Teaching Generative Theory

Wendy E. Mackay

Traction Workshop

6 May 2026

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Inria
INVENTEURS DU MONDE NUMÉRIQUE

COLLÈGE DE FRANCE
1530

Website:

https://ex-situ.lisn.upsaclay.fr/workshops

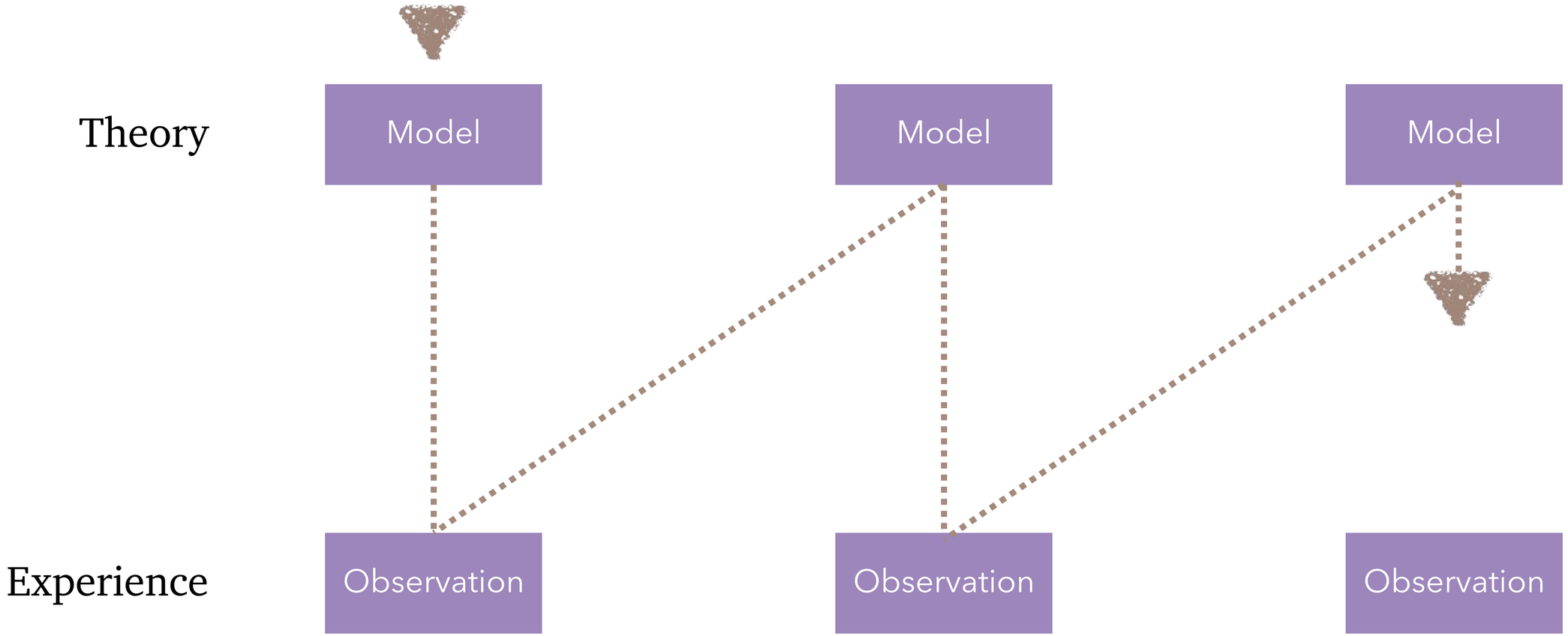
HCI requires multiple research and design disciplines

How can we bring research principles into design practice?

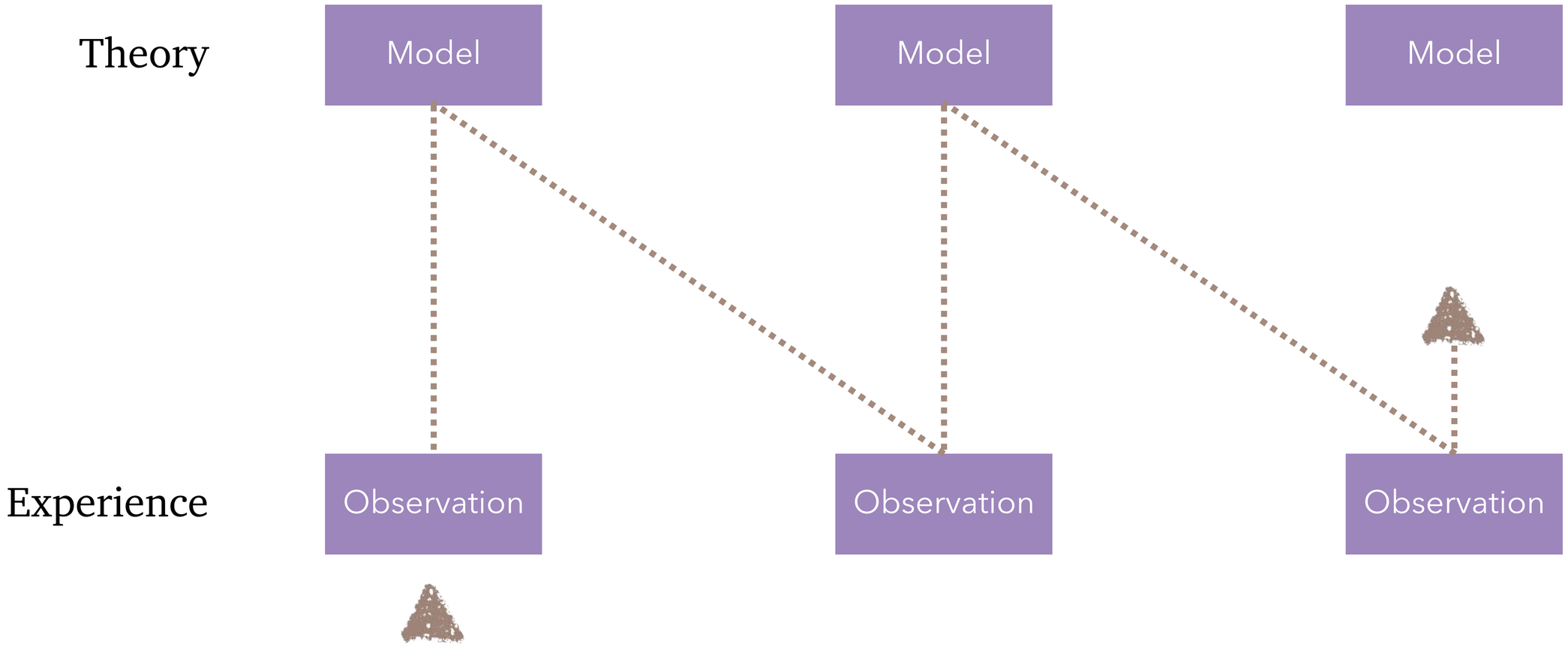
Back and forth between theory and observation

Interaction is a phenomenon in its own right

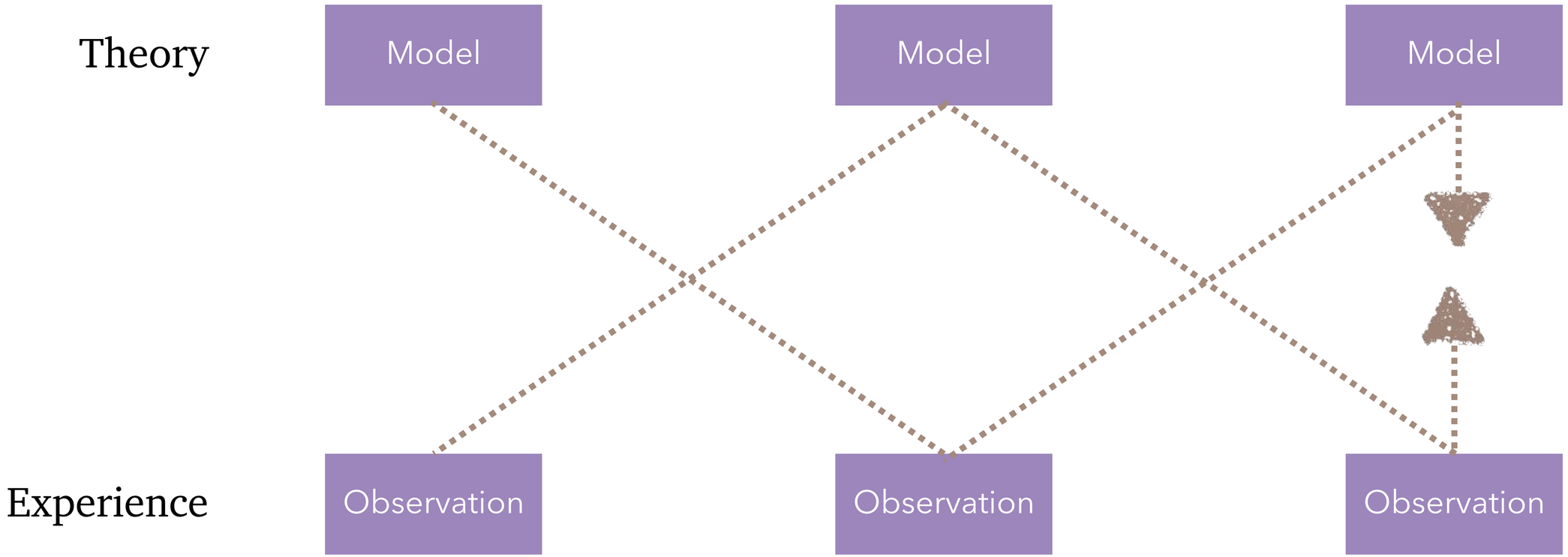
Sciences: Physics, Biology, Psychology



Sciences: Astrophysics, Geology, Anthropology



Fitts' Law: MT = a + b log(1 + D/W) (Fitts, 1954)

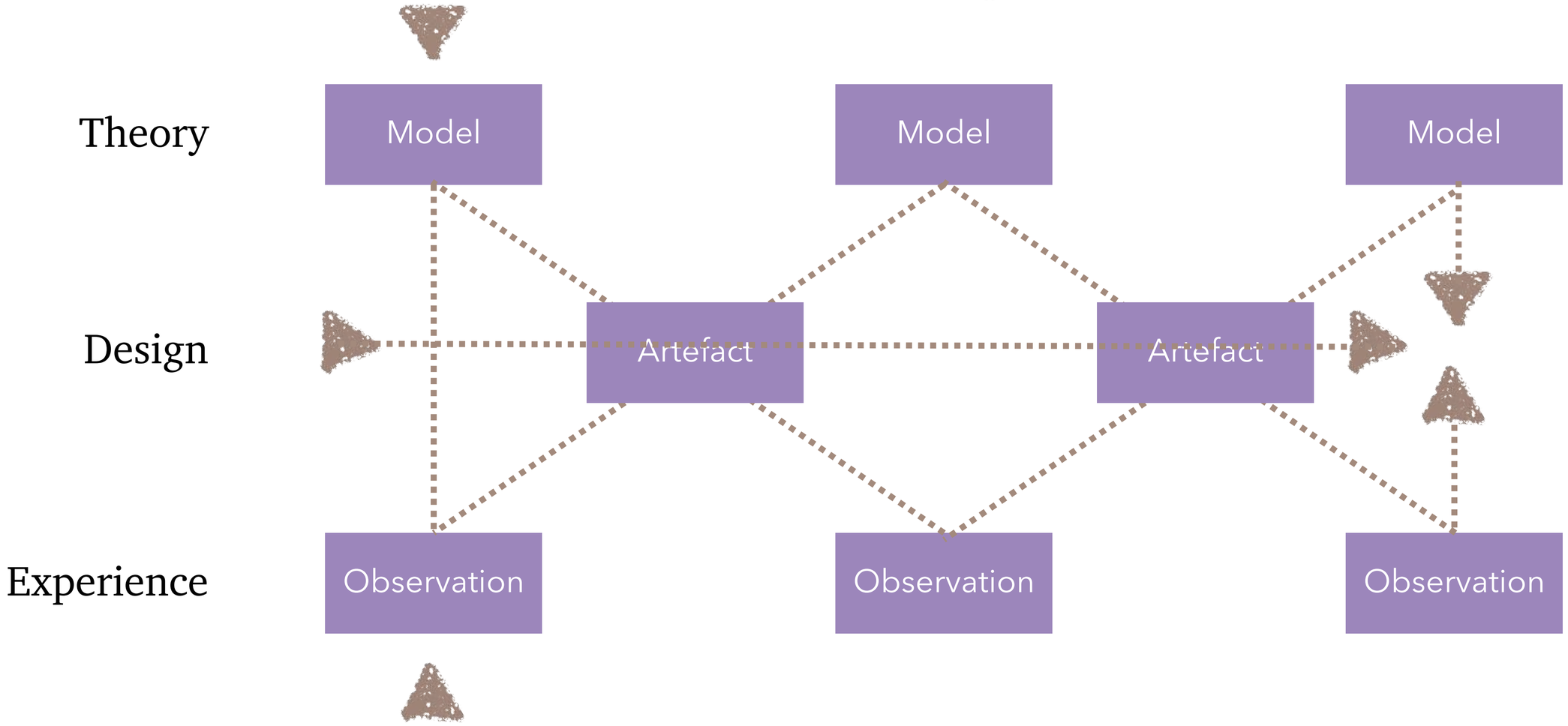


Distributed Cognition (Hutchins, 1995)

What about technology we design ourselves?

Design

Mackay & Fayard (1997)
HCI, Natural Science and Design: A Framework for Triangulation Across Disciplines

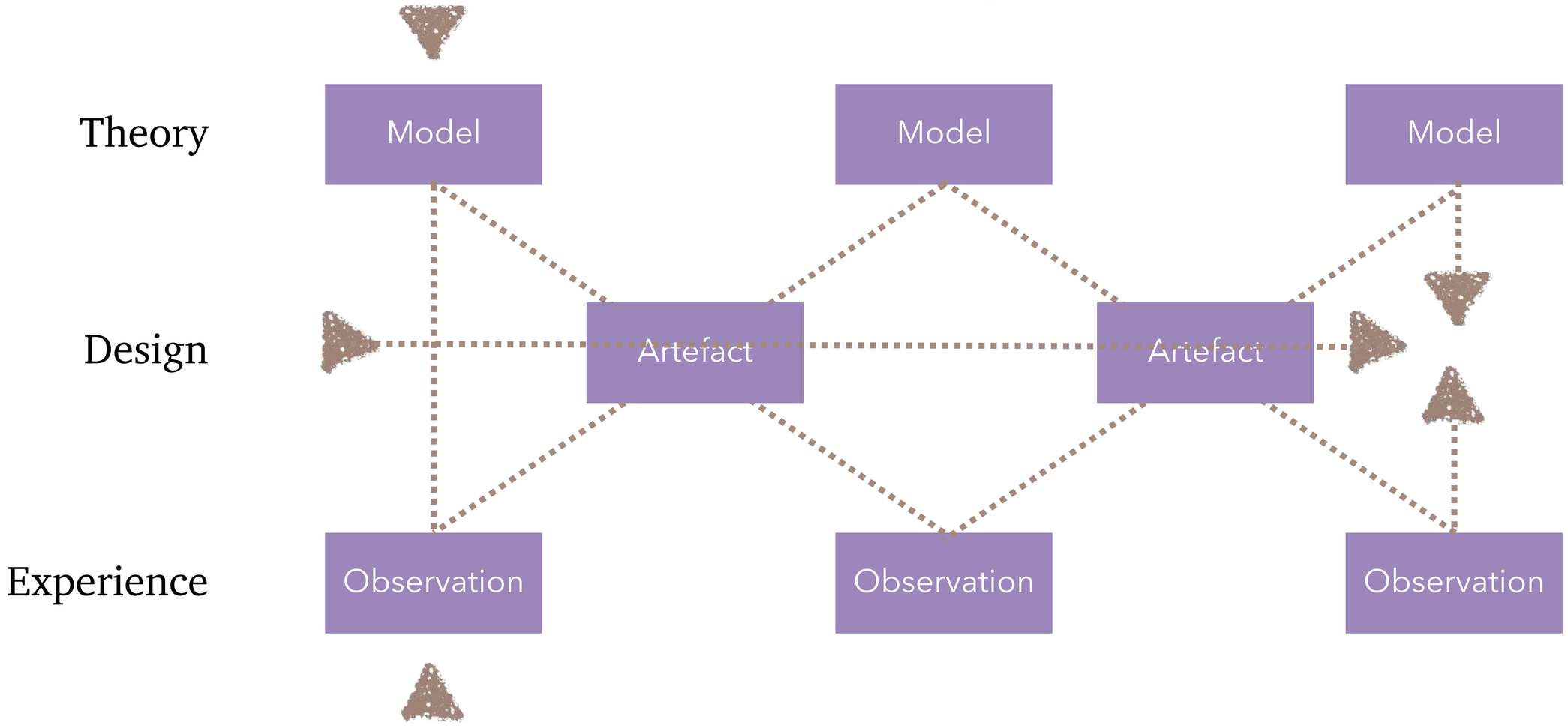


Two kinds of Science:

"things that are inescapable" (physics)
"things that are contingent" (evolution)

Mark Vellend
Everything Evolves: Why Evolution Explains More Than We Think, From Proteins to Politics

Mackay & Fayard (1997)
HCI, Natural Science and Design: A Framework for Triangulation Across Disciplines

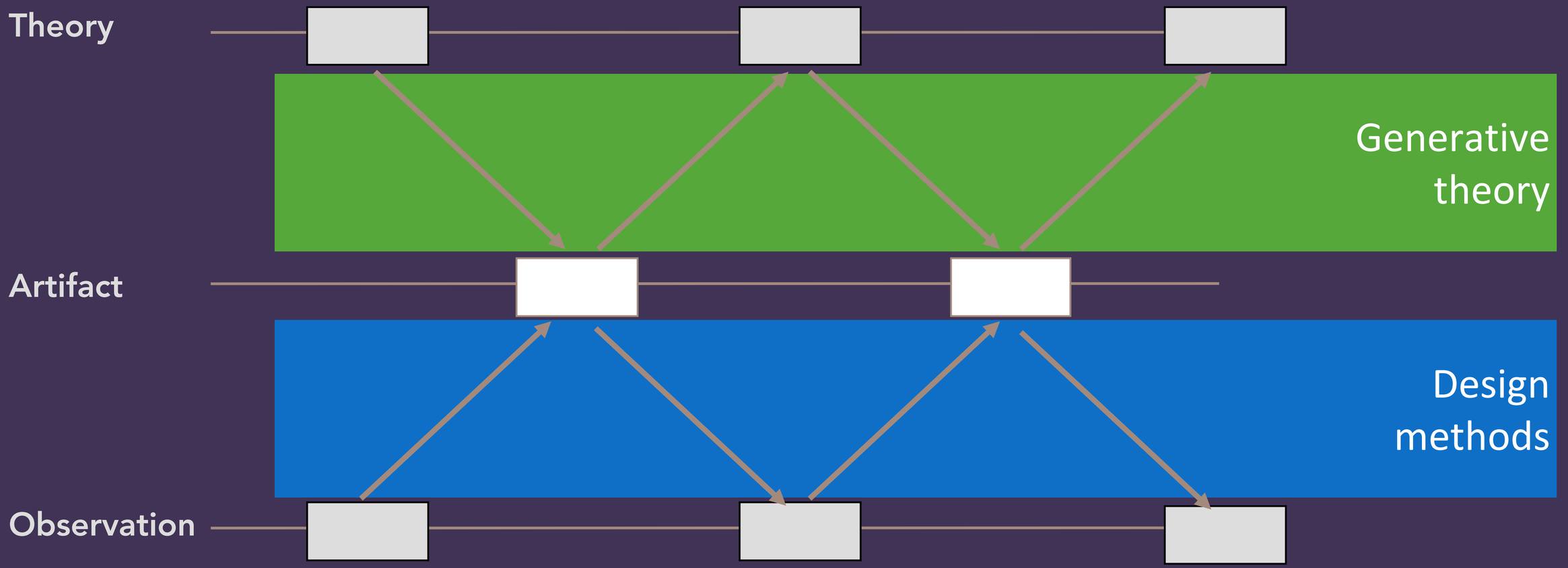


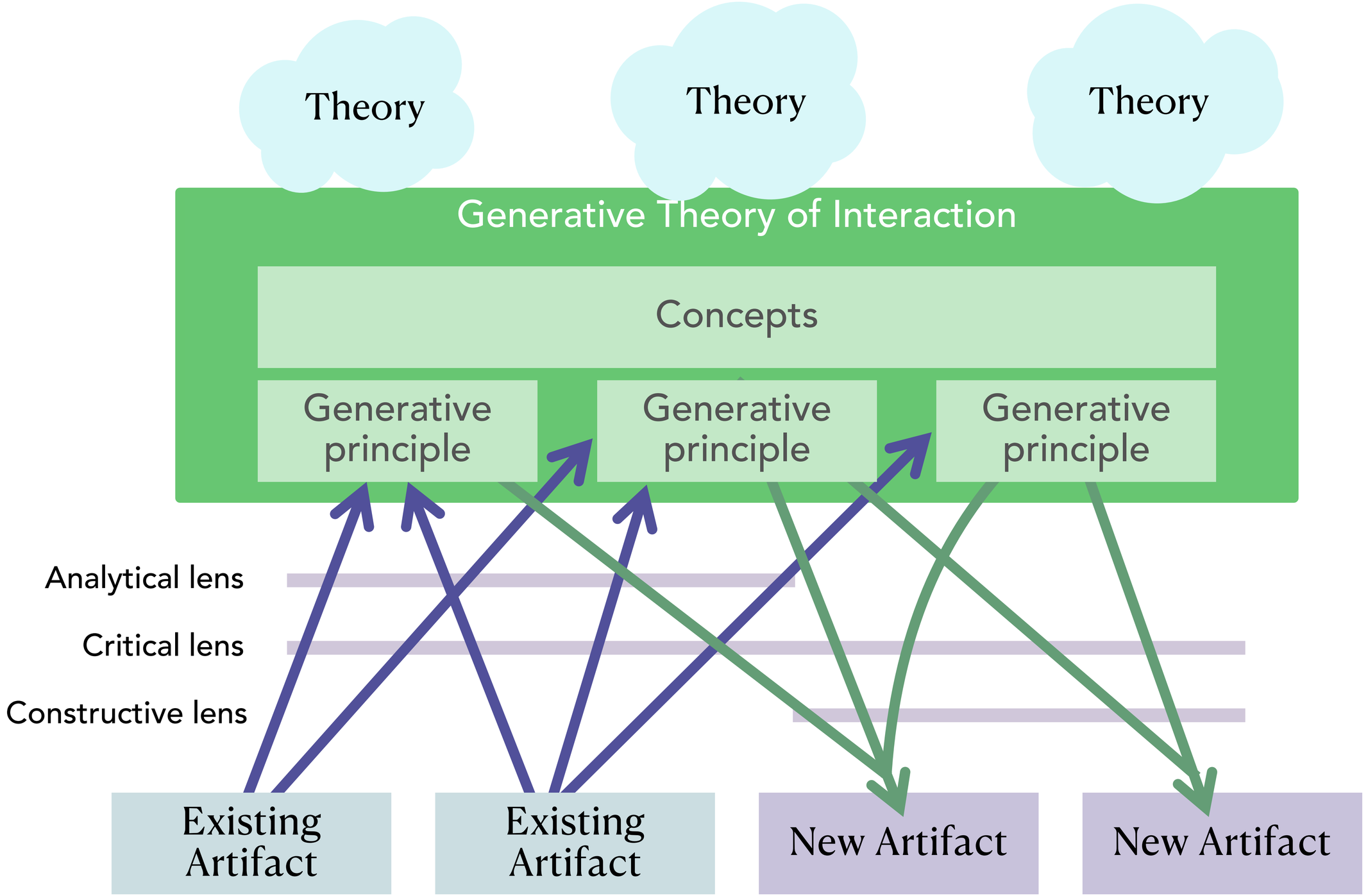
Generative Theory

Beaudouin-Lafon, Bødker & Mackay (2022)
Generative Theories of Interaction
ACM TOCHI **9:4**

Treat *Interaction*
as a phenomenon
to study and design

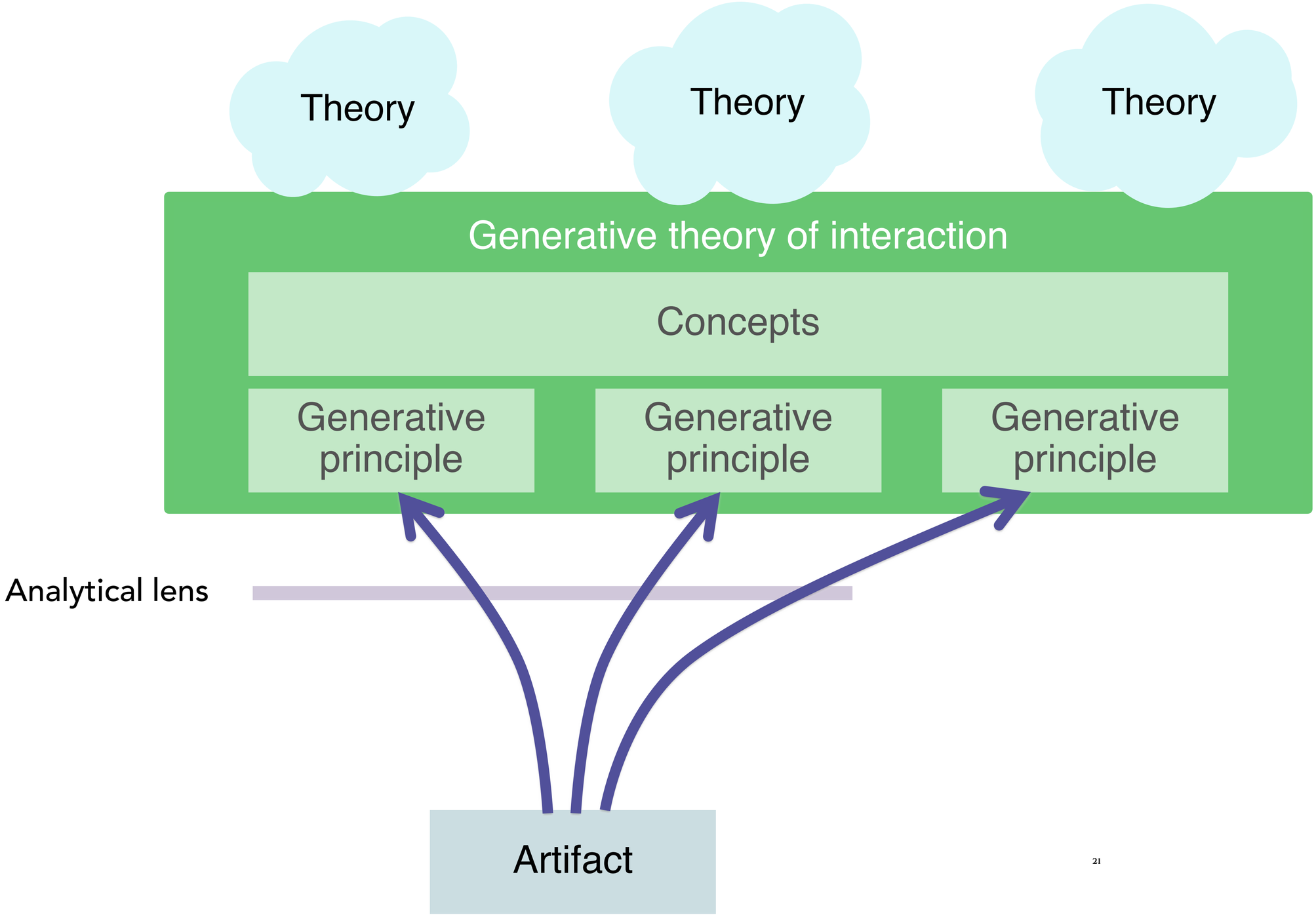
How does HCI fit?




Theory
Theory
Theory
Generative Theory of Interaction
Concepts
Generative principle
Generative principle
Generative principle
Analytical lens
Critical lens
Constructive lens
Existing Artifact
Existing Artifact
New Artifact
New Artifact

Generative Theories of Interaction

Beaudouin-Lafon, Bødker & Mackay, TOCHI 2021


Theory
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Generative principle
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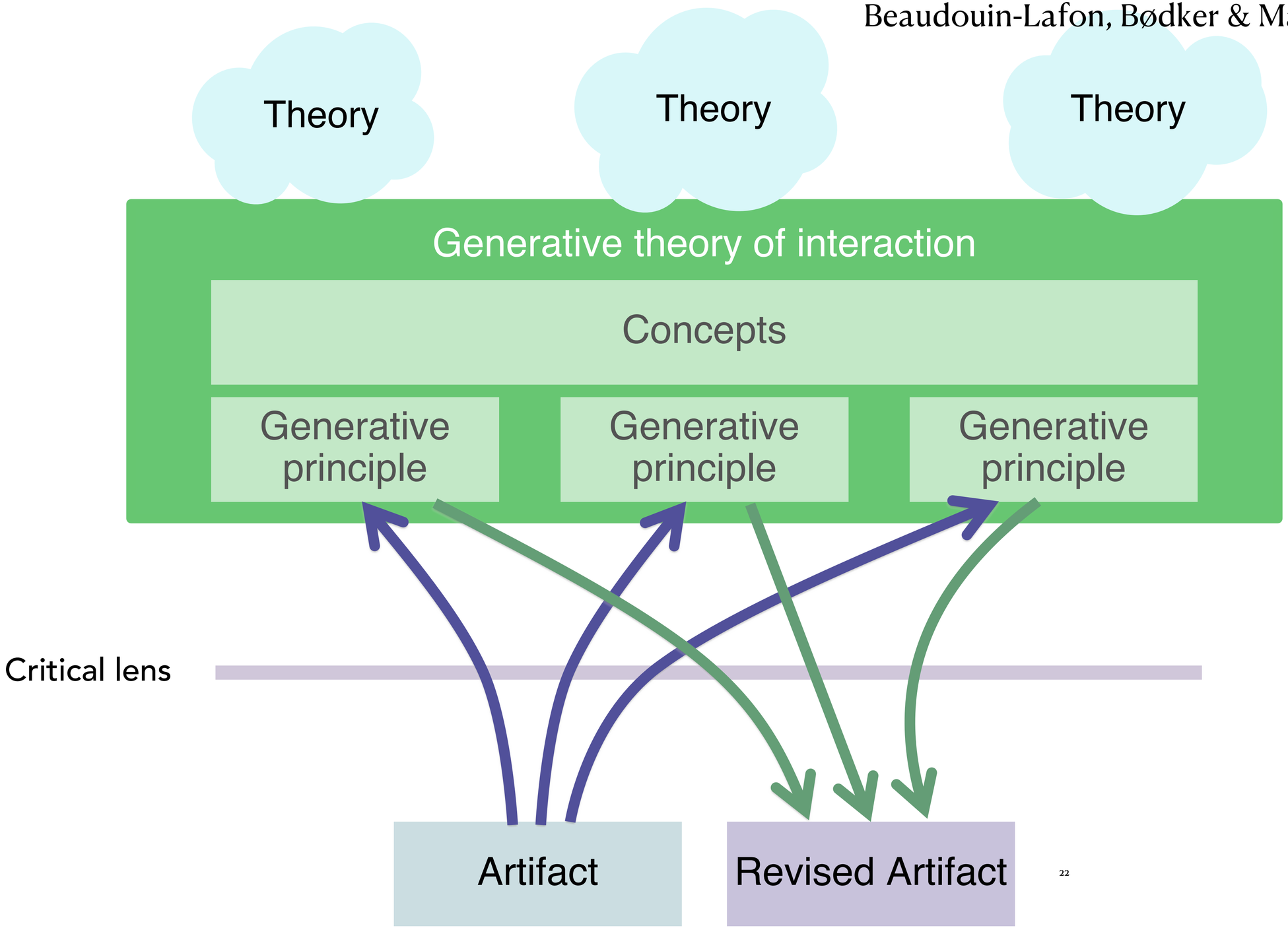
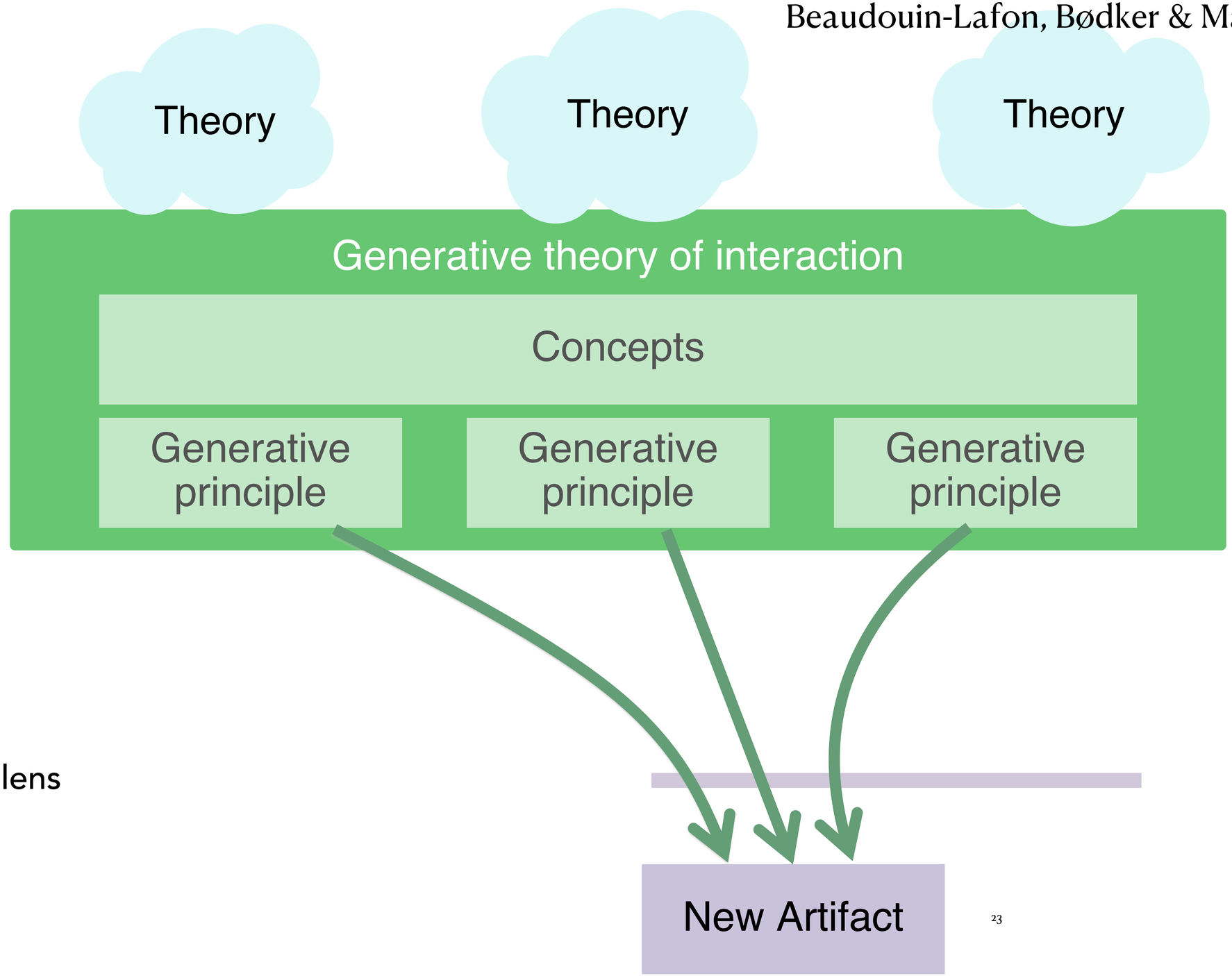
Generative principle
Analytical lens
Artifact

Beaudouin-Lafon, Bødker & Mackay, TOCHI 2021

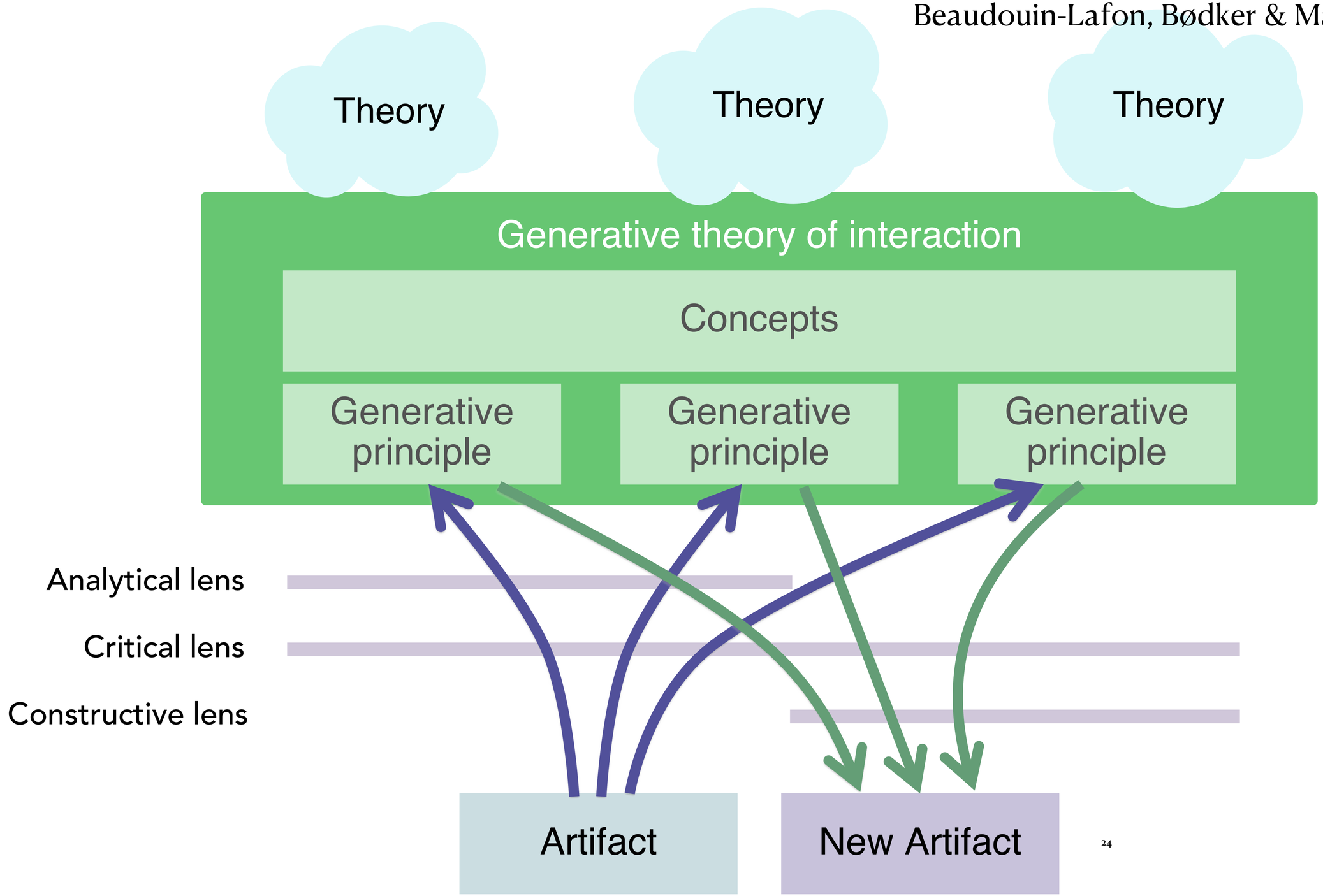


Beaudouin-Lafon, Bødker & Mackay, TOCHI 2021



Constructive lens

Beaudouin-Lafon, Bødker & Mackay, TOCHI 2021



What are the key elements of an interactive system?

Objects of interest

the conceptual objects that users manipulate
in order to achieve their goals

We focus on objects

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1 DO IT: Design of Interactive Things
Term 2
Wendy Mackay
03 September 2021

2 Discovery
Who is the user ?

3 Invention
What is possible ?

4 Design
What should it be ?

5 Evaluation
Does it work ?

6 Redesign
How to improve it ?

Invention

What is possible ?

Click to add speaker notes

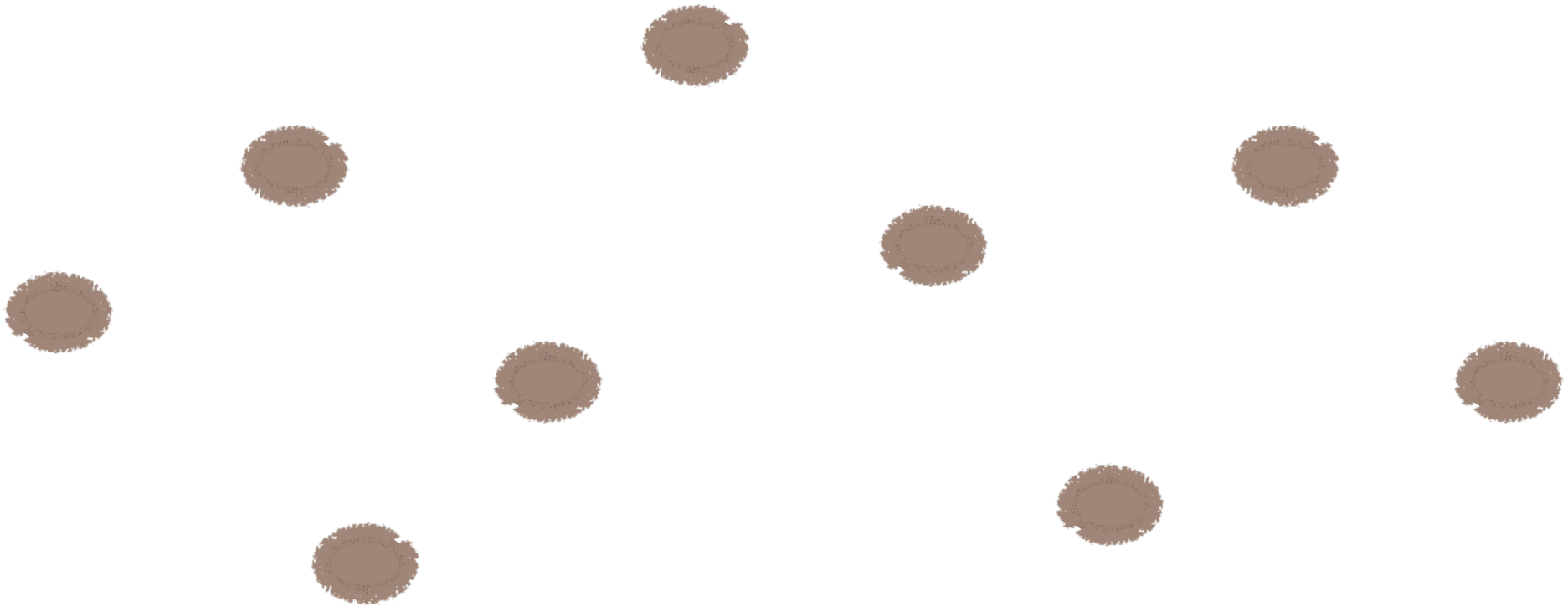
Substrates

create spaces for interaction

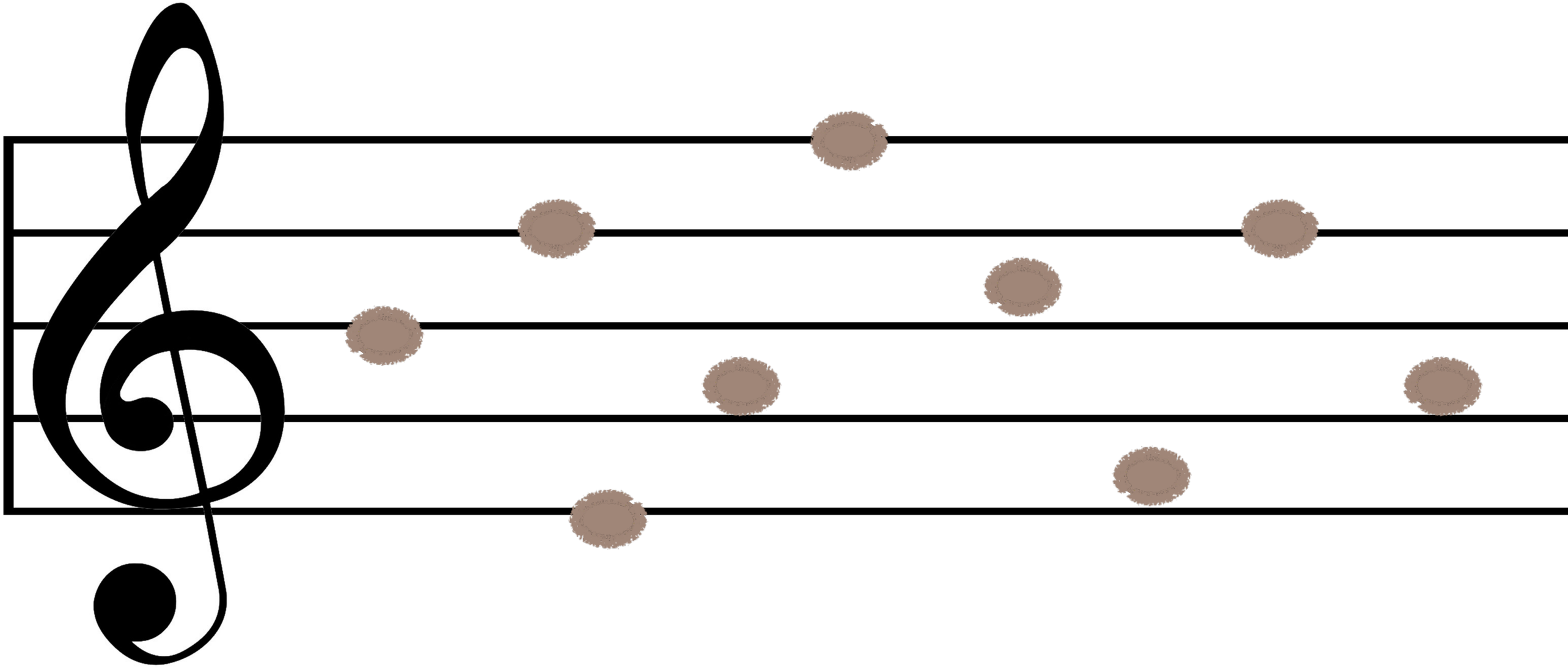
Substrates

contain and structure objects of interest
and manage constraints and dependencies

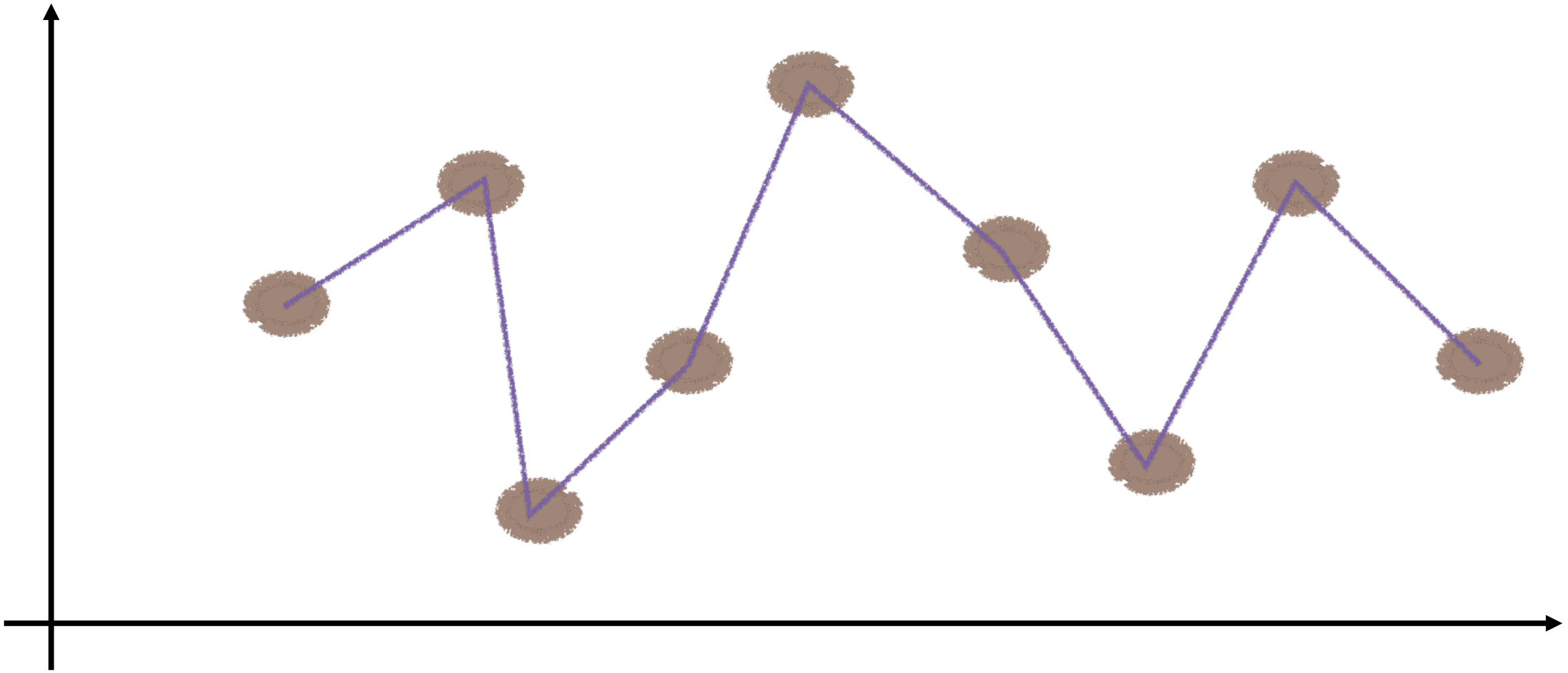
Substrates give meaning



Substrates give meaning



Substrates give meaning

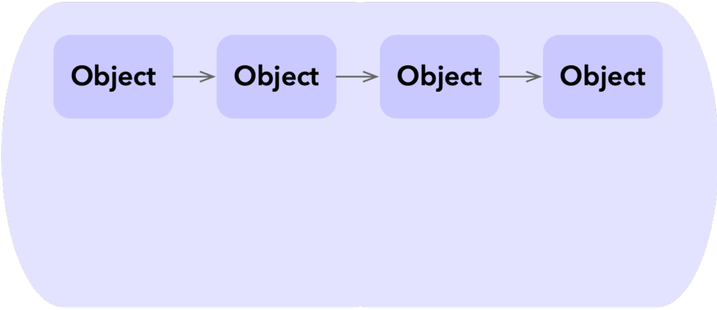


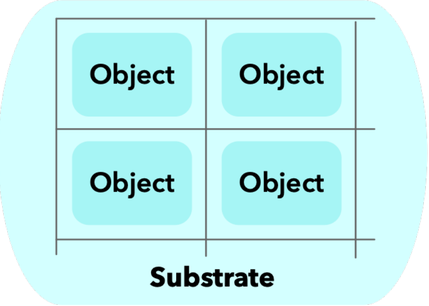
Substrates give meaning

Definition

A **substrate:**

structures the objects of interest it **contains**,



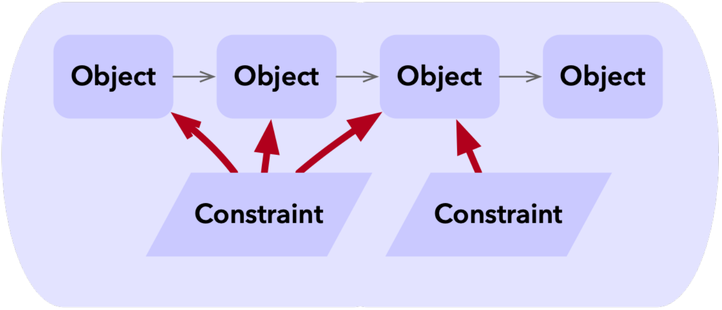


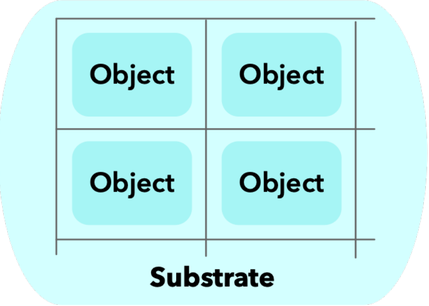
Definition

A **substrate:**

structures the objects of interest it **contains**,

manages **constraints** among **internal** objects,





Definition

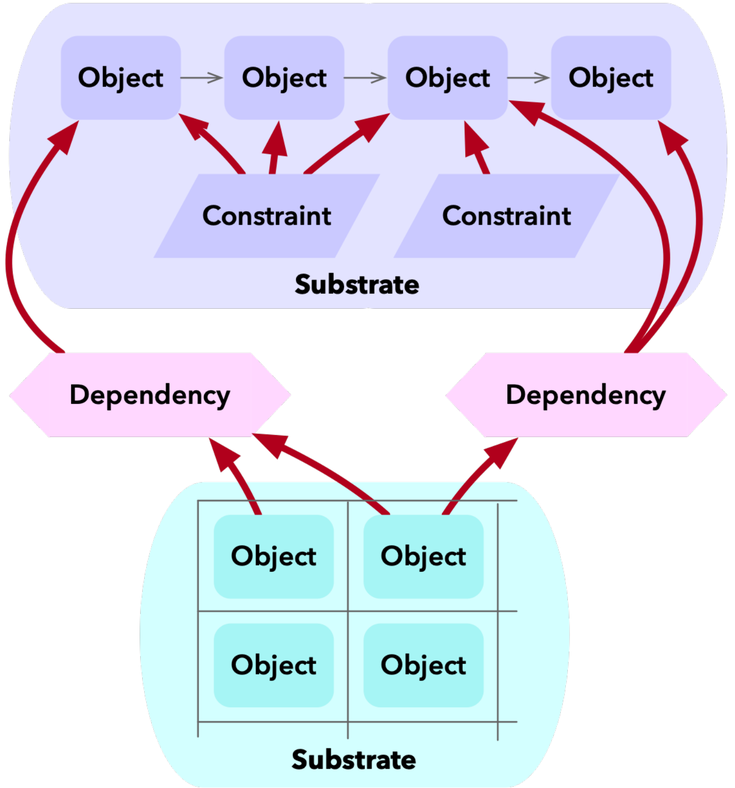
A **substrate:**

structures the objects of interest it **contains**,

manages **constraints** among **internal** objects,

manages **dependencies** with **external** objects,

including other substrates



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1

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03 September 2021

2

3

4

5

Evaluation
Does it work ?

6

Redesign
How to improve it ?

7

Design of Interactive Things

Lectures (in class)
- Generative design process
- Applicable for research and industry

Design activities (in class or at home)
- Individual *and* group exercises
- Each activity builds upon previous results of earlier activities

Project (in class and at home)
- Groups of 4

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Generative Design Process

Each group will design ... *and redesign*
a novel user interface
This course will help you in your future courses and your final Master's project

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Fundamentals of Situated Interaction

Term 3
Michel Beaudouin-Lafon & Wendy Mackay
03 September 2021

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Who are we?

Wendy MACKAY Research Director, Inria
Head of ExSitu research lab at Inria, member of HCC
Michel BEAUDOUIN-LAFON Professor, Univ. Paris-Saclay
Head of Human-Centered Computing lab at LRI, member of ExSitu

Focus on Human-Computer Interaction
- to augment human capabilities
- to generate novel forms of interaction
- to explore the next generation of interactive systems

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ex)situ

Interaction paradigms
Participatory design
Distributed comunication
Engineerin

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Fundamentals of situated interaction?

How do we use the principles of
- instrumental interaction (reification, polymorphism, reuse)
- substrates
- Human-computer partnerships (co-adaptive systems)

to fundamentally rethink the design of interactive systems?

Interaction Museum

Examining interaction from HCI research

Creating a resource for designers and other

Advanced Design of Interactive Systems

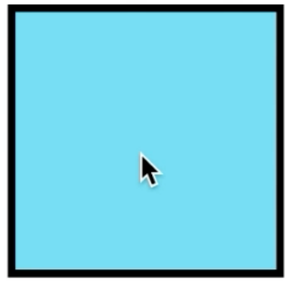
Term 3
Wendy Mackay

Participatory Design

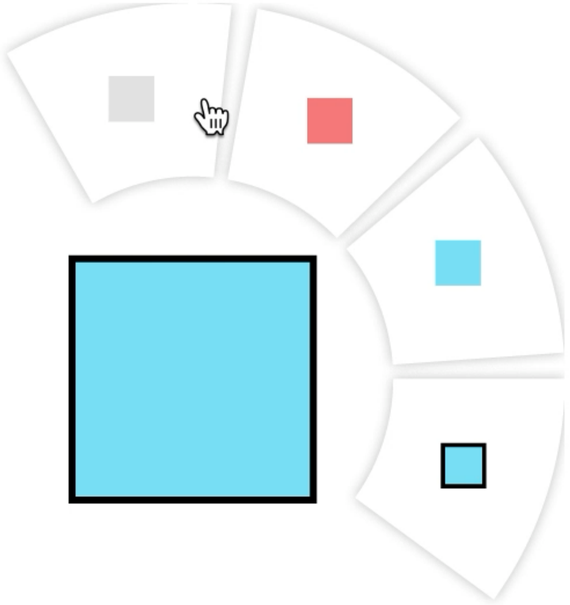
- … focuses on **situated interaction** between users and technology
- … involves **users throughout** the design process
- … is fundamentally **generative** not evaluative
- … values iteration and rapid **redesign**
- … explores **breakdowns** and the unexpected

Reifying a substrate

Turn an object's history into a substrate



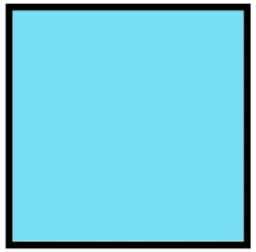
Turn an object's history into a substrate

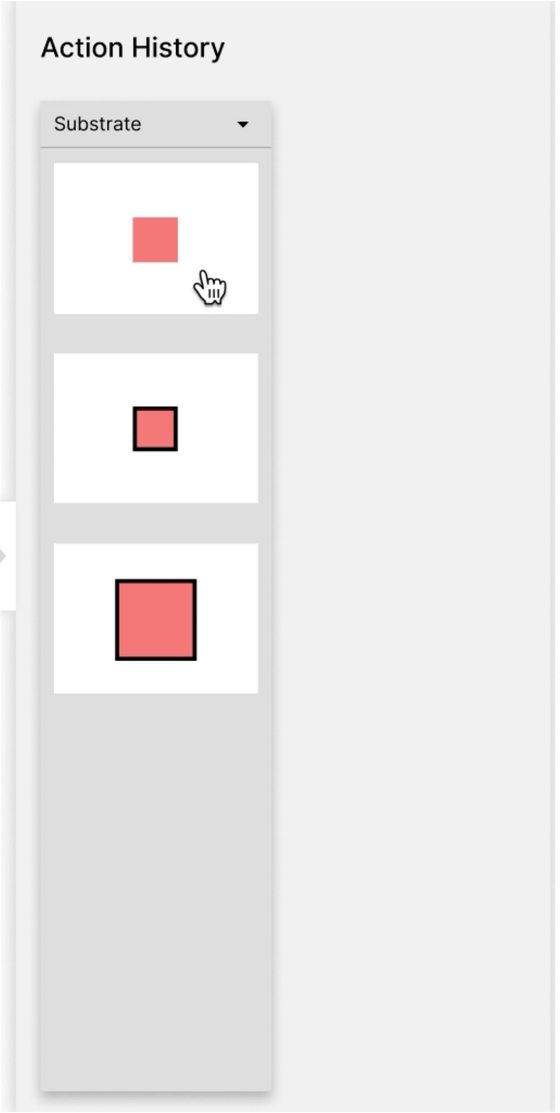


Action History

Apply a **command** from the history …

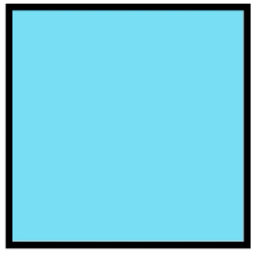
Lorem Ipsum

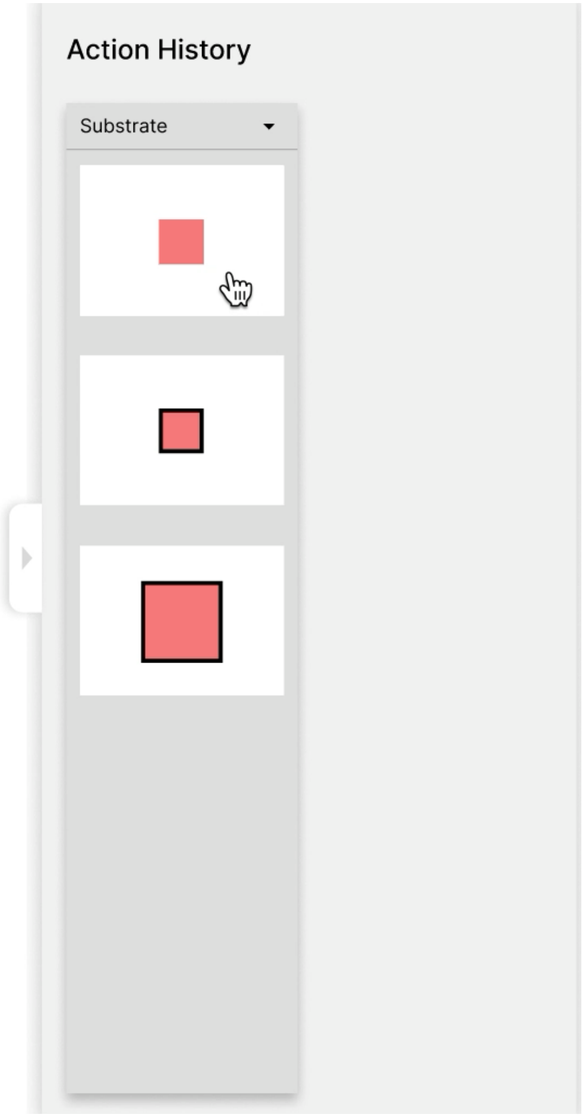




or a set of commands

Lorem Ipsum



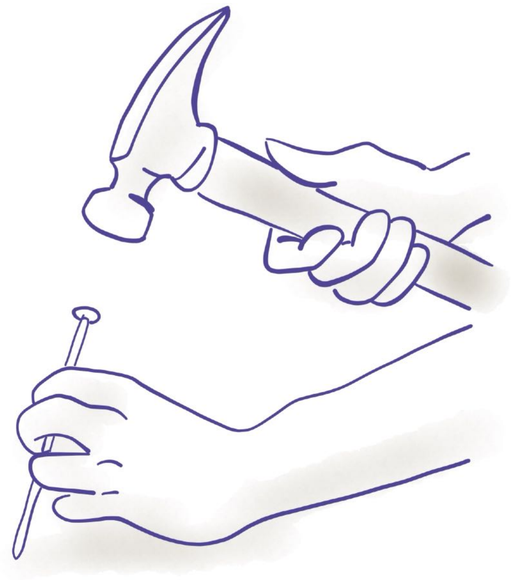


Instruments

mediate digital interactions
with the objects of interest

Instruments let us modify objects

We can use tools as they were designed



Instruments let us modify objects

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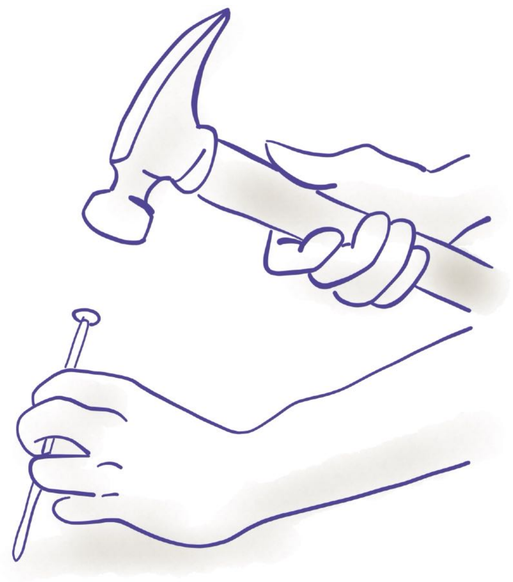
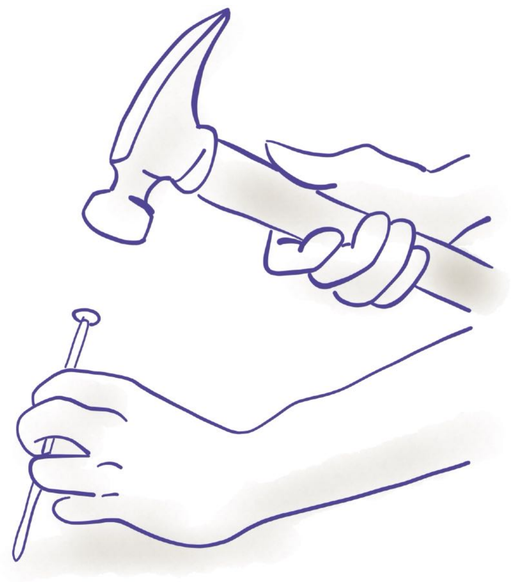


We can also innovate by using an object's properties to accomplish a task

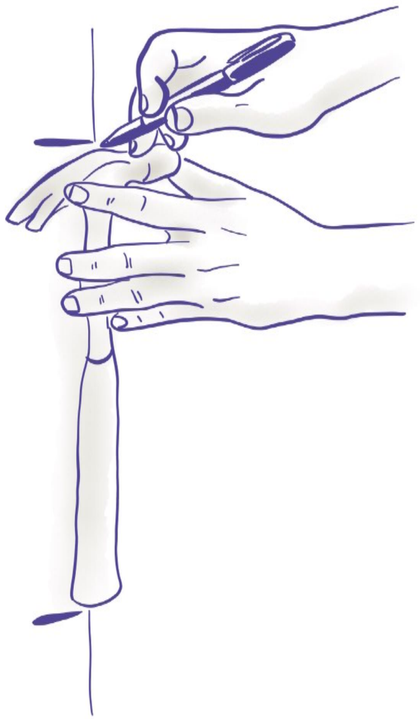
Instruments let us modify objects

We can use tools as they were designed



We can also innovate by using an object's properties to accomplish a task

We can also re-use tools for other purposes



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- Table
- Image
- Borders & lines
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- Clear formatting ⌘\

Image submenu:
- Crop image
- Replace image
- Reset image

Format options

Size & Rotation

Position

Recolor

Adjustments

Opacity 100 %

Brightness 0 %

Contrast 0 %

Reset

Drop shadow

Reflection

2 Discovery *Who is the user ?*

3 Invention *What is possible ?*

4 Design *What should it be ?*

5 Evaluation *Does it work ?*

6 Redesign *How to improve it ?*

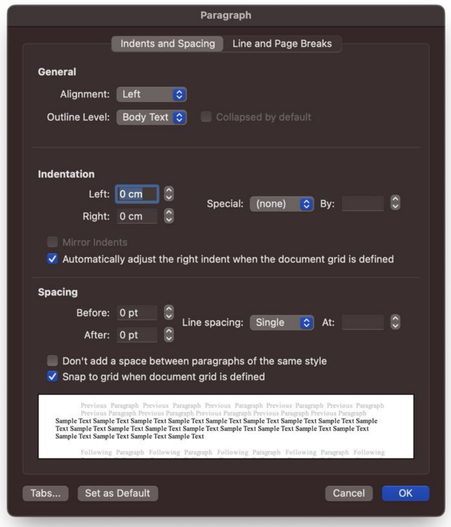
7 Design of Interactive Things
Lectures (in class)
Generative design process
Applicable for research and industry
Design activities (in class or at home)
Individual and group exercises
Each activity builds upon previous results of earlier activities
Project (in class and at home)
Groups of 4

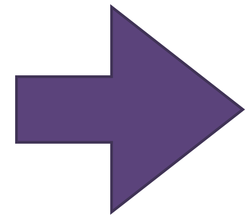
Click to add speaker notes

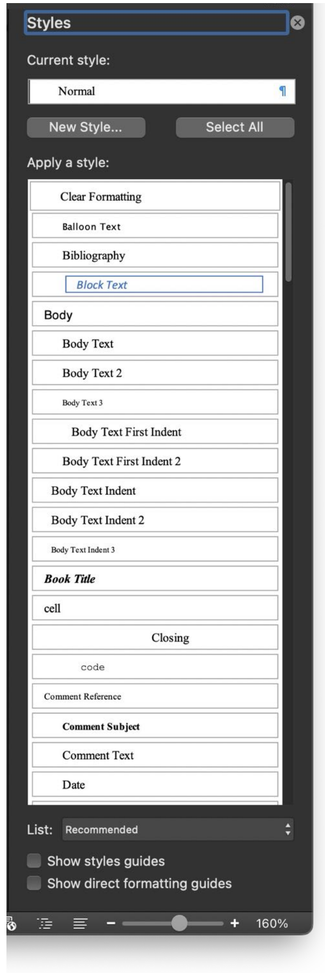
	Instrument	Substrate
Reification	Turn commands into instruments	Turn command effects into substrates
Polymorphism	Apply commands to multiple types of objects	Apply constraints to multiple types of objects
Reuse	Apply previous commands to objects	Apply previous effects to objects

Reification

Example: style





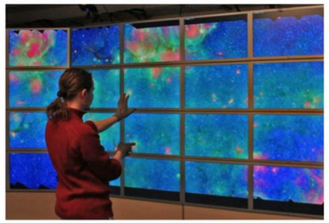


Polymorphism

Example: move instrument

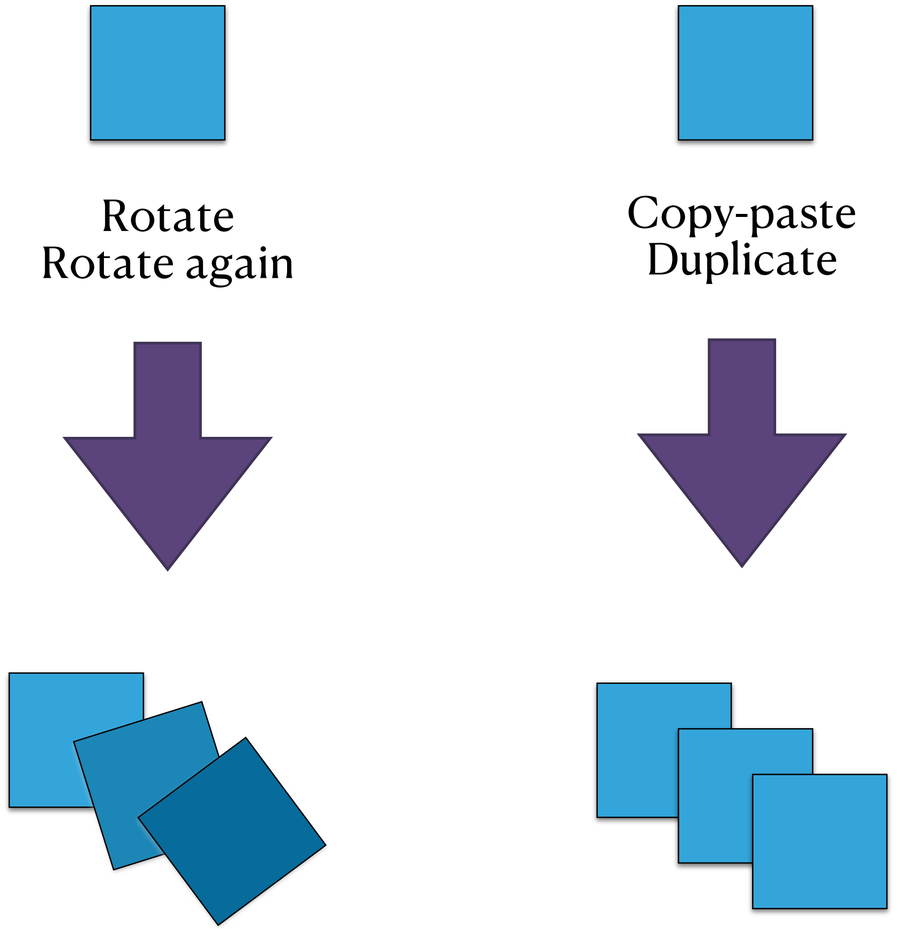
Invention

What is possible ?



Reuse

Example: create shapes



Generative Principles

Reification

Generate new objects

Polymorphism

Apply commands to different objects

Reuse

Apply previous commands to objects

Generative Principles

Reification

Generate new objects

ex: *Style* becomes an object

Polymorphism

Apply commands to different objects

ex: *Drag-&-drop* moves text, icons, shapes

Reuse

Apply previous commands to objects

ex: *Duplicate* not create from scratch

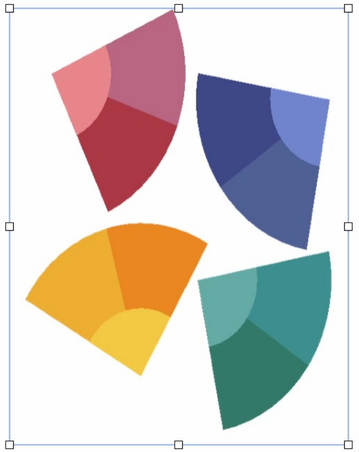
	Instrument	Substrate
Reification	Turn commands into instruments	Turn command effects into substrates
Polymorphism	Apply commands to multiple types of objects	Apply constraints to multiple types of objects
Reuse	Apply previous commands to objects	Apply previous effects to objects
Feedforward	Display available commands	Display potential constraints
Feedback	Display previously executed commands	Display existing constraints

Feedforward

Example: alignment guides

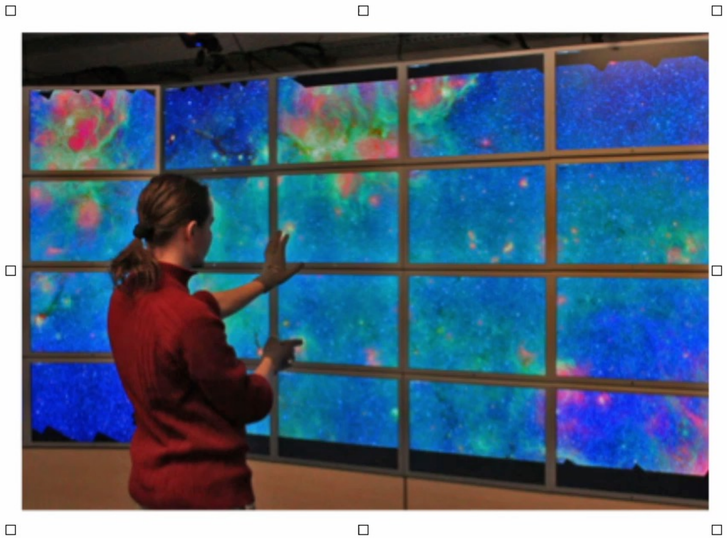
Invention

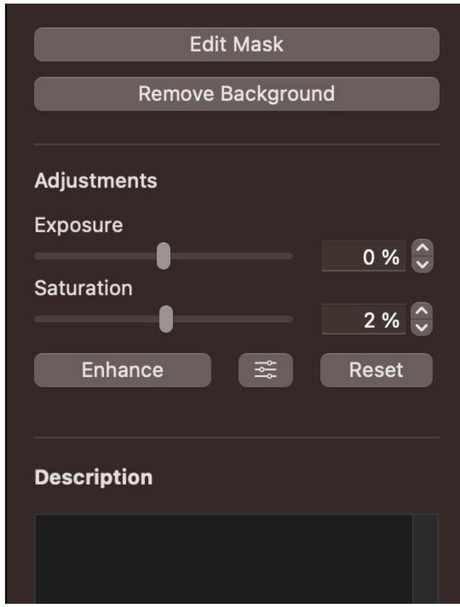
What is possible ?



Feedback

Example: image control





Generative Principles: Discovery

Feedforward

Tell user what is possible or is about to happen

ex: Preview *alignment*

Feedback

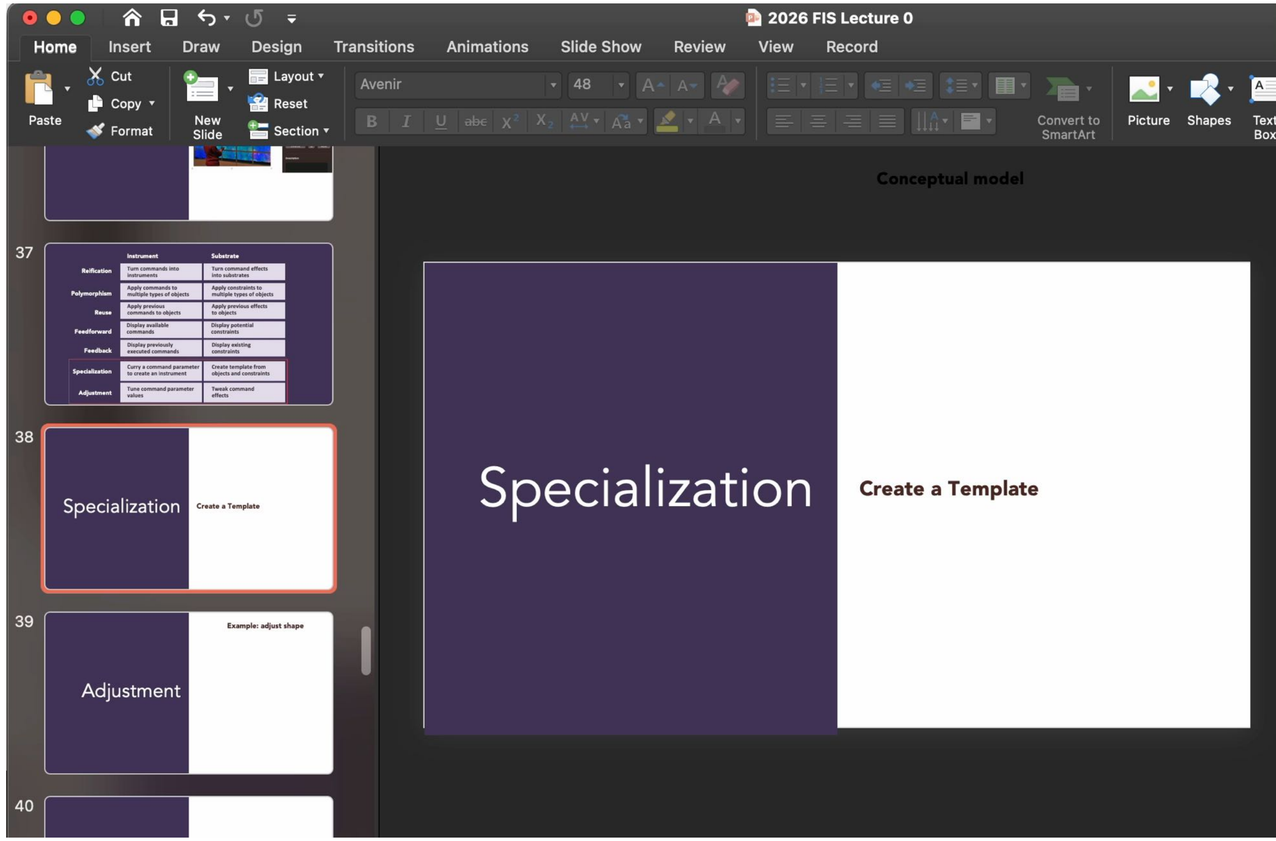
Tell user what is happening or has just happened

ex: See *effect* immediately

	Instrument	Substrate
Reification	Turn commands into instruments	Turn command effects into substrates
Polymorphism	Apply commands to multiple types of objects	Apply constraints to multiple types of objects
Reuse	Apply previous commands to objects	Apply previous effects to objects
Feedforward	Display available commands	Display potential constraints
Feedback	Display previously executed commands	Display existing constraints
Specialization	Curry a command parameter to create an instrument	Create template from objects and constraints
Adjustment	Tune command parameter values	Tweak command effects

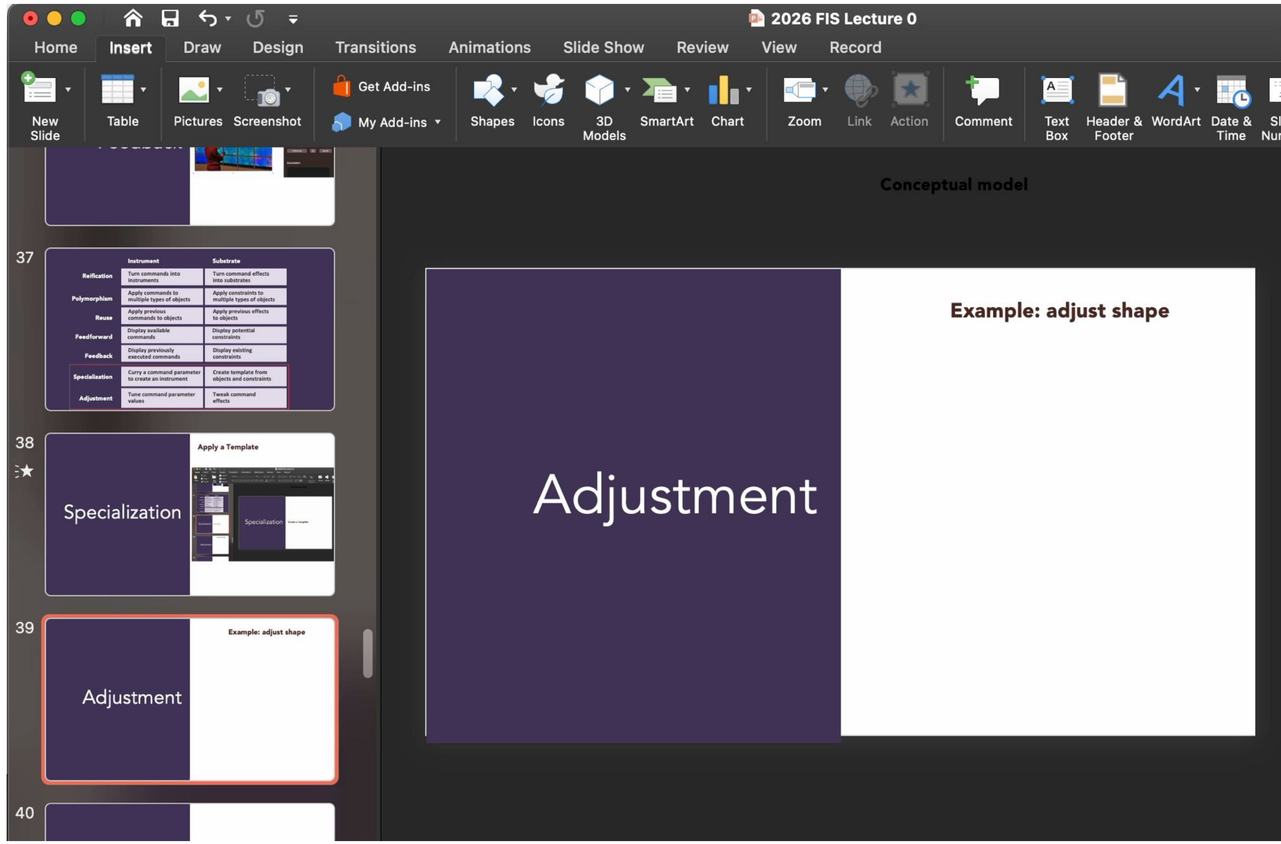
Specialization

Apply a Template



Adjustment

Example: adjust shape



Generative Principles: Appropriation

Specialization

Let user customize the application

ex: Create and apply a *template*

Adjustment

Let user fine-tune command parameters

ex: Control *size* and *position*

Alignment example

Menu-based alignment is cumbersome…

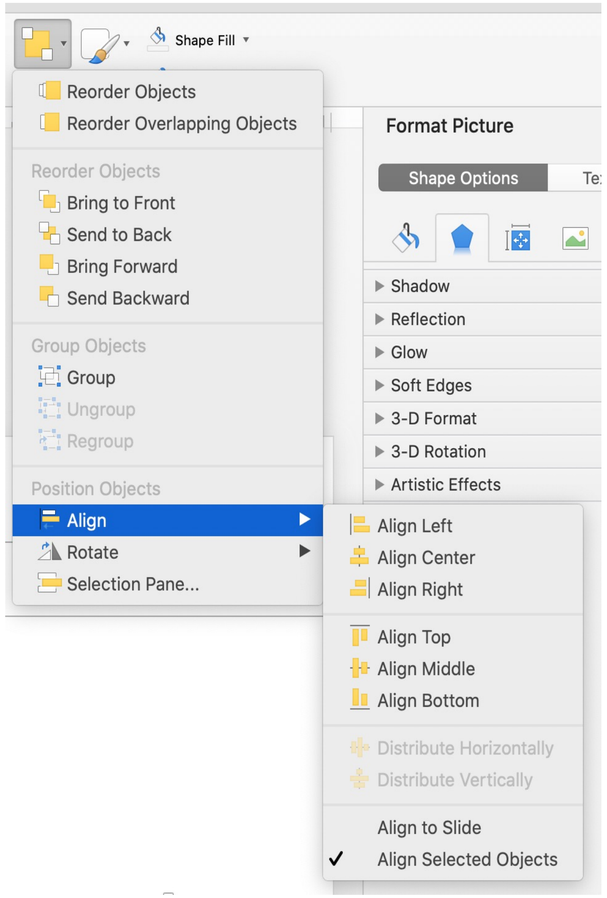
Hierarchical menu

Hard to find correct alignment

Fitts' law issue

Tricky to click on the correct item

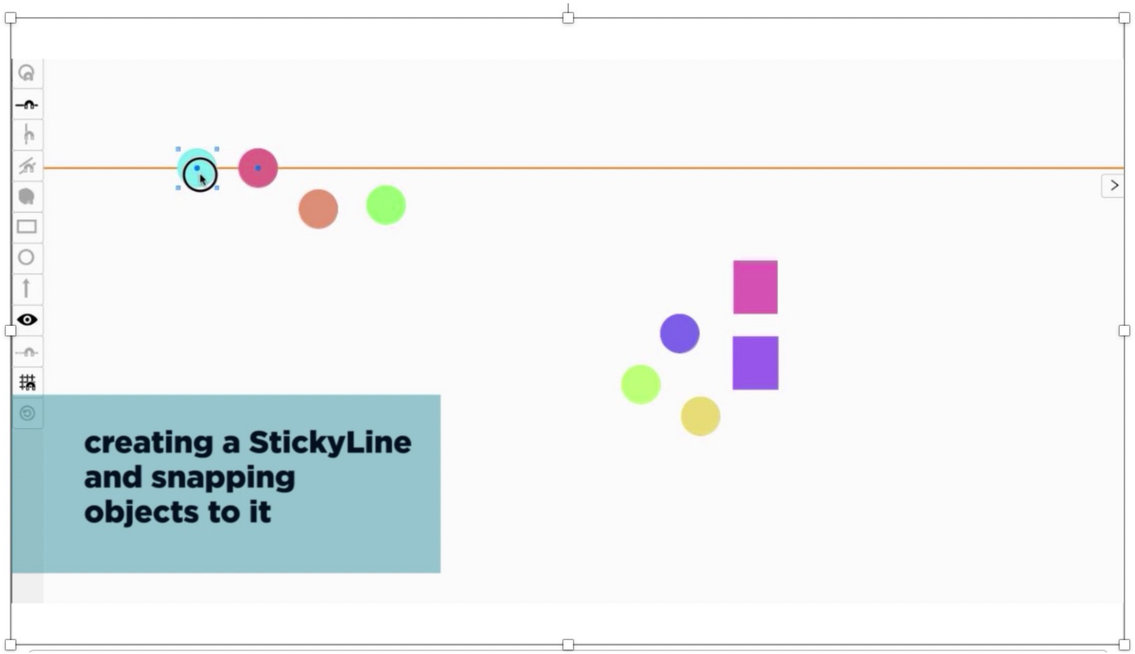
Every new aligment requires navigating the menus again



Stickylines

Ciolfi et al. (2016)

What if the aligment command is reified into an interactive alignment tool?



Key principles

Reification

Transforms commands that disappear into interactive tools

Polymorphism

Applies tools to multiple types of conceptual objects

Reuse

Takes advantage of previous actions and past results

Beaudouin-Lafon (2000), Beaudouin-Lafon & Mackay (2000)

Instrumental interaction

Generative design strategy

Reification

First:
Identify a command that disappears after being used once

Then: Make it persist
Make it interactive
Make it a tool

Example:
StickyLines reifies the alignment command

Instrumental interaction

Beyond Snapping

Persistent, Tweakable Alignment and Distribution with StickyLines

Marianela Ciolfi Felice Nolwenn Maudet Wendy Mackay Michel Beaudouin-Lafon

LRI, Université Paris-Sud, CNRS, Inria, Université Paris-Saclay
Orsay, France

Example: Create a route

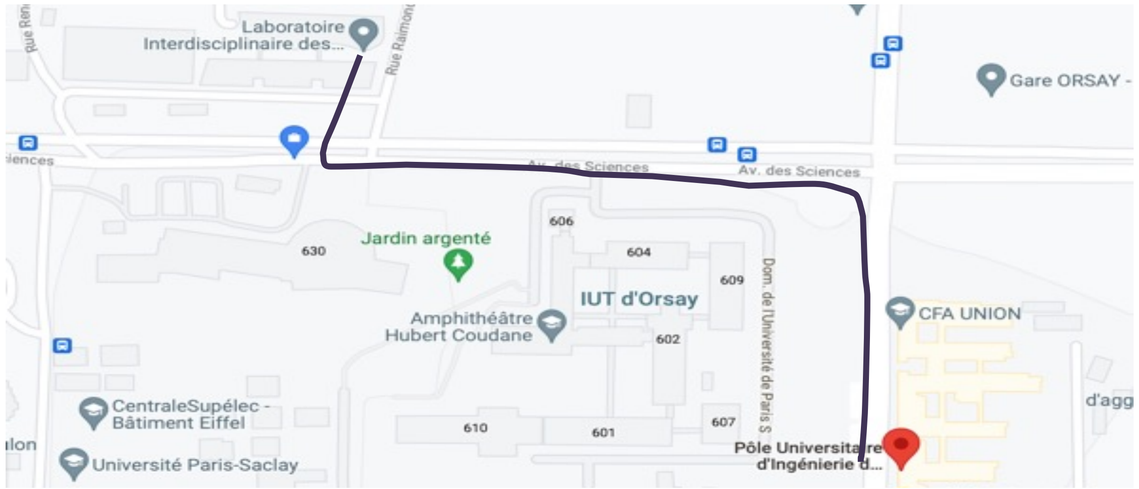
Command

“Show me how to go to the C.S. building”

Result

The route appears on the map

But if I use another command, it disappears



Reify a route on a map

Example: Create a route

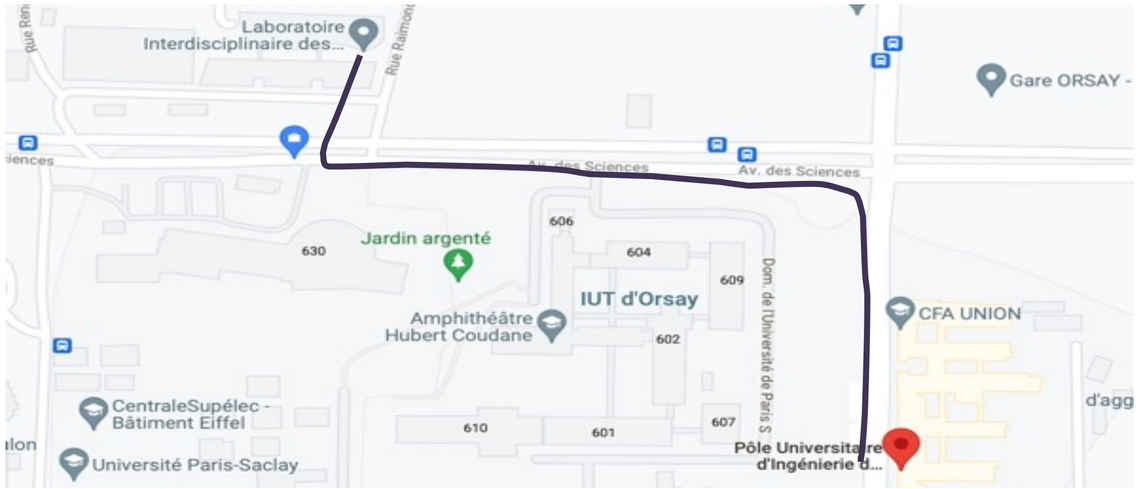
Reified command

“Show me how to go to the C.S. building”

Result

The route persists as an **interactive object**

Modify it, Copy it, Share it, Reuse it…



Reify a route on a map

			Generative Theories of Interaction	Instruments Command focus	Substrates Effect focus	
Instrumental Interaction	Instruments	Reification		**Transform** a command into an embedded, in-hand or remote instrument	**Transform** an effect into a substrate: Contains and structures objects of interst, manages internal constraints among objects and supports external dependencies	**Interaction Substrates**
		Polymorphism		**Apply** a command to multiple types of objects	**Apply** a constraint to multiple types of objects	
		Reuse		**Apply**previous commands to objects	**Apply** previous effects to objects	
Co-Adaptation	Discovery	Feedforward		**Display** available commands	**Display** potential constraints	**Reciprocal Co-Adaptation**
		Feedback		**Display** previously executed commands	**Display** existing constraints	
	Appropriation	Specialization		**Curry** a command paramenter to create a new instrument	Create a **Template** from objects and or constraints	
		Adjustment		**Tune** command paramenter values	**Tweak** command effects	

Thank you!