

Parametric Design Theories and Applications

Morteza Hazbei

June 2020

Parametricism

Parametric Design

My PhD Research



18 slides , 25 mins



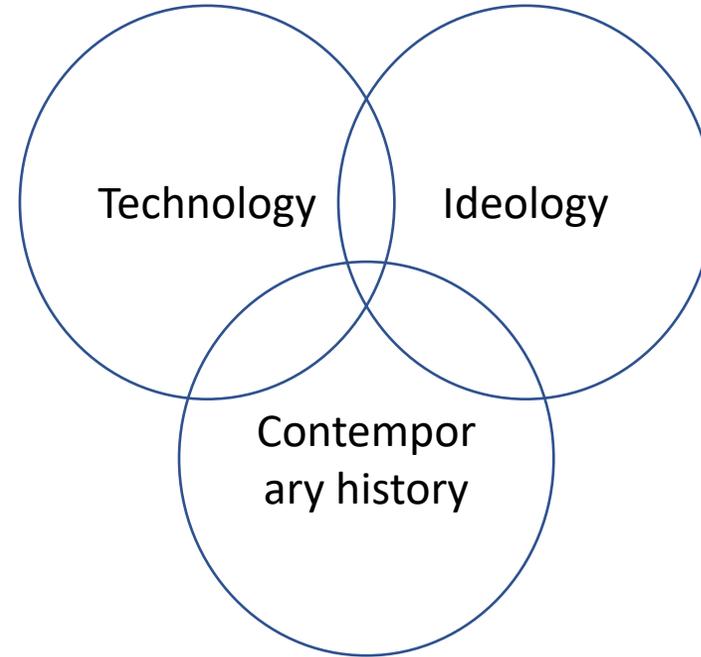
11 slides, 15 mins

8 slides

Parametricism

- What is Parametricism?^[1]

- Is it a style?^[2]



Discourse analyze

- What is and what is not “parametricism”?
- Distinguish Schumacher’s “parametricism” from the more diverse field of “parametrics” in architecture. ^[3]

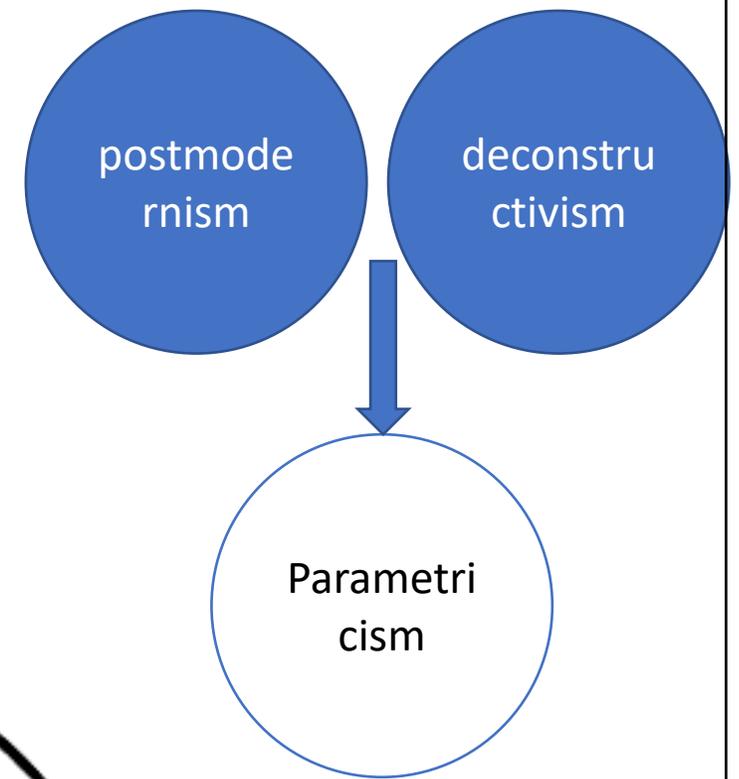
1- Parametricism

2- Digital Design

3- Algorithmic
Design

4- Parametric
Design

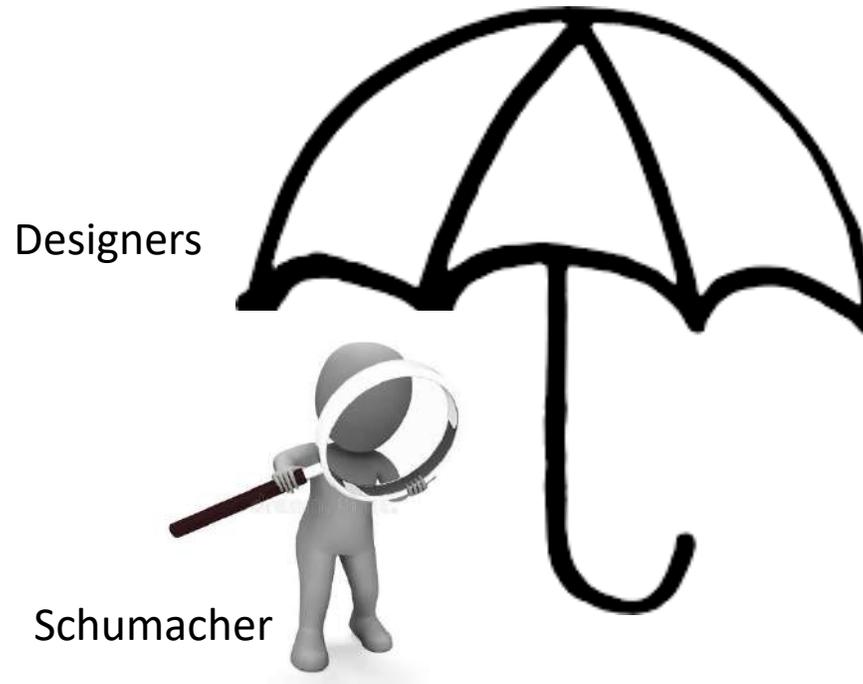
• What is the origin of **Parametricism** ? [4]



• “Parametrics” or “parametric design” [5]



• “algorithmic Design” [6]



- All design is at some level “Parametric” [7]
- This is a generic discourse! [8]

Parametricism: candidate epochal style for the twenty-first century

Building / Architecture	Society / Socio-Economic Epoch
Tradition-Bound Building	
Medieval Vernacular	Feudalism
Romanesque	Feudalism
Transition	
Gothic	Feudalism + Rising Cities
Architectural History: Epochal Styles	
Renaissance	Early Capitalism / City States
Baroque	Mercantilism / Absolutism
Neo-Classicism / Historicism	Bourgeois Capitalism / Nation States
Modernism	Fordism / International Socialism
Parametricism	Global / Post-Fordist Network Society

Figure 2.1 Epochal alignments of styles.

- Conceptual definition of parametricism [9]
- Can This style be reduced to new design techniques and tools? [10]
- I found a contradiction in parametric design and predefined Patterns (like Islamic, Jewish patterns or Christianity patterns)[11]



Operational definition of parametricism:

Formal heuristics:

Negative principles (taboos): avoid rigid forms (lack of malleability)
avoid simple repetition (lack of variety)
avoid collage of isolated, unrelated elements
(lack of order)

Positive principles (dogmas): all forms must be variable and adaptive
(deformation = information)
all systems must be differentiated
(gradients)
all systems must be interdependent
(correlations)

Functional heuristics:

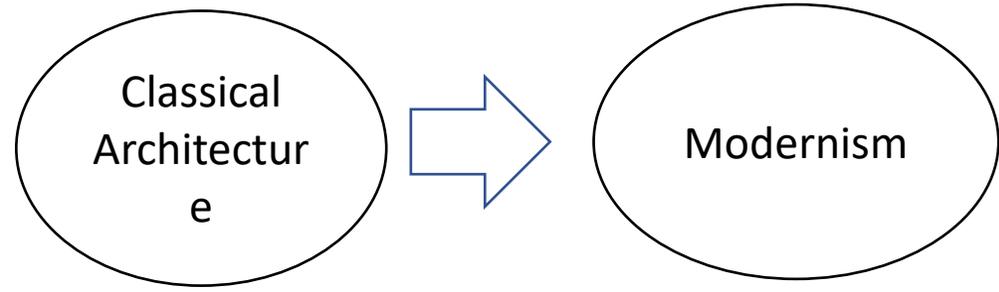
Negative principles (taboos): avoid rigid functional stereotypes
avoid segregative functional zoning

Positive principles (dogmas): all functions are parametric activity/event
scenarios
all activities/events communicate with each
other

The background features a stylized illustration of a group of people in a discussion. In the foreground, three individuals are shown in profile, facing right. They are drawn with simple lines and flat colors. Above them, numerous thought bubbles of various shapes and sizes float, containing abstract symbols like circles, squares, and lines. The overall color palette is warm, with shades of orange, peach, and light blue.

Unified Theory and Style of Architecture

- a unified collective architectural agenda like Modernism [12]
- There is no comprehensive poststructuralist theory of contemporary society. [13]
- Pluralism of styles [14]



- Parametrisim = Order + Freedom [19]

Progression of Styles

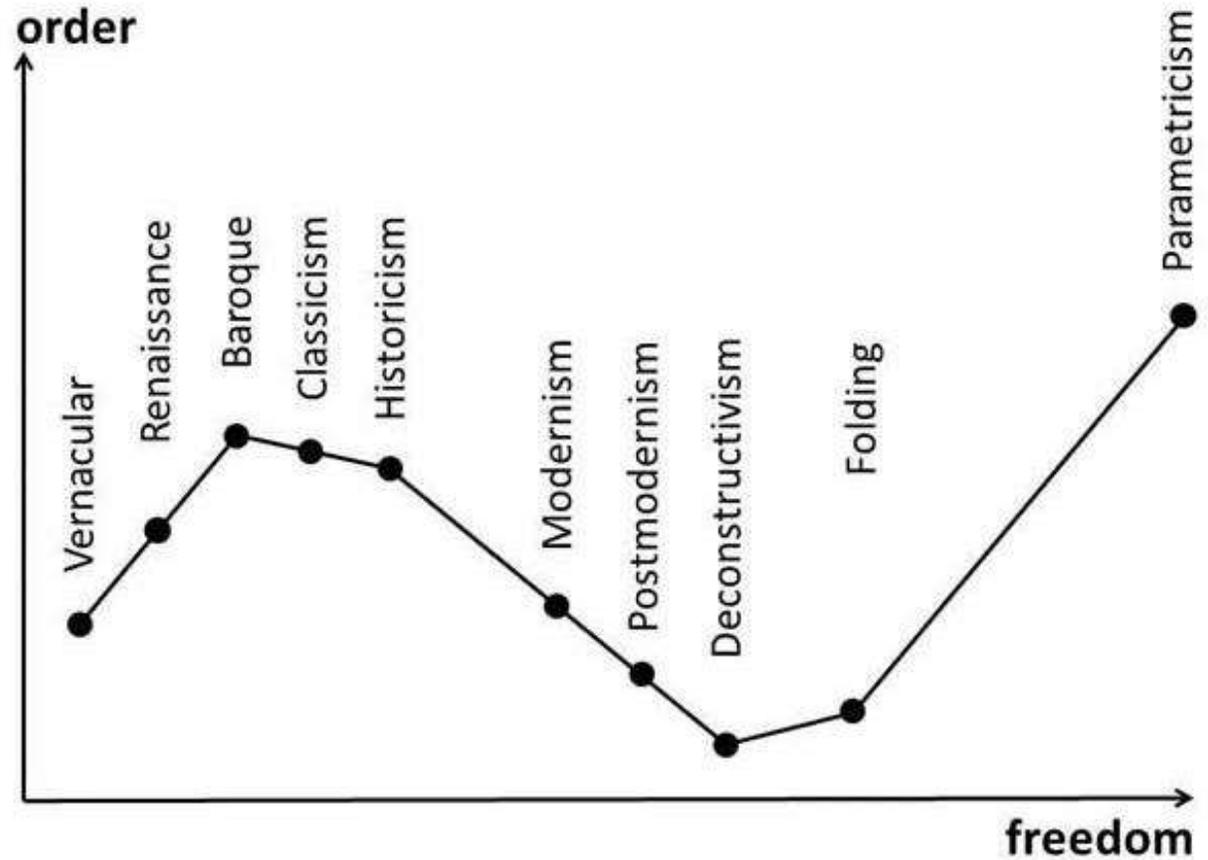
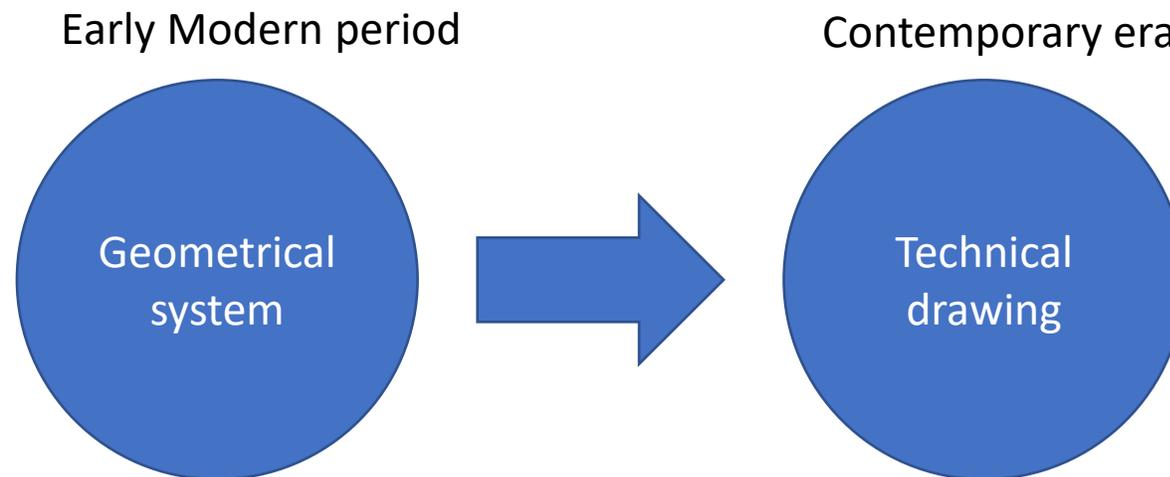


Fig. 10 The simultaneous enhancement of freedom and order: inversion of architecture's entropy law



fig. 11 Parametricism: Complex Variegated Order via multi-author coherence, Studio Hadid, Yale University, 20

- Can Postmodernism, and Deconstructivism overcome the visual chaos into global sameness? [20]
- Parametricist order does not rely on the uniform repetition of patterns as Modernist urbanism does [21]



- Lyotard explains that “in postindustrial [computerized] societies the normativity of law is replaced by the performativity of procedure”
- In architecture



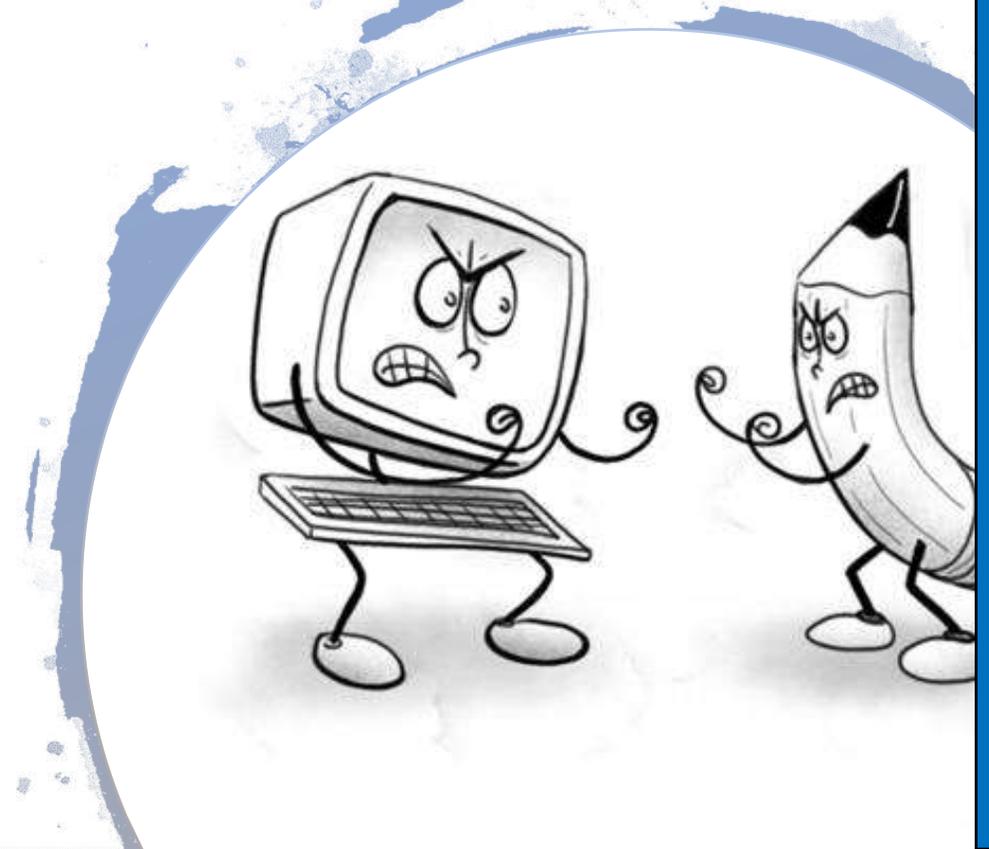
There is no such thing as digital architecture

- **DIGITAL:** as distinct from “analog” is to refer to tools.--- be understood in terms of processes where these tools are deployed.[24]

Is there any such thing as “ a digital design” or “ a digital building” ?
What is “a digital Design” exactly?

- adjective “digital,” refers primarily to a noun, “tool,” used in the process of the design.
 - Noun: “a design” [25]
 - Verb: “to design”
-
- “Designing digitality” or “ a digital design” [26]

- So what exactly do people mean when they refer to “digital design” or indeed “parametric design” as a style?
- Is Patrik Schumacher correct in identifying **a new aesthetic** that owes its origin to the development of new digital tools?
- **We might ask, whether there is anything that could be drawn using a computer that could not also be drawn using a pencil?**
- Equally, we might ask whether there is anything that could be fabricated by a robot that could not also be fabricated by hand?[27]



Innovation in technology that have a direct impact on innovation in design.

- Elevator: [28]
- Air conditioning unit
- Invention of certain software programs



Guggenheim museum Bilbao, 1997

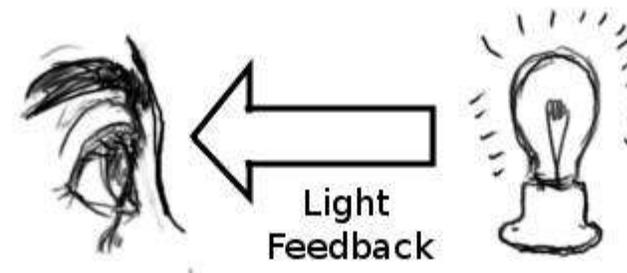
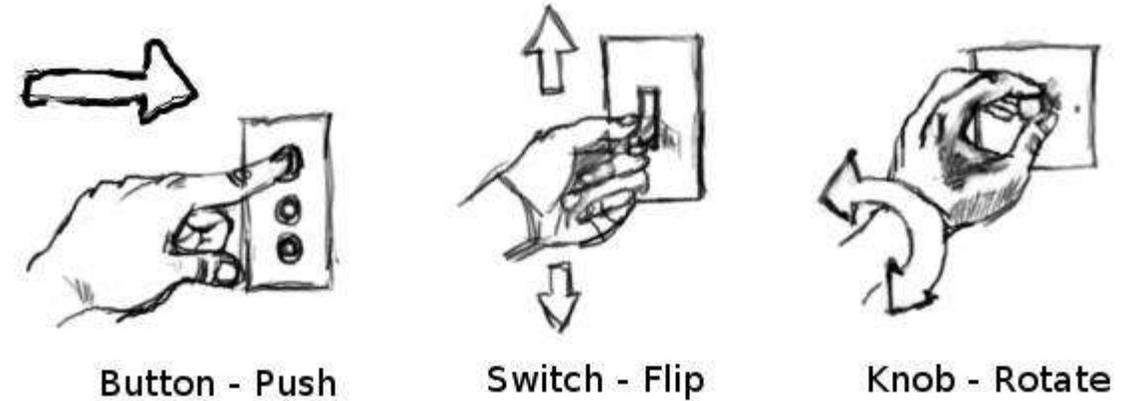


Disney concert hall, Los Angles 2003

- The term “a digital design” is therefore seemingly absurd. [29]

- Toward a Theory of Affordances [30]

- What is the theory of Affordances? [31]



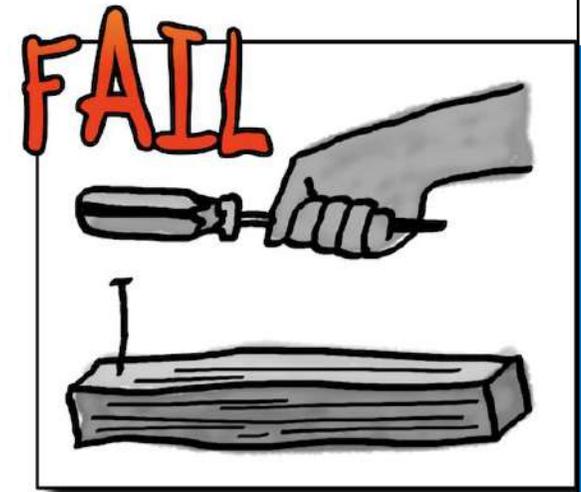
Source: <https://paaralan.blogspot.com/2010/09/affordance-and-educational-games.html>

The technique of doing something by a certain tool afforded a limited range of possible operation. [32]



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“searching” becomes increasingly popular in a culture colonized by the logic of search engines, such as Google.

Embark on any research through the use of search engine effects the research result. [33]



Source: <https://www.clipartmax.com/>



No such
thing as a
digital
architecture

west coast pavilion Beijing
2006



Parametric Design

- Parametrics is more about an attitude of mind than any particular software application [34].

As a concept parametrics is far more likely to be understood by a musician than by an artist. This is because the musician is dedicated rehearsing for performance - which is an essential characteristic of a virtuoso in parametrics.[35]



- **Conventional and parametric design tools:**[36]

The system takes care of keeping the design consistent with the relationships and thus increases designer ability to explore ideas by reducing the tedium of rework.

New skills

- 1- Conceiving data flow**
- 2- Dividing to conquer**
- 3- Naming**
- 4- Thinking with abstraction**
- 5- Thinking mathematically**
- 6- Thinking algorithmically**

New (parametric) strategies

- 1- Sketching**
- 2- Throw code away**
- 3- Copy and modify**
- 4- Search for form**
- 5- Use mathematics and computation to understand design**
- 6- Defer decisions**
- 7- Make modules**
- 8- Help others**
- 9- Develop your toolbox**

1- Sketching

- **11** qualities of design sketches:

sketches are (or have) *quick; timely; inexpensive; disposable; plentiful; clear vocabulary; distinct gesture; minimal detail; suggest and explore rather than confirm; appropriate degree of refinement; and ambiguity.*[37]

- with the 2B religion, students use the media at hand, and today such media are mostly digital. [38]

2- Throw code away

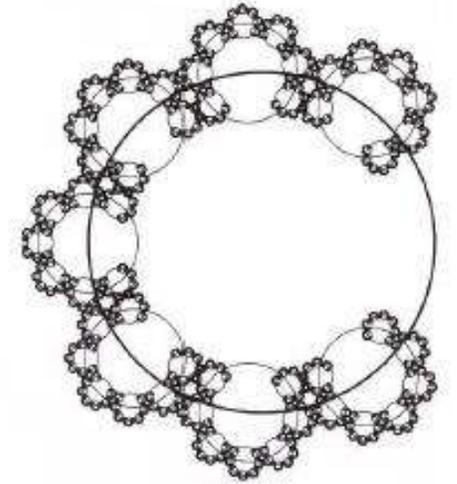
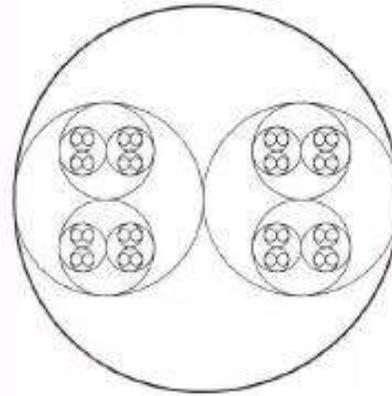
- Designers do design, not media.[39]
- Patent Office Building (Peters, 2007) by Foster+Partners. [40]
- Throw-away code is a fact of parametric design.



Source: <https://www.slideshare.net/binary-studio/academy-pro-uiux-introduction>

3- Copy and Modify

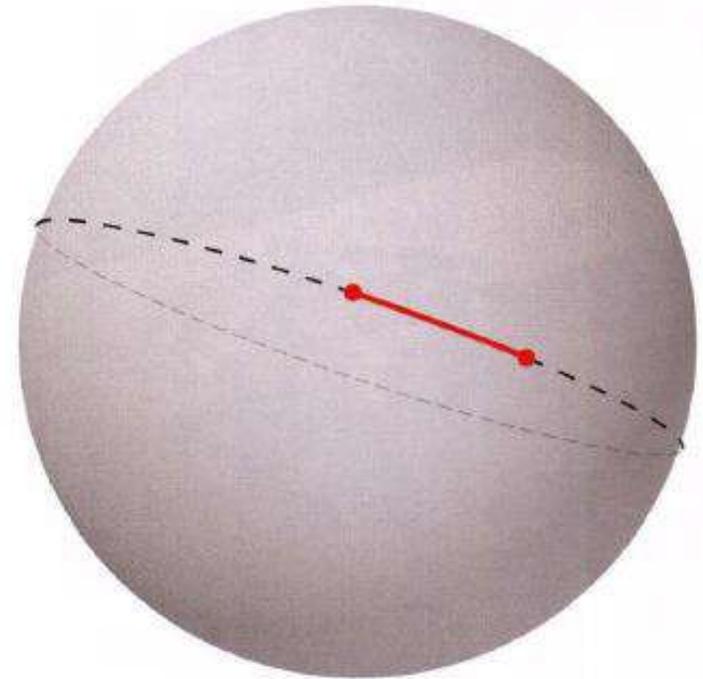
- In an engineering design domain, Gantt and Nardi (1992) report script finding and reuse as an important mode of work.
- Existing code reduces the job of making a model[41]
- Copy and-modify is the flip side of throw-away code.[42]



3.15: The figure on the left was copied and modified by a designer learning recursion to create the figure on the right.
Source: Dieter Toews.

4- Search for form [43]

5- Use mathematics and computation to understand design [44]



3.20: A geodesic curve on sphere is a fragment of a great circle.

6- Defer decisions

- **Conventional way of design:**

Without precise size and location, models look messy.

- **Parametric way of design:**

A parametric design commits to a network of relations and defers commitment to specific locations and details.[45]



3.23: The *International Terminal Waterloo* by Nicholas Grimshaw & Partners. The station was designed around an existing path for the track system.

Source: Jo Reid and John Peck.

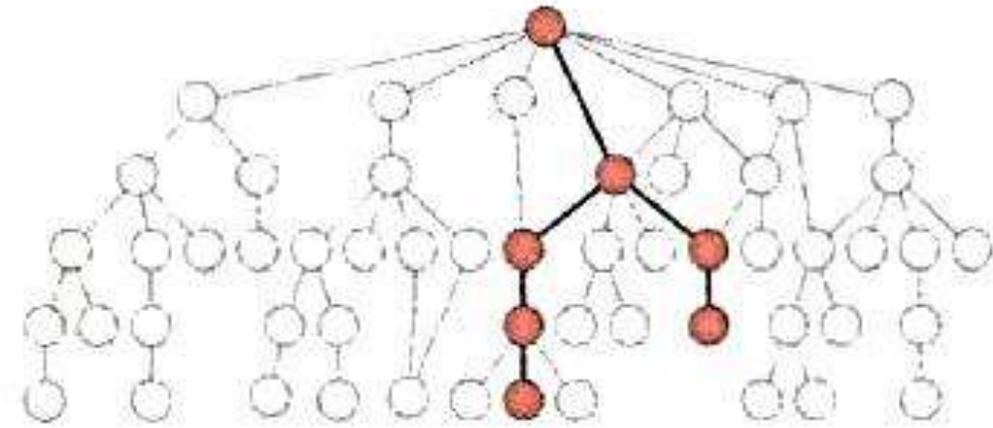


3.26: The *Eden Project*, Cornwall, United Kingdom.
Source: ©2006 Jürgen Matern (<http://www.juergen-matern.de>).

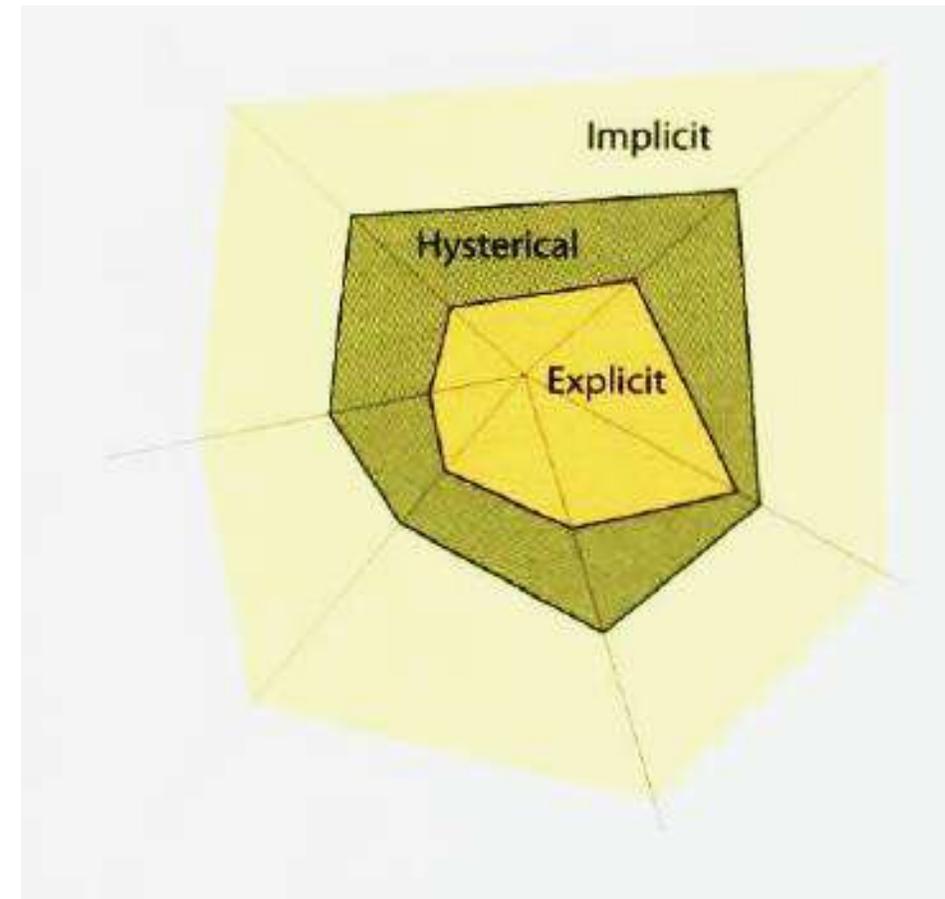
7- Make modules [46]

- **Design space**
- Despite the differences in design theories, we can claim that all of them admit the existence of a space that contains the solutions to a design problem.
 - 1- Implicit Design Space
 - 2- Explicit Design Space
 - 3- Design Hysteresis

1- Implicit Design Space



2- Explicit design space



3- Design Hysteresis

The image features a large, irregular orange splash shape centered on a white background. The splash has a textured, watercolor-like appearance with darker orange and brownish tones at the edges and lighter orange in the center. The text "My PhD Research" is written in a clean, white, sans-serif font across the middle of the splash.

My PhD Research

It was on my proposal when I applied .**Problem: Limit the scope of my research**

Dr. Carmela
The overuse of computer tools on architectural designs affects the formal qualities of buildings. Parametricism is the era that computers and parameters entirely create architecture.

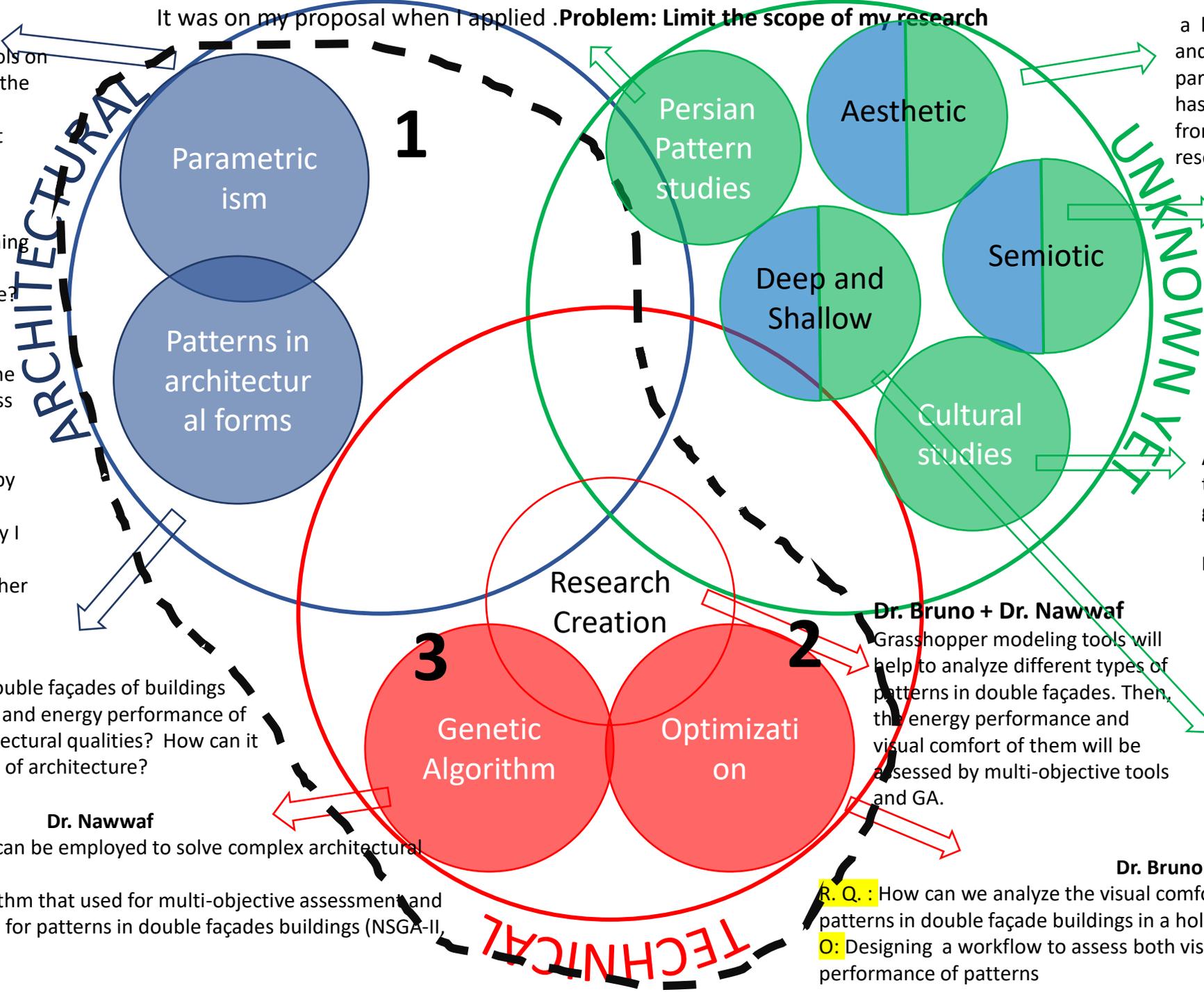
R.Q: How this style or designing with parameters change the formal quality of architecture?

Method: map contemporary designed buildings (during the parametricism style) to assess their formal qualities.

Still unknown: what I mean by formal qualities? Aesthetic? Formal richness? In what way I want to compare the formal qualities of this style with other precedents?

R.Q: Applying patterns on double façades of buildings increases the visual comfort and energy performance of buildings. What about architectural qualities? How can it improve the formal qualities of architecture?

Dr. Nawwaf
R.Q: How genetic algorithm can be employed to solve complex architectural problems? (Patterns)
O: classifying different algorithm that used for multi-objective assessment and proposed a proper algorithm for patterns in double façades buildings (NSGA-II, JcGA-DE, GA, FIS, FAST)



a lot of research on the aesthetic and formal qualities of parametrically designed buildings has been published. But it is far from the technical part of my research.

Advantage:
It is very relevant if I want to work on patterns

Problem:
Personally, I don't like this line of research, because I think it is not tangible and it is based on the interpretation!

This subject alone worth a full PhD

Advantage: reconcile technology and culture seems a great project.

Problem: culture is so broad

Advantage:
Good title, and good analyze

Problem:
1- I should theorize this subject, (As broad as cultural studies)

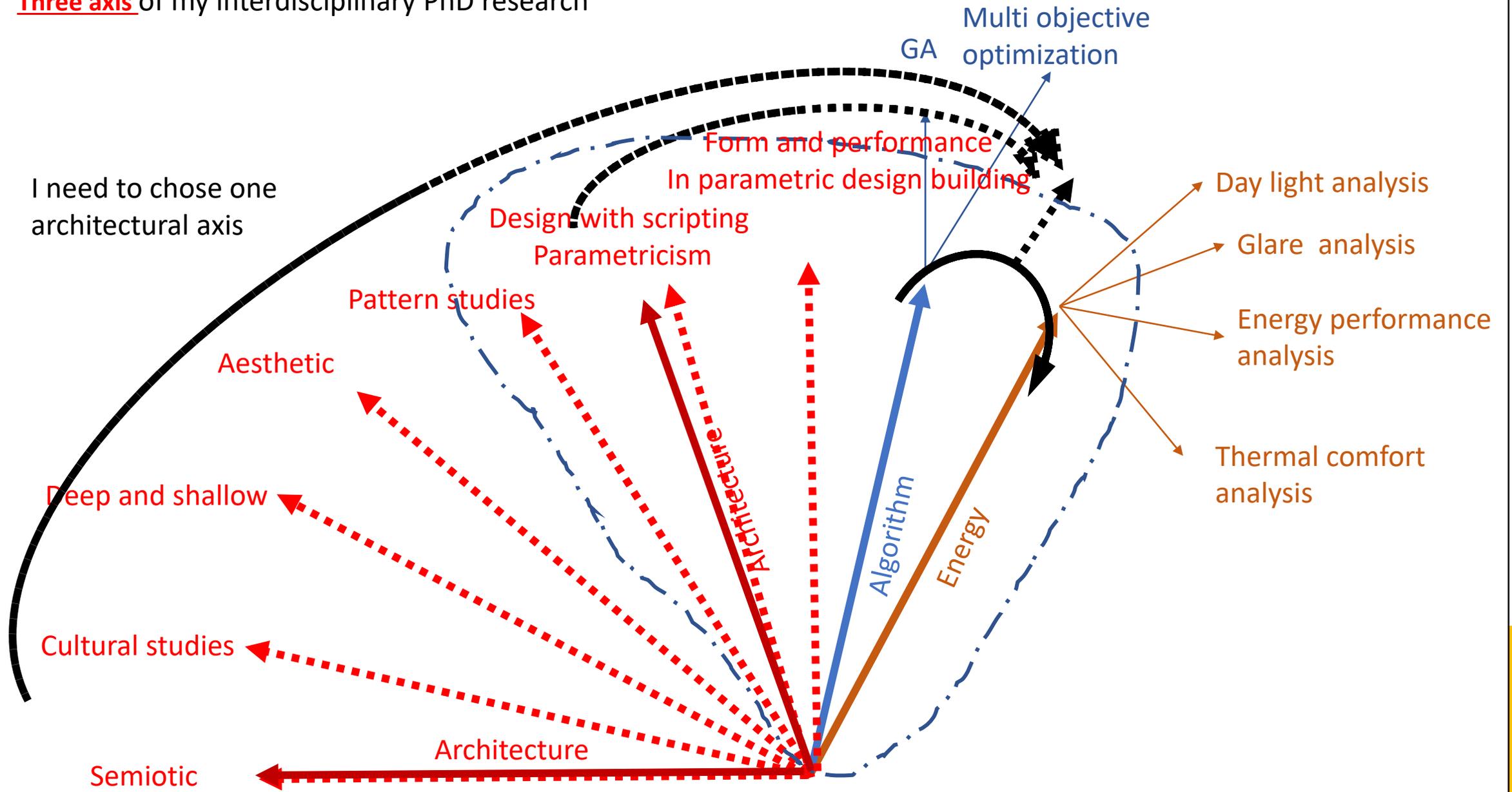
2- double façade consider as a shallow not rich architectural design

Dr. Bruno + Dr. Nawwaf
Grasshopper modeling tools will help to analyze different types of patterns in double façades. Then, the energy performance and visual comfort of them will be assessed by multi-objective tools and GA.

Dr. Bruno
R. Q. : How can we analyze the visual comfort and energy performance of patterns in double façade buildings in a holistic way?

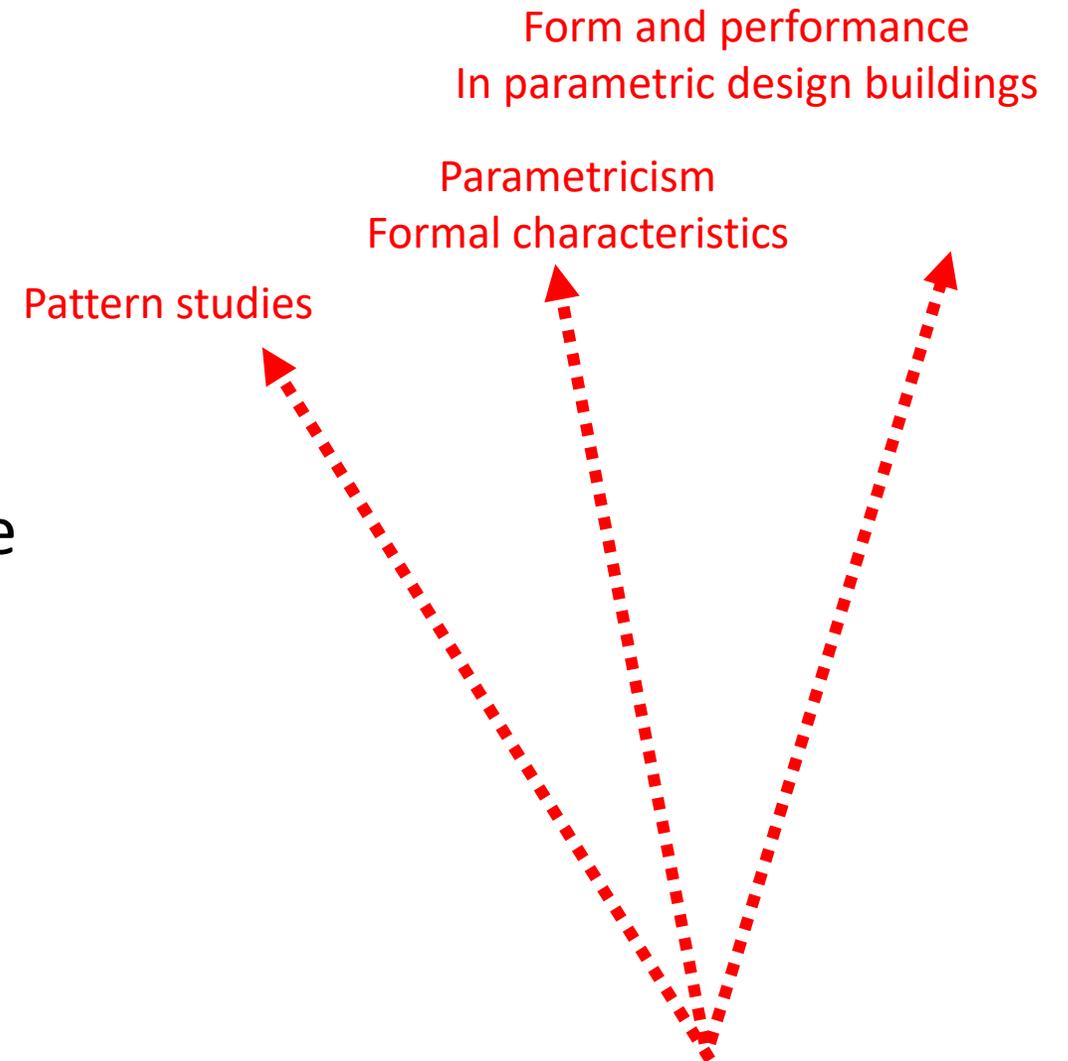
O: Designing a workflow to assess both visual comfort and energy performance of patterns

Three axis of my interdisciplinary PhD research



Why one architectural axis need to be chosen?

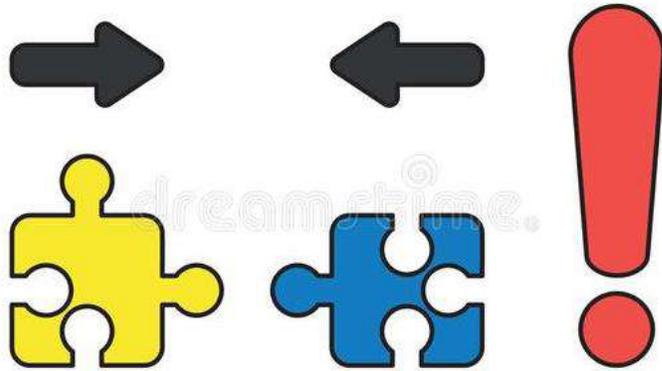
- Reasons:
- Having two or three axes makes my research superficial. Yet, Doctorate research needs to be in deep.
- Having one architecture axis increase the possibility of cohesion and coherence with two other technical axes.



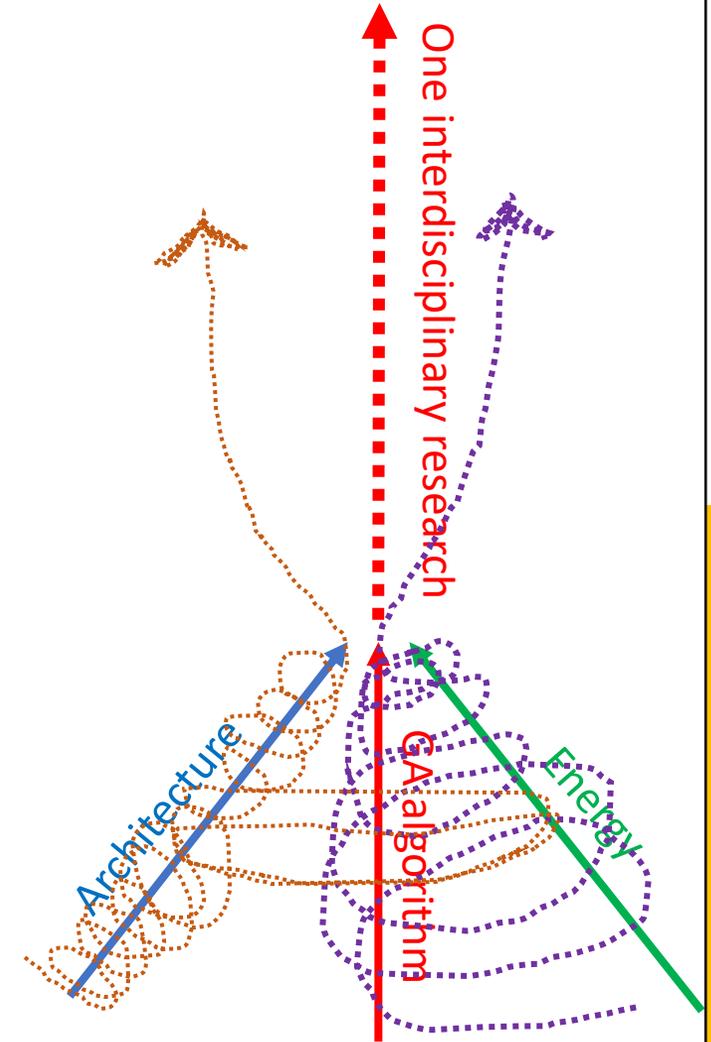
The story that I narrate connects three different pieces of interdisciplinary research **But**



Source: <https://www.popularmechanics.com/home/a28172758/how-to-remove-super-glue/>



Source: <https://www.dreamstime.com/illustration/incompatible.html>



1- Patterns in architectural design axis

- **Research Questions:**

- How using patterns increase formal qualities of architecture?
- How patterns in double facades increase visual and functional qualities?

- **Objectives:**

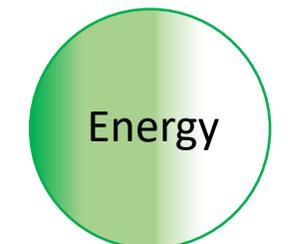
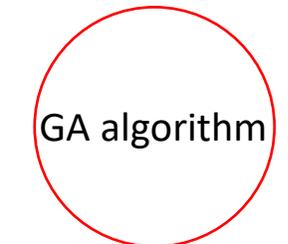
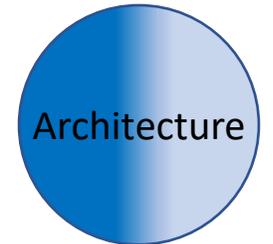
- Achieving proper ways of using patterns in architectural designs.
- Achieving proper approaches to applying double façades in architectural designs.

- **Methods:**

- Qualitative inductive methods will be applied.
- A descriptive study of buildings that employed patterns in their facades will be conducted
- Buildings with double facades will be investigated in comparative ways.

- **Unknows:**

- What do I mean by the formal qualities?
- How will formal qualities be assessed?
- What do I mean by functional qualities?



2- Parametricism Formal characteristics axis

- Research Questions:

- What are the effects of parametric designs on the architectural forms?
- How do energy factors in the parametric design affect architectural forms?

- Objectives:

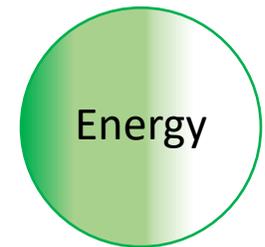
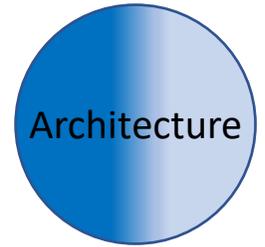
- Defining overarching formal characteristics of parametricism style.
- Identifying technical factors that have the most effects on architectural forms.

- Methods:

- Qualitative inductive methods will be applied.
- a comparative study will be conducted to compare the formal characteristics of precedent styles with parametricism.

- Unknowns:

- Is there any difference between computerized design buildings and conventional design buildings regarding form design?
- Based on which criteria, architectural forms of different styles are going to be compared?



3- Form and performance In parametric design buildings

• Research Questions:

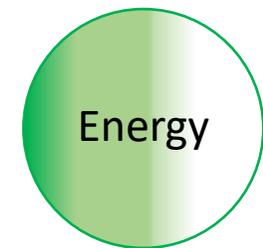
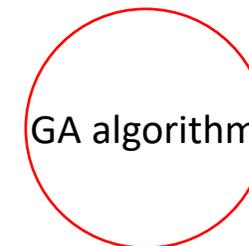
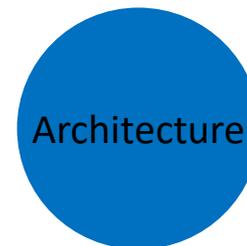
- Does the overemphasize on the technical aspect of design such as energy or visual or thermal comfort lead to weakness architectural forms? How?
- Designs driven by pragmatic functional parameters are generally only concerned with the performance of a building, does this sacrifice the aesthetic form of a building? How?
- To what extend the relation between form and performance is established in the parametric design?
- Forms could be considered as the exterior, and performance could be considered as the function of the interior. Based on this assumption, Is there any coherence between the interior and exterior of the parametrically designed buildings?

• Objectives:

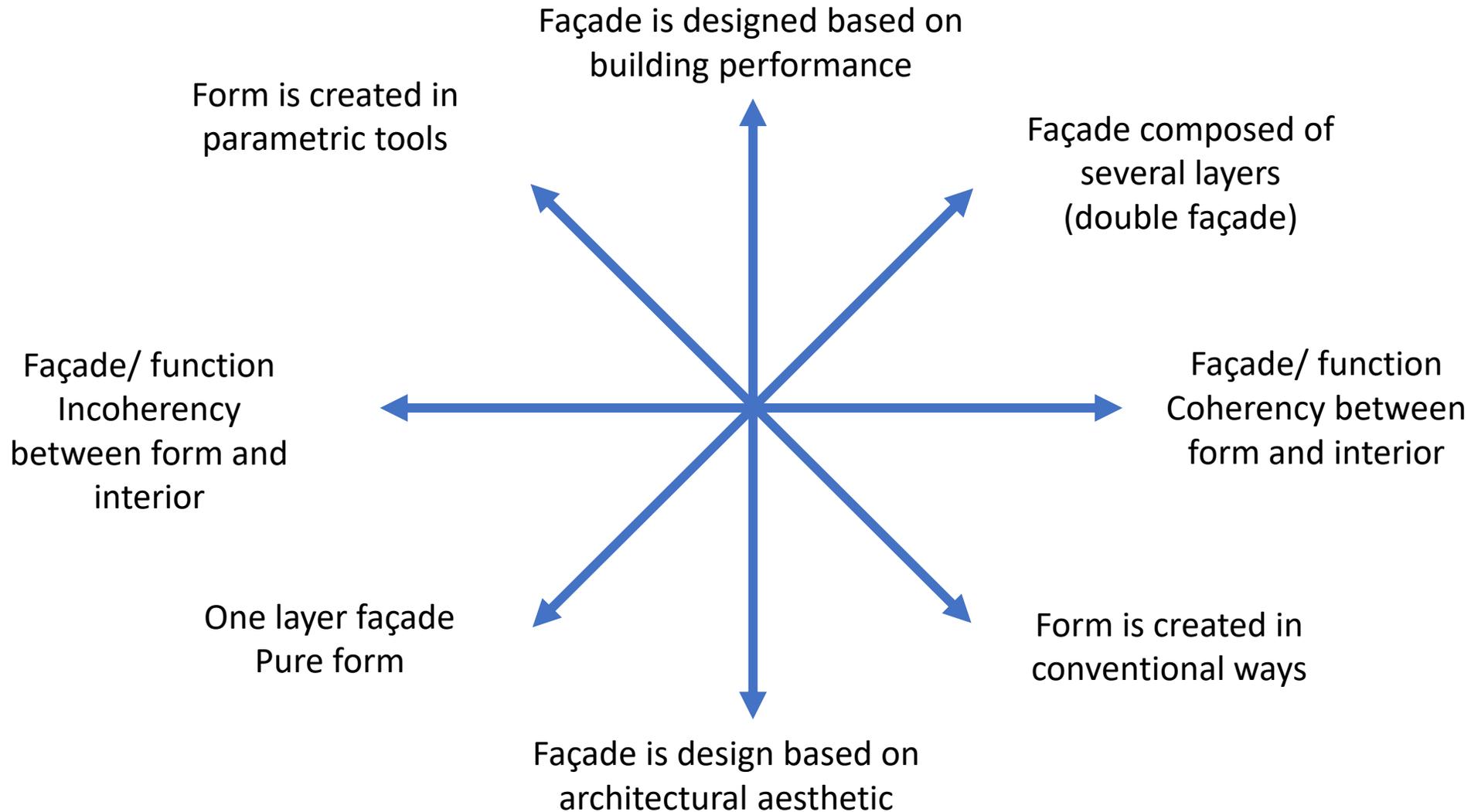
- Identifying, main factors of parametric design, which leads to augmenting and weakening the relation of Form and performance.
- Map out the relation between Form and performance in the parametricism style and precedent styles.
- Measurement and verification of coherency between the Form and interior space of parametrically designed buildings, because it could be one sings of cohesion between Form and performance.

• Methods:

- Qualitative inductive methods will be applied.
- a comparative study will be conducted



Some tensions and polarities on this subject:



Comments on the June 10 meeting:

- Dr.nawf + affordances preceptive
- Some computer related stuff to parametrisim
- Question of affordances in parametric design
- The use of GA in architecture and affordances .
- Overuse of GA and the relation of affordances.
- What is the essence of affordances ? characterization of affordances
- Assessing of affordances in parametric designed buildings
-
- **Possible papers:**
- **Common formal characteristics of parametric designed buildings**
- **Assessing the theory of affordances in the parametric design**
-
- **Use and abuse of computers tools for designing architectural forms**
-
- **Systemic thinking is the way that all circles need to be connected. Draw a line between them and how the question of GA answer the question of architecture and so on**

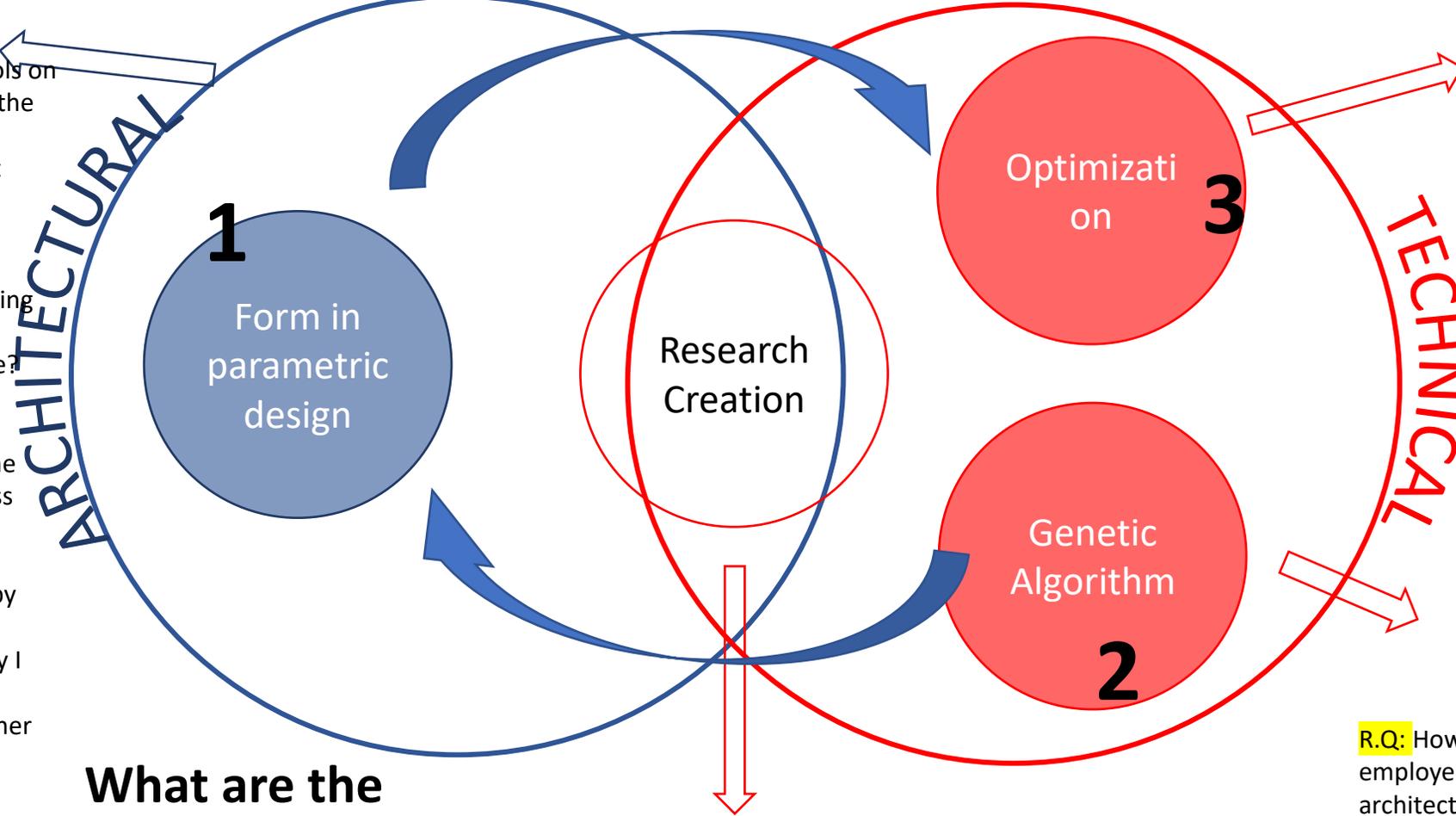
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What are the relation between these circles?

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