1. <mark>Open</mark> it in your Adobe Reader

2. Hover the square at the top left of the page is you see one.

3. <mark>Lecture notes</mark> will pop out (if there are any), example is as follow:

Week 7
Digital design cognition and research

This week we will be exploring digital design thinking, cognition and research. This week's slides serve as an introduction of your assessments, aiming to give a clear context of **what will be assessed** and **rationale** behind your grading rubric. Assessment documents will be released before Week 8.
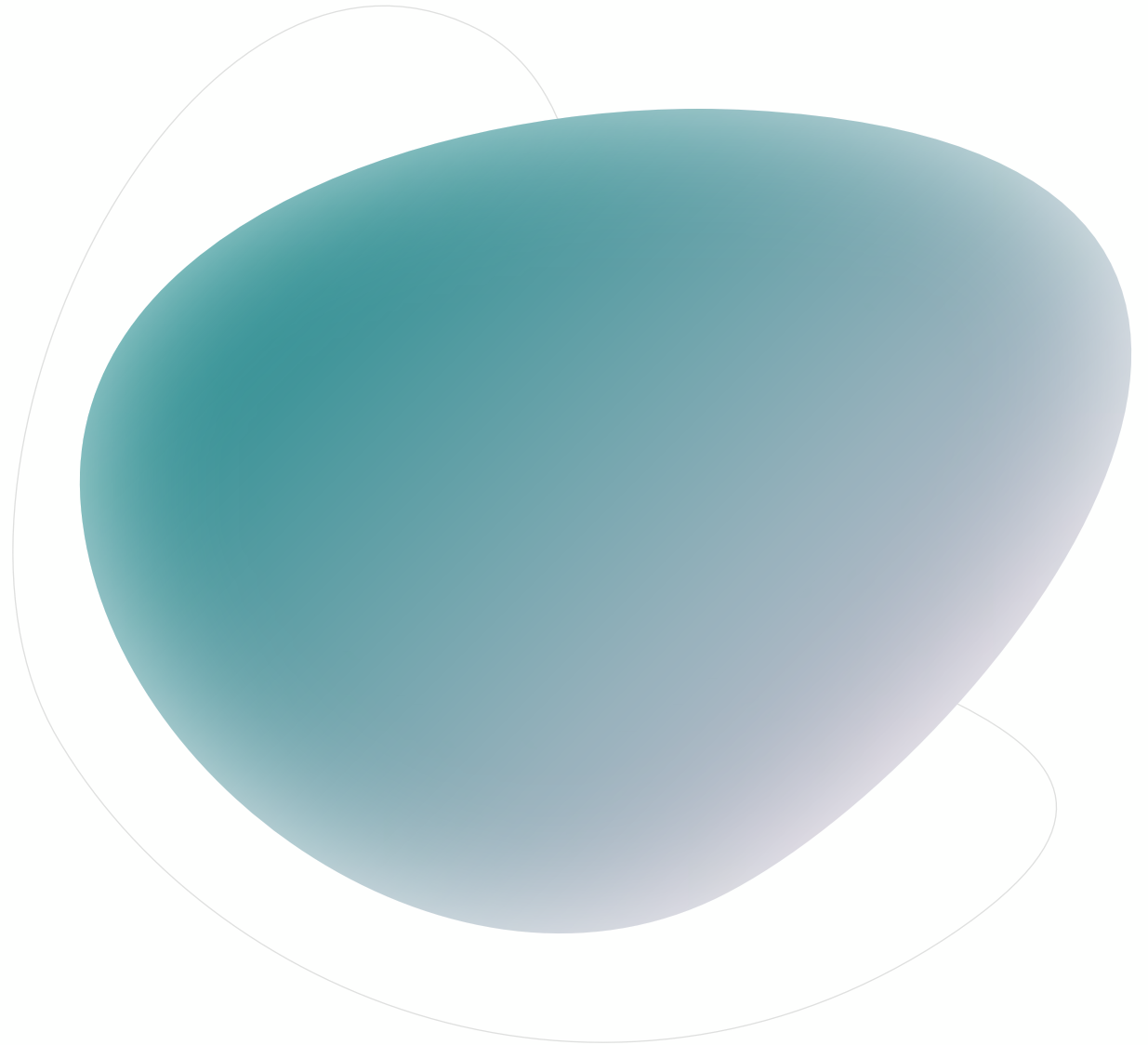
Outline

01

Introduction of design cognition

Evolution of important paradigms in design thinking will be enumerated, serving as a point of departure.

02

Parametric design thinking and research

Different parametric design thinking lenses will be elaborated: concepts and models, pedagogical approach, digital workflow and design by research.

03

Summary of concepts

This set of concepts are to be illustrated, documented and communicated for the assessment.

Aims and objectives

- To relate what students have learnt related to digital design cognition ==previous weeks.==

- To elicit ==evolution of paradigm in design thinking==, starting from pen-and-paper based thinking up to the parametric design thinking.

- To demonstrate ==changes== in terms of studying design behaviour and changes in design behaviour itself.

- To provide ==contextualisation== of the upcoming assessments.

Learning outcomes

Students will be able to..

01 Summarise **important paradigms** in design thinking.

02 Synthesise **different aspects** of parametric design thinking and research.

03 Draw **comparison** of traditional design thinking and recent design thinking.

04 **Hypothesise** concepts into their early assessment planning.

Software skills
Rhino, Grasshopper, etc

Theory, history and current debate
Understand historical background of this notion and relevant debates.

Research skills
Designing through extensive research

(module)
Overarching skills

Important concepts
Digital fabrication and construction
Digital design cognition
Human-computer interaction
Digital craftmanship
etc

Personal interest
Exploring a preferred scope of design to be developed further

Design precedents
Learning through analysis of completed project

Discussion

F123456 + Name

Blablabl

0 Comments   Mia Tedjosaputro   Login

♡ Recommend   Tweet   f Share   Sort by Newest

Start the discussion…

LOG IN WITH   OR SIGN UP WITH DISQUS ?

Name

Reflect on the concepts of design thinking, make a ==short description== on how your current design practice is. Use these bullet points:
(Explanation of these bullet points can be found towards end of slides, p50-57)

1. **Solution space**
2. **Exploration**
3. **Emergence**
4. **Reflection**
5. **Modification**
6. **Adaptation**
7. **Media**

https://miatedjosaputro.com/2020/04/07/week-7-discussion/

Design cognition

Design cognition is: Study of human information processing in design

Eastman, C. (2001). Chapter 8 - New Directions in Design Cognition: Studies of Representation and Recall. *In:* Eastman, C. M., McCracken, W. M. & Newstetter, W. C. (eds.) *Design Knowing and Learning: Cognition in Design Education.* Oxford: Elsevier Science.

In other words.. Design cognition is: Study of design behaviour

My previous research: Study of design behaviour, utilisation of sketches and mental imagery.

Mia A. Tedjosaputro
http://miatedjosaputro.com/

Load data

Please select the .csv file

FILE   20170507_SCRIPT INPUT_

Parameters

Adjust the rendering parameters
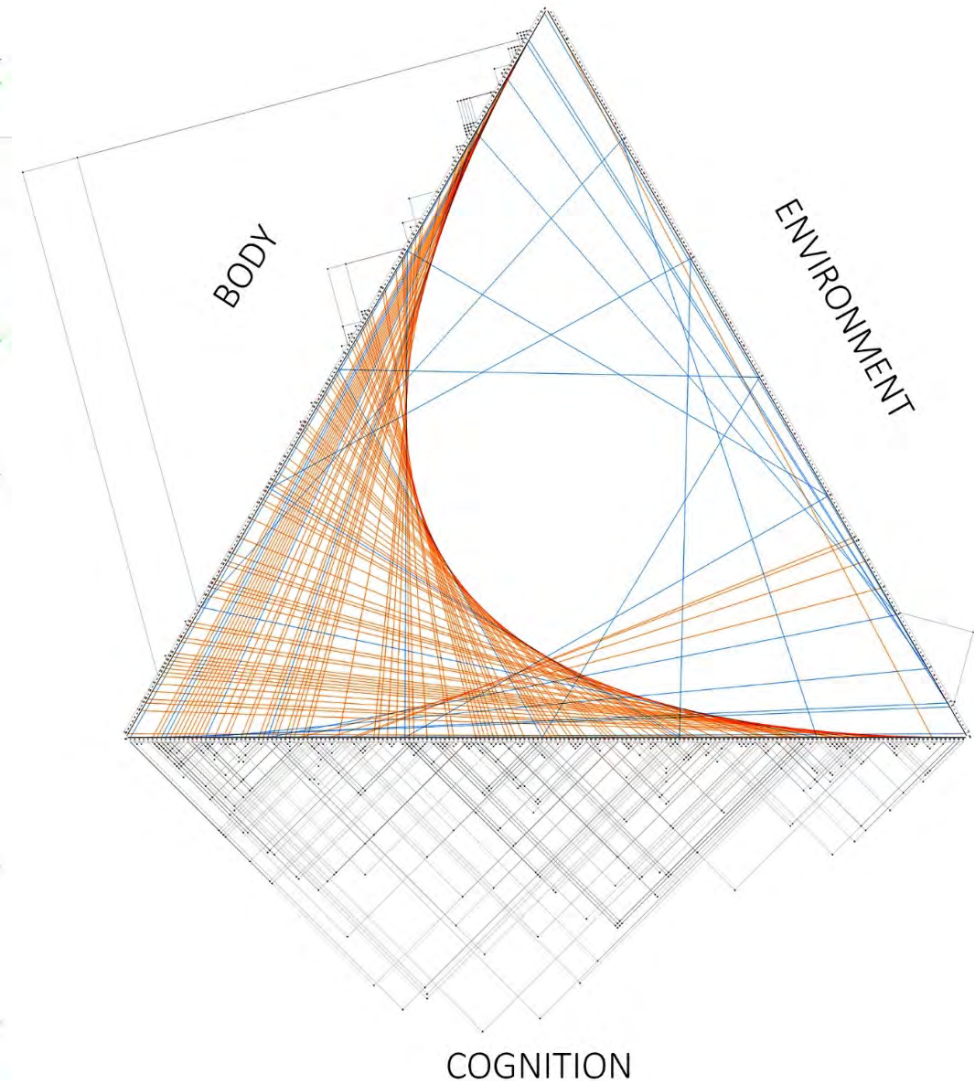
Start point   End point
6   14

of categories (2 or 3)

Show Backlinks and Forelinks?

On

Dot size

Font and number size

APPLY

BODY

ENVIRONMENT

COGNITION

My previous research:

transcript:

#133 Roll element that you hang actually climb up the stuff (gesture) from the loft that you build yourself.

#181 Just the small housing in US, similar.

#274 (long pause) Okay.. One meter, two meter, three meter. One meter, two meter.
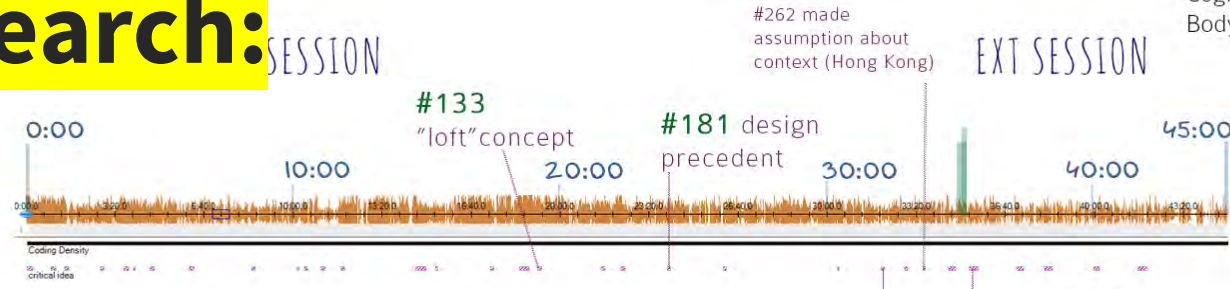
1 what participants SAID

2 what participants REPORTED
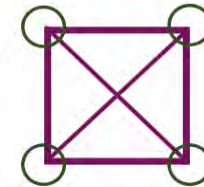
direct observation by researcher

what participants DID

3 field notes
40. Ceiling height
41. Mention something she did previously
42. I assume it's safe (making assumption)
43. So I have loft.. #133
44. Assume 4m ceiling height
45. More layers for the room
46. What should be the size of the loft
47. 1m, 2 meters

3 and coded utterances
Cognition code: C-as
Cognition link: #132
Body code: M-hg

#262 made assumption about context (Hong Kong)

EXT SESSION

#133 "loft" concept

#181 design precedent

#274 started with plan

#248 illustrated a section with gesture

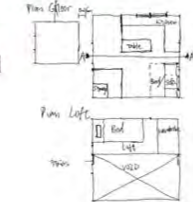0:00   10:00   20:00   30:00   40:00   45:00

Coding Density
critical idea

design summary with selected critical ideas: #133, #181, #274
These critical ideas **were triangulated** from what EG1 said, reported, did and also from direct observations.

2 prompted questions:
Q1: What kind of design precedent did you use?
Yeah, I use the one-- the American kind of small house I have be to in US. #181

Q2: How did you get the idea from?
Um, because it is a small family unit, so I- I also get the reference from IKEA. They have their flexible use of furniture and the space. And also the idea of house I have been to in St Louis, they have a kind of loft- they put the bedroom and storage above their kitchen. So they can use more space. #133

design marks, for example artefacts (plan drawing). or body gesture she produced.

My previous research: Each design move was visualised and analysed

No	Time	Transcript	Critical Ideas	Cog code	Links (Cog)	Bo code	Links (Bo)	Env code	Links (Env)
6	0:57.6 - 1:09.1	Let's say that if, firstly I need to have the client analysis and what do they really want, I think.	CI	C-hy		D-sy			
7	1:08.4 - 1:19.7	What they really want? Please read..		C-hy	6	D-sy	6		
8	1:19.0 - 1:38.6	And also this like, dining set up. A place to eat and-- and entertain.. Entertainment. And what else?		C-re	6,7	D-wo	6,7	E-db	
9	1:37.6 - 1:50.9	Learning space. Ok, I think it's normally the same with the adults, like. What's for the children?		C-as	6,7	D-wo	6,7,8	E-db	8
10	1:49.8 - 2:05.9	(long pause) What a child need, for you? Play around..		C-re	9,7	D-sy	6		
11	2:04.9 - 2:12.7	What else, read? Yes..		C-re	7	D-wo	10		
12	2:12.0 - 2:18.0	For study? Dining is for eating right, of course..		C-re	9,8,7	D-wo	11,10,11		
13	2:18.0 - 2:33.6	What else, is there any special one? (long pause) nothing spec..		C-re	6	M-hg	10		
14	2:32.4 - 2:42.8	Play around.. before. And..							
15	2:41.8 - 3:01.9	Mixed use.. place of wha..							
16	3:01.9 - 3:05.9	What if I sep.. that..							
17	3:04.4 - 3:15.4	One part is f.. say, if we lea.. for children..							
18	3:15.4 - 3:24.6	And another.. the adult? A..							
19	3:24.6 - 3:36.8	Adults.. Or m.. have the sam..							
20	3:36.8 - 3:42.7	They don't ha.. they can play at the same space.					19		
21	3:41.7 - 3:53.1	If I imagine the furniture as space or [inaudible mumble]. What it could be?	CI	C-tr	5				
22	3:52.6 - 4:07.7	Let's say, it's quite like um, a sofa or something like that (long pause).		C-at	21	D-c			
23	4:07.0 - 4:17.7	What if the sofa have--um, two sides? (long pause)		C-co	22,17,18	M-og	22		
24	4:16.4 - 4:44.6	If we put the sofa into-- select-- dividing into two part, and then one is for adult one is for children. How to make it interesting? (long pause)		C-fu	16,23				
25	4:44.0 - 4:51.6	But this is too close-- too close. Is not-- what it should be?		C-se	24				

#6-#7: Created first hypothesis with symbol depiction.

#8-#9: Created textual aids and looked at design brief while retrieving and making an association.

#10-#12: Retrieved brief content in form of texts and symbols.

#13-#14: Retrieved and made an association with gestures.

#15-#16: Synthesized, created text and mentally transform the idea (separation of functions).

#17-#19: Created second hypothesis by making inferences from design brief, noted down and considered preinventive structure in different context (mixed use space).

#20-#23: Synthesized with aids of text, transformed an idea mentally and searched emergent feature ('sofa' feature) and made an interpretation of feature (two sides of sofa).

#24-#25: Inferring thought functions to design and searched for limitations of idea.
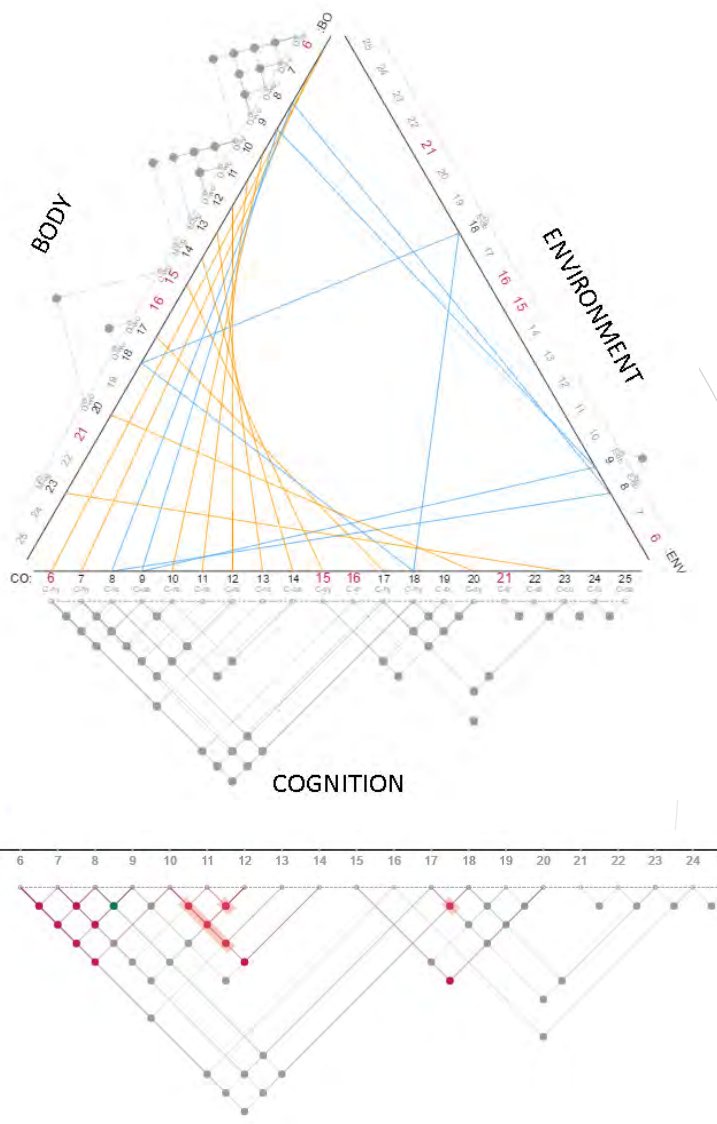
1- PROTOCOL DATA WAS GENERATED IN FORM OF VERBATIM TRANSCRIPTIONS, EACH DESIGN MOVE WAS PARSED AND ANALYSED.

2- PROTOCOL ANALYSIS, SHOWING AN EXAMPLE, AN EXCERPT OF MOVE #6-#25

3- LINKOGRAPHY OF DESIGN MOVES (MOVE #6-#25). VISUALISATION WAS GENERATED USING SCRIPT

Design thinking paradigms

Adapted from: Oxman, R. (2017). Thinking difference: Theories and models of parametric design thinking. *Design Studies,* 52**,** 4-39.

01 EARLY MODELS OF DESIGN THINKING

02 DESIGN THINKING IN EARLY COMPUTER-AIDED DESIGN MODELS

03 KNOWLEDGE-BASED COMPUTATIONAL MODELS OF DESIGN

04 ADVANCED COMPUTATIONAL DESIGN, ALGORITHMIC THINKING AND SCRIPTING

05 PARAMETRIC DESIGN THINKING

Photo by 贝莉儿 DANIST on Unsplash

01 # Early models of design thinking

"Designerly ways of knowing"

Cross, N. (2006). *Designerly ways of knowing : with 15 figures / Nigel Cross,* Springer.

How the designer works through the complex iterative cognitive processes of conceptualisation, modification and refinement in solution space.

Sketch modification as refinement process.

01 Early models of design thinking

"Reflection-in-action"

Schon, D. A. (1991). *The reflective practitioner : how professionals think in action / Donald A. Schèon*, Ashgate.
Schon, D. A. & Wiggins, G. (1992). Kinds of seeing and their functions in designing. *Design Studies,* 13**,** 135-156.

Radical proposal after the rational problem solving process. It perceives design tasks are unique and designing as a reflective dialogue which base on the interaction of ==designing and discovering==, ==seeing-moving-seeing.==

01 Early models of design thinking

	Rational problem solving	**Reflection-in-Action**	**Co-evolution**
Designer:	**Information processer (in an objective reality)**	**Person constructing his/her reality**	**Person developing and refining reality**
Design problem:	**Ill defined, unstructured**	**Essentially unique**	**Clarifiable**
Design process:	**A rational search process**	**A reflective conversation**	**An interaction between problem and solution space**

02 # Design thinking in early computer-aided design models

Early CAD system tries to mimic pen-and-paper based thinking.

Early CAD system exploit the ability to explore <mark>one-off design</mark>.

Media technological developments.

Continuous mapping of early cognitive model.

03 **Knowledge-based computational model of design**

Early research and development on Artificial Intelligence (AI) and Knowledge-based Design (KBD).

Begin to provide perspectives related to: *cognitive structures*, *algorithmic systems*, *computational mechanisms* **in design creativity and innovation.**

04 Advanced Computational Design, Algorithmic Thinking and Scripting

Integrated processes of simulation, evaluation and fabrication.

Relevant principles from domains of science and philosophy, mathematics and computer science have introduced <mark>way of new thinking and morphogenetic processes.</mark>

04 Advanced Computational Design, Algorithmic Thinking and Scripting

Pen on pen-and-paper based design thinking has now been replaced by computer's ==algorithmic mode of thinking==.

'Software is a tool for mind'.

Being *reflective* means designer's ability to ==control== computational and scripting tools.

04 # Advanced Computational Design, Algorithmic Thinking and Scripting

Designers are no longer making choices of a single object, but creating "a matrix encompassing entire population of <mark>possible designs'</mark>.

Algorithmic code is related to structure of visual representation.

05 Parametric Design Thinking

PDT is seen as ==an advance form== of computational design.

Based on the conception that: exploration and re-editing happen in ==geometrical solution space==, through process of ==associative relationship==.

Characteristics of a parametric design system

Jabi, W. (2013). *Parametric design for architecture*, Laurence King Publishing.

Object-orientation

Object oriented approach, which is a well-established computer science topic. Interaction with parametric system that reflects its internal algorithmic structure. Each object has *values* that determines its *attributes.*

Methods

Methods are functions and algorithms that act on an object by modifying its attributes.

Families and inheritance

Objects which share certain characteristics can be organized as members of a *class* or *family* of objects. Sharing certain attributes with their siblings and inherit certain attributes from their parents is the advantage.

Parameters

Parameter usually signifies a variable term in equations that determine other values. It is characterized by having a range of possible values.

Parametric Design Thinking

Previously in week five..

Week 5 Outline

01

Introduction to Parametric Design

02

Brief historical account

03

Parametricism

04
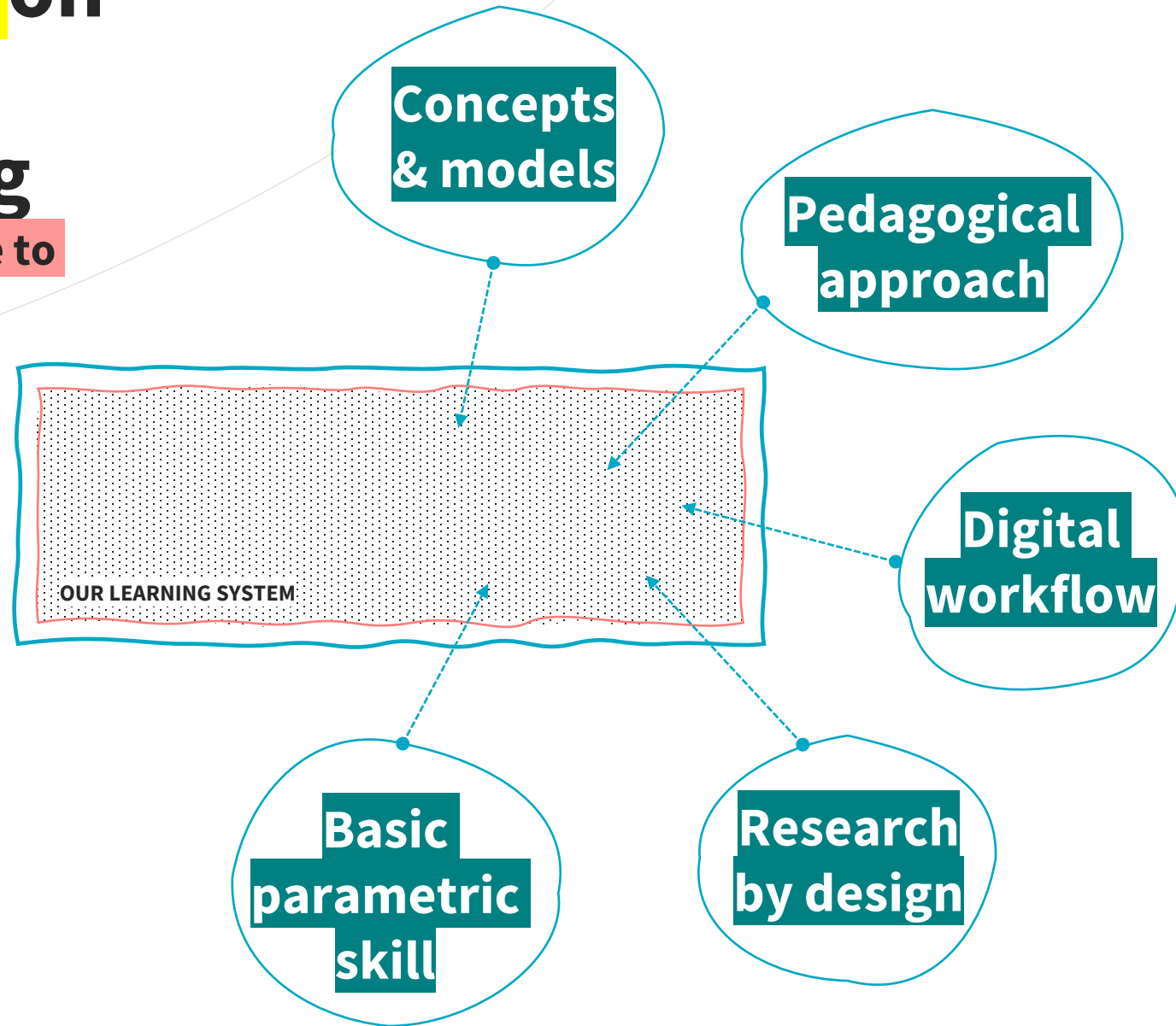
Parametric Design Thinking

05

Characteristics of Parametric Design System

06

How Designers Use Parameter

A **broader view** on Parametric Design Thinking

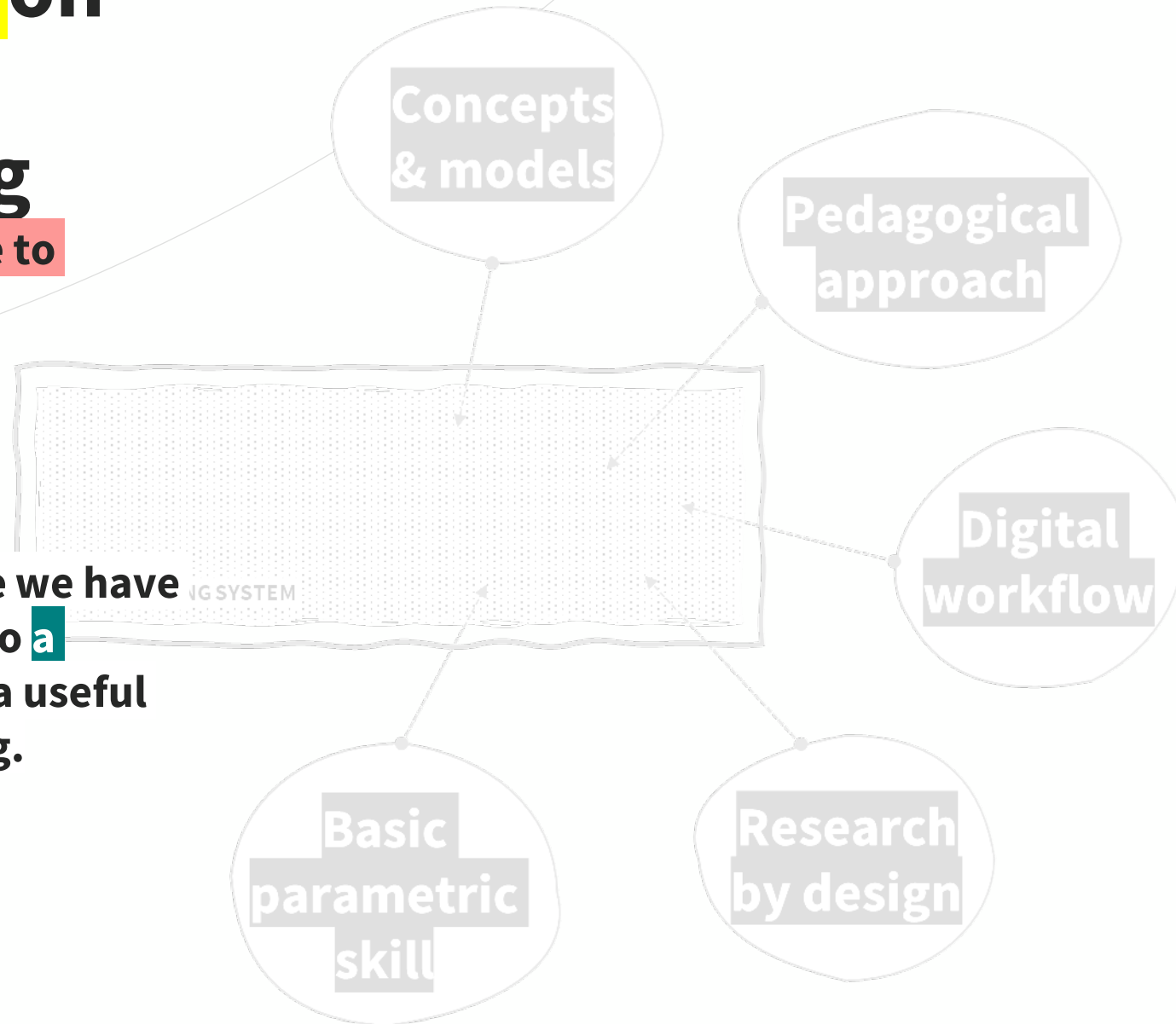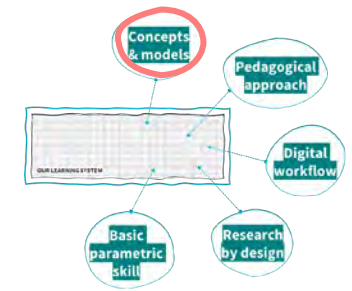**For the purpose of being able to express parametric design**

Concepts & models

Pedagogical approach

Digital workflow

OUR LEARNING SYSTEM

Basic parametric skill

Research by design

A **broader view** on Parametric Design Thinking

For the purpose of being able to express parametric design

Rationale:
Bringing together knowledge we have gathered in previous weeks to a univocal view, which will be a useful for your assessment planning.

Concepts & models

Pedagogical approach

Digital workflow

NG SYSTEM

Basic parametric skill

Research by design

1: Concepts and models

1.1: PDT (Parametric Design Thinking) as ==intersection== between seminal parametric design concepts.

1.2: ==Typological== to ==topological== thinking in creative design.

1.3: ==Differentiation== as key strategy.

1.4: New symbolic role of imagery, requires ==different thinking==.

1: Concepts and models

Oxman, R. (2017). Thinking difference: Theories and models of parametric design thinking. *Design Studies,* 52, 4-39.

1.1: PDT (Parametric Design Thinking) as ==intersection== between seminal parametric design concepts.

Algorithmic schema

Cognitive schema

Computational schema
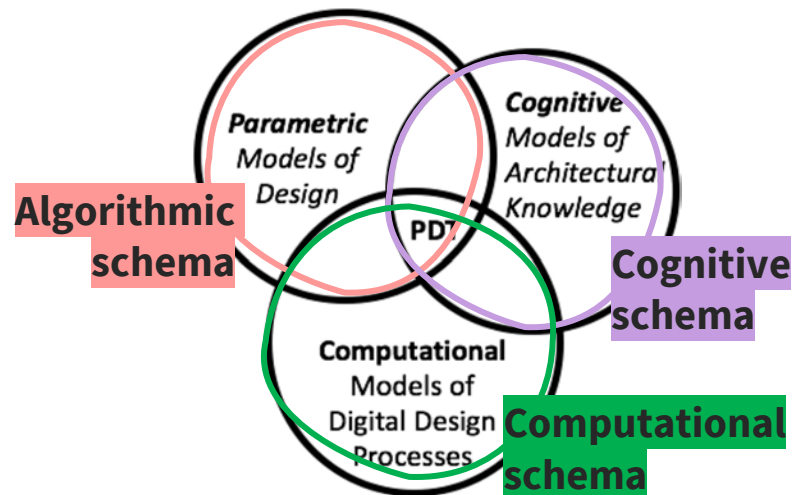
Algorithmic schema
The algorithmic parametric schema can be modified and adapted during design process.
Parametric schema is "*unique type of mathematical model that supports algorithmic processes of shape generation.*"

Cognitive schema
Re-editing of parametric schema as a basis of solution space's exploration.
Typological knowledge to topological knowledge (see next slide)

Computational schema
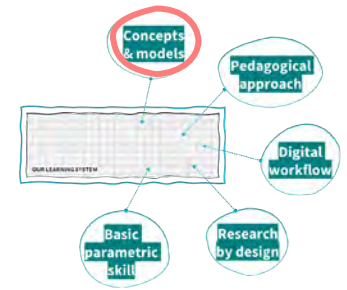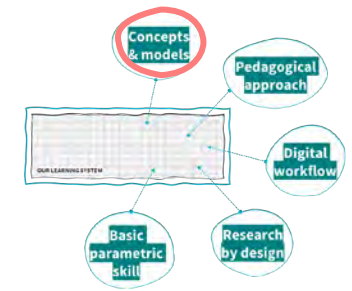**Informational flow processes in PDT**
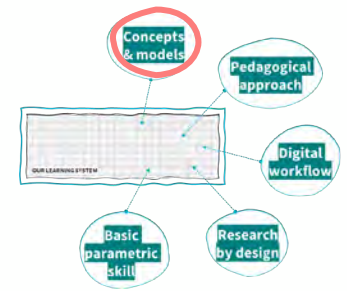
1: Concepts and models

Oxman, R. (2017). Thinking difference: Theories and models of parametric design thinking. *Design Studies*, 52, 4-39.

1.2: Typological to topological thinking in creative design.

**The evolution is:
From *typological thinking* to *topological thinking*.**

Typological thinking: design by sub-types
Topological thinking: design of versioning types, by changing values of their associative relationships.

1: Concepts and models

1.3: Differentiation as key strategy.

Read lecture notes

Differentiation is a term in the field of calculus**, and continuous differentiation** can be considered as the *'geometrical transcoding of parametric variations into differential geometries driven by iterative versioning processes of parametric design in a continuous rhythm' (Jabi, 2013).*
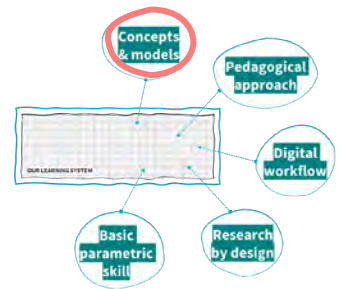
1: Concepts and models

Oxman, R. (2017). Thinking difference: Theories and models of parametric design thinking. *Design Studies*, 52, 4-39.

1.3: Differentiation as key strategy.

Example of differentiation in different context (1)
Read lecture notes

http://degroot.co.il/lyen56.asp?gj=com&hl=en&shop=nike+air+max+by+year&xi=3&xc=11&pl=0&pr=75.99&you=0

EVOLUTION OF THE AIR MAX

1: Concepts and models

Oxman, R. (2017). Thinking difference: Theories and models of parametric design thinking. *Design Studies,* 52, 4-39.

1.3: Differentiation as key strategy.

Example of differentiation in different context (2)
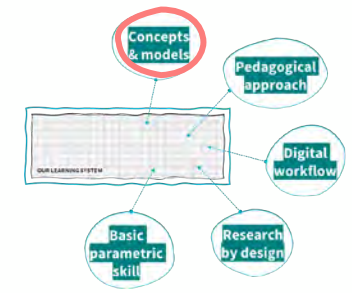Read lecture notes

fig. 5 A family of Scottish doors.

1: Concepts and models

Oxman, R. (2017). Thinking difference: Theories and models of parametric design thinking. *Design Studies,* 52, 4-39.

1.4: New symbolic role of imagery, requires different thinking.

Design modification.

In traditional ways of thinking → usually achieved by visual operation of re-drawing and re-modelling object of design.

In parametric design → Re-editing refers to design process represented by a set of algorithmic rules defined by the designer.
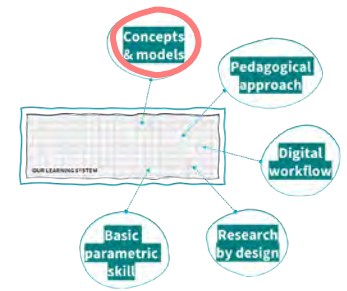
2: Pedagogical approach

Aish, R. & Hanna, S. (2017). Comparative evaluation of parametric design systems for teaching design computation. *Design Studies,* 52**,** 144-172.
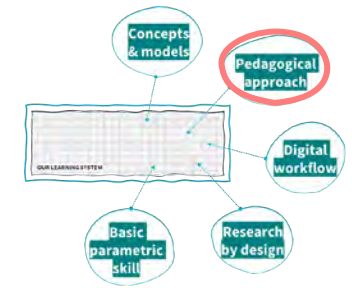
2.1: *Cognitive dimensions*

2.2: Cognitive challenges

2.3: *Learning curves* of parametric design systems (in this case, software)
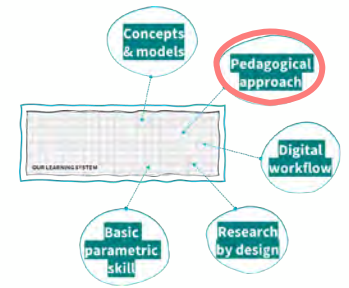
2: Pedagogical approach

Aish, R. & Hanna, S. (2017). Comparative evaluation of parametric design systems for teaching design computation. *Design Studies,* 52**,** 144-172.

2.1: *Cognitive dimensions*

Cognitive dimensions, **developed by Green and Blackwell (1998) are discussion tool to evaluate usability of information-based artefacts. It focuses on the process of interaction.**

Aish and Hannah (2017) adapted 9 dimensions from Green and Blackwell (1998). They analysed 3 parametric design system using the dimensions.
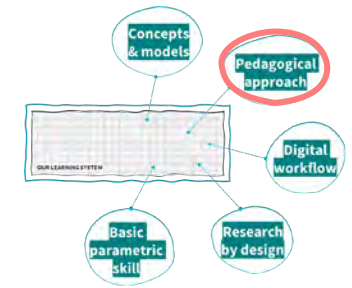
2: Pedagogical approach

Aish, R. & Hanna, S. (2017). Comparative evaluation of parametric design systems for teaching design computation. *Design Studies,* 52**,** 144-172.

2.1: *Cognitive dimensions*

The dimensions are:
1. **Abstraction barrier**
2. **Semantic interference**
3. **Consistency between representations**
4. **Discoverability**
5. **Flexibility**
6. **Side effects**
7. **Work around**
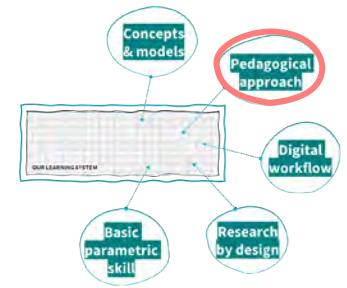8. **Convoluted workflow**
9. **Liveness**

2: Pedagogical approach

Aish, R. & Hanna, S. (2017). Comparative evaluation of parametric design systems for teaching design computation. *Design Studies,* 52**,** 144-172.

2.2: *Cognitive challenges*

Cognitive challenges might occur during modelling, or can be at the earlier and later phases.
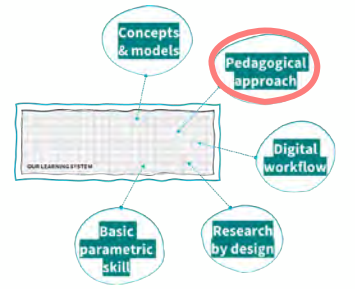
Cognitive challenges over the <mark>duration of learning process</mark> are illustrated in the *learning curves (2.3),* in form of the <mark>vertical lines</mark>.

2: Pedagogical approach

Aish, R. & Hanna, S. (2017). Comparative evaluation of parametric design systems for teaching design computation. *Design Studies,* 52**,** 144-172.
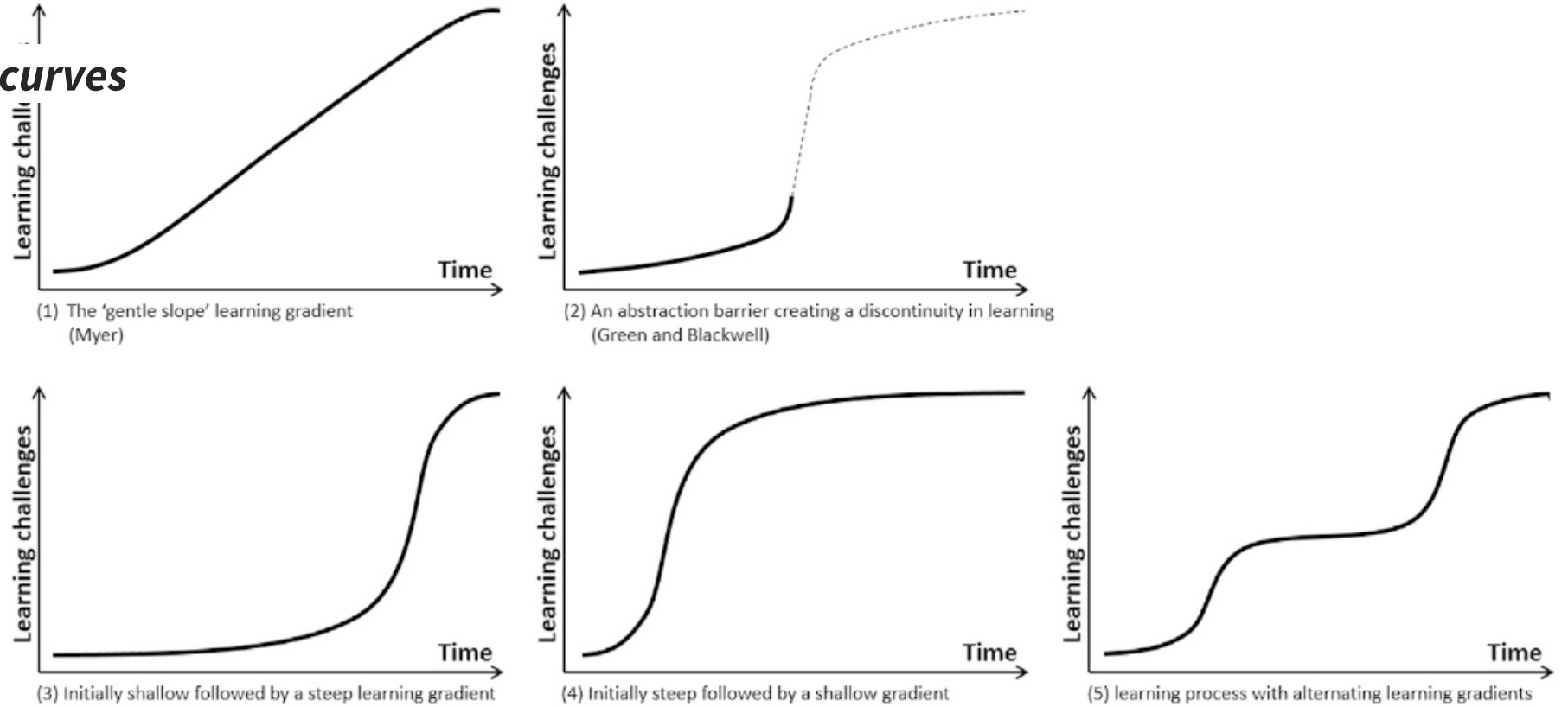
2.3: *Learning curves*

(1) The 'gentle slope' learning gradient (Myer)

(2) An abstraction barrier creating a discontinuity in learning (Green and Blackwell)

(3) Initially shallow followed by a steep learning gradient

(4) Initially steep followed by a shallow gradient

(5) learning process with alternating learning gradients

Figure 1 Five possible learning curves

3: Digital workflow
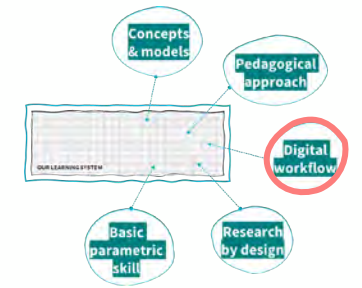
3.1: Great level of detail and ==differentiation== *(similar with item 1.3)*

## 3.2: ==Master Model== shared between architects, consultants and contractors.

3.3: Strength of PD (Parametric Design) is not only generating design variants, but realising highly specific, differentiated, rule-based designs.

4: Research by design

Bhooshan, S. (2017). Parametric design thinking: A case-study of practice-embedded architectural research. *Design Studies,* 52**, 115-143.

Definition of Parametric design thinking (PDT) according to Bhooshan (2017):
Computationally augmented form of design thinking
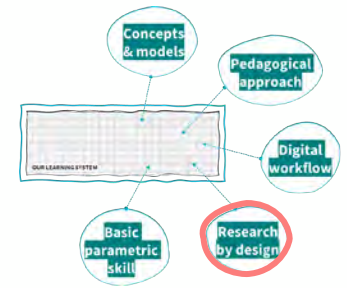
Three components of PDT derived from practice:

4.1: PDT Cognitive Model

4.2: Design Method

4.3: Information Processing Model

Bhooshan (2017)

Bhooshan, S. (2017). Parametric design thinking: A case-study of practice-embedded architectural research. *Design Studies,* 52**,** 115-143.

**He also highlights the need for architectural design and practice to follow a research programme,
Instead of ad-hoc solutions to design tasks.**

Cumulative research enabling network involving *academic institutions, professional firms and embedded research groups* to effectively realise architectural projects.

Academic research, practice and the in-between
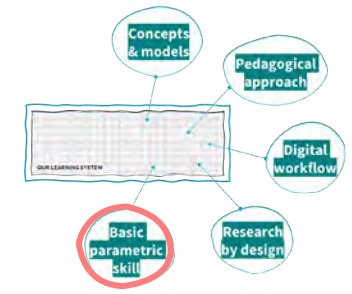
Collaboration

Research

Practice
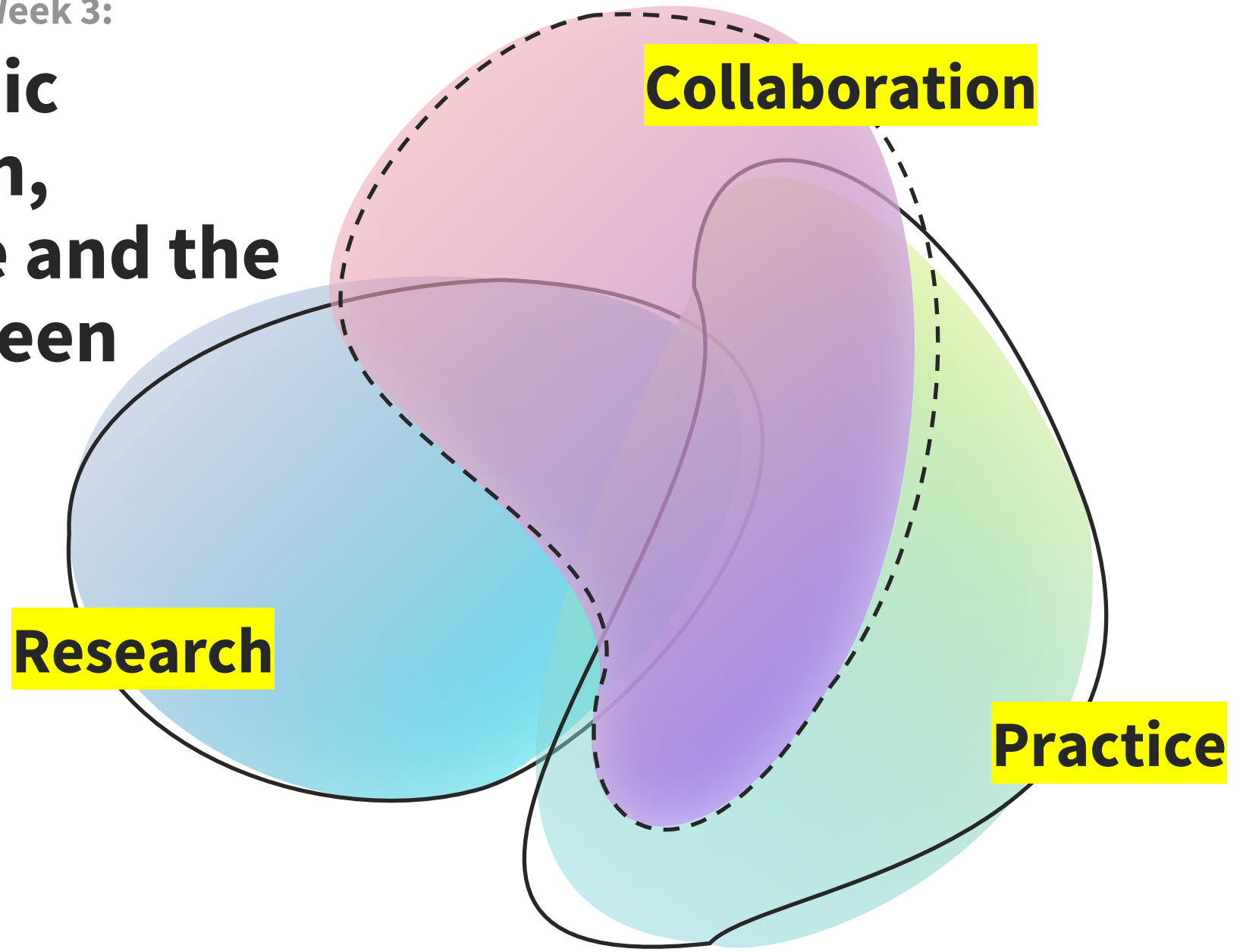
5: Basic parametric skill

Woodbury, R. (2010). Elements of parametric design.

5.1: The shift between conventional and parametric

5.2: New skills

5.3: New strategies

Previously in Week 5..

How designers use parameters

Woodbury, R. (2010). Elements of parametric design.

1. **The shift between conventional and parametric**
2. New skills
3. New strategies

Parametric modelling relies on **establishing relationships.**

The cost is it depends on **designers' ability** to **redefine relationships**, and willingness to consider relationship-definition phase as **integral design process.**

"Relationship creation"

How designers use parameters

Woodbury, R. (2010). Elements of parametric design.

1. The shift between conventional and parametric
2. **New skills:**
3. New strategies

1. CONCEIVING DATA FLOW
2. DIVIDING TO CONQUER
3. NAMING
4. THINKING WITH ABSTRACTION
5. THINKING MATHEMATICALLY
6. THINKING ALGORITHMICALLY

THESE ARE BASIC SKILLS OF PARAMETRIC CRAFT.
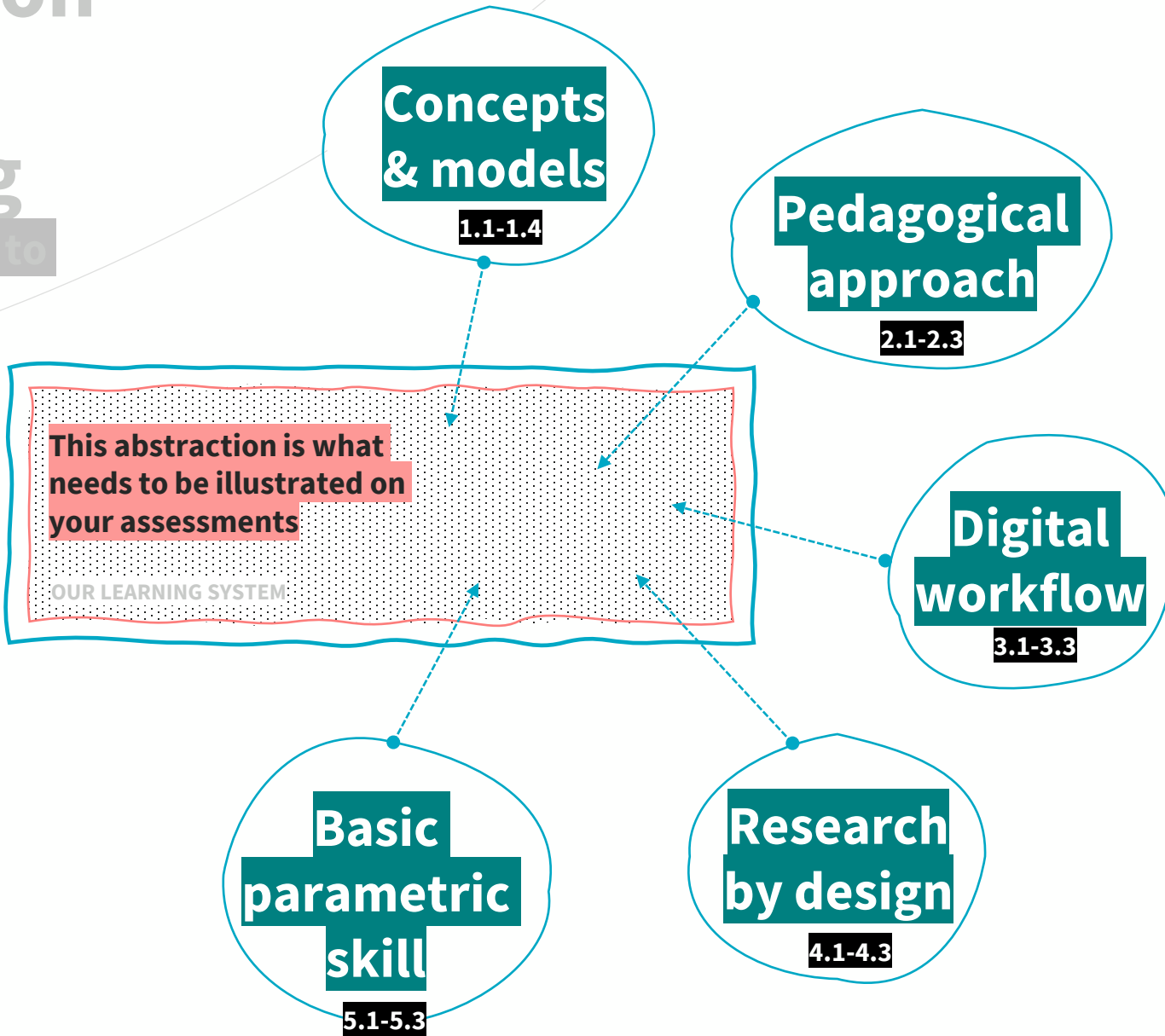
Previously in Week 5..

How designers use parameters

Woodbury, R. (2010). Elements of parametric design.

1. The shift between conventional and parametric
2. New skills
3. New 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

A broader view on Parametric Design Thinking

For the purpose of being able to express parametric design

Concepts & models
`1.1-1.4`

Pedagogical approach
`2.1-2.3`

Digital workflow
`3.1-3.3`

This abstraction is what needs to be illustrated on your assessments

OUR LEARNING SYSTEM

Basic parametric skill
`5.1-5.3`

Research by design
`4.1-4.3`

Note: to be read in conjunction with assessment documents (brief, grading rubric, etc)

Summary of concepts

Summary: concepts of design thinking

1. Search of solution space
2. Exploration
3. Emergence
4. Reflection
5. Modification
6. Adaptation
7. Media:
   Media used
   Algorithmic design
   Scripting language
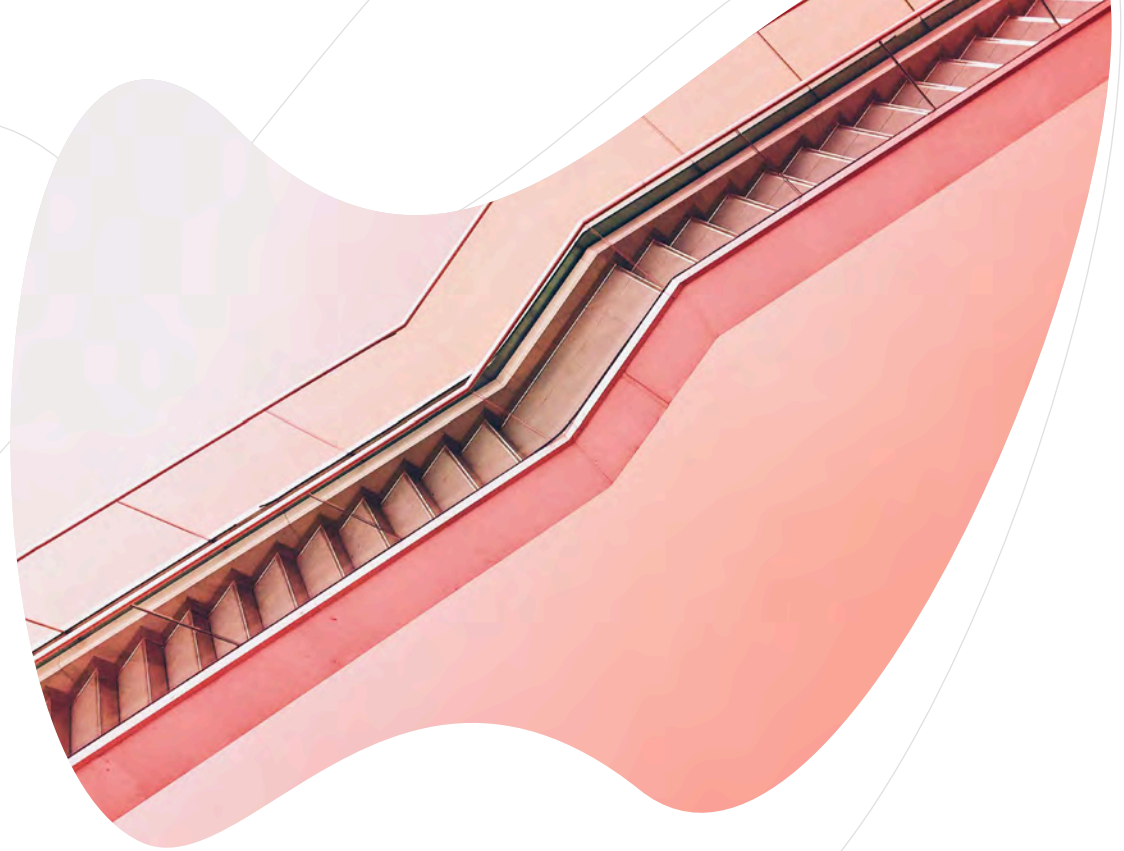
Summary: concepts of design thinking

1. **Search of solution space**
2. Exploration
3. Emergence
4. Reflection
5. Modification
6. Adaptation
7. Media:
   Media used
   Algorithmic design
   Scripting language

A solution space is an abstract space where designers go through complex cognitive processes to develop and deliver solution. Usually it involves the processes mentioned on item 2-6.

Also it is highly related with problem space.

Summary: concepts of design thinking

1. Search of solution space
2. **Exploration**
3. Emergence
4. Reflection
5. Modification
6. Adaptation
7. Media:
   Media used
   Algorithmic design
   Scripting language

The process of developing solutions by generating and analysing them.

Summary: concepts of design thinking

1. Search of solution space
2. Exploration
3. **Emergence**
4. Reflection
5. Modification
6. Adaptation
7. Media:
   Media used
   Algorithmic design
   Scripting language

Recognition of visual entities in design enables emergence, supporting the ability 'to think with an image'.

Summary: concepts of design thinking

1. Search of solution space
2. Exploration
3. Emergence
4. **Reflection**
5. Modification
6. Adaptation
7. Media:
   Media used
   Algorithmic design
   Scripting language

Framing and re-framing design problems and solutions.

Summary: concepts of design thinking

1. Search of solution space
2. Exploration
3. Emergence
4. Reflection
5. **Modification**
6. Adaptation
7. Media:
   Media used
   Algorithmic design
   Scripting language

Modification or refinement refer to the process of transformation from schematic state to specific state.

Oxman, R. E. & Oxman, R. M. (1992). Refinement and adaptation in design cognition. *Design Studies,* 13**,** 117-134.

Summary: concepts of design thinking

1. Search of solution space
2. Exploration
3. Emergence
4. Reflection
5. Modification
6. **Adaptation**
7. Media:
   Media used
   Algorithmic design
   Scripting language

Adaptation refers to the transformation process of modifying existing design.

Oxman, R. E. & Oxman, R. M. (1992). Refinement and adaptation in design cognition. *Design Studies,* 13**,** 117-134.
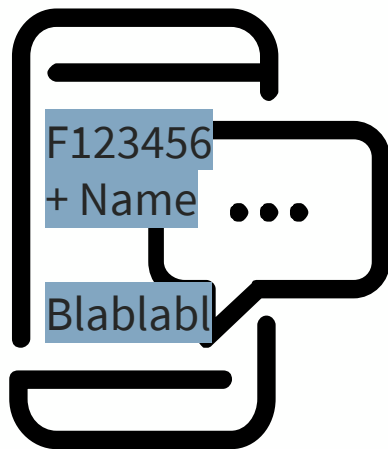
Summary: concepts of design thinking

1. Search of solution space
2. Exploration
3. Emergence
4. Reflection
5. Modification
6. Adaptation
7. **Media:**
   Media used
   Algorithmic design
   Scripting language

What are designing mediums you use? How do they affect your design thinking?
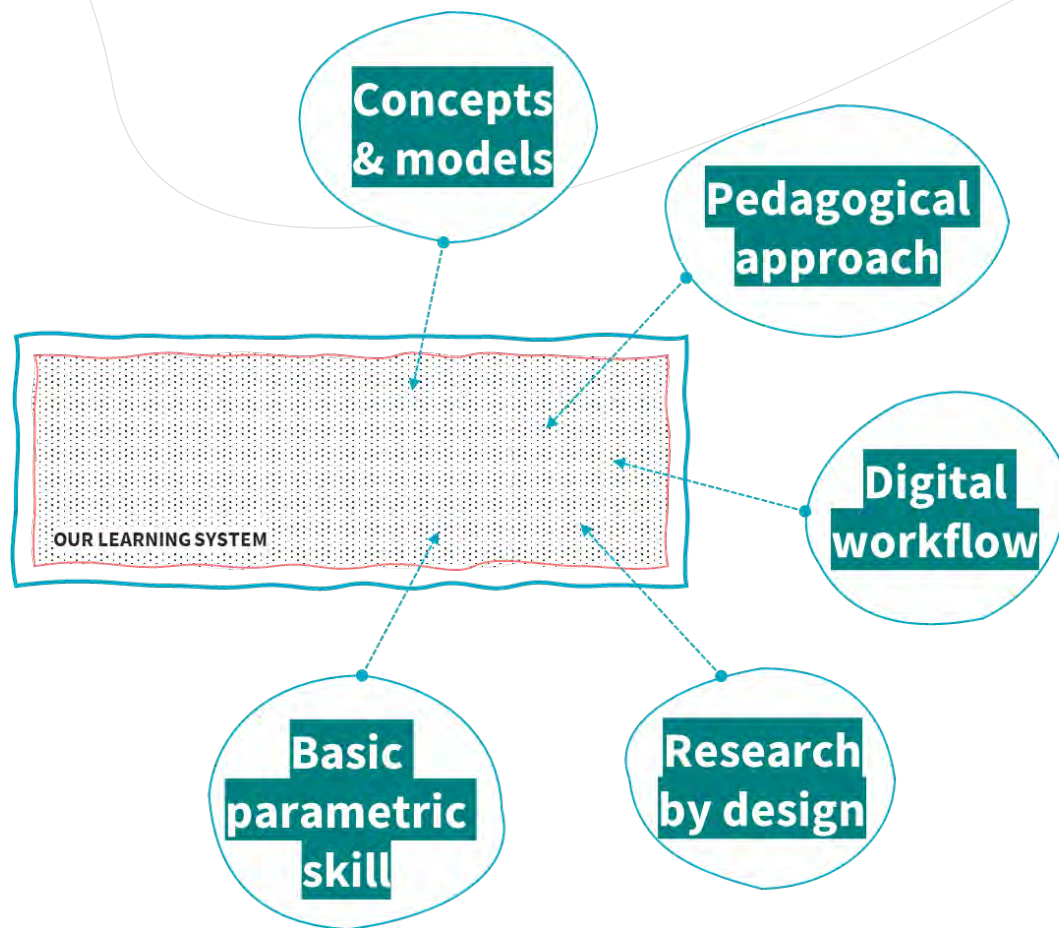
Discussion

F123456
+ Name

Blablabl

0 Comments Mia Tedjosaputro Login

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Start the discussion…

LOG IN WITH OR SIGN UP WITH DISQUS ?

Name

Reflect on the concepts of design thinking, make a short description on how your current design practice is. Use these bullet points:

1. Solution space
2. Exploration
3. Emergence
4. Reflection
5. Modification
6. Adaptation
7. Media

https://miatedjosaputro.com/2020/04/07/week-7-discussion/

Re-iterating aims and objectives

- To relate what students have learnt related to digital design cognition **previous weeks.**
- To elicit **evolution of paradigm in design thinking**, starting from pen-and-paper based thinking up to the parametric design thinking.
- To demonstrate **changes** in terms of studying design behaviour and changes in design behaviour itself.
- To provide **contextualisation** of the upcoming assessments.

To sum up, for your assessments

Concepts & models

Pedagogical approach

Digital workflow

OUR LEARNING SYSTEM

Basic parametric skill

Research by design

\+

Summary:
concepts of
design thinking

1. Search of solution space
2. Exploration
3. Emergence
4. Reflection
5. Modification
6. Adaptation
7. Media:

   Media used
   Algorithmic design
   Scripting language