

الخط العربي

استكشاف بالحاسب الآلي

هدى مصطفى
كريشنا مرتي راميش

الرياضيات
والتصميم
٢٠٠١

جامعة كارنيجي ملون

Arabic Calligraphy

A Computational Exploration

Mathematics
& Design
2001

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Outline

Arabic Calligraphy

Introduction (script and applications)

Examples of calligraphic symmetries

Interactive Calligraphy Exploration

Concepts - symbols, regulators, dynamic associations

Symmetry manipulation: demonstrations

Multiple regulators, change propagation, flexibility

Examples of calligraphic compositions

Conclusion

Future investigations

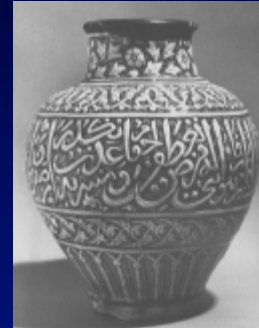
Arabic Calligraphy

An art form that combines
spiritual meaning with
aesthetic beauty

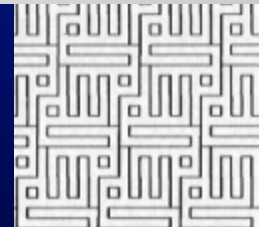
A fundamental decorative
element in **Islamic art**

- From architecture to ornamental design
- Historical to modern times

Frieze and **wallpaper** patterns



Vase (circa 14th century)
(Source: Massoudy, 1981 p. 100)



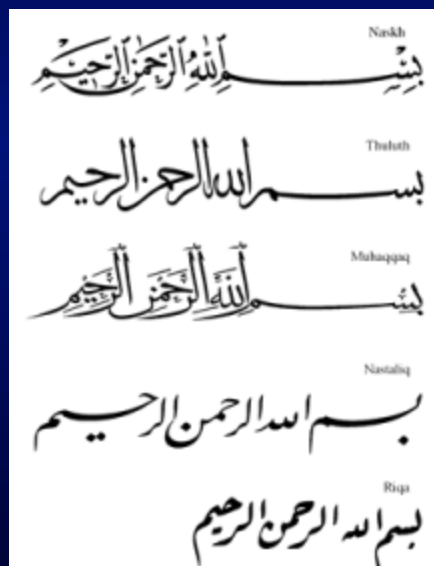
Allah used in a *p2* wallpaper pattern
(Source: Abbas and Salman, 1998, p384)



Hassan repetitively used in a frieze
pattern. Designed by M. Chafiq.
(Source: Massoudy, 1981, p87)

Arabic Script

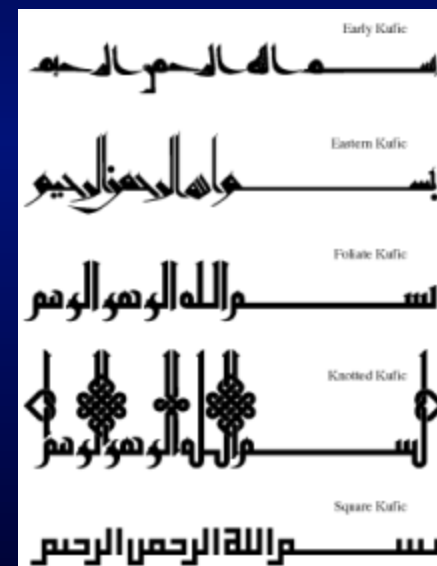
Cursive styles



Bismillah al Rahman al Rahim.
In the Name of God, the beneficial,
the merciful

(Source: www.sakkal.com)

Kufic styles



Arabic Script

The fluidity of Arabic script offer indefinite possibilities for designing calligraphic expressions within a single word

Letters can be stretched and transformed in numerous ways to create different motifs



Bismillah al Rahman al Rahim
designed by Raqim in 1908
(After: Massoudy, 1981, p121)



Bismillah al Rahman al Rahim
(Source:
khat.hypermart.net/misc3.htm)



Bismillah al Rahman al Rahim
Designed by al Rifa' i in 1924
(After: Massoudy, 1981, p120)

Calligraphic Symmetries

True symmetry

Due to transformations



Allahu Ahad Allah is one
(Source: www.sakkal.com)

Implied symmetry

Due to organization



Surat al Ikhlas, Faith
(Source: www.islamiccity.org)

The focus of our interactive
calligraphy exploration

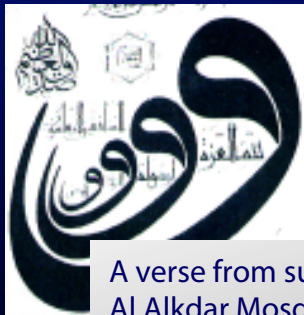
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Calligraphic Symmetries

Identity



Wa Hua 'ala kul shai' Kadir
And He is all powerful.
(Source: www.islamiccity.org)



A verse from surat the Hypocrites
Al Alkdar Mosque, Turkey
(Source: Massoudy 1981, p105)

Vertical reflection



La ilaha illa Hua
There is no god but him
(Source: www.islamiccity.org)

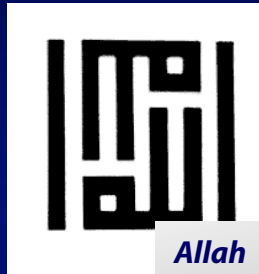


Muhammed
Designed by Al Kharmani
(Source: Massoudy 1981, p134)

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Calligraphic Symmetries

Half turn rotations

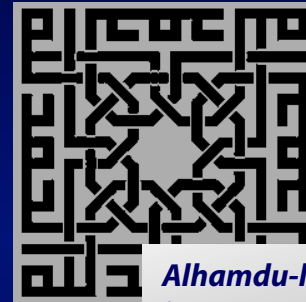


Allah
(Source: Massoudy 1981, p75)



Al Sharq al Alwsat Middle East
(Source: www.sakkal.com)

4-fold symmetry



Alhamdu-lillah Thank God
(Source: www.sakkal.com)



Iqra Read
(Source: www.sakkal.com)

skip

Calligraphic Symmetries

3- and 6-fold symmetry



Ali
(Source: Massoudy 1981, p95)



Verses from **Surat al Shams** (the Sun),
each starting with the letter **Waw**
(Source: Massoudy 1981, p81)

8-fold symmetry



Allahu Ahad Allah is one.
(Source: www.sakkal.com)



Iqra (Read)
The first word of the Quranic revelation.
(Source: www.sakkal.com)

skip

Calligraphic Symmetries

5-fold symmetry



Al Tahrir (To liberate).
(Source: www.sakkal.com)

N-centers of symmetry



Al Horreyya Freedom.
Designed by Hassan Massoudy.
(Source: Massoudy 1981, p177)

Calligraphy Design

A calligraphic composition is composed of

Elements (letters)

Relations (relative arrangement of the letters)

Calligraphy design is **iterative**



Interactive Calligraphy Exploration (ICE)

A computational environment for designing symmetrical calligraphic compositions

Supports **two types** of manipulation

- Manipulating **letters**
- Manipulating the **symmetry**

Approach

- **Abstract** the organizational dimension (**symmetry**) from the physical dimension (**letters**)
- **Manipulate** each dimension **separately**

Calligraphy Symbols

Simplified abstractions of letters of the [Arabic alphabet](http://www.arabic2000.com/arabic/alphabet.html)

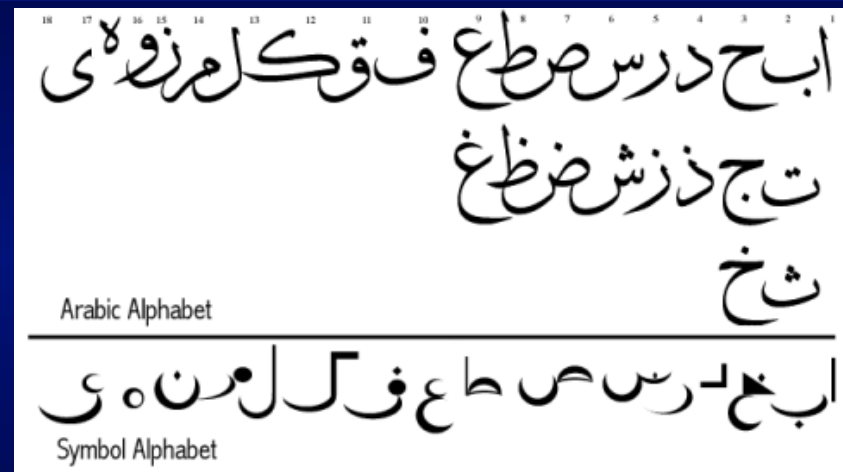
Representation

- Straight lines
- Triangles
- Dots and circles
- Crescents

Manipulation

- Translation, scale, rotation, shear and deformation + through changing color, fill, line width and transparency

<http://www.arabic2000.com/arabic/alphabet.html>



Symmetry Regulators

Control the behavior of calligraphic symbols

- Generates symmetrical images from seed symbols
- Maintains a symmetry relation between images and seed upon manipulation
- Changes to the regulators transform the configuration of image symbols

Regulator Types

Non-destructive plane isometries

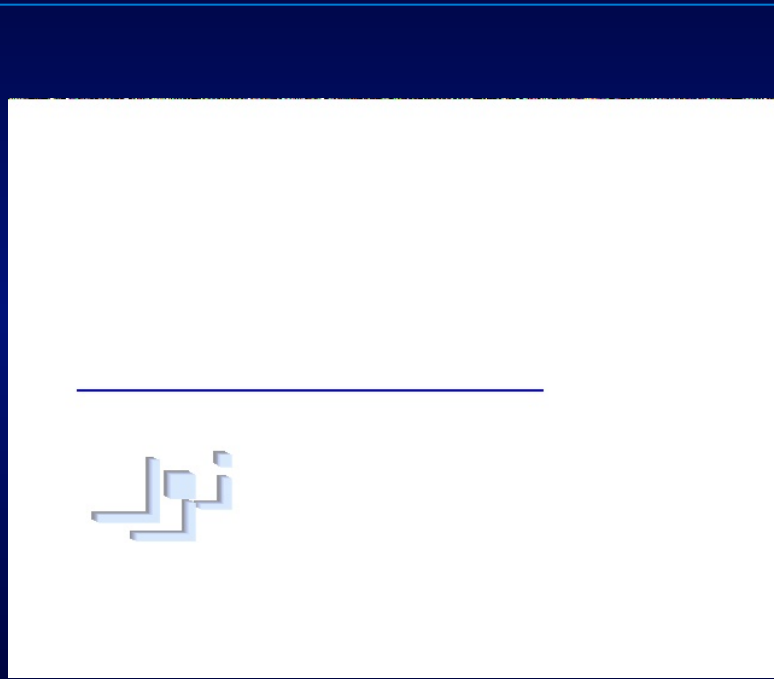
- translation: **T**
- rotation: **R**
- reflection: **M**
- glide: **G**

Each regulator has **two sets of parameters** –

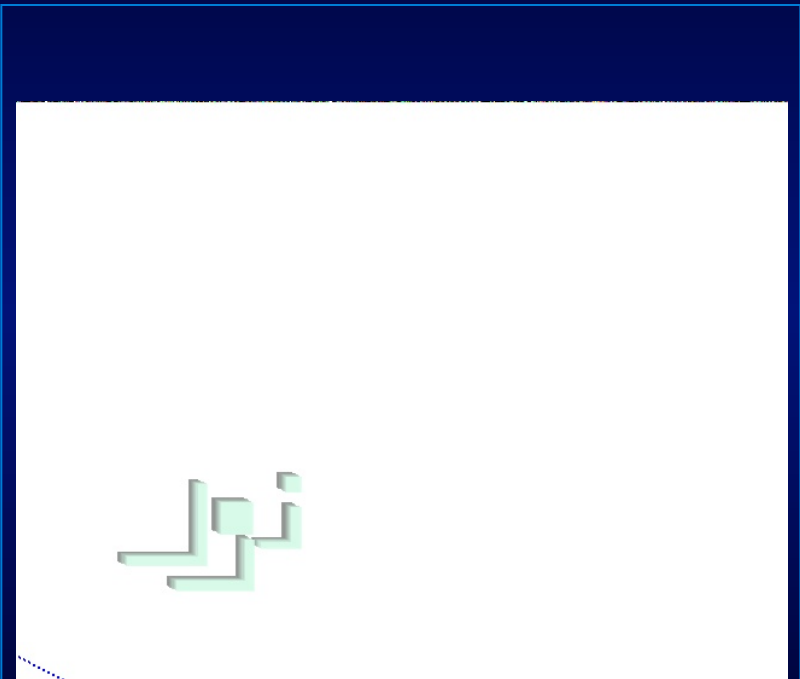
- **symmetry preserving** and **gradation effects**

Regulator Types

Depiction of the word *Noor* (light)



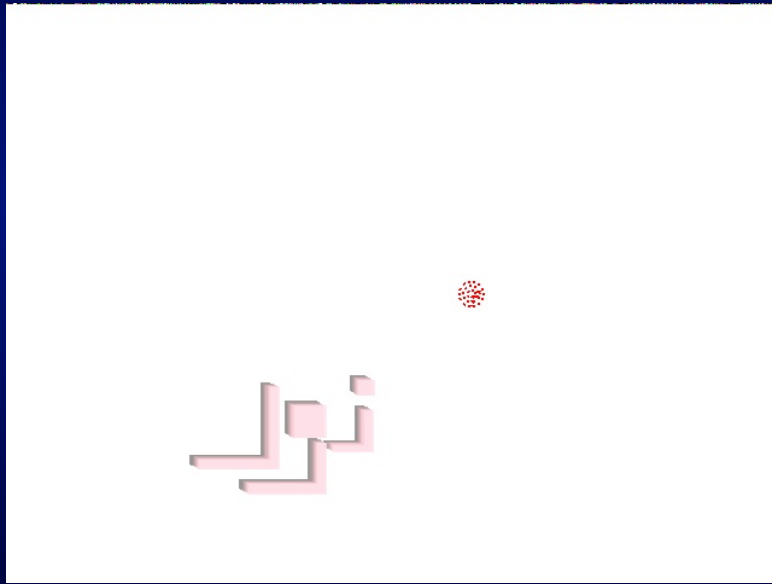
$T(d, q, n) \cdot (Dd, Df, Ds)$



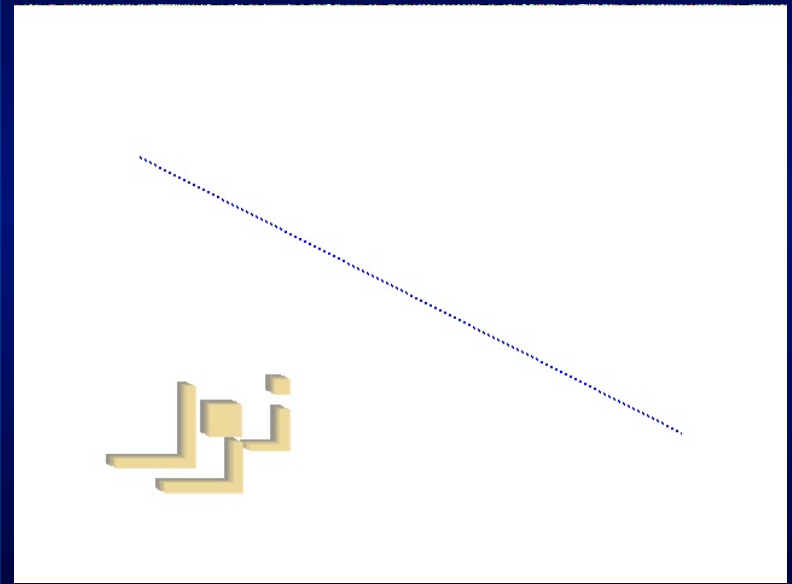
$M(x, y, q)$

Regulator Types

Depiction of the word *Noor* (light)



$R(x, y, q, n) \cdot (Df, Ds)$



$G(x, y, d, q, n) \cdot (Dd, Df, Ds)$

Dynamic Association

Dynamic association and dissociation of symbols and regulators (at any time during the design)

Associations are many-to-many

- Multiple symbols and multiple regulators

Control strategy

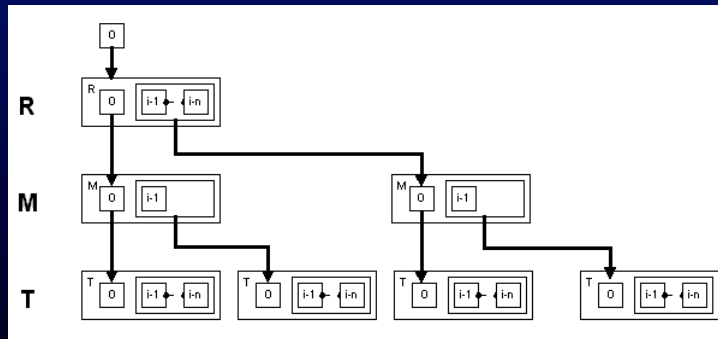
- Regulators ‘observe’ symbols within their associations
- When a symbol changes, it ‘notifies’ its regulators, which propagate changes across symmetric symbols depending on their index

Multiple Regulators

In a multiple regulator scheme

- Symbols become seed and images simultaneously
- Images are subject to composition of isometries
- Possible combinations of regulators is 4^r

Data structure



In a multiple symbol multiple regulator scheme the data structure becomes an acyclic graph.

Change Propagation

A change in a symbol or a regulator initiates a recursive flow of notifications across regulators

Changes in regulators are propagated forward

Changes in symbols are propagated forwards and backwards



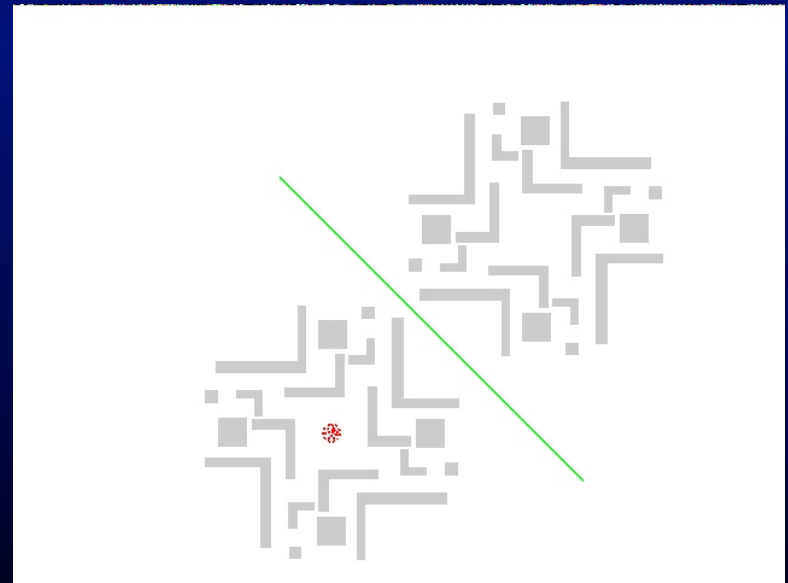
Flexibility – a priority

Symbols and regulators can be **replaced** by other symbols and regulators

Design sequence does not affect manipulations except for the following

The order of associating regulators is not changeable

Implied symmetries are not captured by the system, and cannot be manipulated

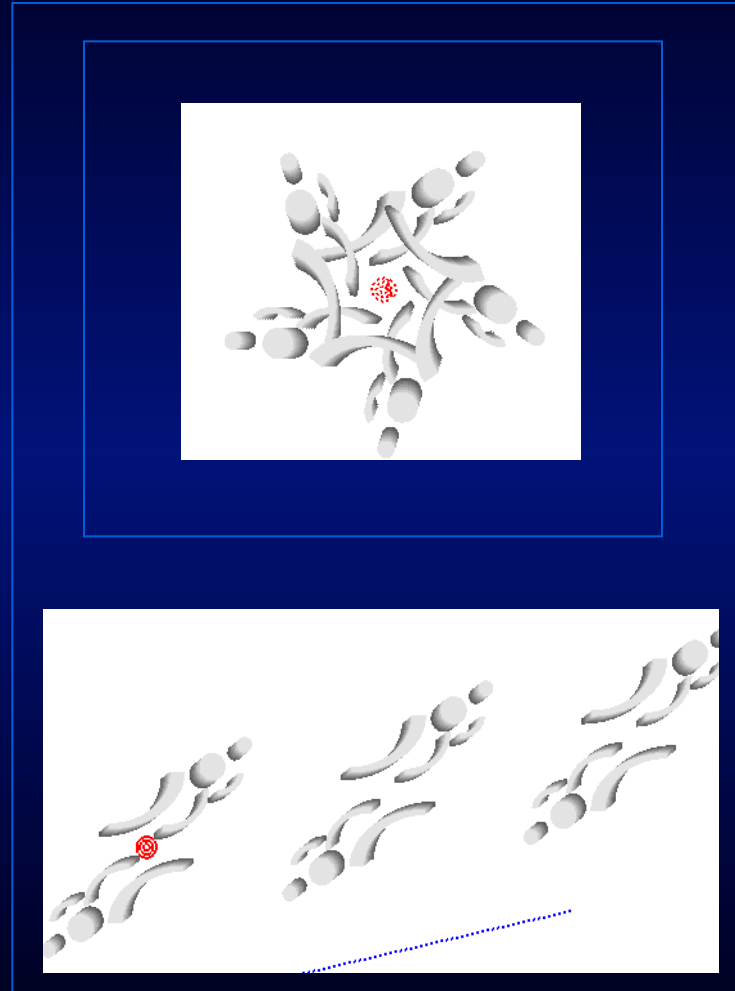
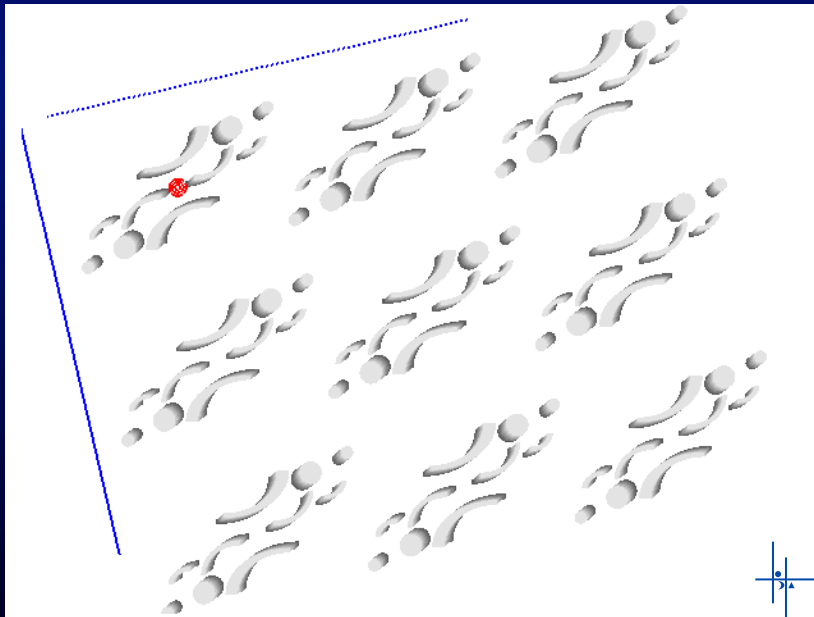


Patterns - symmetry groups

Rosette

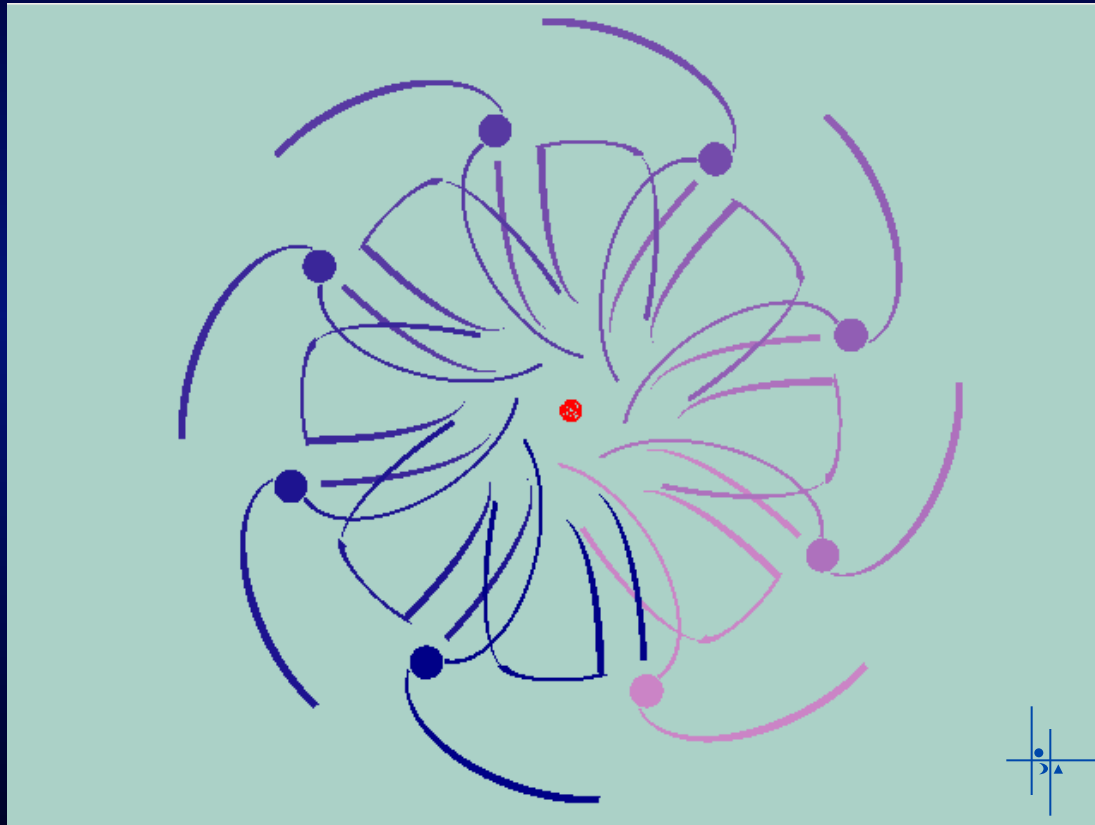
Frieze

Wallpaper pattern



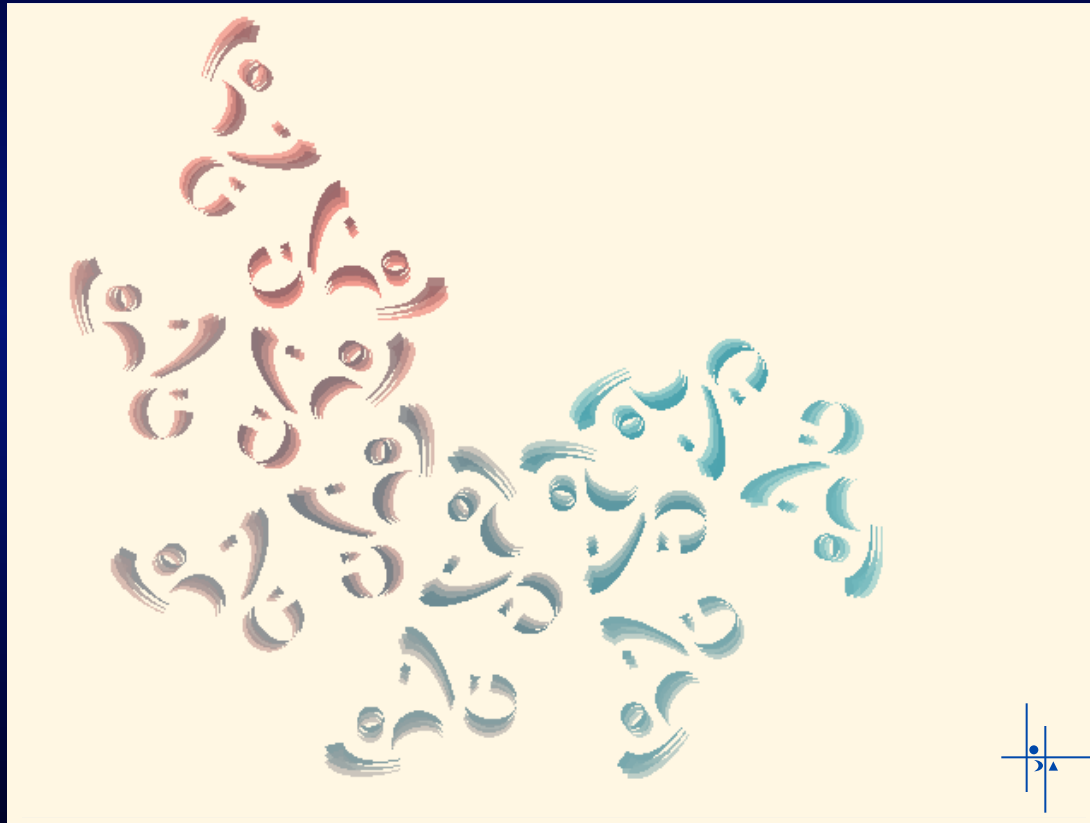
Calligraphy Examples

Al-Salam (Peace)



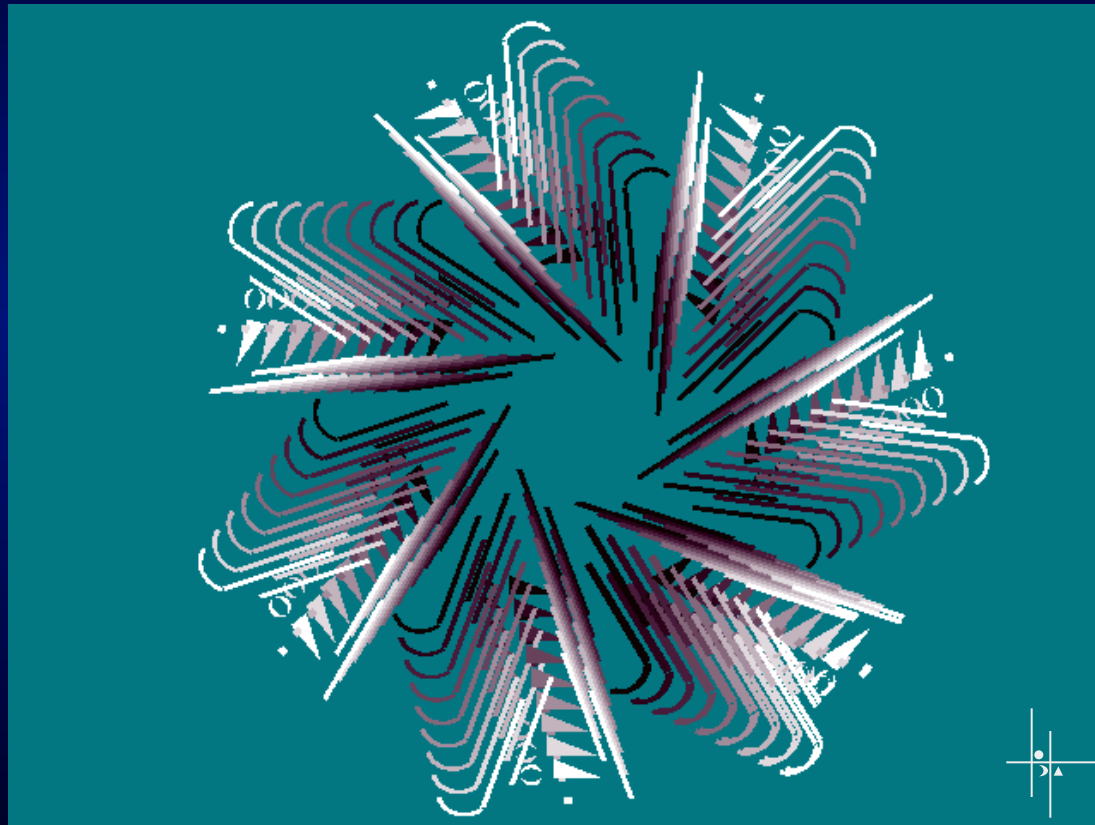
Calligraphy Examples

Ramadan



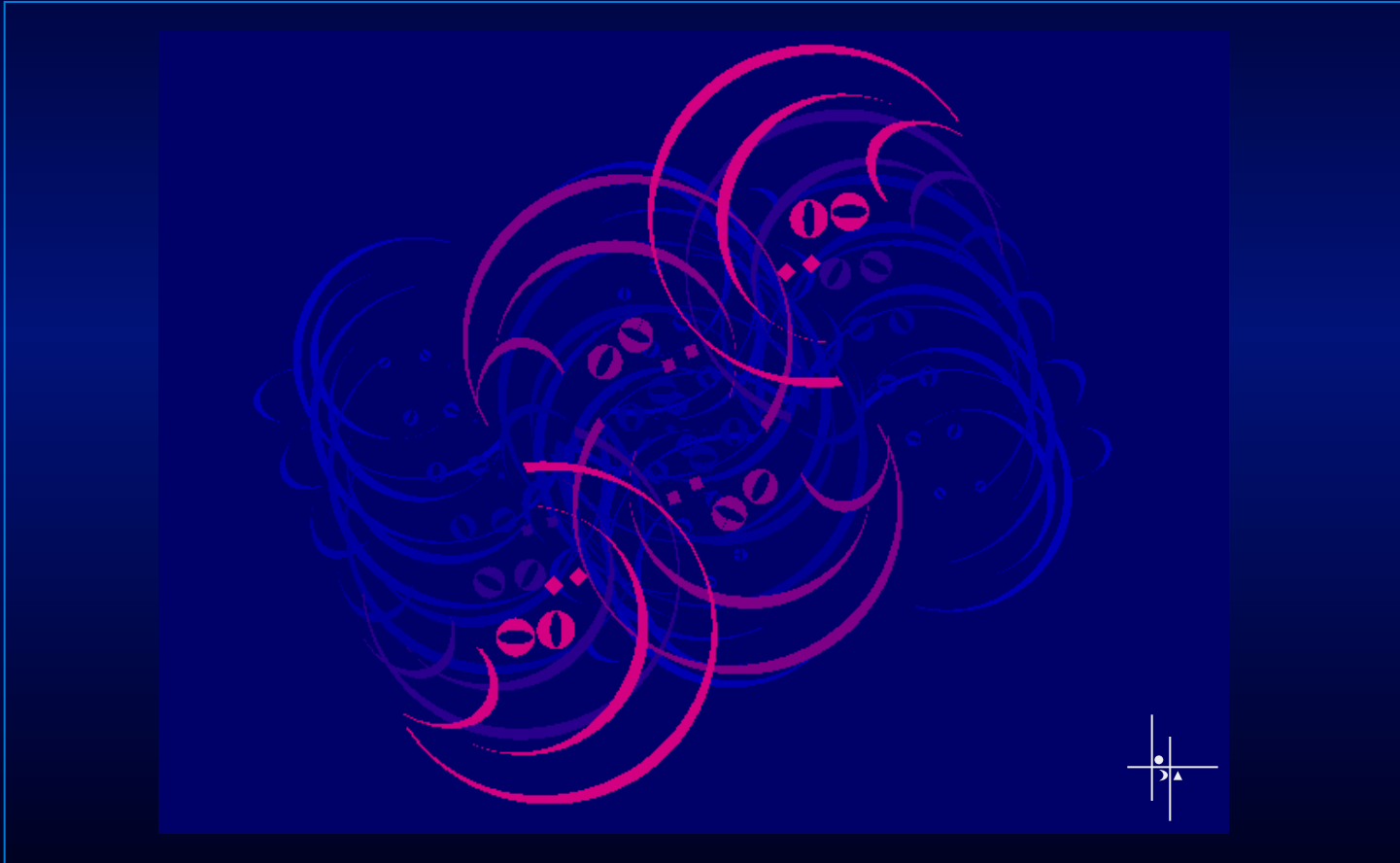
Calligraphy Examples

Al-Jamal (Beauty)



Calligraphy Examples

Al-Qamar (The Moon)



Conclusion

Regulators

- Facilitate fine tuning of design configurations
- Support radical transformations of configurations in a few simple steps

Conclusion

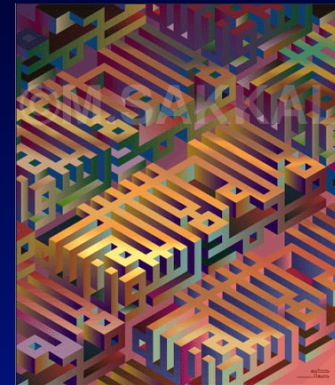
Dynamic Abstractions

- Present interesting new means for design exploration
- Enable designers to work directly and interactively with relational spatial properties
- Facilitate interactions and the production of configurations that go beyond traditional methods of calligraphic design

Wish List

Improving support for calligraphy design

- Arabic script with complete representation of letters including correct Arabic syntax
- Determine the aesthetic and syntactic behavior for the script with its various styles
- Include other languages and explore compositions that combine several languages
- Three dimensional calligraphy
- Explore compositions which fit in a complex boundary



Future Investigations

Increase flexibility of regulators

- Other regulator types such as alignments and boundaries
- Regulators with variable curvatures
 - Translating along a curve
- Regulators with multiple identities
 - Simultaneously a mirror and an alignment line

Future Investigations

A regulating line is an inevitable element of Architecture ... It is an assurance against capriciousness ... it confers on the work the quality of rhythm ... The regulating line is a satisfaction of a spiritual order which leads to the pursuit of ingenious and harmonious relations ... The choice of regulating line fixes the fundamental geometry of the work

(Le Corbusier, *Towards a new architecture*, 1960, p.71)

Mathematics & Design

