Instrumental Interaction

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Inria INVENTORS FOR THE DIGITAL WORLD

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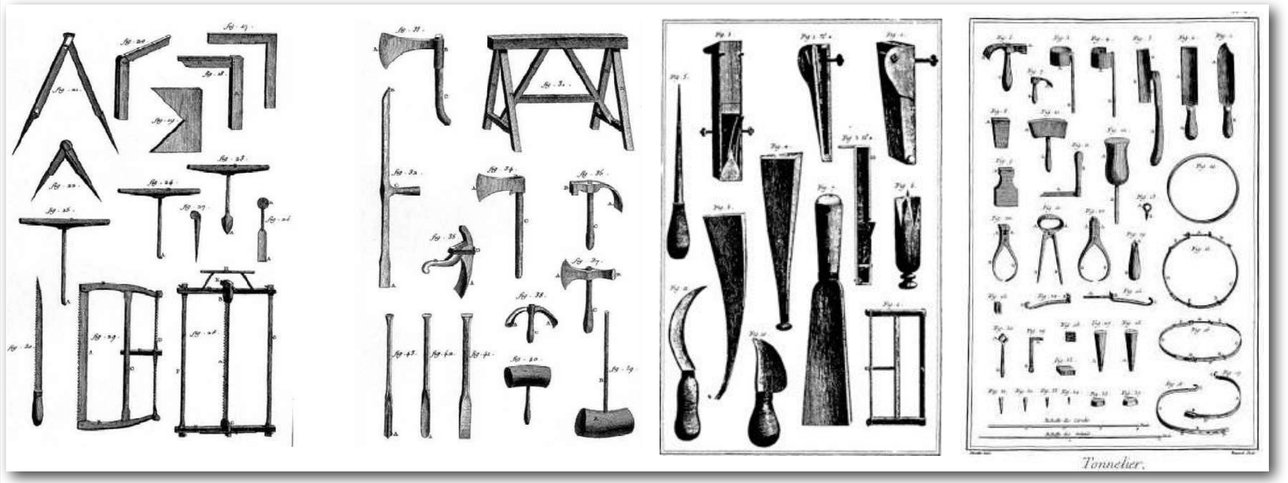
Interaction in the real world is mediated by tools

Humans are the only species that creates tools to shape their environment

Traces of tools have been found as far back as 3.3 million years

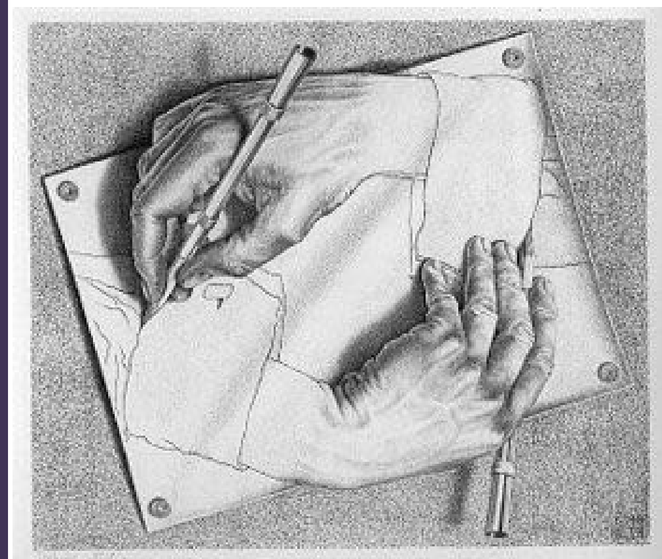


L'encyclopédie - Diderot & d'Alembert, 1751-1772

2001, A Space Odyssey

Sonia Harmand, anthropologist

We use tools to shape our environment

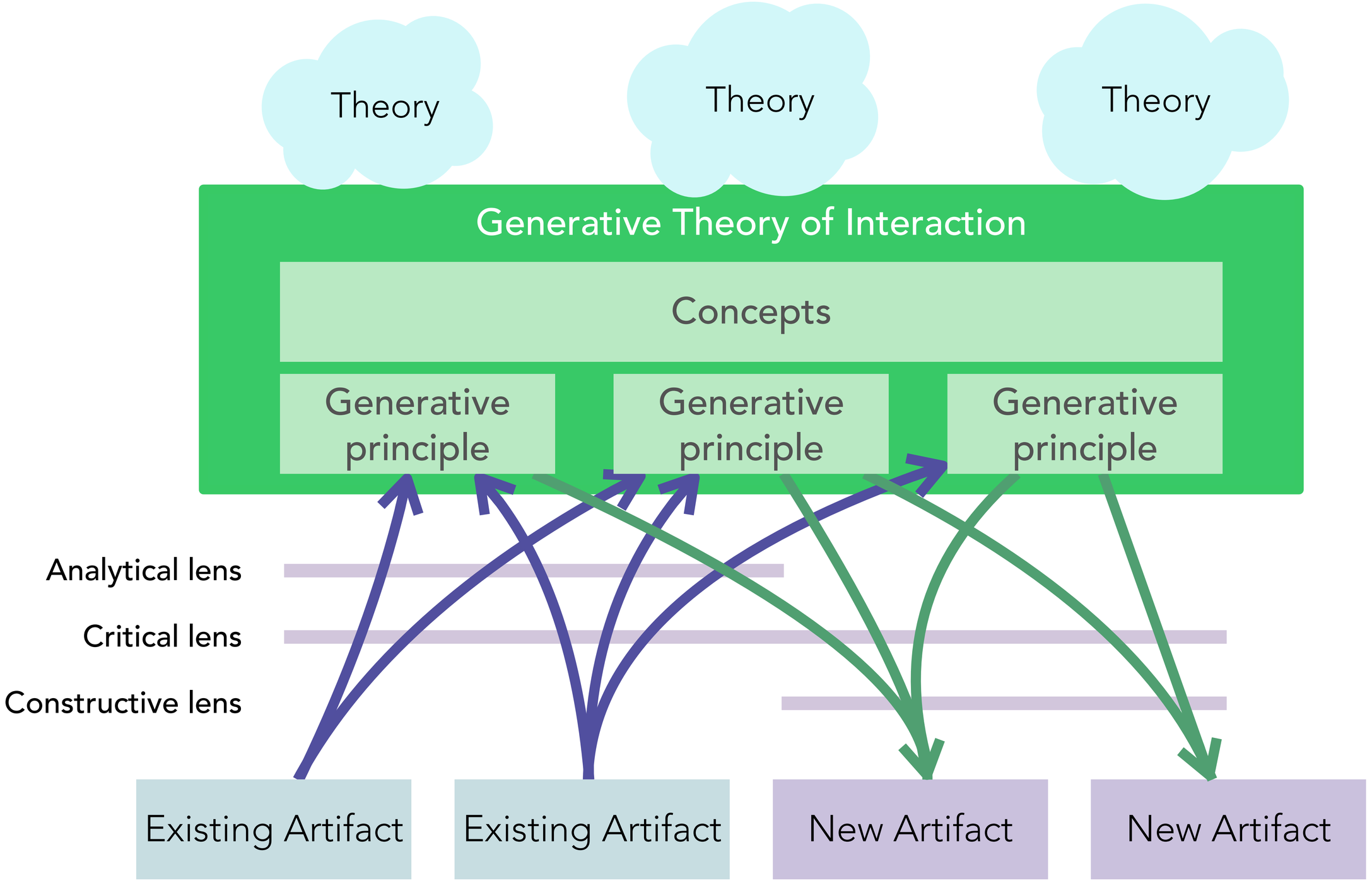


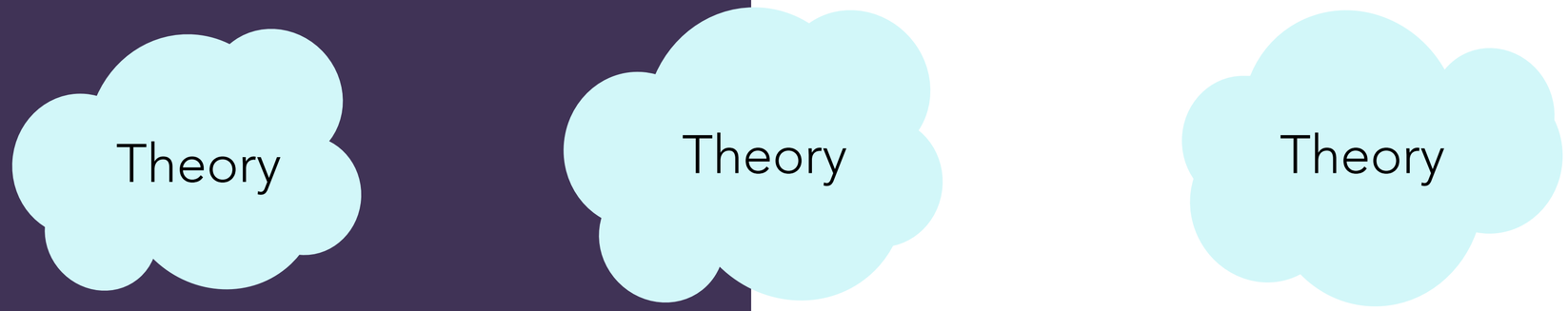
We use tools to shape our environment

We learn to use tools (and instruments) even if it is difficult

Can we leverage our ability to
create and use tools
to interact with the digital world?

“Computers are like
a bicycle for our minds”
Steve Jobs


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



A bit of psychology

Theory of affordances

Perceptual learning

Technical reasoning

Exercise 1

What can you do with a pencil?

List as many uses as you can (at least **20**!)

Exercise 1

What can you do with a pencil?

List as many uses as you can (at least **20**!)

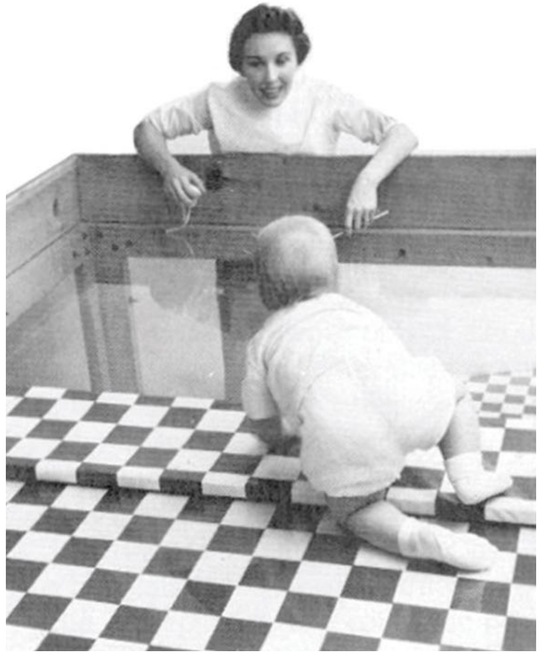
What are the relevant properties for each use?

James Gibson

Affordances

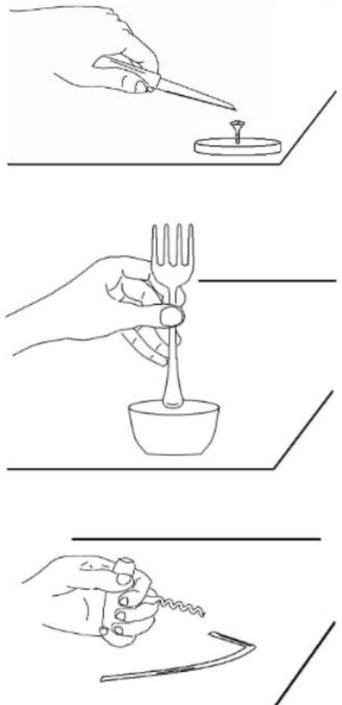
Eleanor Gibson

Perceptual learning

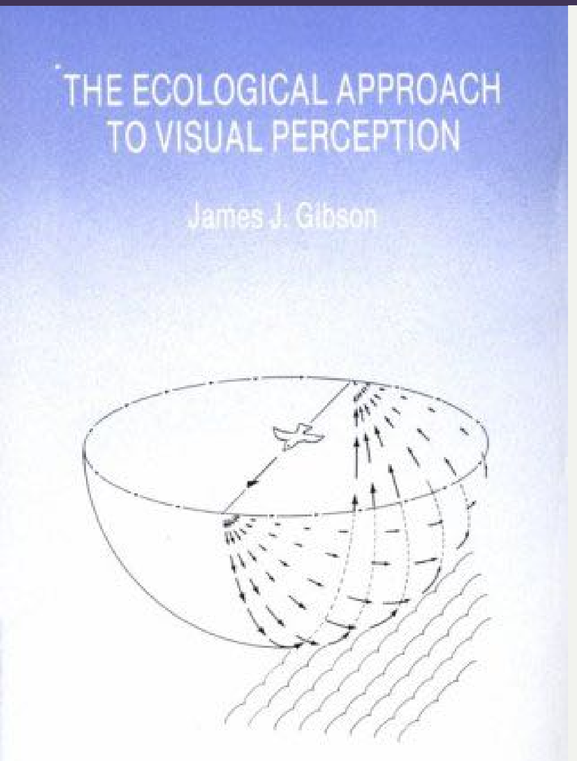


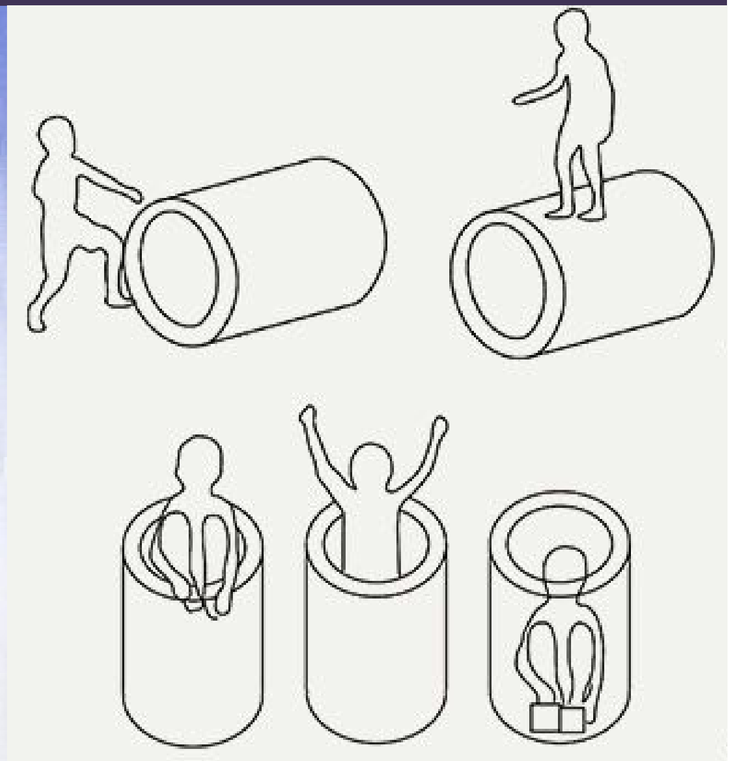
François Osiurak

Technical reasoning



Theory of affordances





James Gibson

"The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill"

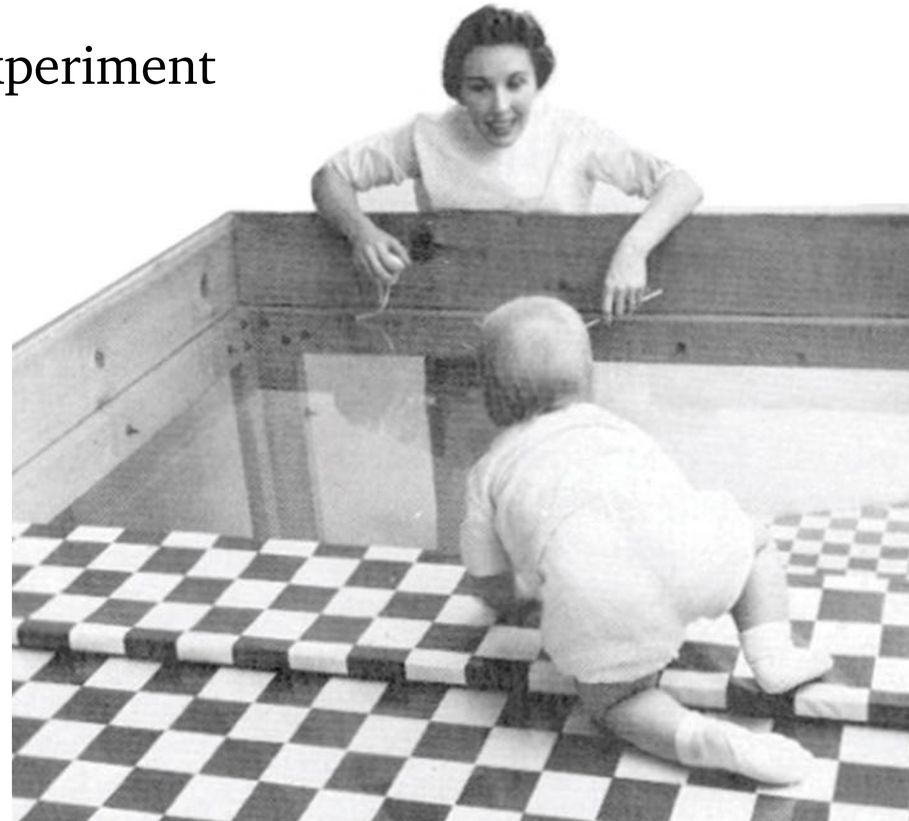
"a specific combination of the properties of its substance and its surfaces taken with reference to an animal"

Perceptual learning

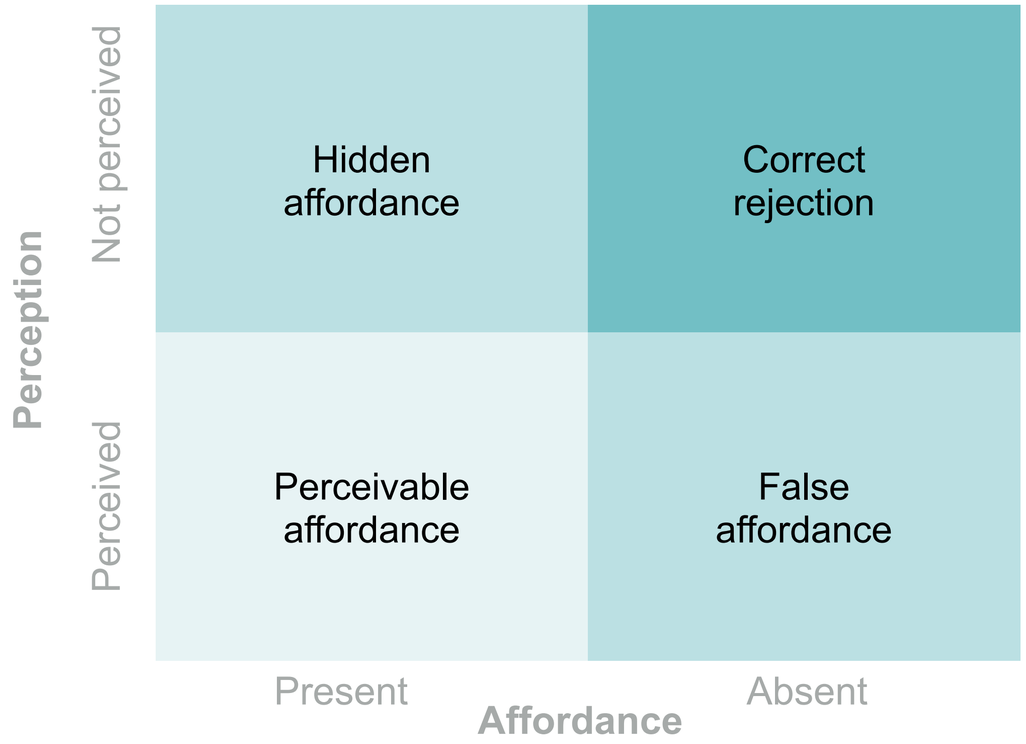
Eleanor Gibson

“We perceive to learn,
as well as learn to perceive”

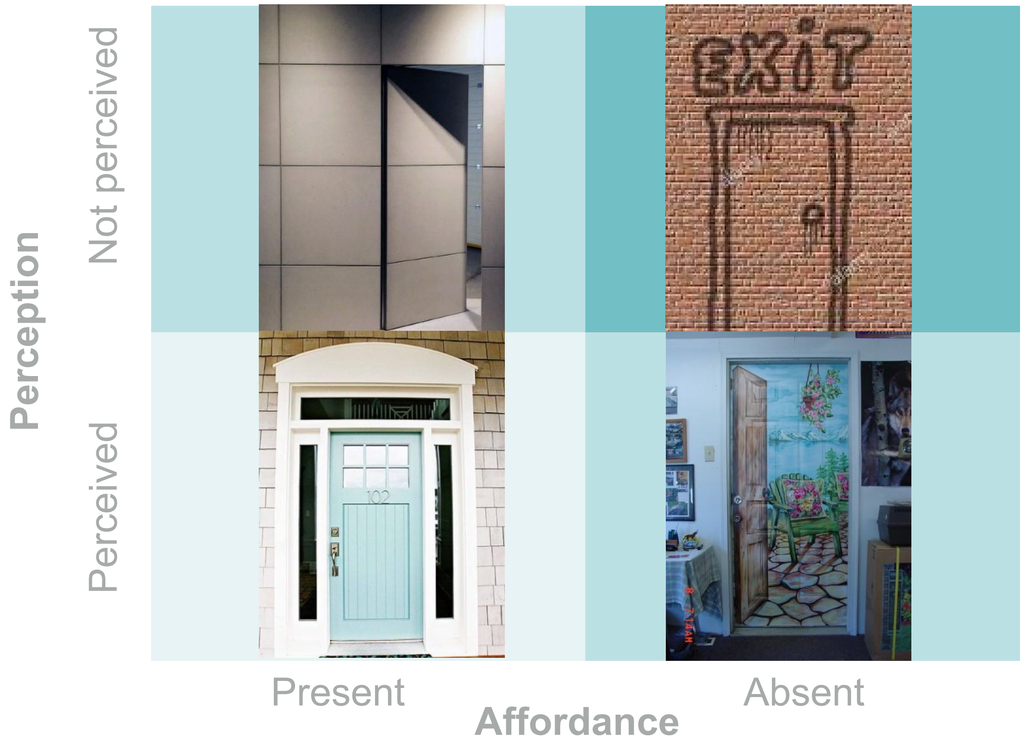
Visual cliff experiment



Perception of affordances

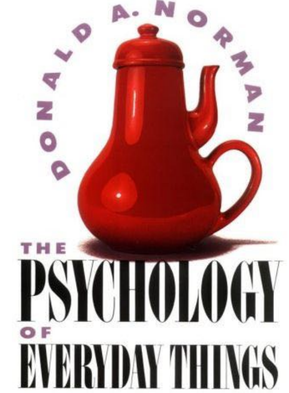


Perception of affordances

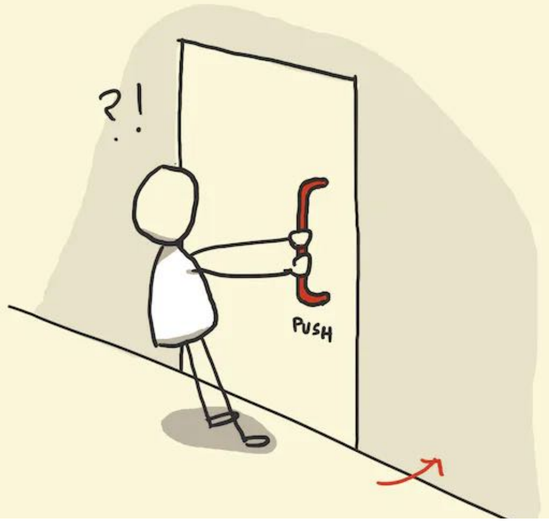


Signifiers

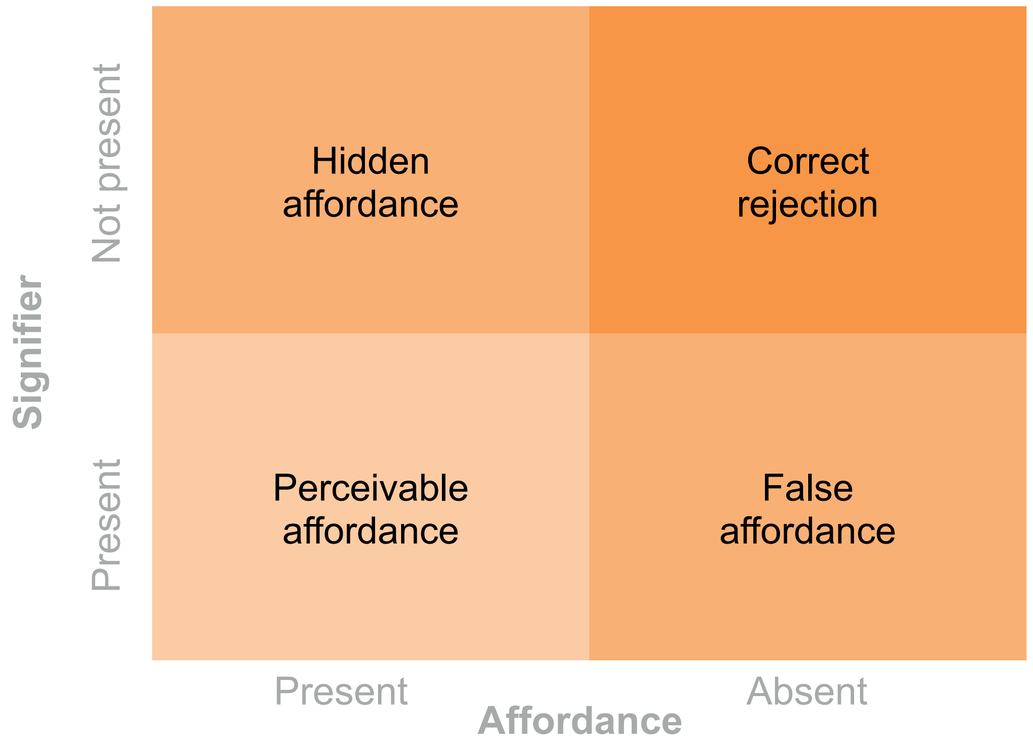
Don Norman



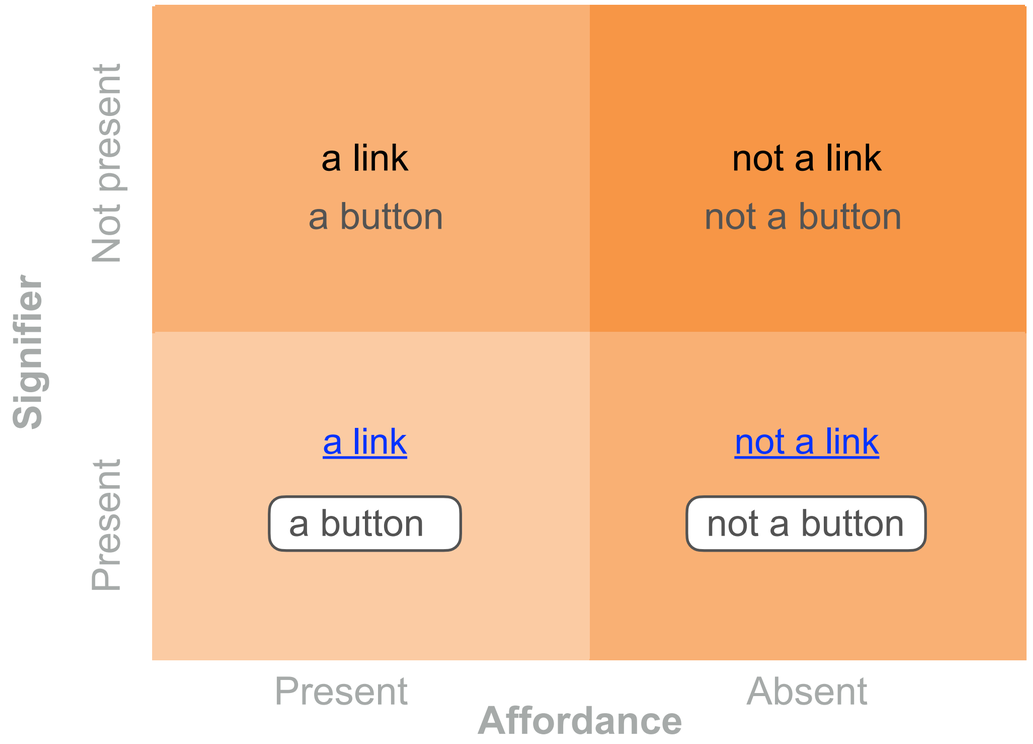
"Affordances define what actions are possible. Signifiers specify how people discover those possibilities: signifiers are signs, perceptible signals of what can be done.
Signifiers are of far more importance to designers than are affordances."



Affordances vs. signifiers



Affordances vs. signifiers

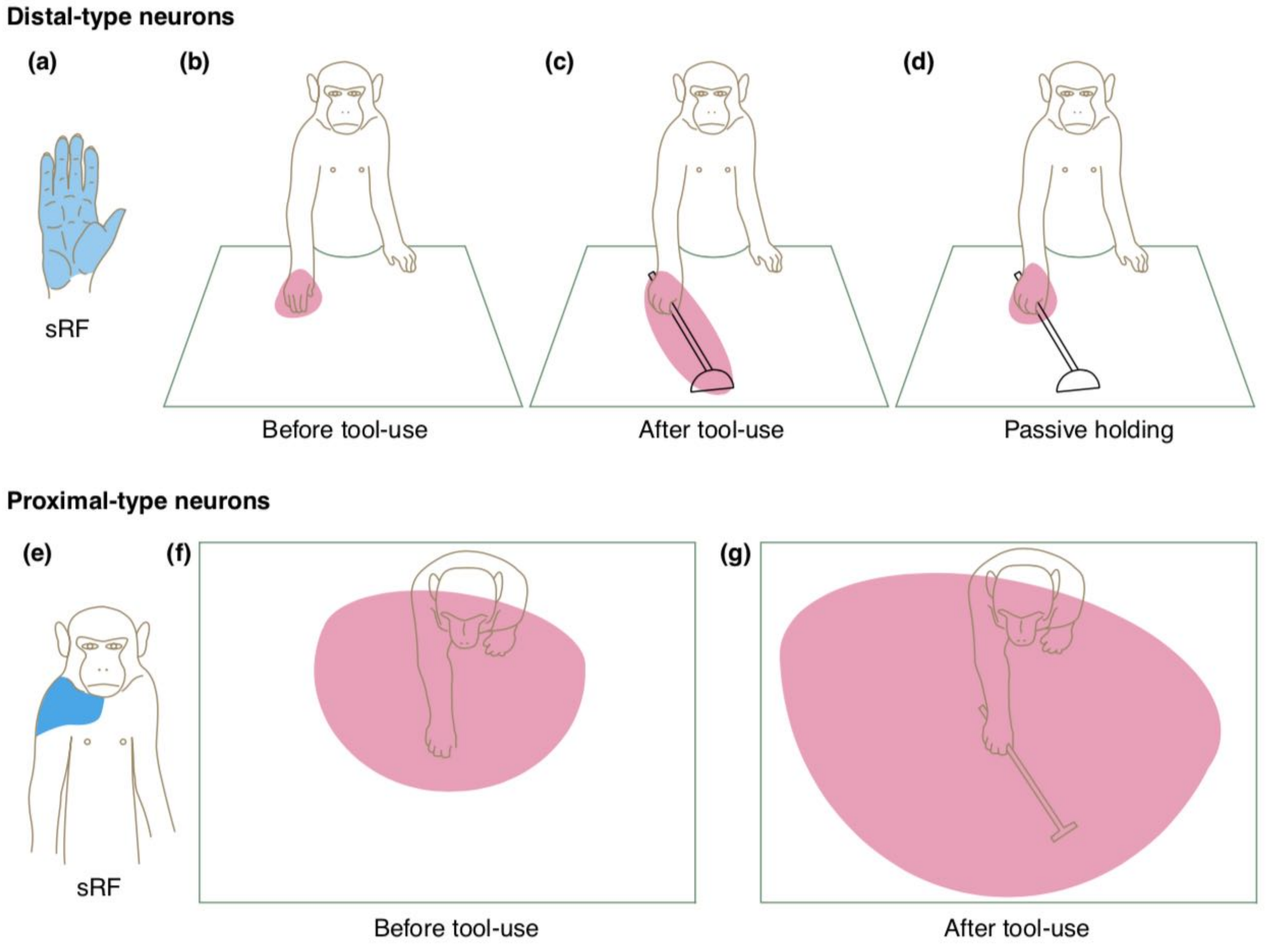


Affordances and tools

James Gibson

“When in use, a tool is a sort of extension of the hand, almost an attachment to it or a part of the user's own body”

Tool use redefines the body schema



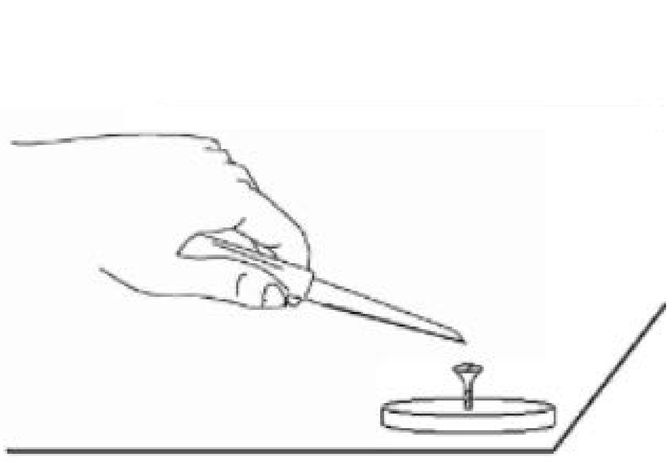
Iriki,A. et al. (1996) **Coding of modified body schema during tool use by macaque postcentral neurones**. *Neuroreport* 7, 2325–2330.

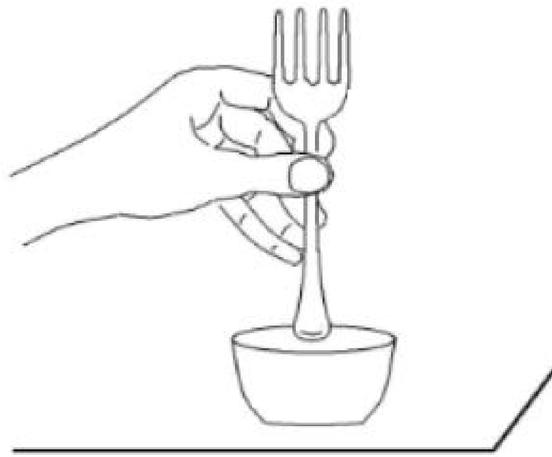
Technical reasoning

François Osiurak

Use of objects as tools based
on their properties and
abstract technical principles

Simulation of the physical mechanism
to solve a problem





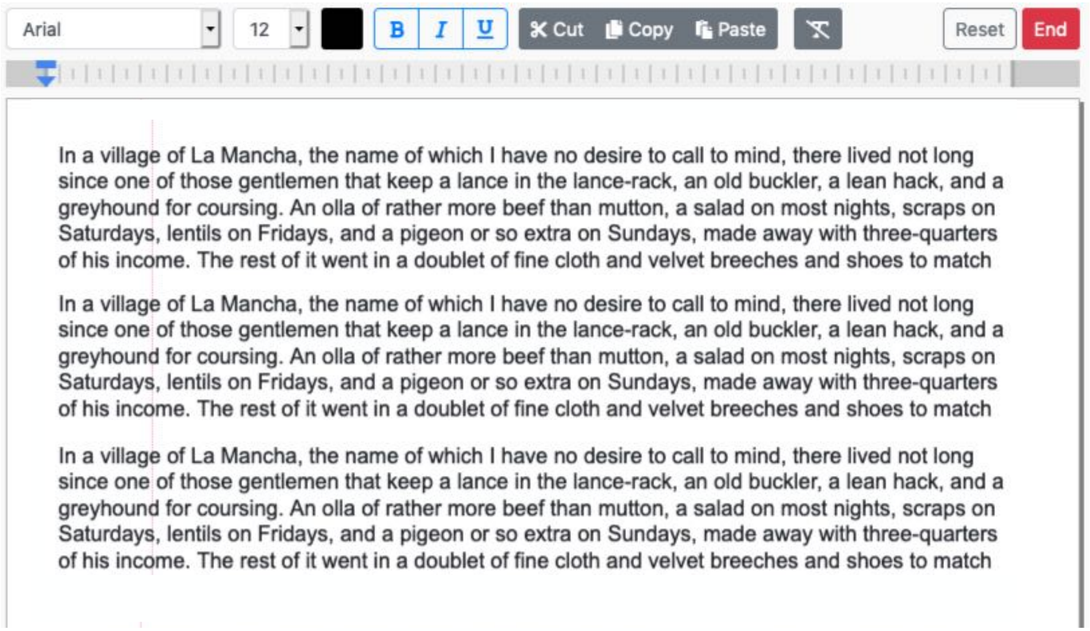
Appropriation of everyday objects as tools

Is technical reasoning at play when we interact with digital tools?

Exploring Technical Reasoning in Digital Tool Use

Interaction Knowledge: Understanding the ‘Mechanics’ of Digital Tools

Renom, Caramiaux & Beaudouin-Lafon, CHI 22 & CHI 23



In a village of L
since one of those gentle
greyhound for coursing. A
Saturdays, lentils on Frid

Exercise #2

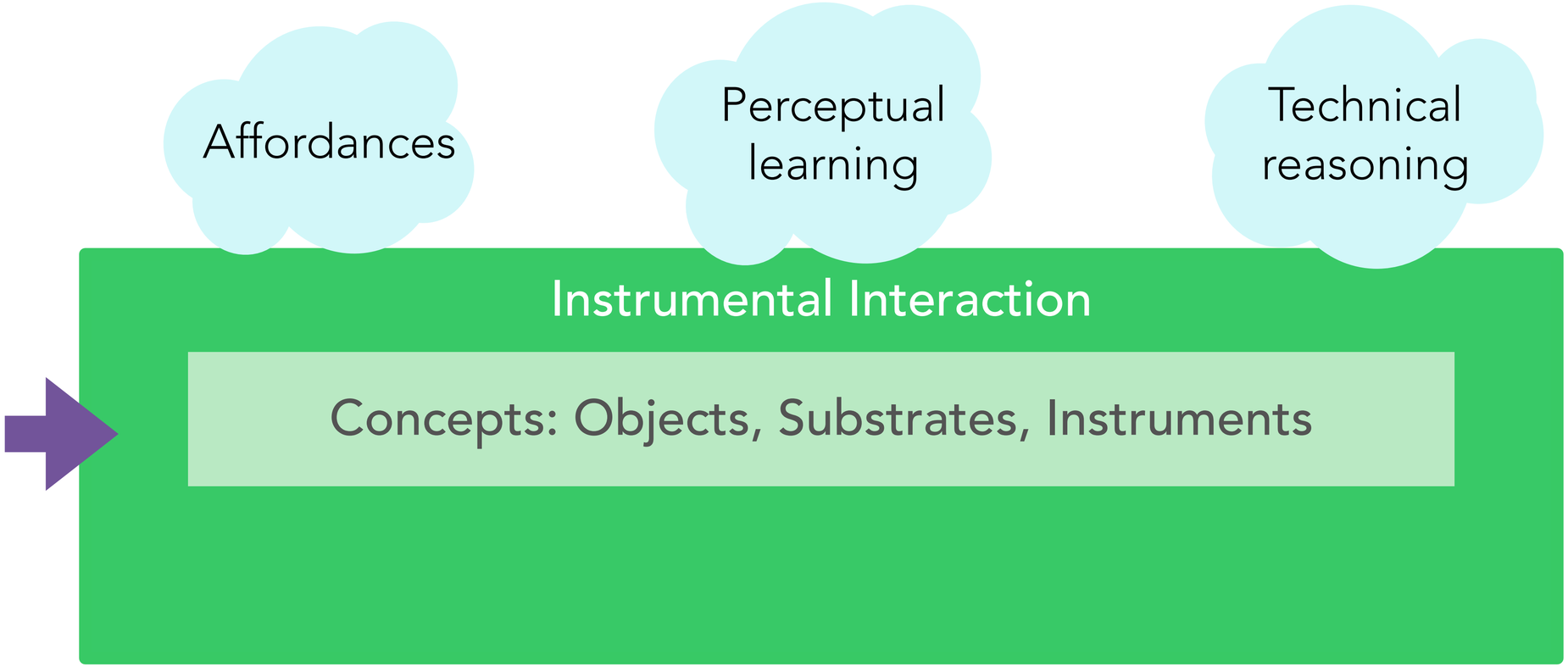
Open a document in a word processor (Microsoft Word, Apple Pages, Google doc…).

Paste or type a short paragraph of text, and make 6 copies of it.

Indent the first line of the first paragraph.

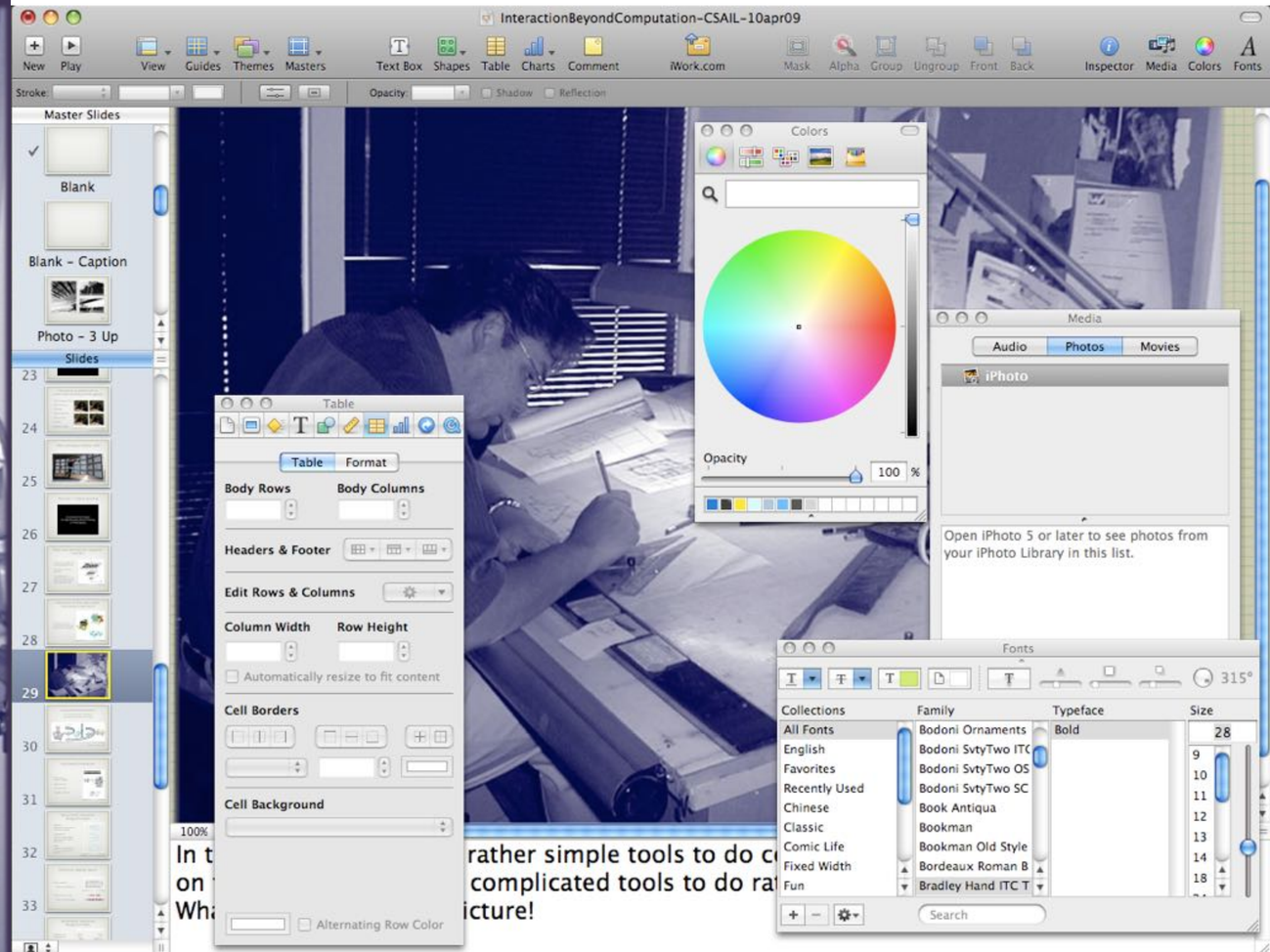
Then indent the first line of the second paragraph *with a different method than for the first one.*

Then try again with the third paragraph, etc.


Affordances
Perceptual learning
Technical reasoning
Instrumental Interaction
Concepts: Objects, Substrates, Instruments

Physical interaction

Digital interaction



Digital objects

The objects of interest to the user

Described by their
- properties
- representations

The same object may have multiple representations

Substrate

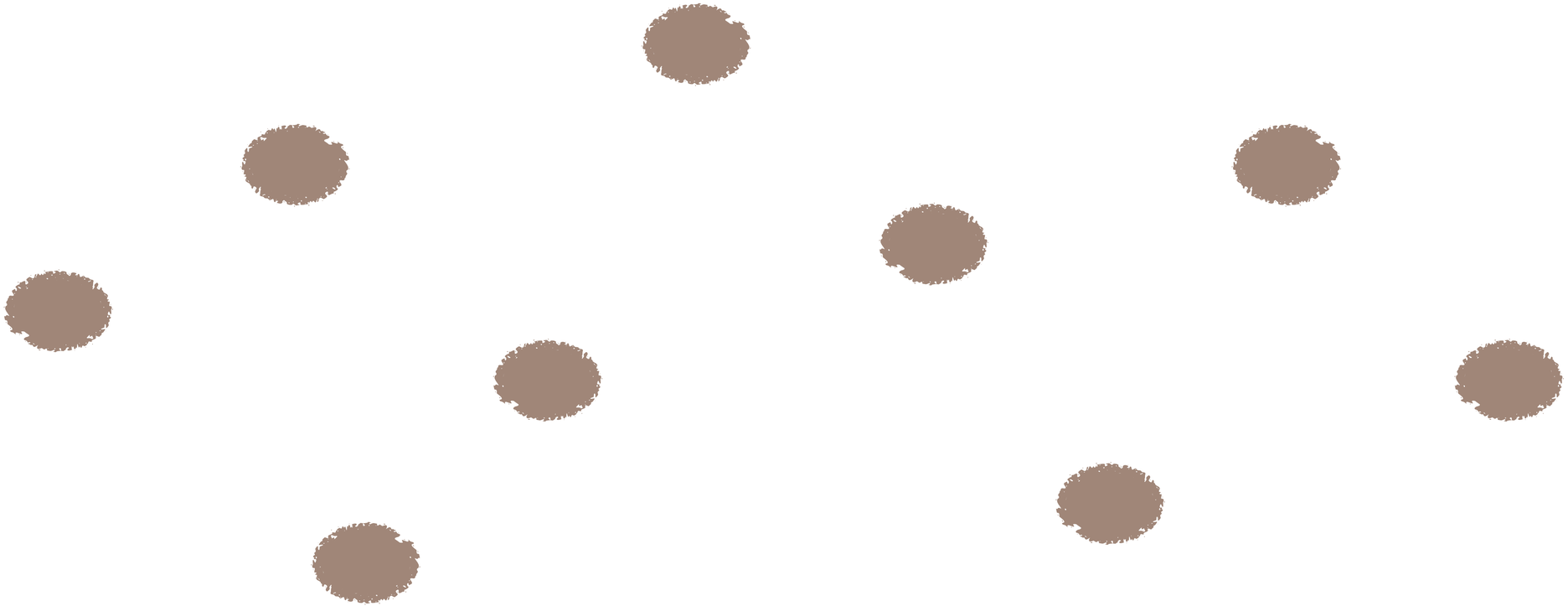
The context (or container) for the objects of interest

Gives meaning to their content

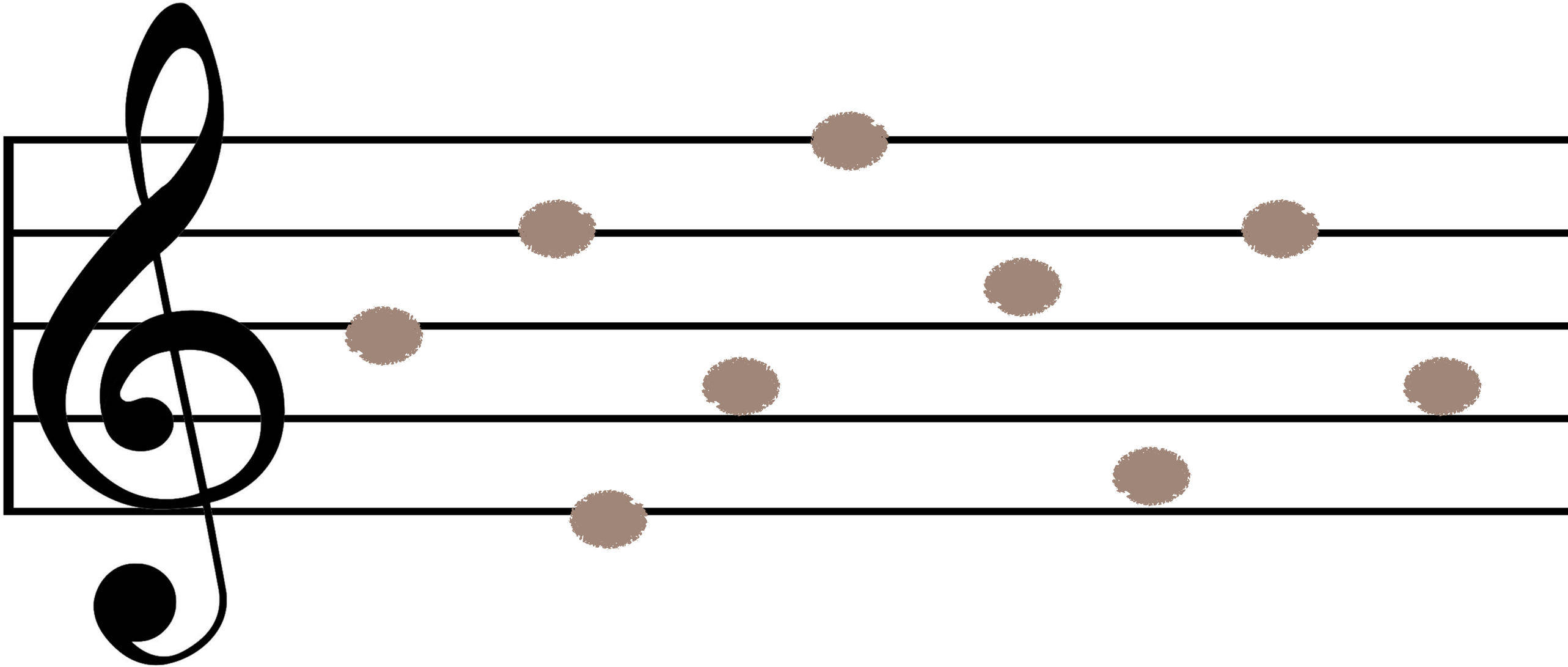
May impose constraints and relationships on the content

Substrates are themselves objects, and can be contained in other substrates

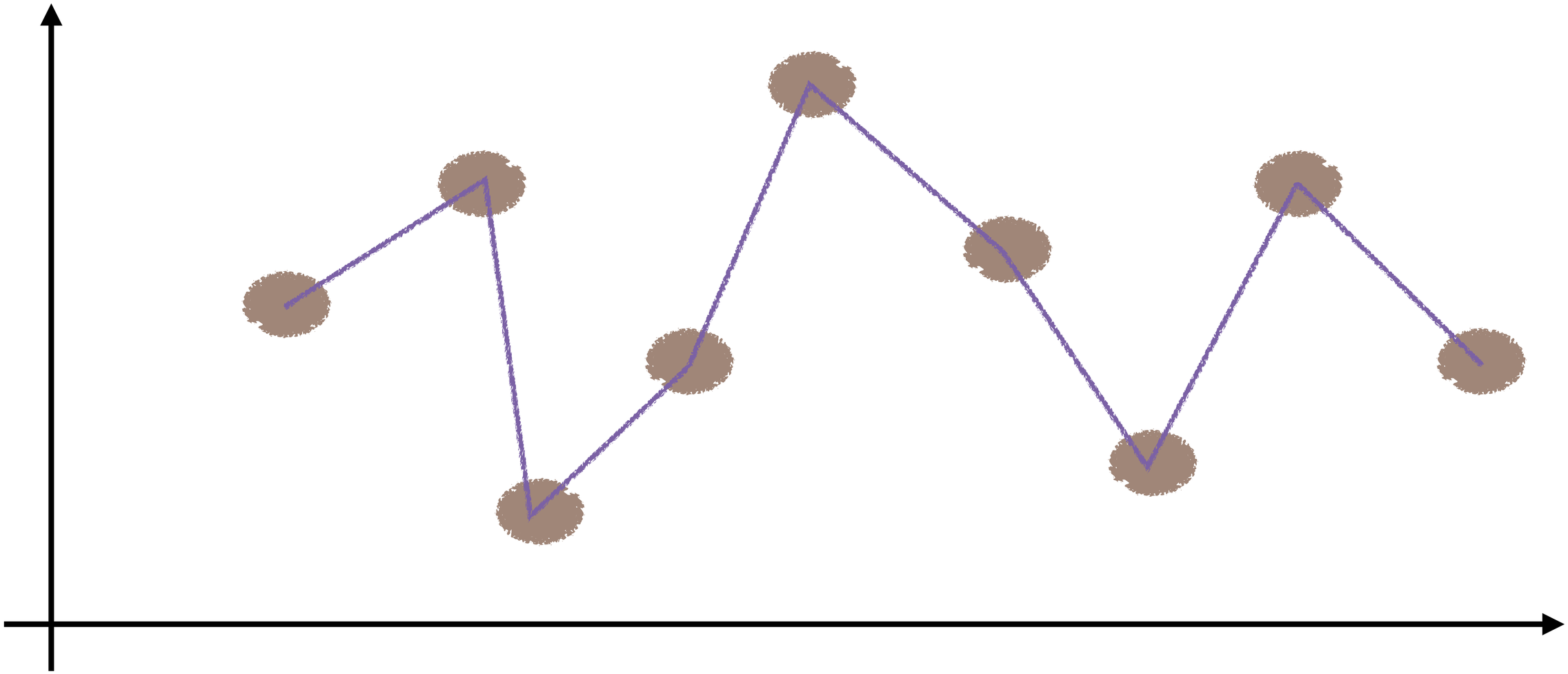
Substrates give meaning



Substrates give meaning

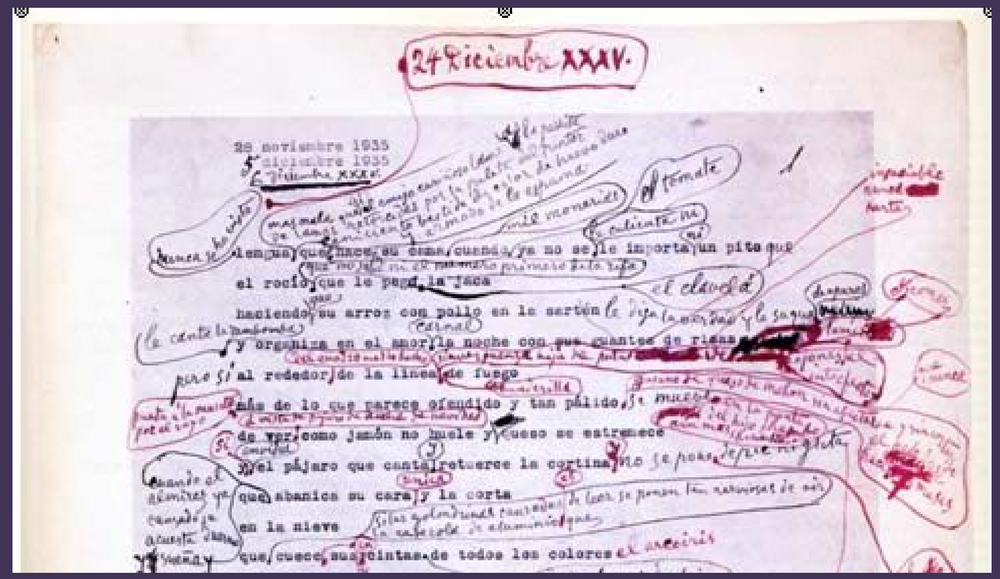


Substrates give meaning

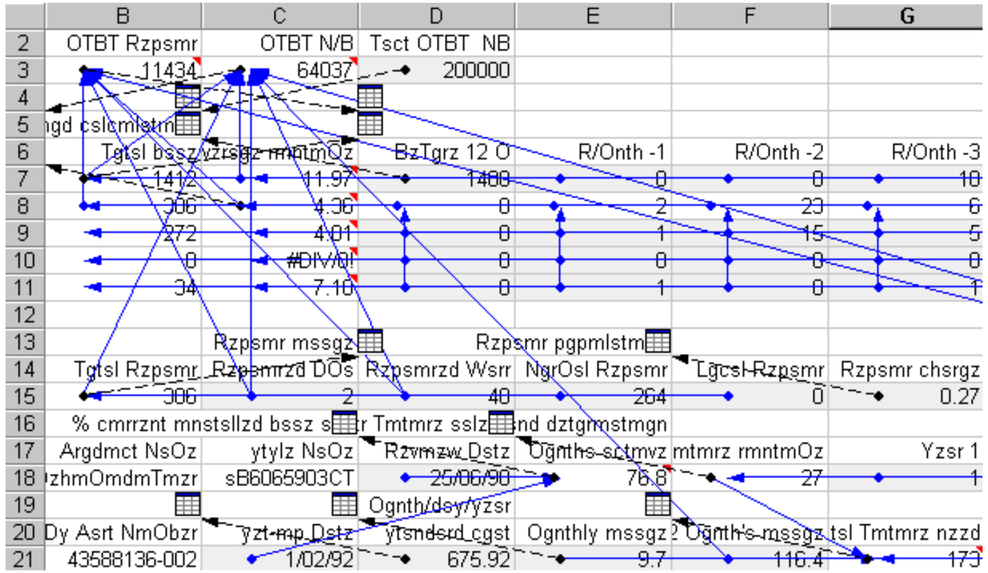


Substrates give meaning

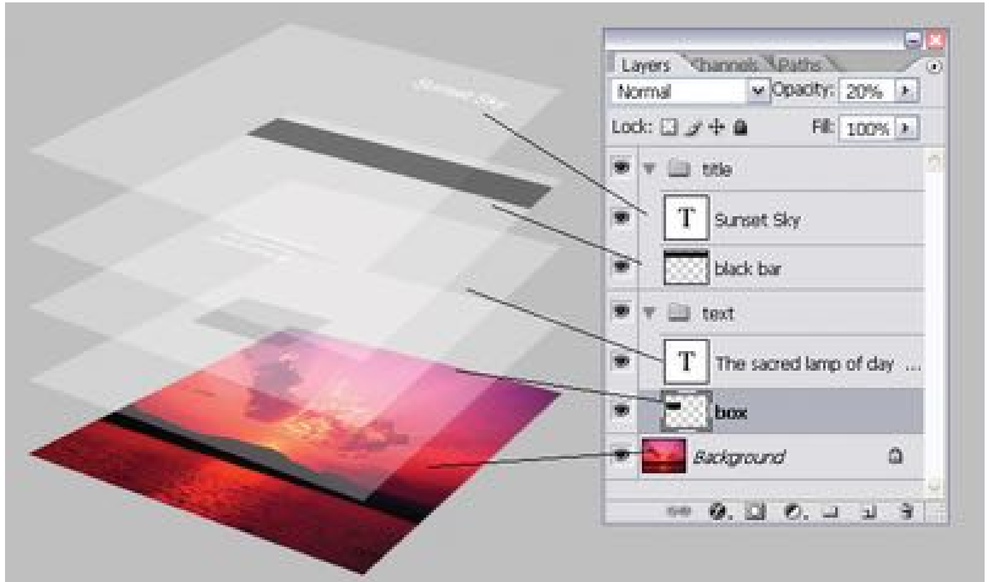
Physical substrates



Digital substrates



	B	C	D	E	F	G
2	OTBT Rzpsmr	OTBT N/B	Tsct OTBT NB			
3	11434	64037	200000			
4						
5						
6	Tgtsl bssz vzrsgz rmntmOz		BzTgrz 12 O	R/Onth -1	R/Onth -2	R/Onth -3
7	1412	11.97	1488	0	0	10
8	306	4.36	0	2	23	6
9	272	4.01	0	1	15	5
10	0	#DIV/0!	0	0	0	0
11	34	7.16	0	1	0	1
12						
13		Rzpsmr mssgz		Rzpsmr pgpmlstm		
14	Tgtsl Rzpsmr	Rzpsmrzd DOs	Rzpsmrzd Wsrr	NgrOsl Rzpsmr	Lgcsl Rzpsmr	Rzpsmr chsrgz
15	306	2	40	264	0	0.27
16	% cmrrznt mnstsllzd bssz s	r Tmtmrz ssl	nd dztgrnstmgn			
17	Argdmct NsOz	ytylz NsOz	Rzvmzw Dstz	Ogmths sctmvz mtmrz rmntmOz		Yzsr 1
18	zhmOmdmTmzr	sB6065903CT	25/06/90	76.8	27	1
19			Ognth/dsy/yzsr			
20	Dy Asrt NmObzr	yzt-mp Dstz	ytsndsud cgst	Ognthly mssgz	Ogmth's mssgz	tsl Tmtmrz nzzd
21	43588136-002	1/02/92	675.92	9.7	116.4	173

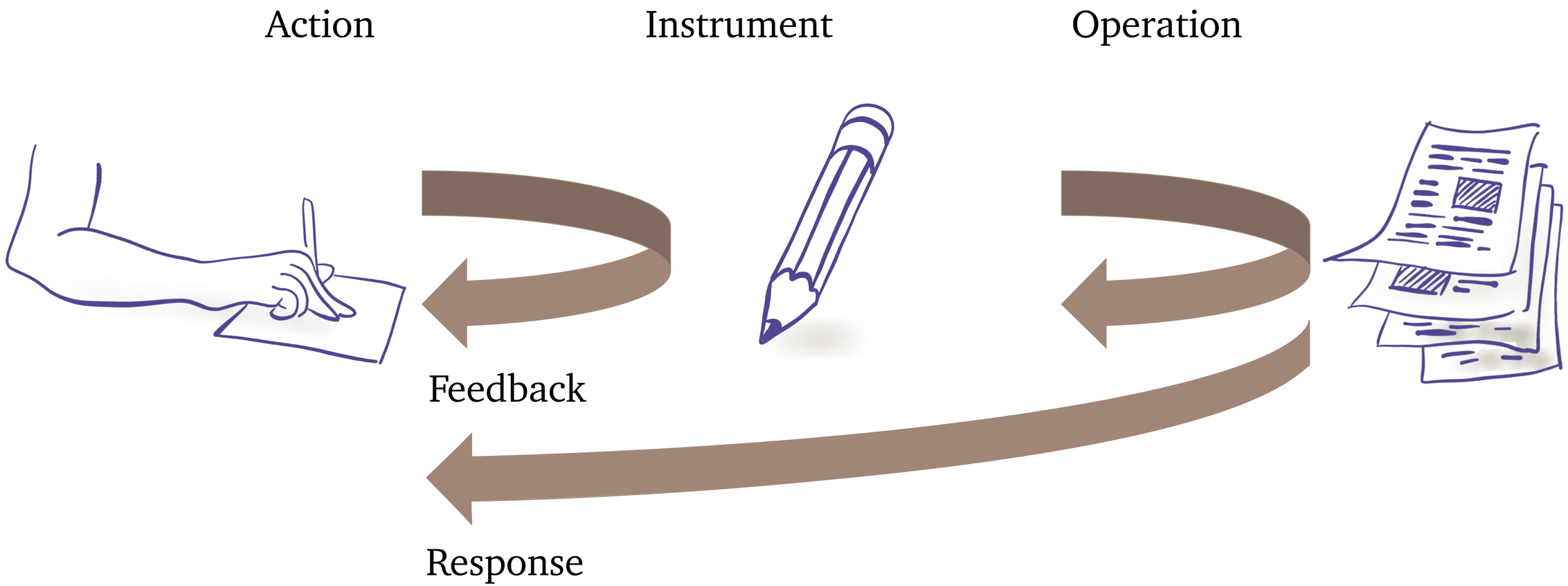


Instrument

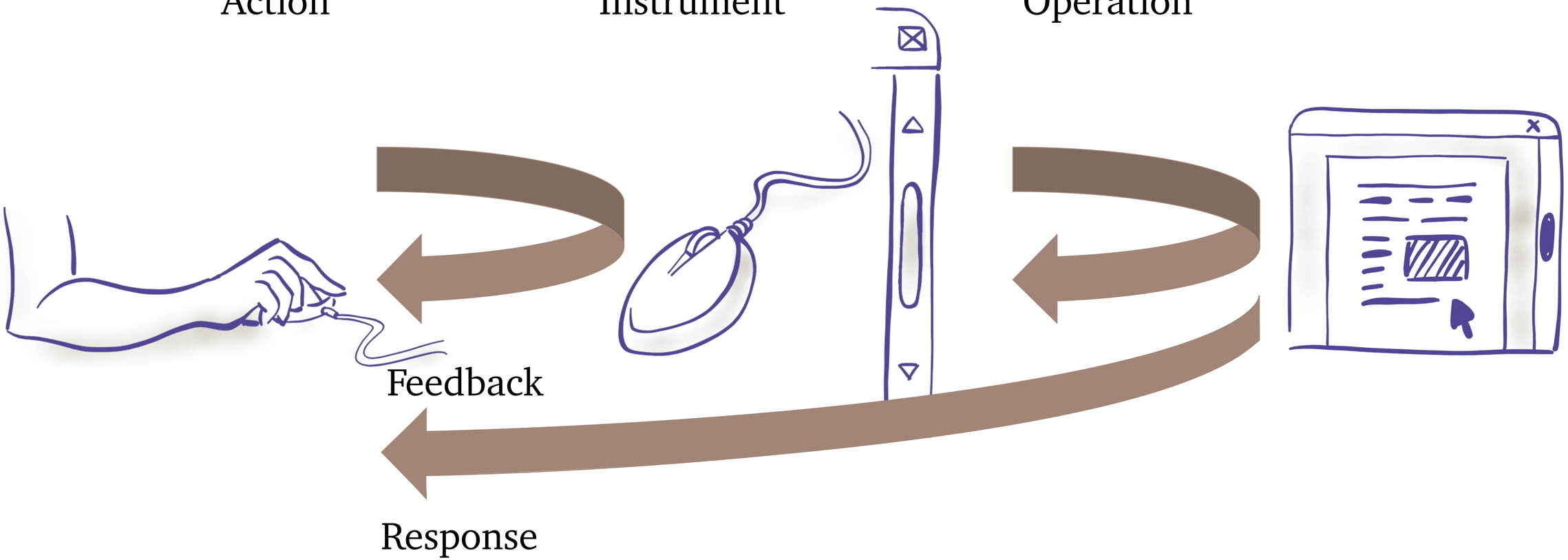
The means by which one manipulates digital objects and substrates

Shift from “indirect” manipulation through menus and buttons to interaction through digital tools/instruments

Instrumental interaction



Instrumental interaction



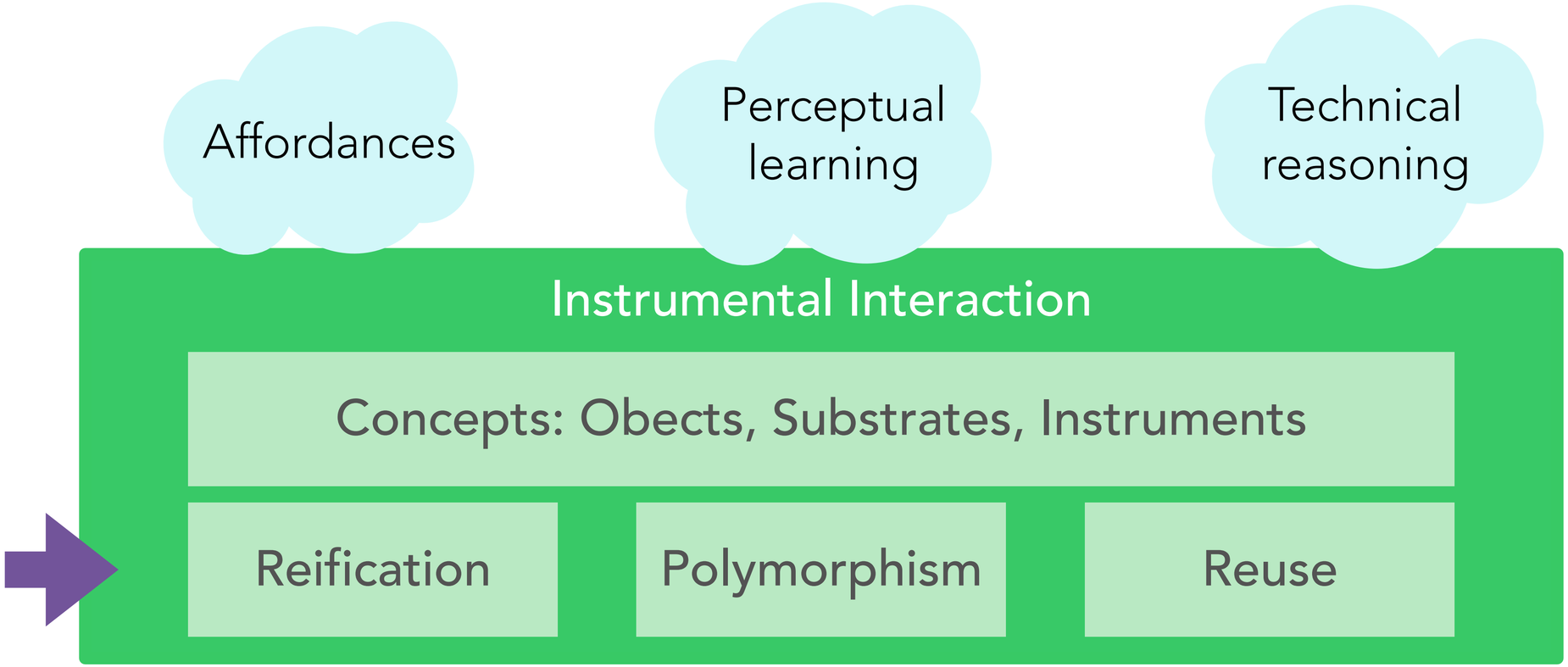
Instrument

Interacts with objects within a substrate

Interacts with a substrate

Interacts with the relationships among objects in a substrate

Can create/delete/change properties of substrates, objects, relationships, … and other instruments


Affordances
Perceptual learning
Technical reasoning
Instrumental Interaction
Concepts: Obects, Substrates, Instruments
Reification
Polymorphism
Reuse

Generative principles

Reification

Transform abstractions into objects

Polymorphism

Make objects more generic

Reuse

Reuse objects and actions

Reification

Transform abstractions into objects that can be manipulated by users

Identify the objects of interest

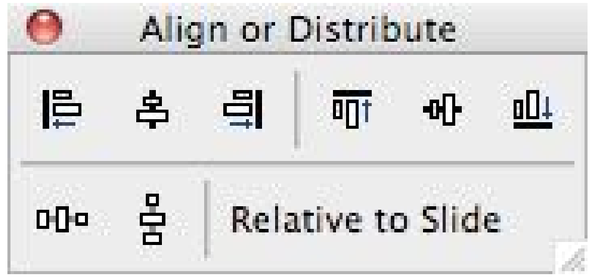
Turn commands into instruments

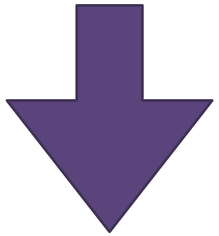
Turn relationships into substrates

Reification

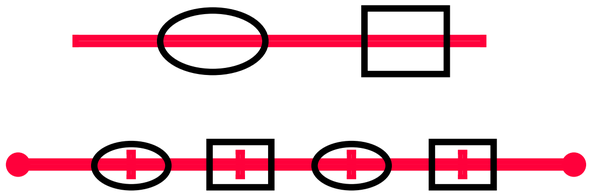
Example: alignment

Command





Instrument



Polymorphism

Make objects more generic

Manipulate objects based on their properties rather than their type

Make instruments work with objects of different types (based on their properties)

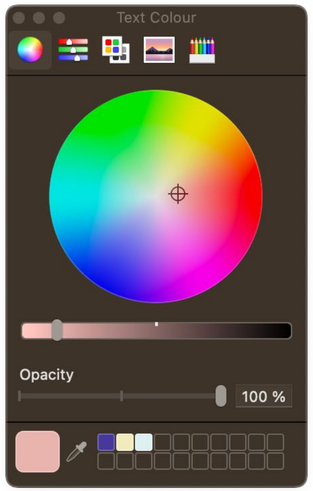
Make substrates hold objects of different types and relationships work with the properties of objects

Polymorphism

Example: color picker

Highlight | Fill | Brush | Border

Same color tool for all



Reuse

Reuse objects and actions

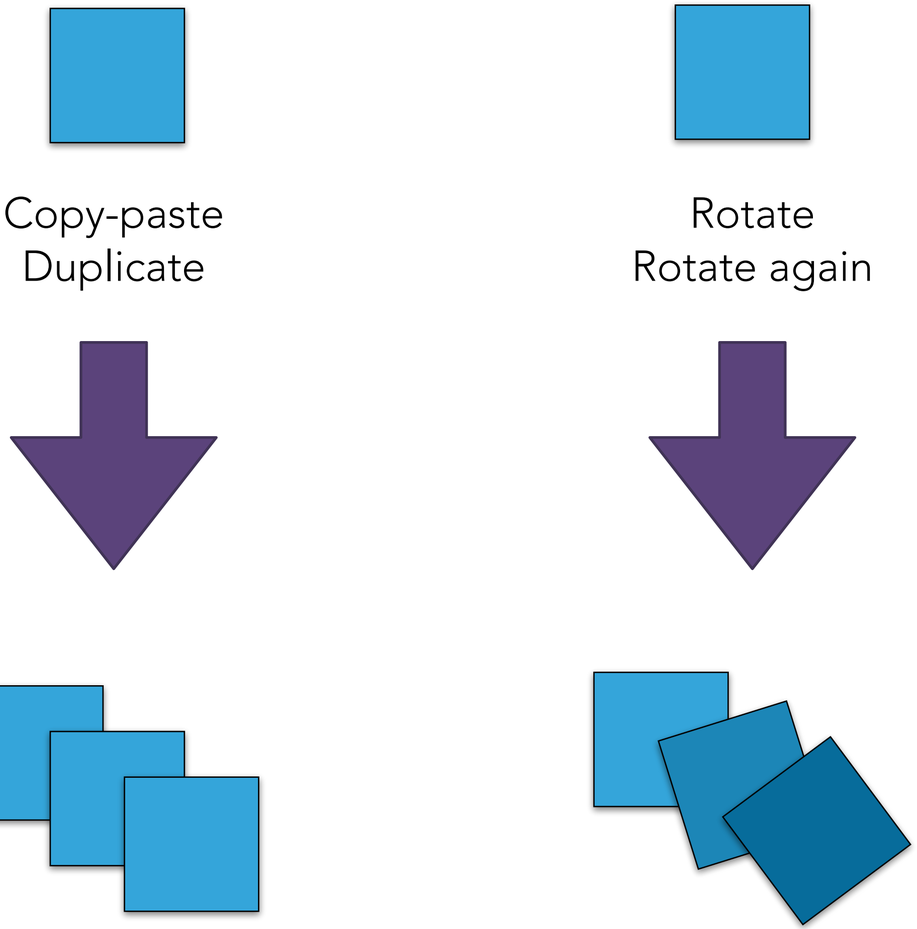
Objects can be reused and modified

Relationships can be reused and modified

Actions can be reused and modified

Reuse

Example: create shapes



Principles work together

Reification

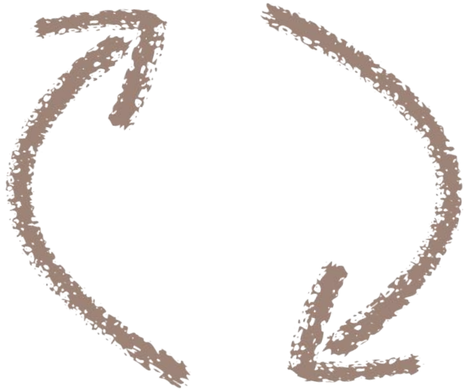
Extend the notion of what constitutes an object

Polymorphism

Handle multiple types of objects

Reuse

Three design principles



Capture and reuse previous interactions

Instruments: input focus

Transform command input into an interactive tool

Substrates: output focus

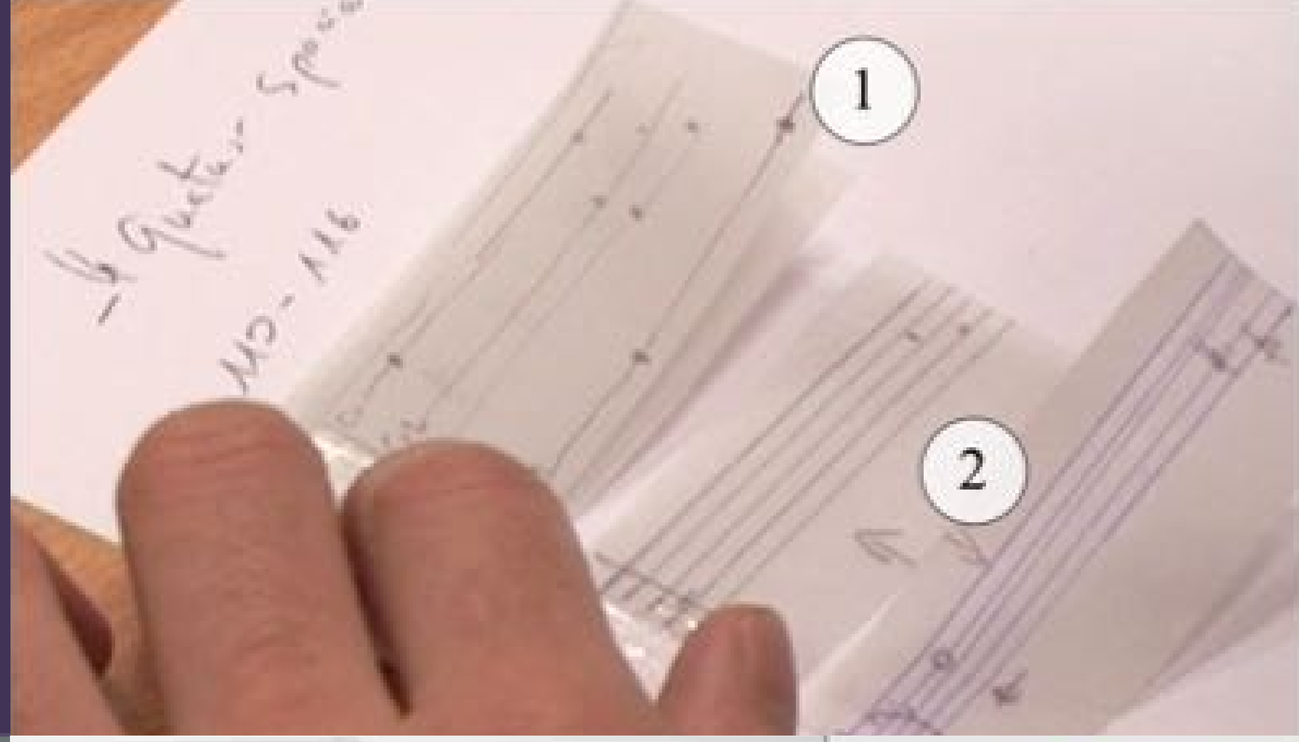
Preserve output relationships to form an interactive structure

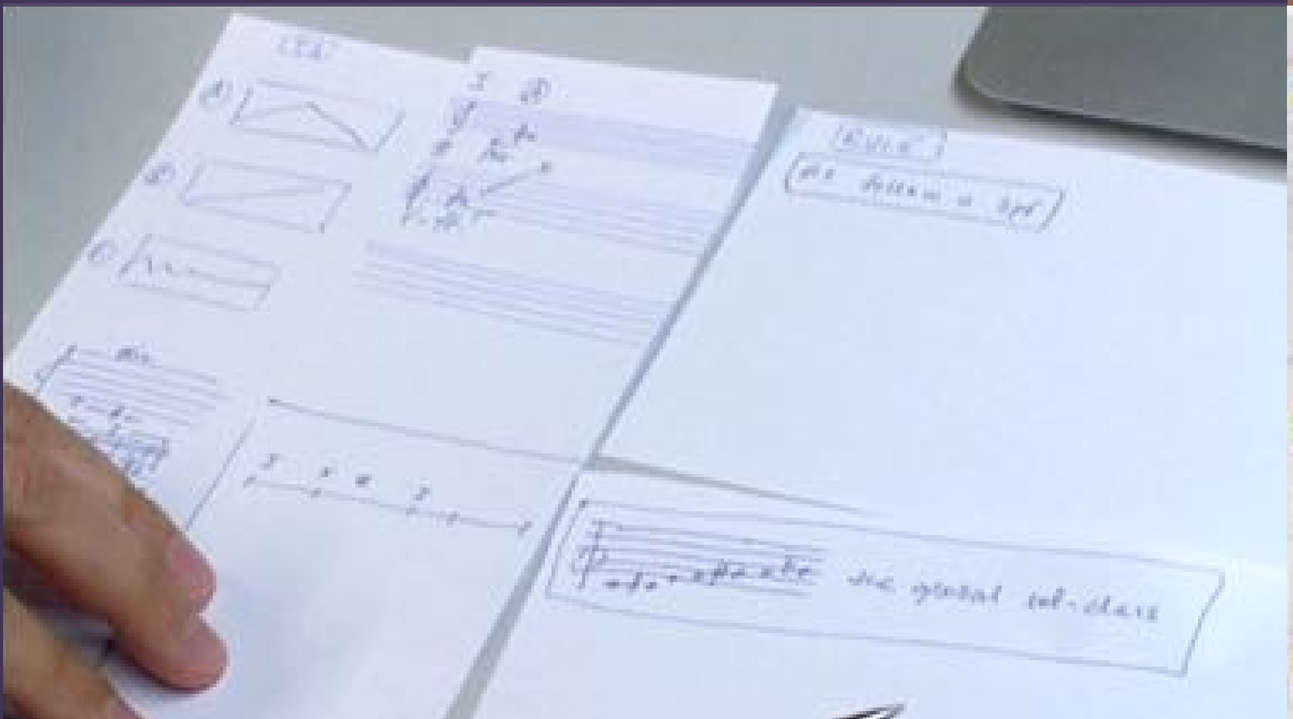
	Instrument	Substrate
Reification	Turn **commands** into **objects** that become **instruments**	Turn **relationships** into **objects** that become **substrates**
Polymorphism	Operate on **multiple types** of **objects**	Maintain **multiple types** of **relationships**
Reuse	Make **previous command input** available for **reuse**	Make **results** of **previous commands** available for **reuse**

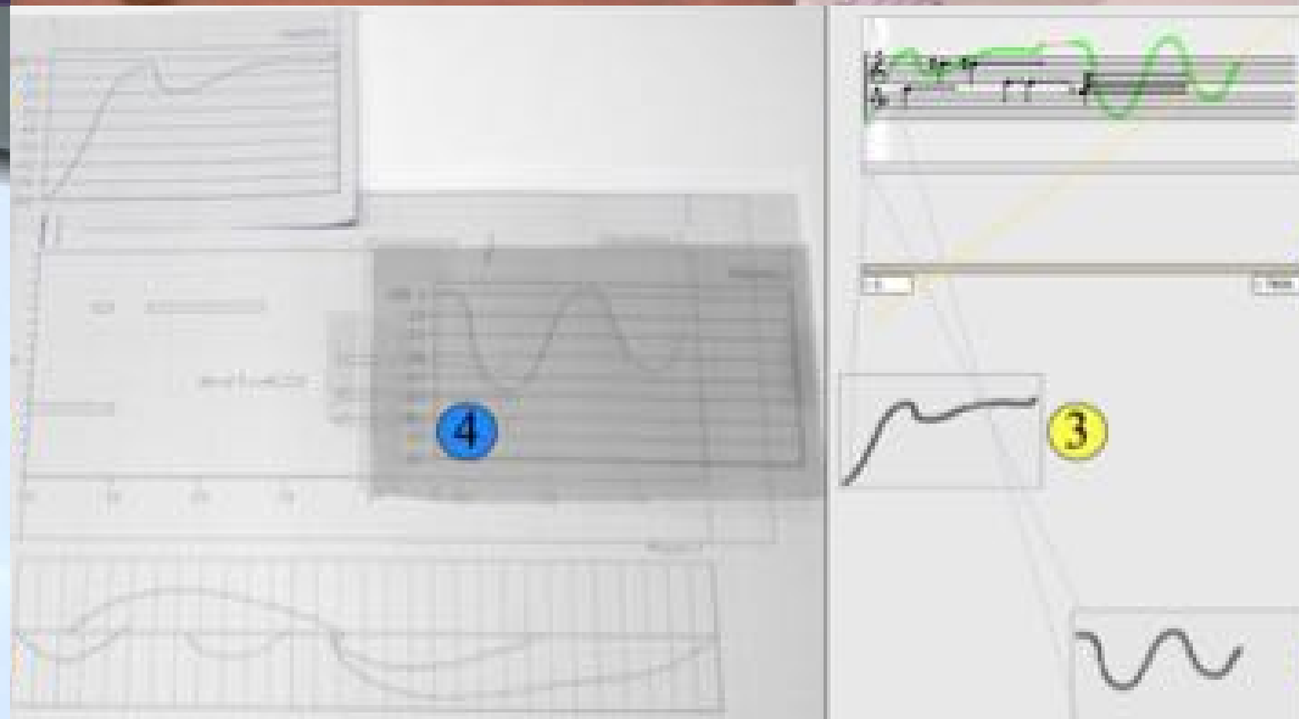
Examples

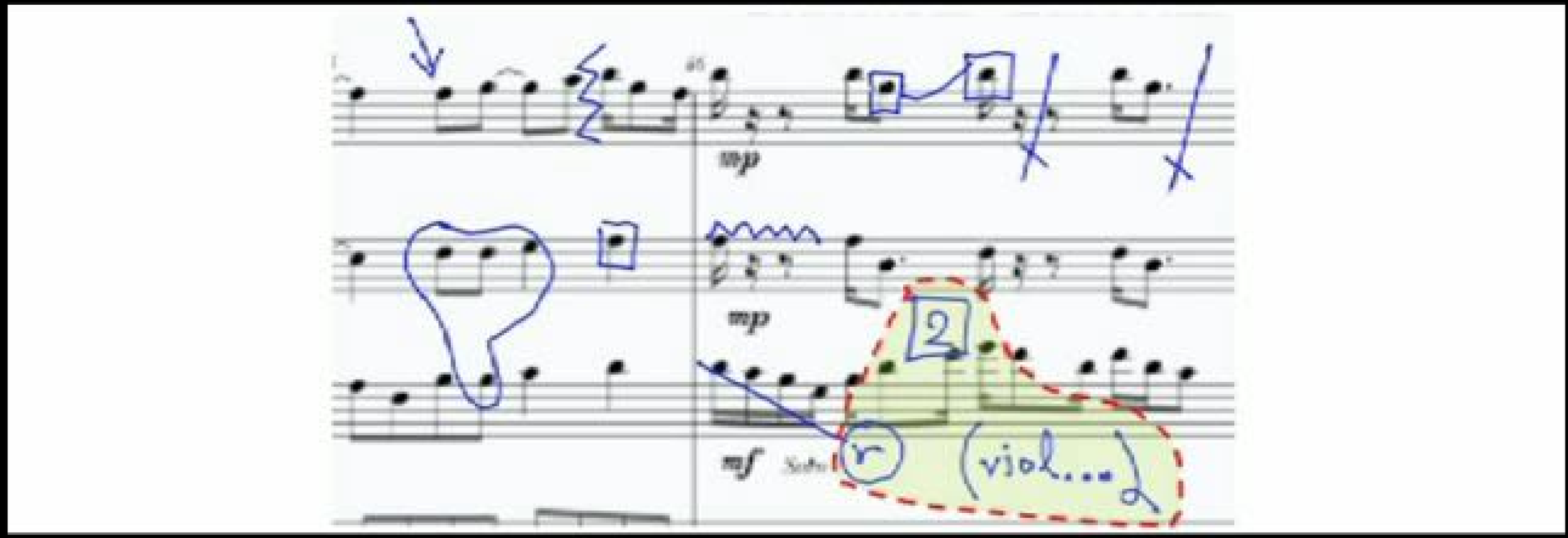
Paper substrates

Support the
music composition process
by combining and interpreting
notations in various ways







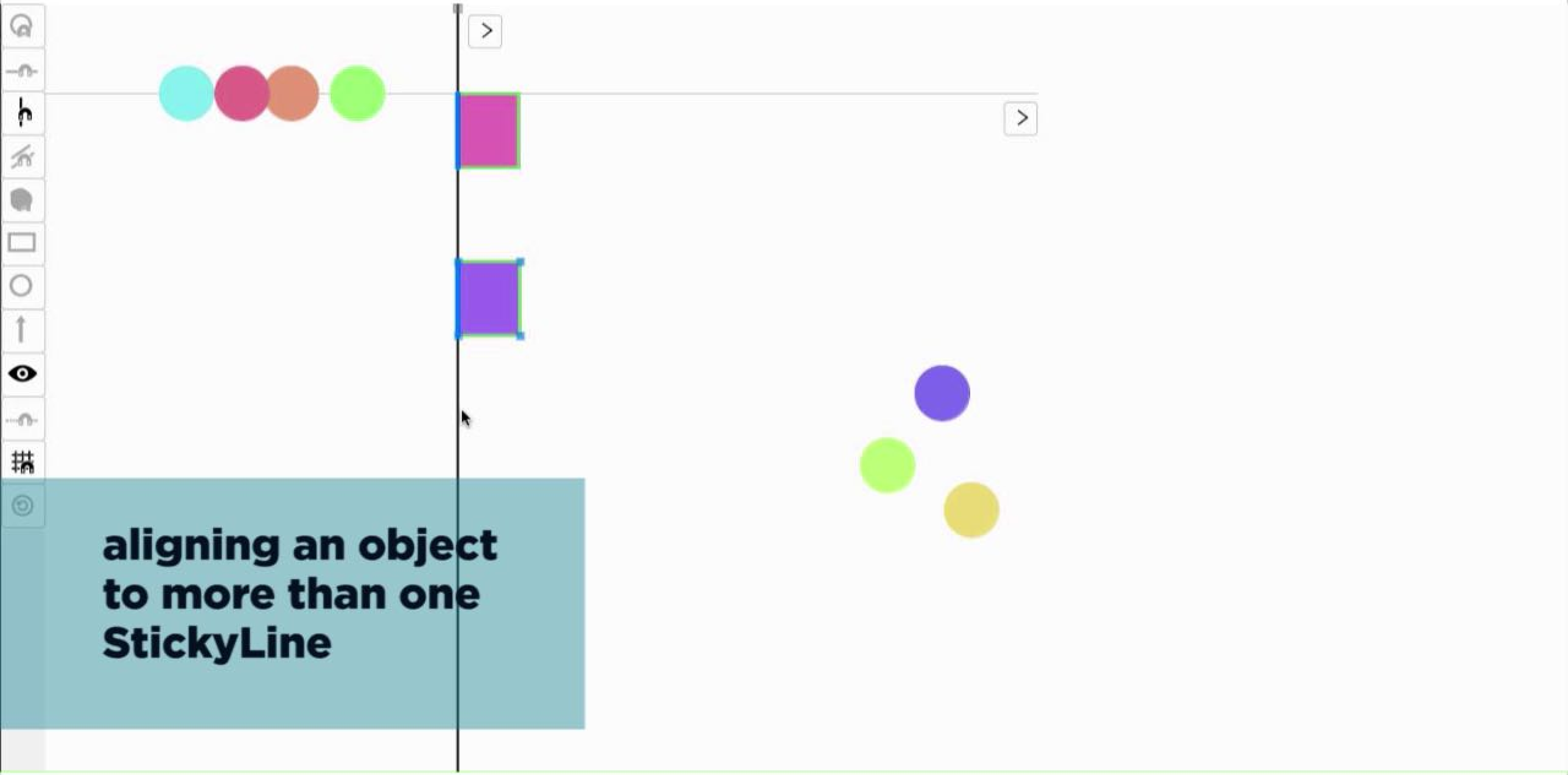


textual & numerical elements

Tsandilas, Letondal, Mackay

Prototype demonstrating a simple scenario:

Working on a piece for piano and electronics


aligning an object
to more than one
StickyLine

Generative principles in StickyLines

Reification

Alignment becomes a *StickyLine*

Polymorphism

StickyLines align text, icons, shapes

Reuse

StickyLines remember alignment

Introducing Textlets

B *I* <> Insert Type...

ABSTRACT

Writing technical documents frequently requires following constraints and consistently using domain-specific terms. We interviewed 12 legal professionals and found that they all use a standard word processor, but must rely on their memory to manage dependencies and maintain consistent vocabulary within their documents.

We introduce **Textlets**, interactive objects that reify text selections into persistent items. We show how Textlets help manage consistency and constraints within the document, including selective search and replace, word count, and alternative wording.

Eight participants tested a search-and-replace Textlet as a *technology probe*. All successfully interacted directly with the Textlet to perform advanced tasks; and most (6/8) spontaneously generated a novel replace-all-then-correct strategy. Participants suggested additional ideas, such as supporting collaborative editing over time by embedding a Textlet into the document to flag forbidden words.

We argue that Textlets serve as a generative concept for creating powerful new tools for document editing.

Textlets

Create Basic Textlet

x 12 legal professionals

x Textlets

x technology probe

Han, Renom, Mackay, Beaudouin-Lafon

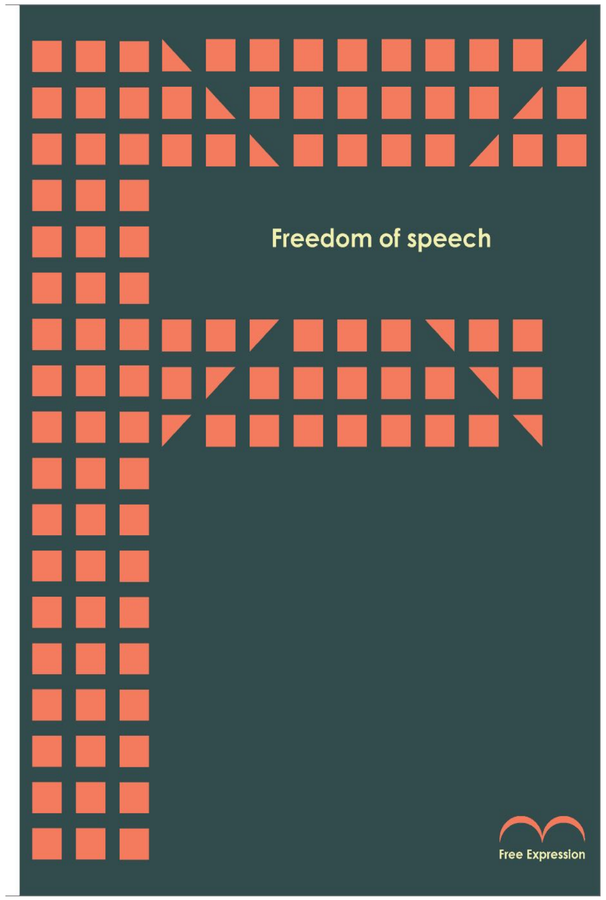
Object-Oriented Drawing (OOD)

Xia, Araujo, Grossman, Wigdor

Exercise #3

Graphical objects as tools

Recreate this drawing



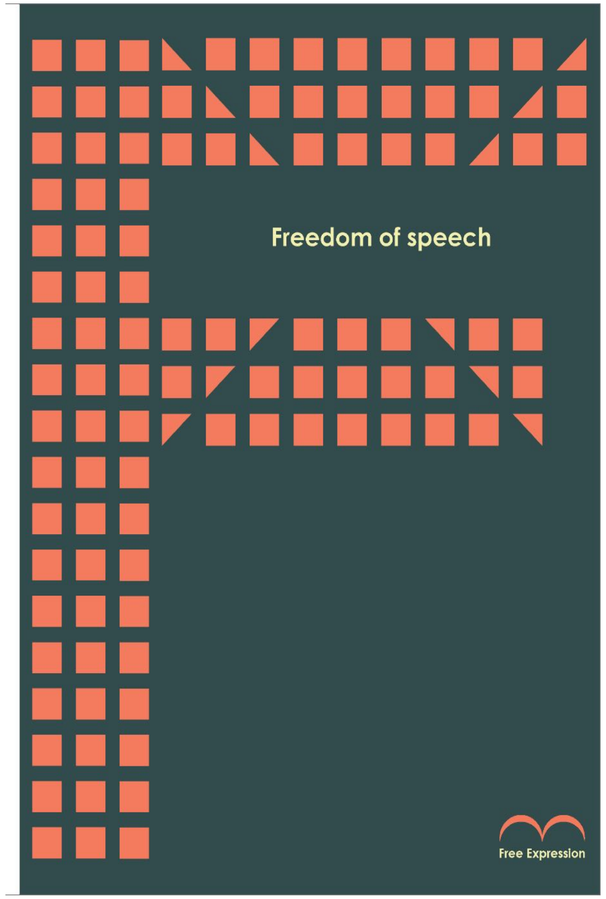
Homework exercise

Exercise #3

Graphical objects as tools

You may use:

create, delete,
copy, paste,
move, resize,
apply color
shapes, text



Homework exercise

Exercise #3

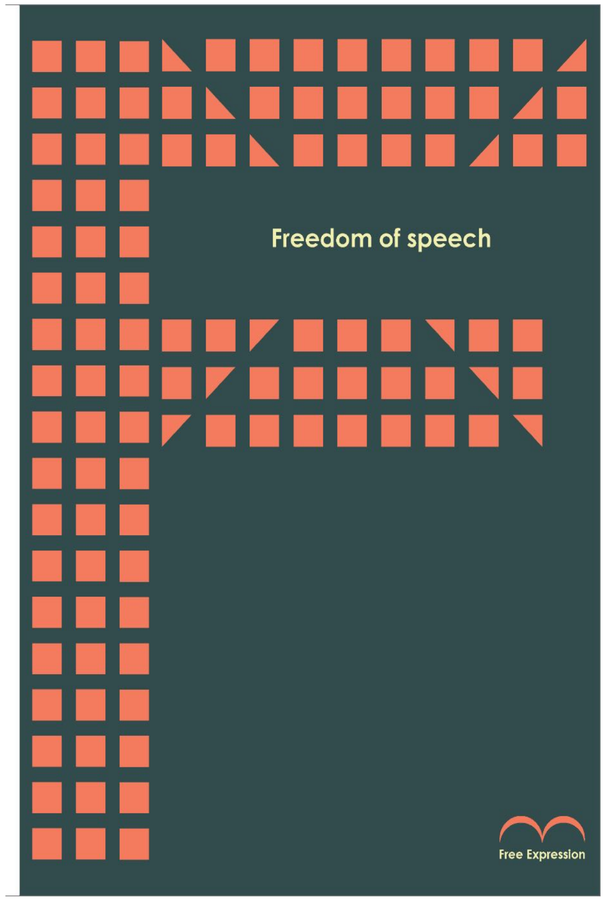
Graphical objects as tools

You may not use dedicated tools, such as:

“align”
“distribute”
“rotate”

Only use circles, squares and triangles

No special shapes



Homework exercise

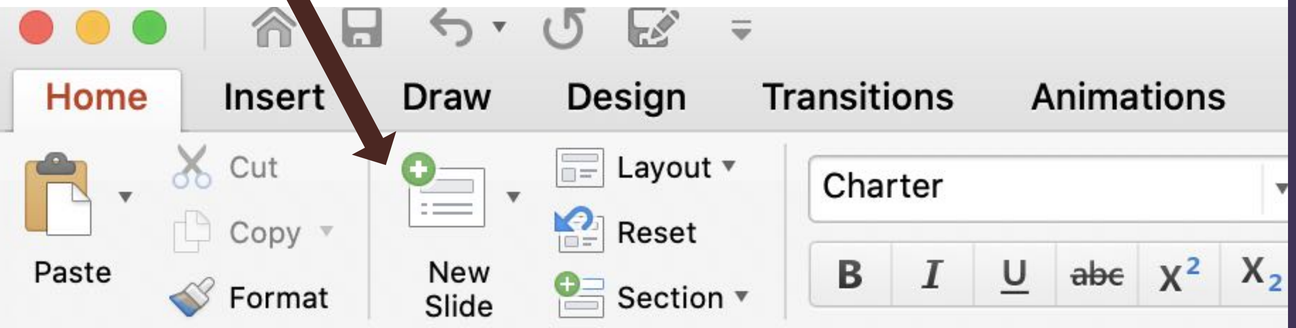
Exercise #4

Finding digital tools

Open a 'creative' application such as Word,
Figma, InDesign, or Illustrator.

Take a screenshot of a toolbar.
Count, label and describe each tool.

Create a
new slide



Homework

Exercise #5

Cross-application tools

Group exercise (15 + 15 minutes)

1. Find tools that are used **across multiple applications.** For each tool:
    - How similar / disimilar are they?
    - What do they reify?
    - Are they polymorphic?
    - Are they reusable?

2. Find tools that exist **in only one application.** For each tool:
    - How could it be used in another application?

Class exercise

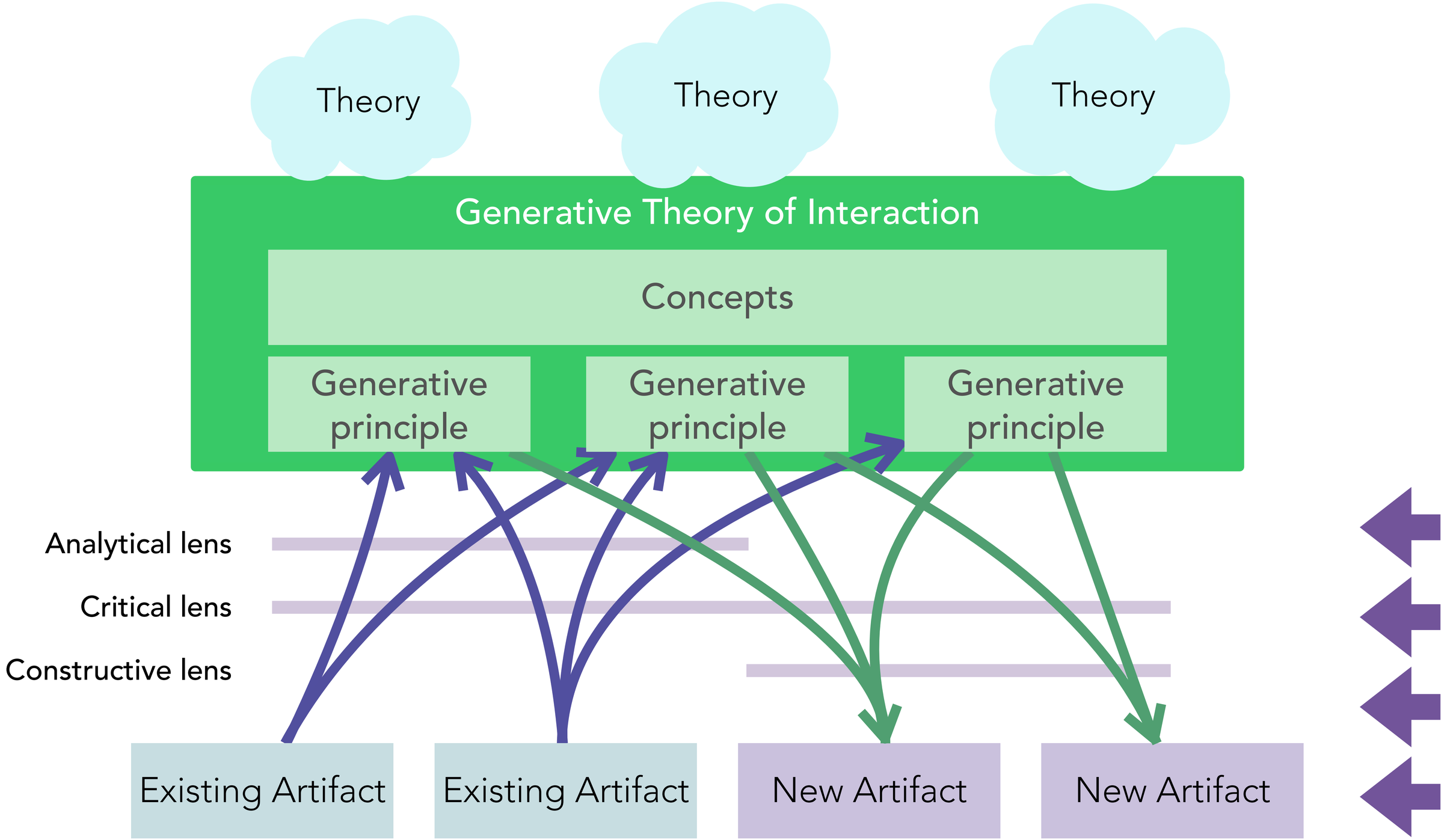
Summary

Instrumental interaction takes advantage of humans' abilities to interact through tools and to appropriate objects as tools

Substrates create a form of "digital matter" for which the designer can create "laws of information", like the laws of physics in the physical world

Instruments let users manipulate this matter

Reification, polymorphism and reuse are generative principles that help analyze, critique and generate interactive systems


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