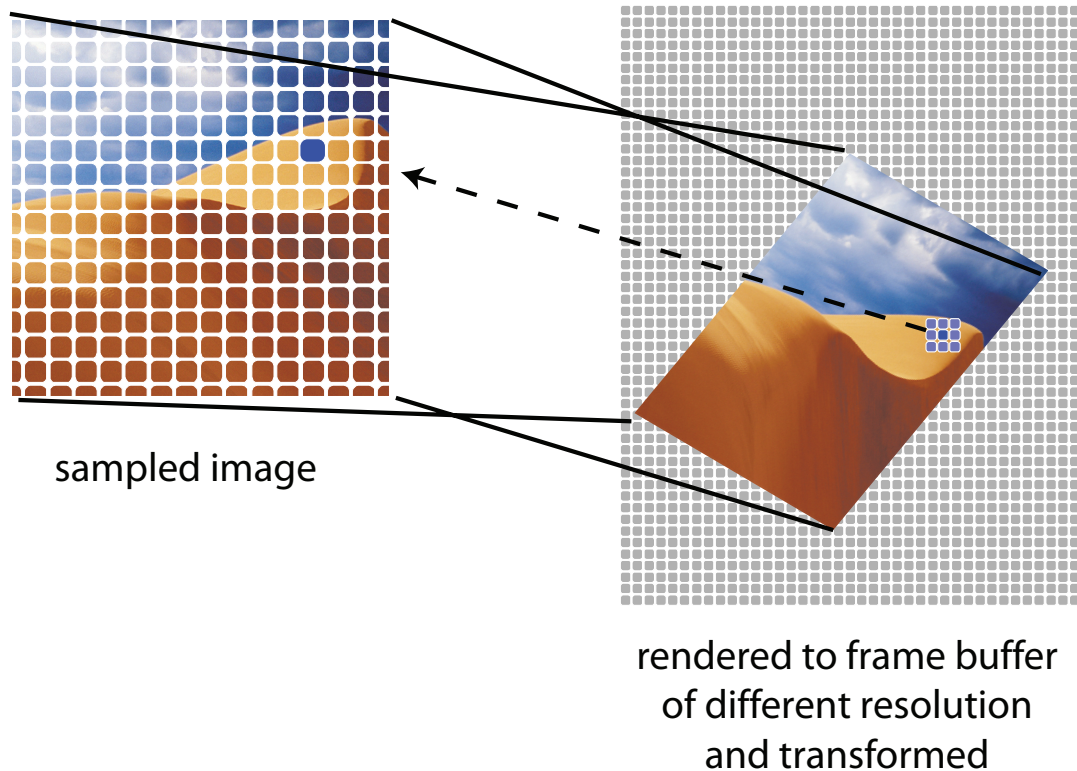


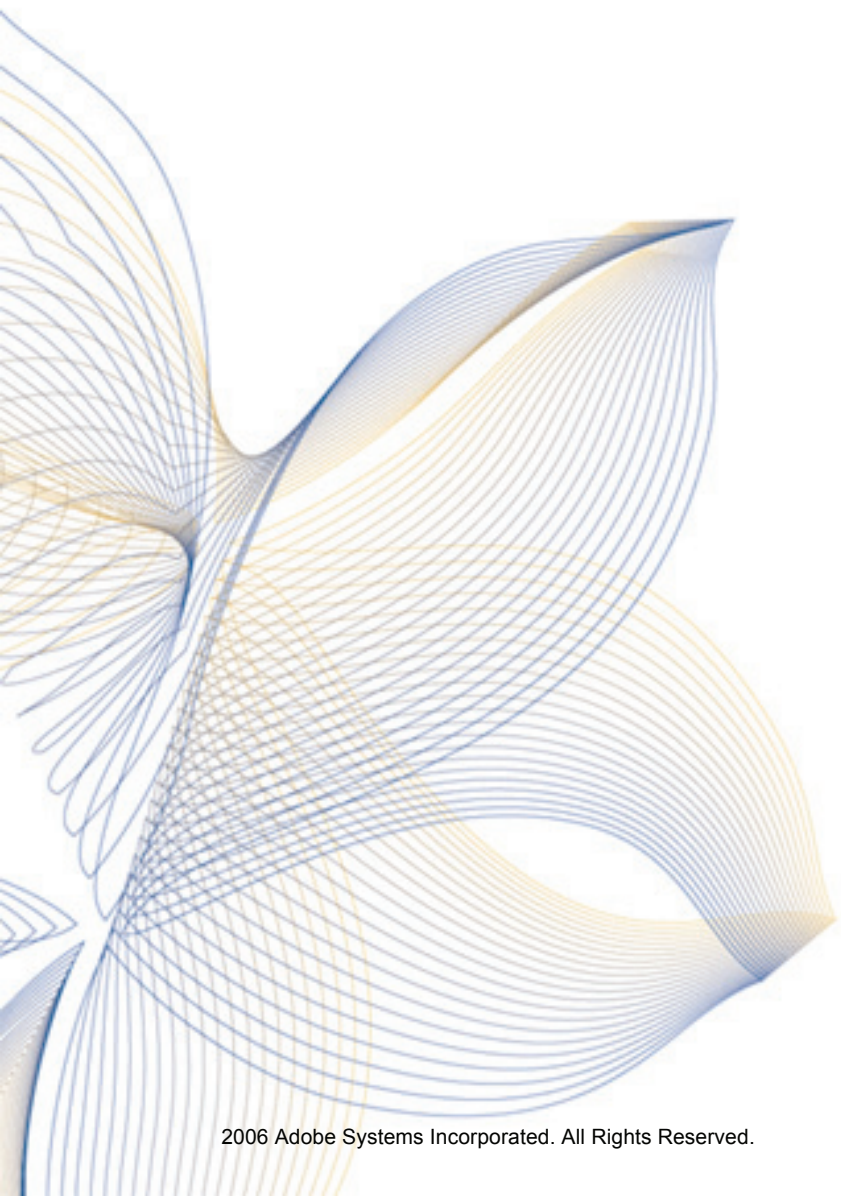
rendered to frame buffer
of different resolution
and transformed



Sampled Images

- **Back compute to source pixel**





Vector Graphics

Resolution Independence





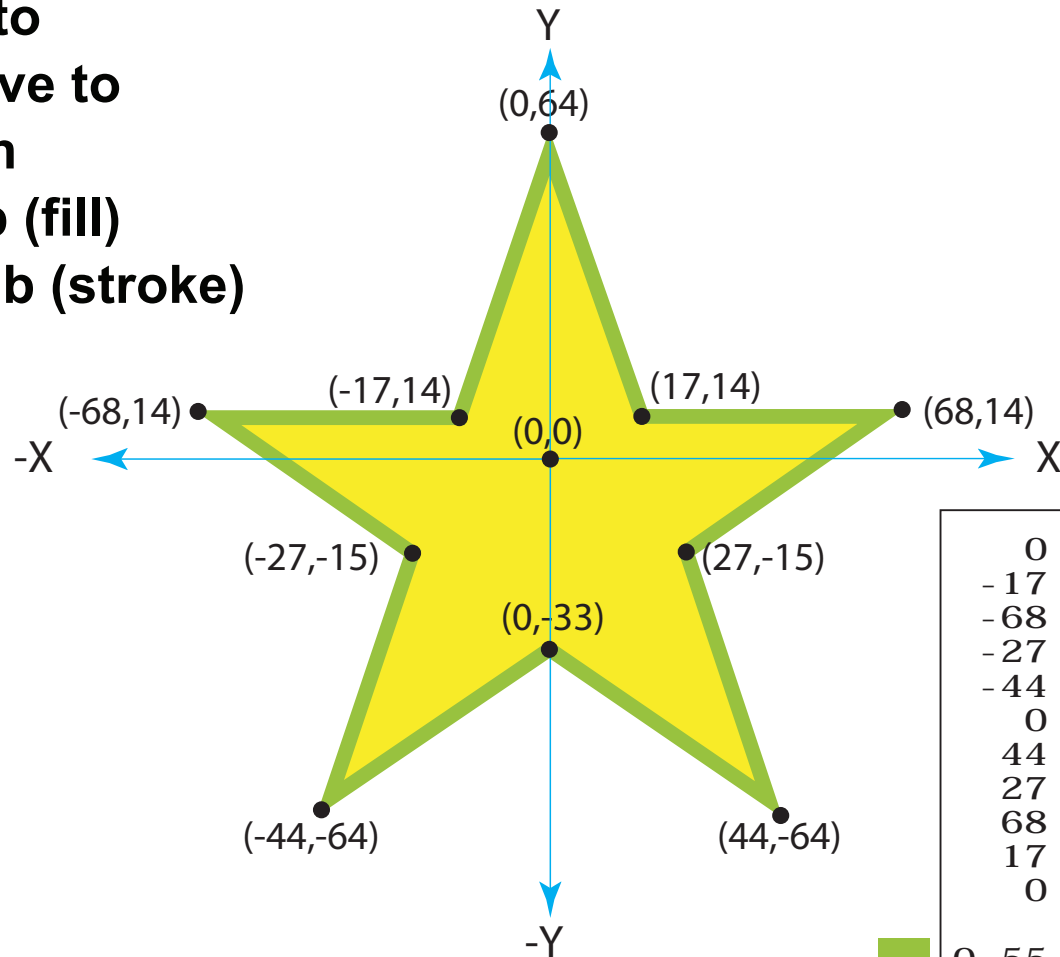
Vector Graphic

- Paths positioned in a 2-D coordinate space
- Then “filled” and/or “stroked”



Star Path Filled and Stroked (PDF)

- l - line to
- m - move to
- b - both
- rg - rgb (fill)
- RG - rgb (stroke)



0	64	m
-17	14	l
-68	14	l
-27	-15	l
-44	-64	l
0	-33	l
44	-64	l
27	-15	l
68	14	l
17	14	l
0	64	l
0.55	0.76	0.0 RG
1.00	1.00	0.0 rg
b		



Bezier Curves

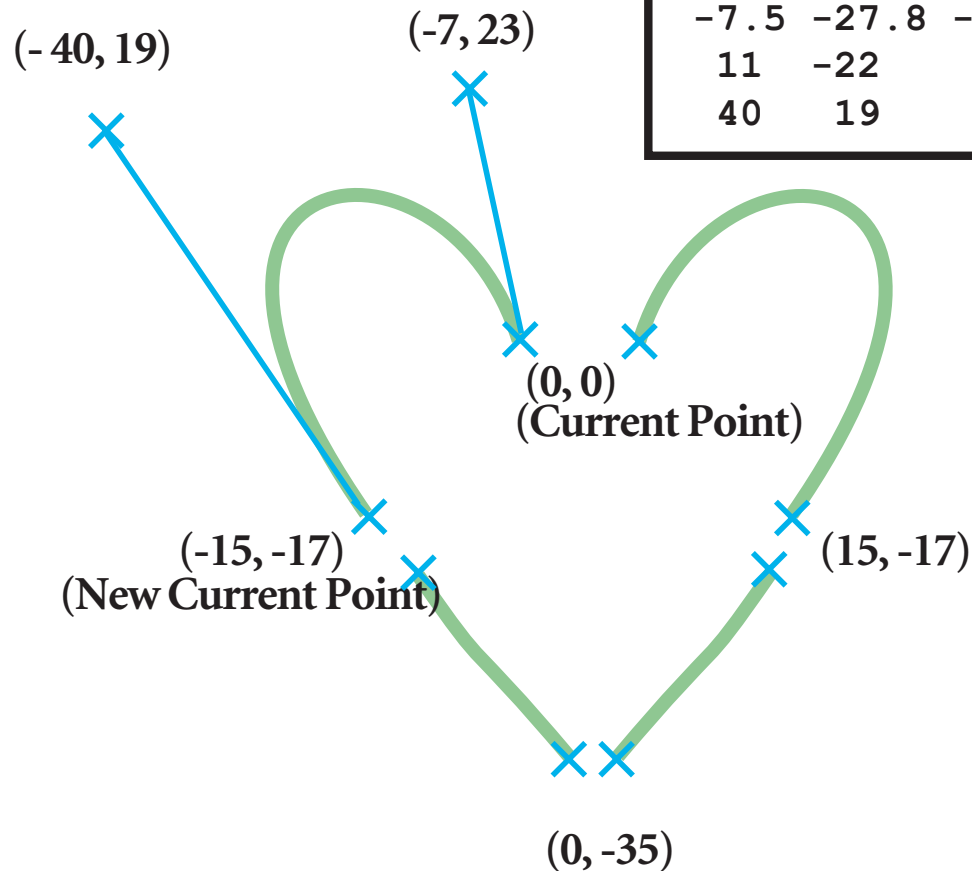
- **Smooth shapes**



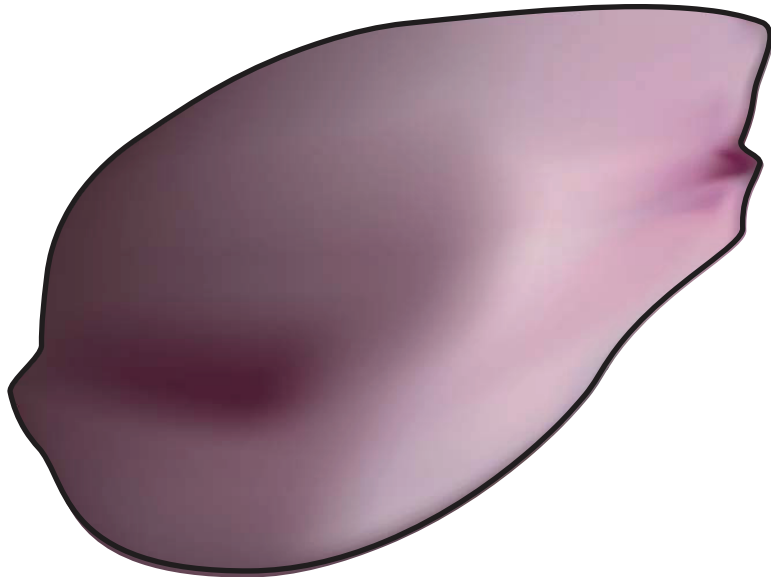
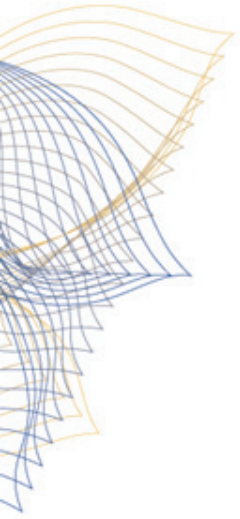
Bezier Curves

x1 y1 x2 y2 x3 y3 c

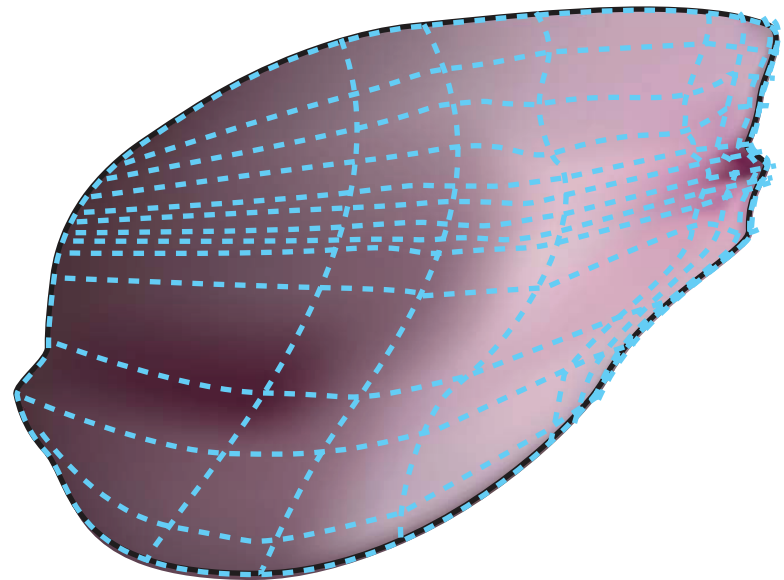
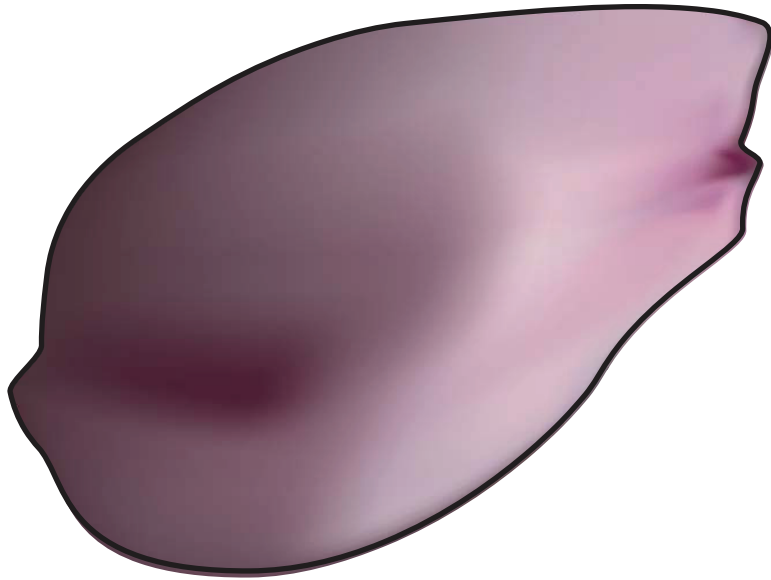
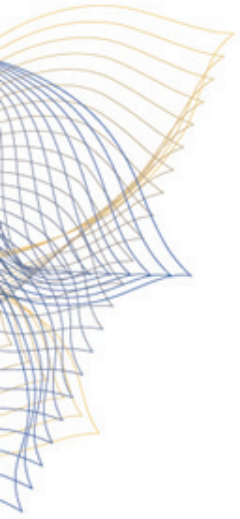
0	0	m				
-7	23	-40	19	-15	-17	c
-7.5	-27.8	-11	-22	0	-35	c
11	-22	7.5	-27.8	15	-17	c
40	19	7	23	0	0	c



Shapes And A Little More



Shaded-Filled Paths





Typographic Text

Outline fonts



Outline Fonts

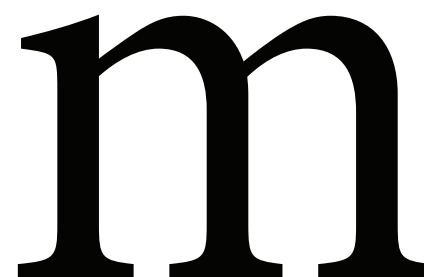
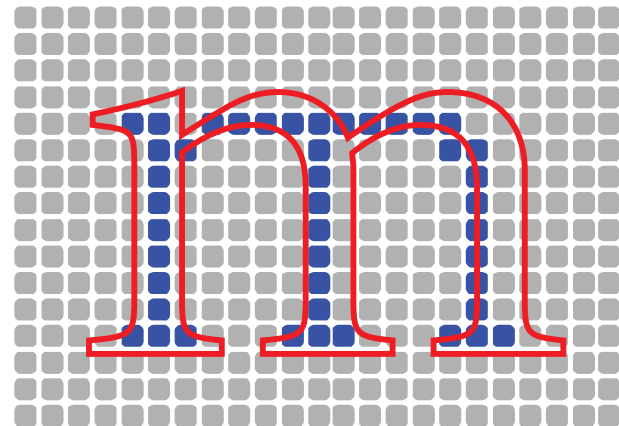
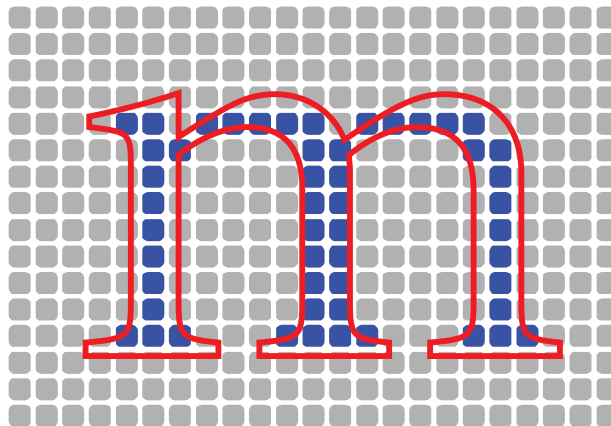
- **Characters drawn as graphic outlines**
- **Transformed suitably**
- **Rasterized and cached**

Typographic Text



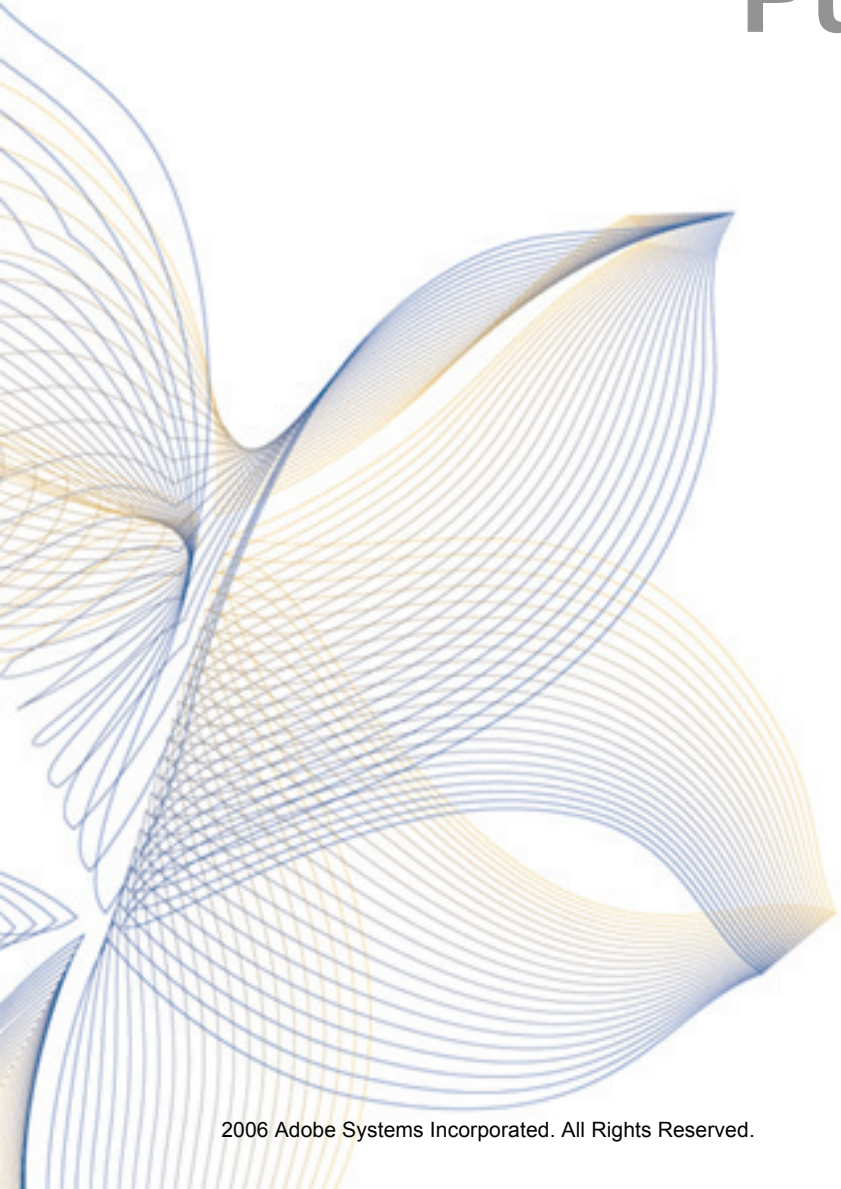
Rendering Outline Fonts

- Anomalies
 - Uneven stem widths
 - Use hints and/or anti-aliasing



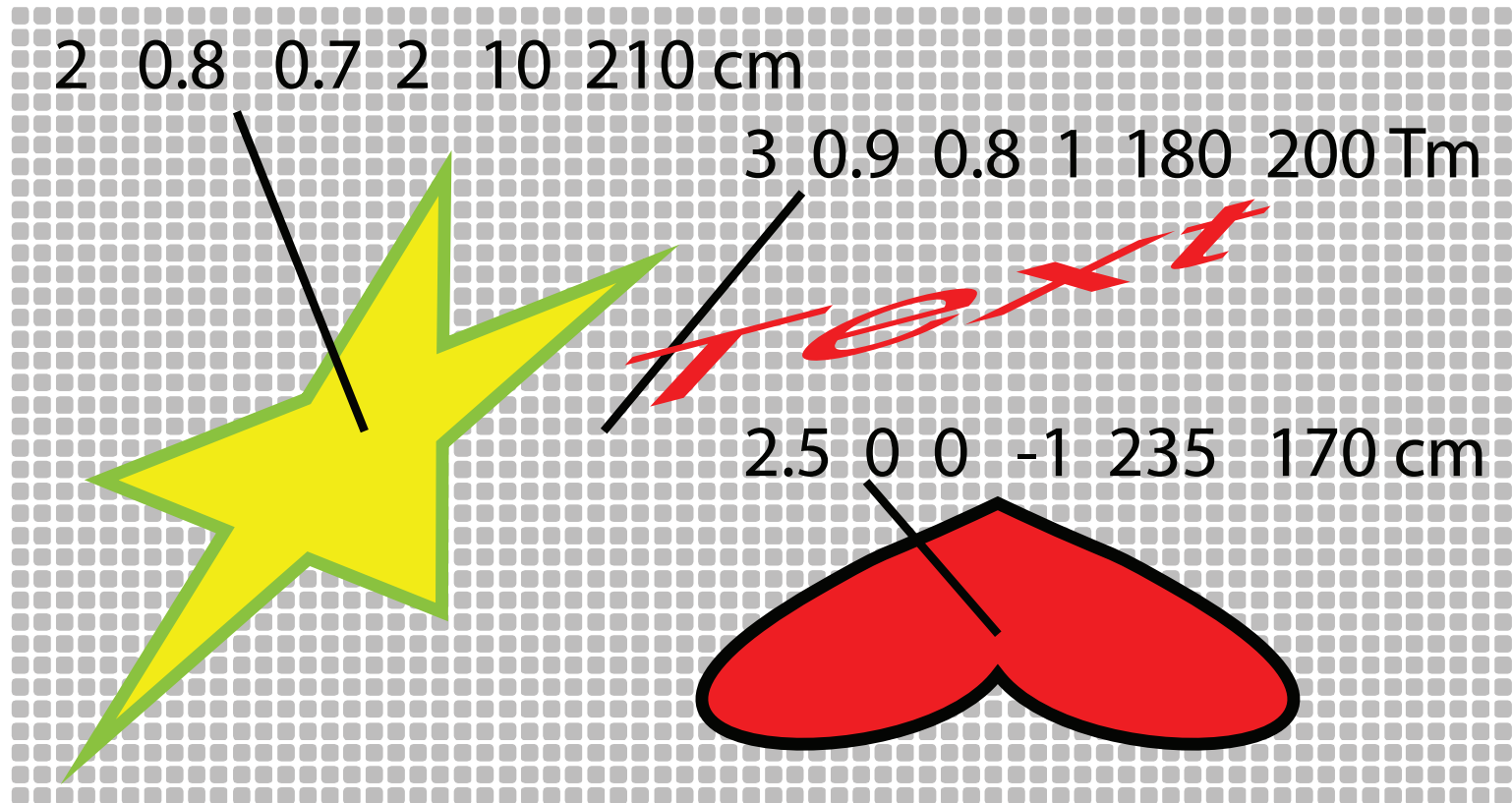
Putting It All Together

Graphic Transformations and 2-D Coordinate System



Coordinate Transforms

- x-scale, rotate/skew, rotate/skew, y-scale, x-pos, y-pos



Operating Systems and Applications

- **Need for speed and quality**





On Low Resolution Displays

- **Detailed graphics for menus and palettes**
 - Every pixel counts (1 or 2)
 - Need careful spacing
 - Need small features to be uniform
 - Need good looking text
 - Needed bit-blt speeds (less true today)
- **Custom crafted images**
 - Different image for each resolution
 - Not resolution independent





On High Resolution Displays

- **Need to use resolution independent methods**
 - Vector graphics, sampled images, outline fonts
- **Every pixel not so important**
 - 4 or 5 versus 1 or 2
- **Big change for OS Vendors and Applications**



Adobe

**Revolutionizing how the world
engages with ideas and
information**

Slides found at:

<http://home.comcast.net/~jk05/presentations>

