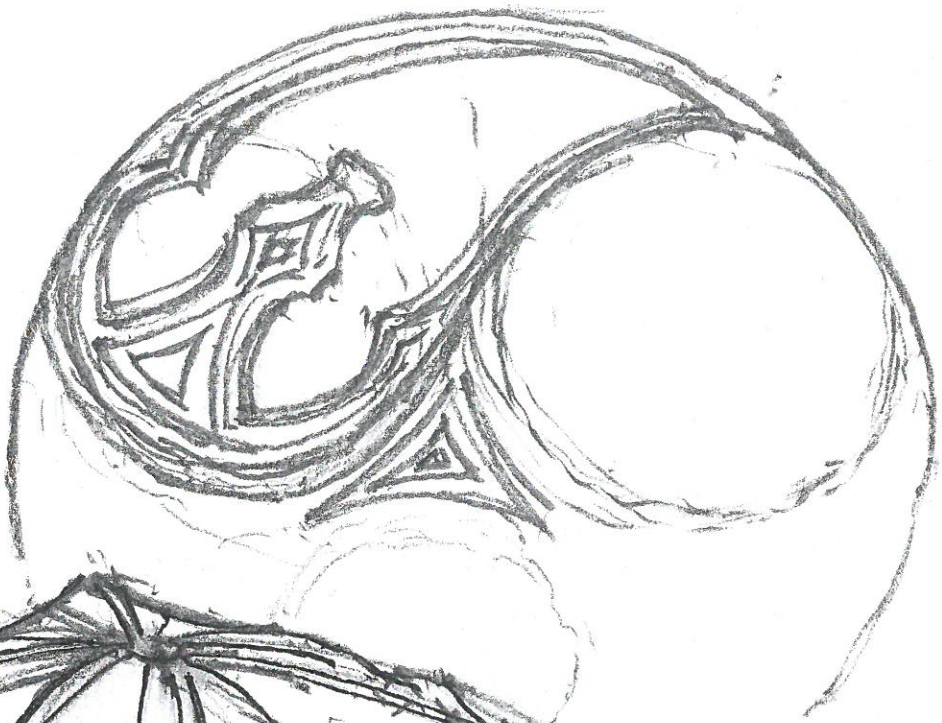
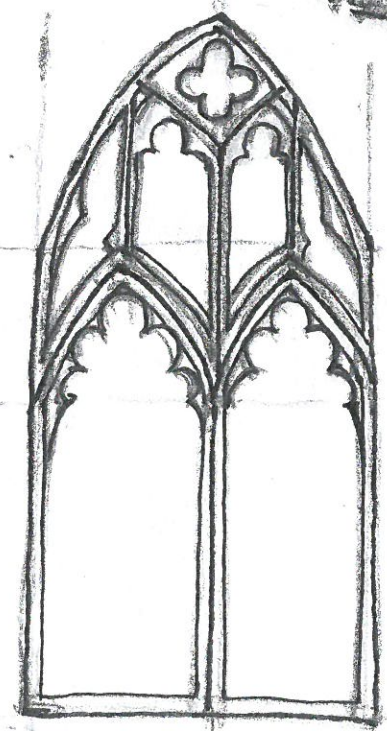
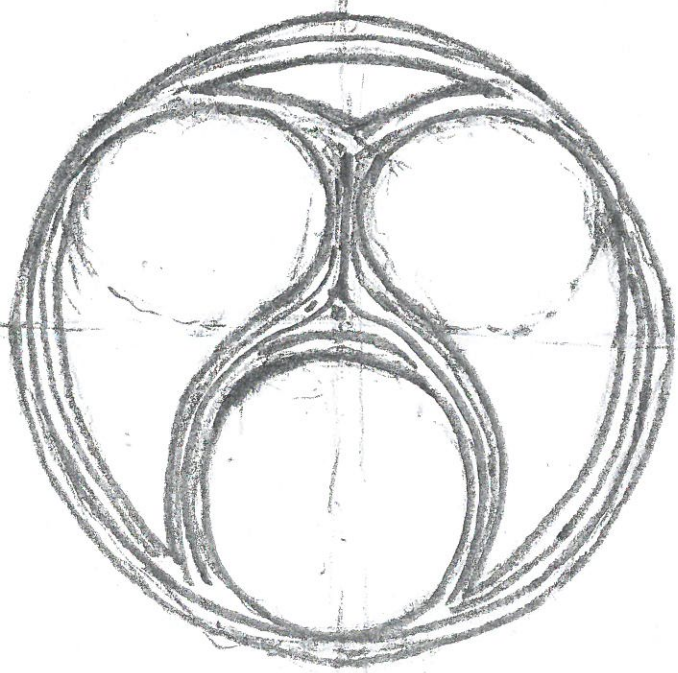
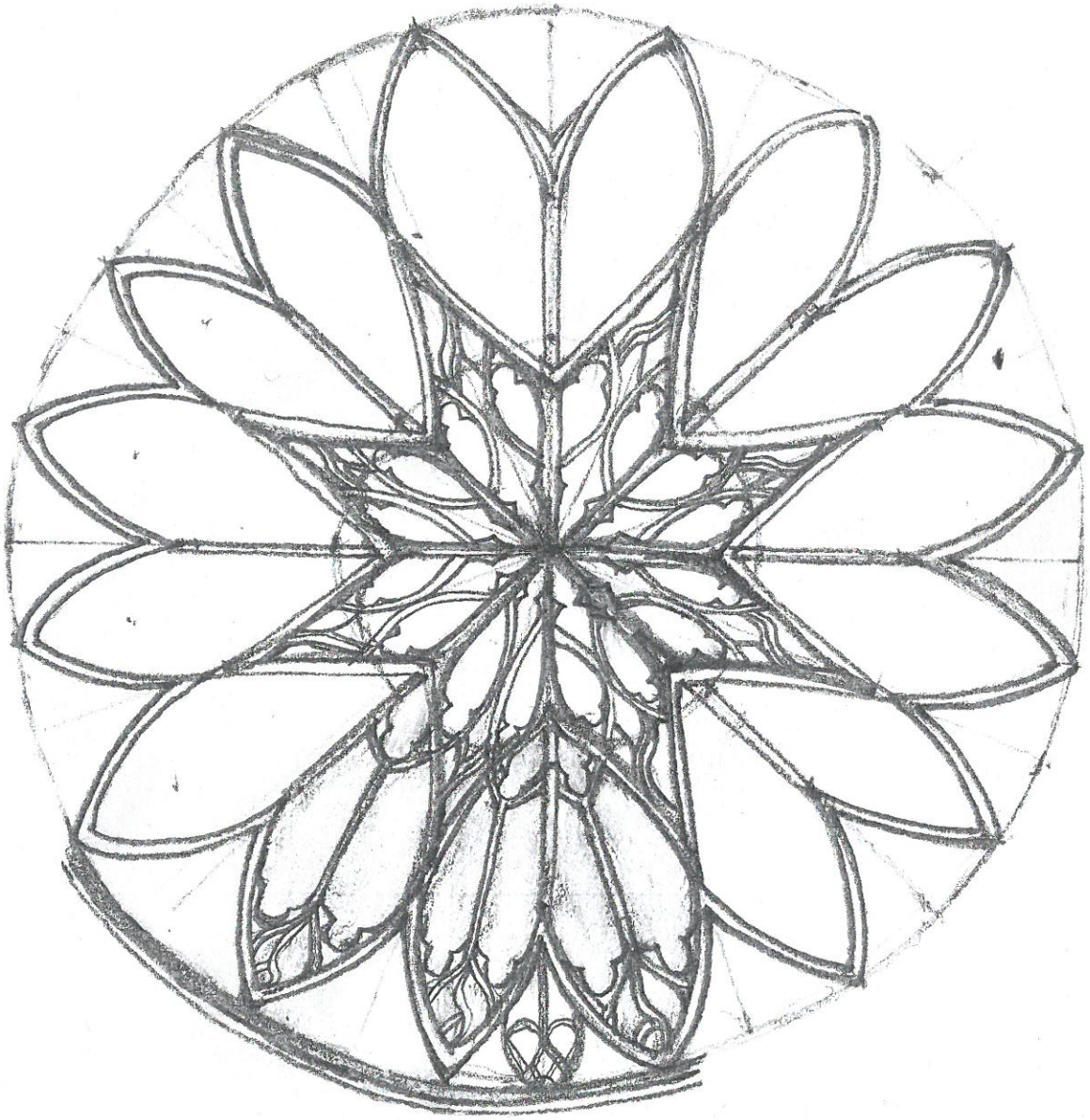
• Amiens Cathedral Rose Window





exploring geometries
for object shapes/forms





Symmetries

$$v' = Av + h$$

point / vector

- Rotation (anticlockwise)

$$A = \begin{bmatrix} \cos\varphi & -\sin\varphi \\ \sin\varphi & \cos\varphi \end{bmatrix} \text{ and } h = 0 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

centred in O of an angle φ

$\varphi = 0 \rightarrow$ identity

$\varphi = \pi \rightarrow$ symmetry through O

$\varphi \in [0, 2\pi]$ often $2\pi/n$

- Symmetry: Axis

$$A = \begin{bmatrix} \cos 2\varphi & \sin 2\varphi \\ \sin 2\varphi & -\cos 2\varphi \end{bmatrix} \text{ and } h = 0$$

$\varphi = 0 \rightarrow$ x axis

$\varphi = \frac{\pi}{2} \rightarrow$ y axis

Symmetry axis through O

$\varphi \in [0, \pi]$

- Rotation + Scaling

$$A = \begin{bmatrix} \lambda\cos\varphi & -\lambda\sin\varphi \\ \lambda\sin\varphi & \lambda\cos\varphi \end{bmatrix} \text{ and } h = 0 \quad \lambda > 0$$

- **cyclic** symmetry - no axis but centre of symmetry
- **dihedral** symmetry: at least one symmetry axis
- more than one symmetry axis - has a centre of symmetry (the intersection of the axes)

C_n - cyclic symmetry only

D_n - having n symmetry axes (also cyclic)

C_n - n rotations of motif around the centre

D_n - can also be generated by n reflections through O

- to find the product $t_1 \circ t_2$: t_1 in row, t_2 in column (down)
- i always appear first

C_1	i
i	i

– transformed in itself by identity

D_1	i	S_1
i	i	S_1
S_1	S_1	i

– transformed in itself & by a reflection S_1 : with symmetry axis

C_2	i	r_π
i	i	r_π
r_π	r_π	i

– transformed in itself & rotation r_φ (with $\varphi = \pi$)

D_2	i	S_1	S_2	r_π
i	i	S_1	S_2	r_π
S_1	S_1	i	r_π	S_2
S_2	S_2	r_π	i	S_1
r_π	r_π	S_2	S_1	i

– transformed in itself & rotation r_φ ($\varphi = \pi$) & two reflections (S_1, S_2)

C_3	i	$r_{\frac{2\pi}{3}}$	$r_{\frac{4\pi}{3}}$
i	i	$r_{\frac{2\pi}{3}}$	$r_{\frac{4\pi}{3}}$
$r_{\frac{2\pi}{3}}$	$r_{\frac{2\pi}{3}}$	$r_{\frac{4\pi}{3}}$	i
$r_{\frac{4\pi}{3}}$	$r_{\frac{4\pi}{3}}$	i	$r_{\frac{2\pi}{3}}$

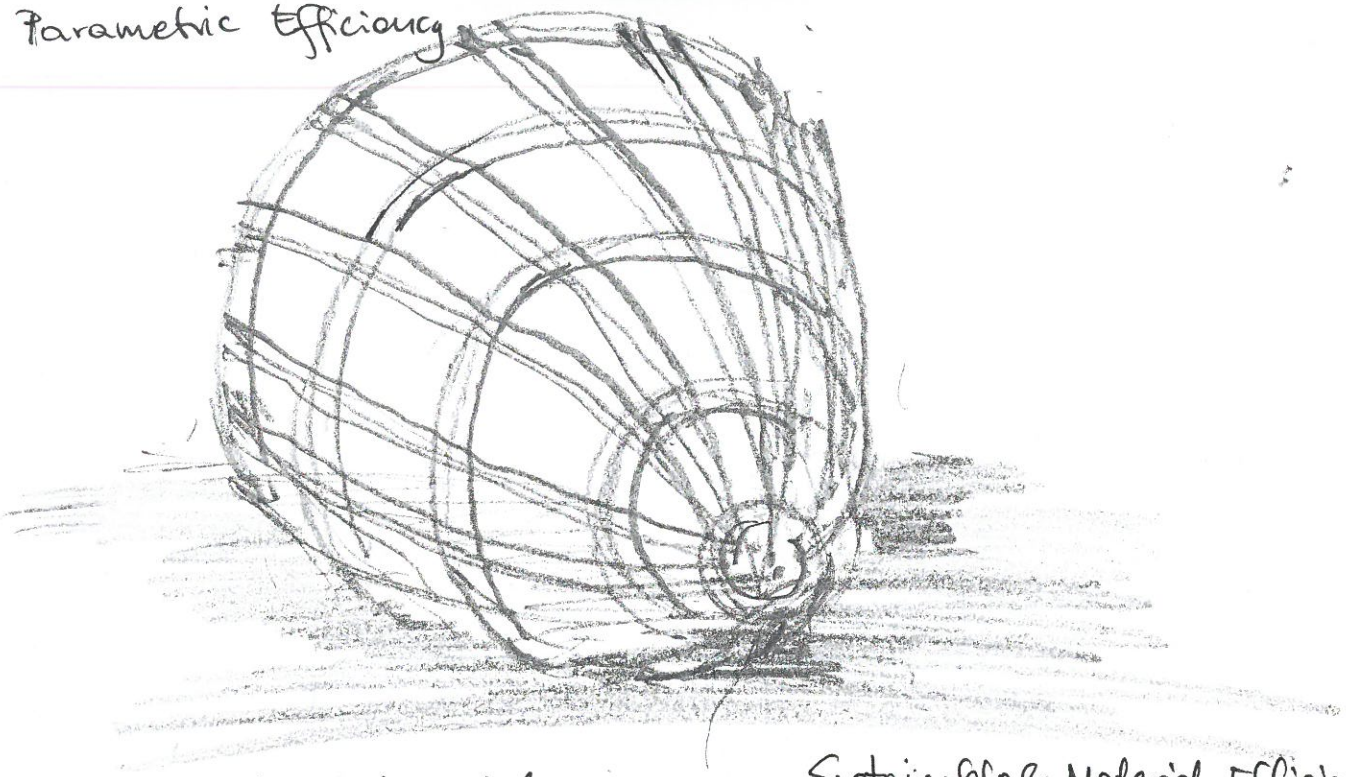
– transformed in itself & rotations r_φ ($\varphi = \frac{2\pi}{3}$, $\varphi = \frac{4\pi}{3}$)

D_3	i	S_1	S_2	S_3	$r_{\frac{2\pi}{3}}$	$r_{\frac{4\pi}{3}}$
i	i	S_1	S_2	S_3	$r_{\frac{2\pi}{3}}$	$r_{\frac{4\pi}{3}}$
S_1	S_1	i	$r_{\frac{4\pi}{3}}$	$r_{\frac{2\pi}{3}}$	S_3	S_2
S_2	S_2	$r_{\frac{2\pi}{3}}$	i	$r_{\frac{4\pi}{3}}$	S_1	S_3
S_3	S_3	$r_{\frac{4\pi}{3}}$	$r_{\frac{2\pi}{3}}$	i	S_2	S_1
$r_{\frac{2\pi}{3}}$	$r_{\frac{2\pi}{3}}$	S_2	S_3	S_1	$r_{\frac{4\pi}{3}}$	i
$r_{\frac{4\pi}{3}}$	$r_{\frac{4\pi}{3}}$	S_3	S_1	S_2	i	$r_{\frac{2\pi}{3}}$

– transformed in itself, by rotations $\varphi = \frac{2\pi}{3}$, $\varphi = \frac{4\pi}{3}$ and by reflections S_1, S_2, S_3 (axis)

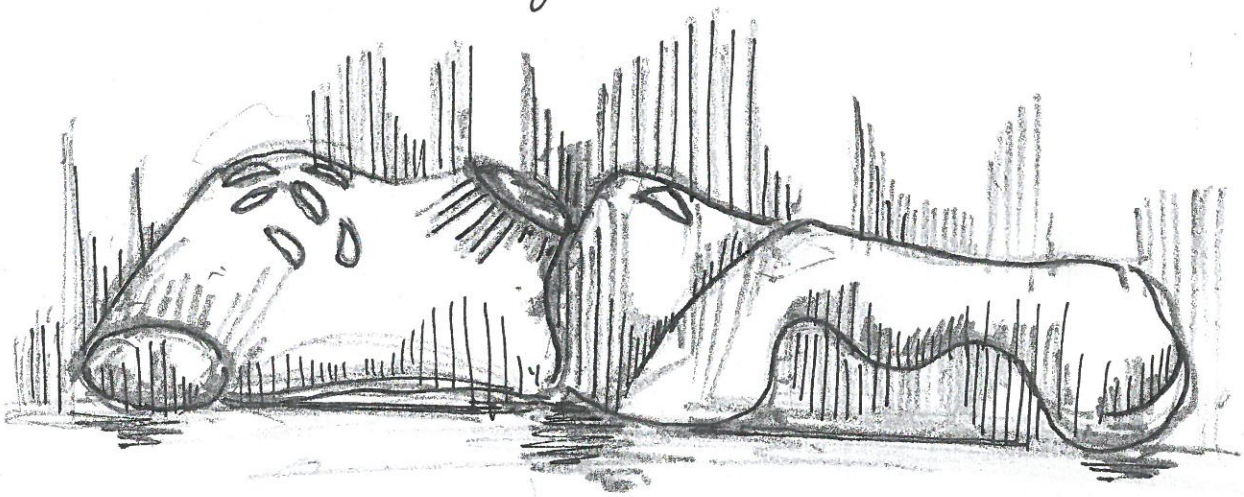
D_3 includes all previous tables

Parametric Efficiency



Sustainable & Material Efficient Structure

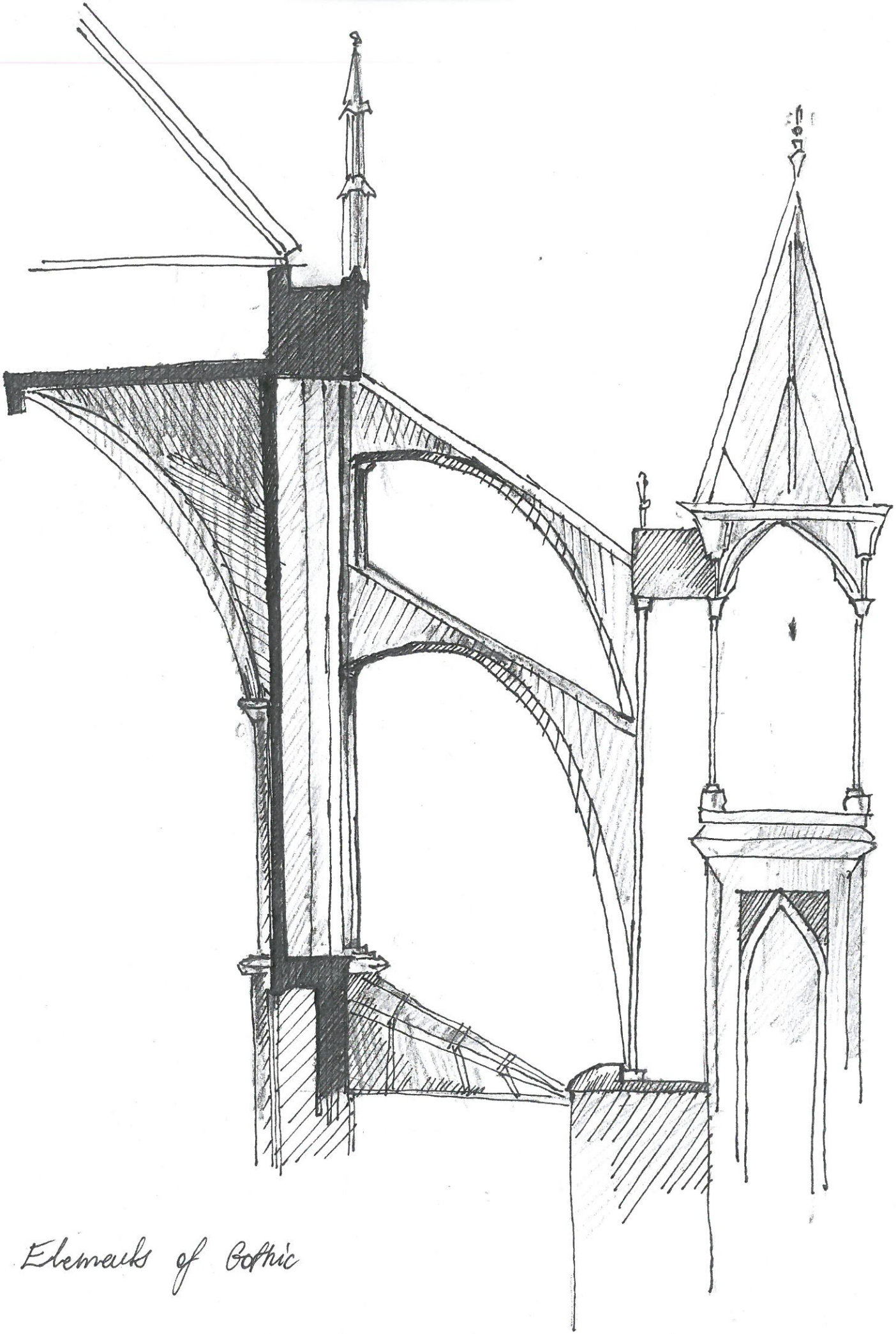
Comparison between traditional & new ways of construction. Scripting & parametric design could be a means to reducing carbon footprint & cruel material consumption.



Architecture in the Digital Age

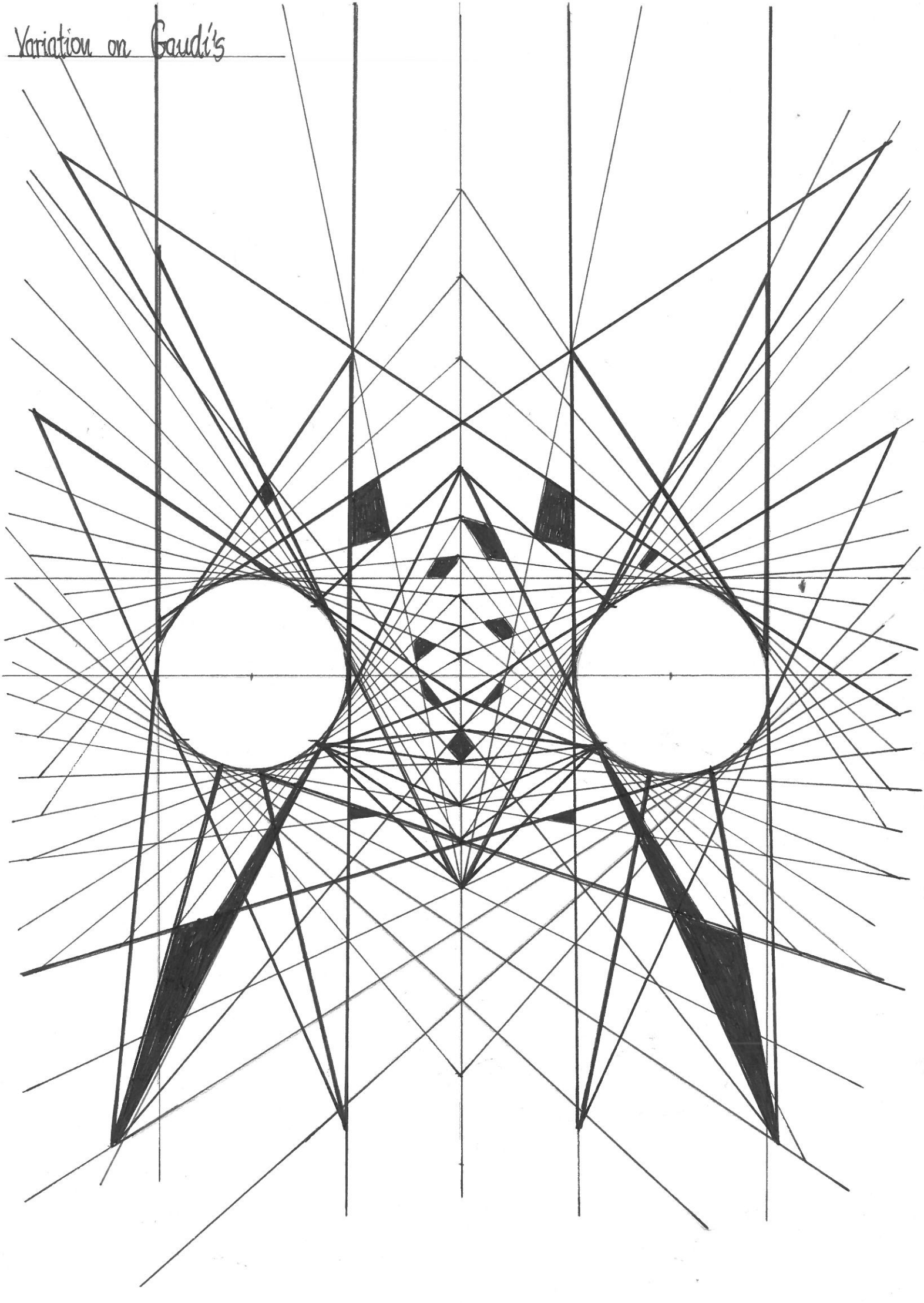
B.12

- Mathematical research about rules for elements belonging to different architectural styles/eras ?
  - Gothic
  - (Gaudi's Sagrada)
  - Corynthian
  - Classical

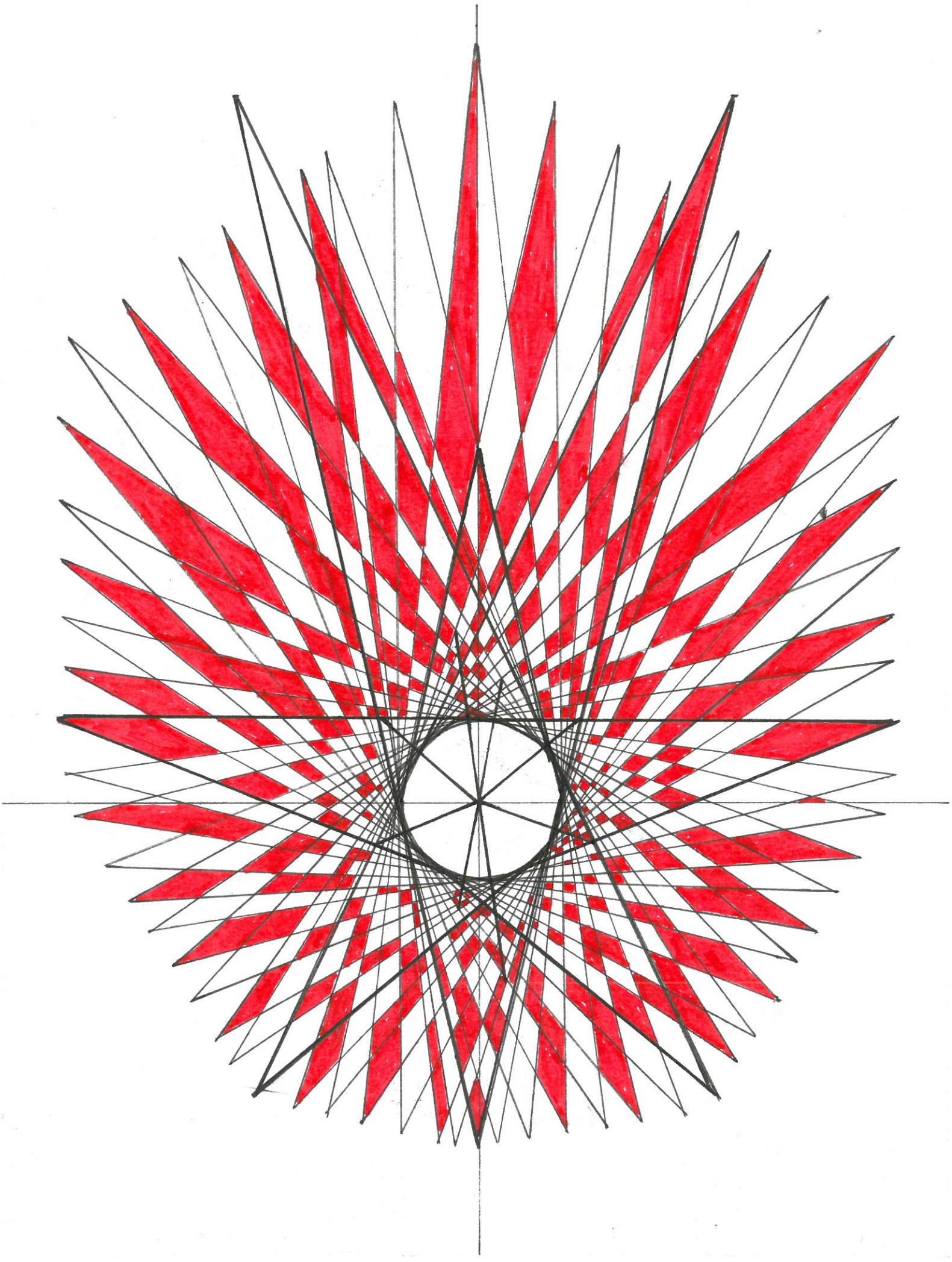


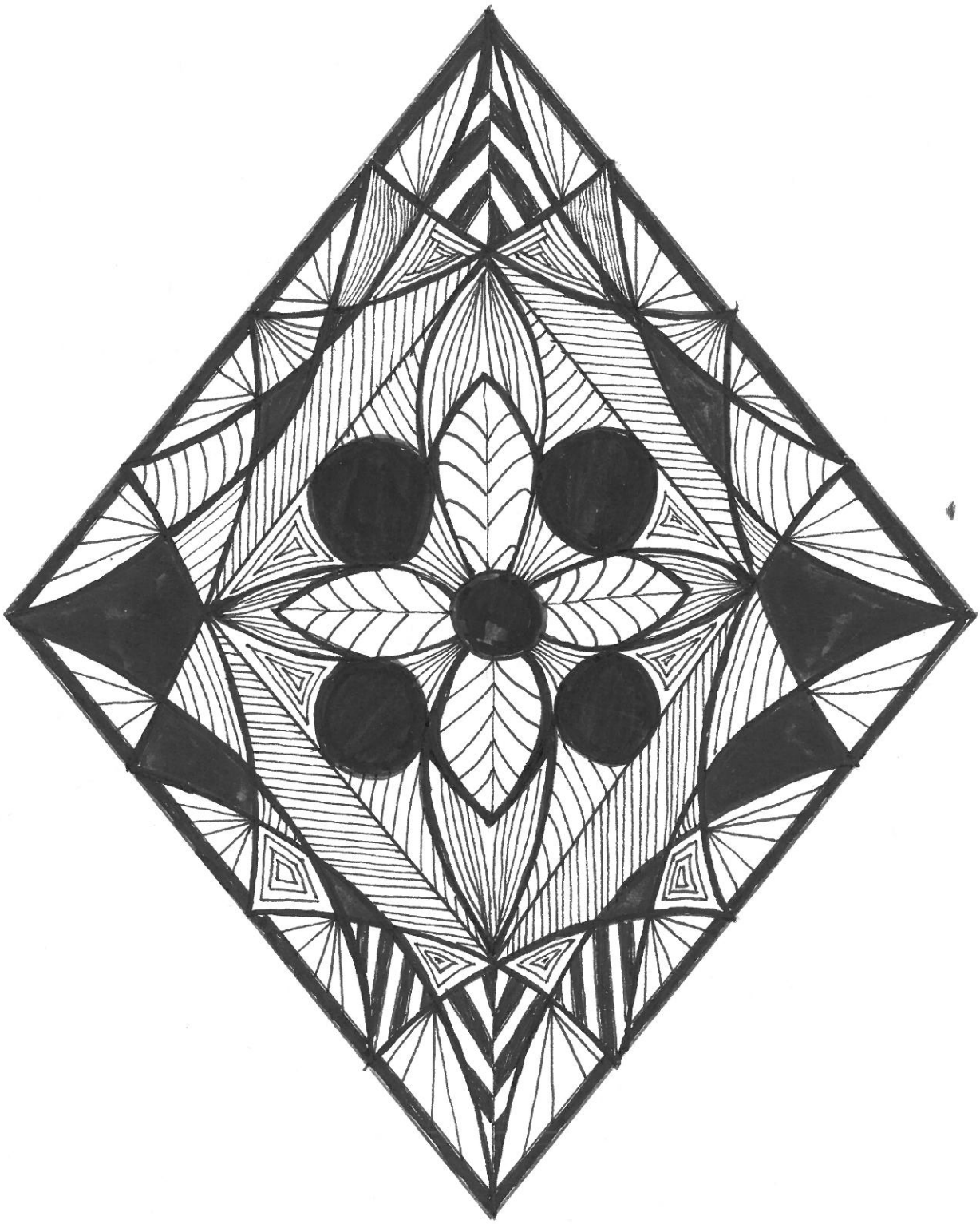
Elements of Gothic

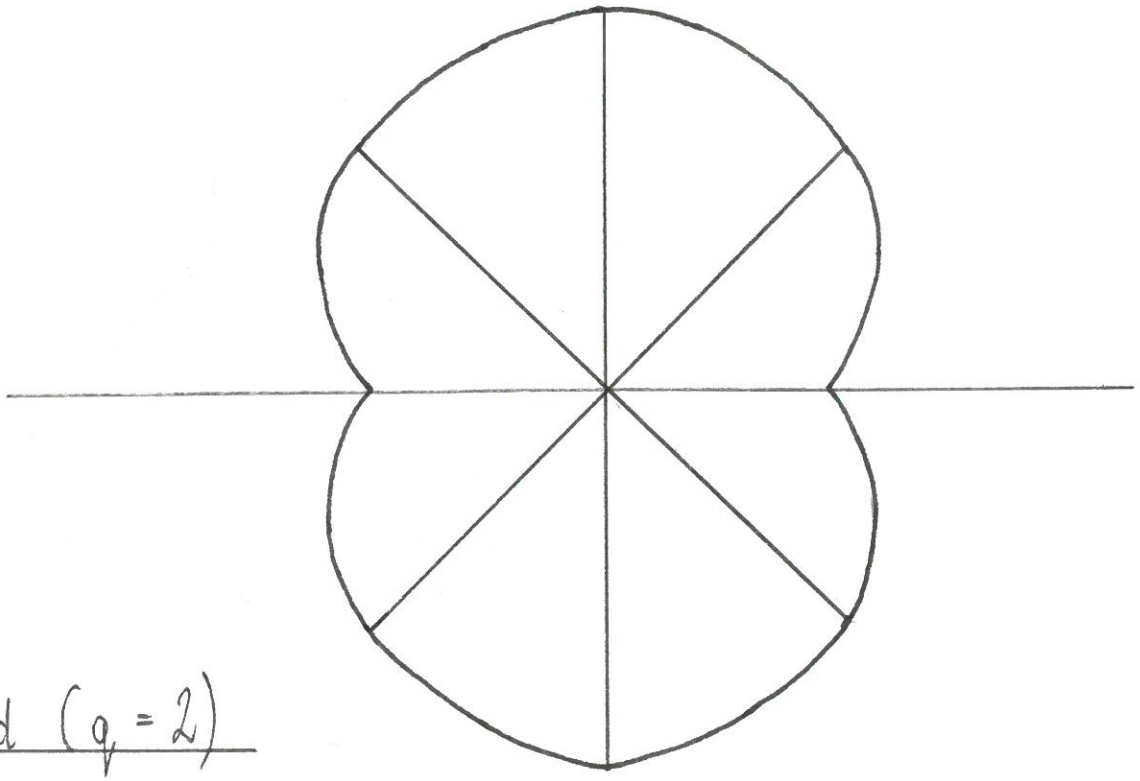
Variation on Gaudí's



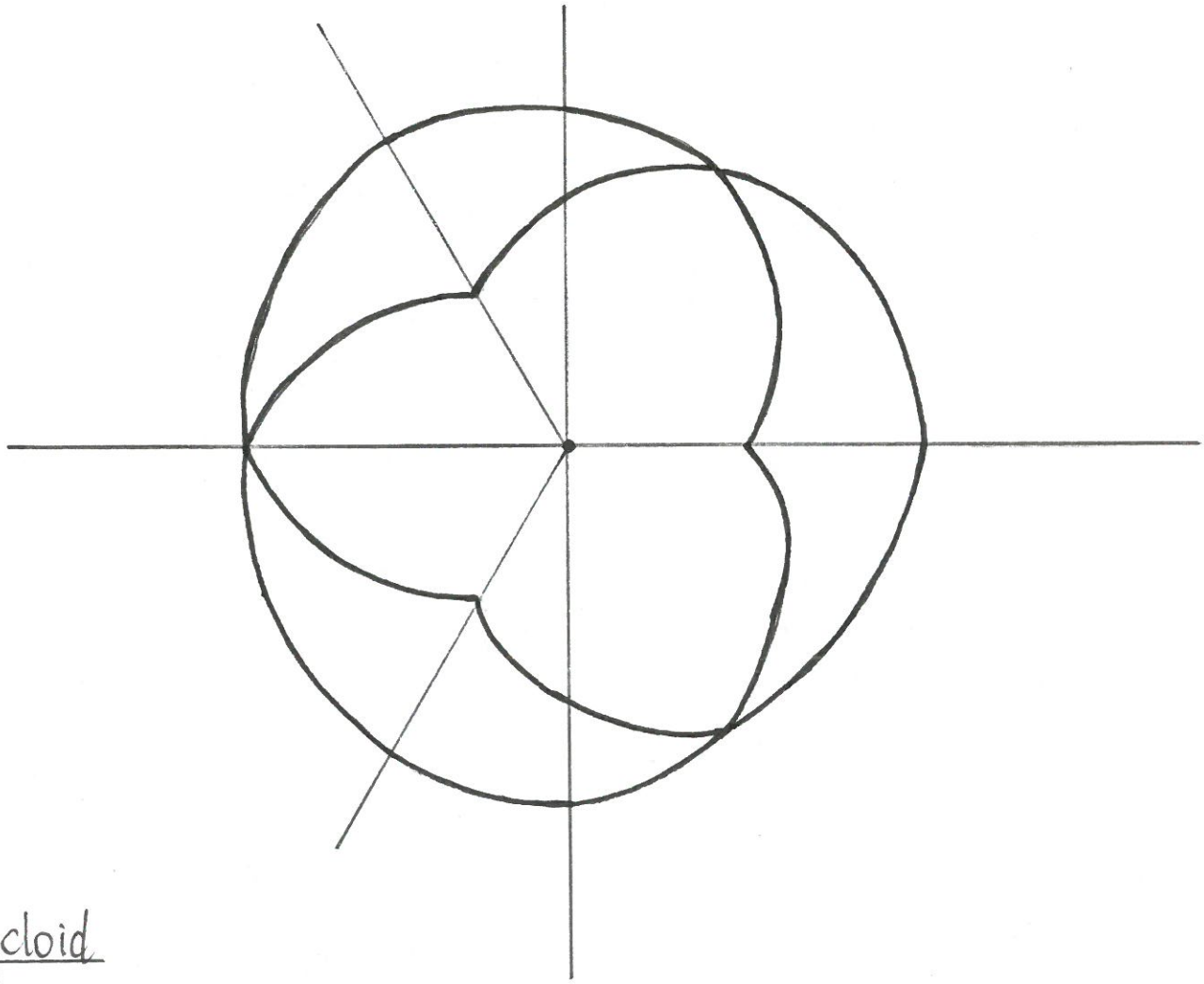
Symmetries





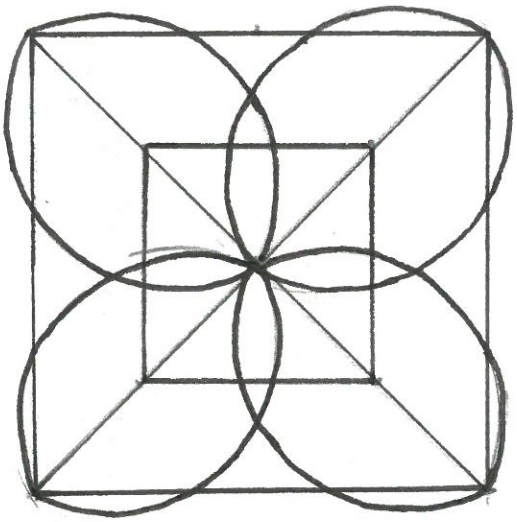


Nephroid ($q = 2$)

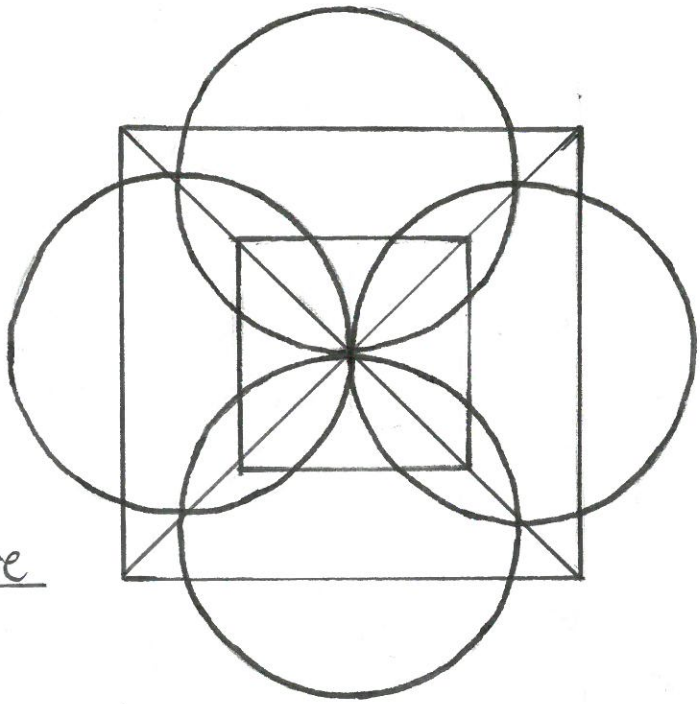


Hypocycloid

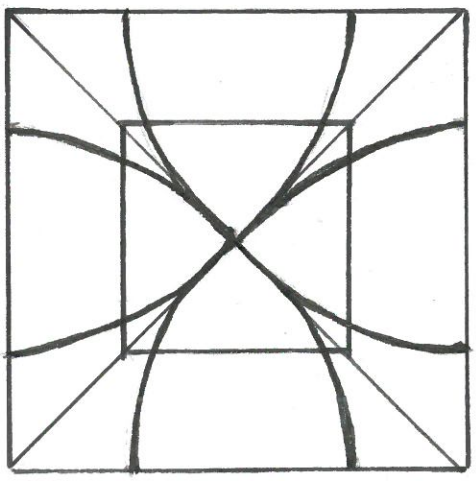
Sacred Cut



Cut: two squares



Rotated circles / centre



Arcs equal to d/2